ISCR Workplan for the Northwest Parking Lot for the Former Holley Automotive / Coltec Industries Facility Water Valley, Mississippi

(Corrective Action Workplan Addendum No. 1)

Bernard T Delaney

Bernard T. Delaney, Ph.D., P.E., BCEE

December 22, 2017

Prepared for: EnPro Industries, Inc.
5605 Carnegie Boulevard, Suite 500
Charlotte, NC 28209

Prepared by: First Environment, Inc.
91 Fulton Street
Boonton, New Jersey 07005

FIRST ENVIRONMENT

CERTIFICATION STATEMENT

I Bernard T. Delaney, Ph.D., P.E., BCEE certify that I am currently a registered professional engineer in the State of Mississippi and had primary direct responsibility for the implementation of the subject environmental assessment activities. I certify that this ISCR Workplan for the Northwest Parking Lot was completed in conformance with the laws and regulations of the State of Mississippi. I certify that all information and statements in this certification form are true.

11041	12/22/2017	
Mississippi Professional Engineer No.	Date	Signature

Contents

FIGURES

APPENDICES

1.0 Introduction

Pursuant to Section 4.A. of the Agreed Order No. 6789-17 entered on September 11, 2017, First Environment, Inc. (First Environment), on behalf of EnPro Industries, Inc. (EnPro), submits this ISCR Workplan for the Northwest parking lot regarding the former Holley Automotive/Coltec Industries Facility located in Water Valley, Mississippi (the “Plant”) and known downgradient plume area (collectively referred to as the “Site”). The Plant is located at 600 State Highway 32 in Water Valley, Yalobusha County, Mississippi, as depicted on Figures 1 and 2.

As discussed in Section 7.1 and Appendix A of the Corrective Action Work Plan (CAWP) submitted to the Mississippi Department of Environmental Quality (MDEQ) on November 10, 2017, to further address the plume migrating off of the Plant site, First Environment proposes in-situ chemical reduction (ISCR) injection in the northwestern parking lot of the Plant as part of the remediation systems for the Site. The hospital property and the Yalobusha County Health Department (Health Dept.) are located within approximately four hundred (400) feet of the northwestern parking lot of the Plant. First Environment proposes ISCR injection in the northwestern parking lot immediately upgradient from the hospital property and the Health Dept.: (1) to treat the portion of the plume in that area; and (2) to prevent further migration of the plume from the Plant. First Environment is continuing to evaluate the need for further investigation and/or expansion of the ISCR injection to the parking lot north of the Plant. This ISCR Workplan provides details on the proposed ISCR injection program.

2.0 Site Investigation Background

2.1 Previous Investigations

As discussed in the CAWP, Site assessment activities were first initiated in 1988 in response to a 1988 groundwater assessment performed by the Mississippi State Department of Health which revealed trichloroethene (TCE) in groundwater in the vicinity of the Plant. Since that time, environmental assessment activities have been conducted throughout the Site to determine the extent of contaminants in groundwater and to plan and implement remedial actions. These historical investigations and remedial activities at the Site have been well documented in reports previously submitted to the Mississippi Department of Environmental Quality (MDEQ). (E&E 2015)

2.2 Site-Specific Geology and Hydrogeology

First Environment reviewed and evaluated all available historical and more recent boring log data and generalized the geological strata underneath the Site in six categories:

1. The uppermost layer consists of silt and silty sand. According to the Unified Soil Classification System (USCS), these soils fall into the category of ML (silt with low plasticity) and SP (poorly graded sand).
2. The layer underneath the uppermost layer consists of loose silty clays. According to the USCS, this layer is classified as CL (clay with low plasticity).
3. Silt, silty sand, and generally sandy soils underlay the clay unit. These are classified as ML (silt with low plasticity), SM (sand with silt), and SP (poorly graded sand), which is significantly more permeable with respect to overlying strata and conducts groundwater laterally.
4. Underlying the sandy soils is dense clay, which acts as a confining unit (i.e., an aquiclude) and does not transmit appreciable amounts of water vertically. This unit is classified as CL (clay with low plasticity).
5. A sandy confined aquifer underlies the clayey aquiclude. The soils of this aquifer are classified as SM (sand with silt), SP (poorly graded sand), and SC (sand with clay).
6. The lowermost geologic stratum is stiff, grey clay, classified as CL (clay with low plasticity).

