Durango Midstream, LLC
Hnulik 6 Lateral #1
32.80236°, -104.3429°
NMOCD Reference # nAPP2214534062
Terracon Project # AR227115

Attn: New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: **Closure Report**
Hnulik 6 Lateral #1
Unit M, Section 25, Township 17 South, Range 26 East
32.80236°, -104.3429°
Eddy County, New Mexico
Terracon Project No. AR227115

To Whom It May Concern:

Terracon Consultants, Inc. (Terracon) is pleased to submit our Closure Report for the site referenced above. The scope of services was developed in accordance with the New Mexico Oil Conservation Division (NMOCD) regulations concerning clean-up actions required for releases of crude oil and produced water. The investigative response actions resulted from a natural gas release from a corroded Hnulik 6 Lateral #1 line. The below sections detail Terracon's assessment and remediation actions in response to the noted release.

Action Items

Completed Actions

1)	Remedial Action Plan Approved on March 27, 2024
2)	The NMOCD also requested additional background samples to verify background sample findings.
3)	Terracon returned to the site to collect confirmation samples following the approval of the Remedial Action Plan.
4)	Terracon collected approximately 12 composite confirmation samples from the floor and walls of the excavation. Additionally, 30 additional background grab samples were collected from 2 feet bgs to 4 feet bgs, from the 10 original background sample locations.
5)	The soil removed from the area where the release occurred totaled approximately 350 cubic yards, from an area of 1,600 square feet. Excavated material was disposed under an approved form C-138. Excavated materials were disposed of at Lea Land Landfill (Lea Land) by Gandy Corporation (Gandy).
6)	Terracon conducted confirmation sampling utilizing the approved background chloride concentration for the area calculated to be 22,389 milligrams per kilogram (mg/kg) as approved in the Remedial Action Plan.

Durango Midstream, LLC
Hnulik 6 Lateral #1
32.80236°, -104.3429°
NMOCD Reference # nAPP2214534062
Terracon Project # KH227015

Anticipated Actions

1) NMOCD Approval

Terracon appreciates this opportunity to provide environmental services to Durango Midstream LLC (Durango). Should you have any questions or require additional information, please do not hesitate to contact our office.

Sincerely,
Terracon Consultants, Inc.

Travis Casey
Senior Staff Scientist
Carlsbad

Erin Loyd, P.G. (TX)
Senior Principal
Office Manager – Lubbock

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Durango Midstream, LLC
Hnulik 6 Lateral #1
32.80236°, -104.3429°
NMOCD Reference # nAPP22214534062
Terracon Project # AR227115

Section 1 – Incident Information

The following table provides detailed information regarding the April 13, 2022, natural gas and petroleum liquid release at the Hnulik 6 Leak #1 site in Eddy County, New Mexico:

Required Information	Site and Release information	
Responsible party	The facility is operated by Durango Midstream, LLC.	
Local contact	Contact: Mr. Sebastian Orozco	Contact: sorozco@durangomidstream.com
NMOCD Notification	Notice of the release was provided to the NMOCD District 2 Artesia Office by Ms. Amber Groves on May 24, 2022. nAPP2214534062	
Facility Description	Hnulik 6 Lateral #1 is in Eddy County, New Mexico. It is in an area located within Unit M, Section 25, Township 17 South, Range 30 East, approximately 3.6 miles southeast of Artesia, New Mexico. The site is predominantly undeveloped native privately owned pastureland.	
Time of incident	April 13, 2022, discovered at approximately 2:30 p.m.	
Discharge event	The natural gas pipeline leak was caused by corrosion of the steel line and was discovered leaking/seeping to the surface during normal field inspections. The Site is illustrated in Exhibits 1 and 2 of Appendix A	
Type of discharge	The documented natural gas and fluids release occurred in an open privately owned native pastureland site and is affected at the surface to depth.	
Quantity of spilled material	Total Fluids: <5 bbls	Total Fluids: <5 bbls
Site characteristics	Relatively flat with drainage following the native ground surface; very gently sloping to the southeast.	
Immediate corrective actions	The leaking pipeline was closed in at the nearest isolation valve and blown down. A backhoe was utilized to excavate soils to discover the source of the release.	

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Section 2 – General Site Characteristics

Physical Characteristic	Site Ranking Characteristics
Groundwater NMOSE POD Location Map – (Exhibit 6 in Appendix A)	POD Number: (RA-11547-POD2) Depth to Groundwater: 25 ft. bgs Distance to Well: 0.51 miles to the northwest Date Drilled: April 3, 2010
	Groundwater Quality: Groundwater quality at the site is predominately used for livestock production.
Surface Water NM Wetland Map – (Exhibit 7 in Appendix A)	Pecos River, approximately 0.85 miles to the east.
100-Year Flood Plain	This site is located within the 100-year flood plain of the Pecos River.
Soil Characteristics	Soils at the site are mapped as Arno-Harkey series soils, 0 to 1 percent slopes, well-drained, 0 to 9 inches silty clay loam, 9 to 60 inches silty clay (Arno setting) and 0 to 9 inches very fine sandy loam, 9 to 60 inches very fine sandy loam (Harkey setting). Restrictive features are assumed present at more than 80 inches bgs resulting in the formation being categorized with a very high runoff classification.
Karst Characterization Cave Karst Public UCP Map – (Exhibit 8 in Appendix A)	Terracon evaluated data from the NMOCD Public FTP Site, Karst map designations in reference to the site location. The site appears to be within a moderate-level Karst risk area. Based on on-site observations within the extent of the release margins the potential for Karst formations in this specific area is of moderate potential. Restrictive features were not encountered from surface to 54 inches below grade surface (bgs) within the release margins. The full extent of release quantities and excavation activities did not extend greater than 54 inches bgs.

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Section 3 – Regulatory Framework and Response Action Levels

Oil and gas exploration and production facilities in New Mexico are generally regulated by the New Mexico Oil Conservation Division (NMOCD). The NMOCD has issued the *Closure Criteria for Soils Impacted by a Release, June 21, 2018,* and *Restoration, Reclamation, and Re-vegetation (19.15.29.13) NMAC – D (Reclamation of areas no longer in use)* as guidance documents for the remediation and reclamation of sites impacted by releases from oil and gas exploration and production activities. Sections detailed below the applicability of these guidance documents to the site-specific characteristics associated with the Hnulik 6 Lateral #2 site.

Section 3.1 – Reclamation Levels (Surface to 4 ft. bgs)

The below Reclamation Limits for chlorides, TPH (GRO+DRO+MRO), BTEX (includes benzene, toluene, ethylbenzene, and xylenes), and benzene are defined within the New Mexico Administration Code (NMAC) *Restoration, Reclamation, and Re-vegetation* (19.15.29.13) *New Mexico Administration Code (NMAC) – D (Reclamation of areas no longer in use)* for soils extending to 4 ft. bgs.:

Constituent	Remediation Limits
Chloride	600 mg/kg
TPH (GRO+DRO+MRO)	100 mg/kg
BTEX	50 mg/kg
Benzene	10 mg/kg

Section 3.2 – Remediation Levels (> 4 ft. bgs)

Based on the site-specific characteristics, the applicable NMOCD remediation levels for Total BTEX, chloride, and TPH within soils, exclusive of the Reclamation Zone (surface to 4 ft. bgs), are as follows:

Constituent	Remediation Limit
Chloride	600 mg/kg
TPH (GRO+DRO+MRO)	100 mg/kg
BTEX	50 mg/kg
Benzene	10 mg/kg

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Section 3.2 – Background Chloride Remediation Levels

Terracon conducted a background evaluation of soils present greater than 50 feet outside of the release margins to establish chloride background levels surrounding and upgradient of the site (NMOCD Reference # nAPP2214534062). Chloride concentrations appear to be naturally elevated in this area due to the natural accumulation of soil salinity resulting from the wetting and drying of chlorides within the Pecos River and from the rising and falling of the alluvial perched water. Based on the evaluation of the detected chloride concentrations evaluated utilizing the EPAs ProUCL calculator to determine a 95% Upper Confidence Limit (UCL), the background chloride concentration for the area is calculated to be 22,389 milligrams per kilogram (mg/kg) as displayed in Figure 1 of Appendix B.

Constituent	Remediation Limit
Chloride	22,389 mg/kg

Section 4 – Analytical Results and Additional Field Activities

On April 11, 2024, eight confirmation soil samples were collected from the side walls of the excavation and the floor, none of the eight samples exhibited concentrations of BTEX or TPH above laboratory sample detection limits (SDL). The eight samples exhibited concentrations of chloride above laboratory SDLs their concentrations ranged from 496 mg/kg in FS-3 (4 ft bgs) to 8,400 mg/kg in S-SW-1 (surface to 4 ft bgs), and all chloride concentrations were below the established background concentration for the area of 22,389 mg/kg for chloride.

On May 16, 2024, four additional confirmation soil samples were collected from the floor of the excavation, none of the four samples exhibited concentrations of BTEX or TPH above laboratory SDL's. The four samples exhibited concentrations of chloride above laboratory SDLs ranging from 144 mg/kg in FS-07 (4 ft bgs) to 2,320 mg/kg in FS-06 (4 ft bgs), and all chloride concentrations were below the established background concentration for the area of 22,389 mg/kg for chloride.

On June 10, 2024, at the request of the NMOCD Terracon personnel returned to the site to collect 30 additional background samples from 2 ft bgs to 4 ft bgs at the 10 previously sampled background locations. Chloride was the only analysis run on these samples.

A summary of BTEX, chloride, and TPH concentrations of all collected soil samples is attached as Table 1.

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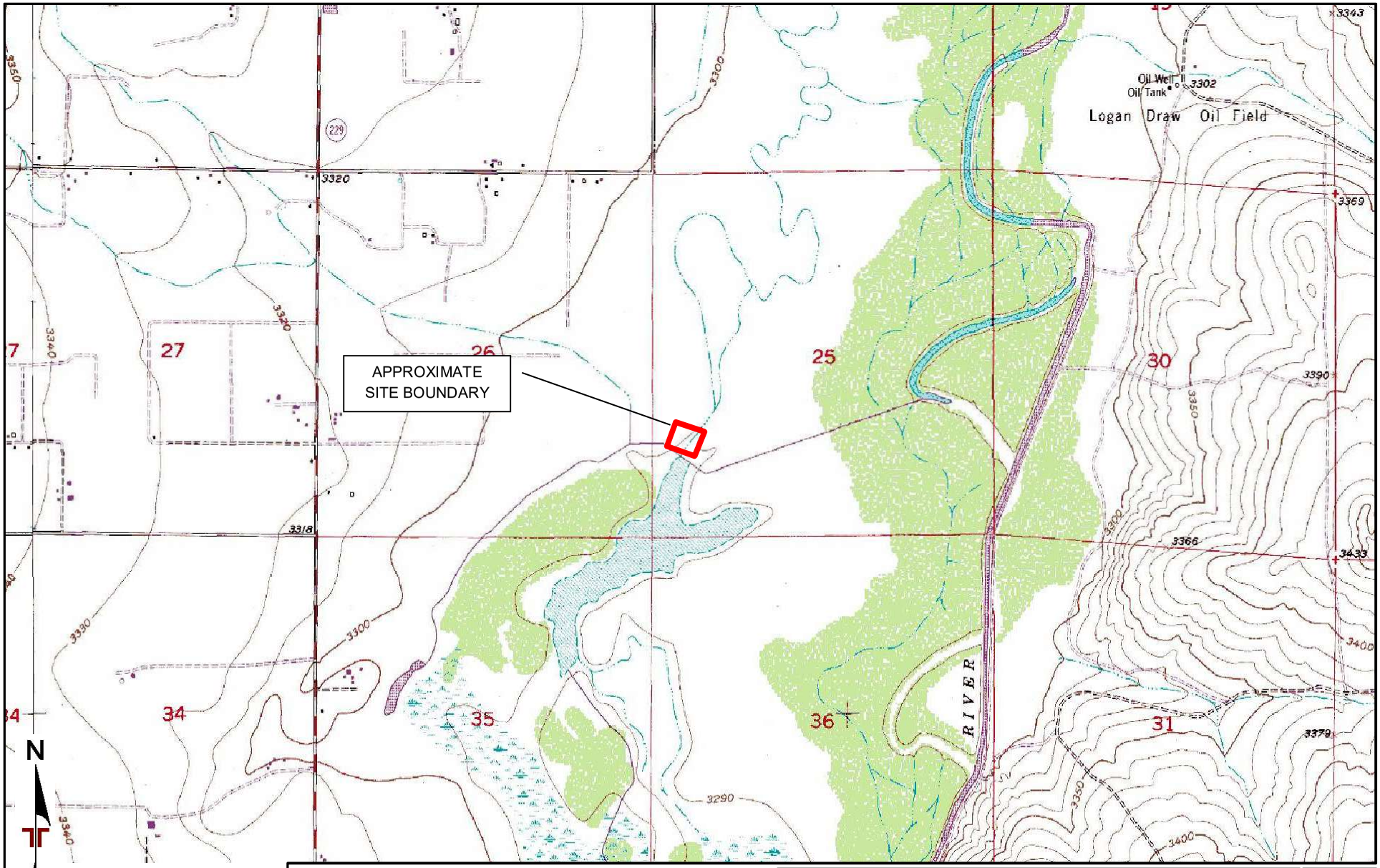
Section 5 – Conclusion and Closure Request

Terracon recommends closure of incident nAPP2214534062 following the completion of our confirmation soil sampling of the open excavation in accordance with NMAC 19.15.29.12. The confirmation sampling activities and remediation of the impacted material are complete in accordance with the recommended chloride standard based on the soil and perched alluvial water evaluations.

APPENDIX A – EXHIBITS



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: ARTESIA, NM (1/1/1975) and SPRING LAKE, NM (1/1/1975).

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	Joe Guesnier
Drawn by:	Austin Worley
Checked by:	Click
Approved by:	Click

Project No.	AR227115
Scale:	1"=2,500'
File Name:	Click
Date:	8/30/2022

Terracon

5847 50th Street

Lubbock, Texas 79424

TOPOGRAPHIC MAP

Hnulik 6' Lateral #1

32.80215, -104.34084

Artesia, New Mexico

Exhibit

1

Site Boundary

Project No.:	AR227115
Date:	May 28 2024
Drawn By:	JWL
Reviewed By:	JRG

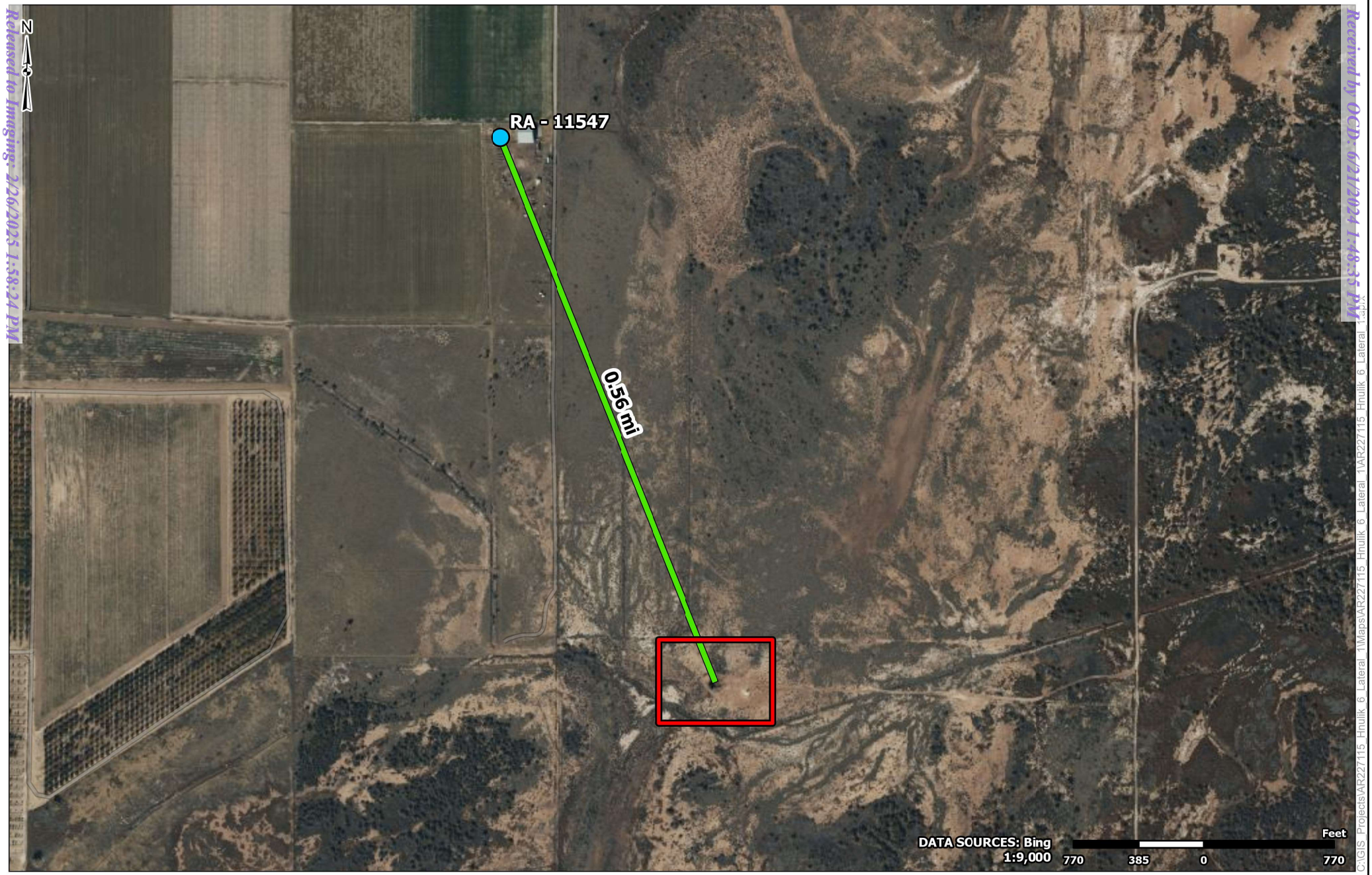
terracon
4526 W Pierce St
Carlsbad, NM
PH. 806-300-0140 terracon.com

Site Location Map

Hnulik 6- Lateral #1
Durango Midstream LLC
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

