ADVANTAGE ENVIRONMENTAL CONSULTANTS, LLC

Dual Phase System Design Pilot Study Work Plan

Gasoline Fueling Station – Royal Farms #96
500 Mechanics Valley Road
North East, Cecil County, Maryland 21901

OCP Case No. 2011-0729-CE
MDE Facility No. 13326

AEC Project Number: 05-056 RF096

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1.0 INTRODUCTION

Advantage Environmental Consultants, LLC (AEC) has prepared this Dual Phase System Design Pilot Study Work Plan for the Royal Farms Store No. 96 located at 500 Mechanics Valley Road in North East, Maryland. Site Vicinity and Site Features Maps are provided in Appendix A as Figures 1 and 2, respectively.

This Work Plan was prepared as a companion to the document titled Design Basis Summary - Dual Phase Recovery System, prepared by AEC and dated September 13, 2011, and Maryland Department of the Environment (MDE) correspondence dated October 6, 2011, which are included as Appendix B and C, respectively.

The aforementioned MDE correspondence requires an additional pilot test to confirm that proposed system modifications outlined in the Design Basis Summary will be capable of achieving the previously established radius of influence. The report of the pilot studies outcome should include estimates of the maximum, minimum, and optimal flow rates needed to establish hydraulic control, with consideration to a phased lowering of the pumps over time to establish optimum recovery of the plume.

1.1 Project Overview

Based on abbreviated enhanced fluid recovery (EFR) pilot studies conducted on July 21 and 22, 2011 a Corrective Action Plan (CAP) was prepared and submitted to the MDE on July 25, 2011. The CAP presented the following remediation system design criteria: radius of influence (ROI) - 20 feet; individual recovery well flow rate – 3.2 gallons per minute (gpm); individual recovery well drawdown - 2 feet below static groundwater; and, individual recovery well air flow rate - 50 cubic feet per minute (cfm). Data collected during the course of the initial pilot study did not provide some necessary final design parameters associated with the feasibility of the technology and process/treatment equipment sizing. As such, the performance of a full scale EFR pilot study was recommended in the CAP.

Based on the full scale EFR pilot study conducted on July 27, 2011, using equipment enabling the necessary design data to be collected, a CAP Addendum (August 3, 2011) was developed. The full scale EFR pilot study indicated the following remediation system design criteria: ROI - 25 feet; individual recovery well flow rate – 4 to 6 gpm; individual recovery well drawdown - 4 feet below static groundwater; and, individual recovery well air flow rate - 50 cfm.

Both the CAP and the CAP Addendum planned on an EFR design using liquid ring pump (LRP) technology. The CAP and CAP Addendum selected the LRP technology based on recovery at eight recovery wells. Based on a technical meeting with the MDE, an expansion of the recovery system to 10 wells was required. As a result of the increased system flow rates from the additional wells, the standard LRP equipment would be reaching its maximum design capabilities. As such, a Design Basis Summary was created which introduced the dual phase approach using integrated vapor extraction/groundwater extraction (VE/GE) recovery technology. The VE/GE will be implemented using pneumatic submersible pumps for liquid removal and a positive displacement vacuum blower for vapor removal. This technology is similar to LRP induced EFR but offers the capability for increased flow rates.

1.2 Technology Background

Both EFR and VE/GE systems are designed to draw down the water table through groundwater extraction so that residual Liquid Phase Hydrocarbon (LPH) saturations in the smear zone may be removed by vacuum effects. An LPH smear zone may develop when mobile LPH is floating on the aquifer capillary fringe and water table elevations first drop, then rise. During water table decline, some LPH is left behind in the unsaturated zone as residual saturations held in capillary tension in soil pore spaces. During water table rise, a significantly larger residual saturation of LPH is trapped below the water table in the saturated zone. It is the submerged LPH in the smear zone that must be removed to significantly lower dissolved phase hydrocarbon (DPH) concentrations in groundwater.

The groundwater extraction component must partially dewater portions of the site in order for the VE/GE system to achieve remedial objectives. Since the VE/GE system emphasizes VE as the active mechanism in remediating dewatered soils it is especially important that a conservative VE design be utilized. Application of vacuum to a GE well increases the effective gradient to groundwater flow and increases well yield for a given drawdown (specific capacity). GE system well spacing should be such that intersecting cones of depression create interference sufficient to meet target drawdown objectives for the remedial zone (defined as the LPH and moderate to high DPH area).

The process of designing a VE/GE system is similar to that of a stand alone VE system. The subsurface design is based on pilot test results and the extrapolation of these results to air and liquid flows in the entire treatment zone. It should be noted that there is not a specific set of criteria by which to measure the success of an EFR or dual phase pilot study. Instead there are various lines of evidence that must together be evaluated to reach an appropriate judgment as to the success of the pilot study (COE, 1999).

1.3 Project Objectives

The primary objective of this work plan is to confirm that the proposed system modifications outlined in the Design Basis Summary are capable of achieving the previously established ROI (25 feet). In order to accomplish this task the following studies will be performed: a constant rate aquifer pumping test; and, a modified step drawdown and dual phase recovery test.

1.3.1 Pilot Study 1 – Aquifer Pumping Test

A constant-rate aquifer pumping test will be conducted at select recovery and monitoring wells to estimate aquifer parameters (hydraulic conductivity, coefficients of transmissivity and storage) and the effective area of influence (capture zone) of each well under a constant pumping rate. Recovery measurements will also be obtained for similar time intervals and duration as the drawdown measurements. The data will be used to establish GE well spacing, depth, and discharge rates. The objective will be partial aquifer dewatering for the remedial zone. The flow modeling objective is to optimize the required number of wells and pumps, total system discharge, and degree to which partial dewatering target levels are achieved to obtain minimum capital and operation and maintenance (O&M) costs.

1.3.2 Pilot Study 2 – Modified Step Drawdown and Dual Phase Recovery Tests

The modified step drawdown test entails pumping the recovery well at successively higher flow rates for equal, or nearly equal, time steps. The step drawdown testing will be used to evaluate an optimal flow rate for targeted drawdown levels of 2-, 4- and 6-feet under VE conditions. It should be noted that application of vacuum to the recovery well (or a nearby well) increases the effective gradient to groundwater flow and increases well yield for a given drawdown (specific capacity). Using the results of the step drawdown testing, flow rates for the targeted drawdown levels will be used for the dual phase recovery test. The dual phase recovery test will be used to determine if equivalent water and air flows as the design basis summary (4 to 6 gpm water flow and 50 cfm air flow) produce a similar radius of influence as the recent EFR test.

1.4 Site Description and Background

The Site is located southeast of the intersection of Mechanics Valley Road and Pulaski Highway in a commercial/residential area in North East, Cecil County, Maryland. The Site is developed with a convenience store/gasoline fueling station and associated landscaped, asphalt- and concrete-paved areas. The surrounding properties include single family residences to the west, and commercial properties to the south, east and north. A Site Area Map is included as Figure 3 in Appendix A.

The Site recently underwent an underground storage tank (UST) system upgrade. The Site formerly operated three double-walled, composite (steel with fiberglass reinforced plastic (FRP)) USTs which distributed fuel to 12 product dispensers, including two satellite diesel dispensers. The former system was installed in 1999 and consisted of the following: a 20,000 gallon unleaded regular UST, a 12,000 gallon super unleaded UST, and a 12,000 gallon diesel UST. The replacement USTs consist of one 20,000-gallon and one 30,000-gallon double walled FRP USTs. The 20,000-gallon UST is split into a 12,000-gallon compartment for diesel and an 8,000-gallon compartment for premium unleaded gasoline. The entire 30,000-gallon UST contains regular unleaded gasoline. Product piping consists of double-walled flexible plastic within plastic corregated chase pipes, and stage II vapor recovery piping consists of double-walled FRP.

On June 8, 2011, AEC was performing an annual groundwater sampling event in accordance with Code of Maryland Regulations (COMAR) 26.10.02.03-04, when approximately two-inches of LPH were detected in groundwater monitoring well MW-3. The LPH was observed to be golden in color, indicating ‘un-weathered’ gasoline. AEC inspected the submersible turbine pump (STP) containment sumps, which were observed to be free of LPH. Royal Farms was informed of the field observations made by AEC and a suspected release of petroleum was reported to the MDE Oil Control Program (OCP) on June 8, 2011. On June 13, 2011 the MDE opened a case in response to a report of evidence of a petroleum spill at the Site. Based on LPH plume configuration, laboratory analytical data and field observations during UST system piping removal, the source of the release is likely in the vicinity of dispensers 3/4 and 7/8 (see Figure 2 in Appendix A).

During July and August 2011, the three USTs and all associated piping components were removed from the Site. Specifically, the UST removal was conducted on August 4 and 5, 2011. Removal of fuel dispensers and piping located beneath the canopy was performed from July 21 to 28, 2011, and removal of two satellite diesel dispensers was performed on August 11, 2011. The USTs were empty at the time of removal activities. Suspect pinholes were observed in the secondary fiberglass layer of the 20,000-gallon regular gasoline UST. During removal of product piping, petroleum impacted liquid was encountered within the corregated chase piping. Perched water was identified on the western side of the pump island trenching and the western end of the satellite diesel trench.

1.5 Site Investigative Activities

Pursuant to the various MDE OCP directives the following documents and reports have been prepared for the release investigation activities:

Emergency Subsurface Environmental Investigation Report, prepared by AEC and dated July 19, 2011. This report details the collection of soil and groundwater samples from 24 boring locations (B-1 through B-24). The borings were advanced to depths ranging from 15 to 20 feet bgs. Temporary piezometers were installed in all but one of the borings. In order to delineate the horizontal and vertical extent of the release , the initial borings were advanced around MW-3 and the subsequent borings arrayed outward from MW-3. Also conducted as part of the investigation was the collection and analysis of groundwater samples from potable drinking water wells located in the Site vicinity.