Figure 3 depicts a 3-dimensional cross-section of Site geology. Figure 4 depicts the groundwater elevation contours. Groundwater flow is towards the northwest generally.

3.0 ISCR Injection Program in the Northwestern Parking Lot of the Plant site

The objective of this ISCR Workplan is two-fold: (1) to reduce/minimize dissolved phase contaminant of concern (COC) concentrations to levels which would not pose a vapor intrusion risk to the hospital and Health Dept.; and (2) to reduce the further migration of contaminants to downgradient portions of the Site. The proposed ISCR injection program in the northwestern parking lot of the Plant site is designed to be protective of human health and the environment and would operate at least four years.

The proposed ISCR injection program will consist of four tasks:

1. a Membrane Interface Hydraulic Profiling Tool (MiHpt) investigation in three locations in the northwestern parking lot;
2. installation of two additional monitoring wells in the northwestern parking lot;
3. establishment of a reactive curtain (RC) for in-situ chemical reduction (ISCR) of COCs; and
4. long-term monitoring and performance evaluation of the RC treatment technology.

3.1 MiHpt Investigation and Additional Monitoring Well Installation and Sampling

In order to fully assess existing soil and groundwater conditions in the northwestern parking lot area, First Environment proposes a MiHpt investigation in three locations and the subsequent installation of monitoring wells in two locations, as depicted on Figure 5.

The MiHpt investigation will aid in the determination of: (1) the screen interval for the proposed wells; and (2) specific depths for reagent injection from the water table to the dense clay layer (i.e., the zone of influence).

A Geoprobe® will be utilized to push the MiHpt probe to the approximate depth of the clay layer. The MiHpt system will be equipped with an Electrical Conductivity (EC) probe, an Electron Capture Detector (ECD), a Photo Ionization Detector (PID), a Flame Ionization Detector (FID), and a Halogenated Specific Detector (XSD). During the advancement of the borings in the area, the response of each detector, relative to depth, will be recorded in accordance with the standard operating procedures for the MiHpt system.

First Environment proposes to install two additional monitoring wells (PMW-1 and PMW-2) within the proposed treatment area to assess baseline conditions and the subsequent monitoring of the RC discussed in Section 3.4. The proposed monitoring well locations are depicted in Figure 5.

The wells will be constructed of two-inch diameter PVC risers and 25-foot screens to be situated between 10.0 to 35.0 feet below ground surface (bgs) (i.e., approximately to the depth of the underlying dense clay layer [Layer No. 4]). The monitoring wells will be placed directly within the zone of influence, as determined by the MiHpt investigation, and immediately upgradient and downgradient of the injection zone (i.e., RC). During installation, representative soil and groundwater samples will be collected to assess geochemical parameters and volatile organic compounds (VOCs). The groundwater samples will further be analyzed for other parameters pertaining to ISCR chemistry, such as dissolved gases (oxygen, methane, ethane, and ethene), anions (sulfate, sulfide, nitrate, nitride, and chloride), cations (manganese, and ferric and ferrous iron), alkalinity, total organic carbon, dissolved organic carbon, dehalococcoides (DHC) analysis, and volatile fatty acids (VFAs) to establish baseline conditions. See the QAPP, Appendix D to the draft CAWP submitted in November 2017.

The proposed monitoring wells, along with the existing monitoring wells, will be utilized in a long-term monitoring program to assess the effectiveness of the RC as outlined below.

3.2 Description of ISCR Technology

First Environment will utilize propriety products, EHC® and EHC+®, manufactured by PeroxyChem in the construction and operation of the RC at the northwestern parking lot.

EHC® is a solid product and is composed of controlled-release carbon, zero valent iron (ZVI) particles, and nutrients used for stimulating ISCR of otherwise persistent organic compounds in groundwater. Standard EHC® has 60 percent organic carbon and 40 percent ZVI. Following placement of EHC® into the subsurface environment, a number of physical, chemical, and microbiological processes combine to create very strong reducing conditions that stimulate rapid and complete dechlorination of organic solvents. The chlorinated ethenes and ethanes are destroyed via multiple pathways. An abiotic pathway resulting in direct reduction on the surface of the ZVI particles, a biotic pathway (sequential reductive dechlorination) where the organic carbon serves as the electron donor, and an indirect abiotic pathway where the ferrous iron produced from ZVI corrosion can form reactive iron and iron plus sulfide minerals. Because it is solid in nature, EHC® has to be applied or injected in the subsurface as a slurry.

