



Site Investigation, Remediation, and Reclamation of Oil & Gas and Brine Spills in North Dakota

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Overview

- **Major Contaminants in the oil industry**
- **Field Screening methods**
 - Electrical Conductivity (EC)
 - Chlorides
 - Organic Vapors
- **Site Assessment**
 - Limited Site Investigation (LSI)
 - Corrective Action Plan (CAP)
- **Corrective Action**
 - Remediation/Excavation
 - Reclamation
- **Case Studies**

Major Contaminants in the oil industry

Produce Water (Brine)



Petroleum Hydrocarbons





Field Screening Methods

Produced Water

- Electrical Conductivity
- Chlorides

Petroleum Hydrocarbons

- Organic Vapors



Electrical Conductivity (EC)

- EC meter equipped with stainless steel probe
- Measures a material's ability to conduct an electric current
- Microsiemens per centimeter ($\mu\text{S}/\text{cm}$)



Chlorides

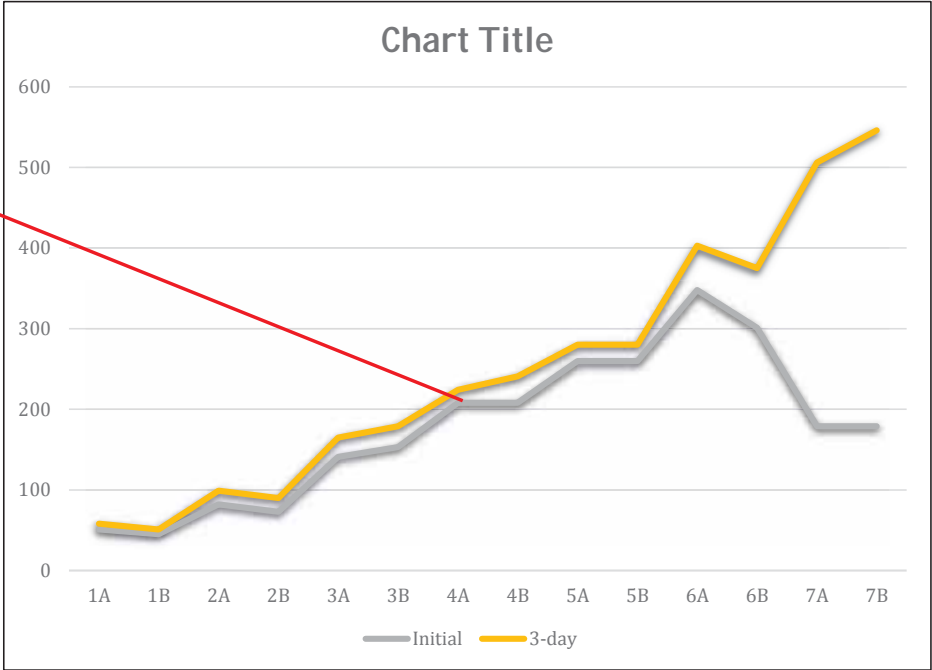
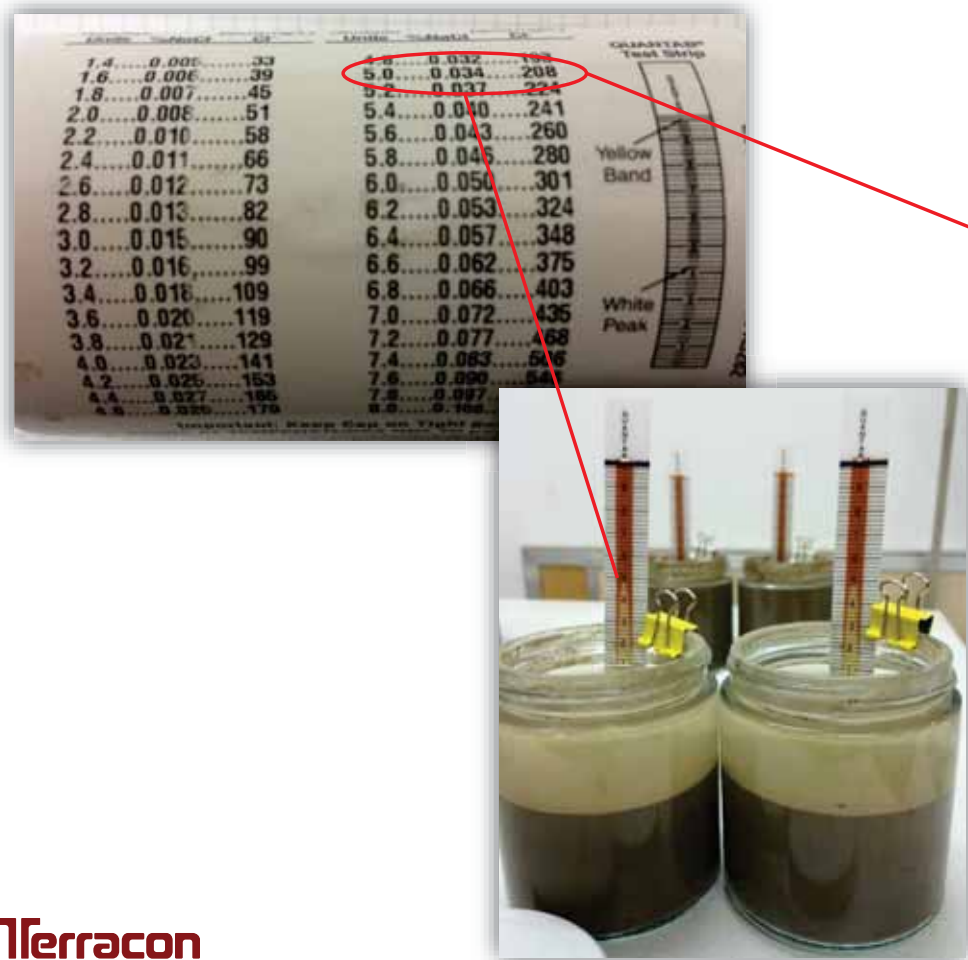
- QuanTab® titration test strips
- Measures the chloride content from a solution
- Milligrams per liter (mg/L)



Chlorides - Experiment

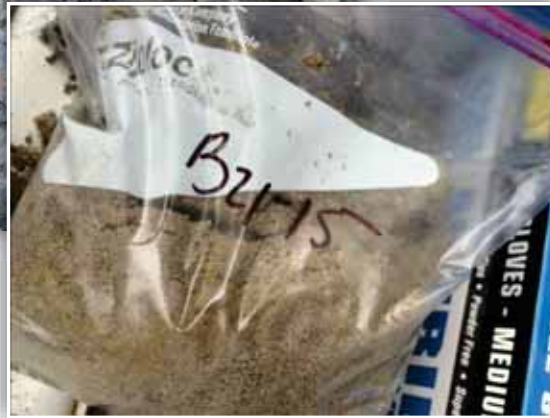


Chlorides - Experiment



Organic Vapors

- Photoionization detector (PID) meter
- Measures organic vapors (isobutylene equivalents)
- Parts per million (ppm)



Site Assessment

Limited Site Investigation (LSI)

- Evaluate the extent and magnitude, vertically and horizontally, of impacted material
- Assessing surface and depth (soil borings)
- Assess groundwater if soil borings extend to groundwater level

Corrective Action Plan (CAP)

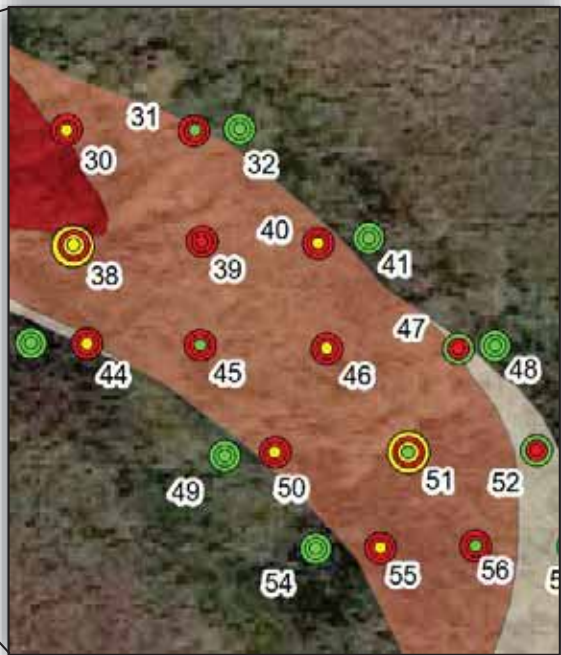
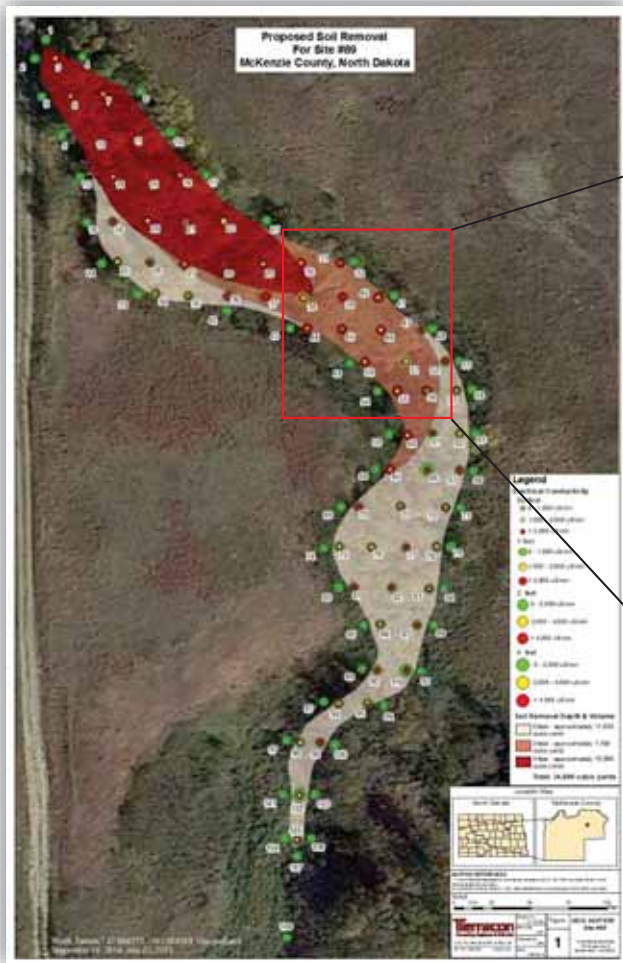
- Designed after site investigation and results are evaluated
- Should address volume of contaminated material, analytical program, disposal, backfilling, and other site specific reclamation activities required

