KINDER MORGAN

By Certified Mail, Return Receipt Requested

August 18, 2014

Mr. Charles A. Barnes
Enforcement Officer/Project Coordinator
U.S. EPA, Region 6
Technical Section (6EN-HE)
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2750

Re: Administrative Order on Consent (AOC)
EPA Docket No. RCRA-VI-7003-01-01
El Paso Merchant Energy-Petroleum Company Elementis Site, Corpus Christi, TX
Soil Vapor Extraction System Annual Progress Report

Mr. Barnes:

El Paso Merchant Energy-Petroleum Company (El Paso) is pleased to submit three hard copies and one electronic copy of the Soil Vapor Extraction System Annual Progress Report for the Elementis Site in Corpus Christi, TX. This report has been prepared in accordance with the ***Soil Vapor Extraction System Construction Completion Report*** submitted in August 2012.

If you have any questions or comments, please contact me at (713) 420-3414.

Sincerely,

David W. Zuvanich, P.G.
(Texas License No. 1537)
Project Manager
Kinder Morgan, Inc.

Enclosure

cc: C. Todd Counter, Corrective Action Section, TCEQ, Austin, TX
Joel Barnhart, American Chrome & Chemical L.P.
Vince Blout, Kinder Morgan, Inc. – w/o enclosure
File

CERTIFICATION

(AOC Provision VII.4.H, U.S. EPA Docket No. RCRA-VI-7003-01-01)

I certify that, to the best of my knowledge, the information contained in or accompanying this submission is true, accurate, and complete. I am aware that there are significant penalties for submitting false information under 18 U.S.C. Section 1001.

David W. Zuvanich, P.G.
(Texas License No. 1537)

08.18.2014
Date

Soil Vapor Extraction System
Annual Progress Report

El Paso Merchant Energy-Petroleum Company
Elementis Chromium, L.P. Site
Corpus Christi, Texas

August 2014

Prepared for:
El Paso Merchant Energy-Petroleum Company
Houston, Texas

Prepared by:
URS Corporation
9400 Amberglen Boulevard
Austin, Texas 78729

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Acronyms and Abbreviations

%	percent
>	greater than
ACC	American Chrome and Chemicals L.P.
AFJ	Agreed Final Judgment
AI	air injection
AOC	Administrative Order on Consent
ASTM	American Society for Testing and Materials
bgs	below ground surface
btoc	below top of casing
CCIH	Corpus Christi Inner Harbor
CO	carbon monoxide
Coastal	Coastal Refining & Marketing, Inc.
DTW	depth to water
Elementis	Elementis Chromium, L.P.
El Paso	El Paso Merchant Energy-Petroleum Company
EPA	U.S. Environmental Protection Agency
ft	foot/feet
HCPB	high concentration process blower
ICA	Interim Corrective Action
IM	Interim Measures
Kinder Morgan	Kinder Morgan, Inc.
lb air/ft^3	pounds air per cubic foot
lb benzene/min	pounds benzene per minute
lb/hr	pounds per hour
lb/lb-mole	pounds per pound-mole
lb O_2/lb air	pounds oxygen per pound air
lb O_2/min	pounds oxygen per minute
LCPB	low concentration process blower
LEL	lower explosive limit
LNAPL	light non-aqueous phase liquid
LPZ	LNAPL piezometers
Magellan	Magellan Terminal
Mol %	Molar percent
MW	molecular weight
N/A	not applicable
NO_x	nitrogen oxides
OUR	oxygen utilization rate
PBR	Permit by Rule
PM_{10}	particulate matter less than 10 microns
PPG	Pittsburgh Plate Glass Industries, Inc.
PVC	polyvinyl chloride
Q_{vapor}	Vapor flowrate
scfm	standard cubic feet per minute
SO_2	sulfur dioxide

Acronyms and Abbreviations (Continued)

SVE	soil vapor extraction
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
ThermTech	ThermTech, Inc.
TI	technical impracticability
TO	thermal oxidizer
TPH	total petroleum hydrocarbons
tpy	tons per year
URS	URS Corporation
Valero	Valero Energy Corporation
VMP	vapor monitoring point
VOC	volatile organic compound
WBZ	water bearing zone

1.0 INTRODUCTION

URS Corporation (URS) prepared this Annual Report to document the performance of the soil vapor extraction (SVE) system at the Elementis Chromium, L.P. (Elementis) site in Corpus Christi, Texas in accordance with the ***Soil Vapor Extraction System Construction Completion Report*** (URS, August 2012). The SVE system was installed as part of "Facility Light Non-Aqueous Phase Liquid (LNAPL) Removal System Upgrade" required by the Administrative Order on Consent (AOC) signed by El Paso Merchant Energy-Petroleum Company (El Paso) and the U.S. Environmental Protection Agency (EPA) Region 6 in September 2002 (EPA, September 2002). The ***LNAPL Removal System Upgrade Work Plan Rev. 1*** (URS, April 2011) presented a comprehensive site-wide SVE approach for the first phase of the LNAPL Removal System Upgrade. The ***Soil Vapor Extraction System Construction Completion Report*** provided a record for the drilling and installation of the initial 25 SVE wells, vapor monitoring points (VMPs), LNAPL piezometers (LPZs) and air injection (AI) wells; connection of the SVE wells to conveyance piping and treatment skids; and start-up and initial operation (through April 10, 2012) of the SVE system. The ***Soil Vapor Extraction System Annual Report*** (URS, August 2013) provided an update of the system operation through May of 2013. This Annual Progress Report provides an update of the SVE system operation through May 2014, including a description of the SVE system expansion that occurred between August 2012 and September 2013.

1.1 Facility Background

The Elementis property is located in an industrial area characterized by manufacturing and refining operations. The Elementis property consists of a manufacturing facility and associated undeveloped land located at 3800 Buddy Lawrence Drive in Corpus Christi, Nueces County, Texas (Figure 1-1). The Elementis facility occupies approximately 425 acres of property located adjacent to the Valero Refinery (formerly the Coastal Refinery) and south of the Corpus Christi Inner Harbor (CCIH) Ship Channel near the Avery Point Turning Basin. The southern border of the eastern portion of the Elementis site is adjacent to the Citgo Refinery and the Magellan Terminal (Magellan).

In a joint venture, American Cyanamid Corporation and Pittsburgh Plate Glass Industries, Inc. (PPG) constructed the original facility, now known as Elementis, in 1931 for the manufacturing of soda ash, chlorine, and other alkalis. In 1960, PPG built a chromate plant to produce sodium chromate and sodium dichromate using a high-lime process. American Chrome and Chemicals L.P. (ACC) assumed ownership of the property in 1979 and continued manufacturing chromate using a no-lime process.

Sinclair Refining Company originally established what is now the Valero Refinery in 1944. Coastal States Petroleum Company acquired the refinery in 1962 and began a series of expansions that continued until 1984. In 1984, the name of the company was changed to Coastal Refining & Marketing, Inc. (Coastal); and in 2001, El Paso became the successor over the refinery as a result of a merger between El Paso Corporation and Coastal Corporation, Inc. Soon after the merger, El Paso leased the refinery to Valero Energy Corporation (Valero) until 2003, when El Paso completed the sale of the refinery to Valero. In 2012, Kinder Morgan, Inc. (Kinder Morgan) acquired El Paso; however, all regulatory issues are currently still being handled under administrative orders made between El Paso and the State of Texas and the EPA.

1.2 Regulatory Background

Administrative orders between El Paso and the State of Texas and the EPA prescribe work required to identify, investigate, contain, and control migration of waste constituents within and adjacent to the Elementis property. The following subsections summarize the two legal orders for the Elementis site.

1.2.1 Agreed Final Judgment

El Paso became involved in environmental activities associated with Elementis upon the merger of El Paso and Coastal in 2001. At that time, Coastal had an existing Agreed Final Judgment (AFJ) that is currently regulated by the Texas Commission on Environmental Quality (TCEQ). The AFJ was signed between the TCEQ and Coastal in April 1998 (TCEQ, April 1998) and amended in September 2003. The April 1998 AFJ obligated Coastal to remediate hydrocarbons under the Elementis site and under the refinery itself. Several obligations of the AFJ had already been implemented, including an Interim Corrective Action (ICA) System, which consists of recovery wells across the Facility. Upon merging with Coastal, El Paso became the respondent to the AFJ.

The AFJ area includes the Coastal Refinery (now Valero Refinery) and the Elementis site west of Cantwell Lane, consisting of mostly vacant land and former disposal areas for a distance of approximately 4,500 feet from Cantwell Lane to Navigation Boulevard. The AFJ area is shown on Figure 1-2. In 2003, Valero purchased the former Coastal Refinery from El Paso. Responsibilities defined in the September 2003 amended AFJ were delegated between the parties as follows:

- Valero will operate, maintain, and, when necessary, enhance their onsite groundwater monitoring system and the ICA Systems.
- El Paso will operate and maintain the offsite groundwater monitoring system and the ICA Systems located on the adjacent property owned by Elementis.

Together, these systems were designated the ICA Systems.

1.2.2 Administrative Order on Consent

In September 2002, El Paso and EPA Region 6 signed an AOC. The AOC obligated El Paso to investigate and remediate hydrocarbon contamination on the Elementis property east of Cantwell Lane. Specifically, the AOC refers to two areas of concern, the Facility Area, and the Interim Measures (IM) Area, which are shown on Figure 1-2. The separation of the AOC from the AFJ was documented in the ***Joint Supplement to the Agreed Final Order*** that was signed on January 23, 2003 (TCEQ, January 2003).

