RECR – 5

Enersource Refinery

SVE Design Report

2/8/13

INTERA Incorporated
6000 Uptown Blvd, NE
Suite 220
Albuquerque, NM 87110
Telephone: (505) 246-1600
Fax: (505) 246-2600

February 8, 2013

Mr. Jim Griswold, Hydrologist
Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Soil Vapor Extraction System Design Status Report, Former Enersource Facility Monument, Lea County, New Mexico

Dear Mr. Griswold,

INTERA has completed the above-referenced report for the former Enersource facility. One hard copy of the report is enclosed. INTERA appreciates the opportunity to work with the Oil Conservation Division. Please do not hesitate to contact me at (505) 246-1600 if you have any questions or require further information.

Sincerely,
INTERA Incorporated

Joe A. Galemore
Senior Project Manager

Enclosure

FILE: NMGSD.M002.ENER

SOIL VAPOR EXTRACTION SYSTEM DESIGN STATUS REPORT

Former Enersource Facility
Monument, Lea County, New Mexico

Submitted to:

New Mexico Energy, Minerals, and Natural Resources Department
New Mexico Oil Conservation Division

Submitted by:

Geosciences & Engineering

6000 Uptown Boulevard NE, Suite 220
Albuquerque, New Mexico 87110

February 8, 2013

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

AQB	Air Quality Bureau
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
cfm	cubic feet per minute
EDC	1,2-dichloroethane
EPA	U.S. Environmental Protection Agency
ft	feet *or* foot
INTERA	INTERA Incorporated
LNAPL	light non-aqueous phase liquid
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
NOI	Notice of Intent
OCD	New Mexico Oil Conservation Division
OMM	operation/maintenance/monitoring
Ri	radius of influence
Site	former Enersource facility
SVE	Soil Vapor Extraction
TDS	total dissolved solids
UA	Universal Application

1.0 INTRODUCTION

This report presents work performed by INTERA Incorporated (INTERA) for the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals and Natural Resources Department to design a soil vapor extraction (SVE) system for the former Enersource facility (Site). The work was authorized under purchase order number 52100-00000374354 issued on August 22, 2012. INTERA completed a portion of the work specified in the work plan dated August 16, 2012 (INTERA, 2012a), and in accordance with the terms and conditions of Price Agreement 10-805-00-07208. For reasons discussed below, work on the design was stopped by OCD on October 24, 2012. This report summarizes the work performed to date.

The Enersource facility is located in the northwest quarter of Section 1, Township 20 South, Range 36 East, in Lea County, New Mexico. Figure 1 illustrates the location of the Site. The Site was formerly used as a refinery and later as a crude-oil reclamation facility. Land in the vicinity of the Site is currently used for ranching, oil and gas production, brine disposal, and natural gas processing.

Subsurface contamination reportedly exists at several facilities in the area and, given the historical land use, unreported contamination likely exists at many others. Documented petroleum hydrocarbons and chloride contamination exists at the following facilities (INTERA, 2012b) (Figure 1):

- The Versado Gas Processing Plant (OCD remediation permit # 1R-281) located adjacent to the Site's northern property boundary
- The Rice Operating Company's Salt Water Disposal pipeline located to the south of Site
- The former Climax Chemical Company, which is a U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Information System site, located approximately 1-mile to the northwest of the Site

Previous investigations at the Site revealed that groundwater (1) occurs between 35 and 40 feet (ft) below ground surface (bgs), (2) flows towards the southeast, and (3) has dropped about one ft since monitoring commenced in June of 2009. Contamination is widespread in both the vadose zone and in groundwater and includes an approximate 5 acre mobile light non-aqueous phase liquid (LNAPL) plume in the southeastern portion of the Site (Figure 2). Contaminants of concern in groundwater include benzene, toluene, ethylbenzene, and xylenes (BTEX); total naphthalenes (i.e., naphthalene, 1-methylnaphthaleen, and 2-methylnaphthalene); 1,2-dichloroethane (EDC); chloride; and total dissolved solids (TDS). As discussed above, hydrocarbon chloride contamination is also present updradient of the Site and some of the contamination detected in groundwater samples may originate from an offsite source. The same

COCs are also present in soil along with 1,2-dibromoethane, which was detected in one sample collected from an offsite location (i.e., MW-13).

The latest investigation, which was performed in May 2012, identified groundwater contamination that extends south and southeast (i.e., downgradient) from the Site to offsite properties owned by the New Mexico State Land Office and most likely to property owned by El Paso Natural Gas. The areal extent of the dissolved-phase plume has not been defined to the east, south, and west. The limits of the mobile LNAPL plume are undefined to the east of MW-03, and the exact boundary includes some uncertainty (Figure 2) (INTERA, 2012b).

The latest investigation also included LNAPL remediation feasibility testing consisting of a baildown/recovery test. This test indicated that the average LNAPL recovery rate is 1.02 gallons/day and the LNAPL transmissivity is 0.70 ft^2/day (INTERA, 2012b). This recovery rate and LNAPL transmissivity suggests that LNAPL recovery by skimming is not a viable remediation option (ITRC, 2009); consequently, INTERA recommended that an SVE system be implemented to remove LNAPL from the Site and adjoining properties. This report is a follow up to that recommendation.

Design of an SVE system to mitigate the on-site LNAPL contamination was started in August 2012; however, a decision was reached by OCD to discontinue remediation of sites in the area because of the lack of receptors and the widespread poor water quality. Reflecting this decision, INTERA received notice to cease work on the SVE system design on October 24, 2012 and prepare a report that summaries the status of the design. This information is provided below.

The work plan specified that the SVE design was to be divided into the following seven tasks (INTERA, 2012a):

- Task 1: Planning and Permitting
- Task 2: Well Field Design
- Task 3: Underground Piping System
- Task 4: Above-Ground System
- Task 5: Operation, Maintenance, and Performance Monitoring
- Tasks 6 and 7: Deliverables

Sections 2.0 through 5.0 of this report summarize the work performed to date on tasks 1 through 4. Since no work was performed on tasks 5 through 7, they are not addressed in this report.

2.0 PLANNING AND PERMITTING

Prior to the installation and operation/maintenance/monitoring (OMM) of the SVE system, a plan must be developed and approved by the OCD and permits must be received by various agencies. This document presents the plan for the installation and OMM of the system that will be submitted to OCD for approval. A discussion of permits required to install and operate the SVE system follows.

INTERA researched permitting and notification requirements specified by the New Mexico Office of the State Engineer (NMOSE), the New Mexico Environment Department (NMED) Air Quality Bureau (AQB), and local utility authorities. This section lists the forms and notices of intent to obtain requisite regulatory approvals.

2.1 NMOSE Well Permits

As a part of the installation of the SVE wells, it will be necessary to complete and submit to the NMOSE the "Application for Permit to Drill a Well with No Consumptive Use of Water" (form wr-07). Form wr-07 can be downloaded from the NMOSE website at: http://www.ose.state.nm.us/water_info_rights_apps_forms.html.

2.2 Notice of Intent to the NMED AQB

On October 16, 2012, Ms. Elizabeth Bisbey-Kuehn of the NMED AQB was contacted to discuss air permitting for SVE systems. As stipulated by the NMED AQB, a Notice of Intent (NOI) is required for any owner or operator intending to construct a new stationary source, which has a potential emission rate greater than 10 tons per year. Ms. Bisbey-Kuehn stated that most SVE remediation systems require an NOI.

A NOI requires the completion and submission of a Universal Application (UA) form, which consists of three parts: Part 1 (UA1) includes Section 1, General Facility Information; Part 2 (UA2) contains Section 2, Tables; and Part 3 (UA3) is the Attachments portion, which contains 21 Sections (Sections 3–23). NOI submittals must include hard copies of the following:

- Form UA1
- Tables 2A (Regulated Emission Sources), 2D (Maximum Emissions), and 2F (Additional Emissions during Startup, Shutdown, and Routine Maintenance)
- Section 3 (Application Summary)
- Section 23 (Certification Page with appropriate signatures)

The SVE emission rate for the Site would need to be calculated for the purpose of filling out the tables on the application. An accurate initial vapor concentration can be used to calculate the potential emission rate. It is recommended that an initial vapor sample be collected to determine the soil gas composition. The UA form files (UA1, UA2, and UA3) can be downloaded from the NMED AQB website at: http://www.nmenv.state.nm.us/aqb/permit/Permit_Apps/Permit_Apps_1_Universal_Application.html.

2.3 Permits from Local Municipal Authorities

Construction and operation of the SVE system will require building permits prior to obtaining electrical service. Building permits should be submitted to Lea County. Electrical service is provided to Monument by Southwestern Public Services Company, a division of Xcel Energy. Electrical service can be requested online at: https://www2.xcelenergy.com/webapp/InternetAppsWebApp/StartServiceCom.jsp.

3.0 SVE WELL FIELD DESIGN AND PREDICTED SOIL VAPOR FLOW RATES

The design of the SVE well field is based, primarily, on (1) the areal extent of the mobile LNAPL, (2) the subsurface interval containing the LNAPL, and (3) the predicted SVE well radius of influence (Ri). These parameters, along with estimated vapor extraction flow rate and wellhead vacuum are discussed below.

3.1 Areal and Vertical Extent of LNAPL

According to Site investigations conducted in 2009 and 2012, LNAPL covers approximately 5 acres; however, the on-site areal extent is estimated to be approximately 2 acres (INTERA, 2009, 2012b) (Figure 2). Future monitoring of LNAPL thicknesses in monitoring wells may reveal a larger areal extent and, in order to refine the limits of the LNAPL plume, additional information concerning the extent of the mobile LNAPL should be collected while installing the SVE wells.

Contamination was first encountered within the footprint of the LNAPL plume at a depth of approximately 10 ft bgs (INTERA, 2009). Given the soil descriptions from MW-02 and MW-03, which are located within the LNAPL plume footprint, and the high concentrations of total TPH in soil samples collected below 10 ft bgs in MW-02 and MW-03, it is likely that the entire interval below 10 ft to the water table (and below) is contaminated with high concentrations of hydrocarbons. This interval of gross soil contamination will be screened in the SVE wells resulting in an approximate 30 foot screen interval (10 ft bgs to 40 foot bgs, which is at or a couple of ft below the water table). This parameter should be further evaluated in light of the

remediation objective of only effecting LNAPL removal. Soil gas samples should be collected at discrete intervals to help evaluate optimum screen intervals.

3.2 Ri Analysis

The Ri was estimated based on the soil types, associated intrinsic permeability, and experience from other sites. As indicated in Figure 3, the 30 ft of screen proposed for the SVE wells will be within Stratigraphic Unit 2, which is composed of caliche (INTERA, 2009 and 2012b). This unit, in general, extends from approximately 6 ft bgs to just above the water table. Some SVE well screens will cross Stratigraphic Unit 3, which is composed of sandy clay and clayey sand.

The ability of the caliche in Unit 2 to transmit vapors is directly related to its intrinsic permeability (Johnson et al., 2009). Intrinsic permeability values were not measured at the Site, but are estimated to be on the order of 10^{-09} cm^2, which was used for design purposes. It should be noted that this value may vary largely due to the wide variety of materials that may be in caliche and the common existence of fractures.

