ReSolution Partners, LLC

Remediation Work Plan

Former Harman-Becker Automotive Systems, Inc.
1201 South Ohio St., Martinsville, Indiana
IDEM Project Site # 1998-06-183

April 2014

Prepared by:

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ReSolution Partners, LLC

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Executive Summary

ReSolution Partners, LLC has prepared this Remediation Work Plan (RWP) on behalf of the Ecolonomic Realty Group (ERG) for the former Harman-Becker facility located in Martinsville, Indiana (the Site). This work is being performed under the Indiana Department of Environmental Management (IDEM) State Cleanup Program, IDEM SCP # 1998-06-183.

The Site is currently owned by For Bare Feet, Inc., for the manufacturing of sportswear. Past operations that included the use of tetrachloroethene (PCE) and ketones resulted in volatile organic compound (VOC) impacts to soil and groundwater. While PCE is the primary potential contaminant, related breakdown compounds (i.e., trichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and chloroethene) and chlorinated ethanes have also been detected in soil and groundwater. Aromatic hydrocarbons have been present on the Site but investigations to-date have found no releases to the environment due to the historical use of hydrocarbons.

Site characterization conducted to-date has determined subsurface geologic characteristics and defined the nature and extent of impacts to soil and groundwater. Subsurface conditions consist of predominantly silt and clay to a depth of about 10 feet below ground surface (bgs). This is underlain by approximately 60 to 90 feet of sand and gravel that rests on shale bedrock. The water table is approximately 10 feet bgs, and the sand and gravel forms an aquifer with flow from east to west.

Soil impacts are limited in concentration and extent, and are below pavement or the building floor on the Site. An environmental restrictive covenant is proposed to eliminate and manage any potential exposures to soil.

Groundwater impacts extend off-site to the west in the direction of groundwater flow beneath an area of mixed commercial and residential property approximately parallel and beneath Poston Road. The western edge of the VOCs extends beneath farmland in the White River floodplain to the west of the City. VOCs are found near the water table immediately west of the Site, but a wedge of clean groundwater forms above the VOCs as precipitation infiltrates to the water table. Historical remedial actions have included air sparing and vapor extraction in the area of a release of ketones, engineered enhanced *in situ* reductive dechlorination in the area of a PCE release, and air sparging and vapor extraction of groundwater leaving the plant area.

There are no current potable water-supply wells affected by the VOCs in the groundwater. However, there are several shallow wells within the footprint of the VOC migration that provide groundwater for non-potable uses. A groundwater monitoring program and proposed environmental restrictive ordinance and covenants (ERO and ERCs) are proposed to mitigate potential future exposures to groundwater by potable and non-potable water-supply wells.

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Due to the volatile nature of PCE and its breakdown products to off gas into the unsaturated soil, assessment to determine the potential for vapor intrusion (VI) has been conducted both on-site and off-site. The on-site VI pathway has been determined to be complete and does not present any unacceptable risk to human health, even when a previously installed subsurface vapor mitigation system is not operating. Off-site VI investigation evaluations conducted to-date have also found the VI pathway to be complete and also does not present any unacceptable risk to human health, even when previously installed subsurface vapor mitigation systems in several homes near the Site are not operating.

This RWP presents an integrated remediation and exposure prevention strategy that incorporates historical mass removals of Site-related potential contaminants, prevents exposure to soil and groundwater, protects receptors, and provides for long term stewardship to manage remaining risk from residual potential contaminants. The objective of this RWP is to achieve a no-further-action (NFA) determination in accordance with a Site-specific, risk-based approach, as provided for in IDEM's Guidance, including the Remediation Closure Guide (RCG) guidance document, dated March 22, 2012 and updates to the RCG from March 2013; and H.E.A 1162, specifically including I.C. 13-25-5-8.5 (as amended). The release of hazardous substances and petroleum constituents that are addressed by, and is the subject of this RWP, covers the list of potential contaminants provided in the RWP. ERG is seeking an NFA with conditions subsequent that: (a) cover all the potential contaminants listed in the RWP; and, (b) covers the entire Site and areas off-site where potential contaminants have migrated or may potentially migrate in the future. This RWP accomplishes this strategy with the following key components:

1. ***Source Area Remediation*** – Previous remedial actions have destroyed the ketones and have reduced the mass of PCE in two source areas.

2. ***Vapor Intrusion Assessment*** – Investigations completed to-date have not found exposures to VOCs in air above screening levels both within the manufacturing building on the Site and within 22 residences and one church located above the VOCs in groundwater. This lack of exposure was determined when previously installed VI mitigation systems were not operating. The VOCs in soil and groundwater on the Site and groundwater to the west of the Site do not present any unacceptable risk to human health.

3. ***Engineering Controls*** –The Site plant floor likely contributes to the lack of current vapor exposure in the plant above acceptable screening levels and provides a barrier to direct contact with soil below the plant. The maintenance of the floor and appropriate management procedures for disturbance of the floor and underlying soil are addressed in a proposed ERC.

4. ***Groundwater Exposure Prevention*** – On-Site and Off-Site characterization conducted to-date has demonstrated that under current conditions, there are no completed exposure pathways between receptors and potable and non-potable groundwater exposures, soil vapor and soils at levels above specific screening levels published in the 2012 RCG. However, measures to ensure that presently incomplete pathways remain incomplete are necessary to ensure long-term protectiveness of the remedy within an Exposure Control Area (or ECA). For that portion of ECA that lies within the City Limits, the RWP proposes development of an Environmental Restrictive Ordinance (ERO) with the City of Martinsville that precludes certain future groundwater uses that have the potential to result in unacceptable exposures. Where the ECA extends beyond the City Limits individual property owners will be approached to place an Environmental Restrictive Covenant (ERC) on the property deeds.

   Groundwater use monitoring will be conducted in conjunction with a Long-Term Stewardship Plan and will include contingency plans for reasonable scenarios specifying procedures to be followed should groundwater use or land use change where the ERO and the ERCs are in effect.

5. ***Groundwater Monitoring*** - A groundwater monitoring program will track the extent and concentration of residual potential contaminants in groundwater and ensure that impacted groundwater does not migrate outside the Exposure Control Area within the City and the current extent in non-City properties. Groundwater monitoring will be conducted until analysis demonstrates understanding of plume behavior, or until groundwater concentrations decline to below residential screening levels or site-specific levels. As noted above, groundwater within the ECA is not used as a source of potable water. Non-potable groundwater use will be allowed in portions of the area where site-specific non-potable screening levels are met.

6. ***Long-Term Stewardship*** – A Long-Term Stewardship Plan will be developed as part of Site closure to document monitoring requirements, responsibilities, and contingency plans to ensure that pathways will remain incomplete or pose no risk. The Stewardship Plan will provide the technical details of how and by whom exposure prevention measures (e.g., land use monitoring, groundwater use monitoring, mitigation systems, etc.) that are selected in the RWP will be implemented, maintained, enforced, modified, and terminated. The Stewardship Plan will be executed as part of a legally enforceable instrument with IDEM.

The integrated remediation and exposure prevention approach detailed herein was developed to ensure long-term protectiveness in a manner that is consistent with the governing statute.

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1.0 Introduction

The industrial facility under consideration (the Site) is located at 1201 South Ohio Street, Martinsville, Morgan County, Indiana 46151. The approximate 21-acre site is located in a mixed residential, commercial, industrial area on the east site of Martinsville (Figure 1). The current building covers approximately 180,000 ft^2 and includes manufacturing, warehouse, and office areas. There are no basements or underground structures. Commercial activity began on the site in ca. 1948 and industrial operations began in 1955 and continued to the present day under several owners.

The first noted environmental investigations were undertaken in 1988 in response to surface water discharges. In 1995, the Harman-Becker Automotive Systems reported the presence of ketones and chlorinated ethenes in soil and groundwater. Several investigations and remedial actions have been completed over the last 18 years to address groundwater and vapor intrusion. These activities culminate in this Remediation Work Plan (RWP).

The RWP scope and content is guided by the Indian Department of Environmental Management (IDEM), including the Remediation Closure Guide (RCG) guidance document, dated March 22, 2012, and updates to the RCG by the IDEM Risk-based closure web page, http://www.in.gov/idem/4153.htm. The RWP applies risk-based remediation objectives as established by IC 13-25-5-8.5 (as amended), as provided for in IDEM's Guidance, including the RCG) as updated through March 2013.

ReSolution Partners issued On-Site and Off-Site Characterization Reports in June and July 2013, respectively. The IDEM provided comments on these reports in January 2014 (IDEM, January 2014a and IDEM January 2014b). Where appropriate, ReSolution Partners' responses to those comments are presented in highlighted boxes rather than in a separate response to comments.

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2.0 Remedial Action Objectives

2.1 Remedial Action Objectives

The goal of the remedial action is to prevent future exposures to residual chlorinated volatile organic compounds in groundwater beneath the former Harman-Becker Facility and in groundwater downgradient (to the west) of the Site within the ECA.

2.2 Remediation Strategy

Historical remedial actions have substantially reduced the concentrations of VOCs in on-site groundwater. However, residual VOC concentrations above RCG risk-based screening levels (IDEM, March 2012) remain in groundwater. Groundwater flow over the approximately 50 years since the potential earliest release of VOCs to the environment has resulted in VOC migration for a distance of at least 5,000 feet from the Site, completely crossing the City of Martinsville to undeveloped farmland between the City and the White River. Exposure pathways by non-potable uses are present but do not pose unacceptable risks. Potential exposure pathways by ingestion of groundwater are currently not present based on investigations completed to-date. Modeling (and recent groundwater sampling results) suggest the plume has reached an approximate steady-state with respect to migration. Natural attenuation processes are reducing the concentrations of VOCs in groundwater toward the RCG screening levels in the deep plume and the southern shallow plume. The northern, shallow plume migrates to the west under residential areas following the same path used by earlier releases for VOCs for the Site.

The groundwater monitoring data suggest that residual VOCs may be found in soil beneath the southeast corner of the plant. There is a potential for worker exposure if there are excavations below the plant.

Vapor intrusion studies in 2013 found no exceedances of conservative default commercial/industrial screening levels when existing mitigation systems were turned off. Those studies also found no consistent exceedances of conservative default vapor intrusion screening levels in residential settings during the summer of 2013 and the winter of 2014.

The remediation strategy consists of several parts as follows:

- An **Environmental Restrictive Covenant will be placed on the For Bare Feet property** to preclude potential exposure to soil contamination below portions of the facility. Future construction activities that extend into the soil will require environmental assessment and, if necessary, appropriate soil management plans will be developed and implemented. The ERC will also require that existing flooring will be maintained to preclude direct contact with soil and to mitigate vapor intrusion into the plant buildings.

- An **Environmental Restrictive Ordinance will be placed over appropriate portions of the VOC plume beneath the City** to preclude the installation of potable and non-potable water-supply wells for public or private uses that may result in future unacceptable human exposures. Discussions with the City have been initiated.

- An **Environmental Restrictive Covenant will be requested of the owners of the non-City property at 309 West Poston Road** to preclude the installation of additional potable and non-potable water-supply wells for public or private uses that may result in future unacceptable human exposures. If such a request is denied, an alternative plan will be developed for IDEM approval.

- An **Environmental Restrictive Covenant will be requested of the owners of the farmland between the City and the White River** to preclude the installation of potable and non-potable water-supply wells for public or private uses that may result in future unacceptable human exposures. If such a request is denied, an alternative plan will be developed for IDEM approval.

- A **Groundwater Monitoring Program** will be implemented to:

  - Confirm the continued degradation of the VOCs by natural attenuation;
  - Confirm that the VOCs are not migrating beyond the Exposure Control Area as defined by the ERO; and
  - Demonstrate an understanding of plume behavior or until groundwater concentrations decline to below residential screening levels.

- A **Vapor Intrusion Monitoring Plan** will be prepared if future groundwater monitoring shows increases in the VOC concentrations at the water table of a factor of four above the most recent groundwater results in the Clore Street neighborhood.

- A **Long-Term Stewardship Plan** will be developed as part of Site closure to document monitoring requirements, responsibilities, and contingency plans to ensure that pathways will remain incomplete or that completed pathways pose no risk. The Stewardship Plan will provide the technical details of how and by whom exposure prevention measures (e.g., land use monitoring, groundwater use monitoring, mitigation systems, etc.) that are selected in the RWP will be implemented, maintained, enforced, modified, and terminated. The Stewardship Plan will be executed as part of a legally enforceable instrument with IDEM.

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3.0 Background

3.1 Site Information

3.1.1 Location, Ownership, and Contacts

The industrial facility under consideration (the Site) is located at 1201 South Ohio Street, Martinsville, Morgan County, Indiana (T11N, R1E, Sec. 4; Lat. 39.414894, Long. 86.421096). The facility has been owned by For Bare Feet, Inc. since February 2014 when it began operations for the production of sportswear. A list of contacts for the Site project is provided here:

Site Owner:

Randy Bode, Plant Manager
For Bare Feet, Inc.
1201 South Ohio Street
Martinsville, IN 46151 E-mail: rbode@fbforiginals.com

Responsible Party (RP) for Remedial Action:

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Ecolonomic Realty Group
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Dillsburg, PA 17019 E-mail: s.alves@ecolonomicrealty.com

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David R. Gillay
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Indianapolis, IN 46040 E-mail: david.gillay@btlaw.com

Consultant for RP:

Bernd W. Rehm L.P.G. Mobile: 608.669.1249
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IDEM Project Manager:

Jeffrey J. Kavanaugh Office: 317.234.0970
Senior Environmental Manager E-mail: jkavanaugh@idem.in.gov
Voluntary Remediation Program
Indiana Dept. of Environmental Management
100 North Senate Avenue
Indianapolis, IN 46204

Martinsville Contact with respect to the ERO:

Robert Holloway
Holloway Engineering and Surveying
PO Box 234
Moorseville, IN 46158

Office: 800.831.7981

3.1.2 Facility Operational History

Cities Service Oil Company acquired the Site in 1948. Known industrial operations on the Site began in the mid-1950's. Heritage Environmental Services (HES, October 1995) noted that the Site has been occupied by a slaughterhouse and several manufacturing operations since the early 1950's as follows:

Unidentified slaughter house	late 1940's or early 1950's
Basco Aluminum	1955 (colored aluminum consumer products)
Twigg Corporation	1960 (aircraft engines)
Altamil Cabinet	1973 (residential cabinetry)
Essex Group, Inc. (UTC)	October 1975 (automotive and cabinet audio speakers)
Harman-Motive, Inc.	July 1981 (automotive audio speakers)
Harmon-Becker Automotive Systems, Inc.	2007 (automotive audio speakers)
ERG	October 2009 (no use of the facility)
Wal Mart, Inc.	June 2010 (warehouse)
T. S. Magnuson, Inc.	November 2010 (sportswear)
For Bare Feet, Inc.	January 2014 (sportswear)

ERG Martinsville I, LLC purchased the property in October 2009 and maintains the responsibility for the remediation of historical environmental conditions.

Heritage (October 1995) notes that Harmon-Motive used ketones in the manufacturing of automotive audio speakers, however chlorinated solvents were not used. Heritage (October 2003) states that the Twigg Corporation used the eastern portions of the Site for the storage of as a many as 500 drums that may have contained chlorinated ethenes.

Oversight of the remediation of the site by the IDEM State Cleanup Section began in 1996 under project site no. 1996-06-183.

3.2 Hydrogeologic Setting

Site hydrogeologic characterizations have previously been prepared by Heritage Environmental Services (HES, October 1995) and the SESCO Group (SESCO, July 2011) for the Site, and by Bruce Carter Associates, Inc. (BCA, October 2011) for the adjacent Twigg Corporation facility. The findings of these documents are summarized in the following paragraphs. The regional hydrogeologic characterization in the area of Martinsville has been prepared by Wittman Hydro Planning Associates, Inc. (Wittman, November 2004) and Hydrophase, Inc. (Hydrophase, March 2005). All historical site data is provided in Appendix 1.

3.2.1 Geology

Bedrock below the area consists of poorly permeable siltstone and shale with minor sandstone and limestone units of the 500- to 800-foot thick Mississippian Borden Group. The rock dips toward the center of the Illinois Basin to the southwest. The upper 150 feet of the bedrock can be sufficiently weathered to serve as a water-supply aquifer when glacial outwash is not present.

The Site is just to the south of the furthest extent of glacial advances approximately 15,000 to 20,000 years ago. Melt waters from the retreat of this glacier and subsequent glaciers that stopped further to the north carved a large valley into the bedrock, which is followed by today's White River. Regionally, the valley was filled with sand and gravel that was washed southward from the melting glaciers. Lenses of clay can be found interbedded with the sand and gravel, especially near the base of the deposits. The valley can be up to 4 miles wide and the deposited sand and gravel can be up to 120 feet deep. The sand and gravel deposits are the primary water-supply aquifers in the region when present.

The geology below the Site and extending approximately 5,000 feet west-southwest (downgradient) of the site was defined by SESCO 2010 borings (SESCO, July 2011) completed to the bedrock surface, by borings for the long-screened wells installed by SESCO, and from the CMT well borings installed by Eco-Innovators in January and February 2013. Locations for off-site borings, monitoring wells, and residential wells are provided on Figure 2. A geologic cross-section for the off-site area is provided on Figure 3. Several units were identified from bottom to top in the off-site borings as follows:

- Unit 5: Is stiff clay to very hard weathered shale found at depths of approximately 95 feet below ground surface (bgs), at an elevation of 500 to 510 feet mean sea level (MSL). The western-most boring (CMT-A) has the clay appearing at a shallower depth of 63 ft bgs or elevation of 532 ft MSL. This results in a thinning of the overlying units that form an unconfined aquifer across the Site. A laboratory permeability test of the weathered shale yielded a vertical hydraulic conductivity of 9.0 $x10^{-9}$ cm/s (SESCO, July 2011).

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IDEM On-Site Report Comment 11. The IDEM requests "…a pump test or other type of in-situ evaluation … indicative of site-specific horizontal and vertical hydraulic conductivities." The laboratory test measures the vertical hydraulic conductivity of intact shale that would control the vertical migration of groundwater through the shale if there is a vertical gradient to drive the flow. Fracturing could increase the vertical permeability by several orders of magnitude depending the spacing and size of the fractures. As described below, the overlying sand and gravel aquifer is very permeable, and would likely remain several orders of magnitude more permeable than fractured shale (Freeze and Cherry, 1978). The available hydraulic head data collected in the overlying aquifer does not show a consistent vertical flow direction in the lowest portions of the alluvial of the aquifer. The mean gradient is -0.00050, downward, at the base of the aquifer compared to an average horizontal gradient of 0.0018, three times greater than the vertical gradient. The direction of vertical flow across the shale is not known. However, given that the White River is a likely regional discharge area, flow is likely upward or horizontal. The aquifer is also vertically stratified, consistent with its alluvial origins. This will also tend to direct groundwater flow in a horizontal direction (Freeze and Cherry, 1978), further minimizing the potential for vertical flow into the shale. This horizontal flow preference is demonstrated in Section 5 of the RWP which show that the vertical distribution of VOCs does not reach the base of the aquifer (top of the shale). In conclusion, we do not believe further in-situ testing of the shale permeability is warranted.

- Unit 4: Is a fine to coarse, generally well-graded sand with trace silt and varying amounts of gravel, from trace gravel to gravelly overlies the shale at thickness between 15 to 25 feet. A grain-size analysis contained 22 percent gravel, 74 percent sand, and 4 percent silt and clay (SESCO, July 2011). One test for total organic carbon (defined as loss on ignition) yielded a value of 0.048 percent (SESCO, July 2011).

- Unit 3: Is fine to coarse poorly- to well-graded sand with a trace of silt, occasional clayey layers. A laboratory permeability test of a clay seam in this unit yielded a value of 1.1×10^{-8} cm/s.

- Unit 2: Approximately 4,000 feet west of the site, the geology between approximately 70 to 15 feet bgs is predominantly fine to coarse poorly- to well-graded sand with a trace of silt and varying amounts of gravel; from no gravel to gravelly, with occasional thin lenses of silt.

- Unit 2a: Beyond 4,000 feet of the Site, the unit appears to converge with Unit 4 (described above) to an alternating fine to coarse poorly- to well-graded sand; and fine to coarse well-graded gravel, all with a trace of silt. Three grain-size analyses

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contained from 0 to 12 percent gravel, 85 to 97 percent sand, and 3 to 12 percent silt and clay (SESCO, July 2011). The hydraulic conductivity of this sand unit has not been determined below the Site. Investigations at the nearby Twigg Corporation found the hydraulic conductivity of the unit to range from 2.6 x 10^{-3} to 1.3 x 10^{-1} cm/s with a geometric mean value of 1.9 x 10^{-2} cm/s (BCA, October 2011).

- Unit 1: The uppermost unit is composed of alternating zones of clay, silt, clayey sand, silty sand and fine to medium poorly- to well-graded sand. The sandy zones have no to some silt and occasionally have trace gravel. The surface, 1 to 1.5 feet, occasionally has gravelly fill. The unit tends to thin and have a higher clay concentration to the west. Two grain-size analyses contained from 2 to 12 percent gravel, 83 to 95 percent sand, and 3 to 5 percent silt and clay (SESCO, July 2011). One test for total organic carbon (defined as loss on ignition) yielded a value of 0.072 percent (SESCO, July 2011). This uppermost geologic unit is from 15 to 25 feet thick.

3.2.2 Hydrogeology

The glacial outwash sands and gravels in the Martinsville area form the primary aquifer for the White River floodplain (White River aquifer system) (Hydrophase, March 2005). The aquifer is generally confined upgradient of CMT-B by the silty and clayey sand of Unit 1, where Unit 1 thins. The aquifer is generally 100 feet thick and is underlain by relatively impermeable rock of the Borden Group (Wittman, November 2004). The aquifer has a production potential of 100 to 2,000 gpm (Hydrophase, March 2005).

3.3 Surface Water

The Site and the City of Martinsville lies in the lower end of the Upper White River Watershed (USGS Cataloging Unit: 05120201), where the water in the floodplain flows to the White River. The White River lies between 2,500 to 7,700 feet west of the Martinsville city limits and lies more approximately 11,000 feet west of the Site, where the river flows to the south-southwest.

Indian Creek is a tributary to the White River and lies approximately 6,500 feet south of the site and south of Highway 37, where Indian Creek flows to the west. Indian Creek joins the White River approximately 18,000 feet southwest of the site.

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3.4 Groundwater Use

3.4.1 Municipal Wells

The Martinsville Water Utility well field (municipal wells #3, #4 and #5, located approximately one mile northwest of the Site at 410 W. Cunningham Street in Martinsville) produced an average of 635,000 gallons per day from the unconfined glacial outwash sand and gravel aquifer between 1996 and 2000 (Wittman, November 2004). The wells draw from the groundwater at approximately 60 feet below the ground surface and draw from an area of several hundred acres (City of Martinsville, 2011). The well field is approximately 6,500 feet to the northwest of the facility and 6,300 feet from the closest edge of the VOC plume from the Site. The wells are not downgradient of the Site.

According to Indiana Public Media (October 2012), the wells have historically been contaminated with tetrachloroethene (PCE) from a dry cleaner site (the Master Ware facility) approximately ½ mile southeast of the well field (Wittman, 2004). The City has utilized activated carbon filters since 2005 to bring the PCE levels to 1 µg/L or less. Increasing PCE concentrations are causing the lifetime of the carbon filter units to decrease, increasing costs and exceeding budgets. The City is therefore seeking to replace the well field at a new location. Based on a recommendation by Hydrophase (March 2005), a potential new location is 5,500 feet to the west-southwest of the Site and 900 feet from the southern edge of the VOC plume described in the Section 4 of this Report. Concerns for this location have been raised. Another potential new location would be south of the City and south of Indian Creek (Indiana Economic Digest, September 2012). Indian Creek is located approximately 6,000 feet southwest of the Site and on the order of 5,000 feet from the closest edge of the VOC plume described in the Section 4 of this Report. This location is not downgradient of the Site.

3.4.2 Private Wells

Twenty-three residential wells are identified in the general vicinity of the VOCs leaving the Site in groundwater. The locations and depths of these wells are as follows:

Home Owner	Address in Martinsville	Well Depth (feet)
Stierwalt	1240 S. Ohio St. Well #1	24
	1240 S. Ohio St. Well #2	22
Hacker	309 W. Poston Rd. Well #1	115
	309 W. Poston Rd. Well #2	not known
Turney	340 West Poston Road	not known
Bolin	409 West Poston Road	not known
Manley	1430 RJ Boulevard	not known
Williams	1440 RJ Boulevard	not known
Pottorff	809 Hacker Drive	20
Haywood	810 Hacker Drive	20
Dunham	839 Hacker Drive	20
Barrett	859 Hacker Drive	20
Seger	860 Hacker Drive	20
Hubble	889 Hacker Drive	20
Vest	909 Hacker Drive	20
Mathews	939 Hacker Drive	20
Hacker	940 Hacker Drive	not known
Wolfla	959 Hacker Drive	20
Applegate	989 Hacker Drive	not known
O'Dell	1009 Hacker Drive	not known
Hodges	1010 Hacker Drive	20
Meadows	1020 Hacker Drive	20
Bennett	1040 Hacker Drive	20

SESCO has previously noted that the wells at 1201 South Ohio Street, and at 340 and 409 W. Poston Road are used for non-potable purposes; and Eco-Innovators has stated that the Hacker Drive wells are all used for non-potable purposes. The wells on 1430 and 1440 RJ Boulevard are for non-potable uses. The well at 1430 was not operational in 2011 and the homeowner at 1440 did not allow access for sampling. Well number 1 on 309 W. Poston Road is used for potable water supply and well number 2 is no longer functional.

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4.0 Summary of Site Investigations and Results

Historical site investigations are summarized here with documentation provided in Appendix 1. The locations of borings and wells are provided on Figures 4 and 5.

In January 1988, the USEPA completed an inspection of the Site (Ecology and Environment, January 1989) in response to off-site discharges from a Site wastewater lagoon noted in 1977. Wastewater was diverted to the Martinsville sanitary sewer, the lagoon was dredged in 1977 or 1978, and the soil was removed from the Site. The lagoon continued to receive non-contact cooling water. Several soil and sediment samples related to the discharge and one groundwater sample from the Site's non-potable, 125-foot deep water-supply well were collected.

In April 1995, Harman-Motive reported to IDEM that Engineering and Testing Services (ETS) had discovered evidence of volatile organic compound (VOC) contamination in soil during the course of completing geotechnical soil borings. In response, nine soil borings were installed, from which soil samples and two groundwater samples were collected to investigate the VOC occurrence. No laboratory reports or boring information were provided with the letter. Above-ground storage tanks with secondary containment held ketones [acetone and methyl ethyl ketone (MEK)] until 1992 when the tanks were removed. The letter noted that additional investigations would follow.

HES completed a hydrogeologic assessment in October 1995. HES interviews with facility personnel and aerial photograph review found that Twigg had staged drummed PCE waste in an unpaved area on the East Site of the plant (the East Parking Lot Area). The HES summary of ETS investigations noted that 16 direct-push borings were completed with 14 groundwater samples and two soil samples collected to a depth of ≤ 11 feet. The samples were analyzed for VOCs. ETS also installed three shallow monitoring wells (≤ 21 feet deep) around the perimeter of the Site. Boring and well locations are provided on Figures 4 and 5, respectively. HES completed 39 borings at the Site with monitoring or air sparing (AS) wells installed in 38 of the borings to depths of 17 to 75 feet (see Appendix 1, ReSolution Partners, June 2013 for a tabulation of well construction information). Six additional soil vapor extraction (SVE) wells completed to depths of 4 to 8 feet were also installed. One well to the north of the Harman-Motive property (identified as RR Well) was also included in the investigation. HES sampled all monitoring and AS wells using a bailer followed by analyses using USEPA SW-846 Methods 8240A/8260A and 8021. Six monitoring wells (MW-20 through MW-23, MW-26, and MW-27) were installed off-site in August and September 1995. Well locations are provided on Figure 2. These wells have been sampled for VOCs from 1995 to 2012. HES sampled all monitoring wells using a bailer followed by analyses using USEPA SW846 Methods 8240A/8260A and 8021. HES performed investigative work through 2003.

HES completed investigations at the East Parking Lot in 2003 (HES, October 2003), where 40 soil borings (B-35 through B-74) were installed. Most borings were completed to depths of 12 feet and two were completed to 50 feet. Soil samples were collected between depths of 2 to 8

feet from the liners used during the direct-push boring installation. Groundwater samples were collected using Geoprobe screen-point tooling and check-valve equipped polyethylene tubing between depths of 8 to 12 feet. Samples were analyzed by USEPA SW-846 Method 8260B.

Keramida Environmental, Inc., (Keramida) performed investigative work for the Site beginning in 2004 through July 2009, including a Microcosm Study (Keramida, December 2004), a Reductive Dechlorination Field Pilot Test (Keramida, March 2005), a Reductive Dechlorination Work Plan (Keramida, June 2005), a Remediation System Startup and Evaluation Report (Keramida, July 2008), and three Remediation System Evaluation Reports (Keramida, September 2008, 4 June 2009 and 14 June 2009). No well installation records are available for wells DMW-75, DMW-76, and DMW-79. These wells were first sampled in November and December 2004. During that period, Keramida installed the on-site pilot test wells PT-1 through PT-3. Keramida sampled various on- and off-site wells during their investigative work utilizing low-flow sampling techniques, and employed HES to analyze the samples for VOCs using SW846-Method 8260B (Keramida, June 2009).

SESCO conducted a Further Site Investigation in 2010 (SESCO, July 2011), including the advancement of 71 borings and 40 monitoring wells. All the wells were installed with a 10-foot screen. Of these, borings B-75 to B-88, B-90, B-92, B-93, B-95, B-97 to B-105, B-107 to B-112, B-116 to B-121; and the monitoring wells MW-13B, -13C, -13E, -35A, -35E, -36A, -36E, -37A, -38A, -38E, -39A, -39B, -39E, -40A, -40B, -40C, -40E, -41B, -41E, -45A, -45B, -45C, -47C, -49E and -50E were installed on the Site. Boring depths on-Site ranged from 12 to 106 feet. Depths for wells with an “A”, “B”, “C” and “E” suffixes on-Site ranged between 17 to 18 feet, 27 to 34 feet, 45 to 50 feet and 97 to 104 feet, respectively. Borings B-89, B-91, B-94, B-96, B-106, B-113, B-114, B-115 and B-122 to B-145; and monitoring wells MW-20R, MW-21R, MW-26R/C, MW-42B/E, MW-43A/B/C/E, MW-44B/E, MW-46A/C, MW-48B were installed off the Site. Boring depths ranged from 12 to 106 feet. Depths for the off-Site wells with an “A”, “B”, “C” and “E” suffix ranged between 17 to 18 feet, 27 to 35 feet, 45 to 50 feet and 96 to 104 feet, respectively. Soil samples were collected by direct-push methods. Groundwater samples from the borings (“grab” samples) were collected via direct-push sampling drive points and temporary wells in direct-push borings. Groundwater samples were collected from the borings and monitoring wells using disposable tubing with a check valve. The soil and groundwater samples were analyzed by USEPA SW-846 Method 8260B (fixed-base laboratory) and/or 8265 (mobile on-site laboratory).

Sampling results are available, but no boring log or well construction information is available for the following wells:

AS-05	DMW-09AS	DMW-19	MW-11	PT-04D
AS-12	DMW-10AS	DMW-20	MW-12	PT-05S
AS-13	DMW-11	DMW-75	MW-14	PT-05I
AS-16	DMW-12	DMW-76	MW-34	PT-05D
AS-22	DMW-14	DMW-77	MW-34I	RR Well
AS-23	DMW-15	DMW-78	MW-21C	
AS-24	DMW-16	DMW-79	PT-04S	
AS-25	DMW-17	MW-01	PT-04I	

SESCO conducted additional off-site groundwater investigations during 2011 and 2012; including the advancement of 32 borings (B-146 through B-177) and installation of 16 long-screened monitoring wells (MW-51 to MW-66). The borings were advanced as temporary direct-push blind drive points for groundwater sampling at various depths. The boring maximum depths ranged from 30 to 99 feet. The method by which the groundwater samples were collected from the borings is unknown. The long-screened well depths ranged from 90 to 98 feet. The well-screen lengths ranged between 89 to 93 feet. Groundwater samples were collected from the long-screened wells and from a number of on-site monitoring wells using either a low-flow sampling method (bladder-type pump) or using a Hydrasleeve™ no-purge sampling method. The grab and the monitoring well samples were analyzed by USEPA SW-846 Method 8260B (fixed-base laboratory).

ReSolution Partners (November 2012) determined that due to groundwater mixing in the long-screened wells that the wells provided poor profiling information. The long-screened wells were abandoned in 2013. ERG conducted a further off-site investigation including the installation of nine continuous multichannel tubing (CMT) multi-level system wells (CMT-A through CMT-I). Each of these wells has 3 to 4 sample depth intervals across the aquifer. Boring logs and well construction diagrams for these wells are included in Appendix 1 of ReSolution Partners, July 2013, Off-Site Characterization Report. Groundwater samples were collected for VOC analysis from all the intervals in these wells in March 2013, and from select intervals and MW-48B in April 2013. Samples were collected for water quality parameters in all intervals of the CMT wells and from monitoring wells MW-27, MW-44B, MW-44E, MW-48B, and DMW-76 in 2013. Samples were collected from select intervals in the CMT wells in March 2013 for reductive dechlorination indicator parameters.

IDEM Off-Site Report Comments 4, 5, and 6. The IDEM comments generally address the inconsistency between the results of the CMT and earlier grab samples from direct-push borings. In general, the grab samples show higher VOC concentrations. The proposed well locations and sampling depths were provided to the IDEM in November 2012. The locations of the wells were selected on the basis of the overall spatial patterns of VOCs observed in the grab samples. The intent was not to "confirm" grab sample results. With the exception of CMT-I, the new monitoring wells were placed near the previously IDEM-approved locations for the long-screened wells that were abandoned due to vertical mixing of groundwater in the well screens.

CMT-I was placed in a location where monitoring wells had not yet been installed to provide better characterization near the centerline of the plume. In general, the CMT locations were from 25 to 150 feet of the closest boring with groundwater grab samples or long-screen well grab samples. Vertical sampling depths were selected to best define the vertical extent of VOCs and often were placed between two high-concentration grab samples. Overall, the CMT samples show the same spatial trends as the grab samples. However, the shallowest CMT samples generally yielded lower VOC concentrations than the grab samples.

There are at least four reasons why the CMT and grab sample results may not match:

(1) The CMT wells were installed in January 2013 and sampled in March and April 2013. The majority of grab samples were collected in 2010 and 2011, with the westernmost grab samples collected in early 2012. There have likely been concentration changes over the one to three year interval between sampling events.
(2) The CMT and grab samples were not exactly co-located. The data from the site suggests that VOC concentration gradients are steep and the VOC plume is narrow, probably following permeability heterogeneities in the aquifer.
(3) The CMT samples were collected from sand-packed sampling points using low-flow sampling techniques where the intake intervals have been well developed. Entrainment of aquifer sediment that may include adsorbed VOCs is kept to a minimum in the CMT wells. The grab samples were collected from direct-push tooling without the benefit of sand packs and well development. Small amounts of sediment may have been entrained in the samples leading to a high bias in the reported groundwater concentration.
(4) The grab samples collected from the direct-push tubing may have been cross-contaminated as the tools pass through high concentration zones into lower concentration zones.

The IDEM states that monitoring wells "may need to be installed at previous boring locations where concentrations were found to exceed the RTGWSL to more accurately monitor the plume." As the IDEM notes in comment 7, horizontal and vertical extent appear to be reasonably delineated. This is the primary objective of the well placement. The sampling points sufficiently define the extent of the VOCs and are located to monitor concentration trends over time to assess the validity of the natural attenuation conclusions made in the RWP.

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5.0 Contamination Nature and Extent

The discussion in this RWP will focus on current conditions related to contamination nature and extent. Section 3 of this Plan summarizes historical investigations with supporting material in Appendix 1.

IDEM On-Site Report Comment 6 and IDEM Off-Site Report Comments 11 and 12. The IDEM notes that the Site has historically had a gasoline UST and continues to operate above-ground liquefied petroleum gas (LPG) tanks. The current plant manager has stated that there are no LPG tanks currently on the property (R. Bode e-mail of 26 March 2014). The IDEM suggests that the presence of these facilities warrants additional groundwater analyses of benzene, ethyl benzene, toluene and xylene (BTEX) as well as semi-volatile organic compounds (SVOCs). Borings installed in 1995 found BTEX in groundwater in the East-Central Plant Area described below, however all concentrations were less than the RTWSL. With the exception of one well, historical on- and off-site groundwater sampling has occasionally detected very low BTEX concentrations at levels well below the RTWSLs. The exception is MW-46A (not MW-48 as noted in the IDEM comments) where BTEX has been reported in 2010 and 2012. Only benzene exceeds the RTWSL (5 µg/L) in 2012 at 84.3 µg/L. BTEX are the common indicators of gasoline releases. The analyses of SVOCs is not warranted for a potential gasoline leak.

