Stage 2 Abatement Plan determined to be administratively complete. In addition, OCD approves the draft of the Public Notice and Participation Proposal (OCD approval letter at end of report).

STAGE 2 ABATEMENT PLAN (AP-126-0)

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
API # 30-045-08718
NCS1735235018

SEPTEMBER 30, 2019

Prepared for:

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LT Environmental, Inc.
Advancing Opportunity

STAGE 2 ABATEMENT PLAN

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO

Project Number: 017817006

Prepared by: Danny Burns, LTE Project Geologist — September 30, 2019 (Date)

Reviewed by: Ashley Ager, M.S., P.G., LTE Senior Geologist — September 30, 2019 (Date)

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STAGE 2 ABATEMENT PLAN

LT Environmental, Inc. (LTE), on behalf of Hilcorp Energy Company (Hilcorp), presents the following Stage 2 Abatement Plan (AP-126-0) associated with subsurface hydrocarbon impacts encountered at the Standard #1 natural gas production well (Site). This plan summarizes the site description and incident background and initial response and assessment. Details of on-site pilot testing are provided, along with recommendations and design criteria for a remediation system. The plan proposes the installation and implementation of an on-site remediation system consisting of soil vapor extraction (SVE) and liquids recovery, as well as continued monitoring until closure is achieved.

1.0 SITE DESCRIPTION AND BACKGROUND

The Site is located on Crouch Mesa between the Animas and San Juan rivers in Unit J of Section 4 of Township 29 North, Range 12 West, San Juan County, New Mexico, approximately three miles southwest of Flora Vista (Figure 1). The Site is an inactive natural gas production facility consisting of a production wellhead, three-phase separator, a below-grade produced water storage tank, and an aboveground condensate storage tank. On November 28, 2017, the Site was shut down during construction activities when subsurface hydrocarbon impacts were encountered from a suspected historical release from a production dump line. The dump line transported condensate and produced water from the separator to an aboveground storage tank. The duration and volume of the release is unknown. The release was reported to the New Mexico Oil Conservation Division (NMOCD) by Hilcorp on a Form C-141 *Release Notification and Corrective Action Form* dated December 6, 2017.

As documented in a Stage 1 Abatement Plan submitted November 20, 2018, the following remediation action levels apply for soil: 10 milligrams per kilogram (mg/kg) benzene; 50 mg/kg total benzene, toluene, ethylbenzene, and total xylenes (BTEX); 100 mg/kg total petroleum hydrocarbons (TPH); and 600 mg/kg chloride. Additionally, the following New Mexico Water Quality Control Commission (NMWCC) standards apply to groundwater: 10 micrograms per liter (µg/l) benzene, 750 µg/l toluene, 750 µg/l ethylbenzene, and 620 µg/l total xylenes.

Hilcorp conducted subsurface investigations and excavation activities to mitigate the subsurface impacts. The results of the initial response activities and subsequent investigations were detailed in the Stage 1 Abatement Plan, which the NMOCD verified as administratively complete on January 22, 2019. The Stage 1 Abatement Plan concluded that groundwater at the Site is discontinuous and additional data points were needed to evaluate remediation options. Between March 19, 2019 and June 5, 2019, LTE installed additional monitoring wells to better understand groundwater behavior and distribution of hydrocarbon subsurface impacts. The results of the extended investigation were documented in a July 2019 Update and Supplemental Report dated July 26, 2019. The extended investigation delineated soil and groundwater impacts and recommended pilot testing to determine if in-situ remediation technologies would be viable. Quarterly groundwater monitoring and product recovery was implemented with the most recent event occurring on September 17, 2019. This report documents the pilot testing and most recent quarterly monitoring, then proposes remediation appropriate to the site conditions described in the previous reports.

2.0 GROUNDWATER MONITORING

As specified in the Stage 1 Abatement Plan, LTE conducted quarterly groundwater monitoring on all monitoring wells (newly installed and existing) on September 17, 2019. Static groundwater level monitoring included measuring depth to groundwater and/or depth to product in all 26 monitoring wells with an oil/water interface probe. The interface probe was decontaminated with Alconox™ soap and rinsed with deionized water prior to each measurement.

Monitoring wells MW07, MW09, MW13, MW21, and MW24 were dry. Monitoring wells MW01, MW02, MW06, MW10, and MW14 contained measurable product. When product was measured in a monitoring well, a correction factor of 0.8 was applied to the elevation to account for the depression of the water column caused by the weight of the overlying product. Groundwater elevations and product thickness are summarized in Table 1 and depicted on Figure 2.

Product removal was completed using a dedicated bailer and total volume removed was recorded. All product was disposed of in the on-site pit tank. Approximately 0.5 gallons of product was removed from five different monitoring wells during the September 2019 groundwater sampling event. A total of 3.65 gallons of PSH have been removed since remediation and site investigation activities began.

Groundwater samples were collected and submitted for analysis of BTEX from twelve monitoring wells (MW03, MW05, MW08, MW11, MW12, MW15, MW16, MW18, MW19, MW22, MW23, and MW26) that had adequate volume of groundwater for sampling and did not contain product. There was a measurable depth to water in monitoring wells MW04, MW17, MW20 and MW25, but an insufficient volume within the water column to collect a groundwater sample for submission of laboratory analysis. Groundwater samples were submitted under strict chain-of-custody protocol to Hall Environmental Analysis Laboratory (Hall) in Albuquerque, New Mexico, for analysis of BTEX by United States Environmental Protection Agency (EPA) Method 8021B. Due to the variability of groundwater present and recharge rates, LTE used new disposable polyethylene bailers on each well to collect grab samples before the wells purged dry or once stabilization parameters were met. LTE used a YSI 556 hand-held multi-probe water quality field meter to record pH, electric conductivity (EC), and temperature of the groundwater. Stabilization was defined as three consecutive stable readings for each water property (plus or minus (±) 0.4 units for pH, ±10 percent for EC, and ±2 degrees Celsius (°C) for temperature. The interface probe and water quality meter were decontaminated with Alconox™ soap and rinsed with de-ionized water prior to each use to prevent cross-contamination. Groundwater sampling forms are included in Appendix A.

Laboratory analytical results of groundwater samples indicated benzene concentrations exceeded the NMWQCC standard in MW03, MW05, MW12, MW15, MW16, MW18, and MW19 with concentrations ranging from 0.92 milligrams per liter (mg/L) in MW12 to 24 mg/L in MW15. Toluene concentrations exceeded the NMWQCC standard in MW05, MW15, MW16, and MW18. Ethylbenzene concentrations exceeded the NMWQCC standard in MW12, MW15, MW18, and MW19. Total xylenes concentrations exceeded the NMWQCC standard in MW03, MW05, MW15, MW16, MW18, and MW19. The groundwater analytical results as compared to the NMWQCC standards are presented on Figure 3 and summarized in Table 2. The laboratory analytical reports are included in Appendix B.

3.0 REMEDATION PILOT TESTING

Based on the additional assessment that included the installation of monitoring wells to delineate the soil and dissolved-phase petroleum hydrocarbon impacts, LTE estimated the extents of the total petroleum hydrocarbon (TPH) impacts to the subsurface and light non-aqueous phase liquid (LNAPL) aerial extent. LTE used the available information and evaluated remediation technologies which were reasonable alternatives based on site geology and petroleum hydrocarbon impacts. LTE developed and implemented remediation pilot testing on multiple monitoring wells onsite to determine applicability and remediation design parameters. LTE performed SVE pilot testing on two monitoring wells, an LNAPL baildown test on three monitoring wells, and completed a slug test on one monitoring well to evaluate groundwater hydraulic conductivity.

3.1 SVE Pilot Testing

On August 30, 2019, LTE personnel conducted an SVE pilot test using a vacuum truck, an SVE stack manifold with sampling ports, multiple pressure gauges, a photoionization detector (PID) , and an oil-water interface probe. Prior to the start of the SVE pilot test, the depth to water and total volatile organic compounds (VOCs) were measured in the monitoring wells MW02, MW04, MW05, MW06 and MW15 (observation wells) using the interface probe and PID.

LTE first utilized monitoring well MW03 as the SVE test well. LTE chose MW03 because of its proximity to identified soil impacts and historically recorded limited groundwater within the monitoring well. LTE installed the pilot test manifold on monitoring well MW03 and attached the hose from the vacuum truck to the manifold. The manifold included a flow control valve, gauges, meters and a sample port to record the following:

- Applied vacuum, measured inches of water column (in. wc);
- Flow Rate, measured in actual cubic feet per minute (acfm);
- Differential pressure; and
- Total VOC effluent (stack), measured in parts per million (ppm).

The test began by applying vacuum to MW03 at an initial flow of rate of 13 acfm which resulted in an implied vacuum of 27.4 in. wc to 28.5 in. wc. Effluent PID values indicated total VOC concentrations of 619 ppm to 746 ppm. This initial vacuum was applied for a 35-minute period, during which no measured vacuum was observed at the observation wells. The flow rate was increased to 23 acfm for a 30-minute period. During this period, applied vacuum measured 69.9 in. wc to 72.1 in. wc and effluent PID values ranged from 662 ppm to 761 ppm. During this portion of the test, vacuum was observed at monitoring well MW02 ranging from 0.30 in. wc to 0.40 in. wc and at monitoring well MW05 at 0.20 in. wc. These monitoring wells are located 52 feet and 55 feet, respectively, from the test well MW03. For the final part of the test on monitoring well MW03, LTE increased the flow rate to 36 acfm. During this test period, an applied vacuum of 135.9 in. wc to 142.7 in. wc was observed, and the effluent total VOC measurements ranged from 724 ppm to 853 ppm. Again, an observed vacuum was measured at monitoring wells MW02 and MW05. The measured vacuum at monitoring well MW02 ranged from 0.50 in. wc to 0.70 in. wc and ranged from 0.30 in. wc to 0.40 in. wc at monitoring well MW05.

For the second part of the SVE pilot test, LTE used monitoring well MW10 as the test well to evaluate the installation of an SVE system since the monitoring point has historically contained limited volumes of water and its location to identified soil impacts. LTE used monitoring wells MW01, MW02, and MW07 as observation wells. LTE installed the pilot test manifold on the test well and attached the vacuum truck to the manifold. LTE used the vacuum truck to apply an initial flow rate of 17 acfm resulting in a vacuum ranging from 17.5 in. wc to 20.2 in. wc and total VOC effluent ranging from 696 ppm to 780 ppm. During this portion of the test, influence was measured at monitoring well MW01 located 41 feet from the test well. LTE recorded vacuum ranging from 0.20 in. wc to 0.40 in. wc. LTE increased the flow at MW10 to 32 acfm. The applied vacuum at the test well ranged from 45.9 in. wc to 48 in. wc and total measured VOC effluent ranged from 762 ppm to 859 ppm. Influence measurements documented at monitoring wells MW01 and MW02 ranged from 0.30 in. wc to 0.70 in. wc in MW01 and from 0.0 in. wc to 0.20 in. wc at MW02. LTE increased the flow rate to 47 acfm. During this period, the applied vacuum ranged from 69.3 in. wc to 70.2 in. wc and total VOC effluent ranged from 772 ppm to 873 ppm. Influence measurements collected at observation wells ranged from 1.10 in. wc to 1.20 in. wc in MW01 and 0.30 in. wc in MW02.

During the SVE pilot test, two effluent air samples were collected for laboratory analysis of BTEX by EPA Method 8021B and TPH – gasoline range organics (GRO) by EPA Method 8015D. The first effluent air sample was collected from test well MW03 at a flow rate of 36 acfm and resulted in a benzene concentration of 1,800 µg/L and a TPH-GRO concentration of 130,000 µg/L. The second effluent air sample was collected from test well MW10 at a flow rate of 47 acfm, and the sample contained a benzene concentration of 1,600 µg/L and TPH-GRO concentration of 87,000 µg/L. The results of the SVE pilot testing are presented in Table 3 and associated graphs provided in Appendix C. The laboratory analytical report for the effluent air samples is provided in Appendix B.

3.2 LNAPL Baildown Test

From September 4th through 6th, 2019, LTE personnel conducted an LNAPL baildown test to determine LNAPL and groundwater transmissivity. The baildown tests for LNAPL transmissivity were performed on monitoring wells MW06 and MW10. Each test was conducted by first measuring the depth to product (DTP) and depth to water (DTW) using an oil-water interface probe. A volume of product and/or water was then purged from each monitoring well and DTP and DTW were measured over time to determine the rate of recharge at each monitoring well. The results of the baildown test were analyzed using the American Petroleum Institute (API) LNAPL Transmissivity Calculator, which indicated a LNAPL Transmissivity at monitoring well MW06 of 2.13 feet squared per day (ft^2/day) and 2.07 ft^2/day for MW10. The results of the LNAPL baildown testing are presented in Table 4 and the API calculation sheets are provided in Appendix D.

3.3 Slug Test Analysis

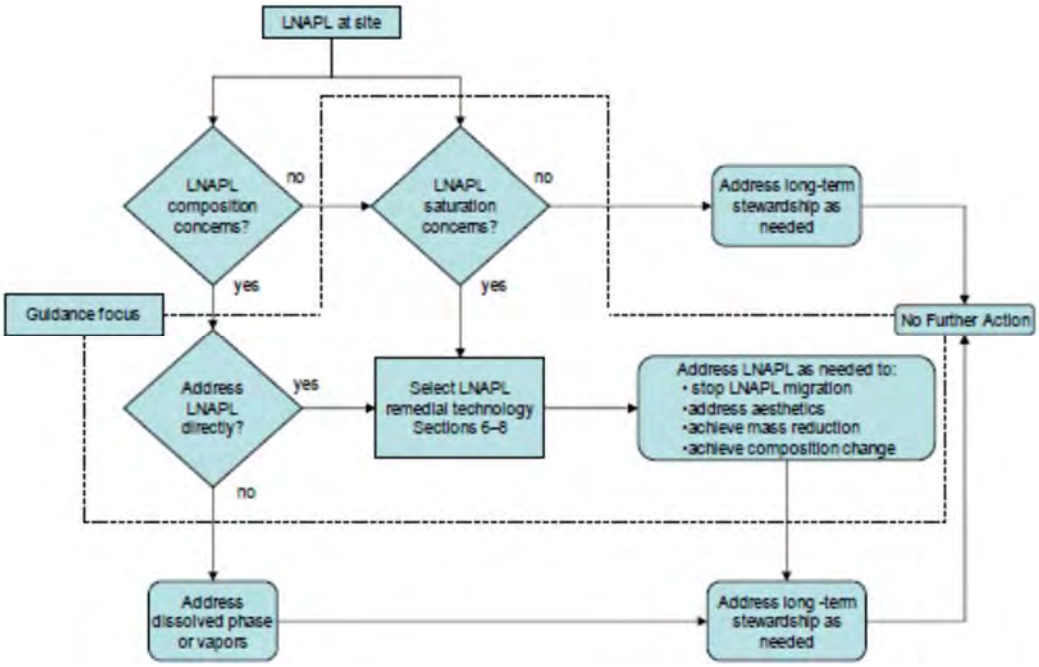
LTE completed a slug test at the Site to evaluate shallow groundwater hydraulic conductivity and to formulate a groundwater flow rate across the Site. LTE installed a transducer within monitoring well MW11 to measure changes in groundwater pressure within the monitoring well as result of the removal or introduction of a slug (mass) or volume of water. The transducer recorded changes over time at equal steps during a test on monitoring well MW11. The data collected during the slug test by the transducer were then analyzed using the AQTESLOV Version 4.5. The results of the analysis indicated a hydraulic conductivity for the shallow groundwater of 1.2 x 10^{-5} centimeters per second (cm/s). The analysis output is provided as Appendix E.

4.0 ASSESSMENT OF ABATEMENT OPTIONS

The investigation results indicate variable lithology and discontinuous lenses of groundwater at variable depths. Upon release discovery, excavation activities were completed in a portion of the Site in attempt to complete mitigation of the release. During the excavation, LNAPL and groundwater were encountered, and subsurface geology observed generally exhibited sands and gravels, with various sized cobbles, which limited excavation depth. The presence of LNAPL and hydrocarbon mass observed indicate that a remediation program such as chemical oxidation application is not likely to be cost effective. Where the concentrations are high, removal through excavation or mechanical system implementation is more practical and reasonable.

LTE completed additional assessment of the LNAPL to evaluate if the LNAPL in the subsurface was considered migrating or if it had reached residual saturation. Based on the completed LNAPL baildown testing, it was determined that the LNAPL at the Site has an LNAPL transmissivity that would suggest the LNAPL is migrating, meaning the LNAPL saturation is greater than residual. As such, LTE completed a remediation alternative evaluation.

LTE referred to the Interstate Technology Regulatory Council (ITRC), Evaluating LNAPL Remedial Technologies for Achieving Project Goals Guidance developed in 2009. The ITRC Guidance provides a generalized LNAPL management overview summarized in the flow chart below.



Based on site observations and ITRC guidance, LTE established project goals as follows:

1. Reduce petroleum hydrocarbon mass in soil and groundwater to achieve site closure criteria.
2. Address impacts to soil in the vadose zone through extraction;

3. Recover LNAPL in the saturated zone to the maximum extent practicable or to an LNAPL Transmissivity of 0.1 to 0.8 ft^2/day; and

4. Use a remedial technology that would create a phase change related to the LNAPL to limit LNAPL dissolution to shallow groundwater.

Previous efforts to complete excavation had been completed at the Site and soil conditions, radial area of petroleum hydrocarbon impacts and depth, the overall physical space to complete the needed excavation, made the alternative unreasonable. In-situ removal of soil vapors through SVE is more appropriate.

The baildown tests determined that LNAPL is recoverable and that a dual-phase remedial alternative would be appropriate for the Site. Continuous fluid removal is not expected to be practical to achieve closure, as much of the impact is adsorbed to soil and is discontinuous in the subsurface. The relatively remote location justifies a system that requires low maintenance, while limiting groundwater recovery and treatment requirements reduces necessary monitoring and maintenance. Focusing fluid recovery at specific locations where LNAPL has accumulated is practical and reasonable. Beyond LNAPL recovery, the second project goal was to change the phase of the LNAPL. To achieve this goal, multi-phase extraction (MPE) is warranted.

5.0 REMEDIATION SYSTEM DESIGN

Based on the results of the SVE pilot test activities and LNAPL baildown testing, LTE has developed the following remediation design.

5.1 SVE Pilot Test Data Analysis

According to the EPA's *How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites*, EPA 510-B-95-007, Chapter II Soil Vapor Extraction, the radius of influence (ROI) is considered to be the distance from the test well at which a vacuum of at least 0.1 in. wc is observed. An effective radius of vacuum influence (R_E) is the distance at which at least 1 percent (%) of applied vacuum can be detected. The vacuum measurements observed at the observation wells during the second portion of the SVE pilot test indicated the minimum 1% observed vacuum was measured at an applied vacuum ranging from 45 in. wc to 48.0 in. wc, with an observed vacuum reading of 1.20 in. wc observed in monitoring well MW02, located 40 feet from the extraction point.

The PID values measured in headspace from observation wells during the second portion of the SVE pilot test indicated a decreasing trend in VOC concentrations, while PID values measured at the blower exhaust revealed VOC concentrations that showed an initial increase, but then leveled off over time. These data demonstrate that the SVE was successfully volatilizing and extracting petroleum hydrocarbons from the vadose zone. It appears from the vacuum data measured at the pilot test monitoring wells that the vadose zone soils did not contribute to conditions which limit the lateral influence of the SVE system.

5.2 SVE Remediation Design Considerations

One goal of the remediation program as presented in this report is to reduce the magnitude and extent of petroleum hydrocarbon impacts in soil and groundwater. The use of an SVE will reduce the mass flux of hydrocarbons to the groundwater. Another goal is to mechanically remove hydrocarbons from the vadose zone. Data collected during the pilot test indicated SVE influence at a vacuum of 45 in. wc to 48 in. wc at approximately 45 feet away. Using the EPA design criteria of 0.1 in. wc vacuum, the SVE influence was observed 45 feet from the test well at an applied vacuum of 45 in. wc to 48 in. wc. For a conservative design, the SVE will be designed with a ROI of 40 feet with an applied vacuum of 45 in. wc. The SVE will be designed for an extraction flow rate of at a minimum of 32 acfm per SVE well.

5.3 LNAPL Recovery

Another goal of the Stage 2 Abatement Plan is to remove LNAPL from the saturated zone. LTE compared the LNAPL transmissivity calculated as a result of the LNAPL baildown data to the target LNAPL transmissivity established by the ITRC. The LNAPL transmissivity value in the ITRC guidance at which recovery becomes limited or ineffective is 0.1 ft^2/day to 0.8 ft^2/day. LTE determined that current LNAPL transmissivities range from 2.03 ft^2/day to 2.16 ft^2/day, and, therefore, hydraulic recovery is recommended. A MPE system added to the SVE system would assist in the recovery of LNAPL while removing petroleum hydrocarbon mass through SVE. The use of a two-part remediation system in combination will aid in mass recovery to remove LNAPL in monitoring wells and achieve LNAPL phase-change to reduce BTEX concentrations in groundwater. Upon operation of the combined system, it is recommended that additional baildown testing will be performed to monitor changes in transmissivity

values and maximize system operation. Once site-specific LNAPL transmissivity values are determined to range from 0.1 ft^2/day to 0.8 ft^2/day, hydraulic recovery will no longer be effective, and the MPE portion of the system stop.

5.4 Proposed System Design

Using a ROI of 40 feet, LTE recommends initially using six of the existing monitoring wells as SVE wells. Of these, LTE recommends that four initially be equipped with a stinger pipe so that they can be operated as an MPE well. The stinger pipe is a one-inch pipe that will be installed at the LNAPL groundwater interface and will be utilized to pull on the LNAPL. The location at which the end of the stinger pipe is placed in the monitoring well will be adjusted during operation and maintenance of the system.

LTE initially recommends that monitoring wells MW01, MW02, MW03, MW06, MW10, and MW15 be used as SVE wells and monitoring wells MW01, MW02, M06, and MW10 will be equipped with a stinger pipe to assist with LNAPL recovery. The SVE well and MPE locations were chosen based on calculated petroleum hydrocarbon mass in the subsurface and to primarily remediate the source area. Over time as the source area is reduced, SVE wells may be changed. The initial SVE system layout is presented on Figure 4.

The extraction blower will be designed to accomplish an applied vacuum of 80 in. wc at a flow rate of 200 cfm. The blower will include an air and fluid separation tank and fluid transfer pump system. Recovered fluid will be temporarily stored in a tank and then periodically transferred for disposal. Each line will include a valve for flow rate adjustment and to make cycling of individual SVE wells possible.

5.5 Detailed Design

Detailed design including piping arrangements, piping sizing, equipment component and motor sizing, control circuits and electrical service requirements will be completed following approval of the Stage 2 conceptual design. Design will include air velocity meters to evaluate the overall flow rate from the blower and the relative flow and vacuum or pressure applied to the SVE and MPE wells. The system will initially be installed as a SVE/MPE system with the capability of expanding in the future as needed.

5.6 Remediation System Operation and Maintenance

The remediation system will be operated to optimize recovery of the subsurface impacts and maintain compliance with other environmental standards including air emissions regulations. System operations will be confirmed on a weekly basis and blower lubrication and required equipment maintenance will be performed in accordance with component manufacturer requirements. Blower flow rates, pressures and vacuum, and general operations will be monitored, and system adjustments will be made to optimize system performance at a minimum on a monthly basis during the first year of system operation. Operational data will be adjusted to improve groundwater remediation by comparing operational data and groundwater monitoring results. System operational visits will be adjusted as needed during the remediation project.