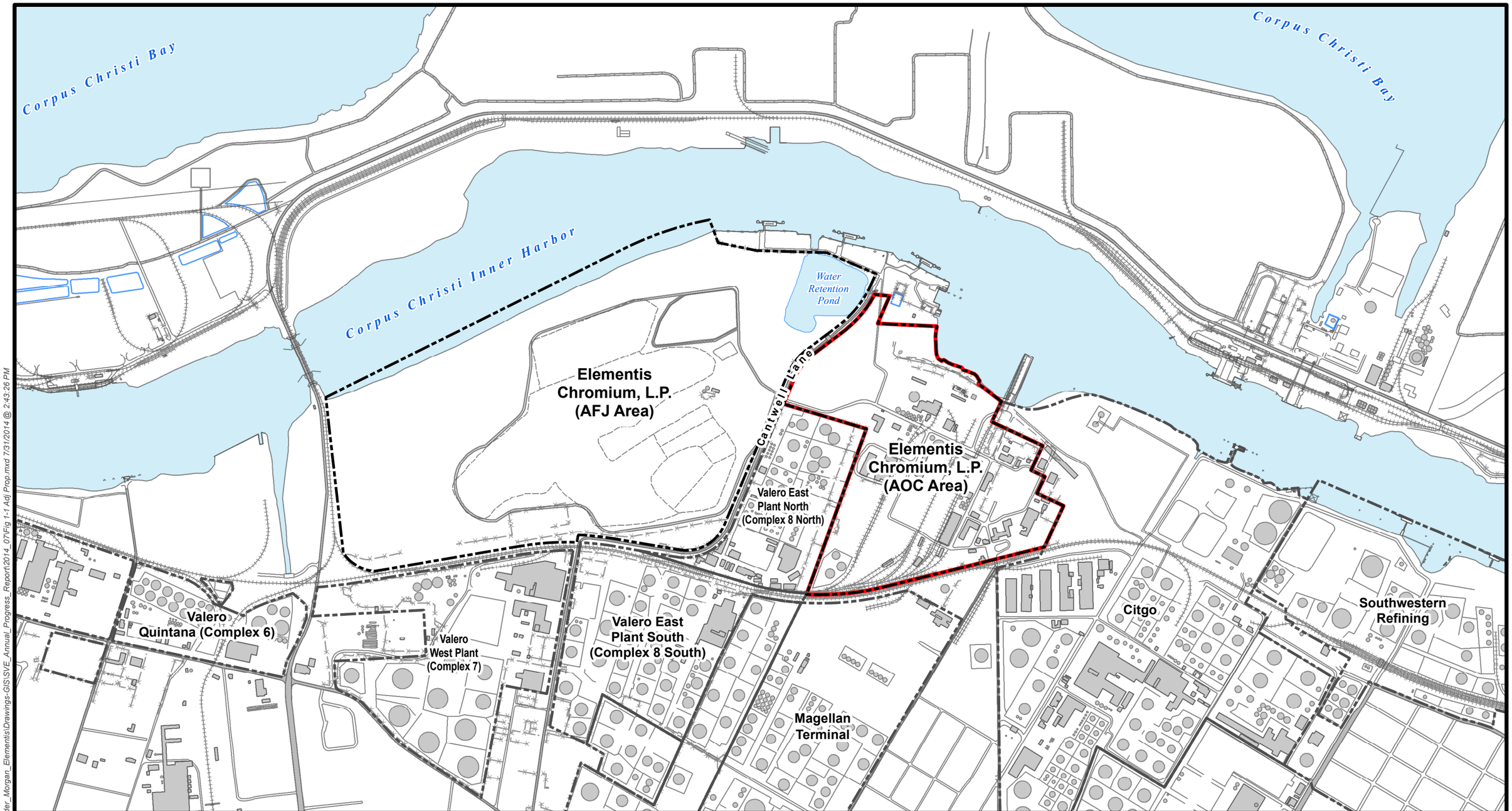
The IM Area is the portion of the AOC area where the Cofferdam System currently recovers LNAPL and impacted groundwater. While the IM boundary does encroach slightly on the Elementis process area, this area is not operational at this time. The IM Area is mostly vacant but does include the Cofferdam Area Extraction Network, as well as the Cofferdam Recovery System, which is located within the southern part of the IM Area.

The northern part of the IM Area that is directly adjacent to the harbor and the surrounding recovery wells, trenches, and subsurface barrier wall is generally referred to as the Cofferdam Area. The Cofferdam Recovery System refers to the IM Area containment, recovery, and treatment system that was installed to mitigate the potential for discharge of hydrocarbons to the ship channel. This system includes a fully penetrating subsurface barrier wall, extraction wells, process piping, and a groundwater recovery system.

1.3 Regulatory Objectives

The AOC required that the Facility LNAPL Removal System Upgrade consider two goals over two specific periods of time to remove the LNAPL plume to the extent technically practicable "within a reasonable time frame." These goals are based on apparent product thicknesses in monitoring wells. According to the AOC, removal to an extent "technically practicable" means removal of LNAPL to a thickness not to exceed 1/8 inch atop groundwater for one year as measured in site monitoring wells. The AOC provides the following performance criteria for the LNAPL Removal System Upgrade:

- Respondent shall operate a full LNAPL Recovery System for three years or until product is reduced to a threshold of 1/10 foot of product, as measured in site monitoring wells, throughout the plume.
- At the end of three years or when the threshold of 1/10 foot of product atop of groundwater is reached, EPA will determine whether Respondent shall enhance the system to further remove LNAPL to 1/8 inch atop groundwater.
- If EPA determines that further removal of LNAPL is required, Respondent shall enhance the system and operate until LNAPL is removed to 1/8 inch atop groundwater.
- After three years of continued operation of the enhanced system or when LNAPL is decreased to 1/8 inch atop groundwater, Respondent may perform a technical impracticability (TI) demonstration, to demonstrate that further LNAPL removal throughout the plume is technically impracticable from an engineering perspective.
- The TI demonstration shall be in accordance with Guidance for Evaluating the TI of Groundwater Restoration (EPA 540-R-93-080) (EPA, September 1993).
- EPA will review the TI demonstration based on EPA guidance.
- EPA may determine that TI is adequately justified and require Respondent to maintain the IM Containment System pursuant to Section VII.1.B.(iv).



Legend

- Elementis Property Boundary
- Adjacent Property Boundary
- AOC Area
- Railroad Track
- Fence

Note:
The Valero Refinery was formerly the Coastal Refinery.

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Feet

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Elementis Site - Corpus Christi, Texas

Report: Soil Vapor Extraction System
Annual Progress Report

Title: **Site Location and Adjacent Properties Map**

Drawn by:	Date:	GIS File:	Figure:
GWC/AUS	7/31/2014	Fig 1-1 Adj Prop.mxd	1-1

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Legend

- Elementis Property Boundary
- IM Area
- Adjacent Property Boundary

Notes:
AFJ - Agreed Final Judgement (TCEQ).
AOC - Administrative Order on Consent (EPA).

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Title: **AFJ and AOC Regulatory Areas**

Drawn by:	Date:	GIS File:	Figure:
GWC/AUS	7/31/2014	Fig 1-2 AFJ AOC.mxd	1-2

2.0 LNAPL DISTRIBUTION

This section presents the source of the LNAPL and current LNAPL distribution at the site.

2.1 LNAPL and Benzene Plume

A phase separated hydrocarbon plume originates at adjacent properties south and southwest of the Elementis Facility, traveling across the Facility from the southern property boundaries (Magellan Terminal and Valero Refinery) to the north-northeast in the direction of groundwater flow. The plume extends to the south bank of the CCIH ship channel where it is intercepted by a subsurface barrier wall and a network of extraction wells. The details of this containment system are discussed in the ***AOC Interim Measures (IM) Implementation Work Plan, Rev. 3*** (URS, November 2009). A halo of dissolved phase benzene encompasses the LNAPL plume. Figure 2-1 shows the distribution and thickness of LNAPL and the areal extent of the dissolved phase benzene plume.

Because the LNAPL plume is wide spread across the site, the AOC LNAPL plume was divided into nine zones. These zones were created after considering several factors, including the history of the various releases, general soil type at the hydraulic surface, the composition of the LNAPL in several areas, and the actual response actions planned. Figure 2-2 shows the locations of the nine zones. Table 2-1 describes the various zones. Detailed discussion of the LNAPL zones, including LNAPL properties, product types, and soil type at the hydraulic surface was presented in the ***LNAPL Removal System Upgrade Work Plan Rev. 1*** (URS, April 2011).

2.2 Source of LNAPL

Other than the releases associated with transfer pipelines (Pipeline North and Pipeline South), there is no apparent evidence that LNAPL was directly released on the Elementis property. It is believed that operations on adjacent facilities, including Coastal and Magellan, resulted in releases that migrated and commingled on the Elementis property. Two areas that appear to be heavily influenced by historical pipeline releases are areas at the northern extent and southwestern extent of the site along the pipeline corridor that runs north-south from CCIH docks to the southwest corner of the Elementis site. Hydrocarbon compositions of these two areas are significantly different than the main portions of the LNAPL plume.