2



Site Boundary

NMOSE_POD_Eddy

Project No.:	AR227115
Date:	May 28 2024
Drawn By:	JWL
Reviewed By:	JRG

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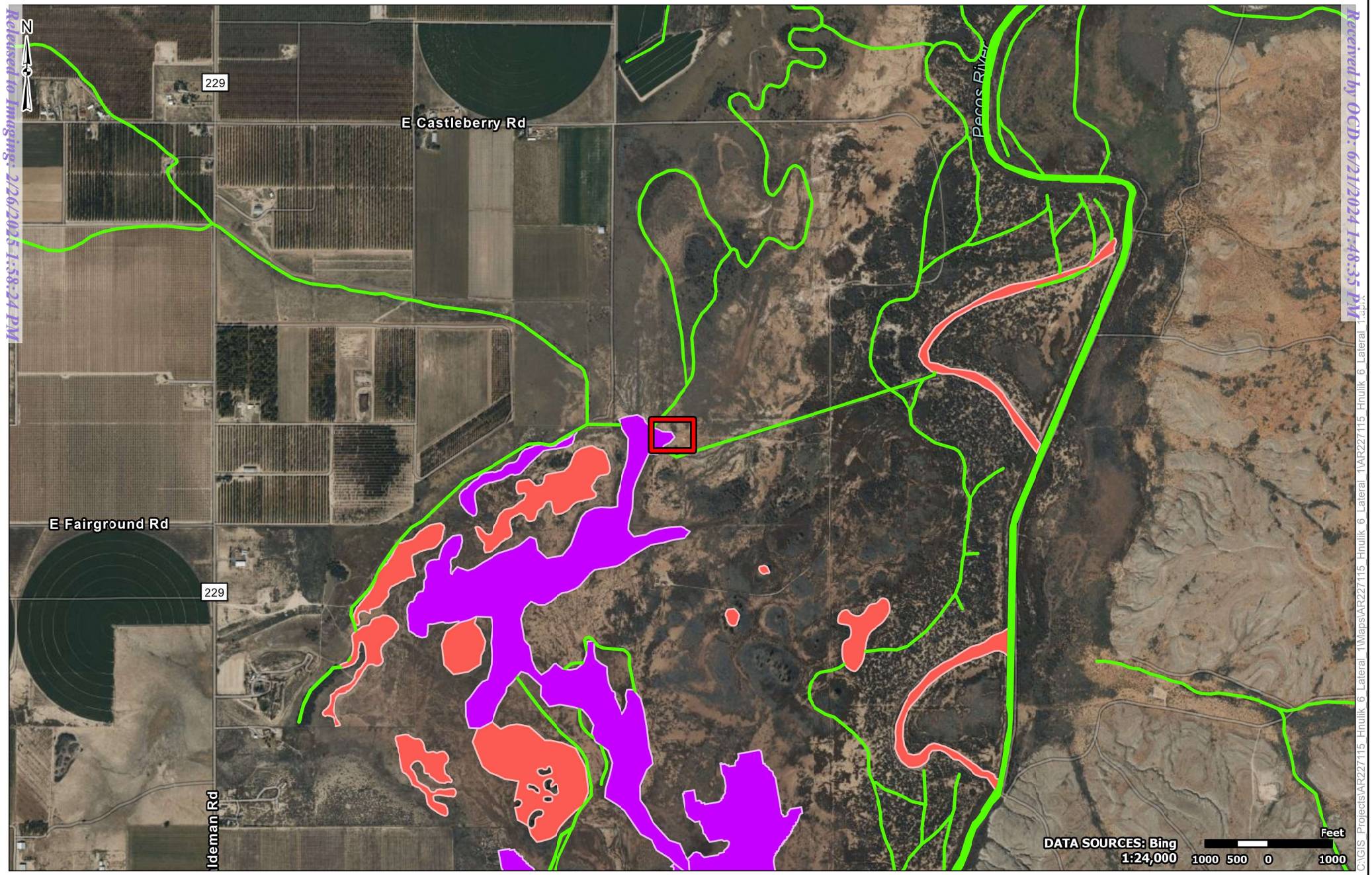
Carlsbad, NM
PH. 806-300-0140 terracon.com

NMOSE POD Location Map

Hnulik 6- Lateral #1
Durango Midstream LLC
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

3



- Site Boundary
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Riverine

Project No.:	AR227115
Date:	May 28 2024
Drawn By:	JWL
Reviewed By:	JRG

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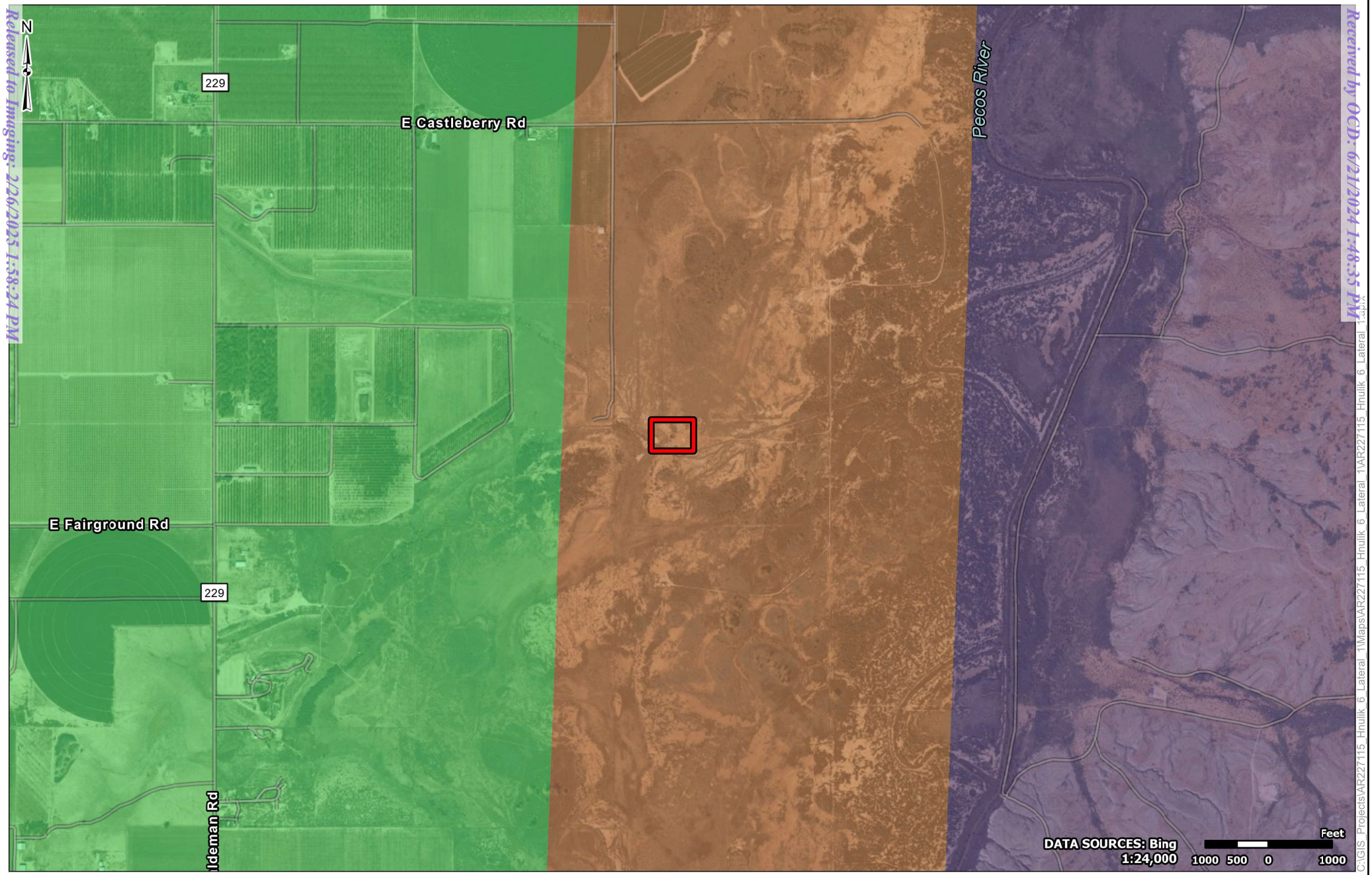
Carlsbad, NM
PH. 806-300-0140 terracon.com

Designated Wetland Area Map

Hnulik 6- Lateral #1
Durango Midstream LLC
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

4



Site Boundary

Karst Potential

- Low
- Medium
- High

Project No.:	AR227115
Date:	May 28 2024
Drawn By:	JWL
Reviewed By:	JRG

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Cave Karst Public UCP Map

Hnulik 6- Lateral #1
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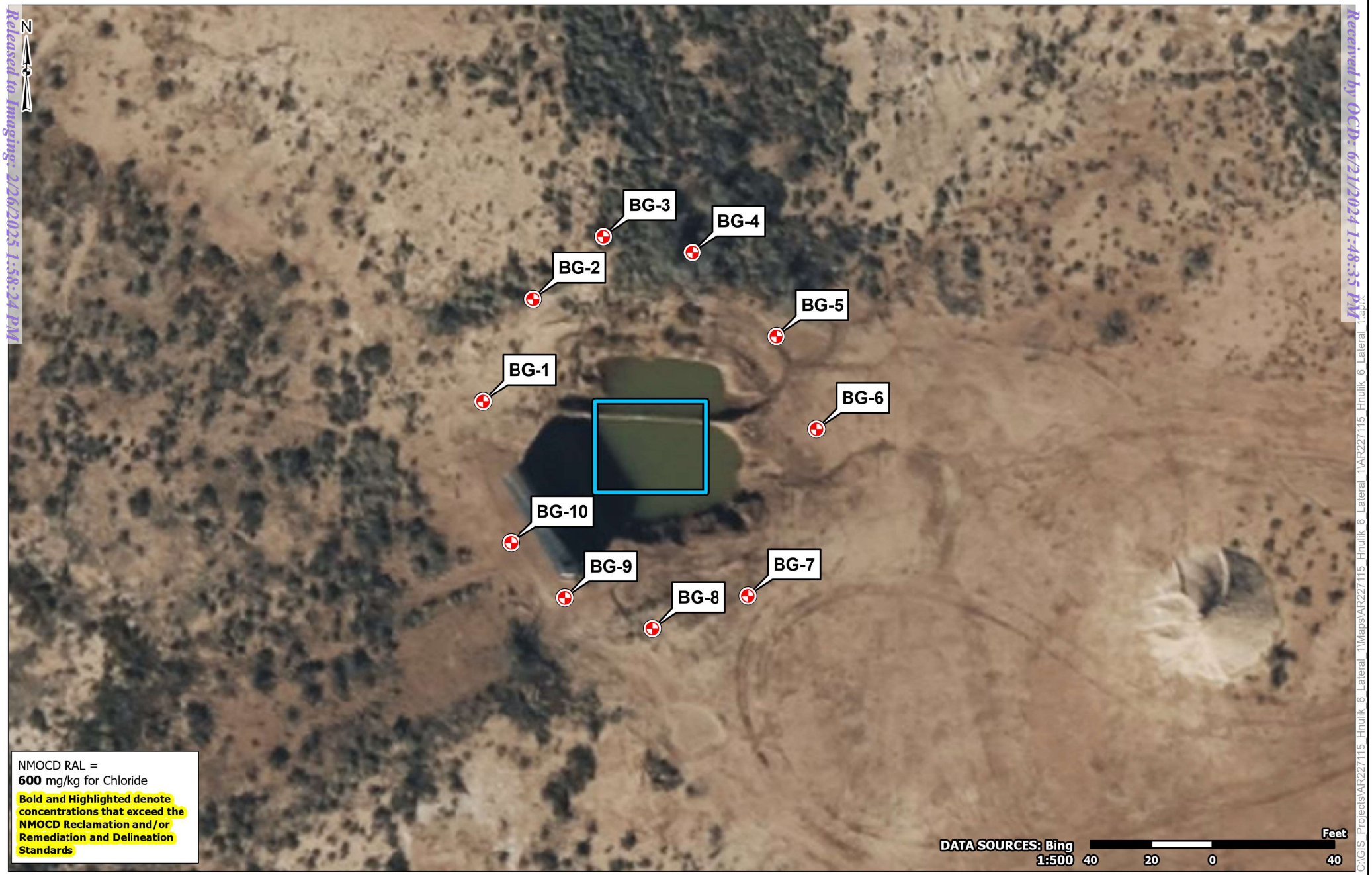
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

5



Background Sample

Inferred Release

Project No.:	AR227115
Date:	Jun 20 2024
Drawn By:	JWL
Reviewed By:	JRG

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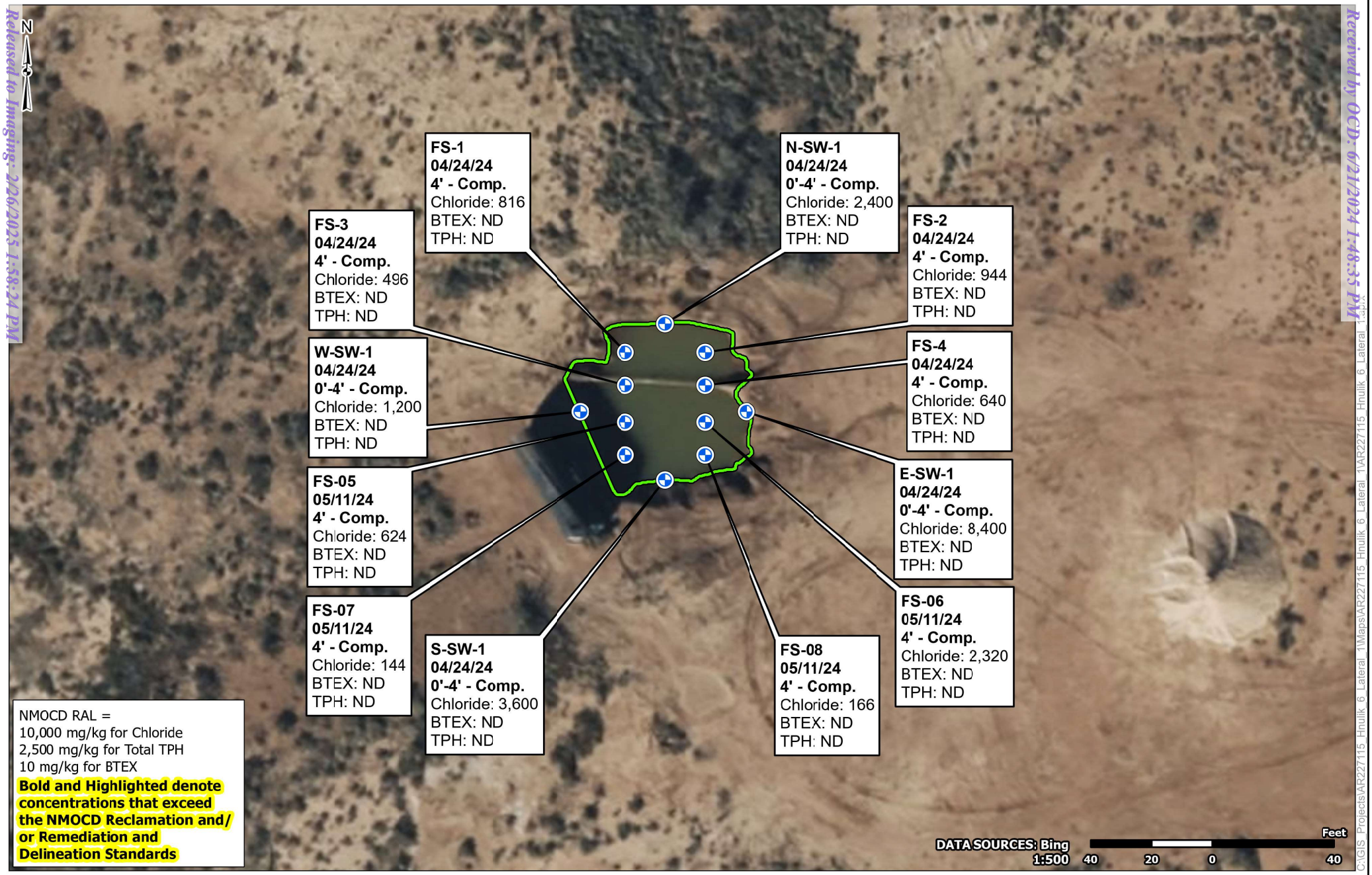
Carlsbad, NM
PH. 806-300-0140 terracon.com

Background Sample Map

Hnulik 6- Lateral #1
Durango Midstream LLC
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

6



Excavation Boundary

Confirmation Sample

Project No.:	AR227115
Date:	May 28 2024
Drawn By:	JWL
Reviewed By:	JRG

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PH. 806-300-0140
terracon.com

Confirmation Sample Map

Hnulik 6- Lateral #1
Durango Midstream LLC
32.8021763, -104.3412663
Artesia, Eddy County, New Mexico

Exhibit

7

APPENDIX B – TABLES, PROCEDURES, AND FIGURES

Table 1
Soil Analytical Results Summary - Background Samples
Project Code:
NMOCD Reference No.

Sample ID	Sample Date	Sample Depth (ft bgs)	Sample Type	Sample Status	Chloride (mg/Kg)	Benzene (mg/Kg)	Total BTEX[1] (mg/Kg)	Total TPH[2] (mg/Kg)	Gasoline Range Organics (C6-C10) (mg/Kg)	Diesel Range Organics (Over C10-C28) (mg/Kg)	Oil Range Organics (Over C28-C36) (mg/Kg)
					EPA Method 300	EPA Method 8021B	EPA Method 8021B	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M
Background Samples											
BG-1	7/25/2022	0.5'-1'	Grab	In-Situ	32,000	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-01	6/10/2024	2'	Grab	In-Situ	1,470						
BG-01	6/10/2024	3'	Grab	In-Situ	1,920						
BG-01	6/10/2024	4'	Grab	In-Situ	2,200						
BG-2	7/25/2022	0.5'-1'	Grab	In-Situ	14,400	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-02	6/10/2024	2'	Grab	In-Situ	1,520						
BG-02	6/10/2024	3'	Grab	In-Situ	1,280						
BG-02	6/10/2024	4'	Grab	In-Situ	1,300						
BG-3	7/25/2022	0.5'-1'	Grab	In-Situ	23,200	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-03	6/10/2024	2'	Grab	In-Situ	3,120						
BG-03	6/10/2024	3'	Grab	In-Situ	2,120						
BG-03	6/10/2024	4'	Grab	In-Situ	1,960						
BG-4	7/25/2022	0.5'-1'	Grab	In-Situ	25,600	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-04	6/10/2024	2'	Grab	In-Situ	1,220						
BG-04	6/10/2024	3'	Grab	In-Situ	1,840						
BG-04	6/10/2024	4'	Grab	In-Situ	2,440						
BG-5	7/25/2022	0.5'-1'	Grab	In-Situ	3,200	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-05	6/10/2024	2'	Grab	In-Situ	1,800						
BG-05	6/10/2024	3'	Grab	In-Situ	1,020						
BG-05	6/10/2024	4'	Grab	In-Situ	1,220						
BG-6	7/25/2022	0.5'-1'	Grab	In-Situ	10,300	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-06	6/10/2024	2'	Grab	In-Situ	1,680						
BG-06	6/10/2024	3'	Grab	In-Situ	2,880						
BG-06	6/10/2024	4'	Grab	In-Situ	3,200						
BG-7	7/25/2022	0.5'-1'	Grab	In-Situ	4,160	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-07	6/10/2024	2'	Grab	In-Situ	4,640						
BG-07	6/10/2024	3'	Grab	In-Situ	3,600						
BG-07	6/10/2024	4'	Grab	In-Situ	2,960						
BG-8	7/25/2022	0.5'-1'	Grab	In-Situ	10,100	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-08	6/10/2024	2'	Grab	In-Situ	5,200						
BG-08	6/10/2024	3'	Grab	In-Situ	4,640						
BG-08	6/10/2024	4'	Grab	In-Situ	3,520						
BG-9	7/25/2022	0.5'-1'	Grab	In-Situ	31,600	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-09	6/10/2024	2'	Grab	In-Situ	1,840						
BG-09	6/10/2024	3'	Grab	In-Situ	1,920						
BG-09	6/10/2024	4'	Grab	In-Situ	2,840						
BG-10	7/25/2022	0.5'-1'	Grab	In-Situ	21,800	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
BG-10	6/10/2024	2'	Grab	In-Situ	2,800						
BG-10	6/10/2024	3'	Grab	In-Situ	1,390						
BG-10	6/10/2024	4'	Grab	In-Situ	2,000						
NMOCD Reclamation Standards[3] (Surface to 4 ft bgs)					22,389	10	50	100	N/A		
NMOCD Remediation Standards[4] (Greater than Depths of 4 ft bgs)					22,389	10	50	100	N/A		

1. BTEX = Benzene, toluene, ethylbenzene, and total xylenes
2. TPH = Total petroleum hydrocarbons
3. New Mexico Administration Code (NMAC) Restoration, Reclamation and Re-vegatation (19.15.29.13), NMAC-D (Reclamation of Areas No Longer in Use) for Soils Extending to 4 ft. bgs
4. New Mexico Oil Conservation Division (NMOCD) Remediation and Delineation Standards (19.15.29.12) NMAC-N, 8/14/2018

< = Constituent was not detected above the indicated laboratory sample detection limit (SDL).
NA = Not Analyzed
Bold denotes concentrations above applicable laboratory SDLs.
Bold and Highlighted denote concentrations that exceed the NMOCD Reclamation and/or Remediation and Delineation Standards.
In-situ = Sample is representative of material which remains in-place at the site.
Excavated = Sample is representative of materials which was excavated and disposed of at a permited disposal facility.