A former fuel retailer (Bizzy Bee, UST Facility Id 19721) was located at 1390 South Ohio Street, northwest and immediately upgradient of monitoring well location MW-46. Review of IDEM files found October 1995 UST removal records for a 3,000-gallon gasoline tank and a 2,000-gallon fuel oil tank, both installed in 1978. A 1,000-gallon gasoline tank installed in 1989 was removed in 1998. The sketches provided in the closure documentation suggest that the 1,000-gallon tank was in the same location as the 3,000-gallon tank, even though the 3,000-gallon tank was apparently still in the ground. Soil samples analyzed for total petroleum hydrocarbons found no detectable concentrations with any of these closures. There was additional information indicating that three USTs on that site were leak tested in 1995 (Environmental Petroleum Service, 24 July 1995): a 3,000-gallon regular gasoline UST; a 2,000-gallon unleaded gasoline UST; and a 2,000-gallon K-1 (kerosene) UST. This indicates there may be a 36-year old 2,000-gallon UST still present on the property at 1390 S. Ohio Street. Evaluation of neighboring properties is not included in the RWP for the Site. Based on this information, IDEM may determine that it is appropriate to follow-up with the current owners of the property regarding the apparent hydrocarbon release from 1390 S. Ohio Street.

LPG consists of propane and butane with trace amounts of propylene, butylene and ethanthiol (an odorant). It is stored under pressure as a liquid, but at atmospheric pressures and environmental temperatures turns to a gas. Any leaks from these tanks would be in the form of vapors and would not enter the soil or groundwater.

The IDEM also notes the historical presence of acetone and methyl ethyl ketone (MEK) tanks and underground pipelines. The releases from these sources are addressed in the East-Central

Plant Area discussions. Both acetone and MEK have been included in the analyses of groundwater samples as discussed in Section 6 of RWP. There have been no recent exceedences of RTWSL for these compounds.

5.1 Soil

5.1.1 East-Central Plant Area (Ketones Release)

Investigation in this area (Baugh, April 1995) found acetone (methyl ketone) and methyl ethyl ketone (MEK) in soil samples. No laboratory reports or boring information were provided with the letter. In 1995, the acetone exceeded the current migration to groundwater from soil screening level. No soil samples were collected following the SVE remedial action described in Section 6. However, as discussed in Section 6, the ketone concentrations in groundwater in the area met the residential tap water screening levels. The soil therefore likely meets all RCG soil screening levels. No further remedial action for soil in this area is required.

5.1.2 East Parking Lot Area

The initial investigation of this area (HES, October 2003) included 20 soil samples with chlorinated ethenes with all but TCE exceeding the migration to groundwater screening level. None of the soil samples contained concentrations of chloroethenes in excess of the conservative direct contact screening levels, and subsequent remedial actions in this area focused on groundwater. No additional soil samples have been collected until 2011 (SESCO, July 2011). The locations and results for the 22 samples are provided in Appendix 1. As noted in ReSolution Partners (June 2013), the soil samples were analyzed without correction for moisture content (i.e., the results were reported "as received" or on a "wet weight" basis). Seven years after the HES investigations, almost all VOC concentrations were below the laboratory reporting limits with the following maximum (and median) concentrations:

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	Tetrachloro-ethene	Trichloro-ethene	cis-1,2-Dichloro-ethene	Chloroethene[1]
Maximum 2003 Soil Concentrations (n=20)	0.55 (0.037)	<0.025	1.1 (0.012)	0.017 (<0.0050)
Maximum 2011 Soil Concentrations (n=22)	1.1 (<0.040)	0.010	0.18	<0.0011
RCG Industrial Direct Contact Soil Screening Levels	170	20	2,000	17
RCG Migration to Groundwater Screening Levels	0.045	0.036	0.041	0.014

1. CE was tested in only 2 of the 22 samples in 2011.

The lack of moisture content correction suggests that the VOC concentrations may be 10 to 20 percent higher than reported. Even with this uncertainty, the most recent residual chlorinated ethenes concentrations are well below the direct contact screening levels.

The VOC concentrations are sufficiently characterized for purposes of evaluating remedial alternatives. Groundwater in this area continues to be contaminated with chloroethenes and the maximum soil concentrations remaining in the area could contribute PCE and cDCE to the groundwater. However, given the groundwater VOC concentrations described below, the ethenes contributing to groundwater are most likely found in soil below the water table.

IDEM On-Site Report Comments 1 and 2. The IDEM notes that three soil gas samples collected by SESCO in 2010 along the west edge of the East Parking Lot found PCE concentrations ranging from 17,000 to 37,000 µg/m^3 resulting in a need for further investigation. The IDEM states that additional evaluation is necessary to "…verify that the source(s) are adequately understood prior to proposing further remediation in the East Parking Lot Area." There are no current vapor intrusion driven risks within the plant building and there are no direct contact risks in the currently paved area that could be the result of the uncertainty posed by the soil-gas results. As noted in Section 11, there is no additional direct remediation proposed for the East Parking Lot Area because future risk is managed through institutional controls, therefore no further investigation is necessary.

5.1.3 Southwest Plant Area

The Southwest Plant Area was initially suspected as a potential VOC source area on the basis of indoor air sampling. Sub-slab gas sample VOC concentrations were the highest observed (maximum of 136,000 µg/m^3) below the plant during surveys conducted in March 2010 (SESCO, April 2010).

Additional vapor samples below the floor in the southwest area were collected in November 2010 (SESCO, January 2011), approximately 6 months after a sub-slab depressurization system was installed in the area. The PCE concentration in the vapor phase of three soil-gas samples collected in the area (SG-4 through SG-6) yielded PCE concentrations of 1,400 to 9,200 µg/m^3 (a 93 to 99 percent decrease).

Six borings were advanced through the floor in the southwest corner of the plant in 2010 (Figure 4) and the results of both mobile and fixed-base soil analyses are presented in Appendix 1, ReSolution Partners, June 2013 (Table 2). The mobile laboratory results were presented on a wet weight basis. As discussed above, the uncertainty in the results from the wet weight analyses are minimal when compared to the concentration levels associated with risk and remediation decision-making.

A total of 15 soil samples were collected from the unsaturated soil in the six borings above a depth of 6 feet bgs, and 27 saturated soil samples were collected between depths of 6 to 24 feet bgs. The maximum (and median) reported concentrations were as follows:

(mg/kg)	Tetrachloro-ethene	Trichloro-ethene	cis-1,2-Dichloro-ethene	Chloroethene[1]
Unsaturated Soil Concentrations (n=15)	4.30 (0.039)	0.0090 (<0.0059)	0.0015 (<0.0042)	<0.0011
RCG Industrial Direct Contact Soil Screening Levels	170	20	2,000	17
RCG Migration to Groundwater Screening Levels	0.045	0.036	0.041	0.014

1. CE was tested in only 8 of the 42 samples in 2010.

The highest PCE concentrations were found at borings B-95 and B-107. However, no specific soil source of the VOCs detected in the sub-slab vapor testing was identified.

All of the reported concentrations were less than the direct contact screening levels, and only seven PCE concentrations exceed the migration to groundwater screening level.

IDEM On-Site Report Comment 4. The IDEM states that the findings to-date suggest the presence of an unidentified source in the southwest corner of the plant that requires further investigation. Vapor intrusion studies in the plant have found that the presence of an unidentified source(s) in the soil is posing no unacceptable risk in the building via inhalation. Only 7 of the 16 unsaturated soil samples exceed the migration to groundwater screening level for PCE. Of these seven, four sample concentrations are more than twice the screening level of 0.045 mg/kg. The area is covered by roof and floor, removing infiltration as the mechanism for transferring VOCs from the soil to the groundwater (the basis for the screening level, IDEM RCG, 2012). The lack of current risk and a mechanism for transfer to groundwater suggests that further investigation in this area is not warranted. As noted in Section 11 of the RWP, institutional controls are proposed for the control of future risks associated with the potential for a VOC source in soil in this area.

As discussed in Section 5.2, the groundwater results to the east of the Southwest Area (5,700 µg/L of PCE [without degradation products] observed at MW-45C) suggest an additional soil source area upgradient (east) of MW-45C and to the west of the facility's east wall. There is no soil sampling in the area upgradient of MW-45C. Vapor monitoring described in Section 5.3 of this Plan found no anomalous VOC concentrations below the plant floor slab.

IDEM On-Site Report Comment 5. The IDEM suggests that the unidentified source(s) suggested by sub-slab gas and soil sampling in the vicinity of borings B-95 and B-107 "…may be associated with the unidentified source area around well MW-45C." We believe that any connection between the boring area and the monitoring well is unlikely given that MW-45C is approximately 200 feet hydraulically upgradient of these borings in an aquifer with a high westward flow rate. The IDEM notes that a groundwater grab sample from boring B-95 at a depth of 41to 45 feet had a PCE concentration of 1,100 µg/L. Low VOC concentrations in soil and groundwater from this boring indicate that the PCE found at a depth of 41 to 45 feet did not originate with downward migration of PCE from the area of B-95. The PCE occurrence at B-95 is part of the deep VOC plume that is also sampled by MW-45C. The lack of current risk associated with the deep VOC plume groundwater suggests that further investigation in this area is not warranted. As noted in Section 11 of the RWP, institutional controls are proposed for the control of future risks associated with the potential for a VOC source in soil in this area.

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5.2 Groundwater

The current on-site groundwater conditions as illustrated on Figure 6 (plan view) and Figure 7 (cross-section) suggest that there are three VOC plumes on the Site that quickly comingle with off-site migration to the west. The shallow northern plume originates with the East Parking Lot Area and is found in the upper ~25 feet of the aquifer. The deep plume appears to originate beneath the southeastern portion of the plant. The VOCs in groundwater are found at depths of up to 45 feet below the plant at MW-45C and consist of predominantly PCE. The shallow southern plume is also found in the upper portion of the aquifer only.

5.2.1 North (Shallow) Plume

The groundwater beneath a broad area of the East Parking Lot Area contained chlorinated ethenes in 1995 at 10,000's µg/L immediately below the water table. The remedial actions completed in this area (discussed in Section 6 of this Plan) changed the form of the VOCs, generally decreasing the PCE concentrations and increasing the cDCE and CE concentrations with limited reductions in the overall amount of VOCs present. The recent February 2013 sampling found that shallow groundwater contains approximately 300 µg/L of PCE, 45 µg/L of TCE, 580 µg/L of cDCE, and 25 µg/L of CE.

The VOCs originating in the East Parking Lot Area move westward (Figure 6) and downward under the hydraulic gradients present in the aquifer. Historically, the highest concentrations immediately downgradient of the parking lot have been found in MW-32 (last sampled in 2008). Nearby well MW-34 is slightly shallower than MW-32 and had lower concentrations in 2008 in response to the downward gradient in the aquifer.

Monitoring well MW-22 is located on Clore Street approximately 600 feet to the west, downgradient of the East Parking Lot Area. The chlorinated ethenes between 2004 and 2008 showed stable to decreasing concentrations. When the well was next sampled in April 2012, the cDCE and CE concentrations had increased. The increase was confirmed in subsequent sampling of this monitoring well. The preponderance of cDCE and significant CE suggest that the VOCs are from the incomplete biodegradation of the PCE in the East Parking Lot Area. As noted by ReSolution Partners (June 2013), VOC migration rates between the East Parking Lot Area and MW-22 are consistent with the production of cDCE by the *in situ* remedial action and the arrival time of the cDCE at MW-22.

The continuation of the northern plume that left the FHBF before the partial remediation of the East Parking lot area changed the nature of the VOCs at the source is shown on Figure 8 as total chlorinated ethenes (tetrachloroethene [PCE] + trichloroethene [TCE] + cis-1,2-dichloroethene [cDCE] + trans-1.2-dichloroethene [tDCE] + chloroethene [CE]) in the shallow aquifer.

The centerline of the plume follows a sinuous path that is controlled by subtle variability in the aquifer's hydraulic conductivity. Concentrations of total chlorinated ethenes greater than 1,000

µg/L are shown to occur within 1,800 feet downgradient of the Site. In the area of MW-22, cDCE was the predominant compound detected at 1,800 µg/L total chlorinated ethenes. Near the leading edge of the 1,000 µg/L contour, in the area of B-135 and B-138, (2,300 µg/L) PCE is the dominant compound at greater than 2,000 µg/L. The change in chemistry reflects the implementation of the *in situ* remediation effort in the East Parking Lot Area, with the initial migration of PCE associated with pre-remediation (2005) conditions, and the DCE/CE associated with post 2005 migration.

Concentrations fall to less than approximately 100 µg/L between 1,500 and 1,700 feet from the facility, while concentrations greater than 10 µg/L extend from 4,100 to 5,300 feet from the facility (Figure 8). The results at CMT-E (20 feet) and CMT-F (20 feet), did not detect chlorinated ethenes, which is not consistent with the boring grab samples collected in the same general vicinity that reported 10 to 50 µg/L of total chlorinated ethenes. The small difference may be due to entrainment of small amounts of suspended solids with adsorbed VOCs in the grab samples. Concentrations at the most downgradient extent of the investigation are greater than 1 µg/L and extend towards the White River beneath farm fields beyond the city limits. CE is the dominant compound present near the leading edge of the plume.

One or more of the constituents have residential tap water screening levels (RTWSL) exceedence within 1,800 feet of the plant (Figures 9 through 13). These include PCE (up to 2,580 µg/L), TCE (up to 231 µg/L), cDCE (up to 1,580 µg/L) and CE (up to 60.6 µg/L). Chloroethene occurs above the 2.0 µg/L RTWSL from 1,800 feet to 5,000 feet downgradient of the Site at several locations with concentrations as high as 19.0 µg/L. No other constituents exceed the RTWSLs.

IDEM Off-Site Report Comment 8. The IDEM requests that maps showing the individual exceedences of RTGWSLs be provided. The maps are included on Figures 9 through 13.

5.2.2 Central (Deep) Plume

The horizontal extent of the total chlorinated ethenes in the deep aquifer is illustrated on Figure 14. The 1,000 µg/L isoconcentration line extends from MW-45C, beneath the plant, to approximately 5,000 feet downgradient of MW-45C. The centerline of the plume follows a sinuous path that is controlled by subtle variability in the aquifer's hydraulic conductivity. This deep plume has its origins beneath the plant to the southwest of the shallow plume origin in the East Parking Lot Area. While having separate origins, the base of the shallow northern plume and the top of the central deep plume begin to comingle approximately 300 feet downgradient of the FHBF.

The plume is approximately 700 feet wide after 1,500 feet of downgradient migration, and the width is relatively constant until near the leading edge of the plume where concentrations above 10 µg/L extend westward to CMT-A and narrows to less than 300 feet in width. Single digit CE concentrations probably occur downgradient of CMT-A. As with the shallow plume, the modeling described by ReSolution Partners (July 2013) suggests that CE > 1 µg/L may have

migrated as a much as 9,000 feet from the Site, comparable to the extent of the original shallow northern plume described previously.

The vertical distribution of chlorinated ethenes along the centerline of the plume is illustrated in the isoconcentration cross-section provided on Figure 15 which illustrates the total ethenes concentrations. Figure 15 shows the highest concentrations occur approximately 2,500 feet downgradient of the Site at CMT-F (50 ft bgs) at 1,100 µg/L, the majority of which is DCEs. The mass of the plume descends from the water table on-site to approximately 60 ft bgs at CMT-B (535 ft MSL). The plume then begins to rise in elevation to approximately 550 feet as the base of the aquifer rises from 505 to 530 feet in elevation.

Individual constituent concentration trends plotted on Figures 16 through 19 illustrate the chemical evolution of the chlorinated ethenes as they are naturally degraded in the aquifer. PCE occurs on-site at 4,480 µg/L in MW-45C (39 to 49 ft bgs) and decreases to below detectable concentrations just west of CMT-I (Figure 16). The decrease in concentration below 49 feet at MW-45C is inferred on the basis of the lack of PCE in deeper sampling points downgradient of CMT-I. The disappearance of PCE is likely due to natural attenuation by reductive dechlorination of the PCE to TCE. TCE occurs on-site at 186 µg/L in MW-45B (24 to 34 ft bgs), decreases to 79 µg/L at CMT-F (50 ft bgs), and then to below detectable levels by approximately 3,000 feet west of the Site between CMT-F and CMT-E (Figure 17). The decrease in concentration below MW-45C on-site is again inferred on the basis of the data from further downgradient. TCE is the first daughter product formed by the reductive dechlorination of PCE and is in-turn naturally degraded. Total DCEs occur on-site at 216 µg/L in MW-45A (8 to 18 ft bgs) (Figure 18). The highest concentrations are approximately 2,500 feet downgradient of the Site at CMT-F (50 ft bgs) at 1,040 µg/L. The downgradient extent of the total DCEs occurs approximately 4,000 feet west of the Site between CMT-E and CMT-B at approximately the 70 ft bgs level. The decrease in concentration below MW-45C on-site is again inferred on the basis of downgradient data. The DCE forms from the reductive dechlorination of the TCE. The highest concentration of CE on- or off-site (154 µg/L) occurs 60 ft bgs approximately 4,400 feet downgradient of the Site at CMT-B (Figure 19). A concentration of 48 µg/L occurs at CMT-I (59 ft bgs). The drawing infers that the CE plume moves between the 50-foot depth at CMT-F (2.9 µg/L) and the 80-foot depth (< 2.0 µg/L). Furthest downgradient, CE was detected at 14.2 µg/L, approximately 5,500 feet west of the Site at CMT-A (40 ft bgs). This concentration is shallower than the highest concentration noted at CMT-B because the rise of the bottom of the aquifer is forcing the plume to higher elevations (shallower depths).

5.2.3 Southern (Shallow) Plume

A second shallow chlorinated ethene plume is leaving the southwest corner of the FHB as defined by the results from 2010 boring grab samples and MW-40A. PCE is the primary constituent in the plume at concentrations as high as 180 µg/L. The PCE concentrations exceed the RTWSL of 5 µg/L. The southern shallow plume comingles horizontally with the shallow northern plume and comingles vertically with the deep central plume. The southern plume

extends only a few hundred feet from the FHBF before being naturally attenuated. This rapid attenuation is likely due to the comingling of a shallow hydrocarbon release downgradient of the facility as noted by the hydrocarbon detections near the corner of Ohio Street and Poston Road.

5.2.4 Natural Attenuation of Chlorinated Ethenes

Groundwater chemistry results provided in Appendix 1 and discussed in detail in ReSolution Partners Summary of Off-Site Groundwater Characterization (July 2013) show the groundwater in the deep plume is generally anaerobic and supportive of naturally-occurring reductive dechlorination while the northern shallow plume remains aerobic.

The off-site groundwater pH is generally between 7.0 and 8.3. A pH of 6.5 to 8.5 is optimal for reductive dechlorination. This pH is neutral to slightly alkaline, which is typical for groundwater that is in contact with carbonate-rich minerals. The water samples ranged from 5.1 to 22.1 ^{O}C. The deep water samples were on average over 4 degrees colder than the water table samples. There does not appear to be any other spacial temperature trend. The specific conductance (SC) values ranged from 286 to 1,226 µmho/cm with an average of 750 µmho/cm with values greater than 1,000 µmho/cm only encountered above 30 ft bgs. The oxidation-reduction potential (ORP) values ranged from 189 to -308 mV with the aquifer becoming more anaerobic with depth and with distance from the former Harman-Becker Facility. The dissolved oxygen (DO) values ranged from 0 to 8.0 mg/L with an average of 1.4 mg/L. Similar to the ORP, the DO tends to decrease with depth from an average of 2.6 mg/L (ranging from 0 to 8.0 mg/L) in the groundwater within 30 ft bgs to an average of 0.45 mg/L (ranging from 0 to 1.6 mg/L) in the groundwater below 30 ft bgs.

The presence of ethane and methane are products of anaerobic microbial metabolism. Microbes utilize a carbon source to produce these compounds. Ethane is present only at CMT-E (40 ft bgs). Methane was detected at CMT-A (62 ft bgs), at CMT-E (40, 70 and 90 ft bgs) and at CMT-I (17 ft bgs). Dissolved manganese and iron are also indicators of an environment depleted in oxygen. In the presence of oxygen, these metals oxidize and precipitate and are not included in the filtered sample in appreciable quantities. Manganese and iron were typically present above 200 µg/L in samples from depths of 40 feet bgs or greater.

Organic carbon, sulfate and nitrate can act as nutrients to certain microbial communities (e.g., sulfate is utilized by sulfate-reducing bacteria). Their presence can indicate an environment favorable to microbial activity that supports reductive dechlorination. Areas depleted in one or more of these nutrients can indicate a significant amount of activity, where the nutrient is or has been utilized. The dissolved organic carbon (DOC) is relatively consistent for all the samples at 1 to 2 mg/L with a decrease from east to west suggesting microbial carbon utilization in the aquifer.

The spatial distribution of volatile compounds suggest that reductive dechlorination is proceeding from PCE to TCE to DCE to CE and finally to complete CE destruction. The

sequential nature of the reductive dechlorination of the ethenes in groundwater was demonstrated with the model BIOCHLOR (Aziz, 2002) in ReSolution Partners (July 2013). This is a screening level model that evaluates the natural attenuation of chlorinated solvents in groundwater as a sequential first-order decay process. The physical hydrogeology of the 10,000-foot long aquifer through which the VOCs migrate is input into the model to establish advective and dispersive VOC transport. A simulation time of 50 years was used to reflect a potential time of solvent release initiation ca. 1960. The model assumed a continuous source of VOC release from the source area. This is conservative since reported chlorinated ethene use ended when Harman-Becker acquired the site some 30 years ago. The model can be run with a source decay function to simulate a fixed release of solvents to the groundwater. However, there is insufficient information with which to estimate a source decay rate at this time.

The model concentrations were matched to field observations as the first-order decay constants were changed. Fitting the model results to the field observations using only a single decay constant for the entire flow path did not yield reasonable matches to the field observations. The model allows the user to enter two zones with differing degradation rates. This feature was applied to the site, creating a 4,000-foot long zone immediately downgradient of the plant followed by a 6,000-foot long zone. The fitted decay constants were as follows:

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Model Zones		1/2 Life (yrs)	1st Order Decay Constant (1/yr)	1st Order Decay Average (Range) [a]
Zone 1	PCE	0.3	2.3	4.0 (0.2 to 20)
	TCE	1.2	0.58	1.0 (0.07 to 70)
	DCE	40	0.017	No data
	CE	500	0.001	0.6 (0.02 to 20)
Zone 2	PCE	0.3	2.3	4.0 (0.2 to 20)
	TCE	1.2	0.58	1.0 (0.07 to 70)
	DCE	20	0.035	No data
	CE	250	0.003	0.6 (0.02 to 20)

(a) from USEPA (1998)

The degradation rates for the PCE and TCE fitted to the site data are of the same general magnitude as the average USEPA values. The model-fitted degradation rate for CE is about 10 times less than the range reported by the USEPA. While the aquifer is anaerobic and supportive of reductive dechlorination, the low degradation rate may reflect the low organic carbon content of the aquifer which limits microbiological activity.

The BIOCHLOR model was then run at a simulation time of 100 years, again assuming the source remains at a constant strength for the next 50 years. Under this very conservative assumption the model VOC concentrations are very similar to the 50-year simulation. This suggests that the ca. 5,000-foot long plume is approaching a steady-state and will not advance significantly to the west.

IDEM Off-Site Report Comments 7, 9 and 10. The IDEM appears to agree that the BICHLOR suggests that the VOC plume is at a steady-state but that additional monitoring is needed to further evaluate plume stability. The sampling plan provided in Section 13 includes additional groundwater monitoring. As discussed in Section 13, the >50 year age of the plume in a large permeable aquifer supports a sampling interval greater than quarterly. Seasonal changes in VOC inputs to the groundwater many years ago and monitoring locations 100's to 1,000's of feet from the source areas have likely attenuated potential seasonal variations in VOC inputs to the aquifer. The large size and high permeability of the aquifer as well as the depth at which much of the VOCs are found also suggest that seasonal variations in surface hydrology will have little effect on groundwater flow and VOC migration.

The IDEM states that additional wells are needed to the west of the most downgradient monitoring well where 9.6 µg/L of CE has been observed at a depth of 40 feet. This concentration is about 15 times less than the CE concentration observed 1,200 feet upgradient at CMT-B. This concentration gradient suggests that CMT-A is already near the front of the plume. Rather than install additional monitoring wells at this time, we propose that new well

installations be contingent upon observing an increasing VOC concentration trend at CMT-A, and a concentration of 40 µg/L.

The IDEM notes that groundwater concentrations are above screening levels and that remedial measures are needed to reduce or eliminate potential exposures. This RWP presents the proposed remedial measures to meet this goal.

5.2.5 Current VOC Impacts to Potable Water-Supply Wells

The 23 residential wells identified in Section 3.4.2 of this Plan were sampled for VOCs as documented in the SESCO Further Site Investigation Report (July 2011). The well locations are shown on Figure 2 and the results of the analyses are summarized in Appendix 1 (ReSolution Partners, July 2013).

There are 15 wells on Hacker Drive more than 400 feet to the south of monitoring well CMT-C where 54 µg/L of CE was found at a depth of 60 feet (<2.0 µg/L was noted at a depth of 20 feet). The wells were sampled as a precautionary measure in 2010 and 2011 before the trajectory of the VOC plume in the aquifer was determined with confidence. When the information was available the well depths were all approximately 20 feet, and all are reportedly used for non-potable purposes. Samples collected from these wells were found to be free of detectable VOC concentrations. These wells are not a potential risk of the plume given the vertical and horizontal separation between the potable wells and the observed VOC occurrence, and the lack of VOC detections in the wells.

There are two wells at the north end of RJ Boulevard, approximately 300 feet to the north of monitoring well CMT-D where 51 µg/L of CE was observed at a depth of 60 feet (<2.0 µg/L was noted at a depth of 20 feet). The depths and uses of the water-supply wells are not known. The well at 1430 RJ Boulevard was reported to be inoperable by the homeowner, and the owner at 1440 RJ Boulevard refused to provide information or allow access to the property. The wells will be included in the monitoring program presented in Section 13 of the RWP if they are deep enough to coincide with the VOC depth noted in monitoring well CMT-D.

There are two wells located at 309 W. Poston Road, located approximately 50 feet to the south of the plume. The wells are a sufficient distance from the plume to not be a potential risk. One well is reported to be 115 feet deep (presumably at the base of the sand and gravel aquifer). It is not known whether this deep well is no.1 or no. 2 as identified by SESCO. Neither well is used for potable water. The deep well was sampled and found to be free of VOCs. Both wells are included in the continuing sampling plan provided in Section 13 of the RWP.

Non-potable water-supply wells are found at 340 and 409 W. Poston Road, within the areas of the shallow and deep VOC plumes. The depths of the wells are not known but both are reportedly used for non-potable purposes. The samples collected in 2011 did not contain

detectable VOC concentrations. Several possibilities are suggested by the apparent inconsistency between the well locations and the water quality:

- The wells may be screened at the base of the aquifer, comparable to the deep well at 309 W. Poston, and are therefore beneath the VOC plume;
- The wells are screened above the VOC plume; or,
- The concentrations in the groundwater drawn into the wells are low enough that the pumping process strips the VOCs from the water before the sampling point.

Both wells are included in the continuing sampling plan provided in Section 13 of the RWP. Inquiries regarding the depths of the wells will be made during the first sampling event described in Section 13 of the RWP.

Two water-supply wells are located at 1240 S. Ohio Street, located approximately 400 feet west of the Site, are between 20 to 25 feet deep, and both are for non-potable uses. One well yielded water with TCE at 33.0 µg/L, below the site-specific non-potable use screening level of 678 µg/L. These wells will be included in the monitoring program presented in Section 13 of the RWP.

5.3 Vapor Intrusion

5.3.1 Former Harmon-Becker Facility

Vapor investigations began in 2008 (see Appendix 1, Kerimeda 2008).

Investigations continued in 2010 (see Appendix 1, SESCO, April 2010) with indoor air, subslab and soil gas sampling within and below the building. Indoor air PCE concentrations by mobile laboratory mass spectroscopy ranged from 0 to 24 µg/m^3 in March 2010 with concurrent subslab concentrations ranging from 0 to 245,000 µg/m^3, and soil gas ranging from 60,000 to 428,000 µg/m^3. TCE, cDCE and CE were not detected. Samples analyzed by gas chromatography in March 2010 found PCE in the indoor air to be between ND and 37.8 µg/m^3 with concurrent soil gas at two indoor air locations with PCE from 65,000 to 279,000 µg/m^3. Canister sampling with TO-15 analyses in March 2010 found PCE in indoor air between 9.9 and 22.5 µg/m^3, and in subslab gas between 1,700 and 98,000 µg/m^3. TCE was detected in some subslab samples but not in the indoor air. cDCE and CE were not detected. As a result of these findings and the action level of 50 µg/m^3 for PCE established at that time, a vapor mitigation system was installed below the plant floor and began operation in May 2010.

SESCO collected vapor samples in November 2010 after about five months of mitigation system operation (see Appendix 1, SESCO, January 2011). No PCE, TCE, cDCE or CE were detected in indoor air samples. Subslab samples ranged from 660 to 6,600 µg/m^3 for PCE, and TCE

ranged from 5 to 540 µg/m^3. One sample contained 4 µg/m^3 cDCE and 2 µg/m^3 of CE. Soil gas samples ranged from 1,400 to 37,000 µg/m^3 of PCE, and 3.0 to 770 µg/m^3 TCE. One sample had cDCE at 540 µg/m^3 and no CE was detected.

Indoor air was sampled in March 2012 (see Appendix 1, SESCO, June 2012) using Summa canisters. PCE was detected from <1.0 to 7.0 µg/m^3.

Soil gas was collected from 21 on-site locations at one to four depths in June 2013 (see Appendix 1, Hartman, September 2013). An area some 300 to 500 feet to the north of the plant, beneath the main facility entrance, was found to have PCE concentrations as high as 160,000 µg/m^3 (SG1). Within about 100 feet to the south of SG1, the concentrations decrease to ≤ 200 µg/m^3. The high soil gas concentration appears to be related to an off-site source to the east of the Site.

IDEM VI Comment 21. The IDEM refers to other sources in this area that may need to be considered in the future. The data collected to-date strongly indicate that an off-site source is the origin of the soil gas PCE. Consideration of the off-site source(s) is not the responsibility of ERG.

A site-specific attenuation factor for vapor intrusion into commercial buildings was determined to be 0.00086, which yields a PCE sub-slab screening level of 209,300 µg/m^3 using the July 2012 IDEM revised PCE screening levels (see Appendix 1, Hartman, May 2013). Continuous subslab monitoring by Hartman in June 2013 found the PCE concentrations to vary between 25,000 and 50,000 µg/m^3 in the northeast portion of the building during mitigation system operation (P1 on Figure 20). The highest sub-slab PCE concentrations measured in July 2013 in the same area after the mitigation was turned off was 51,000 µg/m^3. Both of these results are well below the site-specific screening level.

Hartman sampled indoor air continuously at four locations (P4 through P7, Figure 20) in June 2013 and found maximum PCE concentrations to be less than 20 µg/m^3 with most results typically varying between 2 and 10 µg/m^3.

IDEM VI Comment 2. Continuous monitoring samples were collected at 45-minute intervals, for 32 observations per day over a 21-day period.

The mitigation system was turned off and indoor air samples were collected at six locations with passivated canisters and TO-15 analyses in July 2013. The maximum observed concentration was 13 µg/m^3 of PCE. (Note that one set of duplicate samples were reported at 50 µg/m^3 and ND from location P6. Hartman concluded that the high value was an anomaly not representative of site conditions.) The observed indoor air concentrations were well below the 180 µg/m^3 indoor commercial/industrial screening level.

IDEM VI Comment 4. The IDEM appears to be questioning that the conclusion regarding the anomalous nature of the higher result at location P6. The data collected in January 2014 at this location (P6), plus a duplicate, were both non-detect at a detection level of 3.4 ug/m^3. This confirms the non-detect measured in the one sample in July 2013, and supports the statement in the report that the duplicate sample in July 2013 was compromised.

The four indoor air and two sub-slab locations sampled under summer conditions in June 2013 were resampled by Hartman under winter conditions in January 2014 using USEPA TO-15 methods (Hartman, March 2014). The mitigation systems were shut down since July 2013. PCE and TCE concentrations were all below reporting limits in all samples. These results confirmed the summer observations that indoor air VOCs are well below IDEM's conservative RCG screening levels.

5.3.2 Residential Settings

The first sampling of residential indoor area was completed in 2008 and 2009 (see Appendix 1, Keramida, March 2009). Sampling locations for ten residences are provided on Figure 21. The highest pre-mitigation system concentrations of PCE were found in subslab samples from 1399 Clore St. (149,000 µg/m^3, duplicate mean), 1304 Clore St. (5,500 µg/m^3, duplicate mean), and the crawl space at 1385 Clore St. (1,060 µg/m^3). Pre-mitigation indoor air samples typically ranged from 4.5 to 26.6 µg/m^3 PCE with one residence at 847 µg/m^3 (1385 Clore St.). Subsequently, seven vapor mitigation systems were installed by Keramida at the following locations based on the 4.1 µg/m^3 residential indoor air screening level in effect at that time:

Location	Installation Date	Pre-installation PCE Concentrations (µg/m^3)			
		Living Space	Basement	Crawl Space	Subslab
520 Basca	Feb 2009	4.5	---	6.3	---
1304 Clore St.	Mar 2009	8.0	12.4	4.0	5,500
1334 Clore St.	Mar 2009	6.9	---	44.1	---
1354 Clore St.	Feb 2009	10.2	---	27.0	---
1355 Clore St.	Mar 2009	19.2	---	49.8	---
1385 Clore St.	Feb 2009	847	---	1,060	---
1399 Clore St.	Feb 2009	26.6	32.8	<1.9	149,000

Current Residential Indoor Air Screening Level for PCE = 42 µg/m^3. IDEM (31 July 2012).

Samples collected immediately after mitigation system installations were also collected by Keramida at several homes. Indoor air samples from 1385 Clore St. decreased to an average of 180 µg/m^3 of PCE by March 2009.

The 1354 Clore St. mitigation system was "amended" by Keramida and the home resampled in May (see Appendix 1, Keramida, May 2009). No detectable VOCs were observed in the May

sampling. 1304 Clore St. was also resampled in May with no VOCs in the indoor air and the subslab PCE concentration decreased to 1,000 µg/m^3.

SESCO began sampling residences in 2010, and expanded the program to a total of 20 residences by 2012 (Figure 21). Residences were sampled in March 2010, April 2010, May 2010, February 2011, April 2011, December 2011, February 2012, March 2012, May 2012, and July 2012. (See the table on Figure 21 for specific residences sampled on these dates.) During this period there were no reported exceedences of vapor screening levels.

Soil gas sampling was completed at 21 locations within or immediately adjacent to the residential area west of the plant in June and July of 2013 (see Appendix 1, Hartman, September 2013). PCE concentrations in the Clore and Ohio Street area ranged from ND to 48,000 ug/m^3. Based on a PCE screening level of 1,400 µg/m^3, 13 in-field determinations at five locations exceeded the screening level (SG3, SG4, SG5, SG8 and SG13). Two of the in-field determinations greater than 1,400 µg/m^3 were not confirmed by laboratory analyses, including the 2,550 µg/m^3 field observation at SG8; and the 1,560 µg/m^3 field observation at SG5. The remaining five laboratory samples were comparable to the field observations. This leaves SG4, SG5, SG8 and SG13 exceeding the screening level for PCE. No other VOCs exceeded screening levels for soil gas.

IDEM VI Comment 8. The IDEM notes that the RCG soil gas screening levels are 420 µg/m^3 at less than 5 feet, and 4,200 µg/m^3 at depths greater than 5 feet. The Hartman screening level was based on a new published final USEPA evaluation of vapor intrusion attenuation factors that raise the sub-slab soil gas screening levels by a factor of 3.3. Hartman used the USEPA attenuation factor as part of a site-specific approach to compute the screening levels of 1,400 µg/m^3 (i.e., 3.3 times 420 = 1,386 µg/m^3, rounded to 1,400 µg/m^3).

IDEM VI Comments 22. The IDEM requests clarification regarding the sampling of soil gas with syringes and tedlar bags. Hartman notes that the off-site soil gas confirmation samples used a 60 cc glass syringe to fill a 500 cc tedlar bag. Any moisture in the soil gas sample condenses on the walls of the tedlar bag rather than enters an evacuated canister. Further, since a flow restrictor is not needed for this process, there is no risk of clogging the flow restrictor orifice with any soil particulates present in the soil gas sample. Typically, the sample in the tedlar bag is transferred on-site to a small volume (400 cc to 1000 cc) passivated canister. This was done for the four confirmation samples collected in the June 2013 sampling round. However, for the four confirmation samples collected in July 2013, canisters were not available so the tedlar bags themselves were sent to the laboratory. Studies have shown that both TCE and PCE remain stable in tedlar bags for at least one week. The samples in July were collected on July 9 and analyzed on July 12, within or very close to the 72-hour hold time.