Vapor emission samples will be collected from the effluent of the extraction blower monthly for the first three months of system operation, followed by quarterly sampling for the subsequent period of operation. Air emission samples will be analyzed for VOCs, gasoline range organics and fixed gasses,

oxygen, nitrogen, carbon dioxide, hydrogen sulfide and methane through hexane for the first vapor sampling event. Subsequent sampling will include analyses for any VOCs observed during the initial test including BTEX and gasoline range organics.

5.7 Groundwater Monitoring and Compliance Evaluation

Groundwater samples will continue to be collected and analyzed at available monitoring wells initially on a quarterly basis. Fluid-level measurements will be monitored in all wells using an oil/water interface probe. Based on fluid-level measurements, selected wells containing sufficient groundwater will be purged and sampled. Each well will be purged of three well casing volumes or until the well is purged dry. Groundwater samples will be collected from each monitoring and submitted for laboratory analysis of BTEX by USEPA 8260. Wells with measurable PSH will not be sampled.

Initial sampling will be completed in the following monitoring wells:

- MW05, MW12, MW15, MW16, MW18, MW19, MW20, and MW26

If dry wells previously not sampled contain water, the volume of water and practicality of sampling the well will be evaluated. Wells that are deemed to provide beneficial information will then be added to the sampling schedule. Although several of these wells have groundwater, the absence of available groundwater in other wells precludes the usefulness of these other wells for groundwater monitoring.

As remediation progresses and groundwater monitoring results for wells indicate compliance with remediation goals, monitoring will cease at these wells. Following completion of active remediation, eight quarterly groundwater monitoring events will be accomplished.

5.8 Additional Phases of Remediation

LTE anticipates an additional phase of remediation following successful operation of SVE and MPE systems or once the systems are no longer effective at achieving the goals of site remediation. At least one of the following steps will be included in a second phase of remediation: adjusting the SVE system to operate on additional wells and/or converting the SVE system to an air sparge system to remediate residual dissolved phase remediation in the entire groundwater BTEX plume. LTE will make recommendations for this second phase of remediation as progress is monitored at the Site. Recommendations for changes will be included in monitoring reports submitted to the NMOCD.

5.9 Soil Monitoring Plan

Soil remediation evaluation will be primarily be based on operational results and vapor emission monitoring associated with the SVE system operation. The decline in vapor recovery and emissions will be closely related to soil remediation progress. A soil evaluation will be completed when emissions have declined to an asymptotic level and groundwater conditions are below or within one order of magnitude of groundwater standards.

Soil samples will be collected in the vicinity of the following locations and indicated depths:

- MW12 at 17 to 19 feet bgs; and

- MW15, 18 to 20 feet bgs.

These soil samples exhibited higher concentrations than other samples and cleanup in these areas will be indicative that the systems have been successful. Soil samples will be analyzed for BTEX, TPH - GRO, TPH diesel range organics (DRO) and motor oil range organics (MRO). Soil samples below the groundwater elevation will not be collected and the assumption will be made that if the groundwater is no longer impacted at the monitoring well, then the remaining soil impact will not cause further groundwater impact. Once soil samples indicate impact to soil has been addressed, LTE will initiate the second phase of remediation and monitor for closure by comparing BTEX concentrations in groundwater monitoring locations to NMWQCC standards.

5.10 Reporting

Groundwater monitoring results and remediation system operational results will be summarized in reports that will be provided on a quarterly basis. The reports will include an evaluation of remediation system progress and recommendations for adjusting the remediation and groundwater monitoring programs.

5.11 Implementation Schedule

The remediation system detailed design will commence upon receipt of approval of the Stage 2 Abatement Plan from the NMOCD. The anticipated schedule is provided below:

- Complete final design, specifications, and equipment selection within 3 months of Stage 2 Plan approval;
- Obtain equipment within 6 months of Stage 2 Abatement Plan Approval;
- Complete quarterly groundwater monitoring events during implementation;
- Complete remediation system installation and startup within 9 months of Stage 2 Abatement Plan Approval;
- Operate SVE/MPE system for approximately 1 year and evaluate modifications;
- Continue system operations and adjustments, continue quarterly groundwater monitoring and quarterly reporting for an initial estimate of two years;
- Complete post system operation monitoring including soil boring installation when SVE decline of emissions indicates potential to meet soil standards has been achieved; and
- Implement a second phase of remediation to address dissolved phase impacts.

Evaluation of results will continue and if the useful application of the system is determined to be complete, an alternative remediation program or monitored natural attenuation program will be proposed.

FIGURES

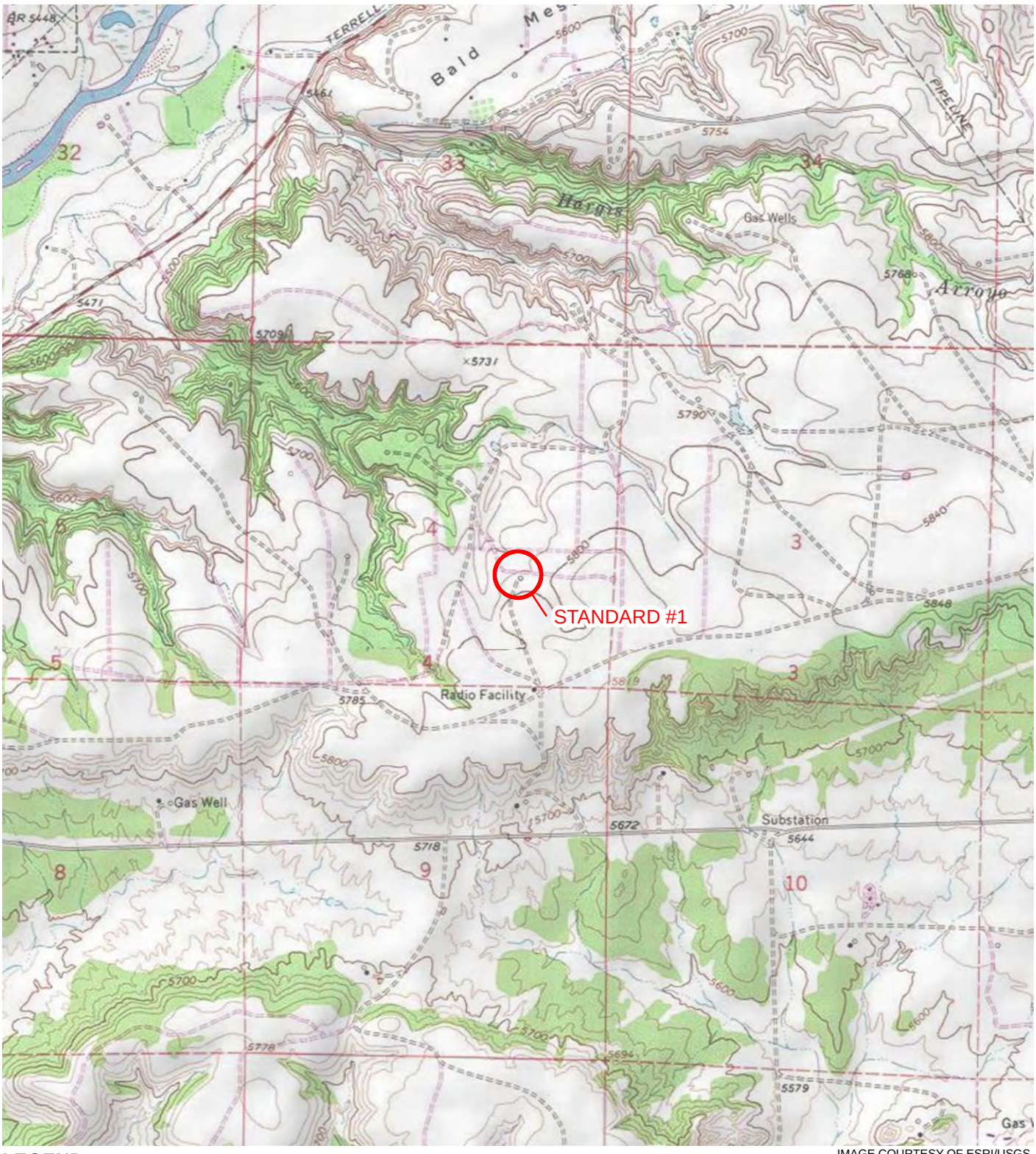


IMAGE COURTESY OF ESRI/USGS

LEGEND

SITE LOCATION

0 2,000 4,000

Feet

N

NEW MEXICO

FIGURE 1
SITE LOCATION MAP
STANDARD #1
SE SEC 4 T29N R12W
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

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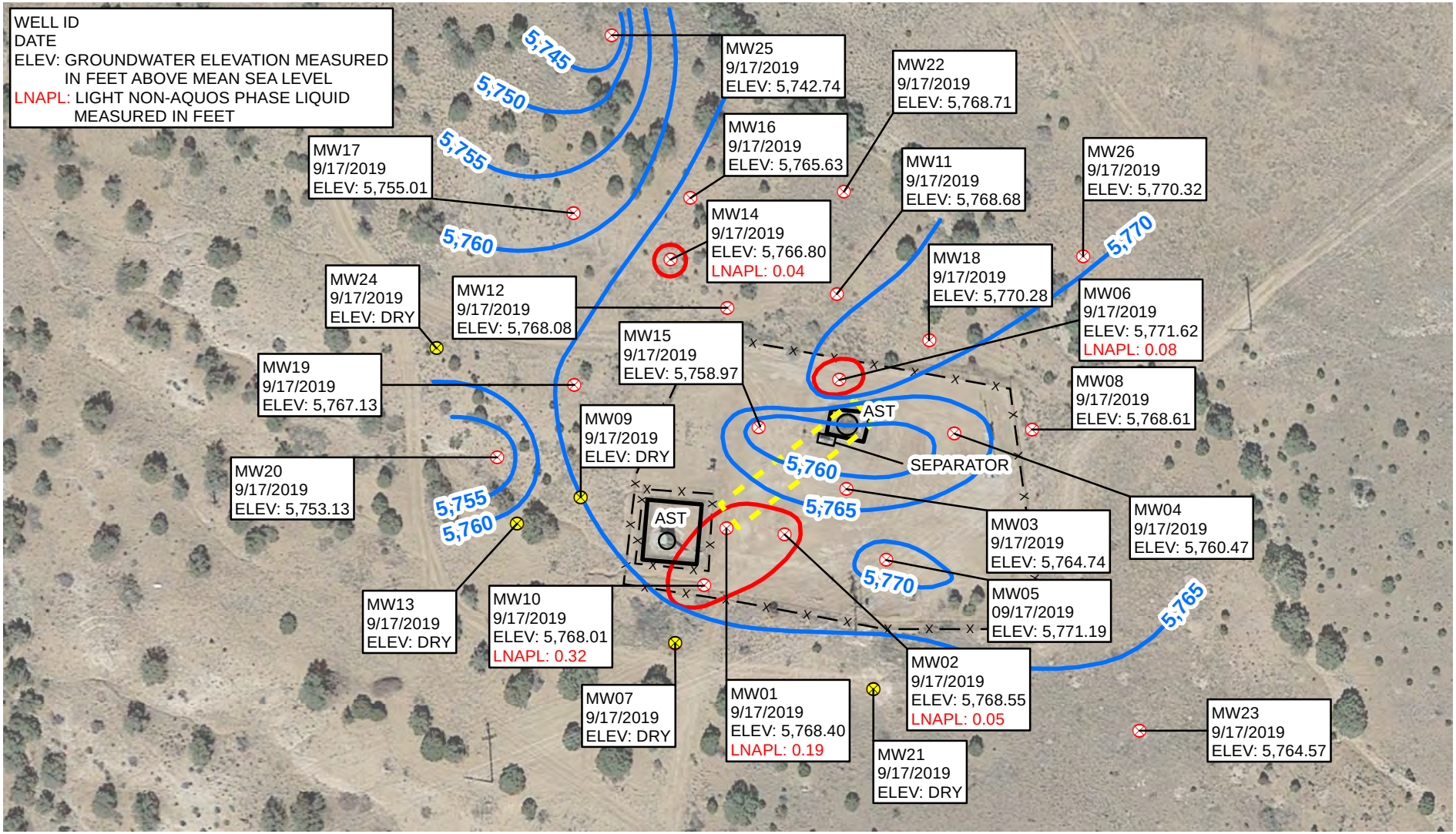

LEGEND

- INSTALLED MONITORING WELL
- DRY MONITORING WELL
- FENCE
- INFERRED GROUNDWATER ELEVATION CONTOUR
- LNAPL EXTENT SEPTEMBER 2019
- REMEDIATION EXCAVATION EXTENT
- BERM
- AST: ABOVEGROUND STORAGE TANK

FIGURE 2
SEPTEMBER 2019 GROUNDWATER POTENTIOMETRIC AND LNAPL THICKNESS MAP
STANDARD #1
N 1/2 SE 1/4 SEC 4 T29N R12W
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

P:\Hilcorp\GIS\MXD\017817006_STANDARD 1\017817006_FIG02_POTENTIOMETRIC_LNAPL_SEPT_2019.mxd

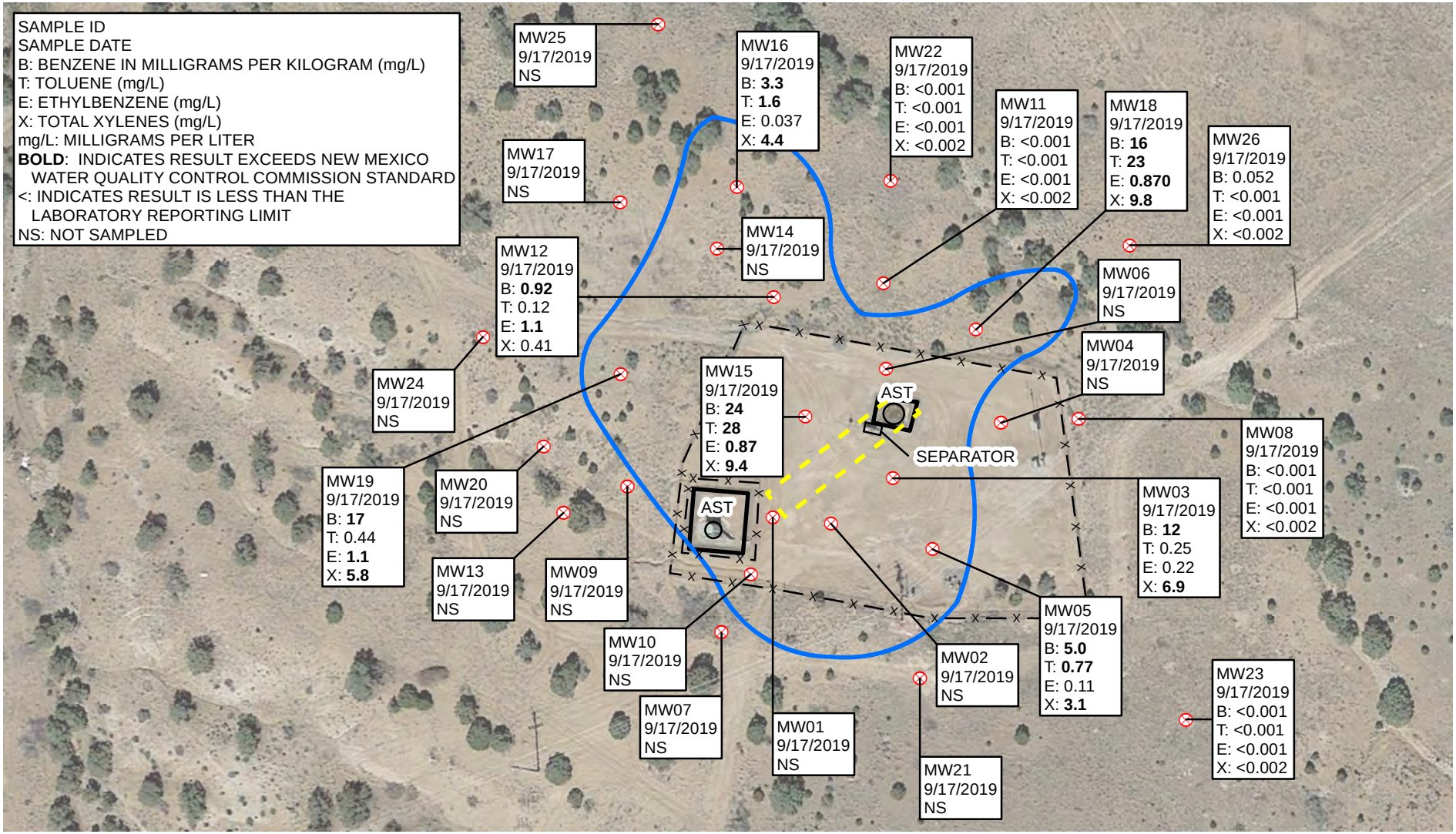

IMAGE COURTESY OF GOOGLE EARTH 2015

LEGEND

- MONITORING WELL
- FENCE
- REMEDIATION EXCAVATION EXTENT
- INFERRED BENZENE IMPACTS
- BERM

AST: ABOVEGROUND STORAGE TANK

0 100 200
Feet

N

FIGURE 3
SEPTEMBER 2019 GROUNDWATER ANALYTICAL RESULTS
STANDARD #1
N 1/2 SE 1/4 SEC 4 T29N R12W
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

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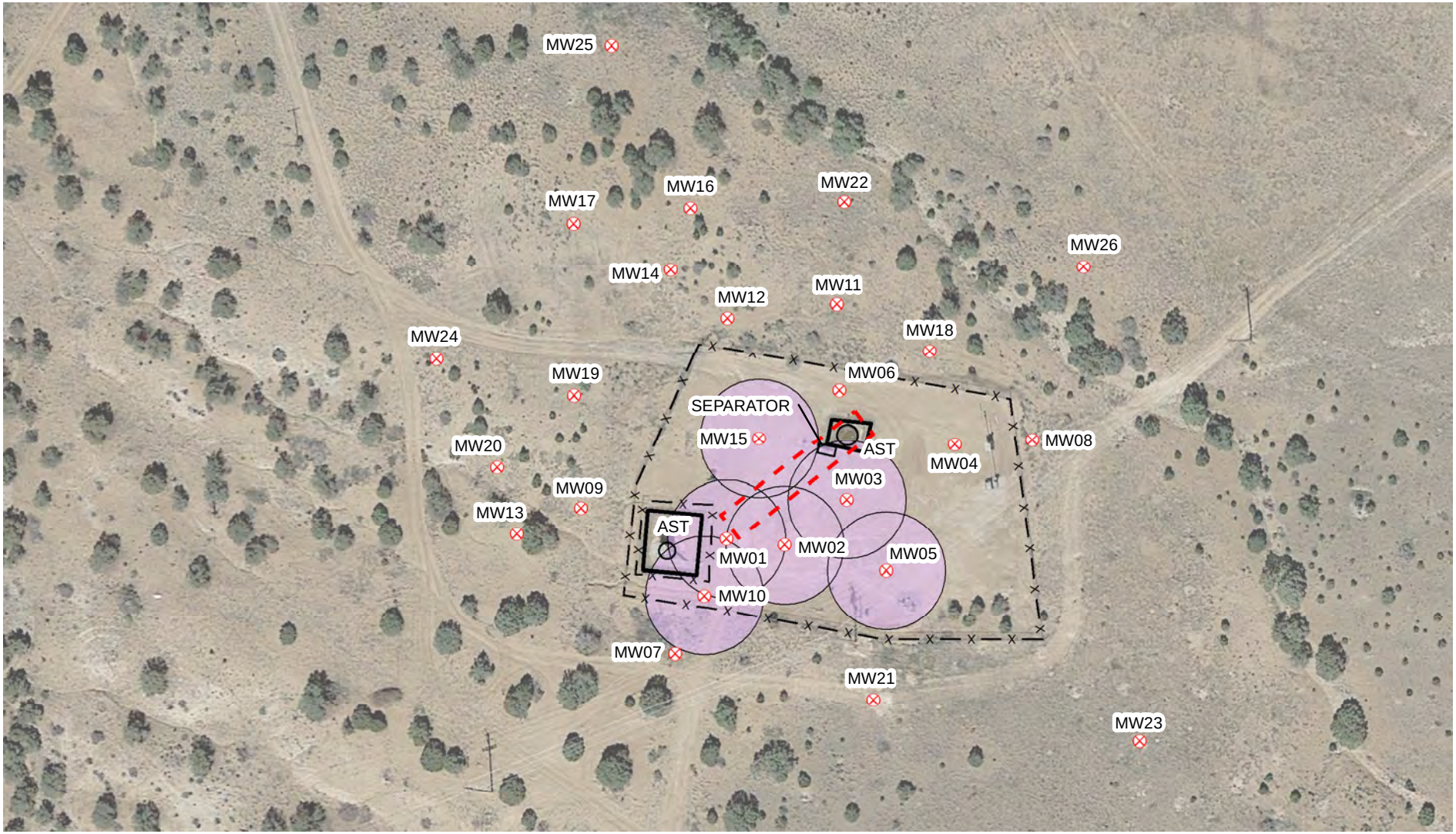

LEGEND

- MONITORING WELL
- FENCE
- REMEDIATION EXCAVATION EXTENT
- BERM
- SVE AREA OF influence (40 FEET)

AST: ABOVEGROUND STORAGE TANK
SVE: SOIL VAPOR EXTRACTION

IMAGE COURTESY OF GOOGLE EARTH 2015

0 100 200
Feet

N

FIGURE 4
SVE SYSTEM LAYOUT ON EXISTING MONITORING WELLS
STANDARD #1
N 1/2 SE 1/4 SEC 4 T29N R12W
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

P:\Hilcorp\GIS\MXD\017817006_STANDARD 1\017817006_FIG04_SVE_LAYOUT_2019.mxd

TABLES

TABLE 1
GROUNDWATER ELEVATION SUMMARY

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Well Name	Date	Top of Casing Elevation (feet)	Depth to Product (feet BTOC)	Depth to Groundwater (feet BTOC)	Product Thickness (feet)	Groundwater Elevation (feet)
MW01	10/17/2018	5,789.08	20.85	21.00	0.15	5,768.20
	10/22/2018		20.80	20.97	0.17	5,768.25
	3/29/2019		20.69	21.35	0.66	5,768.26
	6/28/2019		20.70	21.44	0.74	5,768.23
	9/17/2019		20.64	20.83	0.19	5,768.40
MW02	10/17/2018	5,789.36	--	21.22	--	5,768.14
	10/22/2018		--	21.12	--	5,768.24
	3/29/2019		20.85	21.11	0.26	5,768.46
	6/28/2019		20.95	21.30	0.35	5,768.34
	9/17/2019		20.80	20.85	0.05	5,768.55
MW03	10/17/2018	5,792.06	--	32.52	--	5,759.54
	10/22/2018		--	DRY	--	DRY
	3/29/2019		--	30.90	--	5,761.16
	6/28/2019		--	32.14	--	5,759.92
	9/17/2019		--	27.32	--	5,764.74
MW04	10/17/2018	5,792.35	--	31.84	--	5,760.51
	10/22/2018		--	31.80	--	5,760.55
	3/29/2019		--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	31.88	--	5,760.47
MW05	10/17/2018	5,792.60	--	28.54	--	5,764.06
	10/22/2018		--	28.39	--	5,764.21
	3/29/2019		--	24.65	--	5,767.95
	6/28/2019		--	24.53	--	5,768.07
	9/17/2019		--	21.41	--	5,771.19
MW06	10/17/2018	5,792.31	24.60	24.93	0.33	5,767.64
	10/22/2018		24.08	24.48	0.40	5,768.15
	3/29/2019		23.55	24.00	0.45	5,768.67
	6/28/2019		23.72	23.95	0.23	5,768.54
	9/17/2019		20.67	20.75	0.08	5,771.62