Table 2
Soil Analytical Results Summary - Confirmation Floors
Project Code:
NMOCD Reference No.

Sample ID	Sample Date	Sample Depth (ft bgs)	Sample Type	Sample Status	Chloride (mg/Kg)	Benzene (mg/Kg)	Total BTEX[1] (mg/Kg)	Total TPH[2] (mg/Kg)	Gasoline Range Organics (C6-C10) (mg/Kg)	Diesel Range Organics (Over C10-C28) (mg/Kg)	Oil Range Organics (Over C28-C36) (mg/Kg)
					EPA Method 300	EPA Method 8021B	EPA Method 8021B	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M
Confirmation Table											
FS-01	4/11/2024	4'	Composite	In-Situ	816	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-02	4/11/2024	4'	Composite	In-Situ	944	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-03	4/11/2024	4'	Composite	In-Situ	496	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-04	4/11/2024	4'	Composite	In-Situ	640	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-05	5/16/2024	4'	Composite	In-Situ	624	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-06	5/16/2024	4'	Composite	In-Situ	2320	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-07	5/16/2024	4'	Composite	In-Situ	144	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
FS-08	5/16/2024	4'	Composite	In-Situ	160	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
NMOCD Reclamation Standards[3] (Surface to 4 ft bgs)					22,389	10	50	100	N/A		
NMOCD Remediation Standards[4] (Greater than Depths of 4 ft bgs)					22,389	10	50	100	N/A		

1. BTEX = Benzene, toluene, ethylbenzene, and total xylenes
2. TPH = Total petroleum hydrocarbons
3. New Mexico Administration Code (NMAC) Restoration, Reclamation and Re-vegatation (19.15.29.13), NMAC-D (Reclamation of Areas No Longer in Use) for Soils Extending to 4 ft. bgs
4. New Mexico Oil Conservation Division (NMOCD) Remediation and Delineation Standards (19.15.29.12) NMAC-N, 8/14/2018

< = Constituent was not detected above the indicated laboratory sample detection limit (SDL).
NA = Not Analyzed
Bold denotes concentrations above applicable laboratory SDLs.
Bold and Highlighted denote concentrations that exceed the NMOCD Reclamation and/or Remediation and Delineation Standards.
In-situ = Sample is representative of material which remains in-place at the site.
Excavated = Sample is representative of materials which was excavated and disposed of at a permited disposal facility.

Table 3
Soil Analytical Results Summary - Confirmation Walls
Project Code:
NMOCD Reference No.

Sample ID	Sample Date	Sample Start Depth (ft bgs)	Sample End Depth (ft bgs)	Sample Type	Sample Status	Chloride (mg/Kg)	Benzene (mg/Kg)	Total BTEX[1] (mg/Kg)	Total TPH[2] (mg/Kg)	Gasoline Range Organics (C6-C10) (mg/Kg)	Diesel Range Organics (Over C10-C28) (mg/Kg)	Oil Range Organics (Over C28-C36) (mg/Kg)
						EPA Method 300	EPA Method 8021B	EPA Method 8021B	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M	EPA Method 8015M
Confirmation Wall Samples												
N-SW-1	4/11/2024	0'	4'	Composite	In-Situ	2400	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
E-SW-1	4/11/2024	0'	4'	Composite	In-Situ	3600	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
S-SW-1	4/11/2024	0'	4'	Composite	In-Situ	8400	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
W-SW-1	4/11/2024	0'	4'	Composite	In-Situ	1200	<0.050	<0.300	<10.0	<10.0	<10.0	<10.0
NMOCD Reclamation Standards[3] (Surface to 4 ft bgs)						22,389	10	50	100	N/A		
NMOCD Remediation Standards[4] (Greater than Depths of 4 ft bgs)						22,389	10	50	100	N/A		

1. BTEX = Benzene, toluene, ethylbenzene, and total xylenes
2. TPH = Total petroleum hydrocarbons
3. New Mexico Administration Code (NMAC) Restoration, Reclamation and Re-vegatation (19.15.29.13), NMAC-D (Reclamation of Areas No Longer in Use) for Soils Extending to 4 ft. bgs
4. New Mexico Oil Conservation Division (NMOCD) Remediation and Delineation Standards (19.15.29.12) NMAC-N, 8/14/2018

< = Constituent was not detected above the indicated laboratory sample detection limit (SDL).
NA = Not Analyzed
Bold denotes concentrations above applicable laboratory SDLs.
Bold and Highlighted denote concentrations that exceed the NMOCD Reclamation and/or Remediation and Delineation Standards.
In-situ = Sample is representative of material which remains in-place at the site.
Excavated = Sample is representative of materials which was excavated and disposed of at a permited disposal facility.

	A	B	C	D	E	F	G	H	I	J	K
1	**UCL Statistics for Uncensored Full Data Sets**										
2											
3	User Selected Options										
4	Date/Time of Computation	ProUCL 5.2 4/3/2024 3:39:53 PM									
5	From File	WorkSheet.xls									
6	Full Precision	OFF									
7	Confidence Coefficient	95%									
8	Number of Bootstrap Operations	2000									
9											
10											
11	**C0**										
12											
13	**General Statistics**										
14	Total Number of Observations	10			Number of Distinct Observations	10					
15					Number of Missing Observations	0					
16	Minimum	2240			Mean	15680					
17	Maximum	32000			Median	12350					
18	SD	11574			Std. Error of Mean	3660					
19	Coefficient of Variation	0.738			Skewness	0.318					
20											
21	**Normal GOF Test**										
22	Shapiro Wilk Test Statistic	0.891			**Shapiro Wilk GOF Test**						
23	1% Shapiro Wilk Critical Value	0.781			Data appear Normal at 1% Significance Level						
24	Lilliefors Test Statistic	0.179			**Lilliefors GOF Test**						
25	1% Lilliefors Critical Value	0.304			Data appear Normal at 1% Significance Level						
26	**Data appear Normal at 1% Significance Level**										
27											
28	**Assuming Normal Distribution**										
29	**95% Normal UCL**				**95% UCLs (Adjusted for Skewness)**						
30	95% Student's-t UCL	22389			95% Adjusted-CLT UCL (Chen-1995)	22093					
31					95% Modified-t UCL (Johnson-1978)	22450					
32											
33	**Gamma GOF Test**										
34	A-D Test Statistic	0.388			**Anderson-Darling Gamma GOF Test**						
35	5% A-D Critical Value	0.739			Detected data appear Gamma Distributed at 5% Significance Level						
36	K-S Test Statistic	0.184			**Kolmogorov-Smirnov Gamma GOF Test**						
37	5% K-S Critical Value	0.271			Detected data appear Gamma Distributed at 5% Significance Level						
38	**Detected data appear Gamma Distributed at 5% Significance Level**										
39											
40	**Gamma Statistics**										
41	k hat (MLE)	1.57			k star (bias corrected MLE)	1.166					
42	Theta hat (MLE)	9988			Theta star (bias corrected MLE)	13452					
43	nu hat (MLE)	31.4			nu star (bias corrected)	23.31					
44	MLE Mean (bias corrected)	15680			MLE Sd (bias corrected)	14523					
45					Approximate Chi Square Value (0.05)	13.33					
46	Adjusted Level of Significance	0.0267			Adjusted Chi Square Value	12.03					
47											
48	**Assuming Gamma Distribution**										
49	95% Approximate Gamma UCL	27428			95% Adjusted Gamma UCL	30377					
50											

	E	F	G	H	I	J	K
51	**Lognormal GOF Test**						
52	Shapiro Wilk Test Statistic	0.9	**Shapiro Wilk Lognormal GOF Test**				
53	10% Shapiro Wilk Critical Value	0.869	Data appear Lognormal at 10% Significance Level				
54	Lilliefors Test Statistic	0.176	**Lilliefors Lognormal GOF Test**				
55	10% Lilliefors Critical Value	0.241	Data appear Lognormal at 10% Significance Level				
56	**Data appear Lognormal at 10% Significance Level**						
57							
58	**Lognormal Statistics**						
59	Minimum of Logged Data	7.714	Mean of logged Data	9.309			
60	Maximum of Logged Data	10.37	SD of logged Data	0.978			
61							
62	**Assuming Lognormal Distribution**						
63	95% H-UCL	48271	90% Chebyshev (MVUE) UCL	32963			
64	95% Chebyshev (MVUE) UCL	40323	97.5% Chebyshev (MVUE) UCL	50538			
65	99% Chebyshev (MVUE) UCL	70603					
66							
67	**Nonparametric Distribution Free UCL Statistics**						
68	**Data appear to follow a Discernible Distribution**						
69							
70	**Nonparametric Distribution Free UCLs**						
71	95% CLT UCL	21700	95% BCA Bootstrap UCL	22056			
72	95% Standard Bootstrap UCL	21419	95% Bootstrap-t UCL	23265			
73	95% Hall's Bootstrap UCL	21126	95% Percentile Bootstrap UCL	21630			
74	90% Chebyshev(Mean, Sd) UCL	26660	95% Chebyshev(Mean, Sd) UCL	31633			
75	97.5% Chebyshev(Mean, Sd) UCL	38536	99% Chebyshev(Mean, Sd) UCL	52096			
76							
77	**Suggested UCL to Use**						
78	95% Student's-t UCL	22389					
79							
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.						
81	Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.						
82	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.						
83							

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December 2002

CALCULATING UPPER CONFIDENCE LIMITS FOR EXPOSURE POINT CONCENTRATIONS AT HAZARDOUS WASTE SITES

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, D.C. 20460

Disclaimer

This document provides guidance to EPA Regions concerning how the Agency intends to exercise its discretion in implementing one aspect of the CERCLA remedy selection process. The guidance is designed to implement national policy on these issues.

The statutory provisions and EPA regulations described in this document contain legally binding requirements. However, this document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. Any decisions regarding a particular remedy selection decision will be made based on the statute and regulations, and EPA decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

TABLE OF CONTENTS

1.0 INTRODUCTION

This document updates a 1992 guidance originally developed to supplement EPA's *Risk Assessment Guidance for Superfund (RAGS), Volume 1 – Human Health Evaluation Manual* (RAGS/HHEM, EPA 1989), which describes a general approach for estimating exposure of individuals to chemicals of potential concern at hazardous waste sites. It addresses a key element of the risk assessment process for hazardous waste sites: estimation of the concentration of a chemical in the environment. This concentration, commonly termed the exposure point concentration (EPC), is a conservative estimate of the average chemical concentration in an environmental medium. The EPC is determined for each individual exposure unit within a site. An exposure unit is the area throughout which a receptor moves and encounters an environmental medium for the duration of the exposure. Unless there is site-specific evidence to the contrary, an individual receptor is assumed to be equally exposed to media within all portions of the exposure unit over the time frame of the risk assessment.

EPA recommends using the average concentration to represent "a reasonable estimate of the concentration likely to be contacted over time" (EPA 1989). The guidance previously issued by EPA in 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992), states that, "because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable." The 1992 guidance addresses two kinds of data distributions: normal and lognormal. For normal data, EPA recommends an upper confidence limit (UCL) on the mean based on the Student's *t*-statistic. For lognormal data, EPA recommends the Land method using the *H*-statistic. EPA describes approaches for testing distribution assumptions in *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (EPA 2000b, section 4.2).

The 1992 guidance has been helpful for EPC calculation, but it does not address data distributions that are neither normal nor lognormal. Moreover, as has been widely acknowledged, the Land method can sometimes produce extremely high values for the UCL when the data exhibit high variance and the sample size is small (Singh et al. 1997; Schulz and Griffin 1999). EPA's 1992 guidance recognizes the problem of extremely high UCLs, and recommends that the maximum detected concentration become the default when the calculated UCL exceeds this value. Singh et al. (1997) and Schulz and Griffin (1999) suggest several alternate methods for calculating a UCL for non-normal data distributions. This guidance provides additional tools that risk assessors can use for UCL calculation, and assists in applying these methods at hazardous waste sites. It begins with a discussion of issues related to evaluating the available site data and then presents brief discussions of alternative methods for UCL calculation, with recommendations for their use at hazardous waste sites. In addition, EPA has worked with its contractor, Lockheed Martin to develop a software package, ProUCL, to perform many of the calculations described in this guidance (EPA 2001a). Both ProUCL and this guidance make recommendations for calculating UCLs, and are intended as tools to support risk assessment.

To obtain a copy of the ProUCL software or receive technical assistance in using it, risk assessors should contact:

Director of the Technical Support Center
USEPA Office of Research and Development
National Exposure Research Laboratory
Environmental Sciences Division
Las Vegas, Nevada
702-798-2270.

The ultimate responsibility for deciding how best to represent the concentration data for a site lies with the project team.[1] Simply choosing a statistical method that yields a lower UCL is not always the best representation of the concentration data at a site. The project team may elect to use a method that yields a higher (i.e., more conservative) UCL based on its understanding of site-specific conditions, including the representativeness of the data collection process, and the limits of the available statistical methods for calculating a UCL.

2.0 APPLICABILITY OF THIS GUIDANCE

This document updates 1992 guidance developed by EPA's Office of Emergency and Remedial Response; yet it can be applied to any hazardous waste site. It provides alternative methods for calculating the 95 percent upper confidence limit of the mean concentration, which can be used at sites subject to the discretion of the regulatory agencies and programs involved. The approaches described in this document are not specific to a particular medium (e.g., soil, groundwater), or receptor (e.g., human ecological), but apply to any media or receptor for which the UCL would be calculated.[2]

This document does not substitute for any statutory provisions or regulations, nor is it a regulation itself. Thus, it cannot impose legally-binding requirements on EPA, States, or the regulatory community, and may not apply to a particular situation based upon the circumstances. Any decision regarding cleanup of a particular site will be made based on the statutes and regulations, and EPA decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance to a particular situation. The Agency accepts public input on this document at any time.

This guidance is based on the state of knowledge at present. The practices discussed herein may be refined, updated, or superseded by future advances in science and mathematics.

[1] The project team typically consists of a site manager (e.g., the Remedial Project Manger) and a multidisciplinary team of technical experts, including human health and ecological risk assessors, hydrogeologists, chemists, toxicologists, and quality assurance specialists.

[2] Note that this guidance does not apply to lead-contaminated sites. The Technical Review Working Group for Lead recommends that the average concentration is used in evaluating lead exposures (see http://www.epa.gov/superfund/programs/ lead/trwhome.htm).

3.0 DATA EVALUATION

In the risk assessment process, data evaluation precedes exposure assessment. Because this guidance deals with a component of exposure assessment, it therefore assumes that data have already undergone validation and evaluation and that the data have been determined to meet data quality objectives (DQOs) for the project in question. DQOs are important for any project where environmental data are used to support decision-making, as at hazardous waste sites.

One factor to consider in data evaluation is whether the number of sample measurements is sufficient to characterize the site or exposure unit. The minimum number of samples to conduct any of the statistical tests described in this document should be determined using the DQO process (EPA 2000a). Use of the methods described in this guidance is not a substitute for obtaining an adequate number of samples. Sample size is especially important when there is large variability in the underlying distribution of concentrations. However, defaulting to the maximum value of small data sets may still be the last resort when the UCL appears to exceed the range of concentrations detected.

Another important issue to consider is the method of sampling. All the statistical methods described in this guidance for calculating UCLs are based on the assumption of random sampling. At many hazardous waste sites, however, sampling is focused on areas of suspected contamination. In such cases, it is important to avoid introducing bias into statistical analyses. This can be achieved through stratified random sampling, i.e., random sampling within specified targeted areas. So long as the statistical analysis is constructed properly (i.e., there is no mixing of samples across different populations) bias can be minimized. The risk assessor should always note any potential bias in EPC estimates.

The risk assessor should also consider the duration of exposure and the time scale of the toxicity. For example, a chronic exposure may warrant the use of different concentrations or sample locations from an acute exposure. The time periods over which data were collected should also be considered. See EPA 1989, Chapters 5.1 and 6.4.2, for further details.

Once a set of data from a site has been evaluated and validated, it is appropriate to conduct exploratory analysis to determine whether there are outliers or a substantial number of non-detect values that can adversely affect the outcome of statistical analyses. The following sections describe the potential impact of outliers and non-detect values on the calculation of UCLs and approaches for addressing these types of values.

3.1 Outliers

Outliers are values in a data set that are not representative of the set as a whole, usually because they are very large relative to the rest of the data. There are a variety of statistical tests for determining whether one or more observations are outliers (EPA 2000b, section 4.4). These tests should be used judiciously, however. It is common that the distribution of concentration data at a site is strongly skewed so that it contains a few very high values corresponding to local hot spots of contamination. The receptor could be exposed to these hot spots, and to estimate the EPC correctly it is important to take account of these values. Therefore, one should be careful not to exclude values merely because they are large relative to the rest of the data set.

Extreme values in the data set may represent true spatial variation in concentrations. If an observation or group of observations is suspected to be part of a different contamination source or exposure unit, then regrouping of the data may be most appropriate. In this case, it may be necessary to evaluate these data as a separate hot spot or to resample. The behavior of the receptor and the size and location of the exposure unit will determine which sample locations to include. Such decisions depend on project-specific assessments based on the conceptual site model.

EPA guidance suggests that, when outliers are suspected of being unreliable and statistical tests show them to be unrepresentative of the underlying data set, any subsequent statistical analyses should be conducted both with and without the outlier(s) (EPA 2000b). In addition, the entire process, including identification, statistical testing and review of outliers, should be fully documented in the risk characterization.

3.2 Non-detects

Chemical analyses of contaminant concentrations often result in some samples being reported as below the sample detection limit (DL). Such values are called non-detects. Non-detects may correspond to concentrations that are actually or virtually zero, or they may correspond to values that are considerably larger than zero but which are below the laboratory's ability to provide a reliable measurement. Elevated detection limits need to be investigated, especially if there are high percentages of non-detects. It is not appropriate to simply account for elevated detection limits with statistical techniques; improvements in sampling and analysis methods may be needed to lower detection limits.

In this guidance, the term "detection limit" is used to represent the reported limit of the non-detect. In reality, this could be any of a number of detection or quantitation limits. For further discussion of detection and quantitation limits in the risk assessment, see text box and Chapter 5 of EPA 1989.

Alternative Quantitation Limits

Method Detection Limit (MDL): The lowest concentration of a hazardous substance that a method can detect reliably in either a sample or blank.

Contract-Required Quantitation Limit (CRQL): The substance-specific level that a CLP laboratory must be able to routinely and reliably detect in specific sample matrices. The CRQL is not the lowest detectable level achievable, but rather the level that a CLP laboratory must reliably quantify. The CRQL may or may not be equal to the quantitation limit of a given substance in a given sample.

Source: Superfund Glossary of Terms and Acronyms (http://www.epa.gov/superfund/resources/hrstrain/htmain/glossal.htm

In the statistical literature, data sets containing non-detects are called censored or left-censored. The detection limit achieved for a particular sample depends on the sensitivity of the measuring method used, the instrument quantitation limit, and the nature of dilutions and other preparations employed for the sample. In addition, there may be different degrees of censoring. For instance, some laboratories use the letter code "J" to indicate that a value was below the quantitation limit and the letter "U" to indicate that a value was below the detection limit. These code systems vary among laboratories, however, and it is essential to understand what the laboratory notations indicate about the reliability of its measurements.[3] Censoring can cause problems in calculating the UCL. There are several common options for handling non-detects.

Reexamining the conceptual site model may suggest that the data be partitioned. For instance, it may be clear from the spatial pattern of non-detects in the data that the region sampled can be subdivided into contaminated and non-contaminated areas. Evidence for this depends on the observed pattern of contamination, how the contamination came to be located in the medium, and how the receptors will come in contact with the medium. It may be necessary to collect more samples to obtain an adequate site characterization.