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IDEM VI Comments 23. The IDEM requested a comparison of Method 8260 used by H&P Mobile Geochemistry to Method TO-15. Hartman notes that Method 8260 is a GC-MS method similar to Method TO-15. For the compounds of concern at this site, both methods have been shown by many studies to give reliable results. Method 8260 has higher detection limits and higher calibration limits; hence it is more suitable for soil gas samples where values are often greater than 100 of µg/m^3. Method TO-15 is a more sensitive method and is designed for indoor and ambient air samples where expected concentrations are less than 100 µg/m^3. Since the on-site analysis showed soil gas levels of the three confirmation samples ranging from 390 µg/m^3 to 5,200 µg/m^3, Method 8260 was selected to run the samples.

IDEM VI Comments 26. The IDEM noted that the times for analysis for soil gas samples SG3-8ft, SG4-5 and -8 ft, and SG5-5ft collected in tedlar bags were not provided. Exceedance of holding times could result in low biased results. Hartman notes that for the four soil gas confirmation samples collected in July 2013, canisters were not available so the tedlar bags themselves were sent to the laboratory. Studies have shown that both TCE and PCE remain stable in tedlar bags for at least one week. The samples in July were collected on July 9 and analyzed on July 12. It is possible that the samples were analyzed slightly longer than 72 hours after collection, but the off-site results did not change the conclusions reached from the on-site results as to what structures needed to be sampled for indoor air quality.

The sampling locations near Clore Street, included 16,660 µg/m^3 at 8 feet in SG4; an average of 2,300 ug/m^3 at 5 feet and 5,200 ug/m^3 at 8 feet in SG5; and 2,940 µg/m^3 at 3 feet and an average of 20,900 µg/m^3 at 7.5 feet in SG8. Concurrent indoor sampling in the summer of 2013 and winter indoor air sampling in January 2014 found no unacceptable concentrations in the nearby residences.

One sampling location on East Poston Road, SG13, produced 27,900 µg/m^3 at 5 feet and 48,000 µg/m^3 at 10 feet. Five additional soil gas locations located between 100 to 300 feet to the west, south and east of SG13 produced PCE concentrations ranging from ND to 622 µg/m^3 (average of ~90 ug/m^3). In addition, four residences within 150 feet of SG13 sampled for indoor air, subslab, and crawl space did not exceed their respective screening levels (see below for details). This lack of spatial reproducibility suggests that the SG13 result is anomalous or very localized and does not result in unacceptable human exposures.

IDEM VI Comment 9 and 15. The IDEM states that residents near SG11 and SG13 and the Poston Elementary School near SG12 should be included in future indoor air sampling based on the soil gas results. The IDEM specifically requests that two additional soil gas sampling locations be established on school property.

Only SG13 is of potential concern based on the Hartman screening levels. The indoor air of the three structures within 100 feet of SG-13 (140 E. Poston Road, 160 E. Poston Road and 190 E. Poston Road) has been tested and values were below indoor air screening levels. SG-18 was

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added near the school after SG-13 was sampled and the values at all depths were below detection. In addition, SG12 was located between and to the north of the school building and the high soil gas observation at SG13. The soil gas PCE concentration was at 622 µg/m^3 at 5 feet, and 20 µg/m^3 at 10 feet. Note that this pattern is not consistent with a PCE source in the groundwater.

Both the IDEM and USEPA attenuation factors are based upon residential room exchange rates (1 every 4 hours). Room exchange rates are typically 5 to 10 times faster in schools, so in turn the screening levels would be 5 to 10 times higher. In addition, screening levels should be adjusted upward for the much lower exposure times of school occupants. Conservatively, applying only the air exchange at 1 exchange every 0.4 hours results in screening level of 14,000 µg/m^3 at <5 feet and at > 5 feet. Hence, it is reasonable to conclude that the measured soil gas concentration at SG-12 would be below screening levels if an adjustment for room exchange rate is considered. SG-12 and SG-18, located on the sides of the school facing the highest groundwater concentrations and the high soil gas concentrations at SG13, are adequate to rule out vapor intrusion risk to the school.

Indoor air samples were again collected from living areas, basements and crawl spaces in June and July 2013 (see Appendix 1, Hartman September 2013). Sixteen locations were sampled and are shown on Figure 21. The highest concentrations observed were found on the first floor at 1309 Clore St. (15 to 51 µg/m^3 of PCE). Two of four samples were greater than or equal to the residential indoor air screening level of 42 µg/m^3, and the average of the four samples was 42 µg/m^3. This home does not have a mitigation system. The other homes without mitigation systems ranged from <3.4 to 21 µg/m^3. TCE, cDCE and CE were not detected. Basements in these residences typically had ≤ 13.6 µg/m^3 of PCE, with 1309 Clore St. showing 1 of 3 samples at 65 µg/m^3.

Six of the seven residences with vapor mitigation systems were sampled in 2013 (see Appendix 1, Hartman September 2013). Mitigation system effluents contained 8.3 to 348 µg/m^3 of PCE, with the highest at 1399 Clore St. Prior to turning off the mitigation systems, the PCE concentrations on the first floors ranged from 1.4 to 2.7 µg/m^3. After shut down the concentrations ranged from <3.4 to 34 µg/m^3. The high concentration collected in June was not reproduced in a second sampling event in July. Basement samples collected prior to shut down were ≤ 3.4 µg/m^3, and after shut down the concentrations ranged from <3.4 to 21 µg/m^3.

Eight homes were sampled again during the winter of 2014 in January (see Appendix 1, Hartman, March 2014). Two homes (1355 Clore St. and 1309 S. Ohio St.) had concentrations of PCE above the laboratory reporting limit in the living space between 6.4 and 7.1 µg/m^3, while basement or crawl space observations at 1304 and 1355 Clore St. ranged from 4.1 to 4.4 µg/m^3. The homes at 1334 and 1385 Clore St. yielded estimated concentrations of 1.6 and 2.5 µg/m^3. The remaining observations were less than reporting limits. The inconsistently high results from 1309 Clore St. were not repeated. All results were below the IDEM RCG screening levels.

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IDEM VI Comments 18, 19 and 26. The IDEM notes that full QA/QC documentation for the air monitoring samples is required if the results are intended to be used to support a recommendation for no further sampling. The documentation for indoor air samples is provided in Hartman, March 2014 (see Appendix 1). This is the data on which the recommendation for no further indoor sampling is based.

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6.0 Historical Remedial Actions

The following paragraphs provide a summary of historical remedial actions completed beneath the FHBF that were presented in detail in the "Summary of On-Site Soil and Groundwater Characterization and Remediation" (ReSolution Partners, June 2013) and are included in Appendix 1. Findings of the previous site investigations are provided in Section 2.1 of the On-Site Report and Section 3.0 of the Off-Site Report. Figure 4 provides the locations of the areas discussed in this section.

6.1 Underground Storage Tank Removals

An underground gasoline storage tank was located on the east side of the plant (Figure 4). It was last used in 1984, and sometime between 1984 and April 1986 the tank was closed in place by filling it with concrete (Harman-Motive UST Notifications, May 1986). There is no indication of whether the tank had ever leaked. An underground acetone storage tank was located on the south side of the plant (Figure 4). It was last used in 1984, but the records do not state what became of the tank after it was taken out of service (Harman-Motive UST Notifications, May 1989).

Volatile petroleum hydrocarbons have been analyzed in groundwater downgradient of the tank and none have been found above RCG screening levels.

6.2 East-Central Plant Area (Ketones Release)

Above-ground storage tanks with secondary containment held acetone and MEK until 1992 when the tanks were removed. Harman-Motive suspected that the underground piping connecting the tanks to plant operations had leaked. In the East-Central Plant Area an air-sparge (AS) and soil vapor extraction (SVE) system were installed to remediate acetone, and ketones released from a suspected underground pipe leak. Documentation of the remediation includes the following:

- A construction permit application submitted to the IDEM in January 1996 (Harman-Motive, January 1996).
- A remediation system startup and evaluation report submitted to the IDEM in 2008 (Keramida, July 2008).

The available information suggests that seven SVE and five AS wells were installed in the east-central area.

No soil samples were collected following the SVE remedial action. However, the ketone concentrations in groundwater in the area met the residential tap water screening levels. The soil therefore likely meets all the RCG soil screening levels. No further remedial action for soil in

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this area is required. Monitoring well MW-2 (Figure 5) provides the best documentation of remedial performance in groundwater in this source area (see Appendix 1, ReSolution Partners, June 2013). In 1995, the concentrations of acetone and MEK were 6,600,000 µg/L and 150,000 µg/L, respectively. Concentrations for both compounds were <10 µg/L in samples collected in 2004, 2007, and 2008. Concentrations decreased by a factor of about 1,000,000 times for acetone, and by a factor of about 15,000 times for MEK between 1995 and 2008. This source area has been remediated to concentrations below IDEM Remediation Closure Guide (March 2012).

6.3 East Parking Lot Area

The East Parking Lot Area was subjected to an engineered *in situ* reductive dechlorination remedy to mitigate historical releases of tetrachloroethene at the ground surface in the area. The purpose of the reductive dechlorination remedy was to "…remove the source contaminants and allow natural processes to attenuate the downgradient groundwater plume to acceptable levels" (Keramida, June 2005). Documentation of the remediation includes the following:

- Documentation of a microcosm study (Keramida, December 2004).
- Documentation of a field pilot test (Keramida, March 2005).
- A Work Plan for the implementation of an *in situ* reductive dechlorination remedy (Keramida, June 2005).
- Remediation dechlorination progress reports (Keramida, December 2005; April 2006; October 2008).

Three full-scale injections were completed in August 2005, May 2006, and July 2008. The full-scale injection plan included 40 injection locations within the 100 µg/L isoconcentration line shown on Figure 22. Direct-push injection tooling was used to inject corn syrup solution over 3-foot intervals between depths of: 9 to 12, 12 to 15, and 16 to 19 feet. A total of 16,600 gallons of injection solution containing 2,200 gallons of substrate was introduced into the shallow groundwater by the pilot and full-scale injections. This represents an approximate application of 0.003 weight percent of the target aquifer mass after 4 four years of injections.

The oxidation-reduction potential (ORP) of the groundwater provides an indication of whether the reducing conditions necessary to support reductive dechlorination (Pankow and Cherry, 1996) are present following the injections of the carbon substrate. In general, ORP values less than -100 mV are potentially supportive of reductive dechlorination of chlorinated ethenes (Wiedemeier and others, 1998). Prior to substrate injections, the ORP in the area was on the order of 220 to 270 mV, indicative of aerobic conditions in the shallow groundwater. During the injection period, the ORP ranged from -128 to 265 mV. The carbon injections completed by Keramida could not generate sufficiently low ORP throughout the monitored portion of the treatment area, and where the goal was minimally achieved it could not be maintained for extended periods of time following the injections.

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The six years of observations suggest that the reductive dechlorination of VOCs may have been limited in the East Parking Lot Area, resulting primarily in the conversion of PCE to lesser-chlorinated compounds. The history of chlorinated ethenes concentrations in the East Parking Lot Area is tabulated in Table 5 of Appendix 1 (ReSolution Partners, June 2013) and the data are illustrated graphically on Figure 23. The data are presented in moles rather than mass units to better represent the conversions among the various compounds and the total change in the amount of chlorinated ethenes present. Only data from the shallowest of the HES monitoring wells is shown. The deeper wells had substantial overlap in the depths of their screened intervals and showed trends comparable to the shallow wells. The general trend across all of the monitoring wells shows the amount of PCE and TCE decreased with production of cDCE and a small amount of CE. Keramida attributed the rise in chlorinated ethenes concentrations to the production of alcohols resulting from the fermentation of the added carbon substrate. Keramida believed the alcohol increased the dissolution and desorption of the VOCs into the groundwater.

The concentration trends on Figure 23 suggest that during the introduction of carbon substrates during 2005 through 2008, when mildly reducing conditions were produced, there was reductive dechlorination as shown by the decrease in PCE and increase in degradation products (TCE, cDCE, and CE). At PT-2S and PT-3S, the total VOC content increased over this period suggesting mobilization from upgradient or increased solubilization within the remediation area. However, the proportion of degradation products also increased as degradation proceeded. The total molar decrease in VOCs from the remaining three wells ranged from 44 to 60 percent through 2008.

Monitoring wells PT-1S and PT-5S, at the up- and downgradient ends of the remediation area have been sampled over the eight-year period from 2005 to 2013. The overall amount of chlorinated ethenes as measured in moles shows an 82-percent decrease from the pre-remediation amounts. However, the decrease in the later years appears to be the result of advective groundwater flow (flushing) because all compounds appear to decrease at comparable rates. If degradation had continued, the amount of PCE would have decreased with increases in daughter products.

Overall the compound-specific concentration between pre-remediation conditions and 2013 are as follows (µg/L):

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Constituents	Pre-remediation (2004/2005)		Post-remediation (2013)		Remediation Closure Guide – Residential Tap Water Screening Level
	Mean	Range	Mean	Range	
Tetrachloroethene	3,400	2,600 to 4,200	320	277 to 363	5
Trichloroethene	210	200 to 220	45	32 to 57	5
cis-1,2-Dichloroethene	2,500	2,200 to 2,800	1,100	970 to 1,150	70
trans-1,2-Dichloroethene	9.0	<10 to 13	5.6	<5 to 8.7	100
Chloroethene	<10	<1 to <10	25	13 to 37	2

In summary, the engineered reductive dechlorination converted PCE and TCE to cDCE and CE, and resulted in some VOC destruction during the period of active substrate injection. In the five years since the active remediation was completed the total chlorinated ethenes concentrations continued to decrease likely due to flushing and downgradient transport rather than degradation. VOC concentrations in the area remain probably as a result of sufficient residual non-aqueous phase VOCs and/or adsorbed VOCs in the soil after multiple rounds of substrate injection.

6.4 Southwest Plant Area

No remedial action was specifically targeted for the Southwest Plant Area. However, a sub-slab vapor extraction system was installed during May 2011 in the area as part of an indoor air mitigation effort at the plant (SESCO, January 2011). While the primary purpose of the system is to mitigate vapor intrusion into the plant, the system also serves to remediate the soil below the plant from which the vapor is drawn. The sub-slab vapor extraction was divided into three sub-parts and effluent air samples were collected in November 2010. SESCO estimated annual VOC emission rates based on this data at 0.27 to 12.75 lb/yr (total of 15.46 lb/yr) with PCE concentrations ranging from 29 to 1,800 µg/m^3. No effluent samples have been collected since November 2010. The rate at which VOC concentrations in the subsurface vapor are changing is unknown. Subslab vapor samples were collected from the southwest corner of the plant in March 2010 (see Appendix 1, SESCO, April 2010) and in July 2013 (see Appendix 1, Hartman, September 2013). The vapor mitigation system below the plant floor was not in operation during the sampling events. The concentration of PCE in the subslab vapor decreased by approximately 880percent over the 3-year period, from 136,000 to 16,600 µg/m^3. The reduction indicates a significant improvement in soil and/or shallow groundwater quality beneath this area over the three years of VOC removal by the vapor mitigation system.

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6.5 Groundwater

Remediation of groundwater beyond the immediate source areas described above was implemented by air-sparge/soil-vapor extraction (AS/SVE) systems installed beneath the facility. A pilot test of an air-sparge (AS) and soil-vapor extraction SVE) system was completed in the area of highest acetone concentrations in June 1995 (HES, October 1995). The proposed plan (HES, October 1995) included the installation of eighteen 2-inch diameter SVE to depths of 7 feet bgs, and twenty-four 2-inch diameter AS wells with screened intervals of 58 to 75 feet bgs in the east-central area of the plant. Nutrients (anhydrous ammonia and vapor-phase phosphate) to stimulate biological growth and contaminant degradation were to be introduced with the air stream entering the AS wells.

A construction permit application was submitted to the IDEM in January 1996 (Harman-Motive, January 1996). It is not clear in the application how many AS and SVE wells were included in the application because the VFC document does not include the site plan noted in the application. No further documentation by HES of system construction has been found, although Keramida (June 2009) states that HES installed a system in 1995-1996. There is a 10-year gap in the documentation of the remedial actions in this area, from the submittal of the construction permit application in 1996 to Keramida's discussion of 2006 system modifications (Keramida, July 2008). This document shows that the system installed prior to June 2006 consists of 25 SVE and 20 AS wells. The "as built" drawing included in the 2008 document is not consistent with the 1995 plans.

Keramida (July 2008) states that "[t]he system was installed and/or modified in June and July 2006 and consists of a total of 10 SVE wells [and] 7 AS wells…". Keramida (June 2009) notes that 10 SVE and four AS wells were installed by Keramida. Routine operation beginning on 11 July 2007 and the system ran for 68 percent of the time between July 2007 and March 2008, removing "nearly 28 pounds" of VOCs. From April through June 2008, the AS/SVE removed an estimated 1.51 pound of VOCs over the three-month period for a total of approximately 29.5 pounds of VOCs (Keramida, September 2008). The system was shut down in early June 2008 as a result of high water level caused by flooding of Martinsville.

In 2009, Keramida (June 2009) issued a system diagnostic report in response to the June 2008 flooding. Flooding reportedly brought the water table to the plant's "foundations and subslab". The water table did not return to a normal level (8 to 9 feet bgs) until the end of August 2008. The system was restarted on 21 August 2008, but experienced numerous problems that were attributed to the flooding. A series of diagnostic tests on the system completed in March 2009 concluded that the three original AS wells needed to be replaced, and that the SVE wells be replaced by a "horizontal SVE trench" of unknown length.

The last report in the IDEM VFC was submitted by Keramida on 14 June 2009. It restated the conclusions of the diagnostic report. No schedule was provided for implementation of the recommendations. There is no further discussion of the AS/SVE system in the VFC records.

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This suggests that the revised Keramida AS/SVE system ran only from July 2007 to June 2008, less than one year. No other on-site groundwater remedial actions have taken place after the shutdown of the AS/SVE system in June 2008.

Six monitoring wells were located along the west edge of the facility, in the vicinity of AS/SVE that may have operated over the 12 years from 1996 to June 2008. The deeper monitoring wells (DMW-9AS and DMW-10AS) were essentially free of VOCs. The average total VOC concentrations in the four shallow wells prior to the start of the AS/SVE system were near the center of the plant:

		Total Chlorinated Ethanes (µg/L)		Total Chlorinated Ethenes (µg/L)	
		Average 1995-1998	Last Observed (Date)	Average 1995-1998	Last Observed (Date)
North	MW-18	33	4 (07/2008	73	5 (07/2008)
	MW-09	200	1 (07/2008)	720	16 (07/2008)
	MW-10	12	ND (06/2010)	19	ND (06/2010)
South	MW-17	2	ND (06/2010)	22	230 (06/2010)

PCE, TCE, and CE concentrations at MW-09 increased from 1995 to March 1998, and then decreased through October 2007 to slightly less than the starting concentrations in 1995 (cDCE and tDCE concentrations were not measured). There is no apparent response to the Keramida AS/SVE system modifications in 2006. There was a significant concentration drop in July 2008 immediately following the June 2008 flood with only 1,1,1-TCA and TCE being detected. MW-10 also showed increasing concentrations, with the peak in 2003 to 2004. The Keramida system modifications may have begun the process of concentration reductions but significant decreases were only recorded following the June 2008 flood. By 2010, no VOCs were detected at this well. MW-17 showed a continuous increase in PCE concentrations to peak at approximately 1,000 µg/L in 2008, possibly in response to the June 2008 flood and water table elevation increase flushing VOCs from the shallow unsaturated soil beneath the plant. Since the flood and cessation of the AS/SVE system, the total chlorinated ethenes concentration dropped to 230 µg/L in 2010, the last available observation. MW-18, the northernmost monitoring well, showed the highest concentration (~40 µg/L) in 1995. The lowest concentrations, ≤2 µg/L, were noted between 2000 and 2003, after which time the concentrations rose to ~6 µg/L. There was no apparent response to the AS/SVE remedy. The last observed concentrations included only 1,1,1-TCA and TCE.

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7.0 Wellhead Protection and Ecological Risk Evaluations

7.1 Wellhead Protection Areas

Wellhead protection areas are zones where groundwater is extracted for human consumption and affords a high likelihood for human exposure. Residents of Martinsville are supplied by potable water from the Martinsville Water Utility. The Utility extracts groundwater from three wells (#3, #4 and #5) located at 410 West Cunningham Street in Martinsville. The wells are located approximately 7,000 feet northwest of the FHBF and 6,300 feet north of the northern edge of the groundwater plume downgradient from the Site. The Wellhead Proximity Determinator, an online self-service application on the IDEM website, was accessed on August 5, 2013, to determine if the Site or the plume was in a known wellhead protection program. According to the application output, these areas are not within a wellhead protection program as shown in the IDEM determinations provided in Appendix 2.

7.2 Ecological Risk

A baseline ecological assessment is a determination if there are any ecologically susceptible areas within or near the contaminated zone. A baseline ecological assessment for the Site included a search for threatened or endangered species for Morgan County, Indiana, using U.S. Fish and Wildlife Service (USFWS) online; a search for national parks, forests and wildlife refuges using the USFWS, the U.S. National Park Service (USNPS) and the U.S. Forest Service (USFS) on-line resources; a search for state parks, nature preserves and other protected areas using the Indiana Department of Natural Resources (IDNR) on-line database; and a search for wetlands using the USFWS Wetland Mapper. Documentation for the results of these searches is provided in Appendix 3.

One endangered species, the Indiana Bat (Myotis sodalist) was identified in Morgan County. The county is also known to be a habitat for the Bald Eagle (Haliaeetus leucocephalus). The Bald Eagle is no longer considered an endangered species and no longer protected under the federal Endangered Species Act. However, the Bald Eagle is in recovery status and remains protected under the Bald and Golden Eagle Protection Act. Based on the Site data no potential habitat for these species has been impacted by the release.

Indiana has three national parks as located on the USNPS list of parks: George Rogers Clark Park, Indiana Dunes National Lakeshore and Lincoln Boyhood National Memorial. None of the parks are located in Morgan County.

Indiana has one national forest included on the USFS list of forests, the Hoosier National Forest. The forest is not located in Morgan County. No other wilderness areas, scenic rivers, historic trails or other congressionally-designated areas were identified from the USFS website as existing in Morgan County.

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Indiana has three national wildlife refuges (NWR) included on the USFWL list of wildlife refuges: Patoka NWR, Muscatatuck NWR and Big Oaks NWR. None of the NWRs are located in Morgan County.

A search of all IDNR sites was performed using the IDNR website. A part of the Morgan-Monroe State Park exists in Morgan County at two locations, one more than a mile south of the site and the other is more than 6 miles west of the Site. Neither the FHBF nor VOC plume are on or near either of these locations. The IDNR website search revealed four locations in Morgan County on the White River are state fish and wildlife areas. All of the fish and wildlife areas are more than 5 miles from the FHBF and the plume.

The most recent data from the furthest downgradient monitoring point (CMT-A) in the plume from the Site shows chloroethene at 9.6 µg/L more than 20 feet below the water table. Immediately downgradient of CMT-A, a small freshwater emergent is identified in a search of the USFWS online National Wetlands Inventory. The concentrations are likely passing with the flow of groundwater below the emergent wetland and not discharging to the wetland. The next wetland feature further downgradient is an unnamed lake. The lake is approximately 1 mile beyond CMT-A. No significant concentrations of chloroethene are likely discharging to the lake at this time based on the modeling of VOC migration and attenuation, posing no exposure to humans or animals. Modeling of VOC migration and degradation suggest the VOC migration is near to a steady-state condition. Therefore, the VOCs are not expected to reach the lake. The Site or the associated VOCs pose no risk to ecologically-susceptible areas.

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8.0 Risk Evaluation

8.1 Potential Contaminants

The potential contaminants include chlorinated ethenes in groundwater. While chlorinated ethanes and ketones are present in the groundwater, none of the detected compounds exceed RCG Residential Tap Water or Residential Vapor Intrusion from Groundwater Screening Levels. The specific contaminants of concern (including potential degradation daughter products) and relevant screening level concentrations include the following:

Potential Contaminants	Remediation Closure Guidance for Groundwater					Site-Specific Non-Potable Use Scenario (µg/L)
	Commercial/ Excavation Soil Direct Contact (mg/kg)	Migration from Soil to Groundwater (mg/kg)	Residential Tap Water (µg/L)	Residential Vapor Intrusion from Groundwater (µg/L)	Commercial Vapor Intrusion from Groundwater (µg/L)	
Tetrachloroethene	170/170	0.045	5	110	470	678
Trichloroethene	20/34	0.036	5	9.1	38	104
cis-1,2-Dichloroethene	2,000/2,400	0.41	70	Not available	Not available	890
trans-1,2-Dichloroethene	690/1200	0.59	100	Not available	Not available	4,370
Chloroethene	17/660	0.014	2	2	35	1.68
1,1,1-Trichloroethane	640/640	1.4	200	5,200	22,000	330,000
1,1-Dichloroethane	170/1,700	0.14	24	110	550	Not determined
1,1-Dichloroethene	1,100/1,200	0.05	7	300	1,300	
Chloroethane	Not available					

The non-potable use scenario screening levels have been determined from site-specific exposure evaluations (AECOM, June 2012, included in Appendix 1; IDEM comments, November 2012; ReSolution Partners responses, January 2013; and IDEM responses, November 2013). The non-potable use scenario evaluates a residential child's exposure to groundwater by incidental ingestion, dermal contact, and inhalation of vapors while playing in a groundwater-filled backyard "kiddie pool". 1,1-Dichlorethane and 1,1-dichloroethene were not evaluated in the site-specific scenario because they were not present in the shallow wells that potentially can be used in the non-potable groundwater use scenario.

Remediation goals for vapor exposure pathways are also relevant to the Site. The indoor RCG residential and commercial/industrial screening levels are as follows:

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Potential Contaminants	Remediation Closure Guidance for Vapors	
	Residential ($\mu g/m^3$)	Commercial/Industrial ($\mu g/m^3$)
Tetrachloroethene	4.1	21
Trichloroethene	2.1	8.8
cis-1,2-Dichloroethene	Not available	
trans-1,2-Dichloroethene	63	260
Chloroethene	1.6	28
1,1,1-Trichloroethane	5,200	22,000
1,1-Dichloroethane	15	77
1,1-Dichloroethene	210	880
Chloroethane	Not available	

Hartman noted site-specific considerations for the vapor pathway that increases the subsoil screening level concentrations by a factor of 3.3 based on new USEPA attenuation factors. The site-specific subsoil screening levels are as follows:

Potential Contaminants	Site-specific Subsoil Screening Levels ($\mu g/m^3$)	
	Shallow	Deep
Tetrachloroethene	1,400	14,000
Trichloroethene	73	730
cis-1,2-Dichloroethene	Not available	
trans-1,2-Dichloroethene	2,100	21,000
Chloroethene	53	530
1,1,1-Trichloroethane	270,000	2,700,000
1,1-Dichloroethane	500	5,000
1,1-Dichloroethene	6,900	69,000
Chloroethane	Not available	

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8.2 Exposure Pathways

8.2.1 Soil Exposure

Investigations have found no potential contaminants in soil at concentrations above screening levels in the East Parking Lot Area. However, the presence of the deep VOC plume in groundwater suggests that there may be soil beneath the southeast corner of the plant that could exceed commercial or excavation direct contact screening levels. The responses to this potential exposure are addressed in Sections 10, 11, and 12 of the RWP.

There are no potential soil exposures in residential areas near the Site.

8.2.2 Groundwater Exposure

Investigations have found VOCs in soil at concentrations above screening levels for migration to groundwater in the East Parking Lot Area. As noted above, the presence of the deep VOC plume in groundwater suggests that there may be soil beneath the southeast corner of the Site that could exceed migration to groundwater screening levels.

Groundwater beneath the Site, beneath the City of Martinsville to the west of the Site, and beneath non-city property to the west of the Site exceed the Tap Water Screening Levels for multiple VOCs. The municipal well is sufficiently distant and not downgradient of the Site, therefore it is not affected by the potential contaminants from the Site.

Private water-supply wells within city and outside of city limits are located within or near the area of the VOC plume "footprint." All but three wells have been sampled and only one of the two shallow wells at 1240 South Ohio Street has been reported with 33.0 µg/L of PCE and 17.0 µg/L of 1,1,1-TCA. The two wells at this property are within ~50 feet of each other and both are completed to approximately 23 feet bgs. The reason(s) for the differences are not known. Neither well is used for potable purposes and the concentrations of VOCs are below the site-specific screening levels for non-potable groundwater use.

IDEM Off-Site Report Comment 13. There are two shallow wells at 1260 S. Ohio Street. Neither is used for potable purposes and concentrations observed to-date are less than the site-specific screening level for non-potable uses. As noted in the Monitoring Plan, Section 13 of the RWP, the water-supply wells at 1240 South Street are included in future monitoring.

No unacceptable exposures to potential contaminants by the groundwater pathway are currently completed, most likely due to the vertical position of well screens relative to the potential contaminant locations within the aquifer. Installation of future wells however have the potential to intersect the potential contaminant plume and future exposures cannot be ruled out. Institutional controls in the form of an ERO and several ERCs are intended to mitigate this concern as discussed in Sections 10, 11, and 12 of the RWP.

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8.2.3 Vapor Exposures

Indoor air sampling in the former Harmon-Becker facility completed in 2013 after the mitigation system had been turned off for about one month were well below the commercial/industrial screening level of 180 µg/m^3 for PCE. The residual VOCs found below the plant are not resulting in actionable concentrations within the plant even when the mitigation system is turned off.

Six of the seven residences equipped with mitigation systems in 2009 met indoor area screening levels of 42 µg/m^3 of PCE when the mitigation systems have been turned off under both summer and winter conditions. The seventh is above groundwater that does not contain sufficient VOCs to create a concern for vapor intrusion. These systems will be shut off.

With one exception, the remaining sampled residences without mitigation systems have not exceeded indoor air screening levels. The one residence sampled in the summer of 2013 where PCE concentrations in the indoor air exceeded the screening level in two of four sampling events did not show exceedances of screening levels in the winter of 2014. The remaining residences sampled in the area above the groundwater VOCs met screening levels. Subsequent sampling in January 2014 found no indoor air screening levels were exceeded.

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9.0 Conceptual Site Model

The conceptual site model (CSM) is illustrated on Figure 24. Numbers in parenthesis in the following text correspond to circled numbers on the figure.

(1) Historical releases of CVOCs from the former Harman-Becker Facility have resulted in residual soil contamination beneath the East Parking Lot Area that slightly exceeds migration to groundwater screening levels. Such migration is mitigated by the presence of pavement over the residual CVOCs. The Parking Lot Area residuals do not exceed direct worker contact screening levels.

(2) Historical releases of CVOCs from the former Harman-Becker Facility have likely resulted in residual soil contamination beneath the southeast portion of the facility. This suspicion is based on the presence of high CVOC concentrations in groundwater found beneath the plant. No vapor intrusion into the plant was observed during June and July 2013 when the mitigation system was not in operation.

(3a) Remediation efforts in groundwater from 2004 through 2008 beneath the East Parking Lot Area resulted in the degradation of PCE and TCE to cDCE and CE. The cDCE and CE have recently migrated past the western (downgradient) edge of the facility at concentrations on the order of 1,000 µg/L and 100 µg/L, respectively.

(3b) Older, pre-remediation releases of CVOCs from the East Parking Lot Area have migrated on the order of 5,000 feet to the west of the facility. The CVOC plume reflects the natural attenuation of the CVOCs through degradation by reductive dechlorination as the predominant CVOC progresses from PCE to cDCE and finally to CE with increasing downgradient distance. Total CVOC concentrations decrease from on the order of 1,000 µg/L to <5 µg/L with distance down the plume.

(4) Historical releases of CVOCs from the former Harman-Becker Facility have reached the groundwater beneath the southeast portion of the facility. CVOCs leaving the facility from this deep plume are primarily PCE at the west edge of the plant. As with the shallow plume, the deep CVOC plume reflects the natural attenuation of the CVOCs through degradation by reductive dechlorination as the predominant CVOC progresses from PCE to cDCE and finally to CE with increasing downgradient distance. Total CVOC concentrations decrease from on the order of 5,000 µg/L to 10 µg/L with distance down the plume. A shallow southern plume also leaves the former Harman-Becker Facility above the deep plume. The southern shallow plume reflects the natural attenuation of the CVOCs through degradation by reductive dechlorination of PCE. The degradation appears to be enhanced by mixing with petroleum hydrocarbons that are reaching the water in the vicinity of Poston Road and Ohio Street.

(5) The vapor intrusion pathway into the former Harman-Becker Facility evaluated in the summer of 2013 was found to be incomplete. No exceedences of commercial/industrial

indoor air screening levels were found when subslab mitigation systems were turned off.

(6) Vapor intrusion evaluations of CVOCs at the water table near the plant (east of Ohio Street) found all but one tested residence to be below residential indoor air screening levels. One residence had an average concentration equal to the screening level for four measurements in the summer of 2013. Subsequent sampling in the winter of 2014 found the indoor air concentration to be less than the conservative screening level.

(7) Vapor intrusion evaluations of CVOCs at the water table to residences between Ohio and South Main Streets found all tested residences to be below conservative residential indoor air screening levels.

(8) Existing shallow private wells for potable and non-potable uses are in hydrogeologic settings to potentially draw CVOC-bearing water into the wells. To-date no CVOCs exceeding RTWSLs have been detected in existing potable-use private wells. In addition, a site-specific risk evaluation of non-potable uses (kiddie pool scenario) found no current adverse exposures. The recent migration of the cDCE and CE shallow groundwater plume exceeds the potable and non-potable site-specific risk levels for cDCE and CE.

(9) There is a potential for future private potable wells to be installed to depths where the CVOCs of the deep plume are encountered. This has the potential to create groundwater exposures in excess of the RTWSLs if such wells are installed.

(10) Modeling of CVOC transport and natural attenuation by degradation through reductive dechlorination suggests that the CVOC migration is near to a steady-state and future westward migration will be limited.

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10.0 Evaluation of Remedial Alternatives

10.1 Soil Remedial Alternatives

As described in Section 5 of the RWP, there is one known source area for soil CVOCs migrating to groundwater in the East Parking Lot Area; and one or more potential sources for vapor intrusion[1], migration to groundwater, or direct contact below the southeastern portion of the plant area. The thickness of impacted soil at each source area extends to the water table, which was between 8 to 10 ft bgs in June 2013. There is little soil that could be available for remediation.

The exceedences in the East Parking Lot Area soil are minimal; and it is likely that residual CVOC concentrations are higher below the water table. The reported concentrations in soil above the water table are not high enough to warrant active remedy.

There are VOC concentrations in soil under the southwest and southeast plant area. Vapor intrusion investigations have found no current unacceptable human exposures to vapors in the plant when the sub-slab mitigation systems have been turned off. Given that active manufacturing is occurring in the plant, access for additional subsurface investigations is very limited and source remediation is not viable. Concentrations in this area may or may not be high enough to warrant active remediation. Even if VOC concentrations in soil were found, implementing a remedial action would be constrained by the active manufacturing.

Given the thinness of the unsaturated soil at the site, the low VOC concentrations in soil beneath the FHBF, lack of current exposures to soil or vapors originating with the soil, and the constraints posed by active manufacturing within the plant, no active remedial action is being considered for soil at the site. The remaining alternatives are addressed below.

10.1.1 No Further Action

A determination of no further action indicates that the concentrations of the contaminants have reached levels that are below those protective of human health and the environment, and that no more investigation, remediation, monitoring or reporting is required.

CVOC concentrations in the Site soil may be above the State regulatory criteria. Some effort for mitigation of potential future human exposures, monitoring and reporting may be necessary. Therefore, no future action is not acceptable.

10.1.2 Engineering Controls

Engineering controls are constructed barriers that impede impacts from migrating or otherwise affecting human health and the environment. Engineering controls are not designed to actively reduce the concentration of impacts.

[1] As noted previously, vapor intrusions studies have not found current unacceptable exposures by this pathway.

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The asphalt over the East Parking Lot Area acts to reduce the infiltration of precipitation through the source area; however, the VOC concentrations in soil are minimal and the asphalt does little as an on-going remedy. The building and foundation over the potential source(s) beneath the plant eliminates the precipitation through the potential source(s), reducing the leaching of VOCs from the soil to the groundwater from whatever remaining VOCs are present in the soil. The building floor also prevents direct contact with any VOCs that may be present, and the floor within the plant mitigates the infiltration of vapors into the building atmosphere (as demonstrated by site vapor intrusion investigations).