Corrective Action Plan, prepared by AEC and dated July 22, 2011. The CAP presents the design for a multi-phase EFR system. The design is based upon data collected from the abbreviated EFR pilot studies performed in July 2011, as well as site characterization investigations, review of historical well gauging/sampling data, and vac-truck EFR performance characteristics. Since data collected during the course of the initial pilot study associated with the CAP did not provide some necessary final design parameters with regard to feasibility of the technology and process/treatment equipment sizing, it recommended that a 4- to 8-hour pilot study be conducted using a LRP skid.

Recovery Well Install Data Pack, prepared by AEC and dated August 2, 2011. This document included boring logs, well construction diagrams and soil sample laboratory analytical results from the installation of six groundwater recovery and five groundwater monitoring wells between July 14 and 19, 2011. The wells were completed to depths ranging from 24 to 26 feet bgs. The groundwater quality from the newly installed wells had been recently tested but these results were pending. Figure 2 in Appendix A illustrates the recovery and monitoring well locations.

Corrective Action Plan Addendum, prepared by AEC and dated August 3, 2011. The CAP Addendum describes the results of the EFR pilot study using the LRP skid. The report concluded that the high permeability of the coarse grained soils below the Site presents a challenging environment for the EFR remedy. The combined water flow rate necessary for providing hydraulic control and meeting the primary remedial objective (LPH removal to a sheen) will necessitate the use of relatively large capacity process equipment. The report concluded that the EFR remedy is technically feasible but other approaches to LPH removal may offer significantly reduced time frames for completion of this task.

Surfactant Flush Pilot Study Work Plan, prepared by AEC and dated August 9, 2011. This document was prepared as a companion to the August 3, 2011 CAP Addendum. The primary objective of the work plan was to evaluate the effectiveness of surfactant flushing assisted by EFR extraction for LPH removal. This approach would augment current groundwater remediation efforts by promoting increased solubility and mobility of the residual and mobile LPH within the release area. The work plan described the surfactant injection/extraction means and methods, and pre- and post-flushing groundwater monitoring activities.

August 2011 Groundwater Sampling Data Package, prepared by AEC and dated August 10, 2011. This document included a groundwater gradient map, a groundwater quality map, a table of onsite groundwater sample analytical results, and laboratory analytical reports dated August 4, 2011.

Design Basis Summary, prepared by AEC and dated September 13, 2011. The Design Basis Summary was based on the July 27, 2011 EFR pilot study findings which developed remediation system design criteria. The Design Basis Summary described the dual phase (vapor and liquid) recovery technology which replaced the EFR technology due to water and vapor recovery limitations of the EFR equipment. The document described in detail the equipment to be used in the dual phase approach. The main design change was the use of pneumatic submersible pumps for liquid removal and a positive displacement vacuum blower for vapor removal.

September 2011 Groundwater Sampling Data Package, prepared by AEC and dated September 23, 2011. This document included a groundwater gradient map, a groundwater quality map, a table of onsite groundwater sample analytical results, and laboratory analytical reports dated September 15, 2011.

Underground Storage Tank System Closure Report, prepared by AEC and dated October 17, 2011. This report described the UST system removal activities and the excavation oversight and confirmatory sampling associated with this task. The UST system was removed in order to upgrade the storage and piping infrastructure and further investigate the petroleum release.

AEC has conducted EFR operations via a vac-truck since June 13, 2011. The EFR is conducted using a "stinger" tube which is lowered into the wells to a depth of approximately two-feet below the static water level. The stinger tube is then fitted at the well head with a well seal to allow for both fluid and vapor extraction. Between June 13 and July 18, 2011 the vac-truck EFR operations were conducted on MW-3. As the recovery wells became operational between July 16 and July 19, 2011, they were added to the EFR program via a piping manifold. The vac-truck EFR operation is conducted daily for four hours.

A recent review of the liquid level gauging data from June 13, 2011 through October 23, 2011 indicates the following regarding LPH thicknesses in the recovery and monitoring wells:

Well Identification	Date of Last Appearance of LPH
MW-1, MW-1R, MW-2, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, RW-5, RW-7, RW-8, RW-9, RW-10, RW-11, RW-12	No LPH observed since well installation
MW-3 (Sheen), RW-1 (Sheen),	LPH last observed October 3, 2011
RW-2 (Sheen), RW-3 (Sheen), RW-4 (Sheen)	LPH last observed August 21, 2011
RW-6 (0.01')	LPH last observed October 24, 2011

These reductions in LPH thicknesses have been realized by the sustained vacuum truck recovery efforts.

There has been an expansion of the DPH plume as demonstrated by comparison of the two groundwater testing data sets (August 4, 2011 and September 15, 2011). This comparison is tabulated below:

Well Identification	Groundwater Gradient Position Relative to Release Area	Relative Comparison of DPH Quality (8-4-11 and 9-15-11 data sets)	Specific Comparison of Total BTEX (8-4-11 and 9-15-11 data sets)
MW-2	Down	Increase	BDL/66
MW-4	Side	Static	21.6/12.2
MW-5	Up	Static	14.8/BDL
MW-6	Up	Increase	9/60
MW-7	Down	Increase	1847/26800
MW-8	Down	Increase	24.2/72.2

B = Benzene; T = Toluene; E = Ethylbenzene; X = Xylene
All results in parts per billion or µg/l BDL = Below Detection Limits

The DPH has migrated in a down gradient direction and generally resides in the course grained soil layer within the water bearing unit. EFR pilot studies have shown that this course grained soil layer is highly transmissive for fluid and vapor flow.

Specific findings, results and conclusions from the various testing and investigation events are detailed in the documents introduced in the preceding section.

There are ongoing investigation activities being conducted at the Site. These activities include additional installation of recovery and monitoring wells as required in MDE correspondence dated October 6, 2011. The results of these investigation activities will be provided under separate cover. These new recovery and monitoring wells will be used in the pilot studies and are illustrated on Figure 2 in Appendix A.

2.0 PILOT STUDY PROCEDURES

2.1 Pilot Study Location Selection

The proposed location of the pilot study is on the northeast quadrant of the Site. This area is characterized by multiple temporary piezometers, monitoring and recovery wells. This area is located on the hydraulically upgradient end of the LPH plume and side gradient of the suspect source area (northeastern dispenser islands). Figure 2 in Appendix A illustrates this area.

2.2 Pilot Study 1 – Constant Rate Pumping Test

The following is the site-specific standard operating procedure for the proposed aquifer pumping test to be conducted at the Site. Specifically, the pilot study will use extraction equipment which produces equivalent water flows as the design basis summary descriptions (i.e., 4 to 6 gpm water flow creating a drawdown of approximately 4 feet). This 4 feet drawdown target will assist in avoiding creation of a larger smear zone due to possible drawdown of mobile LPH.

2.2.1 Equipment and Supplies

- QED pneumatic AP-4 Auto Pump – top loading
- Quincy Qt series Air compressor, 5 HP
- 20 KVA, 3-phase mobile generator
- Insitu-brand Troll pressure transducers and data loggers
- Laptop computer for data acquisition
- Water flow meter
- Oil-Water Interface Probe
- Decontamination supplies
- 5-gallon bucket(s)
- Stopwatch

2.2.2 Procedure

The constant rate test is the standard method for determining the aquifer parameters of specific capacity, transmissivity and storativity (storage coefficient). The resultant drawdown data will be plotted verses time and distance to develop these aquifer parameters. The recovery well will be RW-13. Water levels in monitoring wells RW-2, 4, 6, and 7 will be recorded using pressure transducers. Water levels in monitoring wells MW-6, RW-1 and RW-10 will be recorded using a water level meter. Based on the previous EFR pilot study it is expected that equilibrium conditions will be reached in approximately 4 hours. The observation well drawdown data will be evaluated after 4 hours and either the test will go into the recovery phase or will be extended for 2 to 4 more hours.

- Take an initial round of water levels within each monitoring well using an electronic oil-water interface probe accurate to 0.01-feet. The interface probe will be cleaned (Liquinox and water rinse) prior to use in each well.

- Program each Troll pressure transducer/data logger (Troll) with the laptop computer in accordance with the Troll instruction manual. Synchronize the beginning of data collection to begin several minutes before the start of the test. Program the Troll to use drawdown mode relative to the top of the casing. For transducers installed in monitoring wells, obtain 30-second arithmetic data during pumping tests. For recovery well installations and for rebound tests (in both monitoring and recovery wells), collect logarithmic data to obtain more frequent initial data.

- Install the pressure transducers in the recovery well and three or four adjacent monitoring wells. Record the elevation of the pressure transducer. The Troll will not be set deeper than the transducer's pressure range at the highest water level elevation. Transducer-data logger data should be verified with manual (tape) water-level measurements. Periodically manually confirm transducer monitored water levels.

- Complete the installation of the pneumatic pump in the recovery well. The wellhead installation will include an accurate flow-measuring device. The pump intake will be set as deep as possible to maximize drawdown.

- Estimate an initial flow rate for the test (i.e., 5 gpm). Run an initial test to determine whether the flow rate is optimal. Verify the flow rate with the 5-gallon bucket and the stopwatch. Adjust the flow rate using the flow control valves on the pump setup. If the initially estimated flow rate is acceptable, continue the test. Otherwise, stop the test and allow the well to recover. All field equipment will be set in order to ensure that the test runs smoothly from start to finish. The flow rate will remain as constant as possible throughout the test. Early time data will be obtained in all wells expected to respond within the initial 100 minutes.