EHC® is a long-lasting ISCR amendment. Because of its longevity (generally four to six years) and because it provides three degradation pathways, EHC® is a preferred alternative for the northwestern parking lot.

EHC+® is a combination of EHC® and powdered activated carbon (PAC). The composition would be 50-60 percent organic carbon, 40-50 percent ZVI, and < 5 percent PAC. The Site groundwater conditions are conducive for the EHC® technology. The EHC® with ZVI material will be injected using multiple rows of direct-push injections using a Geoprobe® rig. The substance may be amended with powdered activated carbon (PAC) to further assist in biodegradation and to treat as well as sequester some of the contamination moving off of the Plant site towards the northwest.

The advantages of EHC® include:

- Health and Safety. EHC® is a non-hazardous product. Safe handling and easy application with no bulky or hazardous material disposal issues.
- Minimal Methane Production. The presence of ZVI and the complex, controlled-release carbon source help minimize production of potentially problematic fermentation end-products, such as methane.
- ISCR. Combined chemical and biological oxygen scavenging facilitates rapid oxygen consumption and establishment of reduced Eh. Generation of significantly lowered reducing conditions usually eliminates any requirement for specialty microorganisms or inoculants.
- Rapid TCE removal without accumulation of potentially problematic catabolites, such as cis-DCE and VC.
- Remains active in the environment for generally four to six years.
- Facilitates Natural Attenuation Processes. For all the reasons summarized above, EHC® enhances the natural biological processes.
- EHC® will add a carbon source for the microbes to promote biodegradation.

There have been sites where an alkaline buffer has been used with EHC® based applications when background geochemical conditions are not optimal (e.g., pH< 6). EHC® product is designed to naturally release alkalinity (presence of ZVI), and a buffering agent may not be required unless the site background conditions are very acidic (pH< 5.5). Based on groundwater data at the Plant site, it is anticipated that a buffer is not required.

Naturally occurring microbial population may be catabolically limited and the remedial process might benefit from the addition of inoculants with known abilities to rapidly degrade cVOCs. Although not typically required for ISCR as defined above, inoculants have been useful for these situations where the daughter products are present at high concentrations. Inoculants can be injected simultaneously with the substrate. For this proposal, it is assumed that a limited amount of inoculants will be used.

3.3 Reactive Curtain Application

First Environment proposes to construct a RC utilizing EHC® and EHC+® reagents in a closely spaced (i.e., <15-foot) interval in three lines separated by 15-foot interval as shown in Figure 5. The total length of the curtain will be approximately 300 feet. The dense clay layer (Layer No. 4) surface varies from about 30.0 to 40.0 feet bgs; the overlying sand unit is approximately 15 feet in thickness. The RC will be screened in the overlying sand unit. Direct-push drilling method (e.g., Geoprobe®) will be utilized to inject the reagents to the specific depth at the locations shown in Figure 5 as follows:

- Pre-determined quantity of EHC® outlined below will be pressure-injected from top down at the specified interval along the first two lines (Line Nos. 1 and 2). The top-down injection method is preferred because it enables better vertical and lateral distribution of reagents into the formation by creating a vertical pressure gradient to push down the groundwater table, provided that the prevailing hydrostatic pressure is overcome by the injection pressure. This, however, needs to be tested in the field within the first few injection locations. If the field conditions do not prevail, a bottom up (i.e., tremie) injection scheme will be utilized. Engineering judgment based on the actual field conditions will be necessary to make any adjustment at each injection location.
- The third line closest to the hospital and Health Dept. (Line No. 3) will be constructed by using EHC® and EHC+® in a similar fashion. Line No. 3 will promote sequestration of cVOCs that migrate beyond the first two rows.

Approximately two-thirds of the total EHC® material will be injected within the first two curtains. The remaining one-third will be mixed with EHC+® and injected within the third curtain.