Limited Site Investigation

- Screen grid-like pattern at the surface
- Advance soil borings to help determine vertical and horizontal extent
- Install temporary groundwater monitoring wells if groundwater is encountered
- Screen soil and groundwater for EC, chlorides, and organic vapors



Limited Site Investigation



Electrical Conductivity

Field screened with an EC meter

Analyzed in laboratory for electrical conductivity

Legend

Electrical Conductivity

Surface

- 0 - 1,000 uS/cm
- 1,000 - 2,000 uS/cm
- > 2,000 uS/cm

1 foot

- 0 - 1,000 uS/cm
- 1,000 - 2,000 uS/cm
- > 2,000 uS/cm

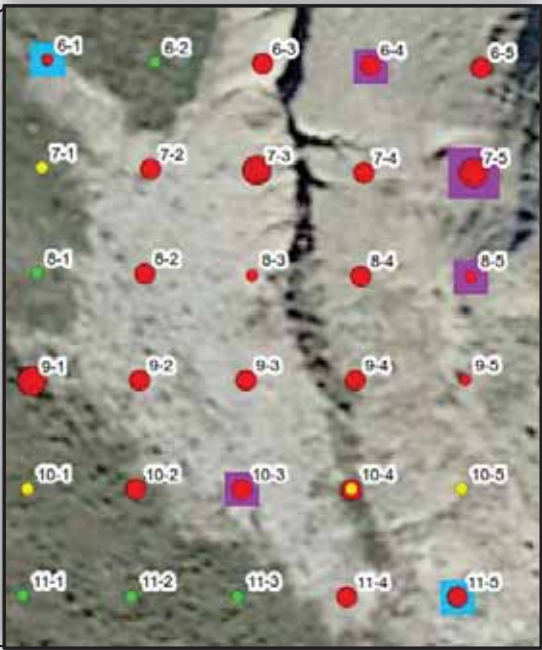
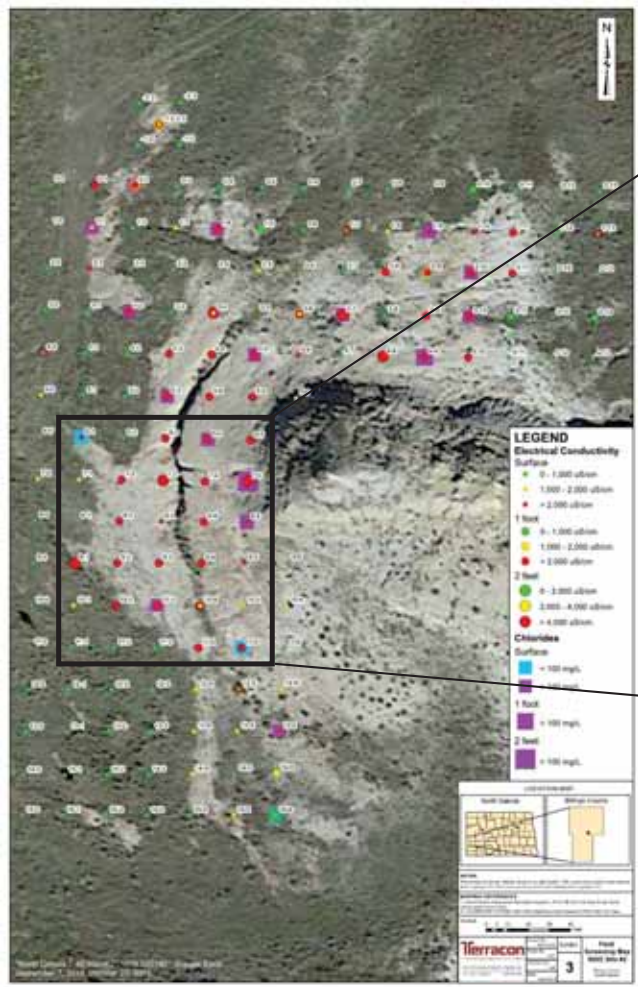
2 feet

- 0 - 2,000 uS/cm
- 2,000 - 4,000 uS/cm
- > 4,000 uS/cm

4 feet

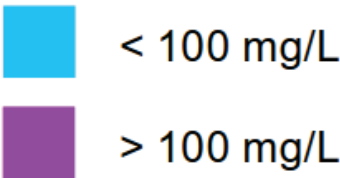
- 0 - 2,000 uS/cm
- 2,000 - 4,000 uS/cm
- > 4,000 uS/cm

Limited Site Investigation

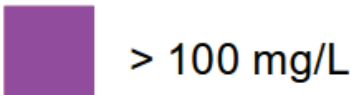


Chlorides

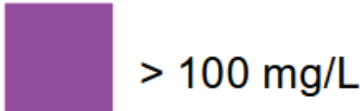
Surface



1 foot



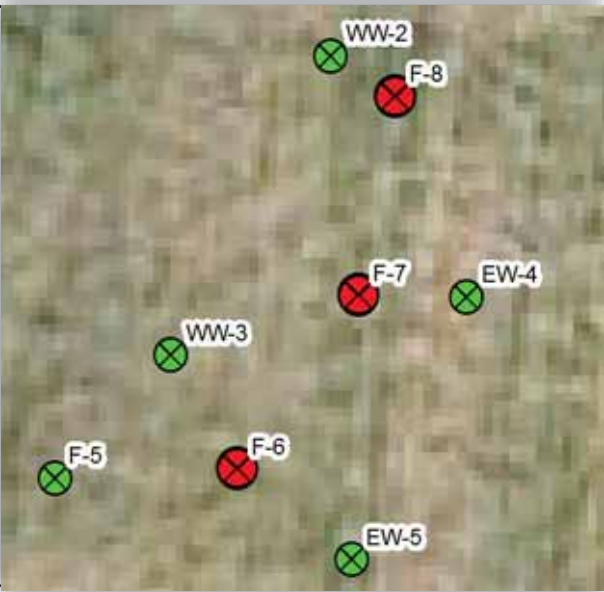
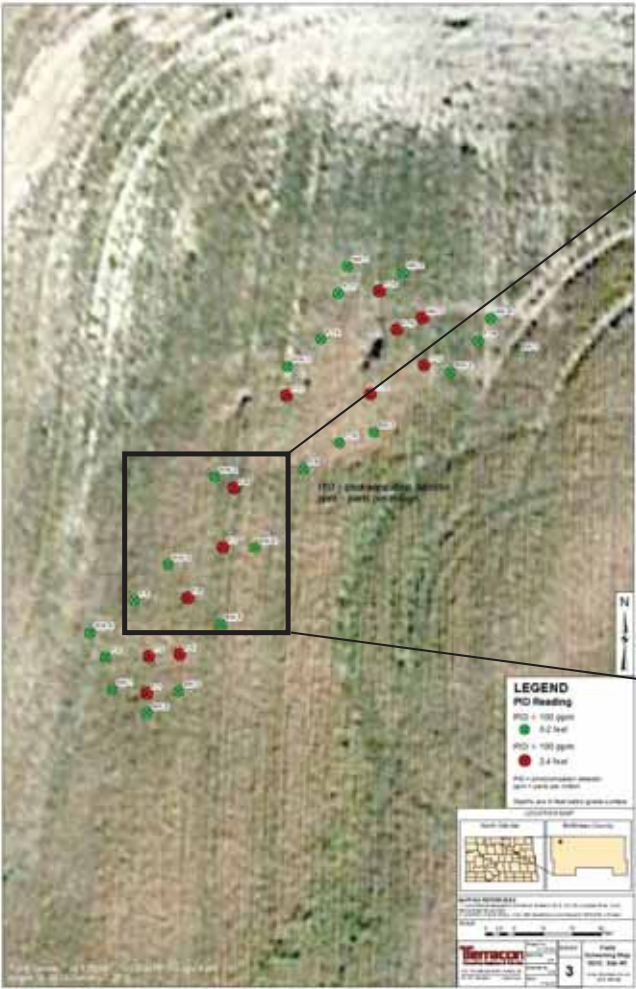
2 feet



Chlorides

Field screened with chloride test strips
Analyzed in laboratory for chloride content

