March 10, 2017

Ms. Olivia Yu, Environmental Specialist
New Mexico Oil Conservation Division
Hobbs District Office
1625 French Drive
Hobbs, New Mexico 88240

SUBMITTED VIA EMAIL
Olivia.Yu@state.nm.us

RE: Remediation Workplan, NMOCD Case No. 1RP-4599
West Dollarhide Queen Sand Unit Satellite 3, T24S, R38E, Sec 31, Unit I
32.1723°N, 103.0921°W
Lea County, New Mexico
Project No. RAMRNM0001

Dear Ms. Yu:

Enviro Clean Cardinal, LLC (ECC) has prepared the following remedial workplan to address the New Mexico Oil Conservation Division (OCD) correspondence concerning the February 8, 2017, release at the RAM Energy Resources (RAM) West Dollarhide Queen Sand Unit Satellite 3 (WDQSU Sat 3), in Lea County, New Mexico. RAM's Form C-141 indicates the release was 10 to 15 barrels (bbls) of produced water which flowed approximately 1,200 feet along a spill path terminating at the West Dollarhide Queen Sand Unit #92 well location. The following photographs represent conditions at the time of release, and current site conditions as observed on February 13th.




This OCD workplan has been prepared to comply with 19.15.29.11 NMAC as well as the *Guidelines for Remediation of Leaks, Spills and Releases* (August 13, 1993) delineation requirements. The attached *Release Location Map* identifies the visibly impacted media covered by this response workplan.

General Site Characteristics

The release site is in the Dollarhide Oil Field, and is situated at approximately 3,135 feet above mean sea level, with a slight slope towards the southwest and the Monument Draw. There is not a Waters of the United States identified watercourse in the vicinity of the site. The primary land use is for livestock grazing, with significant oilfield development in the region. The area is semiarid, with a net annual average precipitation/evaporation loss of approximately 80 inches.

The surface soil surrounding the release site and release-affected area is listed by the USDA-Soil Conservation Service as “SE” (Simona fine sandy loam, 0 to 3 percent slopes) and is a Typic Paleorthid. This indicates a loamy, mixed thermic shallow soil that is well drained, and is derived of calcareous eolian deposits from sedimentary rocks.

The surficial geologic unit is listed as “Qsu” (Quaternary sand deposits, undivided) and is described as windblown deposits, sand sheets and dunes, undivided. The underlying unit is the Tertiary-age Ogallala Formation (lower Pliocene to middle Miocene), which is comprised of alluvial and eolian deposits and petrocalcic soils of the southern High Plains. Site observations indicate the surface soil is shallow to thick wind-deposited sands overlaying carbonate-indurated bedded sands. Scattered cobbles of freshwater limestone and calcareous sandstone were observed during site visits.

The Ogallala Formation is part of the regional High Plains Aquifer system. Records from the Office of the State Engineer indicate there are no water wells or extraction points of diversion within a mile radius of the site. The 2005 *ChevronTexaco Depth to Ground Water Water Wells Facilities* map indicates the depth to water is greater than 100 feet below ground surface (bgs).

Site History and Release Summary

No prior environmental releases were identified at this location, however a nearby release, RP-10-5-2512 (Drinkard Unit 148, May 1, 2010), is about 940 feet west of the WDQSU Sat 3 point of release. At this location, after removing approximately 2,232 cubic yards (cyds) of impacted media, a 20mil polyethylene liner was installed at the base of the 5-foot deep excavation. This 88 bbl release was closed May 24, 2013.

The release that is the subject of this workplan occurred on February 8, 2017. This release was reported as 10 to 15 barrels (bbls) of produced water which flowed approximately 1,200 feet along the main spill path terminating at the West Dollarhide Queen Sand Unit #92 well location. The release-affected soils cover approximately 0.75 acres.

Typically, total fluids releases tend to separate gravimetrically with the release of pressure. This means that the hydrocarbons tend to float on top of salt water, spreading farther downslope than the salt water, and leaving a “bathtub ring” in pooling areas as the briny fluids vertically infiltrate into soil.

Soil Remediation Action Levels

The OCD established the Recommended Remediation Action Level (RRAL) for soils contaminated with petroleum hydrocarbons. The ranking criteria is based on numeric scores to determine the appropriate soil remediation action level for relative threats to public health, fresh water, and the environment. Based on site data, these are the input:

Ranking Score	Depth to Groundwater	<1000 feet from Water Source	<200 feet from Private Domestic Water Source	Distance to Surface Water Body
20	<50 feet	Yes	Yes	<200 feet
10	50 – 99 feet			200 – 1,000 feet
0	>100 feet	No	No	>1,000 feet
TOTAL	0			

The least stringent hydrocarbon cleanup values are assigned to sites with an RRAL less than 9; the WDQSU Sat 3 site has a ranking score of "0", which corresponds to clean-up values of:

- 10 parts per million (ppm) benzene,
- 50 ppm benzene, toluene, ethylbenzene, and total xylenes (BTEX) totaled, and
- 5,000 ppm total petroleum hydrocarbons (TPH).