Prior to injection, a 25 percent solid/75 percent water combination slurry will be mixed in a specialized hopper in the field. For each bag of material, which contains 50 lbs. of EHC® (or EHC+®), 18 gallons of water will be used to mix the reagent, resulting in 22 gallons of slurry to be injected. The details of the reagent mass calculations are provided in Appendix A of this workplan. Based on the actual hydrogeological conditions and the observed dissolved phase concentration of TCE in MW-37, a mass balance calculation was performed with the data provided by PeroxyChem (producer of EHC®) in order to satisfy the total chemical hydrogen demand necessary to induce and sustain reductive dechlorination of TCE. As calculated in Appendix A, the following is the estimated total amounts to be used in the proposed injection program:

Total EHC® Weight = 20,000 lbs. (400 bags)
Total EHC+® Weight = 10,000 lbs. (200 bags)
Total EHC® & EHC+® = 30,000 lbs. (600 bags)
Microbial Culture (inoculants) = 12 L
Total Water Volume = Approximately 10,800 gallons
Total Slurry Volume = Approximately 13,200 gallons
Number of Injection Locations: 60 (20 points per curtain)
Total Slurry Volume per Location = Approximately 110 gallons

Safety protocols protective of health and the environment will be developed prior to construction/implementation of the RC technology. The EHC® and EHC+® are food-grade, non-hazardous materials.

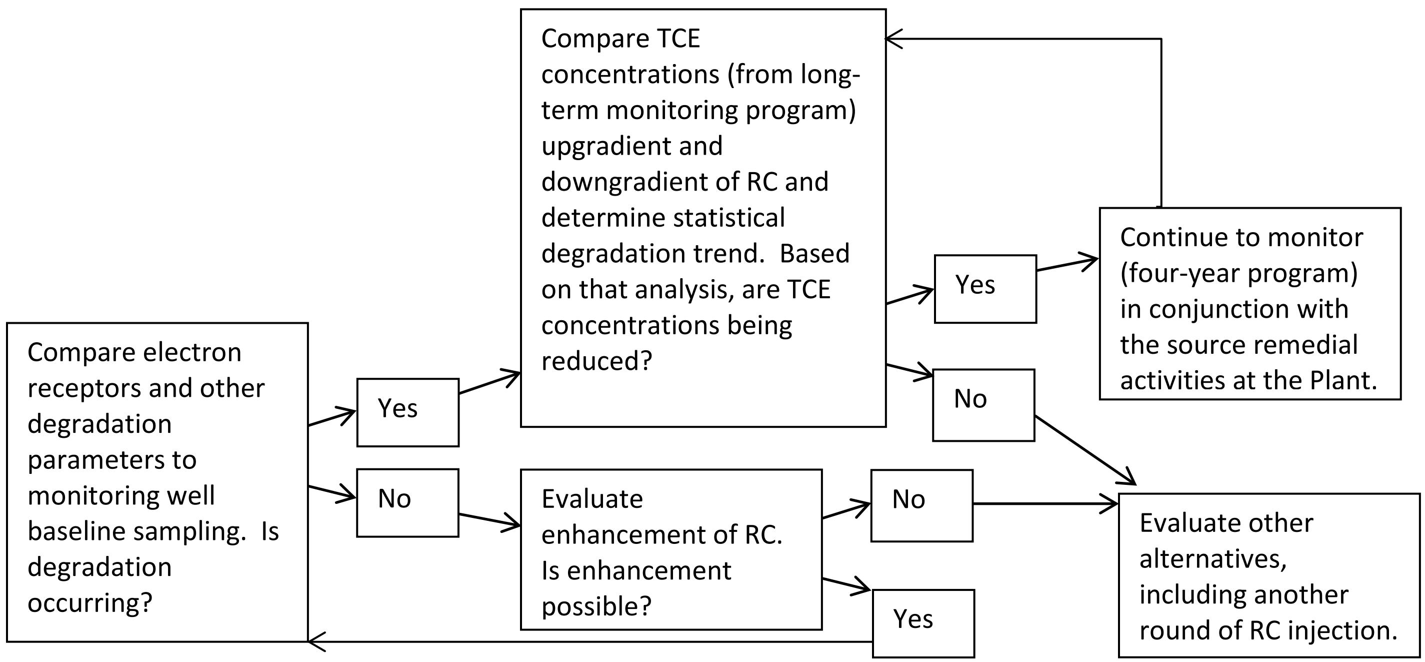
3.4 Long-Term Monitoring Program

A four-year monitoring program will initially be implemented during the longevity of this proposed ISCR injection program. This program will involve quarterly sampling of MW-37, PMW-1, and PMW-2 for the first year following the application of the reactive curtain, and semi-annually thereafter for the next three years. Groundwater data from MW-27, included in the semi-annual sampling schedule set forth in Section 8.2 of the CAWP, will also be assessed for the next four years as part of the long-term monitoring program for the ISCR system.