Simple Substitution methods assign a constant value or constant fraction of the detection limit (DL) to the non-detects. Three common conventions are: (1) assume non-detects are equal to zero; (2) assume non-detects are equal to the DL; or (3) assume non-detects are equal to one-half the DL. Whatever proxy value is assigned, it is then used as though it were the reliably estimated value for that measurement. Because of the complicated formulas used to compute UCLs, there is no general rule about which substitution rule will yield an appropriate UCL. The uncertainty associated with the substitution method increases, and its appropriateness decreases, as the detection limit becomes larger and as the number of non-detects in the data set increases.

Bounding methods estimate limits on the UCL in a distribution-free way. This method involves determining the lower and upper bounds of the UCL based on the full range of possible values for non-detects. If the uncertainty arising from censoring is relatively small, then the difference between the lower and upper bound estimates will be small. It is not possible to bound the UCL by using simple substitution methods such as computing the UCL once with the non-detects replaced by zeros and once with the non-detects replaced by their respective detection limits. Sometimes using all zeros will inflate the estimate of the standard deviation of the concentration values to such a degree that the resulting value for the UCL is larger than the value from using the detection limits (Ferson et al. 2002, Rowe 1988, Smith 1995). See Appendix A for an example of how to compute bounds on the UCL.

Distributional methods rely on applying an assumption that the shape of the distribution of non-detect values is similar to that of measured concentrations above the detection limit. EPA provides guidance on handling non-detects using several distributional methods, including Cohen's method (EPA 2000b, section 4.7). In addition, Helsel (1990) reviews a variety of distributional methods (see also Hass and Scheff 1990; Gleit 1985; Kushner 1976; Singh and Nocerino 2001). EnvironmentalStats for S-PLUS (Millard 1997) offers an array of methods for estimating parameters from censored data sets.

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[3] Information concerning the quantitation limits also should be incorporated into the appropriate supplemental tables in the framework for risk assessment planning, reporting, and review described in the *Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Part D (RAGS, Part D)* (EPA 1998.)

The appropriate method to use depends on the severity of the censoring, the size of the data set, and what distributional assumptions are reasonable. There are five recommendations about how to treat censoring in the estimation of UCLs.

1) Detection limits should always be reported for non-detects. Non-detects should also be reported with observed values where possible.
2) It is inappropriate to convert non-detects into zeros without specific justification (e.g., the analyte was not detected above the detection limit in any sample at the site).
3) If a bounding analysis reveals that the quantitative effects of censoring are negligible, then no further analysis may be required.
4) If further analysis is desired, consider using a distribution-specific method.
5) If the proportion of non-detects is high (• 75%) or the number of samples is small (n<5), no method will work well. In this case, it is reasonable to report the percentage of data below the detection limit, and resort again to a bounding approach in which non-detects are replaced by the detection limit and used to compute a UCL value that is reported as a number likely to be considerably larger than the true mean.

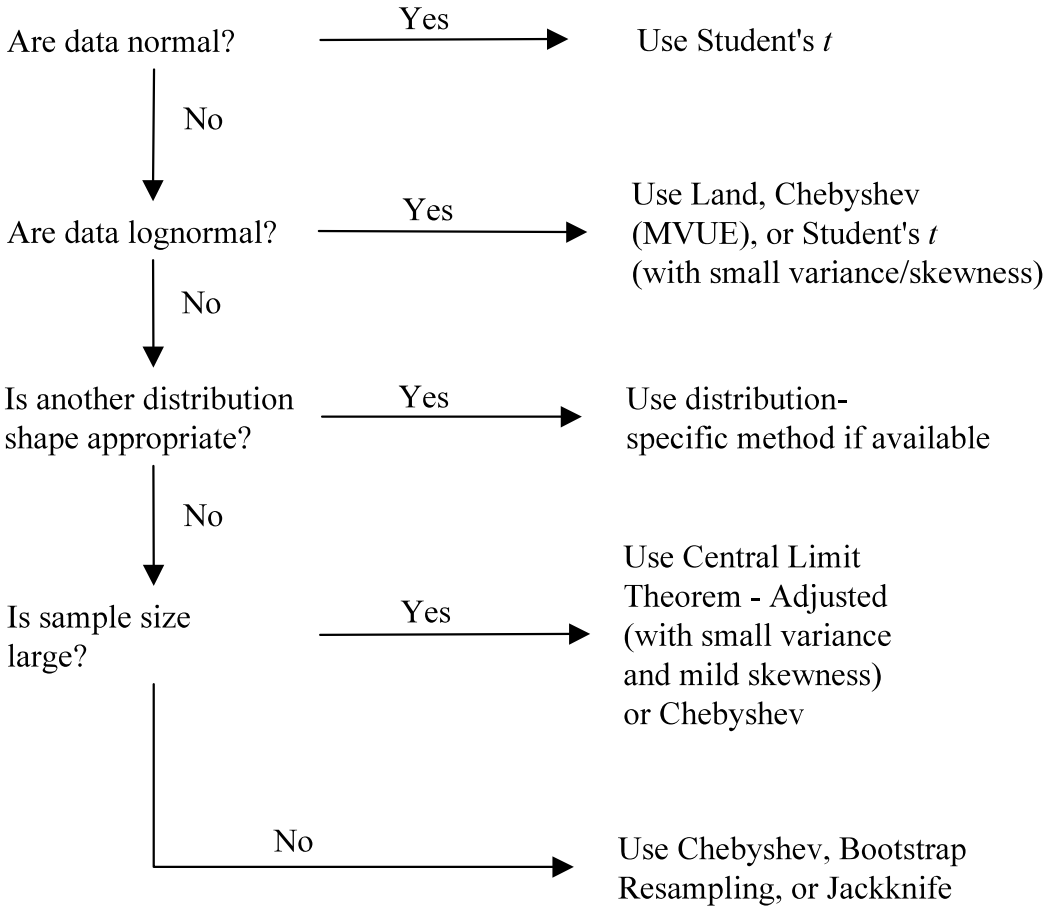
4.0 UCL CALCULATION METHODS

There are a number of different methods for calculating UCLs. Before an appropriate method can be selected the site data must be characterized through exploratory analysis. Fitting distributions to the data is a crucial part of this exploratory data analysis (Schulz and Griffin 1999). As recommended by EPA (1992), "where there is a question about the distribution of the data set, a statistical test should be used to identify the best distributional assumption for the data set." This is necessary because no single distribution type fits all environmental data sets. Risk assessors deal with some environmental data sets that appear normally distributed, and with others that appear lognormally distributed. They also encounter data sets that do not fit either normal or lognormal distributions. Distributions can be analyzed by a variety of methods, many of which are described in Gilbert (1987) and EPA (2000b). Data plotting can also help identify a useful distributional assumption. Some of these methods have been incorporated in the ProUCL software. Whatever method is used, it should be chosen in consultation with the EPA regional risk assessor and other project team members as appropriate. The assistance of a statistician may also be helpful in some cases.

The two most commonly used methods for computing UCLs are distributional methods. When the concentration distribution is normal, the classical approach based on the Student's t-statistic has typically been used. When the distribution is lognormal, the Land method based on the H-statistic has been used. Distribution-free or nonparametric methods are available if the risk assessor cannot reasonably make assumptions about the distributional type. EPA describes several methods (EPA, 2000c). For large data sets, an approach based on the Central Limit Theorem with a correction for positive skewness may be used. For data sets that are not large enough for this approach, there is more than one approach available, although none is ideal in all circumstances. General methods include an approach based on the Chebyshev inequality and an approach based on the bootstrap resampling procedure. These are described in EPA (2000c) and in Schulz and Griffin (1999). Both papers give examples and comparisons of the UCLs calculated by various methods. The flow chart shown in Figure 1 summarizes the recommendations in this guidance.

It should be noted that the "variance" in Figure 1 represents the variance of the log-transformed data. For detailed definitions of skewness, refer to the User's Guide for the ProUCL software.

Figure 1: UCL Method Flow Chart



Risk assessors are encouraged to use the most appropriate estimate for the EPC given the available data. The flow chart in Figure 1 provides general guidelines for selecting a UCL calculation method. This guidance presents descriptions of these methods, including their applicability, advantages and disadvantages. It also includes examples of how to calculate UCLs using the methods. While the methods identified in this guidance may be useful in many situations, they will probably not be appropriate for all hazardous waste sites. Moreover, other methods not specifically described in this guidance may be most appropriate for particular sites. The EPA risk assessor should be involved in the decision of which method(s) to use.

4.1 UCL Calculation with Methods for Specific Distributions

This section of the guidance presents methods for calculating UCLs when data can be shown to fit a specific distribution. Directions for using methods to calculate UCL for normal, lognormal, and other specific distributions are included, as are example calculations.

UCLs for Normal Distributions

If the data are normally distributed, then the one-sided (1-α) upper confidence limit $UCL_{1-\alpha}$ on the mean should be computed in the classical way using the Student's *t*-statistic (EPA 1992; Gilbert 1987, page 139; Student 1908). There is no change in EPA's prior recommendations for this type of data set (EPA 1992). Exhibit 1 gives the procedure for computing the UCL of the mean when the underlying distribution is normal. Exhibit 2 gives a numerical example of an application of the method.

Exhibit 1: Directions for Computing UCL for the Mean of a Normal Distribution — Student's *t*

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the sample mean $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$.

STEP 2: Compute the sample standard deviation $s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$.

STEP 3: Use a table of quantiles of the Student's *t* distribution to find the $(1-\alpha)^{th}$ quantile of the Student's *t* distribution with n-1 degrees of freedom. For example, the value at the 0.05 level with 40 degrees of freedom is 1.684. A table of Student's *t* values can be found in Gilbert (1987, page 255, where the values are indexed by p=1-α, rather than α level). The *t* value appropriate for computing the 95% UCL can be obtained in Microsoft Excel® with the formula TINV((1-0.95)*2, n-1).

STEP 4: Compute the one-sided (1-α) upper confidence limit on the mean

$$UCL_{1-\alpha} = \overline{X} + t_{\alpha,n-1}\, s / \sqrt{n}$$

Exhibit 2: An Example Computation of UCL for a Normal Distribution — Student's *t*

25 samples were collected at random from an exposure unit. The values observed are 228, 552, 645, 208, 755, 553, 674, 151, 251, 315, 731, 466, 261, 240, 411, 368, 492, 302, 438, 751, 304, 368, 376, 634, and 810 µg/L. It seems reasonable that the data are normally distributed, and the Shapiro-Wilk W test for normality fails to reject the hypothesis that they are (W = 0.937). The UCL based on Student's t is computed as follows.

STEP 1: The sample mean of the n=25 values is $\overline{X}$ = 451.

STEP 2: The sample standard deviation of the values is s = 198.

STEP 3: The t-value at the 0.05 level for 25-1 degrees of freedom is $t_{0.05,25\text{-}1}$ = 1.710.

STEP 4: The one-sided 95% upper confidence limit on the mean is therefore

$$UCL_{95\%} = 451 + 1.710 \times 198 / \sqrt{25} = 519$$

Testing for normality. For mildly skewed data sets, the student's t-statistic approach may be used to compute the UCL of the mean. But for moderate to highly skewed data sets, the t-statistic-based UCL can fail to provide the specific coverage for the population mean. This is especially true for small n. For instance, the 95% UCL based on 10 random samples from a lognormal distribution with mean 4.48 and standard deviation 5.87 will underestimate the true mean about 20% of the time, rather than the nominal rate of 5%. Therefore it is important to test the data for normality. EPA (2000b, section 4.2) gives guidance for several approaches for testing normality. The tests described therein are available in DataQUEST and ProUCL, which are convenient software tools (EPA 1997 and 2001a).

Accounting for non-detects. The use of substitution methods to account for non-detects is recommended only when a very small percentage of the data is censored (e.g., • •15%), under the presumption that the numerical consequences of censoring will be minor in this case. As the percentage of the data censored increases, substitution methods tend to alter the distribution and violate the assumption of normality. Moreover, the effect of the various substitution rules on UCL estimation is difficult to predict. Replacing non-detects with half the detection limit can underestimate the UCL, and replacing them with zeros may overestimate the UCL (because doing so inflates the estimate of the standard deviation).

When censoring is moderate (e.g., >15% and • •50%), it is preferable to account for non-detects with Cohen's method (Gilbert 1987). EPA provides guidance on the use of Cohen's method, which is a maximum likelihood method for correcting the estimates of the sample mean and the sample variance to account for the presence of non-detects among the data (EPA 2000b, beginning on page 4-43). This method requires that the detection limit be the same for all the data and that the underlying data are normally distributed.

UCLs for Lognormal Distributions

It is inappropriate to extend the methods of the previous section to lognormally distributed samples by log-transforming the data, computing a UCL and then back-transforming the results. For

concentration data sets that appear to be lognormally distributed, it may instead be preferable to use one of several methods available that are specifically well-suited to this type of distribution. These methods are described in the following sections.

Land Method

In past guidance, EPA had recommended using the Land method to compute the upper confidence limit on the mean for lognormally distributed data (Land 1971, 1975; Gilbert 1987; EPA 1992; Singh et al. 1997). This method requires the use of the *H*-statistic, tables for which were published by Land (1975) and Gilbert (1987, Tables A10 and A12). Exhibit 3 gives step-by-step directions for this method and Exhibit 4 gives a numerical example of its application.

Caveats about this method. Land's approach is known to be sensitive to deviations from lognormality. The formula may commonly yield estimated UCLs substantially larger than necessary when distributions are not truly lognormal if variance or skewness is large (Gilbert 1987). When sample sizes are small (less than 30), the method can be impractical even when the underlying distribution is lognormal (Singh et al. 1997).

Exhibit 3: Directions for Computing UCL for the Mean of a Lognormal Distribution— Land Method

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the arithmetic mean of the log-transformed data $\overline{\ln X} = \frac{1}{n}\sum_{i=1}^{n}\ln(X_i)$.

STEP 2: Compute the associated standard deviation $s_{\ln X} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\ln(X_i) - \overline{\ln X}\right)^2}$.

STEP 3: Look up the $H_{1-\alpha}$ statistic for sample size n and the observed standard deviation of the log-transformed data. Tables of these values are given by Gilbert (1987, Tables A-10 and A-12) and Land (1975).

STEP 4: Compute the one-sided (1-α) upper confidence limit on the mean

$$UCL_{1-\alpha} = \exp\left(\overline{\ln X} + s_{\ln X}^2/2 + H_{1-\alpha}s_{\ln X}/\sqrt{n-1}\right)$$

Testing for lognormality. Because the Land method assumes lognormality, it is very important to test this assumption. EPA gives guidance for several approaches to testing distribution assumptions (EPA 2000b, section 4.2). The tests are also available in the DataQUEST and ProUCL software tools (EPA 1997 and 2001a).

Exhibit 4: An Example Computation of UCL for a Lognormal Distribution — Land Method

31 samples were collected at random from an exposure unit. The observed values are 2.8, 22.9, 3.3, 4.6, 8.7, 30.4, 12.2, 2.5, 5.7, 26.3, 5.4, 6.1, 5.2, 1.8, 7.2, 3.4, 12.4, 0.8, 10.3, 11.4, 38.2, 5.6, 14.1, 12.3, 6.8, 3.3, 5.2, 2.1, 19.7, 3.9, and 2.8 mg/kg. Because of their skewness, the data may be lognormally distributed. The Shapiro-Wilk W test for normality rejects the hypothesis, at both the 0.05 and 0.01 levels, that the distribution is normal. The same test fails to reject at either level the hypothesis that the distribution is lognormal. The UCL on the mean based on Land's H statistic is computed as follows.

STEP 1: Compute the arithmetic average of the log-transformed data $\overline{\ln X}$ = 1.8797.

STEP 2. Compute the standard deviation of the log-transformed data $s_{\ln X}$ = 0.8995.

STEP 3. The H statistic for n = 31 and $s_{\ln X}$ =0.90 is 2.31.

STEP 4: The one-sided 95% upper confidence limit on the mean is therefore

$$UCL_{95\%} = \exp\left(1.8797 + 0.8995^2/2 + 2.31 \times 0.8995/\sqrt{31-1}\right) = 14.4$$

Accounting for non-detects. Gilbert (1987, page 182) suggests extending Cohen's method to account for non-detect values in lognormally distributed concentrations. Cohen's method (EPA 2000b, page 4-43) assumes the data are normally distributed, so it must be applied to the log-transformed concentration values. If $\hat{\mu}_y$ and $\hat{\sigma}_y$ are the corrected sample mean and standard deviation, respectively, of the log-transformed concentrations, then the corrected estimates of the mean and standard deviation of the underlying lognormal distribution can be obtained from the following expressions:

$$\hat{\mu} = \exp(\hat{\mu}_y + \hat{\sigma}_y^2/2)$$

$$\hat{\sigma} = \hat{\mu}\sqrt{\exp(\hat{\sigma}_y^2) - 1}$$

This method requires there be a single detection level for all the data values.

Chebyshev Inequality Method

Singh et al. (1997) and EPA (2000c) suggest the use of the Chebyshev inequality to estimate UCLs which should be appropriate for a variety of distributions so long as the skewness is not very large. The one-sided version of the Chebyshev inequality (Allen 1990, page 79; Savage 1961, page 216) is appropriate in this context (cf. Singh et al. 1997, EPA 2000c). It can be applied to the sample mean to obtain a distribution-free estimate of the UCL for the population mean when the population variance or standard deviation are known. In practice, however, these values are not known and must be estimated from data. For lognormally distributed data sets, Singh et al. (1997) and EPA (2000c) suggest using the minimum-variance unbiased estimators (MVUE) for the mean and variance to obtain an UCL of the mean. (See also Gilbert 1987, for discussion of the MVUE). This

approach may yield an estimated UCL that is more useful than that obtained from the Land method (when the underlying distribution of concentrations is lognormal). This alternative approach for a lognormal distribution is described in Exhibit 5 and is available in the ProUCL software tool (EPA 2001a). A numerical illustration of the Chebyshev inequality method using the sample mean and standard deviation appears in Exhibit 6. In this example the estimate of the UCL based on the Chebyshev inequality is less than that based on the Land method. The Chebyshev inequality estimate of the UCL is 1,965 mg/kg; while applying the Land method to this same data set yields a higher UCL estimate of 2,658 mg/kg.

Exhibit 5: Steps for UCL Calculation Based on the Chebyshev Inequality — MVUE Approach for Lognormal Distributions

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the arithmetic mean of the log-transformed data $\overline{\ln X} = \frac{1}{n}\sum_{i=1}^{n} \ln(X_i)$.

STEP 2: Compute the associated variance $s^2_{\ln X} = \frac{1}{n-1}\sum_{i=1}^{n}(\ln(X_i) - \bar{y})^2$.

STEP 3: Compute the minimum-variance unbiased estimator (MVUE) of the population mean for a lognormal distribution $\hat{\mu}_{LN} = \exp(\overline{\ln X}) g_n(s^2_{\ln X}/2)$, where g_n denotes a function for which tables are available (Aitchison and Brown 1969, Table A2; Koch and Link 1980, Table A7).

STEP 4: Compute the MVUE of the associated variance of this mean

$$\sigma^2_{\mu} = \exp(2\ln X)\left((g_n(s^2_{\ln X}/2))^2 - g_n\left(\frac{n-2}{n-1} s^2_{\ln X}\right)\right)$$

STEP 5: Compute the one-sided (1-α) upper confidence limit on the mean

$$UCL_{1-\alpha} = \hat{\mu}_{LN} + \sqrt{\left(\frac{1}{\alpha} - 1\right)\sigma^2_{\mu}}$$

Caveats about the Chebyshev method. EPA (2000c) points out that for highly skewed lognormal data with small sample size and large standard deviation, the Chebyshev 99% UCL may be more appropriate than the 95% UCL, because the Chebyshev 95% UCL may not provide adequate coverage of the mean. As skewness increases further, the Chebyshev method is not recommended. See the ProUCL User's Guide (2001a) for specific recommendations on use of these two UCL estimates.

