R. T. HICKS CONSULTANTS, LTD.

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Artesia ▲ Carlsbad ▲ Durango ▲ Midland

November 9, 2017

Mr. Mike Bratcher and Ms. Crystal Weaver
New Mexico Oil Conservation Division
811 S. 1st Street
Artesia, NM 88210
Via E-Mail

Ms. Henryetta Price
Bureau of Land Management
620 E. Greene Street
Carlsbad, NM 88220
Via E-mail

RE: Chi Operating – Benson Delaware Unit #6 Battery (32.67997, -103.93143)
Remediation Plan 2RP- 4251

Dear Mr. Bratcher, Ms. Weaver, and Ms. Price:

On behalf of Chi Operating, Inc. (operator), Hicks Consultants submits the following:

- Presentation of data
- Conclusions from data to support a corrective action
- Proposed corrective action

Plate 1 shows the location of the site on a USGS topographic map and Plate 2 is an aerial image of the same area.

Data Presentation

Nature of Release and Initial Response

As indicated in the C-141, the release of crude from the tank battery appears to be an act of sabotage. On May 28, 2017, the valves on the tanks were opened and a significant volume of crude escaped. The footprint of the release is sketched on Plate 3. Plate 3 also shows sampling locations and laboratory results of analysis. Table 1 provides additional sampling data.

The initial response involved vacuuming puddled crude and excavation of nearly 100% of the visually impacted soil/sand. Two stockpiles of excavated earth remain on the location and 212 cubic yards of visually-impacted earth was removed to disposal. Figure 1 is an image of the pool of crude on the production pad adjacent to the source of the release. Figure 2 shows 12-18 inches of excavation occurred near sample S7, at the southern terminus of the spill. A similar removal effort occurred throughout the off-location footprint. Excavation of impacted caliche did not occur on the constructed pads.

Hydrogeologic Setting and Natural Vegetation

From the data presented below stakeholders can make decisions regarding the environmental threat posed by the release.

1. The depth to groundwater at the site is about (3455-3160=) 295 feet (Plate 4).

2. Groundwater flows west-southwest based upon USGS well data from the Quartermaster/Rustler Formation that are shown on the map. Groundwater flow is toward the potash mine tailings pond shown on Plate 4.
3. Plate 4 also shows that the Permian Quartermaster/Rustler Formation is exposed about 500 yards west of tank battery. Figure 3 shows this Permian unit exposed beneath the caliche and dunes on the slope about 800 feet east-northeast of the location.
4. The Permian outcrop extends to the north and west and probably underlies the potash mine tailings pond. This unlined tailings pond, which has held saturated brine for many decades, lies less than 1 mile directly down gradient with respect to groundwater flow.
5. Older alluvium is the maroon outcrop pattern shown on Plate 4. As the Quartermaster/Rustler Formation underlies the caliche and dunes, the Older Alluvium is not present in the area of the tank battery.
6. The Quartermaster Formation is dominated by silty sandstones and siltstones. Due to the reported thickness of this Permian unit and the reported depth to groundwater, any sandstone beds of the Quartermaster will not contain groundwater.
7. Groundwater in the area probably resides in the underlying Rustler Formation.
8. There are no down-gradient wells between the battery and the tailings pond.
9. Plate 2 shows that the nearest surface water and mapped watercourses are approximately ½ mile west of the site. The potash tailings pond is visible in the southwest corner of this Plate. The only mapped streams are “intermittent”.
10. The surface near the battery is low sand dunes that are stabilized by shrubs and grass.
11. The area is a recreation area for riding off-road vehicles and dirt bike motorcycles. Many of these trails are visible through and near the release site.

Soil Sampling, Results and Discussion of Data

Hicks Consultants conducted two sampling campaigns: August 29 and September 20, 2017. Both sampling programs employed hand auger techniques as described in the 2015 EPA Soil Sampling Operating Procedure[1]. The August sampling collected sufficient data to permit design of a more complete characterization. The September sampling event collected samples to a depth of about 3-feet below existing grade to define the potential penetration of the release. We selected sample locations from the excavated area during the September program that were visibly impacted by hydrocarbons, to represent “worst case” conditions.

