

**State of Colorado
Oil and Gas Conservation Commission**

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FOR OGCC USE ONLY

Document #: 2211269

REM 9489

Date 01/15/2016

SITE INVESTIGATION AND REMEDIATION WORKPLAN

This form shall be submitted to the Director for approval prior to the initiation of site investigation and remediation activities. Form 27 is intended to be used whenever possible. Additional documentation will be required when large volumes of soil and groundwater have been impacted or involve large facilities with multiple source areas. See Rule 910. Attach as many pages as needed to fully describe the proposed work.

CAUSE OF CONDITION BEING INVESTIGATED AND REMEDIATED

☒ Spill or Release ☐ Plug & Abandon ☐ Central Facility Closure ☐ Site/Facility Closure ☐ Other (describe): _____

OGCC Employee:

☐ Spill ☐ Complaint
☐ Inspection ☐ NOAV

Tracking No:

OGCC Operator Number: 10456

Name of Operator: Caerus Piceance LLC

Address: 120 North Railroad Ave, Suite D

City: Parachute State: CO Zip: 81635

Contact Name and Telephone:

Jake Janicek

No: 970-285-9606

Fax: 970-285-9619

API Number: _____ County: Garfield

Facility Name: Unocal 5

Facility Number: 335618

Well Name: _____

Well Number: _____

Location: (QtrQtr, Sec, Twp, Rng, Meridian): NESW, 4, 6S, 96W, 6PM

Latitude: 39.55081

Longitude: -108.11447-

(LOC) FAC ID 444666
39.551093 -108.114113

TECHNICAL CONDITIONS

Type of Waste Causing Impact (crude oil, condensate, produced water, etc): Produced Water

Site Conditions: Is location within a sensitive area (according to Rule 901e)? ☐ Y ☒ N If yes, attach evaluation.

Adjacent land use (cultivated, irrigated, dry land farming, industrial, residential, etc.): rangeland

Soil type, if not previously identified on Form 2A or Federal Surface Use Plan: Nihill channery loam, 6 to 25 percent slopes

Potential receptors (water wells within 1/4 mi, surface waters, etc.): none within 1/4 mile, Granlee Gulch, Parachute Creek

Description of Impact (if previously provided, refer to that form or document):

Impacted Media (check):

☒ Soils☐ Vegetation☐ Groundwater☐ Surface Water

Extent of Impact:

20 feet diameter x 40 feet below ground surface

How Determined:

soil sampling

REMEDIALTION WORKPLAN

Describe initial action taken (if previously provided, refer to that form or document):

Please refer to the previous Form 27, COGCC Document Number 2524990 (Remediation #5631).

Describe how source is to be removed:

The source was not removed. The impacted area is being remediated in place.

Describe how remediation of existing impacts is to be accomplished, including removal and disposal at an injection well or licensed facility, land treatment on site, removal of impacted groundwater, insitu bioremediation, burning of oily vegetation, etc.:

Bioremediation injections were conducted on a bi-weekly basis from December 2010 through October 2012. Two passive soil vapor extraction wells with ventilator turbines were installed in January of 2015 in order to promote volatilization of the remaining impacted soil. A comprehensive summary of all remediation activities associated with this project is included as an attachment.

Submit Page 2 with Page 1



REMEDIAL WORKPLAN (Cont.)

Tracking Number: _____
Name of Operator: _____
OGCC Operator No: _____
Received Date: _____
Well Name & No: _____
Facility Name & No: _____

OGCC Employee: _____

If groundwater has been impacted, describe proposed monitoring plan (# of wells or sample points, sampling schedule, analytical methods, etc.):

Groundwater was not encountered during any portion of this project.

Describe reclamation plan. Discuss existing and new grade recontouring, method and testing of compaction alleviation, and reseeding program, including location of new seed, seed mix and noxious weed prevention. Attach diagram or drawing. Use additional sheet for description if required.

The surface area impacted by this project is located on an existing pad's working surface and will not need to be reclaimed until final reclamation.

Attach samples and analytical results taken to verify remediation of impacts. Show locations of samples on an onsite schematic or drawing.

Is further site investigation required? ☒ Y ☐ N If yes, describe

Confirmation soil samples will need to be collected to prove successful remediation.

Final disposition of E&P waste (landtreated and disposed onsite, name of licensed disposal facility, recycling, reuse, etc.):

No E&P waste was generated. The impacted area is being remediated in place.

IMPLEMENTATION SCHEDULE

Date Site Investigation Began: August 2009 Date Site Investigation Completed: December 2010 Date Remediation Plan Submitted: Aug 2009/Oct 2010
Remediation Start Date: December 2010 Anticipated Completion Date: TBD Actual Completion Date: TBD

I hereby certify that the statements made in this form are, to the best of my knowledge, true, correct, and complete.

Print Name: Jake Janicek

Signed: _____

Title: EHS Professional

Date: 1/18/2016

OGCC Approved: Ann C Gekman Title: EPS Date: 2/2/2016

Please resubmit the October 2013 proposal for long term MNA (referenced in the attached Project Summary), as it has not been uploaded to the COGIS data base.

CAERUS PICEANCE, LLC
UNOCAL – ENCANA 23A-4D (UNOCAL 5)
PRODUCED WATER RELEASE - PROJECT SUMMARY



Prepared for:
Caerus Piceance, LLC
120 Railroad Ave, Suite D
Parachute, CO 81635



Prepared by:
HRL Compliance Solutions, Inc.
2385 F ½ Road
Grand Junction, CO 81505

January 2014

TABLE OF CONTENTS

INTRODUCTION.....	1
PROJECT HISTORY.....	1
INITIAL INVESTIGATION.....	1
SITE CHARACTERIZATION.....	1
IN-SITU REMEDIATION.....	2
SAMPLING AND ANALYSIS OF SOIL.....	2
HYDROGEOLOGY STUDY.....	3
SUMMARY.....	3

TABLES

TABLE 1: SOIL BORING ANALYTICAL RESULTS

FIGURES

FIGURE 1: SITE LOCATION MAP

FIGURE 2: GIS MAP OF SITE CHARACTERIZATION SAMPLE LOCATIONS

FIGURE 3: GIS MAP OF IMPACTED AREA AND SAMPLE LOCATIONS

FIGURE 4: STRATIGRAPHIC REPRESENTATION OF SUB-SURFACE SOILS

FIGURE 5: STRATIGRAPHIC REPRESENTATION OF IMPACTS AT DEPTH

ATTACHMENTS

ATTACHMENT A: HYDROGEOLOGY STUDY

INTRODUCTION

This report presents a summary of the initial investigation, site characterization, remediation and sampling activities conducted at the Caerus Piceance, LLC (Caerus) Unocal 23A-4D (Unocal 5) well pad regards to a produced water release that occurred in July 2009.

The Unocal 5 well pad is located in the NE ¼, SW ¼, Section 4, T6S, R96W of the 6th Prime Meridian approximately nine (9) miles north of Parachute in Garfield County, Colorado. The well pad is located near the valley floor with the surrounding topography characterized by steep hillsides. Granlee Gulch is approximately three hundred (300) feet to the north and Parachute Creek is approximately one thousand five hundred (1,500) feet to the west. Refer to Figure 1 for a site location map.

PROJECT HISTORY

A produced water release occurred at the Unocal 5 well pad on July 27, 2009. During tank battery upgrade activities in the vicinity of a partially buried produced water tank, a leak was observed in the produced water sump. An unknown amount of produced water had been released into the subsurface soils within the unlined tank battery. A Form 19 Spill/Release Report (spill/release tracking #2524990) was submitted to the Colorado Oil and Gas Conservation Commission (COGCC) following the release.

The tank battery and produced water tank were removed from location upon discovery of the release. Production was rerouted to a newly installed above ground tank located within a lined SPCC containment structure. The partially buried tank excavation was backfilled with clean fill material and reclaimed to the present grade of the well pad.

A Remediation Work Plan Form 27 was submitted to the COGCC in August 2009 (remediation #5631). The impacted soil was to be treated utilizing in-situ remediation technologies.

INITIAL INVESTIGATION

A soil sampling event was conducted by LT Environmental, Inc. in October of 2009 to establish baseline hydrocarbon concentrations. Baseline soil samples were collected from beneath the location of the partially buried produced water tank. Analytical and field screen results from the baseline sample event indicated the presence of elevated hydrocarbon impacts.

HRL Compliance Solutions, Inc. (HCSI) was assigned to manage the project in November 2010.

SITE CHARACTERIZATION

A site characterization was conducted by HCSI in December 2010 to fully delineate the vertical and lateral extent of the impacts. A CME 55 track rig was utilized to advance a series of twelve (12) investigative soil borings within and around the historic location of the produced water tank. Field screen readings were collected from each soil boring at five (5) foot intervals utilizing standard split spoon sampling methods. Each boring was advanced to approximately fifty five (55) feet below the ground surface (bgs). A Photoionization detector (PID) and PetroFlag hydrocarbon test unit (PetroFlag®) were utilized for field screening activities.

Elevated hydrocarbon impacts were observed between fifteen (15) and fifty (50) feet bgs. The site characterization indicated that approximately three hundred and fifty (350) cubic yards of soil was impacted by the release. Refer to Figure 2 for a GIS map of the impacted area and site characterization sample locations.

IN-SITU REMEDIATION

A series of twenty two (22) treatment ports were installed into the subsurface soil to a maximum depth of fifty (50) feet bgs. The treatment ports were constructed from screened one inch PVC pipe, backfilled with silica sand, and sealed with bentonite and concrete. The treatment ports would be used for in-situ treatment of the impacted soil. Screen intervals were installed at predetermined depths to concentrate the bio-remediation product in the areas with the highest hydrocarbon impacts.

An in-situ remediation schedule was implemented in mid-December, 2010. Bioremediation product and soil amendments were mixed onsite in a water storage tank and injected into the subsurface soil by use of the treatment ports. An average of approximately 1,000 gallons of remediation fluid was injected into the impacted soil during each treatment event. Treatment events were conducted on a bi-weekly basis from December 2010 through October 2012.

SAMPLING AND ANALYSIS OF SOIL

Soil sample events were conducted in March, September, and December of 2011, February, July, and October of 2012, and June of 2013. Soil borings were advanced within the impacted area during each sample event to monitor the status of the treatment. Soil samples were collected utilizing the same sampling methods as described above. Soil samples were submitted for analysis from the depth of each boring with the highest field screen reading.

Analytical results from the soil sample events indicated a small decrease in TPH impacts from the baseline sample, but levels were still exceeding COGCC Table 910-1 standards. See the attached Table 1 for DRO, GRO, and BTEX results from each of the sampling events. See Figure 3 for a map of the impacted area and sample locations.

Soil borings advanced in October and November of 2012 were conducted to determine if impacts had migrated from the initial impacted area (BH 59 through BH 63). Analytical results confirmed that the impacted area was still within the confines of the original site characterization boundary.

Soil boring logs were prepared for each soil boring. Soil samples were collected and observed to document soil lithology, moisture content, color, and indications of potential environmental impacts. The subsurface soil consisted of sand and gravel fill material from the ground surface to approximately twenty five (25) feet bgs. A tight clay layer was observed from twenty five (25) to thirty five (35) feet bgs. Sand, gravel and shale fragments were observed from thirty five (35) to fifty (50) feet bgs. See Figure 4 for a stratigraphic column of the subsurface soils. See Figure 5 for a detailed stratigraphic representation of PID readings and TPH analytical results collected at five foot intervals during the sample events. Groundwater was not encountered during any soil boring event.

HYDROGEOLOGY STUDY

A hydrogeologic study was conducted in the summer of 2013 to investigate if the presence of groundwater would affect the impacted area and allow impacts from the release to migrate off the location. The study indicated that groundwater was not a concern at the Unocal 5 location. See Attachment A for the hydrogeology study.

SUMMARY

Due to the depth of impacts, lithology of the subsurface soils, and an unidentifiable increase in TPH constituents observed during the remediation process, in-situ remediation practices have been unsuccessful in attempting to remediate the impacted soils to below COGCC Table 910-1 standards. For several months TPH levels decreased as a result of the remediation process, but showed an increase in certain areas over time. The source for this TPH increase has yet to be identified, but may be the result of hydrocarbon migration from an abandoned underground pipeline, or may simply be the result of fluid migration within the treatment area where water was applied for remediation efforts. A hydrogeologic study of the aquifers and drainage in the vicinity of the Unocal 5 well pad indicated that groundwater would not be a factor in migration of the contaminants offsite. In October 2013, a proposal was submitted to the COGCC in regards to allowing a risk based approach to long term natural attenuation of the impacted soil.

TABLE 1: SOIL BORING ANALYTICAL RESULTS

Sample ID, Depth (ft.)	Collection Date	DRO (mg/kg)	GRO (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes Total (mg/kg)
B01@19'	7/24/09	6,767	3,732	5.22	41.7	9.7	147.6
BH 18, 30'	3/11/11	1,300	2,400	2.0	26	7.0	98
BH 41, 25'	9/19/11	380	1,200	ND	ND	0.58	7.9
BH 42, 30'	9/19/11	970	1,000	0.51	1.4	2.5	35.0
BH 43, 30'	9/21/11	540	960	0.29	3.5	3.0	61.0
BH 44, 30'	9/21/11	1,100	1,100	1.4	24.0	5.7	110
BH 45, 30'	9/21/11	380	1,000	1.8	7.7	4.2	73.0
BH 46, 30'	9/22/11	21.0	ND	ND	ND	ND	ND
BH 47, 30'	9/22/11	30.0	ND	ND	ND	ND	ND
BH 48, 30'	9/22/11	350	1,000	0.97	11	5.6	100
BH 49, 25'	12/14/11	1,800	1,600	NS	NS	NS	NS
BH 50, 25'	12/14/11	1,800	2,700	NS	NS	NS	NS
BH 51, 25'	12/14/11	2,500	2,000	NS	NS	NS	NS
BH 52, 25'	2/9/12	1,500	1,500	NS	NS	NS	NS
BH 52, 35'	2/9/12	260	73	NS	NS	NS	NS
BH 53, 30'	2/9/12	890	1,600	NS	NS	NS	NS
BH 53, 40'	2/9/12	750	740	NS	NS	NS	NS
BH 54, 20'	7/10/12	1,000	2,300	0.43	4.0	2.9	57.0
BH 55, 30'	7/10/12	2,000	4,800	0.41	0.25	10.0	130
BH 56, 30'	7/10/12	1,600	6,000	0.83	0.29	1.8	84.0
BH 57, 30'	10/17/12	1,400	2,800	NS	NS	NS	NS
BH 58, 30'	10/17/12	690	2,600	NS	NS	NS	NS
BH 59, 25'	10/17/12	150	38	NS	NS	NS	NS
BH 64, 20'	6/4/13	1,300	1,600	0.06	0.50	0.85	14.0
BH 64, 35'	6/4/13	250	230	0.14	0.23	0.16	2.1
BH 65, 15'	6/4/13	510	60	0.044	0.58	0.13	1.4
BH 65, 40'	6/4/13	280	130	0.23	0.26	0.36	3.1
BH 66, 32'	6/4/13	640	2,900	0.85	14.0	3.8	95.0
BH 66, 42'	6/4/13	1,000	540	0.47	0.11	0.084	4.6
BH 67, 30'	6/4/13	870	2,200	0.5	0.79	5.5	100
BH 67, 45'	6/4/13	250	560	0.59	0.71	1.4	17.0
COGCC Table 910-1 Standard		500	500	0.17	85	100	175