- Analyze all field data during the course of the test, especially transducer/data logger data. A preliminary understanding of aquifer parameters will be available before the end of the proposed test period in order to decide whether to extend the test and also how long the recovery period should last. Reasons to extend the test include the appearance of a recharge or discharge boundary and the growth of the cone of depression to intercept wells unaffected during the earlier portions of the test.

- If mechanical problems cause a premature termination of the pumping portion of the test, recovery measurements will be obtained. The aquifer will be allowed to completely recover if a termination of any length occurs within the first 100 minutes; the pumping portion of the test may be continued if the problems are rectified in less than about ten minutes for tests that exceed 100 minutes, however, this will be decided by the analyst in the field and could further depend on the percentage of recovery to static experienced by the test well. If drawdown was continuing to increase after 100 minutes (a possible boundary effect), it may be necessary to allow complete recovery before restart.

- Flow rate measurements will be as accurate and timely as possible to allow a constant flow rate to be maintained during the course of the test. A totalizer-type flow meter will be verified using an alternate method (i.e., pail or five-gallon bucket). Pre-set pump discharge valves will be adjusted to avoid early time rate adjustments which cause water levels in the test well to fluctuate dramatically.

- Convert the raw data from the Trolls into an Excel spreadsheet for further data manipulation.

- The fluids will be piped to a 500-gallon poly tank. During the study the evacuated water will be removed from the holding tank via a vac-truck and appropriately disposed of as hydrocarbon impacted liquids.

2.2.3 Recovery Phase

Recovery measurements will be obtained for similar time intervals and duration as the drawdown measurements, although the length of the recovery test may have other limiting considerations. Field analysis of the drawdown data will indicate what conditions to anticipate for recovery. Recovery analysis in an aquifer test is extremely valuable, especially allowing analysis of pumping rate conditions which may have been slightly variable during the start-up phase.

2.2.4 Data Analysis

The pumping and recovery test data will be interpreted using one or several standard methods for interpreting pumping tests for unconfined aquifers including the modified Theis method (1935), the Theis recovery method (1935), the Cooper method (1946), and the Neuman method (1975). The method will be selected based on an understanding of the physical site conditions. Hydraulic conductivity, transmissivity, specific capacity and storativity values will be estimated. Graphics of the data analysis (typically distance-drawdown and time-drawdown plots) will be created. The pumping test will also be used to establish GE well spacing using capture zone analysis using Keely and Tsang (1983) and Javandel and Tsang (1986). The data will be analyzed qualitatively to assess potential conditions such as multiple soil strata, soil heterogeneity, groundwater sources or sinks, and impermeable areas.

2.3 Pilot Study 2 – Modified Step Drawdown and Dual Phase Recovery Tests

The following is the site-specific standard operating procedure for a modified step drawdown and dual phase recovery tests to be conducted at the Site. Specifically, the pilot study will use extraction equipment which produces equivalent water and air flows as the design basis summary descriptions (i.e., 4 to 6 gpm water flow and 50 cfm air flow) to determine if these flows produce a similar radius of influence as the recent EFR test.

2.3.1 Equipment and Supplies

- Rietschle VLR 250 Vacuum Pump, 7.5 HP
- QED pneumatic AP-4 Auto Pump
- Quincy Qt series Air compressor, 5 HP
- 20 KVA, 3-phase mobile generator
- Extech Model 407119A Hot Wire Anemometer
- MiniRAE 2000 portable Photoionization Device (PID)
- Insitu-brand Troll pressure transducers and data loggers
- Laptop computer for data acquisition
- Magnehelic differential vacuum gauges (0.1, 1 and 100 inch water)
- Water flow meter
- Oil-Water Interface Probe
- Decontamination supplies
- 5-gallon bucket(s)
- Stopwatch

2.3.2 Procedure for Modified Step Drawdown Test

The procedure entails pumping the test well at successively higher flow rates for equal ,or nearly equal, time steps. As originally devised (Jacob, 1946), the well is tested for four or more steps and allowed to fully recover between steps, although current practice is to continue increasing the flow rate without recovery. The flow rate in gpm and pumping well drawdown are recorded at the end of each step. Increases in flow rate are typically evenly spaced (i.e., 4, 5, 6, 7 gpm). The final flow rate should equal or exceed predicted maximum yield of well. The normal time step is one hour. It is anticipated that the pilot study will be conducted in four steps in a total of 4 hours. The step drawdown testing will be used to evaluate optimal flow rates for targeted drawdown levels of 2-, 4- and 6-feet under VE conditions. The recovery well will be RW-13. Water levels in wells RW-2, 4, 6, and 7 will be recorded using pressure transducers. Water levels in wells MW-6, RW-1 and RW-10 will be recorded using a water level meter.

- Take an initial round of water levels within each monitoring well and the recovery well using an electronic oil-water interface probe accurate to 0.01-feet. The interface probe will be cleaned (Liquinox and water rinse) prior to use in each well.

- Set up the recovery well to accommodate both the water and vapor recovery. The recovery well head will be fitted with a 4-inch diameter PVC riser. The pressure transducer cable, pump air supply hose and pump discharge hose will be installed through a well sanitary seal placed on top of the riser. The VE piping will be connected to the riser using a PVC tee below the sanitary seal. The blower will be fitted with an ambient relief valve and a flow control valve.

- Program the recovery well's Troll with the laptop computer in accordance with the Troll instruction manual. Synchronize the beginning of data collection to begin several minutes before the start of the test. Program the Troll to use drawdown mode relative to the top of the casing.

- Install the pressure transducer in the recovery well. Record the elevation of the pressure transducer. Do not hang the Troll deeper than the transducer's pressure range at the highest water level elevation. Transducer-data logger data should be verified with manual (tape) water-level measurements.

- Complete the installation of the pneumatic pump in the recovery well. The wellhead installation will include an accurate flow-measuring device. The pump intake depth will be set near the bottom of the recovery well.

- Vacuum readings will be measured in the observation wells, as well as the recovery well. The vacuum readings will be collected using magnehelic differential vacuum gauges attached to the well heads. Air-flow rates and air quality will be measured at the effluent stack using a hot wire anemometer and PID, respectively. The air flow and quality data will be collected up stream of the ambient dilution valve. Vapor recovery flow rates for the pilot study will be calculated from recorded air velocity readings. Measurements will occur at a frequency of one every five minutes for the first thirty minutes of the pilot study. Subsequent measurements will be collected less frequently (every 15 minutes) as the pilot study progresses. AEC will note the total volume of liquid extracted and the average recovery rate during the pilot study.

- The fluids will be piped to a 500-gallon poly tank and the vapor will be discharged to the atmosphere via a 4-inch diameter stack. During the study the evacuated water will be removed from the holding tank via a vac-truck and appropriately disposed of as hydrocarbon impacted liquids.

2.3.3 Procedure for Dual Phase Recovery Test

Using the results of the step drawdown testing, flow rates for the targeted drawdown levels will be used for the dual phase recovery test. Based on the previous EFR pilot study it is anticipated that each step will take approximately 2 hours to reach water level and vacuum equilibrium. As a result, the test will last between 6 and 8 hours. The recovery well will be RW-13. Water and vacuum levels in wells RW-2, 4, 6, and 7 will be recorded using pressure transducers and differential pressure gauges. Water and vacuum levels in wells MW-6, RW-1 and RW-10 will be recorded using a water level meter and differential pressure gauges.

- Take an initial round of water levels within each monitoring well using an electronic oil-water interface probe accurate to 0.01-feet. The interface probe will be cleaned (Liquinox and water rinse) prior to use in each well.

- Set up the recovery well to accommodate both the water and vapor recovery. The recovery well head will be fitted with a 4-inch diameter PVC riser. The pressure transducer cable, pump air supply hose and pump discharge hose will be installed through a well sanitary seal placed on top of the riser. The VE piping will be connected to the riser using a PVC tee below the sanitary seal. The blower will be fitted with an ambient relief valve and a flow control valve.

- Program each Troll with the laptop computer in accordance with the Troll instruction manual. Synchronize the beginning of data collection to begin several minutes before the start of the test. Program the Troll to use drawdown mode relative to the top of the casing. For transducers installed in monitoring wells, obtain 30-second arithmetic data during pumping tests. For recovery well installations and for rebound tests (in both monitoring and recovery wells), collect logarithmic data to obtain more frequent initial data.

- Install the pressure transducers in the recovery well and the adjacent monitoring wells. Record the elevation of the pressure transducer. Transducer-data logger data will be verified with manual (tape) water-level measurements. The transducer monitored water levels will be manually confirmed periodically.

- Complete the installation of the pneumatic pump in the recovery well. The wellhead installation will include an accurate flow-measuring device. The pump intake depth will be set near the bottom of the recovery well.

- Vacuum readings will be measured in the observation wells, as well as the recovery well. The vacuum readings will be collected using magnehelic differential vacuum gauges attached to the well heads. Air-flow rates and air quality will be measured at the effluent stack using a hot wire anemometer and PID, respectively. The air flow and quality data will be collected up stream of the ambient dilution valve. Vapor recovery flow rates for the pilot study will be calculated from recorded air velocity readings. Measurements will occur at a frequency of one every five minutes for the first thirty minutes of the pilot study. Subsequent measurements will be collected less frequently (every 15 minutes) as the pilot study progresses. AEC will note the total volume of liquid extracted and the average recovery rate during the pilot study.

- The fluids will be piped to a 500-gallon poly tank and the vapor will be discharged to the atmosphere via a 4-inch diameter stack. During the study the evacuated water will be removed from the holding tank via a vac-truck and appropriately disposed of as hydrocarbon impacted liquids.

2.3.4 Data Analysis

The step drawdown data will be interpreted using one or several standard methods including the Bierschenk, W.H., 1964 method. Transmissivity and storativity values will be provided, and an assessment of how well the data fit the model will be presented. Graphics of the data analysis (typically log-log or semi-log plots) will be created.

