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Final

Interim Measure Injection Completion Report
Former Unocal Chemical Distribution Facility

Prepared for:
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List of Acronyms and Abbreviations

%	percent
bgs	below ground surface
cDCE	cis-1,2-dichloroethene
cVOC	chlorinated volatile organic compound
Dhc	*Dehalococcoides* sp.
DPT	direct push technology
EHC®-L	EHC® Liquid
EMC	Environmental Management Company
ERD	enhanced reductive dechlorination
ft	foot, feet
gal	gallon(s)
gal/ft	gallon(s) per foot
gal/min	gallon(s) per minute
HASP	Health and Safety Plan
HPT	hydraulic profiling tool
HRC®	Hydrogen Release Compound®
IP	injection point
JSA	Job Safety Analysis
KDHE	Kansas Department of Health and Environment
L	Liter
lb	pound(s)
mg/L	milligrams per liter
min	minute
N/A	Not applicable
PCE	tetrachloroethene
psi	pounds per square inch
TCE	trichloroethene
TOC	total organic carbon
UIC	Underground Injection Control
Unocal	Unocal Chemical Distribution Facility
URS	URS Corporation
VC	vinyl chloride
VOC	volatile organic compounds
ZVI	zero valent iron

1.0 INTRODUCTION

This Interim Measure Injection Completion Report describes the enhanced reductive dechlorination (ERD) injections performed by the Chevron Environmental Management Company (EMC) for the former Unocal Chemical Distribution Facility (Unocal) in Wichita, Kansas and affected properties surrounding the Unocal site.

The electron donor material that was injected in the groundwater consisted of EHC®, a controlled-release carbon and zero valent iron (ZVI) formulation and EHC® Liquid (EHC®-L), a buffered, microemulsion of controlled release carbon, nutrients, and ferrous iron, to increase the rate of biological and/or chemical reductive dechlorination of chlorinated volatile organic compounds (cVOCs). This activity was performed as a Contingent Remedy in conjunction with the Preferred Remedy designated in the Draft Corrective Action Decision (Kansas Department of Health and Environment [KDHE], February 2013).

URS Corporation (URS) (now AECOM) was responsible for managing the injection activities at the site. The field activities associated with the work covered in this report began on June 23, 2014 and was completed on July 28, 2014.

2.0 SITE BACKGROUND

2.1 Project Site Description

The "site", as defined by the Consent Order for Remedial Investigation and Feasibility Study, Case 91-E-206, March 24, 1992 (hereafter referred to as the Consent Order), refers to the Unocal property located at 2100 East 37th Street North in Wichita, Kansas, in the southeast corner of the southwest quarter of Section 27, Township 26 South, Range 1 East. Future descriptors in the text of "on-site" and/or "off-site," when attributed to wells, plumelets, etc., refer to their location relative to the former Unocal property. Figure 2-1 shows the location of the Unocal site and adjacent properties.

2.2 Project Site History

Operations at the former Unocal property included receiving bulk shipments of liquid chemicals (primarily industrial solvents); temporarily storing these chemicals in above ground storage tanks; and filling orders for both drummed and bulk shipments. All facility structures, including an above ground chemical storage tank farm and the warehouse building, have been removed. A 7-foot (ft) tall chain-link fence with a locked gate secures the site. The former groundwater treatment trailer as well as all monitoring, and former recovery wells are secured with locks.

Figure 2-2 shows the various cVOC plumelets associated with the site and the locations of the historical injection locations. Historical injection events to enhance reductive dechlorination in groundwater impacted with cVOCs have been performed on the former Unocal and Coleman properties by Chevron EMC in September 1999, December 2006, and December 2009. These events are summarized as follows:

- In September 1999, Chevron EMC conducted a pilot test on the former Unocal property in the upgradient Plumelet A area. In the pilot test, Hydrogen Release Compound® (HRC®), a commercial biostimulant that provides a controlled release of lactic acid, was injected into groundwater impacted with cVOCs. The HRC® was distributed using an array of injection borings that formed a reactive zone perpendicular to the direction of groundwater flow. Post-injection groundwater monitoring showed a reduction of tetrachloroethene (PCE) and trichloroethene (TCE) concentrations. The PCE and dechlorination daughter compounds remained low after six years in groundwater downgradient from the reactive zone (Li and Mailloux, 2006).

- In December 2006, Chevron EMC conducted a pilot test on the Coleman property. HRC® was injected into the saturated materials at Coleman Biobarrier

A (downgradient area of Plumelets A and B) and CAP18-ME® was injected into the saturated materials at Coleman Biobarrier B (downgradient area of Plumelet A). The two products were distributed in arrays of injection borings that formed reactive zones oriented perpendicular to the direction of groundwater flow. Post injection groundwater monitoring showed that contaminant concentrations had decreased in wells downgradient of Coleman Biobarrier A (HRC® injections). The CAP18-ME® injections at Biobarrier B, however, were not effective in reducing cVOC concentrations (URS, March 2009).

- In December 2009, Chevron EMC conducted a second injection event at the location where the September 1999 pilot test had been performed on the former Unocal property in the Plumelet A source area. In the 2009 event, a mixture of glycerol and HRC-X® was injected into the on-site portion of Plumelet A. The glycerol/HRC-X® mixture was injected in arrays that formed four reactive zones perpendicular to the direction of groundwater flow. Post-injection monitoring data indicated that ERD had occurred in the onsite portion of Plumelet A; however, the amendments appear to be have been depleted, as evidenced by residual cis-1,2-dichloroethene (cDCE) and vinyl chloride (VC) concentrations (byproducts of PCE and TCE degradation) that remain (URS, February 2014).

The injections conducted during the June-July 2014 event are presented in next section.

3.0 REMEDIAL ACTIVITIES

This section presents the summary of the injection event performed between June 23, 2014 and July 28, 2014. During this event, the injections were performed at Plumelets A, B, and F. Figure 3-1 shows locations of injection points (IPs) and the performance monitoring locations.

3.1 Preliminary Activities

Work was performed as a Contingent Remedy in conjunction with the Preferred Remedy designated in the ***Draft Corrective Action Decision*** (KDHE, February 2013). Deviations from the ***Final Revision 0 Interim Measure Injection Work Plan 2014*** (URS, May 2014) are discussed in Section 3.7. In addition, the following permits and approvals were obtained prior to performing any activities at the site:

- Underground Injection Control (UIC) Permit was obtained from KDHE (Appendix A) (URS, June 2014a);
- Underground Injection Monitoring Plan was submitted to and approved by KDHE (Appendix B) (URS, June 2014b);
- Permission to obtain water from a hydrant on the Hillmann property was obtained from the property owner;
- Permission to obtain water from a spigot on the Coleman property was obtained from Coleman Project Manager; and
- 37th Street right-of-way access permit was obtained from the City of Wichita.

3.2 Preventative Measures

A Health and Safety Plan (HASP) was prepared for work performed by URS at the site. The HASP addressed the unique chemical and physical hazards associated with drilling, injection, and environmental sampling activities. In addition, a Job Safety Analysis (JSA) for the injection task was prepared. All URS personnel and subcontractors were briefed on the JSA, and provisions of the HASP, which includes Chevron EMC requirements.

A daily safety meeting was conducted among all workers every morning before work commenced. A Daily Safety Meeting Log was written and listed possible hazards that could be encountered by the activities planned for that day. All workers were expected to read, discuss, and sign the log at the end of the meeting. Subcontractors, vendors, or visiting personnel entering the site were given a safety orientation.

Exclusion barriers included the placement of orange construction fencing around the drilling locations to prevent visitors and unauthorized personnel from entering the work zone. Hard hats, high visibility vests, and safety glasses were required inside the exclusion barriers. In the event of lightning, all drilling operations were ceased and stalled for a minimum of 30 minutes. Existing utilities on site were identified and marked for protection.

3.3 Hydraulic Profiling Tool (HPT) Drilling

A hydraulic profiling tool (HPT) was used to determine specific target injection intervals for each treatment area. The HPT drilling during this event was performed as per the ***Final Revision 0 Interim Measure Injection Work Plan 2014*** (URS, May 2014).

All HPT drilling was performed by URS subcontractor. The HPT system was equipped to measure the flow of water injected into the subsurface and the resulting hydraulic pressure (relative to depth) to determine the hydraulic conductivity of the subsurface. A total of 16 direct push HPT borings were advanced from the ground surface to a depth between 25 ft to 45 ft below ground surface (bgs). The approximate locations of the HPT borings are presented on Figure 3-2. Dissipation tests were conducted to determine the hydrostatic pressure across the boring interval that is below the water table. From the HPT flow, HPT pressure, and hydrostatic pressure, the estimated hydraulic conductivity was calculated, if possible. Injection depths were determined based on the HPT profiles. HPT boring dissipation depths are presented in Table 3-1. HPT profiles are included in Appendix C.

3.4 Piezometer Installation and Monitoring

Prior to performing injections, three monitoring piezometers (MPZ-1, MPZ-2, and MPZ-3) were installed to provide additional performance monitoring locations (Figure 3-1). MPZ-1 and MPZ-2 were installed on the south side of Biobarrier B14-1. MPZ-3 was installed further downgradient of Biobarrier B14-1 and east of Biobarrier F14-2. The piezometers were constructed and developed per the procedures noted in ***Final Revision 0 Interim Measure Injection Work Plan 2014*** (URS, May 2014). For each piezometer, a 3.25-inch bore hole was drilled using direct push technology (DPT), and a continuous core sample was collected and logged by a URS geologist. Piezometers were installed with 1-inch diameter well casings and 15-ft integral pre-packed well screens and completed as flush mounts with 3x3 ft concrete pads. Piezometer boring logs are included in Appendix D.

Piezometer MPZ-1 was installed on June 26, 2014. The total depth of MPZ 1 boring was 28 ft bgs. The well casing was installed to 26 ft bgs, and the screen was installed between 11ft and 26 ft bgs. Total depth of the gravel and bentonite was 7 ft and 5 ft, respectively.

Piezometer MPZ-2 was installed on June 25, 2014. The total depth of MPZ 2 boring was 24 ft bgs. The well casing was installed to 22 ft bgs, and the screen was installed between 7 ft and 22 ft bgs. Total depth of the gravel and bentonite was 6 ft and 4 ft, respectively.

Piezometer MPZ-3 was installed on June 26, 2014. The total depth of MPZ 3 boring was 23 ft bgs. The well casing installed to 23 ft bgs, and the screen was installed between 8 ft and 23 ft bgs. Total depth of the gravel and bentonite was 7 ft and 5 ft, respectively.

The piezometers were developed first using a bailer to remove coarse-grained particles. A low flow peristaltic pump was then used to purge out approximately 1.1 gallons (gal) and 2.25 gal from MPZ-1 and MPZ-2, respectively, until the wells went dry. MPZ-3 was dry on June 27, 2014. On July 8, 2014, water was noted in MPZ-3, and the piezometer was developed using a bailer and peristaltic pump until the water was clear (not turbid); approximately 3 liters were purged from MPZ-3 during development.

Groundwater samples were collected from MPZ-1, MPZ-2, and MPZ-3 on July 9, 2014. MPZ-1 and MPZ-2 were low-flow purged with a peristaltic pump until the wells went dry. They were then sampled using disposable bailers due to low water volume in the well. MPZ-3 was sampled using disposable bailers due to low water volume in the well. Groundwater samples collected from MPZ-1 and MPZ-2 were analyzed for volatile organic compounds (VOCs), total organic carbon (TOC), volatile fatty acids, anions, total and dissolved iron/manganese, dissolved gases (methane, ethane, ethene, and carbon dioxide), and *Dehalococcoides* sp. (*Dhc*) and functional genes. Due to low well yield, samples collected for MPZ-3 were analyzed for all previously listed parameters except dissolved iron/manganese and *Dhc*. and functional genes.

3.5 In Situ Biobarriers and Gridded Area Injections

Groundwater injections were performed at the site to promote in-situ biological and chemical reduction of cVOCs in groundwater. The injection layout included a total of six biobarriers and one gridded area (Figure 3-1). The gridded area consisted of 20 IPs, which were placed in a staggered grid pattern with 20-ft centers. Each biobarrier was comprised of two rows of IPs spaced 10 ft apart, and the IPs within the rows were placed on 15-ft centers. All biobarriers were oriented perpendicular to groundwater flow.

The amendment selected for this injection included commercially available products EHC® and EHC®-L. All injections were performed using a 6620DT Geoprobe Systems® rig. Based on the current conditions at the site, a dosage of 3,400 milligrams per liter (mg/L) for EHC®-L in Plumelet A and a dosage of 0.1 percent (%) EHC® by weight of the soil in Plumelets B and F were selected.

Injection area A14-1 is located in the upgradient portion of Plumelet A. The first biobarrier A14-2 was placed on the Coleman property, approximately 650 ft hydraulically downgradient of injection area A14-1. Biobarrier A14-2 was constructed between monitoring wells R-6 (upgradient) and R-5 (downgradient) and was comprised of 24 IPs. Biobarrier A14-3 was also installed on the Coleman property, approximately 450 ft hydraulically downgradient of Biobarrier A14-2 and 60 ft upgradient of the Coleman building. Biobarrier A14-3 consisted of 50 IPs. Biobarrier B14-1 was installed along the southern edge of the Unocal property comprised of 31 IPs. Biobarrier F14-1 was installed on the former Hillmann (Pinsker) property, approximately 100 ft downgradient of the Unocal site's western property line, and consisted of 16 IPs. Biobarrier F14-2 was installed along the Coleman property boundary between 37th Street and monitoring well TW-2. Biobarrier F14-2 consisted of 17 IPs. Biobarrier F14-3 was installed along the Coleman property, approximately 20 ft upgradient of monitoring well MW-25, and consisted of 13 IPs.

Select photographs of the operations are included as Appendix E.

3.5.1 EHC®-L Injections

The injection gridded area, A14-1 and two biobarriers, A14-2 and A14-3 were injected with EHC®-L. EHC®-L is a buffered, microemulsion variant of EHC® that contains a controlled release carbon source, nutrients, and soluble iron. EHC®-L was injected at the site between July 8, 2014 and July 15, 2014 over 5-ft intervals using a top-down injection method. SDC-9®, a bioaugmentation culture used for the remediation of sites contaminated with chlorinated ethenes and ethanes, was injected at all IPs except A14-1, which had sufficient concentration of dechlorinating bacteria *Dhc*.

At the injection gridded area, it was targeted to inject a total of 15,000 gal solution (EHC®-L, iron powder, and mix water), estimating about 750 gal per IP which would be injected over four intervals at each of the 20 IPs. At Biobarrier A14-2, it was targeted to inject a total of 6,700 gal solution (EHC®-L, iron powder, SDC-9®, anaerobic water, and mix water), estimating about 275 gal per IP which would be injected over two intervals at each of 24 IPs. At Biobarrier A14-3, it was targeted to inject a total of 15,430 gal solution (EHC®-L, iron powder, SDC-9, anaerobic water, and mix water), estimating about 309 gal per IP which would be injected over two intervals at each of the 50 IPs.

Approximately 15,000 gal of EHC®-L solution was injected at area A14-1. Approximately 6,600 gal and 15,430 gal of EHC®-L solution was injected at Biobarrier A14-2 and Biobarrier A14-3, respectively. For the biobarriers, at the halfway point of each interval 0.20 liters (L) of SDC-9® was injected with a 5-gal anaerobic water pillow before and after injection. The specific

amounts of EHC®-L, iron powder, water, and total slurry injected at each interval of the IPs for the gridded area, A14-1, and biobarriers, A14-2 and A14-3 are provided in Tables 3-2, 3-3, and 3-4, respectively. Injection operations were conducted using accepted industry practices and procedures as per the approved ***Underground Injection Monitoring Plan*** (URS, June 2014b) presented in Appendix B. Cross-sections of injection intervals for each EHC®-L injection area or biobarrier are shown in Figure 3-3.

3.5.2 EHC® Injections

Four biobarriers, B14-1, F14-1, F14-2, and F14-3 were injected with EHC®. EHC® is a solid material composed of a soluble carbon source (e.g., electron donor material) and ZVI. EHC® was injected at the site between July 21, 2014 and July 28, 2014 over 1-ft intervals using a pressure-activated tool and top-down injection approach. SDC-9® was injected at all IPs that were injected with EHC®.

Biobarrier B14-1 was targeted to inject a total of 3,348 gal slurry (EHC®, SDC-9®, anaerobic water, and mix water), estimating about 108 gal per IP which would be injected over 14 intervals at each of the 31 IPs. Biobarrier F14-1 was targeted to inject a total of 2,060 gal slurry (EHC®, SDC-9®, anaerobic water, and mix water), estimating about 128 gal per IP which would be injected over 15 intervals at each of the 16 IPs. Biobarrier F14-2 was targeted to inject a total of 1,594 gal slurry (EHC®, SDC-9®, anaerobic water, and mix water), estimating about 94 gal per IP, which would be injected over 11 intervals at each of the 17 IPs. Biobarrier F14-3 was targeted to inject a total of 1,470 gal solution (EHC®, SDC-9®, anaerobic water, and mix water), estimating about 113 gal per IP, which would be injected over 13 intervals at each of 13 IPs.

Approximately 2,700 gal, 2,060 gal, 1,600 gal, and 1,470 gal of EHC® slurry was injected at B14-1, F14-1, F14-2, and F14-3, respectively. At the halfway point of each location, 0.25 L of SDC-9® was added along with a 10-gal anaerobic water pillow before and after injection. The specific amount of EHC®, iron powder, water, and total slurry injected at each interval of the IPs for biobarriers B14-1, F14-1, F14-2, and F14-3 are provided in Tables 3-5, 3-6, 3-7, and 3-8, respectively. Injection operations were conducted using accepted industry practices and procedures as per the approved ***Underground Injection Monitoring Plan*** (URS, June 2014b) presented in Appendix B. Cross-sections of injection intervals for each EHC® injection biobarriers are shown on Figure 3-4.

3.6 Injection Point Plugging

All 165 temporary injection points were plugged with hydrated bentonite chips from the top of the injection zone to the surface.

3.7 Deviations from Work Plan

The ***Final Revision 0 Interim Measure Injection Work Plan 2014*** (URS, May 2014) stated that 171 IPs would be placed for the one injection grid and six biobarriers. A total of 165 IPs were actually placed to construct the injection grid and six biobarriers. The injection grid (A14-1) and biobarriers (A14-2, A14-3, F14-1, F14-2, and F14-3) were completed as per the approved work plan. Table 3-9 presents a summary table of Work Plan deviations.

Of the 31 IPs planned for Biobarrier B14-1, only 25 IPs were placed. Six IPs (10, 11, 12, 13, 14, and 31) were not placed due to site issues. It is not anticipated that there would be an impact to the overall contaminant management since two additional barriers are downgradient of B14-1. In addition, the Work Plan stated that the target injection depth for B14-1 was 13-25 ft bgs. Based on the HPT results, the injection interval for IPs at B14-1 were changed to 13-26 ft bgs, averaging 7.7 gallons per foot (gal/ft), in comparison to the 8.7 gal/ft as planned in the Work Plan. The Work Plan also stated that approximately 9,346 pounds (lb) of EHC® would be used to complete B14-1. B14-1 was completed using 7,800 lb of EHC®. This deviation was due to the difference between the expected and actual depths to bedrock in the area of the injections and inaccessible IPs.

The Work Plan stated that the target injection depth for A14-1 was 15-34 ft bgs. Based on the HPT results, injections were actually performed between 15-35 ft bgs, averaging 37.5 gal/ft, in comparison to the 39.5 gal/ft as planned in the Work Plan. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that the target injection depth for A14-2 was 20-28 ft bgs. Based on the HPT results, injections were actually performed between 18-28 ft bgs, averaging 27.5 gal/ft, in comparison to the 34.3 gal/ft as planned in the Work Plan. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that the target injection depth for A14-3 was 14-23 ft bgs. Based on the HPT results, injections were performed between 14-24 ft bgs, averaging 30.9 gal/ft, in comparison to the 34.3 gal/ft as planned in the Work Plan. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that the target injection depth for F14-1 was 15-30 ft bgs. Based on the HPT results, injections were performed between 15-29 ft bgs, averaging 8.6 gal/ft, in comparison to the 9.2 gal/ft as planned in the Work Plan. The Work Plan also stated that approximately 6,372 lb of EHC® would be used to complete F14-1. F14-1 was completed using 5,952 lb of

EHC®. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that the target injection depth for F14-2 was 15-24 ft bgs. Based on the HPT results, injections were performed between 14-24 ft bgs, averaging 8.55 gal/ft, in comparison to the 9.3 gal/ft as planned in the Work Plan. The Work Plan also stated that approximately 4,142 lb of EHC® would be used to complete F14-2. F14-2 was completed using 4,590 lb of EHC®. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that the target injection depth for F14-3 was 13-26 ft bgs. Based on the HPT results, injections were performed between 13-25 ft bgs. The Work Plan also stated that approximately 4,602 lb of EHC® would be used to complete F14-3. F14-3 was completed using 4,225 lb of EHC®. This deviation was mostly due to the difference between the expected and actual depths to bedrock in the area of the injections.

The Work Plan stated that 0.5 L of SDC-9® per IP will be injected at all of the IPs except A14-1. However, only 0.25 L of SDC-9® per IP was injected. This deviation was due to an increase in concentration of SDC-9®, which decreased the volume of SDC-9® required per IP.

Lastly, the Work Plan stated that a top-down approach would be used for the injections. A top-down approach was used at all the locations, except at several IPs in Biobarrier F14-3 which were injected using a bottom-up approach. This deviation from the Work Plan was intended as an injectate distribution test for EHC® IPs to determine the best method for injection that created minimal surfacing and distributed product in the target interval.

Table 3-1. HPT Profiling Summary Table

Boring	Date	Time	Total Depth ft bgs	Dissipation Depths ft bgs	Comments
HPT-MPZ1	6/23/2014	14:30	27.73	11.03 26.98	Probe advanced to refusal.
HPT-MPZ2	6/23/2014	12:05	30.10	23.28*	Probe advanced to refusal.
HPT-MPZ3	6/23/2014	13:35	29.68	28.88*	Probe advanced to refusal.
HPT-Area A14-1a	6/23/2014	17:20	38.33	10.98 18.98* 38.33*	Probe advanced to refusal.
HPT-Area A14-1b	6/24/2014	08:30	44.53	11.08 39.08*	Probe advanced to refusal.
HPT-A14-2a	6/24/2014	13:20	43.83	29.18* 34.23* 38.18	Probe advanced to refusal.
HPT-A14-2b	6/24/2014	14:25	43.48	35.63* 41.03*	Probe advanced to refusal.
HPT-A14-3a	6/25/2014	14:50	23.78	None	Probe advanced to refusal.
HPT-A14-3b	6/25/2014	15:45	29.33	None	Probe advanced to refusal.
HPT-A14-3c	6/25/2014	16:50	37.73	11.48 13.63	Probe advanced to refusal.
HPT-F14-1	6/24/2014	10:15	34.25	None	Boring pre-probed to approximately 3 ft bgs. Probe advanced to refusal.
HPT-F14-2	6/24/2014	11:30	25.30	9.58	Probe advanced to refusal.
HPT-F14-2a	6/27/2014	13:40	29.43	28.43	Probe advanced to refusal.
HPT-F14-3	6/24/2014	12:15	27.43	27.18	Probe advanced to refusal.
HPT-B14-1a	6/27/2014	12:50	30.50	22.18*	Probe advanced to refusal.