NOTES: COGCC = Colorado Oil and Gas Conservation Commission

mg/kg = milligrams per kilogram

BTEX = Benzene, Toluene, Ethylbenzene, and Total Xylenes

TPH GRO = total petroleum hydrocarbons gasoline range organics

TPH DRO = total petroleum hydrocarbons diesel range organics

BTEX analyzed by EPA Method 8021B

TPH GRO and TPH DRO analyzed by Method 8015B

NS = Not Sampled

ND = Non Detect

Highlight = Exceeds COGCC Table 910-1 Concentration Levels

FIGURE 1: SITE LOCATION MAP

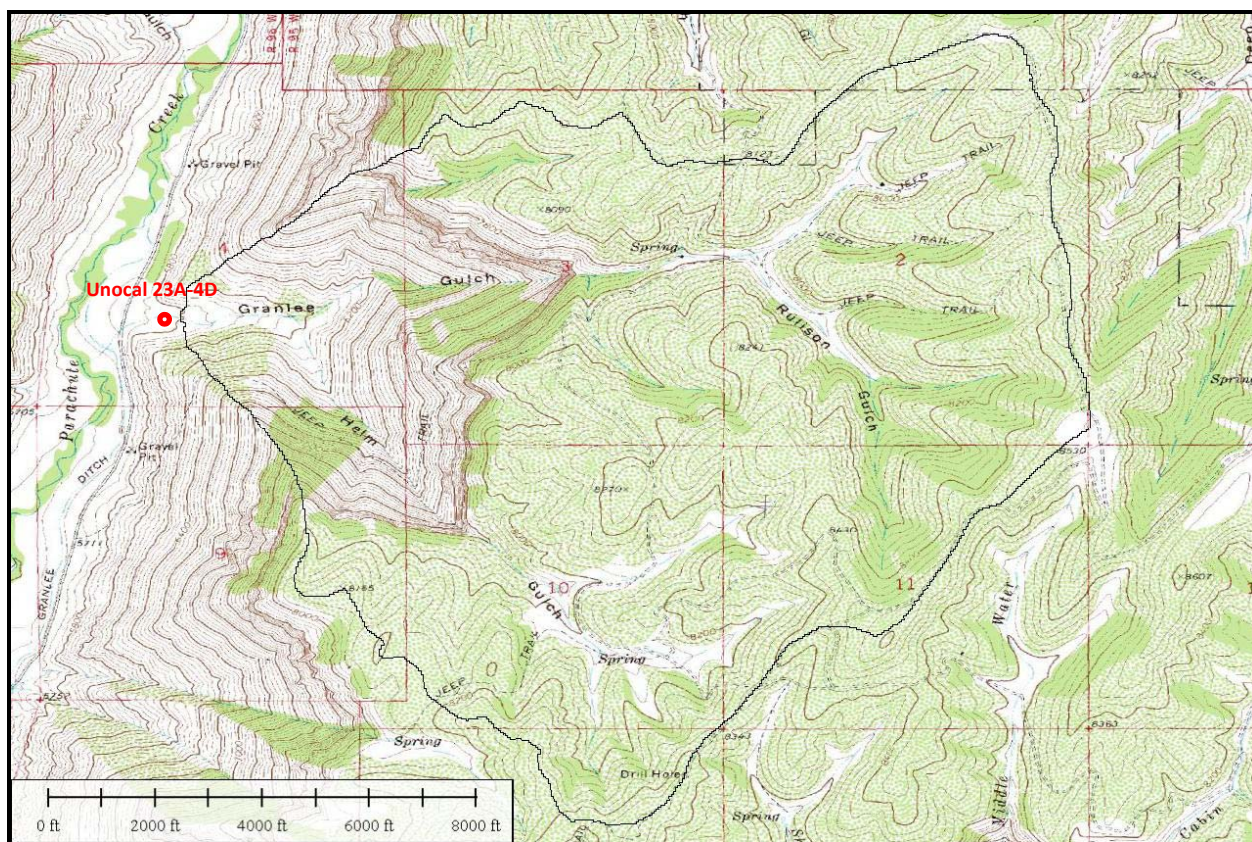


FIGURE 2: GIS MAP OF SITE CHARACTERIZATION SAMPLE LOCATIONS

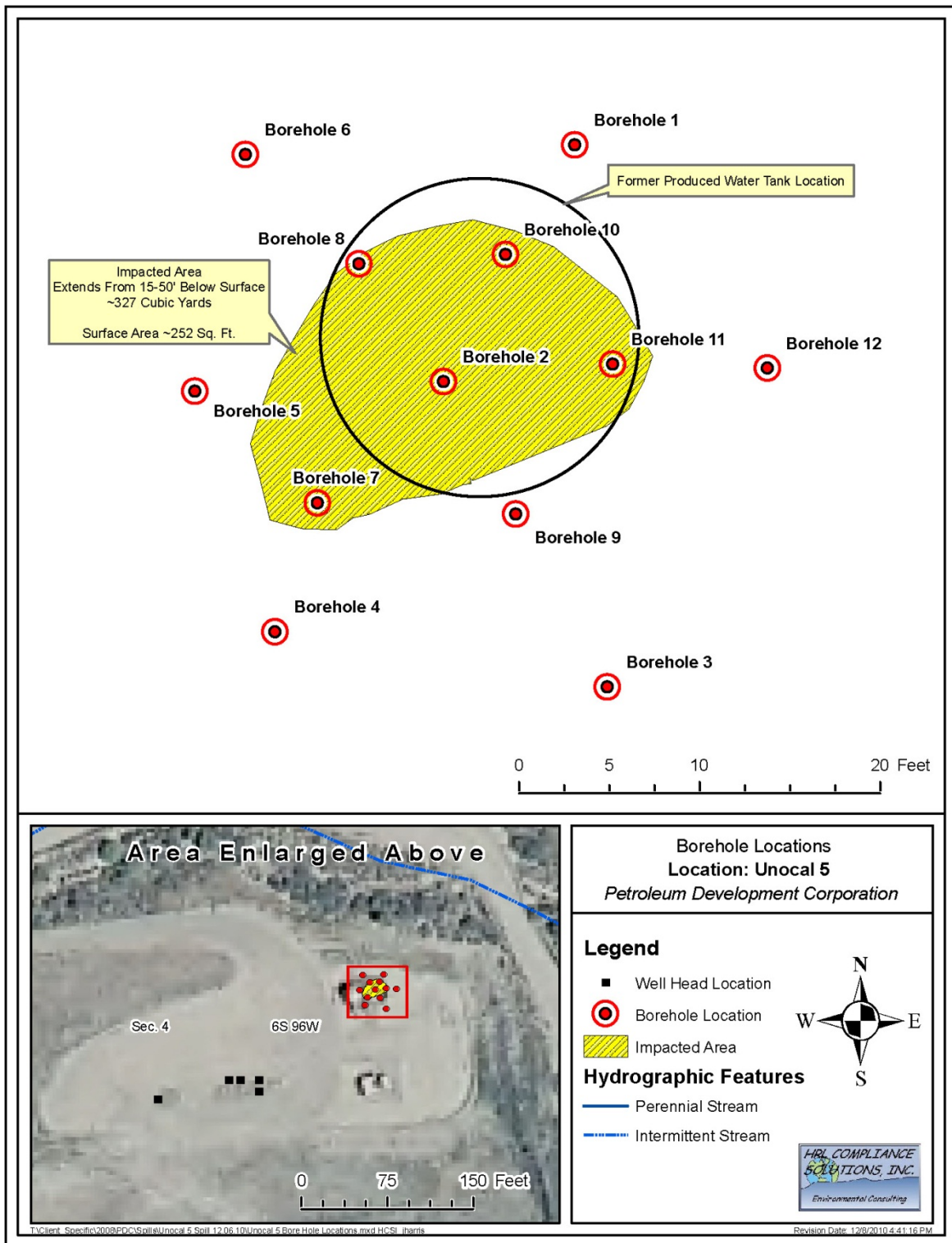
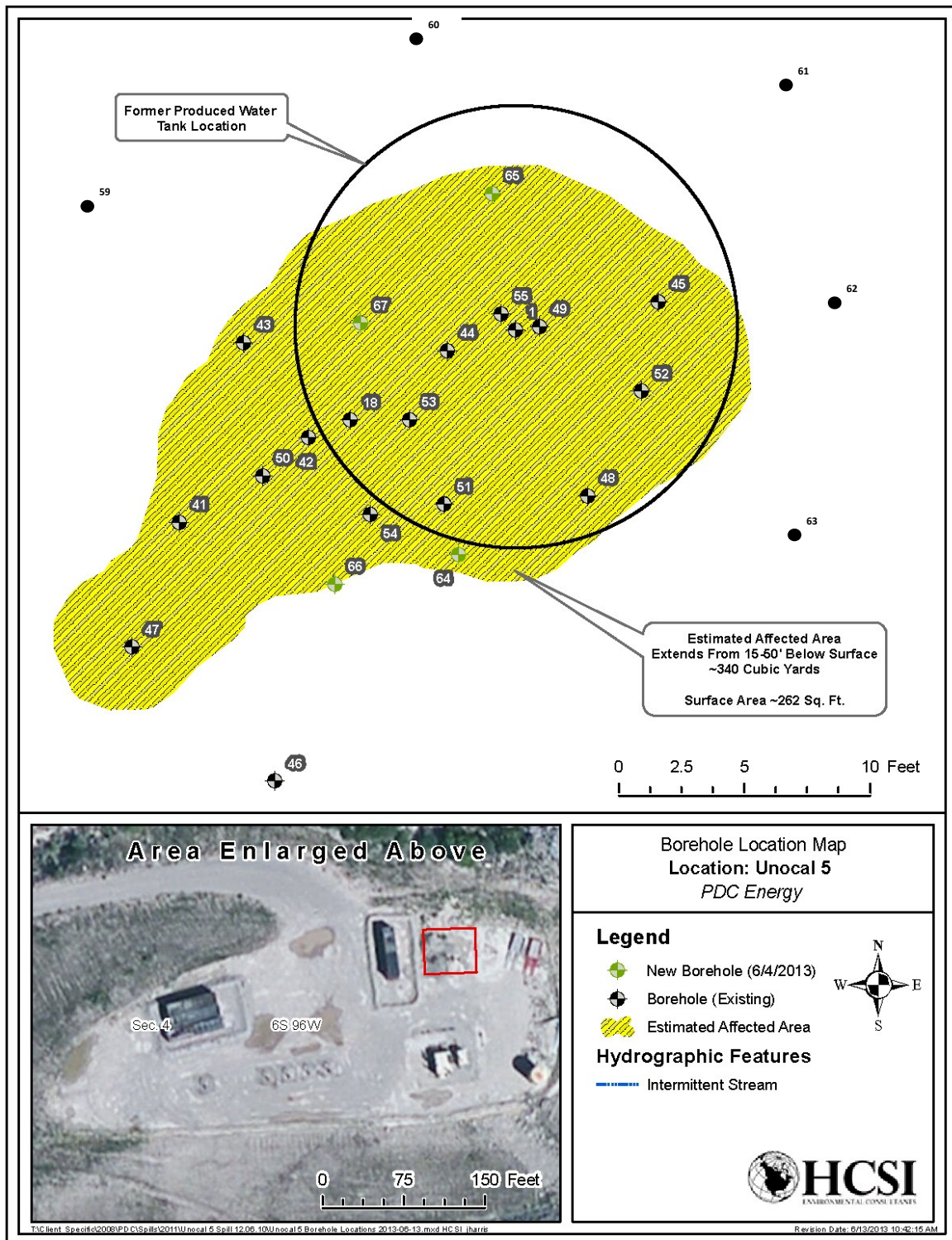


FIGURE 3: GIS MAP OF IMPACTED AREA AND SAMPLE LOCATIONS.



Unocal 5: Sample Location Stratigraphy

Legend

- Gravel - Fill
- Gravel - Clay
- Tight Clay
- Clay - Gravel - Sandstone
- Estimated Plume Extent

DRO (C-10-C28)
mg/Kg-dry

GRO (C6-C10)
mg/Kg-dry

Well Spacing Not to Scale

Revision Date: 2012-08-01
Author: JHarris

FIGURE 5: STRATIGRAPHIC REPRESENTATION OF IMPACTS AT DEPTH

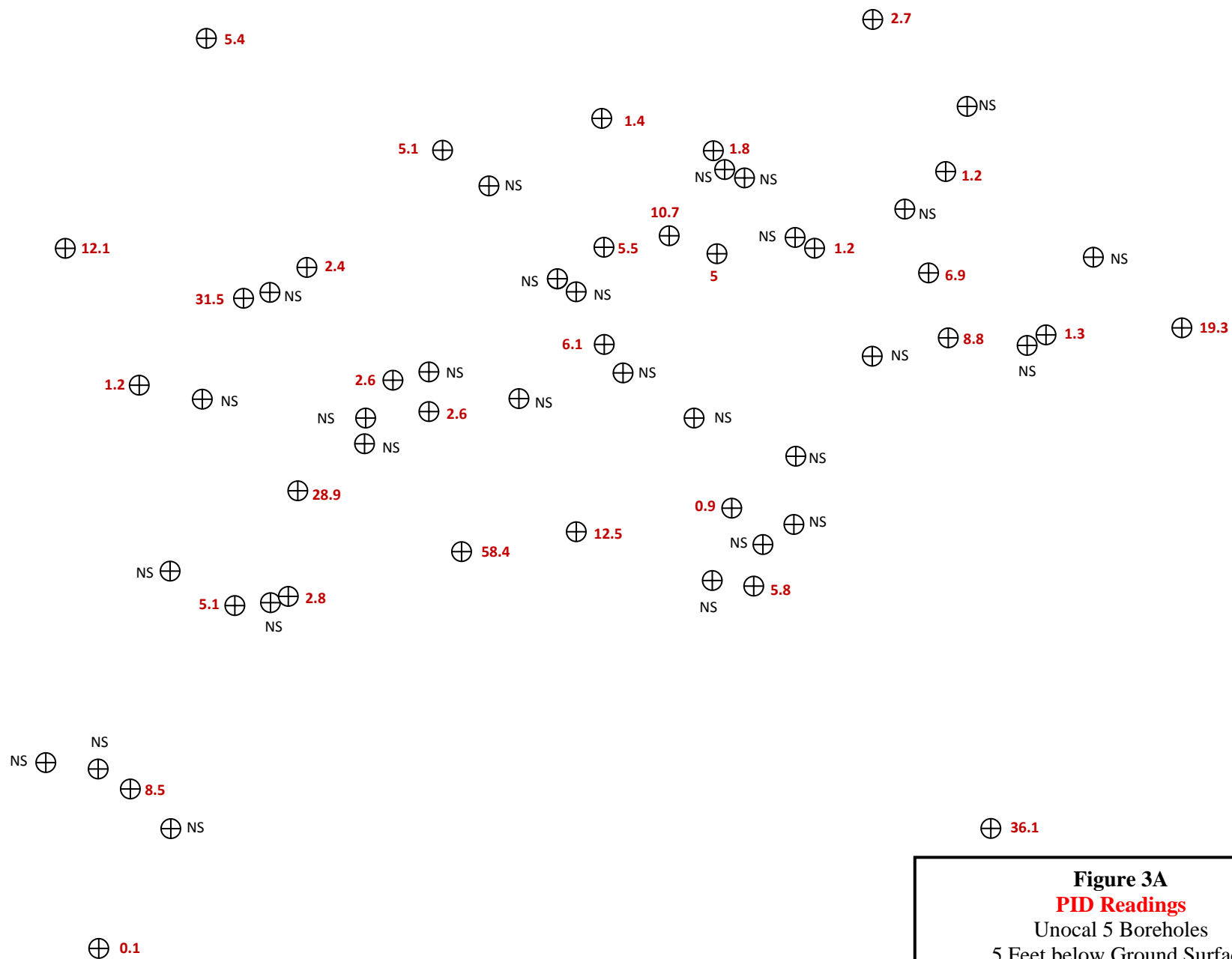


Figure 3A
PID Readings
Unocal 5 Boreholes
5 Feet below Ground Surface
July 2009 to October 2012

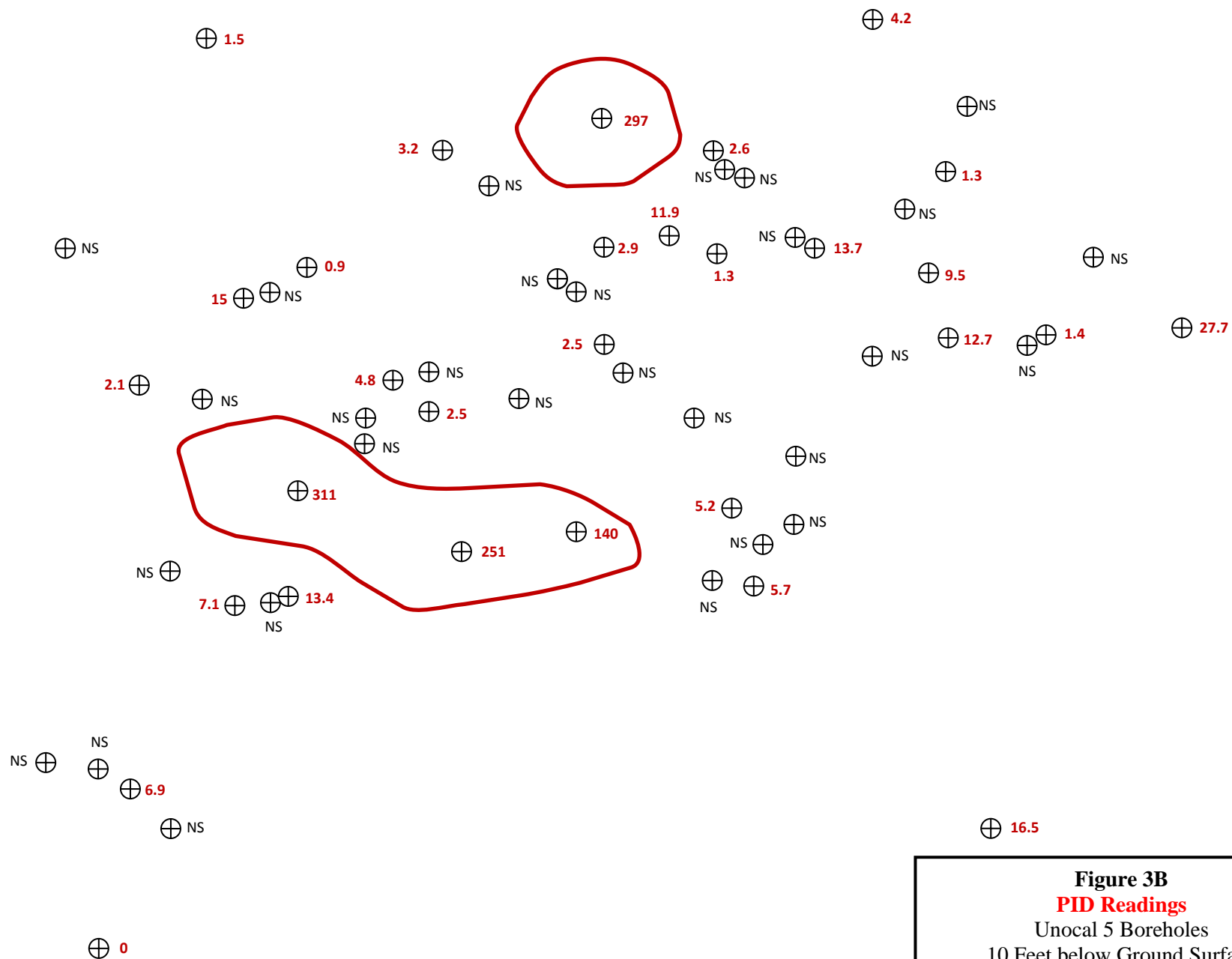


Figure 3B
PID Readings
Unocal 5 Boreholes
10 Feet below Ground Surface
July 2009 to October 2012

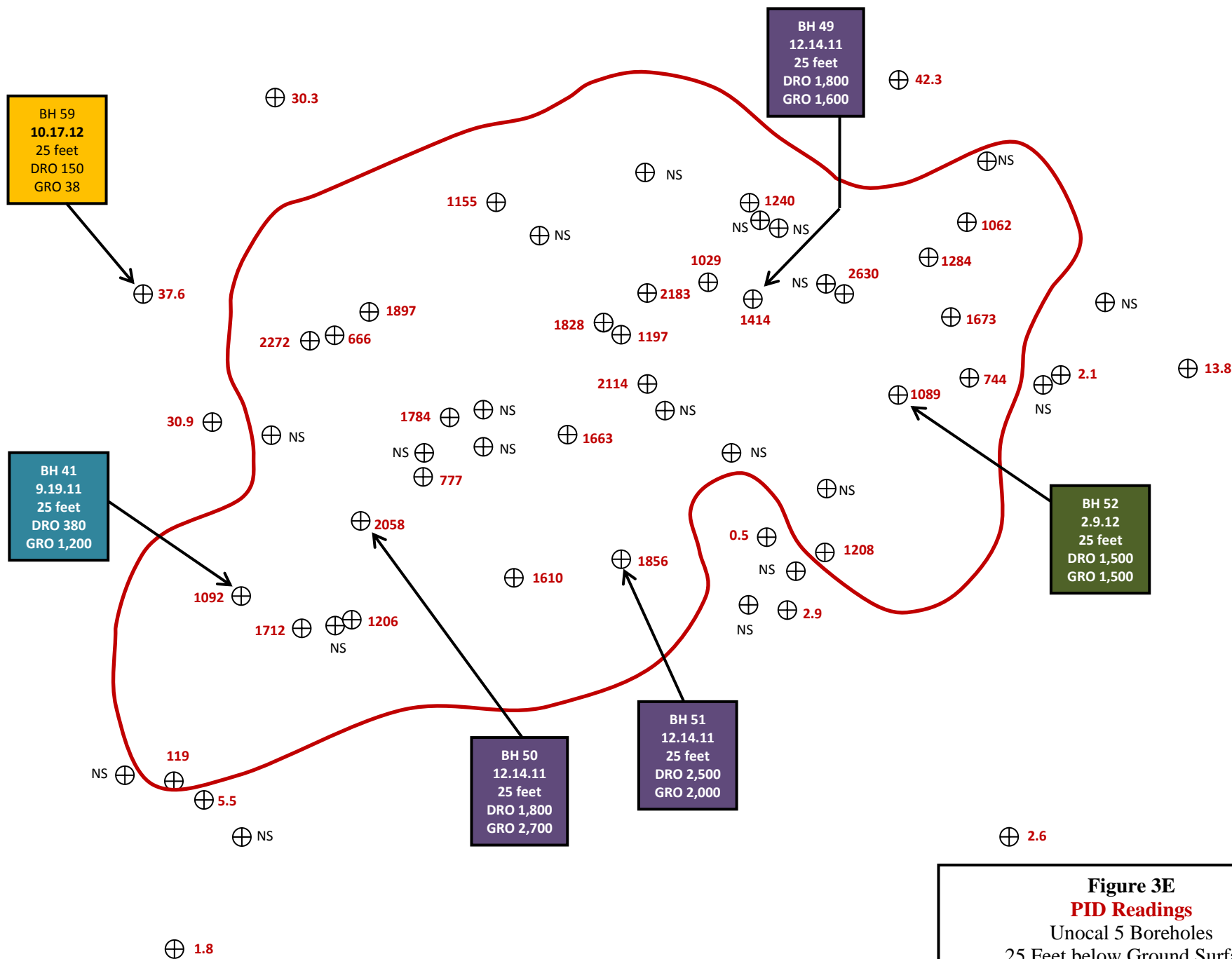


Figure 3E
PID Readings
Unocal 5 Boreholes
25 Feet below Ground Surface
July 2009 to October 2012

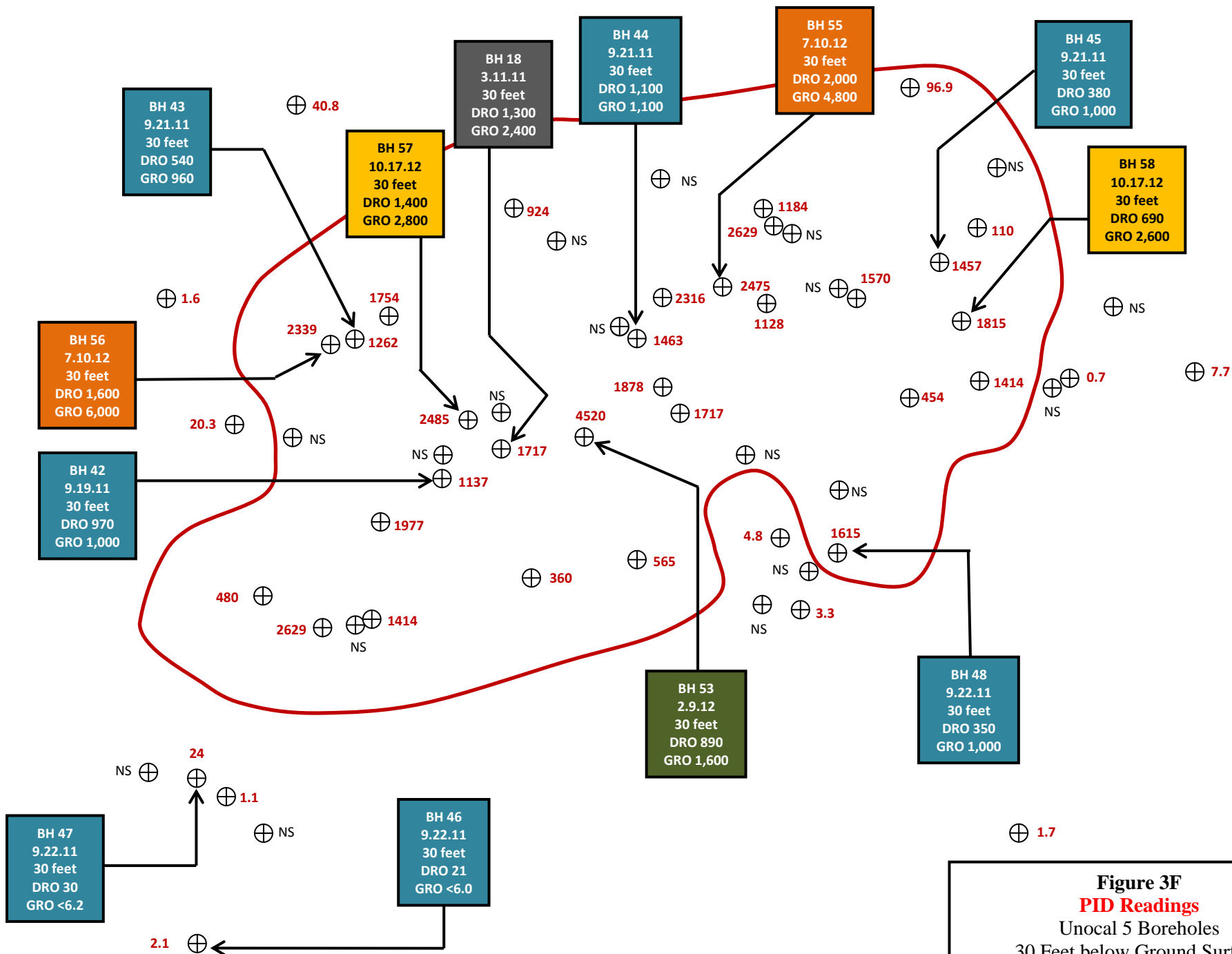


Figure 3F
PID Readings
 Unocal 5 Boreholes
 30 Feet below Ground Surface
 July 2009 to October 2012