In general, the differences in product type are most distinguishable by the carbon range distribution, the percentage of benzene and lighter end material, and to a lesser degree, by the presence of specific compounds. The LNAPL plume was separated into four areas (described in Table 2-1) based primarily on benzene content as described below:

1. Eastern Lobe - characterized by more than 90 percent (%) benzene;
2. Western Lobe - characterized by 35-80% benzene;
3. Pipeline North Area - less than 2% benzene; and
4. Pipeline South Area - less than 2% benzene.

Table 2-1. LNAPL Zones and Sub Areas

LNAPL Zone	Sub Area	Description
1 - IM Area	Mixed Plume	LNAPL from a combination of product types (benzene and diesel) and commingling of LNAPL plumes.
2 - North Benzene Plume	Benzene Plume - Eastern Lobe	Virtually pure aromatic (benzene) product that appears to have originated from Magellan, located south of the eastern portion of Elementis' southern boundary.
3 - Mid Benzene Plume		
4 - South Benzene Plume		
5 - West Area, Valero	Former Coastal (Valero) Releases (Mixed Plume – Western Lobe)	Combination of aromatics and isoparaffins with moderately high benzene content.
6 - Mid Area, Valero		
7 - U16-T Lobe		
8 - Pipeline North Leak	Pipeline Releases (Diesel Plume)	Various combinations of aromatics, paraffins, and isoparaffins within the diesel range and with very low benzene content.
9 - Pipeline South Leak		

IM - Interim Measures.
LNAPL - Light non-aqueous phase liquid.

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Apparent LNAPL Thickness
(1st WBZ)
(April 2014)

Drawn by:	Date:	GIS File:	Figure:
GWC/AUS	13 August 2014	Fig 2-1 LNAPL 2014Apr	2-1

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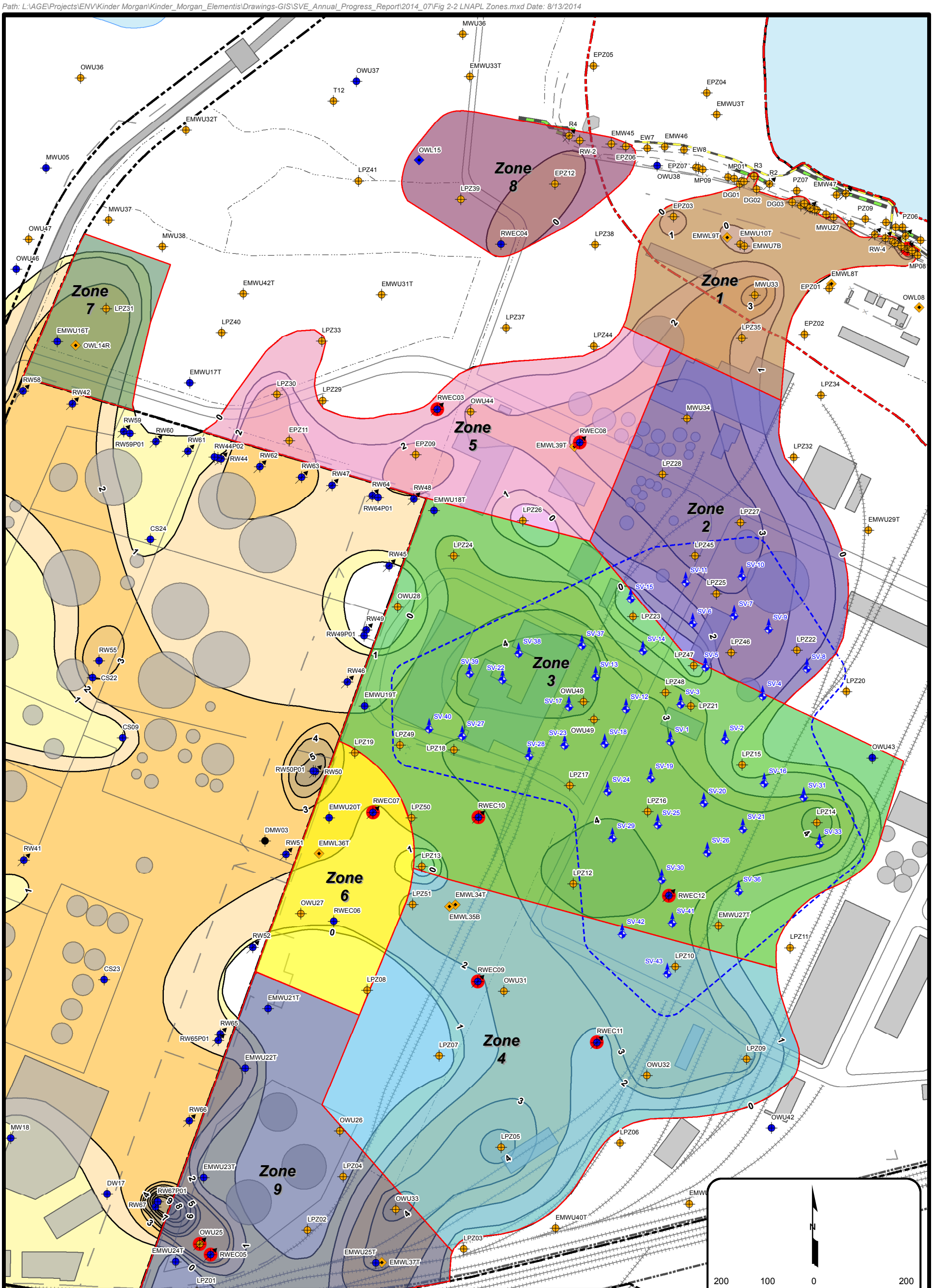

Legend

- Property Boundary
- IM Area
- Extent of SVE System Influence
- Barrier Wall
- Recovery Trench
- Monitor Well Location (Upper WBZ)
- Supplemental Well Location (Upper WBZ)
- Monitor Well Location (Lower WBZ)
- Supplemental Well Location (Lower WBZ)
- Monitor Well Location (Deep WBZ)
- Total Fluid Recovery Well Location (Upper WBZ)
- Supplemental Total Fluid Recovery Well Location (Upper WBZ)
- Product Only Recovery Well Location (Upper WBZ)
- Supplemental Product Only Recovery Well Location (Upper WBZ)
- Soil Vapor Extraction Well

LNAPL Thickness April, 2014

- 0-1'
- 1-2'
- 2-3'
- 3-4'
- 4-5'
- <5

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LNAPL Zones
(April 2014)

Drawn by:	Date:	GIS File:	Figure:
GWC/AUS	13 August 2014	Fig 2-2 LNAPL Zones	2-2

3.0 SVE SYSTEM DESCRIPTION

This section presents a brief description of the SVE system. A more thorough description of the SVE treatment system components and the initial 25 SVE wells was provided in the ***Soil Vapor Extraction System Construction Completion Report*** (URS, August 2012).

3.1 SVE Treatment System

The SVE treatment system consists of four major components:

- High Concentration Process Blower (HCPB) Skid;
- Condensation Skid;
- Low Concentration Process Blower (LCPB) and Thermal Oxidizer (TO) Skid; and
- AI System Skid.

The SVE treatment system skids were manufactured by ThermTech, Inc., (ThermTech) and were installed between December 2011 and January 2012. The system was brought on line in February 2012. The ***Soil Vapor Extraction System Construction Completion Report*** covered installation and start up activities through April 2012.

The ***Soil Vapor Extraction System Annual Progress Report*** (URS, August 2013) provided an update of the SVE system operation through May of 2013. Since this last update, several configuration changes have been made to the SVE system. Most notably, the SVE system was expanded to add 25 new SVE wells within Zone 3 of the LNAPL plume (SV-16 through SV-31, SV-33, and SV-36 through SV-43), 3 new LPZs (LPZ-49 through LPZ-50), additional SVE conveyance piping, and modifications of the inter-skid piping with the inclusion of a new central manifold. The new SVE wells and LPZs were installed between August and October 2012. The piping from the new Zone 3 SVE wells and the new central manifold were completed in September 2013. The new SVE wells were brought online on September 6, 2013.

The 25 new 2-inch diameter SVE wells were installed from 0 to 25.5 feet below ground surface (ft bgs). The SVE wells were constructed using polyvinyl chloride (PVC) casing and stainless steel slotted screen with 0.040-inch slot size, screened from 11.5 to 25.5 ft bgs with a filter pack of 8/16 gradation sand from 9.5 to 25.5 ft bgs. The SVE wells were installed using standard hollow stem auger drilling methods. The screens extend roughly 6 feet above the historical high depth to LNAPL for SVE vapor flow. The bottoms of the SVE wells were set approximately 1 foot below the lowest historical depth to water.

LPZ-49 was installed from 0 to 34 ft bgs, and LPZ-50 and LPZ-51 were installed from 0 to 40 ft bgs. The LPZs were constructed using 2-inch PVC casing and 20-foot stainless steel slotted screen with 0.010-inch slot size. The screens were placed at 13-33 ft bgs, 16-36 ft bgs, and 15.7-35.7 ft bgs at LPZ-49, LPZ-50, and LPZ-51, respectively. The LPZs were installed using standard hollow stem auger drilling methods.