Limited Site Investigation



LEGEND

PID Reading

PID < 100 ppm
● 0-2 feet

PID > 100 ppm
● 2-4 feet

PID = photoionization detector
ppm = parts per million

Depths are in feet below grade surface

Organic Vapors

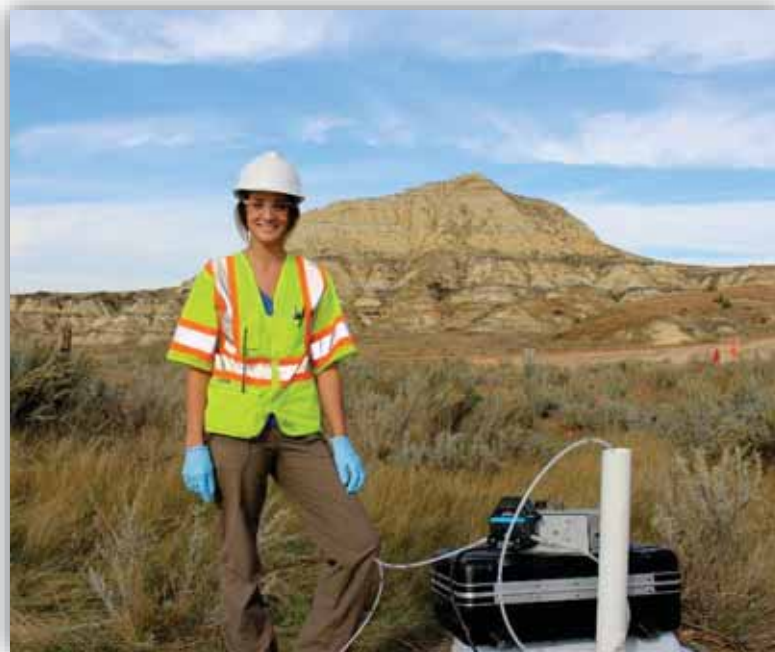
Field screened with a PID meter

Analyzed in laboratory for total petroleum hydrocarbons – GRO, DRO & ORO

Limited Site Investigation



Drilling soil boring to collect soil samples and install temporary groundwater monitoring well.



Collecting groundwater sample from temporary groundwater monitoring well.



Split-spoon soil sampling – scoria, shale cuttings, and petroleum hydrocarbons.

Limited Site Investigation



Site map and boring locations.

BORING LOG NO. B-4														
PROJECT: NDG Site #1					CLIENT: NDG - Oil & Gas Division Bismarck, North Dakota									
SITE: Medora, North Dakota					Page 1 of 1									
LOCATION: Surface to 10' (10' - 10'00")					INSTALLATION DETAILS									
<div>Soils:</div> <div>1.0' - 1.5' SILTY CLAY (CL) (CL) brownish-gray</div> <div>1.5' - 2.0' WELL GRAINED SAND WITH SILT (SW) (SW) fine grained, brownish-gray, slightly moist</div> <div>2.0' - 2.5' SILTY SAND (SM) fine grained, brownish-gray</div> <div>2.5' - 3.0' SILTY CLAY (CL) (CL) brownish-gray</div> <div>3.0' - 3.5' SILTY CLAY (CL) (CL) brownish-gray</div> <div>3.5' - 4.0' WELL GRAINED SAND (SW) fine grained, gray</div> <div>4.0' - 4.5' SILTY CLAY (CL) (CL) gray</div> <div>4.5' - 5.0' WELL GRAINED SAND (SW) fine grained, gray</div> <div>5.0' - 5.5' POORLY GRAINED SAND WITH GRAVEL (SP) fine to coarse grained, brownish-gray, moist</div> <div>5.5' - 6.0' WELL GRAINED SAND (SW) fine grained, gray to medium grained</div> <div>6.0' - 6.5' No recovery</div> <div>6.5' - 7.0' Boring terminated at 25 Feet</div> <div>Modified to 10' as per Appendix 1, Table 1, for location log to grade</div>					Boring Type: Standard									
					Notes:									
					Measurement Method: Boring terminated at 25 feet due to completion					Notes: Boring was completed on 10/10/2014. Boring was completed on 10/10/2014. Boring was completed on 10/10/2014.				
					WATER LEVEL OBSERVATIONS: 27' depth observed at 10' completion					Notes: Boring was completed on 10/10/2014. Boring was completed on 10/10/2014. Boring was completed on 10/10/2014.				
					Terracon					Notes: Boring was completed on 10/10/2014. Boring was completed on 10/10/2014. Boring was completed on 10/10/2014.				

BORING LOG NO. B-5

Page 1 of 1

PROJECT: NDG Site #1

CLIENT: NDG - Oil & Gas Division
Bismarck, North Dakota

SITE: Medora, North Dakota

LOCATION:

Surface to 10' (10' - 10'00")

INSTALLATION

DETAILS

Boring Type:

Standard

Boring Type:

Standard

Boring Type:

Standard

Boring Type:

Standard

Boring Type:

Standard

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Boring logs with field screening results. Boring B-4 was completed for background results and B-5 was within the historical pit.

Limited Site Investigation

GRAPHIC LOG	LOCATION:	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Chlorides (mg/L)	EC (µS/cm)	PID (ppm)
	Latitude: 46.857562° Longitude: -103.533686°							
	DEPTH							
	0.3' TOPSOIL, gray	Temporary Well					110	<1
	SILTY CLAY (CL-ML), brownish-gray						70	<1
							50	<1
							180	<1
							590	<1
							830	<1
							1,380	<1
							2,010	<1
	7.5' WELL GRADED SAND WITH SILT (SW-SM), fine grained, brownish-gray, slightly moist					<27	2,420	<1

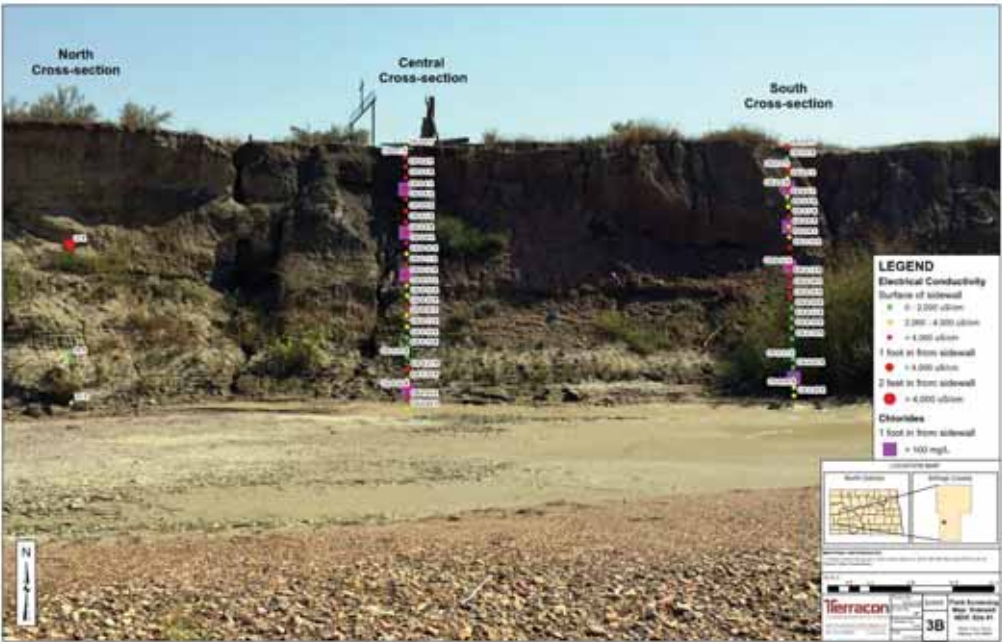
Soil boring B-4 (background).

Soil boring B-5 (within the pit).

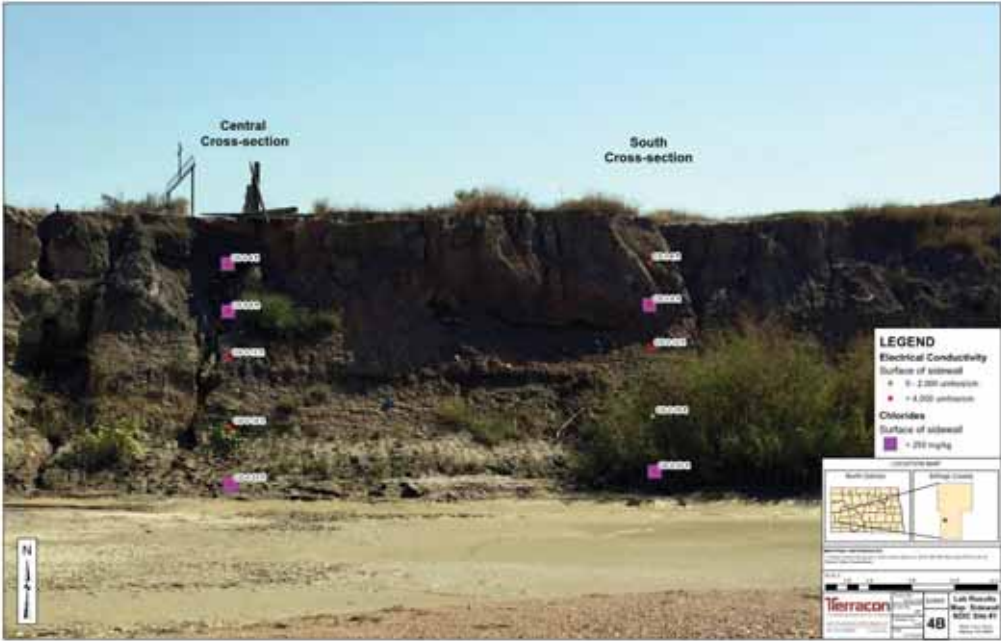
GRAPHIC LOG	LOCATION:	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Chlorides (mg/L)	EC (µS/cm)	PID (ppm)
	Latitude: 46.857126° Longitude: -103.534021°							
	DEPTH							
	SILTY CLAY (CL-ML), brownish gray	Temporary Well					1,930	<1
						1,148	5,140	<1
							3,250	<1
							3,160	<1
							4,600	<1
							3,480	<1
							4,990	<1
							5,730	<1
	9.0' WELL GRADED SAND (SW), fine grained, brownish gray					1,709	7,770	<1
	9.5' No recovery						5,420	<1
	10.0' WELL GRADED SAND (SW), fine grained, brownish gray to gray, layers of silty clay from 10' to 13', small lense of sand and gravel with scoria at 19'						6,360	<1
						4,181	19,370	<1
							12,900	<1



Limited Site Investigation



Field screening results every foot up to 20 feet bgs. Soil was screened up to 2 feet in from sidewall.