The proposed monitoring program will involve collection and laboratory analyses of groundwater samples from MW-27, MW-37, PMW-1, and PMW-2 for USEPA's Target Compound List (TCL) Volatile Organic (VO) analysis, as well as the ISCR degradation parameters. The results of these analyses will be compared with the baseline indicators, which will be established prior to construction of the RC to enable First Environment to evaluate the efficacy of the RC technology. The first sampling event of MW-27, MW-37, PMW-1 and PMW-2 will commence three months after the installation of the RC.

The performance measures for the RC are set forth below.

RC Performance Measures for Four-Year Monitoring Program



4.0 Schedule for Implementation

A proposed implementation schedule is attached in Appendix C to the CAWP, including for the ISCR injection program in the northwestern parking lot. The materials procurement and delivery and EHC activities are proposed to be completed in the first quarter of 2018.

The major milestones associated with this work are as follows:

- private geophysical mark-out;
- procure driller;
- MiHpt investigation;
- proposed monitoring well installation and baseline sampling;
- procure materials;
- install RC;
- site recovery; and
- long-term monitoring.

First Environment expects to conclude its evaluation of the need for further investigation and/or expansion of the ISCR injection to the parking lot north of the Plant after the first of the year.

5.0 BorgWarner

First Environment will work with BorgWarner regarding access to the northwestern parking lot, securing the equipment and materials, and minimizing the disruption to BorgWarner's operations.

FIGURES

Legend

Monitoring Wells

Based on Figure 2-2 of RJRudyLLC Supplemental Assessment Acitivities and Results Report (December 2016)

0 100 200 400 Feet

1 inch = 400 feet

N S E W

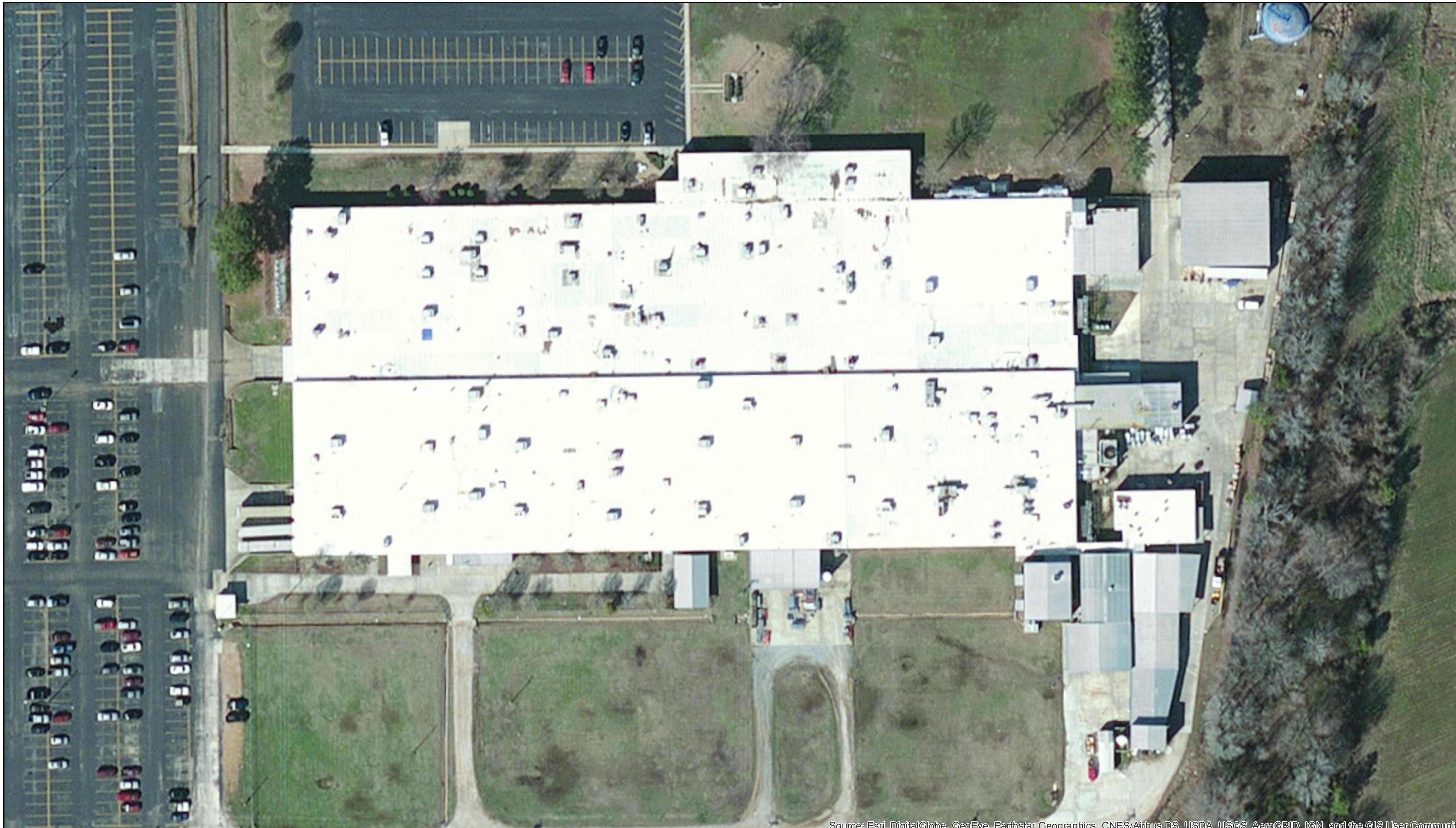
FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