In addition to expanding the SVE system, several modifications were made to the Condensation Skid to prevent ice buildup in the outlet side piping. These modifications included:

- Adding additional 3-inch steel piping on the effluent side of the condensers in September 2013 so that the condensers did not share a common effluent pipe into the knockout pot.
- Removing a 90-degree elbow from within the knockout pot on the outlet side of the condensers in November 2013.
- Modifying the heat trace placement in November 2013 to focus heating on the 90-degree elbows on the outlet side of the condensers.
- Adding additional heat trace in February 2014 on straight-line sections of the outlet piping.

Figure 3-1 shows the as-built arrangement of the SVE skids and as-built inter-skid piping as of May 31, 2014. The locations of the 40 SVE wells within Zones 2 and 3 as well as the SVE conveyance pipe from the SVE wells to the treatment skid are shown on Figure 3-2.

3.2 Permit by Rule Compliance

El Paso submitted a ***§106.533 Notification for a Phase 1A Soil Vapor Extraction and Benzene Recovery Unit*** to the TCEQ in November 2011 (URS, November 2011). The Notification included the "Permit by Rule Applicability Checklist," which showed that the Elementis SVE system would meet all of the requirements of Title 30 Texas Administrative Code § 106.4 (30 TAC § 106.4), and the "Remediation Air Permits by Rule Checklist," which allows the system to operate under a Permit by Rule (PBR). Because the catalyst and heat exchanger were removed from the TO, El Paso submitted a ***§106.533 Notification Update*** to the TCEQ in May 2013 (URS, May 2013) to document the changes made to the SVE treatment system.

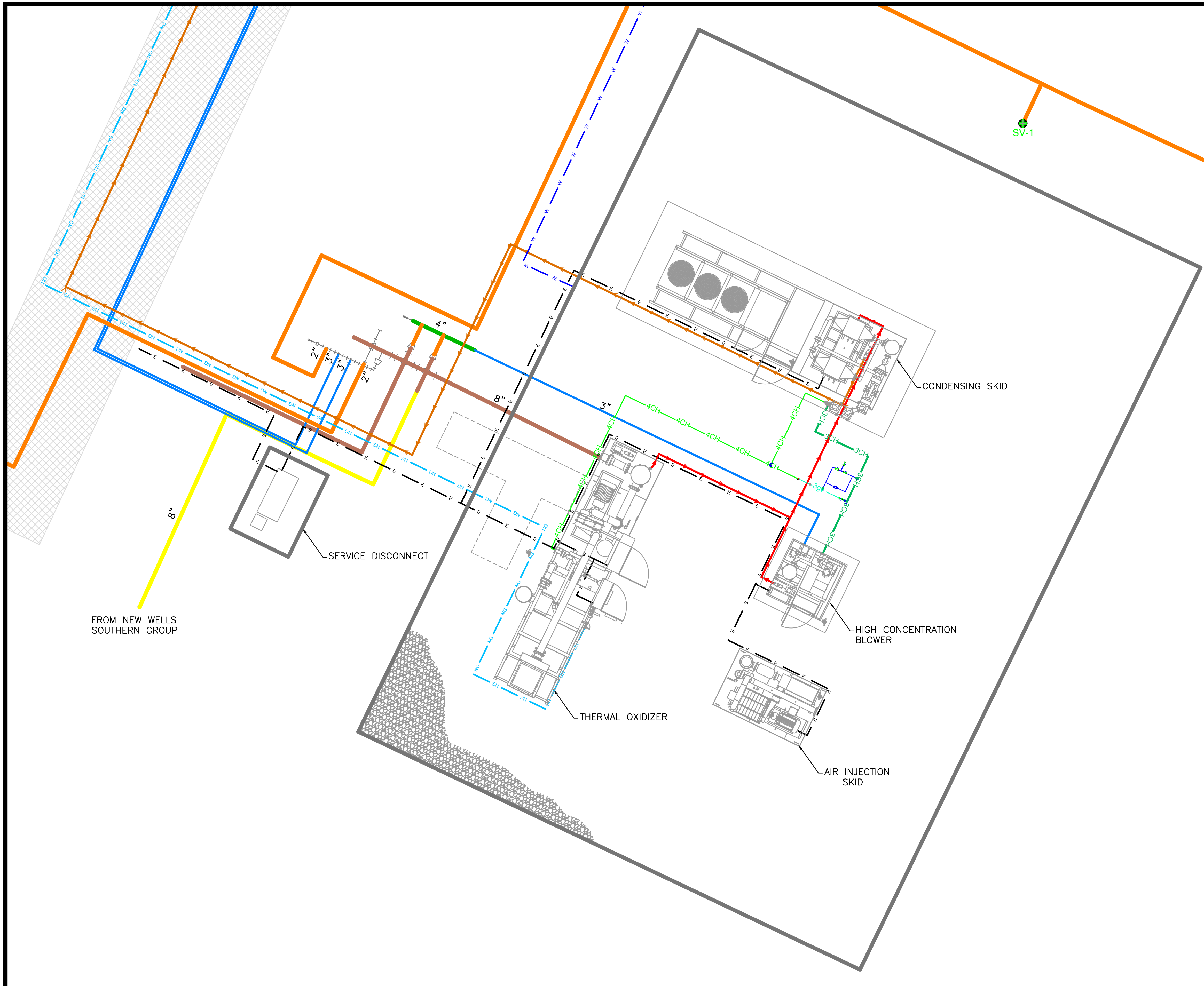
The PBR includes emission limits for total petroleum hydrocarbons (TPH), benzene, and hydrogen sulfide for point sources associated with remediation facilities that are located greater than or equal to 100 feet from the nearest off-site receptor. The expected emissions from the SVE system are provided in Table 3-1. Because the fuel used in the TO is natural gas, criteria pollutant emissions from the TO were included in the total emissions estimate. External combustion emissions estimates from the TO were calculated in accordance with AP-42 Section 1.4 (EPA, July 1998), using emission factors for small boilers.

TPH emissions are limited to 1.0 pound per hour (lb/hr), and the benzene emissions are limited to 0.104 lb/hr under the PBR. As shown in Table 3-1, the SVE remediation system complies with both emissions limits. No appreciable emissions of hydrogen sulfide were expected from the SVE remediation system; therefore, an emissions limit for hydrogen sulfide is not applicable.

Table 3-1. Total Estimated Emissions from the Soil Vapor Extraction Remediation System

Contaminant	Hourly Emissions (lb/hr)	Annual Emissions (tpy)
Carbon Monoxide (CO)	0.30	1.30
Nitrogen Oxides (NO_x)	0.35	1.55
Particulate Matter less than 10 Microns (PM_{10})	0.03	0.12
Sulfur Dioxide (SO_2)	<0.01	0.01
Volatile Organic Compounds (VOCs)	0.02	0.09
Speciated Emissions		
Benzene	2.90E-04	1.27E-03
Total Petroleum Hydrocarbons (TPH)*	3.93E-02	0.17

*Emissions based on methane as the only hydrocarbon in the effluent.
< - Less than.
CO - Carbon monoxide.
lb/hr - Pounds per hour.
NO_x - Nitrogen oxides.
PM_{10} - Particulate matter less than 10 microns.
SO_2 - Sulfur dioxide.
TPH - Total petroleum hydrocarbons.
tpy - Tons per year.
VOC - Volatile organic compound.



LEGEND:

- EXISTING DRAIN
- EXISTING INLINE DRAIN
- HDPE PIPE
- ABOVE GROUND 2–IN HDPE PIPE
- ABOVE GROUND 3–IN HDPE PIPE
- ABOVE GROUND 4–IN HDPE PIPE
- ABOVE GROUND 6–IN HDPE PIPE
- ABOVE GROUND 8–IN HDPE PIPE
- 3–IN FRP PIPE
- 4–IN FRP PIPE
- 8–IN FRP PIPE
- 3CH — ABOVE GROUND 3–IN CHEMICAL HOSE FOR HEATED VAPORS
- 4CH — ABOVE GROUND 4–IN CHEMICAL HOSE
- RECOVERED FLUIDS 1–IN GALVANIZED STEEL PIPE
- RECOVERED FLUIDS 3/4–IN GALVANIZED STEEL PIPE
- E — POWER FEED
- NG — NATURAL GAS LINE
- W — ABOVE GROUND 1–IN WATER LINE
- PIPING/UTILITIES TO BE INSTALLED ON PIPERACKS
- SOIL VAPOR EXTRACTION WELL

N

5 0 10

Feet

URS
9400 Amberglen Blvd.
Austin, TX 78729
Phone: (512) 454-4797
Fax: (512) 419-5474