Exhibit 6: An Example Computation of UCL Based on the Chebyshev Inequality

29 samples were collected at random from an exposure unit. The observed values are 107, 175, 1796, 2002, 109, 30, 273, 83, 127, 254, 466, 12, 403, 31, 1042, 923, 24, 537, 5667, 59, 158, 59, 353, 10, 8, 33, 1129, 3 and 279 mg/kg. The observed skewness of this data set is 3.8, and these data may be lognormally distributed. The assumption of normality is rejected at the 0.05 level by a Shapiro-Wilk W test, but the same test fails to reject a test of lognormality even at the 0.1 level. The UCL on the mean can be computed based on the Chebyshev Inequality as follows.

STEP 1: The arithmetic mean of the log-transformed data $\overline{\ln X}$ is 4.9690.

STEP 2: The associated variance $s^2_{\ln X}$ = 3.3389.

STEP 3: The MVUE of the mean for a lognormal distribution $\hat{\mu}_{LN}$ = 666.95.

STEP 4: The MVUE of the variance of the mean σ^2_{μ} = 88552.

STEP 5: The resulting one-sided 95% upper confidence limit on the mean of the concentration

$$UCL_{95\%} = 666.95 + \sqrt{(19)88552} = 1{,}965$$

The 95% UCL based on the Land method for these data would be 2,658.

EPA (2000c, Table 7) suggests that the Chebyshev inequality method for computing the UCL may be preferred over the Land method, even for lognormal distributions, in certain situations. Exhibit 7 describes the conditions, in terms of the sample size and the standard deviation of the log-transformed data, under which the Chebyshev inequality method will probably yield more useful results than the Land method.

Exhibit 7

Conditions Likely to Favor Use of Chebyshev Inequality (MVUE) over Land Method

Standard deviation of log-transformed data	Sample Size	Recommendation
1 - 1.5	<25	95% Chebyshev (MVUE) UCL
1.5 - 2	<20	99% Chebyshev (MVUE) UCL
	20 - <50	95% Chebyshev (MVUE) UCL
2 - 2.5	<25	99% Chebyshev (MVUE) UCL
	25 - 70	95% Chebyshev (MVUE) UCL
2.5 - 3.0	<30	99% Chebyshev (MVUE) UCL
	30 - <70	95% Chebyshev (MVUE) UCL

UCLs for Other Specific Distribution Types

Methods for computing UCLs on the mean of other types of distributions have appeared in the statistical literature. For example, Johnson (1978) describe a method for computing the UCL for asymmetrical distributions such as the exponential. Schulz and Griffin (1999) described Wong's (1993) method for obtaining confidence limits on the mean of a gamma distribution. In general, if there are arguments that suggest a population of concentrations should fit a particular distribution shape, and if statistical testing confirms the expected shape reasonably conforms with available data, then the UCL computed by a method developed specifically for the distribution shape, if one exists, is likely to be appropriate for the data set. An analyst should consider using a distribution-specific method if possible because it is likely to produce more valid statistical results. The advice and support of a statistician may be invaluable in such cases, both for characterizing the distribution and for identifying and evaluating possible ways to derive confidence limits.

4.2 UCL Calculation With Nonparametric or Distribution-free Methods

There are also distribution-free approaches to computing UCLs on the mean that do not make specific assumptions about the shape of the underlying distribution of concentrations. While these methods assume the samples are representative of the underlying distribution of concentrations, they require no assumptions about the shape of that distribution and are applicable to a variety of situations. Although parametric statistical methods that depend on a distributional assumption are usually more efficient and powerful than nonparametric methods, it can be difficult to justify their use through empirical testing of the shape of the distribution. In such cases, one of the following nonparametric, or distribution-free techniques are often preferred. For information on how to account for non-detects, see the earlier discussion under "Data Evaluation" above.

Central Limit Theorem (Adjusted)

If sample size is sufficiently large, the Central Limit Theorem (CLT) implies that the mean will be normally distributed, no matter how complex the underlying distribution of concentrations might be. This is the case even if the underlying distribution is strongly skewed, has outliers, or is a mixture of different populations, so long as it is stationary (not changing over time), has finite variance, and the samples are collected independently and randomly. However, the theorem does not say how many samples are sufficient for normality to hold. When sample size is moderate or small the means will not generally be normally distributed, and this non-normality is intensified by the skewness of the underlying distribution. Chen (1995) suggested an approach that accounts for positive skewness. Singh et al. (1997) and EPA (2000c) call this approach the "adjusted CLT" method. They suggest it is an appropriate alternative to the distribution-specific Land's method even if the distribution is lognormal when the standard deviation is less than one and sample size is larger than 100. Exhibit 8 describes the steps for this method, and Exhibit 9 gives a numerical example.

Exhibit 8: Directions for Computing UCL Using the Central Limit Theorem (Adjusted)

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the sample mean $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$.

STEP 2: Compute the sample standard deviation $s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$.

STEP 3: Compute the sample skewness $\beta = \frac{n}{(n-1)(n-2)}\sum_{i=1}^{n}\left(\frac{x_i - \bar{x}}{s}\right)^3$. This can be calculated in Microsoft® Excel with the SKEW function.

STEP 4: Let z_α be the $(1-\alpha)^{th}$ quantile of the standard normal distribution. For the 95% confidence level, $z_\alpha = 1.645$.

STEP 5: Compute the one-sided (1-α) upper confidence limit on the mean

$$UCL_{1-\alpha} = \overline{X} + \left(z_\alpha + \frac{\beta}{6\sqrt{n}}\left(1 + 2z_\alpha^2\right)\right)s/\sqrt{n} \ .$$

Exhibit 9: Example UCL Computation Based on the Central Limit Theorem (Adjusted)

60 samples were collected at random from an exposure unit. The values observed are 35, 111, 105, 27, 25, 20, 17, 21, 32, 32, 23, 17, 35, 32, 29, 25, 97, 20, 26, 18, 17, 18, 26, 25, 16, 28, 29, 28, 21, 119, 23, 98, 20, 21, 24, 21, 22, 117, 27, 25, 22, 21, 26, 24, 33, 33, 21, 24, 30, 31, 23, 30, 28, 25, 22, 23, 25, 28, 26, and 107 mg/L. Filliben's test shows that this distribution is significantly different (at the 1% level) from both a normal and a lognormal distribution. The UCL based on the Central Limit Theorem is computed as follows.

STEP 1: The sample mean of the n=60 values is $\overline{X}$ = 34.57.

STEP 2: The sample standard deviation of the values is s = 27.33.

STEP 3: The sample skewness β = 2.366.

STEP 4: The z statistic is 1.645.

STEP 5: The one-sided 95% upper confidence limit on the mean is

$$UCL_{95\%} = 34.57 + \left(1.645 + \frac{2.366}{6\sqrt{60}}\left(1 + 2\times 1.645^2\right)\right) 27.33/\sqrt{60} = 42$$

Caveats about this method. A sample size of 30 is sometimes prescribed as sufficient for using an approach based on the Central Limit Theorem, but when using this CLT or adjusted CLT method and the data are skewed (as many concentration data sets are), larger samples may be needed to approximate normality. EPA's ProUCL User's Guide (2001) suggests that a sample size of 100 or more may be needed, based on Monte Carlo studies by EPA (2000c).

Bootstrap Resampling

Bootstrap procedures (Efron 1982) are robust nonparametric statistical methods that can be used to construct approximate confidence limits for the population mean. In these procedures, repeated samples of size n are drawn with replacement from a given set of observations. The process is repeated a large number of times (e.g., thousands), and each time an estimate of the desired unknown parameter (e.g., the sample mean) is computed. There are different variations of the bootstrap procedure available. One of these, the bootstrap t procedure, is described in the ProUCL User's Guide (EPA 2001a). An elaborated bootstrap procedure that takes bias and skewness into account is described in Exhibit 10 (Hall 1988 and 1992; Manly 1997; Schulz and Griffin 1999; Zhou and Gao 2000).

Caveats about resampling. Bootstrap procedures assume only that the sample data are representative of the underlying population. However, since they involve extensive resampling of the data and, thus, exploit more of the information in a sample, that sample must be a statistically accurate characterization of the underlying population in all respects (not just in its mean and standard deviation). In practice, it is random sampling that satisfies the representativeness assumption. Therefore the data must be random samples of the underlying population. Bootstrapping procedures are inappropriate for use with data that were idiosyncratically collected or focused especially on contamination hot spots.

Exhibit 10: Steps for Calculating a Hall's Bootstrap Estimate of UCL

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the sample mean $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$.

STEP 2: Compute the sample standard deviation $s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$.

STEP 3: Compute the sample skewness $k = \frac{1}{ns^3}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^3$.

STEP 4: For b = 1 to B (a very large number) do the following:
4.1: Generate a bootstrap sample data set; i.e., for i = 1 to n let j be a random integer between 1 and n and add observation X_j to the bootstrap sample data set.
4.2: Compute the arithmetic mean $\overline{X}_b$ of the data set constructed in step 4.1.
4.3: Compute the associated standard deviation s_b of the constructed data set.
4.4: Compute the skewness k_b of the constructed data using the formula in Step 3.
4.5: Compute the studentized mean $W = (\overline{X}_b - \overline{X})/s_b$.
4.6: Compute Hall's statistic $Q = W + k_b W^2/3 + k_b^2 W^3/27 + k_b/(6n)$.

STEP 5: Sort all the Q values computed in Step 4 and select the lower α^{th} quantile of these B values. It is the $(\alpha B)^{th}$ value in an ascending list of Q's. This value is from the *left* tail of the distribution.

STEP 6: Compute $W(Q) = \frac{3}{k}\left(\left(1 + k\left(Q_\alpha - \frac{k}{6n}\right)\right)^{1/3} - 1\right)$.

STEP 7: Compute the one-sided (1-α) confidence limit on the mean.

$$UCL_{1-\alpha} = \overline{X} - W(Q_\alpha)s$$

Exhibit 11: An Example Computation of Bootstrap Estimate of UCL

Using the same concentration values given in Exhibit 4, the UCL can also be computed based on the Bootstrap Resampling method.

STEP 1: The sample mean of the n =31 values is $\overline{X}$= 9.59.

STEP 2: The standard deviation (using n as divisor) of the values is s = 8.946.

STEP 3: The skewness k = 1.648.

The Pascal-language software shown in Appendix B estimates the UCL with 100,000 bootstrap iterations. The one-sided 95% UCL on the mean is 13.3. Because this value depends on random deviates, it can vary slightly on recalculation.

Jackknife Procedure

Like bootstrap, the jackknife technique is a robust procedure based on resampling (Tukey 1977). In this procedure repeated samples are drawn from a given set of observations by omitting each observation in turn, yielding n data sets of size n-1. An estimate of the desired unknown parameter (e.g., sample mean) is then computed for each sample. When the standard estimators are used for the mean and standard deviation, this procedure reduces to the UCL based on Student's t. However, when other estimators (such as MVUE) are used this jackknife procedure does not reduce to the UCL based on Student's t. Singh et al. (1997) suggest that this method could be used with other estimators for the population mean and standard deviation to yield UCLs that may be appropriate for a variety of distributions.

Chebyshev Inequality Method

As described previously, Singh et al. (1997) and EPA (2000c) suggested the use of the Chebyshev inequality to estimate UCLs which should be appropriate for a variety of distributions as long as the skewness is not very large. The one-sided version of the Chebyshev inequality (Allen 1990, page 79; Savage 1961, page 216) is appropriate in this context (cf. Singh et al. 1997, EPA 2000c). It can be applied to the sample mean to obtain a distribution-free estimate of the UCL for the population mean when the population variance or standard deviation are known. In practice, however, these values are not known and must be estimated from data. Singh et al. (1997) and EPA (2000c) suggest that the population mean and standard deviation can be estimated by the sample mean and sample standard deviation. This approach is described in Exhibit 12 and is available in the ProUCL software tool (EPA 2001a). A numerical illustration of the Chebyshev inequality method using the sample mean and standard deviation appears in Exhibit 13.

Caveats about the Chebyshev method. Although the Chebyshev inequality method makes no distributional assumptions, it does assume that the parametric standard deviation of the underlying distribution is known. As Singh et al. (1997) acknowledge, when this parameter must be estimated from data, the estimate of the UCL is not guaranteed to be larger than the true mean with the prescribed frequency implied by the α level. In fact, using only an estimate of the standard deviation can substantially underestimate the UCL when the variance or skewness is large, especially for small sample sizes. In such cases, a Chebyshev UCL with a higher confidence coefficient such as 0.99 may be used, according to Singh, et al.

Exhibit 12: Steps for Computing UCL Based on the Chebyshev Inequality — Nonparametric

Let $X_1, X_2, \ldots, X_n$ represent the n randomly sampled concentrations.

STEP 1: Compute the arithmetic mean of the data $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$.

STEP 2: Compute the sample standard deviation $s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}$.

STEP 3: Compute the one-sided (1-α) upper confidence limit on the mean

$$UCL_{1-\alpha} = \overline{X} + \sqrt{\frac{1}{\alpha} - 1}\,(s/\sqrt{n})$$

Exhibit 13: An Example Computation of UCL Based on Chebyshev Inequality — Nonparametric

Using the same concentration values given in Exhibit 4 and used in Exhibit 11, the UCL on the mean can also be computed based on the Chebyshev inequality.

STEP 1: The sample mean of the n=31 values is $\overline{X}$= 9.59.

STEP 2: The sample standard deviation of the values is s = 9.094

STEP 3: The one-sided 95% upper confidence limit on the mean is therefore

$$UCL_{95\%} = 9.59 + 4.3589 \times 9.094/\sqrt{31} = 16.7$$

5.0 OPTIONAL USE OF MAXIMUM OBSERVED CONCENTRATION

Because some of the methods outlined above (particularly the Land method) can produce very high estimates of the UCL, EPA (1992) allows the maximum observed concentration to be used as the exposure point concentration rather than the calculated UCL in cases where the UCL exceeds the maximum concentration.

It is important to note, however, that defaulting to the maximum observed concentration may not be protective when sample sizes are very small because the observed maximum may be smaller than the population mean. Thus, it is important to collect sufficient samples in accordance with the DQOs for a site. The use of the maximum as the default exposure point concentration is reasonable only when the data samples have been collected at random from the exposure unit and the sample size is large.

6.0 UCLs AND THE RISK ASSESSMENT

Risk assessors are encouraged to use the most appropriate estimate for the EPC given the available data. The flow chart in Figure 1 provides general guidelines for selecting a UCL calculation method. Exhibit 14 summarizes the methods described in this guidance, including their applicability, advantages and disadvantages. While the methods identified in this guidance may be useful in many situations, they will probably not be appropriate for all hazardous waste sites. Moreover, other methods not specifically described in this guidance may be most appropriate for particular sites. The EPA risk assessor and, potentially, a trained statistician should be involved in the decision of which method(s) to use.

When presenting UCL estimates, the risk assessor should identify:

- how the shape of the underlying distribution was identified (or, if it was not identified, what methods were used in trying to identify it),
- the chosen UCL method,
- reasons that this UCL method is appropriate for the site data, and
- assumptions inherent in the UCL method.

It may also be appropriate to include information such as advantages and disadvantages of the distribution-fitting method, advantages and disadvantages of the UCL method, and how the risk characterization would change if other assumptions were used.

Exhibit 14
Summary of UCL Calculation Methods

Method	Applicability	Advantages	Disadvantages	Reference
For Normal or Lognormal Distributions				
Student's *t*	means normally distributed, samples random	simple, robust if *n* is large	distribution of means must be normal	Gilbert 1987; EPA 1992
Land's *H*	lognormal data, small variance, large *n*, samples random	good coverage[1]	sensitive to deviations from lognormality, produces very high values for large variance or small *n*	Gilbert 1987; EPA 1992
Chebyshev Inequality (MVUE)	skewness and variance small or moderate, samples random	often smaller than Land	may need to resort to higher confidence levels for adequate coverage	Singh et al. 1997
Wong	gamma distribution	second order accuracy[2]	requires numerical solution of an improper integral	Schulz and Griffin 1999; Wong 1993
Nonparametric/Distribution-free Methods				
Central Limit Theorem - Adjusted	large *n*, samples random	simple, robust	sample size may not be sufficient	Gilbert 1987; Singh et al. 1997
Bootstrap t Resampling	sampling is random and representative	useful when distribution cannot be identified	inadequate coverage for some distributions; computationally intensive	Singh et al. 1997; Efron 1982
Hall's Bootstrap Procedure	sampling is random and representative	useful when distribution cannot be identified; takes bias and skewness into account	inadequate coverage for some distributions; computationally intensive	Hall 1988; Hall 1992; Manly 1997; Schultz and Griffin 1999
Jackknife Procedure	sampling is random and representative	useful when distribution cannot be identified	inadequate coverage for some distributions; computationally intensive	Singh et al. 1997
Chebyshev Inequality	skewness and variance small or moderate, samples random	useful when distribution cannot be identified	inappropriate for small sample sizes when skewness or variance is large	Singh et al. 1997; EPA 2000c

[1] Coverage refers to whether a UCL method performs in accordance with its definition.
[2] As opposed to maximum likelihood estimation, which offers first order accuracy.

7.0 PROBABILISTIC RISK ASSESSMENT

The estimates of the UCL described in this guidance can be used as point estimates for the EPC in deterministic risk assessments. In probabilistic risk assessments, a more complete characterization of the underlying distribution of concentrations may be important as well. Risk assessors should consult *Risk Assessment Guidance for Superfund, Volume 3 - Part A, Process for Conducting a Probabilistic Risk Assessment* (EPA 2001b) for specific guidance with respect to probabilistic risk assessments.

8.0 CLEANUP GOALS

Cleanup goals are commonly derived using the risk estimates established during the risk assessment. Often, a cleanup goal directly proportional to the EPC will be used, based on the relationship between the site risk and the target risk as defined in the National Contingency Plan. In such cases, the attainment of the cleanup goal should be measured with consideration of the method by which the EPC was derived. For more details, see *Surface Soil Cleanup Strategies for Hazardous Waste Sites* (EPA, to be published).

9.0 REFERENCES

Aitchison, J. and J.A.C. Brown (1969). *The Lognormal Distribution*. Cambridge University Press, Cambridge.

Allen, A.O. (1990). *Probability, Statistics and Queueing Theory with Computer Science Applications*, second edition. Academic Press, Boston.

Chen, L. (1995). Testing the mean of skewed distributions. *Journal of the American Statistical Association* 90: 767-772.

Efron, B. (1982) *The Jackknife, the Bootstrap and Other Resampling Plans*. SIAM, Philadelphia, Pennsylvania.

EPA (1989). *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A). Interim Final.* http://www.epa.gov/superfund/programs/risk/ragsa/, EPA/540/1-89/002. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA (1992). *A Supplemental Guidance to RAGS: Calculating the Concentration Term*. http://www.deq.state.ms.us/newweb/opchome.nsf/pages/HWDivisionFiles/$file/uclmean.pdf. Publication 9285.7-081. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA (1997). *Data Quality Evaluation Statistical Toolbox (DataQUEST) User's Guide.* http://www.epa.gov/quality/qs-docs/g9d-final.pdf, EPA QA/G-9D QA96 Version. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. [The software is available at http://www.epa.gov/quality/qs-docs/dquest96.exe]

EPA(1998). *Risk Assessment Guidance for Superfund, Volume 1 - Human Health Evaluation Manual Part D.* http://www.epa.gov/superfund/programs/risk/ragsd/ Publication 9285:7-01D. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington D.C.

EPA (2000a). *Data Quality Objectives Process for Hazardous Waste Site Investigations.* http://www.epa.gov/quality/qs-docs/g4hw-final.pdf, EPA QA/G-4HW, Final. Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA (2000b). *Guidance for Data Quality Assessment: Practical Methods for Data Analysis.* http://www.epa.gov/r10earth/offices/oea/epaqag9b.pdf, EPA QA/G-9, QA00 Update. Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA (2000c). *On the Computation of the Upper Confidence Limit of the Mean of Contaminant Data Distributions, Draft*. Prepared for EPA by Singh, A.K., A. Singh, M. Engelhardt, and J. M. Nocerino. Copies of the article can be obtained from Office of Research and Development, Technical Support Center, U.S. Environmental Protection Agency, Las Vegas, Nevada.