* Dissipation test failed at this depth.
bgs - Below ground surface.
ft - Feet, foot.
HPT - Hydraulic profiling tool.

Table 3-2. EHC®-L Injection Summary for Biobarrier A14-1

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC®-L gal	Iron Powder lb	Water gal	SDC-9 L	Total Volume gal
IP-1	7/9/2014	15	35	45-225	4.2	37.5	19	713	0	750
IP-2	7/9/2014	15	35	35-175	4.2	37.5	19	713	0	750
IP-3	7/9/2014	15	35	50-150	4.7	37.5	19	713	0	750
IP-4	7/9/2014	15	35	40-150	5.4	37.5	19	713	0	750
IP-5	7/9/2014	15	35	25-125	5.6	37.5	19	713	0	750
IP-6	7/9/2014	15	35	60-120	5.6	37.5	19	713	0	750
IP-7	7/10/2014	15	35	30-125	5.3	37.5	19	713	0	750
IP-8	7/8/2014	15	35	50-275	4.6	37.5	19	713	0	751
IP-9	7/10/2014	15	35	40-110	5.3	37.5	19	713	0	750
IP-10	7/10/2014	15	35	40-100	5.3	37.5	19	713	0	750
IP-11	7/10/2014	15	35	50-150	5.4	37.5	19	713	0	750
IP-12	7/10/2014	15	35	40-150	5.4	37.5	19	713	0	750
IP-13	7/10/2014	15	35	55-110	5.4	37.5	19	713	0	750
IP-14	7/9/2014	15	35	85-175	5.2	37.5	19	713	0	750
IP-15	7/9/2014	15	35	20-150	5.7	37.5	19	713	0	750
IP-16	7/10/2014	15	35	40-150	5.7	37.5	19	713	0	750
IP-17	7/9/2014	15	35	50-175	5.7	37.5	19	713	0	750
IP-18	7/9/2014	15	35	25-110	1.3	37.5	19	713	0	750
IP-19	7/9/2014	15	35	35-125	5.3	37.5	19	713	0	750
IP-20	7/10/2014	15	35	55-110	5.4	37.5	19	713	0	750
					Total	750	380	14,260	0	15,001

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-3. EHC®-L Injection Summary for Area A14-2

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC®-L gal	Iron Powder lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-1	7/11/2014	18	28	100-175	3.9	13.76	7	0.40	20	261	275
IP-2	7/11/2014	18	28	90-200	3.9	13.76	7	0.40	20	261	275
IP-3	7/12/2014	18	28	120-150	2.8	13.76	7	0.33	20	261	275
IP-4	7/12/2014	18	28	125-160	3.4	13.76	7	0.33	20	261	275
IP-5	7/11/2014	18	28	75-200	4.0	13.76	7	0.40	20	261	275
IP-6	7/11/2014	18	28	75-115	4.4	13.76	7	0.40	20	261	275
IP-7	7/12/2014	18	28	120-145	3.4	13.76	7	0.33	20	261	275
IP-8	7/11/2014	18	28	100-180	4.5	13.76	7	0.40	20	261	275
IP-9	7/11/2014	18	28	50-250	4.3	13.76	7	0.40	20	261	275
IP-10	7/11/2014	18	28	150-220	4.5	13.76	7	0.40	20	261	275
IP-11	7/12/2014	18	28	150-220	3.8	13.76	7	0.33	20	261	275
IP-12	7/12/2014	18	28	75-125	4.5	13.76	7	0.25	20	261	275
IP-13	7/11/2014	18	28	75-150	4.9	13.76	7	0.40	20	261	275
IP-14	7/11/2014	18	28	35-150	5.3	13.76	7	0.40	20	261	275
IP-15	7/12/2014	18	28	75-200	5.0	13.76	7	0.25	20	261	275
IP-16	7/11/2014	18	28	75-150	4.9	13.76	7	0.40	20	261	275
IP-17	7/11/2014	18	28	75-179	5.6	13.76	7	0.40	20	261	275
IP-18	7/11/2014	18	28	75-150	4.8	13.76	7	0.40	20	261	275
IP-19	7/12/2014	18	28	100-175	5.1	13.76	7	0.25	20	261	275
IP-20	7/11/2014	18	28	75-120	4.5	13.76	7	0.40	20	261	275
IP-21	7/11/2014	18	28	75-175	4.8	13.76	7	0.40	20	261	275
IP-22	7/12/2014	18	28	100-160	4.7	13.76	7	0.25	20	261	275
IP-23	7/11/2014	18	28	75-150	4.0	13.76	7	0.40	20	261	275
IP-24	7/12/2014	18	28	110-175	4.5	13.76	7	0.25	20	261	275
					Total	330.24	168	8.57	480	6,264	6,600

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-4. EHC®-L Injection Summary for Area A14-3

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC®-L gal	Iron Powder lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-1	7/13/2014	12	22	140-240	5.2	15.43	8	0.25	20	294	309
IP-2	7/13/2014	12	22	100-220	5.0	15.43	8	0.25	20	294	309
IP-3	7/13/2014	12	22	160-200	5.2	15.43	8	0.25	20	294	309
IP-4	7/13/2014	12	22	160-245	5.2	15.43	8	0.25	20	294	309
IP-5	7/13/2014	12	22	140-270	5.1	15.43	8	0.25	20	294	309
IP-6	7/13/2014	12	22	165-270	4.9	15.43	8	0.25	20	294	309
IP-7	7/13/2014	12	22	150-240	4.8	15.43	8	0.25	20	294	309
IP-8	7/13/2014	12	22	100-220	5.2	15.43	8	0.25	20	294	309
IP-9	7/13/2014	12	22	100-150	5.4	15.43	8	0.25	20	294	309
IP-10	7/13/2014	12	22	125-200	4.9	15.43	8	0.25	20	294	309
IP-11	7/13/2014	12	22	125-200	5.1	15.43	8	0.25	20	294	309
IP-12	7/13/2014	12	22	90-190	5.3	15.43	8	0.25	20	294	309
IP-13	7/13/2014	12	22	200-275	4.8	15.43	8	0.25	20	294	309
IP-14	7/13/2014	12	22	100-200	5.3	15.43	8	0.25	20	294	309
IP-15	7/13/2014	12	22	140-170	5.0	15.43	8	0.25	20	294	309
IP-16	7/13/2014	12	22	140-240	5.2	15.43	8	0.25	20	294	309
IP-17	7/14/2014	13	23	140-200	5.1	15.43	8	0.25	20	294	309
IP-18	7/14/2014	13	23	45-175	4.3	15.47	8	0.20	20	294	309
IP-19	7/14/2014	13	23	25-210	4.5	15.47	8	0.20	20	294	309
IP-20	7/14/2014	13	23	50-175	4.5	15.47	8	0.20	20	294	309
IP-21	7/14/2014	13	23	145-260	5.1	15.47	8	0.20	20	294	309
IP-22	7/14/2014	13	23	140-220	5.4	15.47	8	0.20	20	294	309
IP-23	7/14/2014	13	23	60-220	5.2	15.47	8	0.20	20	294	309
IP-24	7/14/2014	13	23	125-250	5.2	15.47	8	0.20	20	294	309
IP-25	7/14/2014	13	23	90-225	5.5	15.47	8	0.20	20	294	309
IP-26	7/14/2014	13	23	190-250	5.2	15.47	8	0.20	20	294	309
IP-27	7/14/2014	13	23	100-170	5.3	15.47	8	0.20	20	294	309
IP-28	7/14/2014	13	23	65-150	5.2	15.47	8	0.20	20	294	309
IP-29	7/14/2014	13	23	75-220	5.2	15.47	8	0.20	20	294	309
IP-30	7/14/2014	13	23	50-180	5.2	15.47	8	0.20	20	294	309

Table 3-4. EHC®-L Injection Summary for Area A14-3 (Continued)

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC®-L gal	Iron Powder lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-31	7/14/2014	13	23	100-175	5.1	15.47	8	0.20	20	294	309
IP-32	7/14/2014	13	23	65-170	5.1	15.47	8	0.20	20	294	309
IP-33	7/14/2014	13	23	250-275	5.1	15.47	8	0.20	20	294	309
IP-34	7/15/2014	14	24	45-150	5.1	15.42	8	0.20	20	293	308
IP-35	7/15/2014	14	24	40-220	5.1	15.42	8	0.20	20	293	308
IP-36	7/15/2014	14	24	60-120	4.8	15.42	8	0.20	20	293	308
IP-37	7/15/2014	14	24	55-100	5.1	15.42	8	0.20	20	293	308
IP-38	7/15/2014	14	24	25-75	5.2	15.42	8	0.20	20	293	308
IP-39	7/15/2014	14	24	35-70	5.1	15.42	8	0.20	20	293	308
IP-40	7/15/2014	14	24	25-70	5.2	15.42	8	0.20	20	293	308
IP-41	7/15/2014	14	24	35-50	5.3	15.42	8	0.20	20	293	308
IP-42	7/15/2014	14	24	25-60	4.7	15.42	8	0.20	20	293	308
IP-43	7/15/2014	14	24	30-75	4.3	15.42	8	0.20	20	293	308
IP-44	7/15/2014	14	24	50-125	5.3	15.42	8	0.20	20	293	308
IP-45	7/15/2014	14	24	55-110	5.2	15.42	8	0.20	20	293	308
IP-46	7/15/2014	14	24	75-90	5.1	15.42	8	0.20	20	293	308
IP-47	7/15/2014	14	24	30-100	5.3	15.42	8	0.20	20	293	308
IP-48	7/15/2014	14	24	40-100	5.1	15.42	8	0.20	20	293	308
IP-49	7/15/2014	14	24	30-120	5.4	15.42	8	0.20	20	293	308
IP-50	7/15/2014	14	24	40-125	5.1	15.42	8	0.20	20	293	308
					Total	771.97	400	10.85	1,000	14,683	15,433

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-5. EHC® Injection Summary for Area B14-1

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC® lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-1	7/28/2014	13	26	200-510	12.0	312	0.25	30	87	108
IP-2	7/28/2014	13	26	250-610	12.0	312	0.25	30	87	108
IP-3	7/27/2014	13	26	350-370	12.0	312	0.25	30	87	108
IP-4	7/27/2014	13	26	250-610	12.0	312	0.25	30	87	108
IP-5	7/27/2014	13	26	400-600	12.0	312	0.25	30	87	108
IP-6	7/27/2014	13	26	310-610	12.0	312	0.25	30	87	108
IP-7	7/28/2014	13	26	410-600	12.0	312	0.25	30	87	108
IP-8	7/28/2014	13	26	270-620	12.0	312	0.25	30	87	108
IP-9	7/28/2014	13	26	310-450	12.0	312	0.25	30	87	108
IP-15	7/24/2014	13	26	250-600	12.0	312	0.25	30	87	108
IP-16	7/25/2014	13	26	200-410	12.0	312	0.25	30	87	108
IP-17	7/24/2014	13	26	225-650	12.0	312	0.25	30	87	108
IP-18	7/25/2014	13	26	210-410	12.0	312	0.25	30	87	108
IP-19	7/24/2014	13	26	310-400	12.0	312	0.25	30	87	108
IP-20	7/24/2014	13	26	310-600	12.0	312	0.25	30	87	108
IP-21	7/24/2014	13	26	280-540	12.0	312	0.25	30	87	108
IP-22	7/25/2014	13	26	310-480	12.0	312	0.25	30	87	108
IP-23	7/25/2014	13	26	290-410	12.0	312	0.25	30	87	108
IP-24	7/25/2014	13	26	280-510	12.0	312	0.25	30	87	108
IP-25	7/25/2014	13	26	260-600	12.0	312	0.25	30	87	108
IP-26	7/26/2014	13	26	220-410	12.0	312	0.25	30	87	108
IP-27	7/26/2014	13	26	220-410	12.0	312	0.25	30	87	108
IP-28	7/25/2014	13	26	250-410	12.0	312	0.25	30	87	108
IP-29	7/25/2014	13	26	250-450	12.0	312	0.25	30	87	108
IP-30	7/26/2014	13	26	220-450	12.0	312	0.25	30	87	108
					Total	7,800	6.25	750	2,175	2,700

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - Liter.
lb - Pound.
min - Minute.
N/A - Not applicable.
psi - Pounds per square inch.

Table 3-6. EHC® Injection Summary for Area F14-1

Point	Date Completed	Top of Interval	Bottom of Interval	Pressure Range	Average Flow Rate	EHC®	SDC-9	Anaerobic Water	Mix Water	Total Volume
		ft bgs	ft bgs	psi	gal/min	lb	L	gal	gal	gal
IP-1	7/27/2014	15	29	340-590	12.0	372	0.25	30	104	129
IP-2	7/27/2014	15	29	290-410	12.0	372	0.25	30	104	129
IP-3	7/27/2014	15	29	180-500	12.0	372	0.25	30	104	129
IP-4	7/27/2014	15	29	220-420	12.0	372	0.25	30	104	129
IP-5	7/27/2014	15	29	270-520	12.0	372	0.25	30	104	129
IP-6	7/27/2014	15	29	190-370	12.0	372	0.25	30	104	129
IP-7	7/27/2014	15	29	460-820	12.0	372	0.25	30	104	129
IP-8	7/27/2014	15	29	250-490	12.0	372	0.25	30	104	129
IP-9	7/26/2014	15	29	300-600	12.0	372	0.25	30	104	129
IP-10	7/26/2014	15	29	360-620	12.0	372	0.25	30	104	129
IP-11	7/26/2014	15	29	290-510	12.0	372	0.25	30	104	129
IP-12	7/26/2014	15	29	230-610	12.0	372	0.25	30	104	129
IP-13	7/26/2014	15	29	430-820	12.0	372	0.25	30	104	129
IP-14	7/26/2014	15	29	360-500	12.0	372	0.25	30	104	129
IP-15	7/26/2014	15	29	220-700	12.0	372	0.25	30	104	129
IP-16	7/26/2014	15	29	310-620	12.0	372	0.25	30	104	129
					Total	5,952	4.0	480	1,664	2,064

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-7. EHC® Injection Summary for Area F14-2

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC® lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-1	7/22/2014	14	24	410-740	12.0	270	0.25	10	76	94
IP-2	7/24/2014	14	24	220-610	12.0	270	0.25	30	76	94
IP-3	7/23/2014	14	24	300-400	12.0	270	0.25	10	76	94
IP-4	7/24/2014	14	24	275-440	12.0	270	0.25	30	76	94
IP-5	7/22/2014	14	24	400-700	12.0	270	0.25	10	76	94
IP-6	7/23/2014	14	24	390-470	12.0	270	0.25	30	76	94
IP-7	7/23/2014	14	24	290-650	12.0	270	0.25	10	76	94
IP-8	7/23/2014	14	24	380-500	12.0	270	0.25	30	76	94
IP-9	7/24/2014	14	24	290-460	12.0	270	0.25	30	76	94
IP-10	7/23/2014	14	24	330-525	12.0	270	0.25	30	76	94
IP-11	7/23/2014	14	24	400-600	12.0	270	0.25	10	76	94
IP-12	7/23/2014	14	24	370-510	12.0	270	0.25	30	76	94
IP-13	7/23/2014	14	24	250-440	12.0	270	0.25	30	76	94
IP-14	7/23/2014	14	24	300-690	12.0	270	0.25	10	76	94
IP-15	7/23/2014	14	24	200-710	12.0	270	0.25	10	76	94
IP-16	7/23/2014	14	24	370-500	12.0	270	0.25	10	76	94
IP-17	7/23/2014	14	24	230-470	12.0	270	0.25	30	76	94
					Total	4,590	4.25	350	1,292	1,598

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - Liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-8. EHC® Injection Summary for Area F14-3

Point	Date Completed	Top of Interval ft bgs	Bottom of Interval ft bgs	Pressure Range psi	Average Flow Rate gal/min	EHC® lb	SDC-9 L	Anaerobic Water gal	Mix Water gal	Total Volume gal
IP-1	7/21/2014	13	26	450-870	11.9	325	0.25	10	91	113
IP-2	7/22/2014	13	26	500-710	12.1	325	0.25	10	91	113
IP-3	7/22/2014	13	26	300-720	12.0	325	0.25	10	91	113
IP-4	7/21/2014	13	26	410-600	12.1	325	0.25	10	91	113
IP-5	7/22/2014	13	26	310-450	12.1	325	0.25	10	91	113
IP-6	7/22/2014	13	26	210-370	12.1	325	0.25	10	91	113
IP-7	7/21/2014	13	26	310-590	12.1	325	0.25	10	91	113
IP-8	7/21/2014	13	26	420-720	11.9	325	0.25	10	91	113
IP-9	7/21/2014	13	26	300-490	12.1	325	0.25	10	91	113
IP-10	7/22/2014	13	26	370-490	12.0	325	0.25	10	91	113
IP-11	7/22/2014	13	26	210-550	11.9	325	0.25	10	91	113
IP-12	7/21/2014	13	26	250-750	13.7	325	0.25	10	91	113
IP-13	7/21/2014	13	26	390-590	12.1	325	0.25	10	91	113
					Total	4,225	3.25	130	1,183	1,469

bgs - Below ground surface.
EHC®-L - EHC® Liquid.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.
L - Liter.
lb - Pound.
min - Minute.
psi - Pounds per square inch.

Table 3-9. Work Plan Deviation Summary Table

Injection Area	Work Plan Injection Depth ft bgs	Actual Injection Depth ft bgs	Work Plan Injection Quantity per Foot gal/ft	Actual Injection Quantity per Foot gal/ft	Work Plan Number of IPs	Actual Number of IPS
A14-1	15-34	15-35	37.5	39.5	20	20
A14-2	20-28	18-28	27.5	34.3	24	24
A14-3	14-23	14-24	30.9	34.3	50	50
B14-1	13-25	13-26	8.7	7.7	31	25
F14-1	14-23	14-24	8.6	9.2	16	16
F14-2	15-30	15-29	8.5	9.3	17	17
F14-3	15-24	14-24	8.7	9.4	13	13

bgs - Below ground surface.
ft - Feet, foot.
gal - Gallon.
IP - Injection point.

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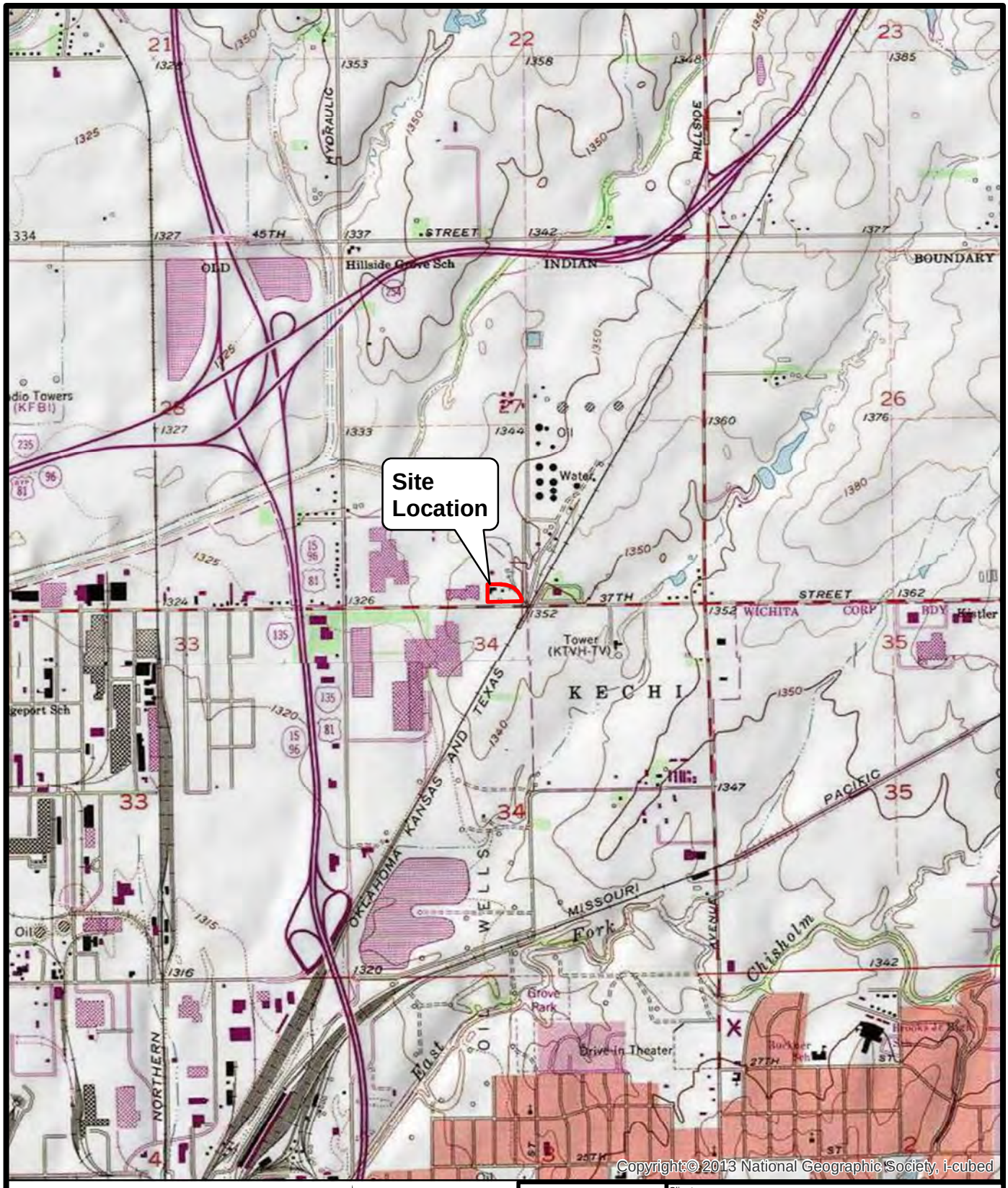
FIGURES



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Feet

URS

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Austin, TX 78729
Phone: (512) 454-4797
Fax: (512) 419-5474