Through pilot testing, a vacuum ROI can be determined as the radial distance from the recovery well at which induced vacuum is too small to be measured. Vacuum radius of influence has often been used as a design parameter to determine recovery well spacing. However, air flow is the primary physical process removing volatile hydrocarbon vapors and air flow rate is a function of both induced vacuum and soil permeability. Recovery well spacing should be defined by the radial distance for which sufficient air flow will occur to adequately remediate soils. Since the distribution of soil permeabilities and air flow cannot be directly measured during pilot testing, the distribution of subsurface vacuum coupled with recovery well air flow rates are used to model idealized subsurface air flow patterns.

A normalized plot of measured vacuum versus radial distance from the recovery well will be prepared for interpreting pilot test results in the field. Assuming subsurface air flow passes through a homogeneous porous media, induced vacuum should decrease exponentially with increasing radial distance from the recovery well. Once vacuum and air flow have stabilized, vacuum measured at a given distance from the recovery well should increase linearly with increasing vacuum applied at the recovery well (i.e., doubling the recovery well vacuum should double the monitoring point vacuum). Normalized pilot test vacuum data measured at similar depth Intervals below the surface should conform reasonably well to a straight line fit when plotted against radial distance from the recovery well on a semi-log graph. The slope of the best-fit line is a function of the ratio of horizontal to vertical permeability (Kh/Kv). Sites with high Kh/Kv ratios have proportionally greater horizontal air flow component and less vertical air flow than sites with low Kh/Kv ratios. The higher the Kh/Kv ratio, the lower the slope of the best-fit line on the normalized vacuum plot.

Pilot test vacuum data should be plotted in the field on semi-log plot paper. Each vacuum step should be plotted separately. For each step, a stabilized vacuum reading for each vacuum monitoring point will be plotted as a function of the radial distance from the recovery well of that point. Stabilized vacuum readings will be normalized by dividing the measured vacuum by the recovery well vacuum. This will yield a vacuum value expressed as a percentage of the recovery well vacuum which is plotted on the logarithmic scale of the semi-log graph. Radial distance from the recovery well of each vacuum monitoring point will be normalized by dividing the radial distance of the point by the depth of the water table at the recovery well. Normalizing both vacuum and distance data will allow comparison of vacuum data from different vacuum steps, and from different recovery wells.

2.4 Waste Management Procedures

Any hydrocarbon impacted water and LPH encountered during testing activities will be collected and containerized in a vacuum truck. The contained fluids will be properly characterized and transported off-site for final disposal or treatment at facility permitted to accept impacted water originating from the State of Maryland. All trucking companies used to transport the impacted soil will be certified, licensed, and insured to transport hazardous waste in the State of Maryland and any other States through which the wastes will travel or where wastes will ultimately be disposed/treated. AEC will retain copies of all bills of lading, manifests, receipts and/or waivers that were signed prior to transport. Copies of these documents will be included in the Work Plan Implementation Report.

3.0 SCHEDULING

All field and reporting activities associated with this work plan are anticipated to be completed within 48 days after authorization by the MDE and the client. The MDE will be notified of AEC's field schedule at least five business days prior to the start of work plan implementation. The following is a summary of major project milestones and associated estimated times of completion:

Event	Approximate Schedule (days)
MDE approves Work Plan	Day X
Complete Constant Rate Pumping Test	X + 7
Complete Dual Phase Extraction Pilot Studies	X + 12
Complete Data Analysis/Reporting	X + 24
Completion of Report Peer Review	X + 26
Submit Pilot Study Implementation Report to MDE	X + 28
MDE approves Pilot Study Implementation Report	Day Y
Submit Final Design Basis Summary or CAP Addendum to MDE	Y + 20

4.0 REPORTING

A report will be prepared that describes the entire work plan implementation. Specifically, the report will include:

- A summary of pilot study results (include tables that summarize analytical results).

- A complete description of the pilot study, including all data necessary to understand the project in its entirety including all pilot study methods and procedures.

- A discussion of key decision points encountered and resolved during the course of the pilot study.

- Graphical displays such as isopleths, cross-sections, plume contour maps (showing concentration levels, isoconcentration contours), and Site maps (showing sample and injection locations, etc.) that describe the report results.

- An analysis of pilot study data to develop estimates of the maximum, minimum, and optimal flow rates needed to establish hydraulic control, with consideration to a phased lowering of the pumps over time to establish optimum recovery of the plume.

- An analysis of the effectiveness of the pilot study and a discussion of a scaled-up design for total Site remediation.

5.0 REFERENCES

Bierschenk, W.H., 1964. Determining well efficiency by multiple step-draw-down tests. Intl. Assoc. Sc. Hydrol. Publ., 64: 493 - 507.