FORMER HOLLEY AUTOMOTIVE/COLTEC INDUSTRIES FACILITY
600 Highway 32E, Water Valley, MS

FIGURE 1
SITE LOCATION MAP

Revised	Drawn	Checked	Approved	Date
	NMT		TCB	11/03/2017



Aerial Source: USDA FSA NAIP 2016

0 20 40 80 Feet

1 inch = 80 feet

N W E S

FIRST ENVIRONMENT

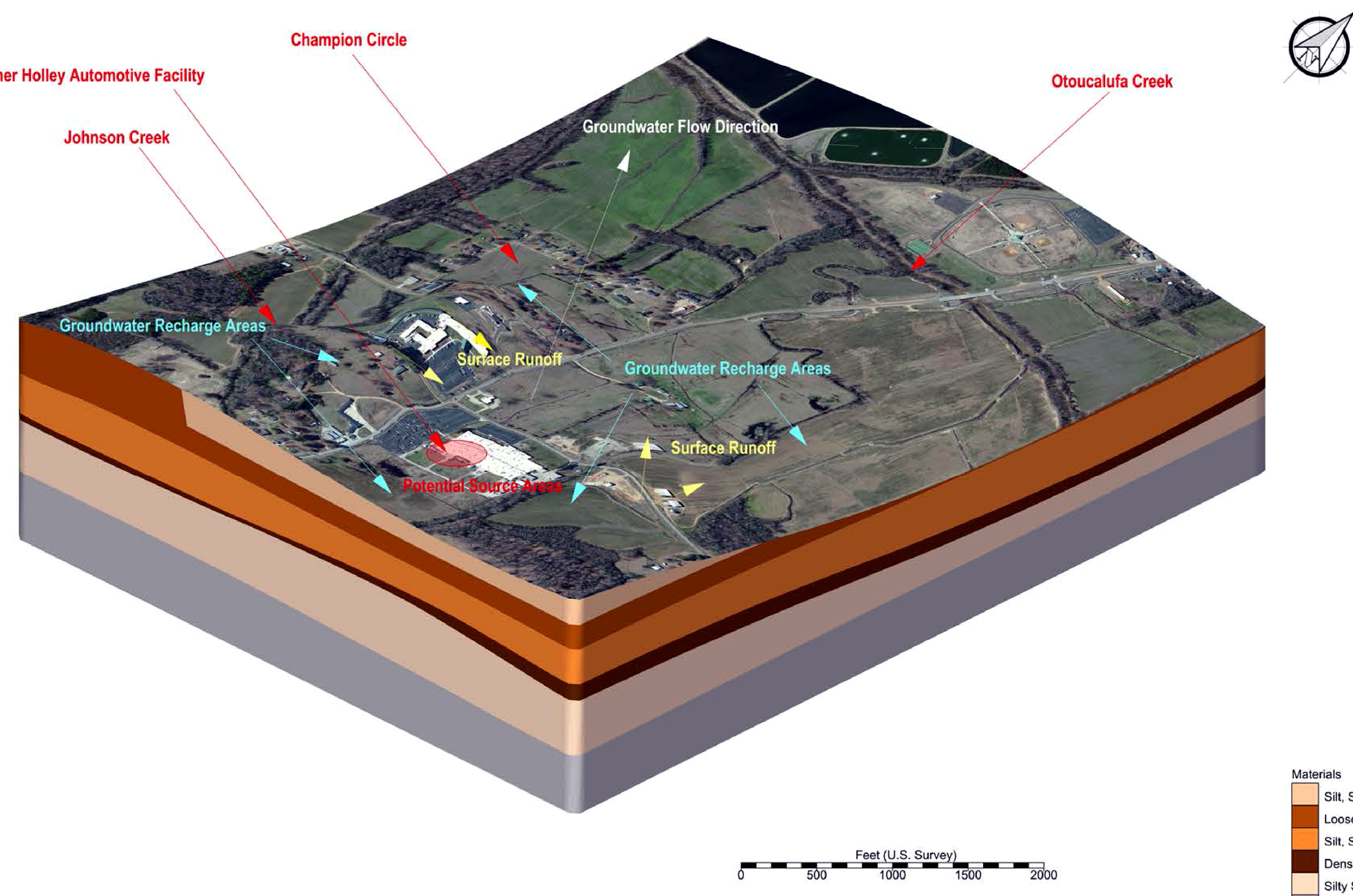
91 Fulton Street
Boonton, New Jersey 07005