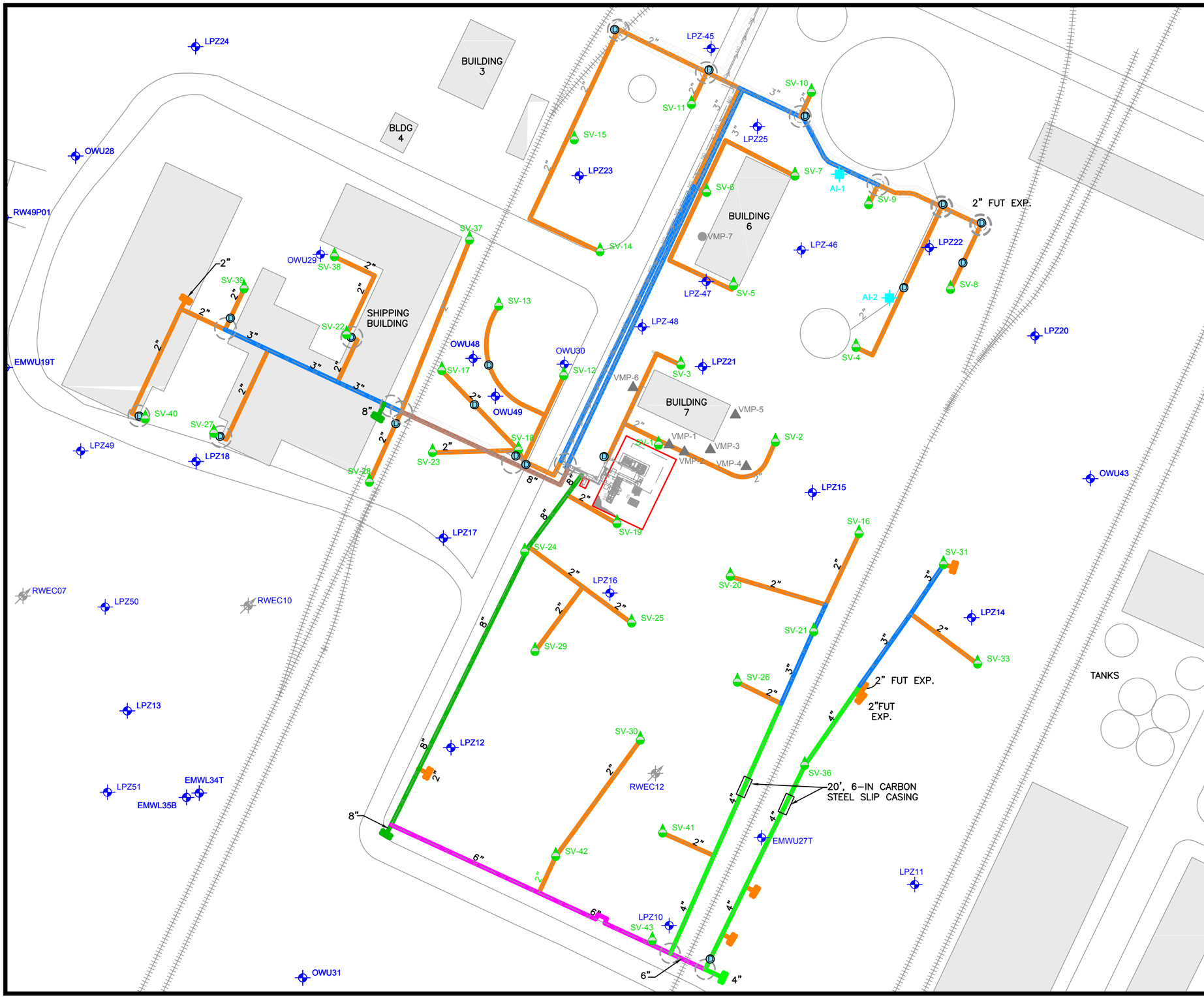
Client: El Paso Merchant Energy - Petroleum Company
Elementis Site - Corpus Christi, Texas

Report: Soil Vapor Extraction System
Annual Progress Report

Title: **SVE TREATMENT SYSTEM LAYOUT (2014 April)**

Drawn by:	Date:	Drawing File:	Figure:
gary_callahan	Aug 14, 2014	SVE SYS LAYOUT DTLS 0414.dwg	3-1

File: L:\AGE\Projects\ENV\Kinder Morgan\Kinder_Morgan_Elementis\Drawings-GIS\SVE_Annual_Progress_Report\2014_07\SVE SYS LAYOUT DTLS 0414.dwg Layout: Fig 3-1 Plotted: Aug 14, 2014 - 2:51pm



LEGEND:

- MONITOR WELL LOCATION
- RECOVERY WELL LOCATION
- VACUUM MONITORING POINT
- AIR INJECTION POINT
- SOIL VAPOR EXTRACTION WELL
- CONDENSATE DRAIN
- HDPE PIPE
- ABOVE GROUND 2-IN HDPE PIPE
- ABOVE GROUND 3-IN HDPE PIPE
- ABOVE GROUND 4-IN HDPE PIPE
- ABOVE GROUND 6-IN HDPE PIPE
- ABOVE GROUND 8-IN HDPE PIPE
- 8-IN FRP PIPE
- RECOVERED FLUIDS 1-IN GALVANIZED STEEL PIPE
- RECOVERED FLUIDS 3/4-IN GALVANIZED STEEL PIPE
- NATURAL GAS LINE
- POWER FEED
- FIBER OPTIC LINE
- WATER LINE (1-in.)
- TREATMENT SKID LOCATION
- PIPING/UTILITIES INSTALLED ON PIPERACKS
- ELEVATION CHANGE TO PIPERACK

N

50 0 100

Feet

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9400 Amberglen Blvd.
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Phone: (512) 454-4797
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Client: El Paso Merchant Energy - Petroleum Company
Elementis Site - Corpus Christi, Texas

Report: Soil Vapor Extraction System
Annual Progress Report

Title: **SVE WELL AND PIPING LAYOUT (2014 April)**

Drawn by:	Date:	Drawing File:	Figure:
gary_callahan	Aug 12, 2014	SVE Piping Layout.dwg	3-2

File: L:\AGE\Projects\ENV\Kinder Morgan\Kinder_Morgan_Elementis\Drawings-GIS\SVE_Annual_Progress_Report\2014_07\SVE Piping Layout.dwg Layout: Fig 3-2 Plotted: Aug 12, 2014 - 9:45am

4.0 SVE SYSTEM OPERATION

This section describes the general system operation for the SVE system from June 1, 2013 to May 31, 2014.

4.1 General SVE System Operation Since June 2013

The SVE system is designed to operate with limited operator oversight. Daily inspections are made to monitor key operating parameters and to ensure the system is operating as intended. If problems are noted during the inspection, appropriate steps are taken to correct the issues.

During normal operation, soil vapor is extracted from the LNAPL-impacted area using the HCPB and/or the LCPB. During the timeframe from June 2013 through May 2014, soil vapor was extracted using both the HCPB and the LCPB. The LCPB extracted soil vapor (approximately 150 standard cubic feet per minute [scfm]) as well as pulled in dilution air to the TO. The soil vapor stream extracted with the HCPB (approximately 250 scfm) was split between the condenser and the bypass line at a roughly 1:1 ratio. The condenser outlet gas stream and the bypass gas stream were combined with the flow from the LCPB and directed through the TO prior to being emitted to the atmosphere. Condensate (water and product) was collected in the Condensation Skid transfer tank prior to being pumped to the groundwater recovery system for further processing.

Several operational issues were encountered between June 2013 and May 2014, which caused the system to be either shut down completely or operated in a modified fashion. Minor SVE system shutdown periods during this timeframe were due to regularly scheduled maintenance events or process faults. Major operational issues and the corrective actions taken included:

- Ice buildup within the condenser outlet piping – June 2013 through February 2014 (modified the effluent piping from condensers in September 2013, modified the placement of the heat trace and removed the extraneous 90-degree elbow from the knockout pot in November 2013, and added an extension to the existing heat trace in February 2014);
- Freezing ambient temperatures - December 2013 through February 2014 (operated using the LCPB only to prevent benzene from freezing in the Condensation Skid lines);
- Faulty expansion valve on the 1013 condenser side – September 2013 (replaced expansion valve in October 2013);
- Faulty thermocouple on TO - October 2013 (replaced thermocouple in October 2013);
- Faulty pump on lower explosive limit (LEL) meter – February 2014 (replaced pump in April 2014);

- Odor concerns from TO effluent stream – March 2014 (sampled TO effluent stream in April 2014 and restarted SVE at a reduced soil vapor flowrate in May 2014);
- Faulty thermocouple(s) on TO – April 2014 (replaced thermocouple(s) in April 2014); and
- Faulty expansion valve on the 1014 condenser side – May 2014 (replaced expansion valve in May 2014).

As stated above, odors were noticeable in the SVE process area during Spring 2014. Because the cause of the odor could not be determined, the SVE system was shut down to investigate possible causes. Samples of the effluent stream from the TO were collected and analyzed for hydrogen sulfide and sulfur dioxide. Neither of these compounds were detected in the effluent gas sample. Other actions taken included a thorough inspection of the system to check for leaks or burnt wiring and communication with Southcross Energy to determine if there had been a change in the natural gas supply. Neither of these actions indicated a cause for the odors. The SVE system was subsequently restarted at a reduced soil vapor flowrate and at an increased dilution air flowrate to mitigate odor issues. Additionally, in order to further mitigate odor concerns at the breathing zone and to return the system to normal operating conditions, a ten-foot extension to the existing TO stack was installed in June 2014.

Since start up in 2012, the SVE system uptime has been greater than (>) 82% with the condenser operating > 51% of the time. For the period of this report, June 2013 through May 2014, the SVE system uptime has been > 76% with the condenser operating > 42% of the time. Considerable down time was experienced during the SVE expansion into Zone 3 due to the modification of inter-skid piping, which required a complete system shutdown. Additionally, the mechanical issues and odor concerns described above contributed to reduced run time.

4.2 LNAPL Gauging

In accordance with the AOC, the ultimate objective of the LNAPL Removal System, which includes the SVE system, is to remove LNAPL to the extent technically practicable (1/10 foot) within a reasonable time frame. As per the ***LNAPL Removal System Upgrade Work Plan Rev. 1*** (URS, April 2011), the SVE system will operate for at least three years. At the end of three years, or when the 1/10 foot LNAPL thickness threshold is met, the EPA will determine whether the system should be enhanced to further remove LNAPL to 1/8 inch atop groundwater.