Client: Former Unocal Chemical Distribution Facility Wichita, Kansas

Title: **Site Location Map**

Drawn by:	Date:	GIS File:	Figure:
gwc/aus	9/2/2014	Fig 1 Site Loc Map.mxd	2-1

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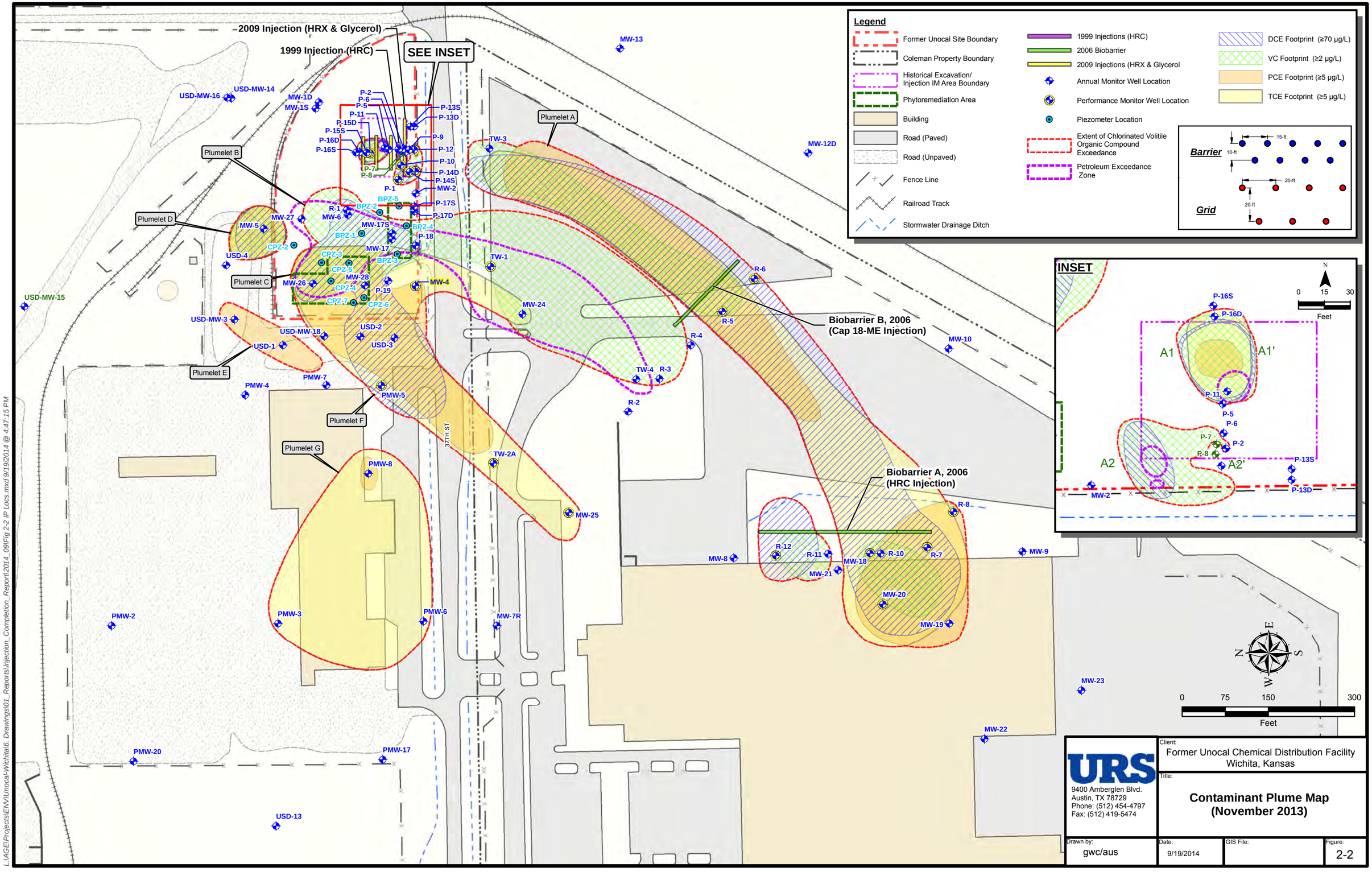

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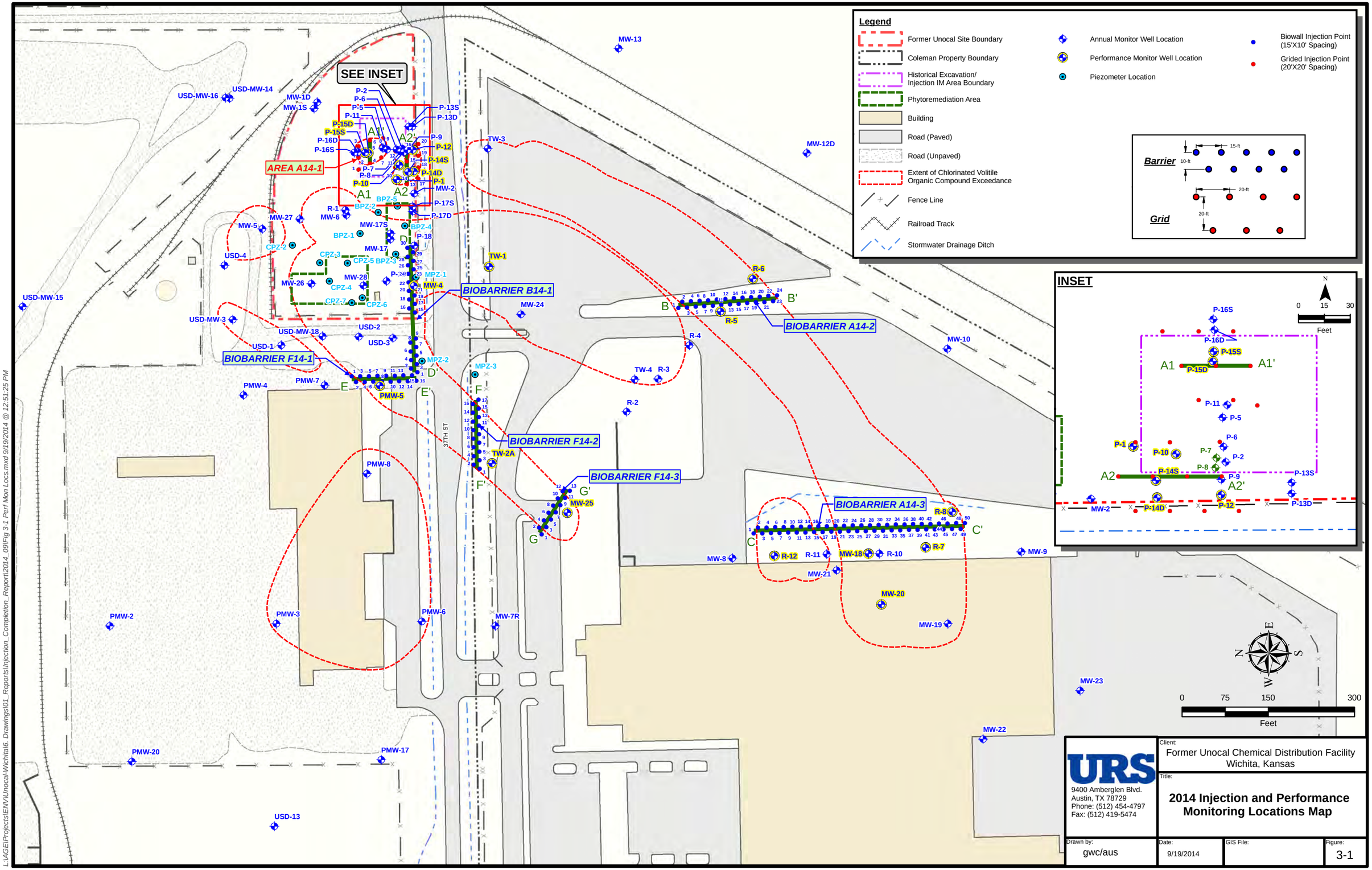
URS 9400 Amberglen Blvd. Austin, TX 78729 Phone: (512) 454-4797 Fax: (512) 419-5474	Client: Former Unocal Chemical Distribution Facility Wichita, Kansas		
	Title: **Contaminant Plume Map (November 2013)**		
Drawn by: gwc/aus	Date: 9/19/2014	GIS File:	Figure: 2-2



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Title: **2014 Injection and Performance Monitoring Locations Map**

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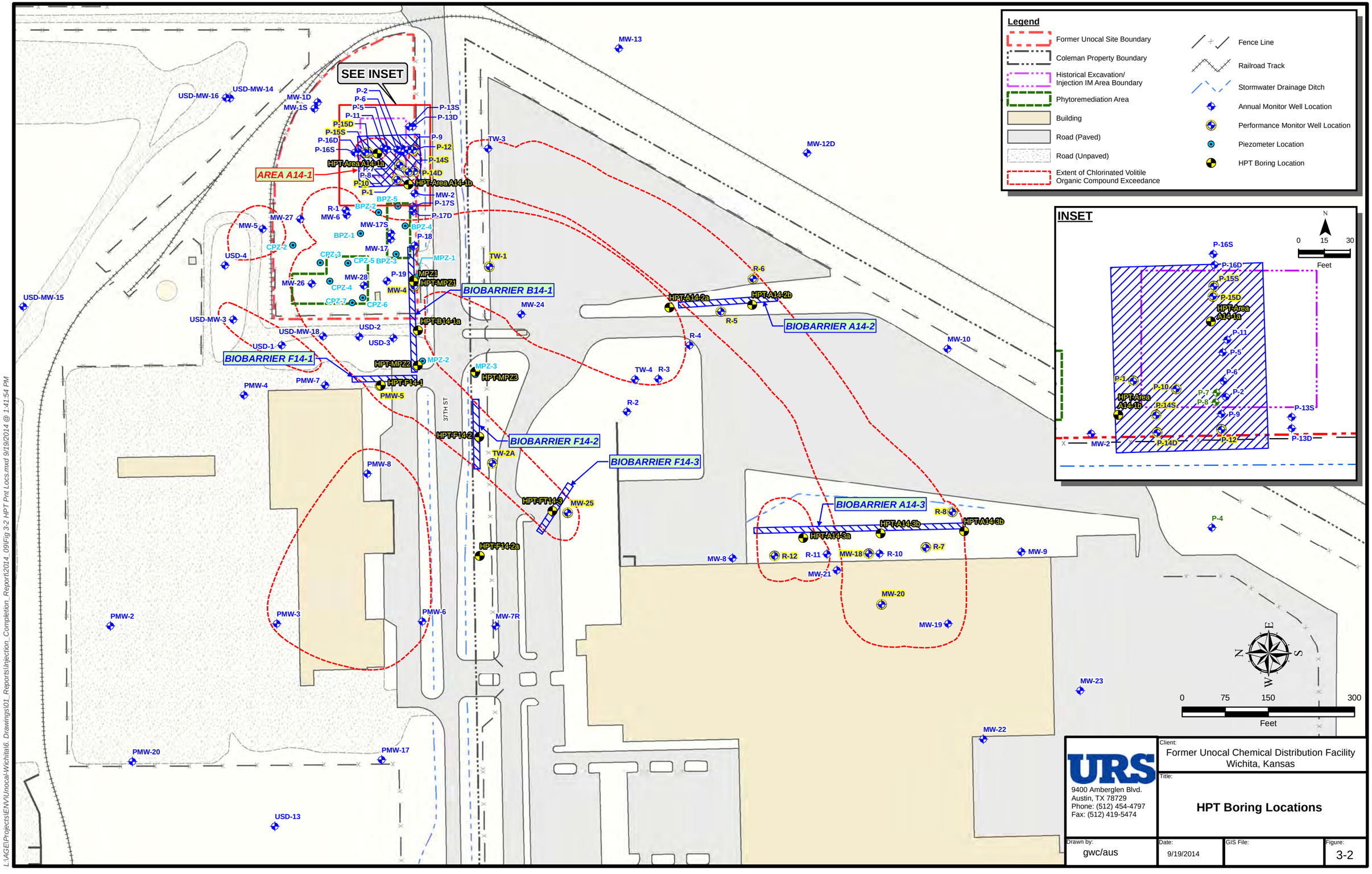

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Title: **HPT Boring Locations**

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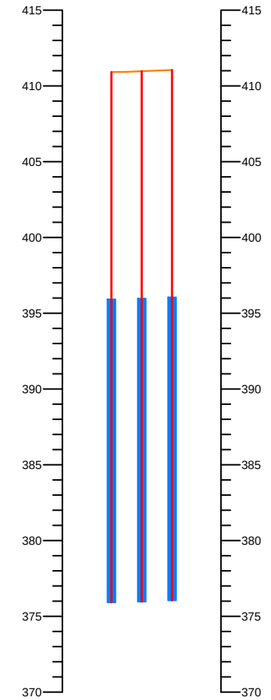
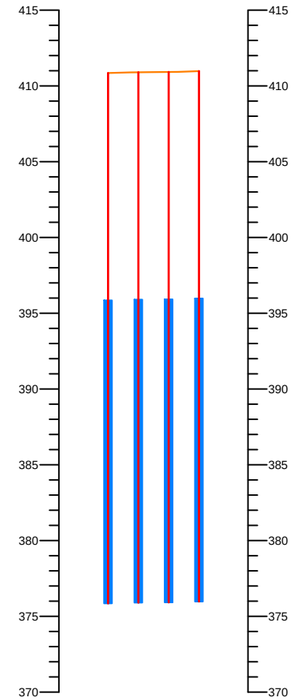
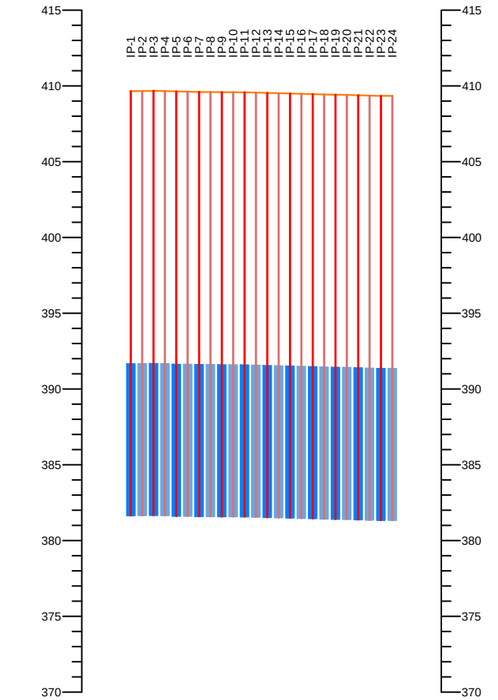
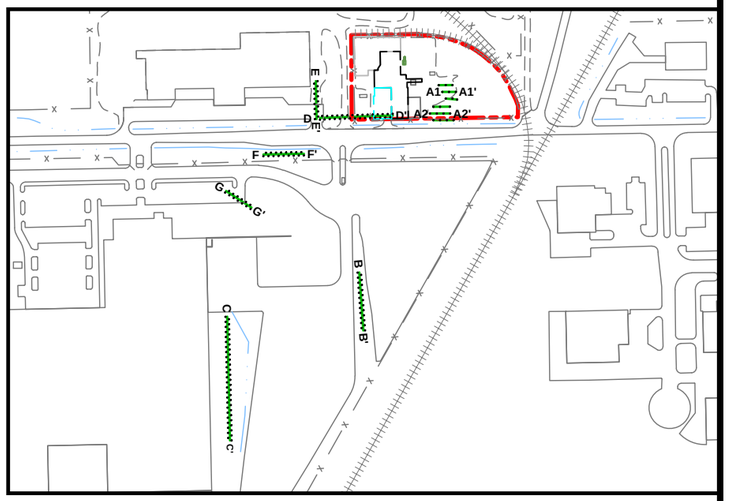








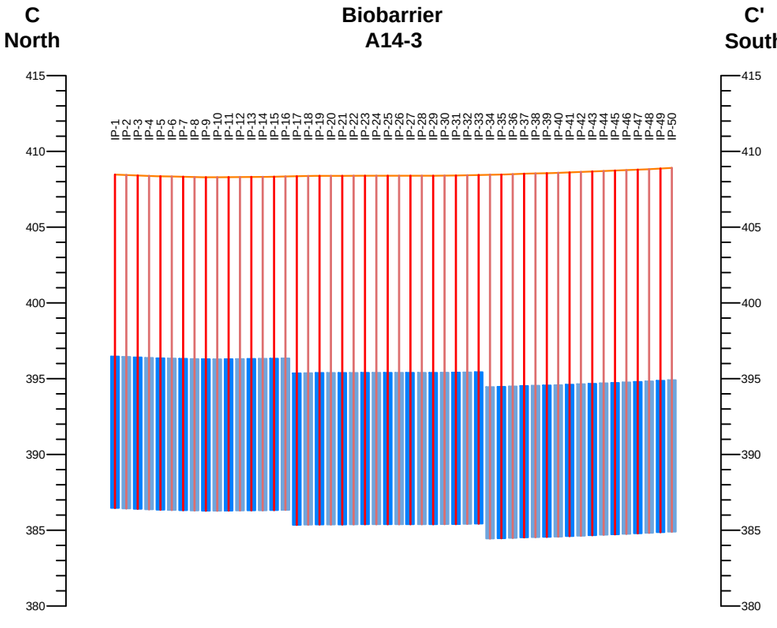
Legend

Lithostratigraphic Units

Ground Surface

Biowall Injection Sample

Injection Interval



50 0 100

Horizontal Scale in Feet
Vertical Exaggeration = 10X

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

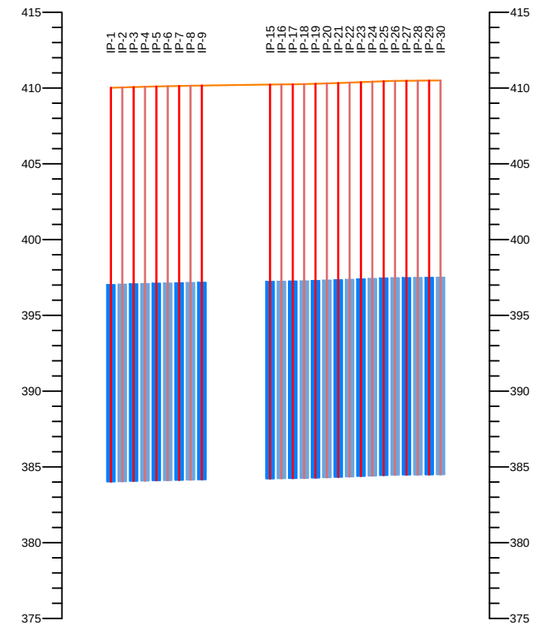
Client: **Former Unocal Chemicals Distribution Facility**

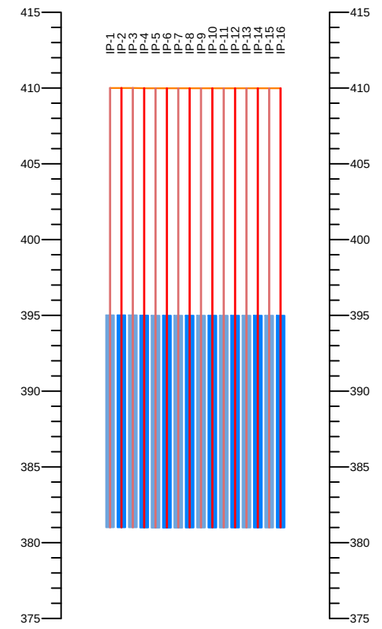
Title:

EHC®-L Barrier Injection Intervals

Drawn by:	Date:	Drawing File:	Figure:
gwc	08/06	IP_Xsections.dwg	3-3

File: L:\AGE\Projects\EW\Unocal-Wichita\6. Drawings\01_Reports\Injection_Completion_Report\2014_09\IP_Xsections.dwg Layout: Fig 3-3 Plotted: Sep 19, 2014 - 2:25pm





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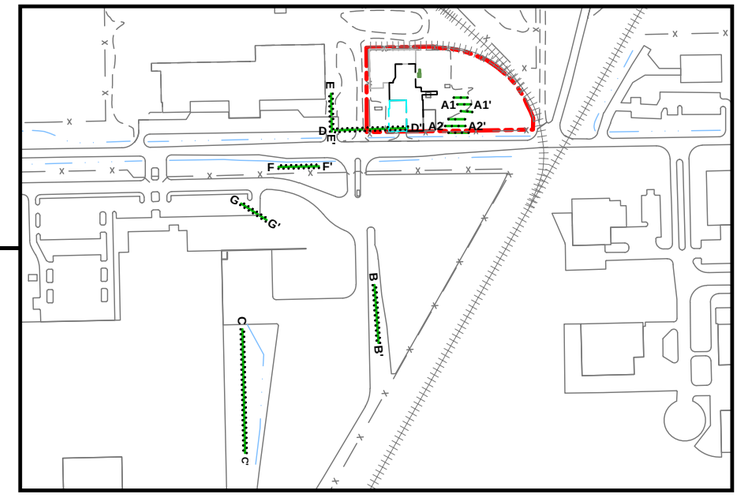
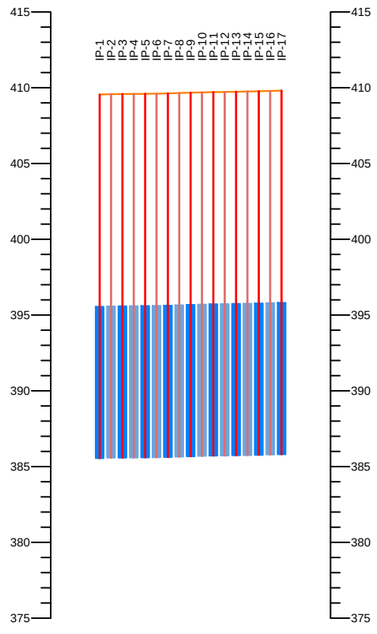
Lithostratigraphic Units

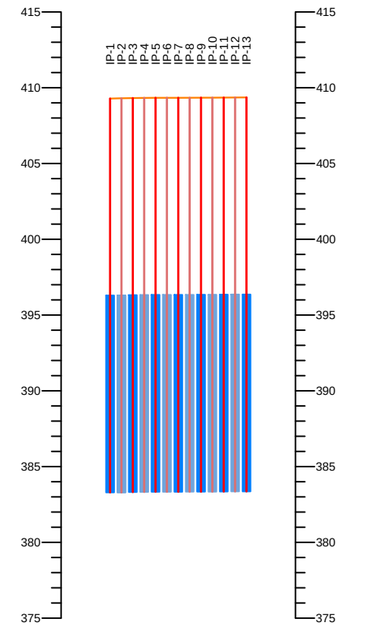
Ground Surface

Biowall Injection Sample

Injection Interval







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Horizontal Scale in Feet
Vertical Exaggeration = 10X

URS
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Client: **Former Unocal Chemicals Distribution Facility**

Title:

EHC® Barrier Injection Intervals

Drawn by:	Date:	Drawing File:	Figure:
gwc	08/06	IP_Xsections.dwg	3-4

File: L:\AGE\Projects\ENV\Unocal-Wichita\6. Drawings\01_Reports\Injection_Completion_Report\2014_09\IP_Xsections.dwg Layout: Fig 3-4 Plotted: Sep 22, 2014 - 9:08am

Appendix A

UIC Permit Application and Approval

URS

June 6, 2014

Mr. Mike Cochran
Environmental Scientist
Bureau of Water – Geology Section
KDHE Bureau of Environmental Remediation
1000 SW Jackson Street, Suite 410
Topeka, KS 66612-1367

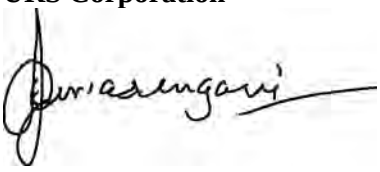
Sub: Submittal of Class V Underground Injection Control Application
Former Unocal Chemical Distribution Facility
2100 East 37th Street North
Wichita, Kansas 67219

Dear Mr. Cochran:

URS Corporation (URS) has prepared the Class V Underground Injection Control Application on behalf of Chevron Environmental Management Company (EMC) that describes the injection activities to promote enhanced reductive dechlorination (ERD) at the subject site. Piezometers are currently scheduled to be installed on June 23, 2014. Injections are currently scheduled to begin the week of June 30, 2014. We would appreciate your prompt review of the attached application.

If you have any questions or comments please feel free to contact me at 512-419-5123.

Respectfully Submitted,
URS Corporation



Purshotam K. Juriasingani, P.E, CEM
Project Manager

cc: Mr. Nathan Blomgren, P.G. (Chevron EMC)
File

Attachments

URS Corporation
9400 Amberglen Boulevard
Austin, TX 78729
P.O. Box 201088
Austin, TX 78720-1088
Tel : 512.454.4797
Fax : 512.454.8807
www.urscorp.com

Class V UIC Information

1. Name of facility and facility owner.

The Interim Measure (IM) will be conducted by URS Corporation (URS) on behalf of Chevron Environmental Management Company (EMC) on the former Unocal Chemical Distribution Facility (Unocal). The facility owner is Union Oil Company of California, care of Mr. Nathan Blomgren, P.G.