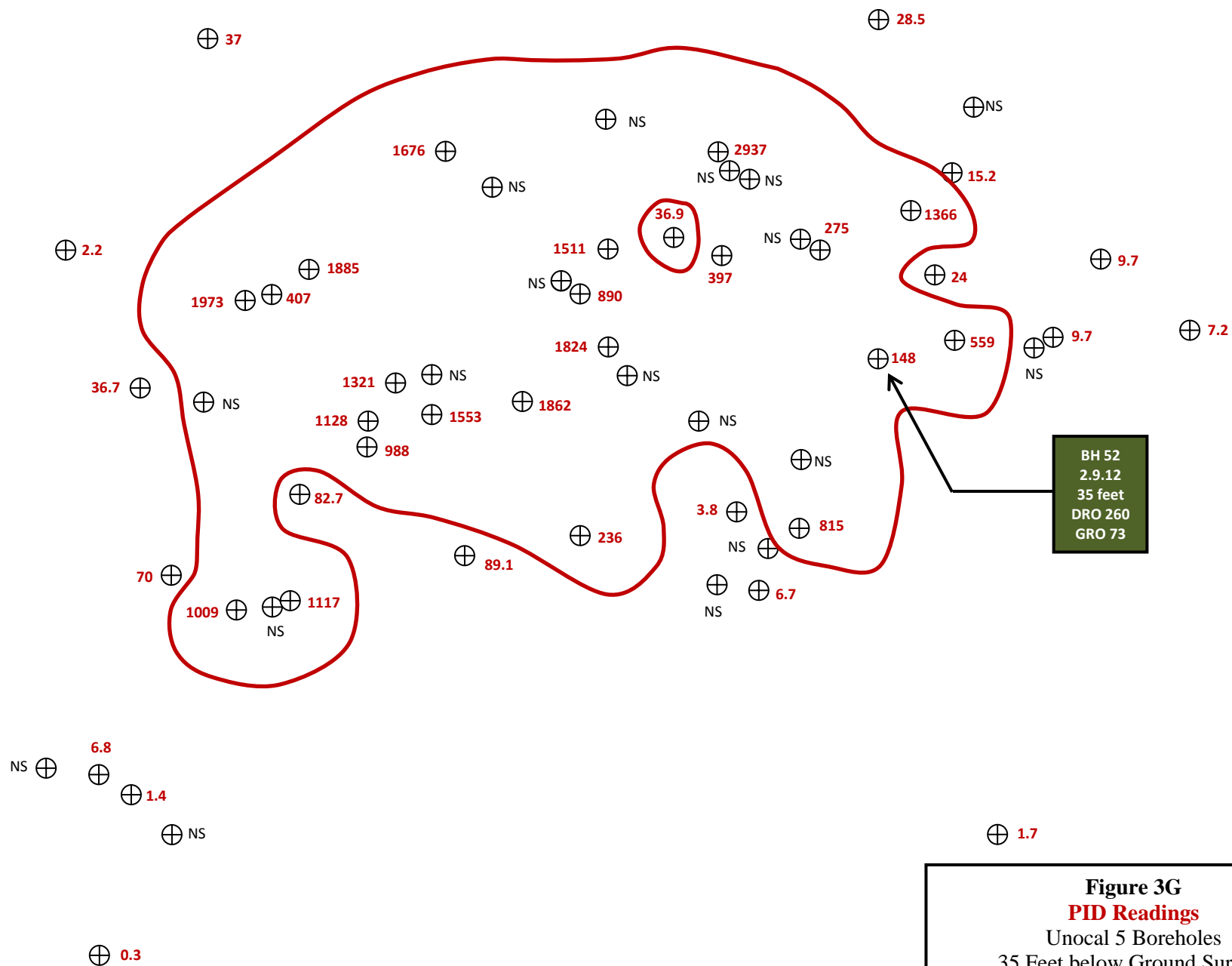


Figure 3G
PID Readings
Unocal 5 Boreholes
35 Feet below Ground Surface
July 2009 to October 2012

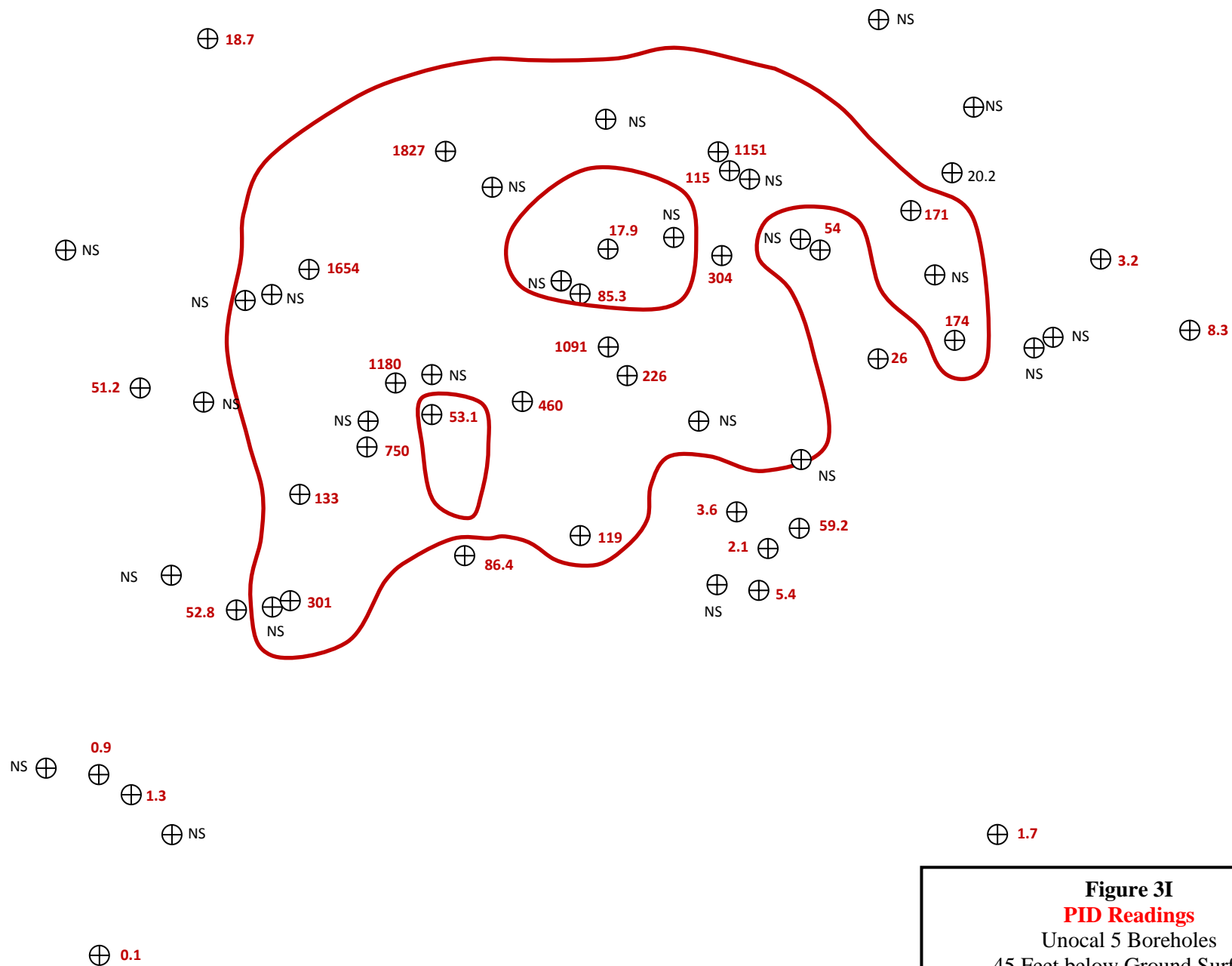


Figure 3I
PID Readings
Unocal 5 Boreholes
45 Feet below Ground Surface
July 2009 to October 2012

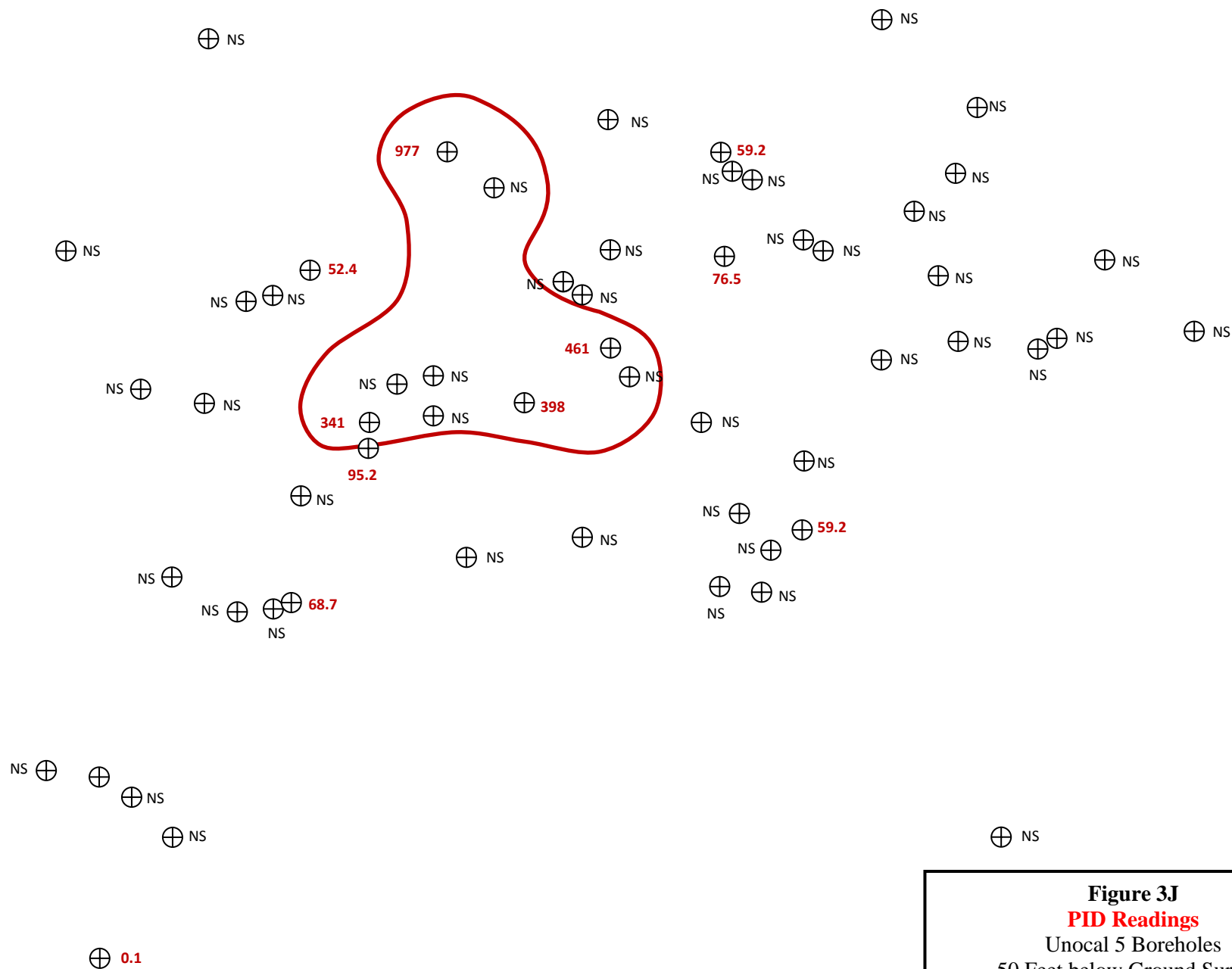


Figure 3J
PID Readings
Unocal 5 Boreholes
50 Feet below Ground Surface
July 2009 to October 2012

ATTACHMENT A: HYDROGEOLOGY STUDY

Unocal #5 Tank Battery
Garfield County, Colorado
Hydrogeologic Engineering Analysis

Prepared for:

Ted Brewster
HRL Compliance Solutions, Inc.
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Prepared by:

Paul C. Currier, P.E.
Water Resource Consultants, LLC
244 Hutton Ave.
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September 4, 2013

PURPOSE AND SCOPE

This report provides a hydrogeologic engineering assessment of the Unocal #5 tank site in Garfield County, Colorado. The purpose of this evaluation is to provide an assessment of the potential for groundwater to disperse contaminants exceeding Table 910-1 limits that are present in the soils at the site. The report was authorized by HCSI on behalf of Petroleum Development Corporation.

The scope of the report is specific to potential surficial, alluvial aquifers, rather than deep aquifers that are thousands of feet below the ground surface.

REGULATORY CONTEXT

COGCC Rule 909(b)(5) states: *Remediation shall be performed in a manner to mitigate, remove, or reduce contamination that exceeds the concentrations in Table 910-1 in order to ensure protection of public health, safety, and welfare, and to prevent and mitigate significant adverse environmental impacts. Soil that does not meet concentrations in Table 910-1 shall be remediated. Ground water that does not meet concentrations in Table 910-1 shall be remediated in accordance with a Site Investigation and Remediation Workplan, Form 27.*

The COGCC rules are structured to be measured by results vs. process. As such they allow for and effectively encourage appropriate technologies to be utilized for site specific conditions. For the Unocal #5 site, in-situ remediation is a plausible means of treatment provided groundwater is not a potential contaminant pathway.

SITE SETTING

Topographic Setting

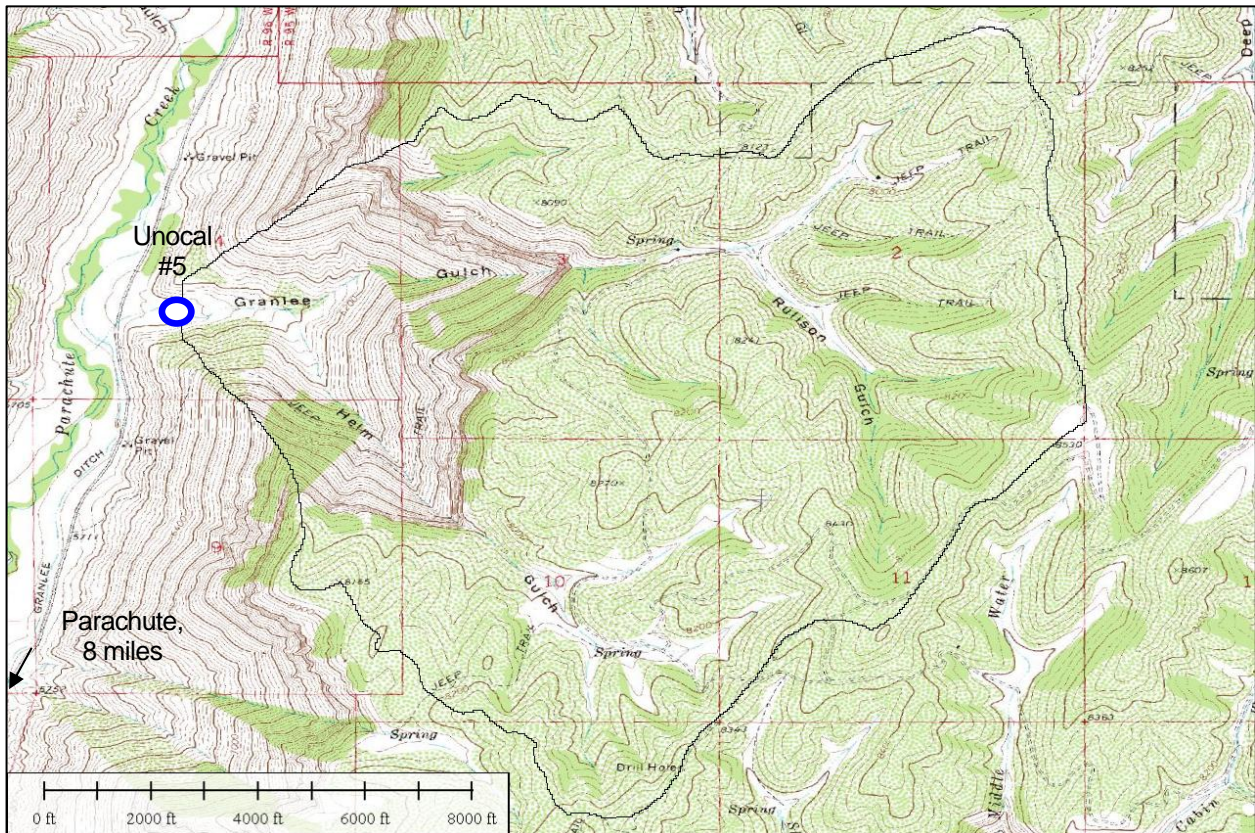
The Unocal #5 facility is located approximately 9 miles north of Parachute, Colorado (Fig. 1). It is located on dry fluvial and colluvial deposits adjacent to Granlee Gulch. The elevation of the site is approximately 5800 feet MSL. Approximately 1500 feet to the west lies Parachute Creek, at a much lower elevation of 5680 feet. The average gradient of Granlee Gulch immediately adjacent to and downslope of Unocal #5 is approximately 8%.

The location of Unocal #5 is near the mouth of Granlee Gulch. It is approximately 100 feet south of Granlee Gulch proper. The surface of Unocal #5 is 10 to 15 feet higher than the thalweg of the adjacent gulch.

Figure 1

Location Map

Unocal #5 and Tributary Watershed



On-site Soils

On-site soils were sampled and characterized by others during previous investigations ¹. Soils are a silty, sandy, clayey matrix, with a continuous, medium dense, sandy-clay lens from approximately 27 to 40 feet below ground surface (bgs). It is our understanding that groundwater has not been observed at the site.

The soil complex is classified as Nihill Channery Loam, 6 to 25 percent slopes, which is common on the valley sides and alluvial fans of tributary streams in the Parachute Creek drainage. The soils tend to form convex, somewhat linear shapes in the down-valley direction, and fan out at the mouths of canyons into broad, alluvial fans. Materials are generally derived from upslope sandstone and shale. Surficial materials tend to be well sorted, well drained, with high permeability. Lenses at depth, such as the sandy-clay lens identified during the remedial investigation, can have a higher clay content, and effectively act as an aquitard, slowing the

¹ LT Environment, Inc., Nov. 6, 2009, letter report to Randall Ferguson, Petroleum Development Corp., by Asher Weinberg, re: *Followup Investigation Results, Unocal #5 Release* (Appendix A).

downward movement of water². It should be noted that the lateral extent of the sandy-clay lens noted in the LTE report is not fully known, but given the relative thickness of 12 feet +/-, it is likely the lens is fairly extensive and would be found several hundred feet from the Unocal #5 site. The limit of the sandy-clay lens to the south is most likely bounded by the rock outcrop, *Torriorthents* complex.

Parachute Creek Aquifer

The Unocal #5 site lies above and adjacent to the Parachute Creek Aquifer. This is a shallow alluvial aquifer immediately adjacent to and under Parachute Creek. Figure 2 shows alluvial aquifers as generally mapped by the Colorado Division of Water Resources³.

