PARSONS
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November 29, 2012

Mr. Joe Bell
Project Manager, Voluntary Cleanup Section
Remediation Division, MC 221
Texas Commission on Environmental Quality
PO Box 13087
Austin, Texas 78711-3087

RE: Phase 3 Enhanced Anaerobic Bioremediation Work Plan
Charlie Burch Site, Montgomery County, Texas.
VCP No. 421

Dear Mr. Bell,

On behalf of Rohm and Haas Texas, Parsons is submitting the enclosed Phase 3 Enhanced Anaerobic Bioremediation (EAB) Work Plan for the above-referenced site for your review. Two copies of the report and one electronic copy on CD-rom are included. Additionally, a completed correspondence identification form is included with the report.

This Work Plan was prepared to describe the Phase 3 EAB activities which are revised from those included in the EAB Work Plan approved by the Texas Commission on Environmental Quality in August 2011. The Work Plan for the Phase 3 EAB activities on the Wert property were revised based on knowledge acquired implementing EAB Phases 1 and 2 and also data from an investigation completed this past year on the Rummell property located immediately upgradient of the Wert property..

If you have any questions or comments on the attached plan, please contact Mr. Rick Wenzel of Rohm and Haas at (281) 228-8190 or me at (713) 871-7010.

Regards,

Darren M DeFabo

Darren M. DeFabo, P.E.
Project Manager
PARSONS

cc: Rick Wenzel, Rohm and Haas (1 electronic copy)
Ron Lantzy, Rohm and Haas (1 electronic copy)
Dan Griffiths, Parsons (1 electronic copy)
File: 447194

Texas Commission on Environmental Quality

Remediation Division Correspondence Identification Form

SITE & PROGRAM AREA IDENTIFICATION			
SITE LOCATION		**REMEDIATION DIVISION PROGRAM AND FACILITY IDENTIFICATION**	
Site Name: **Charlie Burch Site**		Is This Site Being Managed Under A State Lead Contract? ☐ Yes ☑ No	
Address 1: **25529 Richards Road**		Program Area: **VOLUNTARY CLEANUP PROGRAM**	
Address 2:		Mail Code: **MC-221**	
City: **Spring**	State: **Texas**	Is This A New Site To This Program Area? ☐ Yes ☑ No	
Zip Code: **77386**	County: **Montgomery**	**VCP No.:**	**421**
TCEQ Region: **Region 12 - Houston**		**--Leave This Field Blank--**	**--Leave This Field Blank--**

DOCUMENT(S) IDENTIFICATION		
	PHASE OF REMEDIATION	**DOCUMENT NAME**
1.	MISCELLANEOUS	TECHNICAL WORKPLAN NOT OTHERWISE SPECIFIED (NOS)
2.		
3.		
4.		
5.		

CONTACT INFORMATION

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TCEQ INTERNAL USE ONLY			
Document No.	TCEQ Database Term	Document No.	TCEQ Database Term
1.	**TECHNICAL WORKPLAN**	4.	
2.		5.	
3.			

PHASE 3 ENHANCED ANAEROBIC BIOREMEDIATION WORK PLAN

ROHM AND HAAS CHARLIE BURCH SITE SPRING, TEXAS (VCP NO. 421)

Prepared for:

Rohm and Haas Texas, Inc.
A Wholly-Owned Subsidiary of The Dow Chemical Company
3100 State Street
Croydon, Pennsylvania 19021

Prepared by:

PARSONS
8000 Centre Park Drive, Suite 200
Austin, Texas 78754-5140

November 2012

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(Table is provided within the text.)

ACRONYMS

Acronym	Definition / Description
1,2-DCA	1,2-dichloroethane
DHC	Dehalococcoides ethenogenes
DO	Dissolved oxygen
EAB	Enhanced anaerobic biodegradation
ft bgs	Feet below ground surface
HDPE	High density polyethylene
ID	Inner diameter
IW	Injection Well
mg/L	Milligrams per liter
MW	Monitoring Well
ORP	Oxygen reduction potential
PCL	Protective concentration limit
Psi	Pounds per square inch
PVC	Polyvinyl chloride
RAER	Response Action Effectiveness Report
RAP	Response Action Plan
TCEQ	Texas Commission on Environmental Quality
UIC	Underground Injection Control
USEPA	U. S. Environmental Protection Agency
VCP	Voluntary Cleanup Program

1.0 INTRODUCTION

The Charlie Burch site is located approximately 25 miles north of Houston in south central Montgomery County. This property, which has never been owned by Rohm and Haas Texas, Inc. (Rohm and Haas), was used as a disposal site during the 1960s, and reportedly received material from Rohm and Haas and other industrial concerns. Between 1983 and the mid 1990s, several investigations were conducted at the site to determine the nature and extent of impacts associated with the buried waste materials. In mid-1999, with the approval of the Texas Commission on Environmental Quality (TCEQ), Rohm and Haas delineated, excavated, and disposed of off-site buried waste and affected soil from the former disposal area (hereinafter referred to as the Source Area as labeled on Figure 1-1). A Response Action Completion Report documenting the soil remediation was submitted to the TCEQ on March 24, 2000 (GSI 2000) and was subsequently approved by the TCEQ.

Following this soil remediation in the Source Area, a 1,2-dichloroethane (1,2-DCA) plume remains in the uppermost formation of the underlying aquifer. The 1,2-DCA plume begins at the Source Area and has migrated approximately 4,000 feet to the southeast beneath off-site properties (see Figure 1-1). The depth to the uppermost groundwater is approximately 25 feet below ground surface over most of the areal extent of the 1,2-DCA plume. The 1,2-DCA plume extends vertically to a depth of approximately 90 feet in the Source Area and approximately 35-65 feet in downgradient portions of the 1,2-DCA plume. The 1,2-DCA plume is separated from the local drinking water aquifer by approximately 100 feet of fine-grained material consisting of silt and clay with small amounts of interbedded sand. Testing has shown that production wells in this area that are installed in the drinking water aquifer are not impacted by the 1,2-DCA plume.

As part of an interim groundwater response action, a groundwater containment and treatment system was installed in the Source Area (referred to as the Source Area System) immediately downgradient of the excavated disposal area. The system began operating in March 2001 to remediate on-site groundwater and to provide hydraulic control to eliminate further off-site migration from the Source Area. The Source Area System was redesigned and upgraded in late 2011 and began operating in January 2012.