TABLE 1
GROUNDWATER ELEVATION SUMMARY

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Well Name	Date	Top of Casing Elevation (feet)	Depth to Product (feet BTOC)	Depth to Groundwater (feet BTOC)	Product Thickness (feet)	Groundwater Elevation (feet)
MW07	10/17/2018	5,791.15	--	DRY	--	DRY
	10/22/2018		--	DRY	--	DRY
	3/29/2019		--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	DRY	--	DRY
MW08	10/17/2018	5,792.42	--	DRY	--	DRY
	10/22/2018		--	DRY	--	DRY
	3/29/2019		--	DRY	--	DRY
	6/28/2019		--	24.07	--	5,768.35
	9/17/2019		--	23.81	--	5,768.61
MW09	10/17/2018	5,786.16	--	DRY	--	DRY
	10/22/2018		--	DRY	--	DRY
	3/29/2019		--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	DRY	--	DRY
MW10	10/17/2018	5,789.30	--	DRY	--	DRY
	10/22/2018		--	32.26	--	5,757.04
	3/29/2019		21.73	22.04	0.31	5,767.51
	6/28/2019		21.55	21.94	0.39	5,767.67
	9/17/2019		21.23	21.55	0.32	5,768.01
MW11	10/17/2018	5,787.99	--	20.00	--	5,767.99
	10/22/2018		--	19.89	--	5,768.10
	3/29/2019		--	19.63	--	5,768.36
	6/28/2019		--	19.37	--	5,768.62
	9/17/2019		--	19.31	--	5,768.68
MW12	10/17/2018	5,789.57	--	21.90	--	5,767.67
	10/22/2018		--	21.77	--	5,767.80
	3/29/2019		--	21.88	--	5,767.69
	6/28/2019		--	21.67	--	5,767.90
	9/17/2019		--	21.49	--	5,768.08

TABLE 1
GROUNDWATER ELEVATION SUMMARY

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Well Name	Date	Top of Casing Elevation (feet)	Depth to Product (feet BTOC)	Depth to Groundwater (feet BTOC)	Product Thickness (feet)	Groundwater Elevation (feet)
MW13	10/17/2018	5,785.16	--	DRY	--	DRY
	10/22/2018		--	DRY	--	DRY
	3/29/2019		--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	DRY	--	DRY
MW14	10/17/2018	5,785.46	--	DRY	--	DRY
	10/22/2018		--	22.87	--	5,762.59
	3/29/2019		20.26	20.47	0.21	5,765.16
	6/28/2019		19.15	19.16	0.01	5,766.31
	9/17/2019		18.65	18.69	0.04	5,766.80
MW15	3/29/2019	5,792.19	--	DRY	--	DRY
	6/28/2019		--	35.95	--	5,756.24
	9/17/2019		--	33.22	--	5,758.97
MW16	3/29/2019	5,786.54	--	28.59	--	5,757.95
	6/28/2019		--	21.00	--	5,765.54
	9/17/2019		--	20.91	--	5,765.63
MW17	3/29/2019	5,785.25	--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	30.24	--	5,755.01
MW18	3/29/2019	5,789.34	--	DRY	--	DRY
	6/28/2019		--	20.39	--	5,768.95
	9/17/2019		--	19.06	--	5,770.28
MW19	3/29/2019	5,786.48	--	19.60	--	5,766.88
	6/28/2019		--	19.55	--	5,766.93
	9/17/2019		--	19.35	--	5,767.13
MW20	3/29/2019	5,783.34	--	29.61	--	5,753.73
	6/28/2019		--	30.00	--	5,753.34
	9/17/2019		--	30.21	--	5,753.13

TABLE 1
GROUNDWATER ELEVATION SUMMARY

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Well Name	Date	Top of Casing Elevation (feet)	Depth to Product (feet BTOC)	Depth to Groundwater (feet BTOC)	Product Thickness (feet)	Groundwater Elevation (feet)
MW21	3/29/2019	5,800.30	--	DRY	--	DRY
	6/28/2019		--	DRY	--	DRY
	9/17/2019		--	DRY	--	DRY
MW22	3/29/2019	5,786.25	--	22.56	--	5,763.69
	6/28/2019		--	17.62	--	5,768.63
	9/17/2019		--	17.54	--	5,768.71
MW23	6/28/2019	5,804.80	--	45.99	--	5,758.81
	9/17/2019		--	40.23	--	5,764.57
MW24	6/28/2019	5,782.50	--	DRY	--	DRY
	9/17/2019		--	DRY	--	DRY
MW25	6/28/2019	5,775.65	--	32.98	--	5,742.67
	9/17/2019		--	32.91	--	5,742.74
MW26	6/28/2019	5,789.96	--	19.71	--	5,770.25
	9/17/2019		--	19.64	--	5,770.32

Notes:

BTOC - below top of casing

NA- not assessed

A product density factor of 0.8 was used to account for the presence of free product.

TABLE 2
GROUNDWATER ANALYTICAL RESULTS

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Monitoring Well Identification	Sample Date	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Total Xylenes (mg/L)
MW02	10/22/2018	**14**	**7.1**	**1.2**	**12**
MW03	3/29/2019	**21**	0.110	0.270	**11**
	9/17/2019	**12**	0.25	0.22	**6.9**
MW05	3/29/2019	**10**	**0.880**	0.450	**2.9**
	6/28/2019	**5.9**	0.160	0.200	**1.4**
	9/17/2019	**5.0**	**0.77**	0.11	**3.1**
MW08	6/28/2019	<0.001	<0.001	<0.001	<0.002
	9/17/2019	<0.001	<0.001	<0.001	<0.002
MW10	10/22/2018	**22**	**21**	**1.6**	**13**
MW11	10/22/2018	<0.001	<0.001	<0.001	<0.0015
	3/29/2019	0.0036	<0.001	<0.001	<0.0015
	6/28/2019	<0.001	<0.001	<0.001	<0.0015
	9/17/2019	<0.001	<0.001	<0.001	<0.002
MW12	10/22/2018	**2.4**	**3.8**	**1.1**	**5.0**
	3/29/2019	**0.870**	0.018	**1.2**	**1.5**
	6/28/2019	**0.810**	0.055	**1.0**	0.5
	9/17/2019	**0.92**	0.12	**1.1**	0.41
MW14	10/22/2018	**13**	**26**	**1.1**	**10**
MW15	6/28/2019	**24**	**28**	**1.1**	**10**
	9/17/2019	**24**	**28**	**0.87**	**9.4**
MW16	3/29/2019	**7.7**	**14**	**0.940**	**8.6**
	6/28/2019	**3.4**	0.620	0.080	**2.1**
	9/17/2019	**3.3**	**1.6**	0.037	**4.4**
MW18	6/28/2019	**15**	**18**	**0.770**	**9.4**
	9/17/2019	**16**	**23**	**0.870**	**9.8**

TABLE 2
GROUNDWATER ANALYTICAL RESULTS

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Monitoring Well Identification	Sample Date	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Total Xylenes (mg/L)
MW19	3/29/2019	**14**	**10**	**0.930**	**6.2**
	6/28/2019	**13**	0.230	**0.900**	**4.9**
	9/17/2019	**17**	0.44	**1.1**	**5.8**
MW20	3/29/2019	**1.0**	**0.900**	0.030	0.230
MW22	3/29/2019	0.001	0.002	<0.001	0.002
	6/28/2019	<0.001	<0.001	<0.001	<0.002
	9/17/2019	<0.001	<0.001	<0.001	<0.002
MW23	6/18/2019	<0.001	<0.001	<0.001	<0.002
	9/17/2019	<0.001	<0.001	<0.001	<0.002
MW26	6/18/2019	0.0052	<0.001	<0.001	<0.002
	9/17/2019	<0.001	<0.001	<0.001	<0.002
NMWQCC Standard		**0.01**	**0.750**	**0.750**	**0.620**

NOTES: mg/L - milligrams per liter

NMWQCC - New Mexico Water Quality Control Commission

< - indicates result is less than the stated laboratory reporting limit

Bold - indicates value exceeds stated NMWQCC standard

TABLE 3
SOIL VAPOR EXTRACTION PILOT TEST DATA

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Date: 8/30/2019 **Air Samples:** MW03 Effluent PID: 863 ppm @ 12:15

Time of Readings	Vacuum (in. wc) **MW03**	Flow rate (acfm) **MW03**	PID at SVE Stack (ppm)	Well ID **MW02**	Well ID **MW04**	Well ID **MW05**	Well ID **MW06**	Well ID **MW15**	Well ID **MW02**	Well ID **MW04**	Well ID **MW05**	Well ID **MW06**	Well ID **MW15**
Extraction Well (ft):				**52**	**82**	**55**	**73**	**72**	**52**	**82**	**55**	**73**	**72**
				PID measurement (ppm)					**Pressure Measurement (in. wc)**				
9:35	-28	13	619	0.5	0.50	0.2	1.0	216.0	0.00	0.00	0.00	0.00	0.00
9:55	-27.4	13	674	0.9	0.80	0.7	1.1	97.5	0.00	0.00	0.00	0.00	0.00
10:10	-28.5	13	746	1.4	0.60	1.4	2.5	221.0	0.00	0.00	0.00	0.00	0.00
10:25	-72.1	23	662	3.6	2.80	2.9	5.4	266.0					
10:40	-69.9	23	708	1.1	0.80	1.2	1.1	218.0	-0.30	0.00	-0.20	0.00	0.00
10:55	-70.6	23	761	0.3	0.10	0.2	0.2	69.2	-0.40	0.00	-0.20	0.00	0.00
11:40	-142.7	36	724	0.2	0.00	2.5	0.2	168.0	-0.50	0.00	-0.30	0.00	0.00
11:55	-142.7	36	768	7.0	2.40	1.4	6.7	99.0	-0.60	0.00	-0.30	0.00	0.00
12:10	-135.9	36	853	4.2	2.20	2.5	2.6	85.0	-0.70	0.00	-0.40	0.00	0.00

Date: 8/30/2019 **Air Samples:** MW10 Effluent PID: 890 ppm @ 15:00

Time of Readings	Vacuum (in. wc) **MW10**	Flow rate (acfm) **MW10**	PID at SVE Stack (ppm)	Well ID **MW01**	Well ID **MW02**	Well ID **MW07**	Well ID **MW01**	Well ID **MW02**	Well ID **MW07**
Extraction Well (ft):				**41**	**64**	**43**	**41**	**64**	**43**
				PID measurement (ppm)			**Pressure Measurement (in. wc)**		
12:50	-17.5	17	696	8.8	2.80	51.5	-0.20	-0.10	0.00
13:00	-20	17	748	6.8	3.70	2.0	-0.40	-0.10	0.00
13:20	-20.2	17	780	13.9	5.70	48.0	-0.20	0.00	0.00
13:35	-45.9	32	762	2.8	2.40	2.0	-0.30	0.00	0.00
13:50	-48	32	787	3.0	1.30	0.5	-0.70	0.00	0.00
14:05	-48.6	32	859	13.7	4.30	2.4	-0.90	-0.20	0.00
14:20	-69.3	47	873	2.2	1.60	0.7	-1.10	-0.30	0.00
14:35	-70.1	47	845	3.8	2.60	1.9	-1.20	-0.30	0.00
14:50	-70.2	47	772	9.3	2.70	0.8	-1.20	-0.30	0.00

in. wc - inches of water column
ft. - feet
PID - photoionization detector

ppm - parts per million
scfm - standard cubic feet per minute
acfm - actual cubic feet per minute

TABLE 4
BAILDOWN/SLUG PILOT TEST RESULTS

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Date: 9/4/2019 **Well:** **MW01**

LNAPL Removal Start Time	Volume LNAPL Removed (ft^3)	Volume Water Removed (ft^3)	LNAPL Removal Completion Time	Depth to air/LNAPL Interface (ft)	Depth to LNAPL/water Interface (ft)	LNAPL Thickness (ft)
Pre-bail down readings				20.58	21.20	0.62
1:42:00 PM	0.6680	0.0334	1:52:00 PM	20.78	21.14	0.36
LNAPL Recharge Observations			Time			
			2:02:00 PM	20.72	20.99	0.27
			2:12:00 PM	20.70	20.97	0.27
			2:22:00 PM	20.69	20.95	0.26
			4:05:00 PM	20.65	20.92	0.27
			4:35:00 PM	20.65	20.92	0.27
			5:05:00 PM	20.66	20.95	0.29
9/5/2019			7:20:00 AM	20.66	20.95	0.29
			10:20:00 AM	20.66	20.95	0.29
			1:30:00 PM	20.66	20.95	0.29

NOTES:

TABLE 4
BAILDOWN/SLUG PILOT TEST RESULTS

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Date: 9/4/2019 **Well:** **MW06**

LNAPL Removal Start Time	Volume LNAPL Removed (ft^3)	Volume Water Removed (ft^3)	LNAPL Removal Completion Time	Depth to air/LNAPL Interface (ft)	Depth to LNAPL/water Interface (ft)	LNAPL Thickness (ft)
Pre-bail down readings				20.66	20.92	0.26
2:35:00 PM	0.0084	0.0167	2:45:00 PM	21.01	21.06	0.05
LNAPL Recharge Observations			Time			
			2:55:00 PM	21.00	21.07	0.07
			3:05:00 PM	20.98	21.07	0.09
			3:15:00 PM	20.96	21.04	0.08
			4:10:00 PM	20.89	20.98	0.09
			4:40:00 PM	20.86	20.98	0.12
			5:10:00 PM	20.86	20.95	0.09
9/5/2019			7:25:00 AM	20.71	20.79	0.08
			10:25:00 AM	20.71	20.79	0.08
			1:35:00 PM	20.70	20.78	0.08

NOTES:

TABLE 4
BAILDOWN/SLUG PILOT TEST RESULTS

STANDARD #1
SAN JUAN COUNTY, NEW MEXICO
HILCORP ENERGY COMPANY

Date: 9/4/2019 **Well:** **MW10**

LNAPL Removal Start Time	Volume LNAPL Removed (ft^3)	Volume Water Removed (ft^3)	LNAPL Removal Completion Time	Depth to air/LNAPL Interface (ft)	Depth to LNAPL/water Interface (ft)	LNAPL Thickness (ft)
Pre-bail down readings				21.00	21.28	0.28
1:00:00 PM	0.0125	0.0209	1:02:00 PM	21.22	21.43	0.21
LNAPL Recharge Observations			Time			
			1:10:00 PM	21.22	21.43	0.21
			1:20:00 PM	21.20	21.41	0.21
			1:30:00 PM	21.20	21.41	0.21
			4:00:00 PM	21.14	21.34	0.20
			4:30:00 PM	21.16	21.34	0.18
			5:00:00 PM	21.15	21.34	0.19
9/5/2019			7:15:00 AM	21.13	21.32	0.19
			10:15:00 AM	21.12	21.31	0.19
			1:15:00 PM	21.11	21.30	0.19

NOTES:

APPENDIX A: GROUNDWATER COLLECTION FORMS

Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW01
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 20.83
Time: 08:57
Total Depth of Well: 28.73
Depth to Product: 20.64

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

NS-FP

Comments: No Sample due to presence of free product
bailed 10 oz of yellow product

Describe Deviations from SOP:

Signature:

Date: 9/17/2019

Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW02
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 20.85
Time: 09:55
Total Depth of Well: 25.09
Depth to Product: 20.80

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

NS-FP

Comments: NO sample due to presence of free product
Bailed 1 oz of yellow product

Describe Deviations from SOP:

Signature:
Date: 9/17/2019

Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW03
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer ; 12:20
Shipping Method: Hand Delivery

Depth to Water: 27.32
Time: 08:50
Total Depth of Well: 32.54
Depth to Product: NA

Vol. of Water to Purge: 5.22x.1631=.85x3=2.55gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer - Grab

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
12:06	0.25	0.25	7.08	64.0	4.29	Clear, H2S odor, no sheen
12:09	0.25	~~0.25~~ 0.50	7.16	63.0	4.34	sag
12:11	0.20	.70 mm	7.17	62.8	4.32	sag
				6		

Comments: Had to grab sample after bailing .70 gallons. Began to bail dry.

Describe Deviations from SOP: see above.

Signature: Mary Mrdjenovich Date: 9/17/2019

Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW04
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 31.88
Time: 0848
Total Depth of Well: 32.00
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample due to low amount of water in well.

Describe Deviations from SOP:

Signature: May mrdjenovich
Date: 9/17/2019

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T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW05
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer ; 12:45
Shipping Method: Hand Delivery

Depth to Water: ~~MW05~~ 21.41
Time: 08:52
Total Depth of Well: 23.65
Depth to Product: NA

Vol. of Water to Purge: 2.24x.1631 = .36x3 = 1.09 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer ; 9 Grab

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Took grab sample, too low amount of water to take parameters. Water was lgt gray, H_2S odor, no sheen, sediment.

Describe Deviations from SOP: ~~see~~ see above

Signature: Mary Mrdjenovich
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW06
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 20.75
Time: 10:05
Total Depth of Well: 23.84
Depth to Product: 20.67

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

NS - FP

Comments: No Sample due to presence of free product
Bailed 25 oz of yellow product

Describe Deviations from SOP: None

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW07
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: Dry
Time: 09:02
Total Depth of Well: 4.31
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Dd not sample, well dry.

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW8
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer ; 14:45
Shipping Method: Hand Delivery

Depth to Water: 23.81
Time: 0945
Total Depth of Well: 26.91
Depth to Product: NA

Vol. of Water to Purge: 3.1x.1631=.50x3=1.51 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
14:38	0.25	0.25	7.27	63.5	4.25	Clear, no odor, no sheen
14:40	0.20	0.45	7.26	61.5	4.63	lgt brown, cloudy, no odor/sheen

Comments:

Describe Deviations from SOP: Took grab sample after bailing 0.45 gallons, began to bail dry.

Signature: Mary Mrdjenovich
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW09
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: Dry
Time: 09:05
Total Depth of Well: 27.50
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample, dry well.

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW10
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 21.55
Time: 09:00
Total Depth of Well: 34.94
Depth to Product: 21.23

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

NS-FP

Comments: No sample due to presence of free product
Bailed 35 oz of yellow product

Describe Deviations from SOP:

Signature: Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW11
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer 1330
Shipping Method: Hand Delivery

Depth to Water: 19.31
Time: 0930
Total Depth of Well: 27.36
Depth to Product: NA

Vol. of Water to Purge: 8.05 x .1631 = 1.31 x 3 = 3.94 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
1315	0.25	0.25	7.07	21.5	3.51	grey, no odor
1317	0.25	0.5	7.03	20.7	3.51	↓
1319	0.25	0.75	7.00	20.1	3.51	light brown, no odor
1321	0.25	1	6.94	19.6	3.51	↓
1323	0.25	1.25	6.91	19.1	3.51	
1325	0.25	1.5	6.89	18.9	3.51	
1326	0.25	1.75	6.90	18.9	3.51	

Comments: Bailed dry before full purge, sampled after 1.75 gallons bailed
ST = 1330

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW12
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 21.49
Time: 0927
Total Depth of Well: 24.35
Depth to Product: NA

Vol. of Water to Purge: 2.86x.1631 = .46x3 = 1.39 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
1259	0.25	0.25	6.98	17.4	3.40	Clear, diesel smell
1301	0.25	0.5	6.98	17.1	3.38	↓
1305	0.25	0.75	6.98	16.9	3.41	↓

Comments: bailed dry before full purge, sampled after ~.75 gallons
ST = 1310

Describe Deviations from SOP:

Signature: [signature]
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW13
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: Dry
Time: 09:07
Total Depth of Well: 22.91
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample, dry well.

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW14
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 18.69
Time: 0923
Total Depth of Well: 22.84
Depth to Product: 18.65

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

NS-FP

Comments: No sample due to free product
Baited 0.5 oz Product

Describe Deviations from SOP:

Signature:

Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW15
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer ; 11:45
Shipping Method: Hand Delivery

Depth to Water: 33.22
Time: 08:45
Total Depth of Well: 38.29
Depth to Product: NA

Vol. of Water to Purge: 5.07x.1631=.83x3=2.48 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer, grab

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
11:32	0.50	0.50	6.73	63.3	~~19.9~~ 5.84	Clear, H_2S odor, no sheen, lgt brown
11:35	0.50	~~0.5~~ 1	6.81	61.9	~~2~~ 5.73	saa
11:37	0.25	1.25	6.81	62.2	5.76	saa
11:38	0.25	1.50	6.80	62.4	5.75	saa
11:40	0.25	1.75	6.81	62.2	5.73	saa
11:41	0.25	2	6.81	62.0	5.73	saa

Comments: Well began to boil dry at 2 gallons removed, took grab sample.

Describe Deviations from SOP: see above.

Signature: Mary Mrdjenovich Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW16
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 20.91
Time: 0920
Total Depth of Well: 29.73
Depth to Product: NA

Vol. of Water to Purge: 8.82x.1631=1.44x3=4.32 (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
1235	0.5	0.5	7.08	19.3	4.96	Clear, diesel smell
1237	0.25	0.75	7.02	18.9	5.05	
1239	0.25	1	6.98	18.8	5.01	
1241	0.25	1.25	6.96	18.8	5.13	
1243	0.25	1.5	6.94	18.6	5.16	
1245	0.25	1.75	6.94	18.6	5.15	

Comments: Bailed dry before full purge, sampled after 1.75 g removed
STC 1250

Describe Deviations from SOP:

Signature: [signature]

Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW17
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 30.24
Time: 0915
Total Depth of Well: 30.35
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample due to low amount of water in well.

Describe Deviations from SOP:

Signature: May Mrdjenovich Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW18
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer 1410
Shipping Method: Hand Delivery

Depth to Water: 19.06
Time: 0940
Total Depth of Well: 30.28
Depth to Product: NA

Vol. of Water to Purge: 11.74 x .1631 = 1.9 x 3 = 5.74 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
13:31	0.25	0.25	7.14	65.5	5.17	clear, HC odor, no sheen
13:33	0.25	0.50	7.03	63.7	4.90	saa
13:35	0.25	0.75	7.02	63.0	5.34	saa
13:38	0.50	1.25	6.96	62.4	5.28	saa
13:41	0.40	1.65	6.90	61.9	5.31	saa
13:44	0.50	~~2.15~~	6.90	61.7	5.34	saa

Comments:

Describe Deviations from SOP: Well began to bail dry after purging 2.15 gallons. Took grab sample

Signature: Mary Mrdjenovich
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW19
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer 1445
Shipping Method: Hand Delivery

Depth to Water: ~~Dry~~ mm 19.35
Time: 09:11
Total Depth of Well: 30.30
Depth to Product: NA

Vol. of Water to Purge: 10.95 x .1631 = 1.78 x 3 = 5.34 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
14:30	.5	.5	7.08	18.9	J.M	Clear, no odor
1432	.5	1	7.07	18.1	3.09	grey, no odor
1434	.5	1.5	7.02	17.9	3.08	"
1436	.5	2	7.00	17.5	3.09	

Comments: well bailed dry before full purge
sampled after purging 2 gallons
ST= 1445

Describe Deviations from SOP:

Signature: _____ **Date:** 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW20
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 30.21
Time: 09:09
Total Depth of Well: 30.34
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample due to low amount of water in well.