Figure 2

Alluvial Aquifer, Parachute Creek

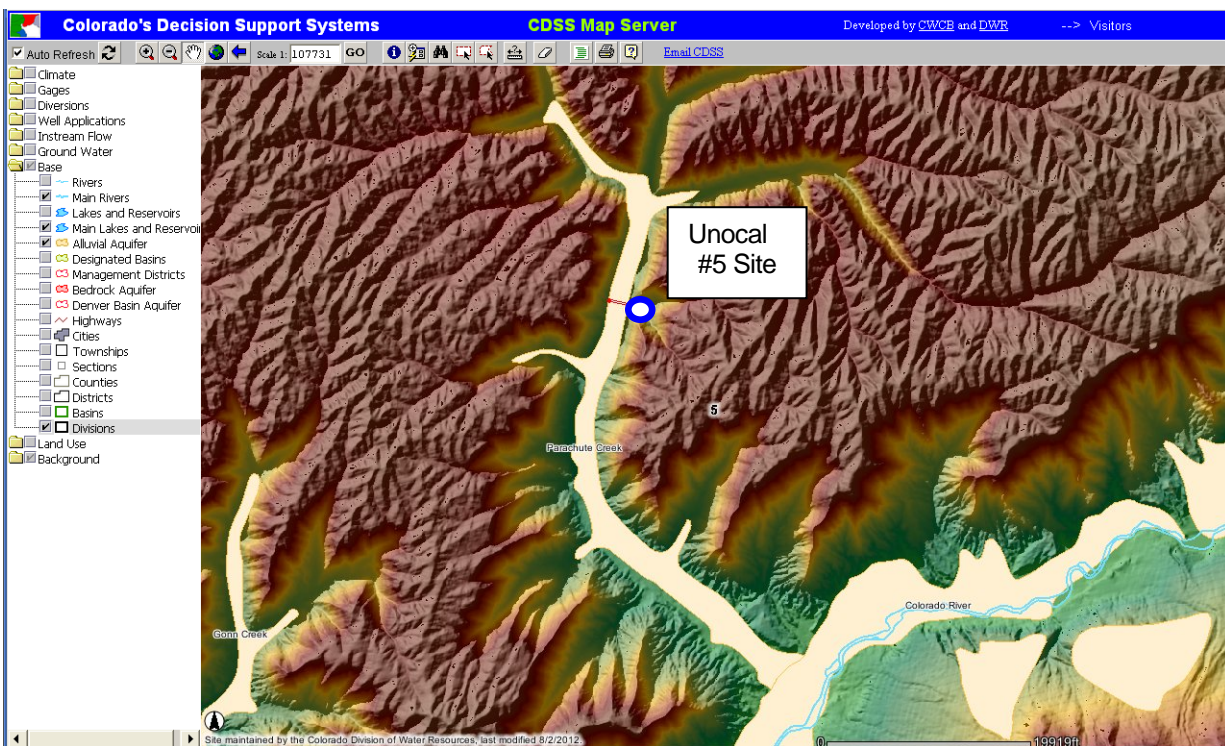


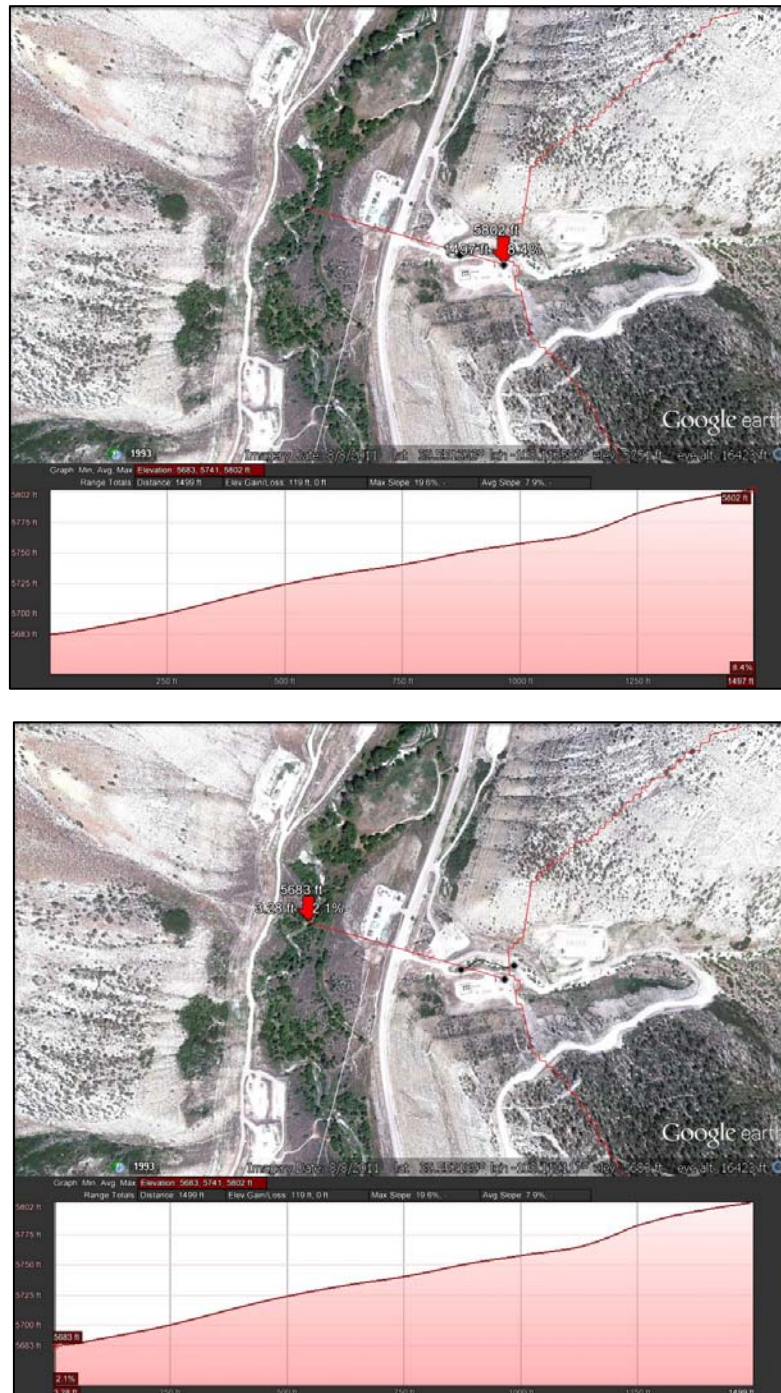
Figure 3 shows the relative elevations of the site in relationship to Parachute Creek, and the Parachute Creek aquifer.

² Appendix B, Borehole Logs

³ CDSS web site, <http://165.127.23.41/website/cdss/viewer.htm>

Figure 3

Relative Elevation of Unocal #5 Site in relationship to Parachute Creek and the Parachute Creek Aquifer. Note Parachute Creek is fully 120 feet lower than the ground surface at the site.



Parachute Creek, being fully 120 feet lower than the surface of the site, and at least 70 lower than 50 feet bgs at the site, is not a plausible source of groundwater to the site. Since the soils along Parachute Creek are similar to the soils adjacent to Granlee Gulch, the potential for influence by groundwater from Parachute Creek is virtually non-existent, and can be ruled out as potential source of ground water to the site.

Hydrogeologic Setting – Granlee Gulch

The Unocal #5 site has been characterized to depth of nearly 50 feet bgs. This equates to 30-35 feet below the bottom of the adjacent Granlee Gulch. Of particular interest to this investigation is whether the surface and groundwater hydrology of Granlee gulch is such that groundwater could saturate the site, resulting in a potential contaminant pathway. The duration of inundation, if any, is also of concern, in that soluble contaminants not bound with soil would be prone to dislocation if a saturated groundwater condition existed.

Granlee Gulch is an intermittent, ephemeral stream. It only runs water during snowmelt runoff, and after heavy rainstorms. Lighter rainstorms tend to be initially abstracted (absorption and adsorption) by the high permeability sandstones and shales that make up the soils of the Granlee Gulch basin. Heavy rainstorms can and do result in flash floods, and even debris flows.

The basin has a drainage area of 4.23 sq. mi. Nearly 83 percent of the basin is above 7500 feet in elevation. This elevation is an arbitrary but useful marker utilized by the USGS, which simply indicates most runoff is driven by snowmelt, rather than rainfall. The exception is summertime storm cells which can result in localized but oft dramatic flash floods. The USGS estimates mean annual precipitation at 21 inches (total rain and snow precipitation combined). Mean streamflow predictions as estimated by USGS Streamstats⁴ are tabulated in Figure 4.

Figure 4

Estimated Peak Flows for Various Probabilities of Recurrence, Granlee Gulch at Mouth

Peak-Flows Streamflow Statistics					
Statistic (Recurrence Interval, Years)	Flow (ft³/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2 (p = 0.50)	23.8	110			
PK5 (p = 0.20)	39.3	88			
PK10 (p = 0.10)	51.6	79			
PK25 (p = 0.04)	69.8	74			
PK50 (p = 0.02)	86.2	74			
PK100 (p = 0.01)	105	75			
PK200 (p = 0.005)	122	76			
PK500 (p = 0.002)	157	79			

⁴ USGS Streamstats, http://streamstatsags.cr.usgs.gov/co_ss/default.aspx?stabbr=co&dt=1378286434705

Figure 4 should be interpreted very carefully and in context. It is a predictor of peak flow events at the mouth of Granlee Gulch, given a specific probability of being met or exceeded in any given calendar year. For example, for an event that has a 1% chance of being equaled or exceeded in any given year ($p = 0.01$), the USGS model estimates the peak flow will be at approximately 105 cfs (+/- 75%). An event with a 1% chance is often – and often incorrectly – thought of as the “100 year event,” with the common notion that such an event will only happen once every 100 years. This is incorrect, because in reality such an event can happen twice in two weeks, or three times in five years, or every other day, etc. Interpreted correctly, it states that in any given year there is a 1% chance of the peak flow being met or exceeded. That’s the theoretical side. The practical side is that the USGS streamstats program is based on regression analysis of hundreds of USGS stream gauging stations. The USGS then models areas above and below 7500 feet elevation, and further by geographic location within the State. Based on our experience, we’ve found the USGS Streamstats program to reasonably represent the $p = 0.01$ event, but have found it to poorly represent low flows in regions like Parachute Creek and its tributaries.

Based on personal observations of Granlee Gulch, we believe it is plausible to have $p = 0.01$ flows of nearly 100 cfs. Additionally, peak flows from flash floods may exceed this. Evidence of boulders and stream geomorphology indicates high flows have occurred. However, nothing was observed that indicated that the Unocal #5 site was at substantial risk from being eroded by peak streamflows in the Gulch.

Additionally, the duration of peak flows is minimal. When heavy snowmelts occur (e.g., 1983-1984, 2011), the peak is usually short lived, being no more than a couple of days to at best, a week. Thunderstorm driven rainfall events are much, much shorter, on the order of a few minutes to a few hours.

The flow rates and duration of runoff are important because together they equal the total volume of runoff (rate x time). And ultimately, if groundwater is to be present, the volume would have to be such that that exfiltration from the bottom and sides of the gulch is sufficient enough to create a viable aquifer by “leaking” from the Gulch faster than water can move through the aquifer. This is indeed the case along Parachute Creek, which is a perennial stream that flows year around, and thus sustains an aquifer underneath and adjacent to the creek. However, for Granlee gulch, the short duration of flow, coupled with the typically small flows ($\ll 0.25$ cfs, and often completely dry), provides insufficient water to create a groundwater table. Additionally, the porous nature of the Nihill channery loam holds water very poorly, e.g., the soils underneath and adjacent to the channel have very low water holding capacity⁵.

Thus, we conclude that groundwater from the Granlee Gulch is not a viable contaminant pathway.

Surface Run-on

Of greater potential than groundwater is the issue of surface run-on, e.g., surface waters on the existing developed site running onto the Unocal #5 tank battery site, and percolating into the contaminated soils. This can be easily averted by berming around the contaminated area, which is approximately 40 to 50 feet in diameter. Additionally, a clay or geosynthetic clay liner cap could be placed over the contaminated area to further limit infiltration from rainfall and snowmelt.

⁵ Appendix B, NRCS Soils Report, Unocal #5

SUMMARY OF OPINION

It is our opinion that neither Granlee Gulch nor Parachute Creek create a viable water table aquifer underneath or adjacent to the Unocal #5 tank battery remedial action site. Therefore, in-situ remediation of soils is viable from the perspective that contaminants will not be transported off site via groundwater.

Additionally, we recommend that surface run-on onto the site be averted. This can be done with a berm around the site, and a clay or geosynthetic clay liner placed on the top of the contaminated area.

Respectfully submitted,

WATER RESOURCE CONSULTANTS, LLC



Paul C. Currier, P.E., CFM

PCC:pcc

492 - Unocal #5 evaluation.doc

Attachments:

- Appendix A: LTE Letter, Nov. 6, 2009, *Followup Investigation Results, Unocal #5 Release*
- Appendix B: NRCS Soils Mapping, 2013
- Appendix C: LTE, Unocal #5 – Borehole Logs

Appendix A

LTE Letter, Nov. 6, 2009
Followup Investigation Results, Unocal #5 Release



DRAFT

November 6, 2009

Mr. Randall Ferguson
Petroleum Development Corporation
1775 Sherman Street, Suite 3000
Denver, Colorado 80203

RE: Follow-Up Site Investigation Results
Unocal #5 Release
Garfield County, Colorado

Dear Mr. Ferguson:

LT Environmental, Inc. (LTE) conducted a follow-up site investigation at the Unocal #5 Pad (Site) located near Garden Gulch in Garfield County, Colorado (Figure 1). The purpose of this follow-up investigation was to address Petroleum Development Corporation's (PDC's) request for vertical chemical profiling of the source area beneath the former location of the produced water tank.

Soil Boring

LTE advanced one boring (UN01A) in the source area approximately 3 feet west of boring UN01 on October 23, 2009. All soil boring locations are presented on Figure 2. LTE contracted Dakota Drilling of Denver, Colorado to install the boring using a CME-55 drill rig equipped with hollow stem augers.

The soil boring was logged by an LTE geologist who inspected the soil for the presence or absence of petroleum hydrocarbon odor and/or staining. The soils were characterized by visually inspecting the soil samples collected in three-foot long split-spoon samplers and field-screened the soil headspace using a photo-ionization detector (PID) to monitor for the presence of volatile organic vapors. The soil boring log is included in Attachment 1.

Soil identified within the former location of the produced water tank was predominantly characterized as a sand and gravel mixture that extended from the ground surface to 50 feet below ground surface (bgs). A sandy clay soil was observed between 27 feet and 40 feet bgs.

Soil Sampling

The soil boring was advanced using hollow stem auger drilling techniques and sampled every 5 feet from 25 feet to 50 feet bgs using a split-spoon sampler. Soils from the ground surface to 25 feet bgs were characterized through visual inspection but were not sampled. The purpose of sampling below 25 feet bgs was to provide vertical chemical profile data below the previous pot



hole assessment conducted in the source area which identified hydrocarbon impact from 7 feet bgs (at the hole in the produced water sump to 19.5 feet bgs (the base of the pot hole).

Seven soil samples were transferred into laboratory prepared 4-ounce, wide mouth glass jars. The soil samples were placed on ice and delivered with a completed chain-of-custody (COC) form to Origins Laboratory, Inc. of Denver, Colorado (Origins). The soil samples were submitted for analysis of benzene, toluene, ethylbenzene and xylenes (BTEX) by Environmental Protection Agency (EPA) Method 8260 and Total Petroleum Hydrocarbons (TPH) by EPA modified Method 8015. TPH results are reported as Gasoline Range Organics (GRO) and Diesel Range Organics (DRO).

The soil sample with the highest organic vapor concentration in the soil headspace from the boring UN01A (labeled as UN01A 28'-30') was also submitted for additional analyses listed in Colorado Oil and Gas Conservation Commission (COGCC) Table 910-1 as indicated in the table below.

Analyte	Method
Polynuclear Aromatic Hydrocarbons (PAHs)	EPA Selective Ion Method (SIM) 8270
Sodium Absorption Ratio (SAR)	USDA Agriculture Handbook Saturated Paste Method
Electrical Conductivity (EC)	USDA Agriculture Handbook Saturated Paste Method
pH	USDA Agriculture Handbook Saturated Paste Method
Arsenic	EPA Method 6010B
Barium	Louisiana Department of Natural Resources (LNDR) method for True Total Barium
Boron (Hot Water Soluble)	Gupta Method
Chromium (III)	Calculated
Chromium (VI)	SW7196
Copper	EPA Method 6010B
Lead	EPA Method 6010B
Mercury	SW7471A
Nickel (soluble salts)	EPA Method 6010B
Selenium	EPA Method 6010B
Silver	EPA Method 6010B
Zinc	EPA Method 6010B



Background Soil Sampling

In order to establish background levels for specific analytes, LTE collected a soil sample of native material to the south of the pad and off of the pad surface. The background soil sample (BG01 0.5'-1.5') was submitted for analysis of the analytes listed above with the exception of PAHs.

Soil Analytical Results

Soil analytical results indicate benzene levels in the soil samples collected from the boring at 24 feet to 26 feet bgs, 28 feet to 30 feet bgs, and 40 feet to 42 feet bgs exceeded COGCC Table 910-1 Concentration Levels. Toluene and total xylenes levels in the soil sample collected from boring UN01A at 24 feet to 26 feet bgs also exceeded COGCC Table 910-1 Concentration Levels. TPH levels in each of the four soil samples collected between 24 feet bgs and 42 feet bgs exceeded COGCC Table 910-1 Concentration Levels. The analytical results for organic compounds from the pot hole assessment, initial investigation, and this follow-up investigation are summarized in Table 1.

PAHs were not detected at concentrations above those listed in Table 910-1 in the sample collected from 28 feet to 30 feet bgs. Based on these results, LTE has concluded that the potential for PAHs to exceed the values listed in Table 910-1 is low. Since each of the PAH compounds were not detected above regulatory limits and only one set of analysis was performed, LTE did not prepare a table summarizing the results of the PAHs analysis. The laboratory analytical report details the analytical results of the PAH analysis in Attachment 2.

Analysis of the inorganics in both the background sample and the sample from 28 feet to 30 feet bgs indicates that arsenic is the only metal that exceeds the Table 910-1 values. While the background sample contains arsenic at a lower concentration, LTE believes that both values are within the background ranges for arsenic in Colorado based on available published literature and LTE's experience working in the region. The analytical results for the background sample and the sample from boring UN01A are summarized in Table 2. Laboratory analytical reports are included in Attachment 2.

Physical Testing of Soil

LTE collected undisturbed soil samples using a California Tube from approximately 30 feet bgs to 40 feet bgs. Based on sample recovery and representativeness of the clay layer in question, the sample from 30 feet to 31 feet bgs was submitted to Advanced Terra Testing (ATT) in Lakewood, Colorado for analysis of specific gravity, dry bulk density, moisture content, porosity, and grain size distribution.

Analytical results indicate that the soil type is a sandy clay as described by LTE's geologist in the field. The grain size distribution indicates that 67% of the material is finer than the #200



sieve size which is in the silt/clay range. Approximately 33% of the material is coarser than silt/clay. With a measured porosity value of 39.44% and dry bulk density value of 101.1 pounds per cubic foot, laboratory analysis further confirms the expected soil type as sandy clay. The laboratory analytical report for the physical soil analysis is included in Attachment 2.

Summary and Conclusions

Based on the results of this investigation, the vertical extent of impact has been defined more precisely than the previous investigation. Based on this most recent data, the previous investigation, and the initial pot hole assessment, it appears the vertical extent of impact is from 7 feet to approximately 43 feet bgs. This is approximately 7 feet less than LTE's initial estimate.

The physical soil analysis confirms the geologic characteristics of the sandy clay layer present at the site from approximately 27 feet to 40 feet bgs as described by LTE's field geologist. Based on the density, porosity, and grain size analysis, LTE does not anticipate that this finer grained material would significantly inhibit in-situ remedial approaches.

The analysis of PAHs in soil in the source area suggests that PAHs are not present at concentrations above the levels established in Table 910-1. Further analysis of PAHs in soil from the remaining intervals sampled was suspended indefinitely.

The analysis of inorganics indicate that arsenic is present in soil above the Table 910-1 values. Based on the concentration detected in the source area, a comparison to the value from the background sample, LTE's experience, and published literature, it appears likely that arsenic levels are present throughout the region at concentrations above the Table 910-1 value.

LTE plans to revise the remediation alternatives letter dated September 22, 2009 with the new information obtained during this investigation, as necessary. This summary will be submitted under separate cover.

Please call us at (303) 433-9788 if you have any questions regarding this letter report or require additional information.

Sincerely,

LT ENVIRONMENTAL, INC.

