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December 18, 2012

Mr. Christopher Black
U.S. EPA Region 5
Corrective Action Section 2
Remediation and Reuse Branch, LU-9J
77 West Jackson Boulevard
Chicago, IL 60604-3590

RE: First 2012 Semiannual Monitoring Report, Chevron Cincinnati Facility, Hooven, Ohio

Dear Mr. Black:

Chevron Environmental Management Company (Chevron) is submitting the above referenced document to the United States Environmental Protection Agency (USEPA) in accordance with the November 1, 2006 Administrative Order on Consent (2006 AOC) between Chevron and USEPA and the December 13, 2007 *Operation, Maintenance, and Monitoring Plan for Final Groundwater Remedy, Chevron Cincinnati Facility (OMM Plan)*. This report summarizes the results of routine monitoring completed as part of final groundwater corrective measures implementation at the Chevron Cincinnati Facility for the period from January 1 through June 30, 2012. The report is organized into the following sections:

- Section 1.0 describes the purpose of routine monitoring and provides a brief history of the former refinery and off-site properties, including the processes acting to deplete the light non-aqueous phase liquid (LNAPL) smear zone.
- Section 2.0 provides a summary of the infrastructure, methods, and results of monitoring activities conducted during the first semiannual monitoring period in 2012.
- Section 3.0 presents the qualitative and quantitative lines of evidence supporting the efficacy of natural attenuation mechanisms to degrade petroleum hydrocarbons across the smear zone. Data collected during the first semiannual monitoring period continue to demonstrate that the intrinsic processes in the saturated zone are degrading petroleum hydrocarbons. These same processes are reducing dissolved phase constituents of concern to levels that are protective of sensitive receptors at the point of compliance boundaries.

The smear zone and associated dissolved phase constituents attributable to releases from the refinery remain stable and there has not been redistribution of constituents following termination of continuous hydraulic control (i.e., year round pumping) following execution of the 2006 AOC. Monitoring results continue to demonstrate that the final groundwater remedy at the former refinery is progressing as anticipated and will meet remedial goals while ensuring that sensitive receptors remain protected.

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If you have any questions regarding the enclosed documents, please contact me at (713) 432-2631 or Matt Mitchell at (513) 353-1323, ext. 23.

Sincerely,

Gene Choquette

Gene Choquette – Site Manager
Chevron Cincinnati Facility
Chevron Environmental Management Company

500-020-094

cc: Matt Mitchell, Trihydro

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FIRST 2012 SEMIANNUAL MONITORING REPORT

CHEVRON CINCINNATI FACILITY

HOOVEN, OHIO

December 18, 2012

Project #: 500-020-094

PREPARED BY: Trihydro Corporation

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EXECUTIVE SUMMARY

This report presents results of the routine monitoring conducted by Chevron Environmental Management Company (Chevron) between January 1, 2012 and June 30, 2012 at the former Gulf Oil refinery situated approximately 20 miles west of Cincinnati, Ohio. Monitoring during this semiannual period was performed following the methods described in the *Remedy Implementation Plan for Final Groundwater Remedy, Chevron Cincinnati Facility* (*RIP*, Trihydro 2007a) and the *Operation, Maintenance, and Monitoring Plan for Final Groundwater Remedy, Chevron Cincinnati Facility* (*OMM Plan*, Trihydro 2007b), in fulfillment of requirements provided in the 2006 Administrative Order on Consent (2006 AOC, Docket No. RCRA-05-2007-0001). Monitoring that was performed during the first 2012 semiannual period include:

- Fluid level gauging including continuous monitoring using pressure transducers as well as weekly, monthly, and bimonthly manual measurements to track hydraulic gradients and light non-aqueous phase liquid (LNAPL) occurrence
- Groundwater sampling to demonstrate dissolved phase plume stability and efficacy of monitored natural attenuation
- Lysimeter monitoring to collect data regarding precipitation infiltrate to assist in understanding electron acceptor flux into the upper portions of the saturated zone
- Rapid Optical Screening Technology (ROST) monitoring to confirm stability of the LNAPL at the lateral edge of the smear zone
- River monitoring to evaluate groundwater and surface water quality adjacent to, beneath, and within the Great Miami River

Monitoring results continue to demonstrate that the final groundwater remedy at the former refinery is progressing as anticipated and will meet remedial goals while ensuring that sensitive receptors remain protected. The United States Environmental Protection Agency (USEPA) has established performance monitoring criteria for remedies incorporating intrinsic natural attenuation processes (USEPA 1999, USEPA 2003). These performance monitoring criteria have been used to evaluate the progress of the final groundwater remedy at the Chevron Cincinnati Facility. Specifically the data collected at the Chevron Cincinnati Facility demonstrate the following:

1. Vapor phase source concentration trends and vertical profiles from nested wells installed over the limits of the smear zone on the refinery and off-site properties continue to demonstrate that intrinsic biodegradation combined with focused LNAPL and vapor recovery during high-grade events is reducing smear zone mass and concentrations over time. Nested vapor monitoring was not performed in Hooven or on the facility during the first

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semiannual period in 2012, in accordance with the schedule provided within the *OMM Plan* (Trihydro 2007b). Evidence of natural attenuation processes occurring in the vadose zone have been provided within previous semiannual reports, as well as the *Five-Year Groundwater Corrective Measures Implementation Review, Chevron Cincinnati Facility, Hooven, Ohio* (*Five-Year Review*, Trihydro 2011). Additional data demonstrating biodegradation processes within the vadose zone will be presented in the second semiannual report for 2012.

2. Dissolved phase data collected during the first half of 2012 continue to demonstrate that the concentrations of constituents of concern in groundwater are decreasing over time. Decreasing dissolved phase constituent trends are more pronounced at the margins of the smear zone compared to the interior portion of the plume. At its margins, the smear zone is thinner and LNAPL saturations are lower. In addition, groundwater enriched in electron acceptors intercepts the smear zone north of the facility and again to the southeast of the Buried Valley Aquifer-bedrock interface in Hooven creating a situation whereby petroleum hydrocarbons including benzene are attenuated more quickly along the margins than within the interior of the smear zone. These observations are consistent with the expectation of outside-in attenuation of petroleum hydrocarbons within the smear zone.

3. ROST and dissolved phase monitoring results verify that the LNAPL and dissolved phase plume were stable beneath the Southwest Quad and on the facility. Localized changes in dissolved phase conditions were identified at the point of compliance boundary in the Southwest Quad in May 2012 with arsenic reported in groundwater samples collected from sentinel monitoring well MW-35 and point of compliance well MW-133 above the USEPA Maximum Contaminant Levels (MCLs). These changes have previously been associated with variations in hydraulic conditions as well as alternate sources present in the Southwest Quad. During May 2012, there was significant redirection of flow within the portion of the Southwest Quad where monitoring wells MW-35 and MW-133 are located. The local disturbance in the groundwater flow directions beneath the Southwest Quad, caused by rapid rise and fall of the water table following flooding, may have mobilized arsenic associated with an alternate source near wells MW-35 and MW-133. The two wells were re-sampled at the end of May 2012 and dissolved arsenic was not detected above the USEPA MCL in samples collected from either well. Based on historical monitoring performed in the Southwest Quad, it is reasonable to conclude that the dissolved phase plume is stable and there has not been redistribution of constituents following termination of continuous hydraulic control (i.e., year round pumping) following execution of the 2006 AOC.

4. Dissolved phase monitoring conducted along the west bank of the Great Miami River continues to indicate that constituents of concern present in the smear zone are not migrating beneath the partial penetrating barrier wall. The surface water screening standards were not exceeded in any of the hyporheic or surface water samples collected during the first half of 2012 and sensitive receptors along the riverbank remain protected.

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1.0 INTRODUCTION

Chevron is performing final groundwater corrective measures implementation and monitoring of the remedy performance at the former Gulf Refinery located approximately 20 miles west of Cincinnati, Ohio, near the intersection of Ohio State Route 128 and US Highway 50 as shown on Figure 1-1. The groundwater remedy was designed to be protective of human health and the environment, with the long-term objective of reducing dissolved phase hydrocarbon concentrations to meet groundwater cleanup standards. Achieving this objective was estimated to take up to 42 years; therefore, the following interim objectives have been adopted for the groundwater remedy:

- Monitor soil vapor concentrations and prevent migration of volatile petroleum hydrocarbons into indoor air above risk based limits
- Measure the stability of LNAPL and dissolved phase petroleum hydrocarbons
- Remove recoverable LNAPL to agreed upon end-points
- Stabilize the west bank of the Great Miami River on the main facility and in Gulf Park to prevent erosion of soils containing petroleum hydrocarbons

Groundwater remediation and monitoring efforts are being conducted in accordance with the 2006 AOC between Chevron and the USEPA (Docket No. RCRA-05-2007-0001). The primary components of the groundwater remedy specified in the 2006 AOC include:

- Re-establishment of natural hydraulic conditions beneath the facility, Hooven, and off-site properties to the southwest (commonly referred to as the Southwest Quad) through discontinuance of year round groundwater recovery
- Focused LNAPL removal during periods of extreme low water table conditions through high-grade pumping over the next decade
- Combined operation of the horizontal soil vapor extraction (HSVE) system beneath Hooven with high-grade recovery
- Continued seasonal operation of the Gulf Park biovent system during low water table conditions
- Engineered stabilization of the bank of the Great Miami River at the former refinery and Gulf Park to prevent erosion of soil containing petroleum hydrocarbons
- Long-term monitoring of natural source zone attenuation including dissolved and vapor phase biodegradation

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A fundamental concept of the final groundwater remedy is the continued stability of the LNAPL and dissolved phase petroleum hydrocarbons. The majority of recoverable LNAPL has been removed beneath the former refinery and off-site properties over the past two decades. This is especially true in the upper and middle reaches of the smear zone, where LNAPL saturations are low. High-grade recovery is intended to focus on remaining LNAPL removal within the lower reaches of the smear zone and portions of the smear zone with the highest remaining LNAPL saturations. However, it is understood that the long-term remedy objective will be accomplished primarily through natural attenuation processes that drive contaminant degradation and removal over time. A detailed discussion of the objectives and activities to be conducted to achieve the groundwater remedy goals are described in the *RIP* (Trihydro 2007a) and the *OMM Plan* (Trihydro 2007b).

1.1 SUMMARY OF SITE CONCEPTUAL MODEL

A detailed site conceptual model (SCM) for groundwater was presented in the First 2008 Semiannual Monitoring Report, Chevron Cincinnati Facility, Hooven, Ohio (Trihydro 2009a). A summary of the SCM, including iterative updates made using assessment and routine monitoring results collected since early 2008, was provided in the semiannual reports submitted between 2008 and 2011 and most recently updated in the *Five-Year Groundwater CMI Review* (Trihydro 2011). Future updates to the SCM will be presented in subsequent groundwater corrective measures implementation reviews, submitted to the USEPA on five-year intervals. Figure 1-2 shows a diagrammatic SCM for the facility, Hooven, and Southwest Quad.

1.2 PURPOSE

The primary purpose of this report is to provide a summary of the operations and monitoring conducted in accordance with the 2006 AOC, *RIP* (Trihydro 2007a), and *OMM Plan* (Trihydro 2007b) from January 1, 2012 to June 30, 2012. This report will also provide a summary of additional assessment and operational activities performed during the first half of 2012. The remainder of this report is organized into the following sections:

- Section 2.0 – Describes the infrastructure, methods, and results of monitoring activities conducted during the first semiannual reporting period in 2012.
- Section 3.0 – Presents the preliminary qualitative and quantitative lines of evidence supporting the efficacy of natural attenuation mechanisms to degrade petroleum hydrocarbons within the smear zone.

It should be noted that remedial construction and limited operational activities were conducted in Gulf Park during the first half of 2012. These activities included:

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- Installation and connection of 14 additional biovent wells south of the existing injection network to enhance aerobic biodegradation of the petroleum hydrocarbons present from historical pipeline releases. This system expansion was completed in accordance with the design presented in the *Five-Year Groundwater Corrective Measures Implementation Review, Chevron Cincinnati Facility, Hooven, Ohio* (*Five-Year Groundwater CMI Review*, Trihydro 2011).
- Installation of an interior and exterior groundwater monitoring well along the southern barrier wall adjacent to Gulf Park in March 2012 in accordance with the *Remedial Measures Work Plan for Sheet Pile Barrier Construction and Bank Stabilization along the East Bank of the Great Miami River, Gulf Park, Cleves, Ohio* (Trihydro 2008).
- Initialization, operation, and monitoring of the bioventing system in Gulf Park sporadically in April and June 2012 in accordance with the OMM Plan (Trihydro 2007b).

A detailed discussion of these activities along with the operations and monitoring results conducted during the second half of 2012 will be summarized in the forthcoming *Second 2012 Semiannual Monitoring Report, Chevron Cincinnati Facility, Hooven, Ohio* (*Second 2012 Semiannual Monitoring Report*).

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2.0 MONITORING NETWORK AND RESULTS

The primary component of the final groundwater corrective measures program is routine monitoring to evaluate the progress towards meeting the interim and long term remedy objectives. The monitoring network has been established to meet multiple performance and compliance monitoring criteria including collection of data to support remedial system operation; confirmation of high-grade pumping and HSVE system effectiveness; determination of compliance at boundaries where sensitive receptors are present; and evaluation of natural attenuation mechanisms. For the purpose of this report, monitoring has been divided into the following activities:

- Fluid level gauging including continuous monitoring using pressure transducers as well as weekly, monthly, and bimonthly manual measurements
- Groundwater sampling to demonstrate dissolved phase plume stability, protection of sensitive receptors, and efficacy of monitored natural attenuation
- Lysimeter monitoring to collect data regarding precipitation infiltrate to assist in understanding electron acceptor flux into the upper plane of the smear zone
- ROST monitoring to confirm stability of the LNAPL plume at the lateral edge of the smear zone
- River monitoring to evaluate groundwater and surface water quality adjacent to, beneath, and within the Great Miami River

The following sections describe the results of monitoring conducted to support the groundwater remedy between January 1 and June 30, 2012. A description of the methods used for installation, monitoring, and analysis have been previously described within the *RIP* (Trihydro 2007a) and *OMM Plan* (Trihydro 2007b). Additional information pertinent to these activities is described herein when deviations from these plans was necessary.

2.1 FLUID LEVEL MONITORING

Pressure transducers are generally deployed across the monitoring well network listed on Figure 2-1 to evaluate rapid fluctuations in hydraulic conditions across the facility. The pressure transducers are relocated as the goals of short term monitoring change such as during flood events or high-grade recovery. Transducers log groundwater elevations on a daily or more frequent basis. Groundwater elevation data recorded using pressure transducers are provided in Appendix A.

Pressure transducers were deployed during a portion or all of the first semiannual monitoring period in an expanded network (including wells MW-17, MW-20S, MW-21, MW-26R, MW-35, MW-44S, MW-48S, MW-78, MW-79,

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MW-85S, MW-94S, MW-96S, MW-100, MW-104S, MW-112, MW-131, and MW-132 across the site, Hooven, and Southwest Quad. Transducers were also located in the northern and southern barrier monitoring networks along the west bank of the Great Miami River as described in Section 2.5.1. Transducer were deployed in wells MW-135S, MW-135I, MW-135D, MW-137S, MW-137I, MW-137D, BSW-1, and BSW-3 to track hydraulic gradients across the partially penetrating sheet pile wall.

Manual fluid level gauging is conducted on a bimonthly basis in each of the shallow monitoring wells located on the facility, Hooven, Southwest Quad, and Gulf Park. In addition, fluid levels are gauged weekly in select groundwater monitoring wells and river bank gauging point RBGP-44 located along the west bank of the river. Weekly gauging in these wells is conducted to supplement the bimonthly fluid level measurements in tracking trends in river and groundwater table elevations, as wells as LNAPL thickness.

Appendix B provides manual fluid level gauging data collected during the first half of 2012. Potentiometric surface maps for January, March, and May 2012 generated using data collected during bimonthly monitoring are provided as Figures 2-2 through 2-4. As shown on the January 2012 potentiometric surface map, groundwater flow was predominantly to the west across the main facility and Southwest Quad. This is in contrast to typical flow conditions in the Buried Valley Aquifer, which are to the south and southwest as shown on the potentiometric surface maps for March and May 2012. This is due to the large amount of precipitation and flooding of the west bank of the Great Miami River during early 2012.

2.2 DISSOLVED PHASE MONITORING

Dissolved phase monitoring is conducted at the facility, Hooven, and Southwest Quad to assess plume stability, evaluate natural attenuation within the saturated portions of the smear zone, and measure performance of the final groundwater remedy. Groundwater samples are analyzed for the constituents of concern including benzene, ethylbenzene, toluene, total xylenes, chlorobenzene, arsenic, and lead. Benzene is the constituent most frequently reported in groundwater samples above remedial objectives, with historic concentrations as high as 13 milligrams per liter (mg/L); therefore many of the analyses conducted as part of the final remedy monitoring focus upon benzene depletion within the smear zone. Dissolved phase benzene is not generally detected more than 200 feet outside the LNAPL smear zone due to intrinsic biodegradation at the plume periphery.

Groundwater samples are also collected from selected wells for analysis of natural attenuation indicators including alkalinity, total calcium, total chloride, chemical oxygen demand, ferric iron (Fe^{3+}), ferrous iron (Fe^{2+}), total iron,

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dissolved manganese, total manganese, methane, nitrogen, nitrogen as ammonia, nitrate, nitrite, total potassium, total sodium, sulfate, sulfide, and total organic carbon.

Field forms for groundwater samples collected between January and June 2012 are included in Appendix C. Laboratory analytical reports for groundwater samples collected during the first 2012 semiannual monitoring period are provided in Appendix D-1. Data validation reports for each of the analytical packages provided by the laboratory are provided in Appendix D-2. It should be noted that, Analytical Laboratory Services (ALS) located in Cincinnati, Ohio began analyzing groundwater and soil samples collected at the Chevron Cincinnati Facility beginning in 2011, following approval from the USEPA. The analytical summary reports provided by ALS and included in Appendix D-1, reference the laboratory reporting limits rather than the method detection limits. The method detection limits have been referenced on the summary tables and figures included within previous semiannual monitoring reports and remain so herein. Both the laboratory reporting limits (as listed on the analytical summary reports) and the method detection limits (included in the electronic data deliverable as well as the summary tables and figures) are below remedial goals for this project (USEPA MCLs). The following subsections present the results of dissolved phase monitoring conducted between January and June 2012.

2.2.1 SENTINEL AND POINT OF COMPLIANCE MONITORING

There are three sentinel wells (MW-35, MW-131, and MW-132) and four point of compliance monitoring wells (MW-37, MW-120, MW-133, and MW-134) located at the down-gradient edge of the dissolved phase plume in the Southwest Quad. The sentinel and point of compliance monitoring networks are presented on Figure 2-5. Groundwater samples were collected from the sentinel and point of compliance monitoring wells during May 2012, as part of semiannual monitoring activities in accordance with the schedule described in the *OMM Plan* (Trihydro 2007b).

Groundwater analytical results for the dissolved phase constituents of concern are provided on Table 2-1. Groundwater samples collected in May from sentinel well MW-35 and point of compliance well MW-133 had detections of arsenic above the USEPA MCLs (0.010 mg/L). The dissolved arsenic concentrations were reported at 0.014 and 0.012 mg/L, respectively. Dissolved arsenic was not reported above the USEPA MCL within the groundwater samples collected from any of the other sentinel or point of compliance (POC) wells during this event. In addition, arsenic was not reported in the sample collected from monitoring well MW-138, located directly up-gradient of this monitoring transect. However, there were several other samples collected from the monitoring wells adjacent to the landfill with arsenic reported above the USEPA MCL (including wells MW-115, MW-139, and MW-142).

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There was a large amount of precipitation (approximately1.8 inches) in the days prior to the groundwater monitoring in the Southwest Quad, which caused a rapid rise in both the Great Miami River and the water table. Groundwater elevations were increasing across the Southwest Quad when these samples were collected. Groundwater flow during this monitoring event was primarily from the northeast to the southwest, which is typical of regional flow within the Buried Valley Aquifer. However, there was significant redirection of flow within the portion of the Southwest Quad where monitoring wells MW-35 and MW-133 are located. Appendix F presents potentiometric surface maps and hydrographs showing the flow conditions in the Southwest Quad when these low levels of dissolved phase constituents of concern were detected in the samples from the sentinel and point of compliance wells.

Arsenic has been sporadically detected in groundwater collected from monitoring wells located throughout the Southwest Quad and along the river bank for more than two decades and are believed to be indicative of background metals measured in soils. There are elevated, naturally occurring levels of arsenic in soils throughout Ohio as reported in the *Evaluation of Background Metal Concentrations in Ohio Soils* (Cox-Colvin & Associates, Inc. 1996) and the *Closure Plan Review Guidance for RCRA Facilities* (OEPA 1999). In addition, the United States Geologic Survey reports an average background concentration of arsenic of 9.248 milligrams per kilogram in sediment samples collected in Hamilton County within the *National Geochemical Survey - Database and Documentation*.

Samples were re-collected from monitoring wells MW-35 and MW-133 on May 23, 2012 for analysis of the dissolved phase constituents of concern. Dissolved arsenic was not detected above the USEPA MCL in either the sentinel well or the POC well (0.0085 and 0.0088 mg/L respectively).

Dissolved arsenic measured in samples collected from wells MW-35 and MW-133 in May 2012 is not attributable to changes in the smear zone or dissolved phase plume distribution beneath the Southwest Quad. Dissolved arsenic was not detected above the USEPA MCLs in monitoring well MW-138 located directly up-gradient of this well transect, nor within any of the samples collected from the remaining sentinel/POC well transects. The local disturbance in the groundwater flow directions beneath the Southwest Quad caused by rapid rise and fall of the water table following flooding may have mobilized naturally occurring arsenic or that associated with an alternate source near wells MW-35 and MW-133. Based on these results and monitoring performed in the Southwest Quad during this semiannual period, it is reasonable to conclude that there has not been redistribution of constituents following termination of continuous hydraulic control.

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2.2.2 PERIMETER, INTERIOR, AND SUPPLEMENTAL MONITORING

As discussed in the *Five-Year Groundwater CMI Review* (Trihydro 2011) and supported by data collected to date, the LNAPL and dissolved phase petroleum hydrocarbons are laterally stable and degrading over time. Remaining LNAPL in the smear zone is gradually depleted through several mass loss mechanisms including dissolution into groundwater and subsequent dispersion and biodegradation, as well as volatilization and degradation within the vadose zone. As such, groundwater samples were collected from three groups of monitoring wells for evaluation of natural attenuation mechanisms within the saturated zone: perimeter, interior plume, and supplemental monitoring wells.

- Perimeter groundwater monitoring wells include those wells situated at the margins of the smear zone but not considered to be compliance boundaries for dissolved phase petroleum hydrocarbons in the saturated zone. Monitoring wells that are included in this network include MW-26R, MW-33, MW-48S, MW-85S, MW-94S, MW-95S, MW-100S, MW-104S, and MW-115S.
- Interior plume monitoring wells are those wells located within the smear zone that will be tracked on a consistent basis over the course of the remedy and include eleven wells: MW-10, MW-17, MW-18R, MW-20S, MW-22, MW-58S, MW-81S, MW-85D, MW-88, MW-93S, and MW-96S. A groundwater sample could not be collected from monitoring well MW-58S and MW-88 during the first 2012 semiannual monitoring period due to the presence of LNAPL within the well. Monitoring wells MW-57S and MW-103S were selected as alternative interior plume monitoring locations during this semiannual period.
- Supplemental monitoring wells include additional wells that will be targeted for sampling to support evaluation of natural attenuation over the long-term remedy. The supplemental well network may be modified based upon data gaps identified during previous monitoring periods. Supplemental monitoring wells sampled during the first semiannual monitoring period in 2012 include wells L-1RR, L-3R, MW-21, MW-33, MW-51, MW-64, MW-80, and MW-99S.

Groundwater analytical results for the dissolved phase constituents of concern reported in samples collected from the perimeter, interior plume, and supplemental monitoring wells are provided on Table 2-2.

Groundwater samples were also collected from 15 monitoring wells for analysis of natural attenuation indicators during the first semiannual monitoring period including wells L-1RR, MW-18R, MW-20S, MW-33, MW-37, MW-38, MW-51, MW-81S, MW-85S, MW-96S, MW-100S, MW-112, MW-114, MW-115S, and MW-131. Groundwater analytical results for the dissolved phase natural attenuation indicators are included on Table 2-3.

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2.3 LYSIMETERS

Two soil moisture lysimeters were constructed at the grouped media locations near wells MW-18, MW-20, MW-21, and MW-93, in accordance with details presented in the *RIP* (Trihydro 2007a). The lysimeters are used to measure the makeup of recharge water (particularly oxidizers) from infiltrating precipitation and evaluate the contribution of the makeup water to biodegradation within the upper limits of the saturated zone. A shallow and deep lysimeter were installed at each grouped media location, the first set at a depth well above the smear zone and the second set at an elevation within or near the upper smear zone limit. Placement of each lysimeter was a function of the elevation of the top of the smear zone.

In accordance with the *OMM Plan* (Trihydro 2007b), a vacuum was applied to the shallow and deep lysimeters on May 16, 2012. Subsequently, on June 5, 2012, the rainwater infiltrate was collected from the shallow lysimeters at L-18, L-20, and L-93. Due to poor soil moisture recovery in the shallow lysimeter at location L-21, the deeper lysimeter was sampled in its place. Infiltrating precipitation collected from the lysimeters was analyzed for dissolved O_2 and oxidation-reduction potential (ORP) in the field prior to preserving the samples and submitting them for laboratory analysis of methane, nitrate, sulfate, as well as dissolved and total iron and manganese.

Field forms for samples collected from the lysimeters in June 2012 are included in Appendix C. Laboratory analytical reports for the lysimeter samples are provided in Appendix D-1 and data validation reports for each of the analytical packages provided by the laboratory are included in Appendix D-2. The lysimeter analytical results from the first half of 2012, along with historical results are presented in Table 2-4.