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW21
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: Dry
Time: 1000
Total Depth of Well: 38.04
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample, dry well.

Describe Deviations from SOP:

Signature: Mary Mrdjenovich
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW22
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer 13:15
Shipping Method: Hand Delivery

Depth to Water: 17.54
Time: 0935
Total Depth of Well: 23.49
Depth to Product: NA

Vol. of Water to Purge: 595 x .1631 = .97 x 3 = 2.91 gal (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer - grab

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
13:01	0.25	0.25	7.66	67.5	7.61	Clear, H_2S odor, no sheen, lgt brown.
13:04	0.75	0.50	7.65	64.6	7.76	saa
13:05	0.75	0.75	7.63	63.5	7.86	saa
13:08	0.50	~~0~~ 1.25	7.91	62.8	7.92	saa

Comments:

Describe Deviations from SOP: Took grab sample after purging 1.25 gallons, began to bail dry.

Signature: Mary Mrdjenovich Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW23
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer / 15:15
Shipping Method: Hand Delivery

Depth to Water: 40.23
Time: 0955
Total Depth of Well: 48.51
Depth to Product: NA

Vol. of Water to Purge: 8.28 x .1631 = 1.35 x 3 = 4.05 (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
15:07	0.25	0.25	7.166	61.2	3.32	Clear, no odor, no sheen
15:10	0.25	0.50	7.67	59.5	3.24	saa
15:12	0.25	0.75	7.54	59.2	3.29	saa

Comments:

Describe Deviations from SOP: Took grab sample after purging 0.75 gallons, began to run dry.

Signature: Mary Mrdjenovich
Date: 9/17/2019

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Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW24
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: Dry
Time: 09:13
Total Depth of Well: 33.12
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample, dry well.

Describe Deviations from SOP:

Signature: [signature] Date: 9/17/2019

LT Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002
Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW25
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021
Matrix: Groundwater
Sample Time: PVC Bailer
Shipping Method: Hand Delivery

Depth to Water: 32.91
Time: 10:10
Total Depth of Well: 33.15
Depth to Product: NA

Vol. of Water to Purge: (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments

Comments: Did not sample due to low amount of water.

Describe Deviations from SOP:

Signature: Mary Mrdjenovich Date: 9/17/2019

Advancing Opportunity

LT Environmental, Inc.
848 E. 2nd Ave.
Durango, Colorado 81301
T 970.385.1096

Groundwater Sample Collection Form

Project Name: Quarterly GW Monitoring
Project Number: 017817006.002

Project Location: Standard #1
Sampler: M. Mrdjenovich/T. Short

Sample ID: MW26
Sample Date: 9/17/2019
Laboratory: Hall Environmental
Analyses: BTEX 8021

Matrix: Groundwater
Sample Time: PVC Bailer 1415
Shipping Method: Hand Delivery

Depth to Water: 19.64
Time: 0950

Total Depth of Well: 31.58
Depth to Product: ~~Dry~~ NA

Vol. of Water to Purge: 11.94 x .1631 = 1.94 x 3 = 5.84 (height of water column * 0.1631 for 2" well or 0.6524 for 4" well) * 3 well vols
Method of Purging: Disposable HDPE Bailer
Method of Sampling: Disposable HDPE Bailer

Time	Vol. Removed	Total Vol. Removed (gallons)	pH (std. units)	Temp. (F)	Conductivity (µs or ms)	Comments
1340	0.5	0.5	6.92	18.4	3.25	Clear, no odor
1342	0.5	1	6.90	18.4	3.25	
1344	0.5	1.5	6.88	18.4	3.23	
1346	0.5	2	6.90	18.3	3.22	
1348	0.5	2.5	6.91	18.3	3.21	
1410	0.5	3	6.91	18.3	3.21	
1412	0.5	3.5	6.91	18.3	3.21	
1414	0.5	4	6.92	18.3	3.21	
~~Bailed~~						

Comments: Bailed dry before full purge, sampled after 4 gallons. ST = 1415 1350 - Pause for thunderstorm, 1410 - Continue Purge

Describe Deviations from SOP:

Signature: [signature]

Date: 9/17/2019

APPENDIX B: LABORATORY ANALYTICAL REPORTS

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

September 20, 2019

Danny Burns

Hilcorp Energy
PO Box 61529
Houston, TX 77208-1529
TEL: (337) 276-7676
FAX:

RE: Standard 1 OrderNo.: 1909919

Dear Danny Burns:

Hall Environmental Analysis Laboratory received 12 sample(s) on 9/18/2019 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results, it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifiers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0901

Sincerely,

Andy Freeman

Laboratory Manager

4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-03
Project: Standard 1
Collection Date: 9/17/2019 12:20:00 PM
Lab ID: 1909919-001 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	12000	500		µg/L	500	9/18/2019 9:16:39 PM	B63006
Toluene	250	50		µg/L	50	9/18/2019 9:39:21 PM	B63006
Ethylbenzene	220	50		µg/L	50	9/18/2019 9:39:21 PM	B63006
Xylenes, Total	6900	100		µg/L	50	9/18/2019 9:39:21 PM	B63006
Surr: 4-Bromofluorobenzene	97.2	80-120		%Rec	50	9/18/2019 9:39:21 PM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
PQL	Practical Quanitative Limit
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Limit

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-08
Project: Standard 1
Collection Date: 9/17/2019 2:45:00 PM
Lab ID: 1909919-002 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	ND	1.0		µg/L	1	9/18/2019 11:11:13 PM	B63006
Toluene	ND	1.0		µg/L	1	9/18/2019 11:11:13 PM	B63006
Ethylbenzene	ND	1.0		µg/L	1	9/18/2019 11:11:13 PM	B63006
Xylenes, Total	ND	2.0		µg/L	1	9/18/2019 11:11:13 PM	B63006
Surr: 4-Bromofluorobenzene	94.1	80-120		%Rec	1	9/18/2019 11:11:13 PM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-11
Project: Standard 1
Collection Date: 9/17/2019 1:30:00 PM
Lab ID: 1909919-003 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	ND	1.0		µg/L	1	9/18/2019 11:34:17 PM	B63006
Toluene	ND	1.0		µg/L	1	9/18/2019 11:34:17 PM	B63006
Ethylbenzene	ND	1.0		µg/L	1	9/18/2019 11:34:17 PM	B63006
Xylenes, Total	ND	2.0		µg/L	1	9/18/2019 11:34:17 PM	B63006
Surr: 4-Bromofluorobenzene	93.1	80-120		%Rec	1	9/18/2019 11:34:17 PM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-12
Project: Standard 1
Collection Date: 9/17/2019 1:10:00 PM
Lab ID: 1909919-004 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	920	50		µg/L	50	9/18/2019 11:57:15 PM	B63006
Toluene	120	5.0		µg/L	5	9/19/2019 12:20:09 AM	B63006
Ethylbenzene	1100	50		µg/L	50	9/18/2019 11:57:15 PM	B63006
Xylenes, Total	410	10		µg/L	5	9/19/2019 12:20:09 AM	B63006
Surr: 4-Bromofluorobenzene	146	80-120	S	%Rec	5	9/19/2019 12:20:09 AM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-15
Project: Standard 1
Collection Date: 9/17/2019 11:45:00 AM
Lab ID: 1909919-005 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	24000	500		µg/L	500	9/19/2019 1:52:29 AM	B63006
Toluene	28000	500		µg/L	500	9/19/2019 1:52:29 AM	B63006
Ethylbenzene	870	50		µg/L	50	9/19/2019 2:15:43 AM	B63006
Xylenes, Total	9400	100		µg/L	50	9/19/2019 2:15:43 AM	B63006
Surr: 4-Bromofluorobenzene	105	80-120		%Rec	50	9/19/2019 2:15:43 AM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-16
Project: Standard 1
Collection Date: 9/17/2019 12:50:00 PM
Lab ID: 1909919-006 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	3300	200		µg/L	200	9/19/2019 3:01:44 AM	B63006
Toluene	1600	20		µg/L	20	9/19/2019 3:24:47 AM	B63006
Ethylbenzene	37	20		µg/L	20	9/19/2019 3:24:47 AM	B63006
Xylenes, Total	4400	40		µg/L	20	9/19/2019 3:24:47 AM	B63006
Surr: 4-Bromofluorobenzene	104	80-120		%Rec	20	9/19/2019 3:24:47 AM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-18
Project: Standard 1
Collection Date: 9/17/2019 2:10:00 PM
Lab ID: 1909919-007 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	16000	200		µg/L	200	9/19/2019 4:11:10 AM	B63006
Toluene	23000	500		µg/L	500	9/19/2019 10:28:42 AM	B63046
Ethylbenzene	870	20		µg/L	20	9/19/2019 4:34:13 AM	B63006
Xylenes, Total	9800	400		µg/L	200	9/19/2019 4:11:10 AM	B63006
Surr: 4-Bromofluorobenzene	111	80-120		%Rec	20	9/19/2019 4:34:13 AM	B63006

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-19
Project: Standard 1
Collection Date: 9/17/2019 2:45:00 PM
Lab ID: 1909919-008 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	17000	200	P	µg/L	200	9/19/2019 10:52:07 AM	B63046
Toluene	440	20	P	µg/L	20	9/19/2019 11:15:36 AM	B63046
Ethylbenzene	1100	20	P	µg/L	20	9/19/2019 11:15:36 AM	B63046
Xylenes, Total	5800	400	P	µg/L	200	9/19/2019 10:52:07 AM	B63046
Surr: 4-Bromofluorobenzene	105	80-120	P	%Rec	20	9/19/2019 11:15:36 AM	B63046

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-22
Project: Standard 1
Collection Date: 9/17/2019 1:15:00 PM
Lab ID: 1909919-009 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	ND	1.0		µg/L	1	9/19/2019 12:49:24 PM	B63046
Toluene	ND	1.0		µg/L	1	9/19/2019 12:49:24 PM	B63046
Ethylbenzene	ND	1.0		µg/L	1	9/19/2019 12:49:24 PM	B63046
Xylenes, Total	ND	2.0		µg/L	1	9/19/2019 12:49:24 PM	B63046
Surr: 4-Bromofluorobenzene	105	80-120		%Rec	1	9/19/2019 12:49:24 PM	B63046

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-26
Project: Standard 1
Collection Date: 9/17/2019 2:15:00 PM
Lab ID: 1909919-010 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	ND	1.0		µg/L	1	9/19/2019 1:12:48 PM	B63046
Toluene	ND	1.0		µg/L	1	9/19/2019 1:12:48 PM	B63046
Ethylbenzene	ND	1.0		µg/L	1	9/19/2019 1:12:48 PM	B63046
Xylenes, Total	ND	2.0		µg/L	1	9/19/2019 1:12:48 PM	B63046
Surr: 4-Bromofluorobenzene	93.6	80-120		%Rec	1	9/19/2019 1:12:48 PM	B63046

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-23
Project: Standard 1
Collection Date: 9/17/2019 3:15:00 PM
Lab ID: 1909919-011 **Matrix:** GROUNDWA **Received Date:** 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	ND	1.0		µg/L	1	9/19/2019 1:36:14 PM	B63046
Toluene	ND	1.0		µg/L	1	9/19/2019 1:36:14 PM	B63046
Ethylbenzene	ND	1.0		µg/L	1	9/19/2019 1:36:14 PM	B63046
Xylenes, Total	ND	2.0		µg/L	1	9/19/2019 1:36:14 PM	B63046
Surr: 4-Bromofluorobenzene	104	80-120		%Rec	1	9/19/2019 1:36:14 PM	B63046

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909919**
Date Reported: **9/20/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Hilcorp Energy
Client Sample ID: MW-05
Project: Standard 1
Collection Date: 9/17/2019 12:45:00 PM
Lab ID: 1909919-012
Matrix: GROUNDWA
Received Date: 9/18/2019 8:10:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	5000	200		µg/L	200	9/19/2019 1:59:39 PM	B63046
Toluene	770	20		µg/L	20	9/19/2019 2:23:09 PM	B63046
Ethylbenzene	110	20		µg/L	20	9/19/2019 2:23:09 PM	B63046
Xylenes, Total	3100	40		µg/L	20	9/19/2019 2:23:09 PM	B63046
Surr: 4-Bromofluorobenzene	99.4	80-120		%Rec	20	9/19/2019 2:23:09 PM	B63046

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

QC SUMMARY REPORT
Hall Environmental Analysis Laboratory, Inc.

WO#: **1909919**
20-Sep-19

Client: Hilcorp Energy
Project: Standard 1

Sample ID: **RB**	SampType: **MBLK**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **PBW**	Batch ID: **B63006**	RunNo: **63006**
Prep Date:	Analysis Date: **9/18/2019**	SeqNo: **2148890** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 4-Bromofluorobenzene	18		20.00		89.7	80	120			

Sample ID: **100NG BTEX LCS**	SampType: **LCS**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **LCSW**	Batch ID: **B63006**	RunNo: **63006**
Prep Date:	Analysis Date: **9/18/2019**	SeqNo: **2148891** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	93.4	80	120			
Toluene	19	1.0	20.00	0	94.7	80	120			
Ethylbenzene	19	1.0	20.00	0	95.4	80	120			
Xylenes, Total	55	2.0	60.00	0	91.6	80	120			
Surr: 4-Bromofluorobenzene	19		20.00		94.2	80	120			

Sample ID: **1909919-001AMS**	SampType: **MS**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **MW-03**	Batch ID: **B63006**	RunNo: **63006**
Prep Date:	Analysis Date: **9/18/2019**	SeqNo: **2148894** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	12000	50	1000	11290	87.4	80	120			E
Toluene	1200	50	1000	247.4	97.1	75.5	120			
Ethylbenzene	1200	50	1000	217.6	97.7	80	120			
Xylenes, Total	9500	100	3000	6863	88.7	77.3	119			
Surr: 4-Bromofluorobenzene	980		1000		98.1	80	120			

Sample ID: **1909919-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **MW-03**	Batch ID: **B63006**	RunNo: **63006**
Prep Date:	Analysis Date: **9/18/2019**	SeqNo: **2148905** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	12000	50	1000	11290	29.3	80	120	4.89	20	ES
Toluene	1100	50	1000	247.4	89.9	75.5	120	6.04	20	
Ethylbenzene	1100	50	1000	217.6	91.7	80	120	5.21	20	
Xylenes, Total	9100	100	3000	6863	75.3	77.3	119	4.33	20	S
Surr: 4-Bromofluorobenzene	1000		1000		102	80	120	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
PQL	Practical Quanitative Limit
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1909919**

20-Sep-19

Client: Hilcorp Energy

Project: Standard 1

Sample ID: **RB**	SampType: **MBLK**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **PBW**	Batch ID: **B63046**	RunNo: **63046**
Prep Date:	Analysis Date: **9/19/2019**	SeqNo: **2150207** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 4-Bromofluorobenzene	19		20.00		92.9	80	120			

Sample ID: **100NG BTEX LCSB**	SampType: **LCS**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **LCSW**	Batch ID: **B63046**	RunNo: **63046**
Prep Date:	Analysis Date: **9/19/2019**	SeqNo: **2150208** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	97.3	80	120			
Toluene	20	1.0	20.00	0	98.0	80	120			
Ethylbenzene	20	1.0	20.00	0	98.2	80	120			
Xylenes, Total	59	2.0	60.00	0	98.8	80	120			
Surr: 4-Bromofluorobenzene	20		20.00		97.9	80	120			

Sample ID: **1909919-008AMS**	SampType: **MS**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **MW-19**	Batch ID: **B63046**	RunNo: **63046**
Prep Date:	Analysis Date: **9/19/2019**	SeqNo: **2150212** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	15000	20	400.0	15120	66.6	80	120			ES
Toluene	880	20	400.0	439.9	109	75.5	120			
Ethylbenzene	1500	20	400.0	1080	113	80	120			
Xylenes, Total	7200	40	1200	5962	105	77.3	119			E
Surr: 4-Bromofluorobenzene	430		400.0		108	80	120			

Sample ID: **1909919-008AMSD**	SampType: **MSD**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **MW-19**	Batch ID: **B63046**	RunNo: **63046**
Prep Date:	Analysis Date: **9/19/2019**	SeqNo: **2150213** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	16000	20	400.0	15120	114	80	120	1.23	20	E
Toluene	900	20	400.0	439.9	115	75.5	120	2.50	20	
Ethylbenzene	1600	20	400.0	1080	120	80	120	1.81	20	
Xylenes, Total	7400	40	1200	5962	118	77.3	119	2.13	20	E
Surr: 4-Bromofluorobenzene	470		400.0		117	80	120	0	0	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
PQL	Practical Quanitative Limit
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: HILCORP ENERGY Work Order Number: 1909919 RcptNo: 1

Received By: **Erin Melendrez** 9/18/2019 8:10:00 AM

Completed By: **Anne Thorne** 9/18/2019 10:35:47 AM

Reviewed By: DM 9/18/19

Chain of Custody

1. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
2. How was the sample delivered? Courier

Log In

3. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
4. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
5. Sample(s) in proper container(s)? Yes ☑ No ☐
6. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
7. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
8. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
9. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
10. Were any sample containers received broken? Yes ☐ No ☑
11. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
12. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
13. Is it clear what analyses were requested? Yes ☑ No ☐
14. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: LB 9/18/19

Special Handling (if applicable)

15. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

16. Additional remarks:

17. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.4	Good	Yes			

Chain-of-Custody Record

Client: Hilcorp

Mailing Address: 382 Road ~~1600~~ 3100
Aztec NM 87410

Phone #: 3 505 324 5128

email or Fax#: JDean@hilcorp.com

QA/QC Package:
☒ Standard ☐ Level 4 (Full Validation)

Accreditation: ☐ Az Compliance
☐ NELAC ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: Standard #1

Project #: 01781700G

Project Manager: Daniel Burns

Sampler: Travis Short / Mary Mrdjenovich

On Ice: ☒ Yes ☐ No

# of Coolers: 1

Cooler Temp(including CF): 3.8-0.4(CF)=3.4°C

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Name	Container Type and #	Preservative Type	HEAL No. 1909919	BTEX / MTBE / TMB's (8021)	TPH:8015D(GRO / DRO / MRO)	8081 Pesticides/8082 PCB's	EDB (Method 504.1)	PAHs by 8310 or 8270SIMS	RCRA 8 Metals	Cl, F, Br, NO_3, NO_2, PO_4, SO_4	8260 (VOA)	8270 (Semi-VOA)	Total Coliform (Present/Absent)
9/17	1220	GW	MW-03	3 (VOAs)	HCL	201	X									
	1445		MW-08			202	X									
	1330		MW-11			203	X									
	1310		MW-12			204	X									
	1145		MW-15			205	X									
	1250		MW-16			206	X									
	1410		MW-18			207	X									
	1445		MW-19			208	X									
	1315		MW-22			209	X									
	1415		MW-26			210	X									
	1515		MW-23			211	X									
	1245		MW-05			212	X									

Date	Time	Relinquished by:	Received by:	Via:	Date	Time
9/17	1602	Travis Short			9/17/19	1602
9/17/19	1814			Courier	9/18/19	0810

Remarks:
Per Danny - change to rush due 9/20
Danny 9/18

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

September 09, 2019

Jennifer Deal
HILCORP ENERGY
PO Box 4700
Farmington, NM 87499
TEL: (505) 564-0733
FAX

RE: Standard 1 OrderNo.: 1909150

Dear Jennifer Deal:

Hall Environmental Analysis Laboratory received 2 sample(s) on 9/4/2019 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results, it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifiers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0901

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1909150**
Date Reported: **9/9/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: HILCORP ENERGY
Client Sample ID: MW03 Effluent
Project: Standard 1
Collection Date: 8/30/2019 12:15:00 PM
Lab ID: 1909150-001 **Matrix:** AIR
Received Date: 9/4/2019 8:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	130000	500	E	µg/L	100	9/6/2019 12:42:40 PM	G62709
Surr: BFB	151	53-256		%Rec	100	9/6/2019 12:42:40 PM	G62709
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	1800	10	E	µg/L	100	9/6/2019 12:42:40 PM	B62709
Toluene	1600	10	E	µg/L	100	9/6/2019 12:42:40 PM	B62709
Ethylbenzene	71	10		µg/L	100	9/6/2019 12:42:40 PM	B62709
Xylenes, Total	650	20		µg/L	100	9/6/2019 12:42:40 PM	B62709
Surr: 4-Bromofluorobenzene	94.0	81.6-133		%Rec	100	9/6/2019 12:42:40 PM	B62709

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Analytical Report
Lab Order **1909150**
Date Reported: **9/9/2019**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: HILCORP ENERGY
Client Sample ID: MW10 Effluent
Project: Standard 1
Collection Date: 8/30/2019 3:00:00 PM
Lab ID: 1909150-002 **Matrix:** AIR
Received Date: 9/4/2019 8:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8015D: GASOLINE RANGE						Analyst: **NSB**	
Gasoline Range Organics (GRO)	87000	500	E	µg/L	100	9/6/2019 1:06:11 PM	G62709
Surr: BFB	167	53-256		%Rec	100	9/6/2019 1:06:11 PM	G62709
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**	
Benzene	1600	10	E	µg/L	100	9/6/2019 1:06:11 PM	B62709
Toluene	1200	10	E	µg/L	100	9/6/2019 1:06:11 PM	B62709
Ethylbenzene	90	10		µg/L	100	9/6/2019 1:06:11 PM	B62709
Xylenes, Total	700	20		µg/L	100	9/6/2019 1:06:11 PM	B62709
Surr: 4-Bromofluorobenzene	102	81.6-133		%Rec	100	9/6/2019 1:06:11 PM	B62709

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
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Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **HILCORP ENERGY FAR** Work Order Number: **1909150** RcptNo: **1**

Received By: **Daniel Marquez** **9/4/2019 8:00:00 AM**

Completed By: **Leah Baca** **9/4/2019 3:16:57 PM** Leah S Baca

Reviewed By: DAO 9/4/19

Chain of Custody

1. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
2. How was the sample delivered? Courier

Log In

3. Was an attempt made to cool the samples? Yes ☐ No ☐ NA ☑
4. Were all samples received at a temperature of >0° C to 6.0°C Yes ☐ No ☐ NA ☑
5. Sample(s) in proper container(s)? Yes ☑ No ☐
6. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
7. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
8. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
9. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑ TO
10. Were any sample containers received broken? Yes ☐ No ☑
11. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
12. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
13. Is it clear what analyses were requested? Yes ☑ No ☐
14. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: 9/9/19 (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

15. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

16. Additional remarks:

17. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	NA	Good	Yes			

Chain-of-Custody Record

Client: Hilcorp Energy Company
Attn: Jennifer Deal
Mailing Address:

Phone #: 505-324-5128
email or Fax#: jdeal@hilcorp.com
QA/QC Package:
☑ Standard ☐ Level 4 (Full Validation)
Accreditation: ☐ Az Compliance
☐ NELAC ☐ Other
☑ EDD (Type) EDF

Turn-Around Time:
☒ Standard ☐ Rush
Project Name: Standard #1
Project #:
Project Manager: Hilcorp-Jenifer Deal
LTE - Danny Burns
Sampler:
On Ice: ☐ Yes ☑ No
# of Coolers: /
Cooler Temp(including CF): N/A