The building floor is currently protective of human health and the environment. Measures need to be put in place to ensure that the engineering controls are maintained into the future to provide continuing protection. Such maintenance is included in site institutional controls as discussed in Section 10.1.4 of the RWP.

10.1.3 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) observes the progress of CVOC reduction by natural processes in soil. MNA is implemented when active remediation is not feasible or when rate of natural contaminant degradation is acceptable for protecting human health and the environment. Periodic monitoring is performed to test the effectiveness of the natural attenuation.

The vadose zone is aerobic, resulting in little potential for indigenous microbial metabolism of PCE, TCE and DCEs to contribute to natural attenuation. Natural attenuation in the soil does occur when CVOCs desorb from the soil particles to the vapor phase and migrate to the surface air or to the groundwater surface. Concentrations would decrease relatively slowly by this means and over time this option would achieve the remedial criteria. Natural soil attenuation by transfer of CVOCs to the underlying groundwater by infiltration of precipitation is prevented by the building.

Soil sampling cannot be completed for the potential concentrations below the plant source area. However, since migration to groundwater appears to be the primary concern, groundwater samples could be periodically collected downgradient of the potentially-impacted soil and analyzed for the CVOCs to measure concentration trends and the effectiveness of the natural attenuation.

This option would be protective of human health and the environment. MNA used along with engineering controls would be an appropriate remedy for the source area(s) beneath the plant.

There would be no additional cost for this option beyond that of the groundwater monitoring required for groundwater remediation described below.

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10.1.4 Institutional Controls

Institutional controls (ICs) are non-engineered legal controls that limit the access or activity of a property owner at a particular site in order to protect human health, the environment, and/or the integrity of a remedy. Examples of ICs are an environmental restrictive covenant (ERC) placed on the facility.

ICs are commonly used when residual contamination remains at a level that does not allow for unrestricted use and unlimited exposure after cleanup. ICs are intended to supplement other remedial alternatives. In order to mitigate future exposure by migration to groundwater, the IC would address maintenance of the plant building as a barrier to direct contact and vapor infiltration.

The process for instituting an IC requires the property owner to include the ERC as part of the property deed. An ERC for the facility is described in Section 12 of the RWP.

10.2 Groundwater Remedial Alternatives

The depth to groundwater on the Site is between 8 to 10 ft bgs, and downgradient of the Site is between 6 to 15 ft bgs. The aquifer is approximately 100 feet of alluvial sediments. There are three separate on-site occurrences of chlorinated ethenes that form commingling plumes near the plant's western boundary.

- The original northernmost plume is found near the top of the aquifer and extends from the east side of the plant approximately 5,000 feet across Martinsville toward the White River. This plume has "matured" over 50 years, demonstrating chlorinated ethenes biodegradation from PCE to TCE to DCE and finally to CE. The newer portion of this plume formed in response to incomplete remedial actions in the East Parking Lot Area completed during the period between 2004 and 2008. The remedial action converted the PCE remaining in the East Parking Lot Area to cDCE and CE. These compounds are more mobile than the parent PCE and arrived at the western edge of the plant property sometime between 2010 and 2012, and extends several hundred feet downgradient of the plant. The renewed plume is expected to follow the same path as the older plume.

- The second plume begins beneath the south-central portion of the plant and continues for approximately 5,000 feet past the most downgradient monitoring points. Given the length of the plume, the VOCs were released to the groundwater at approximately the same time as the releases in the East Parking Lot Area. This plume has also "matured" over 50 years, demonstrating chlorinated ethenes biodegradation from PCE to TCE to DCE and finally to CE. However, this plume is deeper in the aquifer, probably because the release include solvents that migrated downward into the aquifer as a dense non-aqueous phase liquid (DNAPL). The VOCs are observed at depth of approximately 40 to 50 feet bgs, comingling with the base of the shallower northern plume. Near the west

side of Martinsville, the base of the aquifer becomes shallower, forcing the deeper VOC plume upward, further commingling the two plumes.

- The southernmost plume is found below the water table and extends from the southwest corner of the plant several hundred feet to the west where is commingles laterally with the northernmost plume and vertically with the top of the deep plume.

- Exceedence of RTWSLs are present among the chlorinated ethenes in both the shallow and deep portions of the aquifer. In the shallow aquifer, the exceedences are generally east (upgradient) of East Main Street. In the deeper portions of aquifer, they occur along the entire 5,000-foot length of the plume.

- Exceedences of the site-specific non-potable groundwater use screening levels are only found near the FHBF.

- Exceedences of residential vapor exposure from shallow groundwater are less than screening levels for all constituents of concern except for chloroethene near the Site.

The evolution of the chlorinated ethenes downgradient of the Site clearly demonstrates natural attenuation by reductive dechlorination concurrent with an overall reduction in chlorinated compound concentrations. Modeling of the natural attenuation process supports the conclusion that reductive biodegradation is occurring in the aquifer downgradient of the Site, and that CVOC migration may be at, or near to, a steady-state that will release CVOCs to the groundwater at the same rate for the next 50 years.

The volume of groundwater containing chlorinated ethenes downgradient of the former Harman-Becker facility is on the order of 1,800,000 m^3 (~480,000,000 gallons) with a daily flux of approximately 140 m^3/day (37,000 gallons per day). Given this volume of water and flow it is not practical to remediate the plume to IDEM RTWSL (NRC, 2013). Investigations completed to-date demonstrate that natural attenuation is occurring and suggest that the plume may be stable (i.e., VOC migration rates are balanced by attenuation rates).

Even if the source of CVOCs is **immediately removed** it will still take time for the CVOCs to be removed from the aquifer. Removal of the VOCs would occur by advective flushing of groundwater through the aquifer and by naturally-occurring biodegradation. A batch flushing model can be used to estimate the number of pore volumes required to pass through a plume volume to reduce the CVOC concentrations to target levels (NRC, 1994). The model will under estimate remediation duration because it does not address the release of VOCs from lower permeability zones in the aquifer to the more permeable zones were groundwater flow is concentrated. The duration is also under estimated because the rapid and complete reduction of CVOC concentrations in source area beneath the FHBF to RTWSL is not likely to be achieved (NRC, 2013). Not including the fact that naturally-occurring degradation in the model over

estimates the remediation duration. The number of pore volumes (PV) required to reach a target concentration (C_t) is estimated by

$$PV = -R \cdot \ln (C_t / C_0)$$

Where R is the VOC retardation factor and C_0 is the initial VOC concentration. Retardation factors used in the BIOCHLOR modeling effort ranged from 1 to 4 for CE and PCE, respectively. Assuming a starting concentration of 500 µg/L and a target concentration of 5 µg/L for PCE, and 100 µg/L and 2 µg/L for CE results in 4 to 18 pore volumes for CE and PCE, respectively. At a daily flux of 140 m^3/day and a plume pore volume of 1,800,000 m^3 it would take about 35 years to pass one pore volume through the aquifer; or a minimum of 140 to 630 years to flush the aquifer.

Given the many years required to bring the CVOC concentrations in the plume to the IDEM RTWSLs it will be necessary to institute institution controls on groundwater for the foreseeable future. Currently, there are no unacceptable human exposures and once such controls are in place, future exposure should be mitigated. Therefore, the evaluation of remedial alternatives will focus only on those actions that support exposure control by institutional controls.

10.2.1 No Further Action

A determination of no further action indicates that the concentrations of the contaminants have reached levels that are below those protective of human health and the environment and that no more investigation, remediation, monitoring or reporting is required.

CVOC concentrations in groundwater downgradient of the Site are above State regulatory criteria. Therefore, no further action is not acceptable.

10.2.2 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a method used to observe the progress of CVOC reduction by natural processes in groundwater. MNA is not an active remediation. MNA is implemented when active remediation is not feasible or when the rate of natural contaminant degradation is acceptable for protecting human health and the environment. Monitoring is performed by periodically analyzing groundwater samples for the CVOCs to test the effectiveness of the natural attenuation.

As described above, the evolution of the chlorinated ethenes downgradient of the Site clearly demonstrates natural attenuation by reductive dechlorination concurrent with an overall reduction in chlorinated compound concentrations. Groundwater samples would be periodically collected downgradient of the Site and analyzed for the CVOCs to measure concentration trends and the effectiveness of the natural attenuation.

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This option would be protective of human health and the environment and would need no treatability study. This option would not raise any issues regarding community acceptance. MNA used along with engineering controls would be an appropriate remedy for the Site source areas.

10.2.3 Institutional Controls

Institutional controls (ICs) are non-engineered legal controls that limit the access or activity of a property owner at a particular site in order to protect human health, the environment and/or the integrity of a remedy. Examples of ICs are an environmental restrictive ordinance (ERO) or covenant (ERC). ICs are drafted by an attorney and are implemented by the local governing authority.

ICs are commonly used when residual contamination remains at a level that does not allow for unrestricted use and unlimited exposure after cleanup. ICs are intended to supplement engineering controls and MNA. Section 12 of the RWP outlines the institutional controls that are proposed as part of this remedy.

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11.0 Selected Remedy

The selected remedy is predicated on the following observations:

- VOC concentrations in soil where observed are less than direct contact screening levels, however there may be soil exceeding screening levels beneath the southeast corner of the plant.
- VOC concentrations in soil beneath the East Parking Lot Area are only slightly above migration to groundwater screening levels.
- VOCs in groundwater beneath the Site, beneath the City of Martinsville downgradient of the Site, and beneath non-city property downgradient of the Site exceed tap water screening levels.
    - The deep VOC plume and the shallow southern VOC plume demonstrate natural attenuation at rates that suggests the plumes are at a steady-state.
    - The shallow northern plume, which is the result of partial *in situ* remediation by reductive dechlorination in the East Parking Lot Area, is not at a steady-state. Based on the existing data, there is no evidence for significant natural attenuation of this plume.
- There are no current exposures to the VOCs in groundwater and in potable water from water-supply wells. However, it is possible that future well placement could result in extraction of VOCs above tap water screening levels.
- VOC concentrations in vapor samples collected during 2013 within the plant are below commercial/industrial screening levels when the mitigation system is not operating. The VI pathway is not complete within the plant building.
- PCE concentrations in residences between Ohio Street and the facility in 2013 and 2014 were less than residential indoor air screening levels in all but one home, even when mitigation systems were not operating. In one home without a mitigation system, the average of four observations was equal to the indoor air screening level in 2013, but below the screening level in 2014.
- PCE concentrations in residences between Ohio and Main Streets measured in 2013 and 2014 continue to be below the screening level.

The selected remedy consists of the following components:

- An Environmental Restrictive Ordinance (ERO) will be established by the **City of Martinsville to preclude the installation of new water-supply wells in the area** of the VOC migration as described in Section 12 of the RWP. A request will be made of the owner of 1240 Ohio Street to properly abandon the two non-potable water-supply wells on that property. If the owners decline to abandon the wells they will be sampled as

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described in Section 13 of the RWP. Water-supply wells that provide non-potable water 340 W. Poston Road and 409 W. Poston Road will be grandfathered, allowed to continue to operate, and will be periodically sampled and compared to relevant screening levels as described in Section 13 of the RWP. The depths and uses of the water-supply wells on RJ Boulevard will be requested of the owners. If the wells draw water from the depth of the VOC plume as defined by the nearby monitoring wells, the wells will be periodically sampled and analyzed and compared to relevant screening levels as described in Section 13 of the RWP.

- An Environmental Restrictive Covenant (ERC) will be put in place for the Site that requires that future disturbance of the floor and soil beneath the floor be evaluated and managed appropriately as described in Section 12 of the RWP.
- A request will be made of the current Holden property to establish an ERC on the farmland between the City and the White River to preclude the installation of new water-supply wells in the area of the VOC migration. If the request is denied, alternative measures will be prepared for review by the IDEM.
- An ERC will be requested of the owner of 309 W. Poston Road (outside of the City Limits) that precludes the installation of new water-supply wells to the north of the existing water-supply wells. The two existing water-supply wells at 309 W. Poston Road will be grandfathered and allowed to continue to operate as described in Section 12 of the RWP. The existing water-supply wells will be periodically sampled and analyzed for the VOCs as described in Section 13 of the RWP.
- Periodic groundwater sampling and analyses will be completed from monitoring wells to confirm the continuing natural attenuation process, to verify the continued lateral stability of the VOC plume, and to assess the advance and attenuation of the shallow northern plume.
- Indoor air samples collected from residences near the Site in 2013 and 2014 have not found indoor air concentrations above screening levels in the presence of the shallow northern VOC plume. The groundwater data collected from the shallow northern plume will be evaluated to determine whether changing conditions warrant additional vapor intrusion surveys as described in Section 13 of the RWP. Should groundwater concentration increase four times above current VOC concentrations in groundwater, a VI Sampling Plan consistent with the observed groundwater chemistry changes will be submitted to the IDEM.

IDEM VI Comments 7, 11, 12, 14, 18, 19 and 20. The IDEM notes that VI investigations and/or mitigation may be necessary at residences on Clore and South Ohio Streets, in the area where RVIGWSL are exceeded at the water table. A long-term groundwater monitoring plan is included in Section 13 of the RWP. The need for a VI Monitoring Plan is contingent upon the groundwater monitoring and will be prepared in response to the specific groundwater observations. The long-term groundwater

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monitoring plan forms the basis for vapor evaluations as noted in the previous bullet. VI sampling has not found VOCs at unacceptable levels in homes with the current groundwater VOC concentrations; therefore, additional VI monitoring is not required as long as the groundwater concentrations do not increase four times above current VOC concentrations in groundwater. Section 13 of the RWP provides the proposed response action to increases in groundwater concentrations.

The selected remedy is protective of human health because:

- Current direct contact of soil with potential VOC concentrations above screening levels by Site workers is mitigated by structures and future potential direct contact is mitigated through institutional controls as described in Section 12 of the RWP.
- There are no current unacceptable exposures to VOC-bearing groundwater by Site workers or by residents using private potable or non-potable water-supply wells. Institutional controls as described in Section 12 of the RWP will mitigate:
    - Future groundwater exposures by groundwater ingestion through prohibition of potable water-well use within the City of Martinsville Exposure Control Area defined by the ERO;
    - Future groundwater exposures by non-potable water uses will be mitigated through periodic sampling of existing and future non-potable water supply wells and new well construction restrictions within the City of Martinsville Exposure Control Area defined by the ERO as described in Sections 12 and 13; and
    - Future groundwater exposures on the property at 309 West Poston Road, and the farmland between the City and the White River will be mitigated by a request for an ERC of the property owners and by periodic well sampling as described in Sections 12 and 13 of the RWP.
- Natural attenuation processes will further reduce VOC concentrations in groundwater. Additional groundwater monitoring as described in Section 13 of the RWP will confirm natural attenuation.
- Exposure by vapor intrusion is not occurring within the Site when the mitigation system is turned off. No further action with respect to the facility is required.
- Eight residences with mitigation systems were found not to exceed indoor air screening levels with the systems turned off. The systems will remain off as there are no further concerns for vapor intrusion at these homes.
- Fifteen residences without mitigation systems were found to meet indoor air screening levels in the summer of 2013 and winter of 2014. There are no further concerns for vapor intrusion at these homes. Future groundwater monitoring near the Site will be reviewed and used to initiate additional sampling and, if necessary, appropriate response actions.

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- There are no current ecological exposures to CVOC-bearing groundwater. Modeling suggests that the current CVOC plume is stable and will not discharge to the surface where potential ecological exposures could occur.

IDEM On-Site Report Comment 7. States that "…additional remedial activities will be necessary to reduce source(s) from migrating further downgradient off-site and/or eliminated the potential for future exposure." The remedy as described above would eliminate the potential for future exposures. Therefore, additional remedial action is not required.

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12.0 Institutional Controls

IDEM Off-Site Report Comments 20, 21, 22, and 23. The IDEM notes that the Off-Site Groundwater Characterization Report did not address institutional controls, specifically environmental restrictive ordinances and covenants. These issues were intentionally left for the RWP as presented here in Section 12.

12.1 City of Martinsville Environmental Restrictive Ordinance

As defined by the IDEM (RCG, March 2012), an Environmental Restrictive Ordinance (ERO) is adopted by a municipal corporation that limits, regulates, or prohibits withdrawal, human consumption, and any other use of groundwater. The IDEM will review the ERO to ensure that it is protective of human health.

There are on-going discussions between the City of Martinsville, Eco-Innovators, and the law firm of Barnes & Thornburg, LLP, regarding the creation of an ERO in the City. The ERO associated with this Site will be consolidated with the ERO being requested for the Twigg Corp. facility immediately to the north of the Site.

The ERO will apply two exposure control areas as shown on Figure 25. The ERO extends from the west edge of the Site to the west edge of the City, southward from a line that generally parallels west Dickenson Street, and northward from the south edges of the largest parcels on the south side of Poston Road. The ERO is divided into exposure control areas as illustrated on Figure 25:

- In Zone A, nearest the Site, no future wells will be allowed for any use. This will require negotiation with the owners of 1240 South Ohio Street for the abandonment of the two shallow non-potable water-supply wells on that property. If the owner does not agree to abandon the wells (which currently do not exceed the site-specific screening levels for non-potable groundwater use), they will be included in an on-going groundwater monitoring program described in Section 13 of the RWP. On-going groundwater monitoring will be performed to evaluate whether the extent of Zone A is sufficient to mitigate against future potential non-potable groundwater uses. Eco-Innovators will either request expansion of Zone A or evaluate additional remedial actions to mitigate the VOC migration if groundwater monitoring indicates that VOCs at concentrations above the non-potable screening levels are anticipated to migrate beyond the limits of Zone A.

- In Zone B, the existing non-potable water-supply wells will be "grandfathered" for their current use and new shallow wells less than 25 feet deep will be allowed for non-potable uses. No new wells will be allowed for potable water use. Municipal water is available for potable water throughout the area of the ERO.

Grandfathering of existing wells will include requests for access by Eco-Innovators to periodically collect samples from the wells as described in Section 13 of the RWP for comparison to non-potable site-specific exposure screening levels (see Section 8.1).

City approvals for new non-potable water-supply wells will include access for Eco-Innovators to periodically collect samples from the wells as described in Section 13 of the RWP. New non-potable water-supply wells installed within Zone B of the ERO will be sampled and tested within two months of installation following Eco-Innovator's notification of the installation. The wells will then be added to the sampling schedule as described in Section 13.

The ERO will be prepared in accordance with Section 12.9 of the IDEM Remediation Closure Guidance (2012) and will be provided to the IDEM when it is completed.

IDEM Off-Site Report Comments 23 and 24. The IDEM has stated that it will be providing notice of the submittal of the RWP to the City and will be requesting confirmation that an ERO is being considered. The IDEM will also request information regarding the registration of potable and non-potable wells within the ERO area and of potable and non-potable wells "(which may affect plume stability) that potentially may be near the site." The IDEM will discuss any existing or future planned groundwater use in the area and will solicit City comments regarding the ERO. The City will be notified of the ERO notice requirements in IC 36-4-6-14 (f). A municipal point of contact will also need to be identified. The IDEM notes that the City "…needs to be willing to enact and enforce any groundwater restrictions for the duration that the ERO is effective."

The IDEM suggests that active site remediation coupled with the high groundwater flow rate in the aquifer could result in complete groundwater remediation in approximately 20 years. The basis for the statement is not provided. The basis for the 20-year estimate is not provided. The calculations presented in Section 10.2 of the RWP suggest that it may take more than 100 years to reduce the CVOC concentrations to acceptable levels.

12.2 Former Harman-Becker Facility Environmental Restrictive Covenant (ERC)

An Environmental Restrictive Covenant (ERC) is attached to a private property deed that institutes restrictions and/or requirements on the property owner that are intended to protect human health from exposures to contaminants left on the property. The IDEM will review the ERC to ensure that it is protective of human health and is properly attached to the property deed.

Eco-Innovators will be developing an ERC with the current owners of the Site, For Bare Feet, Inc. The ERC will be prepared in accordance with Section 12.8 of the IDEM Remediation Closure Guidance (2012) and will be provided to the IDEM when it is completed.

The key features of the ERC will include the following:

- No Owner or its Related Parties shall use or allow the use of the Real Estate for residential purposes, including, but not limited to, daily child care facilities or educational facilities for children (e.g., daycare centers or K-12 schools).
- No Owner or its Related Parties shall use or allow the use or extraction of groundwater at the Real Estate for any purpose, including, but not limited to: human or animal consumption, gardening, industrial processes, or agriculture, except that groundwater may be extracted in conjunction with environmental investigation and/or remediation activities.
- No Owner or its Related Parties shall use the Real Estate for any agricultural use.
- All excavation activities shall be performed by appropriately trained workers utilizing appropriate personal protection equipment pursuant to a Soil Management Plan, and a Health and Safety Plan that will comply with all applicable legal requirements and that will mitigate any potential ingestion, direct contact, or inhalation concerns. The Soil Management Plan, and a Health and Safety Plan shall be submitted to IDEM for approval prior to the start of any excavation activities. Information regarding prior soil sampling results is contained in IDEM's Virtual File Cabinet.
- The then-current Owner shall restore soil disturbed as a result of excavation and construction activities in such a manner that the remaining contaminant concentrations do not present a threat to human health or the environment. This determination shall be made using the Department's current risk-based guidance. Upon the Department's request, the Owner shall provide the Department written evidence (including sampling data) showing the excavated and restored area, and any other area affected by the excavation, does not represent such a threat. Contaminated soils that are excavated must be managed in accordance with all applicable federal and state laws, and disposal of such soils must also be done in accordance with all applicable federal and state laws.
- The then-current Owner shall prohibit any activity at the Real Estate that may interfere with the groundwater monitoring or well network.

If the owner does not agree to the ERC an alternative plan will be prepared and submitted to the IDEM.

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12.3 Holden Property Environmental Restrictive Covenants (ERC)

The Holden property borders the western edge of the City and includes current monitoring well CMT-A. The leading edge of the VOC plume is within the Holden property. Modeling suggests that the VOC migration is approaching a steady-state, but as discussed elsewhere in the RWP there may be a need for additional monitoring to verify stability. An ERC will be presented to the current property owner that addresses the groundwater exposure pathway, specifically:

- No Owner or its Related Parties shall use or allow the use of the Real Estate for residential purposes including, but not limited to, daily child care facilities or educational facilities for children (e.g., daycare centers or K-12 schools).
- No Owner or its Related Parties shall use or allow the use or extraction of groundwater at the Real Estate for any purpose including, but not limited to: human or animal consumption, gardening, industrial processes, or agriculture, except that groundwater may be extracted in conjunction with environmental investigation and/or remediation activities.

The then-current Owner shall prohibit any activity at the Real Estate that may interfere with the groundwater monitoring or well network. If the owner does not agree to the ERC an alternative plan will be prepared and submitted to the IDEM.

12.4 309 West Poston Road Environmental Restrictive Covenant (ERC)

This property is outside of the City limits and will not be included in the ERO. Water-supply wells currently in use do not produce VOCs. An ERC will be presented to the current property owner that addresses the groundwater exposure pathway, specifically:

- The Owner or its Related Parties shall allow access to existing water-supply wells for periodic sample collection as described in Section 13 of the RWP,
- No Owner or its Related Parties shall install potable water-supply wells to the north of existing well no. 2,
- No Owner or its Related Parties shall install non-potable water-supply wells to the north of well no. 2 that exceed 25 feet in depth,
- The Owner or its Related Parties shall allow access to sample that newly installed well(s) within two months of installation and the well will be added to the groundwater sampling plan as described in Section 13 of the RWP; and,
- No Owner or its Related Parties shall operate a water-supply well at a pumping rate of greater than 25 gallons per minute to minimize the potential for drawing the VOCs in groundwater to the south.

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If the owner does not agree to the ERC an alternative plan will be prepared and submitted to the IDEM.

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13.0 Monitoring Plan

13.1 Soil

The selected remedy does not include the need further soil sampling.

13.2 Groundwater

Groundwater sampling will be completed to address three areas:

- Verify the continued natural attenuation of VOCs.
- Verify the lateral extent of the VOC migration.
- Evaluate the advance of the shallow northern VOC plume.
- Confirm that the VOC concentrations in the six water-supply wells grandfathered under the City ERO or private property ERC meet the uses defined by the ERO and ERC.

13.2.1 Additional Monitoring Wells

Additional monitoring wells are proposed in advance of the cDCE and CE in the shallow northern plume observed at MW-22 as follows:

- Well CMT-J will be placed on the east side of South Ohio Street approximately midway between MW-20R and MW-26R and approximately 230 feet downgradient of MW-22.
- Public right-of-ways do not allow additional installations near the projected path of CVOC migration from MW-22. The nearest option for CMT-K is on the southeast edge of the corner of Green Street near MW-48B. This location is north of the projected plume centerline and approximately 190 feet to the west of CMT-J.

The wells are proposed as CMT system installations with sampling ports approximately 15, 30, and 40 feet bgs. In lieu of the CMT systems, standard 2-inch diameter PVC wells with 10-foot screens at the water table and 5-screens at depth may be installed.

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IDEM On-Site Report Comment 9. IDEM suggests that if the water table monitoring at MW-17 is confirmed to have been lost or destroyed, it may need to be replaced. We believe replacement is not required. Monitoring well MW-27 is placed at the water table approximately 140 downgradient of the MW-17 location and can fulfill the same monitoring objectives.

IDEM Off-Site Report Comment 7. The IDEM notes that the horizontal extent of the plume is reasonably delineated but goes on to indicate that additional wells are needed to monitor the width of the plume. The plume has likely been in development for 50 to 60 years of short- and long-term hydrologic variations. It is not likely that future naturally-occurring hydrologic changes will result in significant changes in the plume geometry. As noted on Figures 8 and 9, the extent of VOC concentrations to single-digit microgram per litre levels has been defined. This is sufficient to address the needs of the proposed remedy based on an ERO and ERCs for the area of the plume.

The IDEM also requests additional monitoring wells to the west of CMT-A, the most downgradient well currently installed. Chloroethene concentrations at a depth of 40 feet are on the order of 12 µg/L. The VOCs deep in the aquifer are advancing below farmlands in the floodplain of the White River where there are no current human or ecological exposures. In addition, an ERC with the property owner will be pursued to restrict the installation of new groundwater pumping wells in the projected path of the plume. The lack of risk suggest there is no immediate concern for additional monitoring. If future monitoring shows a clear advance of the VOC plume, addition groundwater monitoring will be installed to the west of CMT-A.

13.2.2 Sampling Plan

The following discussion is divided between the south and the north CVOC plumes, as previously discussed, and the water-supply wells. See Figures 2 and 5 for monitoring and water-supply well locations.

13.2.2.1 Monitoring Wells

Variable sampling frequencies are applied to address differences in well locations and analytical programs. The centerline of the plume will be sampled for VOCs the most frequently, every two years. Based on CVOC migration rates adjusted for retardation, CE has the fastest migration of the chlorinated ethenes at an estimated 80 to 210 ft/yr. Over a two-year period the CE would be estimated to move about 160 to 420 feet. Given the length of the plume (>5,000 feet) and the general 500- to 1,000-foot spacing of monitoring wells along the plume, there is a one- to nine-year time-period for changes to advance between sampling locations for the fastest CVOC. Sampling every two years provides a sufficiently frequent interval.

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Points above the plume centerline and at the water table will also be sampled for VOCs every two years because these locations are of particular concern with respect to the vapor intrusion pathway.

The plume has maintained a long and narrow shape since the start of CVOC migration as early as the 1950's. It is unlikely that site conditions will change significantly in the future. The sampling frequency is therefore proposed to be once every four years to confirm the lateral edges of the CVOC migration.

The shallow plume near the Site is not yet stable and appears to be advancing based on the observations from MW-22. The monitoring wells in this area are therefore included on a more frequent schedule than those of the southern plume.

Monitoring wells installed on the centerline on the plume for VOC monitoring near the leading edge of CVOC migration (MW-22, CMT-J and CMT-K) are spaced approximately 200 feet apart and will be sampled once per year. Since the centerline of the plume appears to be at the water table, these wells will also address the vapor intrusion issue. Centerline wells near and in the East Parking Lot Area (MW-34 and PT2-S) will be sampled once every two years since the source decay rate is not very fast based on the historical data.

Monitoring wells on the lateral edges of the plume will again be sampled once every four years.

Once extended concentration time trends have been compiled it will be appropriate to revisit the proposed sampling plan. This reassessment will occur once every six years. The first reassessment will include three to six rounds of VOCs from the groundwater above the plume, one round of VOCs from the plume centerline and the lateral edges of the plume.

Groundwater sampling events for the selected monitoring wells in the northern and southern VOC plumes leaving the site are provided in the following table. All sampling events are planned for April or May.

IDEM Off-Site Report Comment 4. The IDEM requests that CMT-E(20) and CMT-F(20) be resampled to confirm results to-date. These sampling points are included in the program presented in the following table.

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Well Location	Sample Depth (ft bgs)	CMT Channel	Frequency (years)	Field Parameters	Laboratory Analyses
CMT-A (to assess stability of VOC migration)	18	1 & 2	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	40 (centerline)	3 & 4	4		
			4		
	62	7	Not sampled		
CMT-B (to assess stability of VOC migration and potential for VI)	20'	1 & 2	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	60' (centerline)	3 & 4	4		
	85'	7	Not sampled		
CMT-C (to assess lateral migration of VOCs)	20'	1 & 2	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	60'	3 & 4	4		
	85'	7	Not sampled		
CMT-D (to assess lateral migration of VOCs)	20'	1 & 2	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	60'	3 & 4	4		
	85'	7	Not sampled		
CMT-E (to assess stability of VOC migration and potential for VI)	20'	1	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	40'	2	4		
	70' (centerline)	3	4		
	90'	7	Not sampled		

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Well Location	Sample Depth (ft bgs)	CMT Channel	Frequency (years)	Field Parameters	Laboratory Analyses
CMT-F (to assess stability of VOC migration and potential for VI)	20'	1 & 2	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	50' (centerline)	3 & 4	4		
	80'	7	Not sampled		
CMT-G (to assess lateral migration of VOCs)	20'	1 & 2	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	50'	3 & 4	4		
	80'	7	Not sampled		
CMT-H (to assess lateral migration of VOCs)	20'	1 & 2	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	50'	3 & 4	4		
	80'	7	Not sampled		
CMT-I (to assess stability of VOC migration and potential for VI)	17'	4	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	29'	2	4		
	59' (centerline)	3	4		
	84'	7	Not sampled		
MW-43A (to assess potential for VI)		NA	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs

Well Location	Sample Depth (ft bgs)	CMT Channel	Frequency (years)	Field Parameters	Laboratory Analyses
MW-43C (to assess stability of VOC migration)	35-45	N/A	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-43A (to assess potential for VI)		NA	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-46C (centerline, to assess VOC attenuation)	35-45	N/A	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-27 (centerline, to assess potential VI)	8-18	N/A	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
DMW-76 (centerline, to assess VOC attenuation)	30-40	N/A	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-45A (centerline, to assess potential VI)	8-18	N/A	2	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs

Well Location	Sample Depth (ft bgs)	CMT Channel	Frequency (years)	Field Parameters	Laboratory Analyses
MW-45C (centerline, to assess VOC attenuation)	39-49	N/A	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
CMT-J (to be installed to assess attenuation of the shallow north plume and potential for VI)	~15 (centerline)	To be determined	1	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	~30	To be determined	To be determined		
	~45	To be determined	To be determined		
CMT-K (to be installed to assess attenuation of the shallow north plume and potential for VI)	~15	To be determined	1	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
	~30	To be determined	To be determined		
	~45	To be determined	To be determined		
MW-20R (to assess potential for VI)	8-18	N/A	1	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-26R (to assess potential for VI)	8-18	N/A	1	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs

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Well Location	Sample Depth (ft bgs)	CMT Channel	Frequency (years)	Field Parameters	Laboratory Analyses
MW-22 (centerline, to assess attenuation of the shallow north plume and potential for VI)	8-18	N/A	1	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
MW-34 (centerline, to assess East Parking Lot source area reduction)	6-16	NA	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs
PT-2S (centerline, to assess East Parking Lot source area reduction)	12	N/A	4	water level, pH, specific conductance, temperature, ORP, DO, turbidity	VOCs

13.2.2.2 Water-Supply Wells

As noted in Section 12.1 of the RWP, the wells at 1240 South Ohio Street are within Zone A of the proposed ERO, where existing non-potable use wells will be "grandfathered" under the proposed ERO. An attempt will be made to have these wells abandoned so that there are no active water-supply wells in Zone A. If the owner does not agree to abandonment, permission to sample the non-potable water-supply wells will be requested from the owner. If the wells at 1240 South Ohio Street are not abandoned, access will be requested to sample both wells annually in April or May, prior to summer when the site-specific "kiddie pool" exposure scenario could take place.

The non-potable use wells at 340 and 409 West Poston Road will be sampled (if the owners allow access) once every two years in April or May as long as the monitoring well data confirm the current VOC distribution in groundwater. If VOCs appear at the shallowest sampling points just upgradient of these wells, the non-potable wells will be placed on an annual sampling schedule. The property owner at 309 W. Poston Road will be contacted prior to each scheduled water-supply well sampling event for permission to

sample the wells. If the owners refuse permission to sample the wells or if the well is taken out of service by the owner, no further sampling will be required. Sampling will take place once every two years. These wells are located ~3,000 feet downgradient of the Site. The two-year sampling schedule is based on the observation that the plume has had on the order of 50 years to develop under a variety of seasonal and long-term hydrologic conditions. Short-term variation in the plume geometry is not expected. The sampling event will coincide with groundwater sampling events as noted in Section 13.2.2.1.

The owners of the well at 1430 RJ Boulevard and 1440 RJ Boulevard indicated the wells are used for non-potable purposes. Therefore, the wells will not be sampled because the wells are located to the north and above the VOC plume. The wells in the Hacker Drive neighborhood are shallow and intended for non-potable uses as determined by Eco-Innovators. The wells are above and to the south of the VOC plume and will therefore not be sampled.

IDEM Off-Site Report Comment 14. The IDEM requests a minimum of quarterly sampling of residential wells "near or within the groundwater plume". Such frequent monitoring is not proposed because VOC plume development over at least 50 years, in a large and highly permeable aquifer, and potential VOC migration distances of 100's to 1,000's of feet have likely attenuated seasonal variations in concentrations that may have been present in the source areas on the former Harman-Becker Facility.

The IDEM does not define "near". Based on the maturity of the plume and the size of the aquifer, we believe the residential wells on Hacker Drive and RJR Boulevard are not sufficiently near to warrant inclusion in the sampling program.

IDEM Off-Site Report Comment 15. We agree that it would be beneficial for the City of Martinsville to choose a location "furthest away from the plume" for any future municipal water-supply wells. The City is aware of the VOC spatial distribution and the IDEM should contact the City directly if the agency wishes to discuss future well locations.

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13.2.3 Sampling and Handling Procedures

13.2.3.1 Sample Collection

Well sampling will be completed in accordance with the USEPA's Low-Flow (minimal drawdown) groundwater sampling procedures (EPA/540/S-95/504, April 1996) in an effort to reduce the sedimentation in the samples and eliminate false positive laboratory analytical results. This method provides minimal disturbance to the aquifer, minimal volatilization and sediment turbidity.

The procedure involves groundwater purging rates between 0.1 and 0.5 liters per minute while maintaining minimal draw-downs, typically less than 0.3 feet. Positive displacement pumps will be used to evacuate water from the screened portion of the well to the surface apparatus for purging and sampling wells. A micro double valve (MDV) pump will be employed at the CMT wells and a submersible bladder pump will be employed at the other monitoring wells. Both pumps are enabled by intermittent positive air pressure from a controller/air compressor system.

The MDV pump (Solinst Model 408M or equivalent) is attached to a concentric dual-tube system. During operation, air from the controller pushes down on the water column in the drive line, closing the check valve at the base of the pump. This forces the water up the inner 3/16-inch sample line tubing. A vent cycle, during which the gas is released, allows water to refill the pump and drive line. The top check valve prevents water in the sample line from falling back in to the pump body.

During the operation of the bladder pump (QED SamplePro or equivalent), air pressure, produced by a small compressor, closes a check valve and powers a plastic bladder via 0.25-inch poly tubing and water is pushed up another 0.25-inch poly tubing. During the vent cycle, the gas is released from the bladder and water is allowed to refill the bladder area.

At the surface, the pump discharge tubing is attached to a flow-through cell. Located at the top of the flow cell is the multi-probe (Horiba U-52 or equivalent). The multi-probe measures groundwater geochemical parameters: pH, oxidation-reduction potential (ORP), specific conductivity, temperature, turbidity and dissolved oxygen (DO). Each of the probes and their associated meters will be calibrated once each day of use according to the manufacturer's specifications. Water quality parameters are monitored throughout purging to verify stabilization prior to groundwater sample collection. The time and results of the field parameters will be recorded on a sample log at approximately one liter increments until the parameters have stabilized. Once the parameters have stabilized, the discharge groundwater is considered representative of the aquifer.