FORMER HOLLEY AUTOMOTIVE/COLTEC
INDUSTRIES FACILITY
600 Highway 32E, Water Valley, MS

FIGURE 2

BASEMAP

Revised	Drawn	Checked	Approved	Date
	LS	NMT	TCB	11/03/2017



Materials

- Silt, Silty Sand (ML, SP)
- Loose Silty Clay (CL)
- Silt, Silty Sand, Sand (ML, SM, SP)
- Dense Silty Clay (CL)
- Silty Sand, Sand (SM, SP, SC)
- Grey Clay (CL)

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

FORMER HOLLEY AUTOMOTIVE/COLTEC INDUSTRIES FACILITY
600 Highway 32E, Water Valley, MS
FIGURE 3
CONCEPTUAL SITE MODEL

Revised	Drawn	Checked	Approved	Date
	NMT	NMT	TCB	11/03/2017

Legend

Monitoring Wells

Groundwater Elevation Contours (ft, AMSL)

0 150 300 600 Feet

1 inch = 600 feet

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

FORMER HOLLEY AUTOMOTIVE/COLTEC INDUSTRIES FACILITY
600 Highway 32E, Water Valley, MS
FIGURE 4
GROUNDWATER ELEVATION CONTOUR MAP

Revised	Drawn	Checked	Approved	Date
	NMT		TCB	11/03/2017

Legend

- MiHpt Locations
- Reactive Curtain Injection Locations
- Proposed Monitoring Well Locations
- Existing Monitoring Well Locations

0 12.5 25 50 Feet

1 inch = 50 feet

N S W E

FIRST ENVIRONMENT

91 Fulton Street
Boonton, New Jersey 07005

FORMER HOLLEY AUTOMOTIVE/COLTEC INDUSTRIES FACILITY
600 Highway 32E, Water Valley, MS

FIGURE 5

REACTIVE CURTAIN INJECTION LOCATIONS AT NORTHWEST PARKING LOT

Revised	Drawn	Checked	Approved	Date
	LS		TCB	12/11/2017

APPENDIX A

IN-SITU CHEMICAL REDUCTION (ISCR) REAGENT (EHC®) MASS CALCULATIONS FOR PERMEABLE REACTIVE BARRIERS (PRBs)
by
Dr. Mete Talimcioglu
First Environment, Inc.