To monitor the progress of LNAPL removal in areas where SVE is active, four LNAPL gauging events were performed quarterly during the period of June 2013 to May 2014. The August 2013 event served as a baseline for the LNAPL monitoring wells that were added to the program after the Zone 3 SVE expansion.

Table 4-1 presents the LNAPL thickness and depth to water data from the 12 LNAPL gauging events that have been performed since the SVE system was brought online in 2012. Since August 2013, the average LNAPL thickness has decreased by 0.30 feet in wells with measurable LNAPL thicknesses. From the baseline event for each well (see Table 4-1) to April 2014, the

apparent LNAPL thickness has decreased in 21 of the 28 LNAPL monitoring wells; whereas only two of the LNAPL monitoring wells had LNAPL thickness increase over this time period. Five of the LNAPL monitoring wells have not had any measureable LNAPL during any of the gauging events. Based on the results of the gauging events, there appears to be a reduction in LNAPL thickness due to the SVE operation over time.

On April 15, 2014, a site-wide fluid level survey was performed. Based on those field measurements, LNAPL iso-thickness contours for the site were updated. Figure 2-1 shows the April 2014 LNAPL iso-thickness contours.

4.3 Soil Vapor Chemistry

The soil vapor chemistry from the SVE well field has been monitored regularly since April 2012. The results of the benzene (reported as Hexanes Plus in the laboratory analysis) and fixed gas measurements collected at the influent to the HCPB over time are provided in Table 4-2 and are presented graphically on Figure 4-1. These measurements represent how the composite soil vapor from the SVE well field has changed over time.

As expected, benzene (Hexanes Plus), methane, and carbon dioxide concentrations declined initially after the system start-up period and then began to level out. These three gases have generally followed the same trend over time. Measured methane concentrations in November 2012 and from June 2013 through April 2014 were low to non-detect. Methane was observed during the May 2014 sampling event, likely due to the system being brought back online after a lengthy shutdown period.

After startup in 2012 and the Zone 3 expansion in 2014, nitrogen and oxygen concentrations in the soil vapor stream were initially low and generally increased over time as methane and carbon dioxide concentrations declined over time. This is expected as built-up concentrations of biological degradation by-products are flushed from the subsurface. Since the oxygen concentrations are consistently less than atmospheric concentrations and there are persistent elevated carbon dioxide concentrations, it indicates that biodegradation is ongoing in the subsurface.

4.4 Subslab Vacuum Results

Two ports were installed to access the subslabs of Buildings 6 and 7 (Figure 3-2) prior to the SVE system startup. As part of the subsurface monitoring, the vacuum pressures at these locations are measured routinely during SVE operation in 2012 and semiannually in 2013 and 2014 (with the next event scheduled in November 2014). The results of the subslab monitoring are presented in Table 4-3. On May 16, 2014, the vacuum pressure was 0.03 inches of water column at Building 6 and 0.60 inches of water column at Building 7. The results indicate the SVE system is achieving control of the indoor air intrusion pathways.

4.5 SVE System Benzene Mass Removal

The total amount of benzene removed from the subsurface using the SVE system was determined using soil vapor analytical results from samples collected at different points in the SVE system,

measured soil vapor flowrates at these same locations, physical measurements of the benzene to water ratio in the condensate transfer tank, and measured condensate transfer rates. The cumulative volume of benzene removed from the subsurface since start-up of the SVE system in February 2012 is provided on Figure 4-2. The graph also shows the volume of benzene recovered by the condenser and the amount of benzene destroyed by the TO.

As of May 31, 2014, the data showed the following:

- Total pounds of benzene removed from the subsurface – 827,600;
- Total gallons of benzene removed from the subsurface – 112,300; and
- Barrels of benzene removed from the subsurface – 2,673.

These calculations assumed benzene has a density of 7.365 pounds per gallon and a barrel contains 42 gallons.

4.6 Estimation of In Situ Biological Benzene Degradation During SVE Operation

SVE draws atmospheric air into the subsurface and through contaminated soils to volatilize and remove contaminants. This activity in turn provides oxygen to the subsurface for aerobic microbial degradation of hydrocarbons. The aerobic degradation utilizes the oxygen and produces carbon dioxide as a by-product.

During SVE operation, the methane, oxygen, and carbon dioxide concentrations of the composite soil vapor gas stream were measured over time. Flowrate of the vapor stream also was measured over time. These analytical data and field measurements were used to estimate the benzene degradation rate in the subsurface during SVE operation using the oxygen utilization rate (OUR).

The OUR was calculated from the field measurements of vapor flowrate and the oxygen content of the soil vapor. To estimate the benzene biodegradation rate from the OUR, a stoichiometric relationship for the oxidation of benzene was used:

$$C_6H_6 + 7.5\ O_2 \rightarrow 6\ CO_2 + 3\ H_2O$$

Based on the stoichiometric relationship, 7.5 moles of oxygen are utilized for every mole of benzene degraded. The OUR is determined by assuming air enters the vadose zone with an oxygen content of 20.95% by volume and subtracting the measured oxygen content at the SVE wellhead. Mathematically, this rate relationship is:

$$OUR = Q_{vapor} * \rho_{vapor} * ([O_2]_{Air} - [O_2]_{Vapor})$$

where,

OUR	=	Oxygen utilization rate, pounds oxygen per minute (lb O_2/min)
Q_{vapor}	=	Vapor flowrate, scfm

ρ_{vapor}	= Vapor density, pounds air per cubic foot (lb air/ft^3)
$[O_2]_{Air} - [O_2]_{Vapor}$	= Difference in oxygen concentrations between atmospheric air and the vapor, pounds oxygen per pound air (lb O_2/lb air)

The vapor density is calculated using the measured percent concentrations of methane, oxygen, carbon dioxide, and nitrogen. The difference in oxygen concentrations is calculated as follows:

$$[O_2]_{Air} - [O_2]_{Vapor} = \Delta O_2\%/100 * MW_{O2}/MW_{Air}$$

where,

MW_{O2}	= molecular weight of oxygen, 32 pounds per pound-mole (lb/lb-mole) oxygen
MW_{Air}	= molecular weight of air, 28.97 lb/lb-mole air

Using the above stoichiometric ratio of benzene to oxygen and the OUR, the benzene degradation rate can be calculated:

$$m_{BZ} = OUR * (MW_{BZ}/MW_{O2}) * (1/7.5)$$

where,

m_{BZ}	= benzene degradation rate, pounds benzene per minute (lb benzene/min)
MW_{BZ}	= molecular weight of benzene, 78 lb/lb-mole benzene

For the method described above, the mass of benzene degraded in the subsurface was estimated by multiplying the benzene degradation rate for the composite soil vapor by the amount of time the SVE system was operated. The estimated mass of benzene degraded in the subsurface from start-up through May 31, 2014 calculated using the OUR method was 145,800 pounds (19,800 gallons).

Table 4-1. LNAPL Thickness and DTW Gauging Results for SVE Monitoring Wells

Well	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)
	1/16/2012		3/7/2012		3/29/2012		4/17/2012		7/12/2012		10/16/2012		2/18/2013		4/16/2013	
LPZ10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ15	-	22.56	-	22.68	-	23.00	-	22.73	0.06	22.51	ND*	22.67	1.30	23.20	0.30	23.32
LPZ16	4.30	26.03	4.36	26.22	4.06	26.31	4.34	26.26	4.00	25.76	4.26	26.23	4.41	26.51	4.45	26.67
LPZ17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPZ20	-	22.04	-	22.13	-	22.42	-	22.14	-	21.88	-	22.15	0.00	22.43	0.00	22.52
LPZ21	3.53	25.04	3.79	25.35	3.77	25.65	4.09	25.58	4.13	25.53	3.12	24.83	3.40	25.21	3.71	25.66
LPZ22	2.90	25.06	3.24	25.38	3.32	25.82	2.80	25.50	1.95	24.03	2.58	24.90	2.76	25.20	2.58	25.21
LPZ23	-	23.22	-	23.32	-	23.70	-	23.25	-	23.05	-	23.33	0.00	23.52	0.00	23.62
LPZ25	4.24	22.37	4.39	22.56	4.26	22.45	3.98	22.03	2.81	20.87	2.20	20.50	4.02	22.41	4.11	22.60
LPZ27	4.60	26.22	4.56	26.19	4.51	26.46	4.46	26.18	3.68	25.12	4.08	25.86	4.53	26.43	4.53	26.56
LPZ45	3.83	26.19	3.88	26.25	3.85	26.55	3.90	26.29	2.95	25.12	3.41	25.84	3.89	26.51	3.92	26.66
LPZ46	3.86	22.42	3.95	22.61	4.21	23.40	4.12	22.85	3.15	21.44	3.67	22.42	3.80	22.72	3.88	22.91
LPZ47	-	22.20	-	22.31	-	22.55	-	22.32	0.87	22.78	0.36	22.61	0.01	22.52	0.01	22.64
LPZ48	3.85	25.03	3.98	25.24	3.92	25.63	3.99	25.38	3.20	24.32	3.32	24.70	3.59	25.10	3.86	25.50
LPZ49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OWU27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OWU30	-	-	3.69	ND	-	ND	1.95	23.47	3.01	24.37	-	-	3.76	25.43	-	-
OWU43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OWU48	4.62	26.40	4.81	26.74	4.88	27.30	4.77	27.02	4.53	26.36	4.70	26.85	0.00	22.17	4.75	27.09
OWU49	-	-	4.73	26.03	-	ND	-	ND	3.15	ND	3.74	ND	3.45	ND	3.32	ND
EMWU19T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EMWU27T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OWU-29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4-1. LNAPL Thickness and DTW Gauging Results for SVE Monitoring Wells (Continued)