After several phases of groundwater investigation, a plan to address the 1,2-DCA plume was presented to the TCEQ in a Response Action Plan (RAP) dated February 18, 2005 (GSI 2005). Following conditional TCEQ approval of the RAP in 2005, Rohm and Haas installed a groundwater containment and treatment system to capture the 1,2-DCA plume at the southern boundary of the 13-Acre Tract (referred to as the 13-Acre Tract System) to prevent further downgradient migration and to maximize capture of the plume from the downgradient properties. The 13-Acre Tract System became operational in May 2006.

Rohm and Haas selected a final response action plan for the 1,2-DCA plume consisting of continuing groundwater recovery and treatment in the Source Area and the 13-Acre Tract along with enhanced anaerobic biodegradation (EAB) treatment in the portions of the 1,2-DCA plume not captured or addressed by the two recovery systems. A revised RAP (Parsons 2011), which received final TCEQ concurrence on April 7, 2011, presented the proposed response actions for addressing 1,2-DCA in groundwater. In addition to continuing groundwater containment operations, the approved response action consists of implementing treatment in a phased approach through the use of *in-*

situ EAB treatment zones between the Source Area and a portion of the Imperial Oaks subdivision, between the neighborhood and the 13-Acre Tract, and if necessary, downgradient of the 13-Acre Tract.

The *in-situ* EAB treatment zones will be replenished as-needed to maintain progress towards achieving groundwater PCLs. EAB treatment will be implemented in a phased approach to facilitate optimization and incorporation of process improvements into subsequent phases. The primary implementation phases planned include:

- Phase 1: North of Richards Road (Dyring Property). This phase was completed in 2012.
- Phase 2: Neighborhood area between Richards Road and the pipeline right-of-way. This phase was completed in 2012.
- Phase 3: Upgradient of the Phase 1 installation and downgradient of the Source Area (Wert Property). This phase is tentatively scheduled to be completed in 2013.
- Phase 4: North of Richard Road and downgradient of the Source Area (Rummell property). This phase is currently planned to be implemented in 2014.
- Phase 5: Downgradient of the 13-Acre Tract system. Treatment in this area may not be necessary if observed attenuation trends continue. The need for these treatment zones will be determined during 2013 and 2014 by assessing attenuation data collected up to that point.

Please note that the schedules are subject to change and depend in part on access approval and the most recent sampling results indicating progress towards the PCL. The locations of the five Phases are depicted on Figure 1-2. An Enhanced Anaerobic Bioremediation Work Plan for Phases 1 – 5 was submitted to the TCEQ in August 2011 (Parsons 2011) and was subsequently approved by the TCEQ.

This work plan was prepared to describe the implementation of the Phase 3 EAB treatment zone that will be installed on the Wert Property.

1.1 Response Action Objectives

The primary response action objectives at the Charlie Burch site are to prevent further migration of the 1,2-DCA plume and to remove or degrade 1,2-DCA such that PCLs are met within a reasonable time frame of 15 years. These response action objectives will be met through the operation of the Source Area and 13-Acre Tract Systems and through the application of EAB in those portions of the 1,2-DCA plume that will not be remediated within the desired time frame using only the Source Area and 13-Acre Tract Systems.

Specific response action objectives associated with the EAB applications are as follows:

- Completely degrade 1,2-DCA mass through in-situ bioremediation such that 1,2-DCA and dechlorination intermediates (chloroethane) meet PCLs;
- Optimize placement of treatment zones within the plume at approximate spacing of two years travel time (~200 linear feet) in groundwater; and
- Inject organic substrate and buffer solution that is designed to remain active in the treatment zone for three to four years to maximize effectiveness and completeness of plume remediation.

1.2 Document Organization

This work plan is organized into four sections. This introductory section presents a site and regulatory overview in addition to recent site activities and specific plans for remediating the plume. Section 2 presents the Phase 3 remedial activities that will be completed on the Wert Property to meet the remedial action objectives presented in the revised RAP (Parsons, 2011). Section 3 presents the EAB application reporting and documentation requirements and Section 4 provides both in-text and background references.

2.0 RESPONSE ACTION IMPLEMENTATION

2.1 Response Action Design Approach

The EAB application design for the Wert Property includes multiple EAB treatment zones that are spaced within the 1,2-DCA plume (Figure 2-1). The spacing and placement of the EAB treatment zones are primarily based on observed and modeled groundwater flow direction and rate along with contaminant migration rate in the area. The proposed EAB application layout includes installation of injection wells (IWs) at up to 24 locations and new performance monitoring wells (MWs) at four locations. Some IW and MW locations may include a pair of nested wells (i.e., two wells installed near each other [e.g., less than five feet apart] in separate boreholes).

Prior to installing any wells, a subsurface investigation will be completed at 12 direct push boring locations to determine soil lithology (i.e., the thickness and lateral extent of a subsurface clay layer) to establish which well locations will include nested wells. In addition to determining the soil lithology beneath the Wert Property, discrete groundwater samples will be collected from direct push borings to further delineate the 1,2-DCA plume both vertically and horizontally. The data from these direct push borings could enable the actual number of wells installed to be reduced.

The conceptual plan for each treatment zone is to inject sufficient volume of organic substrate and pH buffer to persist in the formation for approximately three to four years. As such, the treatment zones will require replenishment of organic substrate every three to four years, and additional buffer solution may need to be injected on a more frequent basis. Future refresh requirements will be determined through analysis of performance data to ensure continued progress toward achieving remedial goals.

The EAB treatment zones are the critical component that should address the downgradient 1,2-DCA plume. The treatment zones will be created by injecting an organic substrate into the formation generally perpendicular to the direction of 1,2-DCA plume movement to create anaerobic conditions conducive to the biological degradation of the dissolved 1,2-DCA. The organic substrate will be injected to create continuous treatment zones traversing the 1,2-DCA plume so that contaminants will be treated as they migrate with groundwater flow through the treatment zones. A pH buffer will also be injected with the organic substrate to raise and/or maintain the natural pH of groundwater to near-neutral conditions that are more favorable to anaerobic degradation of 1,2-DCA. Additionally, a commercially available bioaugmentation culture acclimated to degrade 1,2-DCA may be injected into the treatment zones after anaerobic conditions have been established to enhance or accelerate the establishment of a viable microbial community capable of degrading 1,2-DCA.