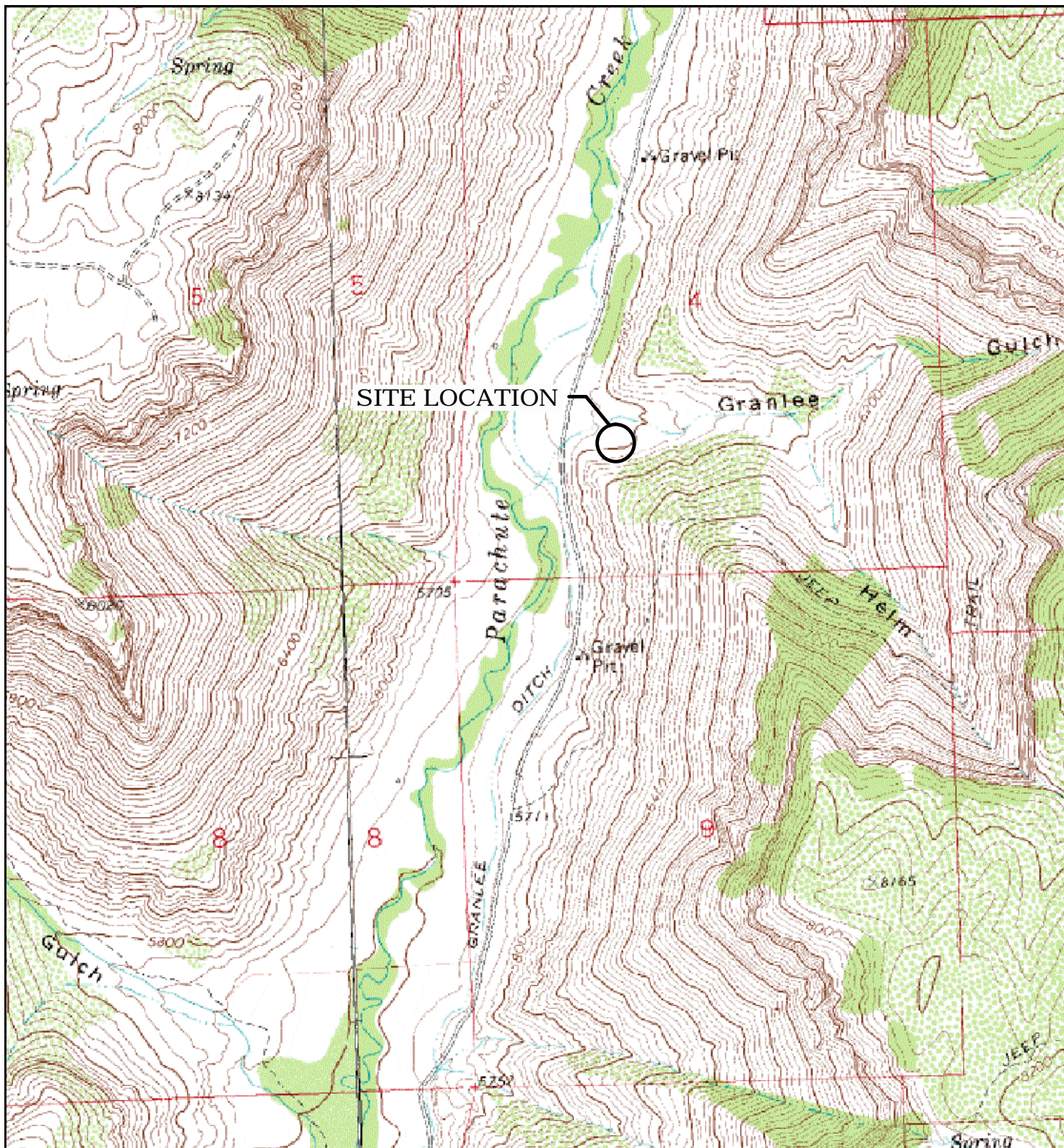
A handwritten signature in black ink, appearing to read 'Asher'.

Asher Weinberg
Staff Environmental Scientist

A handwritten signature in black ink, appearing to read 'John D. Peterson'.

John D. Peterson, P.G.
Principal/Senior Geologist

FIGURES



LEGEND

○ SITE LOCATION



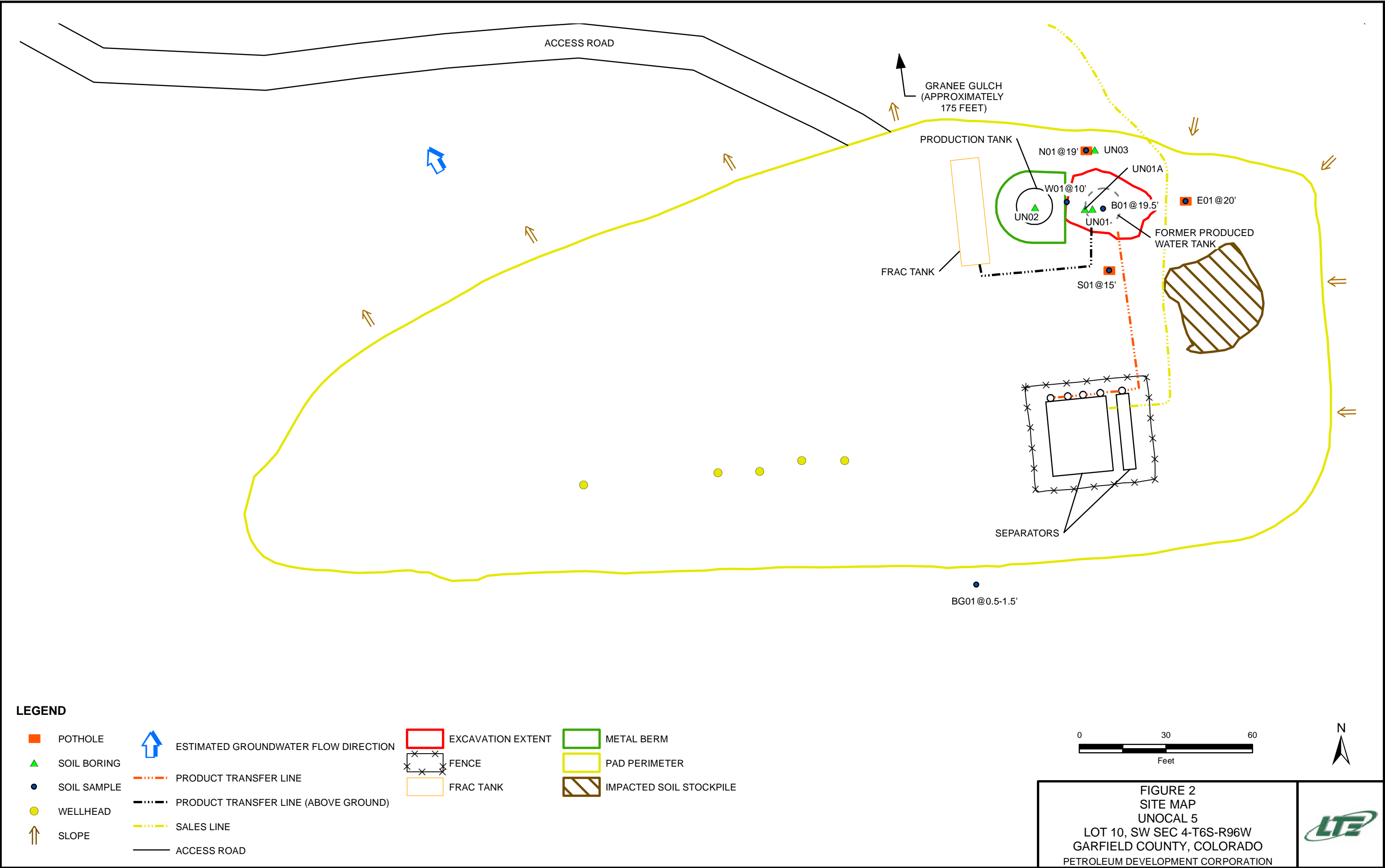
0 375 750 1500
FEET

SOURCE: TOPOZONE.COM
USGS 7.5' QUADRANGLE
(NAD27)

FIGURE 1
SITE LOCATION MAP
UNOCAL 5
LOT 10, SW 4 T6S R96W
GARFIELD COUNTY, CO
PETROLEUM DEVELOPMENT CORPORATION



PDCW091801_SL 8/09



TABLES

TABLE 1
SOIL SAMPLE ANALYTICAL DATA - BTEX & TPH
UNOCAL 5
GARFIELD COUNTY, COLORADO
PETROLEUM DEVELOPMENT CORPORATION

SAMPLE ID	SAMPLE DATE	DEPTH (feet bgs)	BENZENE (mg/kg)	TOLUENE (mg/kg)	ETHYLBENZENE (mg/kg)	XYLENES (Total) (mg/kg)	TPH-GRO (mg/kg)	TPH-DRO (mg/kg)
B01 @19.5'	7/24/2009	19.5	5.22	41.7	9.7	147.6	6,766.87	3,731.82
N01 @19'	7/27/2009	19	< 0.0040	< 0.0040	< 0.0040	< 0.012	<50.0	71.4
W01 @10'	7/27/2009	10	0.594	20.1	1.05	50.44	1,140	427
E01 @20'	7/27/2009	20	< 0.0040	0.0140	< 0.0040	0.1028	<50.0	<50.0
S01 @18'	7/27/2009	18	< 0.0040	0.00696	< 0.0040	0.0260	<50.0	<50.0
UN01 55'-57'	9/2/2009	55-57	< 0.0040	< 0.0040	< 0.0040	< 0.012	<50.0	<50.0
UN02 55'-57'	9/2/2009	55-57	< 0.0040	< 0.0040	< 0.0040	< 0.012	<50.0	<50.0
UN01 55'-57'	9/2/2009	55-57	< 0.0040	< 0.0040	< 0.0040	< 0.012	<50.0	<50.0
UN01A 24'-26'	10/23/2009	24-26	3.35	161	7.72	231.4	5,828.1	2,547.8
UN01A 28'-30'	10/23/2009	28-30	0.883	15.3	2.42	49	816.2	900.8
UN01A 34'-36'	10/23/2009	34-36	0.167	0.852	<0.0040	1.813	173.5	344.4
UN01A 40'-42'	10/23/2009	40-42	0.400	3.42	0.0836	4.283	331.5	592.7
UN01A 44'-46'	10/23/2009	44-46	0.0414	0.0266	<0.0040	0.0238	<50.0	143
UN01A 49'-50.5'	10/23/2009	49-50.5	0.0617	0.321	0.0201	0.2426	<50.0	345.8
COGCC Table 910-1 Level			0.17	85	100	175	500	

< - less than stated laboratory reporting limit

mg/kg - milligrams per kilogram

bgs - below ground surface

COGCC -Colorado Oil and Gas Conservation Commission

BTEX - benzene, toluene, ethylbenzene, and total xylenes

GRO - Gasoline Range Organics

DRO - Diesel Range Organics

TPH - Total Petroleum Hydrocarbons

Analytical results noted in bold exceed the COGCC Table 910-1 Concentration Levels



TABLE 2
SOIL SAMPLE ANALYTICAL DATA - INORGANICS
UNOCAL 5
GARFIELD COUNTY, COLORADO
PETROLEUM DEVELOPMENT CORPORATION

SAMPLE ID	SAMPLE DATE	DEPTH (feet bgs)	ARSENIC (mg/kg)	BARIUM (mg/kg)	BORON (mg/L)	CADMIUM (mg/kg)	CHROMIUM III (mg/kg)	CHROMIUM VI (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	NICKEL (mg/kg)	SELENIUM (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)	EC (mmhos/cm)	pH	SAR
BG01 0.5'-1.5'	10/23/2009	0.5-1.5	4.13	290	0.92	0.583	11.078	0.022	12.7	4.49	0.0213	14.2	<2.43	<2.43	51.8	1.49	9.7	0.240
UN01A 28'-30'	10/23/2009	28-30	8.99	500	0.52	0.701	14.276	0.024	17.3	3.77	0.0258	19.3	<2.46	<2.46	68.5	3.05	6.72	0.254
COGCC Table 910-1 Level			0.39	15,000	2	70	120,000	23	3,100	400	23	1,600	390	390	23,000	<4	6-9	<12

< - less than stated laboratory reporting limit

mg/kg - milligrams per kilogram

mg/L - milligrams per liter

bgs - below ground surface

COGCC -Colorado Oil and Gas Conservation Commission

Analytical results noted in bold exceed the COGCC Table 910-1 Concentration Levels

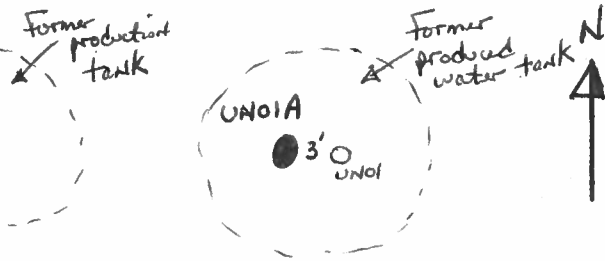
mmhos/cm - millimhos per centimeter



ATTACHMENT 1
SOIL BORING LOG



Well Location Sketch:



Compliance · Engineering · Remediation

LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UNO1A	Project: Unocal 5
Date: 10/23/09	Project Number: PDCW0918
Logged By: Mike Unger	Drilled By: Dakota Drilling
Drilling Method: H.S. Augus	Sampling Method: split spoon/California barrel
Seal: Bentonite 0-50'	Grout:
Casing Type:	Diameter: Length: Hole Diameter: 8" Depth to Liquid:
Screen Type: Slot: Diameter: Length: Total Depth: 50.5' Depth to Water: dry	

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
					2					
					4					
					6					
					8					
					10					
					12					
					14					
					16					
					18					
					20					
					22					
					24					
					26					
					28					
					30					
					32					
					34					
					36					
					38					
					40					

NOTES:

50 201031

Page 1 of 2

Well Location Sketch:



Compliance · Engineering · Remediation

LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number:

UN01 A

Project:

Unocal 5

Date:

10/23/09

Project Number:

PDCW 0918

Logged By:

Mike Unger

Drilled By:

Dakota Drilling

Drilling Method:

H.S. Augers

Sampling Method:

split spoon/California barrel

Seal:

barite chips 0-50'

Grout:

Elevation:

Detector:

mini-hae 2000

Gravel Pack:

Casing Type:

Diameter:

Length:

Hole Diameter:

8"

Depth to Liquid:

Screen Type:

Slot:

Diameter:

Length:

Total Depth:

50.5'

Depth to Water:

dry

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
14/14 13/17 16/16 16/16	491	NO	40-42	40	1153	42	100	SC	Sand, v.f.g. - v.c.g., gravel size shale fragments, clayey to v. clayey, gray to yellow brown, moist	
17/19 21/17 16/16 16/16	214	NO	44-46	44	1225	46	100	GC	Gravel size shale fragments, some sandstone fragments, sandy, clayey, moist, drills harder, some cobble size rock fragments	
34/50 bounding 16/16	89	NO	49-50.5	50	1340	50	55		TD = 50.5' bgs	
54/ bounding 16/16				52	1355	52	55			
				54						
				56						
				58						
				60						
				62						
				64						
				66						
				68						
				70						
				72						
				74						
				76						
				78						
				80						

NOTES:

Page 2 of 2

ATTACHMENT 2
LABORATORY ANALYTICAL REPORTS





4640 Pecos Street | Unit C | Denver, Colorado 80211
303.433.1322 Phone 303.265.9645 Fax

November 06, 2009

LT Environmental, Inc.
4600 West 60th Avenue
Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

Attached are the analytical results for PDCW – Unocal # 5 received by Origins Laboratory, Inc. 10/26/2009 10:10:00AM. Please let us know if you have any questions, or if we can help with anything at all.

A handwritten signature in black ink, appearing to read "Noelle E Doyle".

Noelle E Doyle
Laboratory Manager

The analytical results in the following report were analyzed under the guidelines of EPA Methods specified in SW-846. The analytical results apply specifically to the samples and analyses specified per the attached Chain of Custody. This laboratory report is intended solely for the above addressee and it is only to be used and or reproduced in its entirety.

4640 Pecos Street | Unit C
Denver, Colorado 80211
303.433.1322 | Laboratory
303.265.9645 | Fax



LT Environmental, Inc.
4600 West 60th Avenue
Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

CROSS REFERENCE REPORT

Sample ID	Laboratory ID	Matrix	Sampled	Date Received
BG01 0.5'-1.5'	X910098-01	Soil	10/23/2009 9:00:00AM	10/26/2009 10:10
UN01A 24'-26'	X910098-02	Soil	10/23/2009 10:00:00AM	10/26/2009 10:10
UN01A 28'-30'	X910098-03	Soil	10/23/2009 10:30:00AM	10/26/2009 10:10
UN01A 34'-36'	X910098-04	Soil	10/23/2009 11:15:00AM	10/26/2009 10:10
UN01A 40'-42'	X910098-05	Soil	10/23/2009 11:55:00AM	10/26/2009 10:10
UN01A 44'-46'	X910098-06	Soil	10/23/2009 12:25:00PM	10/26/2009 10:10
UN01A 49'-50.5'	X910098-07	Soil	10/23/2009 1:40:00PM	10/26/2009 10:10

Origins Laboratory, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Noelle E Doyle, Laboratory Manager

Asher Weinberg

Project Number: PDCW0918

Project: PDCW – Unocal # 5

page 1 of 1



Sample ID - Description	Date Sampled	Time Sampled	Number of Containers				Preservative		Matrix	Analysis		metals list:
			Unpreserved	HCl	HNO ₃	Other - ic	Groundwater	Soil		Air - Summa Canister #	Other -	
BG01 0.5'-1.5'	10-23-09	0900	X		X							arsenic chromium III copper nickel selenium zinc barium (LONG trace table airway) boron (not water soluble) *
UN01A 24'-26'	10-23-09	1000	X		X							Sample instructions Hold in 16oz poly 1460
UN01A 28'-30'	10-23-09	1030	X		X							2460
UN01A 34'-36'	10-23-09	1115	X		X							3
UN01A 40'-42'	10-23-09	1155	X		X							5460
UN01A 44'-46'	10-23-09	1225	X		X							6460
UN01A 49'-50.5'	10-23-09	1340	X		X							7460

Relinquished by: Mike Unger

Relinquished by: Mike Unger

Received by: [Signature]

Received by: [Signature]

Date: 10/26/09

Date: 10/26/09

Time: 6:16

Time: 6:16

Turn Around Time: 24-hr
48-hr
72-hr

Same Day
48-hr
Standard

Temperature Upon Receipt: 10

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
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boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
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nickel
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boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

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metals (see list)

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boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
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copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

arsenic
chromium III
copper
nickel
selenium
zinc
barium (LONG trace table airway)
boron (not water soluble) *

Sample instructions
Hold in 16oz poly 1460

2460

3

5460

6460

7460

Champs made per request of Mike Unger 10/26/09

Hold All but BTEX metals

Hold in 16oz poly 1460

metals (see list)

metals (see list)

metals list:

Naucke

Page 3 of 17

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LT Environmental, Inc.
4600 West 60th Avenue
Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

BG01 0.5'-1.5'
X910098-01 (Soil)

Analyte	Result	Reporting					Analyzed	Notes
		Limit	Units	Dilution	Batch	Prepared		

GENAPURE

Conductivity by E120.1

Conductivity	1490	20	US/CM	10	779333	10/28/2009	10/28/2009
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Metals by SW 6010B

Lead	4.49	1.21	MG/KG	1	780452	10/28/2009	11/05/2009
Zinc	51.8	6.06	"	"	"	"	"
Sodium	1230	30.3	"	"	"	"	"
Silver	ND	2.43	"	"	"	"	"
Selenium	ND	2.43	"	"	"	"	"
Potassium	3960	121	"	"	"	"	"
Magnesium	8090	24.3	"	"	"	"	"
Copper	12.7	3.64	"	"	"	"	"
Chromium	11.1	0.606	"	"	"	"	"
Cadmium	0.583	0.606	"	"	"	"	" J
Calcium	31300	24.3	"	"	"	"	"
Nickel	14.2	1.21	"	"	"	"	"

Metals by SW6020

Arsenic	4.13	0.606	MG/KG	1	780398	10/29/2009	11/02/2009
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Metals by SW7196

Chromium, Hexavalent	0.022	0.485	MG/KG	1	780049	11/03/2009	11/03/2009 J
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Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

BG01 0.5'-1.5'
X910098-01 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

GENAPURE

Metals by SW7471A

Mercury	0.0213	0.0105	MG/KG	1	780226	10/28/2009	10/29/2009
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Percent Moisture by D2216

Percent Moisture	17.5	1	%	1	779090	10/27/2009	10/27/2009
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pH by SM4500-H+

pH	9.7		SU	1	779458	10/28/2009	10/28/2009
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Sodium Absorption Ratio by S29B08

Sodium absorption ratio	0.24			1	780491	11/06/2009	11/06/2009
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 24'-26'
X910098-02 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	3.35	0.0500	mg/kg	12.5	9J28002	10/28/2009	10/30/2009
Toluene	161	1.00	"	250	"	"	11/03/2009
Ethylbenzene	7.72	0.0500	"	12.5	"	"	10/30/2009
o-Xylene	20.4	0.0500	"	"	"	"	"
m,p-Xylene	311	2.00	"	250	"	"	11/03/2009