EPA (2001a). ProUCL- Version 2. [software for Windows 95, accompanied by "ProUCL User's Guide."] Prepared for EPA by Lockheed Martin.

EPA (2001b). *Risk Assessment Guidance for Superfund, Volume 3 - Part A, Process for Conducting a Probabilistic Risk Assessment Draft.* http://www.epa.gov/superfund/programs/risk/rags3adt/. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington D.C.

EPA (To be published). *Guidance or Surface Soil Cleanup at Hazardous Waste Sites: Implementing Cleanup Levels, Draft*. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington D.C.

Ferson, S. et al. 2002. Bounding uncertainty analyses. Accepted for Publication in *Proceedings of the Workshop on the Application of Uncertainty Analysis to Ecological Risks of Pesticides*. edited by A. Hart. SETAC Press, Pensacola, Florida.

Gilbert, R.O. (1987). *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold, New York.

Gleit, A. (1985). Estimation for small normal data sets with detection limits. *Environmental Science and Technology* 19: 1201-1206.

Haas, C.N. and P.A. Scheff (1990). Estimation of averages in truncated samples. *Environmental Science and Technology* 24: 912-919.

Hall, P. (1988). Theoretical comparison of bootstrap confidence intervals. *Annals of Statistics* 16: 927-953.

Hall, P. (1992). On the removal of skewness by transformation. *Journal of the Royal Statistical Society B* 54: 221-228.

Helsel, D.R. (1990). Less than obvious: Statistical treatment of data below the detection limit. *Environmental Science and Technology* 24: 1766-1774.

Johnson, N.J. (1978). Modified t-tests and confidence intervals for asymmetrical populations. *The American Statistician* 73:536-544.

Koch, G.S., Jr., and R.F. Link (1980). *Statistical Analyses of Geological Data*. Volumes I and II. Dover, New York.

Kushner, E.J. (1976). On determining the statistical parameters for pollution concentration from a truncated data set. *Atmospheric Environ*. 10: 975-979.

Land, C.E. (1971). Confidence intervals for linear functions of the normal mean and variance. *Annuals of Mathematical Statistics* 42: 1187-1205.

Land, C.E. (1975). Tables of confidence limits for linear functions of the normal mean and variance. *Selected Tables in Mathematical Statistics* Vol III p 385-419.

Manly, B.F.J. (1997). *Randomization, Bootstrap, and Monte Carlo Methods in Biology* (2nd edition). Chapman and Hall, London.

Millard, S.P. (1997). EnvironmentalStats for S-Plus user's manual, Version 1.0. Probability, Statistics, and Information, Seattle, WA.

Rowe, N.C. (1988). Absolute bounds on set intersection and union sizes from distribution information. *IEEE Transactions on Software Engineering*. SE-14: 1033-1048.

Savage, I.R. (1961). Probability inequalities of the Tchebycheff type. *Journal of Research of the National Bureau of Standards-B. Mathematics and Mathematical Physics* 65B: 211-222.

Schulz, T.W. and S. Griffin (1999). Estimating risk assessment exposure point concentrations when the data are not normal or lognormal. *Risk Analysis* 19:577-584.

Singh, A.K., A. Singh, and M. Engelhardt (1997). The lognormal distribution in environmental applications. EPA/600/R-97/006

Singh, A., and J.M. Nocerino (2001). Robust Estimation of Mean and Variance Using Environmental Datasets with Below Detection Limit Observations. Accepted for Publication in *Journal of Chemometrics and Intelligent Laboratory Systems*.

Smith, J.E. (1995). Generalized Chebychev inequality: theory and applications in decision analysis. *Operations Research*. 43: 807-825.

Student [W.S. Gossett] (1908).On the probable error of the mean. *Biometrika* 6: 1-25.

Tukey, J.W. (1977). *Exploratory Data Analysis.* Addison Wesley, Reading, MA.

Wong, A. (1993). A note on inference for the mean parameter of the gamma distribution. *Stat. Prob. Lett.* 17: 61-66.

Zhou, X.-H. and S. Gao (2000). One-sided confidence intervals for means of positively skewed distributions. *The American Statistician* 54: 100-104.

Appendix A: Using Bounding Methods to Account for Non-detects

This appendix presents an iterative procedure that can be used to account for non-detects in data when estimating a UCL. It provides a step-by-step approach for computing an upper bound on the UCL using the "Solver" feature in Microsoft ® Excel spreadsheets.

STEP 1. Enter all the detected values in a column.

STEP 2. At the bottom of the same column, append as place holders as many copies of the formula

=RAND( )*DL

as there were non-detects. In these formulas, *DL* should be replaced by the detection limit.

STEP 3. Copy all the cells you have entered in steps 1 and 2 to a second column.

STEP 4. In another cell, enter the formula for the UCL that you wish to use. For instance, to use the 95% UCL based on Student's *t*, enter the formula

=AVERAGE(*range*)+TINV((1-0.95)*2, *n*-1)*SQRT(VAR(range)/n)

where *range* denotes the array of cell references in the second column you just created and *n* denotes the number of measurements (both detected values and non-detects).

STEP 5. From the Excel menu, select Tools / Solver.

STEP 6. In the "Solver Parameters" dialog box, specify the cell in which you entered the UCL formula as the Target Cell.

STEP 7. To find the upper bound of the UCL click on the Max indicator; to find the lower bound of the UCL click on the Min indicator.

STEP 8. Enter references to the cells containing the place holders for the non-detects in the field under the label "By Changing Cells." (Do not click the "Guess" button.)

STEP 9. For each cell that represents a non-detect, add a constraint specifying that the cell is to be greater than or equal to (">=") the detection limit *DL*.

STEP 10. Click on the Options button and check the box labeled "Assume Non-Negative."

STEP 11. Then click OK and then the Solver button. The program will automatically locate a local extreme value (i.e., maximum or minimum) for the UCL.

STEP 12. Record this value. You can use the Save Scenario button and Excel's scenario manager to do this.

STEP 13. Again copy all the detected values and randomized place holders for the non-detects from the first column to the same spot in the second column.

STEP 14. Select Tools / Solver and click the Solve button.

STEP 15. If calculating the upper bound, record the resulting value of the UCL if it is larger than previously computed. If calculating the lower bound, record the resulting value of the UCL if it is smaller than previously computed.

STEP 16. Repeat steps 13 through 15 to search for the global maximum or minimum value for the UCL.

Appendix B: Computer Code for Computing a UCL with the Hall's Bootstrap Sampling Method

This appendix presents Pascal code that can be used to compute the bootstrap estimate of a UCL. To use it, place data in the vector *x*. Then specify the sample size *n*, the vector *x* and the alpha-level, and call the procedure bootstrap. When the procedure finishes, the estimated value will be in the variable UCL. To obtain a 95% UCL, let alpha be 0.05. Up to 100 data values and up to 10,000 bootstrap iterations are supported, but these limits may be changed.

```
const
  max = 100;
  bmax = 10000;

type
  index = 1..max;
  bindex = 1..bmax;
  float = extended;{could just be real}
  vector = array[index] of float;
  bvector = array[bindex] of float;

var
  qq : bvector;

function getmean(n : integer; x : vector) : float;
  var s : float; i : integer;
  begin
  s := 0.0;
  for i := 1 to n do s := s + x[i];
  getmean := s / n;
  end;

function getstddev(n:integer; xbar:float; x:vector) : float;
  var s : float; i : integer;
  begin
  s := 0.0;
  for i := 1 to n do s := s + (x[i] - xbar) * (x[i] - xbar);
  getstddev := sqrt(s / n); {not n-1}
  end;

function getskew(n:integer; xbar:float; stddev:float; x:vector) :
float;
  var s,s3 : float; i : integer;
  begin
  s := 0.0;
  s3 := stddev * stddev * stddev;
  for i:=1 to n do s:=s+(x[i]-xbar)*(x[i]-xbar)*(x[i]-xbar)/s3;
  getskew := s / n;
  end;

procedure qsort(var a: bvector; lo,hi: integer);
  procedure sort(l,r: integer);
  var i,j : integer; x,y: float;
  begin
  i:=l; j:=r; x:=a[(l+r) div 2];
  repeat
    while a[i]<x do i:=i+1;
    while x<a[j] do j:=j-1;
    if i<=j then
      begin
      y:=a[i]; a[i]:=a[j]; a[j]:=y;
      i:=i+1; j:=j-1;
      end;
```

```
    until i>j;
  if l<j then sort(l,j);
  if i<r then sort(i,r);
  end;
  begin {qsort}
  sort(lo,hi);
  end;

procedure bootsample(n : integer; x : vector; var y : vector);
  var i,j : integer;
  begin
  for i := 1 to n do
    begin
    j := random(n) + 1;
    y[i] := x[j];
    end;
  end;

procedure bootstrap(n:integer; x:vector; alpha:float; var
ucl:float);
{let alpha be 0.05 to compute a 95% UCL}
var
  i,b,bb : integer;
  xbar, stddev, skew, bxbar, bstddev, bskew, k, w, q, a : float;
  bx : vector;
begin
bb := bmax;
for b:=1 to bmax do qq[b] := 0.0;
xbar := getmean(n,x);
stddev := getstddev(n,xbar,x);
skew := getskew(n,xbar,stddev,x);
for b := 1 to bb do
  begin
  bootsample(n,x,bx);
  bxbar := getmean(n,bx);
  bstddev := getstddev(n,bxbar,bx);
  k := getskew(n,bxbar,bstddev,bx);
  w := (bxbar - xbar) / bstddev;
  q := w + skew * w*w / 3 + k*k * w*w*w / 27 + k / (6 * n);
  qq[b] := q;
  end;
qsort(qq,1,bb);
q := qq[round(alpha * bb)];
a := 1 + skew * (q-skew / (6 * n));
if a = 0.0 then w := -3 / skew
           else w := (3 / skew) * (exp((1/3) * ln(a)) - 1);
ucl := xbar - w * stddev;
end;
```

APPENDIX C – PHOTOGRAPHIC LOG

PHOTO 1: View of area prior to Excavation from the East.

PHOTO 2: View of area prior Excavation from the East.

PHOTO 3: View of open excavation, and removal of water.

PHOTO 4: View of final Excavation, after trench dewatering and pipe repair.

APPENDIX D – ANALYTICAL REPORT AND CHAIN OF CUSTODY

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

June 20, 2024

TRAVIS CASEY

TERRACON CONSULTANTS

5827 50TH ST. SUITE 1

LUBBOCK, TX 79424

RE: HNULIK #1

Enclosed are the results of analyses for samples received by the laboratory on 06/18/24 12:40.

Cardinal Laboratories is accredited through Texas NELAP under certificate number T104704398-23-16. Accreditation applies to drinking water, non-potable water and solid and chemical materials. All accredited analytes are denoted by an asterisk (*). For a complete list of accredited analytes and matrices visit the TCEQ website at www.tceq.texas.gov/field/qa/lab_accred_certif.html.

Cardinal Laboratories is accreditated through the State of Colorado Department of Public Health and Environment for:

Method EPA 552.2	Haloacetic Acids (HAA-5)
Method EPA 524.2	Total Trihalomethanes (TTHM)
Method EPA 524.4	Regulated VOCs (V1, V2, V3)

Accreditation applies to public drinking water matrices.

This report meets NELAP requirements and is made up of a cover page, analytical results, and a copy of the original chain-of-custody. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Celey D. Keene

Celey D. Keene

Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
TRAVIS CASEY
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 01 2-2' (H243559-01)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1470**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 01 3-3' (H243559-02)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1920**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 01 4-4' (H243559-03)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2200**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 02 2-2' (H243559-04)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1520**	16.0	06/19/2024	ND	416	104	400	3.92	

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TRAVIS CASEY
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 02 3-3' (H243559-05)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1280**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 02 4-4' (H243559-06)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1300**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 03 2-2' (H243559-07)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**3120**	16.0	06/19/2024	ND	416	104	400	3.92	

Sample ID: BG - 03 3-3' (H243559-08)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2120**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 03 4-4' (H243559-09)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1960**	16.0	06/19/2024	ND	432	108	400	3.77	

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Analytical Results For:

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TRAVIS CASEY
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 04 2-2' (H243559-10)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1220**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 04 3-3' (H243559-11)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1840**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 04 4-4' (H243559-12)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2440**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 05 2-2' (H243559-13)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1800**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 05 3-3' (H243559-14)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1020**	16.0	06/19/2024	ND	432	108	400	3.77	

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Analytical Results For:

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5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 05 4-4' (H243559-15)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1220**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 06 2-2' (H243559-16)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1680**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 06 3-3' (H243559-17)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2880**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 06 4-4' (H243559-18)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**3200**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 07 2-2' (H243559-19)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**4640**	16.0	06/19/2024	ND	432	108	400	3.77	

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LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 07 3-3' (H243559-20)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**3600**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 07 4-4' (H243559-21)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2960**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 08 2-2' (H243559-22)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**5200**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 08 3-3' (H243559-23)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**4640**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 08 4-4' (H243559-24)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**3520**	16.0	06/19/2024	ND	432	108	400	3.77	

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Fax To:

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Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 09 2-2' (H243559-25)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1840**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 09 3-3' (H243559-26)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1920**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 09 4-4' (H243559-27)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2840**	16.0	06/19/2024	ND	432	108	400	3.77	

Sample ID: BG - 10 2-2' (H243559-28)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2800**	16.0	06/19/2024	ND	416	104	400	0.00	

Sample ID: BG - 10 3-3' (H243559-29)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1390**	16.0	06/19/2024	ND	416	104	400	0.00	

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Analytical Results For:

TERRACON CONSULTANTS
TRAVIS CASEY
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	06/18/2024	Sampling Date:	06/10/2024
Reported:	06/20/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Shalyn Rodriguez
Project Location:	DURANGO MIDSTREAM		

Sample ID: BG - 10 4-4' (H243559-30)

Chloride, SM4500Cl-B **mg/kg** **Analyzed By: AC**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2000**	16.0	06/19/2024	ND	416	104	400	0.00	

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PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Notes and Definitions

ND	Analyte NOT DETECTED at or above the reporting limit
RPD	Relative Percent Difference
**	Samples not received at proper temperature of 6°C or below.
***	Insufficient time to reach temperature.
-	Chloride by SM4500Cl-B does not require samples be received at or below 6°C
	Samples reported on an as received basis (wet) unless otherwise noted on report

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Terracon	BILL TO:
Project Manager: Travis Casey	P.O. #:
Address: 4526 W. Pierce Street	Company: Durango
City: Carlsbad State: NM Zip: 88220	Attn:
Phone #: 5756895949 Fax #:	Address:
Project #: AR227115 Project Owner: Durango	City:
Project Name: Hnulik	State:
Project Location: 32.8021763, -103.3412663	Phone #:
Sampler Name: Gus Sanchez	Fax #:

FOR LAB USE ONLY Lab I.D.	Sample I.D.	Depth Start	Depth End	(G)RAB OR (C)OMP	# CONTAINERS	MATRIX: GROUNDWAT	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING: DATE	TIME	ANALYS REQUEST: Chloride (EPA Method4500)	TPH Extended 8015	BTEX (EPA Method 8021B)
H243559																			
1	BG-01	2	2	G	1			X					X		6/10/2024	13:20	X		
2	BG-01	3	3	G	1			X					X		6/10/2024	13:25	X		
3	BG-01	4	4	G	1			X					X		6/10/2024	13:34	X		
4	BG-02	2	2	G	1			X					X		6/10/2024	13:28	X		
5	BG-02	3	3	G	1			X					X		6/10/2024	13:31	X		
6	BG-02	4	4	G	1			X					X		6/10/2024	13:35	X		
7	BG-03	2	2	G	1			X					X		6/10/2024	13:46	X		
8	BG-03	3	3	G	1			X					X		6/10/2024	13:59	X		
9	BG-03	4	4	G	1			X					X		6/10/2024	14:01	X		
10	BG-04	2	2	G	1			X					X		6/10/2024	16:06	X		

Relinquished By:	Date: 6.8.24 Time: 1240	Received By: SRodriguez	Verbal Result: ☐ Yes ☐ No Add'l Phone #:
			All Results are emailed. Please provide Email address:
Relinquished By:	Date: Time:	Received By:	REMARKS: joesph.guesnier@terracon.com;travis.casey@terracon.com;chuck.smith@terracon.com; beckysue.miller@terracon.com gus.sanchez@terracon.com
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Observed Temp. °C 4.1 Corrected Temp. °C	Sample Condition: Cool ☐ Yes ☐ No; Intact ☑ Yes ☐ No	CHECKED BY: (Initials) SR
			Turnarpund Time: Standard ☐ Rush ☑ 48 HR #140 Thermometer ID #113 Correction Factor -0.5°C
			Bacteria (only) Sample Condition: Cool ☐ Yes ☐ No; Observed Temp. °C; Corrected Temp. °C

FORM-005 R 3.2 10/07/21

† Cardinal cannot accept verbal changes. Please email changes to celey.keene@cardinallabsnm.com

2/3

CARDINAL Laboratories

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Terracon	BILL TO:
Project Manager: Travis Casey	P.O. #:
Address: 4526 W. Pierce Street	Company: Durango
City: Carlsbad State: NM Zip: 88220	Attn:
Phone #: 5756895949 Fax #:	Address:
Project #: AR227115 Project Owner: Durango	City:
Project Name: Hnulik	State:
Project Location: 32.8021763, -103.3412663	Phone #:
Sampler Name: Gus Sanchez	Fax #:

FOR LAB USE ONLY Lab I.D.	Sample I.D.	Depth Start	Depth End	(G)RAB OR (C)OMP	# CONTAINERS	MATRIX: GROUNDWAT	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING DATE	SAMPLING TIME	ANALYS REQUEST: Chloride (EPA Method4500)	TPH Extended 8015	BTEX (EPA Method 8021B)
H243559																			
11	BG-04	3	3	G	1			X					X		6/10/2024	16:16	X		
12	BG-04	4	4	G	1			X					X		6/10/2024	16:28	X		
13	BG-05	2	2	G	1			X					X		6/10/2024	16:39	X		
14	BG-05	3	3	G	1			X					X		6/10/2024	16:47	X		
15	BG-05	4	4	G	1			X					X		6/10/2024	16:54	X		
16	BG-06	2	2	G	1			X					X		6/10/2024	17:08	X		
17	BG-06	3	3	G	1			X					X		6/10/2024	17:19	X		
18	BG-06	4	4	G	1			X					X		6/10/2024	17:25	X		
19	BG-07	2	2	G	1			X					X		6/10/2024	12:12	X		
20	BG-07	3	3	G	1			X					X		6/10/2024	12:22	X		

Relinquished By:	Date: 6-18-24 Time: 1240	Received By:	Verbal Result: ☐ Yes ☐ No Add'l Phone #:
			All Results are emailed. Please provide Email address:
Relinquished By:	Date: Time:	Received By:	REMARKS: joesph.guesnier@terracon.com;travis.casey@terracon.com,chuck.smith@terracon.com; beckysue.miller@terracon.com gus.sanchez@terracon.com
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Observed Temp. °C 4.1 Corrected Temp. °C	Sample Condition: Cool ☐ Yes Intact ☐ Yes ☐ No ☐ No	CHECKED BY: (Initials) SR
			Turnaround Time: Standard ☐ Rush ☐ 48HR
			Thermometer ID #140 Correction Factor -0.5°C
			Bacteria (only) Sample Condition: Cool ☐ Yes ☐ No Observed Temp. °C Corrected Temp. °C

FORM-006 R 3.2 10/07/21

† Cardinal cannot accept verbal changes. Please email changes to celey.keene@cardinallabsnm.com

CARDINAL Laboratories

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Terracon	BILL TO:
Project Manager: Travis Casey	P.O. #:
Address: 4526 W. Pierce Street	Company: Durango
City: Carlsbad State: NM Zip: 88220	Attn:
Phone #: 5756895949 Fax #:	Address:
Project #: AR227115 Project Owner: Durango	City:
Project Name: Hnulik	State:
Project Location: 32.8021763, -103.3412663	Phone #:
Sampler Name: Gus Sanchez	Fax #:

FOR LAB USE ONLY

Lab I.D.	Sample I.D.	Depth Start	Depth End	(G)RAB OR (C)OMP	# CONTAINERS	MATRIX: GROUNDWAT	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING DATE	SAMPLING TIME	ANALYS REQUEST: Chloride (EPA Method4500)	TPH Extended 8015	BTEX (EPA Method 8021B)
H243559																			
21	BG-07	4	4	G	1			X					X		6/10/2024	12:31	X		
22	BG-08	2	2	G	1			X					X		6/10/2024	12:40	X		
23	BG-08	3	3	G	1			X					X		6/10/2024	12:45	X		
24	BG-08	4	4	G	1			X					X		6/10/2024	12:50	X		
25	BG-09	2	2	G	1			X					X		6/10/2024	12:51	X		
26	BG-09	3	3	G	1			X					X		6/10/2024	12:54	X		
27	BG-09	4	4	G	1			X					X		6/10/2024	13:08	X		
28	BG-10	2	2	G	1			X					X		6/10/2024	13:01	X		
29	BG-10	3	3	G	1			X					X		6/10/2024	13:07	X		
30	BG-10	4	4	G	1			X					X		6/10/2024	13:10	X		

Relinquished By:	Date: 6-18-24 Time: 1240	Received By:	Verbal Result: ☐ Yes ☐ No Add'l Phone #:
			All Results are emailed. Please provide Email address:
Relinquished By:	Date: Time:	Received By:	REMARKS: joesph.guesnier@terracon.com;travis.casey@terracon.com;chuck.smith@terracon.com; beckysue.miller@terracon.com gus.sanchez@terracon.com
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Observed Temp. °C 4.1 Corrected Temp. °C	Sample Condition: Cool ☑ Yes ☐ No; Intact ☑ Yes ☐ No	CHECKED BY: (Initials) SR
			Turnaround Time: Standard ☐ Rush ☑ Bacteria (only) Sample Condition: Cool ☑ Yes ☐ No; Observed Temp. °C
			Thermometer ID #113 #140 Correction Factor -0.5°C; Corrected Temp. °C

FORM-006 R 3.2 10/07/21

† Cardinal cannot accept verbal changes. Please email changes to celey.keene@cardinallabsnm.com

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

May 23, 2024

JOSEPH GUESNIER

TERRACON CONSULTANTS

5827 50TH ST. SUITE 1

LUBBOCK, TX 79424

RE: HNULIK #1

Enclosed are the results of analyses for samples received by the laboratory on 05/17/24 15:28.