2.4 ROST MONITORING

Three ROST monitoring transects (RT-1 through RT-3) are in place perpendicular to the leading edge of the LNAPL plume, as shown in Figure 2-5. ROST technology was identified as the preferred tool for monitoring the potential for LNAPL migration at the leading edge of the plume because it is designed to provide real-time analysis of the physical and chemical characteristics of the distribution of petroleum hydrocarbons to distinguish between soils containing LNAPL and those outside of the smear zone.

The ROST monitoring transects consist of blank polyvinyl chloride (PVC) casing above the smear at three locations within each transect: an interior location (I) situated at the approximate lateral limit of the smear zone, an intermediate location (M) located 20-feet from the approximate lateral limit of the smear zone, and an outer location (O) installed 40-feet from the approximate lateral limit of the smear zone. A second interior monitoring location has also been

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established within the middle ROST transect (located approximately 20 feet inside the smear zone) to track LNAPL depletion over time. ROST technology and installation methodology is presented in detail in the *RIP* (Trihydro 2007a).

ROST monitoring was completed within the three ROST transects on June 14 and 15, 2012. The tool was advanced from approximately 5 and 10 feet above the water table to approximately 5 and 10 feet below the water table in each of the monitoring location. ROST monitoring results are provided in Appendix E. Data collected during the June 2012 event indicate that the smear zone is stable as there was not an indication of the presence of LNAPL within any of the intermediate or outer ROST monitoring wells based on laser induced fluorescence measurements in the three transects.

2.5 RIVER MONITORING

A partially penetrating sheet pile barrier wall and bank stabilization measures were installed along the west bank of the Great Miami River between September and December 2008. As part of these bank stabilization measures, a barrier wall performance monitoring network was installed along the restored river bank in accordance with the *Performance Monitoring Plan, Sheet Pile Barrier Along Great Miami River, Chevron Cincinnati Facility, Hooven, Ohio* (Trihydro 2007c). This work plan specified measures to characterize baseline conditions and monitor performance of the partially penetrating sheet pile wall during implementation of the final corrective measures for groundwater. The performance of the sheet pile wall is monitored by observing the hydraulic gradients in groundwater and surface water, as well as evaluating groundwater, hyporheic water, and surface water quality over time.

The barrier monitoring network is comprised of three monitoring transects along the northern, central, and southern portions of the barrier wall as illustrated on Figure 2-6. Each transect includes a groundwater monitoring nest (shallow, intermediate, and deep wells) situated inboard of the sheet pile wall and another nest on the outboard side of the wall. In addition, a hyporheic/surface water monitoring well was also constructed outboard of the wall at each monitoring transect. A description of the installation and construction details for the sheet pile wall, stabilization measures, and performance monitoring network is provided in the *Second 2008 Semiannual Monitoring Report, Chevron Cincinnati Facility, Hooven, Ohio* (Trihydro 2009b).

2.5.1 FLUID LEVEL MONITORING

Pressure transducers were deployed on December 1, 2009 in the groundwater and surface water monitoring wells in the northern and southern monitoring transects to evaluate horizontal and vertical gradients across the partial penetrating barrier wall. Transducers are programmed to record groundwater and surface water elevations at a four-hour frequency. High frequency groundwater elevation data recorded using the pressure transducers are provided in Appendix A. Manual fluid level gauging was also conducted on March 28, and May 25, 2012 to supplement the

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transducer data and measure LNAPL gradients (if present) within the inboard portions of the barrier wall. Fluid levels could not be collected concurrently with the January 27, 2012 bi-monthly fluid level gauging event due to flooding. LNAPL was not detected in any of the monitoring wells situated on the west bank of the river during this gauging event. Manual fluid level measurements are included in Appendix B.

Transducer data from select monitoring wells was used to illustrate vertical hydraulic gradients on the interior and exterior of the barrier wall at the north and south monitoring transects (Figure 2-7 and Figure 2-8). Along the northern transect (shown on Figure 2-7), the groundwater elevation on the interior of the wall was generally coincident or higher than the surface water elevation from January through June 2012, with the exception of when high river stage (i.e., flood) events occurred. After these events, the groundwater elevation on the interior of the wall would remain higher than the surface water elevation until hydraulic conditions within the river and aquifer stabilized. In general, there was a neutral to downward gradient on the inside of the wall throughout the first half of 2012. There is a consistent upward gradient on outside of the wall for the majority of first half of 2012 with the exception during flood events and at the end of June where a gradual downward gradient was observed. These results indicate that rapid and large fluctuations to surface water elevations can alter gradients and flow paths along the barrier. In addition, following flood events groundwater may continue to discharge back into the river for several months. The pathway for groundwater discharging back into the river has been altered as designed by installation of the barrier wall. Groundwater discharging into the river must first travel beneath the partially penetrating wall before making its way back into the river.

At the southern transect (shown on Figure 2-8), groundwater elevations are generally higher than surface water elevations with brief reversals during rapid rises in river stage. Generally, there is an upward gradient observed on the outboard side of the partially penetrating sheet pile wall that briefly reverses during river stage increases. On the interior portions of the wall there is generally a small downward vertical gradient that becomes an inverse to the outboard gradient during flooding events observed during the first 2012 semiannual monitoring period. The data collected during the first half of 2012 show that groundwater is typically discharging to surface water beneath the barrier well except during episodic flood events when the gradient reverses and surface water discharges into the aquifer. It should be noted that vertical groundwater and surface flow beneath the wall makes up a small component of the overall flow within the aquifer, as the primary flow direction for groundwater and surface water is generally parallel to the riverbank with limited flux to the river.

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2.5.2 GROUNDWATER, HYPORHEIC, AND SURFACE WATER MONITORING

The groundwater, hyporheic, and surface water monitoring wells were purged and sampled using a low flow methodology to prevent potential disturbance of the water quality. An inflatable packer system was used within the hyporheic/surface water zone monitoring wells to isolate a one foot interval within the uppermost portion of the water column to collect the surface water sample, and then to isolate a portion of the screen at the surface water/groundwater interface to collect the hyporheic water sample. Samples collected from the barrier monitoring network during May and June 2012 were analyzed for the dissolved phase constituents of concern. Field forms from this monitoring event are provided in Appendix C. Groundwater, hyporheic zone, and surface water analytical reports and data validation reports are included in Appendix D.

A summary of the groundwater results for constituents of concern are provided on Table 2-5. During the May and June 2012 monitoring events, low levels of toluene were measured in the sample collected from outboard well BMW-2I. A detection of dissolved phase arsenic was measured in the surface water sample BSW-2S, in addition to groundwater samples collected from interior wells MW-136S and MW-137S. Dissolved phase lead was also detected in the sample collected from interior well MW-136S. Each of these detections were isolated to individual monitoring locations within the transects installed along the wall. The dissolved phase analytical results continue to support that the smear zone along the west bank of the river is stable and has not migrated towards the barrier wall. In addition, the surface water screening standards were not exceeded in any of the hyporheic or surface water samples collected during the first half of 2012.

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3.0 INTERPRETATION

Data collected during the first half of 2012 and included herein continue to demonstrate that intrinsic processes are degrading petroleum hydrocarbons in the smear zone. It should be noted that in accordance with the schedule established in the *RIP* (Trihydro 2007a) and *OMM Plan* (Trihydro 2007b), soil vapor samples were not collected from the nested vapor wells in Hooven or on the facility during the first semiannual monitoring period in 2012. Therefore, this report does not provide an update regarding intrinsic biodegradation processes and stability of petroleum hydrocarbons within the vadose zone. Samples were collected from nested vapor monitoring wells VW-93, VW-96, VW-99, VW-128, and VW-129 in Hooven in July 2012 in accordance with the *OMM Plan* (Trihydro 2007b). Additionally, soil vapor samples have been collected from the 10, 20, 30, and 40 foot intervals in nested wells VW-96 and VW-99 monthly since August 2012, following startup of the HSVE system. An update regarding attenuation processes within the vadose zone and evaluation of the soil vapor conditions beneath Hooven during operation of the HSVE system will be provided in the *Second 2012 Semiannual Monitoring Report.*

In general, natural attenuation occurs as constituents present in the smear zone partition to groundwater and soil vapor, where they are biodegraded via aerobic and anaerobic processes. There are two general lines of evidence provided herein to support the efficacy of natural attenuation processes to degrade petroleum hydrocarbons at a rate that will achieve remedial goals for groundwater (i.e., USEPA MCLs) in a timeframe comparable to active remedial measures. The primary lines of evidence demonstrate the stability of petroleum hydrocarbons in the smear zone beneath the site and protectiveness of sensitive receptors (Section 3.1); as well as meaningful trends of decreasing constituent concentrations over time (Section 3.2). The secondary lines of evidence (Section 3.3) demonstrate indirectly that natural attenuation mechanisms are acting to transform hydrocarbon constituents, reduce concentrations, and inhibit mobility of the LNAPL and dissolved phase impacts. Qualitative and quantitative lines of evidence demonstrating natural depletion of the smear zone over the first five years of groundwater corrective measures implementation were provided in the *Five-Year Groundwater CMI Review* (Trihydro 2011). Updates to these lines of evidence for which data was collected during the first half of 2012 are included herein.

3.1 PLUME STABILITY AND PROTECTIVENESS OF SENSITIVE RECEPTORS

During execution of the final groundwater remedy at the site, Chevron must continue to demonstrate that the LNAPL and dissolved phase plumes are stable and that sensitive receptors remain protected (USEPA 1999). If the extent of the LNAPL, dissolved, or vapor phase petroleum hydrocarbons are determined to be mobile or impacting sensitive receptors above risk based limits, contingency measures would be employed as outlined in the *OMM Plan* (Trihydro 2007b).

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3.1.1 LNAPL

As discussed in the *Update to Site Conceptual Model and Summary of Remedial Decision Basis* (Chevron Cincinnati Groundwater Task Force 2005) and outlined within the *First 2008 Semiannual Monitoring Report, Chevron Cincinnati Facility, Hooven, Ohio* (Trihydro 2009a), LNAPL within the smear zone is stable. This determination was made based on (1) the age of the release; (2) a decrease in LNAPL gradients, transmissivity, and saturations due to natural degradation and engineered recovery; (3) morphology of the smear zone with a "thicker" core, which thins at the lateral edges; (4) there having been no expansion of LNAPL beyond the originally defined limits of the smear zone; and (5) preferential depletion of petroleum related constituents within the LNAPL at the soil gas and groundwater interface (otherwise referred to as outside-in weathering of the plume).

Data collected during the first half of 2012 continue to support that the smear zone is stable based on the laser induced fluorescence measurements in the three ROST monitoring transects conducted between June 14 and 15, 2012. Additionally, LNAPL was not measured in any of the sentinel or point of compliance monitoring wells installed in the Southwest Quad. Fluid level gauging within the performance monitoring network installed along the west bank of the Great Miami River also confirmed the stability of the smear zone along the restored river bank.

Historical petrophysical tests on soil cores collected in the saturated portions of the smear zone indicate two-phase (water-oil) LNAPL residual saturation ranges from about 18 to 25%. Data collected from the facility show an exponential decrease in the ability of LNAPL to migrate at saturations below 20 to 25%. Field testing completed in the late-1990s indicates that the two-phase LNAPL saturations in the majority of the plume were below residual values (i.e., immobilized). Additionally, soil core samples were collected on the facility in late-2008 and in Hooven in early-2009 and LNAPL saturations calculated using the total petroleum hydrocarbon analytical results from soil samples collected from the cores within the upper, middle, and lower portions of the smear zone were below residual values. Additional soil cores will be collected during 2013 and LNAPL saturations estimates will be updated at locations across the smear zone.

3.1.2 DISSOLVED PHASE

Dissolved phase constituents of concern (including benzene, toluene, ethylbenzene, xylene, chlorobenzene, dissolved arsenic, and dissolved lead) have not been measured within routine samples collected from the sentinel and point of compliance groundwater monitoring network with the exception of following flood events as described in Section 2.2.1 herein and further supported within the *Five-Year Groundwater CMI Review* (Trihydro 2011). In addition, dissolved phase constituents have not been measured in groundwater or surface water at concentrations exceeding remedial goals along the Great Miami River. Arsenic and lead have been sporadically detected in groundwater collected from

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monitoring wells located throughout the Southwest Quad and along the river bank over the more than two decades of monitoring and are generally indicative of background metals measured in soils in Ohio as reported in the *Evaluation of Background Metal Concentrations in Ohio Soils* (Cox-Colvin & Associates, Inc. 1996) and the *Closure Plan Review Guidance for RCRA Facilities* (OEPA 1999).

3.2 CONSTITUENT TRENDS

It is expected that the data collected over the course of the remedy will show a meaningful trend of decreasing hydrocarbon mass and/or constituent concentrations over time. Analyses that may be used in evaluating the progress of the long term remedy in meeting remedial goals include evaluation of temporal trends in contaminant concentrations, LNAPL mass, or LNAPL saturations; comparisons of observed contaminant distributions with predictions; as well as comparison of calculated attenuation rates with those necessary to meet remedial goals within the required time frame. These analyses can be complicated as a result of variation in the petroleum hydrocarbon distribution across the site, temporal fluctuations related to seasonal and longer term trends, heterogeneity in the vadose and saturated zones across the plume footprint, along with measurement variability. These complications necessitate the use of multiple lines of evidence and expanded monitoring networks to reduce uncertainty.

3.2.1 DISSOLVED PHASE CONSTITUENT TRENDS

The distribution of total benzene, toluene, ethylbenzene, and xylenes (BTEX) in groundwater for samples collected during the first 2012 semiannual monitoring period are displayed on Figure 3-1. It is useful to evaluate the dissolved phase constituent trends in two ways. First, dissolved phase constituent trends within individual groundwater monitoring wells can be used to assess spatial variability in engineered mass removal and intrinsic biodegradation processes across the smear zone footprint and identify areas that are not behaving as predicted. Temporal trends in individual wells may also indicate changes in climatic, hydrogeochemical, hydrocarbon release, site reuse, or other conditions unrelated to attenuation processes and need to be evaluated in the context of other lines of evidence.

Second, groundwater quality trends can be averaged within areas of the smear zone (i.e., up-gradient, interior, down-gradient) to assess overall trends in natural attenuation processes. These area averages are less sensitive to variations within individual wells that can sometimes complicate temporal analyses and provide an understanding of natural attenuation processes affecting the smear zone as a whole. For discussion purposes, there are two areas up-gradient of the smear zone, one to the north of the facility property and the second to the west along the Buried Valley Aquifer-bedrock interface in Hooven.

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Individual well and area-wide trend analyses performed using data collected from monitoring wells across the smear zone during previous semiannual monitoring events have demonstrated a first order degradation rate for benzene associated with both natural attenuation and engineered mass removal, with preferential depletion along the smear zone margins (i.e., outside-in weathering).

3.2.1.1 TRENDS WITHIN INDIVIDUAL MONITORING WELLS

Historically, groundwater samples have not been collected from the interior plume monitoring wells due to the presence of LNAPL during sampling. For the purpose of this analysis, trends are inferred for wells that have viable groundwater data from at least three monitoring events spanning three separate years. Of the ten interior plume wells, four monitoring wells (MW-20S, MW-58S, MW-88, and MW-96S) do not have data that meet these criteria. Many of these wells have been sampled for at least three consecutive years but due to water table elevations, some of the data was excluded based on potential dilution during high water table elevations or potential for LNAPL during low water table elevations. Constituent of concern concentrations reported in the samples collected from interior monitoring well MW-85D were all reported below the remedial goals, which is expected as this well is screened in the deeper portions of the Buried Valley Aquifer, well below the vertical distribution of dissolved phase petroleum hydrocarbons.

Dissolved phase trends for the six remaining interior plume monitoring wells (MW-10, MW-17, MW-18R, MW-22, MW-81S and MW-93S) are provided on Figures 3-2 through 3-7. Dissolved phase benzene concentrations within each of these wells are decreasing over time. Monitoring wells MW-17 and MW-18R are located in the interior of the smear zone and there is only a slight decreasing trend in benzene concentrations over time. This decreasing trend may become more pronounced over time as the smear zone up-gradient of well MW-17 and MW-18R becomes depleted and attenuation continues from the "outside-in." Monitoring well MW-22 is located north of well MW-17, closer to the up-gradient edge of the smear zone, and accordingly shows a stronger decreasing trend in benzene concentrations over time. Monitoring well MW-10 is located near the southeastern edge of the smear zone and shows a steady decrease in benzene trend over time. Monitoring well MW-81S is situated in the southwest limit of Hooven adjacent to State Route 128 and MW-93S is located in the central portion of Hooven adjacent to the former elementary school. Dissolved phase constituent concentrations in these two wells show a clear decreasing trend between 1996 and 2012. This trend is likely pronounced by groundwater and LNAPL recovery as well as HSVE system operations.

Of the nine supplemental groundwater monitoring wells (L-1RR, L-3R, MW-21, MW-33, MW-38, MW-51, MW-64, MW-80, and MW-99S), only well MW-80 does not have sufficient data (i.e., results from at least three monitoring events spanning more than three years) to complete trend analyses. The dissolved phase results for constituents of

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concern reported in samples collected from wells MW-33 and MW-51 have remained below MCLs over time and therefore trend analyses for these wells are not included herein.

As presented on Figures 3-8 through 3-11, dissolved phase benzene concentrations reported in supplemental monitoring wells L-1RR, L-3R, MW-21, and MW-38 show a first order degradation rate over time. These wells are generally located outside of the footprint of engineered remedial measures at the facility; therefore these decreasing trends are indicative of natural attenuation processes. The rate of decline in benzene concentrations is greater in well MW-21 compared to monitoring wells L-1RR, L-3R and MW-38, as this well is located along the up-gradient edge of the smear zone.

The dissolved phase benzene concentrations reported in samples collected from monitoring wells MW-64 (Figure 3-12) and MW-99S (Figure 3-13) also show decreasing trends over time. These two monitoring wells are located on the eastern and western edge of the smear zone, respectively, and also demonstrate preferential depletion of benzene along the smear zone margins (i.e., outside-in weathering). Moreover, dissolved phase trends observed in monitoring well MW-99S reflect mass loss through engineered recovery like the other wells situated in Hooven.

Temporal analysis of the dissolved phase results can also be conducted for two additional monitoring wells (MW-85S and MW-115S) located within the distribution of hydrocarbons at the facility, as these wells have a sufficient monitoring history with concentrations above remedial goals. MW-115S (Figure 3-14) is located outside the influence of historical remedial efforts in the Southwest Quad. Dissolved phase benzene shows a decreasing trend over time within samples collected from this well, which can be considered indicative of natural attenuation processes.

Monitoring well MW-85S (Figure 3-15) has historically shown a decreasing trend, which was reversed beginning with groundwater monitoring conducted in 2008. It is possible that installation of the partially penetrating barrier wall along the west bank of the Great Miami River in 2008 has subsequently limited the transport of electron acceptors such as dissolved oxygen to this portion of the smear zone along the river. Future groundwater monitoring will help resolve short term and long term dissolved phase benzene trends in this well and other monitoring wells installed along the west bank of the river within the smear zone.

The average first order degradation rate estimated using the dissolved phase analytical results from thirteen monitoring wells (L-1RR, L-3R, MW-10, MW-17, MW-18R, MW-21, MW-22, MW-38, MW-64, MW-81S, MW-93S, MW-99S, and MW-115S) was approximately 6.88×10^{-4} per year. Attenuation rates will be compared over time within individual wells installed across the plume and progress towards meeting the remedial goals will be further considered.

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3.2.1.2 AVERAGE TRENDS ACROSS SMEAR ZONE

The average dissolved phase constituent and total petroleum hydrocarbon concentrations are indicative of ongoing natural smear zone depletion processes, with preferential LNAPL depletion at the smear zone boundaries. Dissolved phase benzene was not detected in samples collected from monitoring wells up-gradient and down-gradient of the smear zone. This indicates that attenuation processes such as dispersion, sorption, and biodegradation reduce the dissolved phase concentration, reduce mobility of the plume, and/or transform constituents of concern as groundwater exits the smear zone.

The average dissolved phase benzene concentration trends for selected monitoring wells located in the up-gradient (MW-21 and MW-22), interior (L-1RR, L-3R, MW-17, and MW-18R), and down-gradient (MW-48S, MW-94S, and MW-115S) portions of the smear zone are presented on Figure 3-16. Dissolved phase concentrations reported during monitoring conducted in 2002, 2004, 2008, 2009, 2010, 2011, and 2012 are averaged for the up-gradient, interior, and down-gradient wells. There is a decreasing trend in the dissolved phase benzene concentration reported between 2002 and 2012 across the smear zone. These decreasing trends are more pronounced at the margins of the smear zone compared to the interior portion of the plume. At its margins, the smear zone is thinner and LNAPL saturations are lower.

As the up-gradient portion of the smear zone is depleted of petroleum hydrocarbons, the benzene removal rates from the interior portion of the smear zone will increase as outside-in weathering continues. It is anticipated that the dissolved phase benzene concentrations reported in monitoring wells L-1RR and MW-17 will show trends similar to those currently observed in wells MW-21 and MW-22. This may then be followed by a similar transition in the dissolved phase benzene trends observed in monitoring wells L-3R and MW-18R. Over time, benzene concentrations in groundwater will continue to decrease across the smear zone, eventually reaching remedial goals.

3.3 HYDROGEOCHEMICAL INDICATORS OF NATURAL ATTENUATION

Characterization of geochemical variations in the vadose and saturated zones provides evidence of the types of biodegradation processes that are thought to be attenuating petroleum hydrocarbons in the smear zone. Many of these processes cannot be measured directly (e.g., biological transformation of constituents). However, changes in geochemical parameters leave an observable "footprint" that can be related qualitatively and quantitatively to the dominant natural attenuation processes (National Research Council 2000). In general, naturally occurring inorganic geochemical species serve as electron acceptors and are reduced during microbial degradation (i.e., oxidation) of petroleum hydrocarbons.

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3.3.1 DISSOLVED PHASE CONSTITUENTS

During microbial degradation of petroleum impacts, dissolved oxygen concentrations steadily decrease until anaerobic conditions prevail. Once anaerobic conditions exist and multiple potential electron acceptors (i.e., oxidizers) are available, microorganisms preferentially use the electron acceptor that is thermodynamically most favorable. In other words, petrophyllic bacteria that utilize the electron acceptor that offers the most energy during consumption of the petroleum hydrocarbon source will proliferate over other bacteria until they exhaust that electron acceptor and then other bacteria that use the next most favorable electron acceptor (based on availability in groundwater) thrive. The general order of preference for anaerobic hydrocarbon biodegradation based on the Gibb's energy of the reaction is:

- Denitrification (reduction of nitrate), with the eventual production of molecular nitrogen
- Reduction of manganese from Mn^{4+} to Mn^{2+}
- Reduction of ferric iron (Fe^{3+}) to ferrous iron (Fe^{2+})
- Sulfate reduction, with eventual production of sulfide
- Reduction of carbon dioxide and generation of methane

These microbial processes generally segregate into distinct zones dominated by oxygen, nitrate, ferric iron, sulfate, and carbon dioxide reduction. Furthermore, given the different electron acceptors consumed and final by-products, it is theoretically possible to differentiate the "zones" of microbial processes across the smear zone. When applied at a field scale this differentiation of microbial zones must be framed in general terms, which accommodate uncertainties, as several of the by-products of microbial metabolism (such as ferric iron, hydrogen sulfide, and methane) are readily transported down-gradient.

The spatial distribution of electron acceptors measured during the first 2012 semiannual monitoring period is displayed on Figure 3-17. Nitrate and sulfate concentrations were higher up-gradient of the smear zone compared to within the smear zone. Specifically, the average nitrate and sulfate concentrations in up-gradient groundwater, as provided in Table 3-1, were 3.6 and 49 mg/L, respectively. Sulfate and nitrate enriched water enters the smear zone with groundwater flowing from the north of the facility and bedrock-aquifer interface in the western portions of Hooven. Nitrate and sulfate concentrations within the smear zone were non-detect. Nitrate and sulfate concentrations showed a rebound in the down-gradient portions of the smear zone as a result of the supply of hydrocarbons in groundwater being depleted by biodegradation processes.

The spatial distribution of reduced species and attenuation by-products including dissolved iron, manganese, and methane are depicted on Figure 3-18. The concentration of each of these oxidation by-products was higher within the

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smear zone compared to up-gradient and down-gradient conditions. As reported in Table 3-1, the average dissolved iron, manganese, and methane concentrations up-gradient of the smear zone were 0.001, 0.3, and 0.004 mg/L, respectively. Average dissolved iron, manganese, and methane concentrations within the smear zone were 12.7, 0.54, and 15.4 mg/L, respectively. The increase in the concentration of these biodegradation by-products indicates iron and manganese reduction, as well as methanogenic processes, are degrading petroleum hydrocarbons. Down-gradient of the smear zone, dissolved iron, manganese, and methane concentrations decrease to 1.3, 0.3, and 0.23 mg/L, respectively.

A summary of hydrogeochemical indicator concentrations versus distance for monitoring conducted during the first half of 2012, along with historical results, is displayed on Figure 3-19. Select hydrogeochemical concentrations are compared to the dissolved phase benzene concentrations through the centerline of the smear zone. Iron and sulfate reduction primarily occurs within 2,000 feet of the up-gradient smear zone boundary where available electron receptors are fully reduced. There is a rapid increase in benzene, methane, and dissolved iron concentrations with an associated decrease in sulfate. Methanogenesis is then the dominant process degrading hydrocarbons through the central portions of the smear zone. These trends reverse toward the down-gradient edge of the smear zone. The concentration versus distance plots further support that outside-in weathering of the smear zone is occurring.

