



Nicholson GeoSolutions, LLC

3433 East Lake Drive
Centennial, CO 80121

October 14, 2020

Mr. Don Wilbourn
Berry Petroleum Company
235 Callahan Avenue
Parachute, Colorado 81635

**Subject: J15 Pipeline Spill
Proposed Additional Groundwater Investigation and Remediation**

Dear Don:

Nicholson GeoSolutions LLC has prepared this letter to propose additional groundwater investigation and remediation procedures for the J15 pipeline spill on Long Ridge. The additional proposed components consist of the following:

- The drilling of four additional borings located to the west, south, and east of the spill location
- Completion of the four borings as 4" monitoring wells
- Sampling of all new wells
- Installation of additional pumps in one or more wells and the continued extraction of fluids
- The addition of oxidizing compound to the excavation to enhance the degradation of residual petroleum constituents in the fractured bedrock
- Additional reconnaissance of the prominent drainage south of the spill site and one additional drainage to the east during the spring of 2021
- Surface water sampling at three locations during the spring of 2021

Each component of the additional work is described below.

Drilling of Additional Borings and Completion as Wells

Four additional borings are proposed as shown on Figure 1. These borings will be drilled to provide delineation of the vertical and horizontal extent of the impacts from the spill and provide additional fluid extraction capability. Monitoring to date suggests that the spill is contained only in fractures of the Uinta Formation sandstone and is perched on the underlying Parachute Creek Member of the Green River Formation.

Care must be taken during drilling to not penetrate through the fine-grained layer that is perching the water within the Uinta Formation fractures above it. Therefore, borings will be drilled to a maximum of 60 feet unless visual observations and PID readings collected during drilling indicate that impacts extend deeper. Boring MW-2, drilled in the center of the spill zone, will be cored for the first 40 feet to evaluate the fracture patterns. The core will be visually logged and screened using a PID for volatile compounds.

All borings will be completed as 4" PVC wells to provide dual capability as monitoring wells and/or extraction wells. Well screen will be extended across the entire fluid-bearing interval. Sampling of all new wells will be conducted after well installation. Laboratory parameters will include VOCs, BTEX, gasoline- and diesel-range TPH, chloride, dissolved sodium, and TDS.

A series of three additional step-out borings are shown on Figure 1 in addition to the four proposed borings. If drilling results indicate significant impacts extend further to the west, east, or south one or more of the step-out borings may also be drilled.

Extraction Well Data

Pumping of water from extraction well MW-1 began on August 25th, 2020. Table 1 provides the pumping data and fluid level measurements collected to date. A total of 265 gallons has been pumped from well MW-1 to date. These data show that the fluid level in the well remained constant from September 4th until October 6th when pumping began again. This suggests that the fluids are not migrating downward below the perched zone.

Table 1 Summary of Extraction Well MW-1 Data

Date	Fluid Level (feet below top of casing)	Water level	Condensate thickness	total gallons pumped
25-Aug	13'-5"	10'-5"	3'-0"	5
26-Aug	11'-7"	10'-3"	1'-4"	5
	11'-4"	10'-4"	1'-0"	5
27-Aug	12'-5"	11'-4"	1'-1"	5
28-Aug	12'-6"	11'-9"	9"	5
31-Aug	12'-6"	11'-6"	1'-0"	5
1-Sep	12'-5"	11'-6"	11"	5
2-Sep	12'-6"	11'-4"	1'-2"	5
3-Sep	12'-5"	11'-4"	1'-1"	5
4-Sep	12'-5"	11'-4"	1'-1"	5
9/5 Pump failed; new pump ordered				
10/5 Received new pump, installed on 10/6. Installed solar panel and battery w/timer				
6-Oct	12'-5"	11'-4"	1'1"	25
7-Oct	pump on no gauge			40
8-Oct	11'-8"	11'-0"	8"	50
9-Oct	10'-4"	9'-6"	10"	50
12-Oct	10'-10"	9'-2"	8"	50
13-Oct	12'-1"	11'-1"	12"	
14-Oct	11'-8"	10'-9"	11"	
TOTAL				265

Installation of Additional Pumps

Additional pumps will be installed in wells with sufficient quantities of fluids. At a minimum, it is expected that fluid extraction will be conducted in well MW-2. Fluids extracted from the wells will be contained in plastic tanks and transported to the Berry 29-17 injection well facility for disposal.

Addition of Oxidizing Compound

Soil sampling conducted in the excavation showed that impacted soil and rock was still present in the floor of the excavation. All samples for the walls of the excavation were below the standards. To provide treatment of the residual petroleum constituents in fractures beneath the excavation, an oxidizing compound (sodium persulfate) will be applied to the floor of the excavation. Clean water will be used to flush the oxidizing compound into the fractures in the Uinta Formation. The oxidizing compound will thus be delivered to the same fractures that allowed the spill to penetrate the sandstone and will chemically oxidize the residual petroleum constituents in the fractures. The northern portion of the excavation will then be backfilled with clean fill to protect the pipeline during the winter.