Well	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	LNAPL Thickness (ft)	DTW (ft btoc)	Change in LNAPL Thickness Since August 2013 (ft)	Change in Depth to GW Since August 2013 (ft)	Overall Change in LNAPL Thickness [1] (ft)
	8/22/2013		10/15/2013		1/15/2014		4/15/2014				
LPZ10	4.19	26.02	3.95	25.60	3.44	25.71	3.78	25.65	-0.41	-0.37	*-0.41*
LPZ11	0.00	22.93	0.00	22.69	0.00	22.77	0.00	22.96	N/A	0.03	*N/A*
LPZ12	4.87	26.32	4.73	26.06	3.56	26.31	4.71	26.14	-0.16	-0.18	*-0.16*
LPZ14	4.95	27.53	4.44	26.79	3.97	26.78	4.27	26.91	-0.68	-0.62	*-0.68*
LPZ15	0.26	23.31	0.00	23.79	0.17	23.31	0.16	23.19	-0.10	-0.12	*-0.10*
LPZ16	4.45	26.74	4.11	26.18	3.69	26.21	3.69	25.99	-0.76	-0.75	*-0.61*
LPZ17	4.62	24.02	4.33	23.55	3.80	23.23	3.54	22.99	-1.08	-1.03	*-1.08*
LPZ18	3.05	23.07	3.03	22.85	3.28	23.18	3.08	23.04	0.03	-0.03	*0.03*
LPZ19	0.50	24.21	0.69	24.35	2.68	26.27	2.76	26.09	2.26	1.88	*2.26*
LPZ20	0.00	25.54	0.00	22.25	0.00	22.65	0.00	22.59	N/A	-2.95	*N/A*
LPZ21	3.33	25.34	2.79	24.60	2.39	24.54	2.46	24.52	-0.87	-0.82	*-1.07*
LPZ22	2.03	24.74	1.55	23.96	1.52	24.45	1.52	24.32	-0.51	-0.42	*-1.38*
LPZ23	0.00	23.63	0.00	23.31	0.00	23.75	0.00	23.63	N/A	0.00	*N/A*
LPZ25	3.49	22.05	2.71	21.00	2.60	21.11	2.90	21.58	-0.59	-0.47	*-1.34*
LPZ27	3.75	29.98	3.55	25.24	3.37	25.3	3.93	26.02	0.18	-3.96	*-0.67*
LPZ45	3.67	26.37	2.84	25.26	2.79	25.68	3.49	26.26	-0.18	-0.11	*-0.34*
LPZ46	3.53	22.57	2.57	21.38	2.66	22.30	3.22	22.33	-0.31	-0.24	*-0.64*
LPZ47	0.00	22.64	0.00	22.32	0.00	22.71	0.00	22.64	N/A	0.00	*-0.87*
LPZ48	3.63	25.30	2.68	24.20	2.65	24.65	2.82	24.51	-0.81	-0.79	*-1.03*
LPZ49	2.94	25.49	2.81	25.25	2.72	25.26	2.51	25.1	-0.43	-0.39	*-0.43*
OWU27	DRY	DRY	1.45	24.55	-	-	1.23	24.49	-0.22	-0.06	*-0.22*
OWU30	3.28	25.11	-	-	3.05	24.86	-	-	-0.23[2]	-0.25[2]	*-0.64*
OWU43	0.00	21.44	0.00	20.97	0.00	21.23	-	-	N/A [2]	-0.21[2]	*N/A*
OWU48	4.77	27.12	3.99	26.10	4.05	26.59	4.08	26.4	-0.69	-0.72	*-0.54*
OWU49	3.26	24.98	3.52	25.07	3.01	24.98	3.18	24.93	-0.08	-0.05	*-1.55*
EMWU19T	2.35	22.27	2.05	21.95	1.84	21.78	-	-	-0.51[2]	-0.49[2]	*-0.51*
EMWU27T	2.14	25.04	2.24	24.90	1.95	24.75	1.83	24.75	-0.31	-0.29	*-0.31*
OWU-29	-	-	-	-	Dry	Dry	Dry	Dry	N/A	N/A	*N/A*

Shaded cells indicate baseline monitoring data for specified well.

[1] Baseline to most recent data.
[2] Based on difference between August 22, 2013 and January 12, 2014.
- Not measured.
* Non detect (ND) likely due to probe malfunction.
** ND due to light non-aqueous phase liquid (LNAPL) measured to total depth of well.

btoc - Below top of casing.
DTW - Depth to water.
ft - Feet.
GW - Groundwater.
N/A - Not applicable.
SVE - Soil vapor extraction.

Table 4-2. Chemistry of Influent Composite Soil Vapor Stream

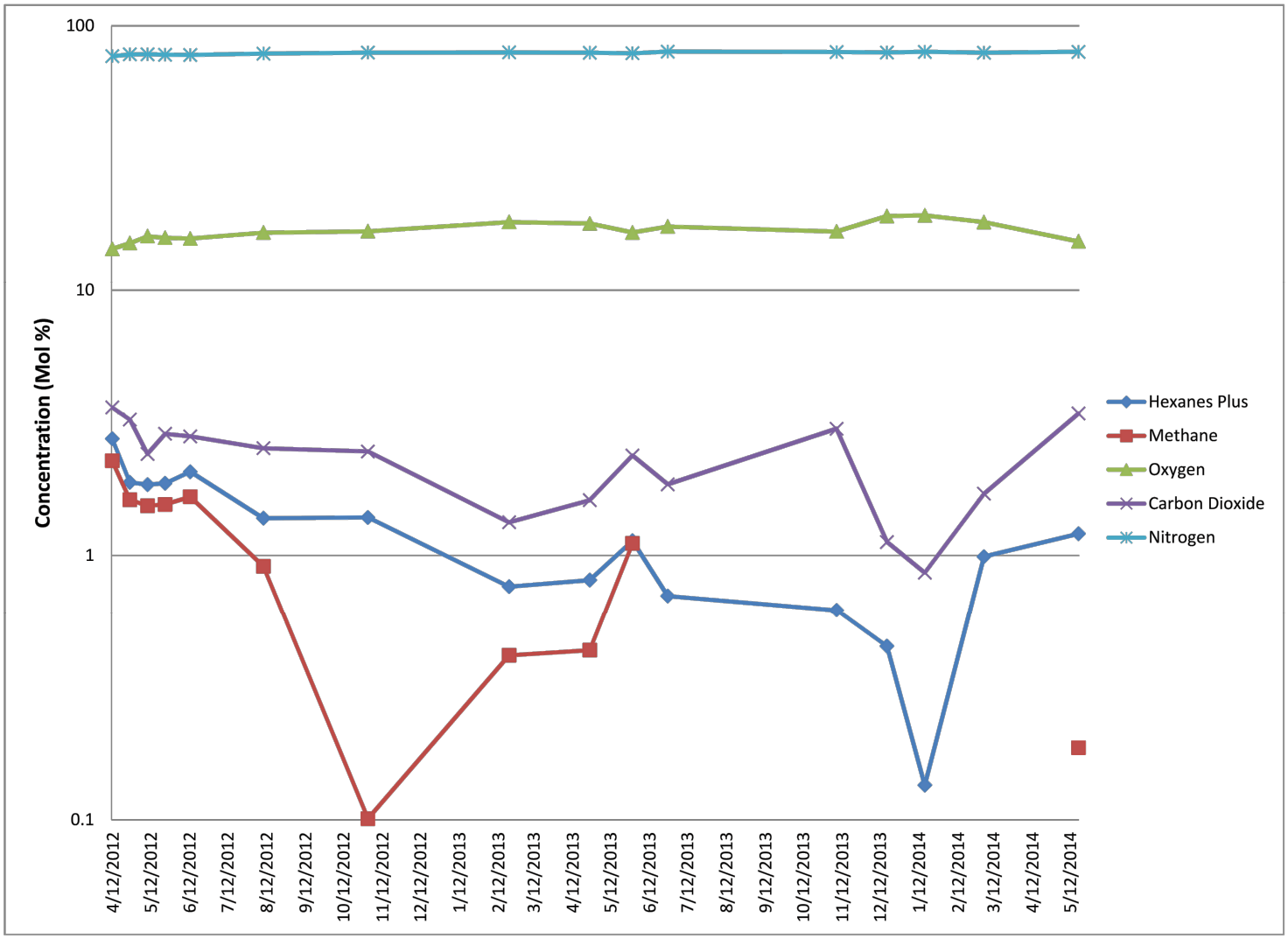
Component	Units	4/12/2012	4/26/2012	5/10/2012	5/24/2012	6/13/2012	8/10/2012	11/1/2012	2/21/2013	4/26/2013	5/30/2013	6/27/2013	11/8/2013	12/18/2013	1/17/2014	3/5/2014	5/19/2014
Hexanes Plus	Mol %	2.754	1.886	1.85	1.871	2.068	1.381	1.391	0.763	0.807	1.136	0.703	0.620	0.452	0.135	0.990	1.207
Methane	Mol %	2.275	1.621	1.539	1.558	1.664	0.910	0.101	0.417	0.436	1.110	0	0	0	0	0	0.187
Oxygen	Mol %	14.404	15.137	16.078	15.86	15.75	16.598	16.786	18.19	17.958	16.609	17.494	16.750	19.151	19.270	18.163	15.379
Carbon Dioxide	Mol %	3.613	3.252	2.413	2.874	2.81	2.536	2.465	1.334	1.616	2.381	1.854	3.004	1.124	0.861	1.709	3.429
Nitrogen	Mol %	76.811	77.991	78.043	77.753	77.629	78.527	79.237	79.361	79.177	78.764	79.949	79.626	79.271	79.734	79.138	79.769
Flowrate	scfm	125.84	153.42	126.74	124.83	124.98	139.93	139.96	235.37	191.3	236.25	204.15	247.51	250	331	310	297

Note: Benzene concentration was measured as “Hexanes Plus” by method American Society for Testing and Materials (ASTM) D1946M.
Mol % - Molar percent.
scfm - Standard cubic feet per minute.