3.3.2 HYDROGEOCHEMICAL FLUX WITH RAINWATER INFILTRATE

During the first half of 2012, the concentrations of electron acceptors measured in the rainwater infiltrate collected from lysimeter L-21S (northernmost location) and lysimeter L-18S (central portion of the smear zone) were generally low or not detected. Reduced byproducts including dissolved manganese and methane were elevated within the samples collected from these locations. This is an indication of ongoing attenuation of petroleum hydrocarbons, and subsequent partitioning of methane and volatile petroleum hydrocarbons from soil vapor to pore water within the vadose zone.

In the southern portions of the smear zone, the pore water generally contains higher levels of electron acceptors including elevated sulfate and nitrate concentrations measured in lysimeter L-20S and L-93S. Reduced by-products were reported at relatively low concentrations in the infiltrate samples collected from these two lysimeters. Based on these results it appears that there is a higher flux of electron acceptors into the saturated portions of the smear zone along the southern portion of the site.

Precipitation and subsequent infiltration comprise an important component of the aquifer budget. Much of this infiltrating water contains electron acceptors that are used by microorganisms in the smear zone to destroy

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hydrocarbons. The lysimeter data are useful in understanding this process, as demonstrated by an analysis of the assimilative capacity. Figure 3-20 presents a summary bar graph of pore water assimilative capacity measured during the first half of 2012 along with results from previous monitoring events conducted over the past six years. The assimilative capacity is estimated by summing the concentrations of electron acceptors and subtracting reduction-oxidation byproducts, scaled to stoichiometric coefficients for attenuation of hydrocarbons. As shown on this figure, pore water in the northern and central portion of the smear zone (as evaluated using lysimeters L-21S and L-18S) has a low or negative assimilative capacity, indicating that precipitation infiltrate at these locations does not have the potential to further degrade hydrocarbons within the saturated zone. On the other hand, the assimilative capacity of infiltrate in the southern portions of the smear zone (assessed using lysimeters L-20S and L-93S) is much higher.

3.4 SUMMARY OF LINES OF EVIDENCE SUPPORTING NATURAL ATTENUATION

Performance monitoring for any corrective measures program is necessary to demonstrate that the remedy is progressing as anticipated and will meet remedial goals while ensuring that sensitive receptors remain protected. The USEPA has established additional performance monitoring criteria for remedies incorporating intrinsic natural attenuation processes for degradation of residual impacts (USEPA 1999, USEPA 2003). Performance monitoring programs in these cases must be designed to:

1. Demonstrate that natural attenuation is occurring according to expectations
2. Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes
3. Identify any potentially toxic and/or mobile transformation products such as methane within the vadose zone
4. Verify that the LNAPL or dissolved phase plume is not expanding down-gradient
5. Verify no unacceptable impact to down-gradient receptors
6. Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy

These performance monitoring criteria have been achieved during this first semiannual monitoring period based upon the qualitative and quantitative lines of evidence used to demonstrate the stability of petroleum hydrocarbons in the smear zone, protectiveness of sensitive receptors, transformation of petroleum hydrocarbon constituents via intrinsic processes, as well as decreasing petroleum hydrocarbon constituent concentrations and mass over time.

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TABLES

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID		Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-26R		11/25/08	0.0030 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	0.00080 J	ND(0.010)	ND(0.0069)
		3/27/09	0.0070	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		11/12/09	ND(0.00050)	ND(0.00080) J	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		5/11/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		10/21/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		5/18/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012) J
		12/2/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		5/8/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	Dup	5/8/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-35		11/19/08	0.13	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	Dup	11/19/08	0.13	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		2/17/09	0.021	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		4/3/09	0.021	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	Dup	4/3/09	0.021	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		4/28/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
		5/27/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
		6/29/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		7/21/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		8/11/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		9/14/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		10/12/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	Dup	10/12/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		11/17/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
		12/11/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
		1/12/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
		2/23/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		3/29/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		4/21/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID		Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-35		5/4/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	Dup	5/4/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
		6/15/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		7/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		8/25/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		9/28/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		3/22/11	ND(0.00051)	ND(0.00051)	0.0012	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		5/11/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		8/23/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		11/15/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		5/2/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.014 JB	ND(0.0012)
		5/23/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.0085	ND(0.0012)
MW-37		11/18/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		4/2/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		10/20/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.0030 JB	ND(0.0069)
		5/5/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.0086 J	ND(0.0069)
		10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		5/16/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		6/2/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	Dup	6/2/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		11/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
		5/7/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-94S		12/8/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	Dup	12/8/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		4/2/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
		5/6/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.017J/ND(0.017)U*	ND(0.0069)
		10/19/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
		5/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-94S	12/1/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	0.0070 J
Dup	12/1/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	0.0085
	5/8/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-115S	12/9/08	ND(0.00050)	ND(0.00080)	0.00080 J	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	4/3/09	0.0090	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	10/12/09	0.00080 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.011 J	ND(0.0069)
	5/5/10	0.011	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.018 J	ND(0.0069)
	10/20/10	0.0030 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.014 J	ND(0.0069)
	5/11/11	0.010	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.011 JB	ND(0.0012)
	11/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.0078	ND(0.0012)
	5/10/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.010	ND(0.0012)
MW-120	11/18/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	4/1/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	10/7/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	3/29/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
Dup	3/29/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	4/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/5/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	6/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
Dup	6/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	7/13/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	8/24/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	9/29/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	10/19/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	3/22/11	ND(0.00051)	ND(0.00051)	0.0016	ND(0.00048)	0.0014	ND(0.00024)	ND(0.0012)
	5/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	8/22/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	11/14/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/10/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-131	11/21/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.016 J	0.022
	2/18/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.014 J	ND(0.0069)
	4/2/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	7/23/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.010 J	ND(0.0069)
	10/20/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.027/ND(0.027)U*	ND(0.0069)
	5/6/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.025 JB	ND(0.0069)
Dup	5/6/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.017J/ND(0.017)U*	ND(0.0069)
	10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.015 J	ND(0.0069)
	5/16/11	0.0078	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	6/1/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.020 JB	ND(0.0012)
	11/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/15/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.0084	ND(0.0012)
MW-132	11/17/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	2/19/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	3/30/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	7/20/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
Dup	7/20/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	10/5/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/5/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
Dup	5/5/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	10/19/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	5/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	11/14/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/3/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-133	11/18/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	2/17/09	0.0030 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-133	4/1/09	0.11	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	4/28/09	0.036	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	5/26/09	0.032	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	6/29/09	0.11	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	7/21/09	0.051	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	8/11/09	0.031	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	9/14/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	10/8/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	11/17/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	12/11/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	1/12/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	2/23/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	3/29/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	4/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/4/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	6/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	7/13/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
Dup	7/13/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	8/24/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	9/27/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
Dup	10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	3/22/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	8/22/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
Dup	8/22/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	11/14/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/2/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.012 JB	ND(0.0012)
	5/23/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.0088	ND(0.0012)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-134	11/17/08	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	2/19/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	3/30/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	7/20/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	10/5/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/5/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.010 J	ND(0.0069)
	10/19/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	5/17/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	11/15/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/3/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-138	3/31/09	0.0050 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.010)	ND(0.0069)
	4/28/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	5/28/09	0.0020 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	6/29/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	7/21/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	8/12/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	9/15/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	10/7/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	11/18/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	12/14/09	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	1/13/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	2/23/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	3/30/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	4/21/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/4/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	6/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	7/14/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	8/25/10	0.0010 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	9/28/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	10/20/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	3/23/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-138	5/18/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012) J
	8/23/11	0.0056	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.0076 JB	ND(0.0012)
	11/15/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/2/12	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
MW-139	3/31/09	0.15	ND(0.00080)	ND(0.00080)	0.0050 J	0.0050 J	0.012 J	ND(0.0069)
	4/28/09	0.019	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	4/28/09	0.098	ND(0.00080)	ND(0.00080)	0.0030 J	0.0030 J	--	--
	5/28/09	0.085	ND(0.00080)	ND(0.00080)	0.0030 J	0.0030 J	--	--
	6/30/09	0.11	ND(0.00080)	0.0009 J	0.0050 J	0.0040 J	0.013 J	ND(0.0069)
	7/21/09	0.12	ND(0.00080)	0.0010 J	0.0060	0.0050 J	0.018 J	ND(0.0069)
	8/12/09	0.12	ND(0.00080)	ND(0.00080)	0.0060	0.0050 J	0.016 J	ND(0.0069)
	9/15/09	0.048	ND(0.00080)	ND(0.00080)	0.0020 J	0.0009 J	0.0097 J	ND(0.0069)
	10/7/09	0.017	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.013 J	ND(0.0069)
	11/18/09	0.0020 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	12/14/09	0.0040 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	1/13/10	0.0009 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	--	--
	2/24/10	ND(0.00050)	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.0095 J	ND(0.0069)
	3/30/10	0.0040 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	4/21/10	0.0070	ND(0.00080)	0.0010 J	ND(0.00070)	ND(0.00080)	ND(0.0072)	ND(0.0069)
	5/4/10	0.0090	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.012 J	ND(0.0069)
	6/14/10	0.0020 J	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	ND(0.0098)	ND(0.0069)
	7/14/10	0.026	ND(0.00080)	0.0030 J	0.0020 J	0.0040 J	0.010 J	ND(0.0069)
	8/25/10	0.050	ND(0.00080)	ND(0.00080)	0.0030 J	0.0030 J	0.018 J	ND(0.0069)
	9/28/10	0.023	ND(0.00080)	ND(0.00080)	0.0010 J	0.0010 J	0.024	ND(0.0069)
Dup	9/28/10	0.024	ND(0.00080)	ND(0.00080)	0.0010 J	0.0010 J	0.024	ND(0.0069)
	10/20/10	0.0090	ND(0.00080)	ND(0.00080)	ND(0.00070)	ND(0.00080)	0.021	ND(0.0069)
	3/23/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
Dup	3/23/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	ND(0.0012)
	5/18/11	0.013	ND(0.00051)	0.0031	0.0017	0.0037	0.010 J	0.0085 J
	8/23/11	0.039	ND(0.00051)	0.0019	0.0054	0.011	0.025 JB	ND(0.0012)

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID		Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-139		11/15/11	0.0011	ND(0.00051)	ND(0.00068)	ND(0.00048)	0.0010	0.011	ND(0.0012)
	Dup	11/15/11	0.0012	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	0.012	ND(0.0012)
		5/2/12	0.014	ND(0.00051)	ND(0.00068)	0.0022	0.0026	0.022 JB	ND(0.0012)
MW-140		3/27/09	0.35	ND(0.0020)	0.43	0.041	0.55	ND(0.010)	ND(0.0069)
		6/15/10	0.12	ND(0.00080)	0.013	0.0040 J	0.033	ND(0.0098)	ND(0.0069)
		3/23/11	0.033	ND(0.00051)	0.016	0.0054	0.024	0.0070	ND(0.0012) J
MW-141		4/1/09	0.51	ND(0.0020)	0.060	0.013	0.039	ND(0.010)	ND(0.0069)
	Dup	4/1/09	0.52	ND(0.0020)	0.062	0.013	0.042	ND(0.010)	ND(0.0069)
		7/23/09	0.40	ND(0.00080)	0.017	0.011	0.016	ND(0.0072)	ND(0.0069)
		10/13/09	0.29	ND(0.00080)	0.045	0.010	0.032	0.013 J	ND(0.0069)
		2/24/10	0.19	ND(0.00080)	0.014	0.0060	0.015	ND(0.0072)	ND(0.0069)
	Dup	2/24/10	0.18	ND(0.00080)	0.014	0.0060	0.015	ND(0.0072)	ND(0.0069)
		5/5/10	0.14	ND(0.00080)	0.019	0.0080	0.024	0.0094 J	ND(0.0069)
		8/26/10	0.13	ND(0.0020)	0.009 J	0.0050 J	0.0080 J	ND(0.0098)	ND(0.0069)
		3/23/11	0.0071	ND(0.00051)	ND(0.00068)	ND(0.00048)	0.0018	ND(0.00024)	ND(0.0012)
		5/19/11	ND(0.00051)	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00024)	0.0072 J
		8/24/11	0.028	ND(0.00051)	0.0060	0.0024	0.0013	0.010 JB	ND(0.0012)
		11/17/11	0.047	ND(0.00051)	0.014	0.0040	0.0032	0.0099	ND(0.0012)
		5/3/12	0.024	ND(0.00051)	0.0079	0.0028	0.0021	0.0052 JB	ND(0.0012)
MW-142		3/31/09	0.13	ND(0.0020)	0.39	0.028	0.35	0.017 J	ND(0.0069)
		5/28/09	0.12	ND(0.00080)	0.53	0.025	0.31	--	--
		6/30/09	0.31	ND(0.00080)	0.023	0.014	0.056	0.021	ND(0.0069)
		7/23/09	0.27	ND(0.00080)	0.045	0.015	0.061	0.025	ND(0.0069)
		8/12/09	0.21	ND(0.0020)	0.31	0.022	0.21	0.017 J	ND(0.0069)
		9/15/09	0.15	ND(0.00080)	0.15	0.019	0.13	0.022	ND(0.0069)
		10/13/09	0.11	ND(0.00080)	0.19	0.021	0.17	0.021	ND(0.0069)
		11/18/09	0.043	ND(0.0020)	0.052	0.011 JB	0.058	--	--
		12/14/09	0.035	ND(0.00080)	0.12	0.013	0.13	--	--

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TABLE 2-1. SOUTHWEST QUAD DISSOLVED PHASE ANALYTICAL RESULTS SUMMARY (NOVEMBER 2008 TO JUNE 2012)
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID		Date Sampled	Benzene (mg/L)	Chlorobenzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-142		1/13/10	0.084	ND(0.0020)	0.023	0.0060 J	0.027	--	--
	Dup	1/13/10	0.085	ND(0.0020)	0.023	0.0060 J	0.027	--	--
		2/24/10	0.090	ND(0.00080)	0.20	0.017	0.11	0.021	ND(0.0069)
		3/30/10	0.066	ND(0.00080)	0.039	0.0090	0.042	0.019 J	ND(0.0069)
		4/20/10	0.13	ND(0.00080)	0.061	0.014	0.073	0.027	ND(0.0069)
	Dup	4/20/10	0.13	ND(0.00080)	0.061	0.013	0.074	0.025	ND(0.0069)
		5/4/10	0.12	ND(0.0020)	0.18	0.016	0.15	0.020	ND(0.0069)
		6/15/10	0.16	ND(0.00080)	0.036	0.013	0.062	0.019 J	ND(0.0069)
		7/13/10	0.16	ND(0.00080)	0.037	0.011	0.061	0.023	ND(0.0069)
		8/26/10	0.10	ND(0.0020)	0.0040 J	0.0080 J	0.031	0.021	ND(0.0069)
	Dup	8/26/10	0.10	ND(0.0020)	0.0040 J	0.0080 J	0.031	0.020	ND(0.0069)
		9/28/10	0.11	ND(0.00080)	0.024	0.012	0.047	0.021	ND(0.0069)
		10/20/10	0.15	ND(0.00080)	0.072	0.014	0.070	0.023	ND(0.0069)
	Dup	10/20/10	0.16	ND(0.00080)	0.074	0.015	0.073	0.024	ND(0.0069)
		3/23/11	0.020	ND(0.00051)	0.052	0.0053	0.033	0.012	ND(0.0012)
		5/18/11	0.067	ND(0.00051)	0.11	0.0098	0.048	0.013	0.012 J
	Dup	5/18/11	0.067	ND(0.00051)	0.11	0.0098	0.047	0.014	0.012 J
		8/24/11	0.055	ND(0.00051)	0.076	0.0079	0.051	0.016 JB	ND(0.0012)
		11/17/11	0.068	ND(0.00051)	0.21	0.010	0.12	0.016	ND(0.0012)
		5/3/12	0.033	ND(0.00051)	0.042	0.0046	0.024	0.018 JB	ND(0.0012)

NOTES:

The method detection limit was used as the reporting limit.

-- - Not analyzed

Dup - Duplicate sample

J - Estimated concentration

JB - Estimated concentration due to detection of analyte within the method blank.

mg/L - milligram per liter

ND - Not detected at the indicated laboratory reporting limit or the method detection limit.

U* - The first result represents the laboratory reported concentration. The second result was evaluated to be undetected at the reported concentration during validation due to detection of the analyte within the method blank.

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TABLE 2-2. PERIMETER, INTERIOR, AND SUPPLEMENTAL WELL GROUNDWATER ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Chlorobenzene (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
L-1RR	4/12/12	0.70	1.8	0.14	6.2	ND(0.00051)	0.048	0.017 J
L-3R	4/11/12	6.6	1.4	0.12	0.51	ND(0.00051)	0.045	0.012 J
Dup	4/11/12	6.4	1.4	0.12	0.60	ND(0.00051)	0.046	0.015 J
MW-10	4/11/12	0.0045	0.0064	0.0015	0.0019	ND(0.00051)	0.0056	ND(0.0012) J
MW-17	5/01/12	5.1	0.19	0.11	0.14	ND(0.00051)	0.063	0.0080
MW-18R	4/12/12	0.49	2.0	0.17	6.5	ND(0.00051)	0.031	0.0088 J
MW-20S	5/09/12	1.0	1.0	0.050	1.0	ND(0.00051)	0.031	0.0095
MW-21	4/30/12	0.075	2.2	0.049	0.43	ND(0.00051)	0.0067 JB	ND(0.0012)
Dup	4/30/12	0.078	2.4	0.051	0.34	ND(0.00051)	0.0076 JB	ND(0.0012)
MW-22	4/30/12	0.0067	0.30	0.0090	0.095	ND(0.00051)	0.025	ND(0.0012)
MW-26R	5/08/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
Dup	5/08/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-33	5/09/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-48S	5/14/12	ND(0.00051)	0.27	ND(0.00048)	1.3	ND(0.00051)	0.031	0.014
MW-51	5/07/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-57	5/15/12	0.012	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.012	ND(0.0012)
Dup	5/15/12	0.012	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.014	ND(0.0012)
MW-64	5/01/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-80	5/08/12	0.0032	ND(0.00068)	0.0036	0.0041	ND(0.00051)	0.041	ND(0.0012)
MW-81S	5/15/12	0.16	0.0040	0.0078	0.0097	ND(0.00051)	ND(0.00024)	0.0080
MW-85S	5/01/12	0.26	0.094	0.034	0.15	ND(0.00051)	0.015	0.0092
MW-85D	5/01/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-93S	5/10/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
Dup	5/10/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-94S	5/08/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-95S	5/10/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-96S	5/10/12	0.063	0.041	0.0022	0.040	ND(0.00051)	0.038	0.0075
MW-99S	5/10/12	0.0022	0.021	0.0012	0.0098	ND(0.00051)	0.019	ND(0.0012)
Dup	5/10/12	0.0023	0.023	0.0014	0.013	ND(0.00051)	0.020	ND(0.0012)

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TABLE 2-2. PERIMETER, INTERIOR, AND SUPPLEMENTAL WELL GROUNDWATER ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Chlorobenzene (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-100S	5/10/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-103S	5/14/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-104S	4/11/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-115S	5/10/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.010	ND(0.0012)

NOTES:
The method detection limit was used as the reporting limit.
J - Estimated concentration
JB - Estimated concentration due to detection of analyte within the method blank.
mg/L - milligram per liter
ND - Not detected at the indicated laboratory reporting limit or the method detection limit.

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TABLE 2-3. DISSOLVED PHASE NATURAL ATTENUATION ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Alkalinity, Carbonate (mg/L)	Calcium, Total (mg/L)	Chemical Oxygen Demand (mg/L)	Chloride (mg/L)	Iron, Ferric (mg/L)	Iron, Dissolved (mg/L)	Manganese, Total (mg/L)	Manganese, Dissolved (mg/L)	Methane (mg/L)
L-1RR	4/12/12	480	140	36	28	ND(0.00097) J	13	0.19	0.19	44
MW-18R	4/12/12	460	140	38	26	0.49 J	15	0.18	0.17	38
MW-20S	5/09/12	510	160	49	53	1.1 J	17	0.22 JB	0.20	4.2
MW-33	5/09/12	480	150	9.5	4.8	ND(0.00097) J	ND(0.00097)	0.34	0.32	0.066
MW-37	5/07/12	410	150	ND(5.0)	130	ND(0.00097) J	ND(0.00097)	ND(0.00023)	ND(0.00023)	ND(0.00083)
MW-38	5/09/12	450	130	18	250	ND(0.00097) J	5.4	0.51	0.52	0.60
MW-51	5/07/12	250	75	ND(5.0)	56	ND(0.00097) J	ND(0.00097)	0.25	0.23	ND(0.00083)
MW-81S	5/15/12	620	160	26	55	ND(0.00097)	14	0.29 JB	0.28	7.7
MW-85S	5/01/12	540	160	45	17	ND(0.00097) J	28	1.1	1.1	5.7
MW-96S	5/10/12	460	120	38	110	0.98	12	0.37	0.36	4.7
MW-100S	5/10/12	290	110	ND(5.0)	140	ND(0.00097)	ND(0.00097)	0.69	0.67	0.0098
MW-112	4/12/12	550	170	32	68	ND(0.00097) J	16	0.27	0.27	49
MW-114	5/07/12	440	140	ND(5.0)	87	0.25 J	ND(0.00097)	ND(0.00023)	ND(0.00023)	ND(0.00083)
MW-115S	5/10/12	480	130	18	87	0.22	6.2	2.0	2.0	0.34
MW-131	5/15/12	420	99	9.5	17	ND(0.00097)	2.6	0.52	0.66	0.46

NOTES:
The method detection limit was used as the reporting limit.
J - Estimated concentration
mg/L - milligram per liter
ND - Not detected at the indicated laboratory reporting limit or the method detection limit.

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TABLE 2-3. DISSOLVED PHASE NATURAL ATTENUATION ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Nitrogen, Nitrate (mg/L)	Nitrogen, Nitrite (mg/L)	Ammonia (mg/L)	Nitrogen, Kjeldahl (mg/L)	Potassium, Total (mg/L)	Sodium, Total (mg/L)	Sulfate (mg/L)	Sulfide, Total (mg/L)	Total Organic Carbon (mg/L)
L-1RR	4/12/12	ND(0.0045)	ND(0.0061)	0.19	ND(0.68)	2.3	19	ND(0.020)	52	7.2
MW-18R	4/12/12	ND(0.0045)	ND(0.0061)	1.5	2.4	3.0	25	ND(0.020)	ND(0.28)	8.3
MW-20S	5/09/12	ND(0.0045)	ND(0.0061)	0.35	1.3	2.9	39	ND(0.020)	ND(0.28)	8.5
MW-33	5/09/12	ND(0.0045)	ND(0.0061)	0.035	ND(0.68)	1.4	4.6	17	ND(0.28)	2.1
MW-37	5/07/12	4.5	ND(0.0061)	ND(0.019)	ND(0.68)	3.8	67	77	ND(0.28)	1.8
MW-38	5/09/12	ND(0.0045)	ND(0.0061)	1.2	2.0	6.3	160	9.1	ND(0.28)	3.8
MW-51	5/07/12	0.53	ND(0.0061)	ND(0.019)	ND(0.68)	4.3	44	45	ND(0.28)	2.2
MW-81S	5/15/12	ND(0.0045)	ND(0.0061)	0.65	1.8	3.6	43	ND(0.020)	2.6	6.8
MW-85S	5/01/12	ND(0.0045)	ND(0.0061)	1.6	3.3	2.5	11	ND(0.020)	110	13
MW-96S	5/10/12	ND(0.0045)	ND(0.0061)	1.1	2.2	5.5	78	ND(0.020)	ND(0.28)	8.9
MW-100S	5/10/12	5.6	ND(0.0061)	0.18	ND(0.68)	6.0	77	38	ND(0.28) J	1.8
MW-112	4/12/12	ND(0.0045)	ND(0.0061)	2.7	3.0	3.8	41	ND(0.020)	ND(0.28)	8.0
MW-114	5/07/12	4.7	ND(0.0061)	ND(0.019)	ND(0.68)	3.9	72	64	ND(0.28) J	2.2
MW-115S	5/10/12	ND(0.0045)	ND(0.0061)	0.026	ND(0.68)	2.6	52	ND(0.020)	ND(0.28)	3.9
MW-131	5/15/12	ND(0.0045)	ND(0.0061)	0.26	ND(0.68)	1.9	13	15	ND(0.28)	3.4

NOTES:
The method detection limit was used as the reporting limit.
J - Estimated concentration
mg/L - milligram per liter
ND - Not detected at the indicated laboratory reporting limit or the method detection limit.