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

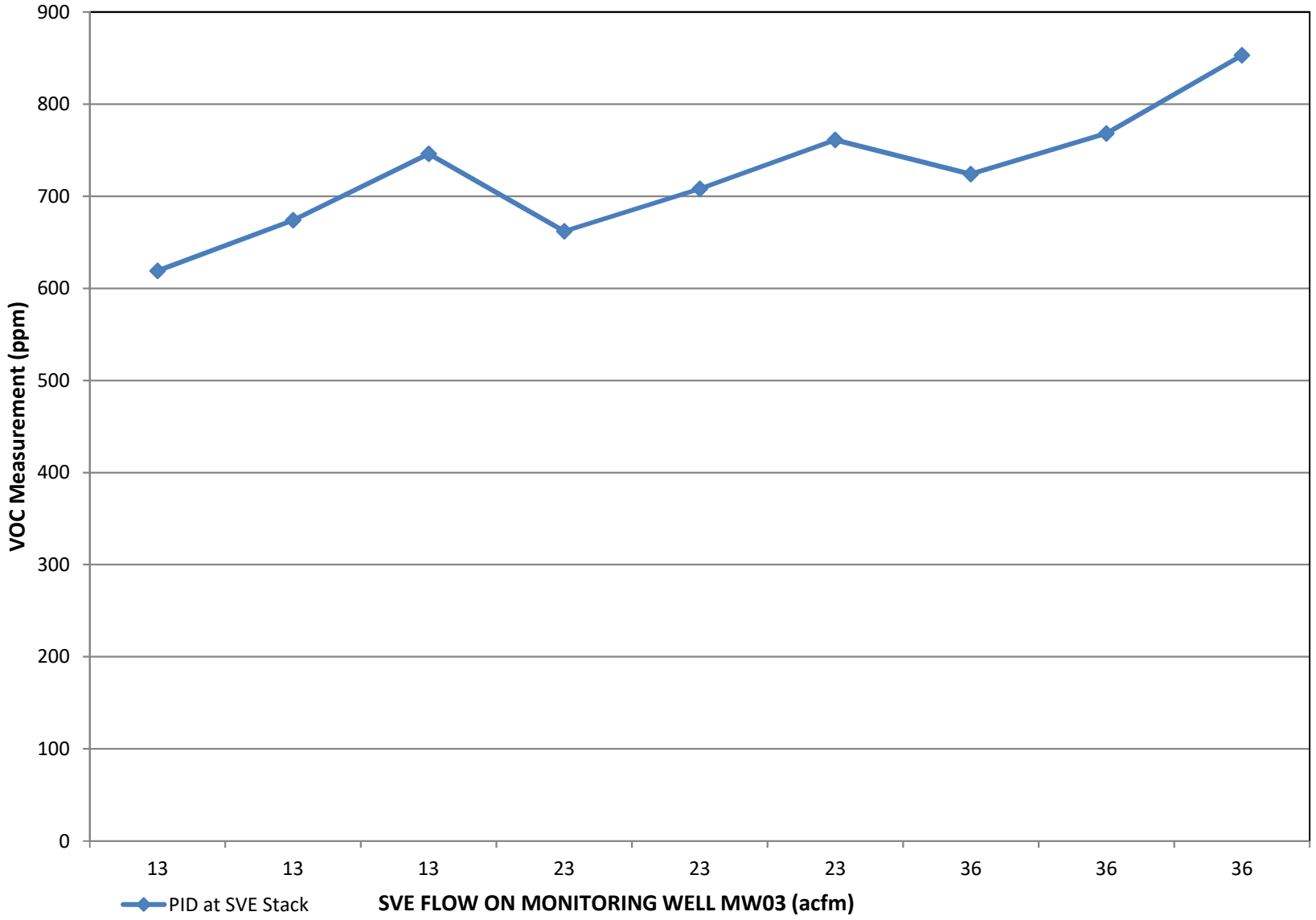
Date	Time	Matrix	Sample Name	Container Type and #	Preservative Type	HEAL No. 1909150	BTEX / MTBE / TMB's (8021)	TPH:8015D(GRO / DRO / MRO)	8081 Pesticides/8082 PCB's	EDB (Method 504.1)	PAHs by 8310 or 8270SIMS	RCRA 8 Metals	Cl, F, Br, NO_3, NO_2, PO_4, SO_4	8260 (VOA)	8270 (Semi-VOA)	Total Coliform (Present/Absent)
8-30	12:15	Air	MW03 Effluent	1 L Tedlar	NA	-001										
8-30	15:00	↓	MW10 Effluent	↓	NA	-002										

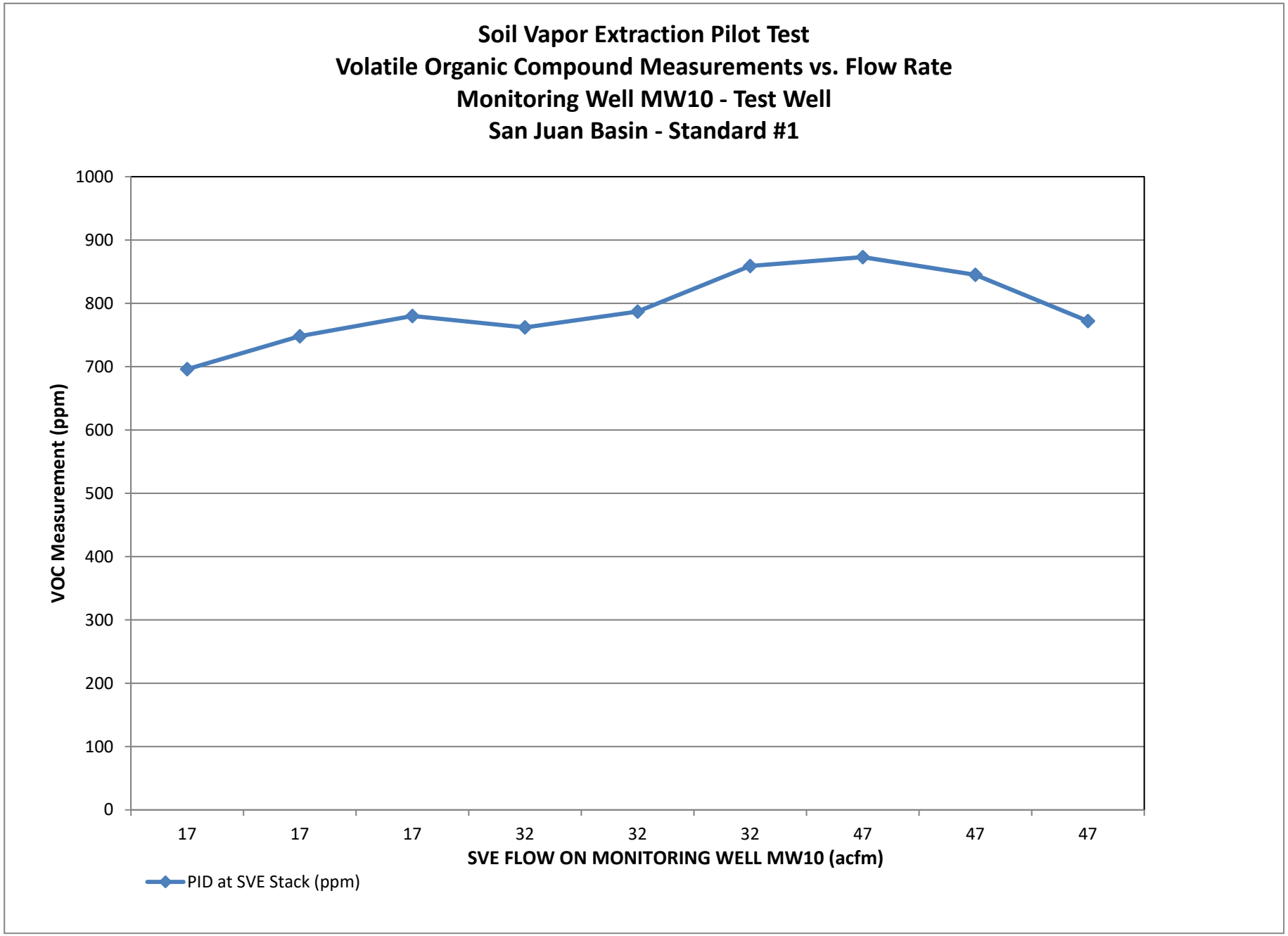
Date:	Time:	Relinquished by:	Received by:	Via:	Date	Time
9/3/19 ~~8-30-19~~	1710 ~~1620~~				9/3/19	1710
9/3/19	2150		Courier		9/4/19	8:00

Remarks:
cc: dburns@ltenv.com
aager@ltenv.com

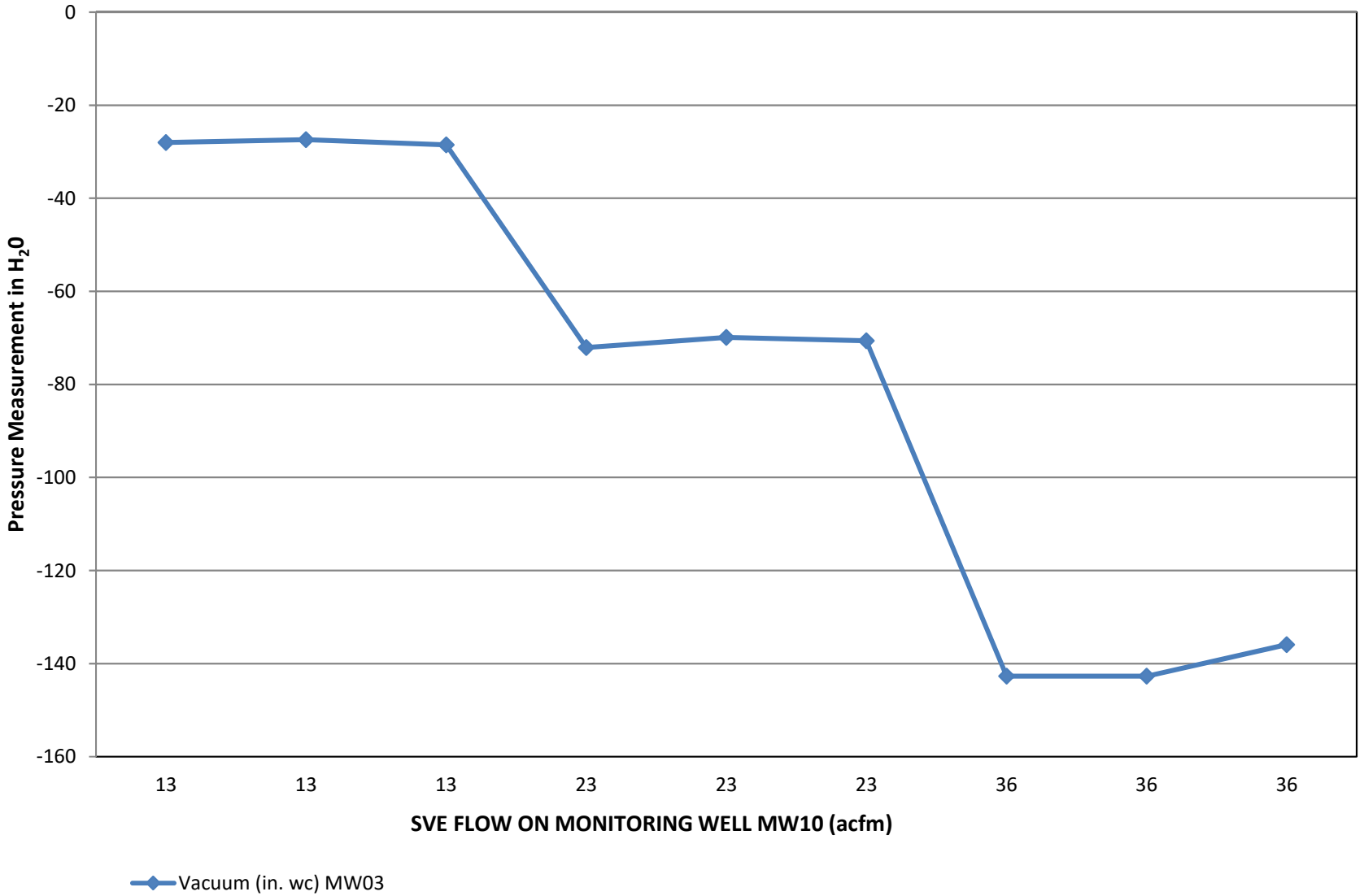
APPENDIX C: SVE PILOT TEST DATA

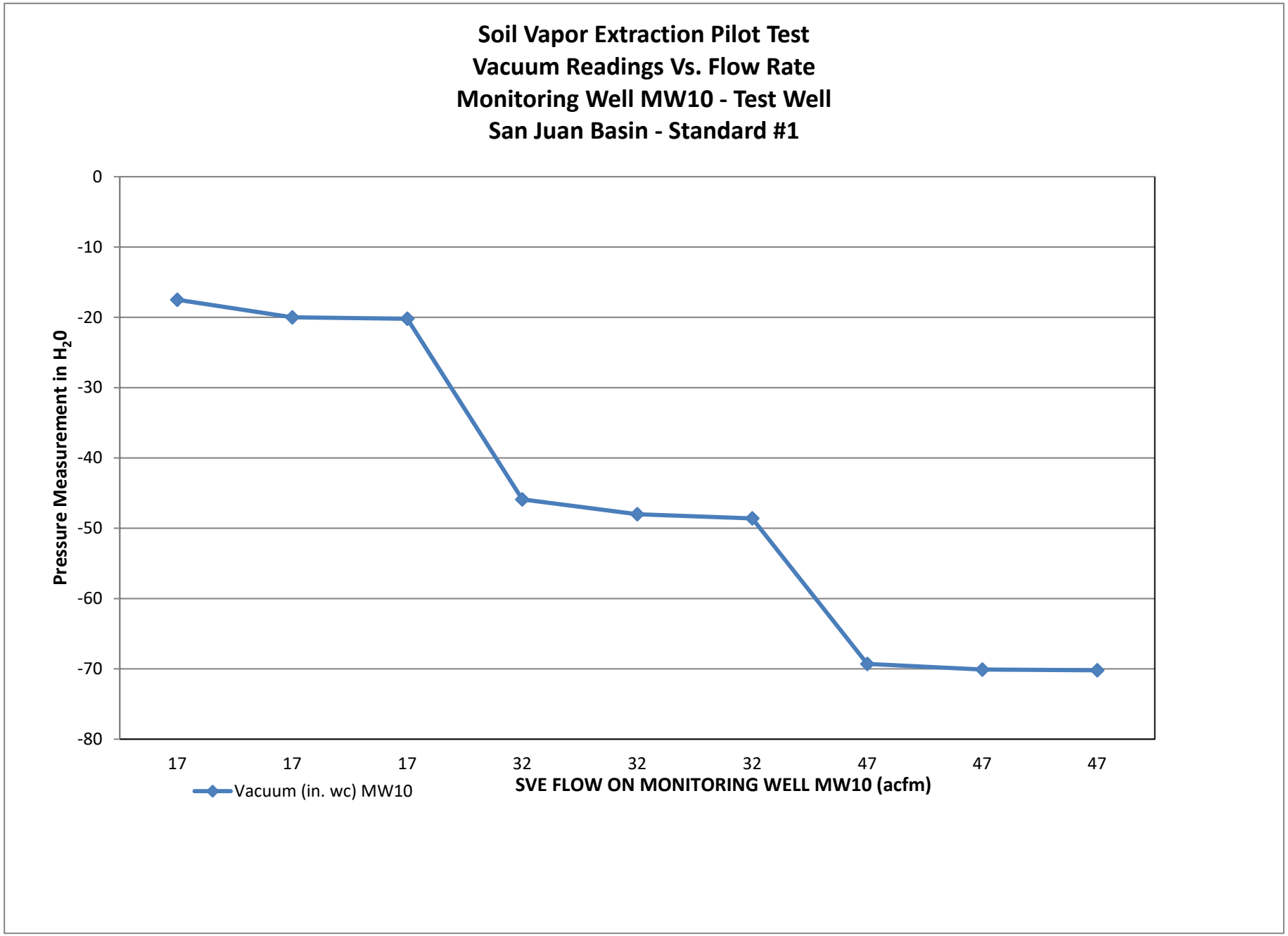
Soil Vapor Extraction Pilot Test
Volatile Organic Compound Measurements vs. Flow Rate
Monitoring Well MW03 - Test Well
San Juan Basin - Standard #1



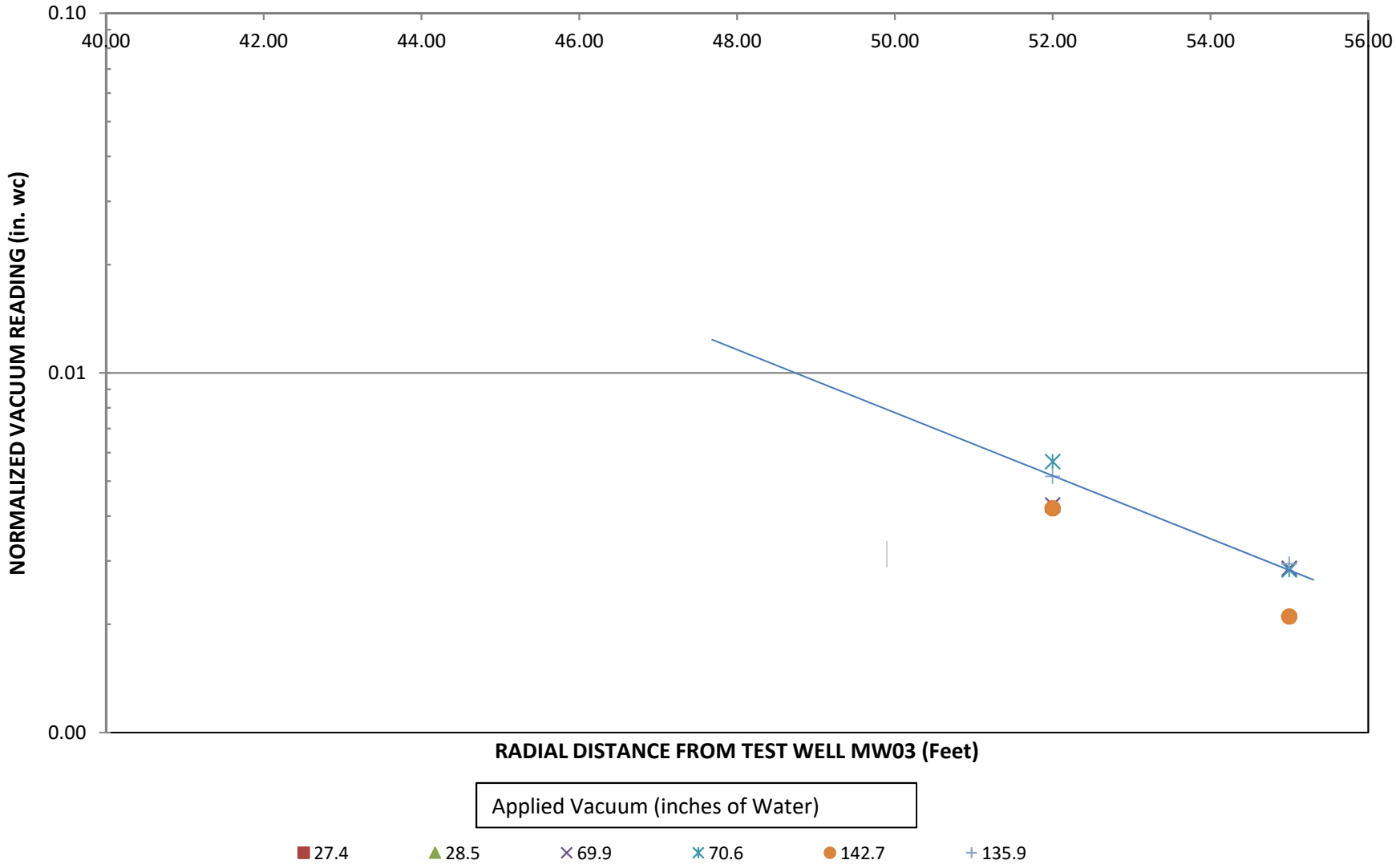


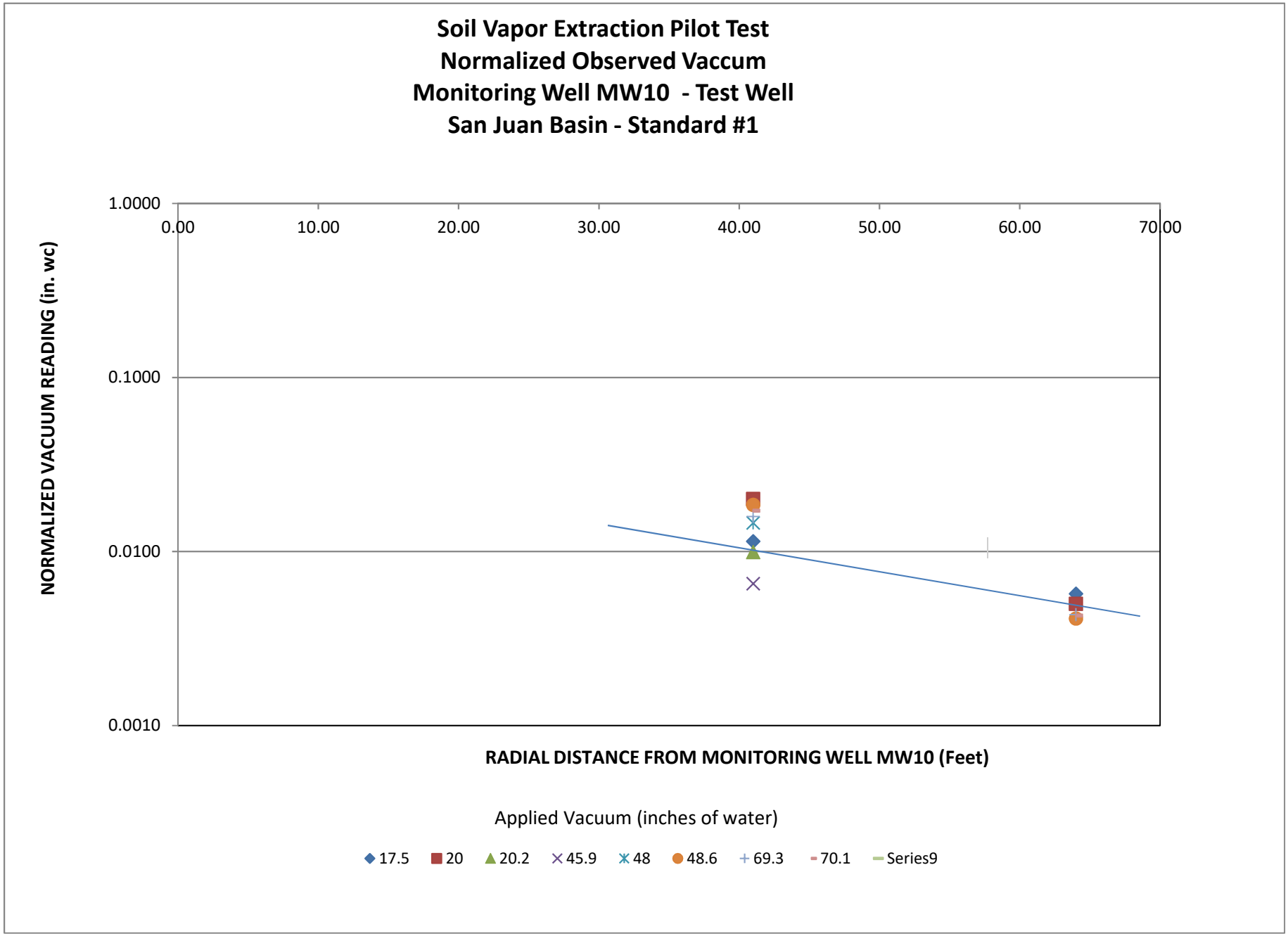
Soil Vapor Extraction Pilot Test
Vacuum Readings vs. Flow Rate
Monitoring Well MW03 - Test Well
San Juan Basin - Standard #1