Table 4-3. Subslab Vacuum Pressures

Date	Wells Online	Vacuum Pressure (Inches of Water Column)	
		6-SS3[a]	7-SS2
2/2/2012	Baseline	0.00	0.00
3/1/2012	SV-1, 4, 8, & 9	0.10	0.00
3/7/2012	SV-1, 2, 4, 8, & 9	0.06	0.08
3/15/2012	SV-1, 2, 3, 4, 8, & 9	0.40	0.14
3/29/2012	All 15 SV Wells	0.18	0.10
4/4/2012	All 15 SV Wells	0.42	0.08
4/12/2012	All 15 SV Wells	0.28	0.06
4/26/2012	All 15 SV Wells	0.42	0.15
5/11/2012	All 15 SV Wells	0.14	3.0
5/24/2012	All 15 SV Wells	0.40	0.08
7/12/2012	All 15 SV Wells	0.13	0.16
8/10/2012	All 15 SV Wells	0.11	0.17
11/2/2012	All 15 SV Wells	0.14	0.05
5/16/2013	All 15 SV Wells	0.68	0.30
11/13/2013	All 40 SV Wells	0.06	0.02
5/16/2014	All 40 SV Wells	0.03	0.60

Note: 6-SS3 is located in Building 6, while 7-SS2 is located in Building 7.
[a] Baseline vacuum pressure for Building 6 port was assumed to be zero.



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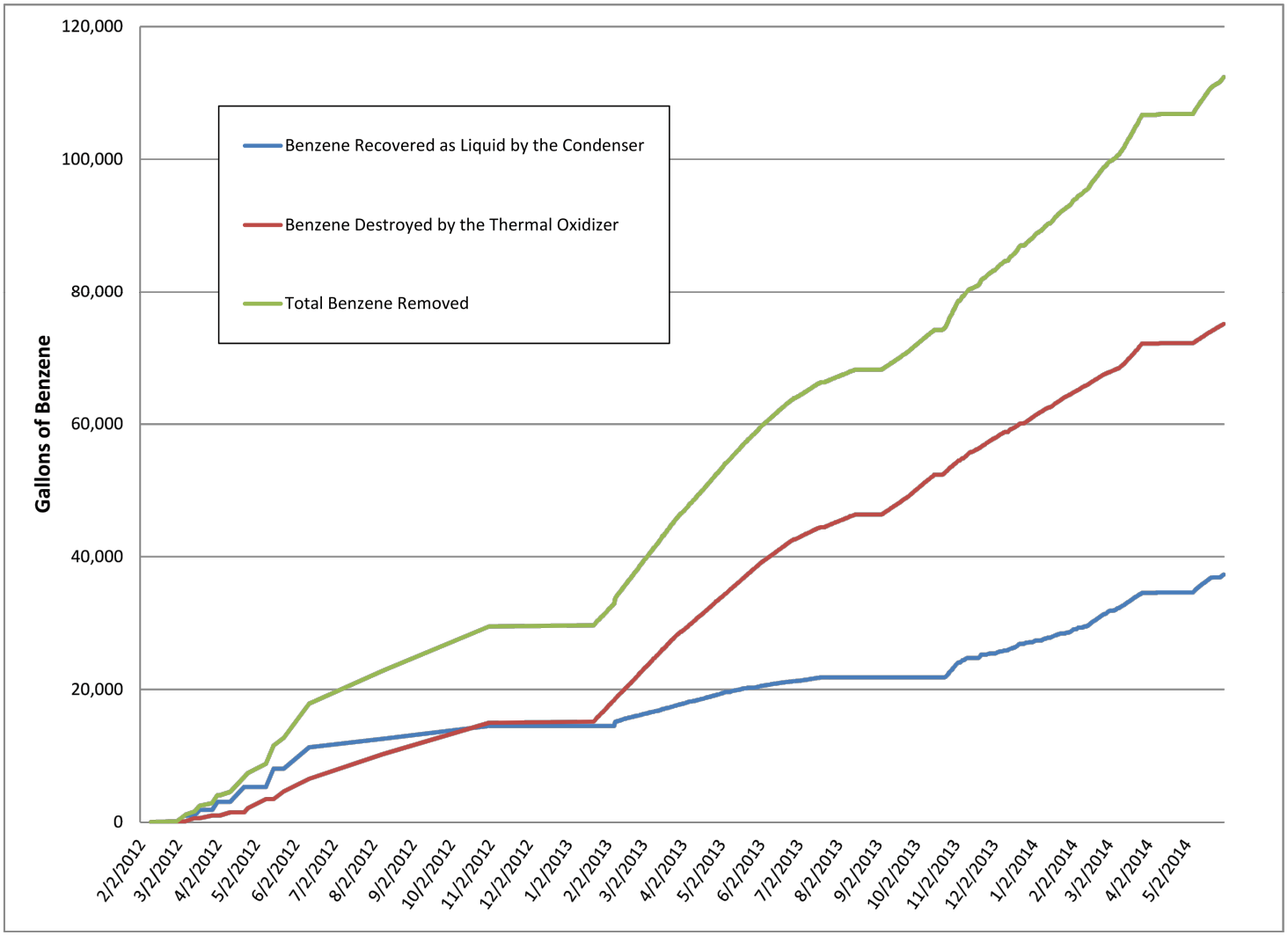
Client: El Paso Merchant Energy - Petroleum Company
Elementis Site - Corpus Christi, Texas

Report: Soil Vapor Extraction System
Annual Progress Report

Title: **Phase Concentrations of Composite Inlet Soil Vapor**

Drawn by:	Date:	Drawing File:	Figure:
gary_callahan	Aug 06, 2014	Charts.dwg	4-1

File: L:\AGE\Projects\ENV\Kinder Morgan\Kinder_Morgan_Elementis\Drawings-GIS\SVE_Annual_Progress_Report\2014_07\Charts.dwg Layout: Fig 4-1 Plotted: Aug 06, 2014 - 12:36pm



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Report: Soil Vapor Extraction System
Annual Progress Report

Title: **Cumulative Benzene Removal by the SVE System Over Time**

Drawn by:	Date:	Drawing File:	Figure:
gary_callahan	Aug 06, 2014	Charts.dwg	4-2

File: L:\AGE\Projects\ENV\Kinder Morgan\Kinder_Morgan_Elementis\Drawings-GIS\SVE_Annual_Progress_Report\2014_07\Charts.dwg Layout: Fig 4-2 Plotted: Aug 06, 2014 - 12:36pm

5.0 CONCLUSIONS

The primary goals of the LNAPL Removal System Upgrade are to reduce the potential pathways for human-health and ecological exposure and to achieve LNAPL mass removal such that apparent thicknesses in site monitor wells decrease to the goals stipulated by the AOC.

The AOC provides the following guidance for progress monitoring for LNAPL removal: *"A sufficient number of piezometers and monitoring wells shall be installed to measure and monitor the effectiveness of the LNAPL Removal System. The system shall be monitored quarterly for the first year and semi-annually thereafter until the Final Remediation Goals are met. Once the Final Remediation Goal is maintained for one year, annual monitoring shall be implemented and continue for five years. If the system is determined not to be effective to contain LNAPL thickness at the Final Remediation Goal, the system shall be enhanced, to contain LNAPL thickness at the Final Remediation Goal. Respondent shall monitor quarterly for the first year and semi-annually thereafter until the Final Remediation Goal is maintained."*

It is expected that, when LNAPL exists above the capillary fringe in the fine sand and contains a relatively high fraction of aromatics, a reduction in apparent thickness in monitor wells is possible. Operation of the SVE system has resulted in reduction of apparent LNAPL thicknesses across most of the area where SVE wells have been installed.

Currently, the SVE system is operating in Zones 2 and 3 to address subslab vapors, as well as target mass removal. To accomplish the AOC-stipulated goals, expansion of the SVE system is planned for all Zones beginning in 2015. LNAPL removal in Zone 1 will target mass removal to establish a buffer between the product plume and the surface water. The presence of fine-grained soils at the hydraulic surface and varying product type in some areas may present challenges. Implementation of SVE in all Zones will be determined after operational data are generated for the current and subsequent SVE application areas.

6.0 REFERENCES

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