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TABLE 2-4. LYSIMETER ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Dissolved Oxygen[1] (mg/L)	ORP[1]	Methane (mg/L)	Manganese Total (mg/L)	Manganese Dissolved (mg/L)	Iron Total (mg/L)	Nitrogen Nitrate (mg/L)	Sulfate (mg/L)	Iron Dissolved (mg/L)	Assimilative Capacity (mg hydrocarbon/L)
L-18S	5/14/09	4.2	190	1.9	0.36	0.36	0.32	ND(0.25)	1.8 J	ND(0.052)	-0.50
	12/09/09	2.8	150	1.4	0.26	0.26	1.4	ND(0.25)	ND(1.5)	ND(0.052)	-0.23
	6/03/10	2.0	45	2.7	0.26	0.26	2.4	ND(0.25)	ND(1.5)	ND(0.052)	-2.27
	12/20/10	1.0	23	2.4	0.13	0.13	8.4	ND(0.25)	ND(1.5)	ND(0.052)	-1.84
	6/16/11	2.0	-24	3.0	1.1	1.0	12	ND(0.0045)	ND(0.020)	7.2	-3.10
	6/05/12	0.80	-29	2.3	0.23	0.22	14	ND(0.0045)	ND(0.020)	1.7	-2.38
L-20S	5/14/09	2.6	210	ND(0.014)U	0.64	0.66	0.27	ND(0.25)	160	ND(0.052)	15
	12/09/09	4.0	160	ND(0.010)	0.098	0.0089	1.0	11	170	ND(0.052)	35
	6/03/10	2.0	86	0.011 J	2.0	1.9	1.1	ND(0.25)	60	ND(0.052)	12
	12/20/10	2.0	120	ND(0.0050)	0.052	0.018	0.35	2.5	130 J	ND(0.052)	25
	6/16/11	2.8	140	0.0024	0.13	0.11	ND(0.00097)	5.0	46	ND(0.00097)	10
	6/05/12	0.60	120	0.0024	0.95	0.94	ND(0.00097)	ND(0.0045)	24	ND(0.00097)	4.7
L-21S	5/14/09	3.0	210	0.27	0.20	0.19	1.2	ND(0.25)	1.6 J	ND(0.052)	0.90
	12/09/09	5.0	190	0.34	0.16	0.16	0.41	ND(0.25)	ND(1.5)	ND(0.052)	1.6
	6/03/10	6.0	67	2.2	0.15	0.14	1.0	ND(0.25)	ND(1.5)	ND(0.052)	-0.55
	12/20/10	3.0	82	0.95	0.12	0.12	3.9	ND(0.25)	ND(1.5)	ND(0.052)	0.33
	6/16/11	2.0	69	0.74	0.17	0.17	1.8	ND(0.0045)	ND(0.020)	ND(0.00097)	-0.25
L-21D	6/05/12	1.0	9.0	0.81	0.069	0.066	14	ND(0.0045)	ND(0.020)	0.62	-0.63
L-93S	5/14/09	6.0	170	ND(0.0050)	0.0039 J	0.0034 J	ND(0.052)	14	120	ND(0.052)	20
	12/09/09	6.0	84	ND(0.010)	0.0034 J	0.0035 J	ND(0.052)	1.3	160	ND(0.052)	31
	6/03/10	6.0	100	ND(0.0050)	0.0036 J	0.0014 J	0.081 J	15	46	ND(0.052)	13
	12/20/10	6.0	120	ND(0.0050)	0.0041 J	0.0034 J	0.11 J	25	33 J	ND(0.052)	13
	6/16/11	2.8	72	ND(0.00083)	ND(0.00023)	ND(0.00023)	ND(0.00097)	15	60	ND(0.00097)	15
	6/05/12	9.0	200	ND(0.00083)	ND(0.00023)	ND(0.00023)	ND(0.00097)	14	34	ND(0.00097)	12

NOTES:
[1] - ORP and DO measured in the field using titration kits
The method detection limit was used as the reporting limit
J - Estimated concentration
mg/L - milligram per liter
mg hydrocarbon/L - milligrams of petroleum hydrocarbons per liter
ND - Not detected at the indicated laboratory reporting limit or the method detection limit
ND(0.014)U - The result was evaluated to be undetected at the reported concentration during validation due to detection of the analyte within the method blank

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TABLE 2-5. BARRIER WALL PERFORMANCE MONITORING ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Chlorobenzene (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
BSW-1S	6/04/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
Dup	6/04/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BSW-1D	6/04/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-1S	5/22/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-1I	5/22/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-1D	5/22/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BSW-2S	6/05/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.0075	ND(0.0012)
BSW-2D	6/05/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-2S	5/23/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-2I	5/22/12	ND(0.00051)	ND(0.00068)	0.0011	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
Dup	5/22/12	ND(0.00051)	ND(0.00068)	0.0012	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-2D	5/22/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BSW-3S	6/05/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BSW-3D	6/05/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-3S	5/30/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-3I	5/30/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
BMW-3D	5/24/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-135S	5/21/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-135I	5/21/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-135D	5/21/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-136S	5/23/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.031	0.0078
MW-136I	5/24/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-136D	5/24/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)

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TABLE 2-5. BARRIER WALL PERFORMANCE MONITORING ANALYTICAL RESULTS SUMMARY
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Location ID	Date Sampled	Benzene (mg/L)	Ethylbenzene (mg/L)	Toluene (mg/L)	Xylenes, Total (mg/L)	Chlorobenzene (mg/L)	Arsenic, Dissolved (mg/L)	Lead, Dissolved (mg/L)
MW-137S	5/30/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	0.0070	ND(0.0012)
MW-137I	5/31/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)
MW-137D	5/31/12	ND(0.00051)	ND(0.00068)	ND(0.00048)	ND(0.00073)	ND(0.00051)	ND(0.00024)	ND(0.0012)

NOTES:

The method detection limit was used as the reporting limit.

Dup - Duplicate sample

mg/L - milligram per liter

ND - Not detected at the indicated laboratory reporting limit or the method detection limit.

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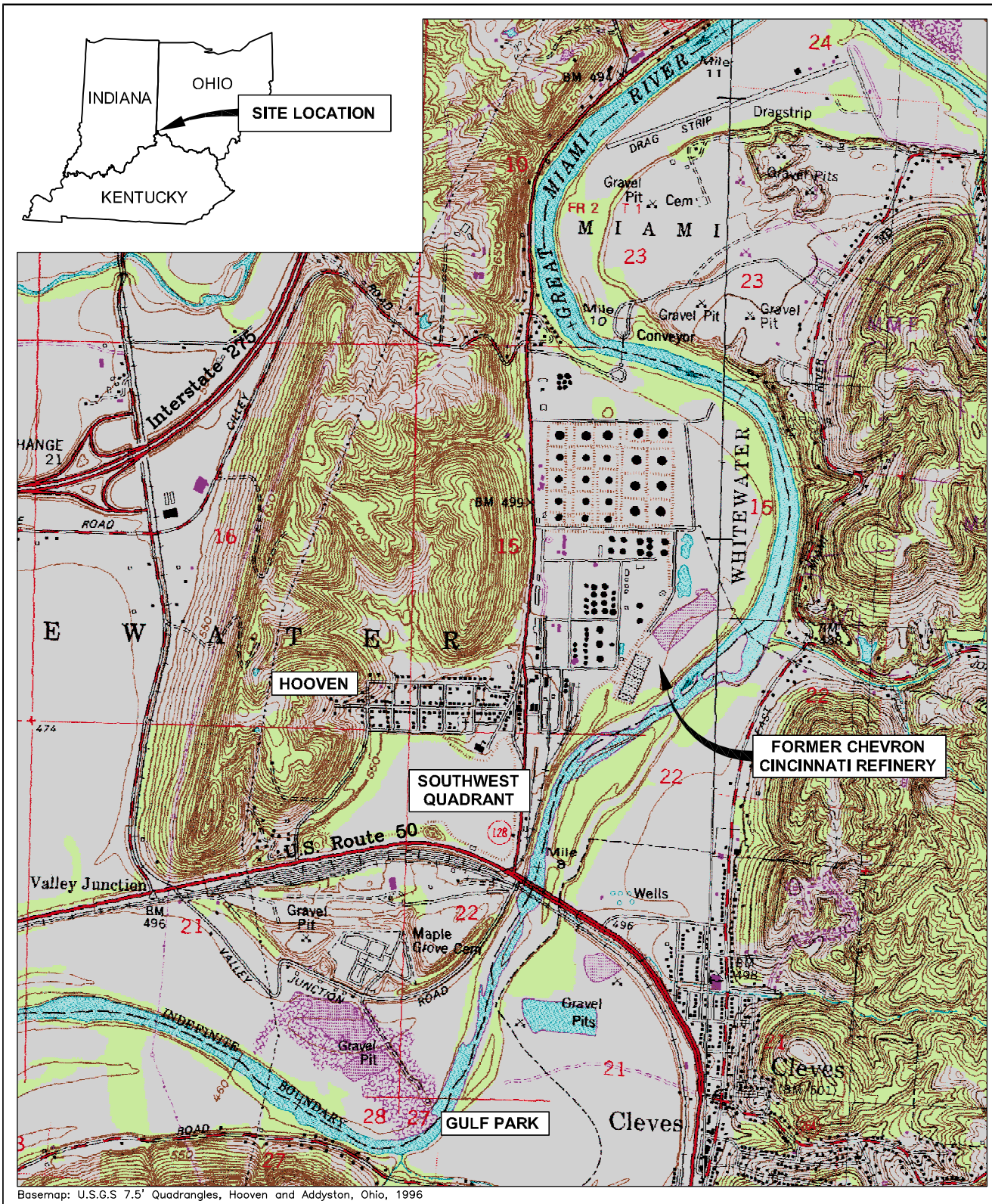
TABLE 3-1. DISTRIBUTION OF DISSOLVED PHASE CONSTITUENTS
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Constituent	Up-Gradient of Smear Zone[1] (mg/L)	Within Smear Zone[2] (mg/L)	Down-Gradient of Smear Zone[3] (mg/L)
Average TPH Concentration	0.34	12	--
Average BTEX Concentration	0.0024	1.6	0.0024
Average Benzene Concentration	0.00051	0.58	0.00051
Average Nitrate Concentration	3.6	0.0045	2.3
Average Sulfate Concentration	49	0.020	46
Average Ferrous Iron Concentration	0.00097	13	1.3
Average Dissolved Manganese Concentration	0.30	0.54	0.33
Average Methane Concentration	0.0035	15	0.23

NOTES:
[1] - Wells Upgradient of Smear Zone include MW-51, MW-95S, MW-100S, and MW-114
[2] - Wells within Smear Zone include L-3R, L-1RR, MW-10, MW-17, MW-18R, MW-20S, MW-21, MW-22, MW-26R, MW-33, MW-38, MW-48S, MW-64, MW-80, MW-81S, MW-85S, MW-93S, MW-94S, MW-96S, MW-99S, MW-104S, MW-112, MW-115S, MW-139, MW-141, and MW-142
[3] - Wells Downgradient of Smear Zone include MW-35, MW-37, MW-120, MW-131, MW-132, MW-133, MW-134, and MW-138
Average values estimated assuming non-detect concentrations equal one half the detection limit, or average of detection limits when all constituents are non-detect
-- Not analyzed
mg/L - milligrams per liter
TPH = Total Petroleum Hydrocarbons
BTEX = Benzene, Toluene, Ethylbenzene, and Xylene

US EPA ARCHIVE DOCUMENT

FIGURES



Basemap: U.S.G.S 7.5' Quadrangles, Hooven and Addyston, Ohio, 1996

N

0 2,000'

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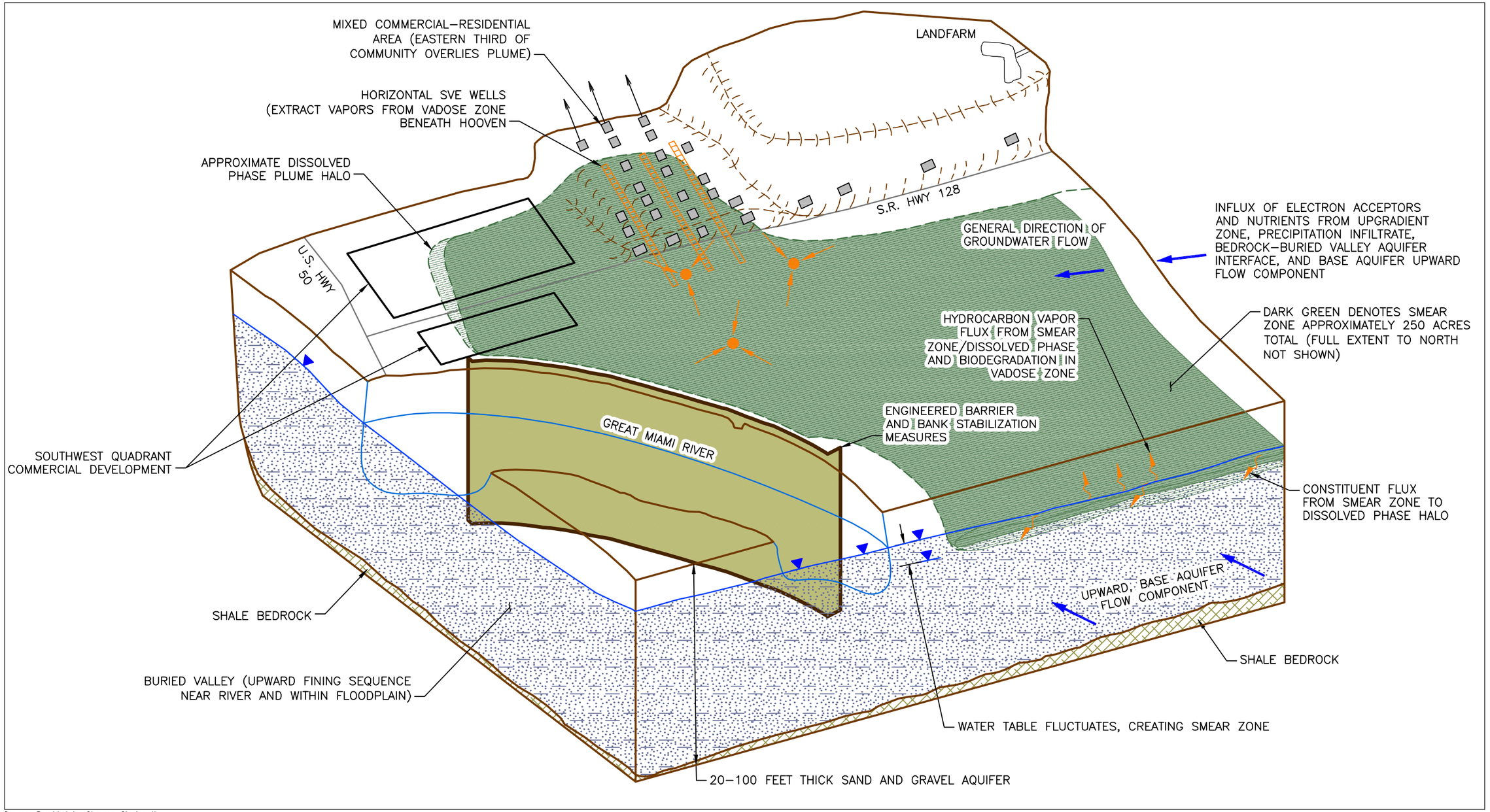
FIGURE 1-1

SITE LOCATION MAP

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: REP	Checked By: JP	Scale: 1" = 2,000'	Date: 1/13/2011	File: 500USGSSITE201210

US EPA ARCHIVE DOCUMENT



Source: Provided by Chevron Cincinnati.

EXPLANATION

HIGH-GRADE PUMPING TARGETED AREAS WITH HIGHEST RESIDUAL LNAPL SATURATION.

WATER LEVEL

DISSOLVED PHASE PLUME EXTENT

SMEAR ZONE EXTENT

N

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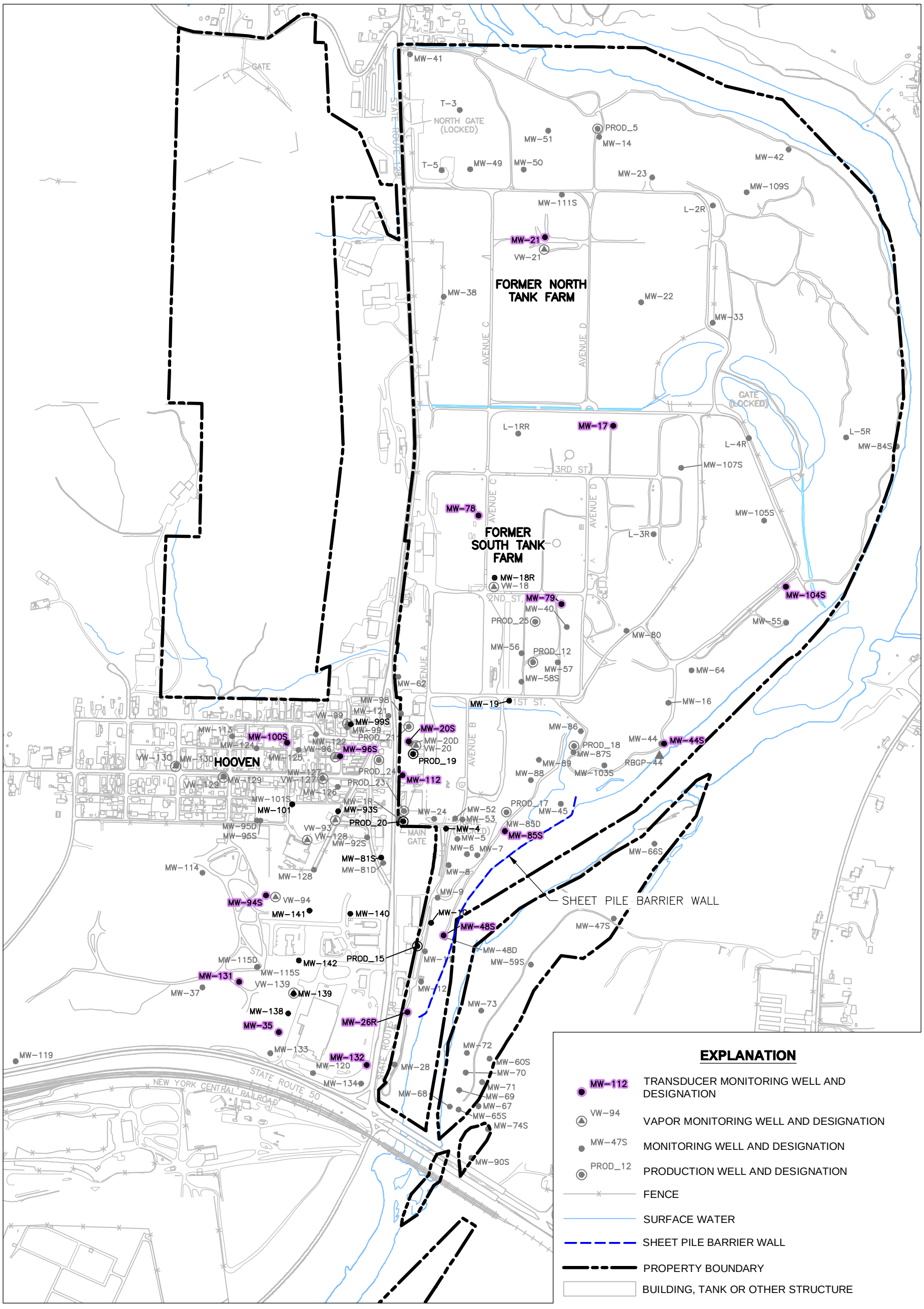
FIGURE 1-2

GROUNDWATER CONCEPTUAL SITE MODEL

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: REP	Checked By: JP	Scale: NONE	Date: 11/19/2010	File: 500GWCONCMODEL-201210



EXPLANATION

MW-112	TRANSDUCER MONITORING WELL AND DESIGNATION
VW-94	VAPOR MONITORING WELL AND DESIGNATION
MW-47S	MONITORING WELL AND DESIGNATION
PROD_12	PRODUCTION WELL AND DESIGNATION
	FENCE
	SURFACE WATER
	SHEET PILE BARRIER WALL
	PROPERTY BOUNDARY
	BUILDING, TANK OR OTHER STRUCTURE

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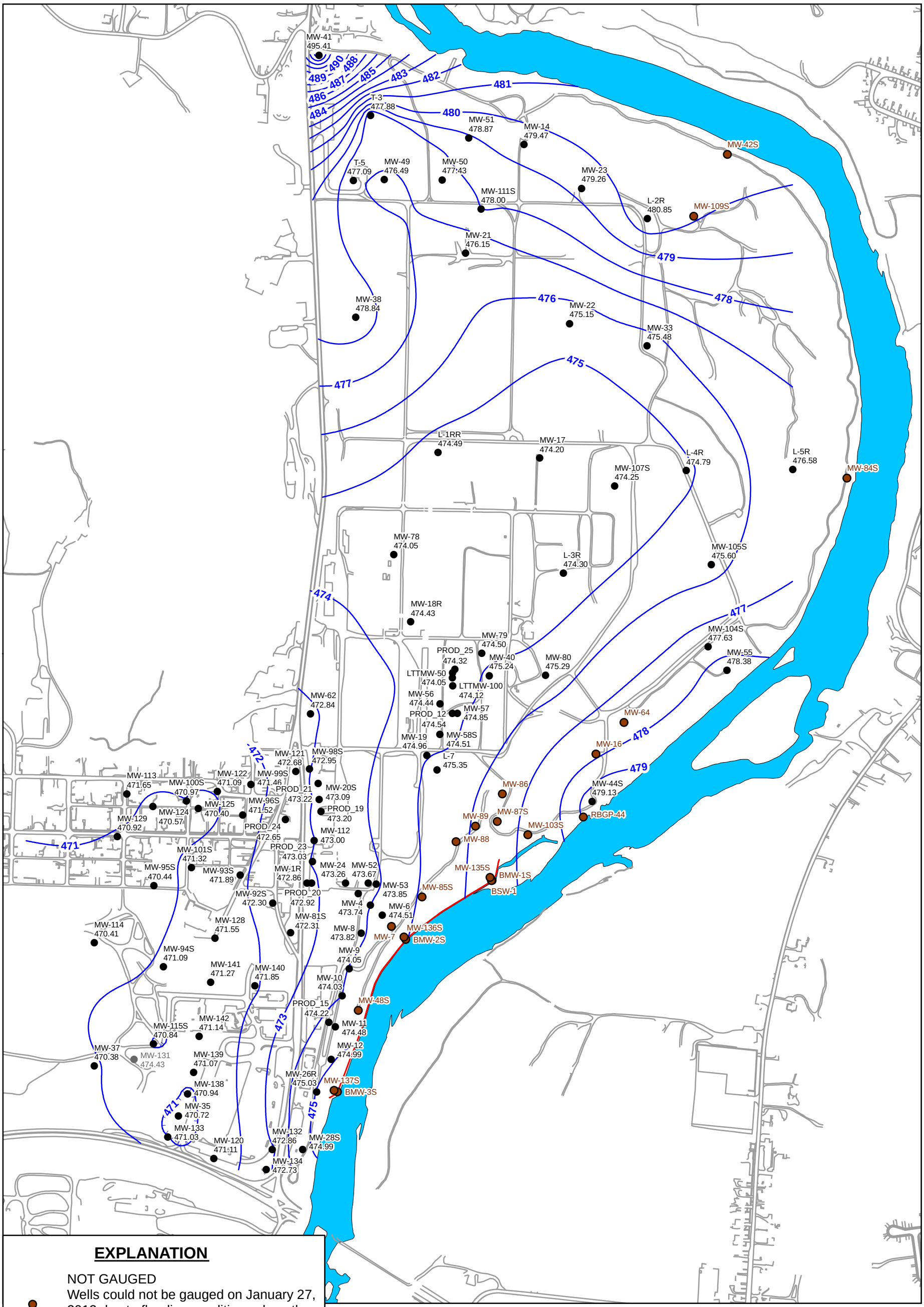
FIGURE 2-1

TRANSDUCER MONITORING WELLS

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: REP	Checked By: MM	Scale: 1" = 650'	Date: 11/14/12	File: 500TRANMONWELLS201211

US EPA ARCHIVE DOCUMENT



EXPLANATION

NOT GAUGED
Wells could not be gauged on January 27, 2012 due to flooding conditions along the Great Miami River.

EQUIPOTENTIAL CONTOUR LINE
Elevation In Feet Above Mean Sea Level
Contour Interval is 1.0 feet
(Line dashed where approximate)

NOTE: Groundwater elevation recorded at well MW-131 was not used for generating the potentiometric surface.

N

0 600'

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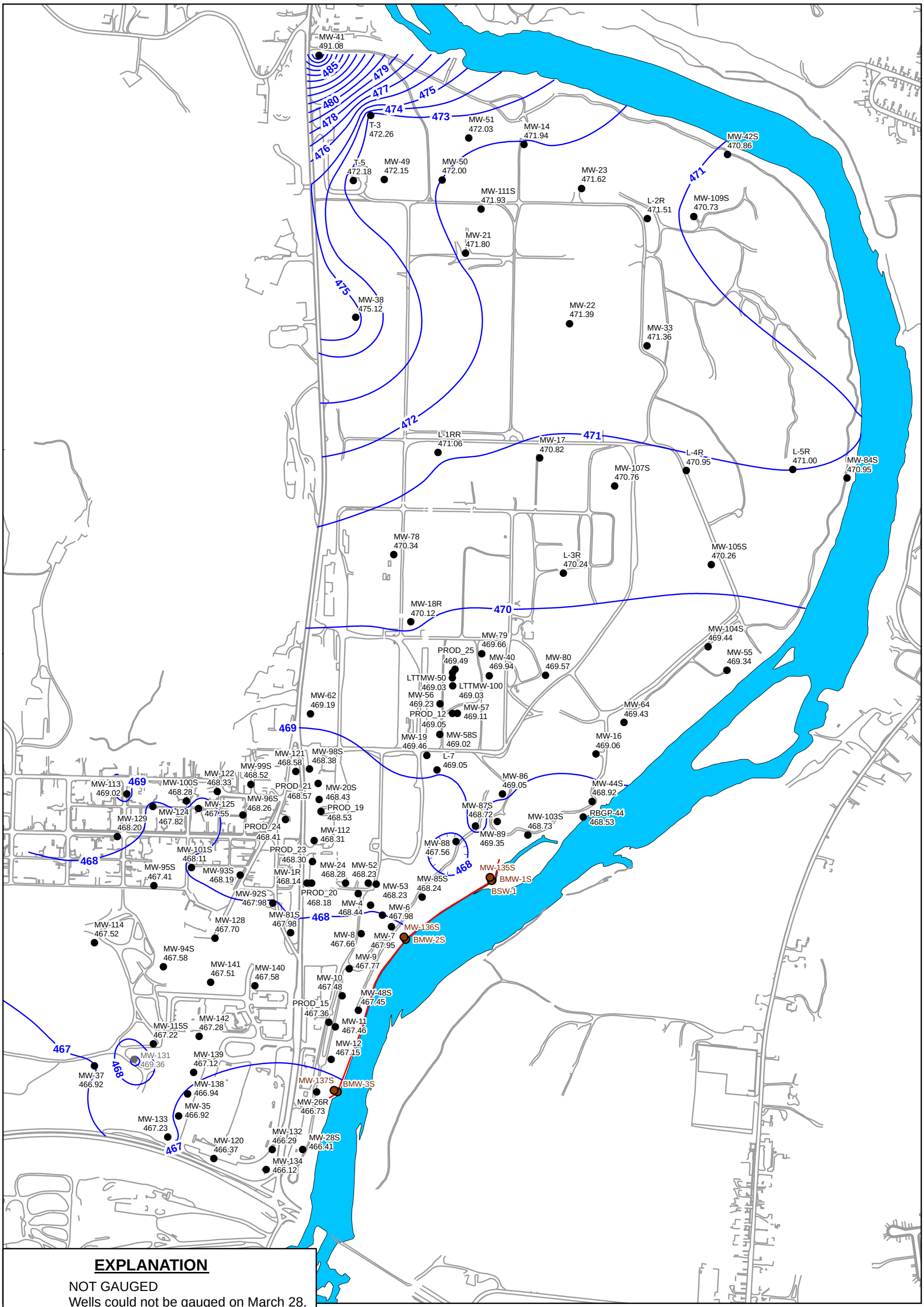
FIGURE 2-2

POTENTIOMETRIC SURFACE MAP
JANUARY 27, 2012

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: PM	Scale: 1" = 600'	Date: 12/14/12	File: Jan_27_2012_Potsurface.mxd

US EPA ARCHIVE DOCUMENT



EXPLANATION

NOT GAUGED
Wells could not be gauged on March 28, 2012 due to flooding conditions along the Great Miami River.