Samples S1, S2 and S5 are from the uppermost 6-inches of the production pad. As the production pad was not excavated, these samples represent the uppermost 6-inchs of the release footprint (prior to excavation). Sample S4 is also within an un-excavated area. We believe the material shipped to disposal was similar to the results presented for S1, S2, S5 and S4 in Table 1. Chloride and hydrocarbon concentrations vary, as is expected with soil sampling, but are obviously above background levels. The consistent result is that benzene concentrations are below detection limits and BTEX concentrations are low.

Approximately 300 cubic yards of excavated material lie in two piles. One is located at S-6 (Plate 3) and the northern pile is located on location on the north side of the lease road. The

[1] https://www.epa.gov/sites/production/files/2015-06/documents/Soil-Sampling.pdf

5-point composite samples from the North and South Stockpiles are the best representation of the concentrations in soil/sand that were last excavated and not removed to disposal. The earth in the stockpiles originated at approximate depths of 6-24 inches below the original grade beneath the off-location spill footprint. The hydrocarbon concentrations are an order of magnitude less than the samples from un-excavated areas. Chloride concentrations are 10 times less than from un-excavated areas (e.g. S2) and 10 time more than samples from off-location. Benzene and BTEX concentrations are very low in these samples.

The deeper samples from off-location hand-auger borings represent conditions at depths of 12-48 inches below the original grade. The sample depths presented in Table 1 are based upon the existing grade after excavation of visually-impact surface soils. For samples SP-3, SP-7 and SP-8, we cannot know exactly what the original grade was prior to soil/sand removal. At sample locations S-3 and S-4, hydrocarbon concentrations decrease with depth. Samples from 0-14 inches below grade are 10 times higher than the deepest sample. This relationship of decreasing concentration with depth is expected for surface releases. At sample location S-7, hydrocarbon concentrations are below detections limits. At S-8, DRO concentrations decrease by an order of magnitude between each sample.

Conclusions

- The observed concentrations and depth to groundwater permit a conclusion that the release poses no threat to groundwater quality.
    - The average chloride concentration of all samples is 385 mg/kg
    - The average chloride concentration of off-pad samples including the stockpile is 36 mg/kg
    - Benzene concentrations are below laboratory detection limits (see laboratory report) for all samples
    - Given a depth to groundwater of 295 feet and competent Permian-age bedrock laying between ground surface and groundwater, the probability that a sufficient flux of released molecules could cause impairment of groundwater is so small as to be nil
- As the production pads should not be vegetated, hydrocarbon or chloride concentrations within or below the compacted caliche surface need not be remediated at this time. Between now and removal of the pad during P&A site restoration, natural processes will reduce the hydrocarbon and chloride concentrations in the soil horizon. At final restoration, the BLM will require the operator to restore these locations to a condition that will support vegetation.
- Crude released to the ground surface can be an environmental concern for a variety of reasons. At this site, we conclude that a corrective action
    - should prevent crude from hardening and reducing soil permeability
    - should prevent crude from forming a crust surface through which vegetation cannot be re-established
    - need not address dispersed hydrocarbons in the soil column

Proposed Corrective Action: Off-Pad Surface Restoration

No action is proposed for the spill footprint on the production pads. At site abandonment, remediation of residual chloride or hydrocarbon will be accomplished under a plan approved by BLM.

Within the spill footprint that is off-location,

A. Use a backhoe and/or end loader to blend the uppermost 12-24 inches of soil/sand to break-up any asphaltic hardpan and increase soil/sand permeability
B. After the upper 2-feet of the existing surface is disaggregated and blended, move all of the stockpiled soil to areas of the spill footprint that are in most need of fill to re-establish original grade
C. Cause the surface of the soil/sand to be uneven thereby minimizing run-off and maximizing infiltration of precipitation
D. Seed the blended and re-graded spill footprint with a seed mixture approved by the BLM.
E. Storm water runoff from the pads and up-slope should be diverted from the restored footprint.

An appropriate design for storm water diversion should be staked in the field by consensus between the operator, the contractor who will implement the remedy, BLM and Hicks Consultants. A sketch of possible diversion locations is presented in Plate 5. This concept calls for the lease road that transects the BDU #6 pad to be the diversion structure. On the pad, a small swale is excavated on the uphill side of the road and the material from the swale is used to raise the lease road slightly. The swale should direct water east and west as the slope allows. West of the BDU 6 pad, a swale on the uphill side of the lease road may be necessary to divert the water westward to an existing drainage that crosses the road about 160 feet west of the edge of the location. East of the BDU 6 pad, the water may be diverted along the north side of the lease road for about 160 feet to an area where water appears to flow across the road toward the production pad associated with the BDU 21 well and Battery. Additional work may be required to continue the diversion to the east as suggested in Plate 5. Berms or fencing should be added to prevent recreational traffic across the restored surface.