The Ri is defined as the greatest distance from an extraction well at which a sufficient vacuum and vapor flow can be induced to adequately enhance the extraction of the contaminants in the soil. A pilot test is typically conducted to measure this parameter and a pilot test is recommended before this design is completed; however, a 15 to 30 foot Ri has been measured at sites with similar stratigraphy.

Given this range of estimated Ri values and the associated spacing between wells, which was calculated from the following equation,

$$L(spacing\ distance, ft) = 2 * Ri\ (ft) * \cos 30°$$

the number of wells was estimated by calculating the ratio of the areal extent of contamination within Site boundaries (i.e., approximately 2 acres) and the area of influence of a single SVE well. The result is depicted in Figures 4a-4d. As Table 3-1 below demonstrates, the Ri value significantly affects the number of wells needed.

Table 3-1
Wells Needed Based on Ri

Ri (ft)	L (ft)	Number of Wells Needed
15	26.0	161
20	34.6	83
25	43.3	59
30	52.0	40

A cost estimate was calculated for the installation of the well field based on the total depth of the well, depth to water at the Site, and an average unit cost per foot. Table 3-2 demonstrates the estimated costs for installing 4-inch SVE wells to a total depth of 40 ft bgs at $50/ft. Each 5-ft decrease in the Ri increases the cost by $40,000 until the point at which the Ri is halved, which increases the cost by a factor of 4.

Table 3-2
Cost Estimate for Well Installation Based on Ri

Ri (ft)	Number of Wells	Cost
15	160	$ 320,000
20	80	$ 160,000
25	60	$ 120,000
30	40	$ 80,000

As indicated in Tables 3-1 and 3-2, a slight change in Ri can have a huge impact in the total number of wells needed to cover the estimated areal extent of LNAPL. Because of this uncertainty, and associated cost affect, a pilot test is recommended so that Ri can be measured. A cost estimate to install nine, 1-inch diameter nested wells in three boreholes with varying screened intervals is provided in Appendix A. These wells would be installed near MW-2 or 3 which would be used as the pilot test extraction well.

For the proposed pilot test, we recommend renting a modular system consisting of an internal combustion engine that provides a vacuum source and emission control and associated flow meters, valves, sample ports, and safety controls. The test will be divided into two parts. The first part will consist of a series of "Quick Tests" (approximately 30 minutes) in which vapor will be extracted from MW-02, MW-03, and the 1-inch diameter wells. Vapor samples will be collected and flow rates and vacuums will be measured. Afterwards a longer term test will be conducted in which vapors are extracted from MW-02 or MW-03 and vacuum responses are measured in nearby observation wells. Vapor samples will be collected for analysis and measured in the field for VOC concentration and select samples will be analyzed at a laboratory for VOCs by EPA Method 8260B, fixed gases, and BTU content. The approximate cost of an SVE pilot test is $25,000. The detailed estimated costs for the pilot test are included in Appendix A.

An alternative to conducting both a pilot test and full system design based on empirical values would **be to conduct a field test that includes operating a smaller scale (5-6 wells) system**

with the empirical design parameters for a short amount of time, followed by design optimization.

3.3 Vapor Extraction Flow Rate

The vapor extraction flow rate is based, primarily, on intrinsic permeability of the soils and wellhead vacuum. The calculation set (including assumptions) that estimates this value is included in Appendix B. As indicated in Appendix B, assuming a screened interval of 30 ft, flow rates will likely range from 1 to 10 cubic feet per minute (cfm) per well (0.03 to 0.3 cfm/ft of screen). Because a wide range of intrinsic permeability values (specified as varying Ri values in the equation) were used in the equation, estimated vacuums also had a large range (i.e., 80 inches [6.7 ft] to 200 inches [16.7 ft] of water vacuum). The large uncertainty in the calculation of estimated flow rates and vacuums is further justification for performing a pilot test. This will provide for an optimal selection of vacuum sources and the volume of air to process.

4.0 SVE UNDERGROUND PIPING SYSTEM

To compensate for the large flow rate associated with a well field that contains many wells, well fields are typically separated into groups, or "circuits," that can be treated in cycles with the appropriate emission control device. A preliminary well field circuit was designed based on a 30-ft Ri and the Site layout as depicted in Figure 4d. Six SVE circuits are included in the preliminary well field layout. The underground piping design (e.g., piping material, diameter, valves, and metering) can be completed following the selection of the well field circuit layout. High density polyethylene piping will most likely be specified.

5.0 SVE ABOVE-GROUND SYSTEM

The above-ground design includes, but is not limited to, the emission control system and the power source. Based on the preliminary SVE circuit layout, three circuits would be operated at a time, likely using a thermal/catalytic oxidizer for emission control. Baker Furnace Inc., a regional vendor based in California, was contacted to discuss a typical 500-cfm thermal oxidizer modular system. Their system would be ready for installation and would include the necessary instrumentation and controls to meet air quality requirements. According to the technical specifications provided to INTERA (Clementz, 2012), the power requirement for an SVE system is 16 horsepower.

To assess the possibility of using solar power to operate the SVE system, INTERA calculated the power requirement and the amount of solar panels that would be needed. It was calculated that

52 kilowatts of photovoltaic power would be needed annually; therefore, a 3,800-ft^2 solar panel area would be required to provide the daily power demand at the Site, which equates to approximately 300 solar panels (panel size = 21.5 square ft) (See Appendix C).

6.0 SUMMARY AND CONCLUSIONS

This report presents the status of the design of an SVE system at the Site. A list of remaining tasks, as well as conclusions about the proposed pilot test and the use of solar power, are provided below:

- Remaining Activities – As of the reporting date, the following activities have yet to be completed:
    - Underground System Layout Design
        - Piping and Conveyance System/Drawings
        - Sump Locations
    - Above-Ground System Layout Design
        - Pump House Location/Equipment Enclosure
        - Power Drop Location
        - Valve Sampling Stations
    - Operation and Maintenance and Monitoring Planning
        - Schedule Development
        - Analysis
    - Electrical Work
        - Control System
        - Power Drops
        - Solar Power cost estimation
    - Air Abatement System Selection
- Prior to completing these activities, an SVE pilot test should be conducted so that Ri, vapor flow rate, extraction vacuums, and soil vapor content can be measured.

7.0 REFERENCES

Clementz, Mark, 2012. Personal Communication between Mr. Mark Clementz of Baker Furnace and Ms. Ashley Arrossa of INTERA. October 18.

INTERA, 2009. *Remedial Investigation and Removal Action Report, Former Enersource Facility, Monument, Lea County, New Mexico.* Prepared for New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division. December 4.

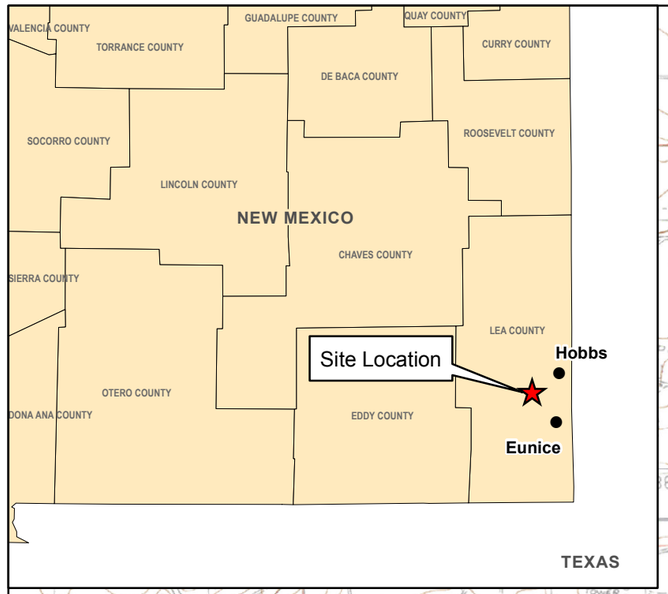
_____, 2012a. *Soil Vapor Extraction System Design Work Plan, Former Enersource Facility, Monument, Lea County, New Mexico*. August 16.

_____, 2012b. *2012 Site Investigation Report, Former Enersource Facility. Monument, Lea County, New Mexico.* Prepared for New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division. June 29.

ITRC, 2009. Evaluating LNAPL Remedial Technologies for Achieving Project Goals. December.

Johnson, P.C., C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart. 1990. "A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems." *Ground Water Monit*. Rev. 10 (2), 159-178.

FIGURES



Estimated Area Containing >10,000 mg/L of Chloride in Groundwater (Rice, 2011)

Versado Gas Processing Plant

El Paso Natural Gas Facility

Rice EME C-1 EOL Chloride Release

Monument

Monument

28 Well

N

S

0 1,000 2,000 4,000

Feet

USGS 7.5 Minute Topographic Map:
Monument North Quadrangle,
1985, Contour Interval 10 Feet;
Monument South Quadrangle,
1985, Contour Interval 5 Feet;
Hobbs West and Hobbs SW Quadrangles,
1969/revised 1979, Contour Interval 5 Feet
Site Location: NW¼ Sec. 1; T20S; R36E

Legend

- Property Boundary

WATERS Database Well Locations

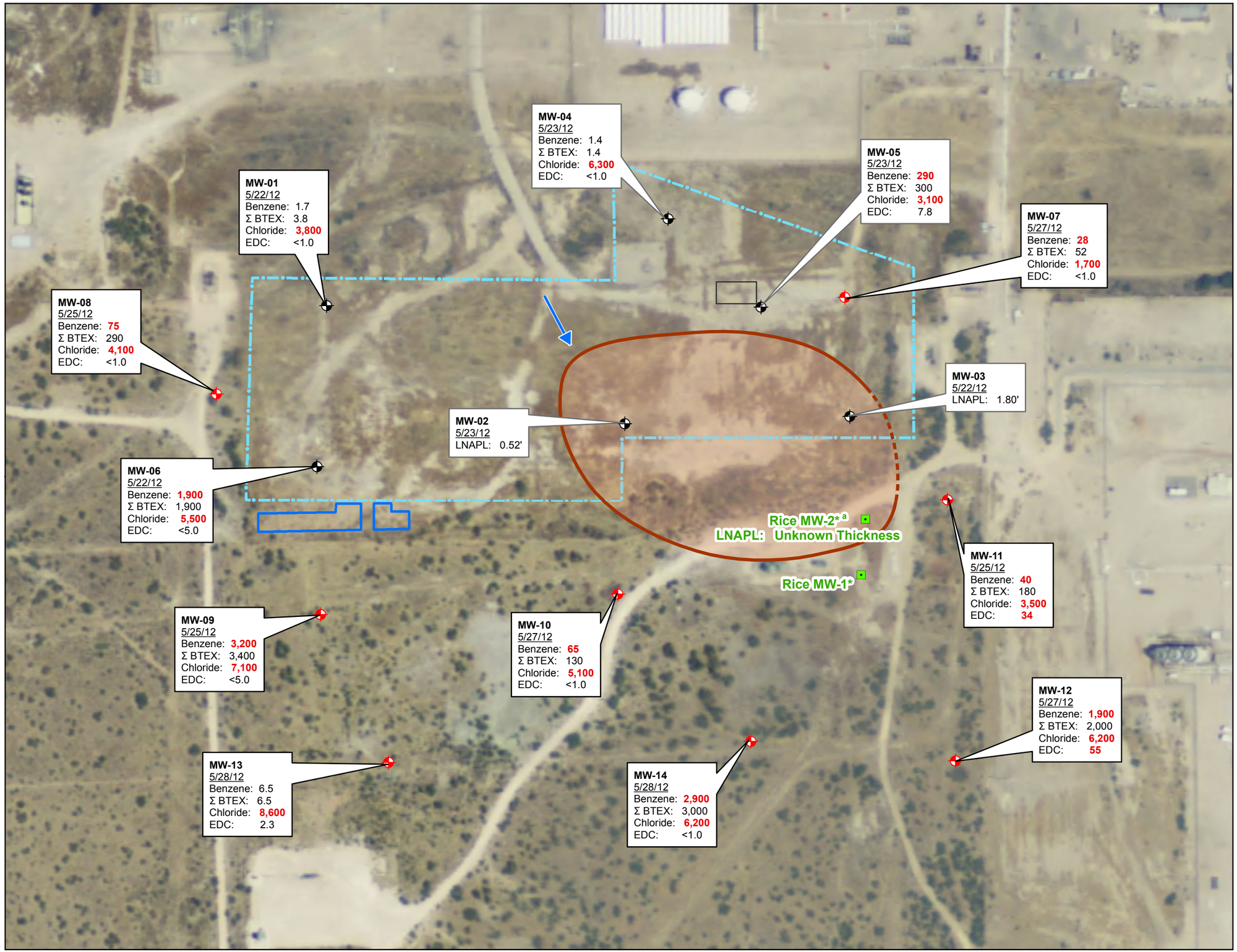
- DOM - Domestic
- PRO - Prospecting/Dev. of Natural Resources
- EXP - Exploration
- MUL - Multiple Domestic
- POL - Pollution Control
- STK - Livestock Watering
- IRR - Irrigation
- SAN - Sanitary