2. Name, address, and telephone number of facility owner.

Mr. Nathan Blomgren, P.G.
Project Manager
Superfund & Specialty Portfolio
Chevron Environmental Management Company
6101 Bollinger Canyon Road
San Ramon, CA 94583
Tel: (925) 408-4889
Fax: (925) 790-6772

3. Site latitude and longitude of each injection well to be used or installed, injection well/point identification numbers and a facility map with the location of the injection wells/points depicted in relation to water supply wells and monitoring wells located at and near the facility.

Chevron EMC plans to inject electron donor material (EHC® [a controlled-release carbon and zero valent iron (ZVI) formulation] and EHC® Liquid [a buffered, microemulsion of controlled release carbon, nutrients, and ferrous iron) into affected groundwater to increase the rate of biological and/or chemical reductive dechlorination of chlorinated volatile organic compounds (cVOCs). There are seven proposed injection areas that include portions of Plumelets A, B, and F. Figure 1 shows the proposed layout of the injection areas. The proposed layout includes one gridded injection area (A14-1) and six biobarriers (A14-2, A14-3, B14-1, F14-1, F14-2, and F14-3), each oriented perpendicular to groundwater flow. A total of 171 injection points (IPs) are proposed. The geographic coordinates for all proposed IPs are included in Table 1. Monitoring wells in the vicinity of the injection barriers will be used for monitoring the effectiveness of the injections.

4. Documentation KDHE's Bureau of Environmental Remediation approves the injection of the remedial compounds for the remediation project.

Discussions regarding this implementation have occurred with Holly Burke from Kansas Department of Health and the Environment's (KDHE's) Bureau of Environmental Remediation. Ms. Burke approved the ***Final Revision 0 Interim Measure Injection Workplan*** on May 28, 2014. A copy of KDHE's approval letter is provided in Attachment 1.

5. A description of the contamination and contamination source.

A groundwater plume of chlorinated solvents is present under the former Unocal site. Previous HRC® injection events were conducted in this area in 1999 and 2009. Four years after the last injection event, residual cVOC concentrations are present, and biological reductive dechlorination may be beginning to stall. Therefore, Chevron EMC has proposed to implement EHC® injections at the seven proposed treatment areas shown on Figure 1.

6. Schematic of typical injection point design.

Direct push technology (DPT) will be used to inject EHC® into the subsurface. Depending on formation conditions, the injections will be performed in either a top-down or bottom-up direction. A schematic is not included, as this is a typical probe injection.

7. Name and description of the geological formation into which the remedial compound will be injected.

The substrates will be injected into the weathered portion of the Wellington Shale (Permian in age) and the overlying Pleistocene alluvium deposits, which consist of unconsolidated clay, silt, sand, and gravel.

8. Approximate depth below ground surface of injection interval.

The depth of the injection interval will range from approximately 8 feet below ground surface (ft bgs) to approximately 34 ft bgs. This depth interval corresponds with the approximate location and thickness of the groundwater table.

9. Detailed description of the injection procedure, including proposed injection pressure.

The installation instructions for EHC® from PeroxyChem (formerly FMC Environmental Solutions) will be followed. EHC® will be injected into the subsurface using a ChemGrout 500 piston pump and a pressure-activated injection tool driven by a portable DPT drilling rig. EHC® Liquid will be injected using a progressive cavity pump and a fixed-open injection screen tool. This pressurized injection process allows the product to be placed into the zone of contamination. For long-term plume cut-off applications, such as the one at this site, a linear barrier of DPT injection points will be used.

Injection pressures will be determined using a hydraulic profiling tool (HPT), a direct-imaging downhole tool that measures the pressure required to inject a unit volume of water into the soil as the probe is advanced. Data collected from HPT testing will be used to select injection intervals and pressures.

10. Description of the contents and characteristics of the remedial compounds to be injected.

EHC® and EHC® Liquid are the amendments selected for different areas of the site, depending on site-specific geochemical conditions and contaminant concentrations. SDC-9®, a bioaugmentation culture, will also be used in some injection points.

EHC® is a solid material composed of a soluble carbon source (e.g., electron donor material) and ZVI. EHC® Liquid is a buffered, microemulsion variant of EHC® that contains a controlled release carbon source, nutrients, and soluble iron. Both formulations are designed to provide long-term (e.g., up to three years) availability of soluble carbon and chemically-reactive iron.

SDC-9® is a bioaugmentation culture used for the remediation of sites contaminated with chlorinated ethenes and ethanes that are lacking the necessary organisms that complete the degradation pathways. SDC-9® contains the dechlorinating bacteria *Dehalococcoides* sp. (*Dhc*). Based on the *Dhc* concentration in the SDC-9® concentrate and the volume of groundwater within the treatment area, a total injection amount of 0.5 L of SDC-9® will be used per IP in all of the areas except A14-1, which is known to have sufficient *Dhc* for continued biodegradation.

11. Amount of remedial compound to be injected.

Based on the current conditions at the site, a dosage of 3,400 milligrams per liter (mg/L) for EHC® Liquid in Plumelet A and a dosage of 0.1 percent (%) EHC® by weight of the soil in Plumelets B and F were selected. To determine the quantities of SDC-9® required, a final concentration of approximately $1x10^6$ *Dhc* per liter of groundwater was selected as a final target concentration. Based on the *Dhc* concentration in the SDC-9® concentrate and the volume of groundwater within the treatment area, a total injection amount of 0.5 L of SDC-9® will be used per IP in all of the areas except A14-1, which is known to have sufficient *Dhc* for continued biodegradation. Table 2 shows the preliminary estimates for quantities of amendments to be distributed within each of the treatment areas.

Treatment area dosage rates range from 8.7 gallons per foot (gal/ft) to 39.5 gal/ft.

12. Frequency of injection.

The frequency of injection will depend on the effectiveness of the system as determined by the monitoring plan. Groundwater monitoring will be used to confirm the reduction of cVOC concentrations, and therefore, the effectiveness of the injections, in area A14-1 and downgradient of the six biobarriers. Annual monitoring will occur at the site as described in the ***Final Revision 3 Sampling and Analysis Plan*** (URS, October 2013). Selected performance monitoring wells will be sampled on a more frequent basis. These performance monitoring wells will be sampled quarterly for the first two sampling events and then semi-annually for an additional four sampling events. The performance monitoring events will be conducted concurrent with the annual monitoring event during 2014, 2015, and 2016. As part of the annual groundwater monitoring reports, the effectiveness of the injections will be analyzed and reported to KDHE.

13. Plugging procedure for the injection point including a schematic of the injection point after plugging.

The plugging procedure will involve utilizing hydrated bentonite chips through gravity feed.

14. Description of the basic chemistry of the remediation process, including products and byproducts.

Anaerobic bacteria degrade chlorinated ethenes and ethanes, such as tetrachloroethene (PCE), through reductive dechlorination. For PCE, a chlorine atom is replaced by a hydrogen atom, reducing the compound to a lesser chlorinated species (trichloroethene [TCE]). Complete reductive dechlorination to ethene can be inhibited due to a lack of sufficient electron donor, the presence of competing electron acceptors (e.g. oxygen, nitrate, and/or sulfate), the absence of the appropriate dechlorinating bacteria, and/or unfavorable geochemical conditions in the aquifer (e.g., oxidative conditions). An incomplete reduction sequence can result in the accumulation of degradation products such as *cis*-1,2-Dichloroethene (cDCE) and vinyl chloride (VC).

Electron donors provide a source of carbon for microbial energy and cell reproduction, as well as a source of electrons to facilitate oxidation-reduction processes. Many electron donors are available for anaerobic biostimulation and can vary in viscosity, breakdown timeframes or longevity, and bioavailability. After injection to the aquifer of electron donor material, anaerobic bacteria grow and reproduce faster and more efficiently than under conditions lacking adequate microbial food sources. When the correct consortium of bacteria is present, increasing microbial growth leads to an increase in the rate of anaerobic biodegradation and thus, an increase in the rate of contaminant destruction.

In addition, certain injectates can facilitate direct chemical reduction of cVOCs in groundwater without the use of native bacteria. Typically, ZVI is used to establish very low redox conditions in a contaminated aquifer. In this scenario, reduction of cVOCs occurs through redox reactions on the surface of the iron through processes called reductive elimination. During beta (β)-elimination, chlorine atoms are released resulting in a lower degree of saturation of the carbon-carbon bond. For example, when TCE undergoes β-elimination, two chlorine atoms are released and chloroacetylene is formed:

$$C_2HCl_3 + 2e^- \rightarrow C_2HCl + 2Cl^-$$

During alpha (α)-elimination, chlorine atoms are released resulting in carbine radical that rapidly degrades to ethene, avoiding the formation of VC. For example, when cDCE undergoes α-elimination, two chlorine atoms are released and ethene is formed:

$$C_2H_2Cl_2 + 2e^- \rightarrow C_2H_2 + 2Cl^-$$

Different injectates can be mixed to both stimulate biological activity and initiate conditions for abiotic chemical reduction. The combination of abiotic chemical reduction, using ZVI, and enhanced anaerobic biodegradation, using organic substrates, has proven effective for cVOCs.

In the areas where high sulfate concentrations in groundwater are present, biogeochemical reductive dechlorination can be an effective way to achieve complete dechlorination. Biogeochemical reductive dechlorination is a three-step process whereby carbon, sulfate, and iron compounds are required for reaction. In the first step, the carbon stimulates native sulfate-reducing bacteria (SRB) to produce hydrogen sulfide (H_2S), which is used in the second step to precipitate mineral iron sulfides (FeS). FeS, a reactive solid, is utilized in the third step to complete the chemical autoreduction of cVOCs. The three steps of the biogeochemical reductive dechlorination process are shown below:

Step 1 – Biological sulfate reduction

$$CH_2O + ½SO_4^{2-} \rightarrow HCO_3 + ½\ HS^- + H2O + H^+$$

Step 2 – Geochemical production of reactive iron sulfide solids

$$3HS^- + 2FeOOH\ (s) \rightarrow 2FeS\ (s) + S^0 + H_2O + 3OH^-$$

Step 3 – Autoreduction of cVOCs (TCE shown)

$$4FeS + 9C_2HCl_3 + 28\ H_2O \rightarrow 4Fe(OH)_3 + 4\ SO_4^{2-} + 9C_2H_2 + 27Cl^- + 35H^+$$

The first step in the process typically begins within a few days after carbon is added to the system assuming that SRBs are ubiquitous in the environment. The second step is a nearly instantaneous reaction that will occur as long as there is a source of native or supplied mineral ferrous or ferric iron. The dechlorination step has a longer duration. The half-life of the cVOCs is on the order of 30-45 days. The advantage of this process over biological reductive dechlorination is that it is rapid and achieves complete dechlorination in one step – no intermediate by-products (cDCE or VC) are formed.

TABLES

Table 1. Proposed Injection Point and Monitoring Piezometer Installation Locations

Location Identification	Longitude	Latitude
Biobarrier B 14-1.8	-97.31034941410	37.75234187460
Biobarrier B 14-1.4	-97.31045316320	37.75234038820
Biobarrier B 14-1.10	-97.31029754020	37.75234261870
Biobarrier B 14-1.6	-97.31040128920	37.75234113140
Biobarrier B 14-1.2	-97.31050503370	37.75233837620
Biobarrier B 14-1.12	-97.31024566500	37.75234336180
Biobarrier B 14-1.18	-97.31009004200	37.75234559190
Biobarrier B 14-1.16	-97.31014191710	37.75234484800
Biobarrier B 14-1.14	-97.31019379110	37.75234410490
Biobarrier B 14-1.26	-97.30988254490	37.75234856400
Biobarrier B 14-1.24	-97.30993441890	37.75234782100
Biobarrier B 14-1.22	-97.30998629290	37.75234707800
Biobarrier B 14-1.20	-97.31003816800	37.75234633500
Biobarrier B 14-1.28	-97.30983066980	37.75234930780
Biobarrier B 14-1.9	-97.31032352950	37.75236907230
Biobarrier B 14-1.1	-97.31053102660	37.75236609860
Biobarrier B 14-1.5	-97.31042727750	37.75236758590
Biobarrier B 14-1.11	-97.31027165440	37.75236981540
Biobarrier B 14-1.7	-97.31037540350	37.75236832910
Biobarrier B 14-1.3	-97.31047914800	37.75236557300
Biobarrier B 14-1.13	-97.31021978030	37.75237055950
Area A 14-1.20	-97.30914155130	37.75248634560
Area A 14-1.14	-97.30921757790	37.75242875630
Area A 14-1.5	-97.30932978020	37.75260561030
Biobarrier A 14-3.47	-97.31150377590	37.74985431940
Biobarrier A 14-3.45	-97.31150476830	37.74993670570
Biobarrier A 14-3.46	-97.31150427210	37.74989551260
Biobarrier A 14-3.21	-97.31153910550	37.74991584600
Biobarrier A 14-3.22	-97.31153860930	37.74987465370
Biobarrier A 14-3.43	-97.31150576180	37.75001909120
Biobarrier A 14-3.44	-97.31150526450	37.74997789800
Biobarrier A 14-3.19	-97.31154009910	37.74999823240
Biobarrier A 14-3.20	-97.31153960290	37.74995703920
Biobarrier A 14-3.26	-97.31151420180	37.75071937060
Biobarrier A 14-3.27	-97.31151370560	37.75067817740
Biobarrier A 14-3.28	-97.31151320830	37.75063698520
Biobarrier A 14-3.29	-97.31151271210	37.75059579200
Biobarrier A 14-3.30	-97.31151221590	37.75055459880
Biobarrier A 14-3.31	-97.31151171970	37.75051340660
Biobarrier A 14-3.32	-97.31151122230	37.75047221340
Biobarrier A 14-3.33	-97.31151072610	37.75043102020
Biobarrier A 14-3.34	-97.31151022990	37.75038982790
Biobarrier A 14-3.35	-97.31150973370	37.75034863480
Biobarrier A 14-3.36	-97.31150923640	37.75030744160
Biobarrier A 14-3.37	-97.31150874020	37.75026624840
Biobarrier A 14-3.38	-97.31150824400	37.75022505610
Biobarrier A 14-3.39	-97.31150774780	37.75018386300
Biobarrier A 14-3.40	-97.31150725040	37.75014266980
Biobarrier A 14-3.41	-97.31150675420	37.75010147750
Biobarrier A 14-3.42	-97.31150625800	37.75006028440
Biobarrier A 14-3.1	-97.31154903570	37.75073970410
Biobarrier A 14-3.2	-97.31154853940	37.75069851180
Biobarrier A 14-3.3	-97.31154804320	37.75065731860
Biobarrier A 14-3.4	-97.31154754700	37.75061612550
Biobarrier A 14-3.5	-97.31154704960	37.75057493320

Table 1. Proposed Injection Point and Monitoring Piezometer Installation Locations

Location Identification	Longitude	Latitude
Biobarrier A 14-3.6	-97.31154655340	37.75053374000
Biobarrier A 14-3.7	-97.31154605720	37.75049254690
Biobarrier A 14-3.8	-97.31154556100	37.75045135370
Biobarrier A 14-3.9	-97.31154506360	37.75041016140
Biobarrier A 14-3.10	-97.31154456740	37.75036896820
Biobarrier A 14-3.11	-97.31154407120	37.75032777510
Biobarrier A 14-3.12	-97.31154357490	37.75028658280
Biobarrier A 14-3.13	-97.31154307760	37.75024538960
Biobarrier A 14-3.14	-97.31154258130	37.75020419640
Biobarrier A 14-3.15	-97.31154208510	37.75016300330
Biobarrier A 14-3.16	-97.31154158890	37.75012181100
Biobarrier A 14-3.17	-97.31154109160	37.75008061780
Biobarrier A 14-3.18	-97.31154059530	37.75003942460
Biobarrier A 14-3.49	-97.31150278240	37.74977193390
Biobarrier A 14-3.48	-97.31150327860	37.74981312710
Biobarrier A 14-3.23	-97.31153811310	37.74983346060
Biobarrier A 14-3.24	-97.31153761690	37.74979226740
Biobarrier A 14-3.50	-97.31150228620	37.74973074070
Biobarrier A 14-3.25	-97.31153711960	37.74975107420
Biobarrier A 14-2.12	-97.31015426620	37.75063320810
Biobarrier A 14-2.11	-97.31015721400	37.75067433600
Biobarrier A 14-2.10	-97.31015780670	37.75071540940
Biobarrier A 14-2.9	-97.31016311190	37.75075659270
Biobarrier A 14-2.8	-97.31016605970	37.75079772060
Biobarrier A 14-2.7	-97.31016900860	37.75083884860
Biobarrier A 14-2.6	-97.31017195640	37.75087997650
Biobarrier A 14-2.5	-97.31017490540	37.75092110530
Biobarrier A 14-2.4	-97.31017785430	37.75096223320
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Biobarrier A 14-2.22	-97.31012415740	37.75069646080
Biobarrier A 14-2.21	-97.31012710520	37.75073758870
Biobarrier A 14-2.20	-97.31013005410	37.75077871750
Biobarrier A 14-2.19	-97.31013300180	37.75081984540
Biobarrier A 14-2.18	-97.31013595080	37.75086097340
Biobarrier A 14-2.17	-97.31013889850	37.75090210220
Biobarrier A 14-2.16	-97.31014184750	37.75094323010
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Biobarrier A 14-2.14	-97.31014774420	37.75102548690
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Biobarrier F 14-3.5	-97.31145061890	37.75170722990
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Biobarrier F 14-3.9	-97.31136420180	37.75166162200
Biobarrier F 14-3.7	-97.31140741040	37.75168442550
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Biobarrier F 14-3.6	-97.31140986750	37.75171869920
Biobarrier F 14-3.10	-97.31132345150	37.75167309130
Biobarrier F 14-3.11	-97.31132099450	37.75163881860
Biobarrier F 14-3.12	-97.31128024300	37.75165028780

Table 1. Proposed Injection Point and Monitoring Piezometer Installation Locations

Location Identification	Longitude	Latitude
Biobarrier F 14-3.13	-97.31127778600	37.75161601420
Biobarrier F 14-2.9	-97.31093128730	37.75204577290
Biobarrier F 14-2.7	-97.31098316910	37.75204558820
Biobarrier F 14-2.5	-97.31103505210	37.75204540260
Biobarrier F 14-2.3	-97.31108693390	37.75204521790
Biobarrier F 14-2.1	-97.31113881570	37.75204503310
Biobarrier F 14-2.8	-97.31095738350	37.75207314300
Biobarrier F 14-2.6	-97.31100926640	37.75207295830
Biobarrier F 14-2.4	-97.31106114830	37.75207277360
Biobarrier F 14-2.2	-97.31111303010	37.75207258880
Biobarrier F 14-2.13	-97.31082752370	37.75204614220
Biobarrier F 14-2.11	-97.31087940550	37.75204595750
Biobarrier F 14-2.12	-97.31085361980	37.75207351320
Biobarrier F 14-2.10	-97.31090550170	37.75207332760
Biobarrier F 14-2.14	-97.31080173690	37.75207369780
Biobarrier F 14-2.15	-97.31077564080	37.75204632680
Biobarrier F 14-2.16	-97.31074985500	37.75207388240
Biobarrier F 14-2.17	-97.31072375900	37.75204651140
Biobarrier F 14-1.8	-97.31060544340	37.75234194160
Biobarrier F 14-1.7	-97.31060577110	37.75238313580
Biobarrier F 14-1.6	-97.31060609880	37.75242433000
Biobarrier F 14-1.5	-97.31060642660	37.75246552320
Biobarrier F 14-1.4	-97.31060675430	37.75250671740
Biobarrier F 14-1.3	-97.31060708210	37.75254791160
Biobarrier F 14-1.2	-97.31060740980	37.75258910570
Biobarrier F 14-1.1	-97.31060773750	37.75263029990
Biobarrier B 14-1.19	-97.31006415720	37.75237278870
Biobarrier B 14-1.17	-97.31011603120	37.75237204560
Biobarrier B 14-1.15	-97.31016790520	37.75237130260
Biobarrier F 14-1.17	-97.31055337960	37.75233613560
Biobarrier F 14-1.16	-97.31057101990	37.75236271190
Biobarrier F 14-1.15	-97.31057134760	37.75240390610
Biobarrier F 14-1.14	-97.31057167540	37.75244510020
Biobarrier F 14-1.13	-97.31057200190	37.75248629440
Biobarrier F 14-1.12	-97.31057232970	37.75252748770
Biobarrier F 14-1.11	-97.31057265740	37.75256868180
Biobarrier F 14-1.10	-97.31057298510	37.75260987600
Biobarrier F 14-1.9	-97.31057331280	37.75265107020
Biobarrier B 14-1.27	-97.30985665890	37.75237576160
Biobarrier B 14-1.25	-97.30990853410	37.75237501860
Biobarrier B 14-1.23	-97.30996040810	37.75237427560
Biobarrier B 14-1.21	-97.31001228210	37.75237353260
Biobarrier B 14-1.29	-97.30980478490	37.75237650450
Area A 14-1.13	-97.30922363620	37.75255015650
Area A 14-1.19	-97.30915446460	37.75254945500
Area A 14-1.8	-97.30929280770	37.75255085790
Area A 14-1.17	-97.30918816680	37.75260472750
Area A 14-1.11	-97.30925733850	37.75260542900
Area A 14-1.16	-97.30918993390	37.75249488390
Area A 14-1.10	-97.30925910540	37.75249558540
Area A 14-1.9	-97.30928412470	37.75237419130
Area A 14-1.15	-97.30921495330	37.75237348980
Area A 14-1.4	-97.30935329610	37.75237489270
Area A 14-1.7	-97.30931782700	37.75242946380
Area A 14-1.12	-97.30925042250	37.75231891880

Table 1. Proposed Injection Point and Monitoring Piezometer Installation Locations

Location Identification	Longitude	Latitude
Area A 14-1.6	-97.30931959380	37.75231962020
Area A 14-1.18	-97.30918125110	37.75231821730
Area A 14-1.3	-97.30938699850	37.75243016520
Area A 14-1.1	-97.30942246750	37.75237559410
Area A 14-1.2	-97.30938876520	37.75232032160
MPZ - 1	-97.30997996730	37.75233637910
MPZ - 2	-97.31048503900	37.75231345430
MPZ - 3	-97.31057145770	37.75206281850