EQUIPOTENTIAL CONTOUR LINE
Elevation In Feet Above Mean Sea Level
Contour Interval is 1.0 feet
(Line dashed where approximate)

NOTE: Groundwater elevation recorded at well MW-131 was not used for generating the potentiometric surface.

N

0 600'

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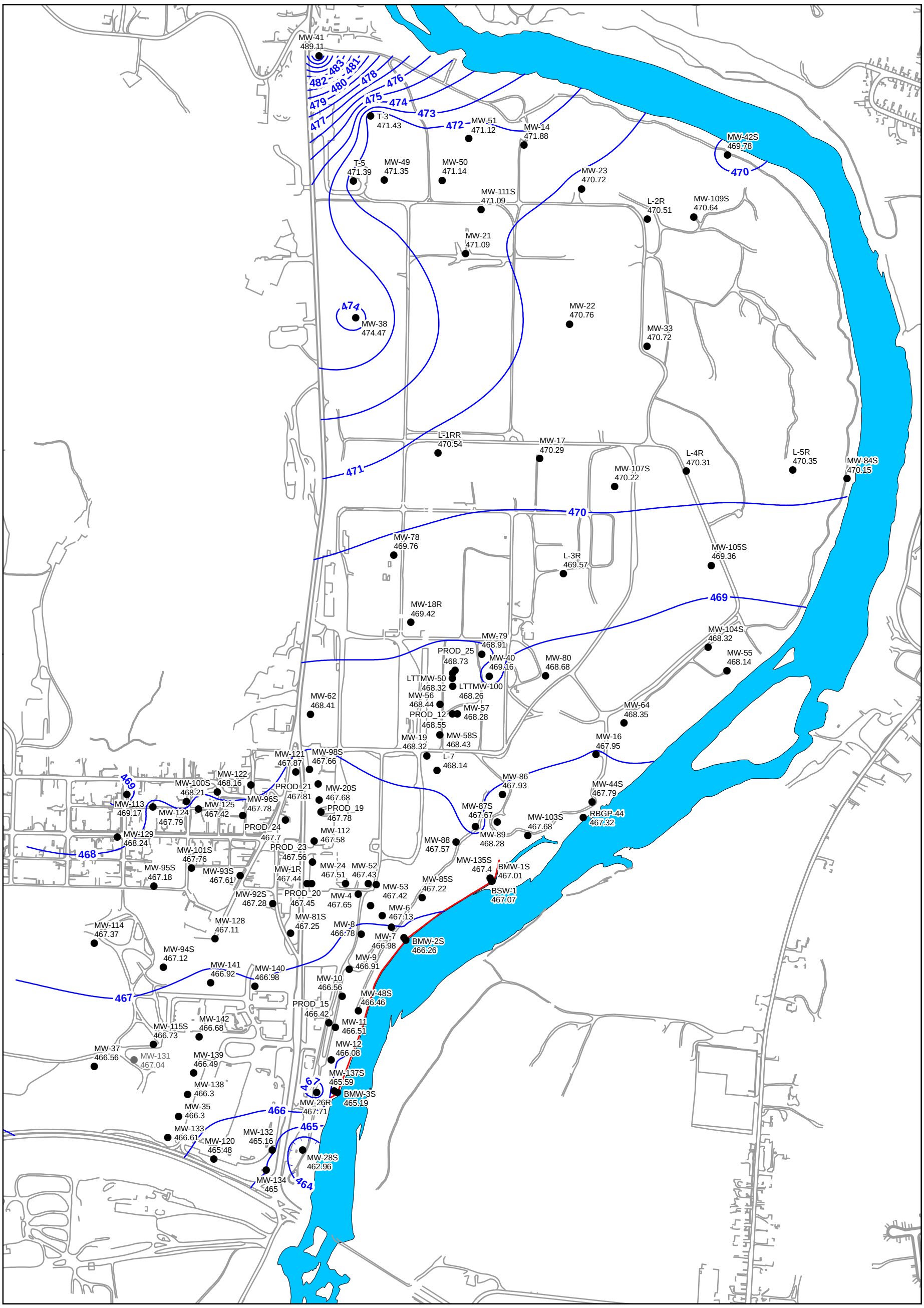
FIGURE 2-3

POTENTIOMETRIC SURFACE MAP
MARCH 28, 2012

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: PM	Scale: 1" = 600'	Date: 12/7/12	File: March_28_2012_Potsurface.mxd

US EPA ARCHIVE DOCUMENT



EXPLANATION

EQUIPOTENTIAL CONTOUR LINE
Elevation In Feet Above Mean Sea Level
Contour Interval is 1.0 feet
(Line dashed where approximate)

NOTE: Groundwater elevation recorded at well MW-131 was not used for generating the potentiometric surface.

N

0 600'

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FIGURE 2-4

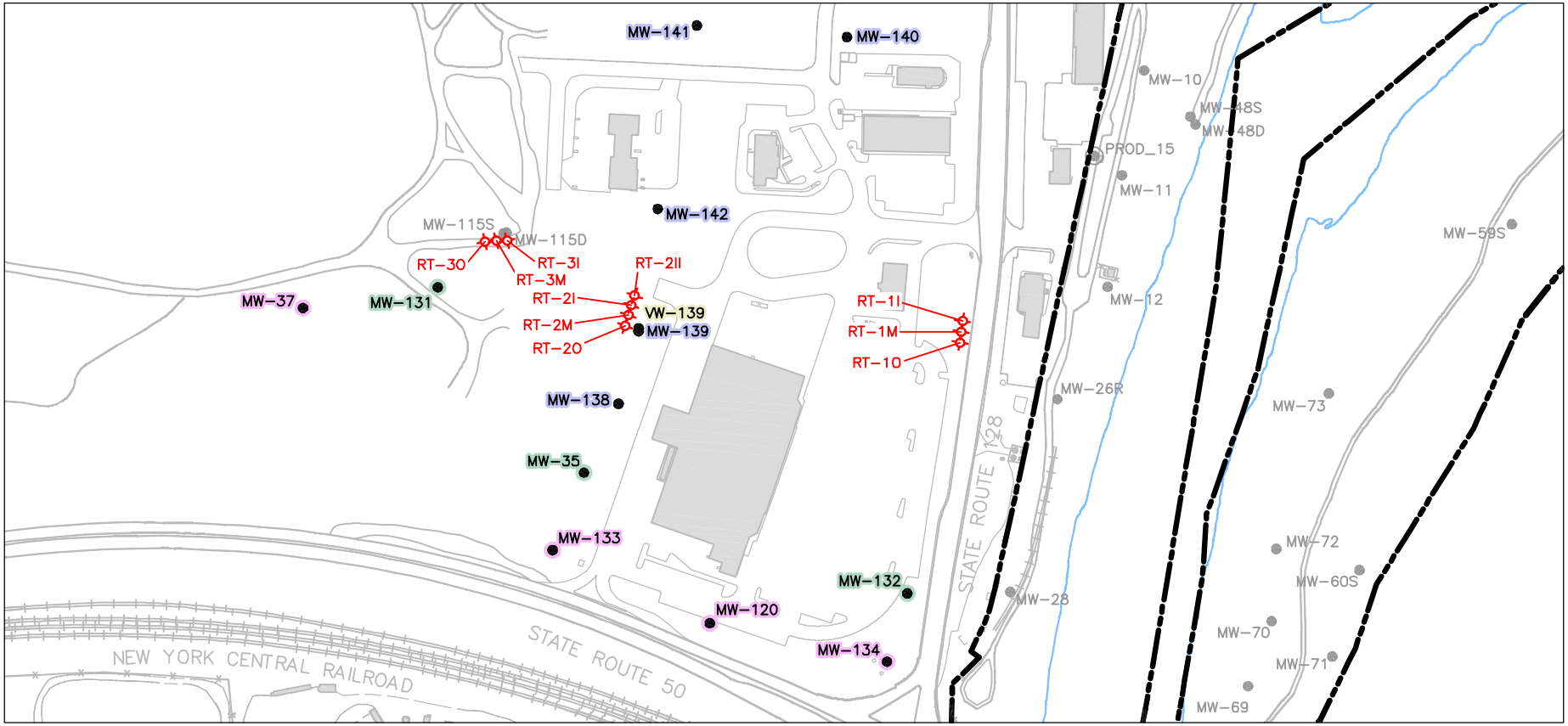
POTENTIOMETRIC SURFACE MAP
MAY 25, 2012

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: PM	Scale: 1" = 600'	Date: 12/7/12	File: May_25_2012_Potsurface.mxd

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT



EXPLANATION

RT-20, RT-2M, RT-2I — PERMANENT ROST TRANSECT AND DESIGNATION (I-INNER, M-MIDDLE, O-OUTER)

MW-138 — MONITORING WELL AND DESIGNATION (INSTALLED MARCH 2009)

MW-35 — SENTINEL MONITORING WELL AND DESIGNATION

MW-37 — POINT OF COMPLIANCE MONITORING WELL AND DESIGNATION

VW-139 — NESTED VAPOR WELL AND DESIGNATION

MW-47S — MONITORING WELL AND DESIGNATION

PROD_12 — PRODUCTION WELL AND DESIGNATION

SURFACE WATER

PROPERTY BOUNDARY

BUILDING, TANK OR OTHER STRUCTURE

N

0 300'

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FIGURE 2-5

SENTINEL, POINT OF COMPLIANCE, AND ROST MONITORING NETWORK

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: REP	Checked By: JP	Scale: 1"=300'	Date: 11/19/2010	File: 500ROST-TRANSECTS201210

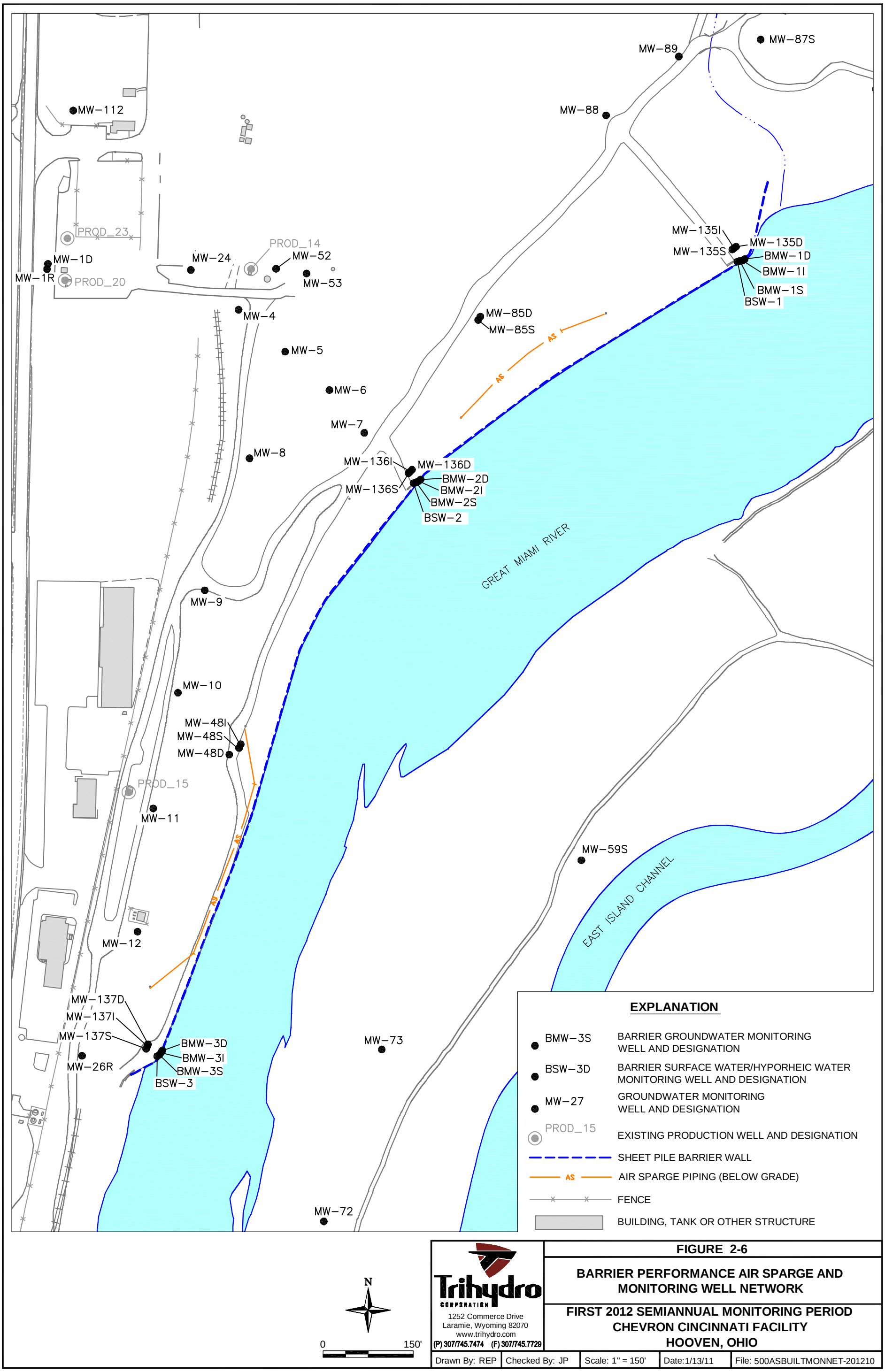

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FIGURE 2-6

BARRIER PERFORMANCE AIR SPARGE AND MONITORING WELL NETWORK

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: REP	Checked By: JP	Scale: 1" = 150'	Date:1/13/11	File: 500ASBUILTMONNET-201210

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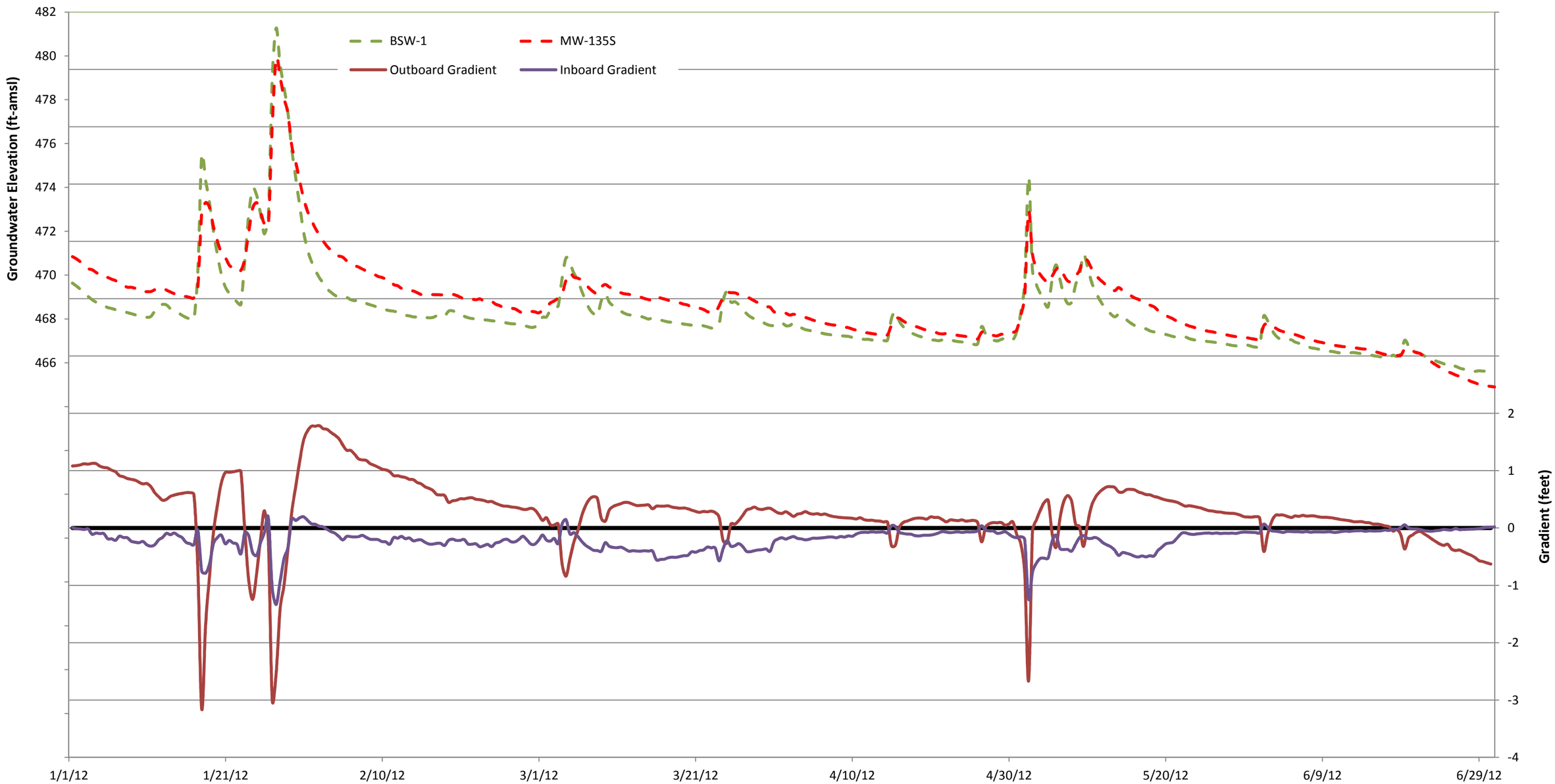
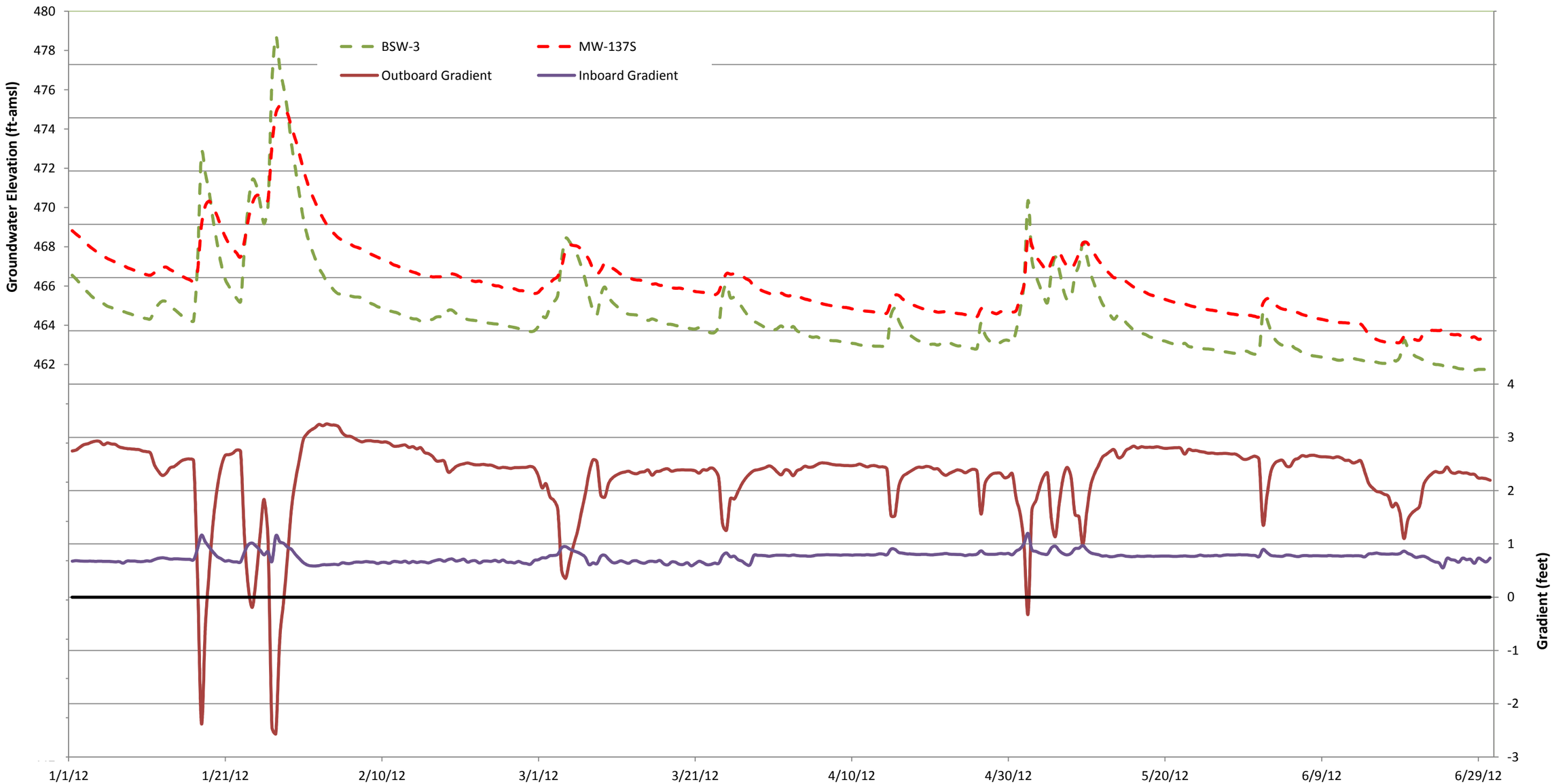
FIGURE 2-7. BARRIER WALL NORTH TRANSECT VERTICAL GRADIENTS
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION
Outboard Gradient - Groundwater elevation at BMW-1D minus the surface water elevation at BSW-1.
Inboard Gradient - Groundwater elevation at MW-135D minus the groundwater elevation at MW-135S.
Upward vertical gradient shown as positive values, downward vertical gradient shown as negative values.