EstimatedClinGWFigure1

Source(s):
Wells – WATERS database, 2011;
Topos – MapTech/USGS.

Figure 1
Site Location Map
Former Enersource Facility
Monument, NM

Path: S:\Projects\OCD - Enersource Facility\graphics\Monument NM\GIS\Additional_Site_Charac\Fig01_LocationMap.mxd



N

S

0 80 160 320

Feet

Legend

- 2009 Monitoring Well Location
- 2012 Monitoring Well Location
- Monitoring Well Installed by Others
- Estimated Groundwater Flow Direction, May 2012
- Property Boundary
- Excavation Area
- Estimated Areal Extent of LNAPL
- (Dashed where Inferred)

Sample Location
Sample Date
Analyte: Result

Notes:
1. Results are in µg/L except Chloride (mg/L)
2. **Bold** indicates concentration above NMWQCC Standard
3. Σ BTEX = Sum of Benzene, Toulene, Ethyl benzene, and total Xylenes concentrations

* = Estimated locations based on field reconnaissance.

[a] = Presence of LNAPL is based on verbal information from OCD

Source(s): 2011 aerial photo – EDAC;
Property boundary/monitoring wells – John West Surveying Co., Hobbs, NM.

Figure 2
Distribution of Contaminants in Groundwater, May 2012
Former Enersource Facility
Monument, NM

Path: S:\Projects\OCD - Enersource Facility\graphics\Monument NM\GIS\Additional_Site_Charac\Fig14_GWContaminants.mxd

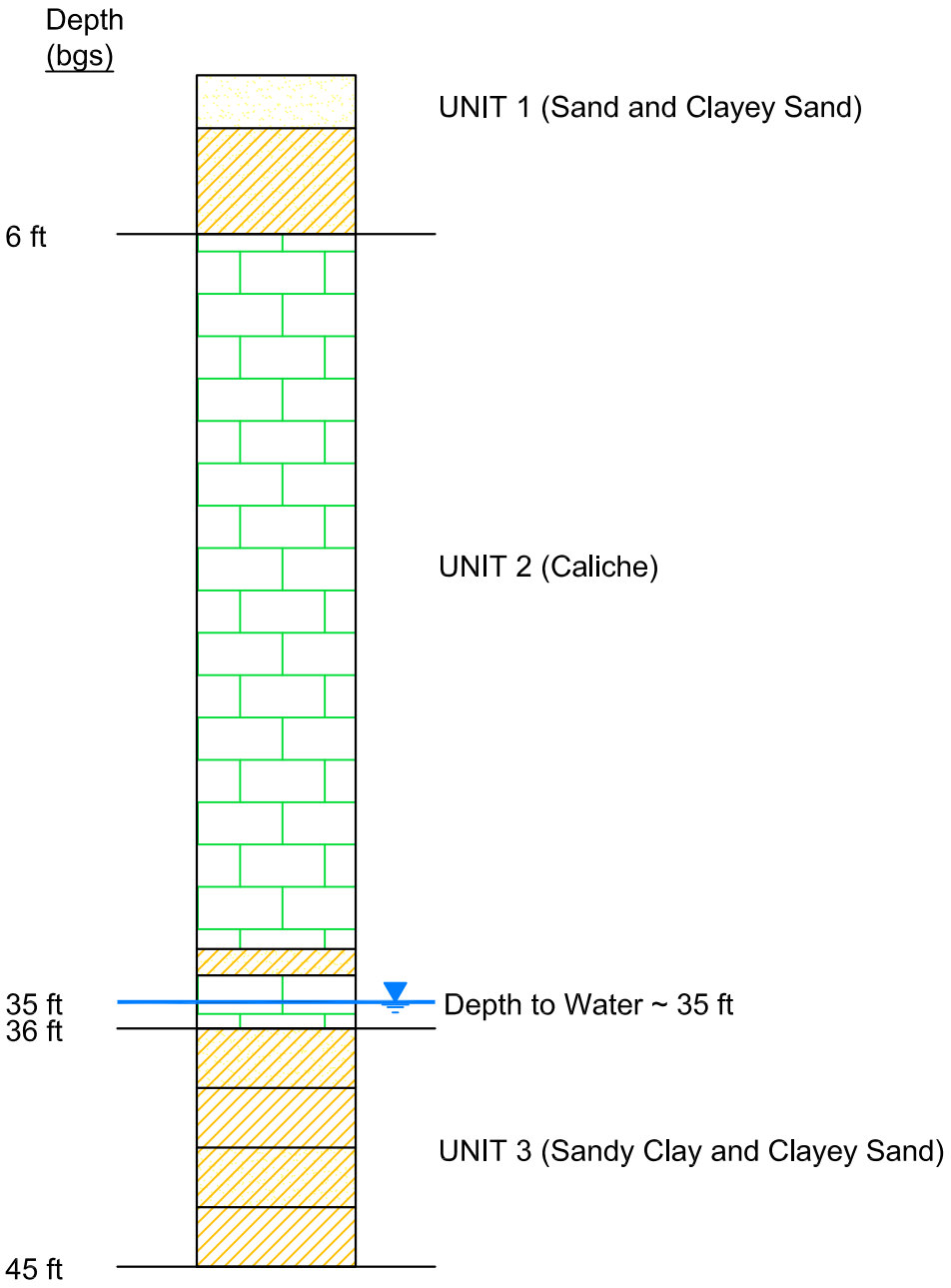
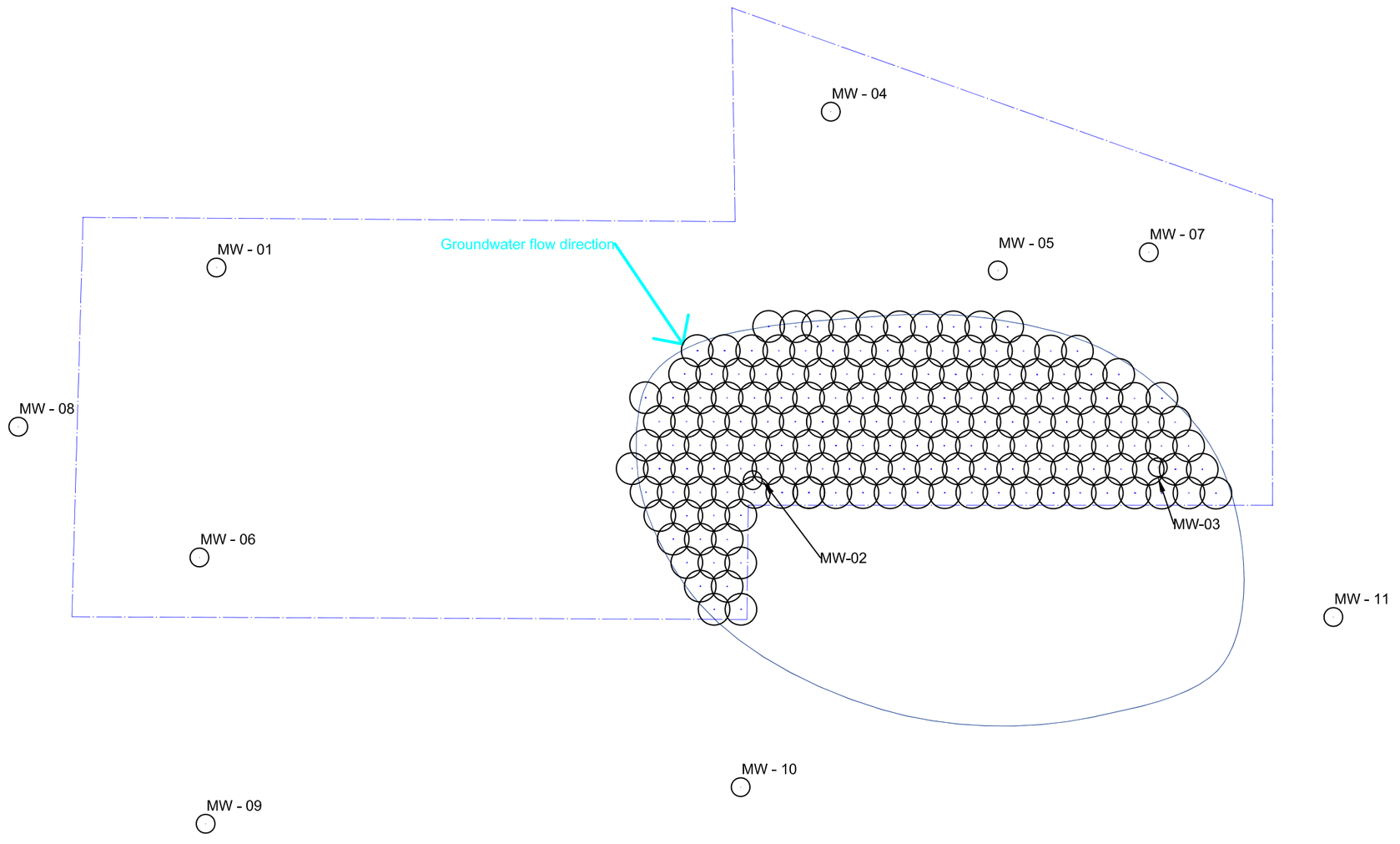
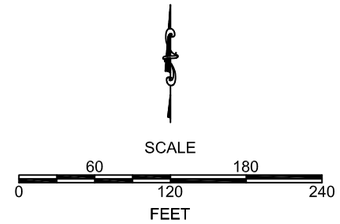