Four new performance MWs will be installed to augment the existing well network on the Wert Property (Figure 2-1). Select monitoring wells and injection wells will be sampled immediately prior to injection to establish baseline conditions and periodically after injection to monitor progress of geochemical changes and 1,2-DCA concentration reductions associated with the treatment zones. Performance monitoring will be performed quarterly during the first year following injection and then assessed and potentially adjusted depending on groundwater contaminant trends, geochemical changes, and projected organic substrate depletion rates. Performance monitoring results will be submitted periodically in accordance with the TCEQ Underground Injection Control (UIC) reporting requirements and the TCEQ Voluntary Cleanup

Program (VCP) documentation requirements. Reporting activities are discussed in detail in Section 3 of this work plan.

2.2 Permitting and Regulatory Compliance

2.2.1 Underground Injection Control Authorization

A Class V UIC Authorization is required for the injections in the proposed treatment zones. Rohm and Haas currently manages injection of treated water and implemented EAB activities to date under a Class V UIC Authorization (UIC Authorization 5X2600416). The injections on the Wert Property will be added to the current UIC authorization by modifying the current UIC Class V Authorization.

2.2.2 Notifications

The TCEQ VCP and the TCEQ UIC Program will be kept abreast of project and field schedule developments through regular status reports.

The Wert Property owner will be notified of field activities, and access will be obtained in accordance with the property owner signed-specific access agreement.

2.3 Response Action Construction Activities

EAB response action construction activities will include: mobilizations to the site; a subsurface investigation; installation of MWs and IWs; on-site preparation and injection of organic substrate and water; site surveys; and performance monitoring groundwater sampling. Preparation and injection of bioaugmentation culture may be conducted.

2.3.1 Subsurface Investigation

Prior to installing any wells on the Wert property, a subsurface investigation will be completed to optimize the number and locations of wells that will need to be installed to implement Phase 3 EAB activities. The objectives of this investigation will be to determine the thickness and lateral extent of a subsurface clay layer and to further delineate the 1,2-DCA plume both vertically and horizontally.

Mobilization

Prior to mobilizing to the site for the subsurface investigation, Texas811 will be contacted to locate existing utilities in the vicinity of the proposed well installation locations. A private utility locator may be used as necessary. The Wert Property owner will be contacted, and access will be obtained in accordance with the property-specific access agreement.

Direct-push Continuous, Statigraphic Logging

A sonic (vibratory) drill rig will be used to advance soil borings at 12 locations. Continuous soil cores will be collected from ground surface to total depth and visually logged by a Geologist for sediment grain size, color, and moisture content. The boreholes will be grouted from total depth to ground surface after completion of logging.

Direct-push Groundwater Vertical Sampling

A sonic drill rig will be used to advance a discreet-interval groundwater sampling device at the 12 locations. Up to five discreet depth intervals will be sampled at each location. The drill rig will advance the sampling device to a depth and the outer casing of the groundwater sampling device will be retracted, exposing the inner screened casing through which groundwater can enter. A Geologist will then lower tubing equipped with a foot valve to the screened interval, purge one tubing volume, and collect a groundwater sample. After each interval is sampled, the sampling device will be removed from the borehole, a decontaminated sampling device will be attached, and the drill rig will advance the sampler to the next depth interval where another groundwater sample will be collected. The sampling procedure will be repeated until the required discreet depth intervals are sampled at each location. The boreholes will be grouted from total depth to ground surface after sampling is completed at each location.

Investigation Derived Waste

Investigation derived waste will consist of soil cuttings generated during stratigraphic logging activities and water generated during decontamination and vertical sampling activities. Soil cuttings will be containerized in drums or roll-off bins and staged in the secured Source Area for characterization and disposal either through spreading on the Source Area ground surface or off-site at a licensed disposal facility depending on the results of the characterization analyses.

Water will be containerized at the point of generation and transported to a storage tank at the Source Area. Water in the storage tank will be processed through the on-site groundwater treatment system.

Site Restoration

Following subsurface investigation activities, equipment and materials will be removed from the work areas. Ground surfaces will be restored to surrounding condition, as necessary.

2.3.2 Monitoring Well Network

The current monitoring program on the Wert Property consists of four existing wells (MW-CB-25A, MW-CB-26A, MW-CB-27A, and MW-CB-6Bs) that are sampled annually. Proposed locations of the four new performance MWs are depicted on Figure 2-1. These wells will be installed concurrent with the IW installation activities.

Mobilization

Prior to mobilizing to the site for well installations, Texas811 will be contacted to locate existing utilities in the vicinity of the proposed well installation locations. The Wert Property owner will be contacted, and access will be obtained in accordance with the property-specific access agreement.

Monitoring Well Installation

As previously noted, new performance monitoring wells will be installed at four locations both upgradient and downgradient of two of the treatment zones (rows of IWs) to assess performance of EAB treatment in the plume. These locations may include a pair of nested MWs if the monitored treatment zone requires organic substrate injection into two depth intervals. MWs will be installed in six-inch-diameter boreholes advanced using rotosonic or hollow stem auger drilling techniques. Construction will consist of four-inch inner diameter (ID) Schedule 40 polyvinyl chloride (PVC) screen with 0.10-inch factory cut slots flush threaded to four-inch ID Schedule 40 PVC riser casing. Screened intervals may be adjusted as necessary depending on the plume vertical profiles in the targeted portion of the 1,2-DCA plume. Each MW will be completed by installing a flush-grade protective cover set in a concrete pad. The locations of the treatment zones and the associated MW locations for the Wert Property are shown on Figure 2-1. Figure 2-2 depicts the proposed well construction details.

Injection Well Installation

IWs will be installed at up to 24 locations. Some locations may include a pair of nested wells. Each treatment zone will consist of multiple IWs installed on approximately 40-foot centers roughly perpendicular to the direction of groundwater flow. The orientation will be adjusted at some locations based on the results of the subsurface investigation, drill rig accessibility, and locations of existing utilities. IWs will be installed in six-inch-diameter boreholes advanced using rotosonic or hollow stem auger drilling techniques. Construction will consist of four-inch ID Schedule 40 PVC screen with 0.10-inch factory cut slots flush threaded to four-inch ID Schedule 40 PVC riser casing. Screened intervals may be adjusted as necessary depending on the plume vertical profiles in the targeted portion of the 1,2-DCA plume. Each IW will be completed by installing a flush-grade protective cover set in a concrete pad. The locations of the treatment zones and the associated injection well locations for the Wert Property are shown on Figure 2-1. Figure 2-2 depicts the proposed well construction details.