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APPENDIX A

FIGURES

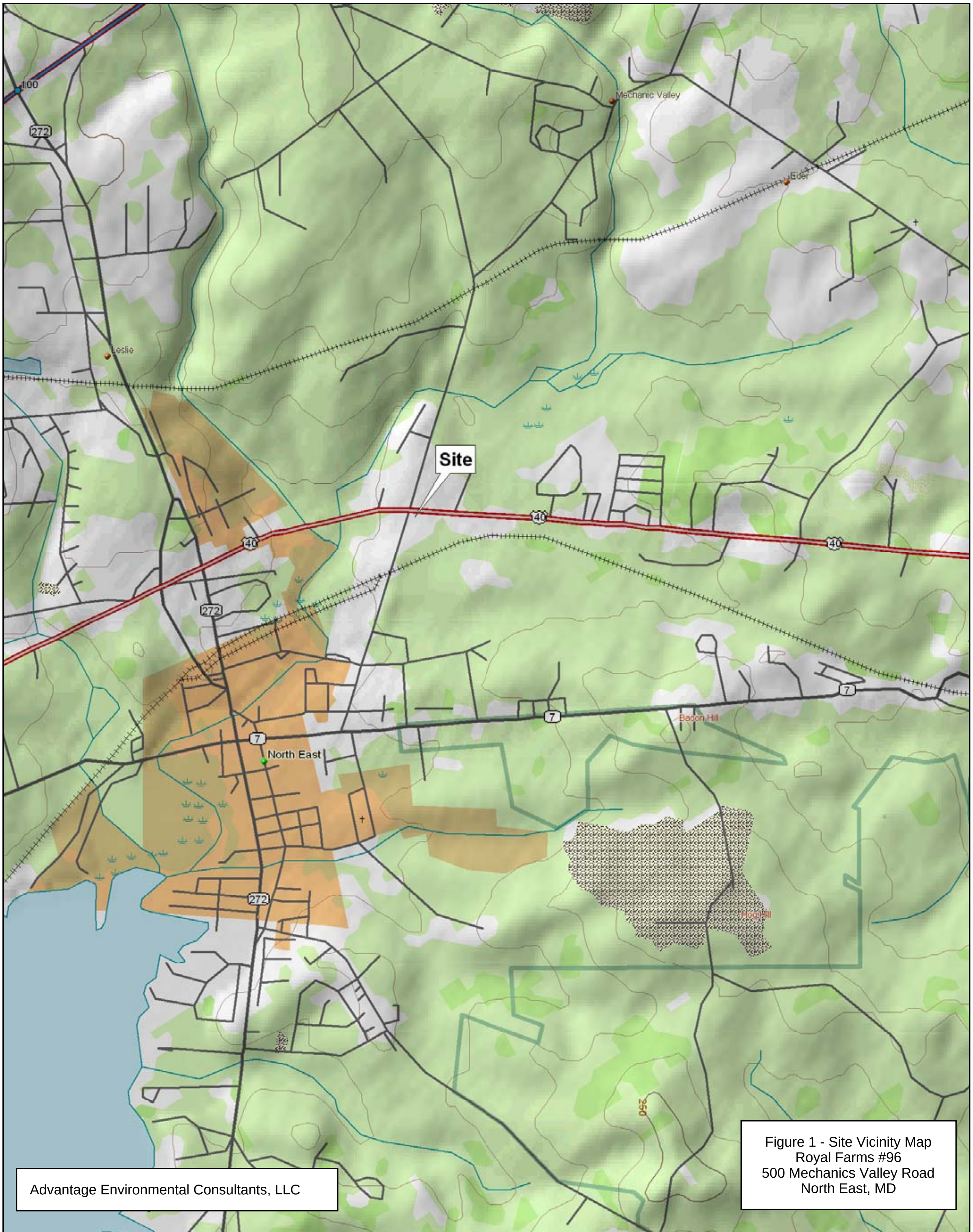


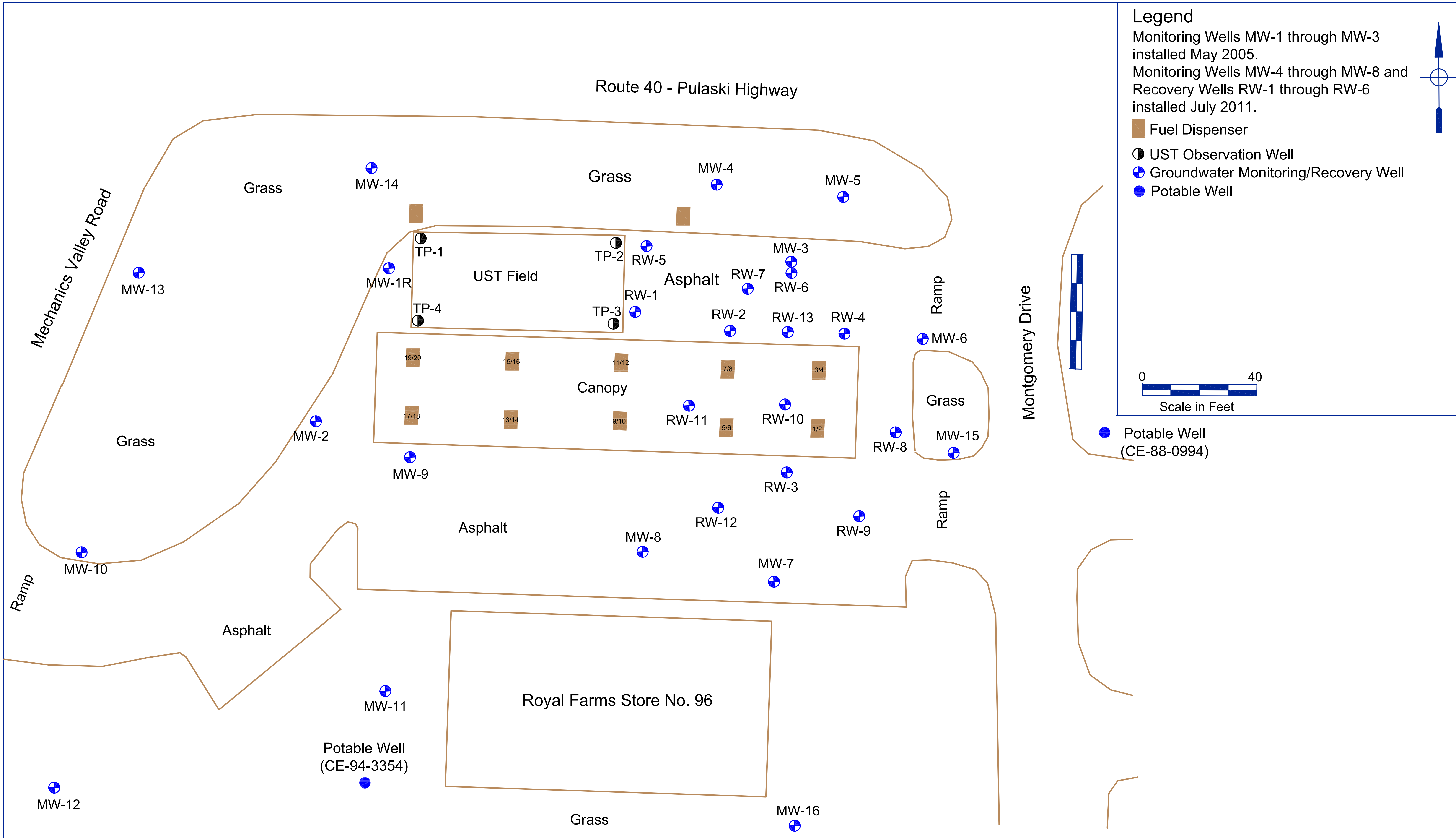
Figure 1 - Site Vicinity Map
Royal Farms #96
500 Mechanics Valley Road
North East, MD

Zoom Level: 12-7 Datum: WGS84

Scale 1 : 28,125

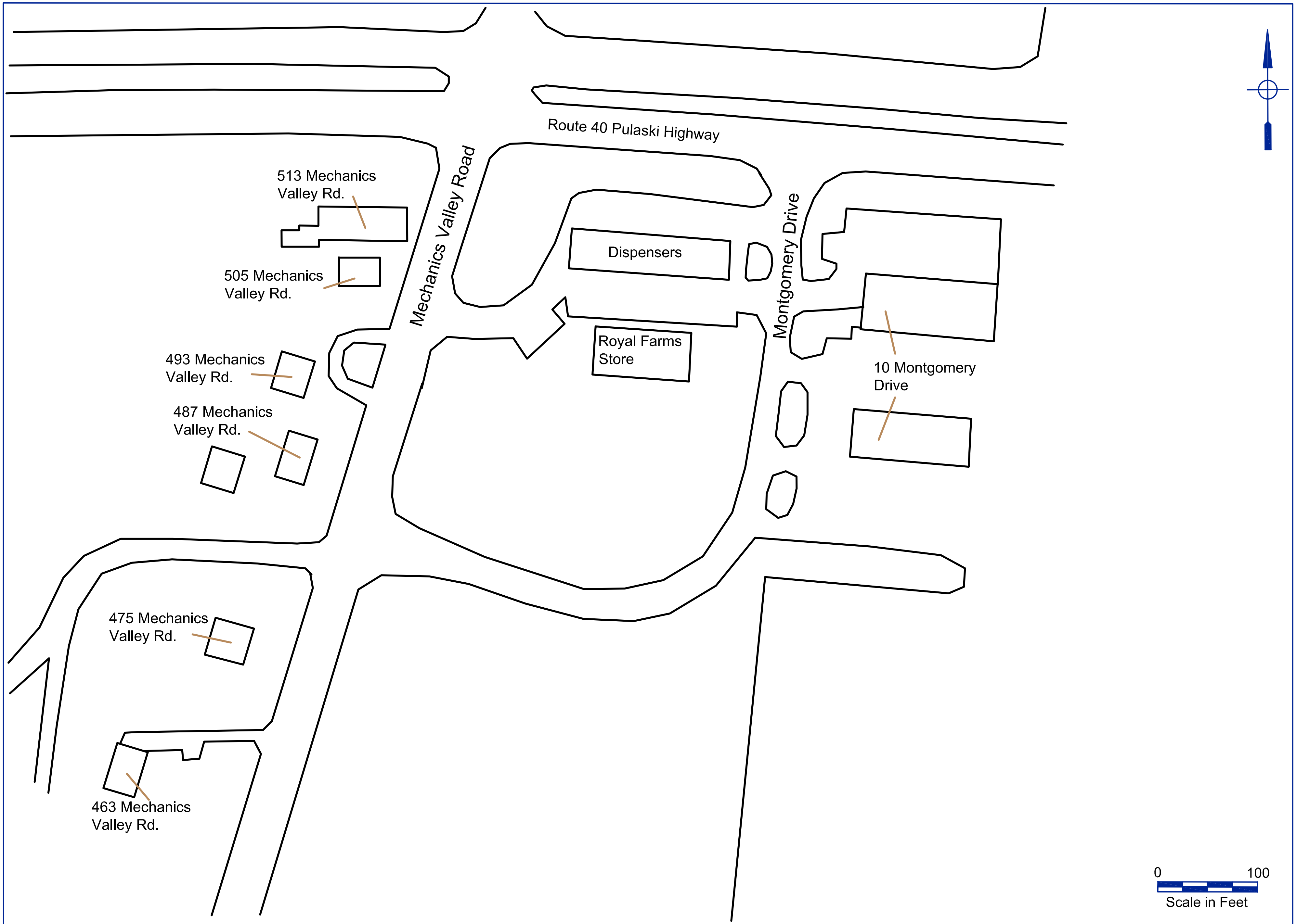
1" = 2,343.75 ft

TN
MN
11.7°W



Advantage Environmental Consultants, LLC
8610 Washington Blvd. Suite 217
Jessup, MD 20794
Phone 301-776-0500 Fax 301-776-1123

Project No.: 05-056	Drawn by: JSS	Figure 2 - Site Features Map Royal Farms No. 96 500 Mechanics Valley Road North East, MD
Task No.: RF96	Date: 8-4-11	
File: Site Features	Revision No.: 1	



Advantage Environmental Consultants, LLC
8610 Washington Blvd. Suite 217
Jessup, MD 20794
Phone 301-776-0500 Fax 301-776-1123

Project No.: 05-056	Drawn by: JSS
Task No.: RF96	Date:7-14-11
File: Site Area	Revision No.: 1

Figure 3 - Site Area Map
Royal Farms No. 96
500 Mechanics Valley Road
North East, MD

APPENDIX B

DESIGN BASIS SUMMARY – DUEL PHASE RECOVERY SYSTEM

Design Basis Summary
Dual Phase Recovery System
Gasoline Fueling Station – Royal Farms #96
500 Mechanics Valley Road
North East, Cecil County, Maryland 21901
OCP Case No. 2011-0729-CE
MDE Facility No. 13326

Introduction

Based on the July 27, 2011 enhanced fluid recovery (EFR) pilot study findings AEC has developed the following remediation system design criteria: Radius of influence (ROI) - 25 feet; Individual recovery well flow rate – 6 gallons per minute (gpm); Individual recovery well drawdown - 4 feet below static groundwater; and, Individual recovery well air flow rate - 50 cubic feet per minute (cfm). Based on a 10 recovery well use scenario the minimum treatment system equipment sizing criteria will be: 30 gpm water flow rate and 500 cfm air flow rate. Dual phase (vapor and liquid) recovery technology has been selected for use at this site. Dual phase recovery will be implemented using pneumatic submersible pumps for liquid removal and a positive displacement vacuum blower for vapor removal. This technology is similar to EFR in concept and application. The following provides a summary of the equipment to be used for the dual phase application at the site. Also provided are a Process and Instrumentation Diagram and Trench and Well Head Details.