Figure 3
Generalized
Hydrostratigraphic Column
Enersource - SVE Design
Summary





LEGEND

15 ft ROI and SVE WELL

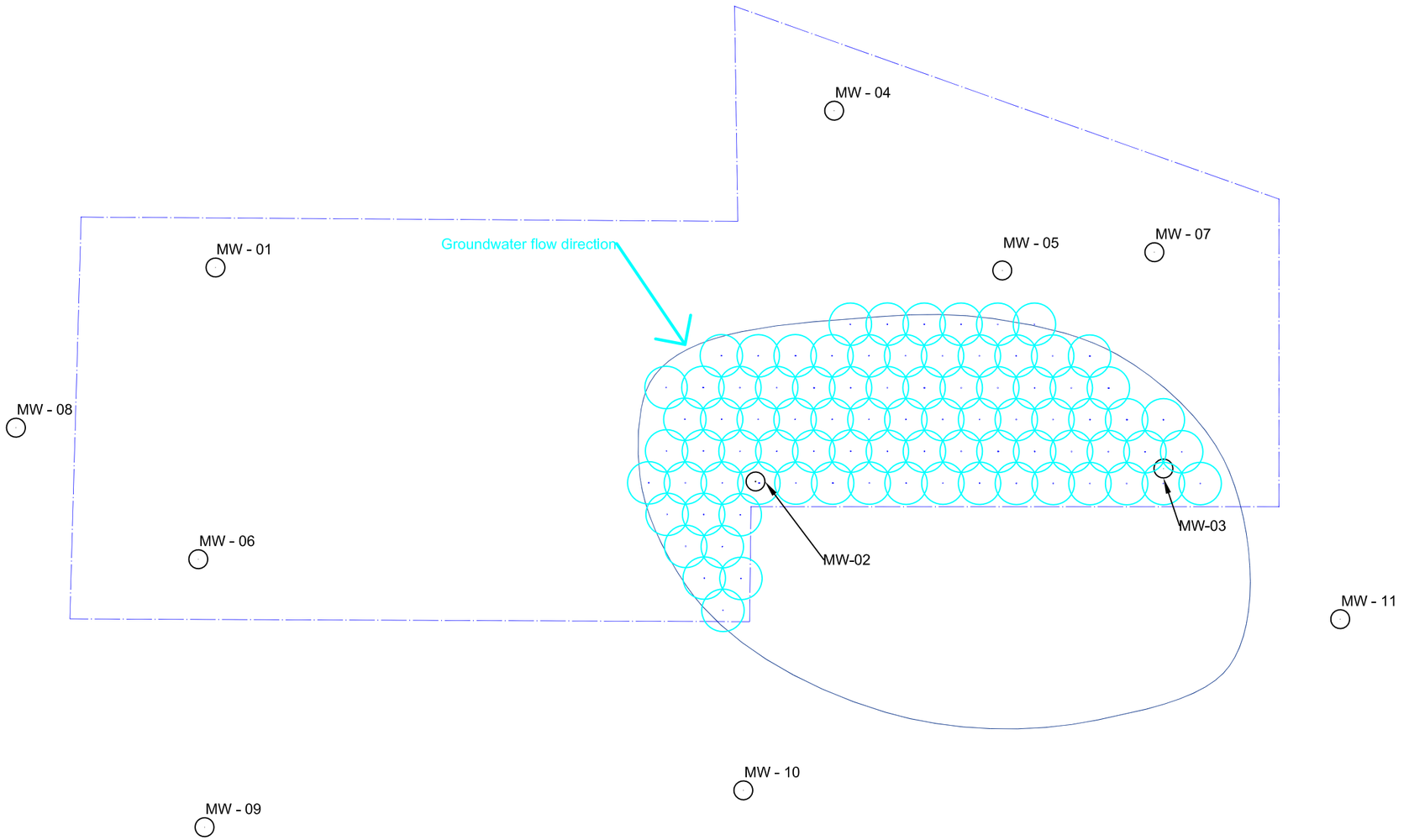
ESTIMATED LNAPL BOUNDARY

PROPERTY BOUNDARY

EXISTING SITE MONITORING WELL

Figure 4a
SVE Well Field - 15 ft
Radius of Influence
Former Enersource Facility
Soil Vapor Extraction Design Summary

S:\Projects\OCD - Enersource Facility\SVE System Design\Design\DWGs\120512SitePlan_ArchD_11x17.dwg



SCALE

60 180

0 120 240

FEET

LEGEND

20 ft ROI and SVE WELL

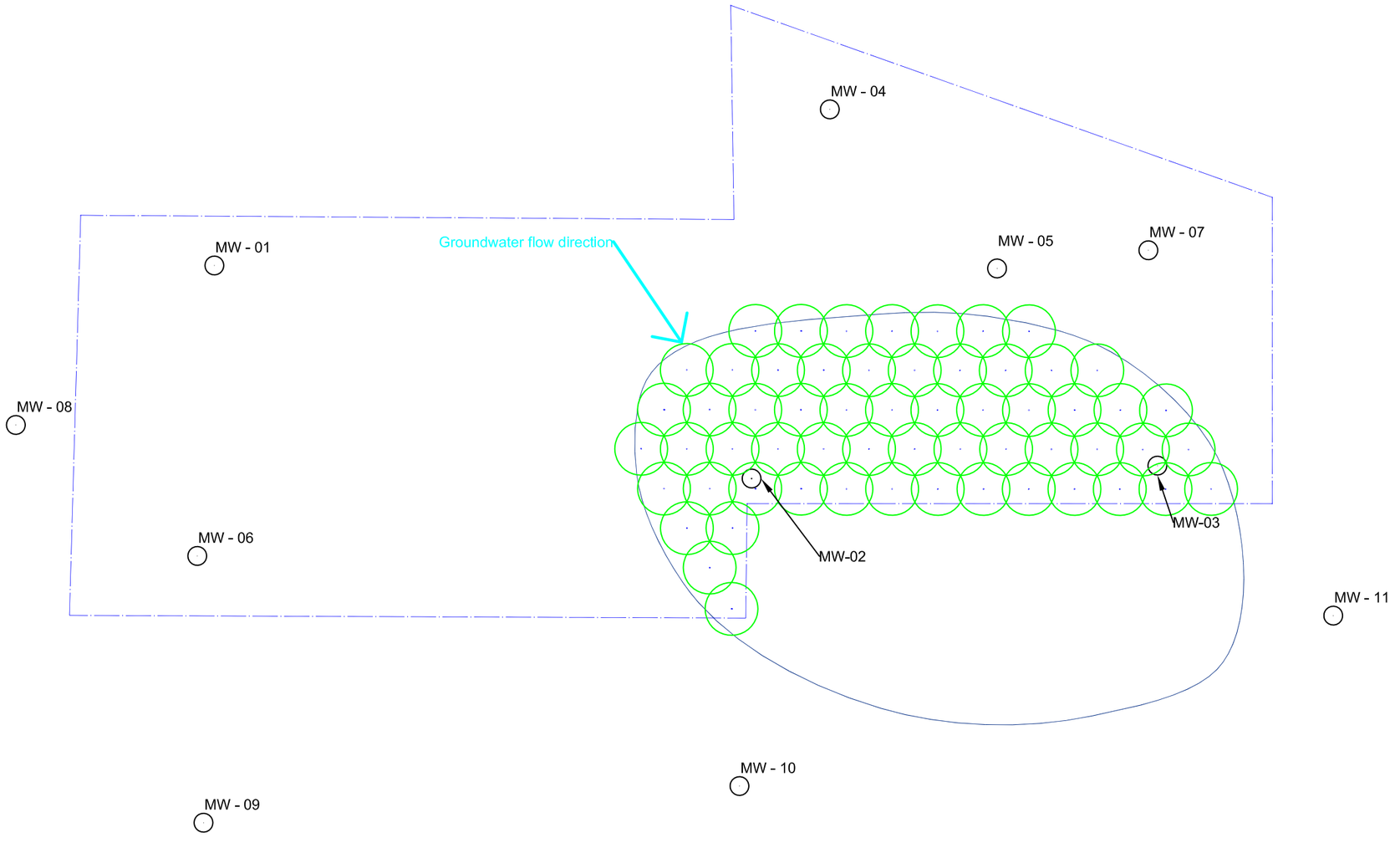
ESTIMATED LNAPL BOUNDARY

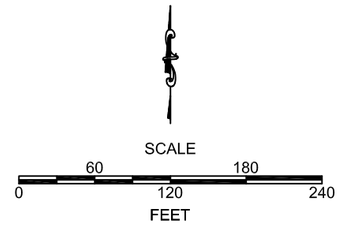
PROPERTY BOUNDARY

EXISTING SITE MONITORING WELL

Figure 4b
SVE Well Field - 20 ft
Radius of Influence
Former Enersource Facility
Soil Vapor Extraction Design Summary

S:\Projects\OCD - Enersource Facility\SVE System Design\Design\DWGs\120512SitePlan_ArchD_11x17.dwg