Well Development

Newly installed MWs and IWs will be developed prior to sampling and organic substrate injection. Wells will be developed by surging with a tight fitting surge block and pumping with a submersible pump. Groundwater parameters including dissolved oxygen (DO), pH, oxidation reduction potential (ORP), electrical conductivity, and turbidity will be measured during the pumping phase with a calibrated field instrument and flow-through cell. Temperature is not defined as a stabilization parameter by the U. S. Environmental Protection Agency (USEPA 2002) but will also be recorded. The field parameters will be allowed to stabilize in accordance with USEPA well development criteria. Well development stabilization criteria are presented Table 2-1.

Table 2-1
Well Development and Sampling Stabilization Criteria

Parameter	Stabilization Criteria
DO	+/- 0.3 grams per liter
Temperature	Not Applicable
pH	+/- 0.1 SU

Parameter	Stabilization Criteria
ORP	+/- 10 millivolts
Electrical Conductivity	+/- 3%
Turbidity	< 10 NTU or +/- 10% if above 10 NTU.

Note: Stabilization criteria are from USEPA 2002.

Investigation Derived Waste

Investigation derived waste will consist of soil cuttings and water generated during well installation activities, water generated during decontamination activities, and water generated during well development. Soil cuttings will be containerized in drums or roll-off bins and staged in the secured Source Area for characterization and disposal either through spreading on the Source Area ground surface or off-site at a licensed disposal facility depending on the results of the characterization analyses.

Water will be containerized at the point of generation and transported to a storage tank at the Source Area. Water in the storage tank will be processed through the on-site groundwater treatment system.

Site Restoration

Following well installation, equipment and materials will be removed from the work areas. Ground surfaces will be restored to the surrounding condition, as necessary.

Final Site Survey

The locations of the newly installed MWs and IWs will be surveyed for northing and easting coordinates and elevation of top of casing by a professional surveyor licensed in Texas. The survey readings will be tied to the Texas State Plane Coordinate System, Texas Central Zone.

2.3.3 Injection Activities

Organic substrate will be injected to create continuous treatment zones traversing the 1,2-DCA plume. A pH buffer will also be injected with the organic substrate to raise and/or maintain the natural pH of groundwater to near-neutral conditions. Additionally, a commercially available bioaugmentation culture acclimated to degrade 1,2-DCA may be injected into the treatment zones.

Organic substrate injections will be conducted by extracting groundwater from nearby MWs and IWs, amending the extracted water with organic substrates inline, and reinjecting the resultant mixture. The extraction, amendment, and reinjection process will be continuous such that the three steps are completed at the same time. Conducting injections in this manner will allow for the formation of groundwater recirculation cells in the subsurface to improve organic substrate distribution and will minimize the amount of equipment and support structures at the surface. Equipment will be limited to a trailer-mounted system consisting of two small tanks (approximately 500 gallons per tank), diaphragm pumps, water-powered dosimeters, a compressor, a small injection manifold, several small generators and associated submersible pumps, and one-inch conveyance hose. The injection system will be moved from point to point. Proposed injection volumes will be based on observed performance of the earlier full-scale injection phases and characterization data collected in each transect location. Groundwater will be extracted from areas of lower 1,2-DCA concentration and amended/reinjected into areas of higher 1,2-DCA concentration to reduce the potential for spreading contaminant mass. Treated water from the Source Area System may also be used to supplement extracted groundwater in some cases. Organic substrate injection is only planned within the plume core and 1,2-DCA concentrations will vary within a relatively narrow range (~10-100 μg/L). This will minimize the potential for impacting areas that were previously unimpacted and significantly reduces the potential for reducing groundwater quality further during injection. In addition, any 1,2-DCA mass that is in the extracted groundwater will be injected with the organic substrates and will be degraded *in-situ* relatively quickly.

Injection Materials

Injection materials will include sweet dairy whey, soybean oil, and pH buffer. These injection materials are described in the following sections.

- Sweet Dairy Whey

  Sweet dairy whey is a food-grade product that will be shipped to the Charlie Burch Site by pallet in nominal 50-pound plastic lined bags. Sweet dairy whey consists primarily of milk sugar (lactose), milk protein, and a small amount of milk fat. The carbon content in whey is almost completely soluble in water and will be distributed during injection through the aquifer matrix much more quickly and readily than the soybean oil substrate. After injection, the lactose mass will remain in the dissolved phase and will be transported by advective groundwater flow through the application area. Sweet dairy whey will be mixed into the extracted water with the soybean oil and the buffer products.

  The sweet dairy whey will provide a highly soluble source of carbon to the *in-situ* microbial population more quickly and over a wider area than the soybean oil substrate, thereby increasing the initial impact of the injection to site groundwater chemistry. The sweet dairy whey will thus serve to pre-condition the chemistry of the groundwater system such that as the soybean oil begins to break down and carbon and hydrogen are released into the system, the groundwater chemistry will already be conducive to reductive dechlorination. After the sweet dairy whey is consumed, the soybean oil will maintain the anaerobic geochemical conditions induced by the degradation of the sweet dairy whey by providing a long-term source of carbon and hydrogen.

- Soybean Oil

  Food-grade soybean oil and liquid lecithin will be obtained from a commercial supplier such as Remediation and Natural Attenuation Services, Inc. of Minneapolis, Minnesota. Soybean oil and lecithin are food-grade materials extracted from soy beans and are used in the food industry for a wide variety of applications. The soybean oil product will be shipped to the site in 255-gallon palletized totes.

  Because soybean oil is relatively insoluble in water, lecithin is added as an emulsifier so that the soybean oil can be mixed with water prior to injection. This mixing step is taken to increase the injection volume (approximately one part oil and 20 parts water) without increasing the soybean oil volume. The result is that a relatively small volume of soybean oil can be distributed into a relatively large volume of aquifer matrix. This will distribute soybean oil such that the soybean oil occupies only a small portion of the interstitial void spaces of the aquifer matrix. In this way, a flow-through treatment cell is maintained, allowing groundwater to continue to flow through the treatment cell and bringing dissolved contaminant mass with it for treatment within the treatment zone.