Soil Vapor Extraction System

25 HP Positive displacement vapor extraction system, Tuthill 5009SL or equal
600 ACFM @ 10"Hg. Capacity
Temperature gauge
High temperature switch
Inlet filter and inlet silencer
Universal SD series or better discharge silencer
Universal SD series or better
Belt drive
Automatic and manual dilution valves with silencer

200 Gallon Vertical Air/water Separator

Conductivity probe level switches
10" diameter clean out ports with vacuum rated quick release lids
Clear PVC sight glass piping to liquid ring pump, to check for water carryover
Liquid filled vacuum gauge
Vacuum assist line
2" drain valves
Vacuum relief valves
Dilution valve with filter/silencer
Inlet screen

MK Coalescing Oil/Water Separator System

Model C85 with 85 GPM capacity

Coalescing separator with product skimming weir
Polypropylene coalescing pack with 1/2" spacing for efficient oil removal
Hopper bottom for sludge removal
Effluent chamber with stainless steel float level sensors

MK Low Profile Cascade Air Stripper System
0-150 GPM flow rating
800 CFM air flow rating
3-tray air stripper unit - Model LP150-3
Low profile air stripper with 7.5 hp AMCA Type B spark resistant aluminum blower
Nylon tube aeration air stripper for high mass removal rates with low maintenance
Low, high, and high-high sump conductivity probes
12" clean out hatch
Epoxy coated carbon steel construction
Sump level sight glass
99.8% Removal for BTEX @ 50 GPM, 60°F

Air Stripper Blower Silencer to Reduce Noise Level of the Stripper Blower

1.5 hp Transfer Pump
3450 rpm, TEFC motor
Cast Iron housing with bronze impeller, anti air lock design
Manual "Pump ON" button inside building for sampling

3 hp Transfer Pump (2)
3450 rpm, TEFC motor
Cast Iron housing with bronze impeller, anti air lock design
Manual "Pump ON" button inside building for sampling

Groundwater Inlet Manifold
Carbon steel with brass valves
2" main with (11) 1" points, with shut off valve, check valve, sample port, barb for each groundwater pump.

Vapor Inlet Manifold
PVC
6" main with (11) 2" points, with shut off valve, union and sample port for each well.

Air Compressor
15 HP rotary vane with continuous run option
90 gallon receiver tank
Air cooled after cooler
Low oil switch
Tank auto drain
1/2" filter regulator
1/2" 3 way Asco solenoid valve

Recovery Pumps - QED AP4 Long Top Fill Pneumatic Pumps (10)
10 GPM maximum flow rate
Down well hoses and support rope per well
Vacuum well seal
3/4" brass shut off at each well for groundwater
1/2" brass ball valve for compressed air at each well

Master Control Panel System
NEMA 3R control panel with blank front cover
Swing out sub panel for gauges, control operators, and switches
IEC Magnetic motor starters, safety switches, H-O-A controls
Control transformer
8 intrinsically safe relays, 8 alarm indicator LED's, 16 output channels
Hard wired relay logic
Exterior GFCI utility outlet
System run-time totalizing hour meter
Blower low pressure alarm
Anti-falsing alarm circuit to prevent nuisance tripping
Three phase voltage and phase monitor
Emergency E-stop LED red indicator light located on swing out sub panel

Telemetry System Model 570
16 analog inputs, expandable to 32
4 digital outputs
24 hour gel cell battery backup
10,000 line data logger
UL listed surge suppression
Manual or automatic control of outputs
8 number dial out list
Programmable dial out intervals
Site telephone with duplex RJ11 jack

Vacuum Transducer
Integrated into telemetry for real time monitoring
4-20mA

System Building
8.5'W x 28'L x 9.5'H aluminum/steel enclosure, fully insulated
Removable sliding wall panels for ease of maintenance
Exterior grade plywood floor, structural steel frame
Includes 100 watt XP interior light, and removable center grate for ease of maintenance
Breaker panel and control panel will be mounted on a vertical steel bracket attached to platform end.
10" structural steel base with 4" steel cross members
Steel corner posts and roof frame

Continuous sheet aluminum roof
2 XP heater with thermostat, 12,000 BTU each

Groundwater Flow Totalizer
Pulse output and flow calibration button

Equipment Electrical Installation
Includes XP wiring, XP seal off connectors, liquid tight flexible conduit
UL listed equipment.

Equipment Mechanical Installation
Includes mounting, piping and connectors
Brass fittings, sample ports, pressure gauges and sight glasses
400 Amp meter base and (2) 200 amp fused disconnects or breakers for the system and oxidizer
Weatherhead with extension pole and bracket support
Electric meter socket base installed

MKE Model 500E Electric Oxidizer with 50% Effective Heat Exchanger
500 CFM capacity 99% destruction efficiency; flame arrestor
Watlow controls
First out detector
Honeywell 2-pen chart recorder
Located outside system enclosure
Includes 200 amp circuit breaker in main panel

Air/water Separator Knock Out Tank
Located prior to oxidizer to minimize condensed liquids from entering burner or vapor phase carbon bed.

VF-400 Vapor Phase Carbon Vessels
Filled with activated carbon for odor control and vapor capture when the oxidizer is off, during remote restart conditions

Air/water Separator Knock Out Tank
Located prior to oxidizer to minimize condensed liquids from entering vapor phase carbon bed for air stripper

500 Gallon Product Holding Tank
UL listed with emergency vents
Stainless steel high-level float switch and intrinsically safe channel in the control panel

Electrical Service Installation
200 amp 3/60/460 volt 3 wire plus ground electrical service to NEMA 3R control panel
Interior electrical will comply with NEC requirements for Class 1, Division 2, Group D Hazardous locations

Motors will be TEFC construction

Nationally Recognized Testing Laboratory (NRTL) Approvals
MET Labs certified manufacturer

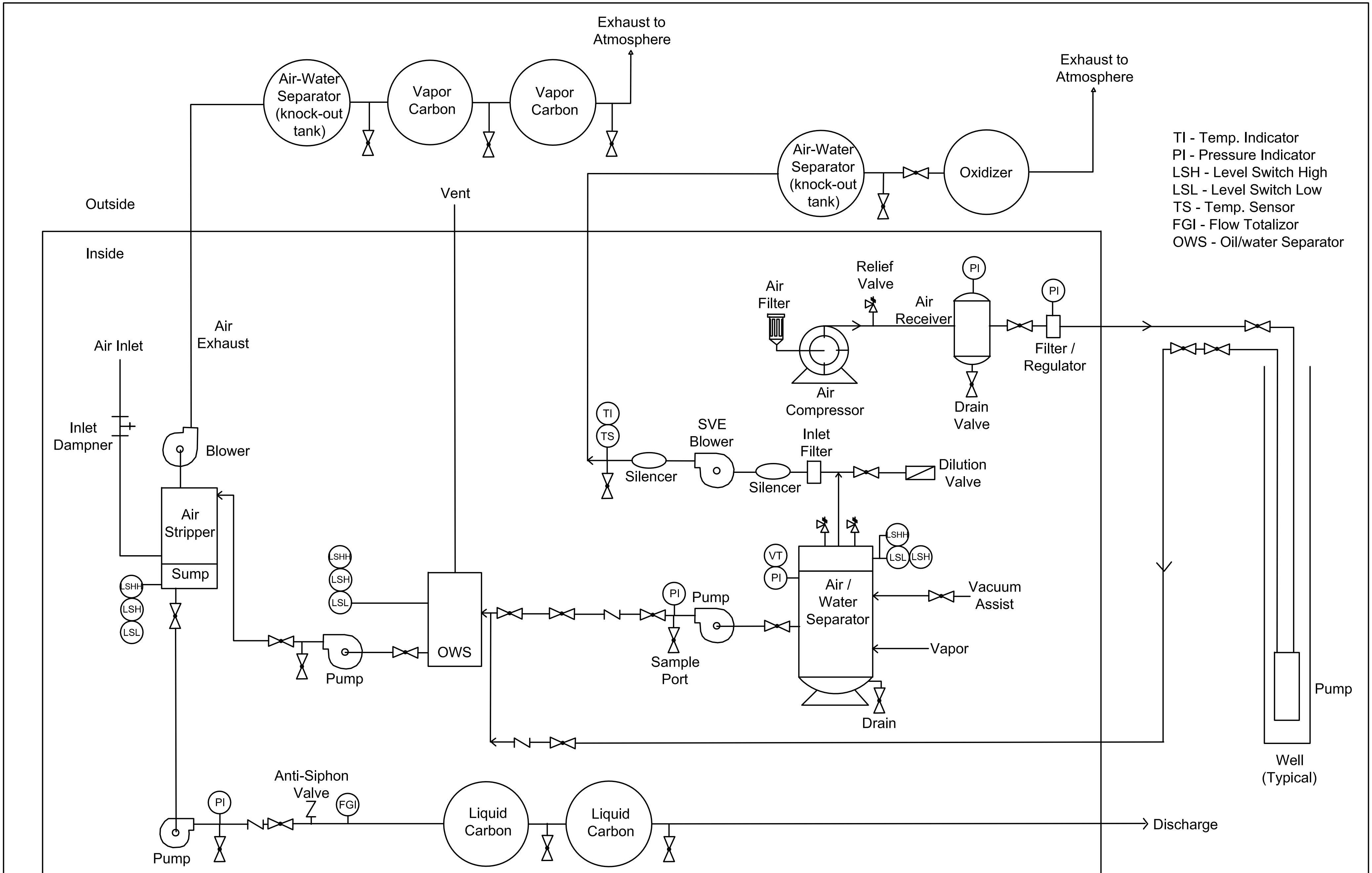
Recovery Well Vaults
2’ by 2’ by 18” side skirt traffic rated well vaults with hydraulic arms

Recovery Well Trenches
Trenches will be saw-cut in asphalt and/or concrete
Trenches will be installed 24” wide and 30” deep
Pipes will be bedded in pea-gravel
Trenches will be backfilled in one foot lifts with crush and run gravel or removed fill
Disturbed areas will be placed back to its original condition i.e. asphalt, concrete, soil

Soil Vapor Extraction System Lines
Recovery wells will have independent SVE lines
Lines will be installed using 2" diameter PVC conduit from treatment building to recovery wells