Soil Vapor Extraction Pilot Test
Normalized Observed Vacuum
Monitoring Well MW03 - Test Well
San Juan Basin - Standard #1





APPENDIX D: API CALCULATIONS

API LNAPL Transmissivity Workbook

Calculation of LNAPL Transmissivity from Baildown Test Data

STEP 1: RESET OUTPUT SUMMARY

STEP 2: ENTER DATA & VIEW FIGURES

STEP 3: CHOOSE WELL CONDITIONS

STEP 4: LNAPL TRANSMISSIVITY SUMMARY

Mean LNAPL Transmissivity (ft^2/d)

2.13

Standard Deviation (ft^2/d)

1.73

Coefficient of Variation

0.81

Well Designation:	MW-06	Beckett and Lyverse (2002)
Date:	4-Sep-19	

Ground Surface Elev (ft msl)	0.0	Enter These Data	**Drawdown Adjustment (ft)**
Top of Casing Elev (ft msl)	0.0		
Well Casing Radius, r_c (ft):	0.083	r_{e1}	0.08
Well Radius, r_w (ft):	0.417		
LNAPL Specific Yield, S_y:	0.175		
LNAPL Density Ratio, ρ_r:	0.780		
Top of Screen (ft bgs):	14.0		
Bottom of Screen (ft bgs):	24.0		
LNAPL Baildown Vol. (gal.):	0.1		
Effective Radius, r_{e3} (ft):	0.190	Calculated Parameters	
Effective Radius, r_{e2} (ft):	0.175		
Initial Casing LNAPL Vol. (gal.):	0.04		
Initial Filter LNAPL Vol. (gal.):	0.18		

Enter Data Here

	Time (min)	DTP (ft btoc)	DTW (ft btoc)	DTP (ft bgs)	DTW (ft bgs)	Water Table Depth (ft)	LNAPL Drawdown s_n (ft)	Average Time (min)	LNAPL Discharge Q_n (ft^3/d)	s_n (ft)	b_n (ft)	r_e (ft)	DTP (ft bgs)	DTW (ft bgs)	LNAPL Volume (gallons)	Ave. r_e (ft)
Initial Fluid Levels:	0	20.66	20.92	20.66	20.92	20.72					0.26					
Enter Test Data:	10.0	21.01	21.06	21.01	21.06	21.02	0.27				0.05				0	0.190
	20.0	21.00	21.07	21.00	21.07	21.02	0.26	15.0	0.327	0.27	0.07	0.190	21.01	21.07	0.02	0
	30.0	20.98	21.07	20.98	21.07	21.00	0.24	25.0	0.327	0.25	0.09	0.190	20.99	21.07	0.03	1.900
	40.0	20.96	21.04	20.96	21.04	20.98	0.22	35.0	-0.163	0.23	0.08	0.190	20.97	21.06	0.03	3.801
	95.0	20.89	20.98	20.89	20.98	20.91	0.15	67.5	0.030	0.19	0.09	0.190	20.93	21.01	0.03	9.977
	125.0	20.86	20.98	20.86	20.98	20.89	0.12	110.0	0.163	0.14	0.12	0.190	20.88	20.98	0.06	18.053
	155.0	20.86	20.95	20.86	20.95	20.88	0.12	140.0	-0.163	0.12	0.09	0.190	20.86	20.97	0.03	23.754
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
												0.020				

Figure 1

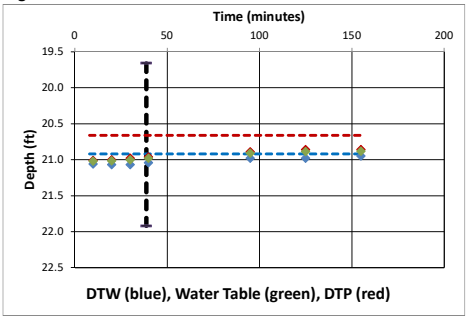
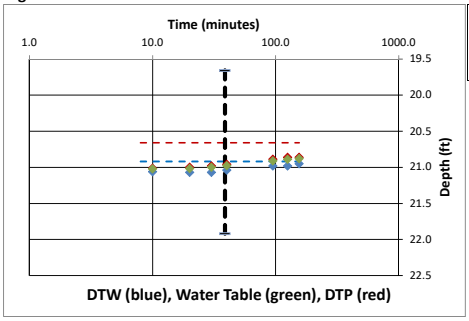


Figure 2



8.0	20.66
155	20.66
8.0	20.92
155	20.92

38.8	19.66	19.7
38.8	21.9	21.9

Figure 3

Q_n (ft³/d)	s_n (ft)
0	0
4	0.38

Drawdown Adjust.	
Δs_n (ft)	0.08

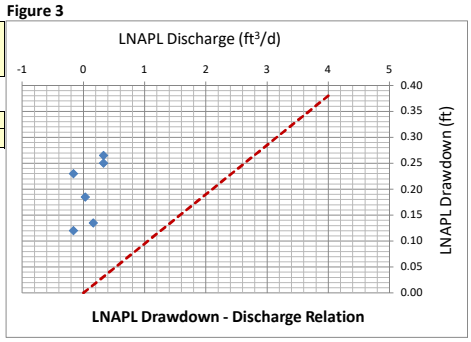
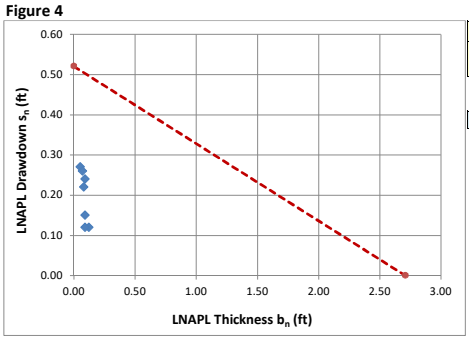


Figure 4



b_n	s_n
2.71	0
0	0.52

J-ratio	-0.192

Figure 5

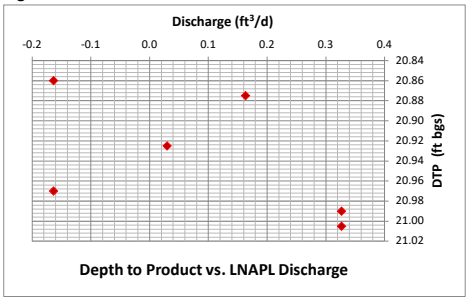


Figure 6

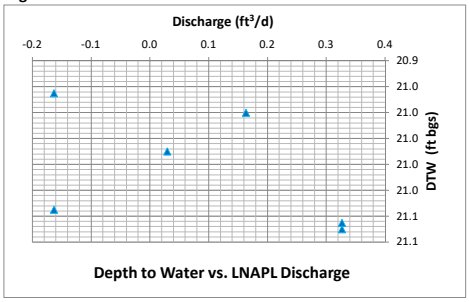


Figure 7

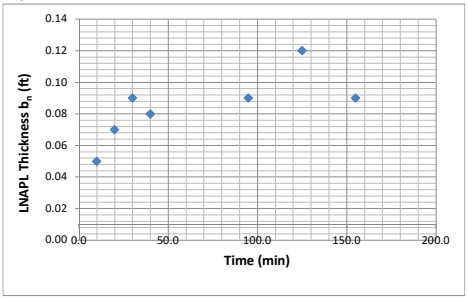


Figure 8

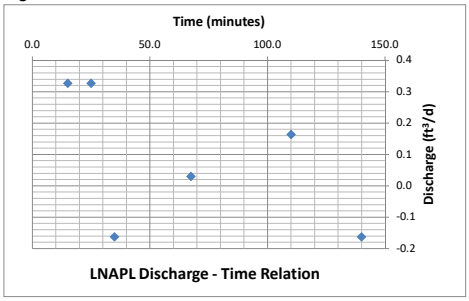


Figure 9

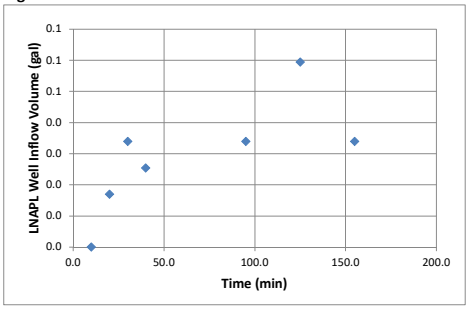
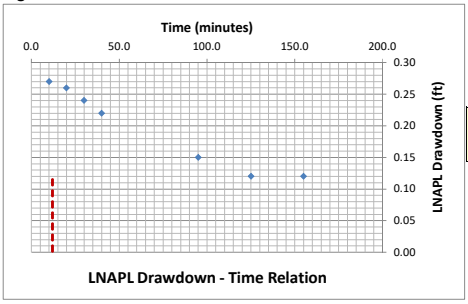


Figure 10



t (min)	s_n (ft)
12	0.115
12	0

Generalized Bouwer and Rice (1976)

Well Designation:	MW-06
Date:	4-Sep-19

$$T_n = \frac{r_e^{\,2}\,\ln(R/r_e)\ln(s_n(t_1)/s_n(t))}{2(-J)(t-t_1)}$$

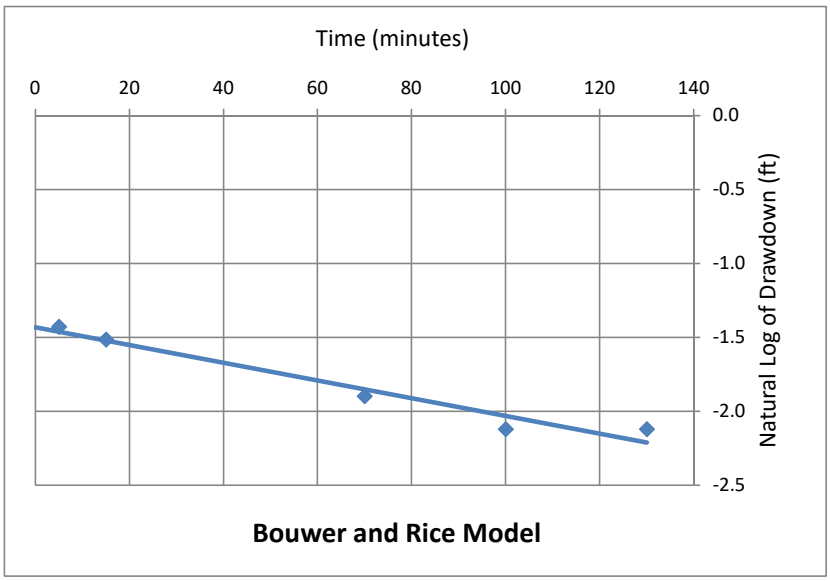
Enter early time cut-off for least-squares model fit

$Time_{cut}$	25	<- Enter or change value here

L_e/r_e
1.4
C
0.85
R/r_e
1.27

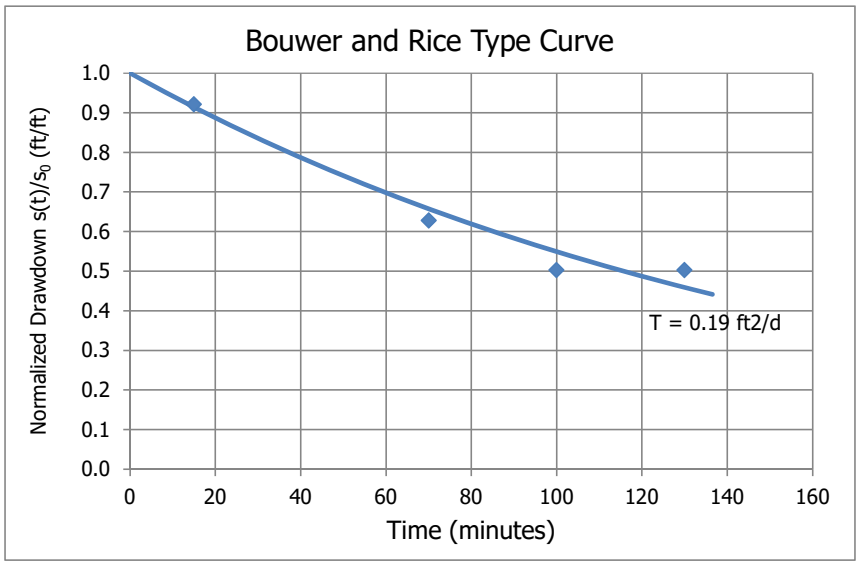
Model Results: T_n (ft^2/d) = 0.20 +/- 0.02 ft^2/d

J-Ratio
-0.192



Coef. Of Variation
0.13

C coefficient calculated from Eq. 6.5(c) of Butler, The Design, Performance, and Analysis of Slug Tests, CRC Press, 2000.



Cooper and Jacob (1946)

Well Designation:	MW-06
Date:	4-Sep-19

$$V_n(t_i) = \sum_j^i \frac{4\pi T_n s_j}{\ln\left(\frac{2.25 T_n t_j}{r_e^2 S_n}\right)} \Delta t_j$$

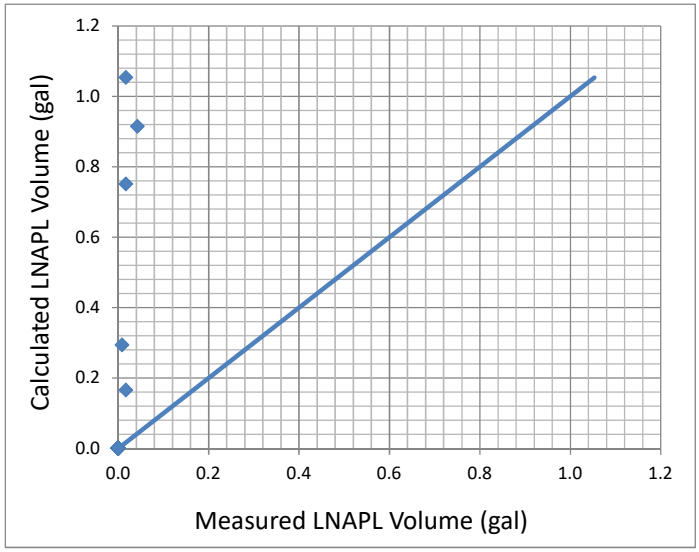
Enter early time cut-off for least-squares model fit

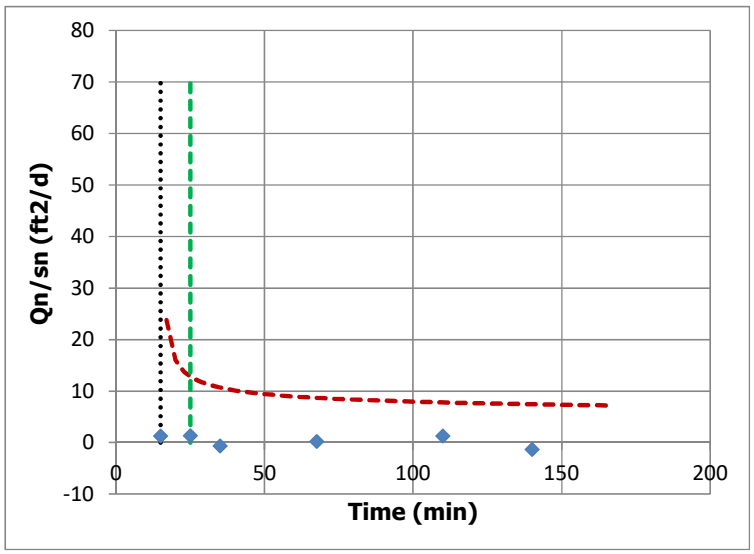
$Time_{cut}$ (min):	25	<- Enter or change values here
Time Adjustment (min):	15	

Trial S_n:	d	<-- Enter d for default or enter S_n value
Root-Mean-Square Error:	1.574	<-- Minimize this using "Solver"
	0.047	<-- Working S_n
Trial T_n (ft^2/d):	3.543	<-- By changing T_n through "Solver"

Add constraint T_n > 0.00001

Model Result: T_n (ft^2/d) = **3.54**





Height
70

Cooper, Bredehoeft and Papadopulos (1967)

Well Designation:	MW-06
Date:	4-Sep-19

Enter early time cut-off for least-squares model fit

$Time_{cut}$ (min):	25	<- Enter or change values here
Initial Drawdown s_n (ft):	0.25	

Trial S_n: d <-- Enter d for default

Root-Mean-Square Error: 0.281 <-- Minimize this using "Solver"

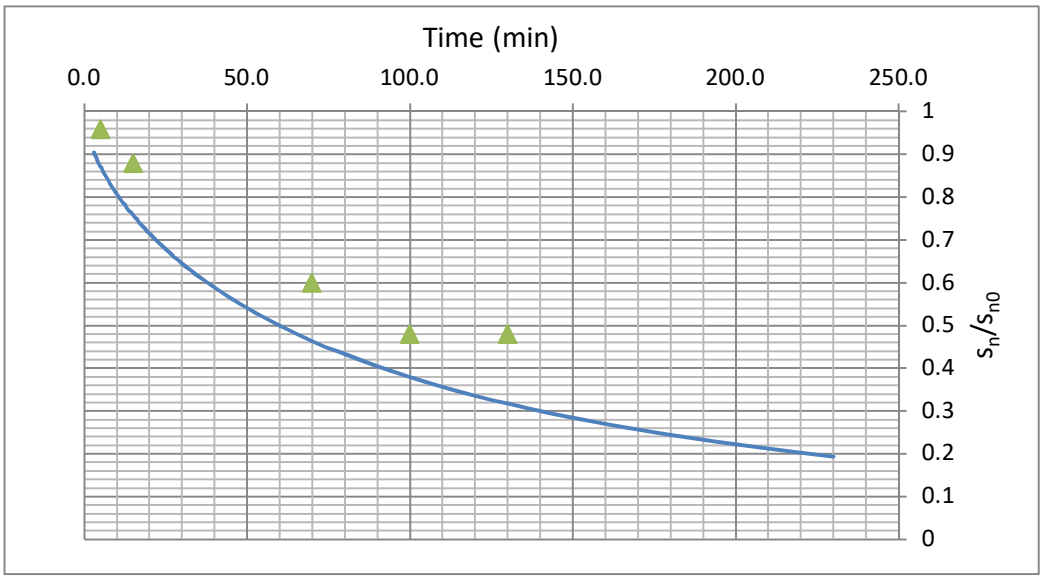
Trial T_n (ft^2/d): 2.642 <-- By changing T_n through "Solver"

0.041 <-- Working S_n

Add constraint Tn > 0.00001

Model Result: T_n (ft^2/d) = **2.64**

T_{min}	3
T_{max}	230



J-Ratio
-0.192

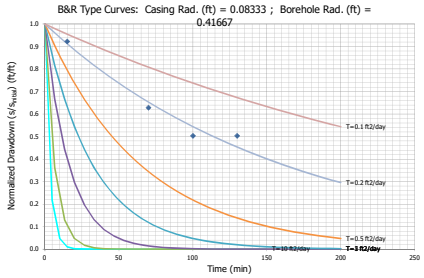
Bouwer and Rice Short Term LNAPL Mobility Test Type Curves

B&R Type Curves: Casing Rad. (ft) = 0.08333 ; Borehole Rad. (ft) = 0.41667

Enter these values

Type Curve ID	Type Curve Name	Notes	Max Time (min)	Transmissivity (ft^2/day)
1	T=10 ft2/day		150	10
2	T=5 ft2/day		200	5
3	T=2 ft2/day		200	2
4	T=1 ft2/day		200	1
5	T=0.5 ft2/day		200	0.5
6	T=0.2 ft2/day		200	0.2
7	T=0.1 ft2/day		200	0.1

J-Ratio	
-0.192	<-- If uncertain use
	-0.22



Type Curve 1	
	T (ft^2/day)
	10
t (min)	s(t)/s$_{to}$
0.00	1.000
5.00	0.218
10.00	0.048
15.00	0.010
20.00	0.002
25.00	0.000
30.00	0.000
35.00	0.000
40.00	0.000
45.00	0.000
50.00	0.000
55.00	0.000
60.00	0.000
65.00	0.000
70.00	0.000
75.00	0.000
80.00	0.000
85.00	0.000
90.00	0.000
95.00	0.000
100.00	0.000
105.00	0.000
110.00	0.000
115.00	0.000
120.00	0.000
125.00	0.000
130.00	0.000
135.00	0.000
140.00	0.000
145.00	0.000
150.00	0.000

Type Curve 2	
	T (ft^2/day)
	5
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.362
13.33	0.131
20.00	0.048
26.67	0.017
33.33	0.006
40.00	0.002
46.67	0.001
53.33	0.000
60.00	0.000
66.67	0.000
73.33	0.000
80.00	0.000
86.67	0.000
93.33	0.000
100.00	0.000
106.67	0.000
113.33	0.000
120.00	0.000
126.67	0.000
133.33	0.000
140.00	0.000
146.67	0.000
153.33	0.000
160.00	0.000
166.67	0.000
173.33	0.000
180.00	0.000
186.67	0.000
193.33	0.000
200.00	0.000

Type Curve 3	
	T (ft^2/day)
	2
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.666
13.33	0.444
20.00	0.296
26.67	0.197
33.33	0.131
40.00	0.087
46.67	0.058
53.33	0.039
60.00	0.026
66.67	0.017
73.33	0.011
80.00	0.008
86.67	0.005
93.33	0.003
100.00	0.002
106.67	0.002
113.33	0.001
120.00	0.001
126.67	0.000
133.33	0.000
140.00	0.000
146.67	0.000
153.33	0.000
160.00	0.000
166.67	0.000
173.33	0.000
180.00	0.000
186.67	0.000
193.33	0.000
200.00	0.000

Type Curve 4	
	T (ft^2/day)
	1
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.816
13.33	0.666
20.00	0.544
26.67	0.444
33.33	0.362
40.00	0.296
46.67	0.241
53.33	0.197
60.00	0.161
66.67	0.131
73.33	0.107
80.00	0.087
86.67	0.071
93.33	0.058
100.00	0.048
106.67	0.039
113.33	0.032
120.00	0.026
126.67	0.021
133.33	0.017
140.00	0.014
146.67	0.011
153.33	0.009
160.00	0.008
166.67	0.006
173.33	0.005
180.00	0.004
186.67	0.003
193.33	0.003
200.00	0.002