US EPA ARCHIVE DOCUMENT

FIGURE 2-8. BARRIER WALL SOUTH TRANSECT VERTICAL GRADIENTS
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION
Outboard Gradient - Groundwater elevation at BMW-3D minus the surface water elevation at BSW-3.
Inboard Gradient - Groundwater elevation at MW-137D minus the groundwater elevation at MW-137S.
Upward vertical gradient shown as positive values, downward vertical gradient shown as negative values

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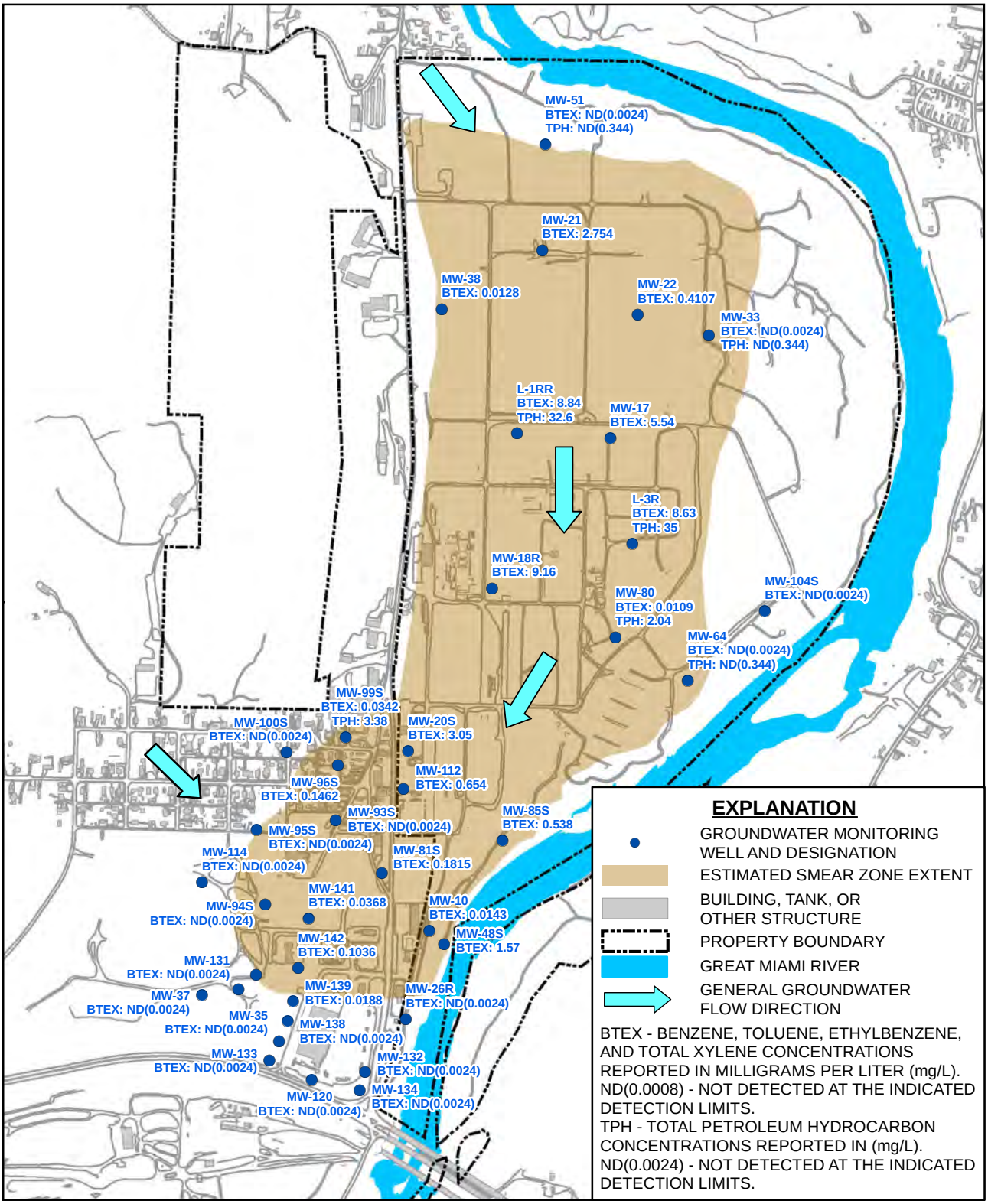

N

0 1,000'

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FIGURE 3-1

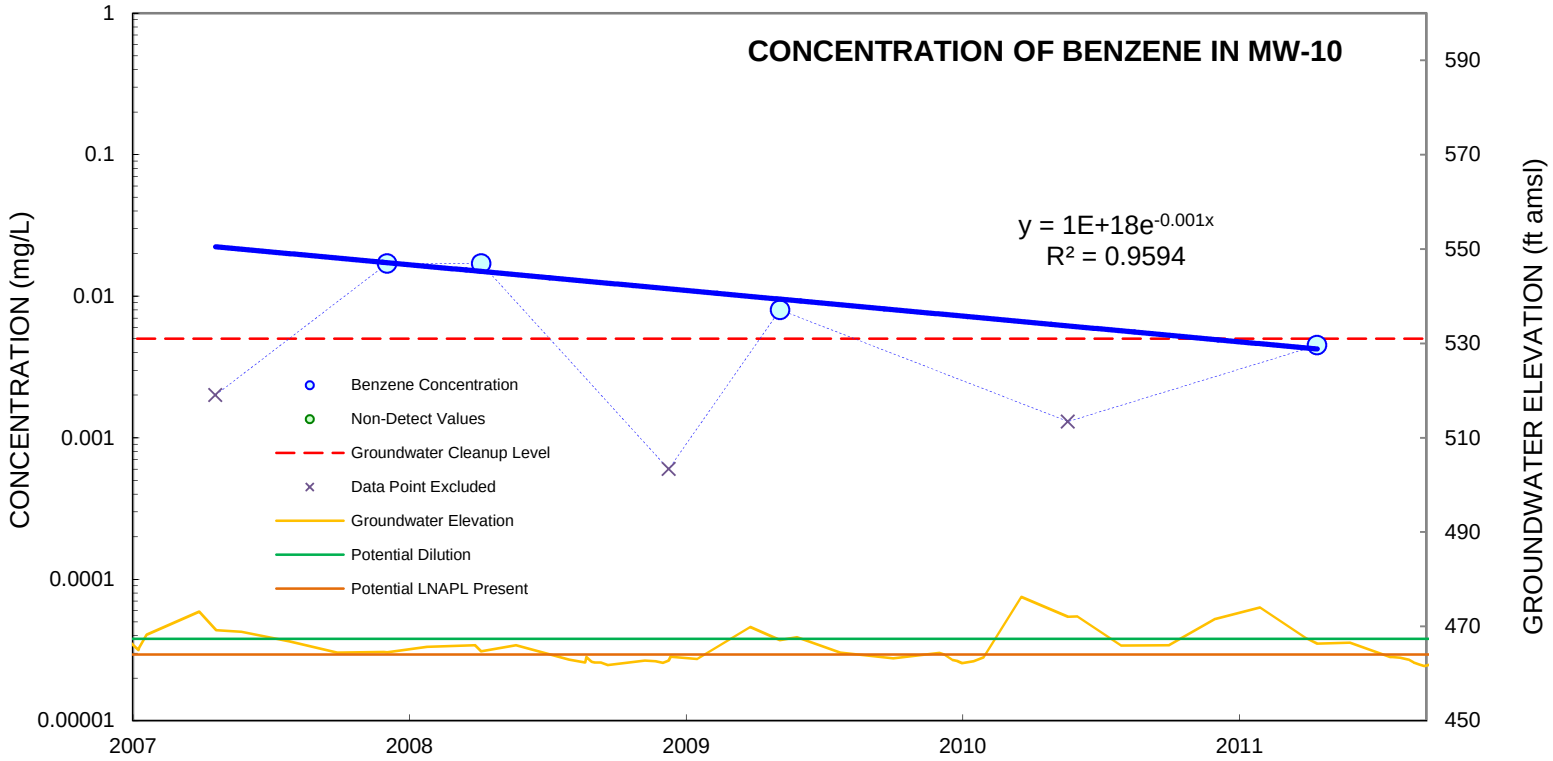
DISSOLVED PHASE CONSTITUENT CONCENTRATIONS

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: JP	Scale: 1" = 1000'	Date: 11/9/12	File: 2012_QI_TPHTrends.mxd

US EPA ARCHIVE DOCUMENT

FIGURE 3-2. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-10
FIRST 2012 SEMIANNUAL MONITORNG PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

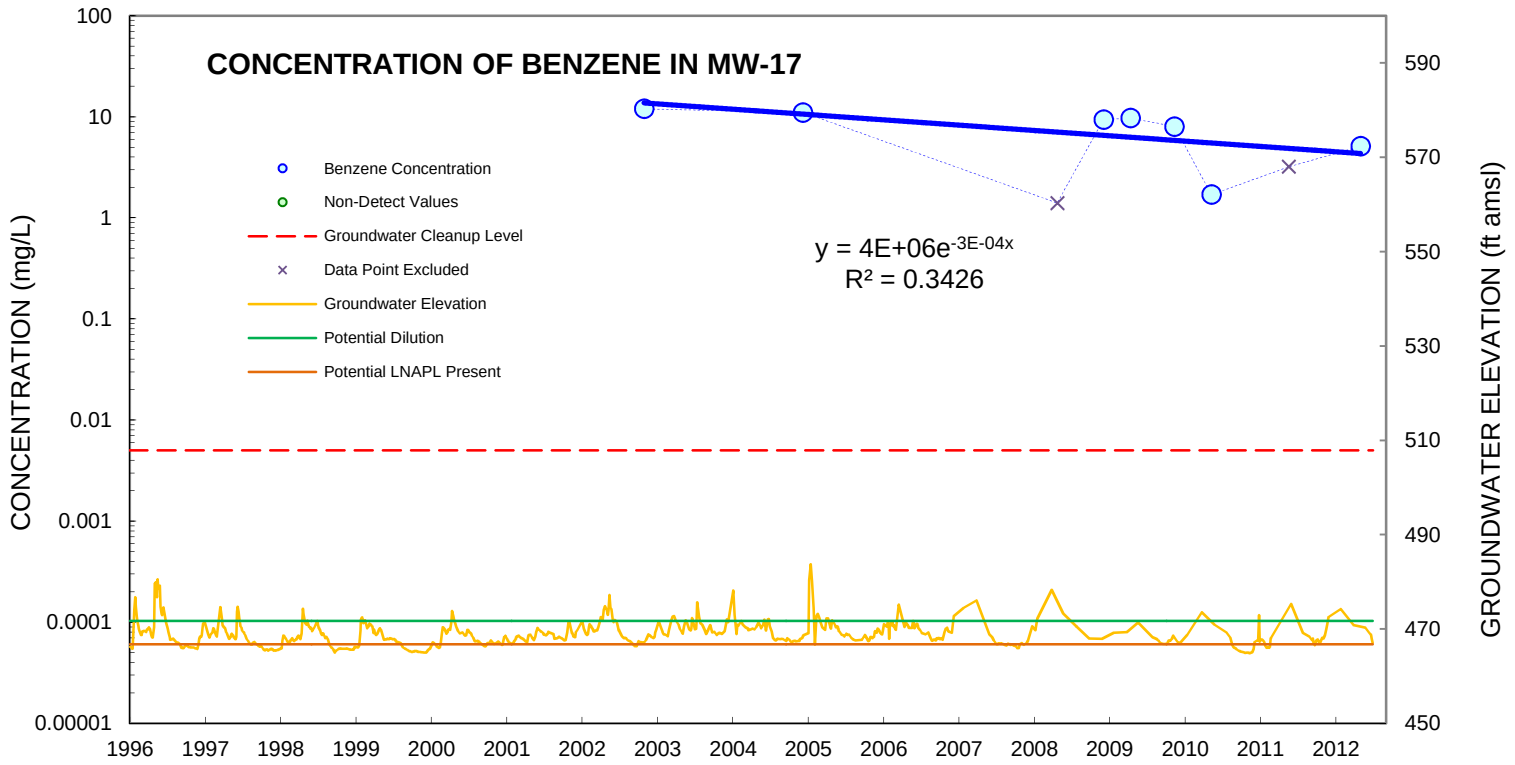
THREE DATA POINTS EXCLUDED (4/18/08, 12/07/09, and 5/18/11)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-3. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-17
FIRST 2012 SEMIANNUAL MONITORNG PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

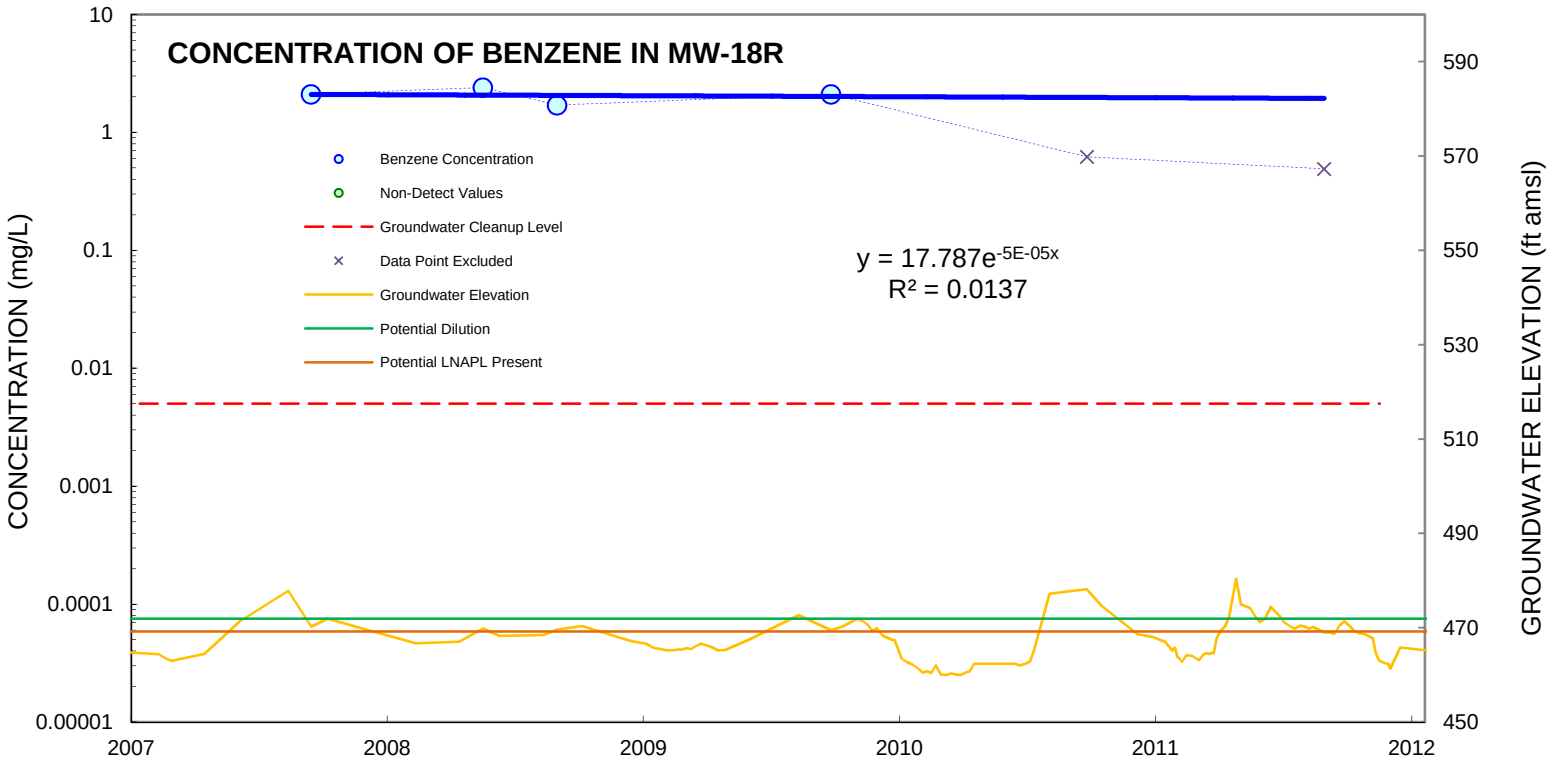
TWO DATA POINTS EXCLUDED (4/23/08 and 5/19/11)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-4. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-18R
FIRST 2012 SEMIANNUAL MONITORNG PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

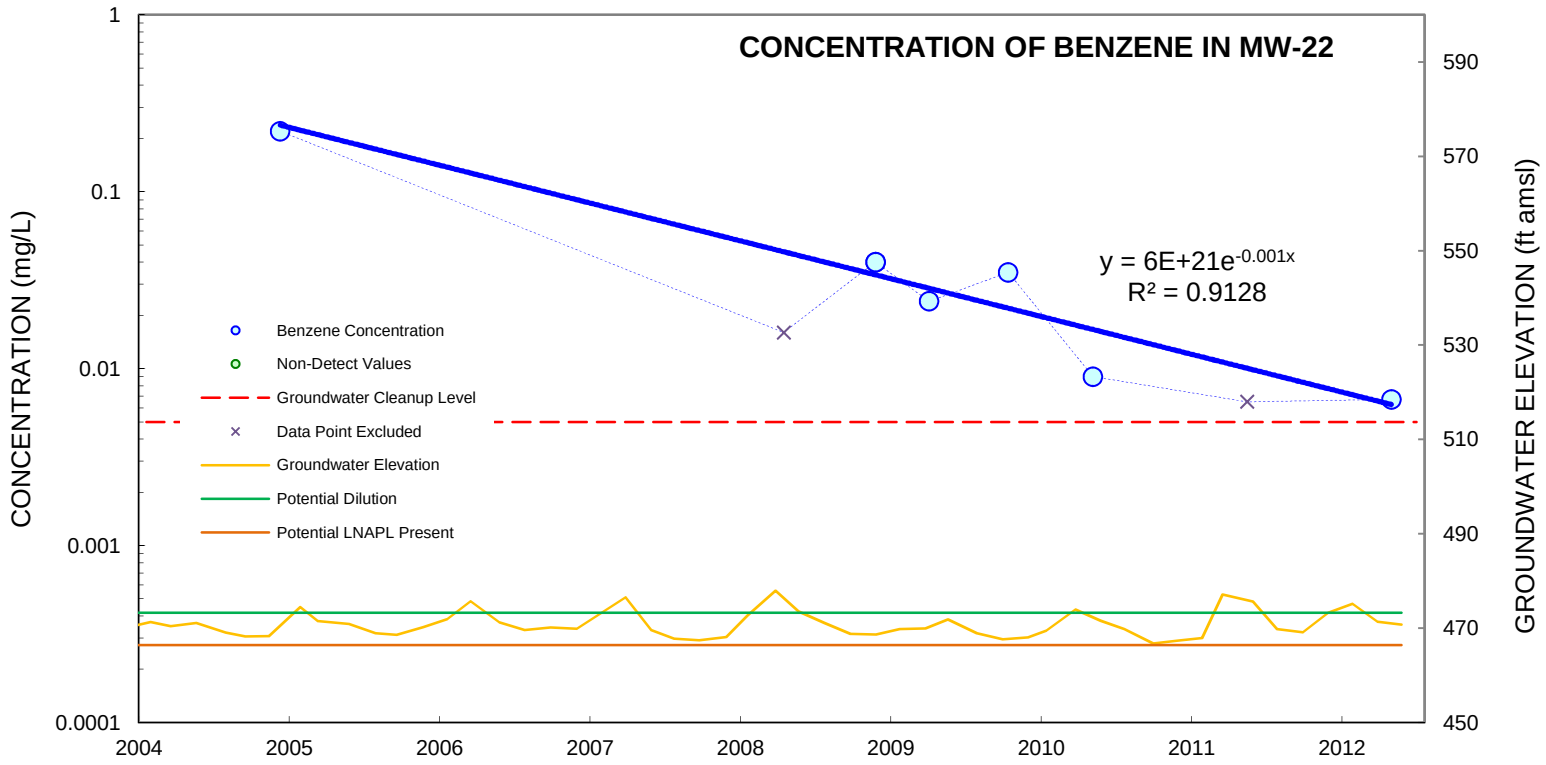


EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.
TWO DATA POINTS EXCLUDED (5/10/11 and 4/12/12)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-5. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-22
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

TWO DATA POINTS EXCLUDED (4/16/08 and 5/16/11)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

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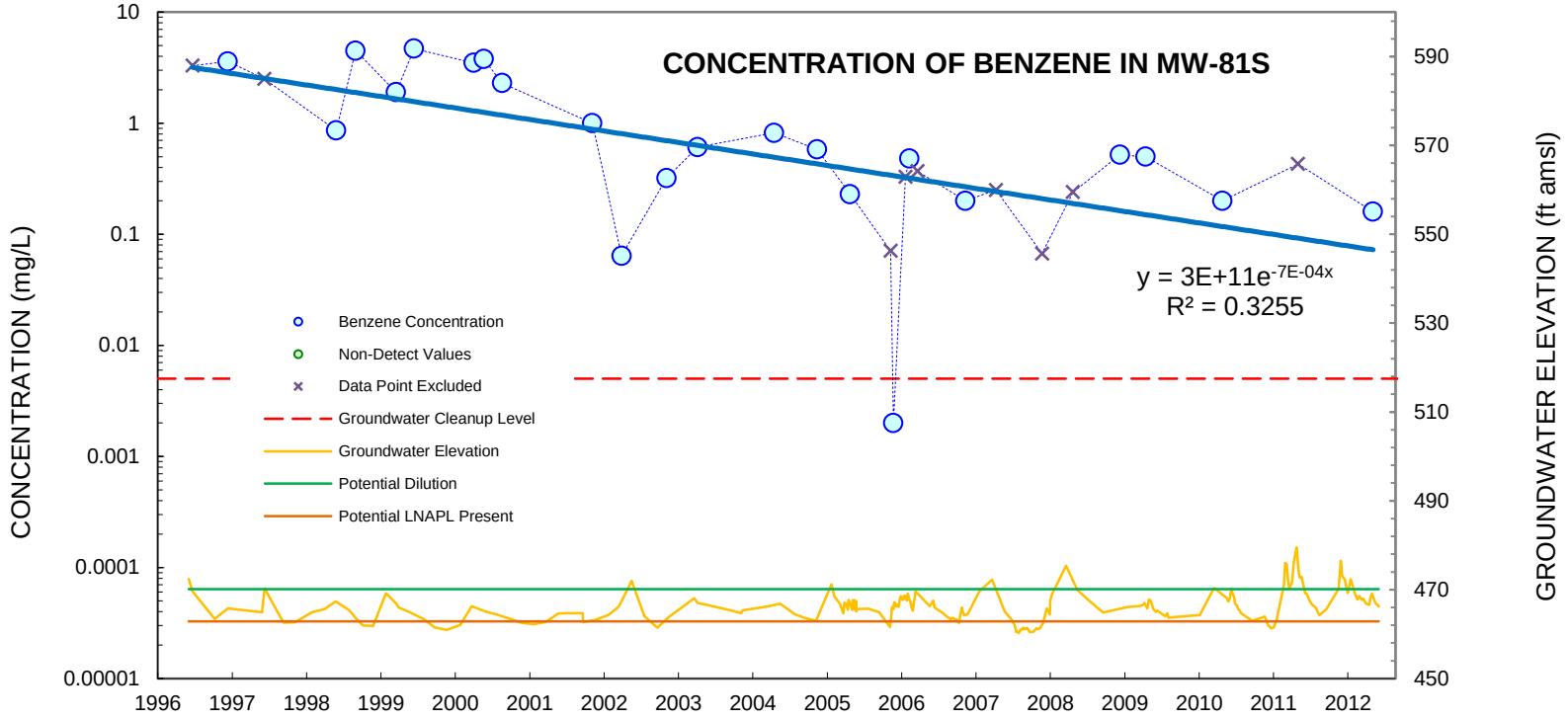
FIGURE 3-6. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-81S
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

NO ANALYTICAL DATA AVAILABLE FOR FALL 2009 BECAUSE LNAPL WAS PRESENT IN THE WELL.

NINE DATA POINTS EXCLUDED (6/20/96, 6/9/97, 11/15/05, 1/27/06, 3/27/06, 4/17/07, 11/30/07, 4/30/08 and 5/12/11)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

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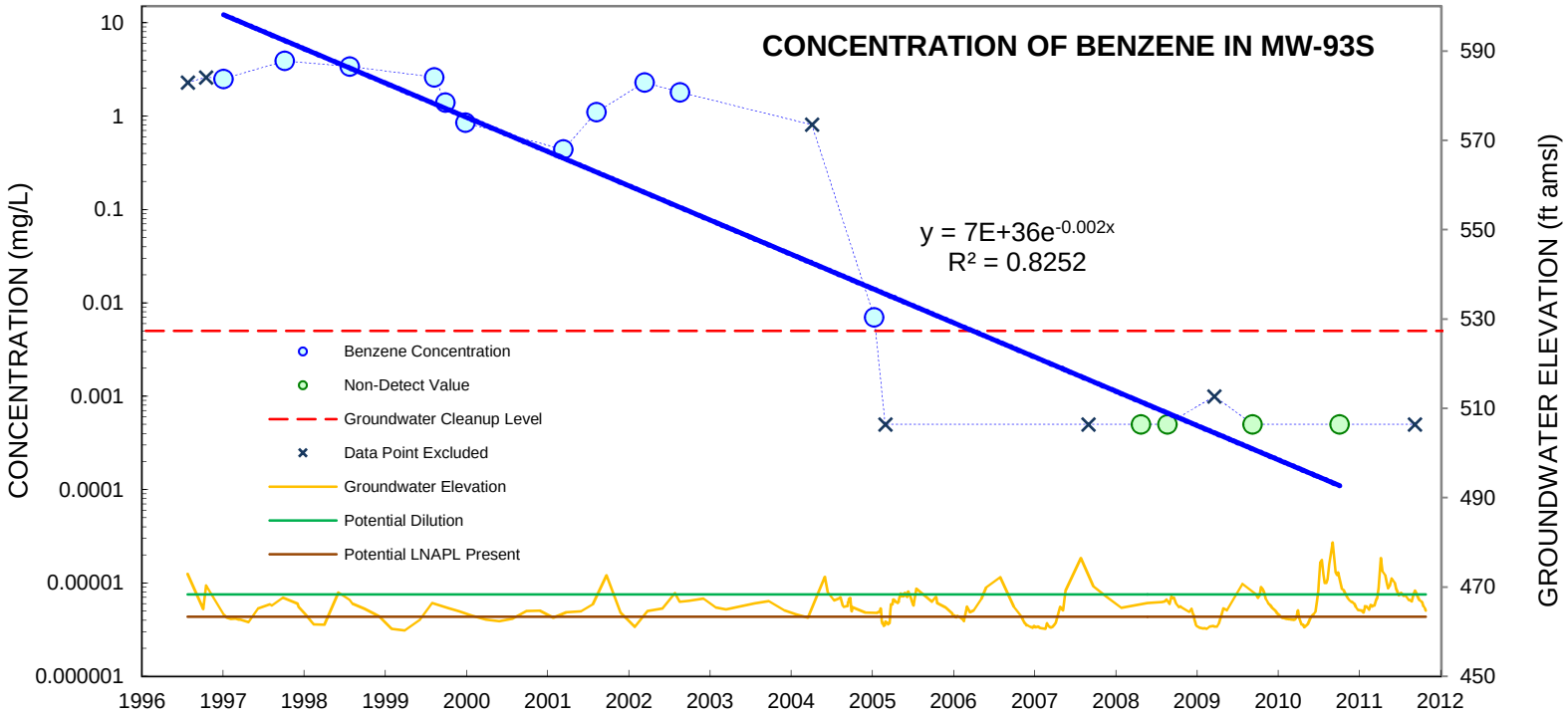
FIGURE 3-7. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-93S
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