After injection, the soybean oil-in-water emulsion will ultimately break down and be distributed as small droplets of oil trapped within the aquifer matrix. This entrapped oil does not migrate with advective groundwater flow; rather, it remains in place as a relatively immobile, slowly soluble, long-term source of carbon.

- pH Buffer

  A long-lasting pH buffer product will be injected with the organic substrates to maintain groundwater pH in the near neutral range (approximately pH 5 to pH 9). The proposed pH product is Neutral Zone, produced by Remediation and Natural Attenuation Services, Inc. of Minneapolis, Minnesota. Neutral Zone is a proprietary mixture of naturally-occurring pH buffer and surfactants to keep the buffer in suspension so that it can be injected. The Neutral Zone product also contains an alcohol preservative to control microbial growth during shipping and storage.

  It is currently estimated that the Neutral Zone product will require refreshing every two to three years. The actual refresh schedule will be determined by evaluating the application performance data to be collected after injection.

  Neutral Zone will be delivered to the site in 55-gallon plastic drums or 255-gallon palletized shipping totes for temporary storage prior to injection.

Injection Materials Preparation and Emplacement

The injection materials will be injected into the IWs as a single solution oil-in-water emulsion to maximize reagent distribution. The soybean oil products and the pH buffer product are liquid materials and will be added to the water stream with in-line water-powered dosimeters. The sweet dairy whey product will shipped to the site as a dry powder to reduce shipping and product costs and will be mixed with water to form a concentrated solution that will then be added to the water stream with the rest of the organic substrates. The organic substrate injection in each IW will be accomplished by extracting groundwater from an adjacent unamended IW, amending the extracted water in-line with the organic substrates using a closed system dosimeter, and re-injecting the organic substrate amended water into the IW. The extraction, amendment, and injection steps will be conducted continuously and at the same time. Thus, the only injection materials that will be stored on-site will be the food grade organic substrates, the pH amendment product, and a small quantity (less than 500 gallons) of groundwater for injection purposes in the event that the injection and extraction rates cannot be balanced. These materials will only be on-site during active injection and will be removed at the end of each day.

Bioaugmentation Culture Preparation and Injection

During the first quarterly sampling event after injection in each phase, field parameters will be evaluated to determine if anaerobic geochemical conditions that are conducive to anaerobic microbial populations have been induced in the subject treatment area. At a minimum this will require a pH within the neutral range (5 to 9), dissolved oxygen below 1.0 mg/L, and negative ORP. Once appropriate subsurface geochemical conditions have been achieved, KB-1®, a commercially available bioaugmentation culture purchased from Sirem Laboratories in Ontario, Canada, may be injected into the previously installed IWs. KB-1® is a concentration of a naturally-occurring microbial population consisting of Dehalococcoides Ethenogenes (DHC) and a collection of other sulfate-reducing and methanogenic-supporting bacteria.

The bioaugmentation culture will be dosed with 1,2-DCA for approximately one to two months prior to shipment to the Site to acclimatize the culture to the presence of 1,2-DCA. The acclimatization process will limit microbial shock and cell death during injection and will result in a healthier population and more rapid cell growth after injection.

The bioaugmentation culture injection will be accomplished by first extracting groundwater from existing IWs and containerizing it in a small portable tank on-site. The containerized groundwater will be amended with a small amount of sweet dairy whey to maintain anaerobic conditions within the tank and to protect the microbial population in the bioaugmentation culture. After the containerized water has been amended, the bioaugmentation culture will be injected directly into each IW. Approximately 100 gallons of the containerized groundwater will then be injected into each IW to push the bioaugmentation culture out of the well casing and into the aquifer formation.

Site Restoration

Following organic substrate injection activities, equipment and materials will be removed from the work areas. Ground surfaces will be restored to the surrounding condition, as necessary.

2.4 Performance Monitoring

During the first year following organic substrate injection at the Wert Property, groundwater performance monitoring sampling will be conducted quarterly to assess the performance of the subject treatment zones and to determine when anaerobic geochemical conditions are induced and when 1,2-DCA degradation commences. Following the first year of monitoring, the groundwater sampling frequency will be reduced to semi-annual to continue to document the performance of the treatment zones and to monitor for signs of organic substrate depletion. System performance monitoring will be conducted at the newly installed MWs, select IWs, and select existing monitoring wells.

Groundwater samples will be collected using a small diameter bladder pump and new disposable or dedicated high density polyethylene (HDPE) tubing. Groundwater will be purged and sampled for volatile organic carbon compounds and the sampling criteria presented in Table 2-1.

Investigation Derived Waste

Investigation derived waste will consist of water generated during performance monitoring sampling activities. Water will be containerized at the point of generation and transported to a storage tank at the Source Area. Water in the storage tank will be processed through the on-site groundwater treatment system.

2.5 Organic Substrate Replenishment

Additional organic substrate will be injected when the emplaced organic substrate becomes depleted as needed to continue making progress towards achieving the PCL. Performance monitoring data collected at each injection area will be evaluated periodically to look for signs of organic substrate depletion. Re-injection activities are expected to occur approximately three to four years after the first injection event at each injection area. However, the actual replenishment schedule will depend entirely on the field monitoring results.

3.0 REPORTING AND DOCUMENTATION

3.1.1 Underground Injection Control As-built Documentation Report

After completing construction of injection Phase 3, a construction completion report will be prepared and issued to document the activities that were completed. This report will include a description of the completed well installation and initial organic substrate injection activities, baseline sampling activities, waste disposal records, copies of the field reports, boring logs, and as-built drawings. The construction completion report will be prepared for submission to the TCEQ UIC.

3.1.2 Semi-Annual Underground Injection Control reports

Monitoring results will be submitted in accordance with the UIC reporting requirements, currently on a semi-annual schedule. The UIC reports will summarize the volume of materials injected for treatment zones installed or refreshed within each subject reporting period. The current semi-annual periods are from June 1 through November 30 and December 1 through May 31 for each year that the UIC report remains active.