Laboratory results at the surface of the sidewall.

Limited Site Investigation

Regulatory levels for soil

Mt1157038 - NDIC Site #1	Table 2: Analytical Laboratory Results - Soil	Terracon Consultants, Inc.
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	Gaseous Range Organics (GRO) by EPA Method 8215 (mg/kg)	Dissolved Range Organics (DRO) by EPA Method 8215 (mg/kg)	Oil Range Organics (ORO) by EPA Method 8015 (mg/kg)	BTEX by EPA Method 8211 (mg/kg)				Electrical Conductivity (EC) by EPA Method 9254A (microsiemens)	Chlorides by EPA Method 9254B (mg/kg)
	GAO	DAO	ORO	Benzene	Toluene	Ethylbenzene	Xylenes, Total	EC	Chlorides
North Dakota Regulatory Guidance ¹	100	100	100	NE	NE	NE	NE	2,000	200
High Electrical Conductivity ²	NE	NE	NE	NE	NE	NE	NE	4,000	NE
North Dakota Industrial Commission ³	NE	NE	NE	NE	NE	NE	NE	35,000	NE
EPA Region 9 Residential RSLs ⁴	NE	NE	NE	1.2	400	5.0	65	NE	NE
EPA Region 9 Industrial RSLs ⁴	NE	NE	NE	5.1	4,700	201	200	NE	NE

Region ID	Depth	Date								
9-1	10-17-00	9/10/2000	<0.100	5.42	7.76	<0.00000	<0.00000	<0.00000	0.546	287
9-2	10-18-00	9/06/2000	<0.100	5.20	0.237	--	--	--	0.200	653
9-3	10-19-00	9/17/2000	<0.100	<0.01	0.088	--	--	--	2.947	209
9-4	21-22-00	9/15/2000	<0.100	<0.01	0.002	--	--	--	0.57	10.0
9-5	11-12-00	9/19/2000	<0.100	1.89	7.90	--	--	--	10.000	6.500
9-6	5-6-00	9/10/2000	<0.100	5.72	0.76	--	--	--	0.700	700
9-7	5-6-00	9/19/2000	<0.100	3.84	0.76	--	--	--	0.000	0.700
9-8	10-11-00	9/10/2000	<0.100	3.84	5.01	--	--	--	0.000	1.010
CS-0	0-0	9/10/2000	<0.100	71.0	0	0.00000	<0.00000	<0.00000	10.700	0.000
CS-1 South	0-0	9/10/2000	3.80	100	7.9	--	--	--	0.000	20.00
CS-2	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-3	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-4	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-5	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-6	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-7	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-8	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-9	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-10	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-11	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-12	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-13	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-14	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-15	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-16	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-17	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-18	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-19	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-20	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-21	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-22	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-23	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-24	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-25	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-26	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-27	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-28	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-29	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-30	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-31	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-32	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-33	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-34	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000
CS-35	0-0	9/10/2000	--	--	--	--	--	--	0.000	0.000

[illegible][illegible]

	GRO	DRO	ORO	Benzene	Toluene	Ethylbenzene	Xylenes, Total	EC	Chlorides
North Dakota Regulatory Guidance ¹	100	100	100	NE	NE	NE	NE	2,000	250
High Electrical Conductivity ²	NE	NE	NE	NE	NE	NE	NE	4,000	NE
North Dakota Industrial Commission ³	NE	NE	NE	NE	NE	NE	NE	35,000	NE
EPA Region 9 Residential RSLs ⁴	NE	NE	NE	1.2	490	5.8	65	NE	NE
EPA Region 9 Industrial RSLs ⁴	NE	NE	NE	5.1	4,700	251	280	NE	NE

Regulatory levels for groundwater

	GRO	DRO	ORO	Benzene	Toluene	Ethylbenzene	Xylenes, Total	EC	Chlorides ^a
North Dakota Regulatory Guidance ¹	500	500	500	5	NE	NE	NE	NE	250,000
EPA Region 9 Residential RSLs ²	NE	NE	NE	0.45	110	1.5	19	NE	NE

Limited Site Investigation

North Dakota Regulatory Guidance ¹
High Electrical Conductivity ²
North Dakota Industrial Commission ³
EPA Region 9 Residential RSLs ⁴

Information from North Dakota Department of Health:
Guidelines for the Assessment and Cleanup of Saltwater
Releases (September, 2016).



Information from the United States Department of
Agriculture Natural Resource Conservation
Services Soil Survey Handbook.



Information from North Dakota Industrial Commission: A
Guide for Remediation of Salt/Hydrocarbon Impacted Soil.



EPA Region 9 Regional Screening Levels (RSLs) June, 2015
- Residential and Industrial Soil Screening Levels in mg/kg.



Limited Site Investigation



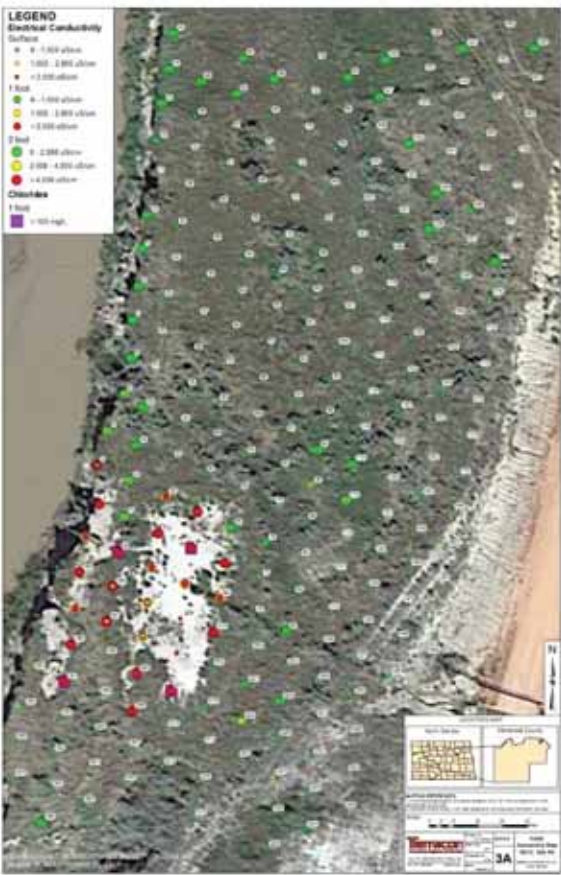
Information from North Dakota Department of Health: Guidelines for the Assessment and Cleanup of Saltwater Releases (September, 2016).



EPA Region 9 Regional Screening Levels (RSLs) June, 2015 Tap water Screening Level in ug/l.



Limited Site Investigation



Field screening results up to 2 feet bgs.



Laboratory results up to 1 foot bgs.



Approximate area of impact anticipated from field and lab results.

Corrective Action

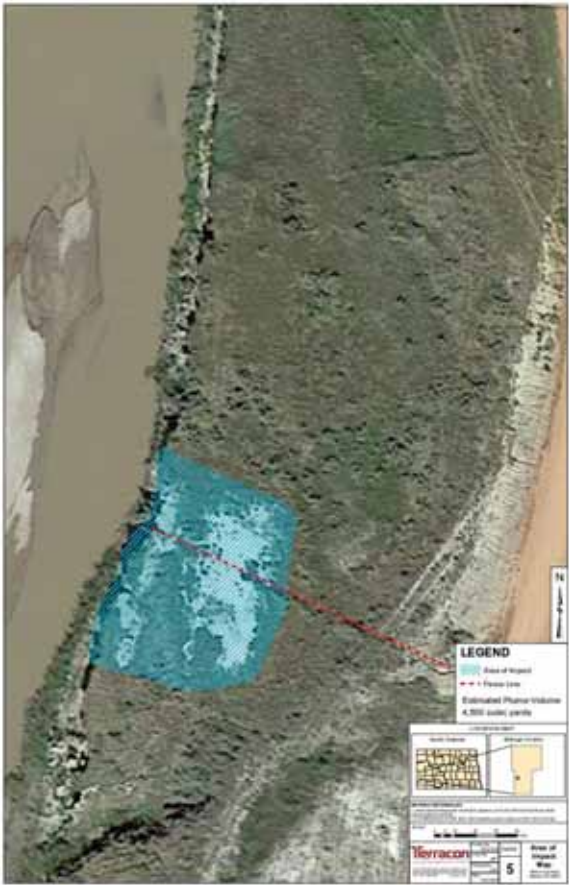
Remediation/Excavation

- Extent of contamination will be determined in the field
- Contaminated material should be loaded directly in trucks for disposal or stockpiled on polyethylene sheeting
- Final field screening & lab samples should be collected and analyzed

Reclamation

- Backfill with material similar to what was there prior to excavation
- Topsoil thickness, revegetation, seed blend, and erosion prevention techniques are site-specific
- Visit site after reclamation

Remediation/Excavation



The area of interest.



The area of interest outlined by flags.



Remediation/Excavation



Bench excavation of the NE sidewall.



View NE at the site.



Excavation of contaminated material.



Contaminated soil being loaded for disposal.



Contaminated material being stockpiled on polyethylene sheeting.



Covered stockpile of contaminated material.