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During laboratory sample collection, the flow cell will be removed and groundwater will be discharged directly into properly preserved laboratory-provided containers. The samples will be labeled, logged on the chain-of-custody, and placed on ice in an insulated cooler for transport to the laboratory.

The pump, tubing, flow-through cell and the multi-probe instruments will be decontaminated between monitoring well samples using a laboratory-grade soap and water rinse.

Water-supply wells will be sampled at the kitchen tap. The taps will be opened to full flows for 10 minutes. The flow rate will then be reduced to less than approximately 100 mL/minute and the sample containers will be filled.

QA/QC samples will be collected as described in the QAPP.

13.2.3.2 Labeling

Each collected and packaged sample will be identified by attaching a water-proof tag or label to the container prior to sampling or immediately thereafter. Tags or labels must be completed using permanent, waterproof ink. They should be protected against detachment from the individual sample containers if they get wet. Labeling schemes are valid as long as they are logical and consistent and documented in such a way as to allow one to easily determine the exact location where each sample was collected.

Each tag or label must contain, at a minimum, the following:

- Sample number that uniquely identifies that sample.
- The project number.
- The project name or site name.
- Date and time of sample collection.
- Preservative added.

13.2.3.3 Transportation

When transporting samples from the site to either the office or laboratory, they must be kept inside a secure storage container at all times the inside of which, if necessary, is kept chilled. The storage container should not be subjected to excessive heat or potential sources of contamination. If samples are relinquished by the sampler to another person for transport to the laboratory, proper chain-of-custody transfer documentation must be followed. Custody of the samples should only be transferred to persons who are qualified to handle or transport them.

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13.2.3.4 Chain-of-custody Procedures

The purpose of chain-of-custody procedures is to permit traceability from the time samples are collected until all data has been generated. The procedures are intended to document sample possession from the time of collection and disposal. This practice provides documentation during each step, that is, during shipping, storage, and during the process of analysis.

As few people as possible should handle samples. The field sampler is responsible for the care and custody of the samples collected until they are properly transferred. Labels or tags should be firmly attached to the sample containers and made of waterproof paper.

As with all other field data, chain-of-custody information should be recorded when sampling is taking place. Record all chain-of-custody sampling data while on-site. The chain-of-custody record accompanies the samples. When transferring possession of samples, the individuals relinquishing, the shipper, and the receiver of the samples are to sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in a laboratory.

13.2.4 Investigative Derived Wastes

Purged well water is to be placed in 55-gallon UN/DOT approved drums and staged in a secure area of the former Harman-Becker site. Containers are to be labeled with site information (name, address, and project number), monitoring well location identification, generation date and contents. Investigative derived wastes will be disposed periodically by Eco-Innovators during the implementation of the RWP.

13.2.5 Chemical Analyses

The analyses of groundwater samples as described in Section 13.2.2 of this Plan will be performed as follows:

Analyte	Method	Reporting Limit
VOCs	8260	5 µg/L for all but CE (2 µg/L)

13.2.6 Quality Assurance/Quality Control

In order to evaluate data quality, QA/QC samples will be collected during the sampling activities as follows: Matrix Spike/Matrix Spike Duplicates (MS/MSD), field duplicates and trip blanks.

The samples collected for the RWP will include groundwater samples to be analyzed for VOCs using Method 8260. Field duplicate samples provide precision information for the entire measurement systems. Duplicate samples will be collected for the laboratory analytical portion of this project. Duplicate samples will be analyzed after every 20 samples or one per project, if less than 20 total samples. A trip blank is an unopened sample that contains only laboratory-grade and organic-free water. The trip blank accompanies field samples scheduled for VOC analysis. Trip blank results are used to indicate whether the field samples have been exposed to VOC sources that are not representative of the Site's subsurface. One trip blank set will be submitted with each cooler transported to the laboratory that contains samples for VOC analysis. MS/MSDs are used by the laboratory for internal control checks. The laboratory normally requires field technical staff to collect triple the sample volume (see the laboratory QAM in Appendix 4) to perform the MS/MSD analysis.

The laboratory quality assurance processes are described in Appendix 4.

Equipment/rinsate blank and field blank samples will be collected only if reusable equipment is decontaminated and reused at another sample point. The rinsate sample will be collected to evaluate the effectiveness of the decontamination process of non-disposable sampling equipment.

13.3 Vapor Sampling

Vapor sampling is currently not planned because sampling to-date has found no VOC concentrations above indoor air screening levels at the VOC concentrations currently observed in the groundwater.

Current groundwater concentrations on the order of 100 to 500 µg/L of PCE below the Clore street neighborhood result in maximum indoor air concentrations on the order of 9 ug/m^3 compared to a RCG screening level of 42 µg/m^3. This suggests that PCE concentrations in groundwater could increase by a factor of four (4) times before screening levels are exceeded. Chloroethene was noted at 60 µg/L in groundwater and was not detected in any of the residential air samples, suggesting that a four-fold increase in groundwater chloroethene concentrations would also be protective of indoor air exposures.

Therefore, if the concentrations of PCE and CE increase by a factor of four over the current maximum concentrations a VI Sampling Plan based on the observed groundwater concentrations will be submitted to the IDEM within 30 days after the groundwater results are obtained. Additional sampling and/or mitigation will be based on the results of the VI Sampling. The specific concentration triggers for the VI Plan would be 2,000 µg/L for tetrachloroethene and 240 µg/L for chloroethene.

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13.4 Reporting and Data Management

This section describes the QA activities that will be performed to ensure that the collected data are scientifically defensible, properly documented, and of known quality, and meet project objectives.

All analytical data collected for this project will be validated. The analytical data will be reduced, validated and reported.

Data reduction includes converting raw data to final results. Project-specific data reduction methods are designed to ensure that data are accurately and systematically reduced into useable form.

The data generated for this investigation will be used to support Site closure using the IDEM RCG cleanup goals. The data will not be used to develop non-default or risk-based cleanup goals.

Data collected during the field activities will be evaluated for usability by conducting a QA review, which will consist of checking the procedures used and comparing the data to previous measurements.

Field QC samples will be evaluated to ensure field measurements and sampling protocols have been followed. Validation checks for these samples include, use of SOPs, calibration method and frequency, date and time sampled, preservation, and chain-of-custody documentation.

QA review of data obtained from field measurements will be performed by the QA Manager. Validity of all data will be determined by checking calibration procedures used in the field and by comparing the data to previous measurements. Large variations (greater than 50%) and inconsistencies will be examined for possible recollection of data or assignment to a lower level of validity. Copies of all raw data and calculations used to generate final results will be retained to allow reconstruction of the data reduction process.

Laboratory data will be summarized in tabular form and included in reports. Complete laboratory reports will be included as appendices to the report including QA/QC reports generated during the analysis of samples. Data to be presented in tabular form will include laboratory analytical results for groundwater in micrograms per liter (µg/L) and groundwater Elevation Data.

Field and laboratory data will also be summarized in figures.

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14.0 Long-Term Stewardship Plan

IDEM Off-Site Report Comment 25. The following discussion has been included in the RWP as requested by the IDEM.

A Long-Term Stewardship plan will be developed to document monitoring requirements, responsibilities, and contingency plans to ensure that pathways will remain incomplete or that completed pathways pose no risk. The project-specific pathways of concern that will be addressed include exposure to VOCs through:

- Use of existing and new potable water-supply wells within Zones A and B of the proposed City of Martinsville ERO Area.
- Use of existing and new non-potable water-supply wells within Zone A of the proposed City of Martinsville ERO Area and parcel-specific ERCs.
- Residential vapor intrusion from groundwater adjacent to the Site.
- Industrial setting vapor intrusion barrier integrity and direct contact with soil within a proposed parcel-specific ERC.

The Stewardship Plan will be completed once the IDEM has approved the proposed remedial action, an ERO has been put in place, and several ERCs have been established with private property owners.

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15.0 Health and Safety Plan

The project Health and Safety Plan is provided in Appendix 5.

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17.0 Environmental Professional Signature

This RWP was prepared in accordance with the IDEM RCG. The Environmental Professional represents that to the best of their knowledge, the above statements and facts are true and correct and that no material facts have been suppressed or misstated.

Bernd W. Rehm LPG #448 Senior Hydrogeologist ReSolution Partners, LLC	Date

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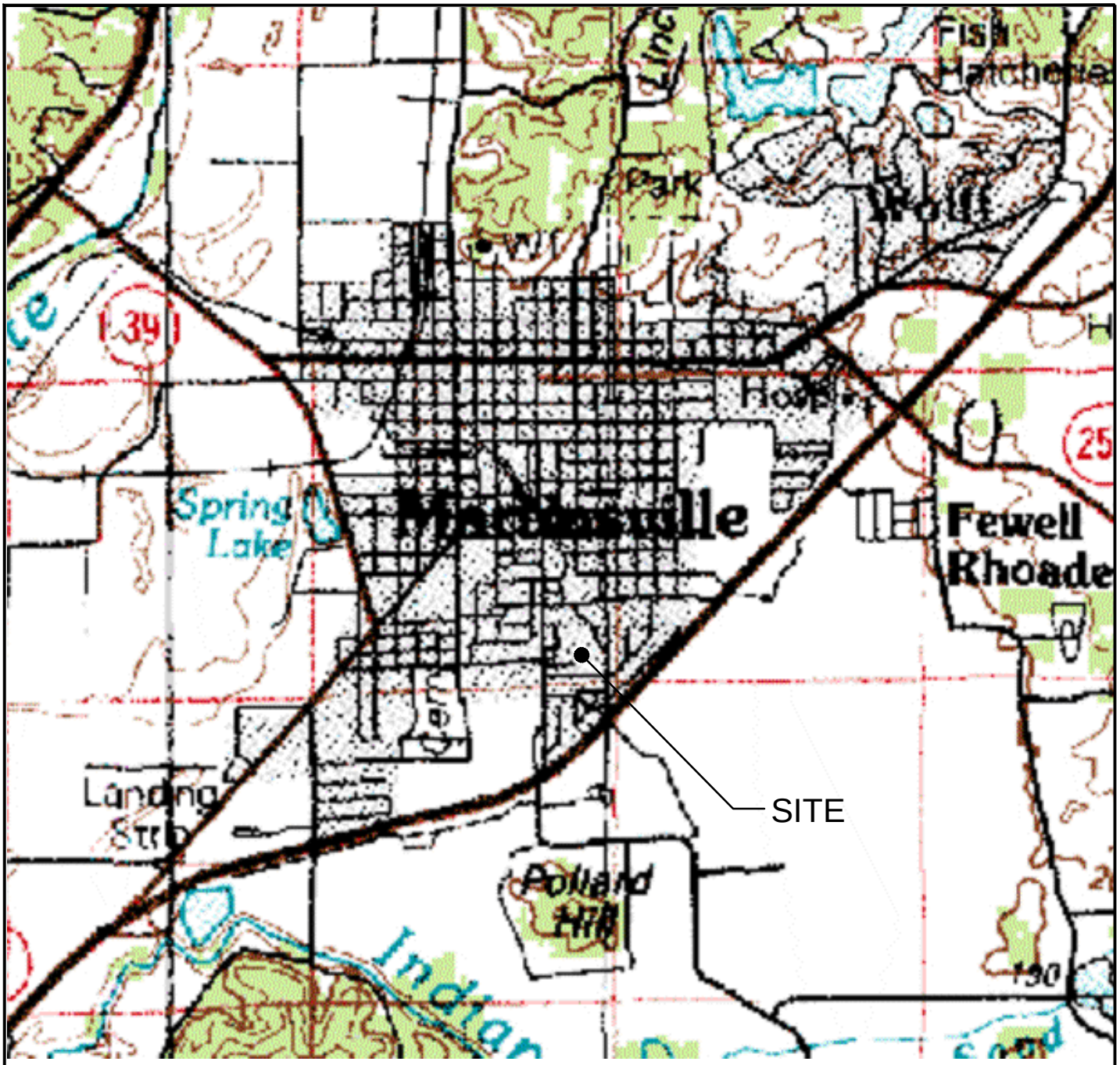


Base map is USGS Quadrangle map "Martinsville".

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

ReSolution Partners, LLC

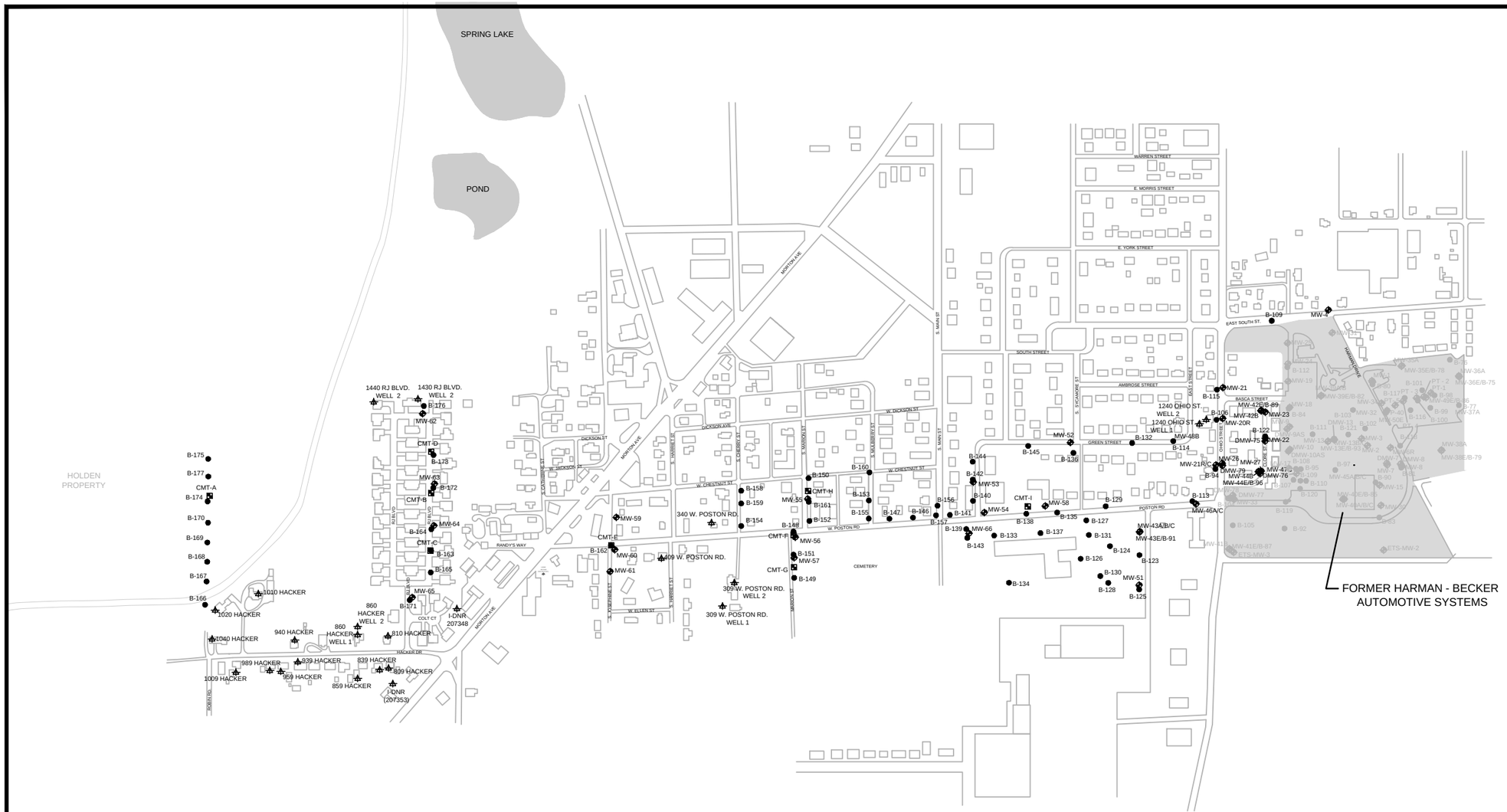
SHEET TITLE

FIGURE 1 - SITE LOCATION MAP

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–01



Note:

1. The Martinsville Water Utility wells are located at 410 West Cunnigham Street, which is located 6100 feet North and 3500 feet East of the fromer Harman–Becker site.

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
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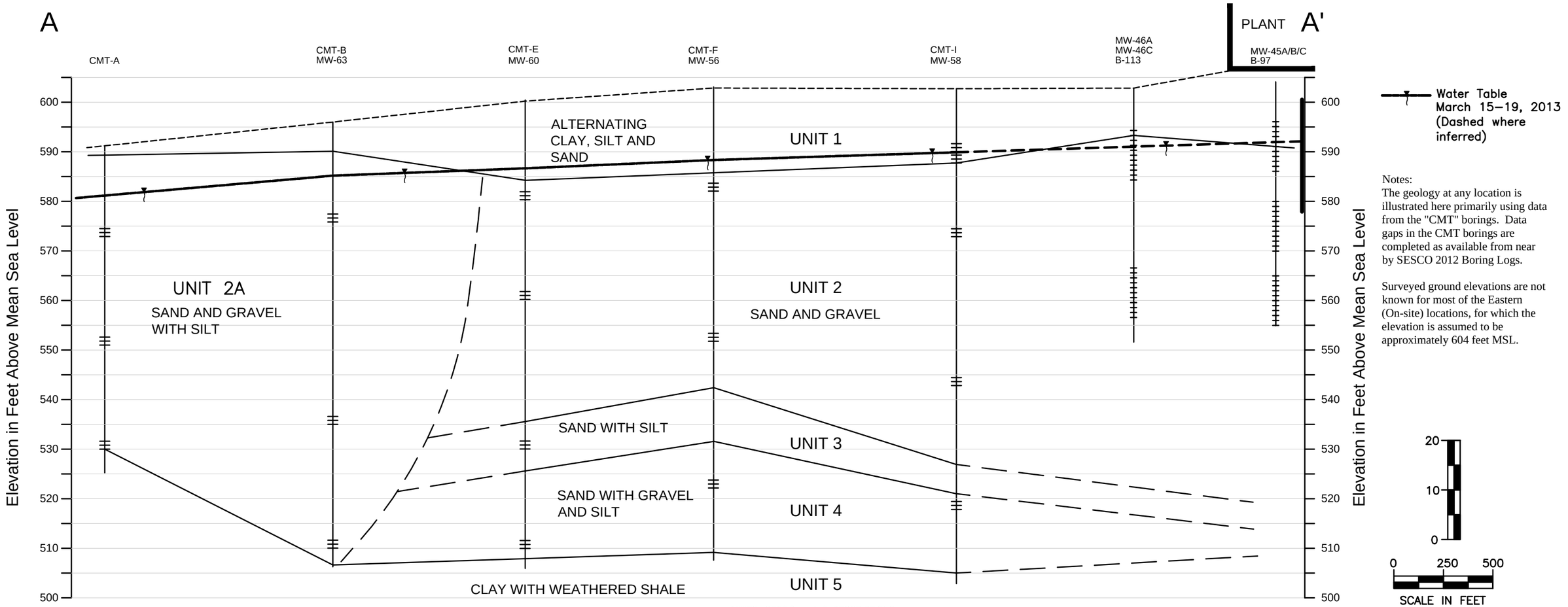
FIGURE 2
BORING, MONITORING WELL AND
RESIDENTIAL WELL LOCATIONS

ReSolution Partners, LLC

DATE: April 2014

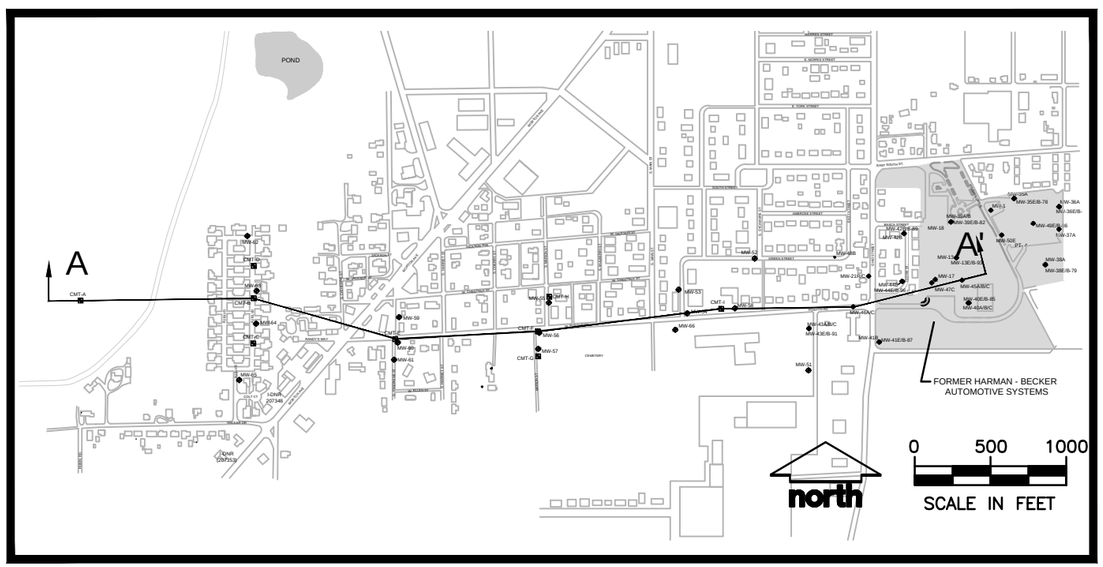
REVISION: REV: 0

DWG: 147–001–02



Notes:
The geology at any location is illustrated here primarily using data from the "CMT" borings. Data gaps in the CMT borings are completed as available from near by SESCO 2012 Boring Logs.

Surveyed ground elevations are not known for most of the Eastern (On-site) locations, for which the elevation is assumed to be approximately 604 feet MSL.



CROSS–SECTION UNIT DESCRIPTIONS:

Unit 1: The uppermost unit is composed of alternating zones of clay, silt, clayey sand, silty sand and fine to medium poorly– to well–graded sand. The sandy zones have no to some silt and occasionally have trace gravel. The surface 1 to 1.5 feet occasionally has gravelly fill. The unit tends to thin and have a higher clay concentration to the west. Two grain–size analyses contained from 2 to 12 percent gravel, 83 to 95 percent sand, and 3 to 5 percent silt and clay (SESCO, July 2011). One test for total organic carbon (defined as loss on ignition) yielded a value of 0.072 percent (SESCO, July 2011). This uppermost geologic unit is from 15 to 25 feet thick.

Unit 2: Approximately 4000 feet west of the site, the geology between approximately 70 to 15 feet bgs is predominantly fine to coarse poorly– to well–graded sand with a trace of silt and varying amounts of gravel, from no to gravelly, with occasional thin lenses of silt.

Unit 2a: Beyond 4000 feet of the site, the unit appears to converge with Unit 4 (described above) to an alternating fine to coarse poorly– to well–graded sand and fine to coarse well–graded gravel, all with a trace of silt. Three grain–size analyses contained from 0 to 12 percent gravel, 85 to 97 percent sand, and 3 to 12 percent silt and clay (SESCO, July 2011). The hydraulic conductivity of this sand unit has not been determined below the site. Investigations at the nearby Twigg Corporation found the hydraulic conductivity of the unit to range from 2.6 x 10–3 to 1.3 x 10–1 cm/s with a geometric mean value of 1.9 x 10–2 cm/s (BCA, October 2011).

Unit 3: Is fine to coarse poorly– to well–graded sand with a trace of silt, occasional clayey layers. A laboratory permeability test of a clay seam in this unit yielded a value of 1.1 x 10–8 cm/s.

Unit 4: Is a fine to coarse generally well–graded sand with trace silt and varying amounts of gravel, from trace gravel to gravelly overlies the shale at thickness between 15 to 25 feet. A grain–size analysis contained 22 percent gravel, 74 percent sand, and 4 percent silt and clay (SESCO, July 2011). One test for total organic carbon (defined as loss on ignition) yielded a value of 0.048 percent (SESCO, July 2011).

Unit 5: Is a stiff clay to very hard weathered shale is found at depths of approximately 95 feet below ground surface (bgs), at an elevation of 500 to 510 feet mean sea level (MSL). The western–most boring (CMT–A) has the clay appearing at a much more shallow depth of 63 ft bgs or elevation of 532 ft MSL. A laboratory permeability test of the weathered shale yielded a value of 9.0 x10–9 cm/s (SESCO, July 2011).

PROJECT

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SHEET TITLE

FIGURE 3
GEOLOGIC CROSS SECTION A-A'

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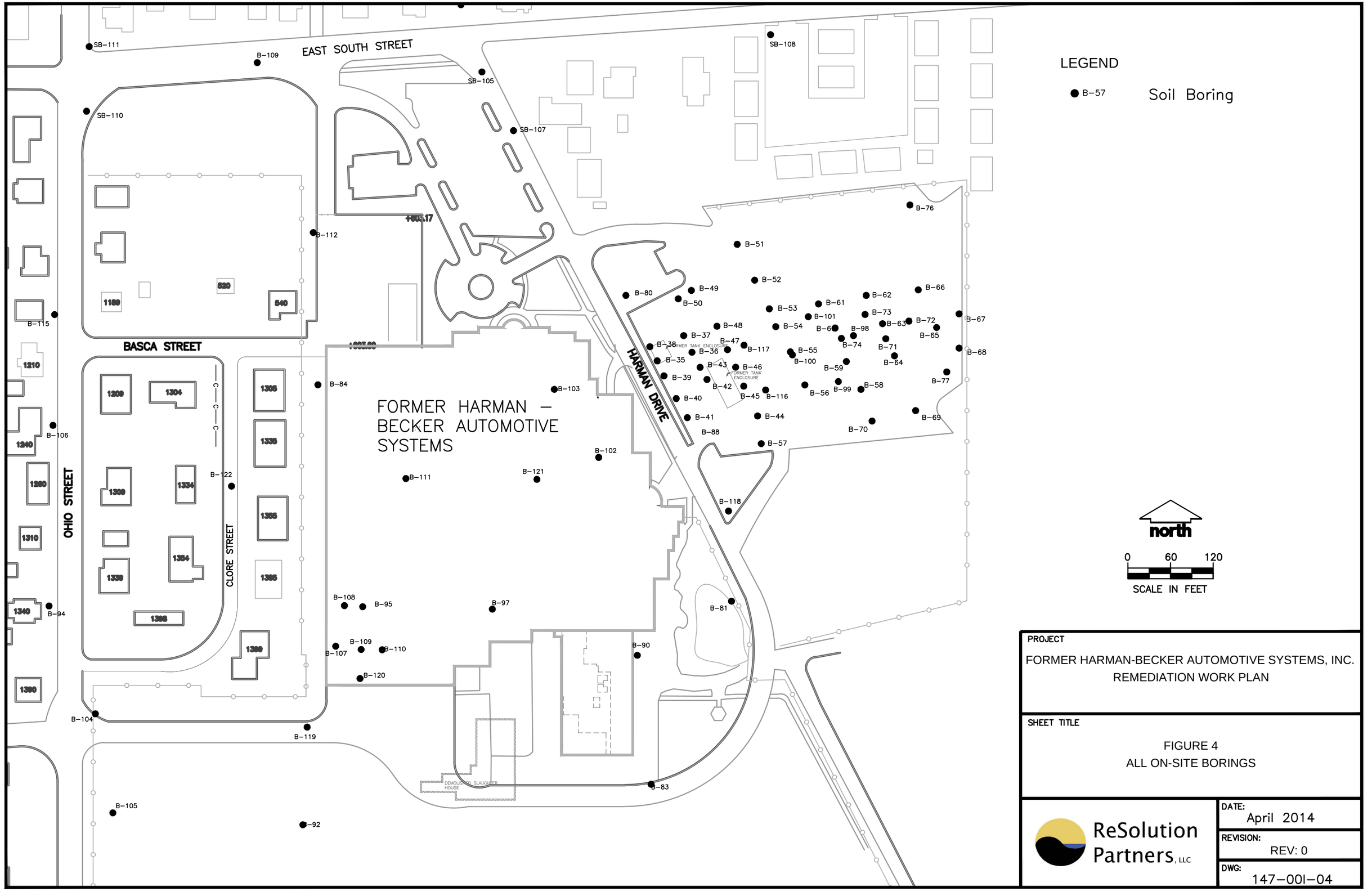

PROJECT

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SHEET TITLE

FIGURE 4
ALL ON-SITE BORINGS

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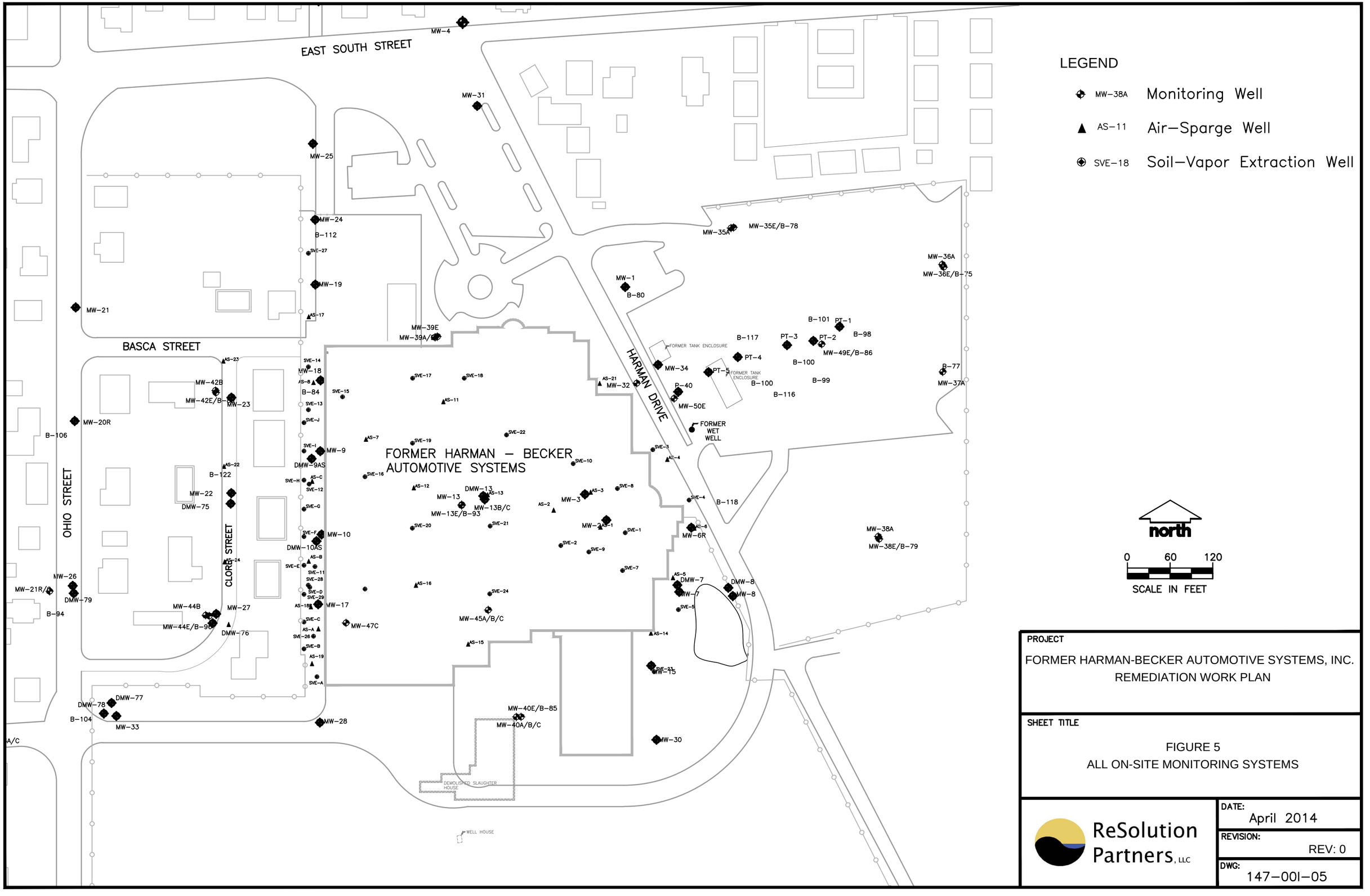
DATE: April 2014

REVISION: REV: 0

DWG: 147-001-04



LEGEND

- MW-38A — Monitoring Well
- AS-11 — Air–Sparge Well
- SVE-18 — Soil–Vapor Extraction Well

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

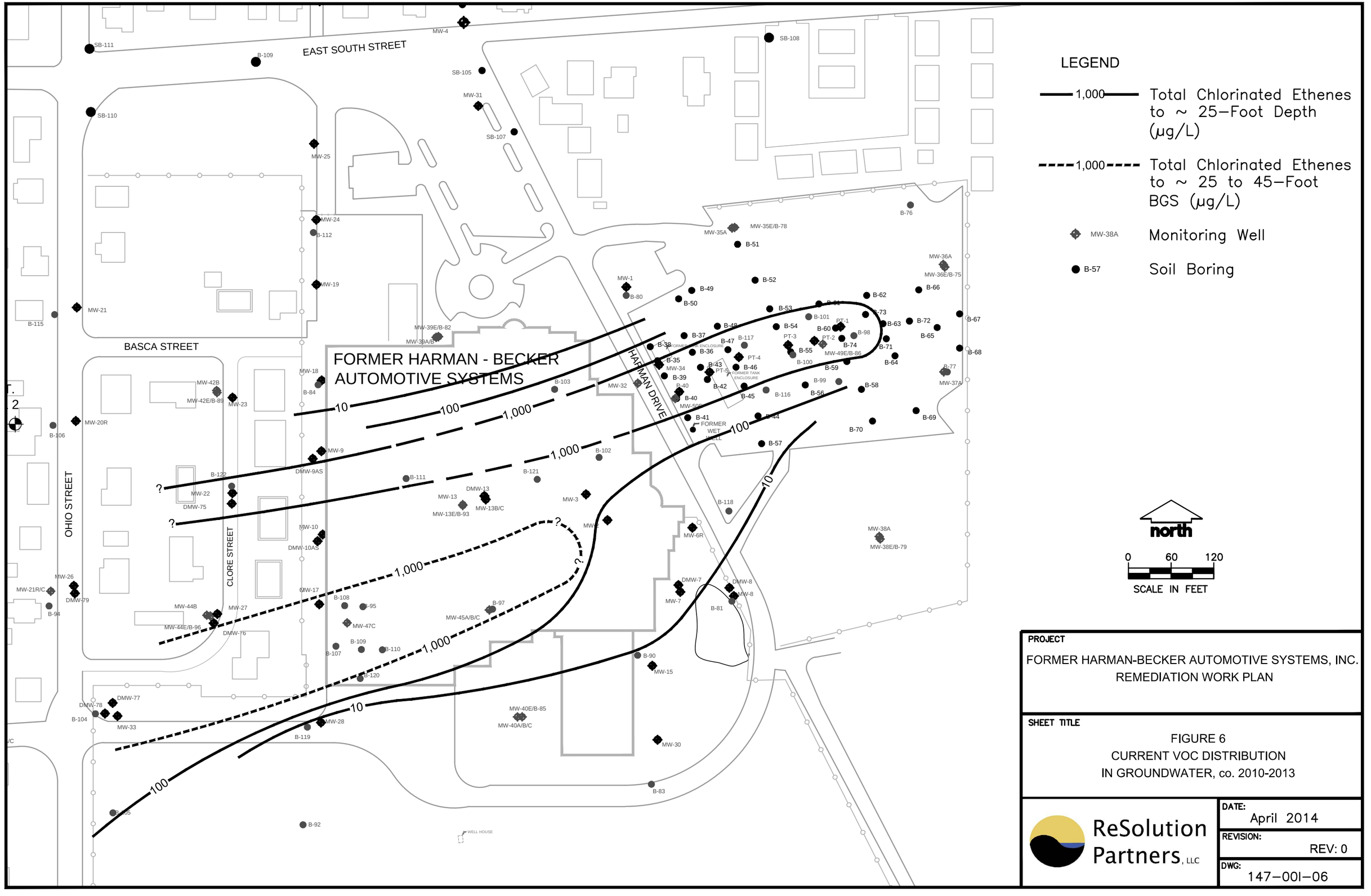
FIGURE 5
ALL ON-SITE MONITORING SYSTEMS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–05



LEGEND

- 1,000 — Total Chlorinated Ethenes to ~ 25–Foot Depth (µg/L)
- 1,000 — Total Chlorinated Ethenes to ~ 25 to 45–Foot BGS (µg/L)
- MW-38A — Monitoring Well
- B-57 — Soil Boring