Please contact me if you have any questions concerning this proposal. We can implement the project upon approval by the OCD and BLM.

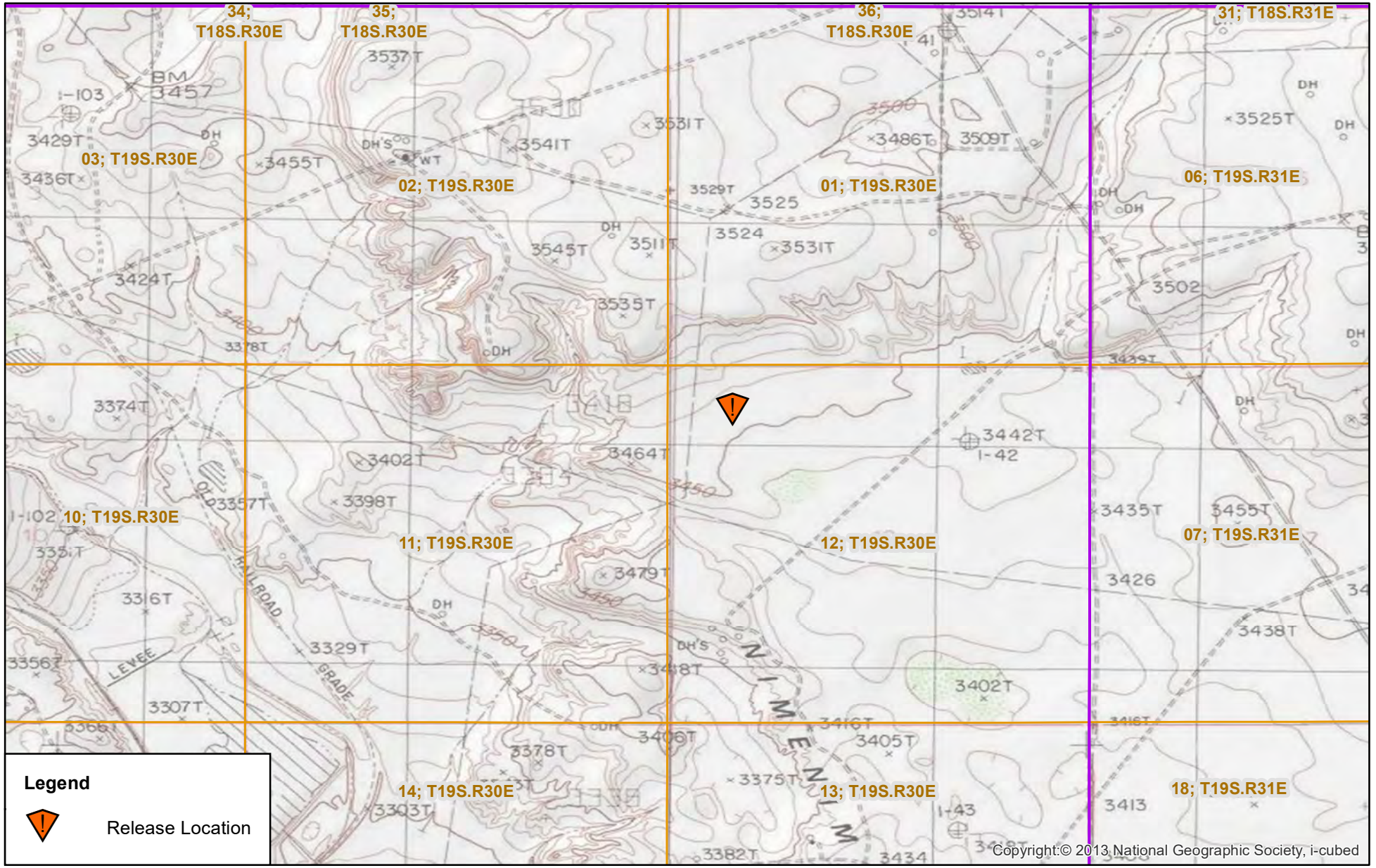
Sincerely,
R. T. Hicks Consultants

Randall Hicks
Principal

Copy: Chi Operating

Table 1 - Laboratory Results, Location and Date of Sampling

Sampling Location	Depth in Inches	Chloride	GRO	DRO	Ext. DRO	BTEX	Benzene	Sampling date	Lat./Long
S-1	0-6"	192.0	443.0	24,600.0	5,710.0	4.4	<0.200	8/29/2017	32.67997, -103.93143
S-2	0-6"	3,880.0	<50.0	1,780.0	497.0	0.3	<0.050	8/29/2017	32.68032, -103.93126
S-5	0-6"	2,320.0	1,190.0	27,400.0	5,820.0	31.1	<0.500	8/29/2017	32.67977, -103.93080
S-3	0-6"	32.0	6,540.0	31,700.0	5,650.0	174.0	<5.00	8/29/2017	32.67920, -103.93107
S-3b	0-6"	16.0	324.0	7,240.0	1,580.0	<0.300	<0.050	9/20/2017	
S-3b	12-14"	32.0	3,590.0	12,400.0	2,110.0			9/20/2017	