3.1.3 Triennial Response Action Effectiveness Report

Performance monitoring results, status of response action plan activities and findings, and recommendations for further work (e.g., organic substrate replenishment, installation of additional EAB treatment areas, etc.) are summarized in the site Response Action Effectiveness Report (RAER) that is required to be submitted every three years following TCEQ approval of the RAP. The first RAER is scheduled to be submitted to TCEQ in May 2014.

4.0 REFERENCES

Groundwater Services, Inc. 2000. Response Action Completion Report, Rohm and Haas Charlie Burch Site. Spring, Texas, VCP 421. March.

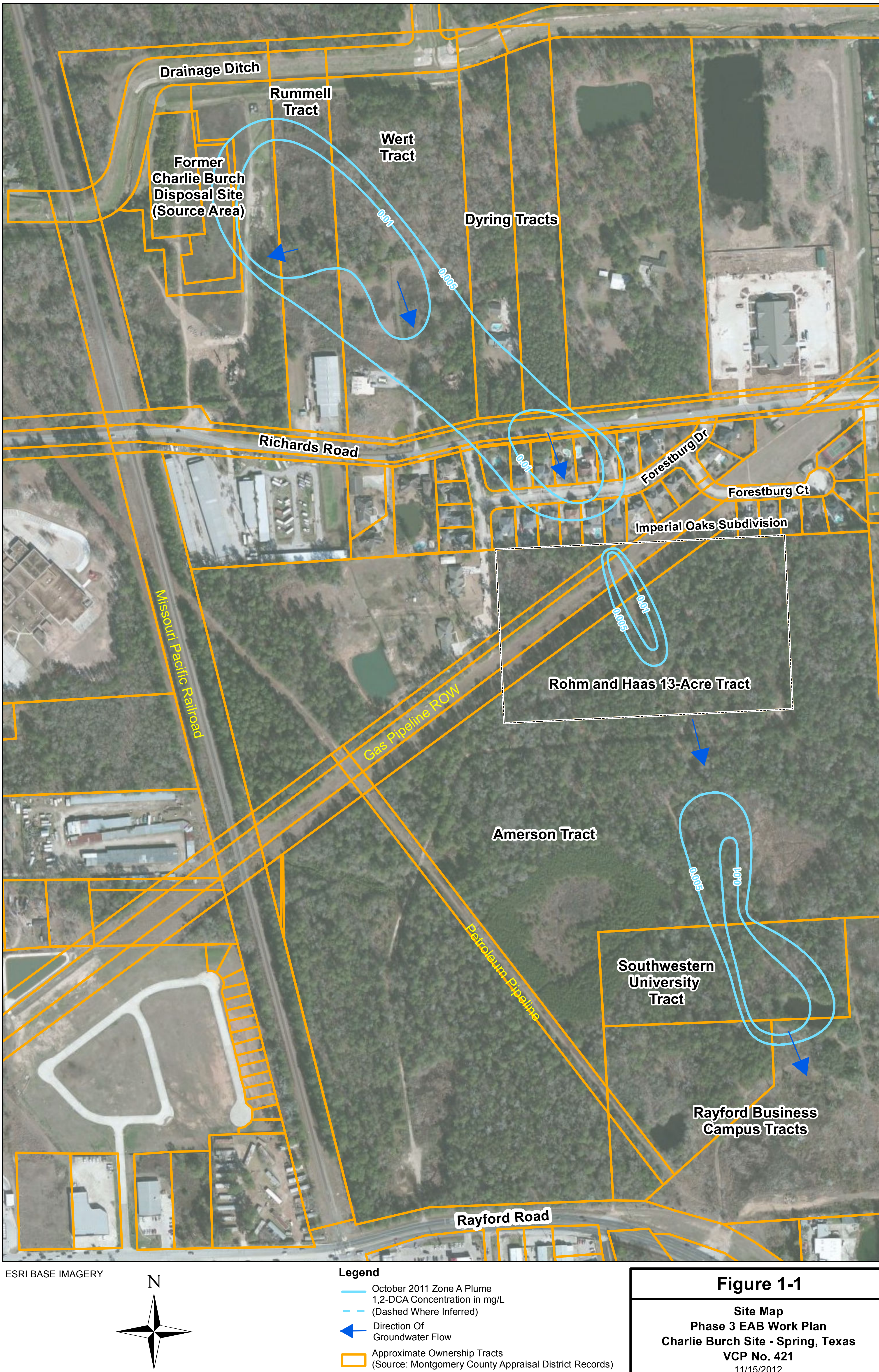
Groundwater Services, Inc. 2005. Response Action Plan, Rohm and Haas Charlie Burch Site, Spring, Texas, VCP 421. May.

Parsons. 2011. Enhanced Anaerobic Bioremediation Work Plan, Rohm and Haas Texas Charlie Burch Site, Spring, Texas, VCP 421. August.

Parsons. 2011. Response Action Plan (Revised), Rohm and Haas Charlie Burch Site, Spring, Texas, VCP 421. May

USEPA. 2002. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. EPA/542/S-02/001. May.

FIGURES



Legend

- October 2011 Zone A Plume 1,2-DCA Concentration in mg/L (Dashed Where Inferred)
- Direction Of Groundwater Flow
- Approximate Ownership Tracts (Source: Montgomery County Appraisal District Records)
- Approximate Rohm and Haas 13 Acre Tract (Source: Montgomery County Appraisal District Records)

Figure 1-1

Site Map
Phase 3 EAB Work Plan
Charlie Burch Site - Spring, Texas
VCP No. 421
11/15/2012