Remediation/Excavation



Sample ID	Location	Soil Chlorides (mg/L)	PID (ppm)	Depth (feet bgs)
Lab Samples				
1-5	Contaminated material from stockpile	>641	231.9	Stockpile
1-10	Contaminated material from stockpile	301	<1	Stockpile

Laboratory analytical data from stockpiled material.



Sampling of the backfill prior to being placed in excavated area for quality control.

Remediation/Excavation



Continuous field screening during excavation.

Remediation/Excavation



Excavation and flags outlining AOI.



View NE at the excavated area.



View at the material surrounding the well.



View east at excavated area and final sampling points (flags).



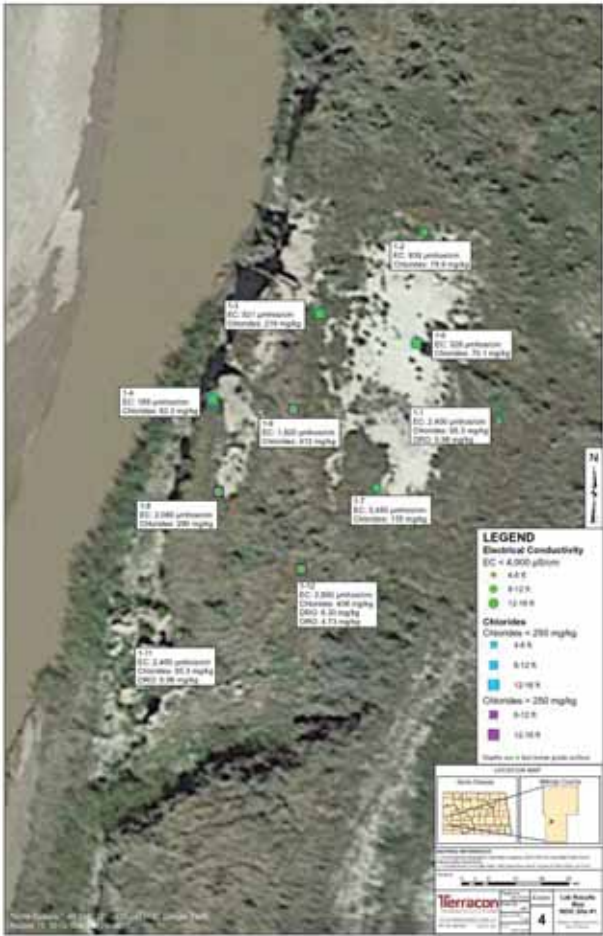
View at the excavation of the historical pit.

Remediation/Excavation

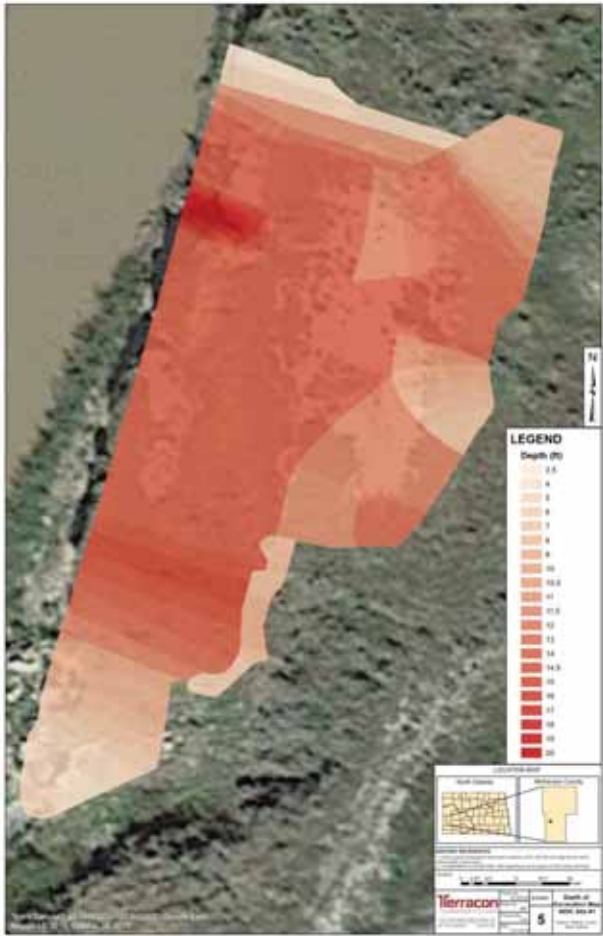


Field screening results (after excavation) up to 20 feet bgs.

Terracon



Laboratory results (after excavation).



Map showing depth of excavation.

Reclamation



Placing rip-rap along excavated area.



Backfilling with clay material and placing rip-rap along excavated area.

Reclamation



Backfilling with clay material with rip-rap placement along excavated area.



Placement of straw matting after backfilling and seeding were completed.

Reclamation



A study was completed to analyze what prevalent species of plants were growing at this specific site.

Terracon



Case Studies

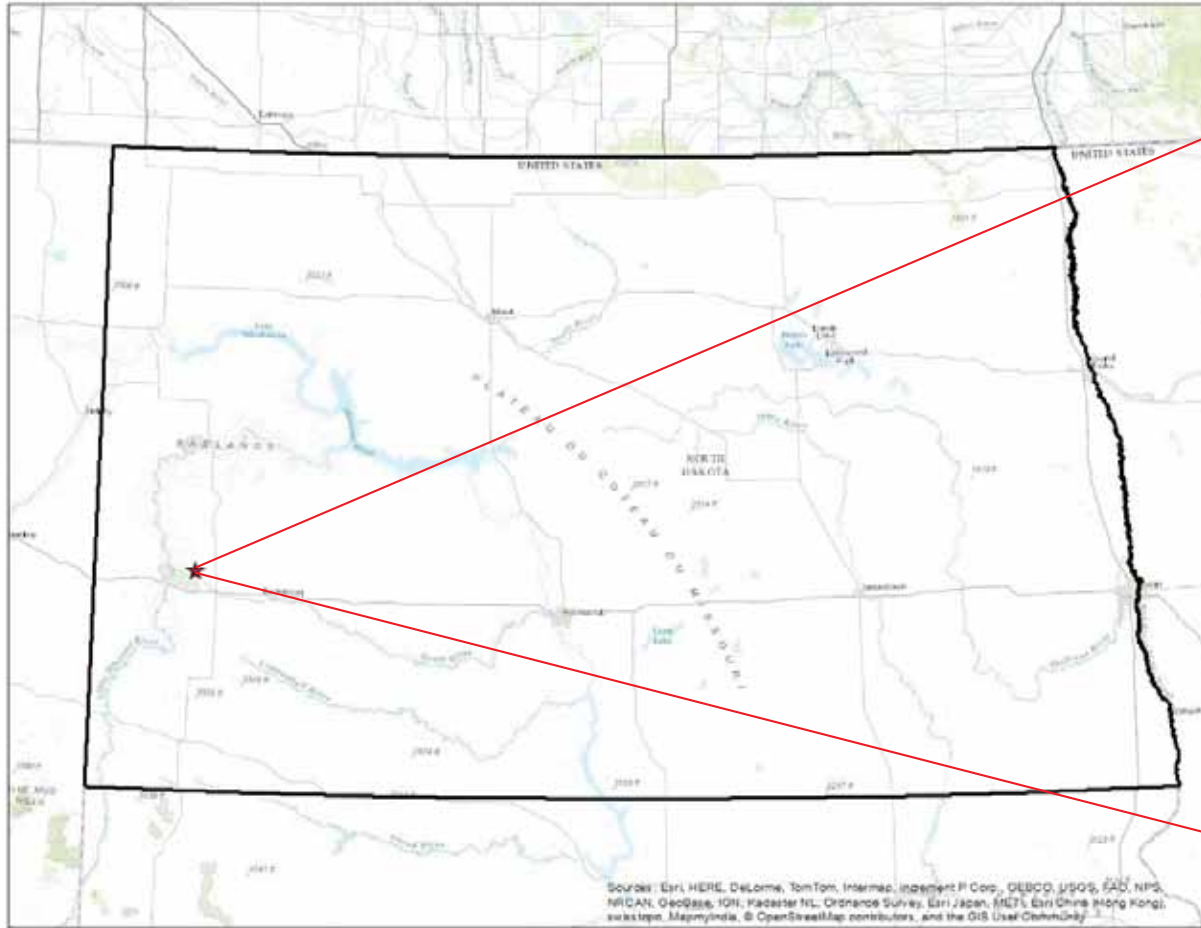
Site Assessments

- Site NW of Belfield, ND: Historical Pit
- Site NE of Keen, ND: Historical Pit

Site Assessment & Remediation

- Site SW of Antler, ND: Historical Piping

Site NW of Belfield, ND



Site NW of Belfield, ND – Site Assessment



NW corner of site (secondary washout area).



Main washout area.



Exposed debris and oily residue in pit area.



Oily core sample.