Surrogate: 1,2-Dichloroethane-d4	115 %	77.6-134			"	"	10/30/2009
Surrogate: Toluene-d8	81.6 %	81.4-121			"	"	"
Surrogate: 4-Bromofluorobenzene	103 %	74.7-123			"	"	"

TPH-Carbon Chain by EPA Method 8015M

Gasoline (C6-C10)	5828.1	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10-C28)	2547.8	50.0	"	"	"	"	"
Residual Range Organics (C28-C36)	ND	200.0	"	"	"	"	"
TPH – Carbon Chain Total	8375.9	50.0	"	"	"	"	"

Surrogate: o-Terphenyl	87.3 %	65-140			"	"	"
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Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 28'-30'
X910098-03 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	0.883	0.100	mg/kg	25	9J28002	10/28/2009	10/30/2009
Toluene	15.3	0.100	"	"	"	"	"
Ethylbenzene	2.42	0.100	"	"	"	"	"
o-Xylene	4.90	0.100	"	"	"	"	"
m,p-Xylene	44.1	0.200	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	111 %	77.6-134	"	"	"
Surrogate: Toluene-d8	94.6 %	81.4-121	"	"	"
Surrogate: 4-Bromofluorobenzene	112 %	74.7-123	"	"	"

Conductivity by E120.1

Conductivity	3050	20	US/CM	10	779333	10/28/2009	10/28/2009
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Metals by SW 6010B

Potassium	4490	123	MG/KG	1	780452	10/28/2009	11/05/2009
Silver	ND	2.46	"	"	"	"	"
Selenium	ND	2.46	"	"	"	"	"
Nickel	19.3	1.23	"	"	"	"	"
Magnesium	12700	24.6	"	"	"	"	"
Zinc	68.5	6.14	"	"	"	"	"
Lead	3.77	1.23	"	"	"	"	"
Copper	17.3	3.69	"	"	"	"	"

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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 28'-30'
X910098-03 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

GENAPURE

Metals by SW 6010B

Chromium	14.3	0.614	MG/KG	1	780452	10/28/2009	11/05/2009
Calcium	52600	24.6	"	"	"	"	"
Cadmium	0.701	0.614	"	"	"	"	"
Sodium	2770	30.7	"	"	"	"	"

Metals by SW6020

Arsenic	8.99	0.614	MG/KG	1	780398	10/29/2009	11/02/2009
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Metals by SW7196

Chromium, Hexavalent	0.024	0.491	MG/KG	1	780049	11/03/2009	11/03/2009 J
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Metals by SW7471A

Mercury	0.0258	0.0107	MG/KG	1	780226	10/28/2009	10/29/2009
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Percent Moisture by D2216

Percent Moisture	18.6	1	%	1	779090	10/27/2009	10/27/2009
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pH by SM4500-H+

pH	6.72		SU	1	779458	10/28/2009	10/28/2009
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Project: PDCW – Unocal # 5

UN01A 28'-30'
X910098-03 (Soil)

Analyte	Result	Reporting					Analyzed	Notes
		Limit	Units	Dilution	Batch	Prepared		

GENAPURE

Polyaromatic Hydrocarbons (PAHs) by SW8270C

Anthracene	ND	0.123	MG/KG	1	779690	10/28/2009	10/29/2009	
1-Methylnaphthalene	0.272	0.123	"	"	"	"	"	
2-Methylnaphthalene	1.24	0.246	"	"	"	"	"	
Acenaphthene	0.309	0.123	"	"	"	"	"	
Benzo(b)fluoranthene	ND	0.123	"	"	"	"	"	
Acenaphthylene	ND	0.123	"	"	"	"	"	
Fluorene	0.044	0.123	"	"	"	"	"	J
Benzo(g,h,i)perylene	ND	0.123	"	"	"	"	"	
Benzo(k)fluoranthene	ND	0.123	"	"	"	"	"	
Chrysene	ND	0.123	"	"	"	"	"	
Dibenz(a,h)Anthracene	ND	0.081	"	"	"	"	"	
Fluoranthene	ND	0.123	"	"	"	"	"	
Pyrene	ND	0.123	"	"	"	"	"	
Indeno(1,2,3-c,d)Pyrene	ND	0.123	"	"	"	"	"	
Naphthalene	0.369	0.123	"	"	"	"	"	
Benzo(a)pyrene	ND	0.081	"	"	"	"	"	
Benzo(a)anthracene	ND	0.123	"	"	"	"	"	
Phenanthrene	ND	0.123	"	"	"	"	"	

Surrogate: 2-Fluorobiphenyl	93 %	59-123	"	"	"
Surrogate: Terphenyl-D14	103 %	43-124	"	"	"

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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN0IA 28'-30'
X910098-03 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

GENAPURE

Polyaromatic Hydrocarbons (PAHs) by SW8270C

<i>Surrogate: Nitrobenzene-d5</i>	101 %	46-137			779690	10/28/2009	10/29/2009
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Sodium Absorption Ratio by S29B08

Sodium absorption ratio	0.254			1	780491	11/06/2009	11/06/2009
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TPH-Carbon Chain by EPA Method 8015M

Gasoline (C6-C10)	816.2	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10-C28)	900.8	50.0	"	"	"	"	"
Residual Range Organics (C28-C36)	ND	200.0	"	"	"	"	"
TPH – Carbon Chain Total	1717.1	50.0	"	"	"	"	"

<i>Surrogate: o-Terphenyl</i>	80.6 %	65-140			"	"	"
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 34'-36'
X910098-04 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	0.167	0.00400	mg/kg	1	9J28002	10/28/2009	10/29/2009
Toluene	0.852	0.00400	"	"	"	"	"
Ethylbenzene	ND	0.00400	"	"	"	"	"
o-Xylene	0.203	0.00400	"	"	"	"	"
m,p-Xylene	1.61	0.00800	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	121 %	77.6-134			"	"	"
Surrogate: Toluene-d8	92.4 %	81.4-121			"	"	"
Surrogate: 4-Bromofluorobenzene	92.4 %	74.7-123			"	"	"

TPH-Carbon Chain by EPA Method 8015M

Gasoline (C6-C10)	173.5	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10-C28)	344.4	50.0	"	"	"	"	"
Residual Range Organics (C28-C36)	ND	200.0	"	"	"	"	"
TPH – Carbon Chain Total	517.9	50.0	"	"	"	"	"

Surrogate: o-Terphenyl	83.3 %	65-140			"	"	"
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 40'-42'
X910098-05 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	0.400	0.0200	mg/kg	5	9J28002	10/28/2009	10/30/2009
Toluene	3.42	0.0200	"	"	"	"	"
Ethylbenzene	0.0836	0.00400	"	1	"	"	10/29/2009
o-Xylene	0.153	0.00400	"	"	"	"	"
m,p-Xylene	4.13	0.0400	"	5	"	"	10/30/2009

Surrogate: 1,2-Dichloroethane-d4	113 %	77.6-134	"	"	"	"
Surrogate: Toluene-d8	95.4 %	81.4-121	"	"	"	"
Surrogate: 4-Bromofluorobenzene	96.6 %	74.7-123	"	"	"	"

TPH-Carbon Chain by EPA Method 8015M

Gasoline (C6-C10)	331.5	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10-C28)	592.7	50.0	"	"	"	"	"
Residual Range Organics (C28-C36)	ND	200.0	"	"	"	"	"
TPH – Carbon Chain Total	924.2	50.0	"	"	"	"	"

Surrogate: o-Terphenyl	86.4 %	65-140	"	"	"	"
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 44'-46'
X910098-06 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	0.0414	0.00400	mg/kg	1	9J28002	10/28/2009	10/30/2009
Toluene	0.0266	0.00400	"	"	"	"	"
Ethylbenzene	ND	0.00400	"	"	"	"	"
o-Xylene	ND	0.00400	"	"	"	"	"
m,p-Xylene	0.0238	0.00800	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	111 %	77.6-134			"	"	"
Surrogate: Toluene-d8	95.2 %	81.4-121			"	"	"
Surrogate: 4-Bromofluorobenzene	98.4 %	74.7-123			"	"	"

TPH-Carbon Chain by EPA Method 8015M

Gasoline (C6-C10)	ND	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10-C28)	143.0	50.0	"	"	"	"	"
Residual Range Organics (C28-C36)	ND	200.0	"	"	"	"	"
TPH – Carbon Chain Total	143.0	50.0	"	"	"	"	"

Surrogate: o-Terphenyl	73.1 %	65-140			"	"	"
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

UN01A 49'–50.5'
X910098–07 (Soil)

Analyte	Result	Reporting		Units	Dilution	Batch	Prepared	Analyzed	Notes
		Limit							

Origins Laboratory, Inc.

BTEX by EPA 8260B

Benzene	0.0617	0.00400	mg/kg	1	9J28002	10/28/2009	11/02/2009
Toluene	0.321	0.00400	"	"	"	"	"
Ethylbenzene	0.0201	0.00400	"	"	"	"	"
o-Xylene	0.0406	0.00400	"	"	"	"	"
m,p-Xylene	0.202	0.00800	"	"	"	"	"

Surrogate: 1,2-Dichloroethane-d4	104 %	77.6–134			"	"	"
Surrogate: Toluene-d8	98.8 %	81.4–121			"	"	"
Surrogate: 4-Bromofluorobenzene	92.8 %	74.7–123			"	"	"

TPH–Carbon Chain by EPA Method 8015M

Gasoline (C6–C10)	ND	50.0	mg/kg	1	9J28003	10/28/2009	10/30/2009
Diesel (C10–C28)	345.8	50.0	"	"	"	"	"
Residual Range Organics (C28–C36)	243.2	200.0	"	"	"	"	"
TPH – Carbon Chain Total	589.0	50.0	"	"	"	"	"

Surrogate: o-Terphenyl	80.0 %	65–140			"	"	"
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Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

Extractable Petroleum Hydrocarbons by 8015M – Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 9J28003 – Default Prep GC-Semi										
Blank (9J28003-BLK1)					Prepared: 10/28/2009 Analyzed: 10/30/2009					
Gasoline (C6-C10)	ND	50.0	mg/kg							
Diesel (C10-C28)	ND	50.0	"							
Residual Range Organics (C28-C36)	ND	200.0	"							
TPH – Carbon Chain Total	ND	50.0	"							
Surrogate: o-Terphenyl	36.3		g	50.0		72.6	65-140			
LCS (9J28003-BS1)					Prepared: 10/28/2009 Analyzed: 10/30/2009					
Gasoline (C6-C10)	ND	50.0	mg/kg				65-140			
Diesel (C10-C28)	367.9	50.0	"	500		73.6	60-140			
Surrogate: o-Terphenyl	41.9		g	50.0		83.7	65-140			
Matrix Spike (9J28003-MS1)					Source: X910095-01		Prepared: 10/28/2009 Analyzed: 10/30/2009			
Gasoline (C6-C10)	ND	50.0	mg/kg		ND		65-130			
Diesel (C10-C28)	416.7	50.0	"	500	92.3	64.9	60-140			
Surrogate: o-Terphenyl	41.5		g	50.0		83.0	65-140			
Matrix Spike Dup (9J28003-MSD1)					Source: X910095-01		Prepared: 10/28/2009 Analyzed: 10/30/2009			
Gasoline (C6-C10)	ND	50.0	mg/kg		ND		65-130		20	
Diesel (C10-C28)	403.5	50.0	"	500	92.3	62.2	60-140	3.21	25	
Surrogate: o-Terphenyl	40.8		g	50.0		81.6	65-140			

Origins Laboratory, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Noelle E Doyle, Laboratory Manager

4640 Pecos Street | Unit C
 Denver, Colorado 80211
 303.433.1322 | Laboratory
 303.265.9645 | Fax



LT Environmental, Inc.
 4600 West 60th Avenue
 Arvada CO 80003

Asher Weinberg
 Project Number: PDCW0918
 Project: PDCW – Unocal # 5

Volatile Organic Compounds by EPA Method 8260B – Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 9J28002 – EPA 5030B

Blank (9J28002–BLK1)

Prepared: 10/28/2009 Analyzed: 10/29/2009

Benzene	ND	0.004	mg/kg
Toluene	ND	0.004	"
Ethylbenzene	ND	0.004	"
o-Xylene	ND	0.004	"
m,p-Xylene	ND	0.008	"

Surrogate: 1,2-Dichloroethane-d4	62.0	ug/L	62.5	99.1	77.6–134
Surrogate: Toluene-d8	63.2	"	62.5	101	81.4–121
Surrogate: 4-Bromofluorobenzene	65.6	"	62.5	105	74.7–123

LCS (9J28002–BS1)

Prepared: 10/28/2009 Analyzed: 10/29/2009

Benzene	0.17	0.004	mg/kg	0.200	85.1	77.2–128
Toluene	0.16	0.004	"	0.200	82.0	76.3–130
Surrogate: 1,2-Dichloroethane-d4	60.9		ug/L	62.5	97.4	77.6–134
Surrogate: Toluene-d8	63.4		"	62.5	101	81.4–121
Surrogate: 4-Bromofluorobenzene	65.0		"	62.5	104	74.7–123

Matrix Spike (9J28002–MS1)

Source: X910098–04

Prepared: 10/28/2009 Analyzed: 10/29/2009

Benzene	0.34	0.004	mg/kg	0.200	0.17	85.0	77.6–132
Toluene	1.00	0.004	"	0.200	0.85	75.6	74–136
Surrogate: 1,2-Dichloroethane-d4	57.7		ug/L	62.5		92.3	77.6–134
Surrogate: Toluene-d8	63.4		"	62.5		102	81.4–121
Surrogate: 4-Bromofluorobenzene	72.3		"	62.5		116	74.7–123

Matrix Spike Dup (9J28002–MSD1)

Source: X910098–04

Prepared: 10/28/2009 Analyzed: 10/29/2009

Benzene	0.40	0.004	mg/kg	0.200	0.17	119	77.6–132	18.3	13.1	QM-07
Toluene	1.27	0.004	"	0.200	0.85	207	74–136	23.1	20.9	QM-07
Surrogate: 1,2-Dichloroethane-d4	62.6		ug/L	62.5		100	77.6–134			
Surrogate: Toluene-d8	62.7		"	62.5		100	81.4–121			
Surrogate: 4-Bromofluorobenzene	56.2		"	62.5		89.9	74.7–123			

Origins Laboratory, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Noelle E Doyle, Laboratory Manager

4640 Pecos Street | Unit C
Denver, Colorado 80211
303.433.1322 | Laboratory
303.265.9645 | Fax



LT Environmental, Inc.
4600 West 60th Avenue
Arvada CO 80003

Asher Weinberg
Project Number: PDCW0918
Project: PDCW – Unocal # 5

Notes and Definitions

QM-07 The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on acceptable LCS recovery.

J Sample result was found between MDL and RL

ND Analyte NOT DETECTED at or above the reporting limit

RPD Relative Percent Difference

Origins Laboratory, Inc.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Noelle E Doyle, Laboratory Manager

**Hazen Research, Inc.**

4601 Indiana Street
Golden, CO 80403 USA
Tel: (303) 279-4501
Fax: (303) 278-1528

DATE October 29, 2009
HRI PROJECT 002-AZV
HRI SERIES NO J391/09
DATE REC'D. 10/27/2009
CUST. P.O.# None Rec'd

Origins Laboratory, Inc.
Noelle E. Doyle
4640 N Pecos St, Unit C
Denver, CO 80211

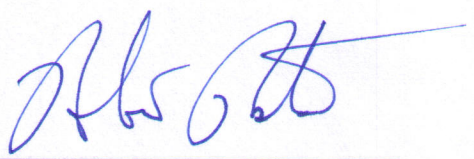
REPORT OF ANALYSIS

SAMPLE NO. J391/09-1

SAMPLE IDENTIFICATION: BG01 0.5'-1.5' - Project Number PDCW 0918 - UNOCAL S
Sampled on 10/23/2009 @ 0900 by Mike Unger

PARAMETER	RESULT	DETECTION LIMIT	METHOD	ANALYSIS DATE	ANALYST
Barium, mg/kg	290	10	LDNR	10/28/2009	RG

Results reported herein relate only to discrete samples submitted by the client. Hazen Research, Inc. does not warrant that the results are representative of anything other than the samples that were received in the laboratory.

By: 
Robert Rostad
Laboratory Manager

CODES: (T) = Total (D) = Dissolved (S) = Suspended (R) = Total Recoverable
(PD) = Potentially Dissolved < = Less Than

**Hazen Research, Inc.**

4601 Indiana Street
Golden, CO 80403 USA
Tel: (303) 279-4501
Fax: (303) 278-1528

DATE October 29, 2009
HRI PROJECT 002-AZV
HRI SERIES NO J391/09
DATE REC'D. 10/27/2009
CUST. P.O.# None Rec'd

Origins Laboratory, Inc.
Noelle E. Doyle
4640 N Pecos St, Unit C
Denver, CO 80211

REPORT OF ANALYSIS

SAMPLE NO. J391/09-2

SAMPLE IDENTIFICATION: UN01A 28'-30' - Project Number PDCW 0918 - UNOCAL S
Sampled on 10/23/2009 @ 1030 by Mike Unger

PARAMETER	RESULT	DETECTION LIMIT	METHOD	ANALYSIS DATE	ANALYST
Barium, mg/kg	500	10	LDNR	10/28/2009	RG

Results reported herein relate only to discrete samples submitted by the client. Hazen Research, Inc. does not warrant that the results are representative of anything other than the samples that were received in the laboratory.

CODES: (T) = Total (D) = Dissolved (S) = Suspended (R) = Total Recoverable
(PD) = Potentially Dissolved < = Less Than

By: 

Robert Rostad
Laboratory Manager

001

WORK ORDER Summary**Evergreen Analytical, Inc.****09-8551****Rpt To:** Noelle Doyle**Email To:** ndoyle@oelabinc.com

Origins Laboratory

4640 N Pecos St. Unit C

Denver, CO 80211

(303) 478-9085

10/27/2009 12:48:18 PM

Client Project ID: UNOCAL S**QC Level:** Level I**Comments**

Sample ID	Client Sample ID	Matrix	Collection Date	Date Received	Test Code	Test Name	Hold	MS	Date Due	Hold Time
09-8551-01A	BG01 0.5'-1.5'	Soil	10/23/09 0900	10/27/09	200.7_SBORON	Hot-Water-Soluble Boron, Leachate Basis	<input type="checkbox"/>	<input type="checkbox"/>	11/03/09	4/21/10
09-8551-02A	UN01A 28'-30'	Soil	10/23/09 1030	10/27/09	200.7_SBORON	Hot-Water-Soluble Boron, Leachate Basis	<input type="checkbox"/>	<input type="checkbox"/>	11/03/09	4/21/10

Definitions: * - Test Code has a Select List

Client: ORIGINS LABProject Manager: JOHN PETERSON

Address: _____

Project Name: UNOCAL 5Project Number: PDCW 0918

Telephone Number: _____

Samples Collected By: MIKE UNGEREmail Address: DDOYLE@GEABUILD.COM

Sample ID Description	Date Sampled	Time Sampled	# of Containers	Preservative				Matrix				Analysis				Sample Instructions			
				Unpreserved	HCl	HNO ₃	Other	Groundwater	Soil	Air Summa Canister #	Other	GROUNDWATER	SOIL	BOSON					
BG0105-1.5'	10-23-09	09:00	1	X					X				X					01	1
UNOCAL 28'-30'	10-23-09	10:30	1	X					X				X					02	2
																			3
																			4
																			5
																			6
																			7
																			8
																			9
																			10
Relinquished By: <u>Ross</u>	Date: <u>10/27/09</u>	Time: <u>12:02</u>	Received By: <u>art</u>				Date: <u>10/27/09</u>	Time: <u>12:02</u>	Turnaround Time: Same Day <input type="checkbox"/> 24 Hr <input type="checkbox"/>										
Relinquished By:	Date:	Time:	Received By:				Date:	Time:	48 Hr <input type="checkbox"/> 72 Hr <input type="checkbox"/>										
									Standard <input checked="" type="checkbox"/>										

Evergreen Analytical, Inc.

Date: 03-Nov-09

Lab Order: 09-8551

Client Project ID UNOCAL S

CASE NARRATIVE

SAMPLE RECEIVING

Sample(s) were hand delivered to the laboratory by the client.

Custody seals were not present.

The temperature of the sample(s) upon arrival was 5.8°C.

Sample(s) were received in good condition, in the proper container, and within holding times. NJO

QUALITY ASSURANCE (QA)

Analyses performed on samples in this work order by EAL meet the requirements of the EAL Quality Assurance Program unless otherwise explained. Analyses of RCRA samples meet the requirements of NELAC and Utah Rule R444-14 unless otherwise explained. TP

CLIENT SERVICES

There are no anomalies to report. EH

METALS ANALYSIS

The matrix spike and matrix spike duplicate (MS/MSD; on the client's sample) recoveries for Boron are above the QC limits. The laboratory control spike (LCS) recovery for Boron is within the QC limit, proving the analysis is in control. There are no other anomalies to report. MB/TP

Evergreen Analytical, Inc.