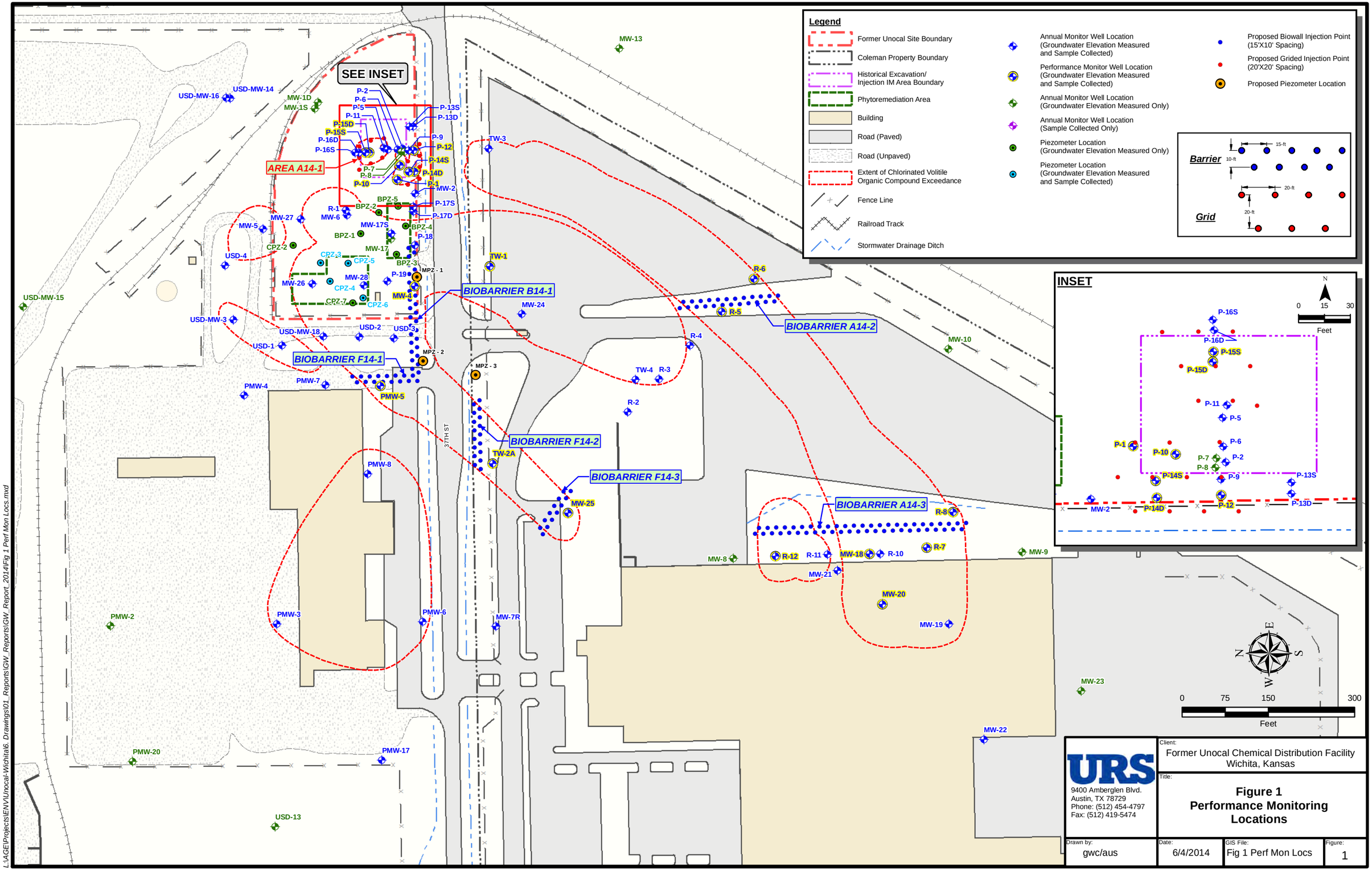
Table 2. Target Injection Depth Selections

Treatment Area	Injection Layout	Amendment Selected	Reference Borehole Logs	Ground Surface Elavation (ft amsl)	Observed Potentiometric Elevation (ft amsl)	Estimated Top of Saturated Zone Elevation (ft amsl)	Top of Bedrock Elevation (ft amsl)	Maximum Injection Interval [1] (ft bgs)	Maximum Injection Thickness [1] (ft)	Maximum Injection Quantity [1,3]	Target Injection Interval [2] (ft bgs)	Target Injection Thickness [2] (ft)	Target Injection Quantity [2,3]	Injection Quantity per Foot (gal/ft)
A14-1	Grid (20 IPs)	EHC® Liquid	P-11, P-12, P-14D, P-15D, P-16D	1349	1341	1334	1315	8-34	26	1,027 gal EHC® Liquid 19,508 gal Water	15-34	19	750 gal EHC-L 14,256 gal Water	39.5
A14-2	Biobarrier (24 IPs)	EHC® Liquid	R-5, R-6	1345	1332	1325	1317	13-28	15	618 gal EHC® Liquid 11,744 gal Water	20-28	8	330 gal EHC-L 6,263 gal Water	34.3
A14-3	Biobarrier (50 IPs)	EHC® Liquid	R-7, R-8, R-10. R-11, R-12, MW-18	1331	1323	1317	1308	8-23	15	1,288 gal EHC® Liquid 24,467 gal Water	14-23	9	773 gal EHC-L 14,680 gal Water	34.3
B14-1	Biobarrier (31 IPs)	EHC®	MW-17S, P-18, P-19, USD-3	1349	1339	1336	1324	10-25	15	14,603 lbs EHC® 4,085 gal Water	13-25	12	11,682 lbs EHC® 3,268 gal Water	10.8
F14-1	Biobarrier (18 IPs)	EHC®	P-5, P-7, USD-3	1346	1339	1331	1316	7-30	23	15,266 lbs EHC® 4,271 gal Water	15-30	15	9,956 lbs EHC® 2,786 gal Water	12.7
F14-2	Biobarrier (17 IPs)	EHC®	TW-2A	1345	1338	1330	1321	7-24	17	9,779 lbs EHC® 2,736 gal Water	15-24	9	5,177 lbs EHC® 1,448 gal Water	11.7
F14-3	Biobarrier (13 IPs)	EHC®	MW-25	1345	1334	1332	1319	11-26	15	6,638 lbs EHC® 1,857 gal Water	13-26	13	5,753 lbs EHC® 1,609 gal Water	11.7

[1] Based on injecting from top of piezometric surface to bedrock (hard weathererd or unweathered shale)
[2] Based on injecting from estimated top of saturated zone to bedrock.
[3] The injection quantities are estimated and may change based on actual top of saturated zone and actual depth to bedrock.

amsl - Above mean sea level.
bgs - Below ground surface.
ft - Foot/feet.
gal - Gallon.
gal/ft - Gallons per foot.
IP - Injectin point.

FIGURES



L:\AGE\Projects\ENV\Unocal-Wichita\6. Drawings\01_Reports\GW_Reports\GW_Report_2014\Fig 1 Perf Mon Locs.mxd

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

Client: Former Unocal Chemical Distribution Facility Wichita, Kansas

Title: **Figure 1 Performance Monitoring Locations**

Drawn by:	Date:	GIS File:	Figure:
gwc/aus	6/4/2014	Fig 1 Perf Mon Locs	1

ATTACHMENT

Bureau of Environmental Remediation
Curtis State Office Building
1000 SW Jackson St., Suite 410
Topeka, KS 66612-1367

Phone: 785.296.1673
Fax: 785.296.7030
www.kdheks.gov

Robert Moser, MD, Secretary | Department of Health & Environment | Sam Brownback, Governor

May 28, 2014

Nathan Blomgren
Chevron Environmental Management Company
6101 Bollinger Canyon Road
San Ramon, California 94583

RE: Proposed Wells for 2014 Annual Groundwater Monitoring Event, dated April 24, 2014;
Quarterly Progress Report No. 87 (January 2014 through March 2014), dated April 25, 2014; and,
Interim Measure Injection Work Plan 2014, dated May 14, 2014;
Former Unocal Chemical Distribution Facility, Wichita, Kansas

Dear Mr. Blomgren,

The Kansas Department of Health and Environment (KDHE) acknowledges receipt of the above-referenced documents, prepared by URS Corporation (URS) on behalf of Chevron Environmental Management Company (EMC), dated as noted above. KDHE has completed its review and approves the document "*Quarterly Progress Report No. 87"* without comment, and approves the documents "*Proposed Wells for 2014 Annual Groundwater Monitoring Event"* and "*Interim Measure Injection Work Plan 2014"* with the following comments.

KDHE COMMENTS ON PROPOSED WELLS FOR THE 2014 ANNUAL EVENT

1. General Comment: Page 2 indicates wells MW-8, MW-10, MW-12D, and MW-13 are being removed from the sampling program for 2014 since 2013 sampling results for these four wells showed results all below detection limits. Although KDHE has not received the 2013 Annual Groundwater Monitoring Report to verify these results as of the date of this letter, KDHE concurs with the current proposal; however, please be advised, KDHE may request sampling of these wells in the future if warranted to monitor site conditions. No revision to the 2014 Well Proposal is required.

2. General Comment: Please note, KDHE recently updated the Appendices of the October 2010 Risk-Based Standards (RSK) for Kansas Manual, available for download at the following webpage http://www.kdheks.gov/remedial/rsk_manual_page.html. Please update the RSK screening levels accordingly in future report submittals.

KDHE COMMENTS ON THE INTERIM MEASURE INJECTION WORK PLAN 2014

3. Section 3.4.3 Permits: The Work Plan discusses necessary permits required for work to be conducted (e.g., KDHE Underground Injection Control Permit, and City of Wichita for water access); however, please be advised, Chevron EMC will also need to obtain a flush-mount waiver of K.A.R. 28-30-6(f) (see http://www.kdheks.gov/waterwell/download/Article_30_AMENDED_2013.pdf) for installation of the three proposed piezometers to be installed as additional performance monitoring wells at the Site. Please contact KDHE's Bureau of Water – Geology Section, Water Well Program, Mr. Richard Harper at 785-296-3565 for the waiver. No revision to the Work Plan is required.

4. Appendix A: Included in the Appendix is a Technical Memorandum discussing the Treatability Test Results of the Bio-Trap Samplers installed in December 2013 at the Site. The Memorandum indicates conclusions of the study will be revisited once the compound-specific isotope analysis (CSIA) results become available. In addition, the Memorandum discussed results from two wells (P15D and MW-18) not originally proposed in the Bio-Trap Sampling Work Plan approved by KDHE. It appears well P15D was used in place of well P15S, and well MW-18 was used in place of well R-10. Although these Work Plan deviations are not discussed in the Memorandum provided, KDHE requests a brief discussion of the deviation be provided in the CSIA test results submittal forthcoming. No revision to the Work Plan is required.

5. General Comment: Page 3-4 in Section 3.4.1 and page 4-1 in Section 4.0 of the Work Plan reference a revised Health and Safety Plan (HASP), dated September 2013, and a revised Sampling and Analysis Plan (SAP), dated October 2013, neither of which have been provided to KDHE. KDHE requests these two documents be submitted to KDHE for inclusion into the Administrative Record. No revision to the Work Plan is required.

No written response to this letter is required by KDHE. Please provide the requested revised HASP and SAP within 30 days of the date of this letter. KDHE appreciates Chevron EMC's continued cooperation in addressing contamination associated with the Site, and looks forward to evaluating the effectiveness of the proposed injection work forthcoming. KDHE will include a brief summary of the Bio-Trap Treatability Study conducted and the additional interim measure injection work planned at the Site in the forthcoming Final Corrective Action Decision for the Site. Should you have any questions regarding this letter, please contact me by phone at 785-296-6242 or email at hburke@kdheks.gov.

Sincerely,

Holly Burke

Holly Burke
Environmental Scientist
Remedial Section/Site Restoration Unit
Bureau of Environmental Remediation

c: Chris Carey, KDHE → Unocal File – C2-087-00431
Purshotam K. Juriasingani, URS

McCoy, Elizabeth

From: Cynthia Khan <ckhan@kdheks.gov>
Sent: Friday, June 20, 2014 11:17 AM
To: McCoy, Elizabeth
Subject: RE: Unocal Injection - Wichita, KS Follow-up

Good Morning Elizabeth:

We have reviewed the changes you have proposed to the Former Unocal Chemical Distribution Facility located at 2100 East 37th Street in Wichita, Kansas. We noted that no actual operating pressures were proposed and that these pressure would be determined in the filed.

We have a standard 50 psi limit on shallow injection that must be followed unless you submit an additional monitoring plan as we discussed (phone conversations). If you intend to use injection pressures (not just pump pressure) above this limit, please notify KDHE immediately and we will review a monitoring plan for the site.

Otherwise, you **are currently authorized to continue injections at the site under the plan submitted June 6, 2014 and the modifications will be noted in our database**. If you have any questions, please let us know.

Regards,

CYNTHIA KHAN, P.G.
KANSAS DEPT OF HEALTH AND ENVIRONMENT
1000 SW JACKSON, SUITE 420
TOPEKA, KANSAS 66612
785-296-5554
CKHAN@KDHEKS.GOV

From: McCoy, Elizabeth [mailto:elizabeth.mccoy@urs.com]
Sent: Thursday, June 19, 2014 10:44 AM
To: Cynthia Khan
Subject: Unocal Injection - Wichita, KS Follow-up

Good morning Cynthia,

We have been corresponding this week over the phone regarding the upcoming injection event at the Unocal Property in Wichita, KS. You mentioned you were going to email me a response for the UIC application. I had not received your email so I wanted to follow up. Our IT Department just changed my email address, and I wanted to make sure your email didn't get lost in cyberspace!

Best,

Elizabeth

Elizabeth McCoy
Hydrogeologist
Remediation Department
URS Corporation
9400 Amberglen Blvd
Austin, Texas 78729

Office: 512.419.6159
Cell: 214.384.7510
elizabeth.mccoy@urs.com

Please note my new email address: elizabeth.mccoy@urs.com

Appendix B

Underground Injection Monitoring Plan and Approval

Underground Injection Monitoring Plan

Prior to and during fluid injection operations, URS and our subcontractor (Vironex) will implement the following procedures to prevent a release of injected fluids to nearby surface water bodies, storm water conduits, or subsurface environs outside of the target treatment zones and to prevent damage to buried utility lines, sewer lines, or other conduits and nearby structures.

1. Buried utility and sewer line locate requests will be placed through the Kansas One-Call 811 system and the City of Wichita Public Works & Utilities for all areas where subsurface drilling are planned within the required timeframe.
2. Proposed drilling and injection locations will be relocated a safe distance from any identified subsurface utility or sewer line.
3. Prior to injection operations, a walking survey will be conducted to identify any water wells or similar conduits within 500 feet (ft) of the proposed injection locations. If any such conduit is identified, the injection locations will be moved an appropriate distance away.
4. The injection pumps will be equipped with pressure recirculation systems which can be utilized to maintain an upper limit of pressure.
5. Injection line pressures will be monitored in real time at the injection cap. A sustained pressure exceeding 300 PSI for greater that one minute will trigger a stop work action to allow formation pressures to diminish prior to resuming injection operations. Should it become evident that fluid injection is not possible at sustained pressures below 300 PSI, URS will contact the KDHE Geology Department to discuss this issue and to seek an acceptable resolution.
6. During injection operations, a walking survey with a radius of 200 ft surrounding the injection work zone will be conducted every two hours to assess whether injected fluids have begun to backflow to the ground surface (i.e., daylight) or have caused damage to infrastructure.
7. Evidence of significant daylighting (greater than one gallon) outside of the immediate injection zone will trigger a stop work action to allow formation pressures to diminish and to control fluid backflow. Injection operations in the neighboring area will not resume until backflow has ceased and any backflow fluids have been property removed and contained in steel drums. Any such backflow feature will be monitored continuously when injection operations resume. If backflow restarts after injection operations resume, the injection location will be abandoned and grouted.
8. All backflow fluids will be containerized and managed as investigation-derived waste according to KDHE requirements.

URS and Vironex will conduct injection operations using accepted industry practice and procedures for the direct injection of beneficial substrates into shallow subsurface to promote groundwater decontamination. No directed fracturing tools/techniques or proppants will be utilized during the injection operation. Because the quantity of fluid injected into the uppermost groundwater zone is less than 2 percent of the target formation void volume, no deleterious ground swelling or movement is anticipated.

Juriasingani, Purshotam

From: McCoy, Elizabeth
Sent: Wednesday, June 25, 2014 8:54 AM
To: Juriasingani, Purshotam
Subject: FW: Unocal Injection - Wichita, KS Follow-up

Response from KDHE below. They have accepted the monitoring plan.

Elizabeth McCoy
Hydrogeologist
Remediation Department
URS Corporation
9400 Amberglen Blvd
Austin, Texas 78729
Office: 512.419.6159
Cell: 214.384.7510
elizabeth.mccoy@urs.com

Please note my new email address: elizabeth.mccoy@urs.com

From: Cynthia Khan [ckhan@kdheks.gov]
Sent: Wednesday, June 25, 2014 8:31 AM
To: McCoy, Elizabeth
Subject: RE: Unocal Injection - Wichita, KS Follow-up

Elizabeth:

I believe that this monitoring plan will be sufficient for this particular site. Please note that we are not requiring monitoring of private wells due to the plan stating that you will stay a sufficient distance from them. You may proceed with your injection activities at this site.

Regards,

Cynthia Khan, P.G.
Kansas Dept of Health and Environment
1000 Sw Jackson, Suite 420
Topeka, Kansas 66612
785-296-5554
ckhan@kdheks.gov<mailto:ckhan@kdheks.gov>

From: McCoy, Elizabeth [mailto:elizabeth.mccoy@urs.com]
Sent: Tuesday, June 24, 2014 6:20 PM
To: Cynthia Khan
Cc: Juriasingani, Purshotam
Subject: RE: Unocal Injection - Wichita, KS Follow-up

Hi Cynthia,

Thank you for your response. Although injection pressures are still to be determined, we currently anticipate that pressures may exceed 50 psi. As required, I submit the attached Injection Monitoring Plan for your review.

Please let me know if you have any questions or require any additional information.

Regards,

Elizabeth

Elizabeth McCoy
Hydrogeologist
Remediation Department
URS Corporation
9400 Amberglen Blvd
Austin, Texas 78729
Office: 512.419.6159
Cell: 214.384.7510
elizabeth.mccoy@urs.com<mailto:elizabeth.mccoy@urs.com>

Please note my new email address: elizabeth.mccoy@urs.com<mailto:elizabeth.mccoy@urs.com>

From: Cynthia Khan [mailto:ckhan@kdheks.gov]
Sent: Friday, June 20, 2014 11:17 AM
To: McCoy, Elizabeth
Subject: RE: Unocal Injection - Wichita, KS Follow-up

Good Morning Elizabeth:

We have reviewed the changes you have proposed to the Former Unocal Chemical Distribution Facility located at 2100 East 37th Street in Wichita, Kansas. We noted that no actual operating pressures were proposed and that these pressure would be determined in the filed.

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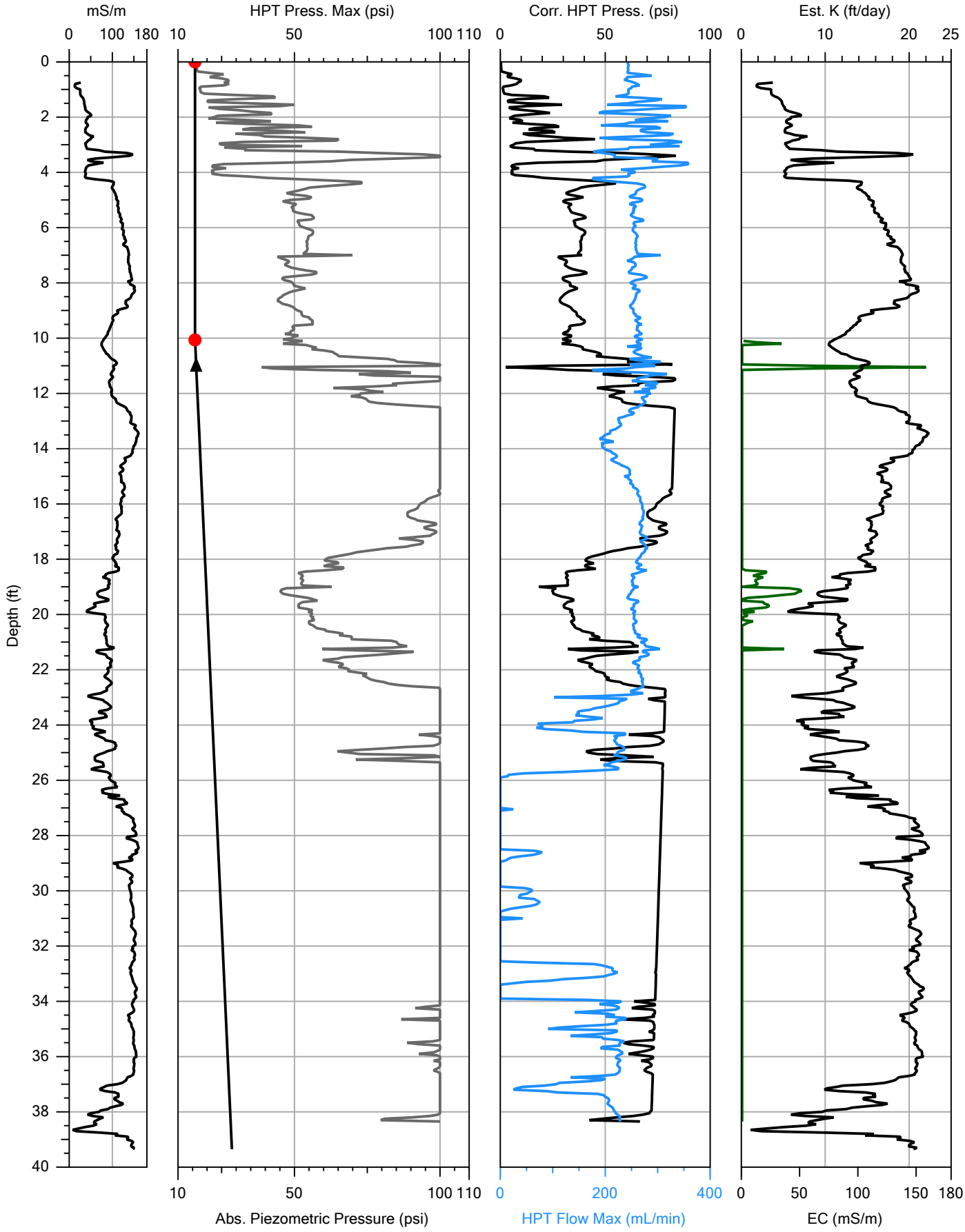
Otherwise, you are currently authorized to continue injections at the site under the plan submitted June 6, 2014 and the modifications will be noted in our database. If you have any questions, please let us know.