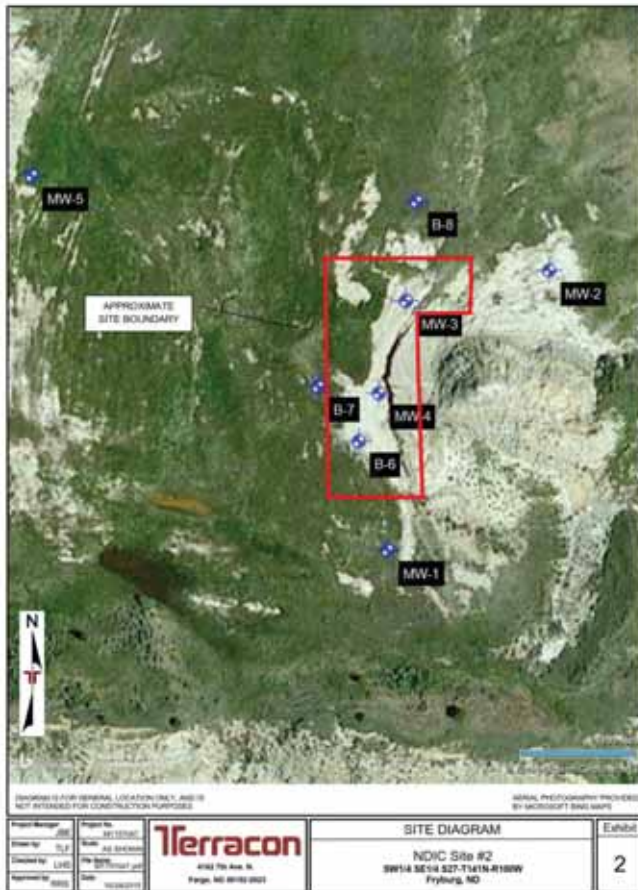


Coal seam (NE corner of site).

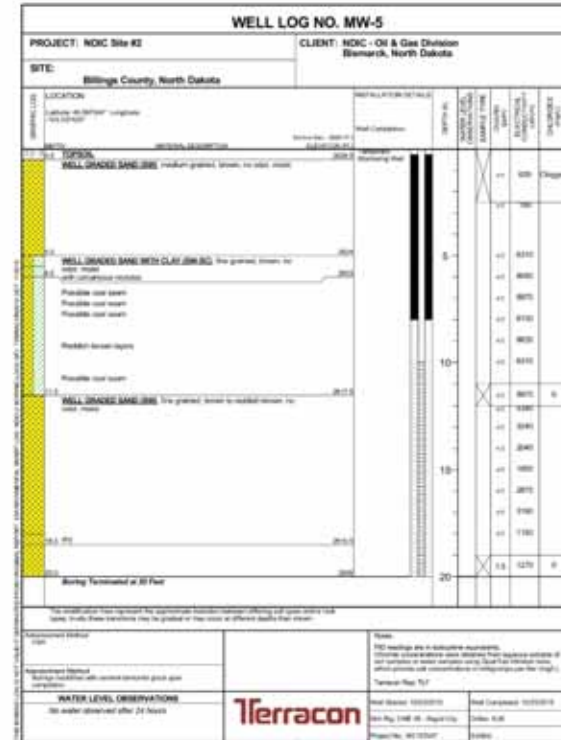
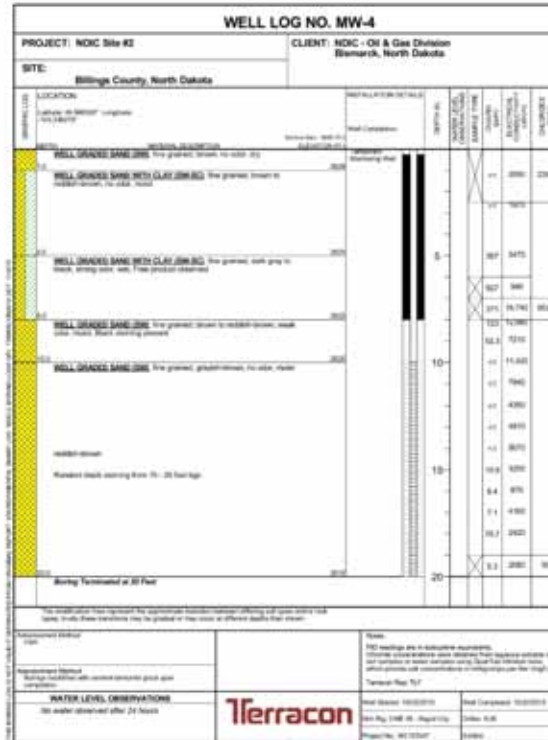


Chloride test from samples collected.

Site NW of Belfield, ND – Site Assessment









Site map and boring locations.









Boring logs with field screening results. Boring MW-5 was completed for background results and MW-4 was within the historical pit.

Site NW of Belfield, ND – Site Assessment

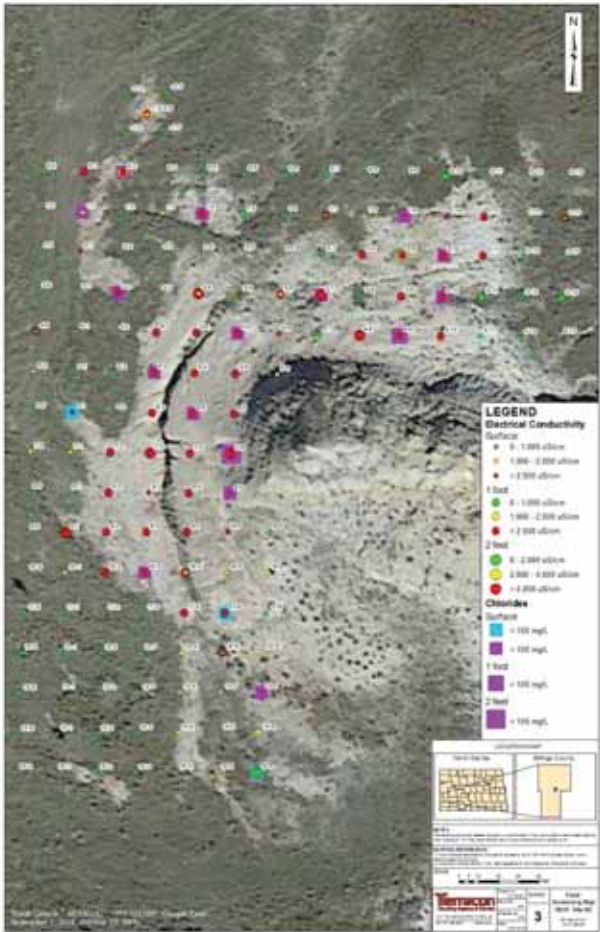
GRAPHIC LOG	LOCATION		INSTALLATION DETAILS		DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	O/V/IRD (ppm)	ELECTRICAL CONDUCTIVITY (uS/cm)	CHLORIDES (mg/L)
	DEPTH	MATERIAL DESCRIPTION	Surface Elev.: 2630 (FL) ELEVATION (ft.)	Well Completion:						
	1.0	WELL GRADED SAND (SW) , fine grained, brown, no odor, dry	2629	Temporary Monitoring Well	5			<1	2050	2398
		WELL GRADED SAND WITH CLAY (SW-SC) , fine grained, brown to reddish-brown, no odor, moist						<1	1970	
	5.0		2625					367	5470	
		WELL GRADED SAND WITH CLAY (SW-SC) , fine grained, dark gray to black, strong odor, wet, Free product observed						527	940	
	8.0		2622	Temporary Monitoring Well	5			371	16,740	6526
		WELL GRADED SAND (SW) , fine grained, brown to reddish-brown, weak odor, moist, Black staining present						133	12,980	

Soil boring MW-4 (within historical pit).

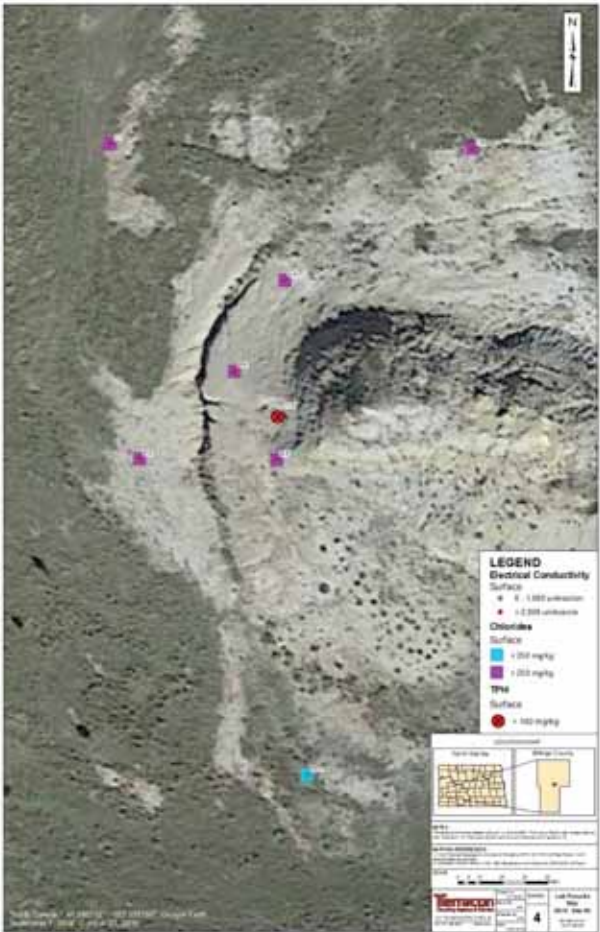
Soil boring MW-5 (background).