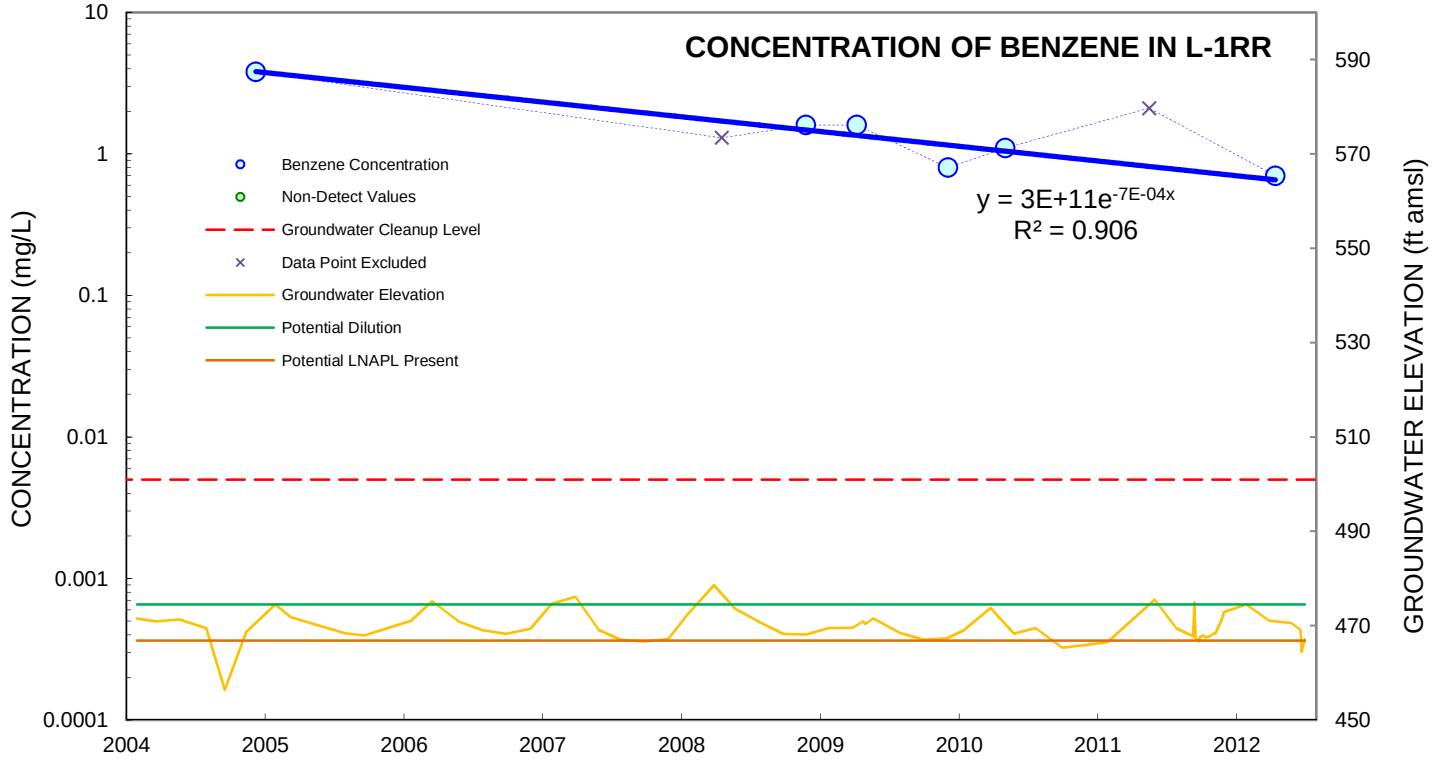
SEVEN DATA POINTS EXCLUDED (3/18/97, 6/9/97, 11/30/04, 10/27/05, 4/30/08, 11/19/09, and 5/10/12)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-8. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL L-1RR
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

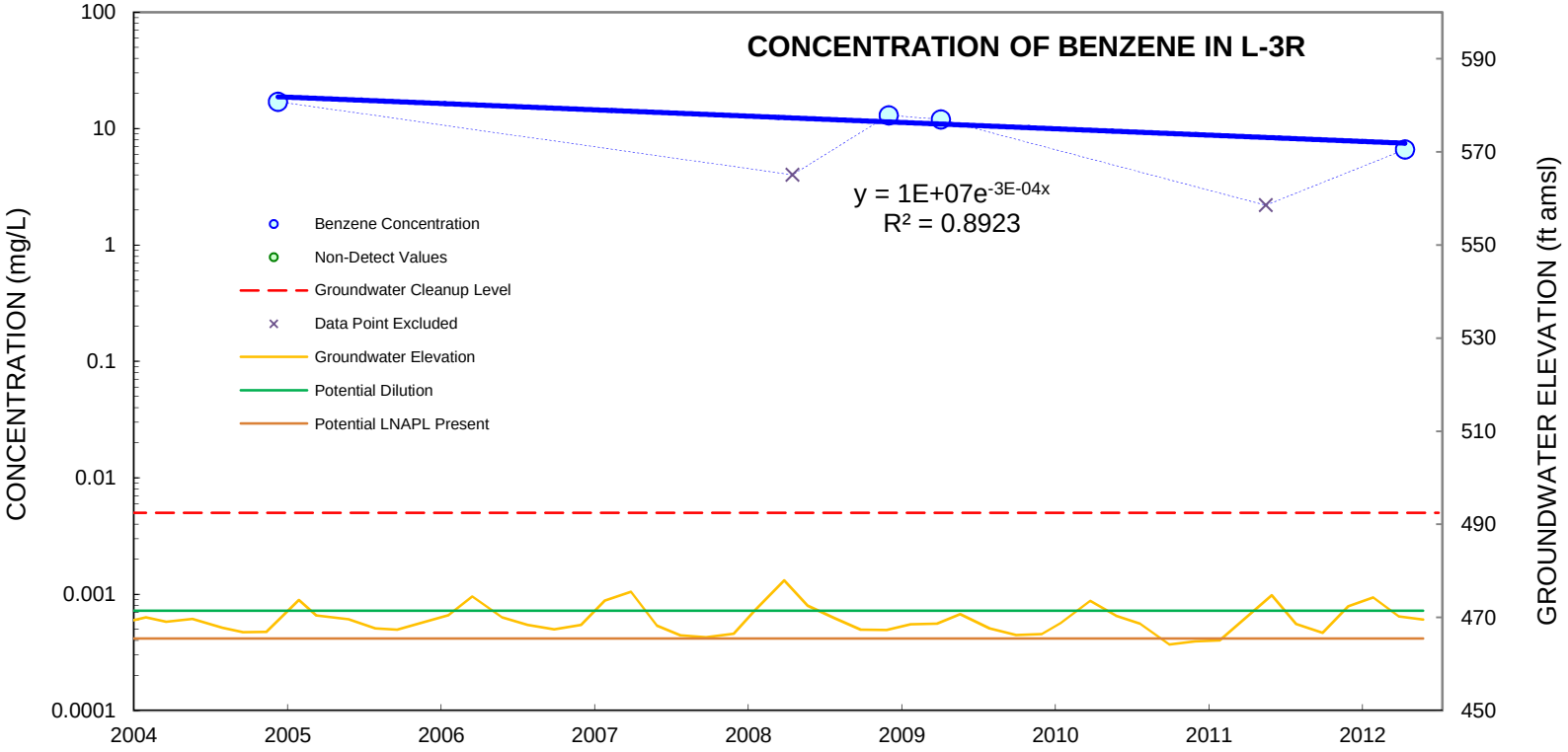


EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION.
TWO DATA POINTS EXCLUDED (4/17/08 and 5/16/11)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-9. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL L-3R
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

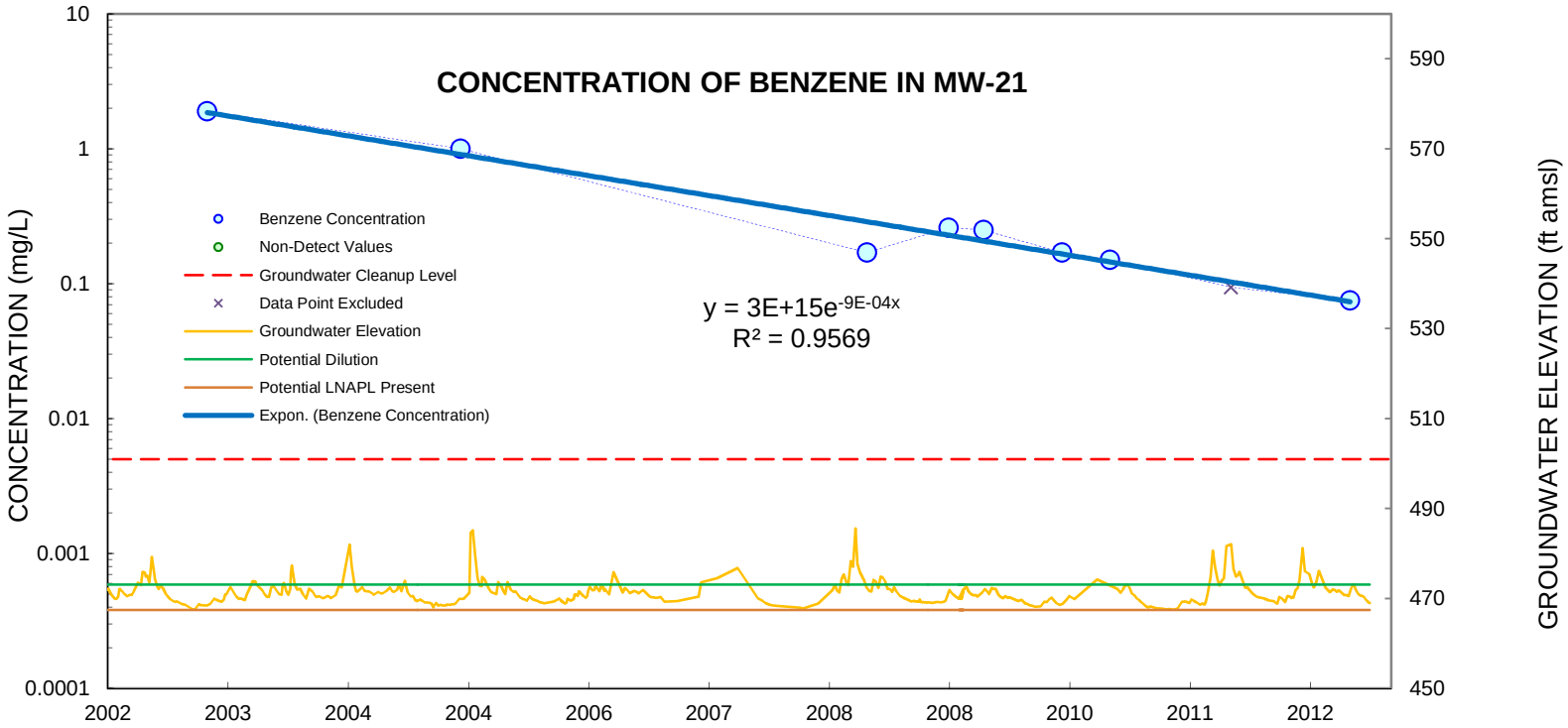


EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.
NO ANALYTICAL DATA AVAILABLE FOR FALL 2009 OR SPRING 2010 DUE TO LNAPL PRESENCE IN WELL.
TWO DATA POINTS EXCLUDED (4/16/08 and 5/16/11)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-10. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-21
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

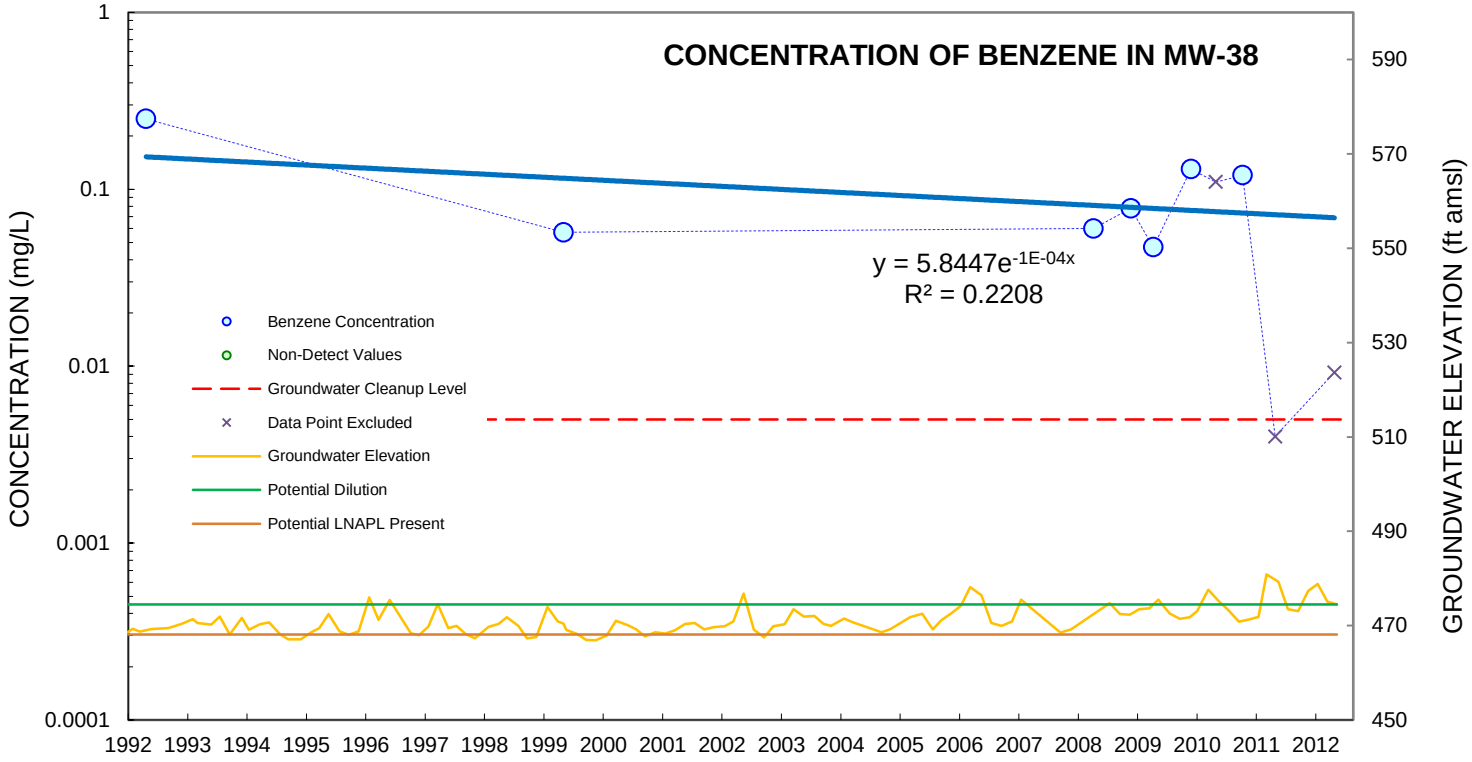


EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.
ONE DATA POINT EXCLUDED (5/5/11)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-11. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-38
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

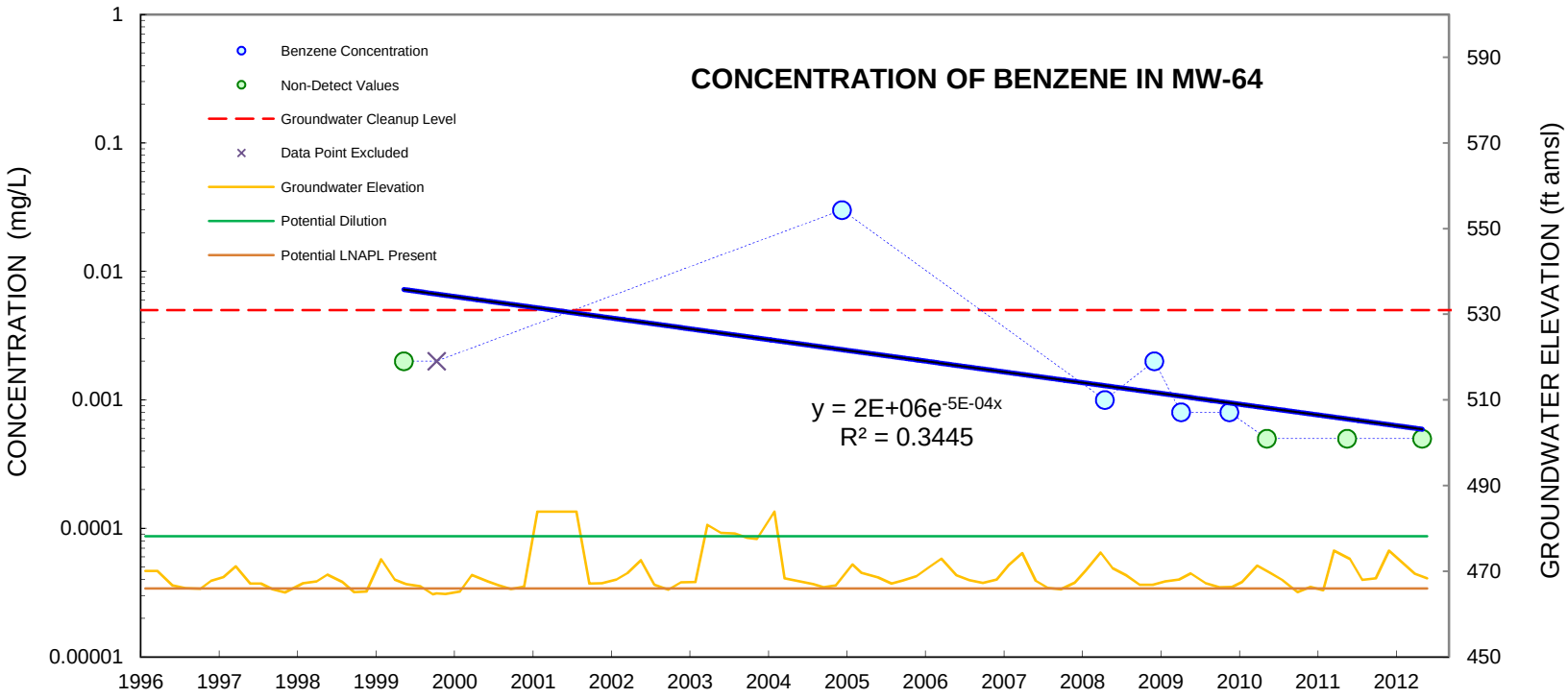
THREE DATA POINTS EXCLUDED (5/10/10, 5/11/11, and 5/9/2012)

FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-12. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-64
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

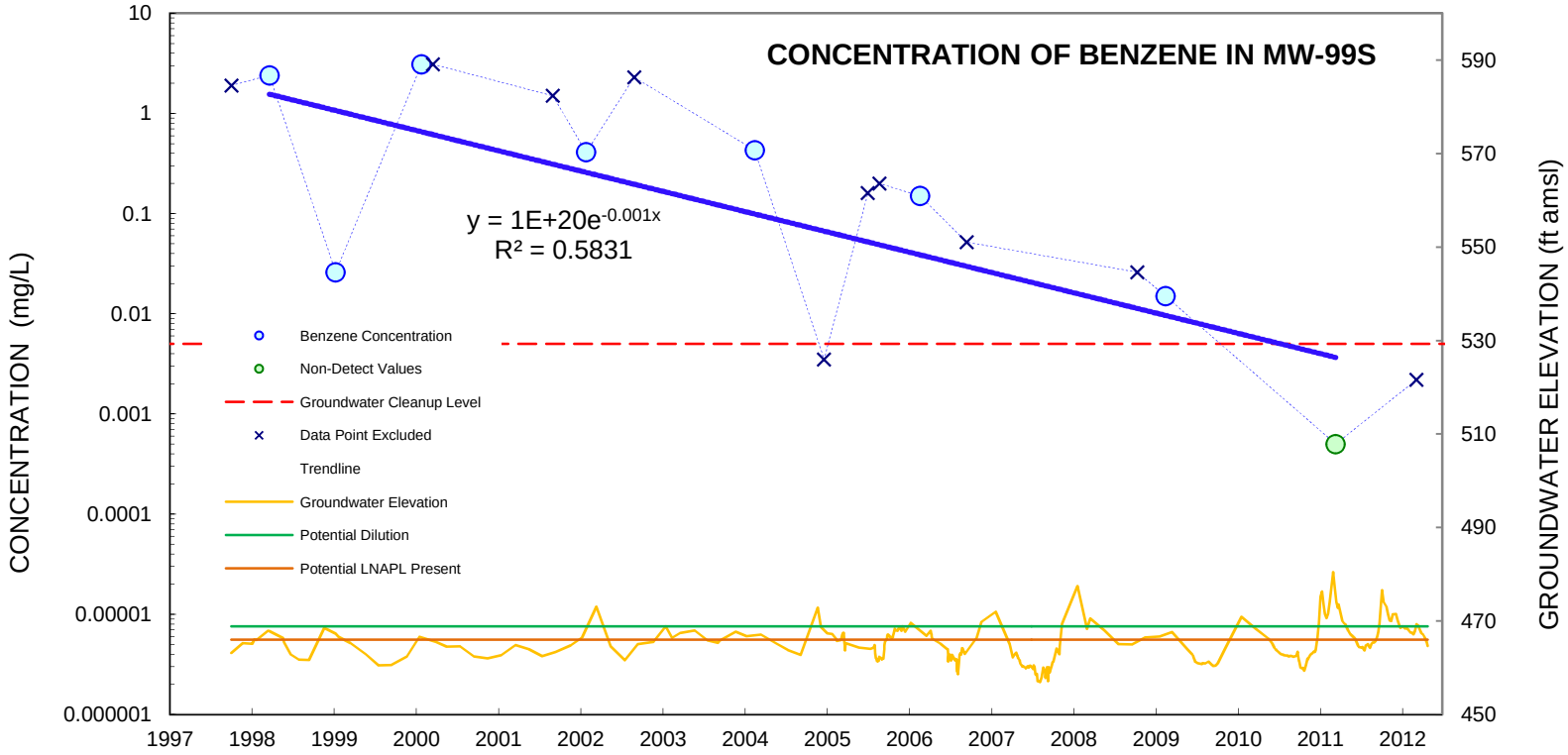


EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.
ONE DATA POINT EXCLUDED (10/12/99)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-13. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-99S
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

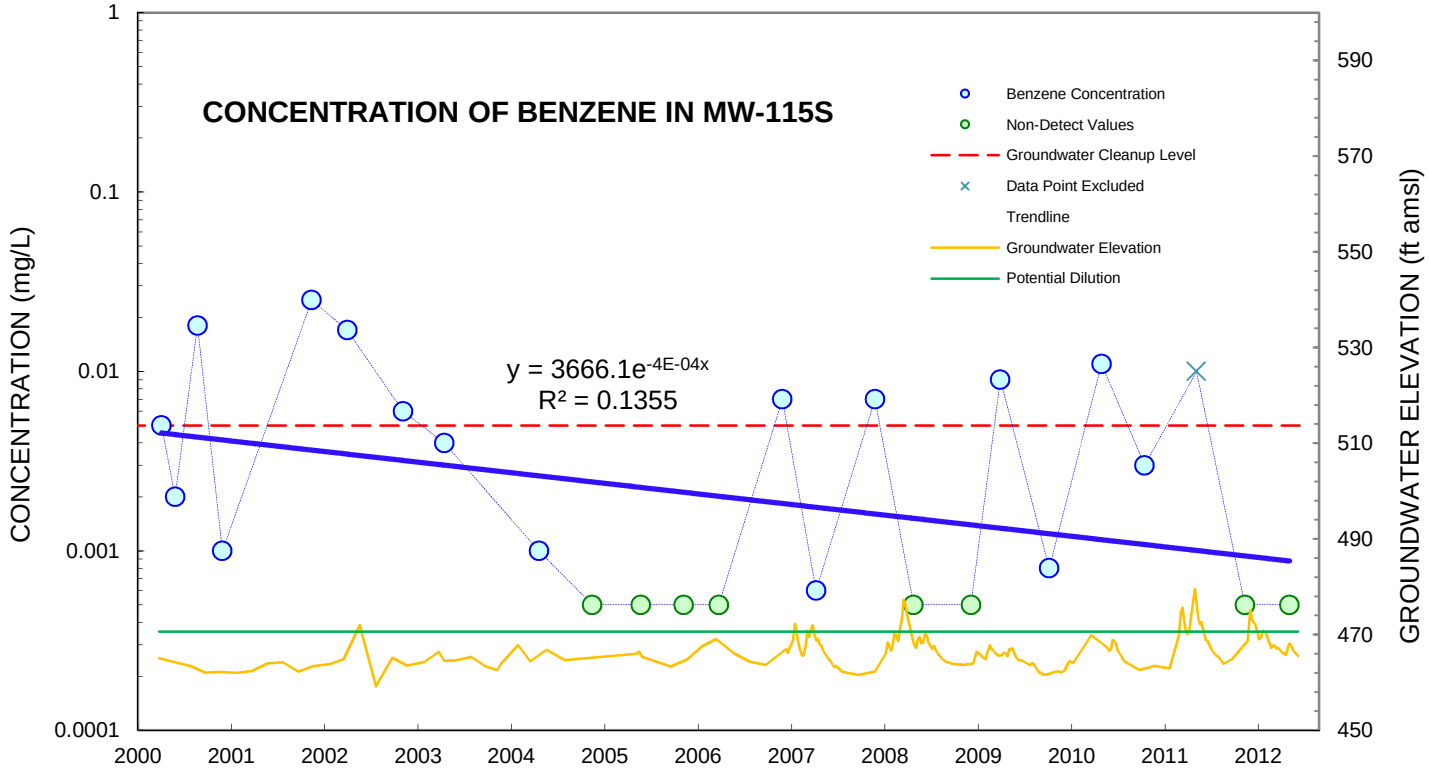


EXPLANATION:

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.
TEN DATA POINTS EXCLUDED (12/10/97, 5/23/00, 11/7/01, 11/4/02, 2/24/05, 9/7/05, 10/28/05, 11/20/06, 12/17/08, and 5/10/12).
WELL NOT SAMPLED IN SPRING 2010 DUE TO LNAPL PRESENCE IN WELL.
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

US EPA ARCHIVE DOCUMENT

FIGURE 3-14. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-115S
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



EXPLANATION

WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION.
ONE DATA POINTS EXCLUDED (5/11/11)
FT AMSL - FEET ABOVE MEAN SEA LEVEL
mg/L - MILLIGRAMS PER LITER