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

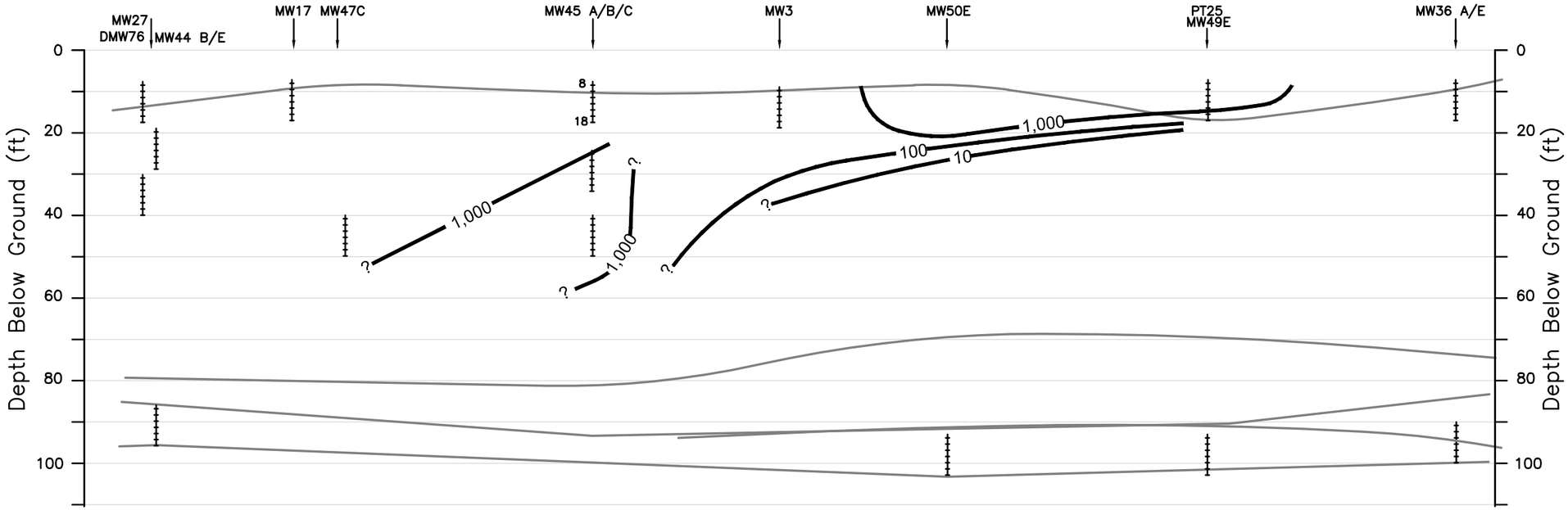
FIGURE 6
CURRENT VOC DISTRIBUTION
IN GROUNDWATER, co. 2010-2013

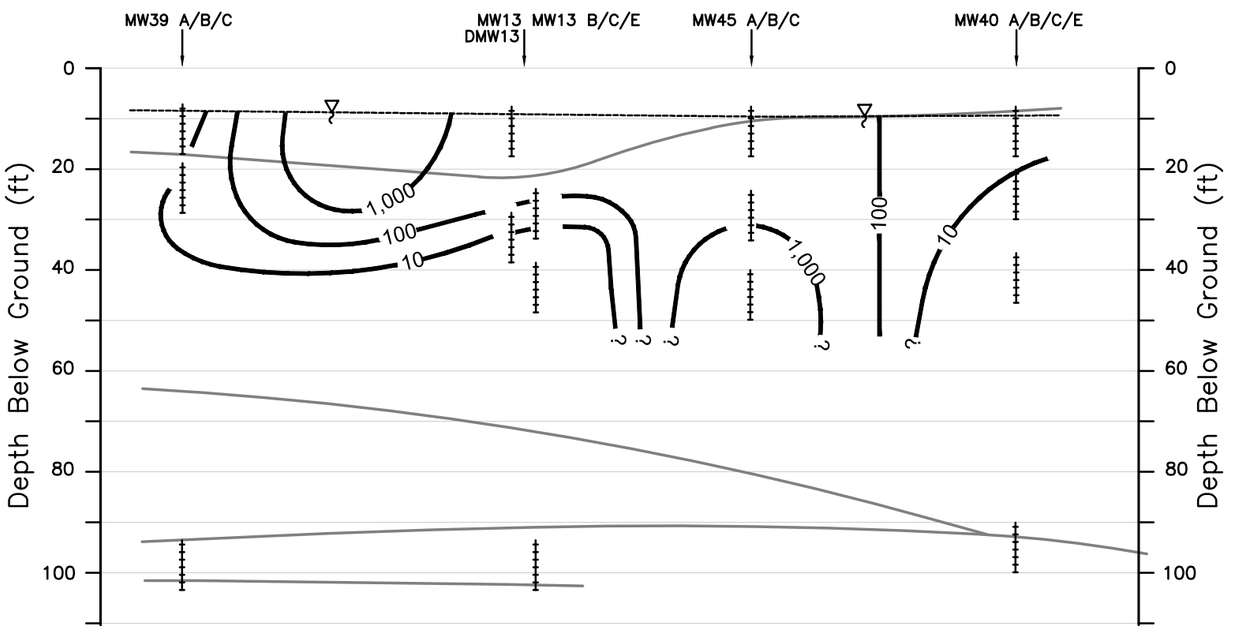
ReSolution Partners, LLC

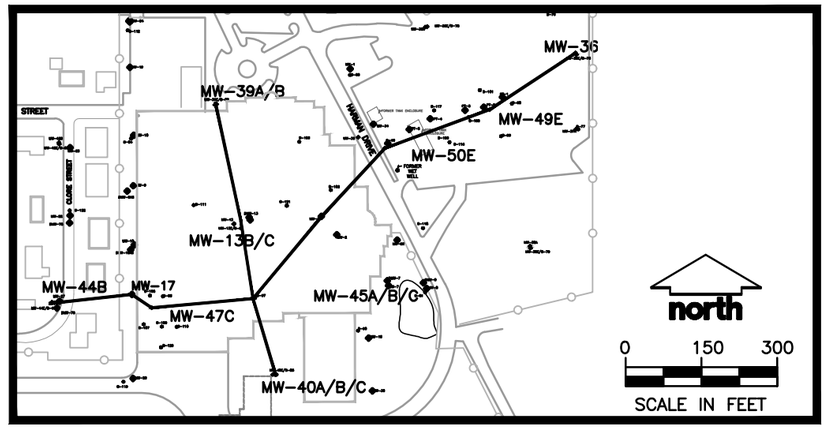
DATE: April 2014

REVISION: REV: 0

DWG: 147–001–06







LEGEND

1000 — Total chlorinated ethenes (µg/L)

Well Screen

Surveyed ground elevations are not known for most locations. Cross-sections presented as depth below ground surface (assumed ~ 604 feet MSL)

0 50 100
SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

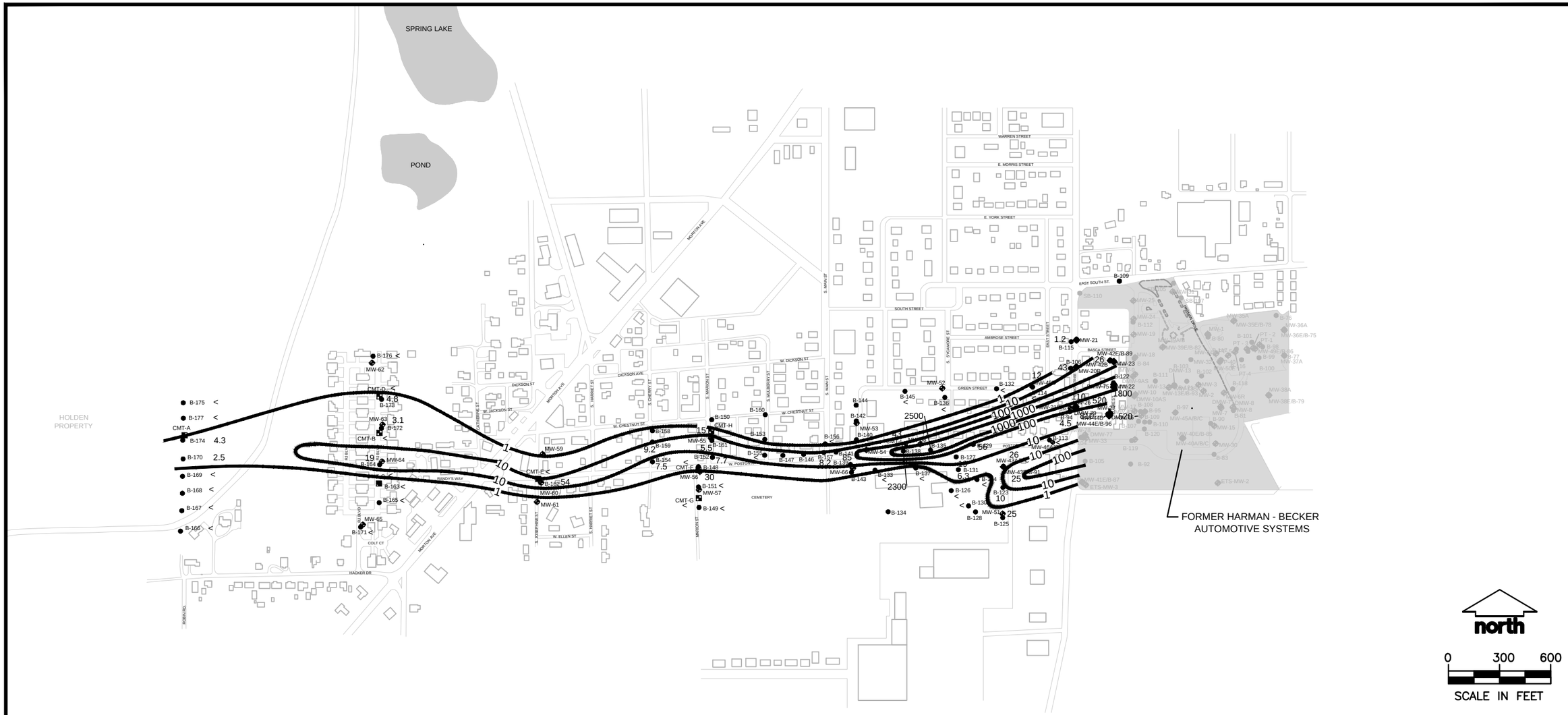
FIGURE 7
CURRENT VOC DISTRIBUTION
IN CROSS-SECTION, co. 2010-2013

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-07



NOTES:

1. Where data is available from multiple intervals during the same collection date at a given location, the highest concentration is listed.
2. Data used to prepare this figure include the most recent fixed lab groundwater results collected 2010-2013 within 30 feet of the ground surface.

LEGEND

9.2	Total Chlorinated Ethenes, (µg/L) Latest Available Data During 2010-2013
<	No Detected Ethenes Concentration
100	Isoconcentration Line (µg/L) Total Chlorinated Ethenes (Dashed Where Inferred)

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

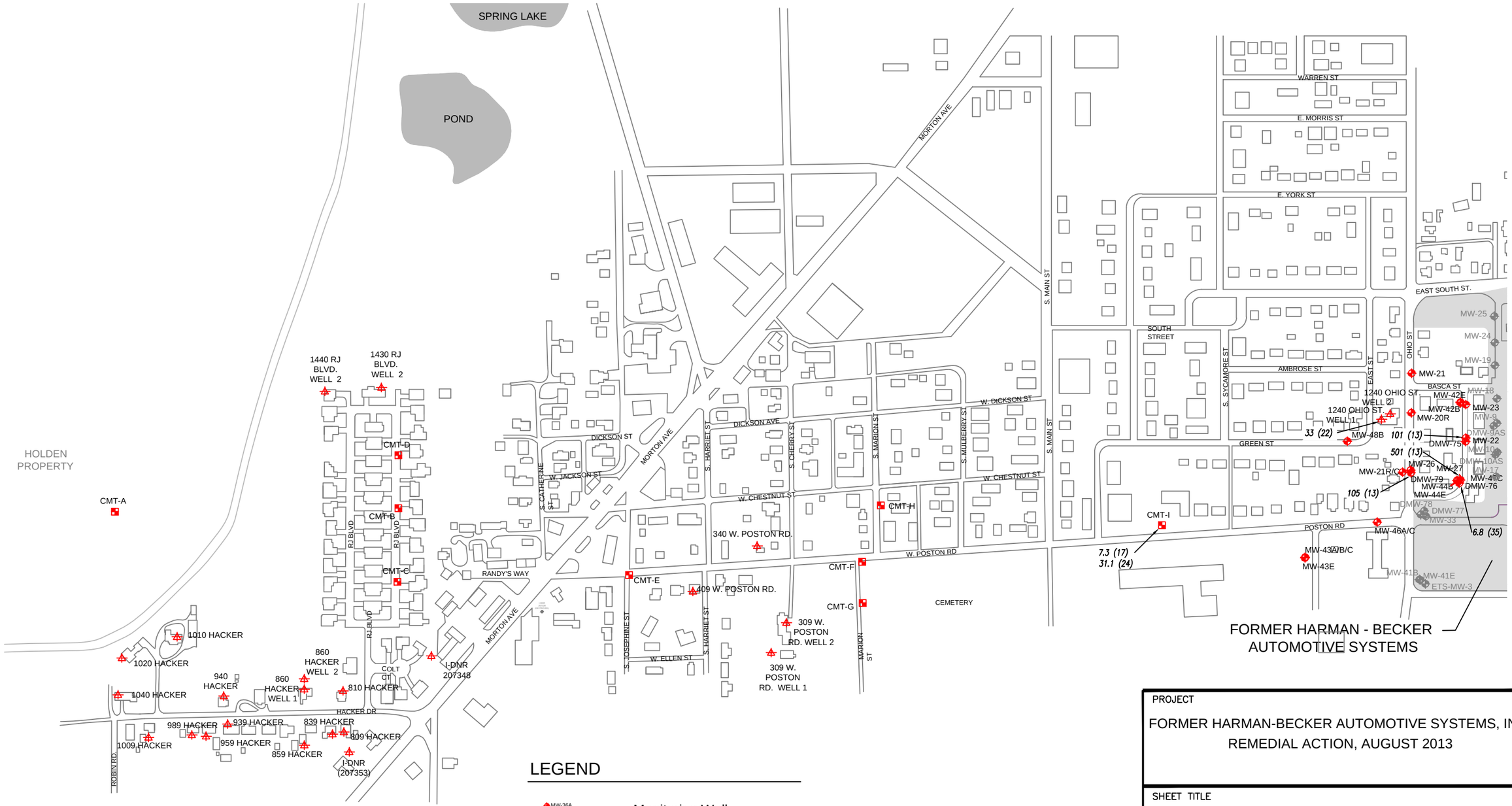
FIGURE 8
TOTAL CHLORINATED ETHENES
2010-2013
SHALLOW AQUIFER

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-08



LEGEND

MW-36A	Monitoring Well
CMT-H	CMT Well
1240 OHIO ST. WELL 2	Resdential Wells
7.3 (17)	µg/L (Depth, Feet). Latest Result in the Period 2010–2013 Greater than 5 µg/L

north

0 200 400

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

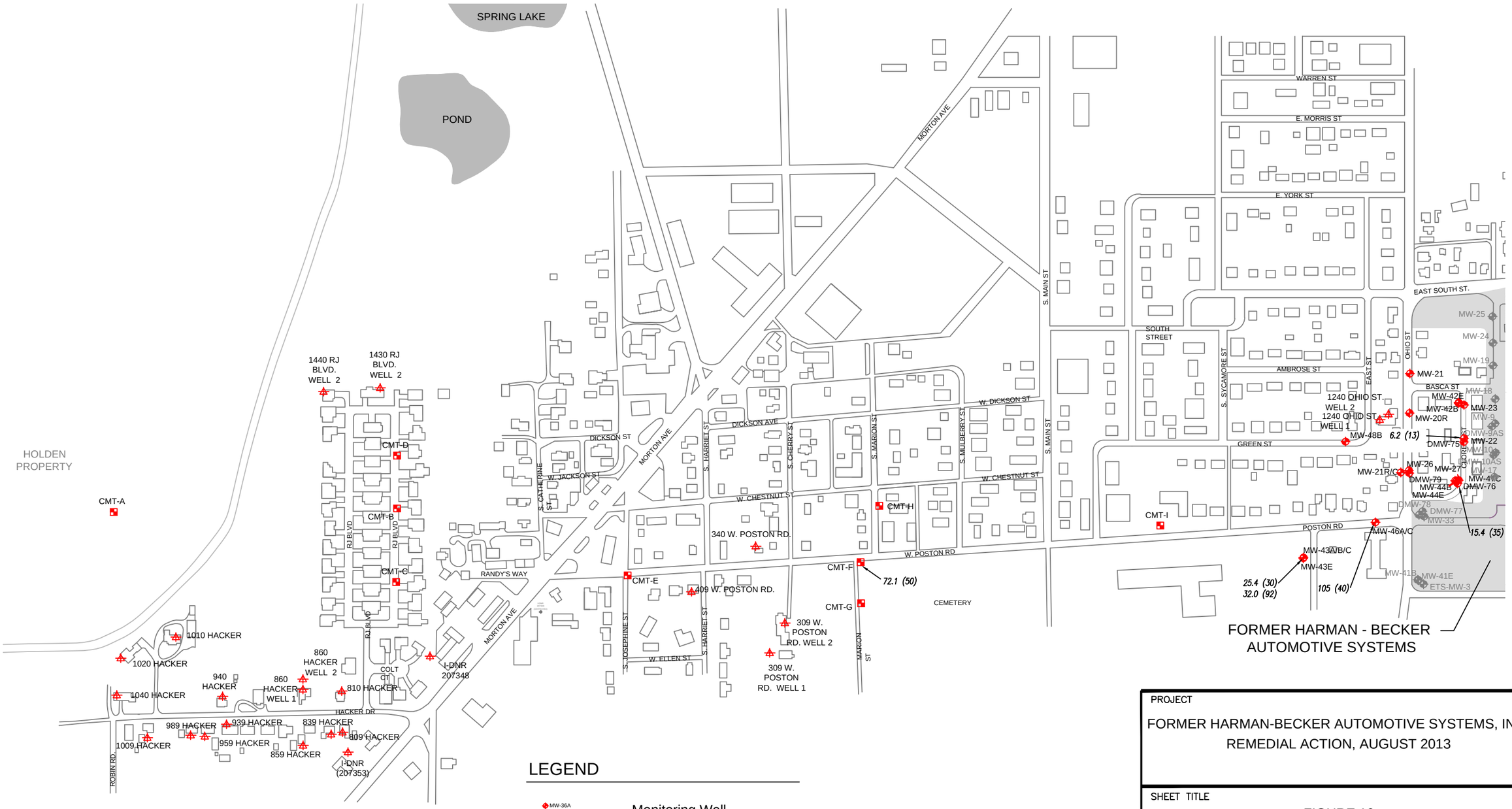
FIGURE 9
TETRACHLOROETHENE IN GROUNDWATER GREATER THAN RCG RESIDENTIAL TAP WATER SCREENING LEVELS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147–001–9.DWG



LEGEND

MW-36A	Monitoring Well
CMT-H	CMT Well
1240 OHIO ST. WELL 2	Resdential Wells
72.1 (50)	*µg/L (Depth, Feet). Latest Result in the Period 2010–2013 Greater than 5 µg/L*

north

0 200 400

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

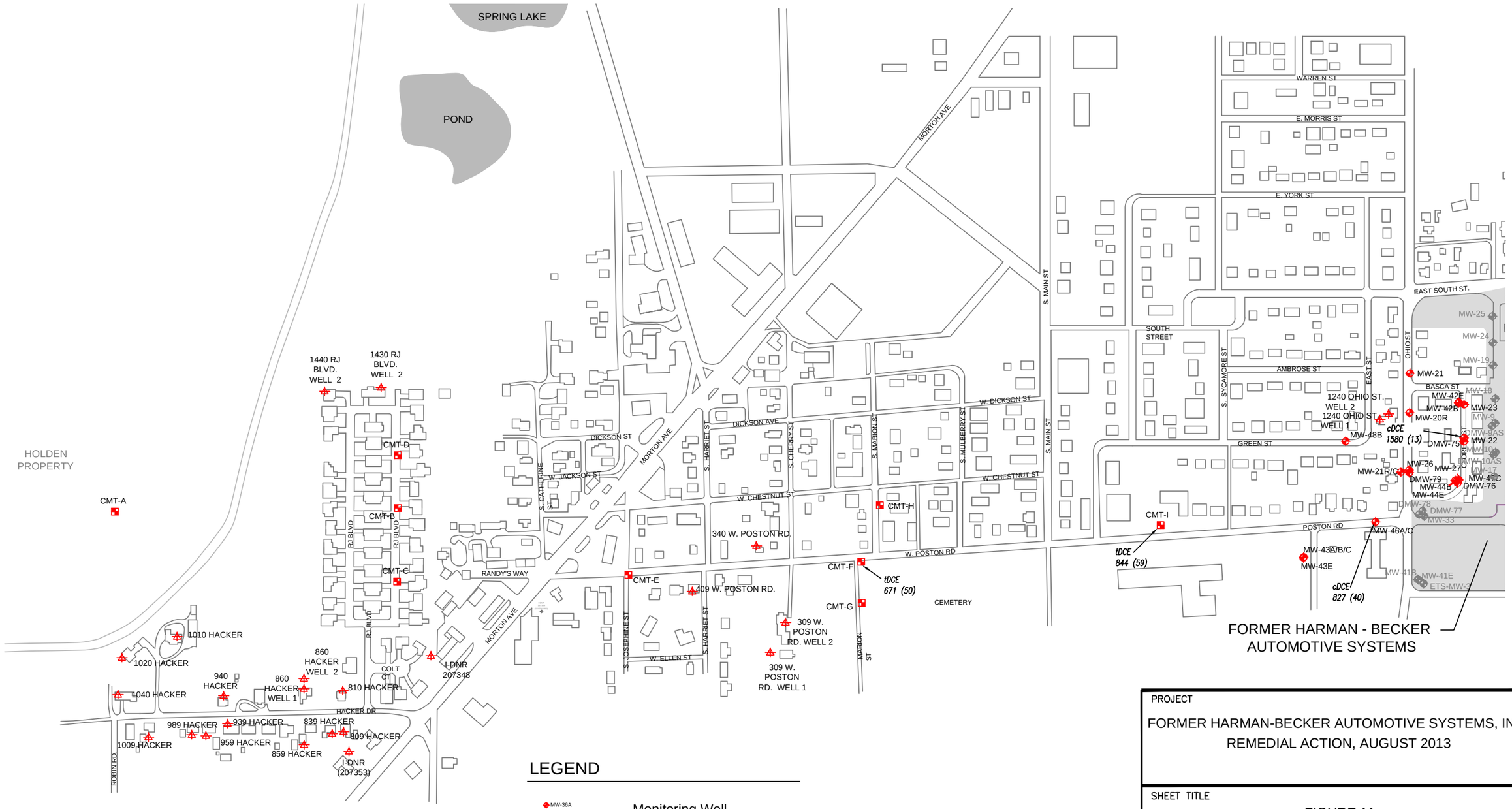
FIGURE 10
TRICHLOROETHENE IN GROUNDWATER GREATER THAN RCG RESIDENTIAL TAP WATER SCREENING LEVELS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147–001–10.DWG



LEGEND

MW-36A	Monitoring Well
CMT-H	CMT Well
1240 OHIO ST. WELL 2	Resdential Wells
827 (40)	*µg/L (Depth, Feet). Latest Result in the Period 2010–2013 Greater than: 70 µg/L for cis-1,2-Dichloroethene (cDCE) 100 µg/L for trans-1,2-Dichloroethene (tDCE)*

north

0 200 400

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

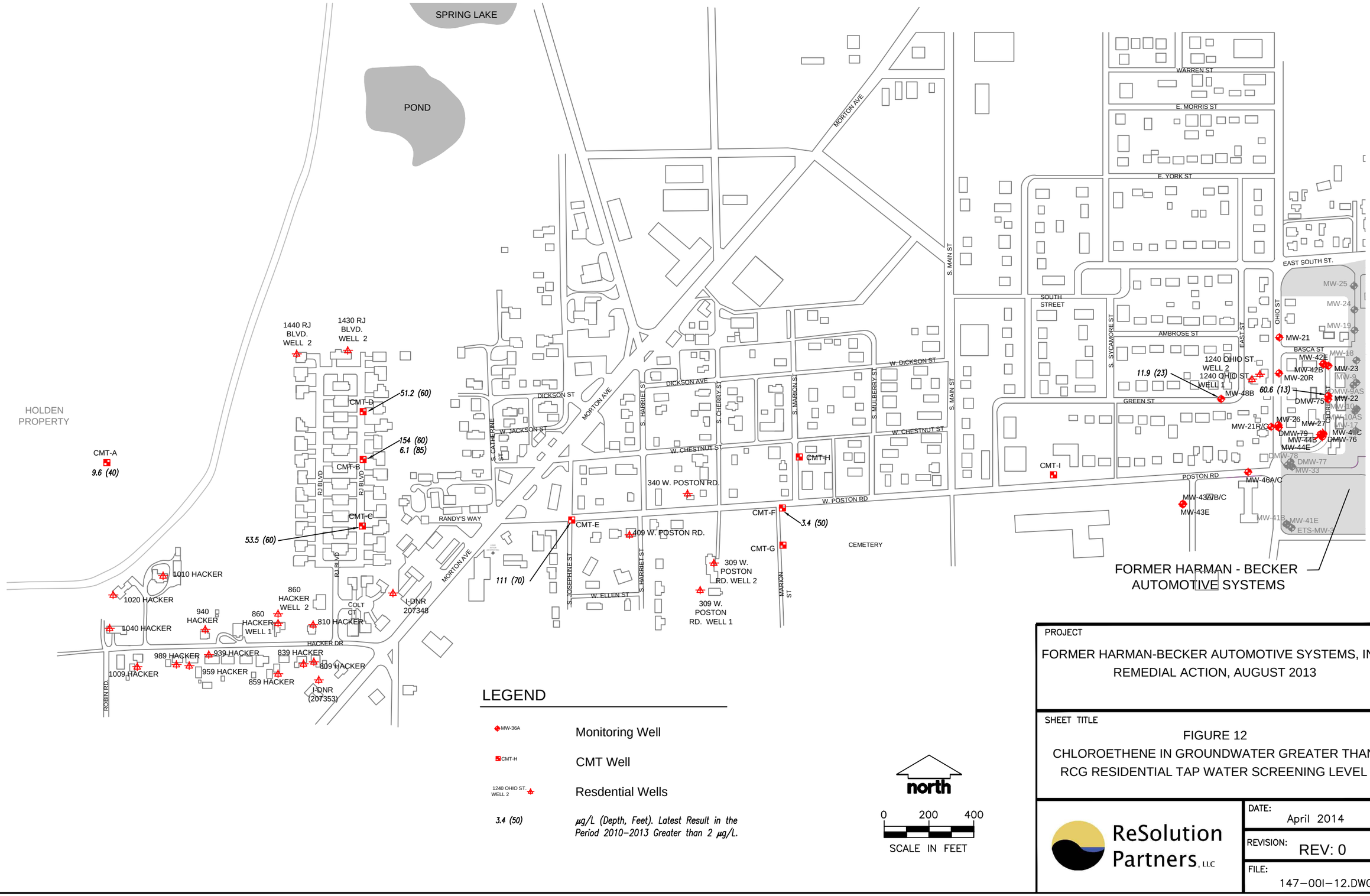
FIGURE 11
DICHLOROETHENES IN GROUNDWATER GREATER THAN RCG RESIDENTIAL TAP WATER SCREENING LEVELS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147-001-11.DWG



LEGEND

MW-36A	Monitoring Well
CMT-H	CMT Well
1240 OHIO ST. WELL 2	Resdential Wells
3.4 (50)	µg/L (Depth, Feet). Latest Result in the Period 2010–2013 Greater than 2 µg/L.

north

0 200 400

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

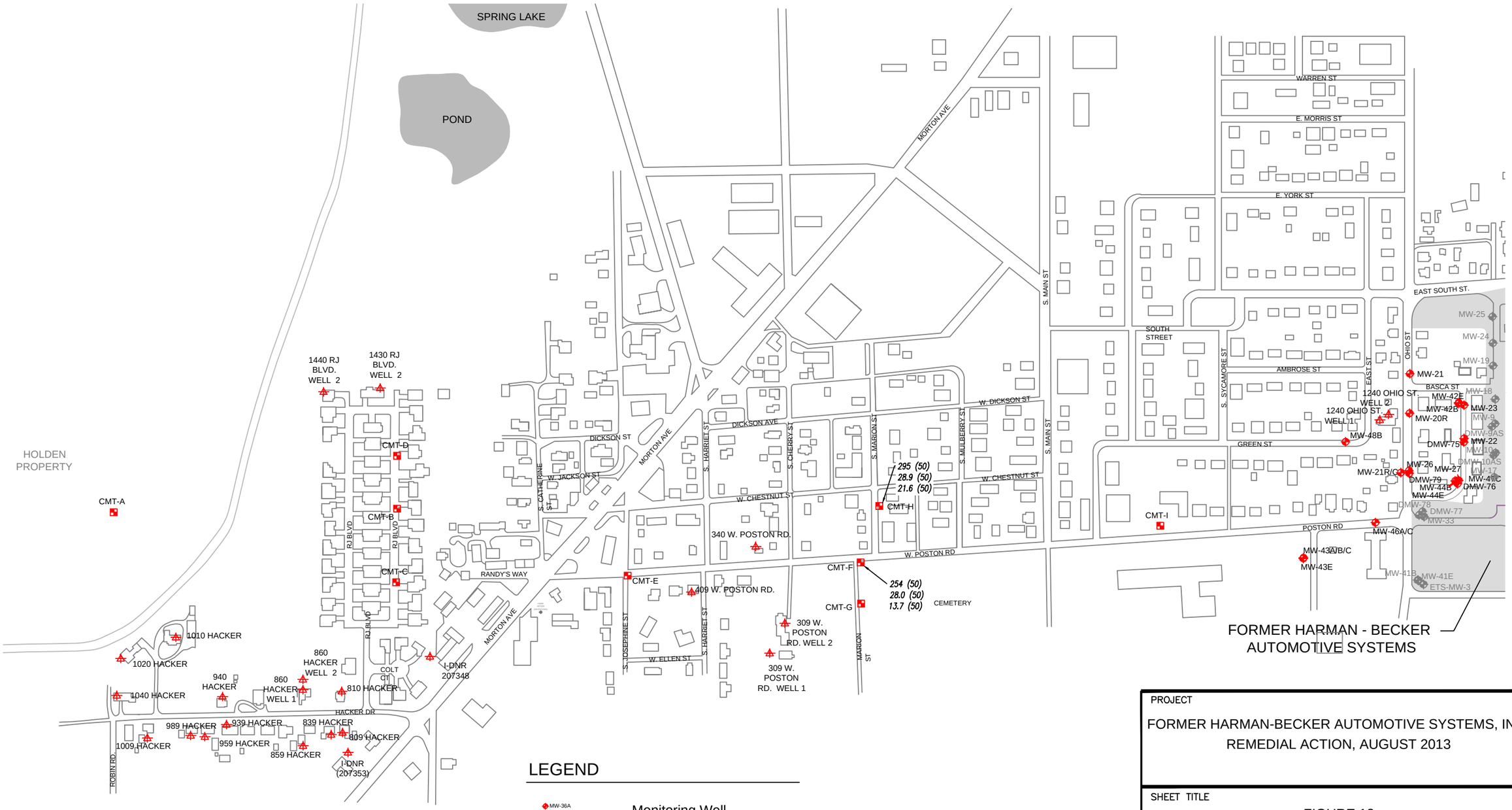
FIGURE 12
CHLOROETHENE IN GROUNDWATER GREATER THAN RCG RESIDENTIAL TAP WATER SCREENING LEVEL

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147–001–12.DWG



LEGEND

MW-36A	Monitoring Well
CMT-H	CMT Well
1240 OHIO ST. WELL 2	Resdential Wells
295 (50)	*µg/L (Depth, Feet). Latest Result in the Period 2010–2013 Greater than:* *200 µg/L for 1,1,1–Trichloroethane* *24 µg/L for 1,1–Dichloroethane* *7 µg/L for 1,1–Dichloroethene*

north

0 200 400

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

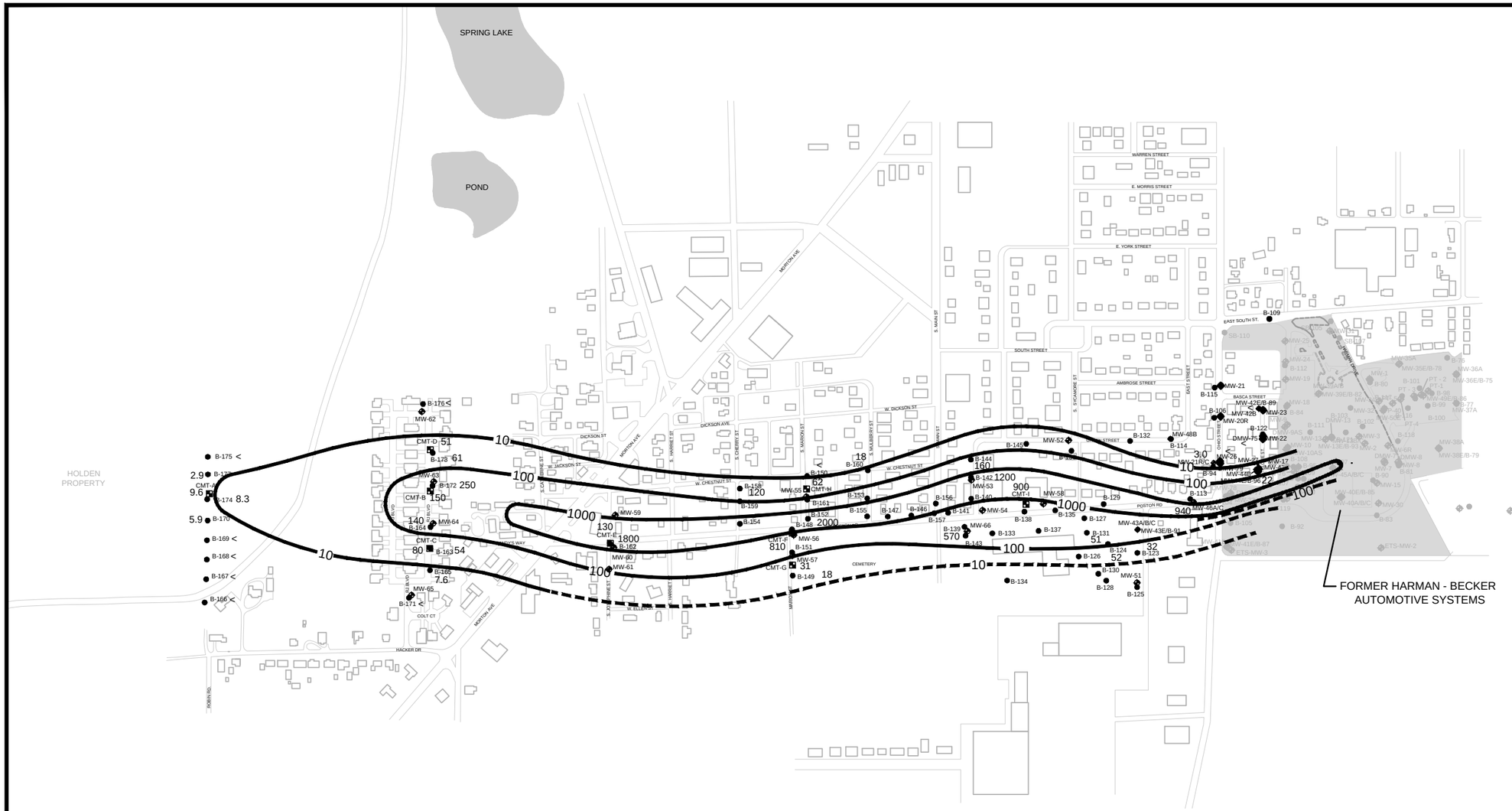
FIGURE 13
CHLORINATED ETHANES IN GROUNDWATER
GREATER THAN RCG RESIDENTIAL TAP WATER
SCREENING LEVELS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147–001–13.DWG



NOTES:

1. Where data is available from multiple intervals during the same collection date at a given location, the highest concentration is listed.
2. Data used to prepare this figure includes the most recent fixed lab results from 2010-2013 collected within the aquifer greater than 30 feet below the ground surface.