The Water Quality Control Commission's (WQCC's) *Standards for Ground Water of 10,000 mg/l TDS Concentration or Less* (20.6.2.3102 NMAC, aka the 3102 list) establishes a 250 ppm chloride delineation standard.

Based on the negotiated values granted at other closed release sites with more sensitive groundwater conditions, ECC respectfully requests that the delineation and cleanup requirements for chlorides be established at 1,500 ppm.

Non-Intrusive Electromagnetic Conductivity Survey

Most of the hydrocarbon-affected area is expected to be less than two feet bgs (about 2,400 cyds of impacted media), however, chloride impacts are suspected to be deeper where fluids pooled in topographic depressions in the fine sands. At this site the released produced water that was not recovered from the surface is suspected to have infiltrated into the subsurface sand. To better delineate the release for response planning, a non-intrusive geophysical technique was employed.

On February 28, 2017, ECC performed an electromagnetic (EM) terrain conductivity survey of the Site using an EM38-MK2 meter manufactured by Geonics Limited. The electromagnetic (EM) terrain conductivity survey uses the principle of induction to measure the ground conductivity of the subsurface. This instrument uses a rectified alternating electric current of a known frequency and magnitude, which is passed through a transmitter coil creating a primary magnetic field in the space surrounding the coil, including the underground. Eddy currents are generated in the ground that induce a secondary current within underground conductors, which result in an alternating secondary magnetic field that is sensed by the receiving coil. The ratio of the magnitudes of the primary and secondary currents is proportional to the terrain conductivity. Apparent electrical conductivity readings will increase with increases in clay content, soluble salt, water and temperature.

The EM38 meter is equipped with two transmitter coils and two receiver coils each with a fixed separation of 0.5-meters (m) and-1 m. The depth of signal penetration and response profile are governed by the coil separation and their orientation of the coil dipole (horizontal or vertical dipole). The amplitude of the secondary field is converted into values of ground conductivity. The ground conductivity is measured in millimhos per meter (mmhos/m) or milliSiemens per meter (mS/m). The surveys at this site were performed with the EM38 meter in the vertical dipole (VD) orientation and the measured ground conductivities are measured to depths of 2.5 feet (0.5-m coil) and 5 feet (1-m coil),

collecting geo-referenced data at the rate of two readings per second. A separate in-phase mode is also used to distinguish metal objects that could interfere with true ground conductivity measurements. During the survey the EM38 provides a constant output of the following four channels of information:

- Ground conductivity from 0 to 2.5 feet in depth (0.5-m VD)
- In-phase response for metal detection (0.5-m VD)
- Ground conductivity from 0 to 5 feet in depth (1-m VD)
- In-phase response for metal detection (1-m VD)

The data from these four channels of information are reduced to spreadsheet tables, which are then importing into drafting programs for mapping.

Using walking traverses that were generally perpendicular to the flowpath of the released fluids, ECC collected 6,369 data-point locations across the site. The pathways are shown as light gray lines on the *Survey Results* maps attached to this workplan.

From ECC's review of the conductivity results, it appears that background levels for the WDQSU Sat 3 site range from 3 to 40 mmhos/m. The maximum 0.5-m and 1-m conductivity measurements at the site were 541.95 and 385.70 mmhos/m, respectively.

The EM results have been contoured using a 60 mmhos/m interval. Soils having background conductivity levels up to 60 mmhos/m are shown in the light green shading. Based upon ECC's experience with this meter, we expect EM conductivities greater than approximately 60 mmhos/m to exceed the WQCC 250 mg/kg chloride level. Within these light green areas, very little to none of the soils are expected to have been impacted above WQCC levels. Areas shaded in yellow, orange and red are progressively more impacted by brine and will likely require remedial delineation. The following potentially impacted areas have been calculated for both the 0.5-m and 1-m EM responses:

- EM38 0.5 m response >60 mmhos/m = 17,045 square feet or 0.39 acres
- EM38 1 m response >60 mmhos/m = 25,095 square feet or 0.58 acres

The relationship between chloride levels in soil and the contoured EM values can only be confirmed by the collection of position-referenced soil samples that are submitted to the laboratory for chloride analyses. Samples that will used to compare the EM38 response to laboratory chloride and field conductivity concentrations are depicted on the *EM-38/Chloride Calibration Map* and are further discussed in the Proposed Remediation and Waste Management section below.