DESIGN PARAMETERS

Contaminant of Concern, *CoC* :	**TCE**	
PRB Design Life, *t* :	4	years
Length of PRB, *L* :	300	ft
Number of PRB Lines, n_p :	3	
Lateral Spacing of PRB Lines, l_p :	5	ft
Width of PRB, *w* :	15	ft
Lateral Spacing Between each Injection Location per PRB Line, l_i :	15	ft
Number of Injection Locations per PRB Line, n_i :	20	
Total Number of Injection Locations, n_t :	60	
Depth to Treatment Zone, d_t :	15	ft
Treatment Zone Thickness, *d* :	15	ft
Treatment Volume V_t :	67,500	ft^3
Total Groundwater Volume, V_{gw} :	20,250	ft^3
Calculated Soil Mass, *M* :	7,425,000	lbs
Advective Migration Distance over Treatment Life, L_t :	3,194	ft
Volume of Groundwater Passing Through Region over Treatment Life, V_{tgw} :	2,874,375	ft^3

HYDROGEOLOGIC PARAMETERS

Porosity of Soil, *n* :	0.3	--
Effective Porosity, n_e :	0.2	--
Bulk density of Soil, ρ_b :	110	lbs/ft^3
Hydraulic Conductivity of Soil, *K* :	87.5	ft/day
Hydraulic Gradient, *i* :	0.005	ft/ft
Specific Discharge, *v* :	0.4375	ft/day
Average Linear Velocity of Groundwater, *v** :	798	ft/yr

CONTAMINANT PARTITIONING

Organic Carbon Fraction, f_{oc} :	0.005	--
Normalized Partitioning Coefficient of CoC, K_{oc} :	107	L/Kg
Adsorption Coefficient, K_d:	0.535	L/Kg
Observed Dissolved Phase Concentration, C_L :	**0.6**	mg/L
Total Sorbed Phase Soil Contamination, C_s:	**0.321**	mg/Kg

CONTAMINANT MASS

CoC Mass in Soil, M_s :	2.4	lbs
CoC Mass in Groundwater in Treatment Zone, M_{gwt} :	0.8	lbs
Total CoC Mass in Groundwater Over Design Period, M_{gw} :	108.6	lbs
Total CoC Mass, M_t :	**111.0**	lbs

STOICHIOMETRY

Stoichiometric Hydrogen Demand Ratio for CoC, *SDR* :	0.3333	mol/mol
Molecular Weight of CoC, *MW* :	131.4	g
Molecular Weight of H_2, *MWH* :	2	g
Stoichiometric Hydrogen Demand Ratio for CoC, *SD* :	21.9	CoC Mass/H_2 Mass
Hydrogen Concentration from Dissolved CoCs in Groundwater, H_d :	0.03	mg/L
Hydrogen Concentration from Sorbed CoCs in Soil, H_s :	0.01	mg/Kg
Hydrogen Concentration from Competing Electron Acceptors, H_{cea} :	11.5	mg/L ---> from PeroxyChem
Total Hydrogen Concentration, H_t :	**11.5**	mg/L

HYDROGEN DEMAND CALCULATIONS

Hydrogen Demand from Soil within Targeted Area, H_{2s} :	0.1	lbs
Hydrrogen Demand from Groundwater within Targeted Area, H_{2gw} :	14.7	lbs
Hydrogen Demand from Groundwater Influx Over Design Period, H_{2inf} :	2089.7	lbs
Total Hydrogen Demand, H_{2t} :	2104.6	lbs

EHC MASS CALCULATIONS

Average H_2 Release Rate from EHC, R_{EHC} :	18.8	g H_2/Kg EHC/yr ---> from PeroxyChem
H_2 Release per Pound of EHC Over Design Period, R_t :	0.075	lbs
Total EHC Required, M_{EHC} :	27,986	lbs

EHC SLURRY CALCULATIONS FOR 25% SOLIDS

Mass of EHC per Bag, M_{bag} :	50	lbs
Number of Bags Required, n_b :	600	--
Percent Solids, *ps* :	25%	
Total Solids:	200	lbs
Total Water:	150	lbs
Average Water Density, ρ_w :	62.4	lbs/ft^3
Volume of Water Required per Bag of EHC, V_{bag} :	18	gals
Specific Gravity of EHC Slurry for 25% Solids , G_s :	1.09	---> from PeroxyChem
Volume of Slurry Generated per Bag of EHC, V_{bsl} :	22	gals

Total EHC Required, M_{design} :	**30,000**	lbs (rounded)
Safety Factor, *SF* :	**1.072**	
Total Volume of Water Required for EHC Slurry, V_w :	**10,800**	gals (rounded)
Total Volume of EHC Slurry to be Injected, V_{sl} :	**13,200**	gals (rounded)
Volume of EHC per Injection Point, V_i :	**220**	**gals**

December 2017