Regards,

Cynthia Khan, P.G.
Kansas Dept of Health and Environment
1000 Sw Jackson, Suite 420
Topeka, Kansas 66612
785-296-5554
ckhan@kdheks.gov<mailto:ckhan@kdheks.gov>

Appendix C

HPT Profiling



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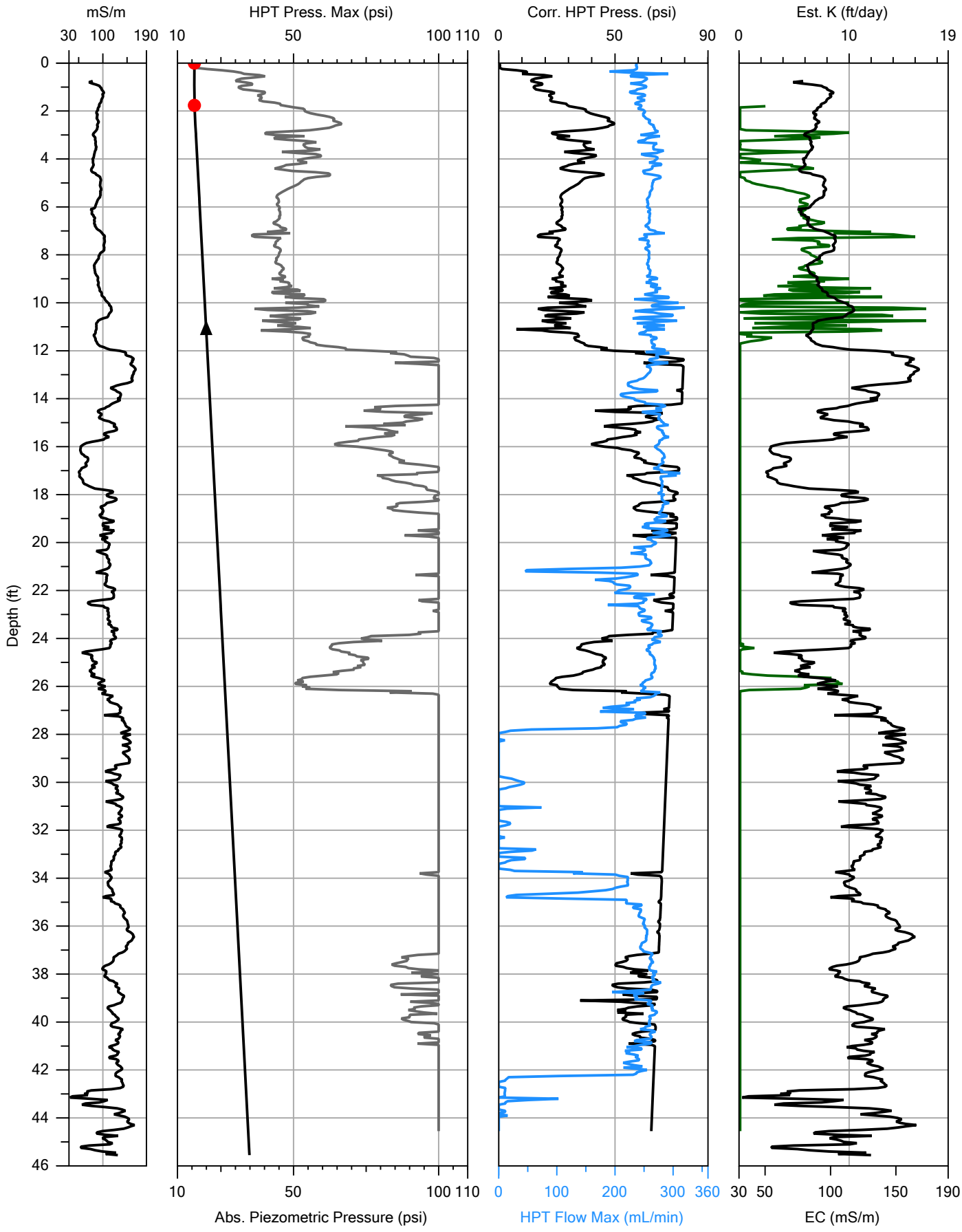
Project ID: Former Unocal	Client: URS	Location:



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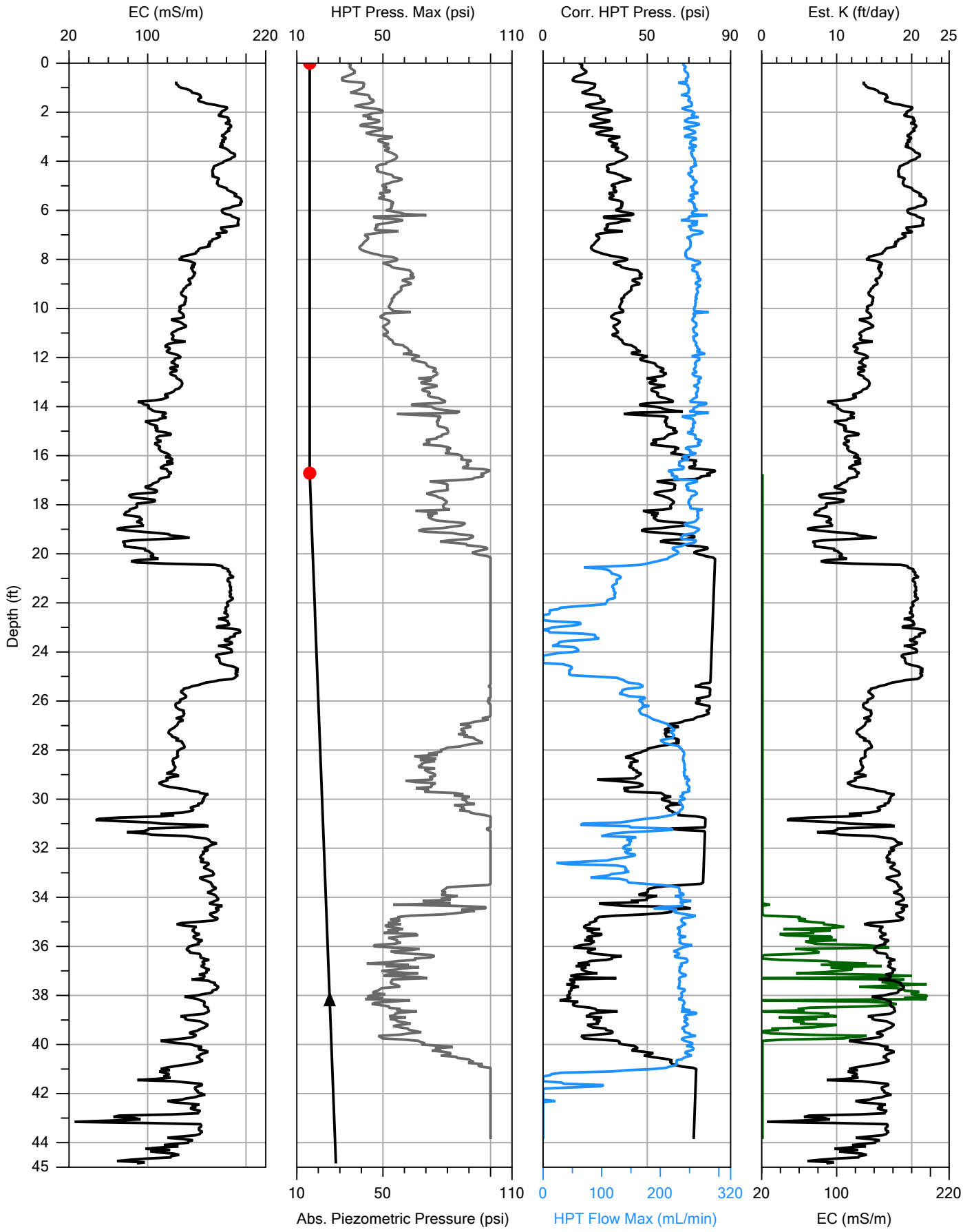
Project ID: Former Unocal	Client: URS	Location:



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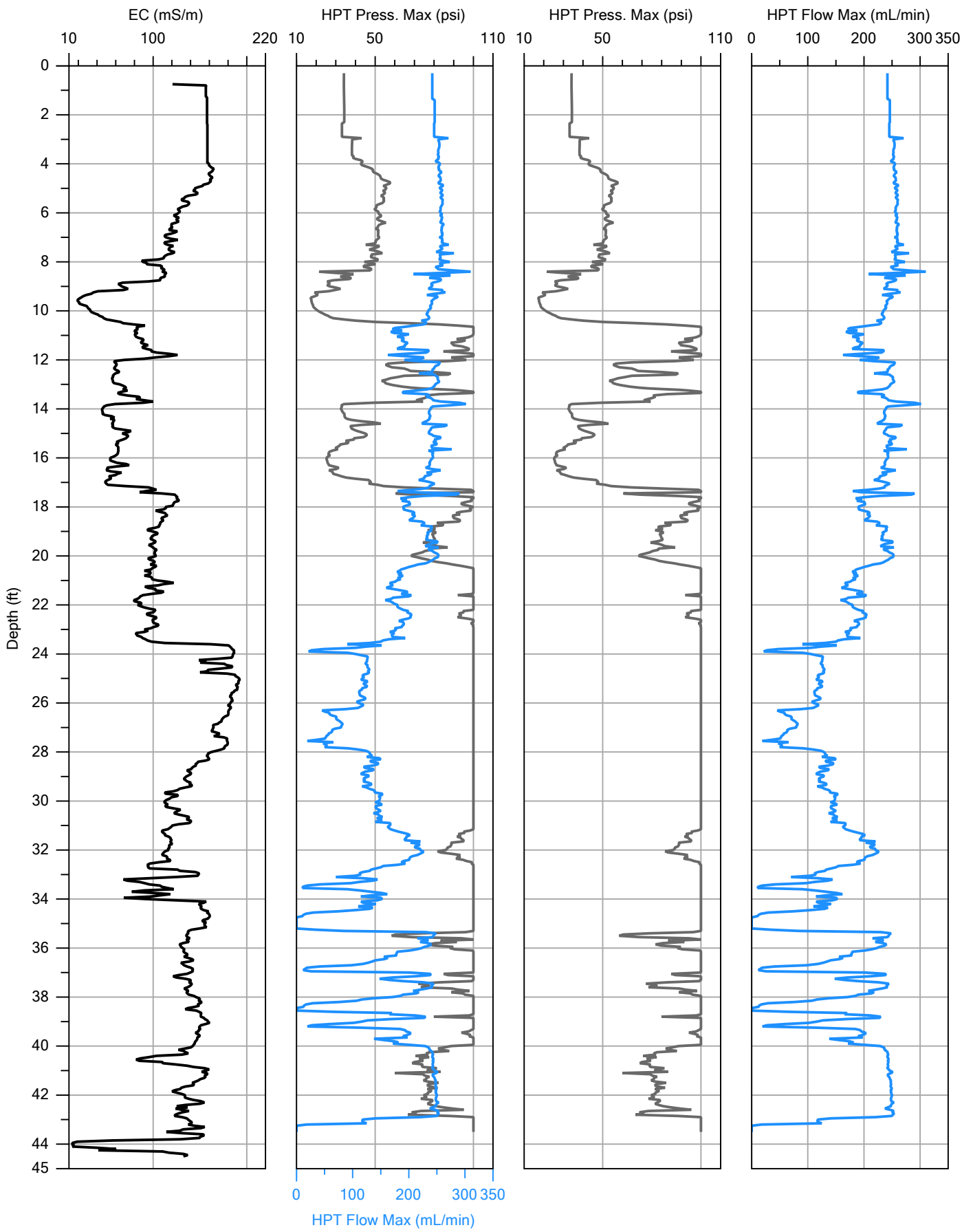

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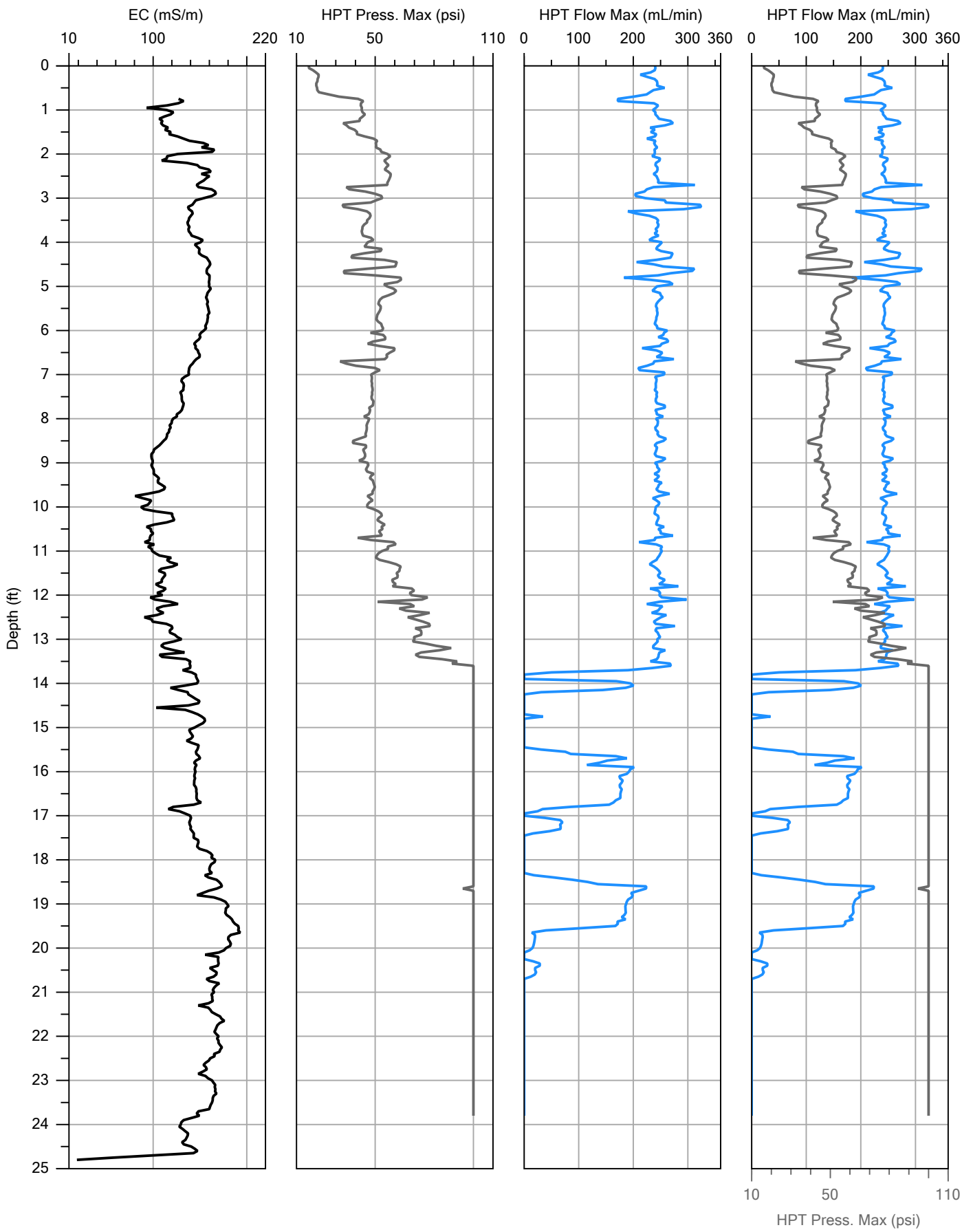

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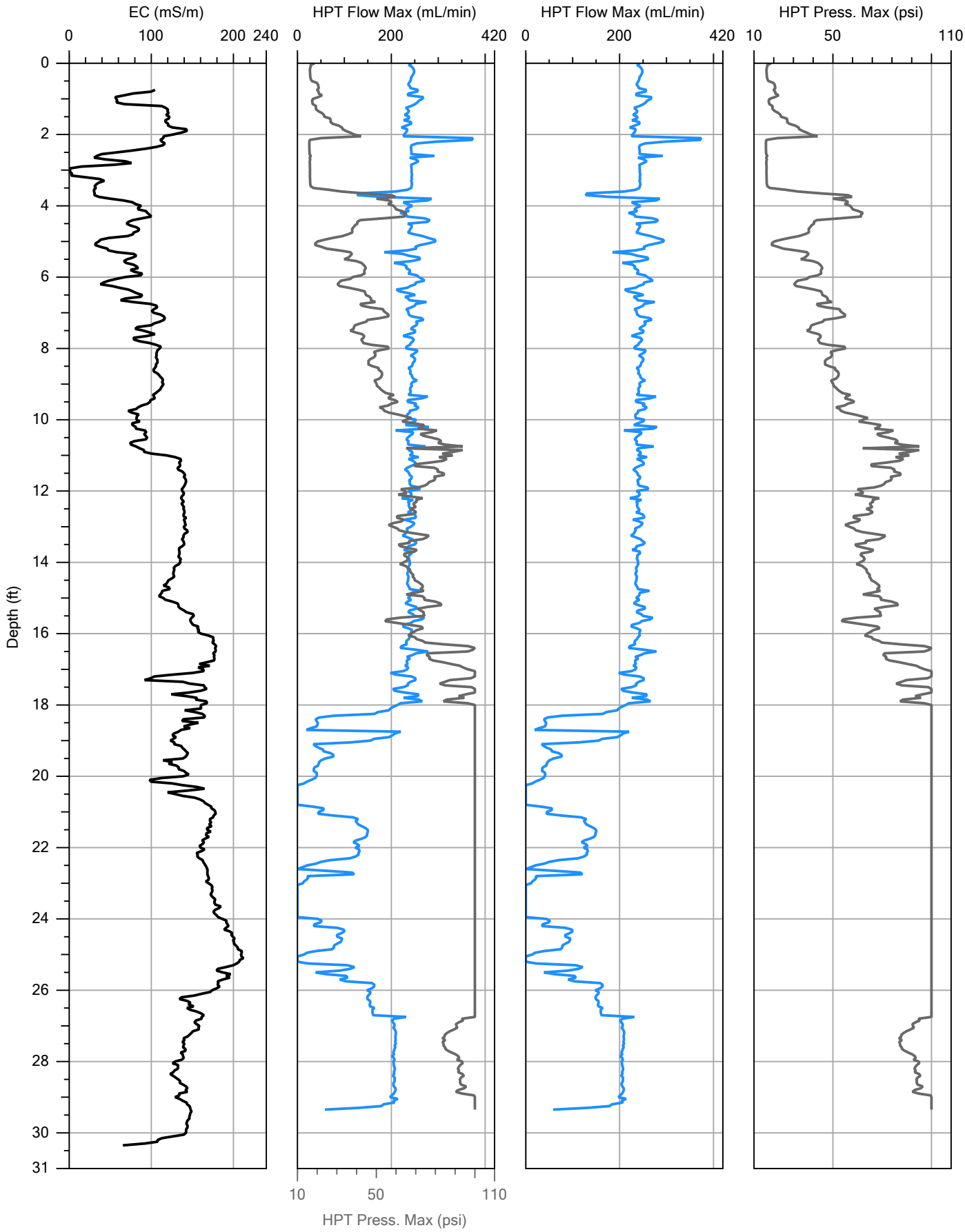

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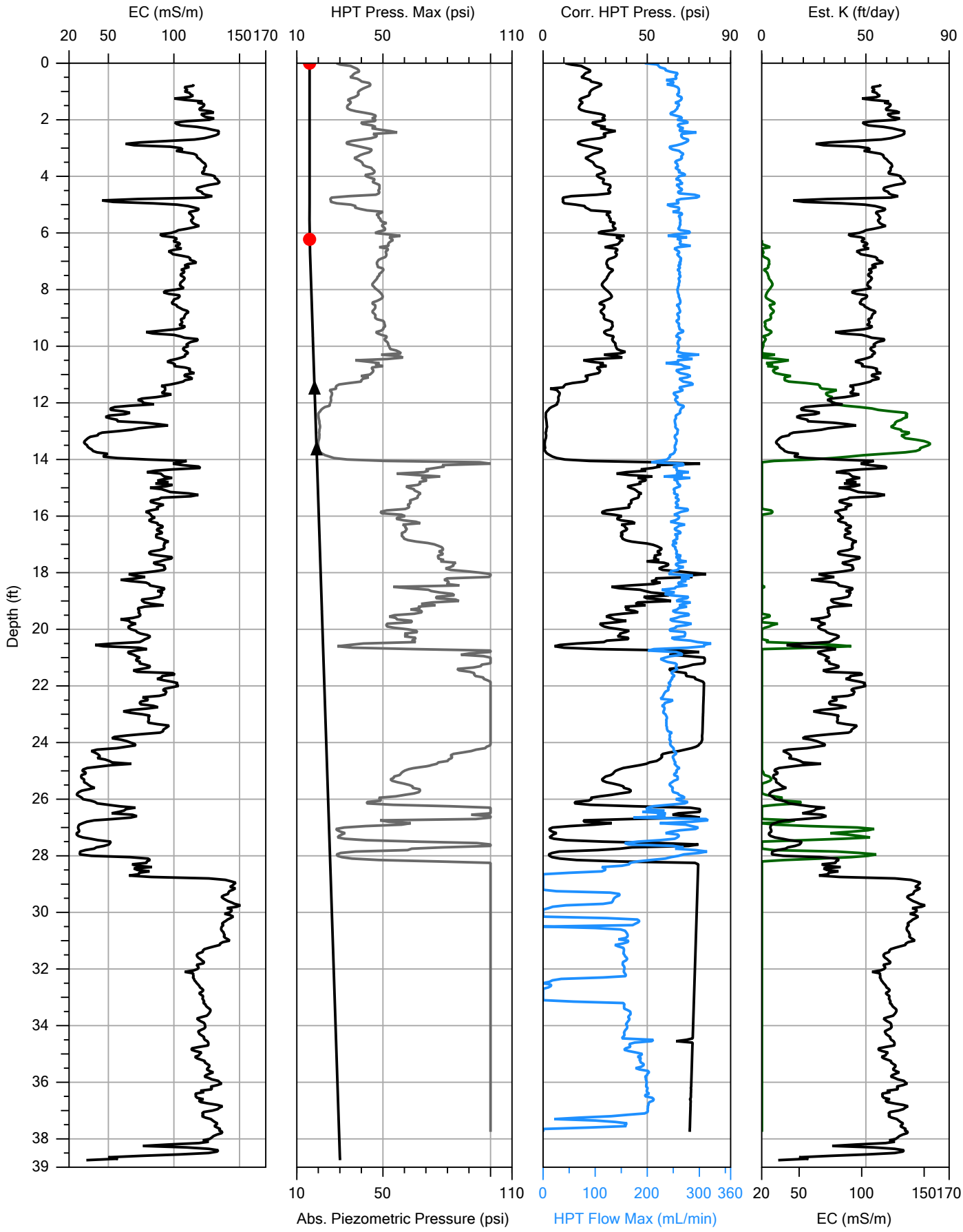

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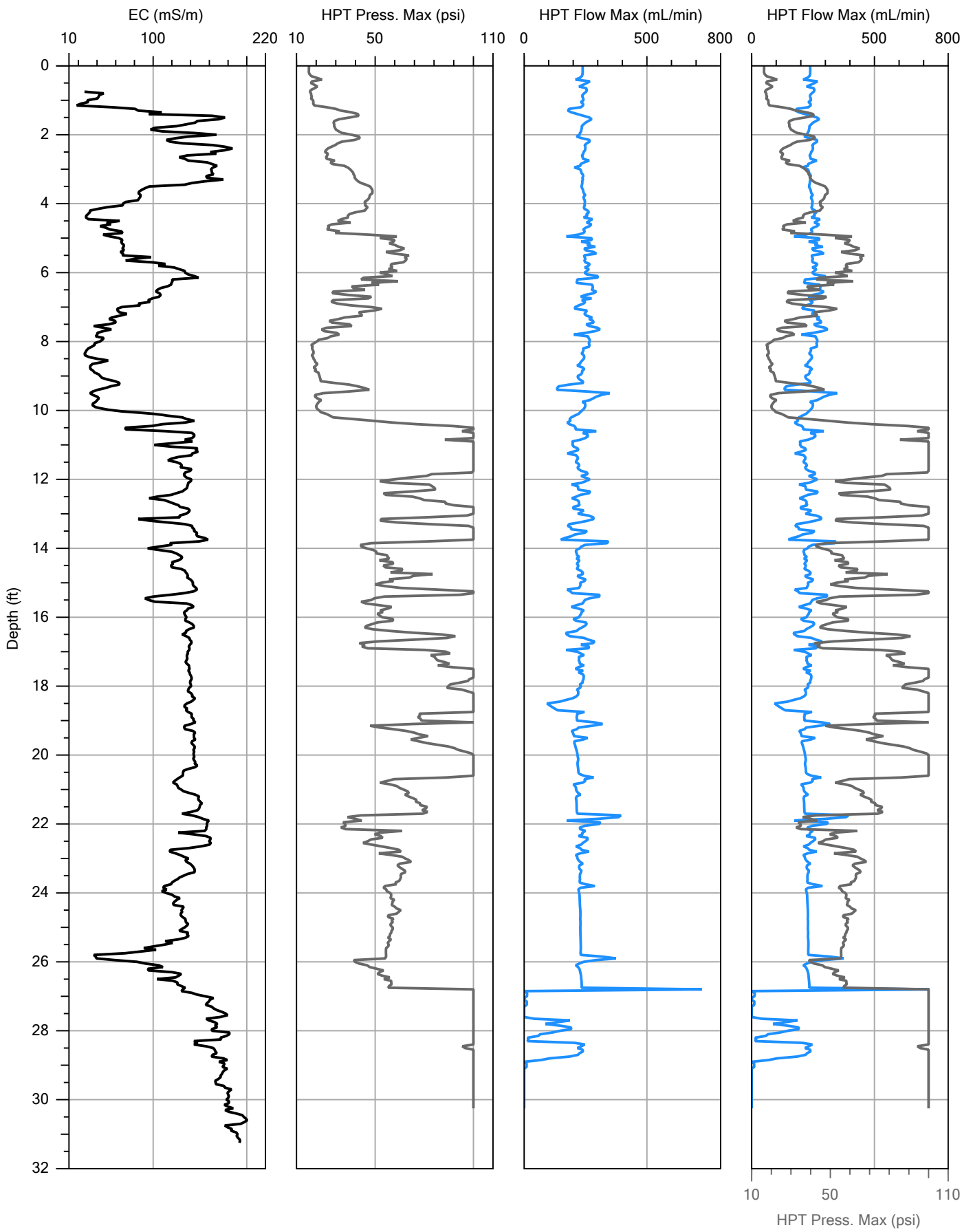
Project ID: Former Unocal	Client: URS	Location:



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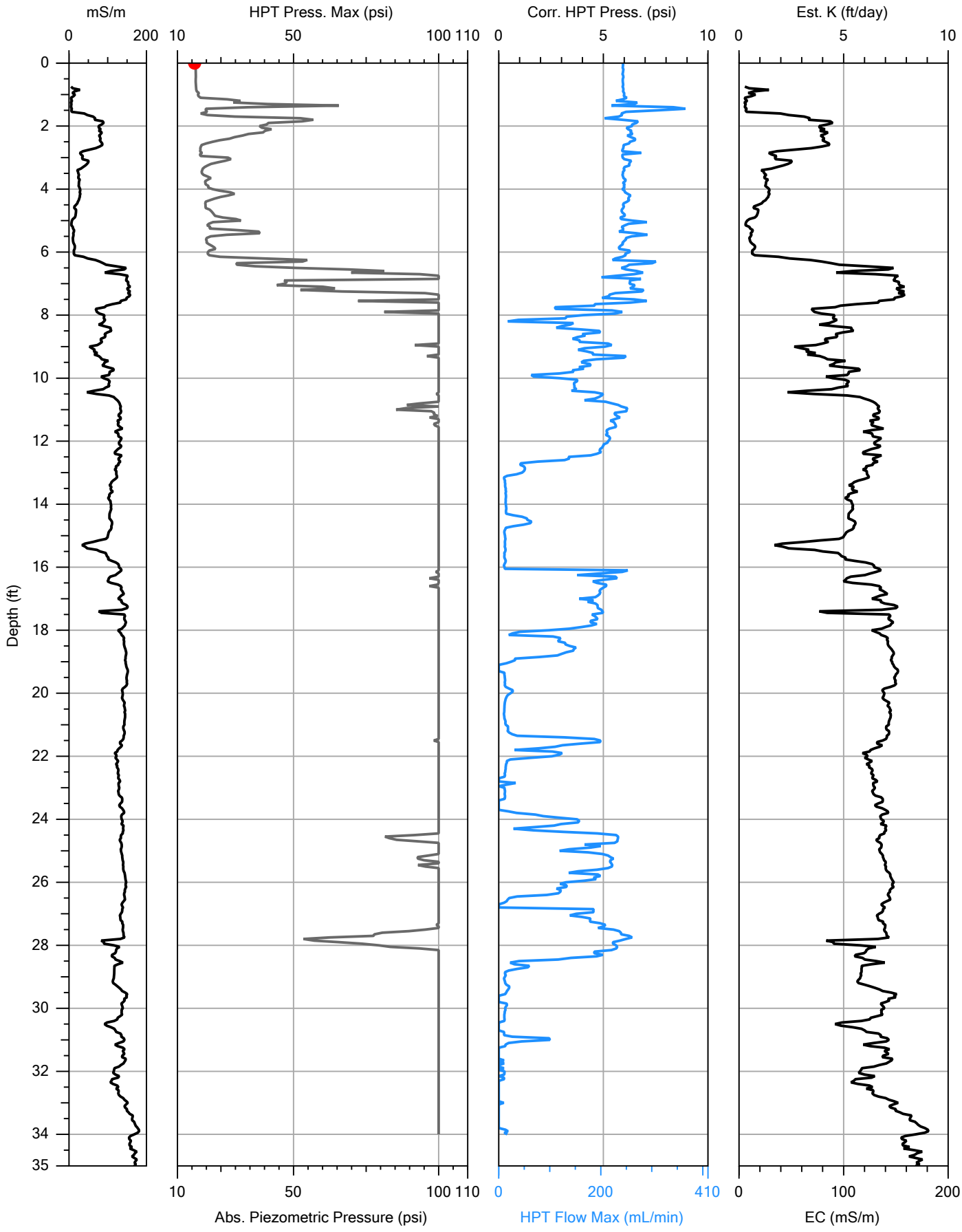

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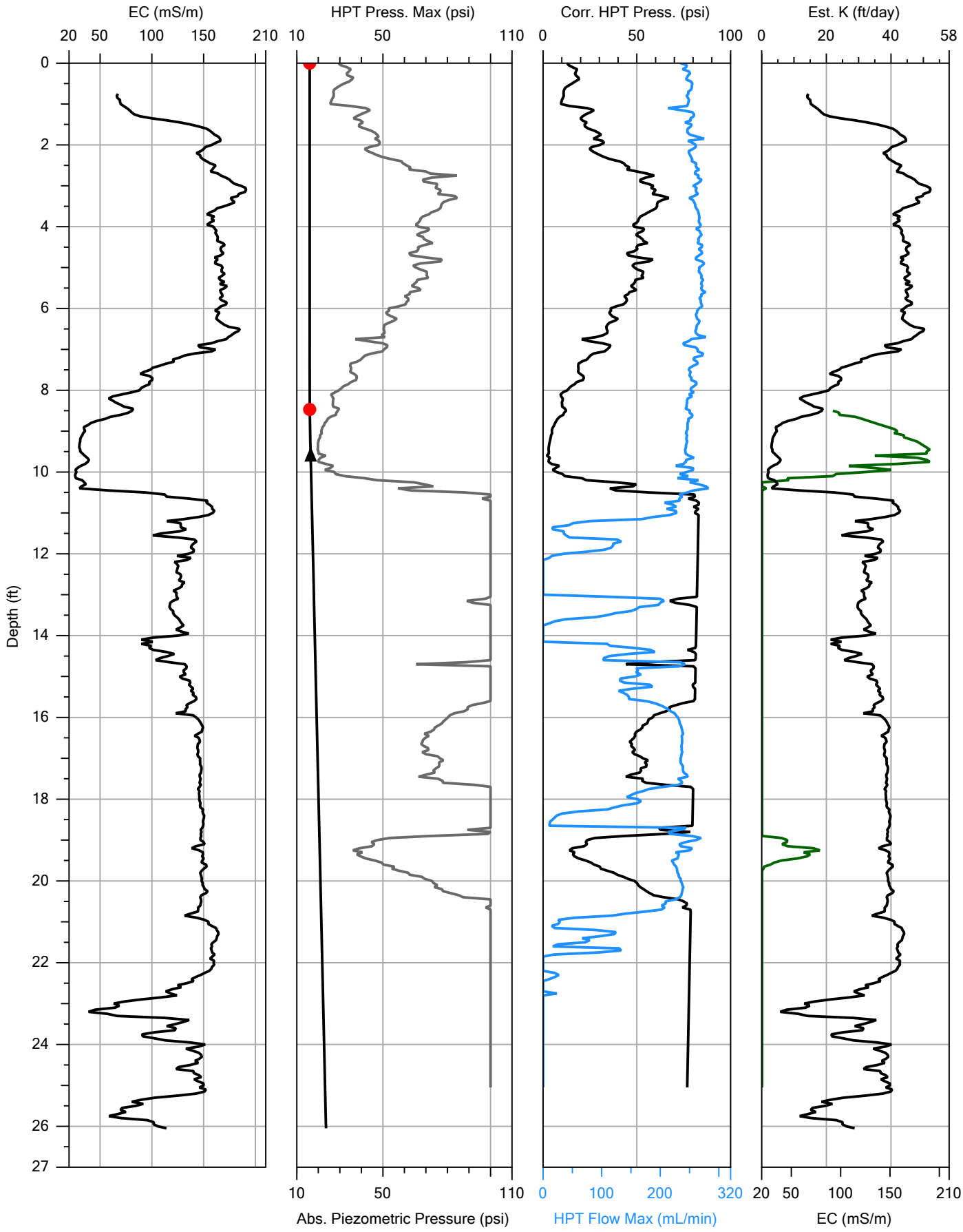
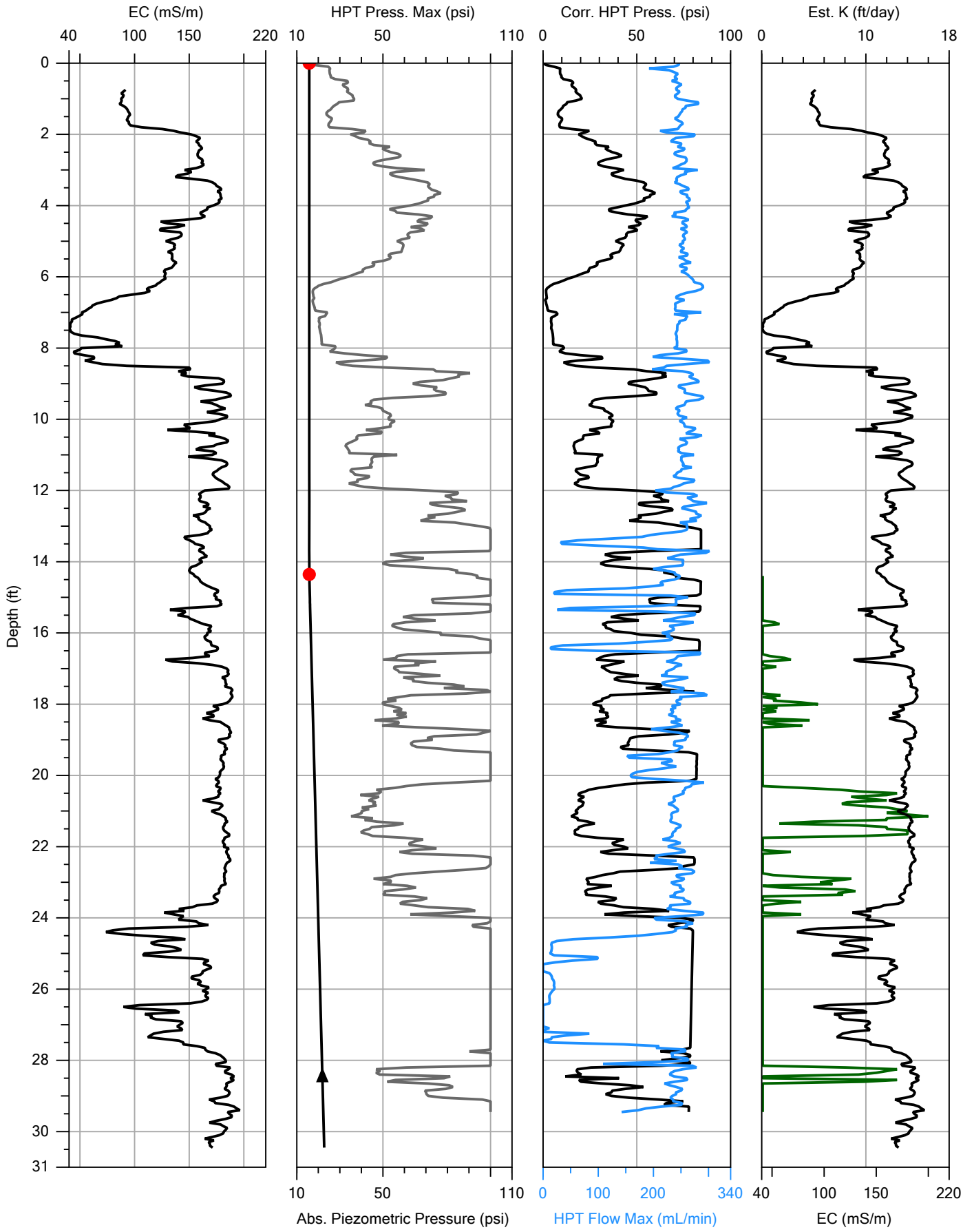
Company: Vironex	Operator: GHH	Date: 6/24/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

		File: HPT-F14-2.MHP
Company: Vironex	Operator: GHH	Date: 6/24/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

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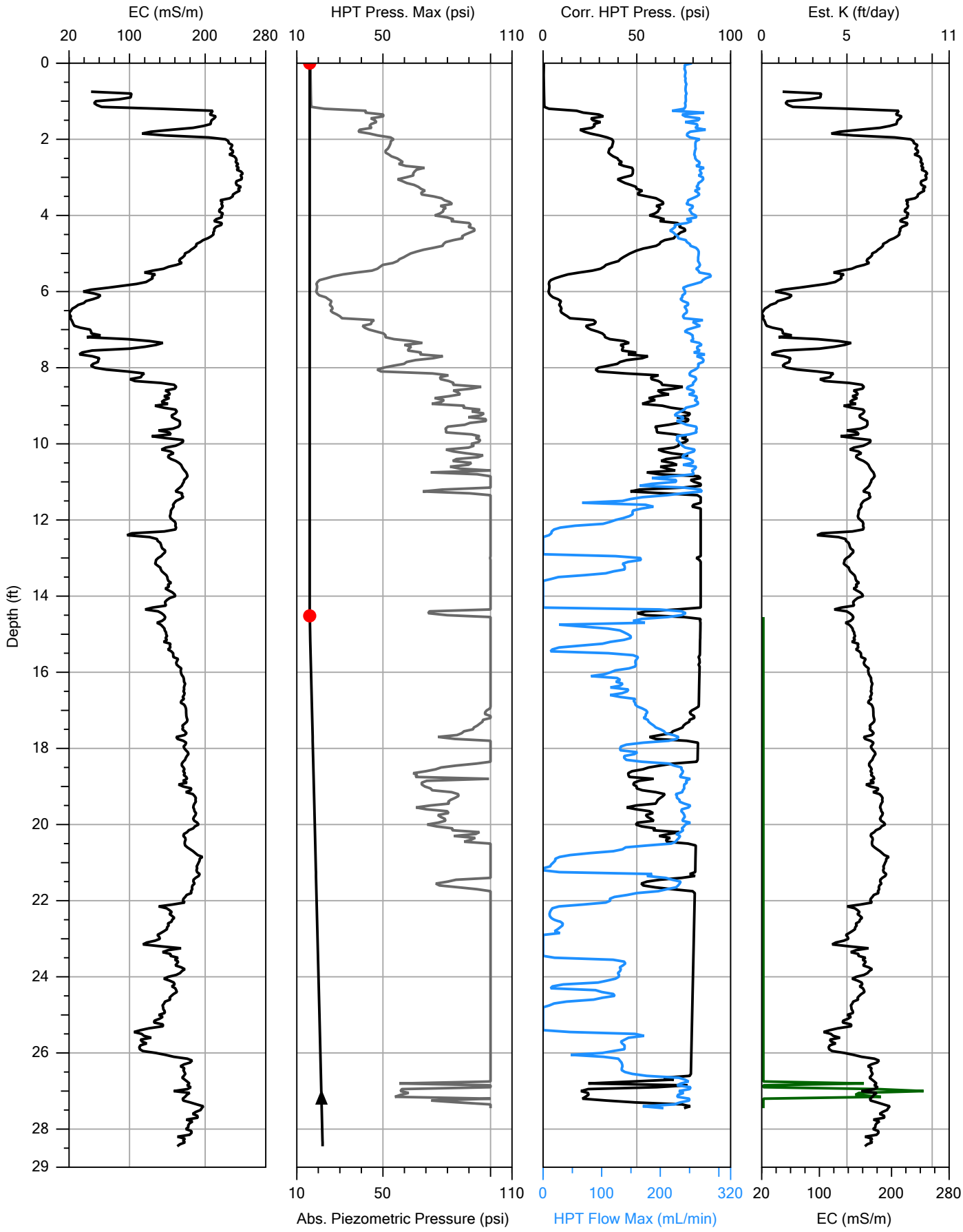
Company: Vironex	Operator: GHH	Date: 6/27/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

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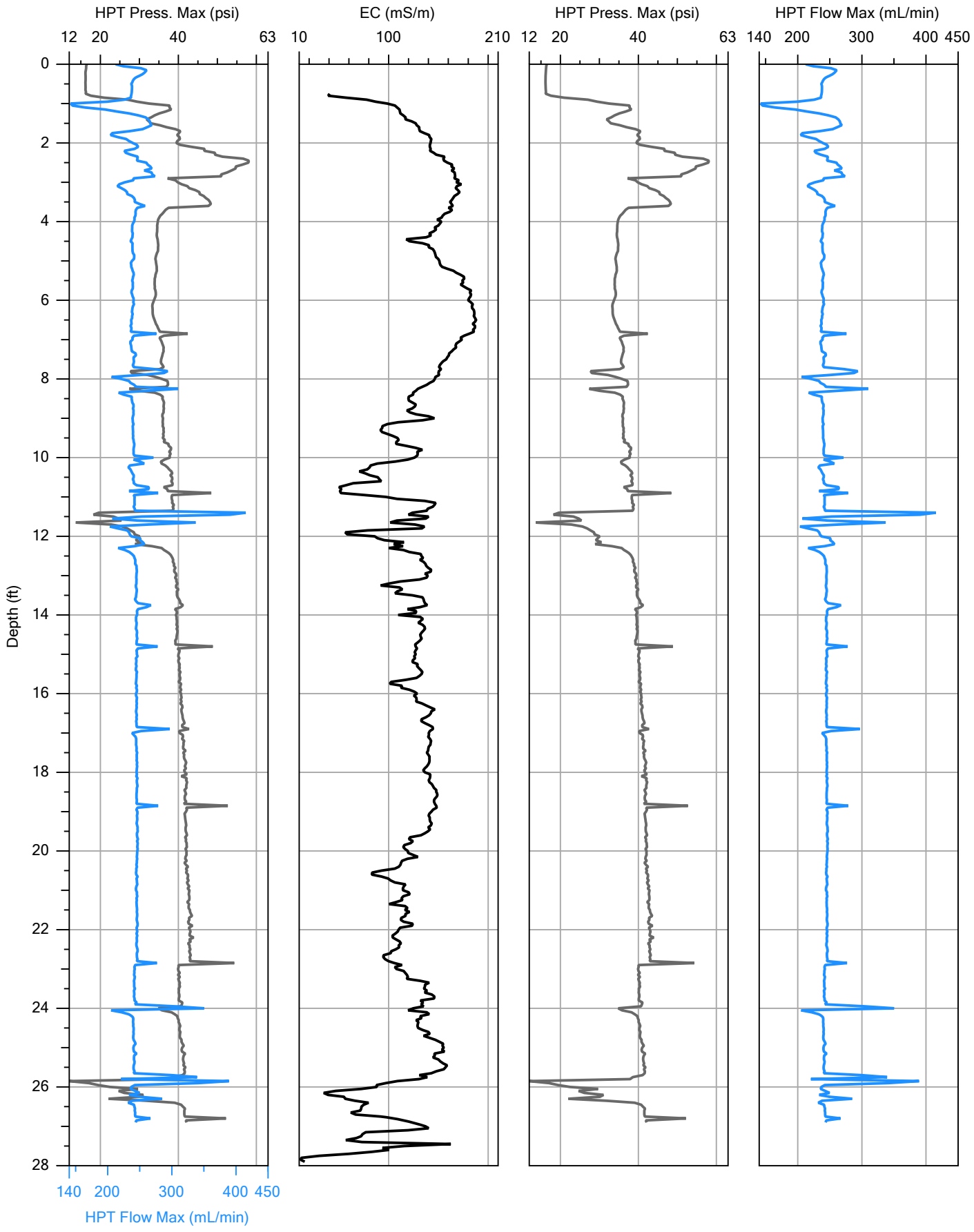
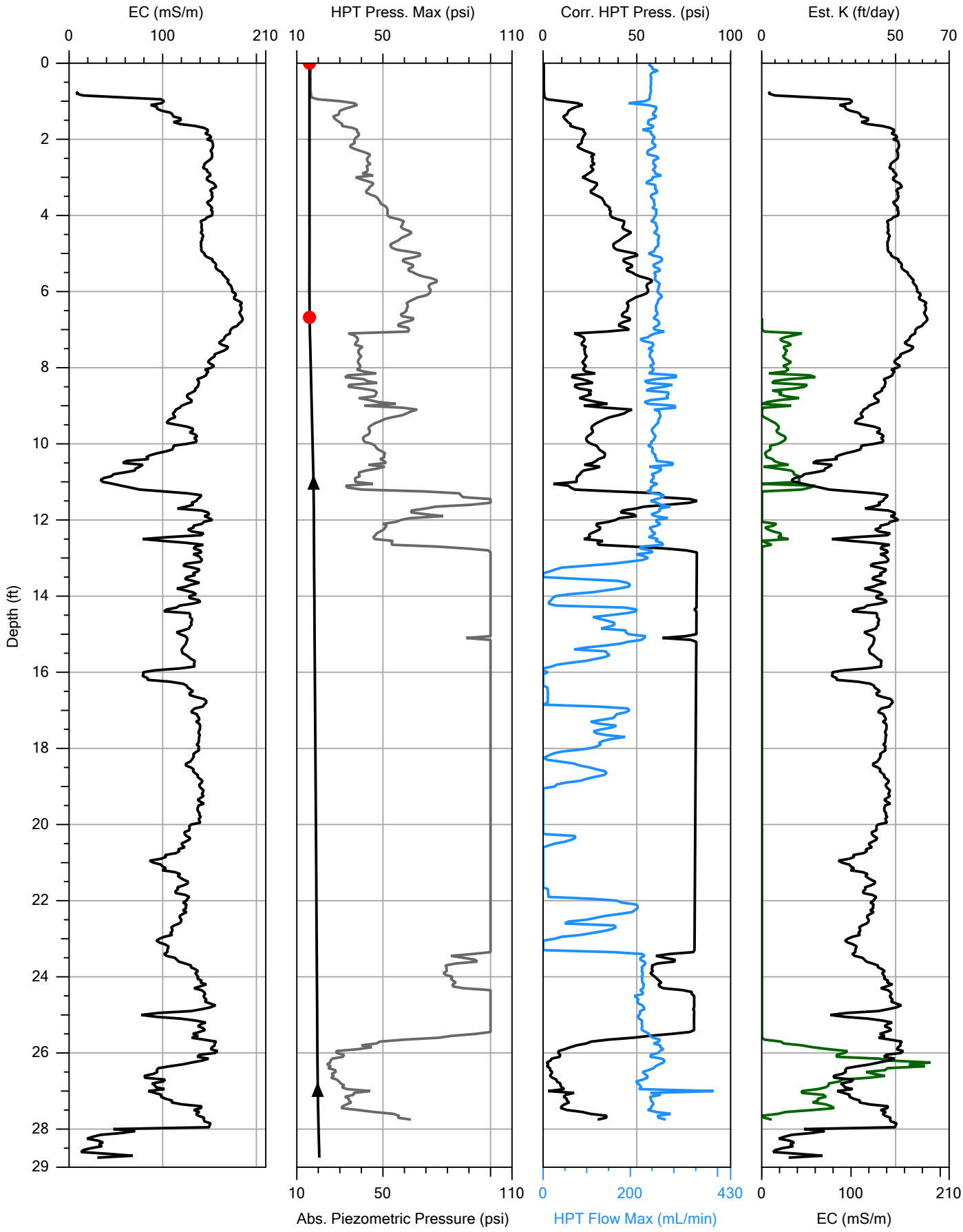
Company: Vironex	Operator: GHH	Date: 6/24/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