Proposed Remediation and Waste Management

BTEX and TPH impacts are expected to be shallow, generally less than 2-feet in depth. The constituent expected to be the driver for delineation and remedial activities is the chloride content. Since chlorides cannot be reduced using degradation processes, the proposed remedial option is the excavation of impacted media for disposal.

There are three distinct remediation areas:

- an upper pooling area near the point of release, impacted with both hydrocarbons and chlorides;
- the main flowpath that terminates near the WDQSU #92 wellhead which is primarily hydrocarbon impacts, but has three small pooling areas with potential chloride impacts; and
- a side channel that appears to be an unrelated less-than-reportable volume crude oil release, but was requested by RAM personnel to be addressed as part of this response.

Initial Chloride Calibration

To start the remediation project, test pits for initial EM38 survey to laboratory chloride concentration calibration will be performed. This is to reduce over-excavating "clean" unimpacted media. To calibrate the EM38 survey results, soil samples will be collected at 1-foot depth intervals from surface to four or five feet bgs at the 10 locations shown on the attached *EM-38/Chloride Calibration Map*. Additionally, field chloride screening will be performed using an electroconductivity meter using 1:1 volumetric soil-to-water extractions.

These chloride calibration laboratory analyses are intended to assess both the low impact and high impact areas identified in the EM-38 survey. Additionally, two background soil samples will be collected for chloride laboratory analyses from profiled locations (light green tinted areas) assumed to be removed from potential impacts. All sample aliquots collected for the calibration will be split in field, one portion used for 1:1 volumetric field electroconductivity measurements, while the other portion will be properly logged onto a chain of custody and placed in an ice-chilled cooler for laboratory analyses.

The laboratory results for chlorides will be cross-referenced to both EM38 and field electroconductivity measurements, to estimate the field measurement values that would be below the chloride delineation values. When further excavation samples are determined to meet or be below the estimated delineation value, laboratory chloride samples will be collected for delineation confirmation.

Upper Pooling Area
In the upper pooling area, if bedrock is encountered, or the depth of an excavation exceeds five feet before delineation to the RRALs, then a separate workplan for second-phase of assessment will be prepared, requesting delineation by drilling, the installation of an impervious liner, or alternative clean-up standards. For lateral delineation, soil samples will be collected from the base of the excavation walls at pooling locations. For vertical delineation by excavation, soil samples will be collected from approximately every 1,000 square feet of excavated area and analyzed for BTEX and TPH until vertical delineation to RRALs is achieved, with chlorides analyses expected to continue to greater depths.

Main Flowpath
For the main flowpath, samples will be collected approximately every 100 feet, beginning at the path terminus and working towards the main flowpath, near the centerline of the excavation and analyzed for BTEX/TPH/chlorides, until each constituent class is vertically delineated.

Side Channel
The side channel is expected to be delineated in shallow soils for BTEX/TPH, but confirmation chloride samples will be collected near the centerline of the excavation about every 100 linear feet.

Waste Disposal and Backfill
Disposal for wastes generated at the WDQSU Sat 3 release site will most likely be at the Lealand facility between Jal and Carlsbad, NM. Suitable backfill material will most likely be sourced either from the disposal facility, or from the landowner, dependent on RAM's contractual requirements.

Operations Personnel
Personnel conducting the evaluations will have completed OSHA Hazwoper and Safeland training. Fire resistant clothing, H_2S monitor, and Level D personal protective equipment will be used by personnel.

Soil Sampling and Analyses

Soil samples will be collected from the bottom of excavated areas as described in the Proposed Remediation and Waste Management section of this workplan.

All confirmation soil samples will be submitted to a National Environmental Laboratory Accreditation Program (NELAP) environmental laboratory for OCD-approved TPH, benzene/BTEX, and chloride analytical methods, requesting the results on the OCD-preferred wet-weight basis. Analytical methods will include:

- TPH by EPA SW-846 method 8015M (modified for OCD carbon ranges)
- BTEX by EPA SW-846 8000-series (either 8021B or 8260B at the laboratory's discretion)
- Chlorides by EPA CWA inorganic anion method 300 series

Activities Timeline

Within ten business days of the workplan approval, begin the approved scope of work (this assumes delineation by excavation will be the accepted remedial technology).

Within ten business days of receipt of all data (laboratory reports, waste documentation, clean fill receipts, etc.), compile and submit electronically, a final form C-141 and report of remedial actions to the OCD with all supporting documentation.