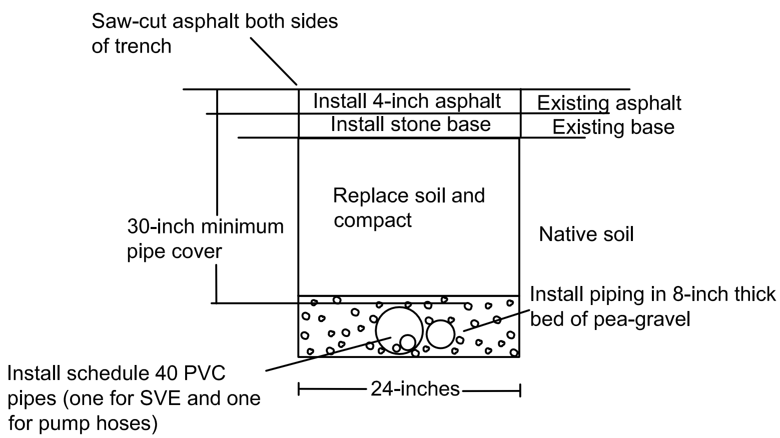
Recovery Pump Air Line and Discharge Line
Recovery wells will have independent air and discharge lines
Lines will be installed within 4" diameter PVC conduit from treatment building to recovery wells
Air lines to recovery pumps will be 1/2" diameter
Discharge lines from recovery pumps will be 3/4" diameter
Due to the number of 90 degree turns, PVC "sweeps" will be used so that the air/water lines can be easily installed and removed for maintenance

Treated Effluent Discharge Line
Discharged approximately 85 feet to the northeast to the sanitary sewer drain
Effluent line will be 1.5” diameter black PE plastic
Installed three feet below grade

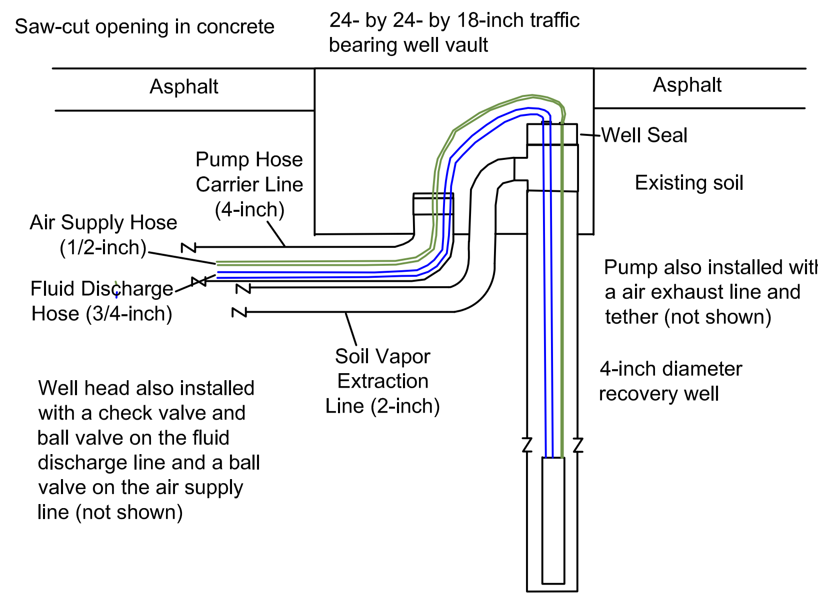


Advantage Environmental Consultants, LLC 8610 Washington Boulavard, Suite 217 Jessup, Maryland 20794 301-776-0500	Drawn by: JSS	Checked by: JSS	Process & Instrumentation Diagram Royal Farms No. 96 500 Mechanics Valley Road North East, Maryland
	Date: 9-13-11	Revision: First	

Trench Section (Typical)



Well Head Set Up (Typical)



Advantage Environmental Consultants, LLC 8610 Washington Boulavard, Suite 217 Jessup, Maryland 20794 301-776-0500	Drawn by: JSS	Checked by: JSS	Vault and Trench Details Royal Farms No. 96 500 Mechanics Valley Road North East, Maryland
	Date: 9-13-11	Revision: First	

APPENDIX C

MDE REQUEST FOR ADDITIONAL MONITORING & RECOVERY WELLS AND SUPPLEMENTAL PILOT TEST

MARYLAND DEPARTMENT OF THE ENVIRONMENT
Oil Control Program, Suite 620, 1800 Washington Blvd., Baltimore MD 21230-1719
410-537-3442 • 410-537-3092 (fax) 1-800-633-6101

Martin O'Malley
Governor

Anthony G. Brown
Lieutenant Governor

Robert M. Summers, Ph.D.
Secretary

October 6, 2011

Mr. Robert Rinehart
Two Farms, Inc.
t/a Royal Farms
3611 Roland Avenue
Baltimore MD 21211

RE: REQUEST FOR ADDITIONAL MONITORING & RECOVERY WELLS AND SUPPLEMENTAL PILOT TEST
Case No. 2011-0729-CE
(Closed Case No. 99-2595-CE)
Royal Farm Store #96
500 Mechanics Valley Road, North East
Cecil County, Maryland
Facility I.D. No. 13326

Dear Mr. Rinehart:

The Oil Control Program recently completed a review of the case file for the above-referenced property, including the following documentation: *Corrective Action Plan - July 22, 2011*; *Corrective Action Plan Addendum - August 3, 2011*; *Surfactant Flush Pilot Study Work Plan - August 9, 2011*; and the *Design Basis Summary Dual Phase Recovery System* (hereinafter referred to as the "*Design Summary*"), received via email September 13, 2011. Following detections of measurable liquid phase hydrocarbons (LPH) in monitoring well MW-3 on June 8, 2011, twenty-four direct push borings were advanced to define the horizontal and vertical extent of petroleum contamination. Based on the preliminary subsurface characterization data, ten additional monitoring and recovery wells were installed on-site. Interim daily vacuum extraction events continue to recover LPH, as required. As of September 13, 2011, it has been estimated that over 1,200 gallons of LPH has been recovered and LPH detections within the monitoring well network continue to fluctuate. Gauging of on-site monitoring wells detected groundwater levels between 6.75 and 18.25 feet below ground surface (bgs). The most recent projections show groundwater flow to the southwest.

The on-site drinking water supply well was retrofitted with a granular activated carbon (GAC) filtration system in 2006 following detection of methyl tertiary-butyl ether (MTBE) at 28 parts per billion (ppb). Sampling of the GAC filtration system for petroleum constituents has been below regulatory levels since 2006. Required off-site private drinking water supply well sampling detected the presence of petroleum constituents above State action levels at two properties (505 and 513 Mechanics Valley Road). The Department required installation of GAC filtration units at these properties and monthly monitoring, which has been initiated.

The on-site monitoring well network currently includes: twenty-four temporary monitoring points; six 4-inch diameter recovery wells; five 4-inch diameter monitoring wells; and three 2-inch diameter monitoring wells. To date, measureable LPH have been detected in monitoring well MW-3; recovery wells RW-1, RW-2, RW-3, and RW-4; and borings B-4, B-6, B-9, B-10, B-13, and B-22. The sampling event conducted August 4, 2011 detected the following dissolved phased hydrocarbons: benzene at 730 parts per billion (ppb); toluene at 2,700 ppb; ethylbenzene at 800 ppb; naphthalene at 400 ppb; total petroleum hydrocarbons/gasoline range organics (TPH/GRO) at 13 parts per million (ppm); and total petroleum hydrocarbons/diesel range organics (TPH/DRO) at 6.6 ppm.

During July and August 2011, Department representatives oversaw removal of the three registered underground storage tank (UST) systems and all associated piping components. Visible perforations were observed in the secondary fiberglass layer of the 20,000-gallon regular gasoline UST. During removal of chase piping, petroleum impacted liquid was encountered within the piping. All soils were field screened with a photo ionization detector (PID); readings ranged from 0.0 to 3,000 units. Perched water was identified on the western side of the pump island trenching and the western end of the satellite diesel trench. The Department awaits submission of the final *UST System Removal Report* documenting the analytical results from all soil samples collected post-UST system removal and a final determination of the quantity of petroleum impacted soils excavated **no later then October 17, 2011**. A preliminary soil sampling results map, received during the August 23, 2011 technical meeting, depicted detections of total BTEX (benzene, toluene, ethylbenzene, and xylene) up to 56,920 ppb and TPH/GRO up to 1,000 ppm.

Based on preliminary pilot testing, your consultant proposed the installation of a dual phase remediation system to enhance the recovery of LPH, dissolved phase hydrocarbons, and absorbed phase hydrocarbons in soils. Pilot study results established a minimum radius of influence of 20 feet utilizing a liquid ring pump. On September 13, 2011, the Department received the "Design Summary", which denoted modifications to the system proposed in the *Corrective Action Plan Addendum - August 3, 2011*. The current equipment modifications propose utilizing submersible pneumatic pumps and vapor extraction with a central blower in lieu of the previously proposed and pilot tested liquid ring pump.

At this time, the Department will not approve the use of surfactants within the subsurface. Based on the aforementioned findings, the Department hereby requires the following:

REQUEST FOR SUPPLEMENTAL PILOT TEST:

(1) Prior to granting approval to implement the *CAP* as modified in the September 13, 2011 "Design Summary," the Department requires an additional pilot test to confirm that proposed system modifications will be capable of achieving the previously established radius of influence. **No later than October 31, 2011,** submit a *Pilot Test Work Plan* to verify that the modified equipment has the capabilities to create the same recovery parameters and meet the same radii of influence. Report findings to the Oil Control Program that include estimates of the maximum, minimum, and optimal flow rates needed to establish hydraulic control, with consideration to a phased lowering of the pumps over time to establish optimum recovery of the plume.