S-3b	18-21"	48.0	428.0	5,390.0	1,370.0	5.5	<0.050	9/20/2017	
S-4	0-6"	32.0	2,070.0	10,200.0	2,010.0	5.6	<0.050	8/29/2017	32.67998, -103.93102
S-4	8-14"	<16.0	5,700.0	12,400.0	2,110.0	127.0	<2.00	9/20/2017	
S-4	24-29"	<16.0	3,650.0	6,850.0	1,140.0	126.0	<2.00	9/20/2017	
S-7	6-9"	<16.	<10.0	13.8	<10.0			9/20/2017	32.678744, -103.930869
S-7	18-20"	<16.0	<10.0	<10.0	<10.0			9/20/2017	
S-7	24-26"	<16.0	<10.0	<10.0	<10.0			9/20/2017	
S-8	6-8"	16.0	993.0	4,270.0	834.0			9/20/2017	32.679597, -103.931647
S-8	12-14"	16.0	11.4	204.0	59.8			9/20/2017	
S-8	23-25"	<16	<10.0	15.0	<10.0			9/20/2017	
North Stockpile		112.0	284.0	6,420.0	1,310.0	1.7	<0.050	9/20/2017	
S-6 S Stockpile		144.0	130.0	2,570.0	528.0	<0.300	<0.050	8/29/2017	32.67992, -103.93112



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	1:24k Topographic Map	Plate 1
	Chi Operating Inc: BDU #6	September 2017