LEGEND

9.2	Total Chlorinated Ethenes, (µg/L) Latest Available Data During 2010-2013
<	No Detected Ethenes Concentration
100	Isoconcentration Line (µg/L) Total Chlorinated Ethenes (Dashed Where Inferred)

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

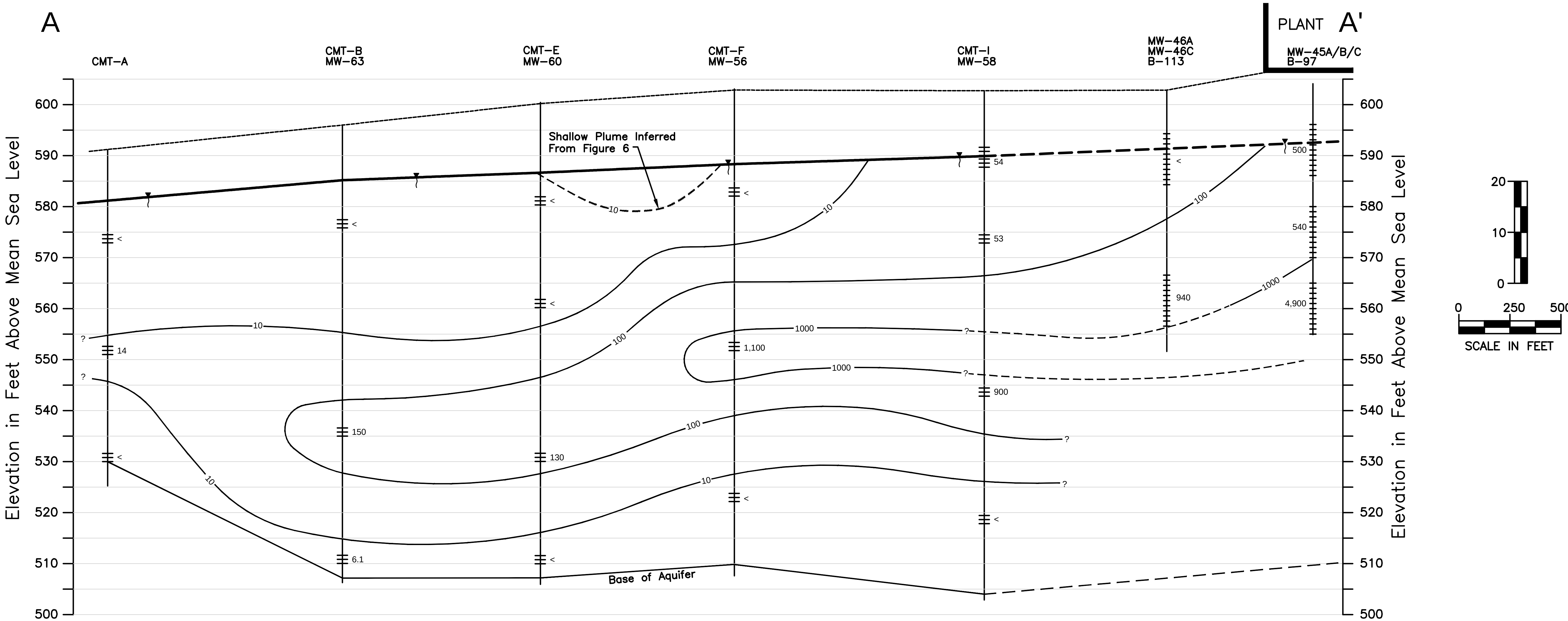
FIGURE 14
TOTAL CHLORINATED ETHENES
2010-2013
DEEP AQUIFER

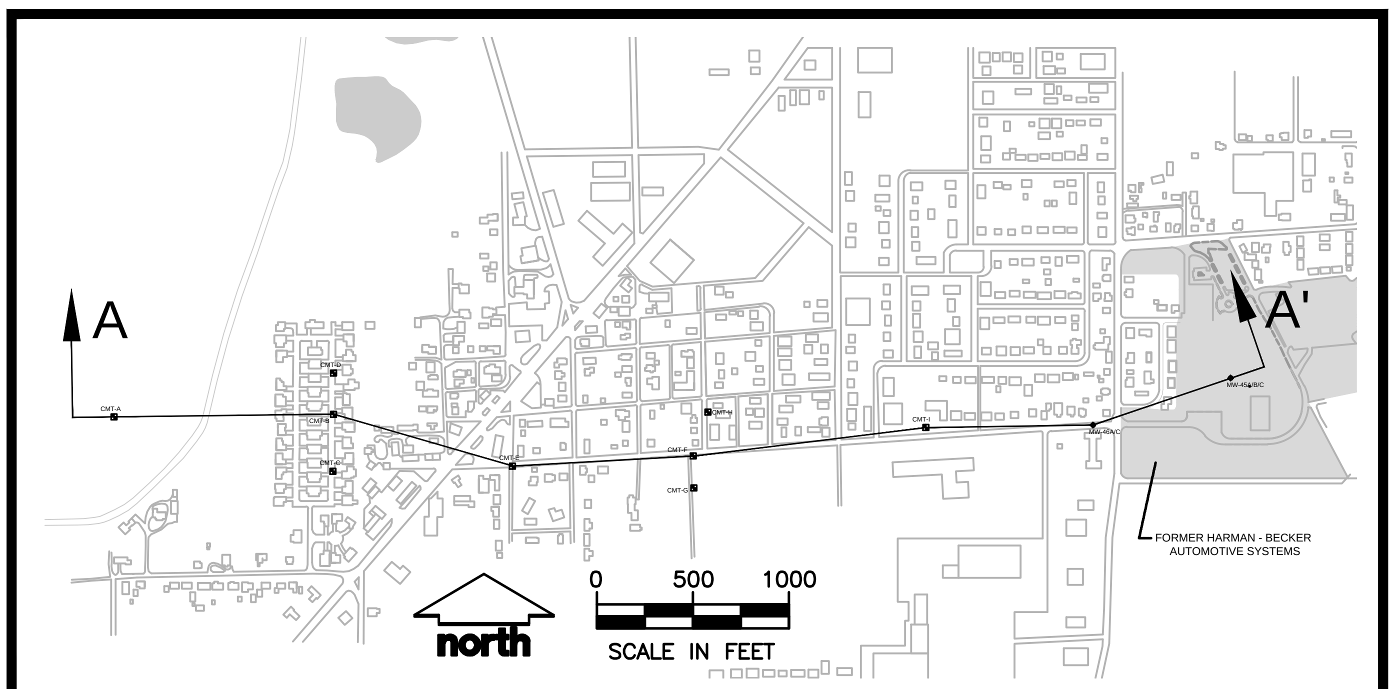
ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-14





LEGEND

Water Table
March 15–19, 2013
(Dashed Where Inferred)

Isoconcentration Contour (µg/L)
(Dashed Where Inferred)

< No Detected Ethenes Concentration

9.2 Total Chlorinated Ethenes (µg/L)

NOTES:

1. Includes the latest available groundwater concentration data for samples collected in February and March, 2013, except for MW–45A (May 2010), MW–45B (March 2010), MW–46A and MW–46B (May 2012).

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

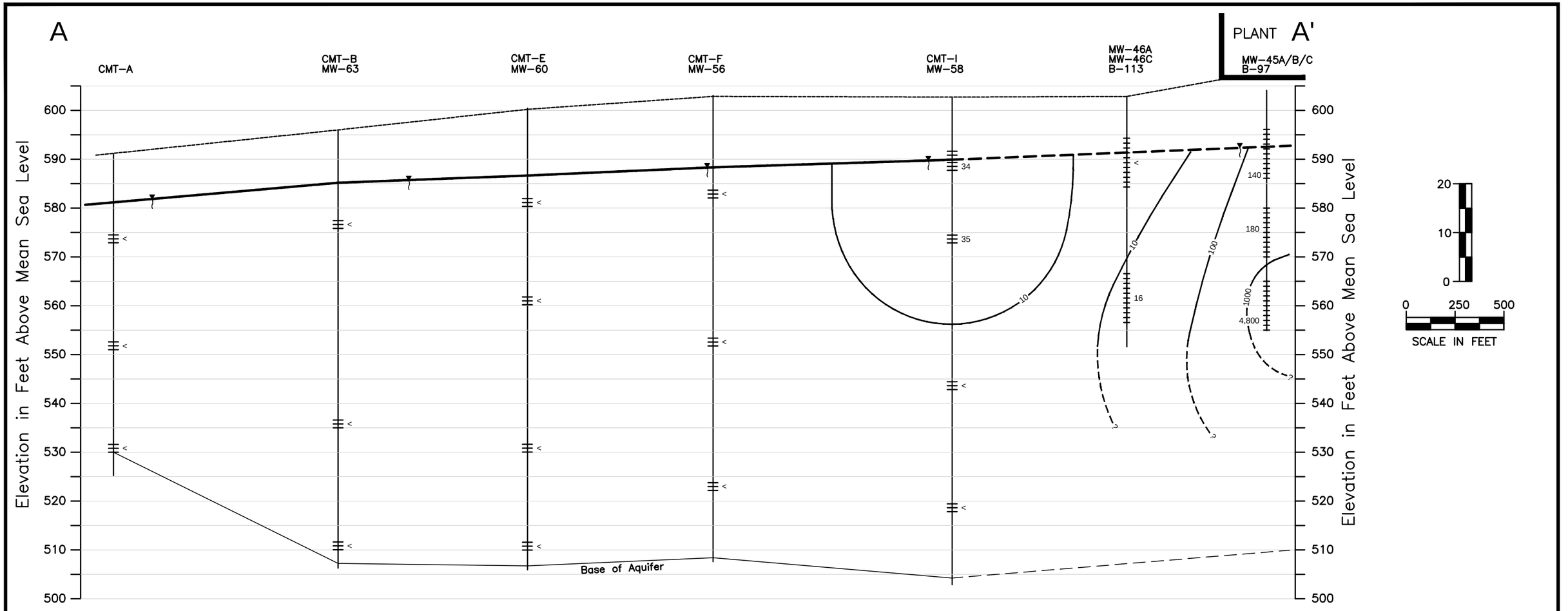
FIGURE 15
ISOCONCENTRATION CROSS SECTION
TOTAL CHLORINATED ETHENES

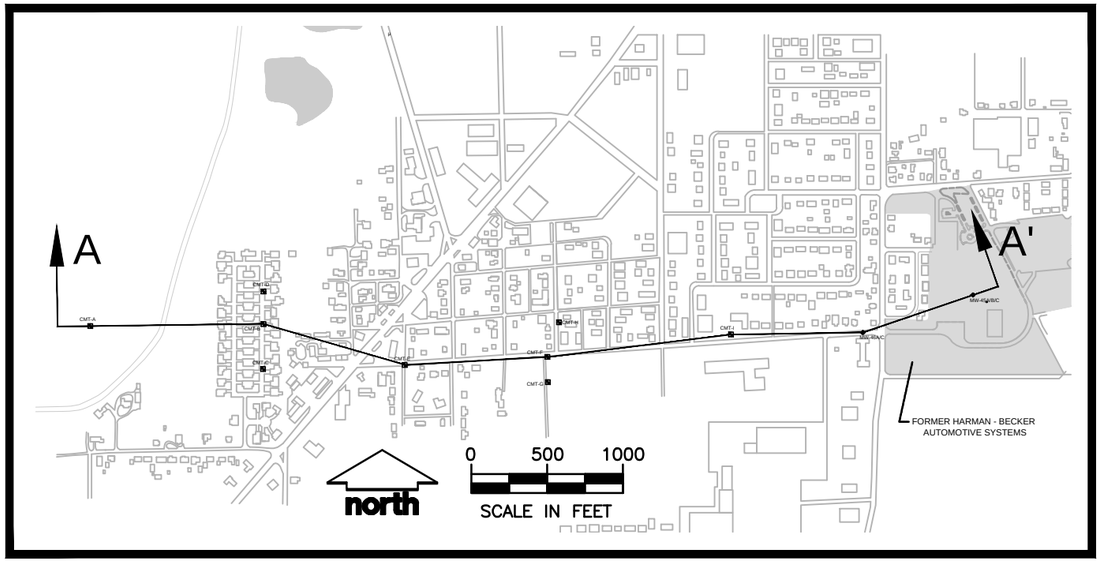
ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–15





LEGEND

- Water Table, March 15–19, 2013 (Dashed Where Inferred)
- 10 — Isoconcentration Contour (µg/L) (Dashed Where Inferred)
- < — No Detected PCE
- 9.2 — PCE Concentration (µg/L)

NOTES:

1. Includes the latest available groundwater concentration data for samples collected in February and March, 2013, except for MW–45A (May 2010), MW–45B (March 2010), MW–46A and MW–46B (May 2012).

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

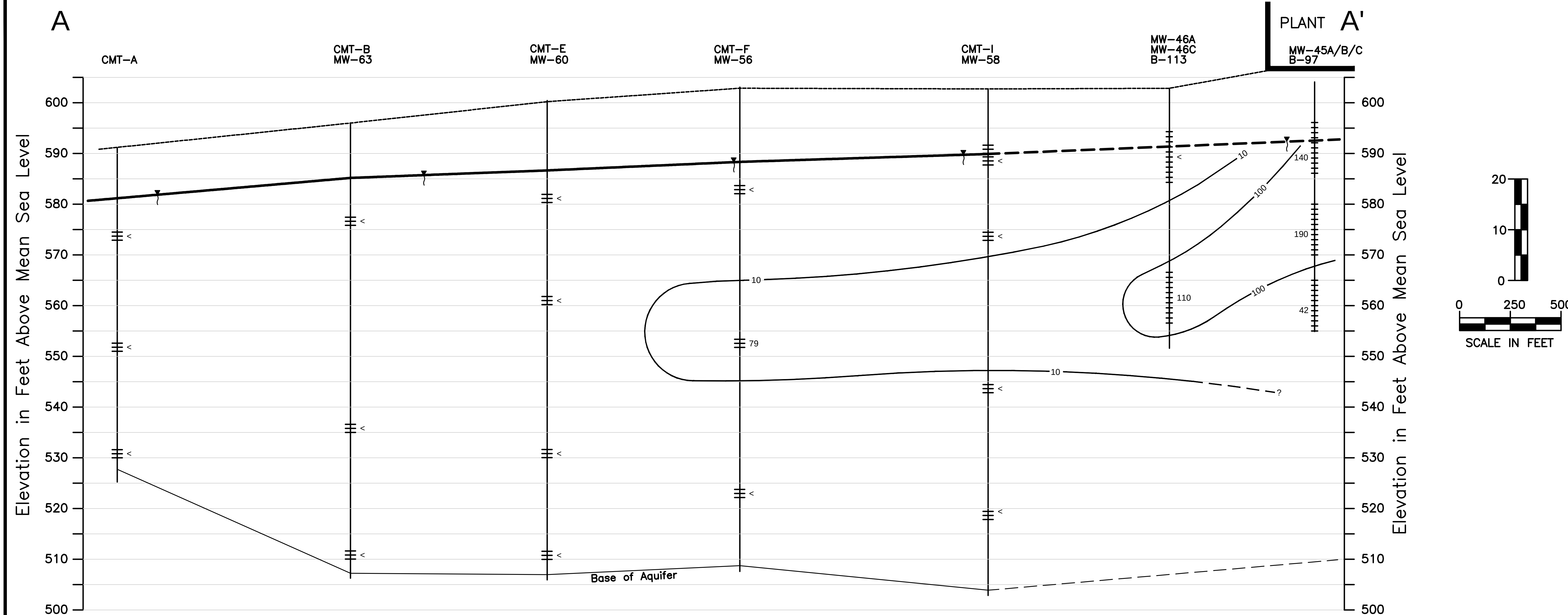
FIGURE 16
ISOCONCENTRATION CROSS SECTION
TETRACHLOROETHENE (PCE)

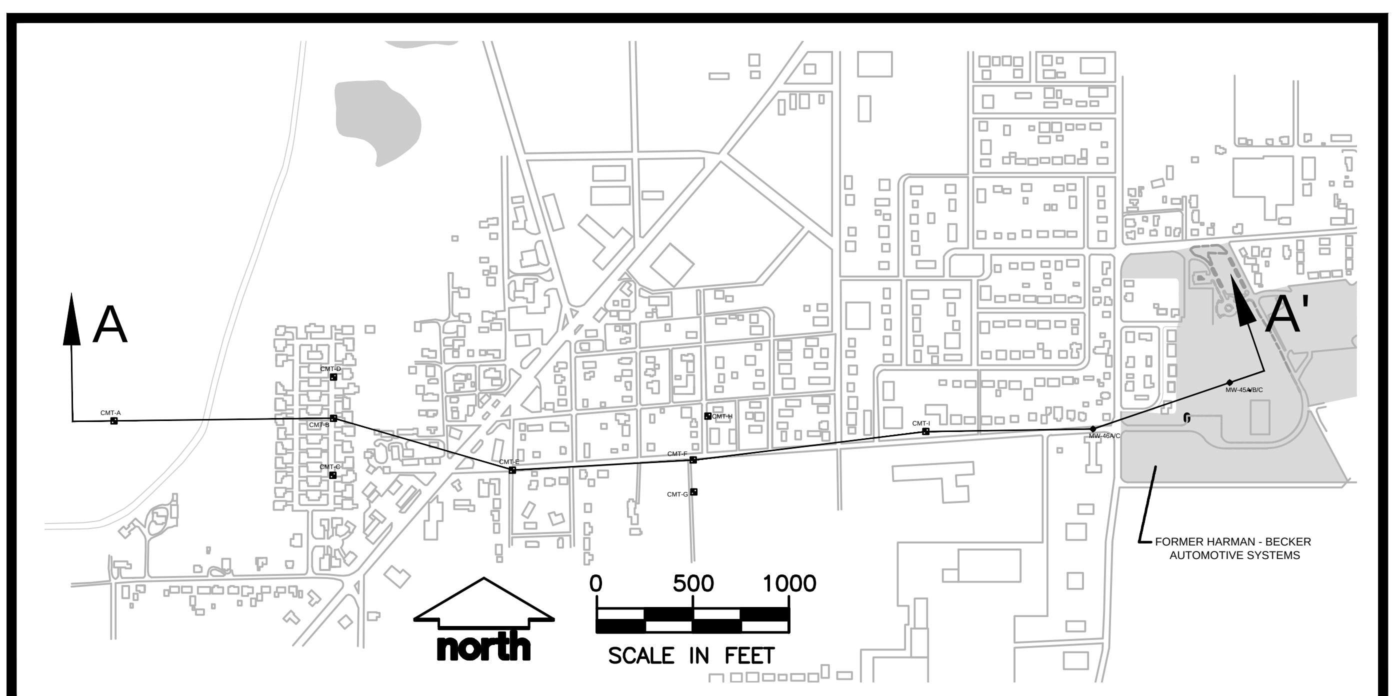
ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–16





LEGEND

Water Table symbol	Water Table March 15–19, 2013 (Dashed Where Inferred)
—10—	Isoconcentration Contour (µg/L) (Dashed Where Inferred)
<	No Detected TCE Concentration
9.2	TCE Concentration (µg/L)

NOTES:

1. Includes the latest available groundwater concentration data for samples collected in February and March, 2013, except for MW–45A (May 2010), MW–45B (March 2010), MW–46A and MW–46B (May 2012).

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

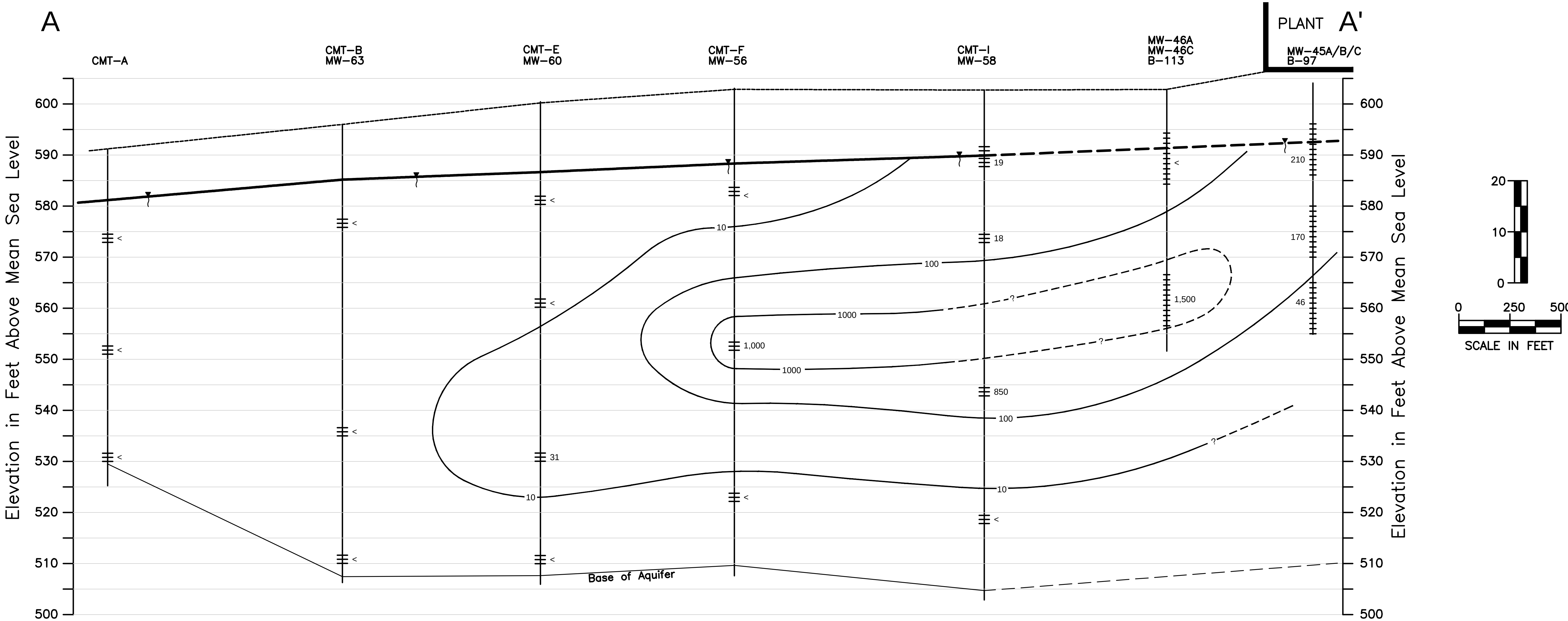
FIGURE 17
ISOCONCENTRATION CROSS SECTION
TRICHLOROETHENE (TCE)

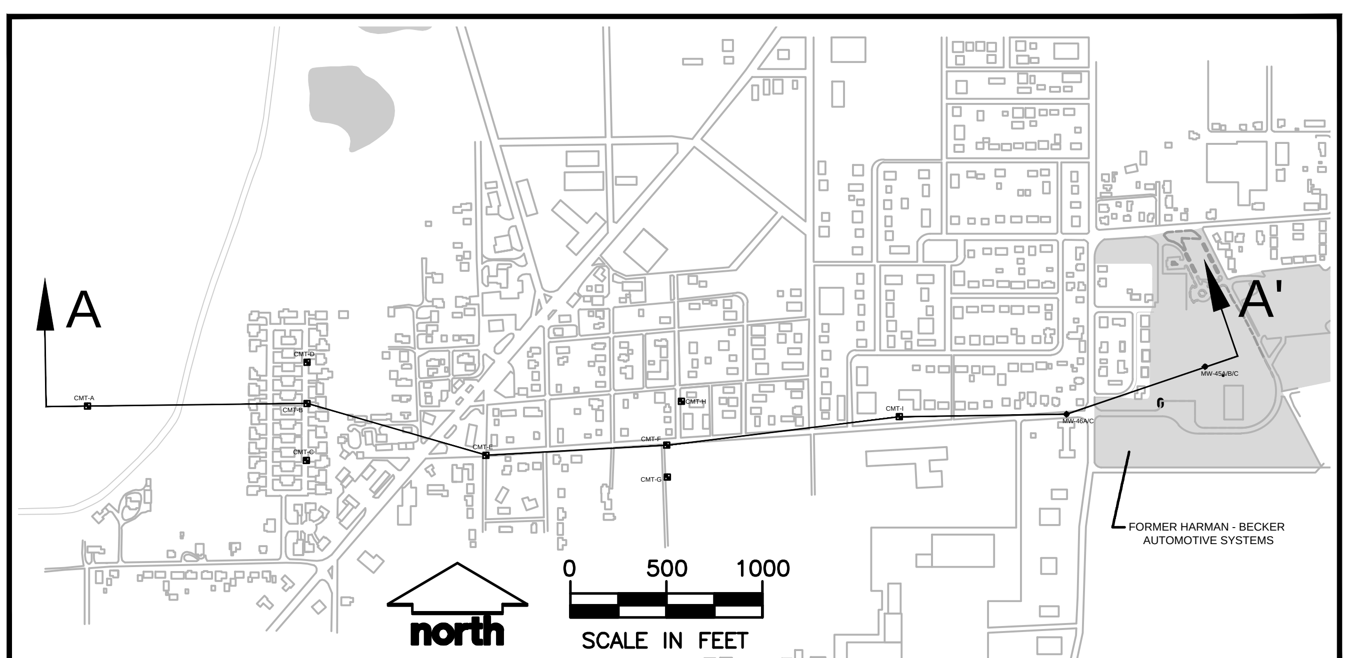
ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–17





LEGEND

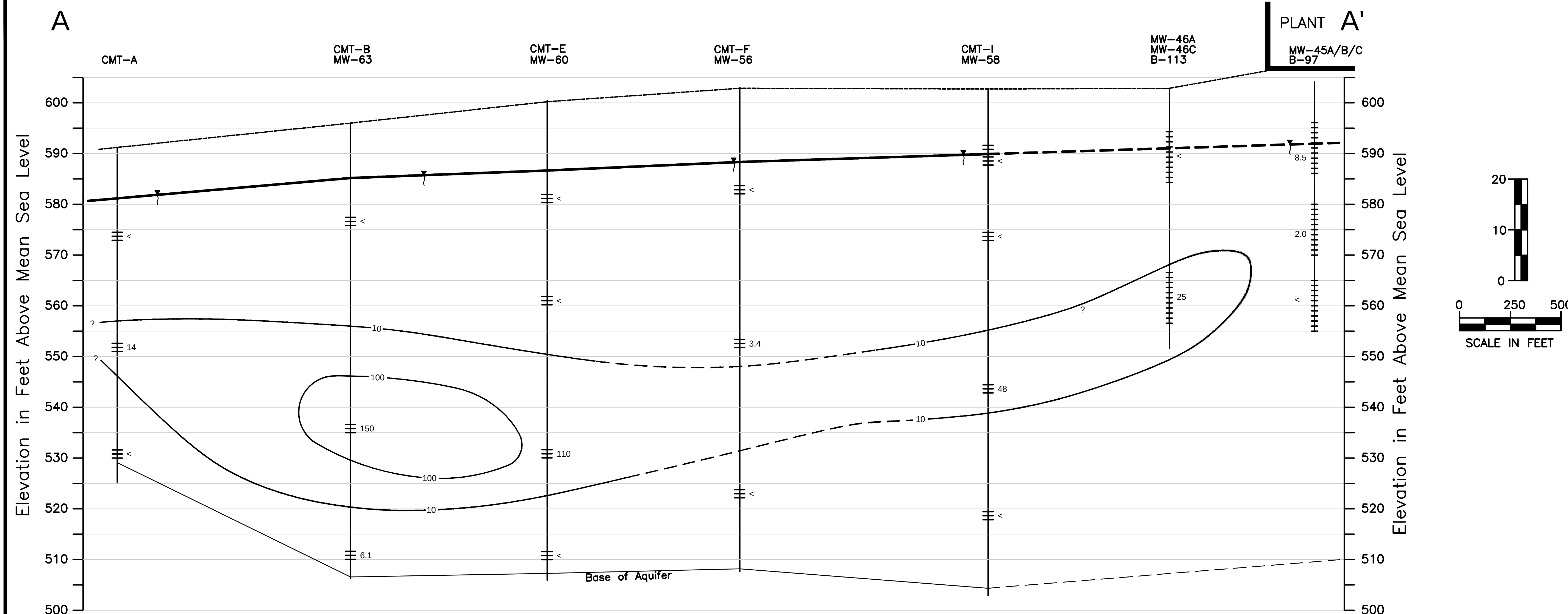
- Water Table March 15–19, 2013 (Dashed Where Inferred)
- —10— Isoconcentration Contour (µg/L) (Dashed Where Inferred)
- < No Detected DCE
- 9.2 DCE Concentration (µg/L)

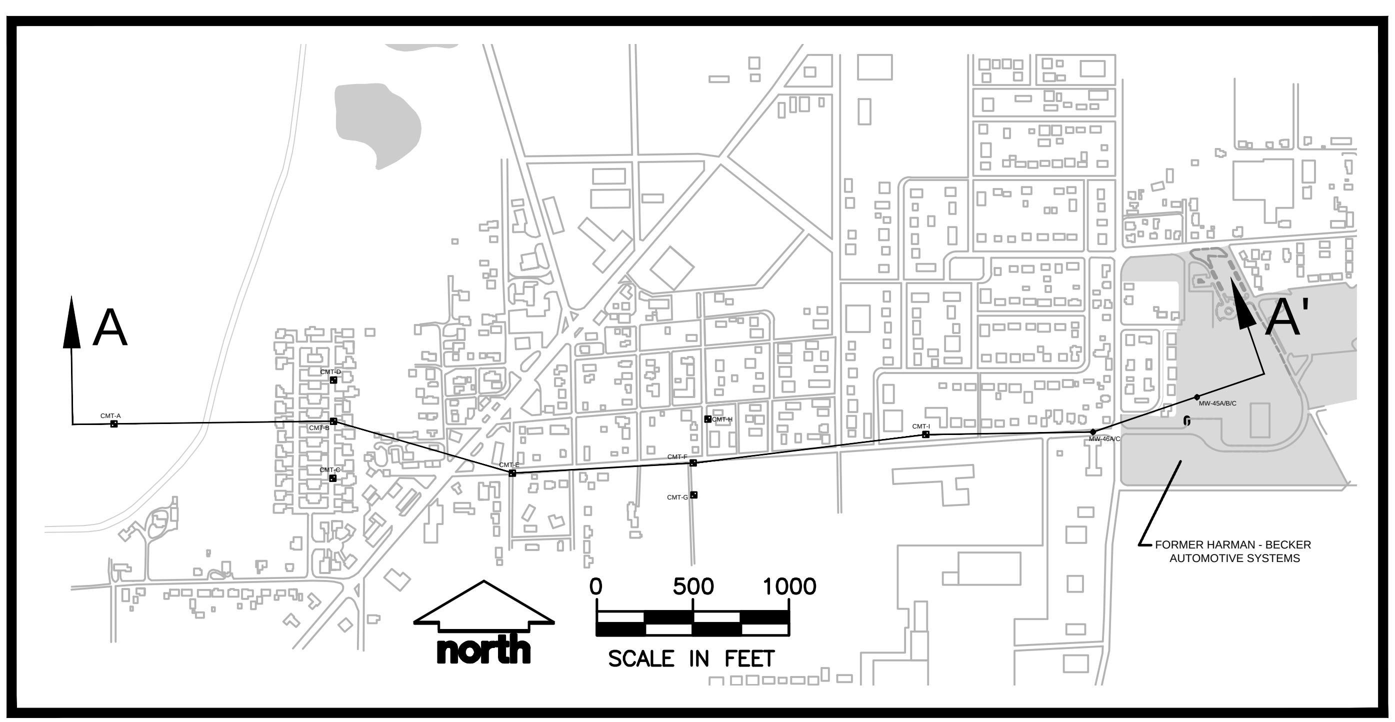
NOTES:

1. Includes the latest available groundwater concentration data for samples collected in February and March, 2013, except for MW–45A (May 2010), MW–45B (March 2010), MW–46A and MW–46B (May 2012).

PROJECT	FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC. REMEDIATION WORK PLAN
SHEET TITLE	FIGURE 18 ISOCONCENTRATION CROSS SECTION TOTAL DICHLOROETHENES (DCE)
DATE:	April 2014
REVISION:	REV: 0
DWG:	147–001–18

ReSolution Partners, LLC





LEGEND

Water Table	March 15–19, 2013 (Dashed Where Inferred)
—10—	Isoconcentration Contour (µg/L) (Dashed Where Inferred)
<	No Detected CE
9.2	CE Concentration (µg/L)

NOTES:

1. Includes the latest available groundwater concentration data for samples collected in February and March, 2013, except for MW–45A (May 2010), MW–45B (March 2010), MW–46A and MW–46B (May 2012).