ADDITIONAL WELLS REQUIRED:

(2) To reduce and control migration of the dissolved phase hydrocarbon plume, the Department requires the installation of two additional recovery wells (MDE-RW1 and MDE-RW2) between the eastern end of
2 the pump island and store (*see enclosed site map*). The Department reserves the right to require additional recovery points as necessary.

(3) Due to the extensive damage during UST installation activities, monitoring well MW-1 must be properly abandoned and replaced by a Maryland-certified well driller (see enclosed site map). Prior to well
1 replacement, obtain a proper well permit from the Cecil County Hearth Department and provide notice of work activities to the Oil Control Program.

(4) The Department hereby approves proper abandonment of the temporary monitoring points installed in June 2011 during the initial emergency subsurface investigation. All remaining temporary well points must be abandoned by a Maryland-certified well driller.

(5) To properly monitor the dissolved phase hydrocarbon plume, the Department requires the installation of a minimum of eight additional monitoring wells, MDE-1 through MDE-8 (see enclosed site map). Once
8 the monitoring wells have been installed, all wells must be surveyed to a reported known elevation point of reference. The Department reserves the right to require additional monitoring and/or recovery wells based on future sampling data.

(6) Upon completion of well installation and abandonment activities, provide a copy of the well completion and abandonment reports to both the Oil Control Program (Attn: Mr. Chad Widney) and the Cecil County Health Department (Attn: Mr. Charles Smyser). The Oil Control Program anticipates receiving the well completion and abandonment reports **no later than November 1, 2011**.

(7) To further assess contaminant migration to private off-site drinking water supply wells, the Department requires a *Work Plan* for the installation of three bedrock monitoring wells located between the known contaminant plume and three off-site bedrock supply wells. The *Work Plan* must include: detailed well construction plans (including proposed depths); specify distance between nested wells; and approximate drilling locations. Preliminary well locations for the deeper wells are present on the enclosed site map (MDE-5D, MDE-6D, MDE-7D). The *Work Plan* must outline a detailed schedule of all work necessary to implement and complete monitoring well installation. The schedule must specify the dates and time frames for implementing and completing each phase of the proposed *Work Plan*. The *Work Plan* must be submitted to the Oil Control Program **no later than November 30, 2011**.

CONTINUED MONITORING:

(8) Begin quarterly (**every three months**) gauging and sampling of the monitoring well network. Sample all monitoring wells that do not exhibit LPH. All samples collected must be analyzed for full-suite volatile organic compounds (VOCs), including fuel oxygenates, using EPA Method 8260B and for TPH/DRO and TPH/GRO using EPA Method 8015C.

(9) If measurable LPH are detected within the monitoring well network, the Department must be notified within 2 hours. If LPH are consistently detected within any given monitoring point after CAP implementation, the Department will require that monitoring point(s) be converted to recovery point(s).

(10) Conduct monthly sampling of the on-site and select off-site drinking water supply wells located at 500, 493, 487, 475, and 463 Mechanics Valley Road and 10 Montgomery Drive. Continue to analyze for full-suite VOCs, including fuel oxygenates, using EPA Method 524.2. If analytical results exceeding State action levels and/or maximum contaminant levels are detected, contact the Oil Control Program and the Cecil County Health Department immediately.

(11) Continue to maintain and sample the GAC filtration systems retrofitted to the private drinking water supply wells located at 513 and 505 Mechanics Valley Road on a **monthly basis**. Continue to collect pre-, mid-, and post filtration samples and analyze for full-suite VOCs, including fuel oxygenates, using EPA Method 524.2.

(12) The Department recommends that carbon within the GAC filtration systems be replaced, at a minimum, on an **annual** (**once a year**) basis. If petroleum constituents are detected at the mid-filter point or beyond, take corrective action, which may include replacement of the carbon. Provide written confirmation to the Oil Control Program regarding all re-bedding/carbon change-out events.

Final approval of the *CAP* will be contingent upon the Department's review of the results of supplemental pilot testing. Upon receiving *CAP* approval and final confirmation of complete system start-up, the Department will approve discontinuance of the required vacuum events.

All information, data, reports, or plans generated for this site must be submitted to the Oil Control Program for review by dates specified and/or agreed upon with the Department. Failure to perform the advised actions may result in enforcement proceedings that could include the issuance of civil penalties and other legal sanctions.

When submitting documentation to the Oil Control Program, provide four (4) hard copies and an electronic copy on a labeled compact disc (CD) for updating the Oil Control Program's *Remediation Sites* list on the MDE website. If you have any questions, please contact the case manager, Mr. Chadwick Widney, at 410-537-3386 (email at cwidney@mde.state.md.us) or the Regional Supervisor, Ms. Susan Bull, at 410-537-3499 (email: sbull@mde.state.md.us).

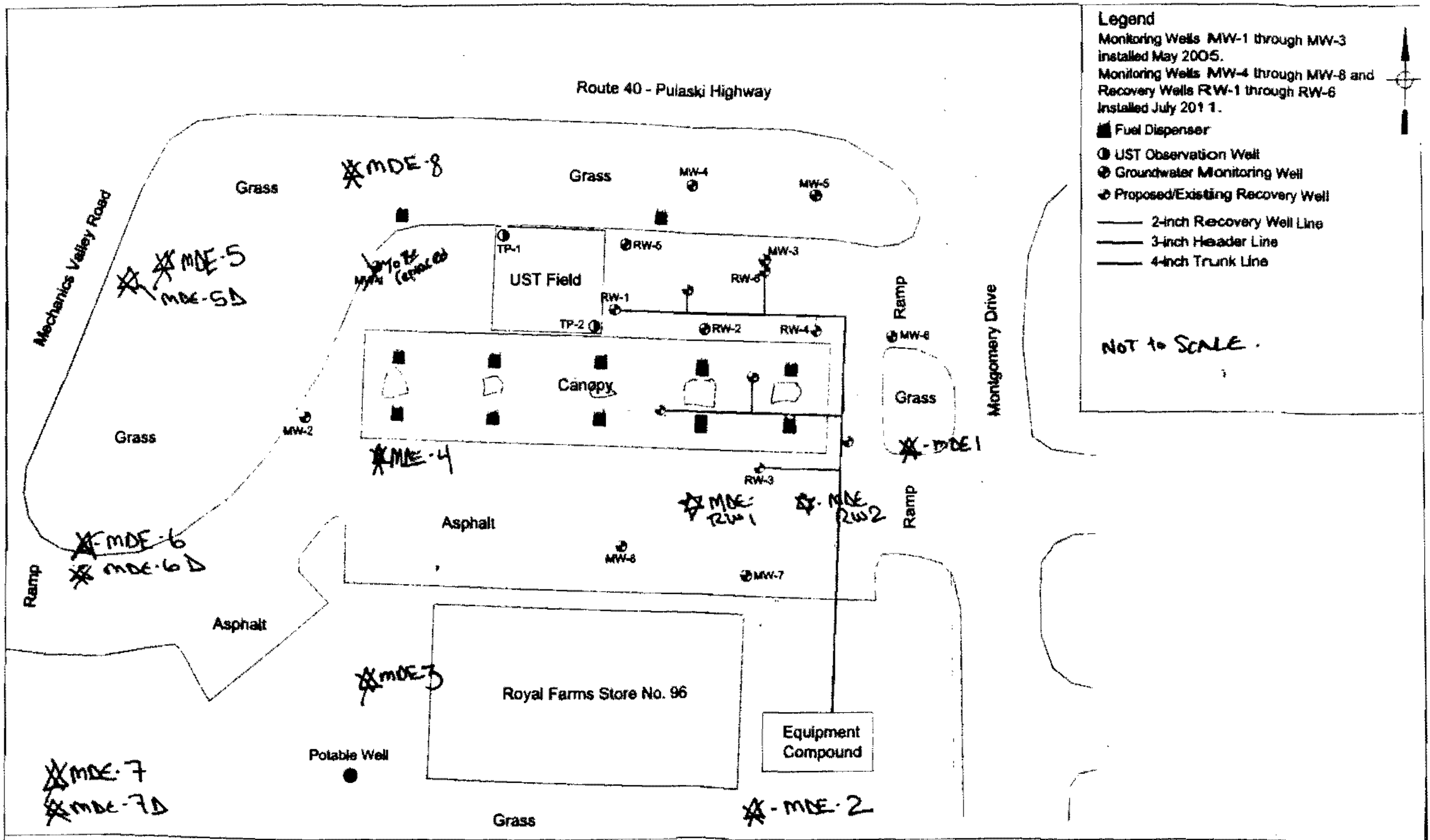
Sincerely,

Christopher H. Ralston, Administrator
Oil Control Program

CW/nln

Enclosure (map)

cc: Mr. David Carter (505 and 513 Mechanics Valley Road)
Raymar, LLC (463 Mechanics Valley Road)
Mr. and Mrs. Curtis and Betty Johnson (475 Mechanics Valley Road)
Mr. and Mrs. Robert and Debra Dean (487 Mechanics Valley Road)
Mr. and Mrs. Charles and Debra Pelletier (493 Mechanics Valley Road)
Montgomery Bros., Inc (10 Montgomery Drive)
Mr. Jeff Stein (Advantage Environmental Consultants, LLC)
Mr. Charles Smyser (Cecil County Health Dept.)
Ms. Susan R. Bull
Mr. Thomas L. Walter
Priscilla N. Carroll, Esquire
Mr. Horacio Tablada



Advantage Environmental Consultants, LLC 8610 Washington Blvd, Suite 217 Jessup, MD 20794 Phone 301-776-0500 Fax 301-776-1123	Project No.: 05-056	Drawn by: JSS	Figure 7 - Proposed Trench Configuration Map Royal Farms No. 96 500 Mechanics Valley Road North East, MD
	Task No.: RF96	Date: 8-2-11	
	File: Line Map	Revision No.: 1	