Cardinal Laboratories is accredited through Texas NELAP under certificate number T104704398-23-16. Accreditation applies to drinking water, non-potable water and solid and chemical materials. All accredited analytes are denoted by an asterisk (*). For a complete list of accredited analytes and matrices visit the TCEQ website at www.tceq.texas.gov/field/qa/lab_accred_certif.html.

Cardinal Laboratories is accreditated through the State of Colorado Department of Public Health and Environment for:

Method EPA 552.2	Haloacetic Acids (HAA-5)
Method EPA 524.2	Total Trihalomethanes (TTHM)
Method EPA 524.4	Regulated VOCs (V1, V2, V3)

Accreditation applies to public drinking water matrices.

This report meets NELAP requirements and is made up of a cover page, analytical results, and a copy of the original chain-of-custody. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Celey D. Keene

Celey D. Keene

Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	05/17/2024	Sampling Date:	05/17/2024
Reported:	05/23/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Alyssa Parras
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS - 05 (H242751-01)

BTEX 8021B mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	05/20/2024	ND	2.19	110	2.00	10.3	
Toluene*	<0.050	0.050	05/20/2024	ND	2.10	105	2.00	6.72	
Ethylbenzene*	<0.050	0.050	05/20/2024	ND	2.12	106	2.00	3.38	
Total Xylenes*	<0.150	0.150	05/20/2024	ND	6.08	101	6.00	3.88	
Total BTEX	<0.300	0.300	05/20/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *92.5 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: HM

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**624**	16.0	05/20/2024	ND	400	100	400	7.69	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	05/20/2024	ND	191	95.6	200	0.788	
DRO >C10-C28*	<10.0	10.0	05/20/2024	ND	186	93.1	200	2.59	
EXT DRO >C28-C36	<10.0	10.0	05/20/2024	ND					

Surrogate: 1-Chlorooctane *86.8 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *106 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	05/17/2024	Sampling Date:	05/17/2024
Reported:	05/23/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Alyssa Parras
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS - 06 (H242751-02)

BTEX 8021B mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	05/20/2024	ND	2.19	110	2.00	10.3	
Toluene*	<0.050	0.050	05/20/2024	ND	2.10	105	2.00	6.72	
Ethylbenzene*	<0.050	0.050	05/20/2024	ND	2.12	106	2.00	3.38	
Total Xylenes*	<0.150	0.150	05/20/2024	ND	6.08	101	6.00	3.88	
Total BTEX	<0.300	0.300	05/20/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *92.6 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: HM

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2320**	16.0	05/20/2024	ND	400	100	400	7.69	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	05/20/2024	ND	191	95.6	200	0.788	
DRO >C10-C28*	<10.0	10.0	05/20/2024	ND	186	93.1	200	2.59	
EXT DRO >C28-C36	<10.0	10.0	05/20/2024	ND					

Surrogate: 1-Chlorooctane *78.4 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *93.5 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	05/17/2024	Sampling Date:	05/17/2024
Reported:	05/23/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Alyssa Parras
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS - 07 (H242751-03)

BTEX 8021B mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	05/20/2024	ND	2.19	110	2.00	10.3	
Toluene*	<0.050	0.050	05/20/2024	ND	2.10	105	2.00	6.72	
Ethylbenzene*	<0.050	0.050	05/20/2024	ND	2.12	106	2.00	3.38	
Total Xylenes*	<0.150	0.150	05/20/2024	ND	6.08	101	6.00	3.88	
Total BTEX	<0.300	0.300	05/20/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *92.1 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: HM

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**144**	16.0	05/20/2024	ND	400	100	400	7.69	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	05/20/2024	ND	183	91.5	200	1.49	
DRO >C10-C28*	<10.0	10.0	05/20/2024	ND	183	91.3	200	2.46	
EXT DRO >C28-C36	<10.0	10.0	05/20/2024	ND					

Surrogate: 1-Chlorooctane *87.9 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *82.2 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	05/17/2024	Sampling Date:	05/17/2024
Reported:	05/23/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115	Sample Received By:	Alyssa Parras
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS - 08 (H242751-04)

BTEX 8021B mg/kg **Analyzed By: MS**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	05/20/2024	ND	2.19	110	2.00	10.3	
Toluene*	<0.050	0.050	05/20/2024	ND	2.10	105	2.00	6.72	
Ethylbenzene*	<0.050	0.050	05/20/2024	ND	2.12	106	2.00	3.38	
Total Xylenes*	<0.150	0.150	05/20/2024	ND	6.08	101	6.00	3.88	
Total BTEX	<0.300	0.300	05/20/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *92.4 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg **Analyzed By: HM**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**160**	16.0	05/20/2024	ND	400	100	400	7.69	

TPH 8015M mg/kg **Analyzed By: MS**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	05/20/2024	ND	183	91.5	200	1.49	
DRO >C10-C28*	<10.0	10.0	05/20/2024	ND	183	91.3	200	2.46	
EXT DRO >C28-C36	<10.0	10.0	05/20/2024	ND					

Surrogate: 1-Chlorooctane *82.8 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *76.9 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Notes and Definitions

ND	Analyte NOT DETECTED at or above the reporting limit
RPD	Relative Percent Difference
**	Samples not received at proper temperature of 6°C or below.
***	Insufficient time to reach temperature.
-	Chloride by SM4500Cl-B does not require samples be received at or below 6°C
	Samples reported on an as received basis (wet) unless otherwise noted on report

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Terracon
Project Manager: Joe Guesnet
Address: 4518 W Pierce St
City: Carlsbad State: NM Zip: 88220
Phone #: Fax #:
Project #: AR227115 Project Owner:
Project Name: Mulik
Project Location: Eddy
Sampler Name:

BILL TO
P.O. #:
Company:
Attn:
Address:
City:
State: Zip:
Phone #:
Fax #:

ANALYSIS REQUEST

FOR LAB USE ONLY Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRESERV.: ACID/BASE:	ICE / COOL	OTHER:	SAMPLING DATE	SAMPLING TIME	BTEX (8021B)	TPH (8015)	Chlorides
H247751	*										✓						
1	FS-015	C	1			X					X		5/17	11:30	X	X	X
2	FS-016	C	1			X					X			11:35	X	X	X
3	FS-017	C	1			X					X			11:40	X	X	X
4	FS-018	C	1			X					X			11:45	X	X	X

PLEASE NOTE: Liability and Damages. Cardinal's liability and client's exclusive remedy for any claim arising whether based in contract or tort, shall be limited to the amount paid by the client for the analyses. All claims including those for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within 30 days after completion of the applicable service. In no event shall Cardinal be liable for incidental or consequential damages, including without limitation, business interruptions, loss of use, or loss of profits incurred by client, its subsidiaries, affiliates or successors arising out of or related to the performance of services hereunder by Cardinal, regardless of whether such claim is based upon any of the above stated reasons or otherwise.

Relinquished By: B Meadows Date: 5/17/24 Time: 1328
Received By: Aparos
Relinquished By: Date: Time:
Received By:

Verbal Result: ☐ Yes ☐ No Add'l Phone #:
All Results are emailed. Please provide Email address:

REMARKS: * Customer requested ID changes. 5/20/24

Delivered By: (Circle One)
Sampler - UPS - Bus - Other:
Observed Temp. °C 5.4'c
Corrected Temp. °C
Sample Condition: Cool ☑ Yes ☐ No Intact ☑ Yes ☐ No
CHECKED BY: (Initials) AP

Turnaround Time: Standard ☑ Rush ☐
Thermometer ID #140
Correction Factor 0°C
Bacteria (only) Sample Condition: Cool ☐ Yes ☐ No Intact ☐ Yes ☐ No
Observed Temp. °C
Corrected Temp. °C

FORM-006 R 3.4 07/11/23

† Cardinal cannot accept verbal changes. Please email changes to celey.keene@cardinallabsnm.com

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

April 18, 2024

JOSEPH GUESNIER

TERRACON CONSULTANTS

5827 50TH ST. SUITE 1

LUBBOCK, TX 79424

RE: HNULIK #1

Enclosed are the results of analyses for samples received by the laboratory on 04/12/24 12:36.

Cardinal Laboratories is accredited through Texas NELAP under certificate number T104704398-23-16. Accreditation applies to drinking water, non-potable water and solid and chemical materials. All accredited analytes are denoted by an asterisk (*). For a complete list of accredited analytes and matrices visit the TCEQ website at www.tceq.texas.gov/field/qa/lab_accred_certif.html.

Cardinal Laboratories is accreditated through the State of Colorado Department of Public Health and Environment for:

Method EPA 552.2	Haloacetic Acids (HAA-5)
Method EPA 524.2	Total Trihalomethanes (TTHM)
Method EPA 524.4	Regulated VOCs (V1, V2, V3)

Accreditation applies to public drinking water matrices.

This report meets NELAP requirements and is made up of a cover page, analytical results, and a copy of the original chain-of-custody. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Celey D. Keene

Celey D. Keene

Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: N - SW - 1 0.4' (H241932-01)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *120 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**2400**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *88.1 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *83.0 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: E - SW - 1 0.4' (H241932-02)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *112 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**3600**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *84.7 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *78.0 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: W - SW - 1 0.4' (H241932-03)

BTEX 8021B mg/kg **Analyzed By: JH**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *106 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg **Analyzed By: CT**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**1200**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg **Analyzed By: MS**

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *87.5 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *80.9 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: S - SW - 1 0.4' (H241932-04)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *110 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**8400**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *85.7 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *79.1 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS 01 4' (H241932-05)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *110 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**816**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *86.1 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *80.6 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS 02 4' (H241932-06)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *112 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**944**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *81.9 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *76.9 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS 03 4' (H241932-07)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *111 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**496**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	195	97.5	200	1.01	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.4	200	0.920	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *83.7 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *79.4 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Analytical Results For:

TERRACON CONSULTANTS
JOSEPH GUESNIER
5827 50TH ST. SUITE 1
LUBBOCK TX, 79424
Fax To:

Received:	04/12/2024	Sampling Date:	04/11/2024
Reported:	04/18/2024	Sampling Type:	Soil
Project Name:	HNULIK #1	Sampling Condition:	Cool & Intact
Project Number:	AR227115 (6IN LATERAL)	Sample Received By:	Tamara Oldaker
Project Location:	DURANGO MIDSTREAM		

Sample ID: FS 04 4' (H241932-08)

BTEX 8021B mg/kg Analyzed By: JH

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Benzene*	<0.050	0.050	04/15/2024	ND	2.16	108	2.00	3.91	
Toluene*	<0.050	0.050	04/15/2024	ND	2.17	109	2.00	3.43	
Ethylbenzene*	<0.050	0.050	04/15/2024	ND	2.23	111	2.00	1.50	
Total Xylenes*	<0.150	0.150	04/15/2024	ND	6.74	112	6.00	0.737	
Total BTEX	<0.300	0.300	04/15/2024	ND					

Surrogate: 4-Bromofluorobenzene (PID *112 %* *71.5-134*

Chloride, SM4500Cl-B mg/kg Analyzed By: CT

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
Chloride	**640**	16.0	04/16/2024	ND	432	108	400	0.00	

TPH 8015M mg/kg Analyzed By: MS

Analyte	Result	Reporting Limit	Analyzed	Method Blank	BS	% Recovery	True Value QC	RPD	Qualifier
GRO C6-C10*	<10.0	10.0	04/15/2024	ND	187	93.4	200	0.0889	
DRO >C10-C28*	<10.0	10.0	04/15/2024	ND	185	92.7	200	1.70	
EXT DRO >C28-C36	<10.0	10.0	04/15/2024	ND					

Surrogate: 1-Chlorooctane *88.4 %* *48.2-134*

Surrogate: 1-Chlorooctadecane *101 %* *49.1-148*

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

PHONE (575) 393-2326 ° 101 E. MARLAND ° HOBBS, NM 88240

Notes and Definitions

ND	Analyte NOT DETECTED at or above the reporting limit
RPD	Relative Percent Difference
**	Samples not received at proper temperature of 6°C or below.
***	Insufficient time to reach temperature.
-	Chloride by SM4500Cl-B does not require samples be received at or below 6°C
	Samples reported on an as received basis (wet) unless otherwise noted on report

Cardinal Laboratories *=Accredited Analyte

Celey D. Keene, Lab Director/Quality Manager

CARDINAL Laboratories

101 East Marland, Hobbs, NM 88240
(575) 393-2326 FAX (575) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Company Name: Terracon		**BILL TO**	
Project Manager: Joseph Guesnier		P.O. #:	
Address: 4518 W. Perice Street		Company: Devon	
City: Carlsbad	State: NM Zip: 88220	Attn: Lupe	
Phone #: 8065077057	Fax #:	Address:	
Project #: AR227115	Project Owner:	City:	
Project Name: Hovlik 6" Lateral #1		State: Zip:	
Project Location:		Phone #:	
Sampler Name: Travis Casey		Fax #:	

FOR LAB USE ONLY

Lab I.D.	Sample I.D.		(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER :	PRESERV.: ACID/BASE:	ICE / COOL	OTHER :	SAMPLING: DATE	TIME	Chloride (EPA Method4500)	TPH Extended 8015	BTEX (EPA Method 8021B)
H241932																		
1	N-SW-1	0-4'	C	1			X					X		4-11	1400	X	X	X
2	E-SW-1	0-4'		1											1420			
3	W-SW-1	0-4'		1											1430			
4	S-SW-1	0-4'		1											1440			
5	FS01	4'		1											1450			
6	FS02	4'		1											1500			
7	FS03	4'		1											1510			
8	FS04	4'		1											1520			

Relinquished By:	Date: 4-12-24	Received By:	Verbal Result: ☐ Yes ☐ No Add'l Phone #:
	Time: 1336		All Results are emailed. Please provide Email address:
Relinquished By:	Date:	Received By:	REMARKS: joesph.guesnier@terracon.com; travis.casey@terracon.com; austin.worley@terracon.com; michael.adams@terracon.com
	Time:		

Delivered By: (Circle One)	Observed Temp. °C 0.2	Sample Condition Cool ☑ Yes ☐ No / Intact ☑ Yes ☐ No	CHECKED BY: (Initials)	Turnaround Time: Standard ☑ Rush ☐
Sampler - UPS - Bus - Other:	Corrected Temp. °C			Thermometer ID #113 #140 Correction Factor -0.5°C 0.4/12/24

Bacteria (only) Sample Condition: Cool ☐ Yes ☐ No / Intact ☐ Yes ☐ No — Observed Temp. °C — Corrected Temp. °C

FORM-006 R 3.2 10/07/21

† Cardinal cannot accept verbal changes. Please email changes to celey.keene@cardinallabsnm.com

APPENDIX E – NMOCD Communications

From: OCDOnline@state.nm.us <OCDOnline@state.nm.us>
Sent: Wednesday, March 27, 2024 11:12 AM
To: Mary Taylor <mtaylor@durangomidstream.com>
Subject: The Oil Conservation Division (OCD) has approved the application, Application ID: 154217

To whom it may concern (c/o Mary Taylor for FRONTIER FIELD SERVICES, LLC),

The OCD has approved the submitted *Application for administrative approval of a release notification and corrective action* (C-141), for incident ID (n#) nAPP2214534062, with the following conditions:

1. **This remediation plan is approved with the following conditions: Submit the EPA ProUCL calculations to demonstrate how a background chloride concentration of 22,389 mg/L was achieved. Complete sidewall samples of the excavation as well as base samples. OCD must approve background samples in the upper four (4) feet of the impacted area before closure is met and deemed complete.**

The signed C-141 can be found in the OCD Online: Imaging under the incident ID (n#).

If you have any questions regarding this application, please contact me.

Thank you,
Michael Buchanan
Environmental Specialist
505-490-0798
Michael.Buchanan@emnrd.nm.gov

New Mexico Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
Santa Fe, NM 87505

From: OCDOnline@state.nm.us <OCDOnline@state.nm.us>
Sent: Tuesday, April 9, 2024 1:45 PM
To: Guadalupe Carrasco <gcarrasco@durangomidstream.com>
Subject: The Oil Conservation Division (OCD) has accepted the application, Application ID: 331180

To whom it may concern (c/o Guadalupe Carrasco for FRONTIER FIELD SERVICES, LLC),

The OCD has received the submitted *Notification for (Final) Sampling of a Release* (C-141N), for incident ID (n#) nAPP2214534062.

The sampling event is expected to take place:

When: 04/11/2024 @ 14:00
Where: M-25-17S-26E 0 FNL 0 FEL (32.80236,-104.34291)

Additional Information: Travis Casey
575-689-5949

Additional Instructions: From the intersection of CR 55 and CR 56 (GPS: 32.813411, -104.343765), head East on E Castleberry Rd for 0.75 miles, then head South on E Castleberry for 0.43 miles then continue West for 0.25 miles then turn south and continue for 0.40 miles and turn west down pipeline right-of-way (GPS: 32.801837, -104.334467), for 0.38 miles and the site to survey will be there (GPS: 32.80215, -104.34084)

An OCD representative may be available onsite at the date and time reported. In the absence or presence of an OCD representative, sampling pursuant to 19.15.29.12.D NMAC is required. Sampling must be performed following an approved sampling plan or pursuant to 19.15.29.12.D.(1).(c) NMAC. Should there be a change in the scheduled date and time of the sampling event, then another notification should be resubmitted through OCD permitting as soon as possible.