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

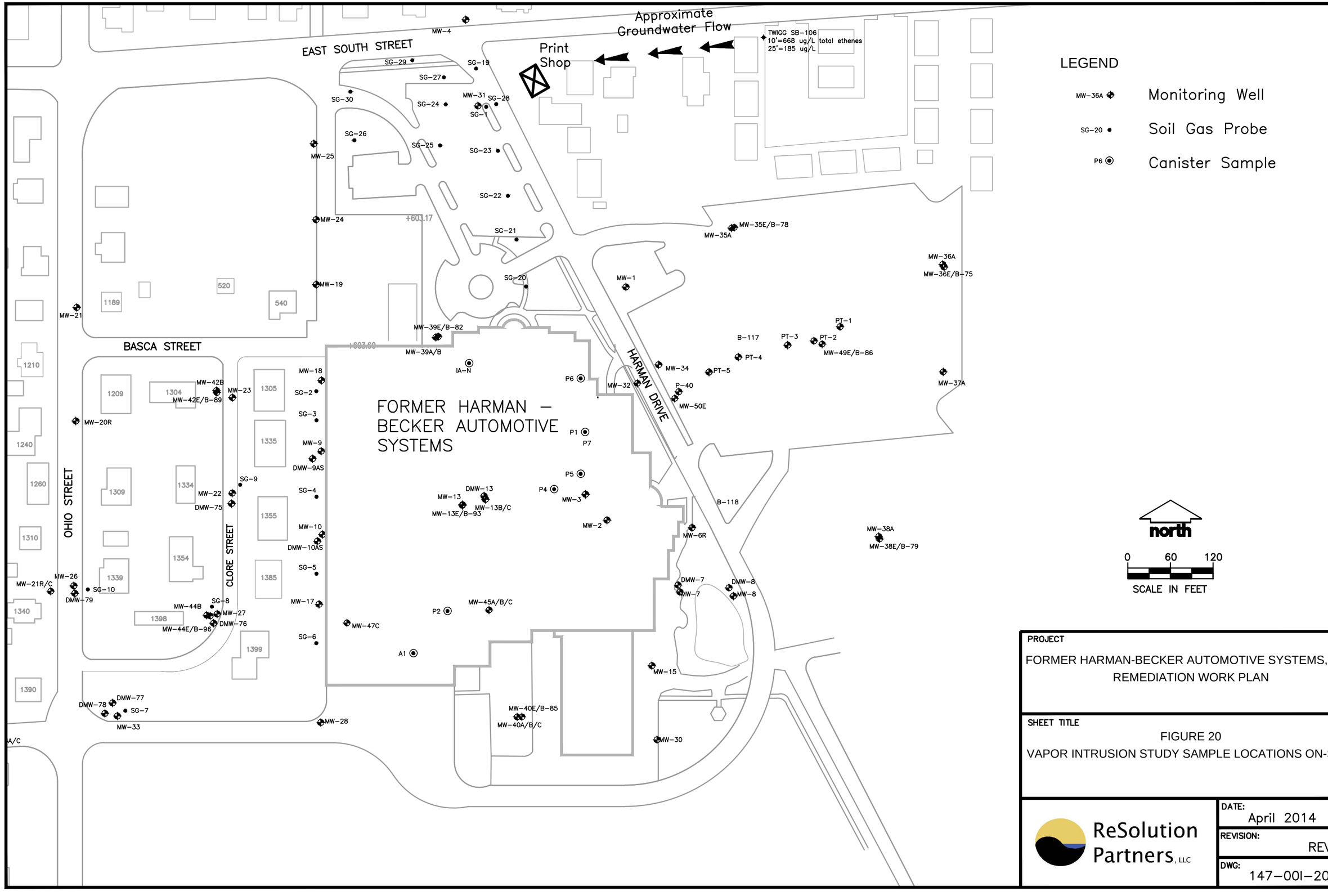
FIGURE 19
ISOCONCENTRATION CROSS SECTION
CHLOROETHENE (CE)

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147–001–19



PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

FIGURE 20
VAPOR INTRUSION STUDY SAMPLE LOCATIONS ON-SITE

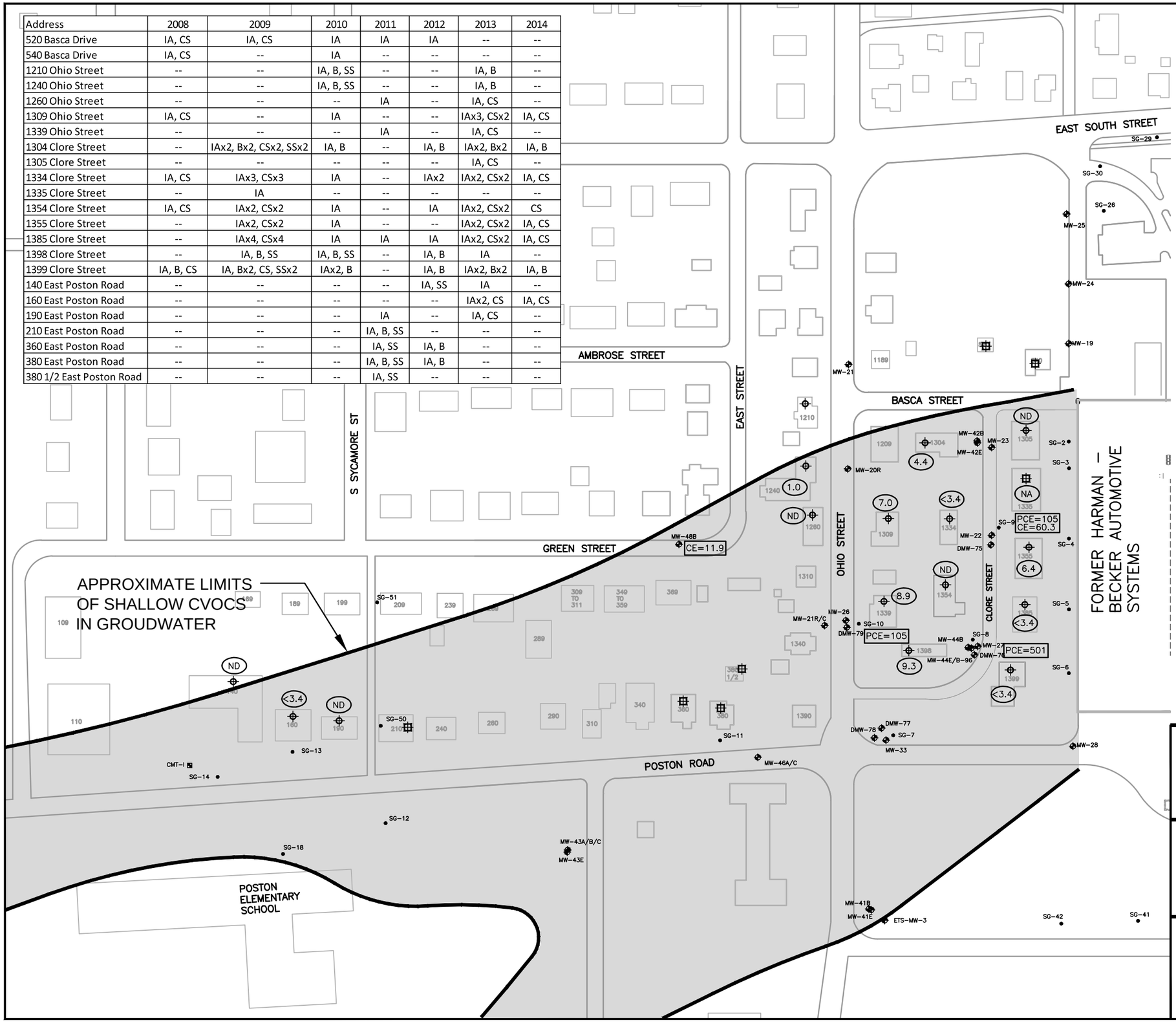
ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-20

Address	2008	2009	2010	2011	2012	2013	2014
520 Basca Drive	IA, CS	IA, CS	IA	IA	IA	--	--
540 Basca Drive	IA, CS	--	IA	--	--	--	--
1210 Ohio Street	--	--	IA, B, SS	--	--	IA, B	--
1240 Ohio Street	--	--	IA, B, SS	--	--	IA, B	--
1260 Ohio Street	--	--	--	IA	--	IA, CS	--
1309 Ohio Street	IA, CS	--	IA	--	--	IAx3, CSx2	IA, CS
1339 Ohio Street	--	--	--	IA	--	IA, CS	--
1304 Clore Street	--	IAx2, Bx2, CSx2, SSx2	IA, B	--	IA, B	IAx2, Bx2	IA, B
1305 Clore Street	--	--	--	--	--	IA, CS	--
1334 Clore Street	IA, CS	IAx3, CSx3	IA	--	IAx2	IAx2, CSx2	IA, CS
1335 Clore Street	--	IA	--	--	--	--	--
1354 Clore Street	IA, CS	IAx2, CSx2	IA	--	IA	IAx2, CSx2	CS
1355 Clore Street	--	IAx2, CSx2	IA	--	--	IAx2, CSx2	IA, CS
1385 Clore Street	--	IAx4, CSx4	IA	IA	IA	IAx2, CSx2	IA, CS
1398 Clore Street	--	IA, B, SS	IA, B, SS	--	IA, B	IA	--
1399 Clore Street	IA, B, CS	IA, Bx2, CS, SSx2	IAx2, B	--	IA, B	IAx2, Bx2	IA, B
140 East Poston Road	--	--	--	--	IA, SS	IA	--
160 East Poston Road	--	--	--	--	--	IAx2, CS	IA, CS
190 East Poston Road	--	--	--	IA	--	IA, CS	--
210 East Poston Road	--	--	--	IA, B, SS	--	--	--
360 East Poston Road	--	--	--	IA, SS	IA, B	--	--
380 East Poston Road	--	--	--	IA, B, SS	IA, B	--	--
380 1/2 East Poston Road	--	--	--	IA, SS	--	--	--



LEGEND

- SG-14 — SOIL GAS LOCATION
- MW-26 — MONITORING WELL LOCATION
- CMT-I — CMT WELL LOCATION
- VAPOR INTRUSION SAMPLING 2013 AND EARLIER
- VAPOR INTRUSION SAMPLING 2008–2012
- <3.4 — INDOOR AIR TETRACHLOROETHENE (µg/m^3) IN JANUARY 2014 OR JUNE/JULY 2013.
- NA — NO ACCESS GRANTED
- ND — NON DETECT
- 105 — TETRACHLOROETHENE (PCE) AND CHLOROETHENE (CE) IN GROUNDWATER GREATER THAN VI SCREENING (µg/L) IN 2012 AND 2013.

Notes for Table:
IA = Indoor Air
B = Basement
CS = Crawl Space
SS = Sub Slab
x3 = Number of sampling events during the year
-- = No sampling performed
Bold entries indicate the location of mitigation systems installed in 2009.

north

0 75 150

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.

SHEET TITLE

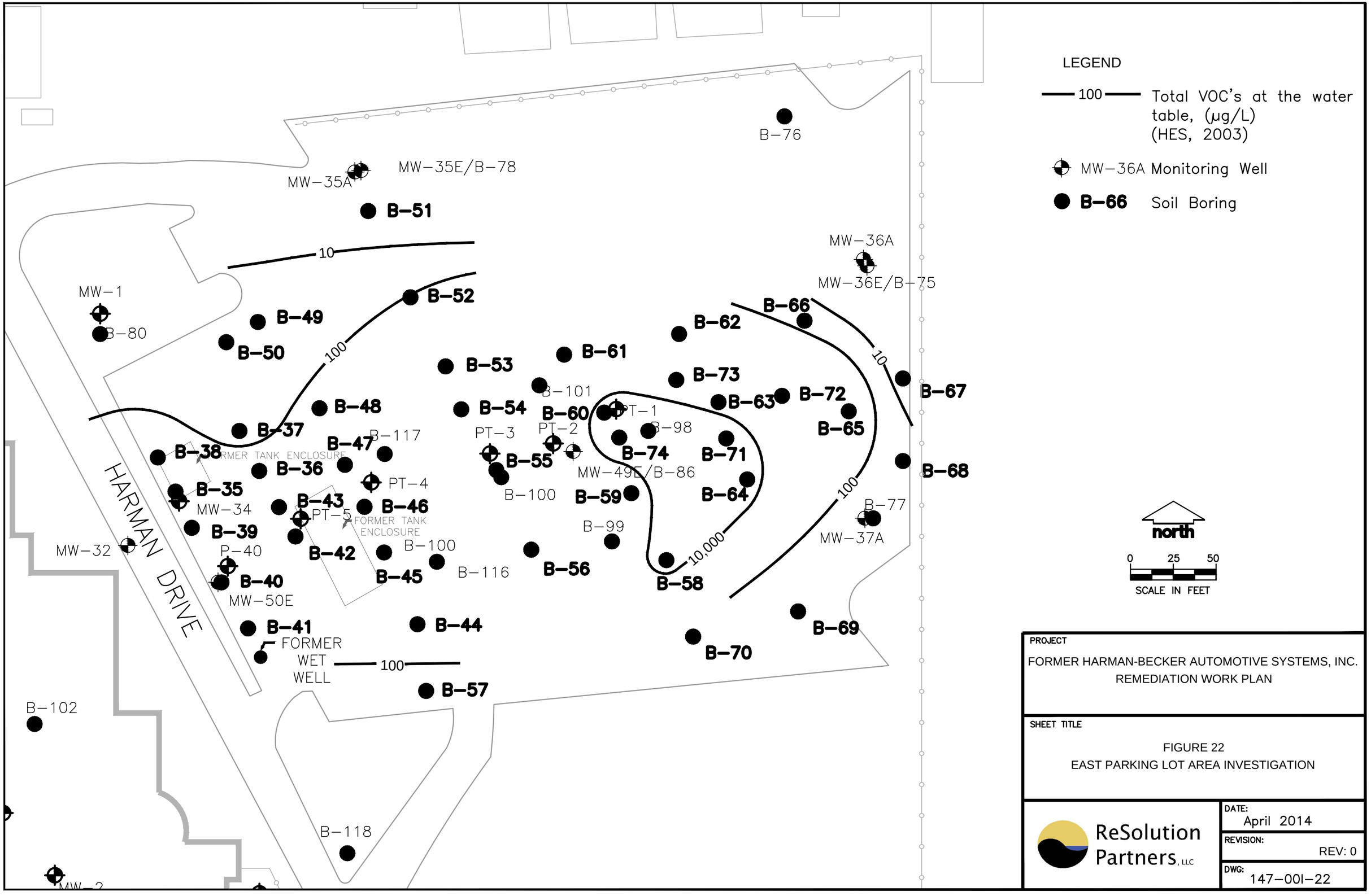
FIGURE 21
RESIDENTIAL INDOOR
AIR AND SOIL GAS SAMPLING LOCATIONS

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147-001-21



PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

FIGURE 22
EAST PARKING LOT AREA INVESTIGATION

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-22

ReSolution Partners, LLC

Figure 23. Reductive Dechlorination in East Parking Lot Area

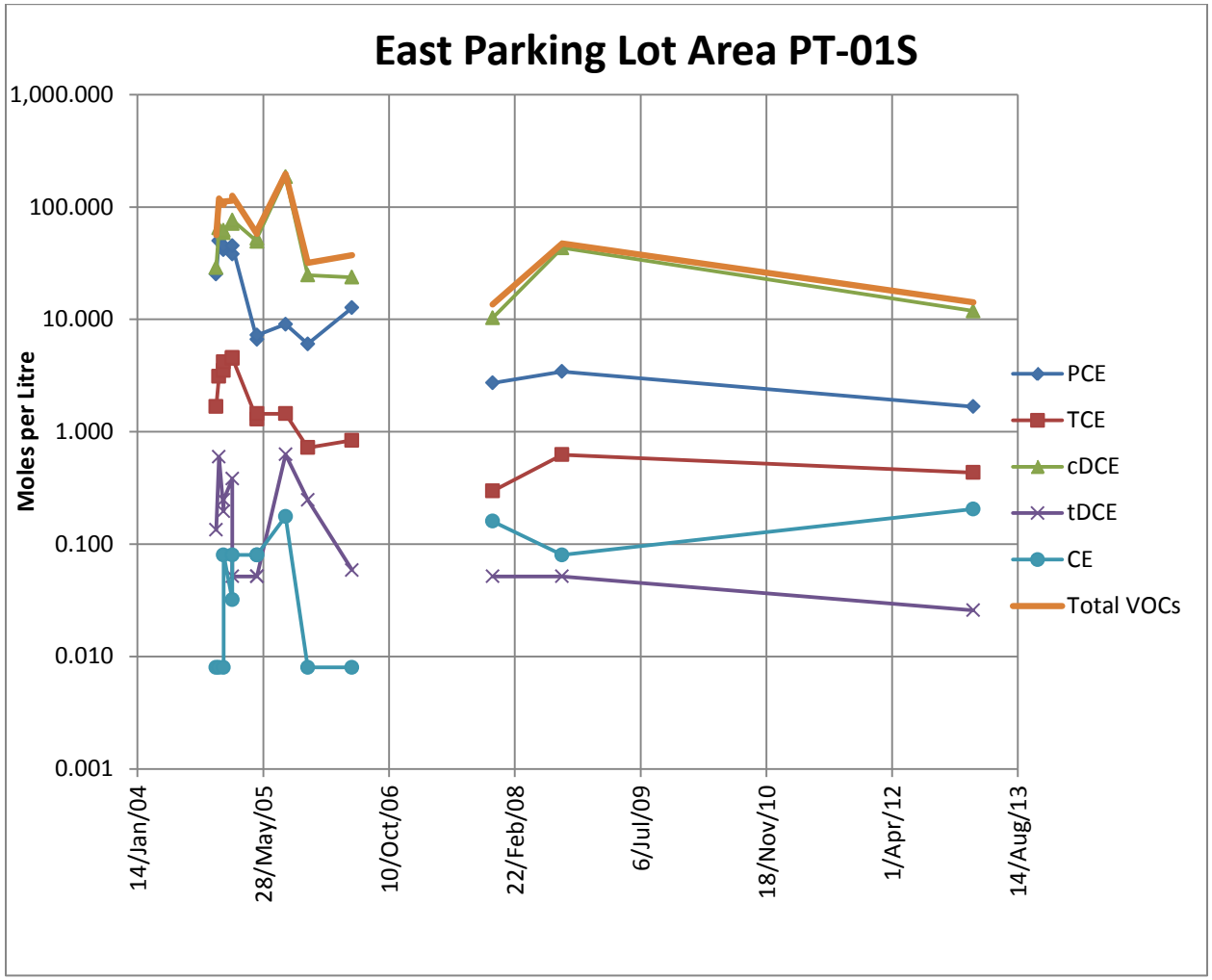
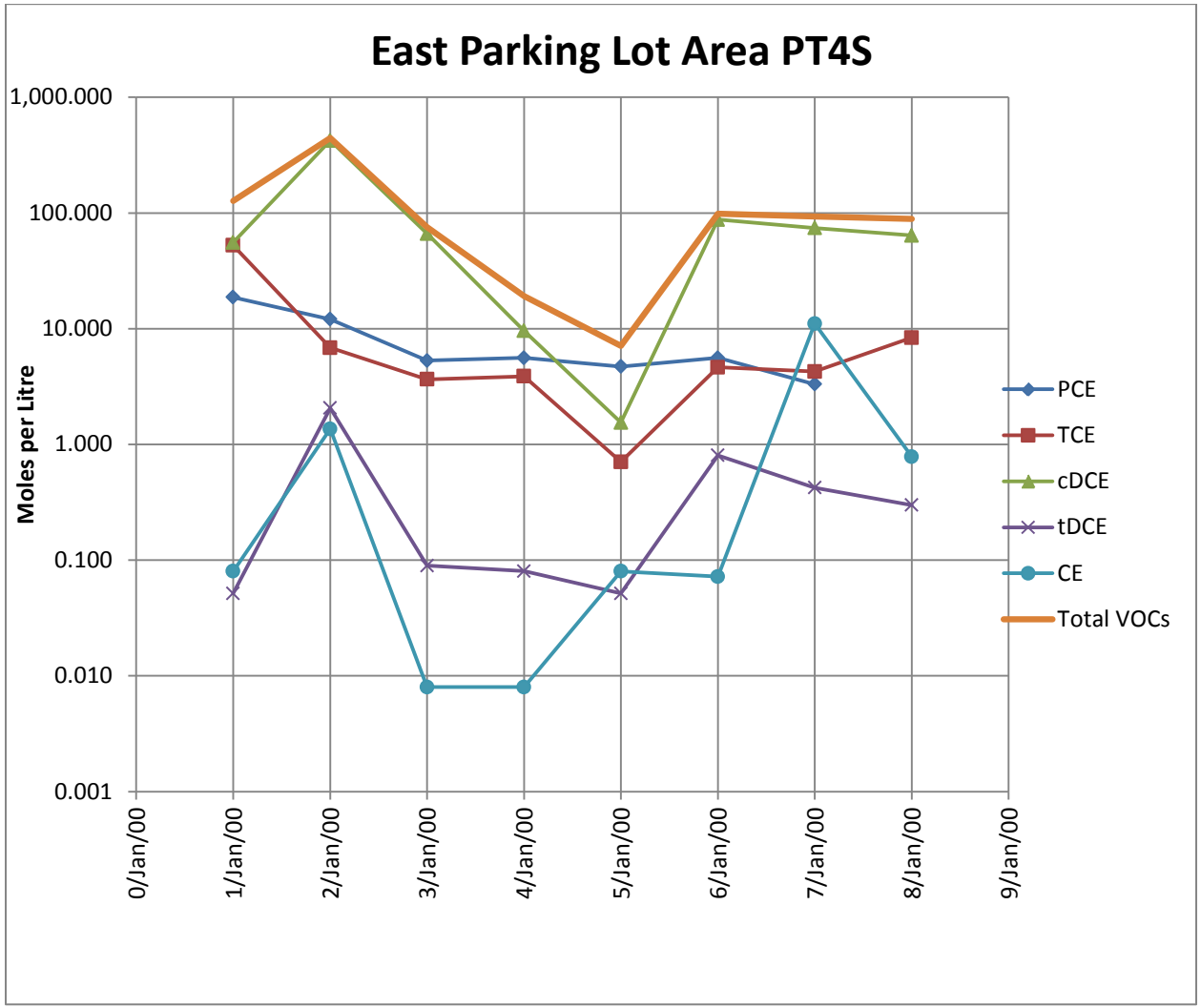


Figure 23. Reductive Dechlorination in East Parking Lot Area



ReSolution Partners, LLC

Figure 23. Reductive Dechlorination in East Parking Lot Area

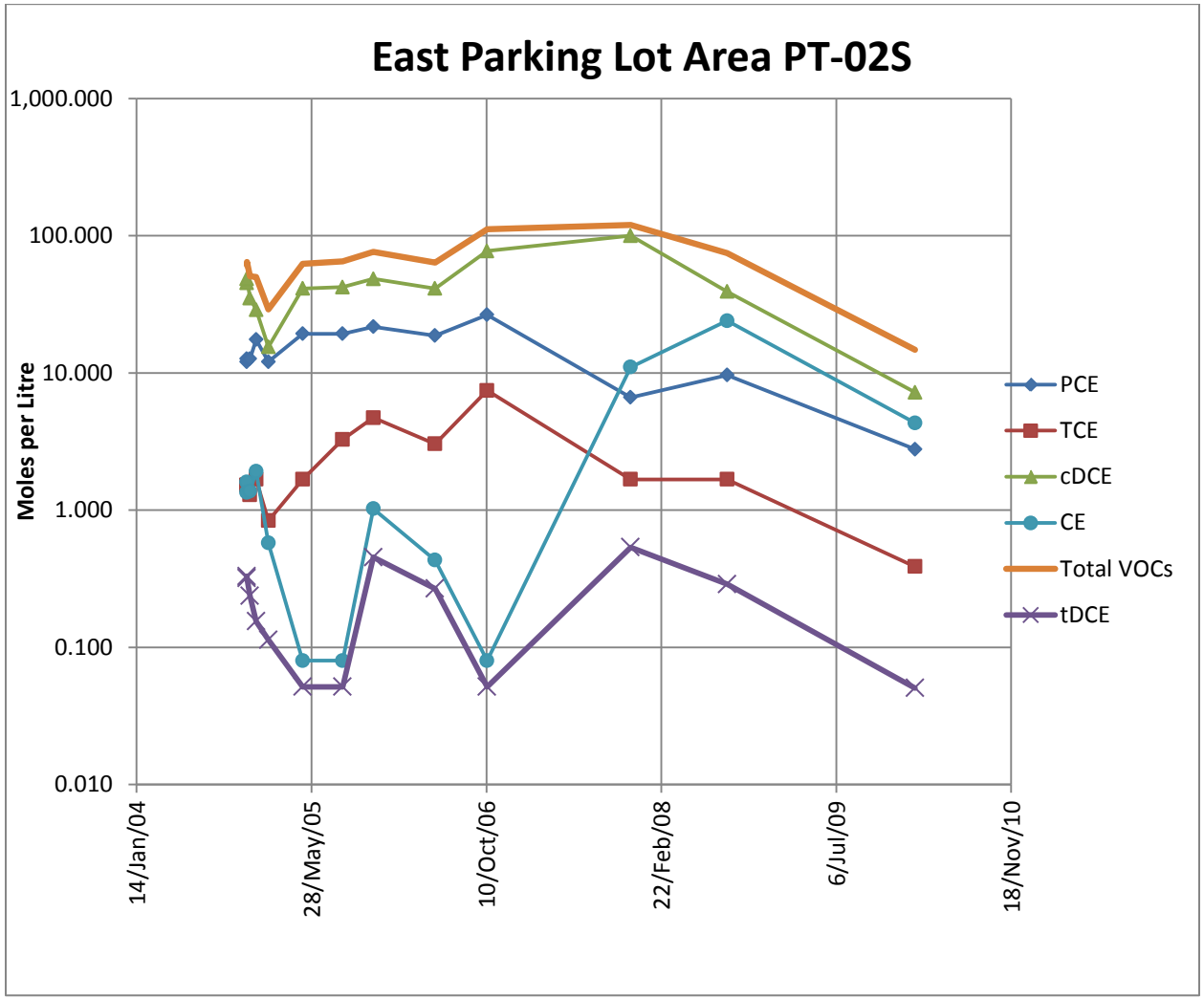
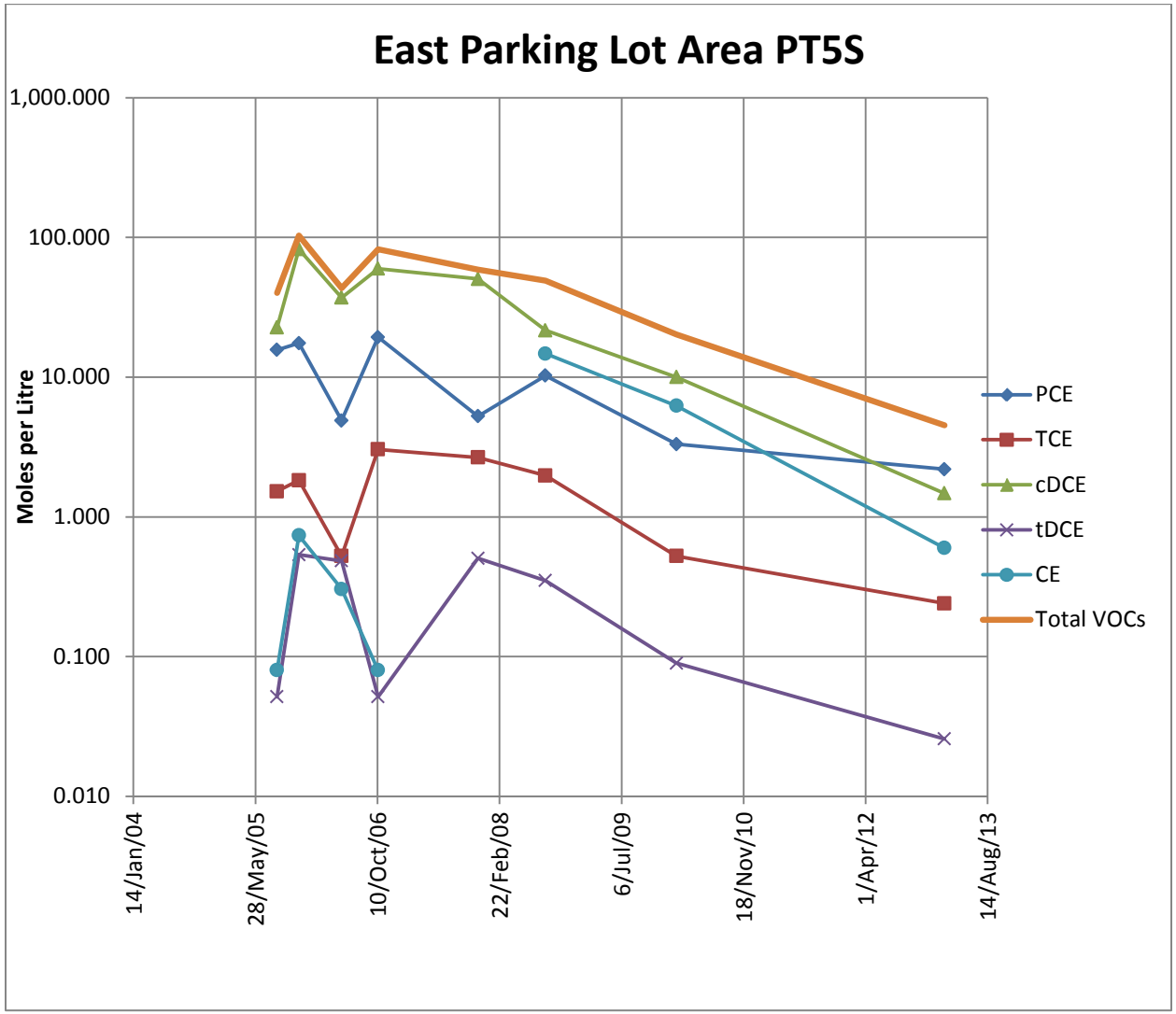
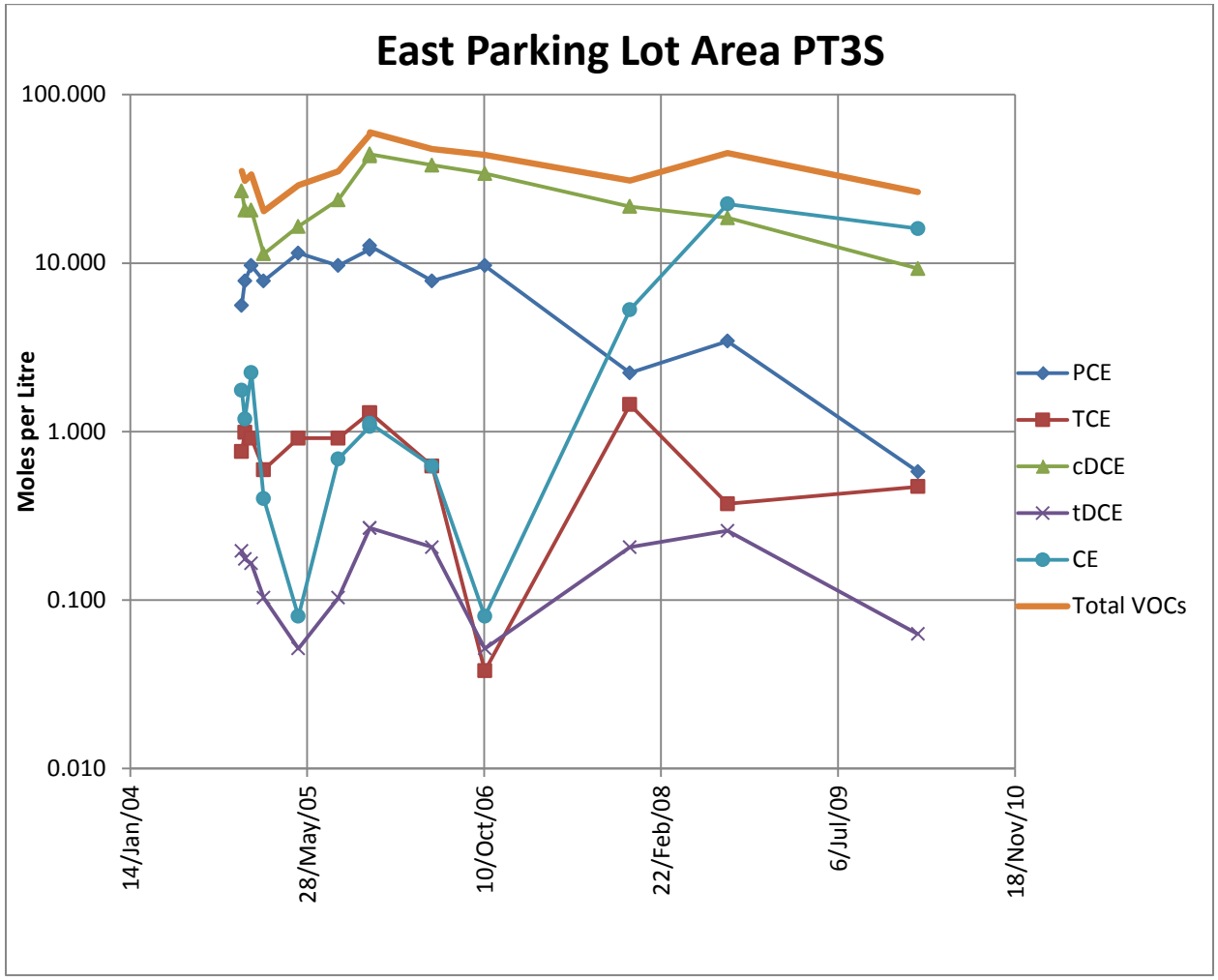


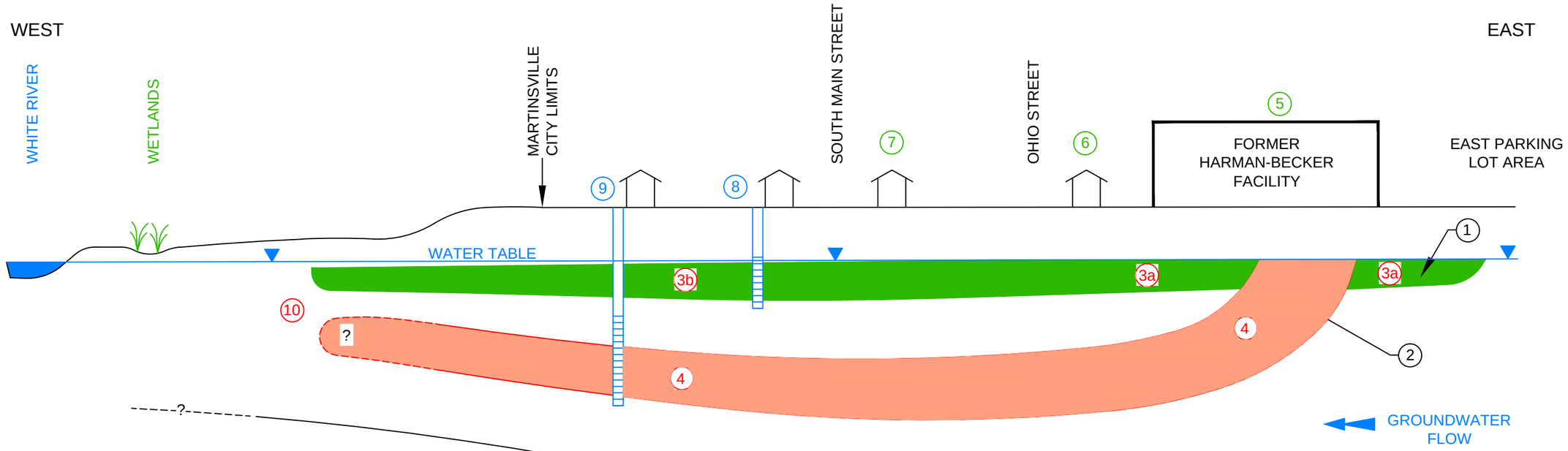
Figure 23. Reductive Dechlorination in East Parking Lot Area



ReSolution Partners, LLC

Figure 23. Reductive Dechlorination in East Parking Lot Area





1 Residual CVOC's in soil and aquifer are a continuing source of CVOC's in groundwater at concentrations greater than TWSL and VISL.

2 Residual CVOC's in soil at concentrations greater than MTGWSL.

3a Residual CVOC's at 1 are a continuing source of CVOC's in groundwater at concentrations > TWSL. Total CVOC's ≈ 2000 µg/L.

3b CVOC's in groundwater from early releases in the East Parking Lot Area have migrate across Martinsville. Total CVOC's west of S. Main Street < 50 µg/L.

4 CVOC's in groundwater extend from below FHB Facility across Martinsville. Total CVOC's > 100 µg/L and > TWSL extend to the west side of Martinsville.

5 Indoor air evaluations in 2013 without mitigation system operations found no exceedance of commercial/industrial indoor air screening levels.

6 Soil gas evaluations east of Ohio Street in the summer of 2013 found low concentrations and residential indoor air did not exceed screening levels.

7 Soil gas evaluations between Ohio and South Main Street found low concentrations and residential indoor air did no exceed screening levels.

8 To date no CVOC's have been detected in existing potable and non-potable wate-supply wells. TWSL and site-specific risk scenario have not been exceeded. The continued westward migration of cDCE and CE 3a may result in future concentration exceedances of TWSL.

9 Future potable water-supply wells could encounter the deeper plume 4 and may exceed TWSL.

10 Modeling studies suggest the CVOC migration is near a steady-state below farmlands in the White River Flood Plain.

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIATION WORK PLAN

SHEET TITLE

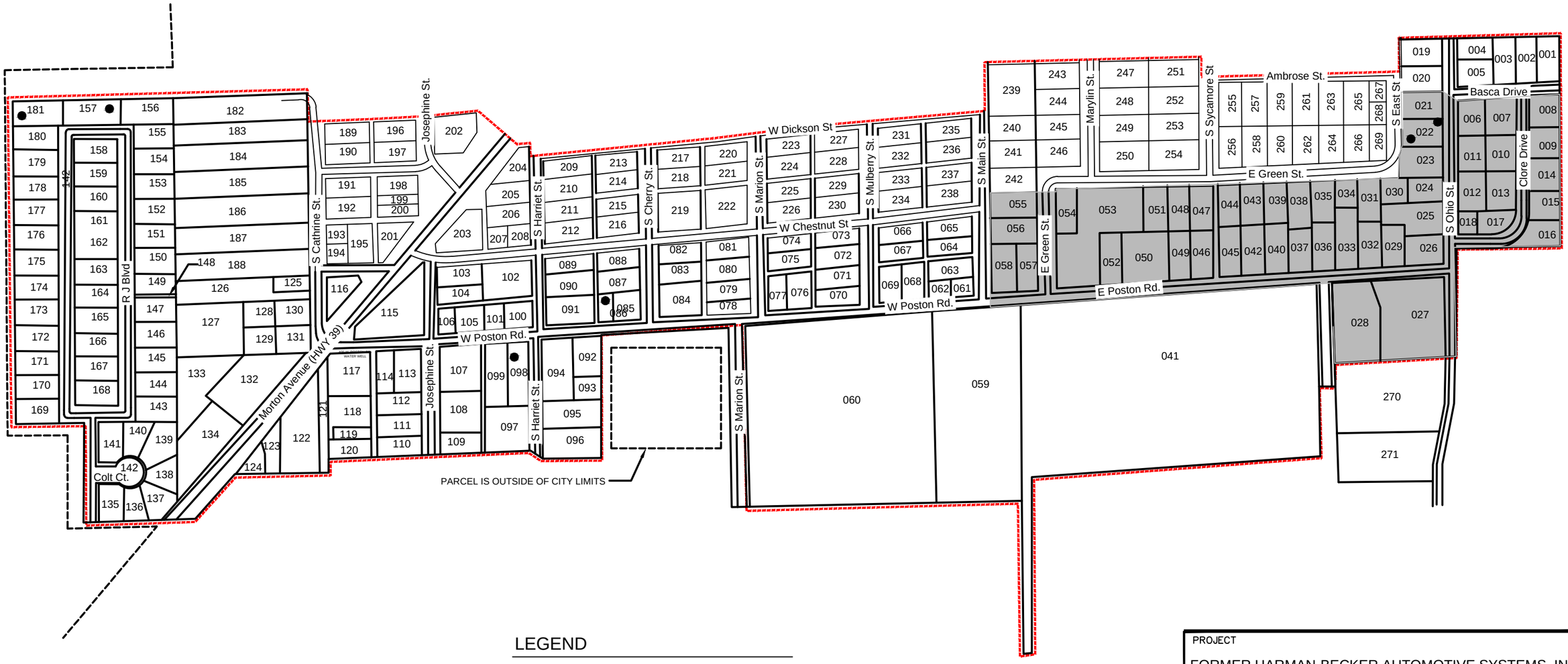
FIGURE 24
CONCEPTUAL SITE MODEL

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

DWG: 147-001-24



LEGEND

- Limits of Environmental Restrictive Ordinance
- Zone A
- Zone B (unshaded)
- City Limits
- Parcel Boundary
- Water Supply Well

north

0 150 300

SCALE IN FEET

PROJECT

FORMER HARMAN-BECKER AUTOMOTIVE SYSTEMS, INC.
REMEDIAL ACTION, AUGUST 2013

SHEET TITLE

FIGURE 25
ENVIRONMENTAL RESTRICTIVE ORDINANCE AREA

ReSolution Partners, LLC

DATE: April 2014

REVISION: REV: 0

FILE: 147-001-25