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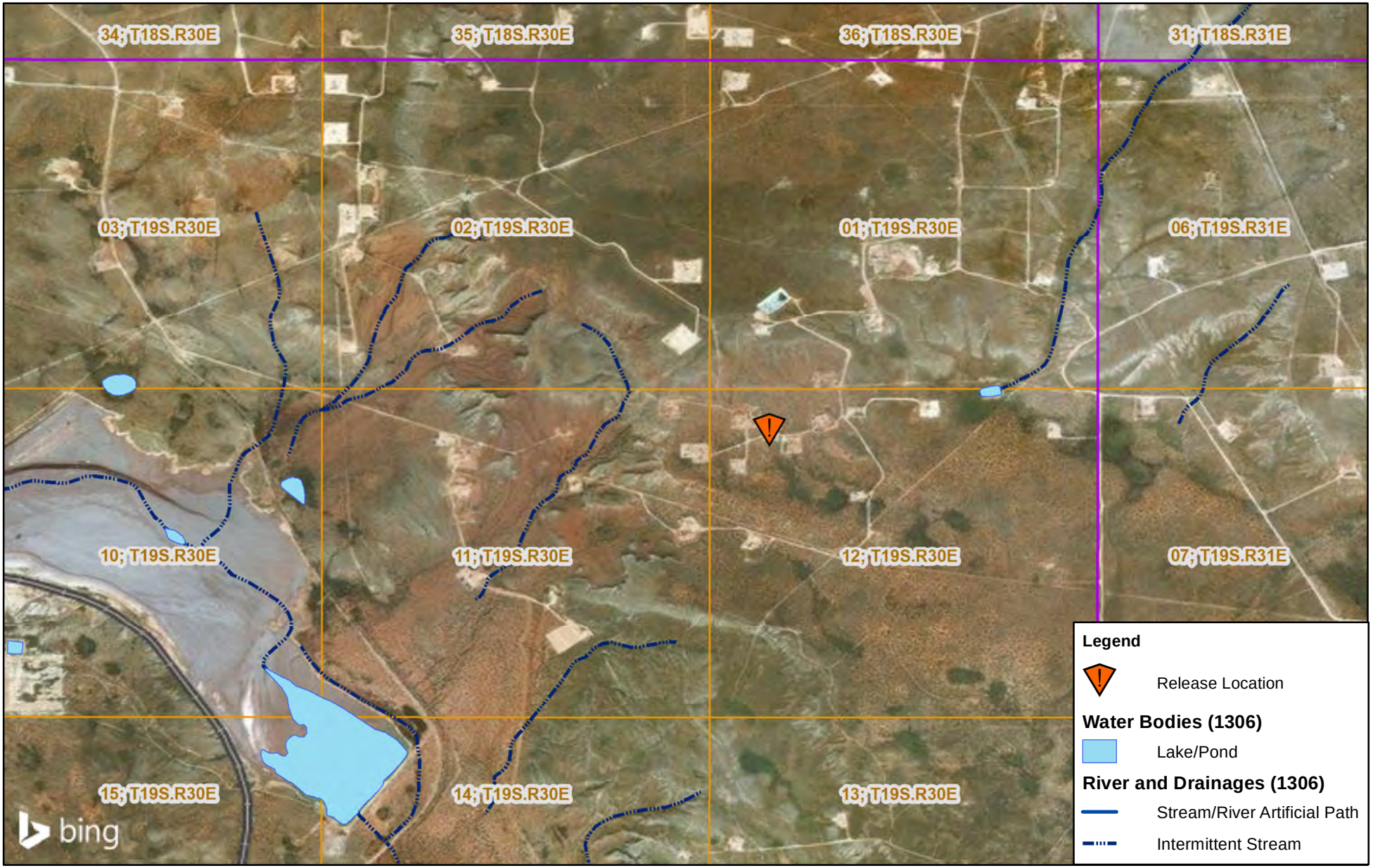