- **Failure to notify the OCD of sampling events including any changes in date/time per the requirements of 19.15.29.12.D.(1).(a) NMAC, may result in the remediation closure samples not being accepted.**

If you have any questions regarding this application, or don't know why you have received this email, please contact us.

New Mexico Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
Santa Fe, NM 87505

From: OCDOnline@state.nm.us <OCDOnline@state.nm.us>
Sent: Tuesday, May 14, 2024 10:10 AM
To: Sebastian Orozco <sorozco@durangomidstream.com>
Subject: The Oil Conservation Division (OCD) has accepted the application, Application ID: 344140

To whom it may concern (c/o Sebastian Orozco for FRONTIER FIELD SERVICES, LLC),

The OCD has received the submitted *Notification for (Final) Sampling of a Release* (C-141N), for incident ID (n#) nAPP2214534062.

The sampling event is expected to take place:

When: 05/16/2024 @ 10:30
Where: M-25-17S-26E 0 FNL 0 FEL (32.80236,-104.34291)

Additional Information: Joseph Guesnier
806-544-9276

Additional Instructions: From the intersection of CR 55 and CR 56 (GPS: 32.813411, -104.343765), head East on E Castleberry Rd for 0.75 miles, then head South on E Castleberry for 0.43 miles then continue West for 0.25 miles then turn south and continue for 0.40 miles and turn west down pipeline right-of-way (GPS: 32.801837, -104.334467), for 0.38 miles and the site to survey will be there (GPS: 32.80215, -104.34084)

An OCD representative may be available onsite at the date and time reported. In the absence or presence of an OCD representative, sampling pursuant to 19.15.29.12.D NMAC is required. Sampling must be performed following an approved sampling plan or pursuant to 19.15.29.12.D.(1).(c) NMAC. Should there be a change in the scheduled date and time of the sampling event, then another notification should be resubmitted through OCD permitting as soon as possible.

- **Failure to notify the OCD of sampling events including any changes in date/time per the requirements of 19.15.29.12.D.(1).(a) NMAC, may result in the remediation closure samples not being accepted.**

If you have any questions regarding this application, or don't know why you have received this email, please contact us.

New Mexico Energy, Minerals and Natural Resources Department
1220 South St. Francis Drive
Santa Fe, NM 87505

From: OCDOnline@state.nm.us <OCDOnline@state.nm.us>
Sent: Thursday, June 6, 2024 9:35 AM
To: Sebastian Orozco <sorozco@durangomidstream.com>
Subject: The Oil Conservation Division (OCD) has accepted the application, Application ID: 351388

To whom it may concern (c/o Sebastian Orozco for FRONTIER FIELD SERVICES, LLC),

The OCD has received the submitted *Notification for (Final) Sampling of a Release* (C-141N), for incident ID (n#) nAPP2214534062.

The sampling event is expected to take place:

When: 06/10/2024 @ 09:45
Where: M-25-17S-26E 0 FNL 0 FEL (32.80236,-104.34291)

Additional Information: Joseph Guesnier
806-544-9276

Additional Instructions: From the intersection of CR 55 and CR 56 (GPS: 32.813411, -104.343765), head East on E Castleberry Rd for 0.75 miles, then head South on E Castleberry for 0.43 miles then continue West for 0.25 miles then turn south and continue for 0.40 miles and turn west down pipeline right-of-way (GPS: 32.801837, -104.334467), for 0.38 miles and the site to survey will be there (GPS: 32.80215, -104.34084)

An OCD representative may be available onsite at the date and time reported. In the absence or presence of an OCD representative, sampling pursuant to 19.15.29.12.D NMAC is required. Sampling must be performed following an approved sampling plan or pursuant to 19.15.29.12.D.(1).(c) NMAC. Should there be a change in the scheduled date and time of the sampling event, then another notification should be resubmitted through OCD permitting as soon as possible.

- **Failure to notify the OCD of sampling events including any changes in date/time per the requirements of 19.15.29.12.D.(1).(a) NMAC, may result in the remediation closure samples not being accepted.**

If you have any questions regarding this application, or don't know why you have received this email, please contact us.

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1220 South St. Francis Drive
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APPENDIX F – TERRACON STANDARD OF CARE, LIMITATION, AND RELIANCE

Standard of Care

Terracon's services were performed in a manner consistent with generally accepted practices of the profession undertaken in similar studies in the same geographical area during the same time. Terracon makes no warranties, either express or implied, regarding the findings, conclusions, or recommendations. Please note that Terracon does not warrant the work of laboratories, regulatory agencies, or other third parties supplying information used in the preparation of the report. These services were performed in accordance with the scope of work agreed with you, Durango Midstream LLC, as reflected in our proposal (PKH227021).

Additional Scope Limitations

The development of this Amended RAP is based upon information provided by the Client and Terracon's remediation and construction services line. Such information is subject to change over time. Certain indicators of the presence of hazardous substances, petroleum products, or other constituents may have been latent, inaccessible, unobservable, nondetectable, or not present during these services. We cannot represent that the site contains no hazardous substances, toxic materials, petroleum products, or other latent conditions beyond those by information provided by the Client. The data, interpretations, findings, and recommendations are based solely upon reformation executed within the scope of these services.

Reliance

This report has been prepared for the exclusive use of Durango Midstream LLC, and any authorization for use or reliance by any other party (except a governmental entity having jurisdiction over the site) is prohibited without the express written authorization of Durango Midstream LLC and Terracon. Any unauthorized distribution or reuse is at Durango Midstream LLC sole risk. Notwithstanding the foregoing, reliance by authorized parties will be subject to the terms, conditions, and limitations stated in the proposal and Durango Midstream LLC and Terracon's Master Services Agreement. The limitation of liability defined in the terms and conditions is the aggregate limit of Terracon's liability to Durango Midstream LLC and all relying parties unless otherwise agreed in writing.

Sante Fe Main Office
Phone: (505) 476-3441

General Information
Phone: (505) 629-6116

Online Phone Directory
https://www.emnrd.nm.gov/ocd/contact-us

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

QUESTIONS

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Prerequisites	
Incident ID (n#)	**nAPP2214534062**
Incident Name	**NAPP2214534062 HNULIK #1 @ 0**
Incident Type	**Natural Gas Release**
Incident Status	**Reclamation Report Received**
Incident Facility	**[fAPP2123229442] Frontier Field Services Gathering System**

Location of Release Source	
Please answer all the questions in this group.	
Site Name	HNULIK #1
Date Release Discovered	04/13/2022
Surface Owner	Private

Incident Details	
Please answer all the questions in this group.	
Incident Type	Natural Gas Release
Did this release result in a fire or is the result of a fire	No
Did this release result in any injuries	No
Has this release reached or does it have a reasonable probability of reaching a watercourse	No
Has this release endangered or does it have a reasonable probability of endangering public health	No
Has this release substantially damaged or will it substantially damage property or the environment	No
Is this release of a volume that is or may with reasonable probability be detrimental to fresh water	No

Nature and Volume of Release	
Material(s) released, please answer all that apply below. Any calculations or specific justifications for the volumes provided should be attached to the follow-up C-141 submission.	
Crude Oil Released (bbls) Details	*Not answered.*
Produced Water Released (bbls) Details	*Not answered.*
Is the concentration of chloride in the produced water >10,000 mg/l	*Not answered.*
Condensate Released (bbls) Details	*Not answered.*
Natural Gas Vented (Mcf) Details	*Not answered.*
Natural Gas Flared (Mcf) Details	*Not answered.*
Other Released Details	Cause: | | Other (Specify) | Released: 0 (Unknown Released Amount) | Recovered: 0 | Lost: 0 .
Are there additional details for the questions above (i.e. any answer containing Other, Specify, Unknown, and/or Fire, or any negative lost amounts)	*Not answered.*

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Nature and Volume of Release (continued)	
Is this a gas only submission (i.e. only significant Mcf values reported)	**More info needed to determine if this will be treated as a "gas only" report.**
Was this a major release as defined by Subsection A of 19.15.29.7 NMAC	*Unavailable.*
Reasons why this would be considered a submission for a notification of a major release	*Unavailable.*
With the implementation of the 19.15.27 NMAC (05/25/2021), venting and/or flaring of natural gas (i.e. gas only) are to be submitted on the C-129 form.	

Initial Response	
The responsible party must undertake the following actions immediately unless they could create a safety hazard that would result in injury.	
The source of the release has been stopped	True
The impacted area has been secured to protect human health and the environment	True
Released materials have been contained via the use of berms or dikes, absorbent pads, or other containment devices	True
All free liquids and recoverable materials have been removed and managed appropriately	True
If all the actions described above have not been undertaken, explain why	*Not answered.*
Per Paragraph (4) of Subsection B of 19.15.29.8 NMAC the responsible party may commence remediation immediately after discovery of a release. If remediation has begun, please prepare and attach a narrative of actions to date in the follow-up C-141 submission. If remedial efforts have been successfully completed or if the release occurred within a lined containment area (see Subparagraph (a) of Paragraph (5) of Subsection A of 19.15.29.11 NMAC), please prepare and attach all information needed for closure evaluation in the follow-up C-141 submission.	

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

I hereby agree and sign off to the above statement	Name: Sebastian Orozco Title: Sr. Environmental Specialist Email: sorozco@durangomidstream.com Date: 06/21/2024

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Site Characterization	
Please answer all the questions in this group (only required when seeking remediation plan approval and beyond). This information must be provided to the appropriate district office no later than 90 days after the release discovery date.	
What is the shallowest depth to groundwater beneath the area affected by the release in feet below ground surface (ft bgs)	Less than or equal 25 (ft.)
What method was used to determine the depth to ground water	NM OSE iWaters Database Search
Did this release impact groundwater or surface water	No
What is the minimum distance, between the closest lateral extents of the release and the following surface areas:	
A continuously flowing watercourse or any other significant watercourse	Between ½ and 1 (mi.)
Any lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark)	Between ½ and 1 (mi.)
An occupied permanent residence, school, hospital, institution, or church	Greater than 5 (mi.)
A spring or a private domestic fresh water well used by less than five households for domestic or stock watering purposes	Between ½ and 1 (mi.)
Any other fresh water well or spring	Between ½ and 1 (mi.)
Incorporated municipal boundaries or a defined municipal fresh water well field	Greater than 5 (mi.)
A wetland	Between ½ and 1 (mi.)
A subsurface mine	Greater than 5 (mi.)
An (non-karst) unstable area	Greater than 5 (mi.)
Categorize the risk of this well / site being in a karst geology	Medium
A 100-year floodplain	Zero feet, overlying, or within area
Did the release impact areas not on an exploration, development, production, or storage site	No

Remediation Plan		
Please answer all the questions that apply or are indicated. This information must be provided to the appropriate district office no later than 90 days after the release discovery date.		
Requesting a remediation plan approval with this submission		Yes
Attach a comprehensive report demonstrating the lateral and vertical extents of soil contamination associated with the release have been determined, pursuant to 19.15.29.11 NMAC and 19.15.29.13 NMAC.		
Have the lateral and vertical extents of contamination been fully delineated		Yes
Was this release entirely contained within a lined containment area		No
Soil Contamination Sampling: (Provide the highest observable value for each, in milligrams per kilograms.)		
Chloride	(EPA 300.0 or SM4500 Cl B)	32000
TPH (GRO+DRO+MRO)	(EPA SW-846 Method 8015M)	0
GRO+DRO	(EPA SW-846 Method 8015M)	0
BTEX	(EPA SW-846 Method 8021B or 8260B)	0
Benzene	(EPA SW-846 Method 8021B or 8260B)	0
Per Subsection B of 19.15.29.11 NMAC unless the site characterization report includes completed efforts at remediation, the report must include a proposed remediation plan in accordance with 19.15.29.12 NMAC, which includes the anticipated timelines for beginning and completing the remediation.		
On what estimated date will the remediation commence		05/16/2022
On what date will (or did) the final sampling or liner inspection occur		06/10/2024
On what date will (or was) the remediation complete(d)		06/10/2024
What is the estimated surface area (in square feet) that will be reclaimed		1600
What is the estimated volume (in cubic yards) that will be reclaimed		0
What is the estimated surface area (in square feet) that will be remediated		1600
What is the estimated volume (in cubic yards) that will be remediated		350
These estimated dates and measurements are recognized to be the best guess or calculation at the time of submission and may (be) change(d) over time as more remediation efforts are completed.		
The OCD recognizes that proposed remediation measures may have to be minimally adjusted in accordance with the physical realities encountered during remediation. If the responsible party has any need to significantly deviate from the remediation plan proposed, then it should consult with the division to determine if another remediation plan submission is required.		

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Remediation Plan (continued)	
Please answer all the questions that apply or are indicated. This information must be provided to the appropriate district office no later than 90 days after the release discovery date.	
This remediation will (or is expected to) utilize the following processes to remediate / reduce contaminants:	
(Select all answers below that apply.)	
(Ex Situ) Excavation and **off-site** disposal (i.e. dig and haul, hydrovac, etc.)	Yes
Which OCD approved facility will be used for **off-site** disposal	GANDY MARLEY LANDFARM/LANDFILL [fEEM0112338393]
OR which OCD approved well (API) will be used for **off-site** disposal	*Not answered.*
OR is the **off-site** disposal site, to be used, out-of-state	*Not answered.*
OR is the **off-site** disposal site, to be used, an NMED facility	*Not answered.*
(Ex Situ) Excavation and **on-site** remediation (i.e. On-Site Land Farms)	*Not answered.*
(In Situ) Soil Vapor Extraction	*Not answered.*
(In Situ) Chemical processing (i.e. Soil Shredding, Potassium Permanganate, etc.)	*Not answered.*
(In Situ) Biological processing (i.e. Microbes / Fertilizer, etc.)	*Not answered.*
(In Situ) Physical processing (i.e. Soil Washing, Gypsum, Disking, etc.)	*Not answered.*
Ground Water Abatement pursuant to 19.15.30 NMAC	*Not answered.*
OTHER (Non-listed remedial process)	*Not answered.*
Per Subsection B of 19.15.29.11 NMAC unless the site characterization report includes completed efforts at remediation, the report must include a proposed remediation plan in accordance with 19.15.29.12 NMAC, which includes the anticipated timelines for beginning and completing the remediation.	
I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.	
I hereby agree and sign off to the above statement	Name: Sebastian Orozco Title: Sr. Environmental Specialist Email: sorozco@durangomidstream.com Date: 06/21/2024
The OCD recognizes that proposed remediation measures may have to be minimally adjusted in accordance with the physical realities encountered during remediation. If the responsible party has any need to significantly deviate from the remediation plan proposed, then it should consult with the division to determine if another remediation plan submission is required.	

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Deferral Requests Only *Only answer the questions in this group if seeking a deferral upon approval this submission. Each of the following items must be confirmed as part of any request for deferral of remediation.*	
Requesting a deferral of the remediation closure due date with the approval of this submission	No

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Sampling Event Information	
Last sampling notification (C-141N) recorded	**351388**
Sampling date pursuant to Subparagraph (a) of Paragraph (1) of Subsection D of 19.15.29.12 NMAC	**06/10/2024**
What was the (estimated) number of samples that were to be gathered	**30**
What was the sampling surface area in square feet	**1600**

Remediation Closure Request	
Only answer the questions in this group if seeking remediation closure for this release because all remediation steps have been completed.	
Requesting a remediation closure approval with this submission	Yes
Have the lateral and vertical extents of contamination been fully delineated	**Yes**
Was this release entirely contained within a lined containment area	**No**
All areas reasonably needed for production or subsequent drilling operations have been stabilized, returned to the sites existing grade, and have a soil cover that prevents ponding of water, minimizing dust and erosion	Yes
What was the total surface area (in square feet) remediated	1600
What was the total volume (cubic yards) remediated	350
All areas not reasonably needed for production or subsequent drilling operations have been reclaimed to contain a minimum of four feet of non-waste contain earthen material with concentrations less than 600 mg/kg chlorides, 100 mg/kg TPH, 50 mg/kg BTEX, and 10 mg/kg Benzene	Yes
What was the total surface area (in square feet) reclaimed	1600
What was the total volume (in cubic yards) reclaimed	0
Summarize any additional remediation activities not included by answers (above)	n/a

The responsible party must attach information demonstrating they have complied with all applicable closure requirements and any conditions or directives of the OCD. This demonstration should be in the form of a comprehensive report (in .pdf format) including a scaled site map, sampling diagrams, relevant field notes, photographs of any excavation prior to backfilling, laboratory data including chain of custody documents of final sampling, and a narrative of the remedial activities. Refer to 19.15.29.12 NMAC.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations. The responsible party acknowledges they must substantially restore, reclaim, and re-vegetate the impacted surface area to the conditions that existed prior to the release or their final land use in accordance with 19.15.29.13 NMAC including notification to the OCD when reclamation and re-vegetation are complete.

I hereby agree and sign off to the above statement	Name: Sebastian Orozco Title: Sr. Environmental Specialist Email: sorozco@durangomidstream.com Date: 06/21/2024

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Reclamation Report	
Only answer the questions in this group if all reclamation steps have been completed.	
Requesting a reclamation approval with this submission	Yes
What was the total reclamation surface area (in square feet) for this site	1600
What was the total volume of replacement material (in cubic yards) for this site	350
Per Paragraph (1) of Subsection D of 19.15.29.13 NMAC the reclamation must contain a minimum of four feet of non-waste containing, uncontaminated, earthen material with chloride concentrations less than 600 mg/kg as analyzed by EPA Method 300.0, or other test methods approved by the division. The soil cover must include a top layer, which is either the background thickness of topsoil or one foot of suitable material to establish vegetation at the site, whichever is greater.	
Is the soil top layer complete and is it suitable material to establish vegetation	Yes
On what (estimated) date will (or was) the reseeding commence(d)	08/01/2024
Summarize any additional reclamation activities not included by answers (above)	n/a
The responsible party must attach information demonstrating they have complied with all applicable reclamation requirements and any conditions or directives of the OCD. This demonstration should be in the form of attachments (in .pdf format) including a scaled site map, any proposed reseeding plans or relevant field notes, photographs of reclaimed area, and a narrative of the reclamation activities. Refer to 19.15.29.13 NMAC.	
I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to OCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the OCD does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to groundwater, surface water, human health or the environment. In addition, OCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations. The responsible party acknowledges they must substantially restore, reclaim, and re-vegetate the impacted surface area to the conditions that existed prior to the release or their final land use in accordance with 19.15.29.13 NMAC including notification to the OCD when reclamation and re-vegetation are complete.	
I hereby agree and sign off to the above statement	Name: Sebastian Orozco Title: Sr. Environmental Specialist Email: sorozco@durangomidstream.com Date: 06/21/2024

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QUESTIONS (continued)

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

QUESTIONS

Revegetation Report	
Only answer the questions in this group if all surface restoration, reclamation and re-vegetation obligations have been satisfied.	
Requesting a restoration complete approval with this submission	No
Per Paragraph (4) of Subsection (D) of 19.15.29.13 NMAC for any major or minor release containing liquids, the responsible party must notify the division when reclamation and re-vegetation are complete.	

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CONDITIONS

Operator: FRONTIER FIELD SERVICES, LLC 303 Veterans Airpark Lane Midland, TX 79705	OGRID: 221115
	Action Number: 356542
	Action Type: [C-141] Reclamation Report C-141 (C-141-v-Reclamation)

CONDITIONS

Created By	Condition	Condition Date
michael.buchanan	The remediation closure report is approved. In the future, a minimum of four (4) background samples will be required to be sampled no closer than fifty (50) feet to the closest edge of the release and sampled at every foot in an undisturbed area from oil & gas activities. The average of each borehole depth for all four (4) borings is then taken for each foot to give the average. Also, in the future, depth to groundwater data will not be accepted further than 1/2 mile from the area of concern. Please proceed to the reclamation plan.	2/26/2025