4036 Youngfield Street, Wheat Ridge, Colorado 80033-3862
(303) 425-6021

Client Project ID UNOCAL S
Date Received: 10/27/09

Lab Order: 09-8551
Date Prepared: 10/29/09
Units: mg/L

Hot-Water-Soluble Boron, Soil Basis

Boron

Method: GUPTA

Prep Method: SW1311,2/3010A

Lab ID	Client ID	Matrix	Date Collected	Date Analyzed	Results	LQL	DF
09-8551-01A	BG01 0.5'-1.5'	Soil	10/23/09	11/2/09	0.92	0.050	1
09-8551-02A	UN01A 28'-30'	Soil	10/23/09	11/2/09	0.52	0.050	1



Analyst



Approved

Qualifiers: B - Analyte detected in the associated Method Blank, value not subtracted from result
E - Extrapolated value. Value exceeds calibration range
H - Sample analysis exceeded analytical holding time
J - Indicates an estimated value when the compound is detected, but is below the LQL
S - Spike Recovery outside accepted limits
U - Compound analyzed for but not detected
X - See case narrative
* - Value exceeded the Maximum Contamination Level (MCL), TCLP limit, or if compound is undetected, LQL exceeds MCL.

Definitions: DF - Dilution Factor
PF - Prep Factor
LQL - Lower Quantitation Limit

Print Date: 11/3/2009

QUALITY ASSURANCE REPORTS

METHOD BLANKS (MB)

LABORATORY CONTROL SPIKES (LCS)

MATRIX SPIKES (MS/MSD)*

DUPLICATES (DUP)*

- **For Metals or Wet Chemistry analyses: only included if requested.**

Work Order: 09-8551

Client Project ID: UNOCAL S

ANALYTICAL QC SUMMARY REPORT

BatchID: 21347

Sample ID: MB-21347	SampType: MBLK	TestCode: 200.7_SBOR	Run ID: ICP-OPTIMA 5300 DV_091101A	Prep Date: 10/29/2009	Units: mg/L						
	Batch ID: 21347	TestNo: GUPTA	FileID: 110109AM	Analysis Date: 11/2/2009	SeqNo: 931644						
Analyte	Result	LQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual

Boron	ND	0.050									
-------	----	-------	--	--	--	--	--	--	--	--	--

Sample ID: LCS-21347	SampType: LCS	TestCode: 200.7_SBOR	Run ID: ICP-OPTIMA 5300 DV_091101A	Prep Date: 10/29/2009	Units: mg/L						
	Batch ID: 21347	TestNo: GUPTA	FileID: 110109AM	Analysis Date: 11/2/2009	SeqNo: 931645						
Analyte	Result	LQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual

Boron	5.088	0.050	4.988	.0	102	85	115	0	0		
-------	-------	-------	-------	----	-----	----	-----	---	---	--	--

Sample ID: 09-8551-01AMS	SampType: MS	TestCode: 200.7_SBOR	Run ID: ICP-OPTIMA 5300 DV_091101A	Prep Date: 10/29/2009	Units: mg/L						
Client ID: BG01 0.5'-1.5'	Batch ID: 21347	TestNo: GUPTA	FileID: 110109AM	Analysis Date: 11/2/2009	SeqNo: 931649						
Analyte	Result	LQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual

Boron	4.561	0.050	4.984	0.9229	73	75	125	0	0		S
-------	-------	-------	-------	--------	----	----	-----	---	---	--	---

Sample ID: 09-8551-01AMSD	SampType: MSD	TestCode: 200.7_SBOR	Run ID: ICP-OPTIMA 5300 DV_091101A	Prep Date: 10/29/2009	Units: mg/L						
Client ID: BG01 0.5'-1.5'	Batch ID: 21347	TestNo: GUPTA	FileID: 110109AM	Analysis Date: 11/2/2009	SeqNo: 931650						
Analyte	Result	LQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual

Boron	4.638	0.050	4.992	0.9229	74.4	75	125	4.561	1.67	30	S
-------	-------	-------	-------	--------	------	----	-----	-------	------	----	---

Qualifiers:

U - Not detected at or above the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside acceptance limits
E - Extrapolated value, value exceeds calibration range.

R - RPD outside acceptance limits
B - Analyte detected in the associated Method Blank
H - Prep or analytical holding time exceeded
X - See case narrative

November 03, 2009

Noelle Doyle
Origins Laboratory
4640 N Pecos St. Unit C
Denver, CO 80211

Lab Work Order: 09-8551
Client Project ID: UNOCAL S

Dear Noelle Doyle:

Enclosed are the analytical results for the samples shown in the Laboratory Work Order Summary.

THE INVOICE WILL BE MAILED FROM OUR NEW JERSEY OFFICE UNDER SEPARATE COVER.


The enclosed data for testing performed at Accutest Laboratory (formerly Evergreen Analytical) have been reviewed for quality assurance. A case narrative is included to describe any anomalies associated with the samples or data.

Accutest will dispose of all samples 44 days from the sample receipt date. If you want samples returned, please advise us by mail or fax as soon as possible.

A copy of this project report and supporting data will be retained for a period of five years unless we are otherwise advised by you. A document retrieval charge will apply.

Thank you for using the services of Accutest Laboratories. If you have any questions concerning the analytical data, please contact me. Please direct other questions to Client Services.

Sincerely,



Joseph J. Egry IV / Tiffany Pham
Quality Assurance

UNIT WEIGHT, MOISTURE CONTENT, SPECIFIC GRAVITY, & TOTAL POROSITY
ASTM D 2937, D 2216, D 854 (RTH 109-93, RTH 108-93, ISRM)

CLIENT: LT Environmental
LOCATION:--

JOB NO. 2247-49

BORING NO. UN01A
DEPTH 30.0-31.0
SAMPLE NO. --
DATE SAMPLED --
SOIL DESCRIPTION PDCW0918

SPECIFIC GRAVITY DETERMINATIONS

Date Tested 10/30/09 MLM
Pycnometer No. Big 9
Wt. of oven dry soil (g) (Wo) 99.410
Wt. of flask, soil,
and water (g) (Wb) 736.740
Temperature (deg. C) (Tx) 26.0
Wt. of water & flask at Tx 674.501
(from cal. curve) (Wa)

SPECIFIC GRAVITY * 2.67

*Specific Gravity = $W_o/[W_o+(W_a-W_b)]$

DENSITY DETERMINATIONS

Date Tested 10/27/09 PW
Sample Height (in) 3.630
Sample Diameter (in) 1.938
Wt. of Wet Soil (g) 336.92
Sample Volume (cu. ft) 0.00620
WET DENSITY (pcf) 119.9
DRY DENSITY (pcf) 101.1

MOISTURE DETERMINATIONS

Date Tested 10/27/09 PW
Wt. of Wet Soil & Dish (g) 374.95
Wt. of Dry Soil & Dish (g) 318.74
Net Loss of Moisture (g) 56.21
Wt. of Dish (g) 15.81
Wt. of Dry Soil (g) 302.93
MOISTURE CONTENT (%) 18.6

TOTAL POROSITY (%) 39.441

Data entry by: MLM

Data checked by: KR

FileName: LTPPN01A

Date:

Date: 11/6/09

11/05/2009



MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-6913

CLIENT LT Environmental Inc.

JOB NO. 2247-49

BORING NO. UN01A
DEPTH 30.0-31.0
SAMPLE NO. --
SOIL DESCR. PDCW0918
LOCATION --

SAMPLED --
DATE TESTED 11/02/09 PW
WASH SIEVE Yes
DRY SIEVE No

MOISTURE DATA

Wt. Wet Soil & Pan (g) 375.0
Wt. Dry Soil & Pan (g) 318.7
Wt. Lost Moisture (g) 56.2
Wt. of Pan Only (g) 15.8
Wt. of Dry Soil (g) 302.9
Moisture Content % 18.6

DENSITY DETERMINATIONS

Sample Height (IN) 3.630
Sample Diameter (IN) 1.938
Wt of Wet Soil (GMs) 336.9
Sample Volume (CU Ft) 0.00620
WET DENSITY (PCF) 119.9
DRY DENSITY (PCF) 101.1

WASH SIEVE ANALYSIS

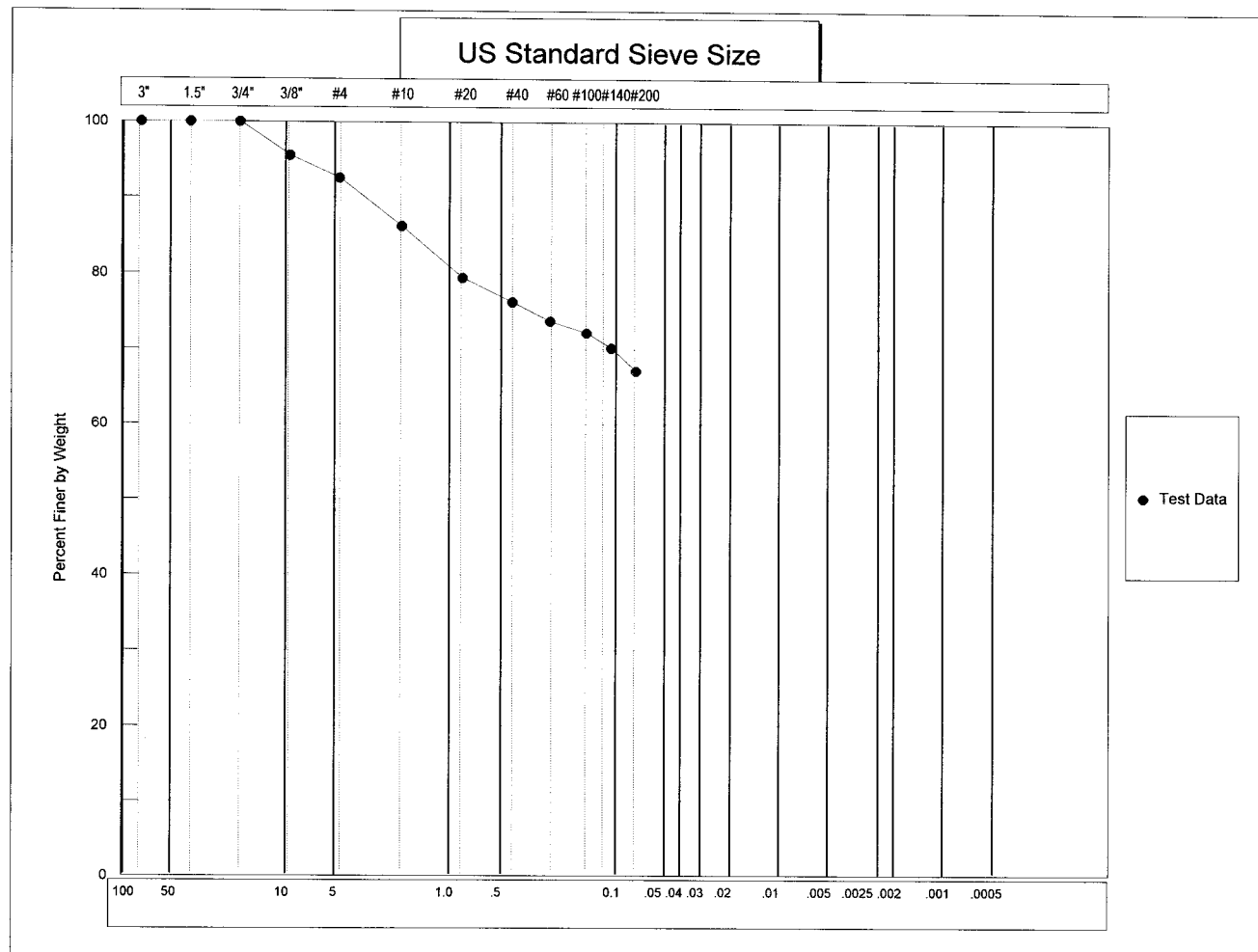
Wt. Wet Soil & Pan 375.0
Before Washing (g) 375.0
Wt. Dry Soil & Pan 318.7
Before Washing (g) 318.7
Weight of Pan (g) 15.8
Wt. of Dry Soil 302.9
Before Washing (g) 302.9
Wt. Dry Soil & Pan 115.6
After Washing (g) 115.6
Wt. of Dry Soil 99.8
After Washing (g) 99.8
-#200 Wash. Out % 67.1

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.27	16.98	13.71	13.71	4.5	95.5
#4	3.03	11.99	8.96	22.67	7.5	92.5
#10	3.14	22.28	19.14	41.81	13.8	86.2
#20	3.26	23.87	20.61	62.42	20.6	79.4
#40	3.01	12.51	9.50	71.92	23.7	76.3
#60	3.19	10.81	7.62	79.54	26.3	73.7
#100	2.97	7.82	4.85	84.39	27.9	72.1
#140	3.07	9.14	6.07	90.46	29.9	70.1
#200	3.17	12.47	9.30	99.76	32.9	67.1

Data entered by: MLM
Data checked by: VR
FileName: LTM0N01A

Date: 11/05/2009
Date: 11/6/09





COBBLES	GRAVEL		SAND			SILT OR CLAY	
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

USCS

WENTWORTH

Client: LT Environmental Inc. Boring No.: UN01A
 Job Number: 2247-49
 Classification: N/A

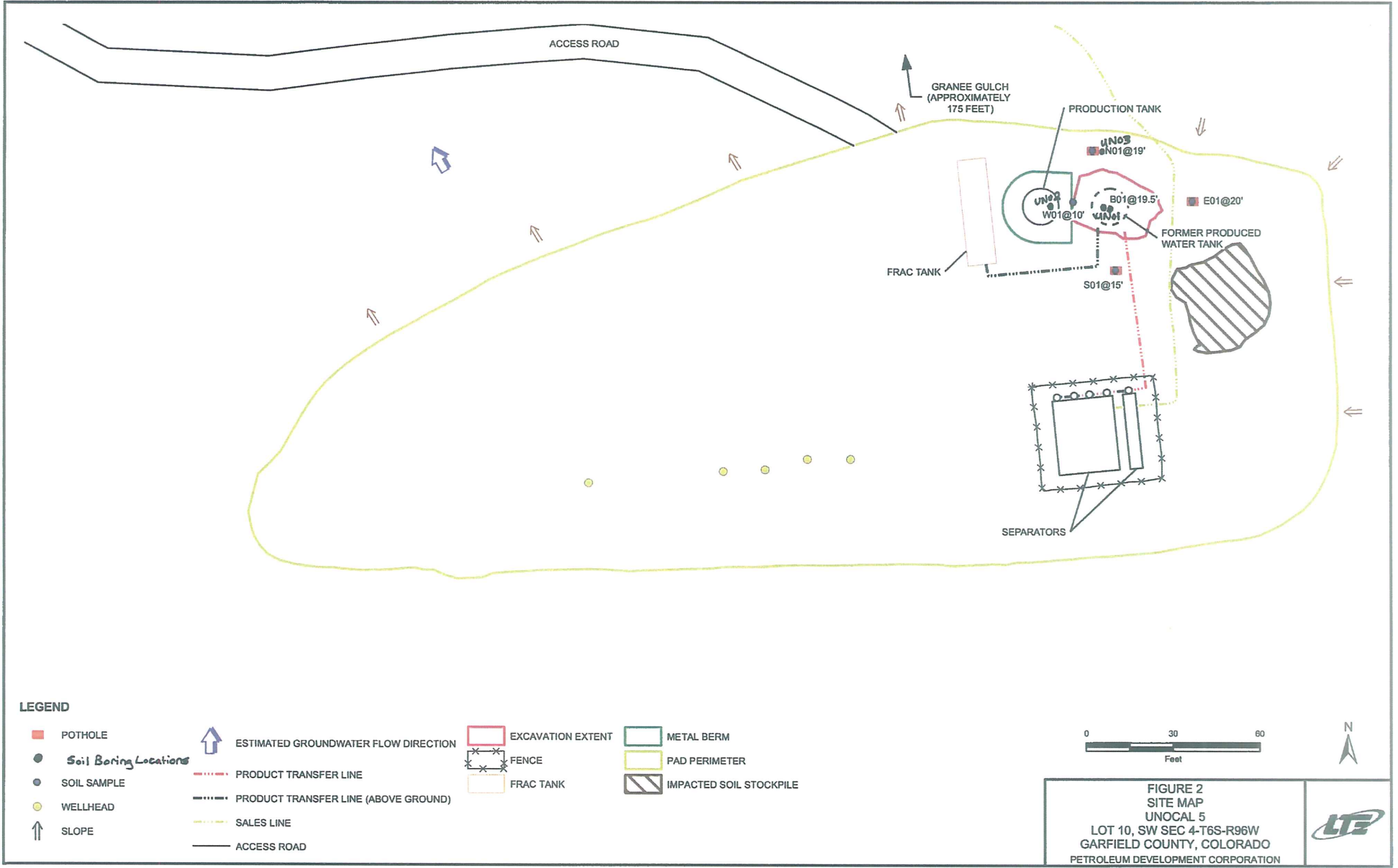
Depth: 30.0-31.0

Sample No.: --

Appendix B

Unocal #5 – Borehole Logs





LEGEND

- POTHOLE
- Soil Boring Locations
- SOIL SAMPLE
- WELLHEAD
- ↑ SLOPE
- ↑ ESTIMATED GROUNDWATER FLOW DIRECTION
- PRODUCT TRANSFER LINE
- PRODUCT TRANSFER LINE (ABOVE GROUND)
- SALES LINE
- ACCESS ROAD
- EXCAVATION EXTENT
- FENCE
- FRAC TANK
- METAL BERM
- PAD PERIMETER
- IMPACTED SOIL STOCKPILE

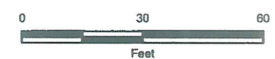
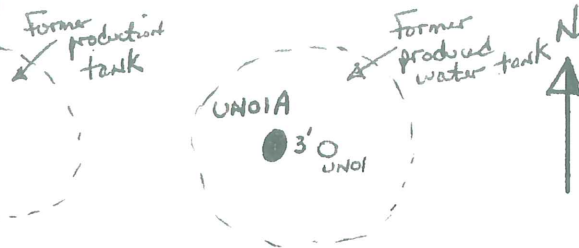


FIGURE 2
SITE MAP
UNOCAL 5
LOT 10, SW SEC 4-T6S-R96W
GARFIELD COUNTY, COLORADO
PETROLEUM DEVELOPMENT CORPORATION



Well Location Sketch:



Compliance · Engineering · Remediation
 LT Environmental, Inc.
 4600 W. 60th Avenue
 Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UNO1A	Project: Unocal 5
Date: 10/23/09	Project Number: PSCW0918
Logged By: Mike Inger	Drilled By: Dakota Drilling
Drilling Method: H.S. Auger	Sampling Method: split spoon/California barrel
Seal: bentonite 0-50'	Grout:

Elevation:	Detector: mini-Rae 2000	Diameter:	Length:	Hole Diameter: 8"	Depth to Liquid:
Gravel Pack:					
Casing Type:					
Screen Type:	Slot:	Diameter:	Length:	Total Depth: 50.5'	Depth to Water: dry

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
					2					
					4					
					6					
					8					
					10					
					12					
					14					
					16					
					18					
					20					
					22					
					24					
					26					
					28					
					30					
					32					
					34					
					36					
					38					
					40					

NOTES:

50 204031

Page 1 of 2

Well Location Sketch:



Compliance • Engineering • Remediation
 LT Environmental, Inc.
 4600 W. 60th Avenue
 Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

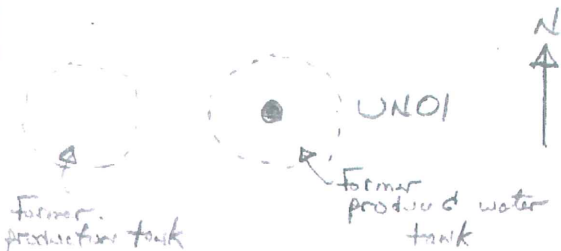
Boring/Well Number: UNOI A	Project: Unocal 5
Date: 10/23/09	Project Number: PDCW 0918
Logged By: Mike Unger	Drilled By: Dakota Drilling
Drilling Method: H.S. Augers	Sampling Method: split spoon / California barrel
Seal: Bentonite chips 0-50'	Grout:
Elevation:	Detector: mini-hac 2000
Gravel Pack:	
Casing Type:	Diameter: Length: Hole Diameter: 8" Depth to Liquid:
Screen Type:	Slot: Diameter: Length: Total Depth: 50.5' Depth to Water: dry

(see page 1)