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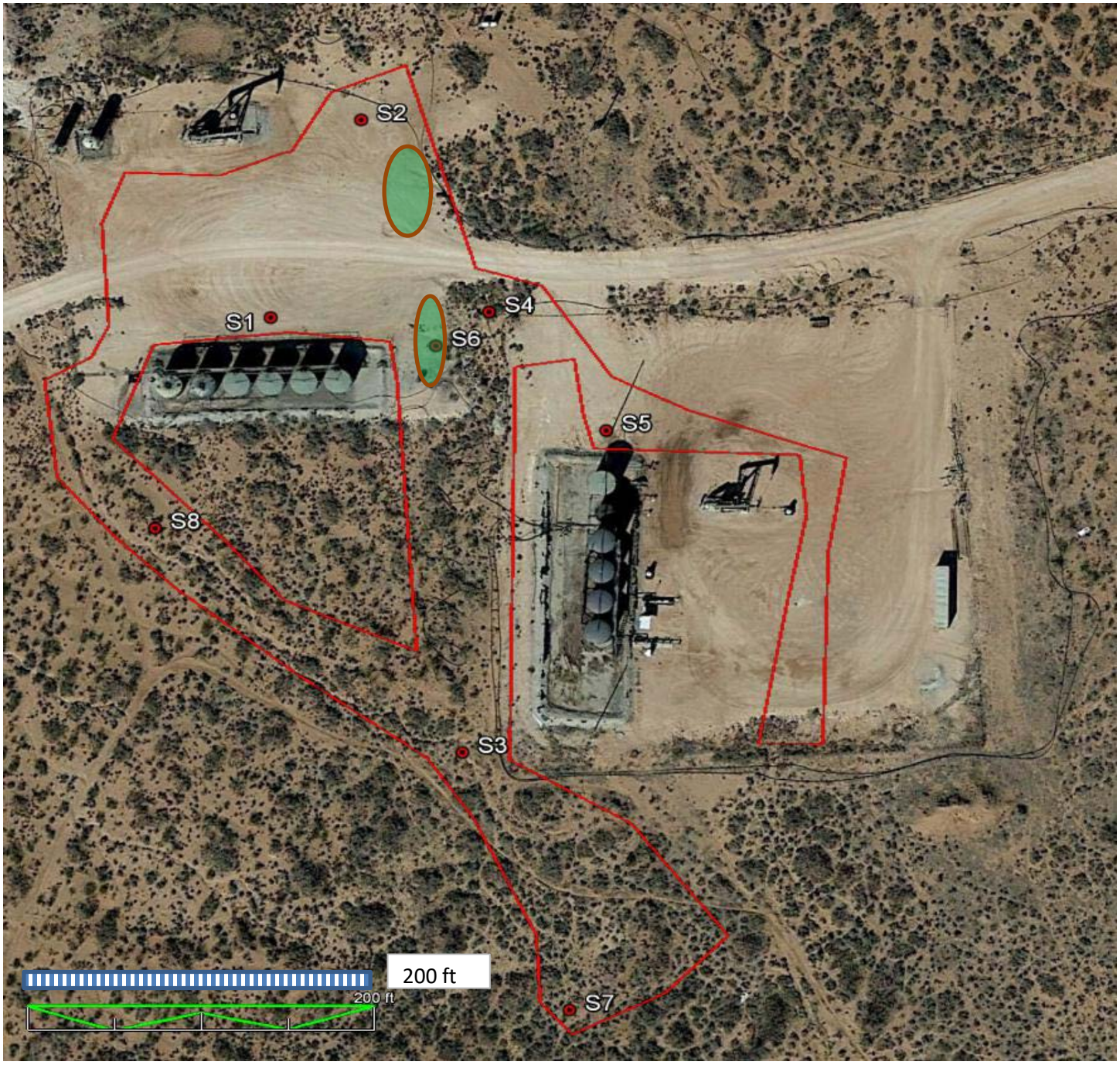
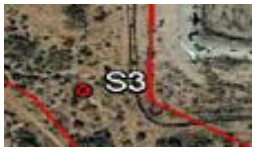
Aerial Photo with Mapped Surface Water	Plate 2
Chi Operating Inc: BDU #6	September 2017





Release footprint is red outline
Sample locations and labels

Soil stockpiles from initial response

Hicks Consultants	**Release Footprint on Google Image**	**Plate 3**
	Chi Operating - BDU 6 Battery	**Oct-17**

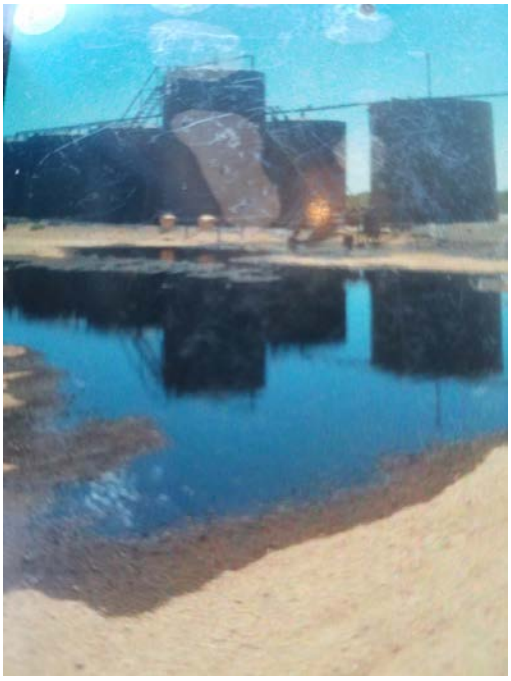


Figure 1- Poor image showing pooling of oil on location during initial response

Figure 2 – Area of excavation near sampling location S7 with the BDU 21 in background. Note that volunteer vegetation is starting to grow in this area. About 18-inches of soil/sand was removed from this portion of the spill footprint.