LEGEND

25 ft ROI and SVE WELL

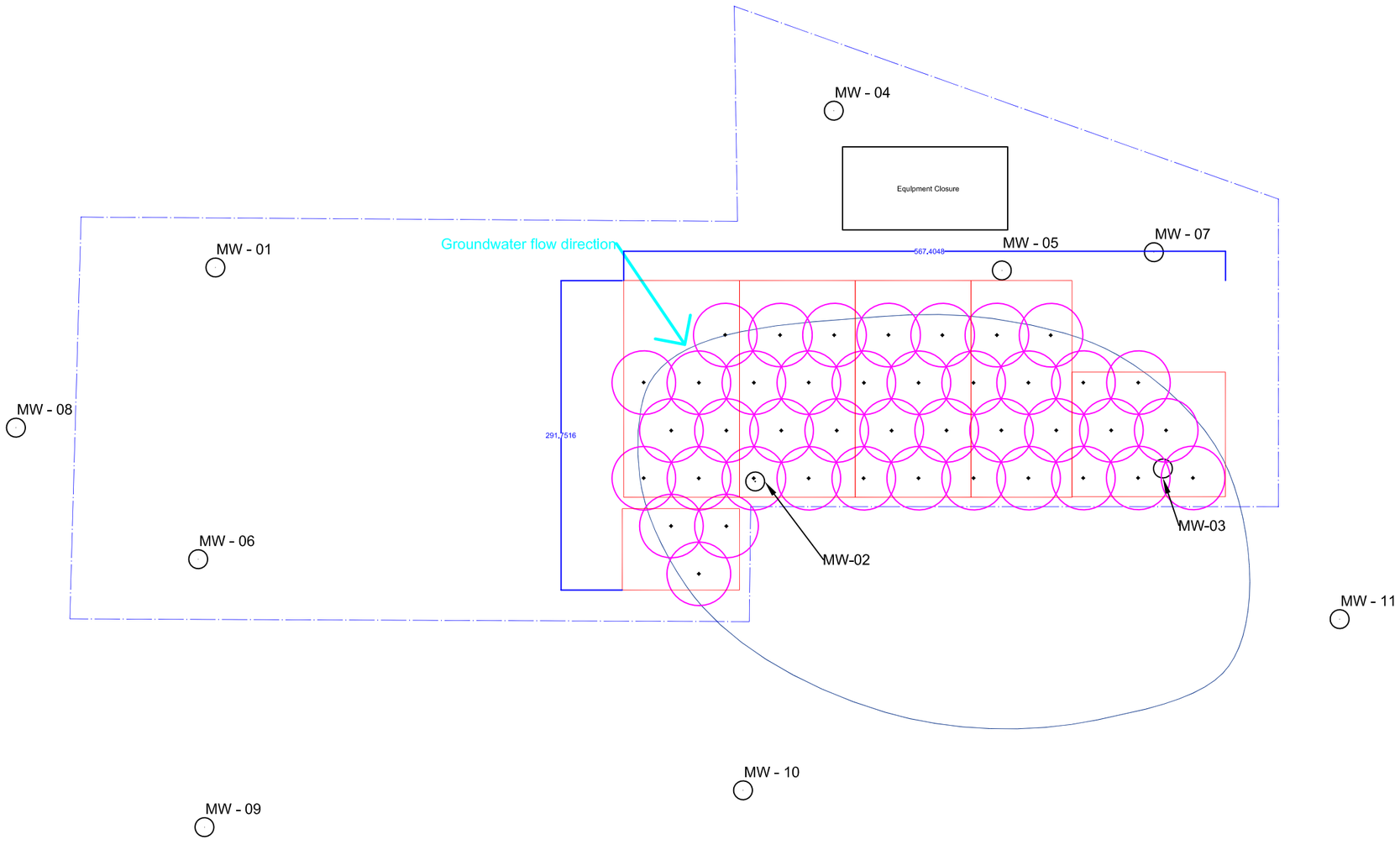
ESTIMATED LNAPL BOUNDARY

PROPERTY BOUNDARY

EXISTING SITE MONITORING WELL

Figure 4c
SVE Well Field - 25 ft
Radius of Influence
Former Enersource Facility
Soil Vapor Extraction Design Summary

S:\Projects\OCD - Enersource Facility\SVE System Design\Design\DWGs\120512SitePlan_ArchD_11x17.dwg



SCALE

0 60 120 180 240

FEET

LEGEND

30 ft ROI and SVE WELL

PROPOSED WELL CIRCUIT

ESTIMATED LNAPL BOUNDARY

PROPERTY BOUNDARY

EXISTING SITE MONITORING WELL

Figure 4d
SVE Well Field - 30 ft
Radius of Influence
Former Enersource Facility
Soil Vapor Extraction Design Summary

S:\Projects\OCD - Enersource Facility\SVE System Design\Design\DWGs\120512SitePlan_ArchD_11x17.dwg

APPENDIX A

Pilot Test Cost Estimate

Appendix A
Cost Estimate for Soil Vapor Extraction Pilot Test
SVE Design Summary -- Former Enersource Facility
Monument, Lea County, New Mexico

TASK : SVE PILOT TEST		
INTERA LABOR	$	3,160.00
EXPENSES	$	1,990.50
SUBCONTRACTED SERVICES	$	18,169.50
TOTAL	**$**	**23,320.00**

TOTAL: ALL TASKS	**$**	**23,320.00**
NMGRTX (7.0%)	**$**	**1,632.40**
GRAND TOTAL: ALL TASKS	**$**	**24,952.40**

Labor rates taken from State of New M Advance three HAS bores to 40'

NOTES: 1) If a lab analysis is not performed, the cost will be reduced by $150 per sample.

2) If SVE pilot test is extended for 1 day, cost will increase by $6,340 (includes NMGRT)

3) Once on Site, if the test is delayed, AcuVac mobilization ($760), mileage ($1,638), per diem ($110 per person), and NMGRT will be charged.

Appendix A
Cost Estimate for Soil Vapor Extraction Pilot Test
SVE Design Summary -- Former Enersource Facility
Monument, Lea County, New Mexico

			Task 1		Tasks 2 and 3		Task 4		Task 5		Total: Task 1-5	
Labor			Work Plan Prep		SVE Pilot Test and Groundwater Monitoring		Reporting		Groundwater Monitoring			
	Rate	**Units**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**
Principal	$150	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Senior Scientist	$110	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Staff Engineer/Scientist	$79	Hours		$0.00	40	$3,160.00		$0.00		$0.00	40	$3,160.00
Draftsperson	$69	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Administrator	$75	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Labor Subtotal				**$0.00**		**$3,160.00**		**$0.00**		**$0.00**		**$3,160.00**
Subcontractors												
Drilliing												
Mobilization/Demobilization/Project Coordination/Suppor Vehicle/PerDiem/Clean-up	$5,100	Each		$0.00	1	$5,100.00		$0.00		$0.00	1	$5,100.00
Advance three HAS bores to 40'	$32	ft		$0.00	120	$3,840.00		$0.00		$0.00	120	$3,840.00
Sample by CC barrel	$4	ft		$0.00	120	$420.00		$0.00		$0.00	120	$420.00
Install nine nested wells	$34	ft	0	$0.00	114	$3,876.00		$0.00		$0.00	114	$3,876.00
Drum Cuttings	$60	Each			15	$900.00		$0.00		$0.00		
Well Head Completions	$500	Each			3	$1,500.00		$0.00		$0.00		
Laboratory												
Air - TPH - GRO (8015B)	$70	Each		$0.00	1	$70.00		$0.00		$0.00	1	$70.00
Air - VOCs (8260B)	$120	Each		$0.00	1	$120.00		$0.00		$0.00	1	$120.00
Groundwater VOCs	$120	Each		$0.00		$0.00		$0.00		$0.00	0	$0.00
AcuVac Remediation	$4,295	Day	0	$0.00	1	$4,295.00		$0.00		$0.00	1	$4,295.00
XiTech Cap	$100	Each		$0.00		$0.00		$0.00		$0.00	0	$0.00
Fee	10%	%	$0.00	$0.00	$4,485.00	$448.50		$0.00		$0.00	4485	$448.50
Subcontractor Subtotal				**$0.00**		**$20,569.50**		**$0.00**		**$0.00**		**$18,169.50**
Direct Expenses												
Gas Detection and Sampling Eq (PID, sampling pump)	$70	Day		$0.00	4	$280.00		$0.00		$0.00	4	$280.00
Misc field Eq (hand tools, sampling tools, cell phone, digital camera, GPS, interface probe, etc.)	$75	Day		$0.00	4	$300.00		$0.00		$0.00	4	$300.00
Water Quality equipment - YSI, and pump*	$90	Day		$0.00	4	$360.00		$0.00		$0.00	4	$360.00
Expendable Field Eq (Nitrogen, Tedlar bags, twine, etc.)	$70	Day		$0.00	4	$280.00		$0.00		$0.00	4	$280.00
Per Diem	$95	Each		$0.00	4	$380.00		$0.00		$0.00	4	$380.00
Partial Per Diem	$30	Day		$0.00		$0.00		$0.00		$0.00	0	$0.00
Vehicle Rental	$55	Day		$0.00		$0.00		$0.00		$0.00	0	$0.00
Mileage	$0.55	Mile		$0.00	710	$390.50		$0.00		$0.00	710	$390.50
Expenses Subtotal				**$0.00**		**$1,990.50**		**$0.00**		**$0.00**		**$1,990.50**
				$0.00		$25,720.00		$0.00		$0.00		$23,320.00

Subtotal	**$23,320.00**
NM GR Tax	**$1,632.40**
Project Total	**$24,952.40**

Appendix A
Cost Estimate for Soil Vapor Extraction Pilot Test
SVE Design Summary -- Former Enersource Facility
Monument, Lea County, New Mexico

			Task 1		Tasks 2 and 3		Task 4		Task 5		Total: Task 1-5	
Labor			Work Plan Prep		SVE Pilot Test and Groundwater Monitoring		Reporting		Groundwater Monitoring			
	Rate	**Units**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**	**Units**	**Price**
Principal	$150	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Senior Scientist	$110	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Staff Engineer/Scientist	$79	Hours		$0.00	50	$3,950.00		$0.00		$0.00	50	$3,950.00
Draftsperson	$69	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Administrator	$75	Hours		$0.00		$0.00		$0.00		$0.00	0	$0.00
Labor Subtotal				**$0.00**		**$3,950.00**		**$0.00**		**$0.00**		**$3,950.00**
Subcontractors												
Drilliing												
Mobilization/Demobilization/Project Coordination/Suppor Vehicle/PerDiem/Clean-up	$5,100	Each		$0.00	1	$5,100.00		$0.00		$0.00	1	$5,100.00
Advance three HAS bores to 40'	$32	ft		$0.00	120	$3,840.00		$0.00		$0.00	120	$3,840.00
Sample by CC barrel	$4	ft		$0.00	120	$420.00		$0.00		$0.00	120	$420.00
Install nine nested wells	$34	ft	0	$0.00	114	$3,876.00		$0.00		$0.00	114	$3,876.00
Drum Cuttings	$60	Each			15	$900.00		$0.00		$0.00		
Well Head Completions	$500	Each			3	$1,500.00		$0.00		$0.00		
Laboratory												
Air - TPH - GRO (8015B)	$70	Each		$0.00	1	$70.00		$0.00		$0.00	1	$70.00
Air - VOCs (8260B)	$120	Each		$0.00	1	$120.00		$0.00		$0.00	1	$120.00
Groundwater VOCs	$120	Each		$0.00		$0.00		$0.00		$0.00	0	$0.00
AcuVac Remediation	$4,295	Day	0	$0.00	2	$8,590.00		$0.00		$0.00	2	$8,590.00
XiTech Cap	$100	Each		$0.00		$0.00		$0.00		$0.00	0	$0.00
Fee	10%	%	$0.00	$0.00	$8,780.00	$878.00		$0.00		$0.00	8780	$878.00
Subcontractor Subtotal				**$0.00**		**$25,294.00**		**$0.00**		**$0.00**		**$22,894.00**
Direct Expenses												
Gas Detection and Sampling Eq (PID, sampling pump)	$70	Day		$0.00	5	$350.00		$0.00		$0.00	5	$350.00
Misc field Eq (hand tools, sampling tools, cell phone, digital camera, GPS, interface probe, etc.)	$75	Day		$0.00	5	$375.00		$0.00		$0.00	5	$375.00
Water Quality equipment - YSI, and pump*	$90	Day		$0.00	5	$450.00		$0.00		$0.00	5	$450.00
Expendable Field Eq (Nitrogen, Tedlar bags, twine, etc.)	$70	Day		$0.00	5	$350.00		$0.00		$0.00	5	$350.00
Per Diem	$95	Each		$0.00	5	$475.00		$0.00		$0.00	5	$475.00
Partial Per Diem	$30	Day		$0.00		$0.00		$0.00		$0.00	0	$0.00
Vehicle Rental	$55	Day		$0.00		$0.00		$0.00		$0.00	0	$0.00
Mileage	$0.55	Mile		$0.00	730	$401.50		$0.00		$0.00	730	$401.50
Expenses Subtotal				**$0.00**		**$2,401.50**		**$0.00**		**$0.00**		**$2,401.50**
				$0.00		$31,645.50		$0.00		$0.00		$29,245.50

Subtotal	**$29,245.50**
NM GR Tax	**$2,047.19**
Project Total	**$31,292.69**

REQUEST FOR QUOTE:

EMAIL QUOTES TO: jgalemore@intera.com

aarrossa@intera.com

INTERA CONTACT: Joe Galemore- (505) 246-1600 x 1211

Ashley Arrossa - (505) 246-1600 x 1220

Fax Number - (505) 246-2600

INTERA Incorporated (INTERA)

6000 Uptown Blvd. Suite 220

Albuquerque, NM 87110

JOB IDENTIFICATION: Enersource SVE Pilot Test, Lea County, New Mexico

LOCATION: The area of investigation, is located in the northwest quarter of Section 1, Township 20 South, Range 36 East, in Lea County, New Mexico; approximately 3 miles southwest of Monument, NM (see Figure 1).