GRAPHIC LOG	LOCATION		INSTALLATION DETAILS		DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	O/V/IRD (ppm)	ELECTRICAL CONDUCTIVITY (uS/cm)	CHLORIDES (mg/L)
	DEPTH	MATERIAL DESCRIPTION	Surface Elev.: 2629 (FL) ELEVATION (ft.)	Well Completion:						
	0.5	TOPSOIL	2628.5	Temporary Monitoring Well	5			<1	620	Clogged
		WELL GRADED SAND (SW) , medium grained, brown, no odor, moist						<1	180	
	5.0		2624					<1	6310	
		WELL GRADED SAND WITH CLAY (SW-SC) , fine grained, brown, no odor, moist with calcareous nodules	2623					<1	8090	
		Possible coal seam		Temporary Monitoring Well	5			<1	8870	
		Possible coal seam						<1		
		Possible coal seam						<1	6130	

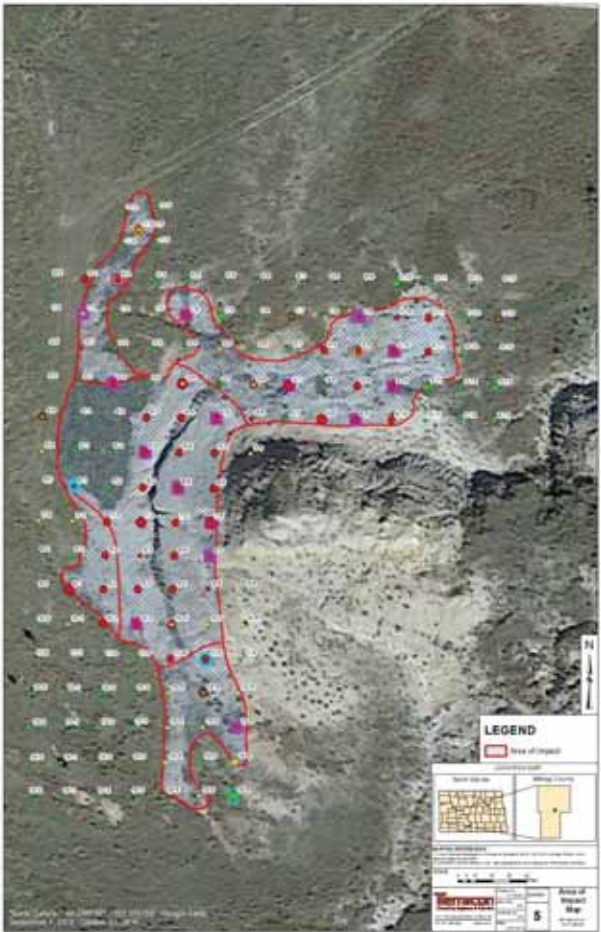
Site NW of Belfield, ND - CAP



Field screening results up to 2 feet bgs.

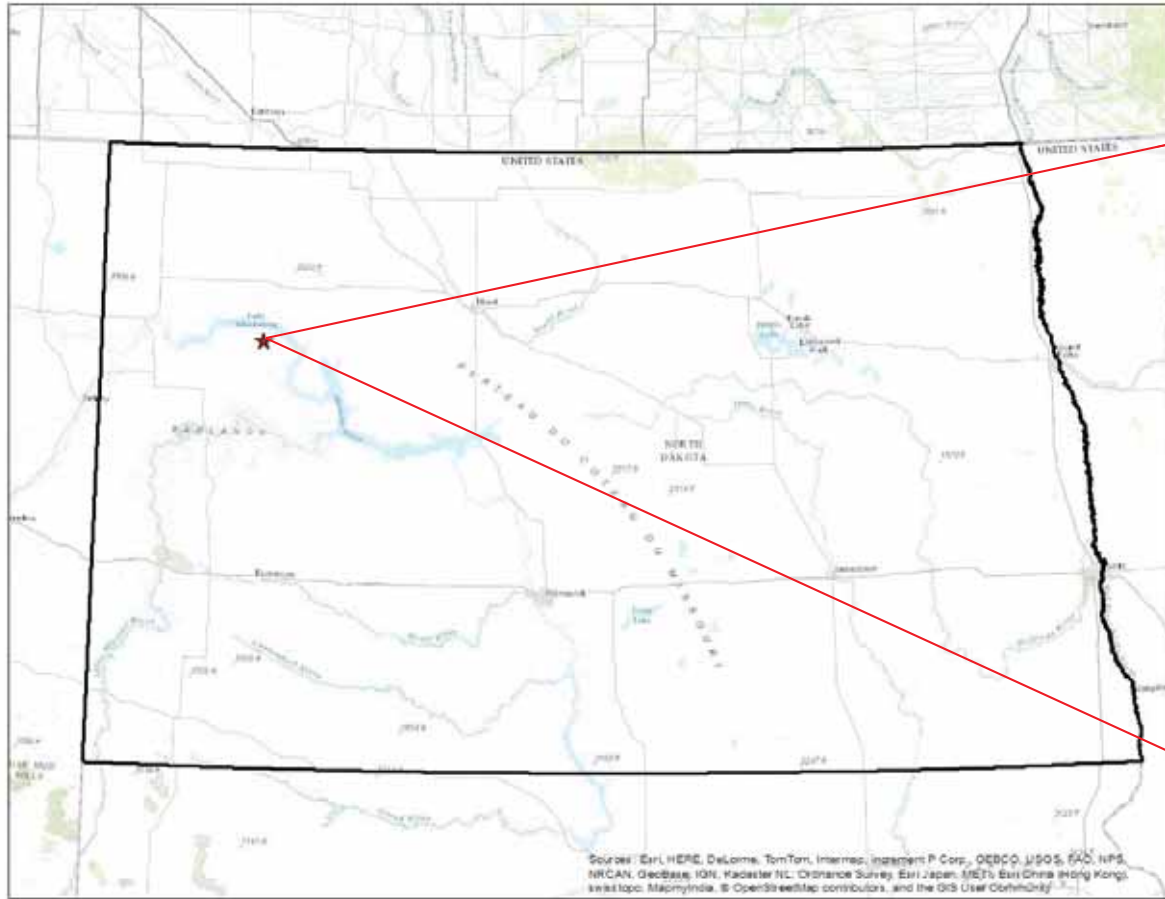


Laboratory results at the surface.



Approximate area of impact anticipated from field and lab results.

Site NE of Keen, ND



Site NE of Keen, ND – Site Assessment



View south at the historical brine pit.



View south at grid pattern.



Chloride testing in the field.



Soil staining from boring 4.

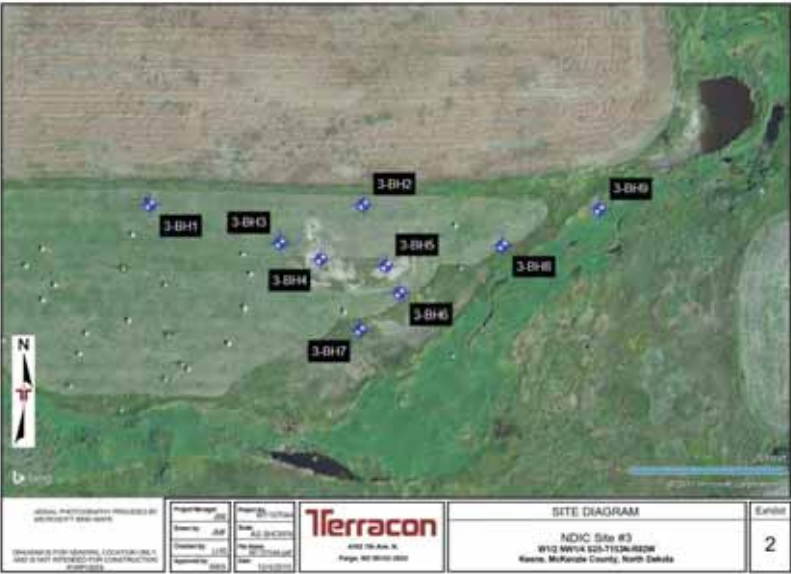


View at stressed vegetation SE of the historical brine pit.



Field screening soil with EC meter.






Site NE of Keen, ND – Site Assessment



Site map and boring locations.










BORING LOG NO. 3-BH1									
PROJECT: NDIC Site #3					CLIENT: NDIC - Oil & Gas Division Bismarck, North Dakota				
SITE: Keene, McKeen County, North Dakota					Page 1 of 1				
DESCRIPTION					INSTALLATION DETAILS				
Log No. 3-BH1					Log No. 3-BH1				
1.00					1.00				
2.00					2.00				
3.00					3.00				
4.00					4.00				
5.00					5.00				
6.00					6.00				
7.00					7.00				
8.00					8.00				
9.00					9.00				
10.00					10.00				
11.00					11.00				
12.00					12.00				
13.00					13.00				
14.00					14.00				
15.00					15.00				
16.00					16.00				
17.00					17.00				
18.00					18.00				
19.00					19.00				
20.00					20.00				
Boring Terminated at 20 Feet					Boring Terminated at 20 Feet				
Boring Log No. 3-BH1					Boring Log No. 3-BH1				
Boring Date: 10/16/2013					Boring Date: 10/16/2013				
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Boring Log: 3-BH1					Boring Log: 3-BH1				
Boring Log: 3-BH1					Boring Log:				

Site NE of Keen, ND – Site Assessment

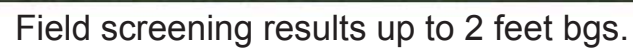
GRAPHIC LOG	LOCATION:		INSTALLATION DETAILS		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	EC (µS/cm)	Chlorides (mg/L)	PID (ppm)
	Latitude: 48.04893° Longitude: -102.84818°									
DEPTH										
	1.0	TOPSOIL , brown, with some organics			5		<input checked="" type="checkbox"/>	370		<1
	2.0	LEAN CLAY (CL) , brown, medium stiff					<input checked="" type="checkbox"/>	940		<1
	3.0	SILT (ML) , light brown, medium dense					<input checked="" type="checkbox"/>	660		<1
		SANDY SILT (ML) , light brown, medium dense, with thin lenses of sand					<input checked="" type="checkbox"/>	1,110		<1
	5.0						<input checked="" type="checkbox"/>	1,750		1.1
	6.0	LEAN CLAY (CL) , light brown, medium stiff, with lenses and laminations of silt, moist					<input checked="" type="checkbox"/>	2,460		<1
		SILT (ML) , brown, medium dense, with lenses and layers of clay, moist					<input checked="" type="checkbox"/>	1,930		<1

Soil boring 3-BH1 (background).