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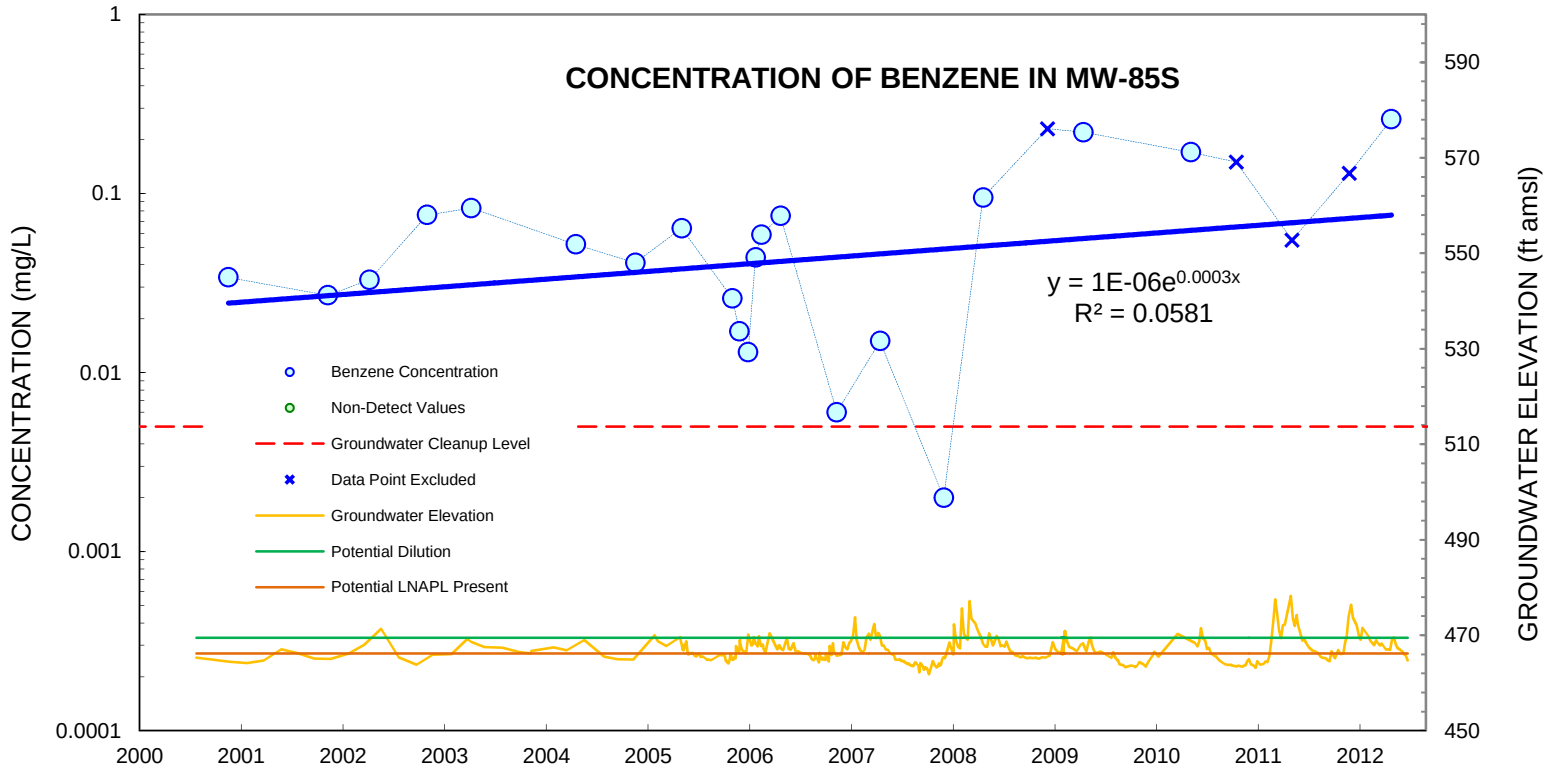
FIGURE 3-15. GROUNDWATER CONSTITUENT CONCENTRATIONS VERSUS TIME, MONITORING WELL MW-85S
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



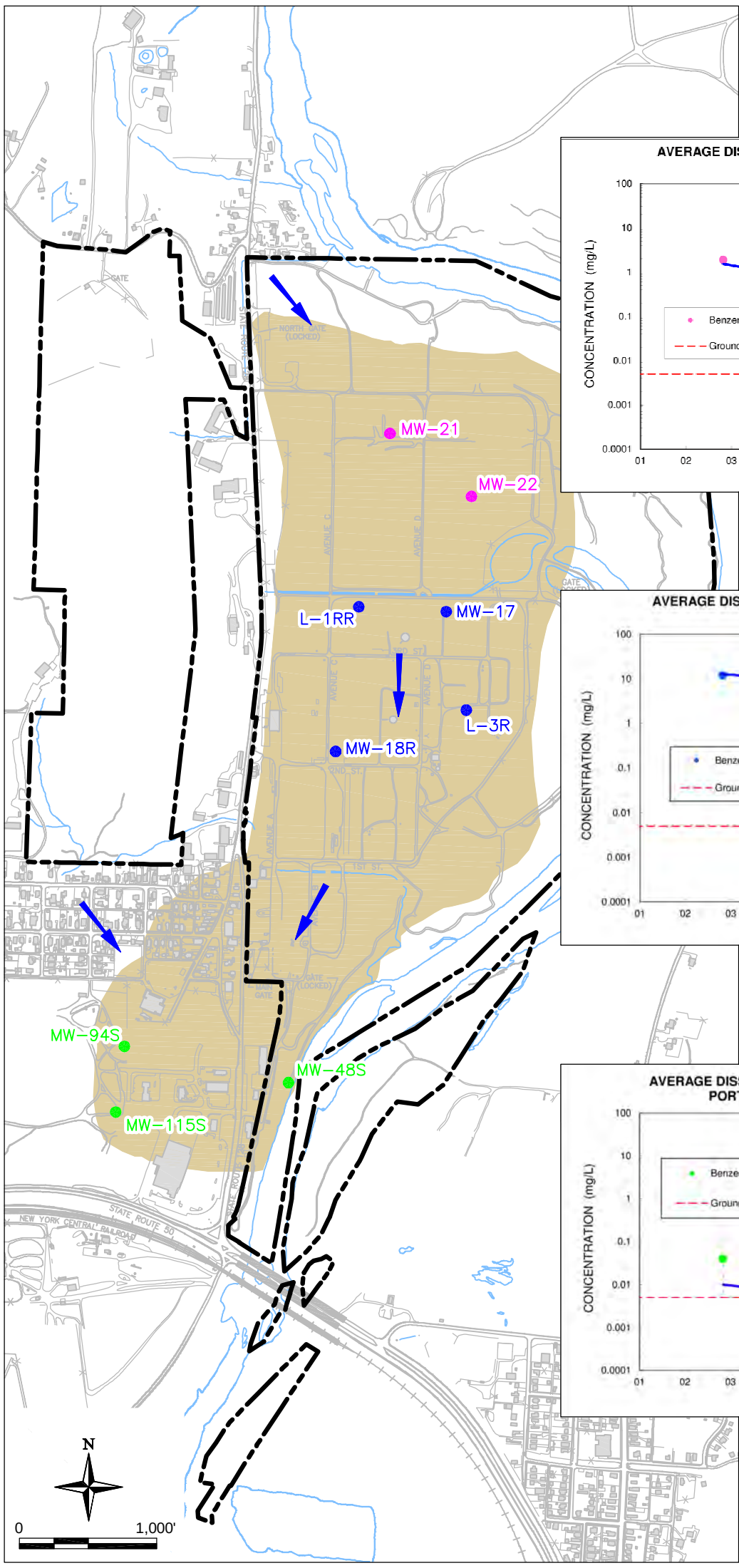
EXPLANATION

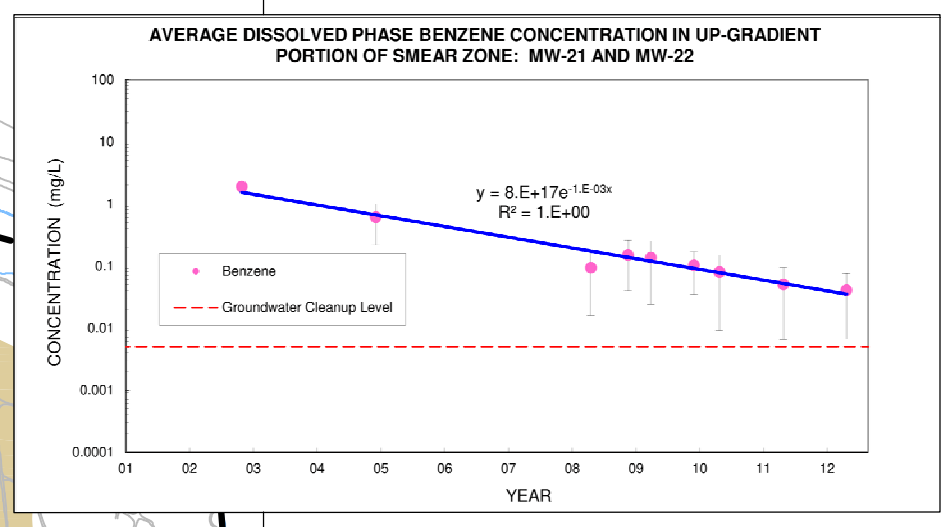
WATER LEVELS PRESENTED FOR POSSIBLE EXCLUSION OF DATA POINTS BASED ON POTENTIAL DILUTION OR PRESENCE OF LNAPL.

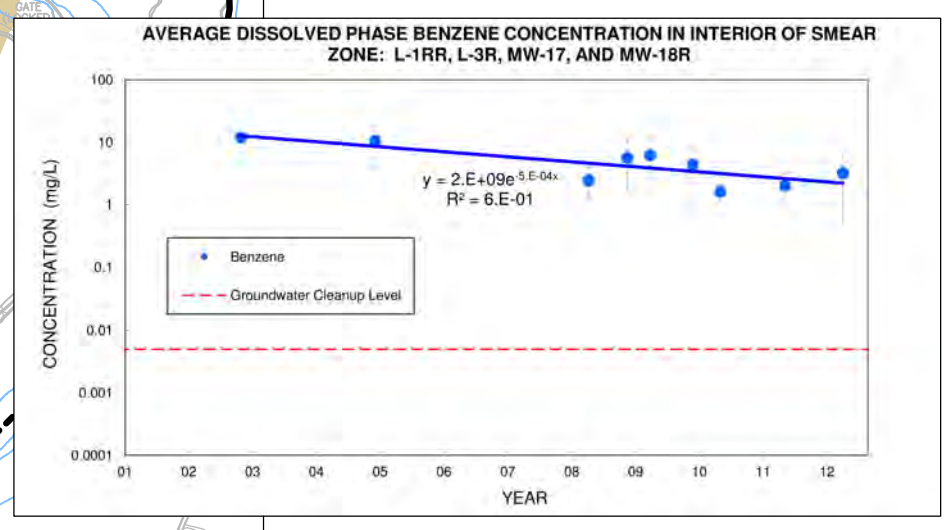
FOUR DATA POINTS EXCLUDED (12/11/08, 10/21/10, 5/10/11, and 12/2/11)

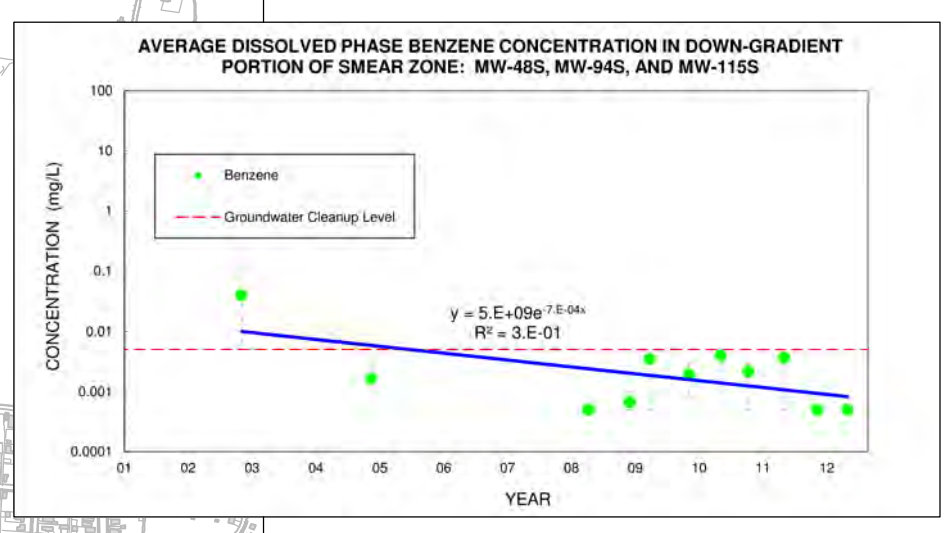
FT AMSL - FEET ABOVE MEAN SEA LEVEL

mg/L - MILLIGRAMS PER LITER









EXPLANATION

- MW-22 — UPGRADIENT MONITORING WELL AND DESIGNATION
- MW-17 — INTERIOR MONITORING WELL AND DESIGNATION
- MW-48S — DOWNGRADIENT MONITORING WELL AND DESIGNATION
- PROPERTY BOUNDARY
- SURFACE WATER
- GROUNDWATER CLEANUP LEVEL (USEPA MCL)
- GENERAL GROUNDWATER FLOW DIRECTION
- BUILDING, TANK OR OTHER STRUCTURE
- SMEAR ZONE

NOTES:

1. ERROR BARS REPRESENT MINIMUM AND MAXIMUM CONCENTRATIONS MEASURED DURING SAMPLING EVENT.
2. NON-DETECT CONCENTRATIONS SET TO REPORTING LIMIT FOR AVERAGING.
3. SAMPLING EVENTS DISPLAYED: FALL 2002, FALL 2004, SPRING 2008, FALL 2008, SPRING 2009, FALL 2009, SPRING 2010, FALL 2010, SPRING 2011, FALL 2011, AND SPRING 2012.

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FIGURE 3-16

AVERAGE DISSOLVED PHASE BENZENE TRENDS ACROSS THE SMEAR ZONE

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY,
HOOVEN, OHIO

Drawn By: REP	Checked By: MM	Scale: AS SHOWN	Date: 11/2/12	File: 500SPATIO201210

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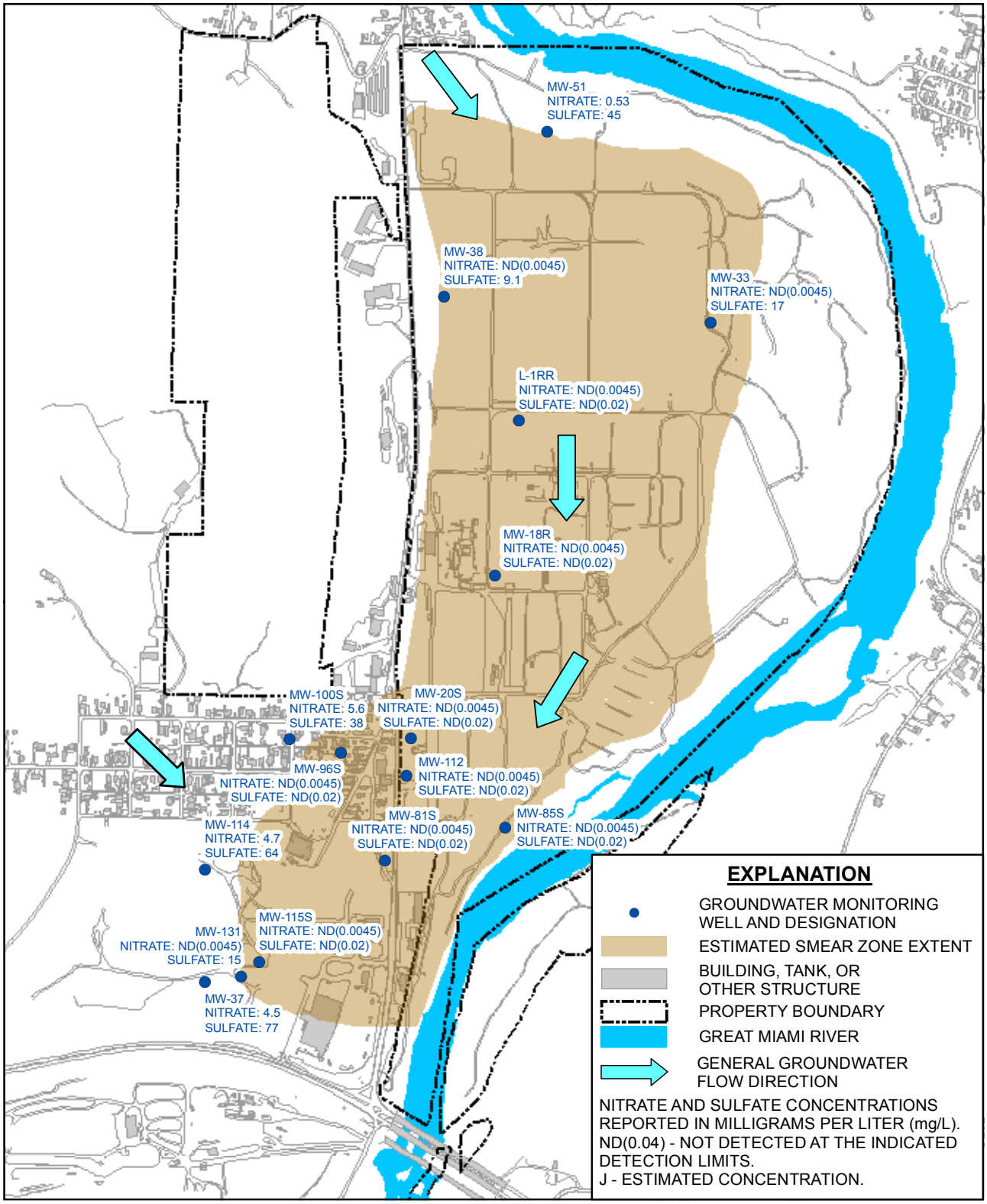

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FIGURE 3-17

DISSOLVED PHASE NITRATE AND SULFATE CONCENTRATIONS

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: JP	Scale: 1" = 1000'	Date: 11/16/12	File: 2012_QI_EAccept_OxTrends.mxd

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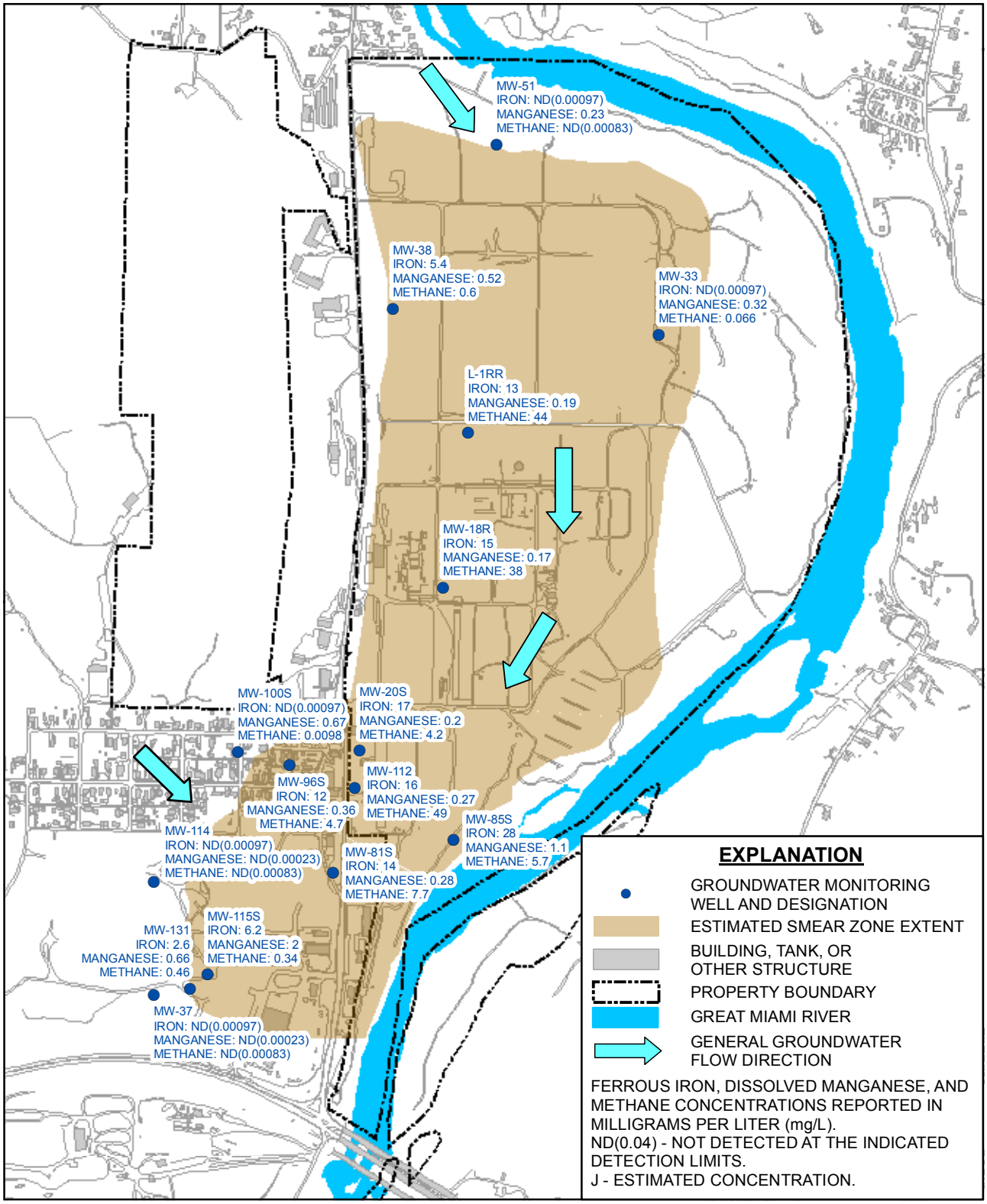

N

0 1,000'

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FIGURE 3-18

DISSOLVED PHASE IRON, MANGANESE, AND AND METHANE CONCENTRATIONS

FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY
HOOVEN, OHIO

Drawn By: JDF	Checked By: JP	Scale: 1" = 1000'	Date: 11/16/12	File: 2012_QI_EAccept_RedTrends.mxd

FIGURE 3-19. DISSOLVED PHASE BENZENE AND HYDROGEOCHEMICAL SUMMARY VERSUS DISTANCE
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

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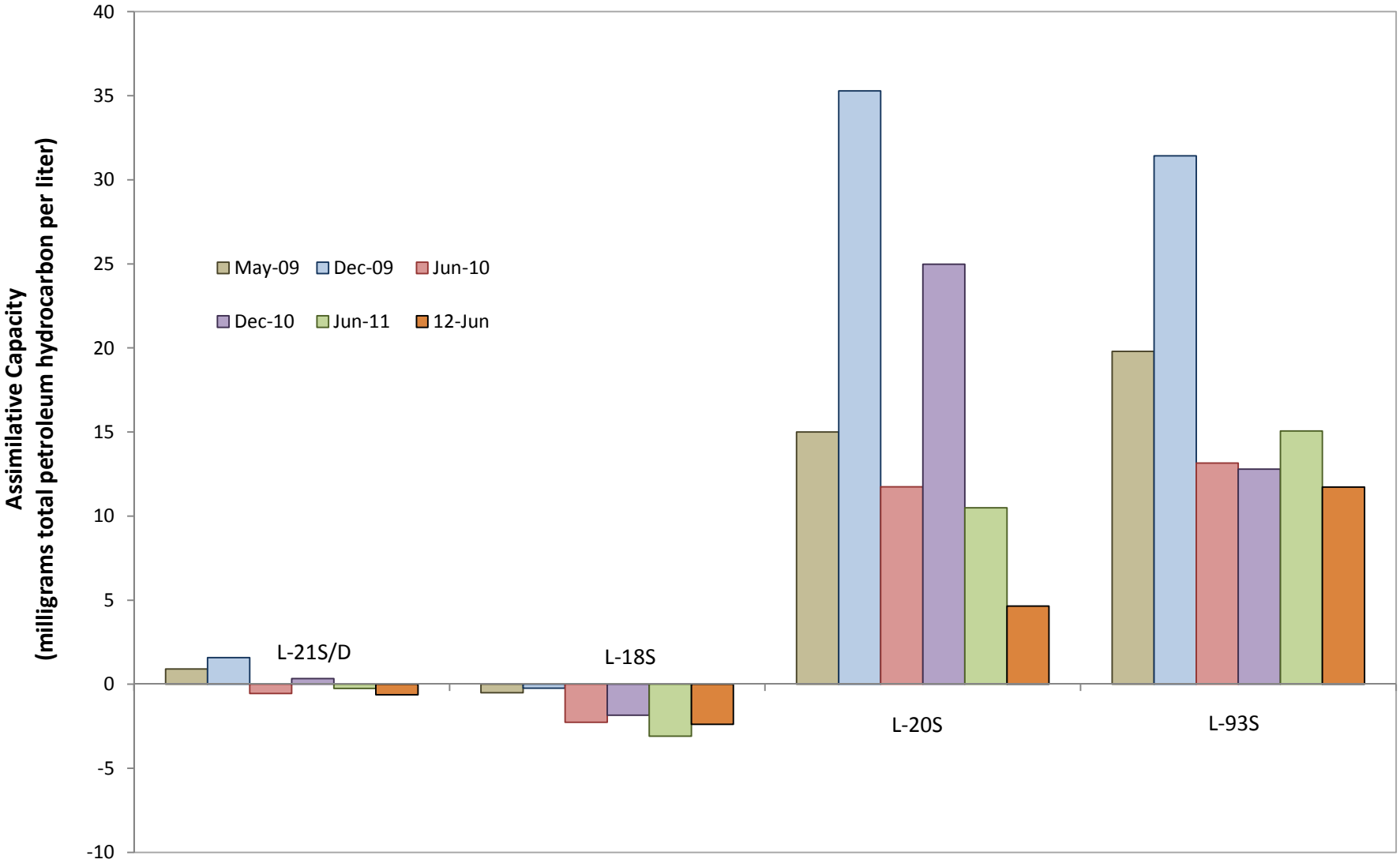
FIGURE 3-20. PORE WATER ASSIMILATIVE CAPACITY OVER TIME
FIRST 2012 SEMIANNUAL MONITORING PERIOD
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO



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APPENDICES A THROUGH F

(PLEASE SEE ATTACHED CD)