SCOPE OF WORK:

Drilling Services will include (1) hollow-stem auger drilling, (2) soil sampling, and (3) the installation of nine nested wells (three boreholes):

(1) Three soil borings will be advanced at the Site. A qualified INTERA geologist or engineer will be onsite to direct the drilling operations, log the borings, and collect material for laboratory analyses.

(2) At the direction of the on-site INTERA geologist/engineer, the driller will collect material samples through the augers using a five foot continuous core sampler.

(3) Additionally, three 1" ID wells, (shallow, medium, and deep) will be installed in each borehole (See Figure 2) at various screened intervals.

All down-hole equipment must be steam cleaned prior to use and in between drilling each monitoring well borehole.

ASSUMPTIONS:

- All materials and equipment needed to complete the scope of work shall be provided by the bidder unless otherwise indicated.
- All personnel must be OSHA 40-hour HAZWOPER certified (with current training) and be able to provide documentation on request. The contractor shall provide all necessary PPE for its employees.
- Utilities will be located by INTERA prior to construction activities.
- **No** potable water is available on site; water necessary for drilling activities will need to be provided by the driller.
- Use of additives, including water, must be approved by INTERA.
- Drill cuttings and fluids generated during drilling will be placed in 55-gallon drums and staged in an area on-Site. Drums to be provided by drilling contractor.
- The drilling contractor shall be responsible for the security of its own equipment. The property owner, INTERA, or other parties will not be responsible for vandalized or stolen equipment or materials.
- The drilling contractor must secure and remove all process generated trash from the site on a daily basis.
- The drilling contractor is responsible for preparing and submitting drilling records to the New Mexico Office of the State Engineer.

Please provide unit costs for the following:

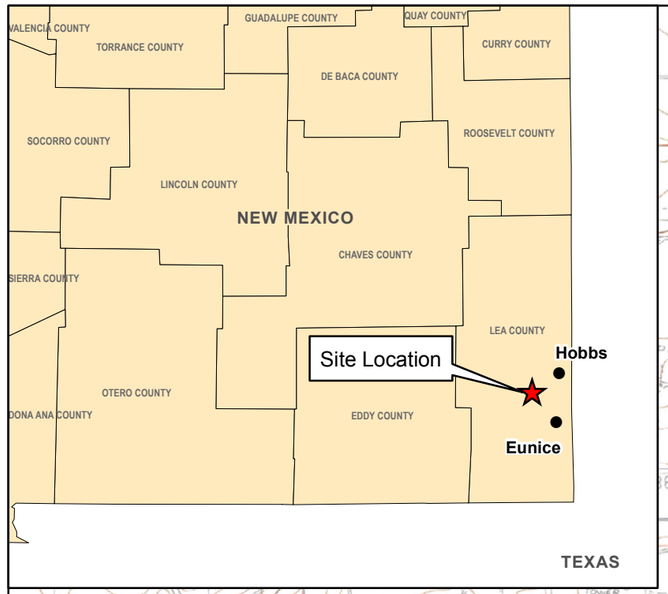
- Mobilization/demobilization (lump sum)
- Hourly rates and statement of conditions for stand-by time

- Footage rates for drilling
- Footage rate for well installation
- Well head completion as described (lump sum per well)
- Estimated time to completion

Thank you for taking the time to respond. Please contact Joe Galemore or myself with any questions or comments.

Regards,

Ashley Arrossa



Estimated Area Containing >10,000 mg/L of Chloride in Groundwater (Rice, 2011)

Versado Gas Processing Plant

El Paso Natural Gas Facility

Rice EME C-1 EOL Chloride Release

Monument

Monument

28 Well

N

S

0 1,000 2,000 4,000

Feet

USGS 7.5 Minute Topographic Map:
Monument North Quadrangle,
1985, Contour Interval 10 Feet;
Monument South Quadrangle,
1985, Contour Interval 5 Feet;
Hobbs West and Hobbs SW Quadrangles,
1969/revised 1979, Contour Interval 5 Feet
Site Location: NW¼ Sec. 1; T20S; R36E

Legend

- Property Boundary

WATERS Database Well Locations

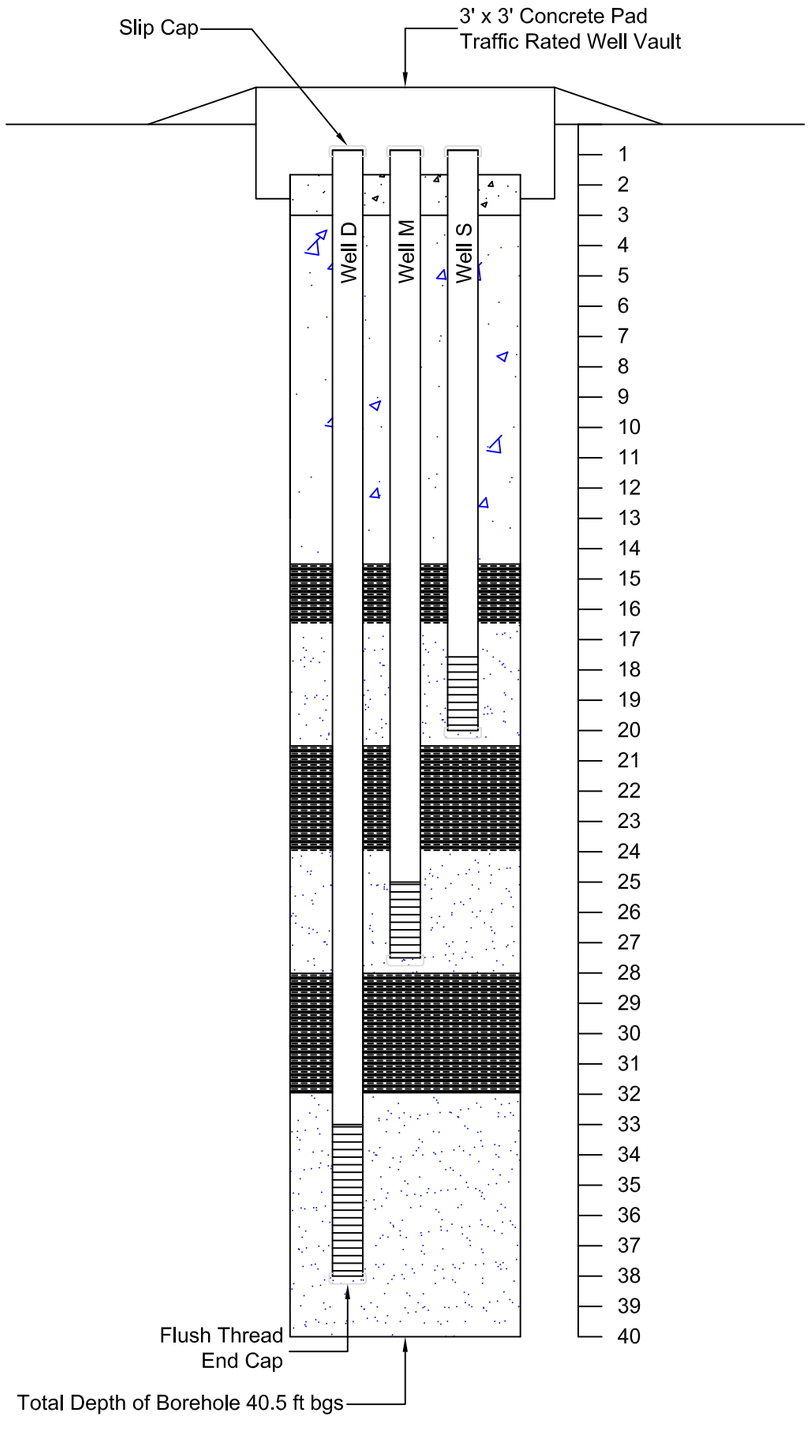
- DOM - Domestic
- PRO - Prospecting/Dev. of Natural Resources
- EXP - Exploration
- MUL - Multiple Domestic
- POL - Pollution Control
- STK - Livestock Watering
- IRR - Irrigation
- SAN - Sanitary

EstimatedClinGWFigure1

Source(s):
Wells – WATERS database, 2011;
Topos – MapTech/USGS.

Figure 1
Site Location Map
Former Enersource Facility
Monument, NM

Path: S:\Projects\OCD - Enersource Facility\graphics\Monument NM\GIS\Additional_Site_Charac\Fig01_LocationMap.mxd



Well S
0 ft bgs to 3 ft bgs Cement
3 ft bgs to 14.5 ft bgs Cement/Bent mix
14.5 ft bgs to 16.5 ft bgs Bentonite
16.5 ft bgs to 20.5 ft bgs Sand Pack

Well M
20.5 ft bgs to 24 ft bgs Bentonite
24 ft bgs to 27.5 ft bgs Sand Pack

Well D
27.5 ft bgs to 32 ft bgs Bentonite
32 ft bgs to 38.5 ft bgs Sand Pack

LEGEND

- Cement Grout
- 94% Cement 6% Bentonite Mix
- #6 or #8 mesh Bentonite Seal
- $\frac{10}{20}$ Gradation Sand Pack

Casing (Spaced at least 1" apart)

Well S 0 ft bgs to 20 ft bgs
Diameter 1.0"
Material: PVC

Well M 0 ft bgs to 27.5 ft bgs
Diameter 1.0"
Material: PVC

Well D 0 ft bgs to 38 ft bgs
Diameter 1.0"
Material: PVC

Screen Interval

Well S 17.5 ft bgs to 20 ft bgs
with flush thread end cap
Slot Size: 0.02"
Diameter 1.0"
Material: PVC

Well M 25 ft bgs to 27.5 ft bgs
with flush thread end cap
Slot Size: 0.02"
Diameter 1.0"
Material: PVC

Well D 33 ft bgs to 38 ft bgs
with flush thread end cap
Slot Size: 0.02"
Diameter 1.0"
Material: PVC

Borehole Diameter: 10 1/4"

Figure 2
Nested Well
Configuration
Profile View
Enersource - SVE Pilot Test

C:\Users\aarrossa\Documents\Working CAD\NestedWells.dwg

PRECISION

PROPOSAL

Presented to:

Company: Intera Albuquerque, NM
Ashley Arrossa: 505 246 1600 ext 1220
6000 Uptown Blvd Suite 220
Project: Enersource SVE Pilot Test
Location: Lea County, NM
Date: 10/17/12

Approximate commencement date: November 2012

RATE SCHEDULE AND PROVISIONS

A. The drill site will be located by an authorized representative of **Intera ,** herein referred to as the client. Precision Sampling Inc. agrees to furnish, pay for, and provide at the site any and all labor, materials, tools, equipment, bits, power, and any other items necessary for this project at the rates and charges that follow:

		QTY	Unit	Price	Estimate
1.	Mobe/Demobe/Prep	1	ls	$4,824	$4,824
2.	Drill and Sample 6-1/4" ID HSA	121.5	lf	$19.75	$2,399.63
3.	Install 3-1" Nested Wells	121.5	lf	$19.75	$2,399.63
4.	12"x12" Flush Mount Well Vault	3	ea	$325	$975
5.	55 Gallon Drums	16	ea	$65	$1040
6.	Support Truck	6	ea	$160	$960
7.	Per Diem	5	ea	$260	$1,300
8.	Mobile Decon Unit	1	ls	$350	$350
9.	Standby (Per Crew) Sample Time	**0**	hr	$221	$0

Estimated Total: $ 14,248.26

B. Materials provided by the client

Materials and/or services to be provided by the client, free of cost to Precision Sampling Inc., include:

1. Site Map (Location of Soil Borings)
2. Site Access
3. Adequate Support For Line Locates (Mark Boring Locations Before One Call)

C. Personnel: (1) 2 Man Crew

D. Work Schedule: Work to be completed in (6) 12 hour days (including Mobe/Demobe)

E. Equipment :

1. 2006 CME 75 Truck Mounted Drill Rig
2. 2006 Chevy 4500 Support Truck w/ Welder/Generator, Fuel Tank and Water Tank.