		File: HPT-MPZ1.MHP
Company: Vironex	Operator: GHH	Date: 6/23/2014
Project ID: Former Unocal	Client: URS	Location:



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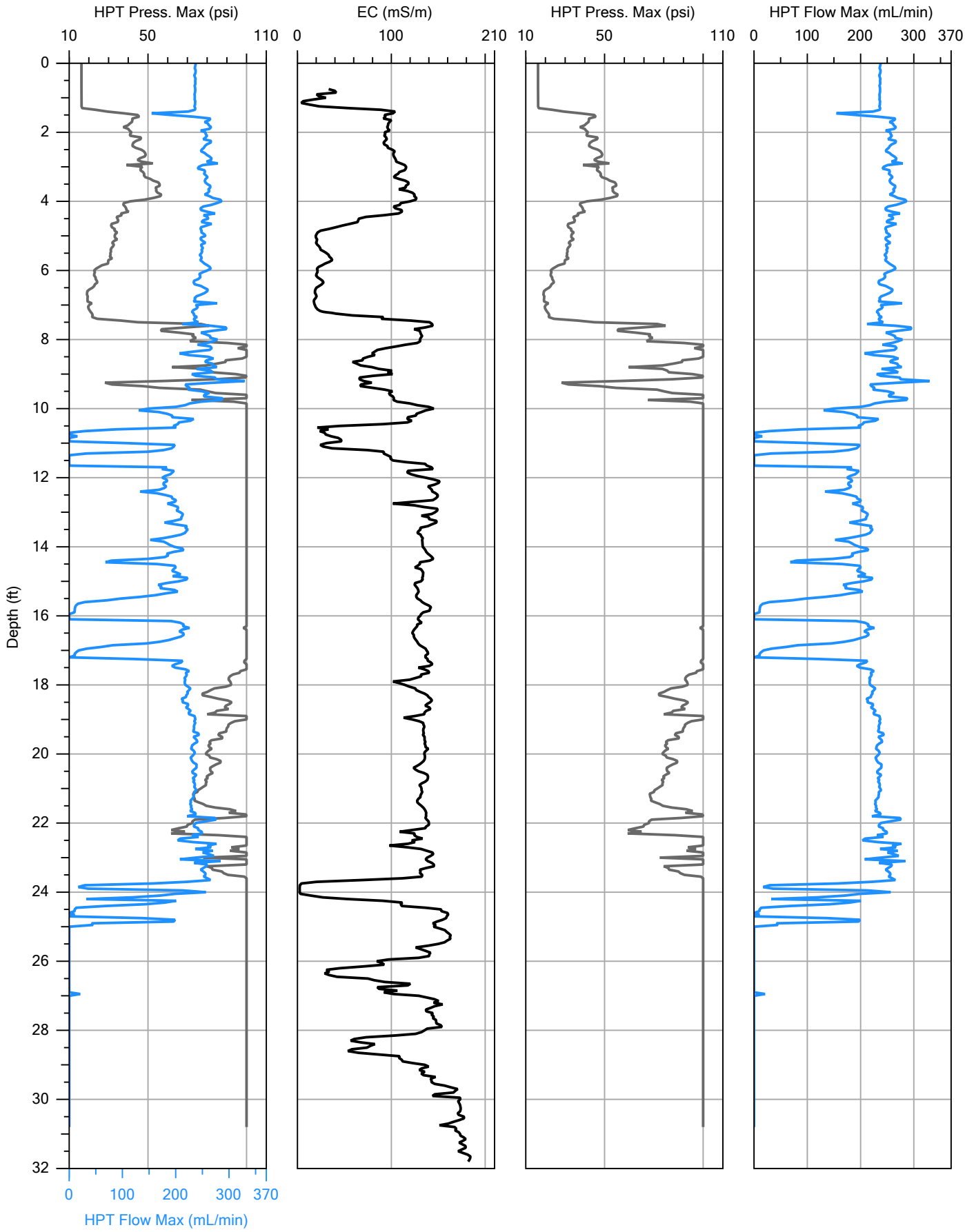
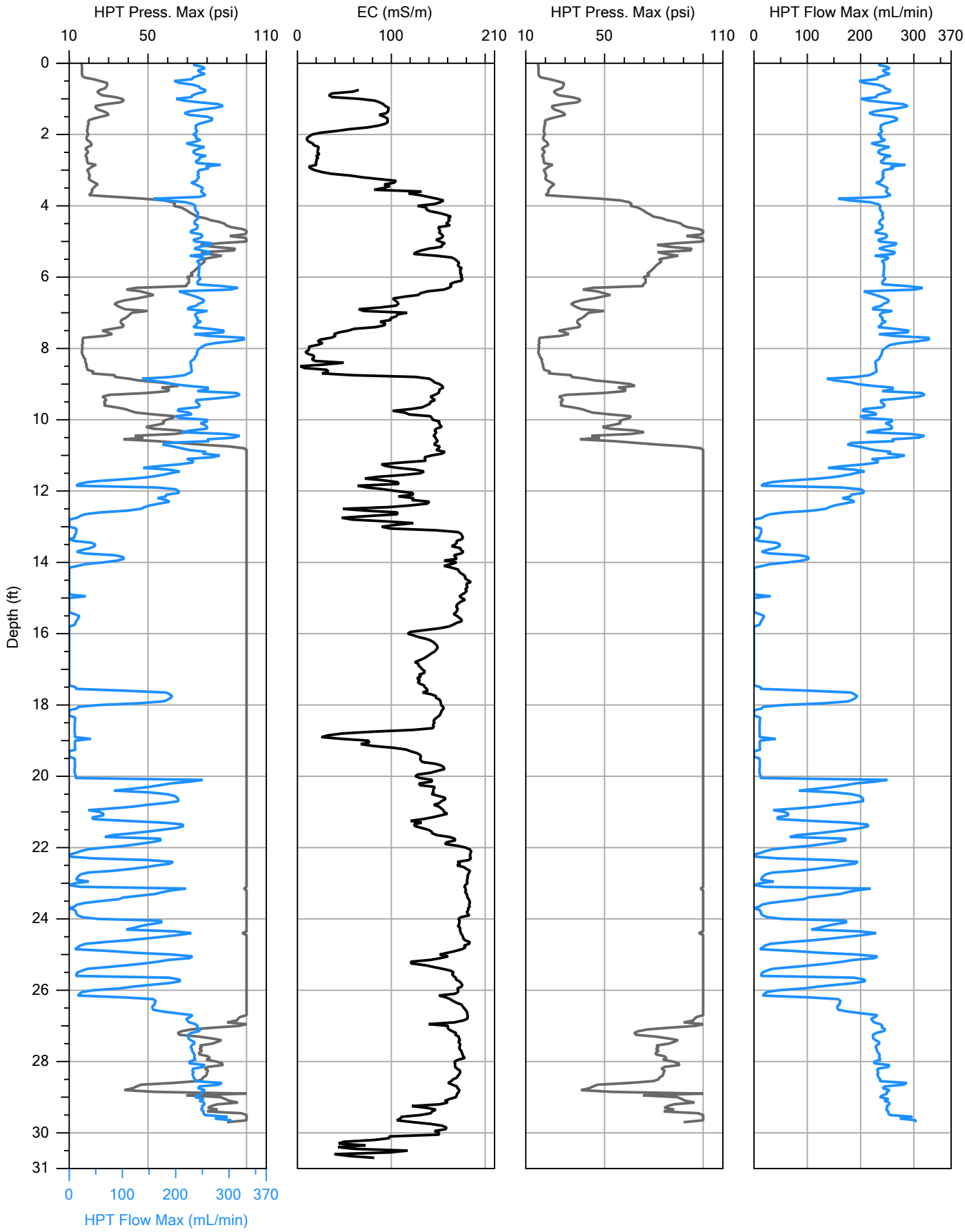
Company: Vironex	Operator: GHH	Date: 6/23/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

		File: HPT-MPZ2.MHP
Company: Vironex	Operator: GHH	Date: 6/23/2014
Project ID: Former Unocal	Client: URS	Location:



VIRONEX

		File: HPT-MPZ3.MHP
Company: Vironex	Operator: GHH	Date: 6/23/2014
Project ID: Former Unocal	Client: URS	Location:

Appendix D

Boring Logs

11-SAND 12-27 8-BENTONITE 10 SACKS 11-26

URS

PROJECT: FORMER UNOCAL WICHITA PROJECT # 41011500.0702

Site: Address 2100 E. 37th ST. North City WICHITA State KS

Date: From 6/25/14 To 6/26/14 CLIENT/OWNER: CHEVRON

DRILL METHOD: DPT SAMPLE METHOD: DT cont core WEATHER: PC / Hot

BORING/WELL #: MPZ 1 DEPTH 27.0' DIA. 3.25 ELEVATION DTW

CASING/SCREEN 0 - 26.0 (PREPACKED) DIA. 1.0" SLOT 0.01" SCREEN LENGTH 15.0' WELL LENGTH 26.0

DEPTH TO GRAVEL PACK 10.0' DEPTH TO BENTONITE 8.0'

SAMPLE INTERVAL	ORGANIC VAPORS (PPM)	Soil Classification	Well Construction	FIELD DESCRIPTIONS
1	0.0	ML		0-1 CLAYEY SILT - TOP SOIL - DK Brw (2.5YR 3/2)
2	0.0	CL		MED stiff, Low Plasticity, Slg moist, rootlets
3	0.0			1-5 SILTY CLAY, trace F.G. SAND. Brw/Gy (2.5YR 5/2)
4	0.0			MED stiff, high Plasticity, Slg moist
5	0.1			@5.0 Gy Brown (2.5YR 6/4) stiff, MED Plasticity, Slg moist
6	0.0			@ 8.0 - 8.75 SILT lgt Gy Brw, soft, Non Plastic moist
7	0.0			8.75 - 10.25 SILTY CLAY, some F.G. SAND Gy Brw (5YR 5/1)
8	0.0	ML		stiff, MED Plasticity, Slg moist
9	0.9	CL		10.25 - 10.75 SAND w/ Fines - Fine grain size Gy Brw (2.5YR 7/4)
10	0.1	SC		Med. Dense, Poor sorting, moist - Vmoist
11	0.0	SP		10.75 - 11.50 SAND, Med grain size Gy Brw (2.5Y 7/4)
12	0.0	CL		Loose, well sorted, wet - Sat.
13	0.0			11.50 - 16.0 (5GY 6/1) SILTY CLAY, some Fine grain Sand
14	0.0			gr/Gy (5GY 5/1) stiff, low Plasticity, friable, Dry
15	0.0			@ 16.0 - 16.5 soft, Slg moist, high Plasticity
16	0.0			@ 16.5 - 18.0 soft, Slg moist, high Plasticity
17	0.0			@ 18.0 - 21.0 soft, Slg moist, high Plasticity
18	0.0			@ 18.5 Gy (5GY 4/1)
19	0.0			@ 21.0 - 21.5 soft, Slg moist, high Plasticity
20	0.0			
21	0.0			
22	0.0			@ 23.0 soft, ↑ in Silt
23	0.0			
24	0.0			
25	0.0			

SAMPLE DEPTH	TIME	FIELD INFORMATION
		1] Name 2] grain size: vf, f, m, c, vc 3] shape: A, I, S, R 4] color;
* USED PrePACKED SCREEN		5] Plasticity-thread: nonPl-no thread, low 1/8-1/4", medium 1/32-1/8", high <1/32"
		6] Consistency-thumb: vy soft >1", soft 1", firm 1/4", hard thnail, vy hard-no indent
		7] water state: dry, moist, wet, saturated 8] other material 9] odor

A=angular AB=after boring, AS=auger sample, C=coarse, Cly=clay, CS=Continuous sample, DIA=diameter, DTW=depth to water, F=fine, GR=ground, Grv=Gravel, I=irregular, M=medium, R=rounded, REF=reference, S=subrounded, Sd=Sand, SL=silt, SS=split spoon, ST-Shelby tube, TOC=top of casing, TOS=top of screen, VC=very coarse, VF=very fine, WD=while drilling

1 001 6 1 2 1 0

log

URS

BORING/WELL #: MP2 1 PROJECT # 41011800.0702

SAMPLE INTERVAL	SOIL CLASSIFICATION	ORGANIC VAPORS (PPM)	Construction	FIELD DESCRIPTIONS
26	CL	0.0		25.0-28.0 SILTY CLAY, some Fine Grain (Brwn) (10YR5/3) Stiff-V. Stiff, Low Plasticity Friable, Dry @ 25.5-27.0 SOM, Sls moist (5GY4/1) @ 27.5 DK Gray - Driving Probing - V. Stiff, Dry 27.5-28.0 Cy weathered Shale @ 28.0 - Probe Refusal
27		0.0		
28		0.0		

EQUIPMENT USED & COMMENTS	FIELD INFORMATION
	1] Name 2] grain size: vf, f, m, c, vc 3] shape: A, I, S, R 4] color;
	5] Plasticity-thread: nonPl-no thread, low 1/8-1/4", medium 1/32-1/8", high <1/32"
	6] Consistency-thumb: vy soft >1", soft 1", firm 1/4", hard thnail, vy hard-no indent
	7] water state: dry, moist, wet, saturated 8] other material 9] odor

A=angular AB=after boring, AS=auger sample, C=coarse, Cly=clay, CS=Continuous sample, DIA=diameter, DTW=depth to water, F=fine, GR=ground, Grv=Gravel, I=irregular, M=medium, R=rounded, REF=reference. S=subrounded, Sd=Sand, SL=silt, SS=split spoon, ST-Shelby tube, TOC=top of casing, TOS=top of screen, VC=very coarse, VF=very fine, WD=while drilling

URS

PROJECT: Former Unocal Wichita PROJECT # 41011500.0702

Site: Address 2100 E. 37th St North City Wichita State KS

Date: From 6/25/14 To 6/25/14 CLIENT/OWNER: Chevron

DRILL METHOD: DPT SAMPLE METHOD: DT Point Core WEATHER: PC/Hot

BORING/WELL #: MPZ 2 DEPTH 24.0 DIA. 3.25 ELEVATION DTW

CASING/SCREEN 0-22.0'/7.22 DIA. 1.0" PrePacked SLOT 0.01" SCREEN LENGTH 15.0' WELL LENGTH 22.0'

DEPTH TO GRAVEL PACK 6.0' DEPTH TO BENTONITE 4.0'

SAMPLE INTERVAL	ORGANIC VAPORS (PPM)	Soil Classification	Flush Well Construction	FIELD DESCRIPTIONS
1	0.0	~~SL~~ ML		0-1 TOPSOIL - CLAY SILT w/some Fine Grained SAND, soft Low Plasticity, Slg Moist rootlets 10YR 5/3 (Brown)
2	0.1	CL		1.0-1.75 GRAVEL FILL
3	0.4			1.75-5.5 SILTY CLAY, Trace Fine Grained Sand 10YR 5/3 (Brn) MED Stiff, high Plasticity, Slg Moist, some (5YR 6/2) (Ovs) Staining
4	0.1			
5	0.0			5.5-6.1 Some GRAVEL APPROX 1CM in SIZE
6	0.1	SL		6.1-7.5 SAND W/ Fines MED-Fine Grain SIZE, Moderate, Poor Sorting, Moist (5G 5/1) (Green GY)
7	0.0	SP		7.5-8.0 SAND Med-Grain SIZE, Loose, Well Sorted, Wet
8	0.0	CL		8.0-8.25 CLAY, Trace Silt, Trace F.G Sand (5G 5/1) (Green GY) Soft, high Plasticity, ~~wet~~ V. moist
9	0.0			
10	1.0			
11	NR			8.25-10.0 SILTY CLAY, some F.G Sand Stiff, NON Plastic, Frush Dry (5G 5/1) (Green GY)
12	NR			
13	NR			10.0-14.0 NO RECOVERY
14	~~0.0~~ NR			
15	0.1			14.0-24.0 SILTY CLAY, Trc-some F.G SAND (5G 6/2 & 7.5YR 5/3) (Green GY & RD Brn) Stiff-V. Stiff, Low Plasticity, friable, Dry
16	0.1			
17	0.1			@ 15.5-17.0 Increase in Plasticity & Moisture -> high Plasticity, moist
18	0.2			
19	1.2			17.0-19.0 Low Plasticity, Slg Moist
20	0.6			@ 19.0 Soft. Moist
21	0.0			@ 19.25 Soft Med Stiff Slg Moist
22	0.0			@ 21.75 Increase in Clay content (5B 7/1) (Dk Gray)
23	0.0			Silty ~~Silty~~ CLAY, high Plasticity, Slg Moist-Moist
24	0.0			@ 22.5-23.5 (5G 6/2 & 7.5YR 5/3) (Green GY & RD Brn), Stiff, Low Plasticity
				@ 23.5-24.0 Soft, Moist, GY mottle, high Plasticity
				T.D. 24.0

SAMPLE DEPTH	TIME	FIELD INFORMATION
		1] Name 2] grain size: vf, f, m, c, vc 3] shape: A, I, S, R 4] color,
* USED PrePACKED SCREEN		5] Plasticity-thread: nonPl-no thread, low 1/8-1/4", medium 1/32-1/8", high <1/32"
		6] Consistency-thumb: vy soft >1", soft 1", firm 1/4", hard thnail, vy hard-no indent
		7] water state: dry, moist, wet, saturated 8] other material 9] odor

A=angular AB=after boring, AS=auger sample, C=coarse, Cly=clay, CS=Continuous sample, DIA=diameter, DTW=depth to water, F=fine, GR=ground, Grv=Gravel, I=irregular, M=medium, R=rounded, REF=reference, S=subrounded, Sd=Sand, SL=silt, SS=split spoon, ST-Shelby tube, TOC=top of casing, TOS=top of screen, VC=very coarse, VF=very fine, WD=while drilling

8'-23' screen

URS

PROJECT: Former Wichita PROJECT # 4101 1500 0702

Site: Address 2100 E. 37th St North City Wichita State KS

Date: From 6/26/14 To 6/26/14 CLIENT/OWNER: Chevron

DRILL METHOD: DPT SAMPLE METHOD: DT Cont CORE WEATHER: Cloudy | 104

BORING/WELL #: MPZ 3 DEPTH 23.0 DIA. 3.25 ELEVATION DTW

CASING/SCREEN 0-23/8-23 DIA. 1.0" Prepacked SLOT 0.01" SCREEN LENGTH 15' WELL LENGTH 23'

DEPTH TO GRAVEL PACK 7.0 DEPTH TO BENTONITE 5.0'

SAMPLE INTERVAL	ORGANIC VAPORS (PPM)	Soil Classification	Flush Well Construction	FIELD DESCRIPTIONS
1.0	0.0	ML		0-2.5 CLAYEY SILT - GY BRN (5Y 2.5/2) some F.G. Sand Med stiff, Low-Med Plasticity, Slg Moist, some Rootlets
2.0	0.1	CL		
3.0	0.1			2.5-5.5 SILTY CLAY, some Fine grain Sand BRN/GY (10YR 2.5/2), stiff, Low-Med Plasticity, Dry
4.0	0.1			
5.0	0.0			5.5-8.3 - ORG BRN. stiff, some Sm. Lith. Nodules (Calcite) (5YR 4/6)
6.0	0.0			
7.0	0.0			8.3-8.6 SAND, Med grain size (Yellow) (2.5Y 8/4) Loose, well Sorted, Dry
8.0	0.0	SP		8.6 - 12.0 SILTY CLAY (GY Yellow) (2.5Y 8/1) Some Fine Grained Sand, stiff, Low Plasticity Friable, Slg. Moist
9.0	0.0	CL		
10.0	0.0			@ 12.25 GRAVEL LENS - V. Moist, Soft
11.0	0.0			13.50 - 13.75 - INCREASE IN SILT, SOFT, Moist
12.0	0.0			
13.0	0.0			
14.0	0.0			@ 15.0 Brownish GY (2.5Y 6/1)
15.0	0.0			@ 17.0 Greenish GY (2.5GY 5/1)
16.0	0.0			17.0 - 19.0 CLAY, some Silt, Trace F.G. Sand Greenish GY (5GY 5/1), stiff, MED Plasticity V. Moist Dense
17.0	0.0			
18.0	0.0			
19.0	0.0			19.0 - 23.0 SILTY CLAY, some Fine Grain Sand, stiff - V. stiff, Low Plasticity, Friable, Dry, Very Hard Probing (5GY 7/1) Grey
20.0	0.0			@ 20-22.0 RD/BRN (2.5YR 4/6)
21.0	0.0			@ 22 5GY 7/1 V. stiff & HARD Probing
22.0	0.0			@ 23.0 Geoprobe Refusal
23.0	0.0			
24.0				
25.0				

SAMPLE DEPTH	TIME	FIELD INFORMATION
		1] Name 2] grain size: vf, f, m, c, vc 3] shape: A, i, S, R 4] color,
* 1" Pre Packed Screen		5] Plasticity-thread: nonPl-no thread, low 1/8-1/4", medium 1/32-1/8", high <1/32"
		6] Consistency-thumb: vy soft >1", soft 1", firm 1/4", hard thnail, vy hard-no indent
		7] water state: dry, moist, wet, saturated 8] other material 9] odor

A=angular AB=after boring, AS=auger sample, C=coarse, Cly=clay, CS=Continuous sample, DIA=diameter, DTW=depth to water, F=fine, GR=ground, Grv=Gravel, I=irregular, M=medium, R=rounded, REF=reference, S=subrounded, Sd=Sand, Slt=silt, SS=split spoon, ST-Shelby tube, TOC=top of casing, TOS=top of screen, VC=very coarse, VF=very fine, WD=while drilling

log

Appendix E

Photographic Logs

Appendix E: Photographic Log

Photo 1: Utilities marked along Biobarrier A14-3 on the Coleman property.

Photo 2: Real-time HPT data reading.

Photo 3: HPT drilling rig.

Photo 4: HPT trailer with cables in the HPT rod shown.

Photo 5: Close up of the HPT injection tip and cables.

Photo 6: 55 gallon drum with EHC-L.

Photo 7: Close up for EHC-L in drum.

Photo 8: Injection manifold.

Photo 9: EHC-L mixing tanks in the injection trailer.

Photo 10: Rig near injection point.

Photo 11: EHC injection rod with hose connected to injection manifold.

Photo 12: EHC injection rod with hose connected to injection manifold.

Photo 13: Hoses connected to injection manifold in trailer.

Photo 14: EHC packages.

Photo 15: Close up of EHC package.

Photo 16: Mixing EHC.

Photo 17: Minor EHC daylighting.

Photo 18: Minor EHC daylighting.

Photo 19: MPZ-2 pad.

Photo 20: MPZ-3 pad.

Photo 21: Injection trailer.

Photo 22: Tank for water storage.