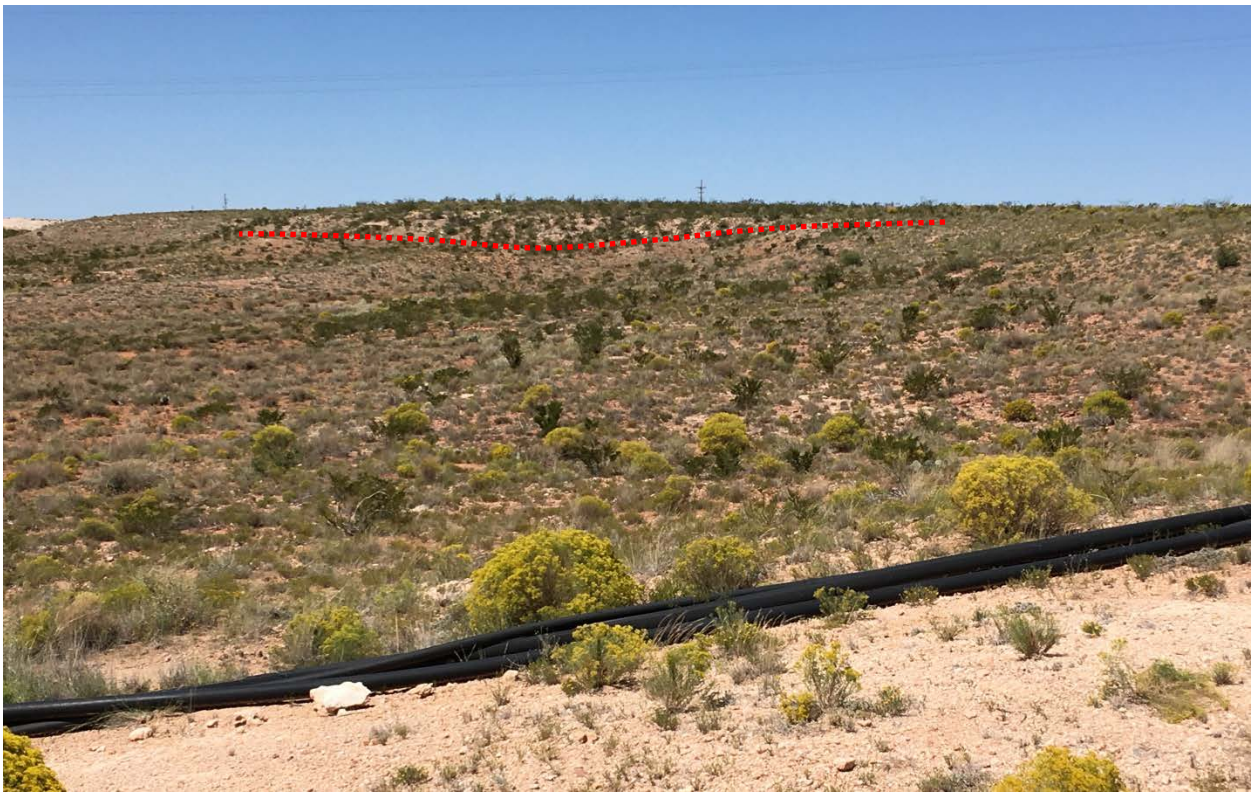


Figure 3 – View west from the north-south lease road about 1300 feet east-northeast of the BDU 6 Battery. The light gray exposure above the dotted red line is caliche and the reddish exposure is mapped nearby as Quartermaster/Rustler Formation. Thus, the conclusion that the BDU 6 site is underlain by this Permian bedrock is fully supported by observation.