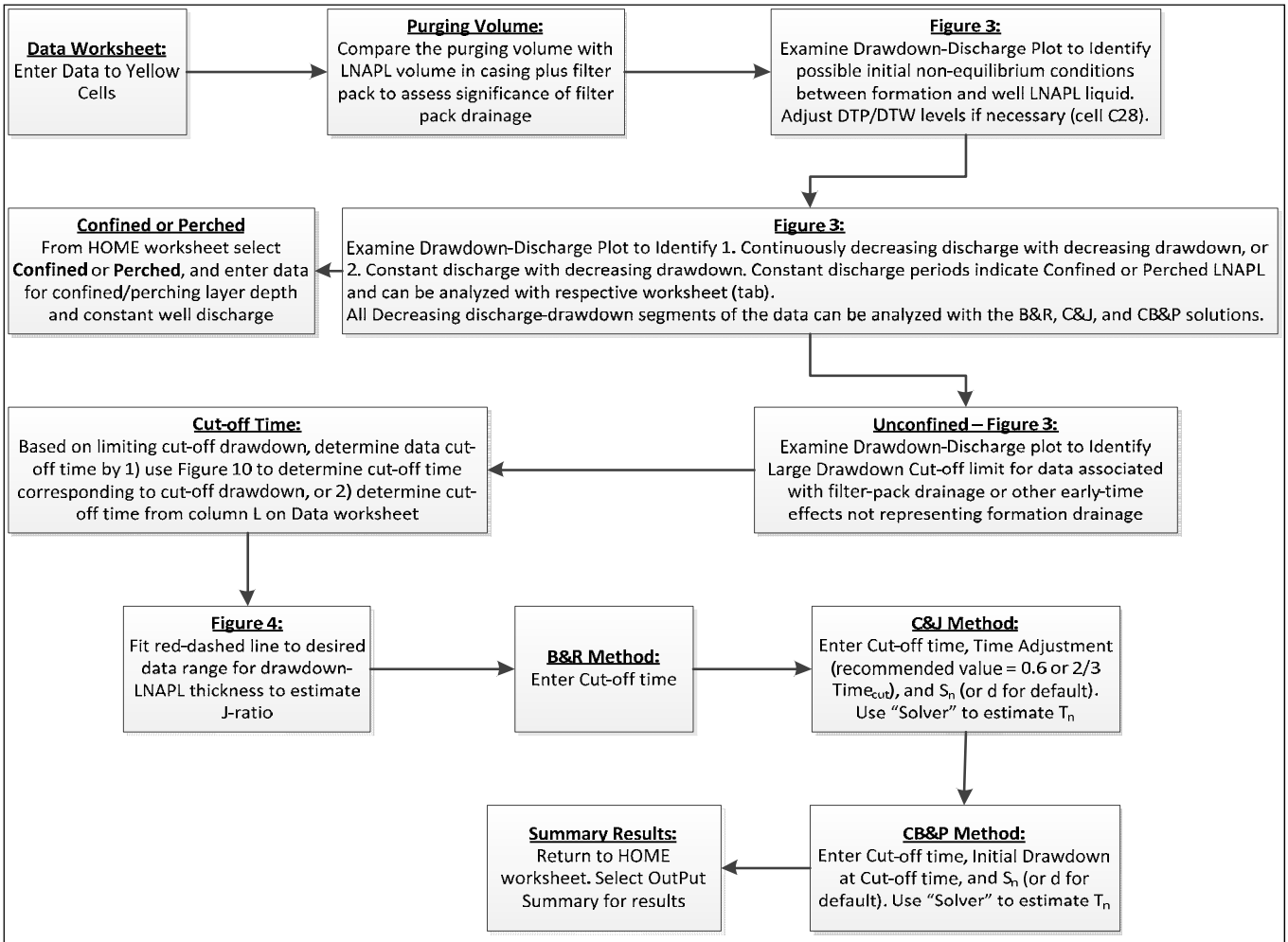
Type Curve 5	
	T (ft^2/day)
	0.5
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.903
13.33	0.816
20.00	0.737
26.67	0.666
33.33	0.602
40.00	0.544
46.67	0.491
53.33	0.444
60.00	0.401
66.67	0.362
73.33	0.327
80.00	0.296
86.67	0.267
93.33	0.241
100.00	0.218
106.67	0.197
113.33	0.178
120.00	0.161
126.67	0.145
133.33	0.131
140.00	0.119
146.67	0.107
153.33	0.097
160.00	0.087
166.67	0.079
173.33	0.071
180.00	0.064
186.67	0.058
193.33	0.053
200.00	0.048

Type Curve 6	
	T (ft^2/day)
	0.2
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.960
13.33	0.922
20.00	0.885
26.67	0.850
33.33	0.816
40.00	0.784
46.67	0.753
53.33	0.723
60.00	0.694
66.67	0.666
73.33	0.640
80.00	0.614
86.67	0.590
93.33	0.566
100.00	0.544
106.67	0.522
113.33	0.501
120.00	0.481
126.67	0.462
133.33	0.444
140.00	0.426
146.67	0.409
153.33	0.393
160.00	0.377
166.67	0.362
173.33	0.348
180.00	0.334
186.67	0.321
193.33	0.308
200.00	0.296

Type Curve 7	
	T (ft^2/day)
	0.1
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.980
13.33	0.960
20.00	0.941
26.67	0.922
33.33	0.903
40.00	0.885
46.67	0.867
53.33	0.850
60.00	0.833
66.67	0.816
73.33	0.800
80.00	0.784
86.67	0.768
93.33	0.753
100.00	0.737
106.67	0.723
113.33	0.708
120.00	0.694
126.67	0.680
133.33	0.666
140.00	0.653
146.67	0.640
153.33	0.627
160.00	0.614
166.67	0.602
173.33	0.590
180.00	0.578
186.67	0.566
193.33	0.555
200.00	0.544

Field Data

Record Data in Fields Below						Calculate and Plot Fields Below		
Well ID		Well Dia. (ft)	Total Depth (ft)					
Notes	Date	Time	Elapsed Time (min)	Depth To Product (TOC)	Depth to Water (TOC)	Product Thickness (ft)	Drawdown (s) DTP-DTP(initial) (ft)	Normalized Drawdown (s/s$_{initial}$)
Initial Measurement								
Stopped Bailing/Start Gauging			0					
Well Starts recovering								



For further information see the *API LNAPL Transmissivity Workbook – User Guide*, API Publication XXXX (2012) and *The Standard Guide for Estimation of LNAPL Transmissivity* ASTM E2856-11, ASTM (2011).

API LNAPL Transmissivity Workbook

Calculation of LNAPL Transmissivity from Baildown Test Data

STEP 1: RESET OUTPUT SUMMARY

STEP 2: ENTER DATA & VIEW FIGURES

STEP 3: CHOOSE WELL CONDITIONS

STEP 4: LNAPL TRANSMISSIVITY SUMMARY

Mean LNAPL Transmissivity (ft^2/d)

2.07

Standard Deviation (ft^2/d)

1.83

Coefficient of Variation

0.88

Well Designation:	MW-10	Beckett and Lyverse (2002)
Date:	4-Sep-19	

Parameter	Value		Drawdown Adjustment (ft)
Ground Surface Elev (ft msl)	0.0	Enter These Data	
Top of Casing Elev (ft msl)	0.0		
Well Casing Radius, r_c (ft):	0.083	r_{e1}	
Well Radius, r_w (ft):	0.417		0.08
LNAPL Specific Yield, S_y:	0.175		
LNAPL Density Ratio, ρ_r:	0.780		
Top of Screen (ft bgs):	15.0		
Bottom of Screen (ft bgs):	35.0		
LNAPL Baildown Vol. (gal.):	0.1		
Effective Radius, r_{e3} (ft):	0.190	Calculated Parameters	
Effective Radius, r_{e2} (ft):	0.175		
Initial Casing LNAPL Vol. (gal.):	0.05		
Initial Filter LNAPL Vol. (gal.):	0.19		

Enter Data Here

	Time (min)	DTP (ft btoc)	DTW (ft btoc)	DTP (ft bgs)	DTW (ft bgs)	Water Table Depth (ft)	LNAPL Drawdown s_n (ft)	Average Time (min)	LNAPL Discharge Q_n (ft^3/d)	s_n (ft)	b_n (ft)	r_e (ft)	DTP (ft bgs)	DTW (ft bgs)	LNAPL Volume (gallons)	Ave. r_e (ft)
Initial Fluid Levels:	0	21.00	21.28	21.00	21.28	21.06					0.28					
Enter Test Data:	2.0	21.22	21.43	21.22	21.43	21.27	0.14				0.21				0	0.190
	10.0	21.22	21.43	21.22	21.43	21.27	0.14	6.0	0.000	0.14	0.21	0.190	21.22	21.43	0.00	0
	20.0	21.20	21.41	21.20	21.41	21.25	0.12	15.0	0.000	0.13	0.21	0.190	21.21	21.42	0.00	1.710
	30.0	21.20	21.41	21.20	21.41	21.25	0.12	25.0	0.000	0.12	0.21	0.190	21.20	21.41	0.00	3.611
	180.0	21.14	21.34	21.14	21.34	21.18	0.06	105.0	-0.011	0.09	0.20	0.190	21.17	21.38	-0.01	18.813
	210.0	21.16	21.34	21.16	21.34	21.20	0.08	195.0	-0.109	0.07	0.18	0.190	21.15	21.34	-0.03	35.915
	240.0	21.15	21.34	21.15	21.34	21.19	0.07	225.0	0.054	0.07	0.19	0.190	21.16	21.34	-0.02	41.616
	1095.0	21.13	21.32	21.13	21.32	21.17	0.05	667.5	0.000	0.06	0.19	0.190	21.14	21.33	-0.02	125.704
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
				#N/A	#N/A	#N/A	#N/A	0.0	#N/A	#N/A	#N/A	0.000	#N/A	#N/A	#N/A	0.000
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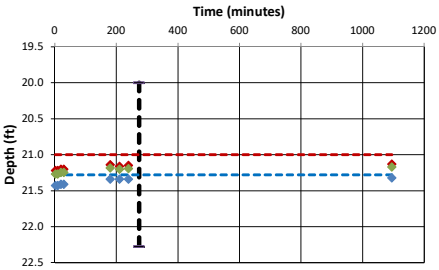
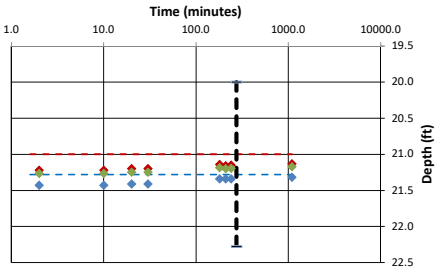
												0.023				

Figure 1



DTW (blue), Water Table (green), DTP (red)

Figure 2



DTW (blue), Water Table (green), DTP (red)

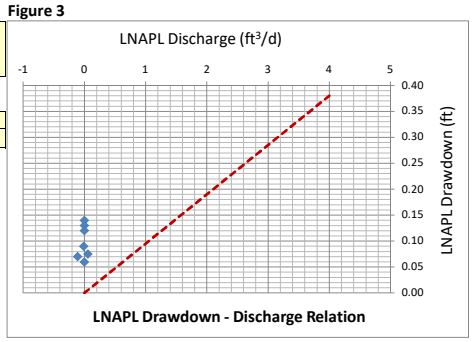
1.6	21.00
1095	21.00
1.6	21.28
1095	21.28

273.8	20	20.0
273.8	22.3	22.3

Figure 3

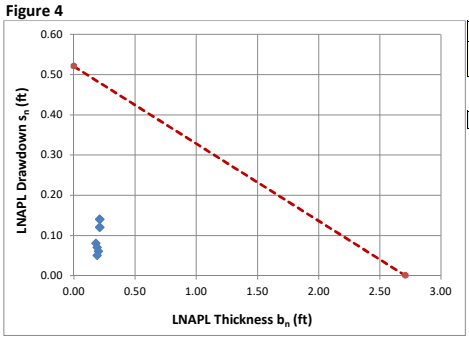
Q_n (ft³/d)	s_n (ft)
0	0
4	0.38

Drawdown Adjust.	
Δs_n (ft)	0.08



LNAPL Drawdown - Discharge Relation

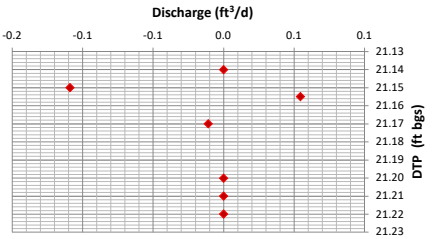
Figure 4



b_n	s_n
2.71	0
0	0.52

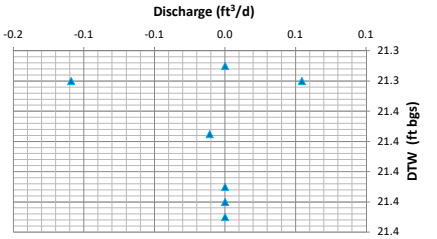
J-ratio	-0.192

Figure 5



Depth to Product vs. LNAPL Discharge

Figure 6



Depth to Water vs. LNAPL Discharge

Figure 7

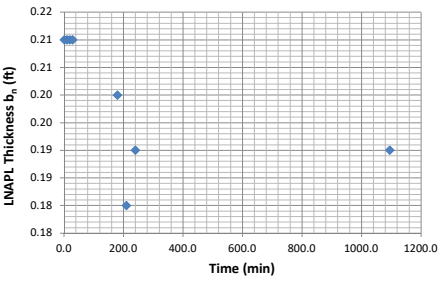
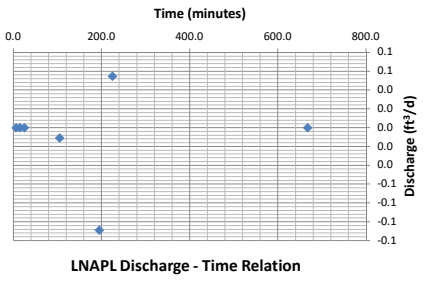


Figure 8



LNAPL Discharge - Time Relation

Figure 9

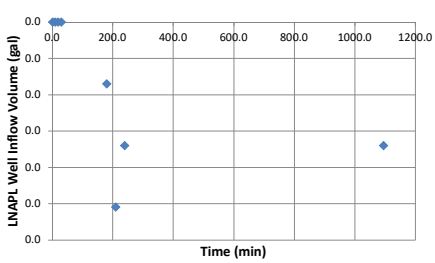
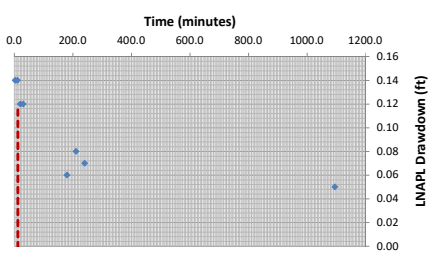


Figure 10



LNAPL Drawdown - Time Relation

t (min)	s_n (ft)
12	0.115
12	0

Generalized Bouwer and Rice (1976)

Well Designation:	MW-10
Date:	4-Sep-19

$$T_n = \frac{r_e^{\,2}\,\ln(R/r_e)\ln(s_n(t_1)/s_n(t))}{2(-J)(t-t_1)}$$

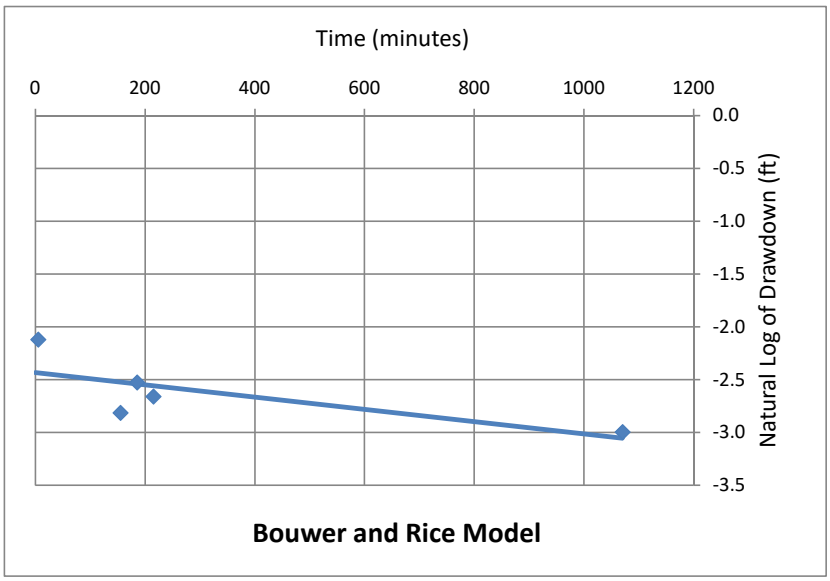
Enter early time cut-off for least-squares model fit

$Time_{cut}$	25	<- Enter or change value here

L_e/r_e
1.5
C
0.85
R/r_e
1.34

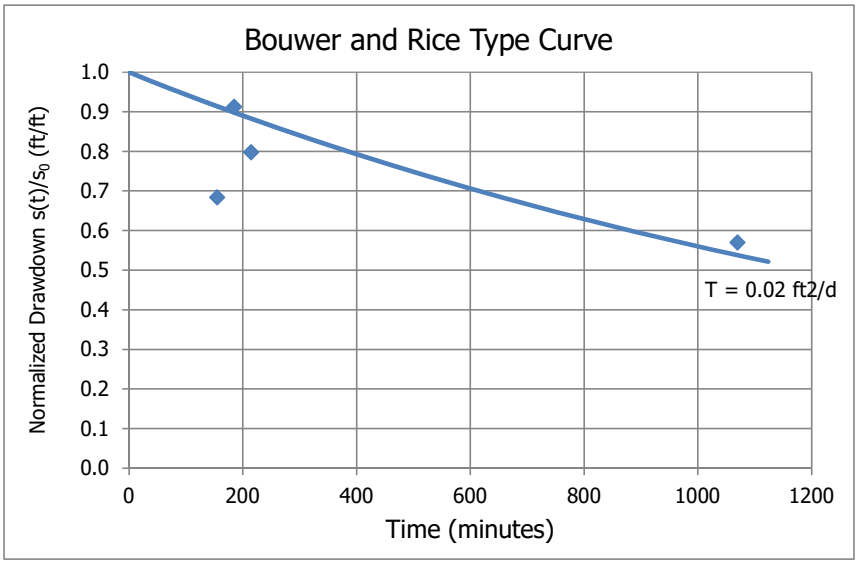
Model Results: T_n (ft^2/d) = 0.02 +/- 0.01 ft^2/d

J-Ratio
-0.192



Coef. Of Variation
0.52

C coefficient calculated from Eq. 6.5(c) of Butler, The Design, Performance, and Analysis of Slug Tests, CRC Press, 2000.



Cooper and Jacob (1946)

Well Designation:	MW-10
Date:	4-Sep-19

$$V_n(t_i) = \sum_j^i \frac{4\pi T_n s_j}{\ln\left(\frac{2.25 T_n t_j}{r_e^2 S_n}\right)} \Delta t_j$$

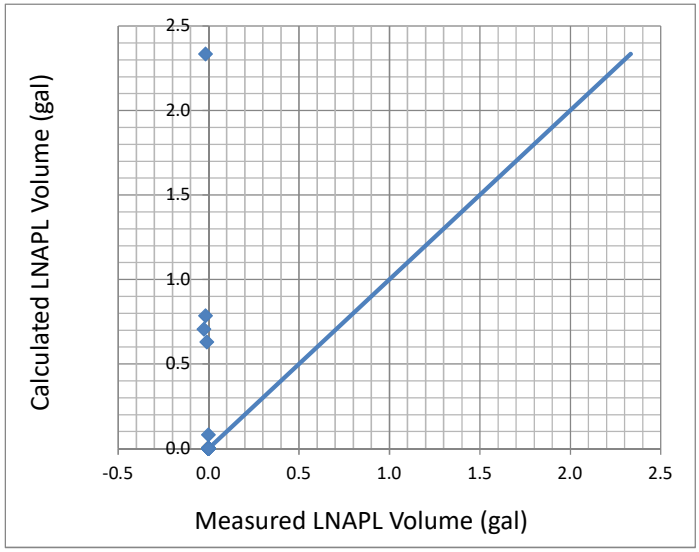
Enter early time cut-off for least-squares model fit

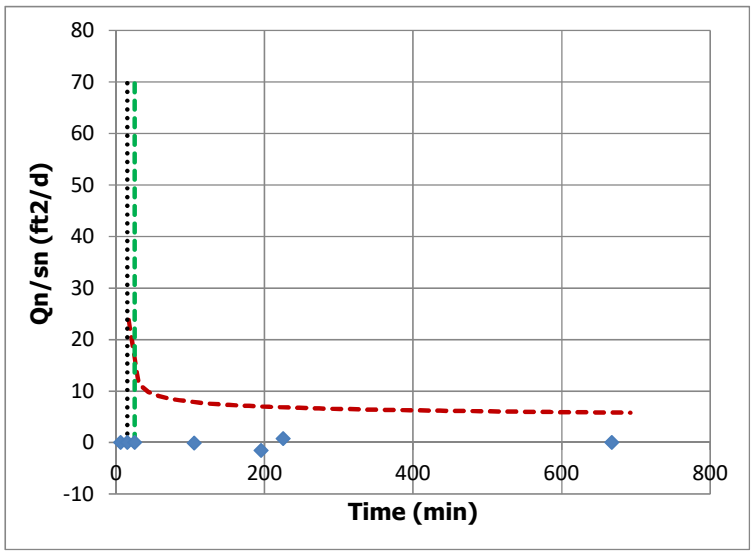
$Time_{cut}$ (min):	25	<- Enter or change values here
Time Adjustment (min):	15	

Trial S_n:	d	<-- Enter d for default or enter S_n value
Root-Mean-Square Error:	2.668	<-- Minimize this using "Solver"
	0.047	<-- Working S_n
Trial T_n (ft^2/d):	3.543	<-- By changing T_n through "Solver"

Add constraint T_n > 0.00001

Model Result: T_n (ft^2/d) = **3.54**





Height
70

Cooper, Bredehoeft and Papadopulos (1967)

Well Designation:	MW-10
Date:	4-Sep-19

Enter early time cut-off for least-squares model fit

$Time_{cut}$ (min):	25	<- Enter or change values here
Initial Drawdown s_n (ft):	0.25	

Trial S_n: d <-- Enter d for default

Root-Mean-Square Error: 0.441 <-- Minimize this using "Solver"

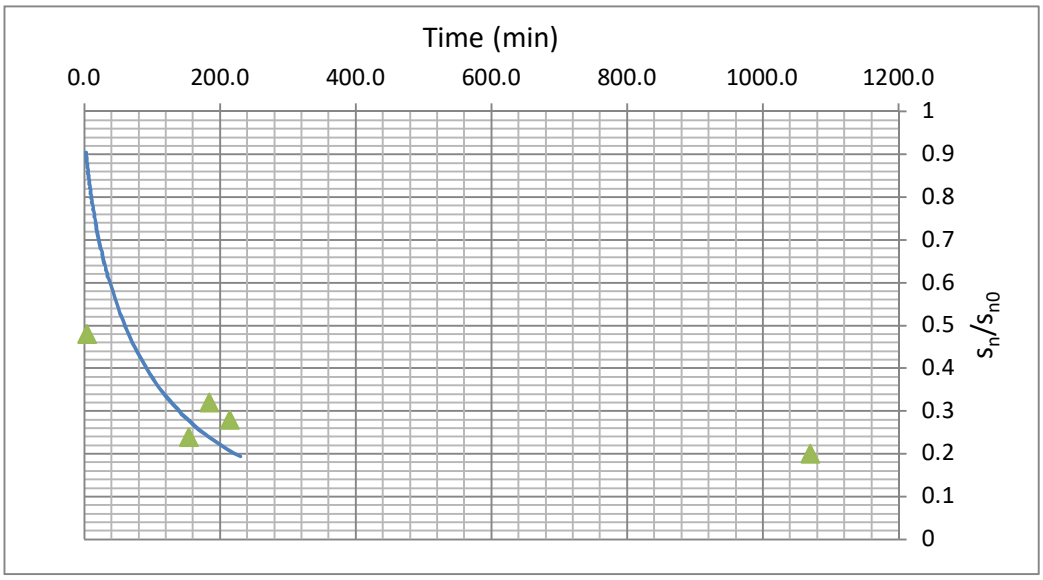
Trial T_n (ft^2/d): 2.642 <-- By changing T_n through "Solver"