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					40					
14/14 13/13 6/6 6/6		491	NO	10-42 1155	42	100		SC	Sand, v.f.g. - v.c.g.; gravel size shale fragments, clayey to v. clayey, gray to yellow brown, moist	
17/19 21/17 10/10 10/10		214	NO	1225 44-46	44	100				
					46					
					48					
34/50 bearing 10/5		89	NO	1340 49-50.5	50	50		GC	Gravel size shale fragments, some sandstone fragments, sandy, clayey, moist, drills harder, some cobble size rock fragments	
54/60 bearing 10/6					52	55				
					54					
					56					
					58					
					60					
					62					
					64					
					66					
					68					
					70					
					72					
					74					
					76					
					78					
					80					

TD = 50.5' bgs

Well Location Sketch:



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LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UNOI	Project: Unocal 5
Date: 9-1-09	Project Number: BCW0918
Logged By: MC	Drilled By: Dakota Drilling
Drilling Method: H.S. Augers	Sampling Method: split screen
Seal: bentonite 0-27'	Grout:
Casing Type:	Diameter: Length: Hole Diameter: 8" Depth to Liquid:
Screen Type: Slot: Diameter: Length: Total Depth: 57' Depth to Water: dry	

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
	dry	0.2			2			GW	Gravel size rocks, sand, shale,	
					4			Fill	sandstone, brown to gray,	
					6				dry, Fill from surface to	
					8				20' bgs	
					10					
	med. moist	82	NO		12					
					14			GW	Gravel size rocks, shale, sandstone,	
					16			Fill	sand, brown, med. moist,	
					18				slight hydrocarbon odor	
					20					
15.15.17.20					22			GC	Gravel size sandstone + shale	
6.6.6.6	med. moist	2473	very minor		24				Fragments, clayey, brown to gray	
					26				med. moist, colluvium, hydrocarbon odor	
50%	med. moist	2677	very minor		28			CL	Clay, sandy, moist to v. moist,	
	moist				30				y. brown to gray, drills	
11.14.22.28					32				easy, hydrocarbon odor	
6.6.6.6		2116	NO		34					
					36			CL	Clay, sandy, v. moist, y. brown to	
13.9.7.4					38				gray, hydrocarbon odor	
6.6.6.6		2867	NO		40					

NOTES:

Well Location Sketch:



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BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number:

UN01

Project:

Unocal 5

Date:

9-1-09

Project Number:

PDCW0918

Logged By:

mu

Drilled By:

Dakota Drilling

Elevation:

Detector:

mini-hoe 2500

Drilling Method:

H.S. Augers

Sampling Method:

split spoon

Gravel Pack:

Seal:

bentonite 0-27'

Grout:

Casing Type:

Diameter:

Length:

Hole Diameter:

8"

Depth to Liquid:

Screen Type:

Slot:

Diameter:

Length:

Total Depth:

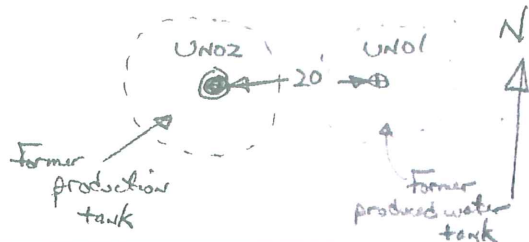
57'

Depth to Water:

dry

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					40				V. clayey	
7190/666	moist	357	NO		42	1320	X	SC	Sand, v.f.g. - v.c.g., some gravel, shale + sandstone fragments, v. moist, slight hydrocarbon odor, brown to gray	2
	v. moist				44					4
23 20 26 24		187	NO		46	175	X			6
					48					8
25 19 25 25		83	NO		50	1430	X	SC	Sand, v.f.g. - v.c.g., v. clayey, gravel size fragments of shale, moist to v. moist, brown to gray	10
24 14 14	if v. moist				52		X			12
					54					14
7785/666		8	NO	55-57	56	1410	X	CL	Clay, sandy, gravel size shale fragments, y. brown to gray, moist to v. moist	16
				1410	58				TD = 57' BGS	18
					60					20
					62					22
					64					24
					66					26
					68					28
					70					30
					72					32
					74					34
					76					36
					78					38
					80					40

Well Location Sketch:



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BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UN02	Project: Unocal 5
Date: 9-2-09/9-3-09	Project Number: PDCW0918
Logged By: M. Unger	Drilled By: Dakota Drilling
Drilling Method: H.S. Augers	Sampling Method: salt spoon
Seal: bentonite 0-30' bgs	Grout:
Casing Type:	Diameter: 8"
Screen Type:	Length: 57'
Slot:	Total Depth: 57'
Diameter:	Depth to Liquid: dry
Length:	Depth to Water: dry

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
					2			GW	Gravel, sandy, brown to gray, dry to med. moist, very slight hydrocarbon odor / fill	
					4					
15/14/16 6/6/6		67	NO		6	1545	X	GW	Gravel, sandy, some cobble size sandstone and shale. Fragments, brown to gray, med. moist, drills hard, colluvium	
					8					
					10	1555	X			
13/15/23/12 6/6/6/6		18	NO		12		X			
					14					
17/33/59 6/6/6		20.5	NO		16	1615	X	GW	Gravel, sandy, some cobble size shale + sandstone fragments, brown to gray, med. moist to moist, colluvium	
					18					
59/25 6/6/6		13	NO		20	1630	X			
					22					
					24					
15/19/24/15 6/6/6/6		7	NO		26	1650	X			
					28					
14/13/15/12 6/6/6/6		8	NO	30-32' 1715	30	1715	X	CL	Clay, sandy, y. brown, moist, some gravel size shale fragments, colluvium	
					32		X			
					34					
grab		7	NO		36		X	CL	Clay, sandy, some gravel size fragments of shale and sandstone, brown to gray, moist	
					38					
					40					

NOTES:

Well Location Sketch:



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LT Environmental, Inc.

4600 W. 60th Avenue

Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number:

UN02

Project:

Unocal 5

Date:

9-2-09/9-3-09

Project Number:

PDCW0918

Logged By:

MC

Drilled By:

Dakota Drilling

Elevation:

Detector:

mini-Rae 2000

Drilling Method:

H.S. Augers

Sampling Method:

split spoon

Gravel Pack:

Seal:

bentonite 0-30' bgs

Grout:

Casing Type:

Diameter:

Length:

Hole Diameter:

8"

Depth to Liquid:

Screen Type:

Slot:

Diameter:

Length:

Total Depth:

57'

Depth to Water:

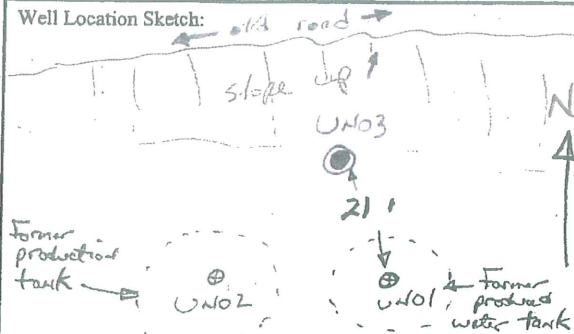
dry

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
grab					40					
	6		NO		42			CL	Clay, sandy, gravel size fragments of shale and sandstone, brown to gray, moist, colluvium	
					44					
grab	7		NO		46					
					48			CL	Clay, v. sandy, more gravel size fragments of shale and sandstone, brown to gray, moist/semi-moist, colluvium	
					50					
grab	6		NO		52					
					54					
					56					
89/4 17/6	2		NO		58					
					60					
					62					
					64					
					66					
					68					
					70					
					72					
					74					
					76					
					78					
					80					

NOTES:

Page 2 of 2

Well Location Sketch:



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BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UN03	Project: Unocal 5
Date: 9-3-09	Project Number: DACW0918
Logged By: M. Unger	Drilled By: Sakota Drilling
Drilling Method: H.S. Augers	Sampling Method: split spoon
Seal: Bentonite 0-25'	Grout:
Casing Type:	Diameter: 8"
Screen Type:	Length: 72'
Slot:	Depth to Liquid: dry
Diameter:	Depth to Water:
Length:	Total Depth:

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
					0					
					2			GW	Gravel, sandy, cobble size	
					4				Fragments of shale and sandstone, dry to med. moist, brown to gray, no odor, fill	
grab	0.9	NO			6					
					8					
					10	0940				
4 3 3 5 16 16 16 16	2	NO			12			GW	Gravel, sandy, cobble size	
					14				Fragments of sandstone and shale, med. moist to moist, brown to gray, no odor, colluvium/fill	
grab	2	NO			16					
					18					
4 4 4 4 16 16 16 16	2.5	NO			20	1000		GW	Gravel, sandy, some cobble size	
					22				Fragments of sandstone and shale, moist, brown to gray, no odor, colluvium	
					24					
	2	NO			26	1015				
					28					
3 9 8 9 16 16 16 16	2	NO		30-32	30	1025		CL	Clay, sandy, gravel size	
				1025	32				Fragments of shale and sandstone, moist, brown to gray, no odor, colluvium	
					34					
	1	NO			36					
					38					
					40					

Well Location Sketch:



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 4600 W. 60th Avenue
 Arvada, Colorado 80003

BORING LOG/MONITORING WELL COMPLETION DIAGRAM

Boring/Well Number: UN03	Project: Unocal 5
Date: 9-3-09	Project Number: UCW0918
Logged By: Mike Unger	Drilled By: Sakota Drilling
Drilling Method: H.S. Augers	Sampling Method: split spoon
Seal: bentonite 0-25'	Grout:
Casing Type:	Diameter: Length: Hole Diameter: 8" Depth to Liquid:
Screen Type: Slot: Diameter: Length: Total Depth: 72' Depth to Water: dry	

Penetration Resistance	Moisture Content	Vapor (ppm)	Staining	Sample #	Depth (ft. bgs.)	Sample Run	Recovery	Soil/Rock Type	Lithology/Remarks	Well Completion Diagram
grab		1	NO		40					
					42			CL	Clay, sandy, some gravel size	
					44				Fragments of shale and sandstone,	
					46				brown to gray, moist to	
grab		2	NO		48				v. moist, no odor, colluvium	
					50					
grab		1	NO		52			CL	Clay, v. sandy, more gravel size	
					54				Fragments of shale and sandstone,	
					56				occasional cobble size rock,	
7/14/1946		1	NO	55-57	58	115			gray to brown, moist to	
6/6/66				115	60				very moist, colluvium, no odor	
grab		1	NO		62					
					64					
grab		1	NO		66			CL	Clay, v. sandy, gravel and	
					68				cobble size rocks (shale	
					70				+ sandstone), brown to	
8/8/1950		2	NO	70-72'	72	1150			gray, moist to v. moist,	
6/6/66				1150	74				some moisture in fractures	
					76				in shale, no odor	
					78					
					80					

NOTES:

Appendix C
NRCS Soils Mapping, 2013



United States
Department of
Agriculture



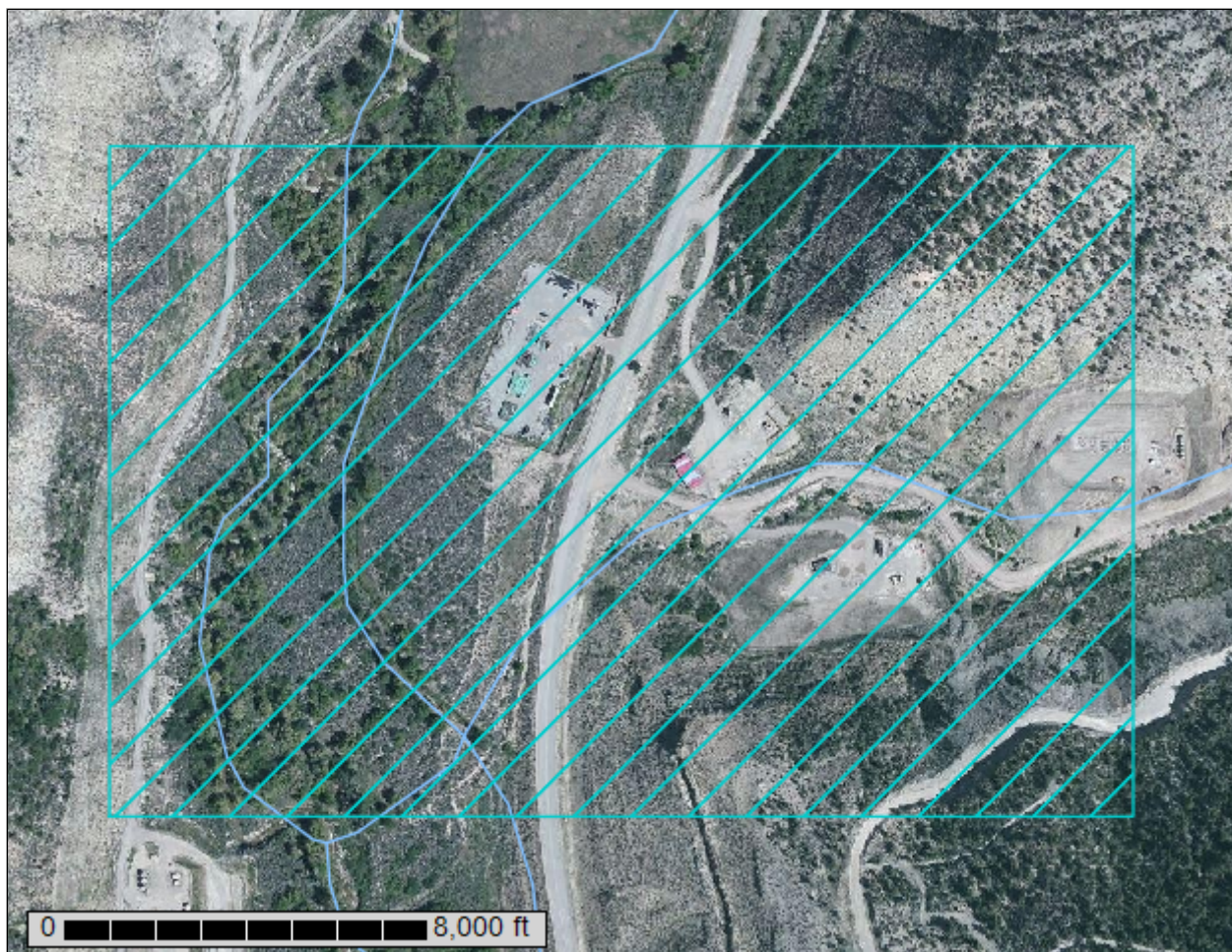
NRCS

Natural
Resources
Conservation
Service

A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for Rifle Area, Colorado, Parts of Garfield and Mesa Counties

Unocal #5 - Soils



September 4, 2013

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://soils.usda.gov/sqi/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<http://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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Contents

Preface	2
How Soil Surveys Are Made	5
Soil Map	7
Soil Map.....	8
Legend.....	9
Map Unit Legend.....	10
Map Unit Descriptions.....	10
Rifle Area, Colorado, Parts of Garfield and Mesa Counties.....	12
36—Irigul channery loam, 9 to 50 percent slopes.....	12
47—Nihill channery loam, 6 to 25 percent slopes.....	12
62—Rock outcrop-Torriorthents complex, very steep.....	13
65—Torrifluvents, nearly level.....	15
References	17

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

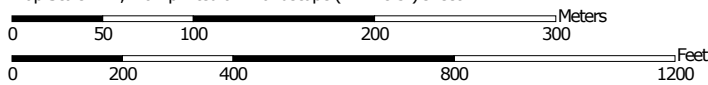
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report Soil Map




Map Scale: 1:4,170 if printed on A landscape (11" x 8.5") sheet.



Custom Soil Resource Report

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features

 Blowout

 Borrow Pit

 Clay Spot


 Closed Depression

 Gravel Pit

 Gravelly Spot


 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry


 Miscellaneous Water


 Perennial Water

 Rock Outcrop


 Saline Spot

 Sandy Spot

 Severely Eroded Spot


 Sinkhole


 Slide or Slip

 Sodic Spot


 Spoil Area

 Stony Spot


 Very Stony Spot

 Wet Spot

 Other


 Special Line Features

Water Features

 Streams and Canals


Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Rifle Area, Colorado, Parts of Garfield and Mesa Counties
Survey Area Data: Version 6, Mar 25, 2008

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 22, 2010—Sep 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Rifle Area, Colorado, Parts of Garfield and Mesa Counties (CO683)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
36	Irigul channery loam, 9 to 50 percent slopes	0.9	1.0%
47	Nihill channery loam, 6 to 25 percent slopes	44.9	48.7%
62	Rock outcrop-Torriorthents complex, very steep	33.7	36.6%
65	Torrifluvents, nearly level	12.6	13.7%
Totals for Area of Interest		92.2	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that

have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Rifle Area, Colorado, Parts of Garfield and Mesa Counties

36—Irigul channery loam, 9 to 50 percent slopes

Map Unit Setting

Elevation: 7,800 to 8,700 feet

Map Unit Composition

Irigul and similar soils: 85 percent

Description of Irigul

Setting

Landform: Ridges, mountainsides

Landform position (three-dimensional): Mountainflank

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Marl and/or residuum weathered from sandstone

Properties and qualities

Slope: 9 to 50 percent

Depth to restrictive feature: 10 to 20 inches to lithic bedrock

Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 1.2 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 7e

Hydrologic Soil Group: D

Ecological site: Loamy Slopes (R048AY303CO)

Typical profile

0 to 6 inches: Channery loam

6 to 17 inches: Extremely channery sandy clay loam

17 to 21 inches: Unweathered bedrock

47—Nihill channery loam, 6 to 25 percent slopes

Map Unit Setting

Elevation: 5,000 to 6,500 feet

Map Unit Composition

Nihill and similar soils: 85 percent

Description of Nihill

Setting

Landform: Valley sides, alluvial fans
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Alluvium derived from sandstone and shale

Properties and qualities

Slope: 6 to 25 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Available water capacity: Low (about 3.6 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Rolling Loam (R048AY298CO)

Typical profile

0 to 11 inches: Channery loam
11 to 18 inches: Very channery loam
18 to 60 inches: Stratified extremely channery sandy loam to extremely channery loam

62—Rock outcrop-Torriorthents complex, very steep

Map Unit Setting

Elevation: 5,800 to 8,500 feet
Mean annual precipitation: 10 to 15 inches
Mean annual air temperature: 39 to 46 degrees F
Frost-free period: 80 to 105 days

Map Unit Composition

Rock outcrop: 65 percent
Torriorthents and similar soils: 30 percent

Description of Rock Outcrop

Setting

Landform: Plateaus, escarpments, hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Free face

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Down-slope shape: Convex, concave

Across-slope shape: Convex, concave

Parent material: Very stony colluvium derived from calcareous shale

Properties and qualities

Slope: 50 to 80 percent

Depth to restrictive feature: 0 inches to paralithic bedrock

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Available water capacity: Very low (about 0.0 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 8s

Hydrologic Soil Group: D

Typical profile

0 to 60 inches: Unweathered bedrock

Description of Torriorthents

Setting

Landform: Plateaus, hillslopes

Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Free face

Down-slope shape: Convex

Across-slope shape: Convex

Parent material: Alluvium derived from calcareous shale

Properties and qualities

Slope: 50 to 80 percent

Depth to restrictive feature: 4 to 30 inches to lithic bedrock

Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)

Available water capacity: Very low (about 2.4 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 8e

Hydrologic Soil Group: D

Typical profile

0 to 4 inches: Variable

4 to 30 inches: Fine sandy loam

30 to 34 inches: Unweathered bedrock

65—Torrifluvents, nearly level

Map Unit Setting

Elevation: 5,000 to 7,000 feet

Mean annual precipitation: 12 to 15 inches

Mean annual air temperature: 46 to 48 degrees F

Frost-free period: 90 to 120 days

Map Unit Composition

Torrifluvents and similar soils: 85 percent

Minor components: 15 percent

Description of Torrifluvents

Setting

Landform: Flood plains, rivers, distributaries

Down-slope shape: Convex, linear

Across-slope shape: Convex, linear

Parent material: Alluvium

Properties and qualities

Slope: 0 to 6 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Moderately well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.60 to 2.00 in/hr)

Depth to water table: About 12 to 36 inches

Frequency of flooding: OccasionalNone

Frequency of ponding: None

Calcium carbonate, maximum content: 5 percent

Gypsum, maximum content: 1 percent

Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)

Sodium adsorption ratio, maximum: 2.0

Available water capacity: Moderate (about 7.6 inches)

Interpretive groups

Farmland classification: Not prime farmland

Land capability (nonirrigated): 7w

Hydrologic Soil Group: D

Typical profile

0 to 36 inches: Loam

36 to 60 inches: Sand

Minor Components

Wann

Percent of map unit: 10 percent

Landform: Terraces

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Fluvaquents

Percent of map unit: 5 percent

Landform: Marshes

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