PARSONS

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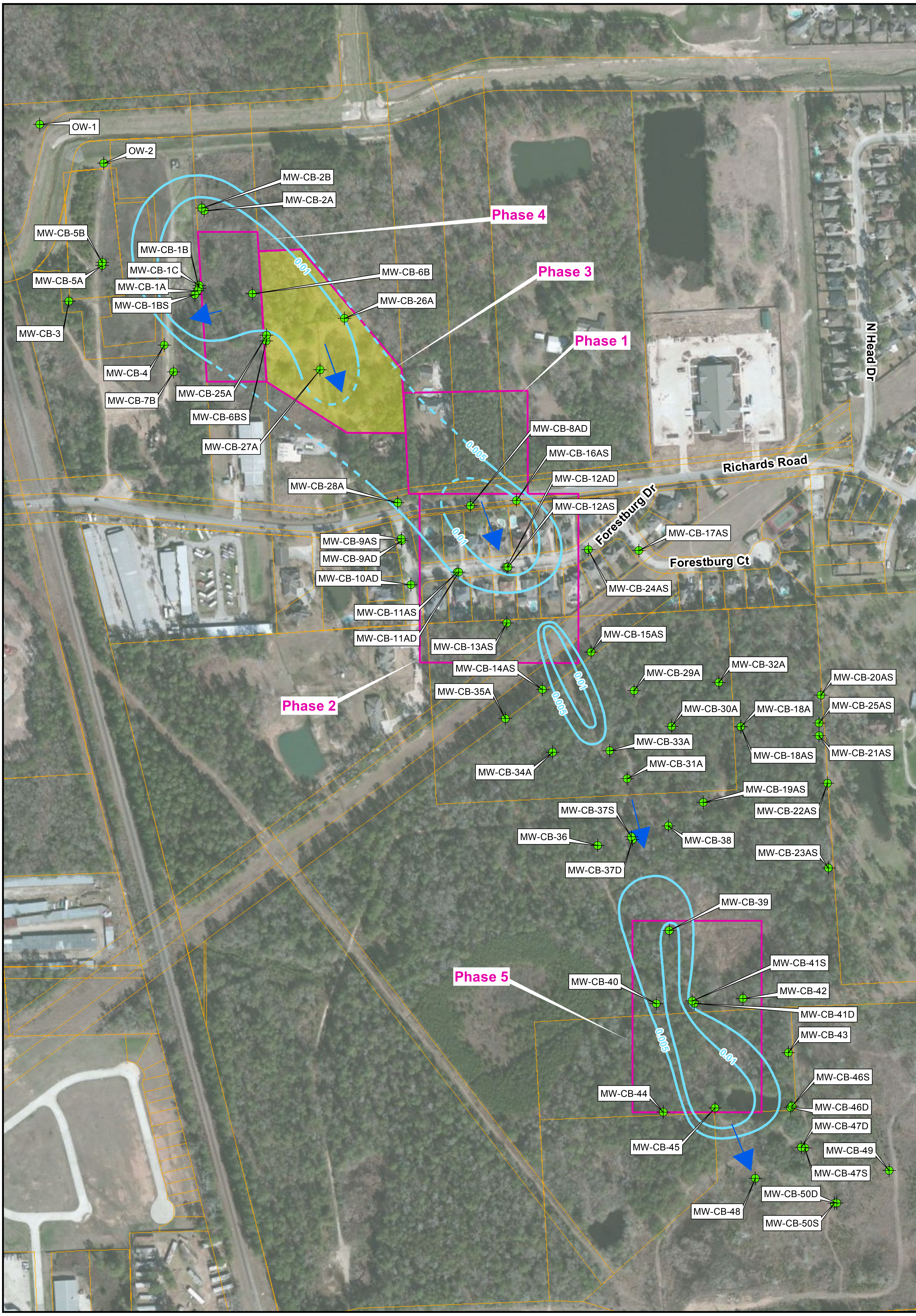

ESRI BASE IMAGERY

N

0 300 600 Feet

October 2011 Zone A Plume 1,2-DCA Concentration in mg/L

(Dashed Where Inferred)

Direction Of Groundwater Flow

Existing Monitoring Well

Approximate Ownership Tracts (Source: Montgomery County Appraisal District Records)

Injection Phase Boundary

Injection Phase 3 Area

Figure 1-2

Current 1,2-DCA Concentrations in Groundwater
Phase 3 EAB Work Plan
Charlie Burch Site - Spring, Texas
VCP No. 421
11/15/12

PARSONS

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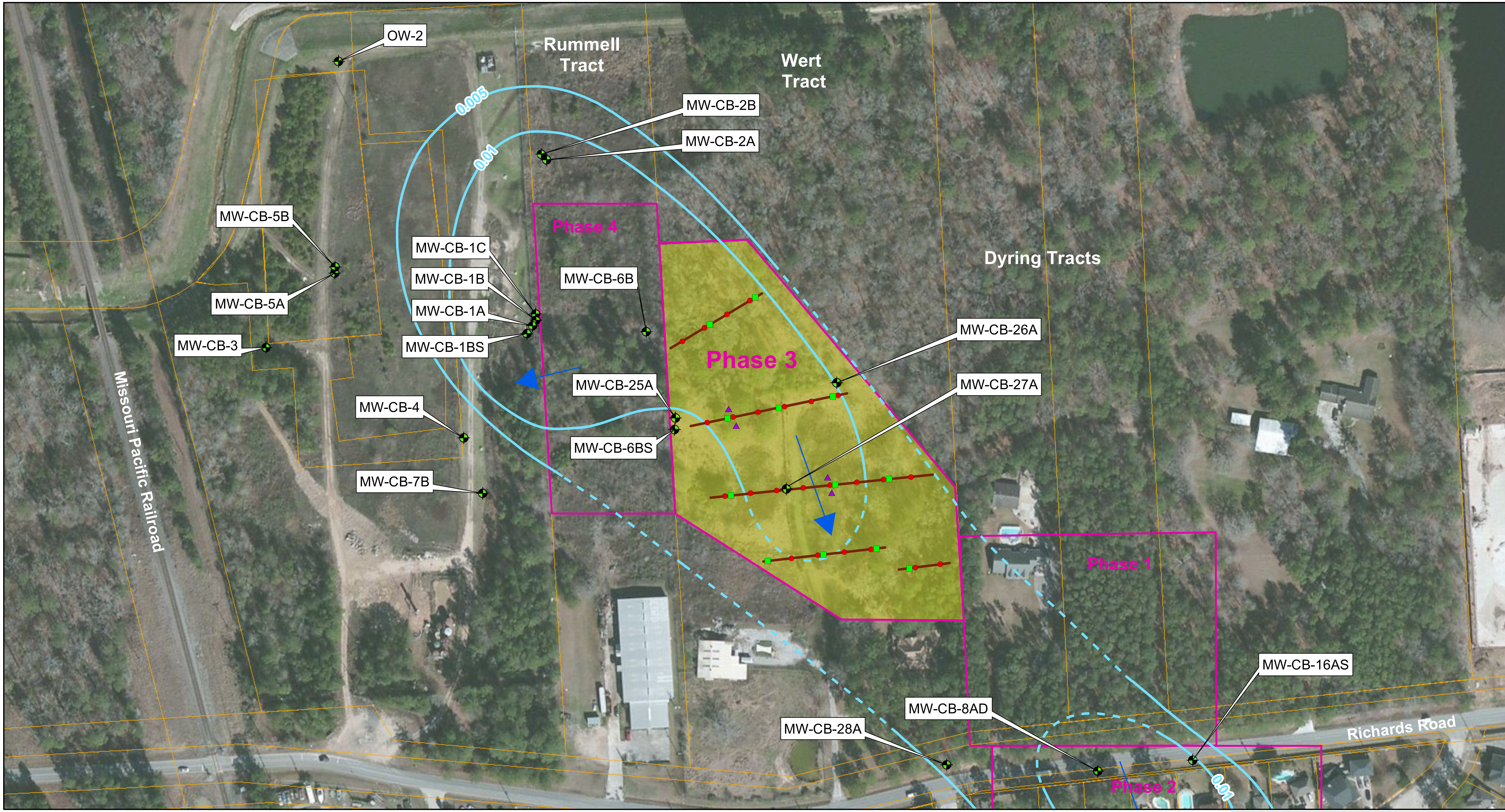