0.041 <-- Working S_n

Add constraint Tn > 0.00001

T_{min}	3
T_{max}	230

Model Result: T_n (ft^2/d) = **2.64**



J-Ratio
-0.192

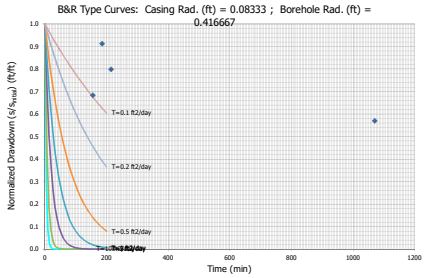
Bouwer and Rice Short Term LNAPL Mobility Test Type Curves

B&R Type Curves: Casing Rad. (ft) = 0.08333 ; Borehole Rad. (ft) = 0.416667

Enter these values

Type Curve ID	Type Curve Name	Notes	Max Time (min)	Transmissivity (ft^2/day)
1	T=10 ft2/day		150	10
2	T=5 ft2/day		200	5
3	T=2 ft2/day		200	2
4	T=1 ft2/day		200	1
5	T=0.5 ft2/day		200	0.5
6	T=0.2 ft2/day		200	0.2
7	T=0.1 ft2/day		200	0.1

J-Ratio	
-0.192	<-- If uncertain use
	-0.22



Type Curve 1	
	T (ft^2/day)
	10
t (min)	s(t)/s$_{to}$
0.00	1.000
5.00	0.284
10.00	0.080
15.00	0.023
20.00	0.006
25.00	0.002
30.00	0.001
35.00	0.000
40.00	0.000
45.00	0.000
50.00	0.000
55.00	0.000
60.00	0.000
65.00	0.000
70.00	0.000
75.00	0.000
80.00	0.000
85.00	0.000
90.00	0.000
95.00	0.000
100.00	0.000
105.00	0.000
110.00	0.000
115.00	0.000
120.00	0.000
125.00	0.000
130.00	0.000
135.00	0.000
140.00	0.000
145.00	0.000
150.00	0.000

Type Curve 2	
	T (ft^2/day)
	5
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.432
13.33	0.186
20.00	0.080
26.67	0.035
33.33	0.015
40.00	0.006
46.67	0.003
53.33	0.001
60.00	0.001
66.67	0.000
73.33	0.000
80.00	0.000
86.67	0.000
93.33	0.000
100.00	0.000
106.67	0.000
113.33	0.000
120.00	0.000
126.67	0.000
133.33	0.000
140.00	0.000
146.67	0.000
153.33	0.000
160.00	0.000
166.67	0.000
173.33	0.000
180.00	0.000
186.67	0.000
193.33	0.000
200.00	0.000

Type Curve 3	
	T (ft^2/day)
	2
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.715
13.33	0.511
20.00	0.365
26.67	0.261
33.33	0.186
40.00	0.133
46.67	0.095
53.33	0.068
60.00	0.049
66.67	0.035
73.33	0.025
80.00	0.018
86.67	0.013
93.33	0.009
100.00	0.006
106.67	0.005
113.33	0.003
120.00	0.002
126.67	0.002
133.33	0.001
140.00	0.001
146.67	0.001
153.33	0.000
160.00	0.000
166.67	0.000
173.33	0.000
180.00	0.000
186.67	0.000
193.33	0.000
200.00	0.000

Type Curve 4	
	T (ft^2/day)
	1
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.845
13.33	0.715
20.00	0.604
26.67	0.511
33.33	0.432
40.00	0.365
46.67	0.308
53.33	0.261
60.00	0.220
66.67	0.186
73.33	0.157
80.00	0.133
86.67	0.113
93.33	0.095
100.00	0.080
106.67	0.068
113.33	0.057
120.00	0.049
126.67	0.041
133.33	0.035
140.00	0.029
146.67	0.025
153.33	0.021
160.00	0.018
166.67	0.015
173.33	0.013
180.00	0.011
186.67	0.009
193.33	0.008
200.00	0.006

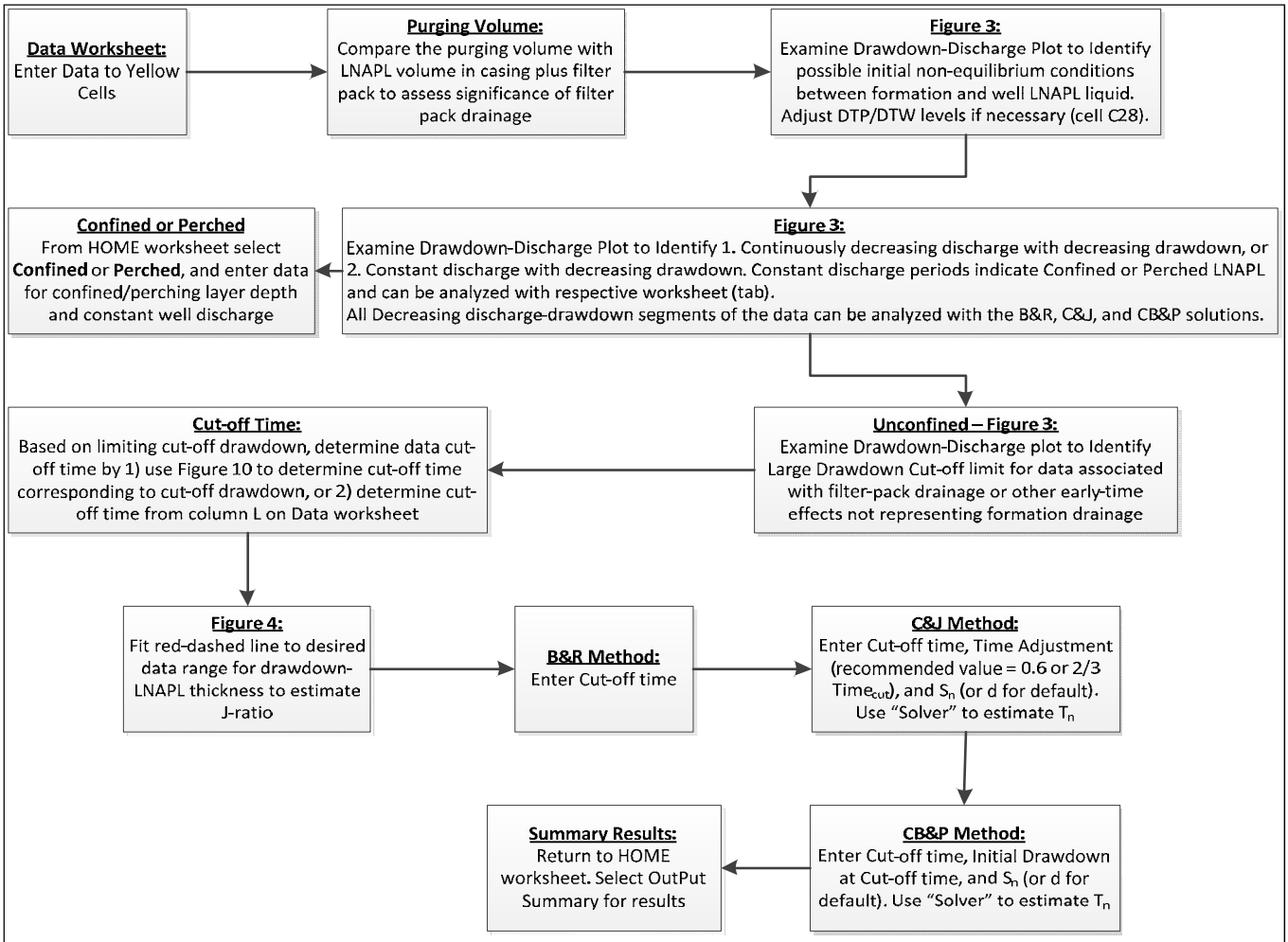
Type Curve 5	
	T (ft^2/day)
	0.5
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.919
13.33	0.845
20.00	0.777
26.67	0.715
33.33	0.657
40.00	0.604
46.67	0.555
53.33	0.511
60.00	0.469
66.67	0.432
73.33	0.397
80.00	0.365
86.67	0.335
93.33	0.308
100.00	0.284
106.67	0.261
113.33	0.240
120.00	0.220
126.67	0.203
133.33	0.186
140.00	0.171
146.67	0.157
153.33	0.145
160.00	0.133
166.67	0.122
173.33	0.113
180.00	0.103
186.67	0.095
193.33	0.087
200.00	0.080

Type Curve 6	
	T (ft^2/day)
	0.2
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.967
13.33	0.935
20.00	0.904
26.67	0.874
33.33	0.845
40.00	0.817
46.67	0.790
53.33	0.764
60.00	0.739
66.67	0.715
73.33	0.691
80.00	0.668
86.67	0.646
93.33	0.625
100.00	0.604
106.67	0.584
113.33	0.565
120.00	0.546
126.67	0.528
133.33	0.511
140.00	0.494
146.67	0.477
153.33	0.462
160.00	0.446
166.67	0.432
173.33	0.417
180.00	0.404
186.67	0.390
193.33	0.377
200.00	0.365

Type Curve 7	
	T (ft^2/day)
	0.1
t (min)	s(t)/s$_{to}$
0.00	1.000
6.67	0.983
13.33	0.967
20.00	0.951
26.67	0.935
33.33	0.919
40.00	0.904
46.67	0.889
53.33	0.874
60.00	0.860
66.67	0.845
73.33	0.831
80.00	0.817
86.67	0.804
93.33	0.790
100.00	0.777
106.67	0.764
113.33	0.752
120.00	0.739
126.67	0.727
133.33	0.715
140.00	0.703
146.67	0.691
153.33	0.679
160.00	0.668
166.67	0.657
173.33	0.646
180.00	0.635
186.67	0.625
193.33	0.614
200.00	0.604

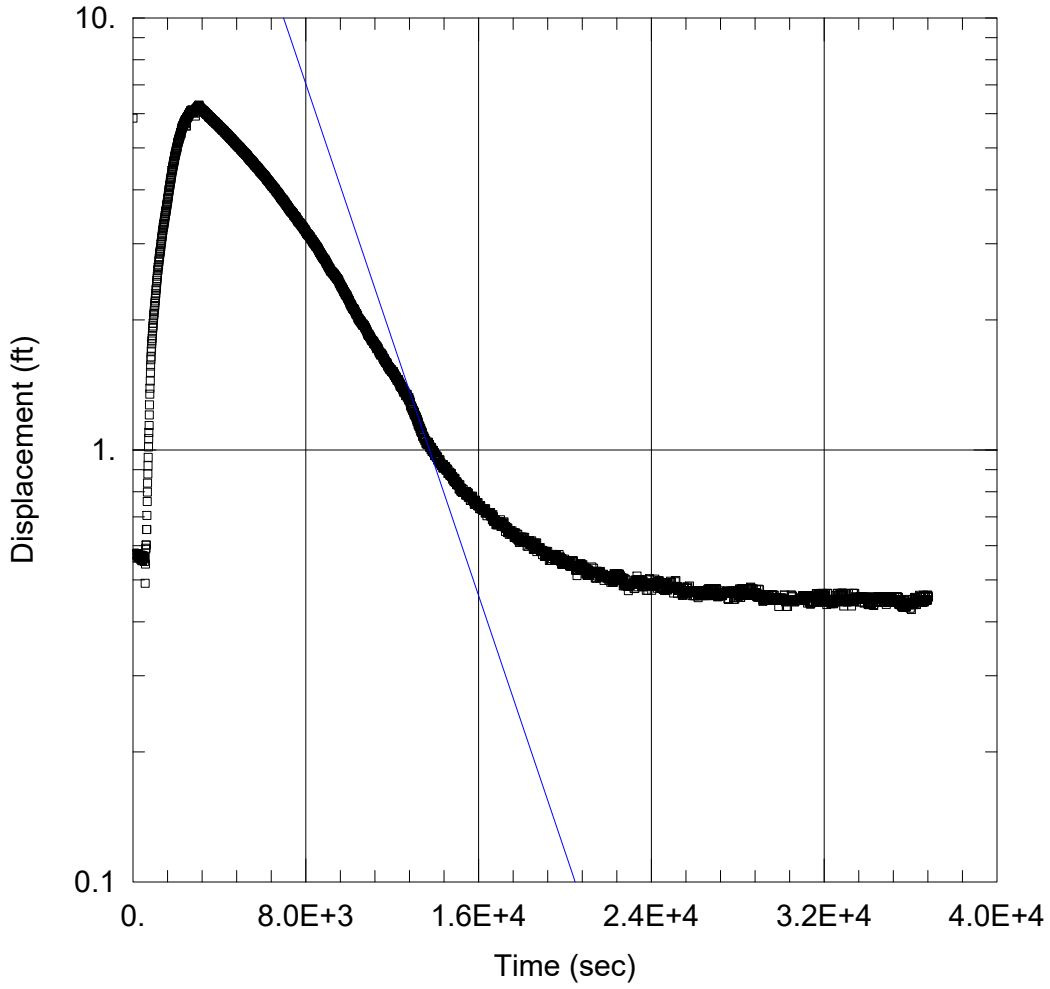
Field Data

Record Data in Fields Below						Calculate and Plot Fields Below		
Well ID		Well Dia. (ft)	Total Depth (ft)					
Notes	Date	Time	Elapsed Time (min)	Depth To Product (TOC)	Depth to Water (TOC)	Product Thickness (ft)	Drawdown (s) DTP-DTP(initial) (ft)	Normalized Drawdown (s/s$_{initial}$)
Initial Measurement								
Stopped Bailing/Start Gauging			0					
Well Starts recovering								



For further information see the *API LNAPL Transmissivity Workbook – User Guide*, API Publication XXXX (2012) and *The Standard Guide for Estimation of LNAPL Transmissivity* ASTM E2856-11, ASTM (2011).

APPENDIX E: GROUNDWATER TRANSMISSIVITY ANALYSIS



GROUNDWATER TRANSMISSIVITY ANALYSIS

Data Set: P:\...\MW-11.aqt
Date: 09/11/19 Time: 09:36:36

PROJECT INFORMATION

Company: LTE
Client: Hilcorp
Project: 017817006
Location: San Juan County, NM
Test Well: MW-11
Test Date: 9/4 - 9/6

AQUIFER DATA

Saturated Thickness: 8.06 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-11)

Initial Displacement: 5.86 ft
Total Well Penetration Depth: 8.06 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 8.06 ft
Screen Length: 8.06 ft
Well Radius: 0.08333 ft
Gravel Pack Porosity: 0.

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 1.184E-5 cm/sec y0 = 107.8 ft

LT Environmental, Inc.
848 East Second Avenue
Durango, Colorado 81301
970.385.1096

September 30, 2019

Mr. Cory Smith
New Mexico Oil Conservation Division
1000 Rio Brazos Road
Aztec, New Mexico 87410

RE: Proposed Public Notice and Participation for Stage 2 Abatement Plan
Hilcorp Energy Company
Standard #1
API # 30-045-08718
NCS1735235018
San Juan County, New Mexico

Dear Mr. Smith:

LT Environmental, Inc. (LTE), on behalf of Hilcorp Energy Company (Hilcorp), proposes the following plan to meet the requirements of 19.15.30.15 of the New Mexico Administrative Code (NMAC) for public notice and participation associated with a Stage 2 Abatement Plan to address soil and groundwater impacts identified at the Standard #1 natural gas production well.

DISTRIBUTION

Hilcorp will provide written notice of the Stage 2 Abatement Plan by United State Postal Service Mail to the following:

- Surface owners of record within 1 mile of the perimeter of the identified impacted area as currently defined in the Stage 2 Abatement Plan. These surface owners are listed in Table 1.
- The County Commission of San Juan County, New Mexico.
- The Office of Natural Resources Trustee for the State of New Mexico.

Please note the release location is not directly within or within 1 mile of any city limits or directly or partially within or within 1 mile of any tribal boundaries. Hilcorp understands that the NMOCD may include additional persons who have requested notification, as well as other local, state, or federal governmental agencies upon approval of the Stage 2 Abatement Plan.

PUBLICATION

Hilcorp will publish the NMOCD approved notice in the *Farmington Daily Times*, a newspaper of general circulation in San Juan County, New Mexico, and in the *Albuquerque Journal*, a newspaper of general circulation in the state of New Mexico.

SCHEDULE

Hilcorp will issue public notice within 15 days after the NMOCD determines the Stage 2 Abatement Plan is administratively complete. This includes public notice to the newspapers and certified mailings to the appropriate local governments and surface owners identified for distribution. The newspaper publication will run for 1 business day.

PROPOSED NOTICE

Hilcorp proposes the following language for public notice:

> Hilcorp Energy Company (Hilcorp) announces publication of a Stage 2 Abatement Plan for soil and groundwater impacts identified at the Standard #1 natural gas production well located at latitude 36.7536011 degrees (°) and longitude -108.1002121° in Unit J of Section 4 of Township 29 North, Range 12 West in San Juan County approximately 3 miles southwest of Flora Vista, New Mexico.
>
> The Stage 2 Abatement Plan addresses subsurface hydrocarbon impacts to soil and groundwater caused by a historical release of unknown volume of natural gas condensate and produced water from a production pipeline identified on November 28, 2017. The subsurface impacts were described in a publicly distributed Stage 1 Abatement Plan dated November 20, 2018 and verified as administratively complete by the New Mexico Oil Conservation Division (NMOCD) on January 22, 2019.
>
> The Director of the NMOCD has approved a Stage 2 Abatement Plan in which Hilcorp proposes to begin remediation of subsurface impacts to soil and groundwater via *in situ* technologies. In determining that the Stage 2 Abatement Plan is administratively complete, the NMOCD Director has complied with Subsection B of 19.15.30.15 of the New Mexico Administrative Code (NMAC) by reviewing the document and concluding that it satisfies the requirements of Subsection C of 19.15.30.13 NMAC.
>
> Members of the public may view a copy of the Stage 2 Abatement Plan at the NMOCD's Santa Fe office at 1220 South St Francis Drive, # 3, Santa Fe, New Mexico or at the NMOCD's district office at 1000 Rio Brazos Road, Aztec, New Mexico. Additionally, the Stage 2 Abatement Plan is available for viewing electronically on the NMOCD public database at http://www.emnrd.state.nm.us/OCD/ .
>
> The NMOCD is accepting written comments and requests for consideration if the NMOCD Director receives them within 30 days after the date of publication of this public notice. A person seeking to comment on a stage 2 abatement plan should submit written comments to:
>
> Mr. Cory Smith
> Environmental Specialist

New Mexico Oil Conservation Division
1000 Rio Brazos Road
Aztec, New Mexico 87410

The NMOCD shall distribute notice of the submittal of the Stage 2 Abatement Plan with the next division and commission hearing docket following receipt of the plan.

Additional information can be obtained from the Hilcorp project contact:
Jennifer Deal
Hilcorp Energy Company
382 Road 3100,
Aztec, New Mexico 87410
505-599-3400

LTE appreciates your review and comment on this proposed public notice and participation plan.

Sincerely,

LT ENVIRONMENTAL, INC.

Ashley L. Ager

Ashley L. Ager, M.S., P.G.
Senior Geologist

cc: Jennifer Deal, Hilcorp

Attachment

State of New Mexico
Energy, Minerals and Natural Resources Department

Mitch Killough
Hilcorp Energy Company
1111 Travis Street
Houston, TX 77002

RE: Determination of Administratively Complete Stage 2 Abatement Plan for Standard #1 Production Well (Incident # nCS1735235018) AP-126

Mr. Killough,

On April 9, 2020, the Oil Conservation Division (OCD) received a Stage 2 Abatement Plan as well as a Proposed Public Notice and Participation submittal prepared on Hilcorp Energy Company's behalf by LT Environmental dated September 30, 2019.

We have reviewed the plan and determined it to be administratively complete.

In addition, OCD approves the draft of the Public Notice and Participation Proposal. The required public notice and participation should now proceed under the provisions of Subsections A and B of 19.15.30.15 NMAC. Proof of notice to be provided to the OCD.

Stage 2 abatement plan document satisfies the requirements of Paragraph (2) of Subsection D of 19.15.30.13 NMAC. The division shall distribute notice of the abatement plan's filing with the next division and commission hearing docket.

As a condition of approval Hilcorp must furnish within 30 days of this approval date, the following;
- An up-to-date executive summary of data from quarterly sampling events or any other activity associated with this specific incident
- A current and up-to-date site map showing monitor wells and any pertinent remedial data
- Any quarterly monitoring collected to the present (summary table only is sufficient)

If you have any questions, please contact Nelson Velez of the Environmental Incident Group at (505) 469-6146 or by email at *nelson.velez@emnrd.nm.gov.*

Respectfully,

Adrienne Sandoval
Division Director
AES/njv

Date: 10/20/2022

District I
1625 N. French Dr., Hobbs, NM 88240
Phone:(575) 393-6161 Fax:(575) 393-0720
District II
811 S. First St., Artesia, NM 88210
Phone:(575) 748-1283 Fax:(575) 748-9720
District III
1000 Rio Brazos Rd., Aztec, NM 87410
Phone:(505) 334-6178 Fax:(505) 334-6170
District IV
1220 S. St Francis Dr., Santa Fe, NM 87505
Phone:(505) 476-3470 Fax:(505) 476-3462

State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

COMMENTS

Action 58603

COMMENTS

Operator: HILCORP ENERGY COMPANY 1111 Travis Street Houston, TX 77002	OGRID: 372171
	Action Number: 58603
	Action Type: [UF-GWA] Ground Water Abatement (GROUND WATER ABATEMENT)

COMMENTS

Created By	Comment	Comment Date
csmith	Manual Application created to move submission out of Email Box. Operator Original Submitted to Email on 4/9/2020	10/29/2021

District I
1625 N. French Dr., Hobbs, NM 88240
Phone:(575) 393-6161 Fax:(575) 393-0720
District II
811 S. First St., Artesia, NM 88210
Phone:(575) 748-1283 Fax:(575) 748-9720
District III
1000 Rio Brazos Rd., Aztec, NM 87410
Phone:(505) 334-6178 Fax:(505) 334-6170
District IV
1220 S. St Francis Dr., Santa Fe, NM 87505
Phone:(505) 476-3470 Fax:(505) 476-3462

State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 58603

CONDITIONS

Operator:	OGRID:
HILCORP ENERGY COMPANY 1111 Travis Street Houston, TX 77002	372171
	Action Number: 58603
	Action Type: [UF-GWA] Ground Water Abatement (GROUND WATER ABATEMENT)

CONDITIONS

Created By	Condition	Condition Date
nvelez	As a condition of approval Hilcorp must furnish within 30 days of this approval date, the following; - An up-to-date executive summary of data from quarterly sampling events or any other activity associated with this specific incident - A current and up-to-date site map showing monitor wells and any pertinent remedial data - Any quarterly monitoring collected to the present (summary table only is sufficient). Hilcorp shall adhere to its scheduling as described in section 5.11 of the abatement plan.	10/21/2022