Please feel free to contact me at 432.301.0209 if you have questions or concerns, or would like to discussed the proposed activities.

Sincerely,

Enviro Clean Cardinal, LLC

William “Bill” Green, PG No. 136, CPM
Texas Professional Geologist, Certified Project Manager
Hydrogeologist/Environmental Compliance Specialist

Attached: Release Location Map
EM38 1.0-Meter Vertical Dipole Survey Results
EM38 0.5-Meter Vertical Dipole Survey Results
EM-38/Chloride Calibration Map

Legend

Visibly Affected Surface Soils

N

N32.1724°

W103.0922°

Release Location Map

RAM Energy Resources - WDQSU Satellite 3

OCD Case No. 1RP-4599

Lea County, New Mexico

Approx. Scale:		Date:
1” = 120’	ENVIRO CLEAN CARDINAL	3/9/2017
2405 E. Co. Rd. 123, Midland, Texas 79706		Project No.: RAMRNM0001

LEGEND

★ LOCATION OF RELEASE POINT

× LOCATION OF EM38-MK2 GROUND CONDUCTIVITY MEASUREMENT IN mmhos/m

APPARENT GROUND CONDUCTIVITIES

Minimum mmhos/m	Maximum mmhos/m	Color
0	60	
60	120	
120	180	
180	240	
240	300	
300	360+	

N

75 0 75 150
SCALE FEET

NOTES:

1) EM SURVEY PERFORMED BY ENVIRO CLEAN CARDINAL, LLC ON FEBRUARY 28, 2017.
2) EM SURVEY CONDUCTED BY GEORGE H. (BUDDY) RICHARDSON, P.G. USING GEONICS EM38-MK2 GROUND CONDUCTIVITY METER.
3) AERIAL PHOTOGRAPH DATED NOVEMBER 22, 2016, GEOREFERENCED FROM GOOGLE EARTH IMAGE SERVICES.

ENVIRO CLEAN CARDINAL
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Tulsa, Oklahoma 74136
918.794.7828
www.EnviroCleanPS.com

DOCUMENT TITLE: EM38 SURVEY RESULTS

FIGURE TITLE: ***EM38 1.0-METER VERTICAL DIPOLE SURVEY RESULTS***

CLIENT: RAM ENERGY RESOURCES
TULSA, OKLAHOMA

LOCATION: WEST DOLLARHIDE QUEEN SAND UNIT SATELLITE 3
SECTION 31, T24S, R38E, LEA COUNTY, NEW MEXICO

DESIGNED BY	GHR		
APPROVED BY	GHR	SCALE	1"= 150'
DRAWN BY	SKG	DATE	2/28/2017

PROJECT NUMBER: RAMRNM0001

FIGURE NUMBER:

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LEGEND

★ LOCATION OF RELEASE POINT

× LOCATION OF EM38-MK2 GROUND CONDUCTIVITY MEASUREMENT IN mmhos/m

APPARENT GROUND CONDUCTIVITIES

Minimum mmhos/m	Maximum mmhos/m	Color
0	60	
60	120	
120	180	
180	240	
240	300	
300	360+	

N

75 0 75 150

SCALE FEET

NOTES:

1) EM SURVEY PERFORMED BY ENVIRO CLEAN CARDINAL, LLC ON FEBRUARY 28, 2017.
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ENVIRO CLEAN CARDINAL

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DOCUMENT TITLE: EM38 SURVEY RESULTS

FIGURE TITLE: ***EM38 0.50-METER VERTICAL DIPOLE SURVEY RESULTS***

CLIENT: RAM ENERGY RESOURCES
TULSA, OKLAHOMA

LOCATION: WEST DOLLARHIDE QUEEN SAND UNIT SATELLITE 3
SECTION 31, T24S, R38E, LEA COUNTY, NEW MEXICO

DESIGNED BY	GHR		
APPROVED BY	GHR	SCALE	1"= 150'
DRAWN BY	SKG	DATE	2/28/2017

PROJECT NUMBER	FIGURE NUMBER
RAMRNM0001	

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Legend

Chloride Calibration Sample Point

Visibly Affected Surface Soils

Yellow and Green Colors are the 1M EM-38 Survey Plot Overlay

N32.1724°

W103.0922°

EM-38/Chloride Calibration Map

RAM Energy Resources - WDQSU Satellite 3

OCD Case No. 1RP-4599

Lea County, New Mexico

Approx. Scale:		Date:
1” = 120’	ENVIRO CLEAN CARDINAL	3/7/2017
2405 E. Co. Rd. 123, Midland, Texas 79706		Project No.: RAMRNM0001