Additional Reconnaissance and Surface Water Sampling

For Long Ridge, all known springs are located on the south side of the ridge just above the cliffs. The spill occurred at a location to the south of the crest of Long Ridge above a prominent surface water drainage. These drainages likely formed in areas where the fracture intensity in the underlying rocks is greater, and therefore may act as preferred pathways for groundwater movement. Groundwater that originates as recharge in the spill area likely moves to the south down the prominent drainage that begins just below the spill area, or down the adjacent drainage to the east, and discharges into Ben Good Creek or the East Fork of Parachute Creek.

Nicholson GeoSolutions will conduct additional hydrologic reconnaissance of both drainages to search for seeps and springs in the spring of 2021 and will sample any springs located. The routes of the proposed reconnaissance are shown on Figure 2. In addition, surface water samples will be collected (when flow is present) from the three locations on the East Fork and Ben Good Creek identified on Figure 2 if flow is present.

Nicholson GeoSolutions LLC



David K. Nicholson, P.G.
Principal Geologist



Figure 1

October
2020

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Legend



Spill Perimeter



Extraction Well



Pipeline



Proposed Monitoring
/Extraction Well



Potential Step-Out
Well Location

0 30 60 Feet

1" = 60'

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Long Ridge J-15 Pipeline
Spill Response
Proposed Additional Wells

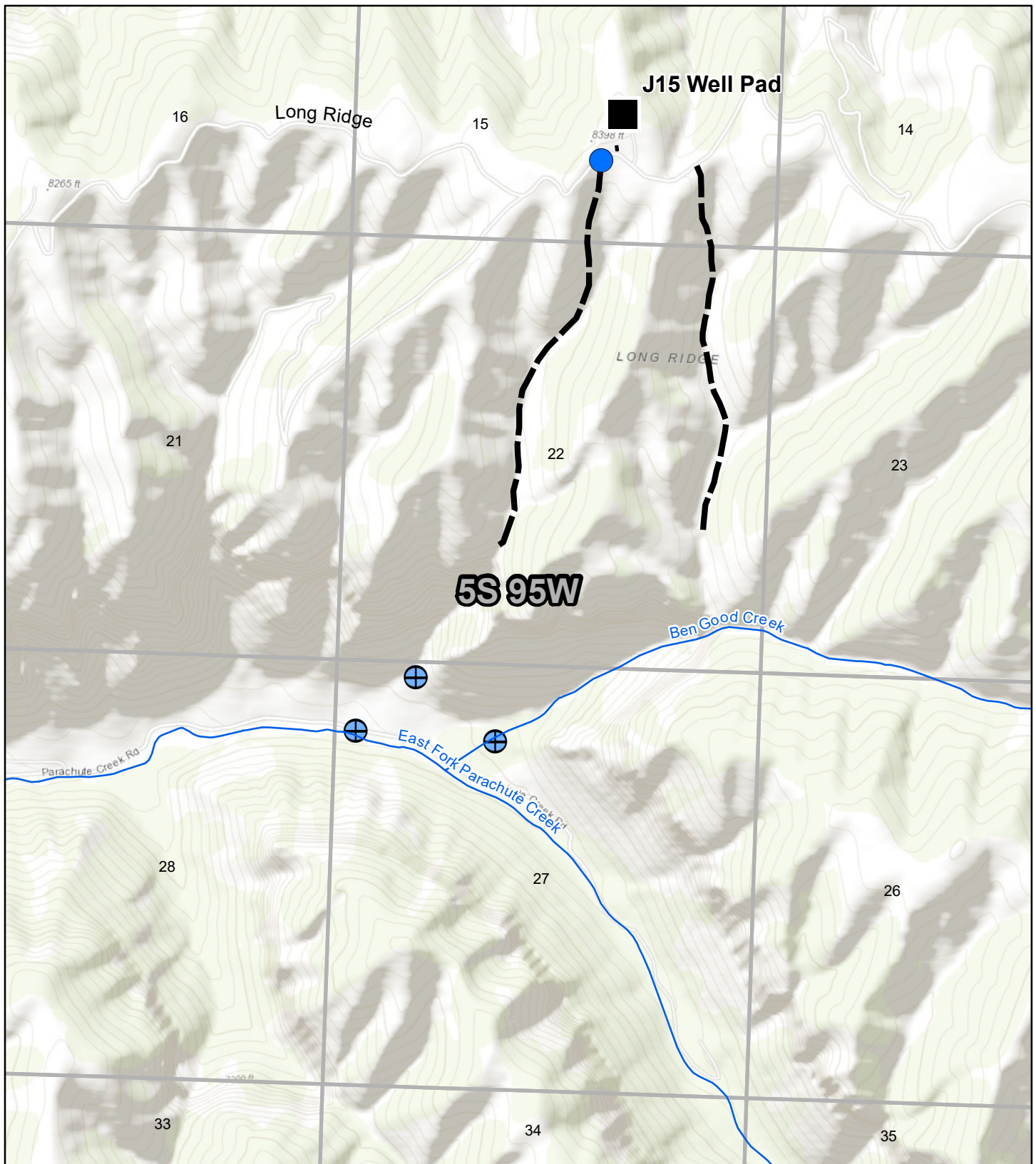


Figure 2

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Legend

- Pad Location
- Spill Location
- Proposed Reconnaissance Route
- + Proposed Surface Water Sampling Location

0 750 1,500 3,000 Feet 1" = 60'

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Long Ridge J-15 Spill
Proposed Surface
Water Monitoring