F. Precision Sampling Inc. (Precision) certifies that we are licensed to work in the state of NM.

G. It will be the client's responsibility to construct drill roads and drill sites free of cost to Precision. Any environmental responsibility relating to the construction, use, or reclamation of the same shall be the responsibility of the client.

H. It will be the clients responsibility to provide at its own expense all rights of way, both of ingress and egress, and the peaceable procession of all real property upon which all necessary temporary buildings, drill rigs and other facilities or equipment may be erected or placed and to hold Precision harmless for any and all damages, claims, costs, or charges of whatsoever kind or character incident to the occupation and use of said real property.

I. It will be the client's responsibility to furnish a representative to advise Precision as to the depth and location of drill holes. That person is, **Ashley Arrossa** .

J. All licenses, land and water use permits, environmental reports, state reports relating to hole plugging, utility locates, etc.; shall be the responsibility of the client.

K. Assuming that access is suitable and all necessary permits are obtained, Precision will drill at the locations and to the depth specified by the client's representative provided the subsurface conditions are as specified and shall be held harmless from and against all costs and liabilities which may arise from any change in access, site or subsurface conditions under this contract.

Precision will enforce strict discipline and maintain good order among its employees as well as enforce good housekeeping practices at the drill site.

L. Precision will conduct its operations in a satisfactory and professional manner, and will take every reasonable effort to conduct its operation in the best interest of the client. Precision will enforce strict discipline and maintain good order among its employees.

M. Precision, representing itself as a competent contractor, will, provided the sub-surface and site conditions are as represented, endeavor to complete each hole to the specified depth. If site or sub-surface conditions are such to preclude the advancement of the drill hole due to water, ground or sub surface conditions where the risk of damaging the drill rig, losing pipe and tooling or risk to the safety of the crew becomes greater than under normal drilling conditions, Precision reserves the right, without prejudge, to discontinue drilling operations. Should the client wish to proceed with drilling operations, the client shall execute a change order and assume responsibility for any and all drill pipe tooling lost or abandoned in the drill hole.

N. Statements will be rendered as promptly as possible at the conclusion of work period and shall be substantiated by the driller's weekly records. Terms will be net 30 days. In the event payment is not made within this period, a service charge of 2% per month, or the maximum permitted by law, whichever is lower, will be charged. The service charge will be computed from the due date to the date payment is received.

O. The foregoing prices, cost, and provisions are firm for a period of 30 days from the date of this proposal, at which time, if the contract has not yet been accepted; Precision reserves the right to revise any prices or conditions of this offer.

P. Prior to commencement of the project, Precision will submit to the client certificates of insurance in the specified amounts.

Q. This proposal is subject to rig availability. Should Precision's proposal be accepted by the client, we ask that this office be contacted for availability of crew and equipment before awarding the project.

Customer

_____

Customer Representative

_____

Date

RODGERS ENVIRONMENTAL SERVICES, INC.

2615 ISLETA BLVD SW • ALBUQUERQUE, NM 87105 • 505-877-1030 • FAX: 505-877-1105

October 16, 2012

Ashley Arrossa
Intera Corp
6000 Uptown Blvd., Suite 100
Albuquerque, NM 87110

re: cost proposal for SVE Pilot Test, Enersource,

Dear Ms. Arrossa:

Thank you for requesting pricing for installation of three nested SVE completions in Monument, NM. Our proposal includes mobilization, drilling, decon, sampling, well completion, and cleanup. We believe there is a good chance we can drill the bores with hsa, but if we encounter refusal, we would be prepared to drill a pilot by air rotary and ream with the auger.

Item	Description	Qty.	Units	Unit Price	Amount
1	Mobilization/Demobilization / Project Coordination / Support Vehicle / Diem / Clean-up	1	ls	$5,100.00	$5,100.00
2	Advance three (3) 10" hollow stem auger bores to approximatley 40'. Includes option to drill initial pass w/ small auger for caliche and continuous core sampling	120	ft	$32.00	$3,840.00
3	Sample by continuous core barrel	120	ft	$3.50	$420.00
4	Installing nine (9) 1" nested SVC wells in three bores to approximatley 38'. Sched 40 PVC flush-thread casing and 0.020" slot screen per plan. Annular fill consisting of 10/20 silica sand, granular bentonite plugs, and bentonite-cement grout to surface.	114	ft	$34.00	$3,876.00
5	Drum cuttings	15	ea	$60.00	$900.00
6	Well head completion (12x12 bolt down traffic rated cover and 3' x 3' concrete slab)	3	ea	$500.00	$1,500.00
	Bid Price				$15,636.00
7	alternate price if air-rotary pilot holes are required to penetrate hard pan	0	ft	$ 26.00	$0.00

Prices are based on drilling boreholes with CME 75 rig by the HSA method. Refusal due to boulders or bedrock would relieve Rodgers Environmental from performing under the listed prices. Prices do not include site access, traffic control, removal or disposal of work-derived wastes, permits, repair of mis-located utilities, or any applicable gross receipts tax. Prices subject to change if not accepted within 15 days. We expect the work scope will require 3 days.

RODGERS ENVIRONMENTAL SERVICES, INC.
Jeff Watson

xc: file

APPENDIX B

SVE Well Field Unit Flow Rate Calculation Set

1. Purpose

The purpose of this calculation set is to determine the extraction flow rate per unit length (Q/h in CFM/ft of screen) in a soil vapor extraction (SVE) system for the former Enersource facility (located in Monument, Lea County, NM) performed for the New Mexico Energy, Minerals, and Natural Resources Department, Oil Conservation Division (OCD) using assumed values provided by the client, Jim Griswald, and empirical values based on soil properties. This information is intended to serve as an alternative to a pilot test, or as a basis prior to a pilot test.

The design flow rate can in turn be used to size the blower for the SVE system, and predict power usage at the Site.

2. Background

The Site is contaminated with LNAPL throughout the vadose zone. The extent of groundwater contamination was been estimated using data from two existing groundwater monitoring wells, MW-02 and MW-03. MW-02 contains 0.52' of product, and MW-03 contains 1.80' of product. INTERA has performed two environmental investigations on-Site. Based on these investigations, the site stratigraphy appears to contain a 30' unit of caliche (extending to the top of the water table) bound by units of clays. According to the client, the soil permeability may be heavily influenced by the secondary porosity component and fractured flow.

3. Procedures

The flow rate described in this calculation is based upon the design criteria in Reference 1, empirical values, and parameters stipulated by the client.

3.1. Data and Assumptions

The following describes the values and methods used to calculate Q/h (CFM/ft).

$$\frac{Q}{H} = \pi \frac{K}{\mu} P_W \frac{[1 - (P_{atm}/P_w)^2]}{ln(R_w/R_i)}$$

Reference 2 presents predicted flow rates per unit well thickness based on a range of soil permeabilities and applied vacuums. This figure is included in Attachment 1.

Mr. Griswald suggested a *Ri* of 30 ft for the SVE system. As a basis of comparison, INTERA has analyzed four radii of influence up to 30 ft to calculate the number of potential wells needed for the SVE system (See Report Figures 4a – 4d).

The wells were spaced using the following equation:

$$L(spacing\ interval) = 2 \times Ri \times \cos 30°$$

The targeted treatment area has been defined as the inferred extent of the measureable LNAPL boundary located within the property boundary (See Figure 1). This two dimensional treatment area is estimated at 93,230 square ft or 2.1 acres. For the purpose of these calculations, the portion of the plume outside of the property boundary is not addressed in this design. The spacing intervals and amount of wells needed for the varying *Ri* are provided below:

Table 3-1 Wells Needed based on Ri

L (spacing interval, ft)	*Ri* (ft)	# of wells needed
26	15	161
35	20	83
43	25	59
52	30	40

Additionally, an intrinsic permeability (*k*) value of $1.0x10^{-9}cm^2$ was assumed for the clay/caliche soils observed at the Site.

Ambient atmospheric pressure (P_{atm}) was estimated at 0.854 atm in Monument, NM (elevation of 3,602 ft amsd) which equates to approximately $8.66x10^5$ decipascals.

The induced vacuum (P_w) observed at the Site during a pilot test at three observation points would provide the radius of influence for a Site. Observed vacuums may range from 1 – 100 inches of water (IW). As demonstrated in Attachment 2, Q/h was calculated utilizing an applied vacuum range of 3.4 ft of water to 30.6 ft of water as presented in Reference 2.

The well radius (R_w) for SVE wells is typically 2" – 6". A 4" SVE well was assumed for the purposes of this calculation set.

Lastly, the air viscosity (μ) was based on a literature value consistent with Reference 2 ($1.80x10^{-04}$ g/cm-s).

3.2. Analysis

In order to assess the effect of both *Ri* and *Pw* on Q/h, the induced vacuum, *Pw*, was varied from 0.1 atm (30.6 ft of H2O vacuum) to 0.9 atm (3.4 ft of H2O vacuum); *Ri* was varied from 15 – 30 ft (in intervals consistent with Table 3-1).

4. Calculations

See Attachment 2 for the calculation spreadsheets.

5. Summary

Based on a screened interval of 30 ft, the flowrate will likely range from 1 – 10 CFM, depending on the vacuum applied at the well. Based on experience the vacuum applied at the well will likely range from 0.20 to 0.50 atm, respectively. The overall flowrate will be dependent upon the number of wells.

6. References

Reference 2: Johnson, P.C., C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colthart. 1990. "A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil-Venting Systems."*Ground Water Monit.* Rev.. 10 (2). 159 - 178.

INTERA Inc. 2012 SITE INVESTIGATION REPORT. Former Enersource Facility, Monument, LeaCounty, New Mexico.