ESRI Base Imagery

N

0 150 300 Feet

- Proposed Phase 3 Injection Well Location
- Proposed Temporary Phase 3 Direct Push Boring Location
- Proposed Phase 3 Monitoring Well Location
- October 2011 Zone A Plume 1,2-DCA Concentrations in mg/L
- (Dashed Where Inferred)
- Direction Of Groundwater Flow
- Existing Monitoring Well
- Phase 3 EAB Treatment Zone
- Injection Phase Boundary
- Injection Phase 3 Area
- Approximate Ownership Tracts (Source: Montgomery County Appraisal District Records)

Figure 2-1

Wert Property Plan View
Phase 3 EAB Work Plan
Charlie Burch Site - Spring, Texas
VCP No. 421
11/15/12

PARSONS

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Fig2-1 Plan View

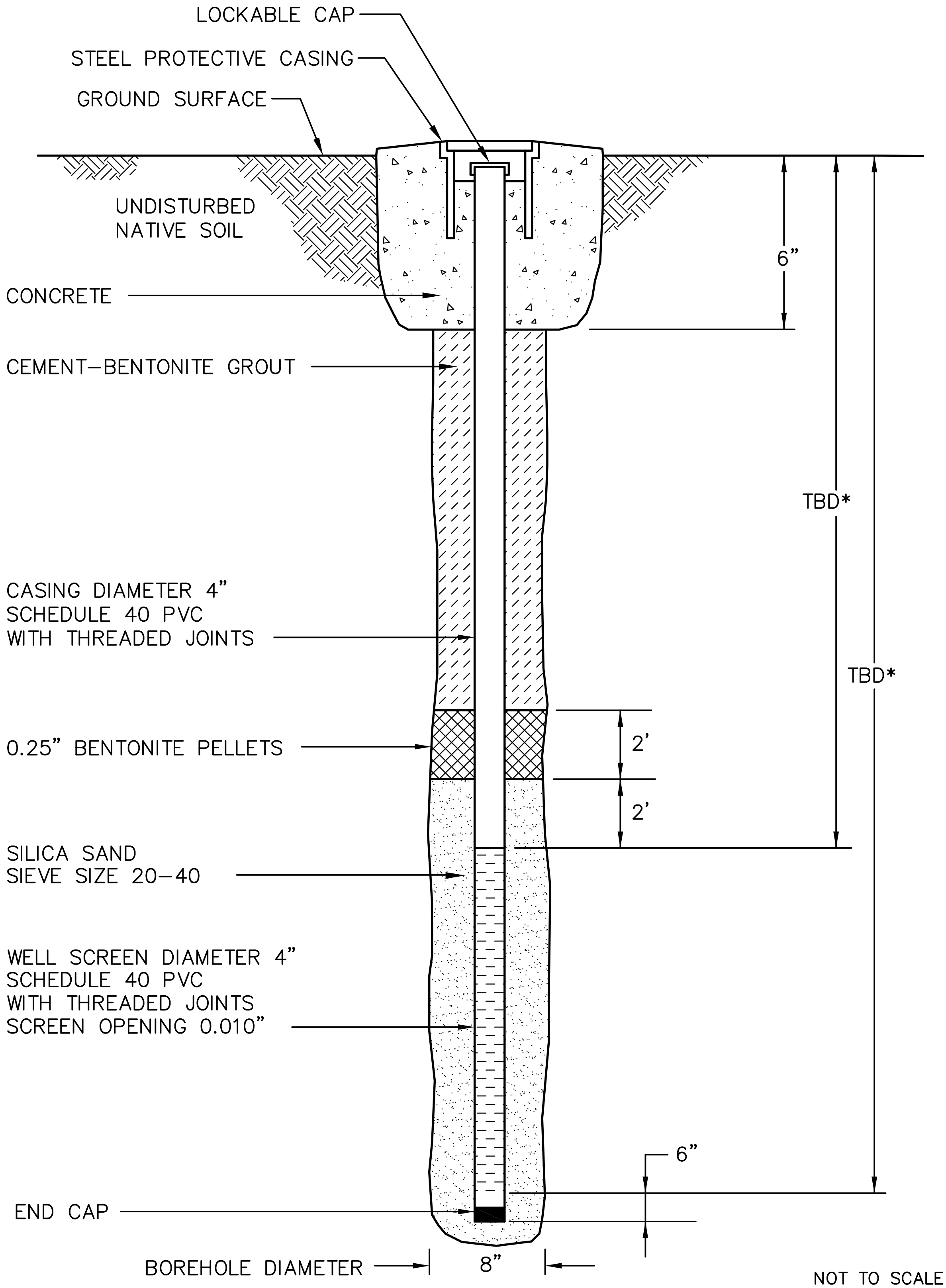

FIGURE 2-2
PROPOSED INJECTION WELL AND MONITORING WELL CONSTRUCTION

TBD* = TO BE DETERMINED BASED ON SITE STRATIGRAPHY

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