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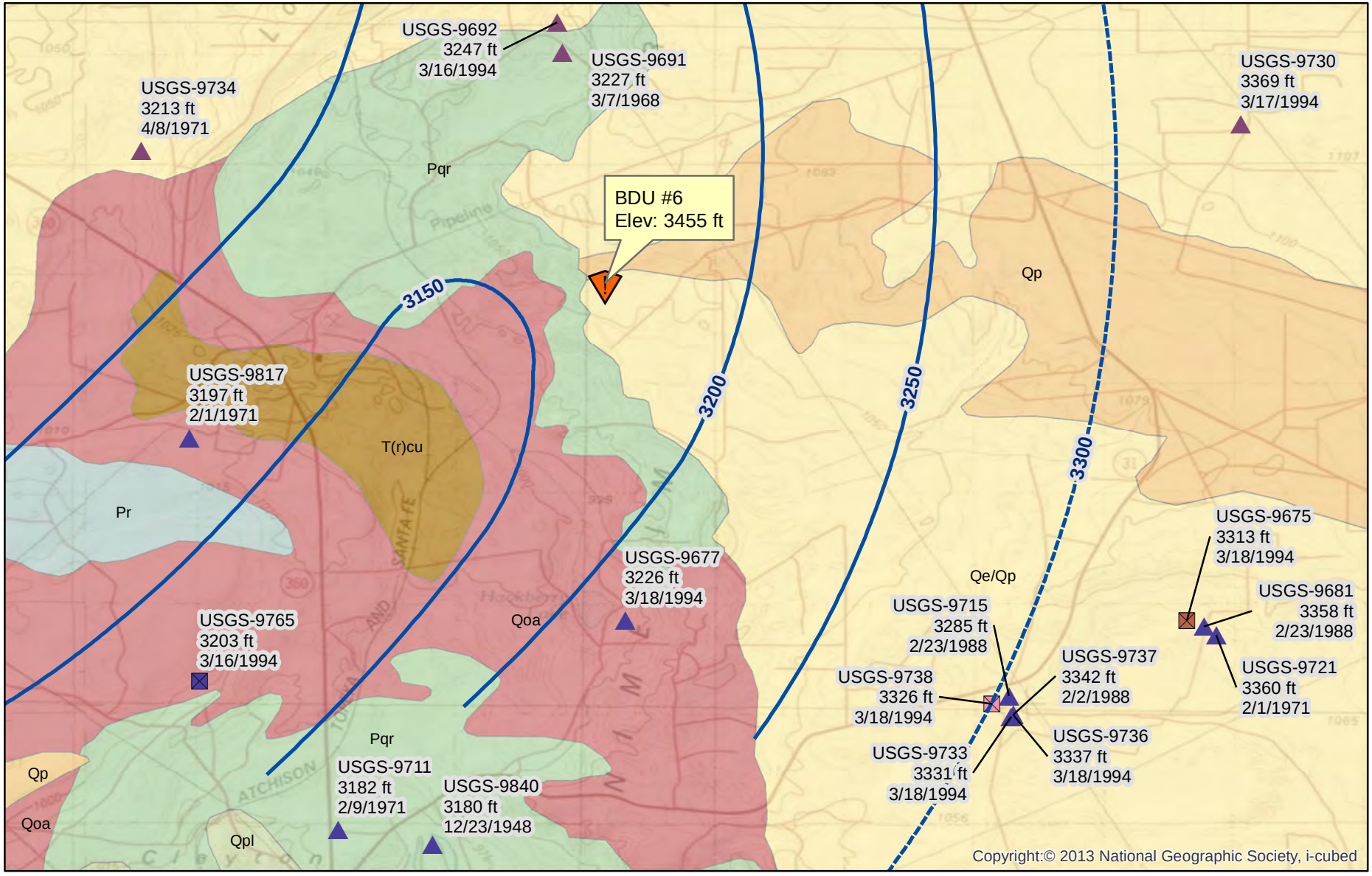

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Potentiometric Surface and Groundwater Elevation

Plate 4

Chi Operating Inc: BDU #6

September 2017

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Legend

Potentiometric Surface (ft msl)

Isocontours

Isocontour

Inferred Isocontour

USGS Gauging Station (GW Elev, Date)

Aquifer Code, Well Status

Chinle

Dockum, Other conditions existed that would affect the measured water level (explain in remarks).

Santa Rosa, Nearby site that taps the same aquifer was being pumped.

Rustler

Rustler, Other conditions existed that would affect the measured water level (explain in remarks).

NM Geology

Map Unit, Description

Pqr, Paleozoic-Quartermaster and Rustler Formations; Upper Permian

Pr, Paleozoic-Ruster Formation; siltstone, gypsum, sandstone, and dolomite; Upper Permian

Qe/Qp, Quaternary-Eolian Piedmont Deposits

Qoa, Quaternary-Older Alluvial Deposits

Qp, Quaternary-Piedmont Alluvial Deposits

Qpl, Quaternary-Lacustrine and Playa Deposits

T(r)cu, Triassic-Upper Chinle Group

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Potentiometric Surface and Groundwater Elevation

Chi Operating Inc: BDU #6

Plate 4
LEGEND

September
2017

Hicks Consultants Albuquerque, NM	Possible Stormwater Diversion	Plate 5
	Chi Operating - BDU 6 Battery	Oct-17