Attachment B-1

This equation is derived from the simplistic steady-state radial flow solution for compressible flow (Johnson et al. 1988), but should provide reasonable estimates for vapor flow rates. If k can be measured or estimated, then the only unknown parameter is the empirical "radius of influence" R_I. Values ranging from 9m (30 ft) to 30m (100 ft) are reported in the literature (Hutzler et al. 1988) for a variety of soil conditions, but fortunately Equation 5 is not sensitive to large changes in R_I. For estimation purposes, therefore, a value of R_I=12m (40 ft) can be used without a significant loss of accuracy. Typical vacuum well pressures range from 0.95 – 0.90 atm (20 – 40 in H_2O vacuum). Figure 5 presents predicted flow rates per unit well screen thickness Q/H, expressed in "standard" volumetric units Q*/H (= $Q/H(P_w/P_{Atm})$ for a 5.1cm radius (4-in diameter) extraction well, and a wide range of soil permeabilities and applied vacuums. Here H denotes the thickness of the screened interval, which is often chosen to be equal to the thickness of the zone of soil contamination (this minimizes removing and treating any excess "clean" air). For other conditions the Q*/H values in Figure 5 can be multiplied by the following factors:

R_w = 5.1cm (2 in) R_I = 7.6m (25 ft) - multiply Q*/H by 1.09
R_w = 5.1cm (2 in) R_I = 23m (75 ft) - multiply Q*/H by 0.90
R_w = 7.6cm (3 in) R_I = 12m (40 ft) - multiply Q*/H by 1.08
R_w = 10cm (4 in) R_I = 12m (40 ft) - multiply Q*/H by 1.15
R_w = 10cm (4 in) R_I = 7.6m (25 ft) - multiply Q*/H by 1.27

As indicated by the preceding multipliers given, changing the radius of influence from 12m (40 ft) to 23 m (75 ft) only decreases the predicted flow rate by 10 percent. The largest uncertainty in flow rate calculations will be due to the air permeability value k, which can vary by one to three orders of magnitude across a site and can realistically only be estimated from boring log data within an order of magnitude. It is prudent, therefore, to choose a range of k values during this phase of the decision process. For example, if boring logs indicate fine sandy soils are present, then flow rates should be calculated for k values in the range of 0.1<k<1.0 darcy.

Will the Contaminant Concentrations and Realistic Vapor Flow Rates Produce Acceptable Removal Rates?

Again, estimated removal rates R_{est}, must be compared with an acceptable rate $R_{acceptable}$, as determined from Equation 4. Maximum removal rates are achieved when the induced vapor flow travels only through the zone of soil contamination and no mass-transfer limitations are encountered. In other words, all vapor flows through contaminated soils and becomes saturated with contaminant vapors. For this "best" case the estimated removal rate is given by Equation 2:

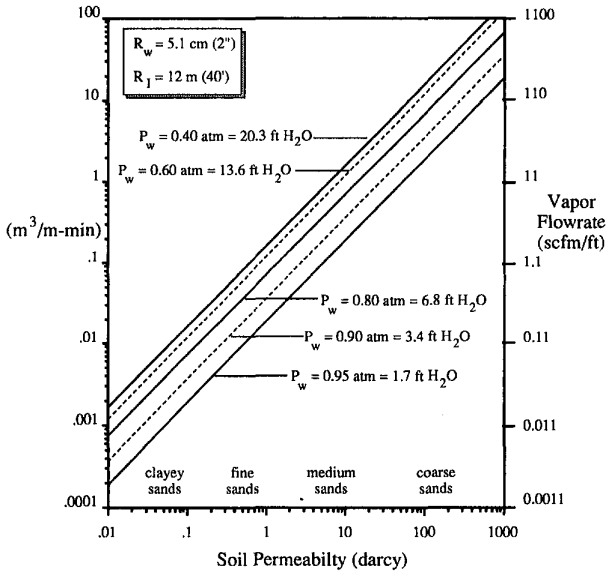


Figure 5. Predicted steady-state flow rates (per unit well screen thickness) for a range of soil permeabilities and applied vacuums (P_w).

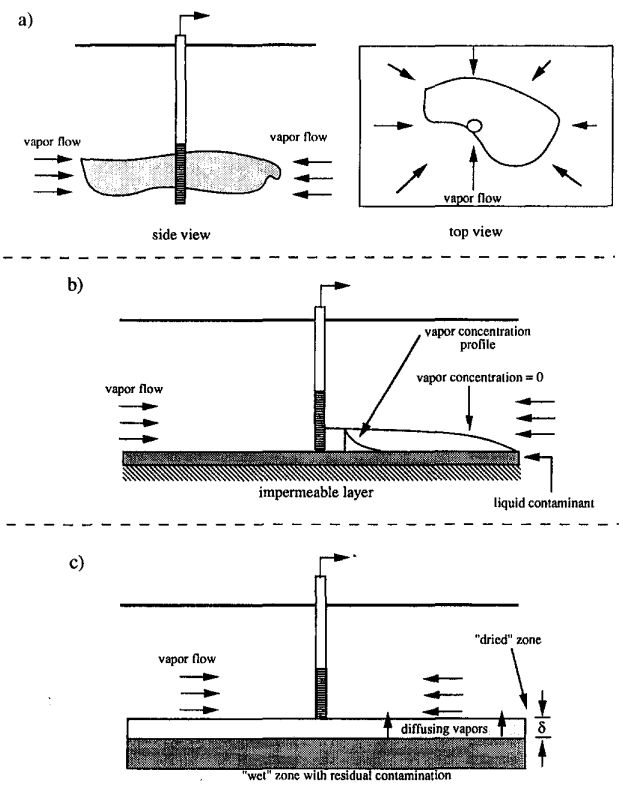


Figure 6. Scenarios for removal rate estimates.

$$R_{est} = C_{est}\, Q \qquad (2)$$

Changes in C_{est} are still being neglected with time due to composition changes. Other less optimal conditions are often encountered in practice and it is useful to be able to quantify how much lower the removal rate will be from the value predicted by Equation 2. We will consider the three cases illustrated in Figures 6a, b, and c.

Attachment B-2

$$\frac{Q}{H} = \pi \frac{k}{\mu} p_w \frac{\left[1 - \left(P_{Atm} / P_w\right)^2\right]}{\ln\left(R_w / R_I\right)}$$

SFCM = Standard Cubic Feet per Minute
ROT - ~ 0.5 SCFM per ft of unsaturated screen as per JG
VOCs > 77000 ppmV

Conversion Factor from SFCM to cm^3/s 471.6981132

Q	flow rate per thickness of well	cm^3/s									
				in	ft						
H	screen height	cm	914.4	360	30						
k	Permeability	cm^2	1.02E-09								
P_{atm}	Ambient air pressure	$g/cm\text{-}s^2$	8.66E+05	0.854 atm							
		atm	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
$P_{w\ (vacuum)}$	Vaccum applied at the well	$g/cm\text{-}s^2$	912,833.85	811,407.86	709,981.88	608,555.90	507,129.91	405,703.93	304,277.95	202,851.97	101,425.98
				in	ft						
R_w	Radius of well	cm	5.08	2							
				in	ft						
Ri	Radius of Influence	cm	914.4	360	30						
π		-	3.141592654								
μ	viscosity of air	cp = 1 g/cm*s	1.80E-04								

Varying Pw; Q/H=

$P_{w=}$	pi*(k/u) *pw		1-(patm/pw)2	ln(rw/ri)	Q/H (cm3/s)/cm	(cm3/s)	cfm	expected flow/SVE well Q (cm3/s)=	SCFM
0.10		1.63E+01	0.100573747	-5.192956851	-0.31	-287.79	-0.61	(287.79)	(0.61)
0.20		1.44E+01	-0.138336351	-5.192956851	0.38	351.86	0.75	351.86	0.75
0.30		1.26E+01	-0.486806663	-5.192956851	1.18	1083.43	2.30	1,083.43	2.30
0.40		1.08E+01	-1.023709069	-5.192956851	2.14	1952.88	4.14	1,952.88	4.14
0.50		9.03E+00	-1.914141059	-5.192956851	3.33	3042.93	6.45	3,042.93	6.45
0.60		7.22E+00	-3.553345405	-5.192956851	4.94	4519.03	9.58	4,519.03	9.58
0.70		5.42E+00	-7.094836276	-5.192956851	7.40	6767.25	14.34	6,767.25	14.35
0.80		3.61E+00	-17.21338162	-5.192956851	11.97	10945.72	23.19	10,945.72	23.20
0.90		1.81E+00	-71.85352648	-5.192956851	24.98	22845.27	48.41	22,845.27	48.43

According to Johnson 1990, Ri has minimal effects to the predicted flow rate

APPENDIX C

SVE System Power Requirement/
Solar Power Assessment Calculation Set

1. Purpose

The purpose of this calculation is to estimate the power requirement for the designed SVE system at the former Enersource facility.

2. Background

The estimated areal extent of LNAPL at the Site is approximately 181,055.310 ft^2 including 93,230 ft^2 within the fenced boundary. The proposed remediation system is soil vapor extraction with a thermal oxidizer for emission control.

3. Procedures

In order to estimate the power requirement for the system, Baker Furnace Inc. provided specifications for a modular system including a 500 CFM Thermal Oxidizer to treat a waste gas stream.

3.1 Power Requirement

According to the documentation, the electrical requirement is 480VAC/3 phase/25A. This parameter can be converted to horsepower (hp) and kilowatts (kW):

$$480\ VAC\ \times 25A \rightarrow 12{,}000\ \cancel{watts}\ \times \frac{'x'\ hp}{746\ \cancel{watts}} \rightarrow 'x' = 16.1\ hp$$

$$12{,}000\ watts = 12\ kW$$

If 12 kW are needed for 24 hrs/day, 365 days/year, 105 MW are needed annually (288 kW/day and 8.8 MW/month).

If solar power only was utilized to produce this annual energy demand, a 53 kW photovoltaic (PV) system would be necessary.

3.2 Solar Power

Based on the annual power requirement, the amount of solar panels needed was calculated using an average solar power area energy production value.

$$[53\ kW] \div \left[\frac{0.150kw}{\cancel{m^2}of\ PV\ area} \times \frac{1}{10.76\ ft^2/\cancel{m^2}}\right] = 3{,}802\ ft^2\ of\ PV\ area$$

One standard size for a solar panel is 21.5 ft^2. If that size panel was used, 176 panels would be needed.

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	NMGSD.M002.ENER Enersource Off Site and LNAPL Recovery Investigation
0	AKA	11/30/2012		12/21/12	Subject:	Solar/Power Requirements Calculations
1	AKA	1/4/2013		1/04/13	Calc. No.	
					Sheet 1 of 2	

4. Data and Assumptions

For this power requirement calculation, the following assumptions have been made:

- The remediation system would be operated 24 hrs/day, 365 days/year
- The average solar radiation/year for southeastern NM is 2,000 kW
- The efficiency of the solar energy system is ~21%
- $1m^2$ will produce 100-200 watts

5. Calculations

See Attachment 1 for details of the calculations.

6. Summary

If the thermal oxidizer modular unit is 16-hp and operated as stated in Section 5, 10 kW of photovoltaic power would be needed on a daily basis. Therefore, 176 panels that are 21.5 ft^2 would be necessary.

7. References

Reference 1: http://www.solar-estimate.org/index.php?verifycookie=1&page=solar-calculations&subpage=&external_estimator=.