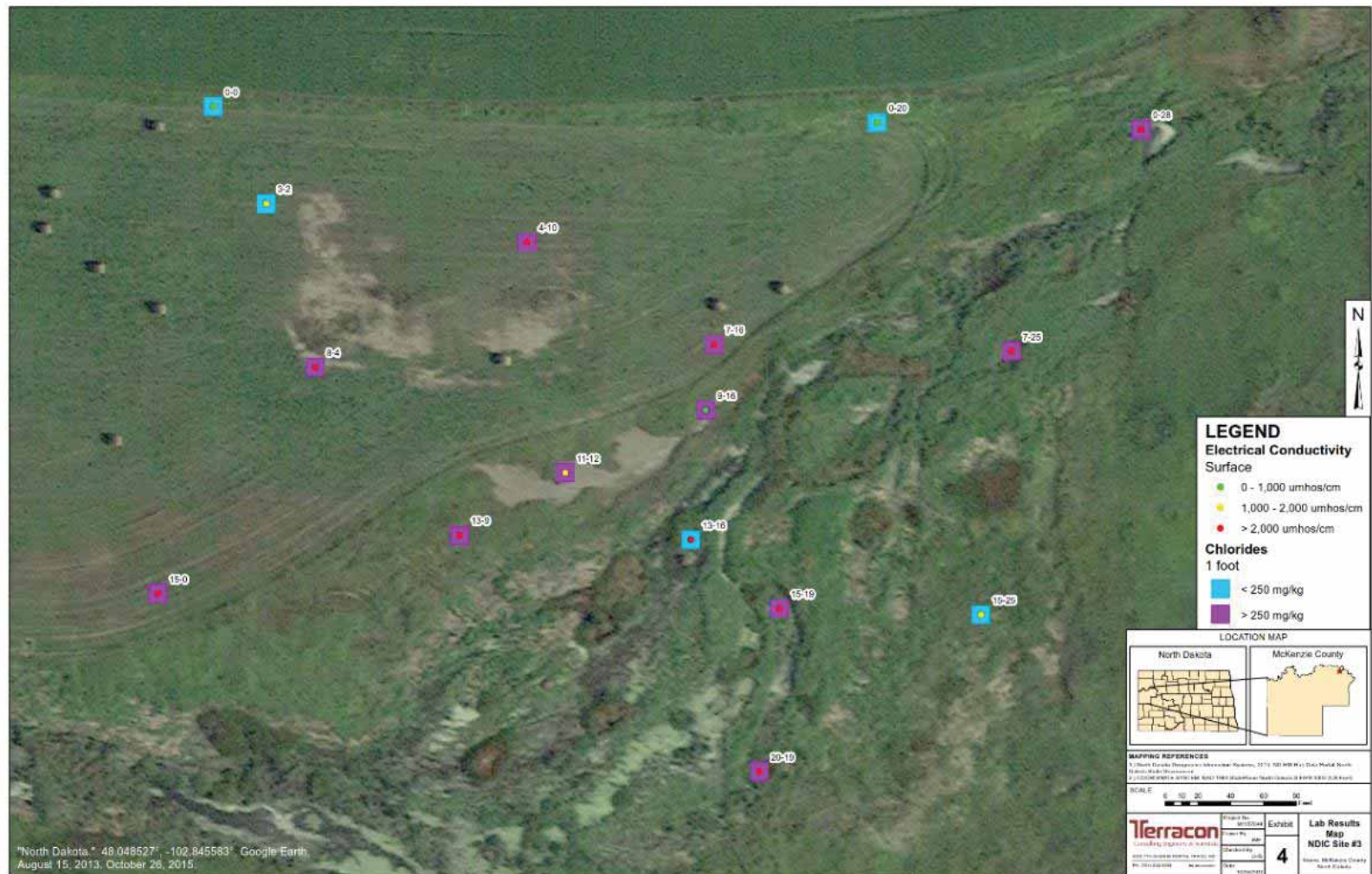
Soil boring 3-BH5 (within the historical pit).

GRAPHIC LOG	LOCATION:		INSTALLATION DETAILS		DEPTH (FL)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	EC (µS/cm)	Chlorides (mg/L)	PID (ppm)										
	Latitude: 48.04886° Longitude: -102.84662°																			
DEPTH																				
	1.0	TOPSOIL, trace gravel, brown, with staining			5			5,780		3.9										
		SILT (ML), trace gravel, brown, medium dense, with lenses and layers of clay and trace organics thin layer of scoria at 2'								13,690	3,777	5.6								
												11,400		2.6						
														14,730		3.2				
																15,060		2.5		
																		12,140		1.2
																				11,220
		salt precipitates at 5'								14,590		2.6								
	8.0																			

Terracon



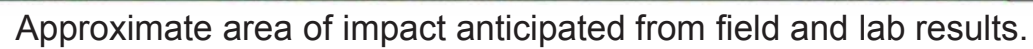
Site NE of Keen, ND - CAP



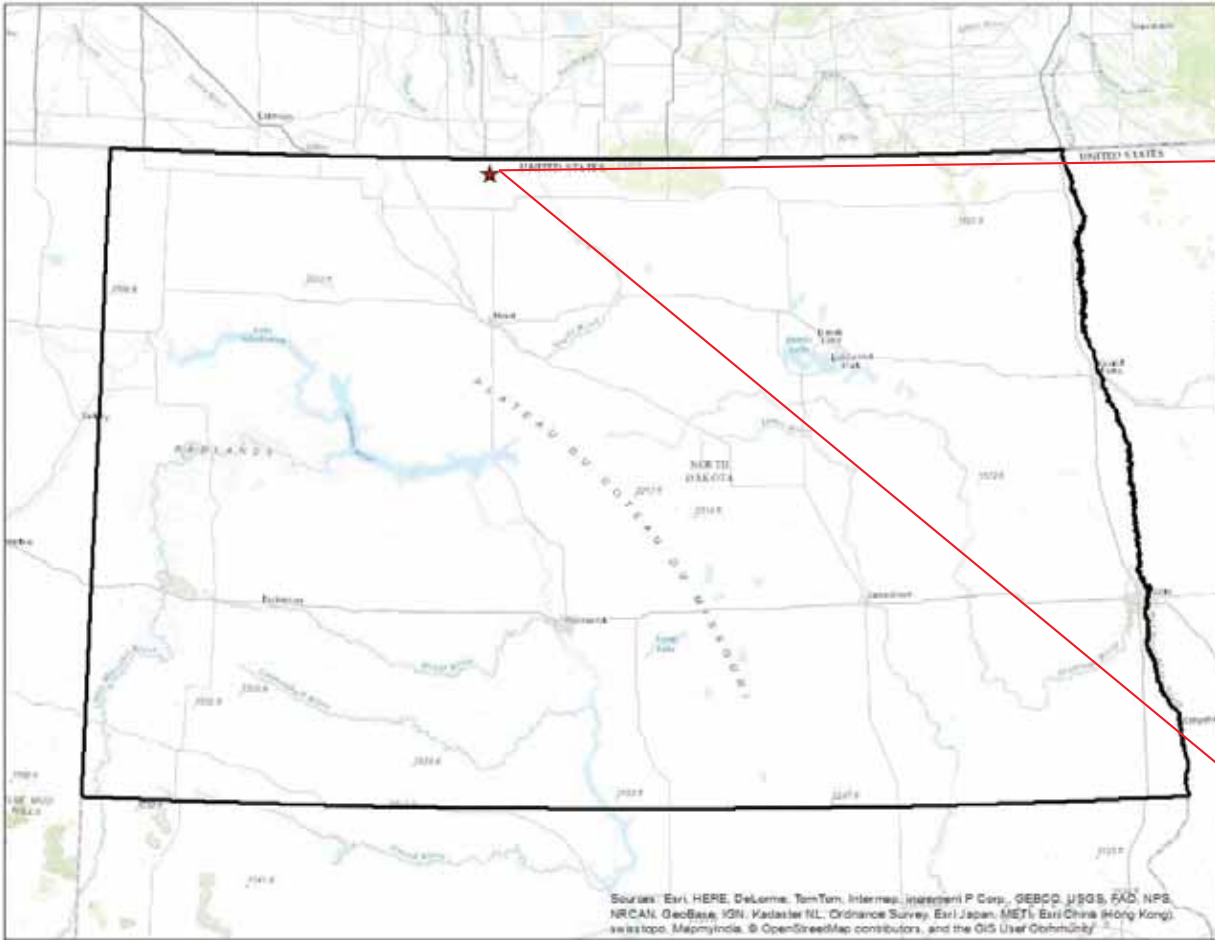
Terracon

Laboratory results at the surface and 1 foot bgs.

Terracon



Site SW of Antler, ND



Site SW of Antler, ND – Site Assessment



Petroleum hydrocarbons at surface from historical piping that leaked.



Petroleum hydrocarbon stained soil.



Approximate area of impact marked by flags.



Approximate area of impact from site assessment (visual).

Site SW of Antler, ND – Site Assessment



View NW at the excavation area.



Layer of impacted soil near surface.



Petroleum hydrocarbon layer.



Locating extent of two-inch piping using electrical current.



Exposed two-inch piping.



Loose material removed during excavation.

Site SW of Antler, ND



View NW at the excavation area.



Impacted material being removed and loaded on side-dump for disposal.



Soil excavation and backfilling.



Completion of backfill and topsoil placed within the excavated area.



Site Diagram showing excavated area and the piping that was removed.

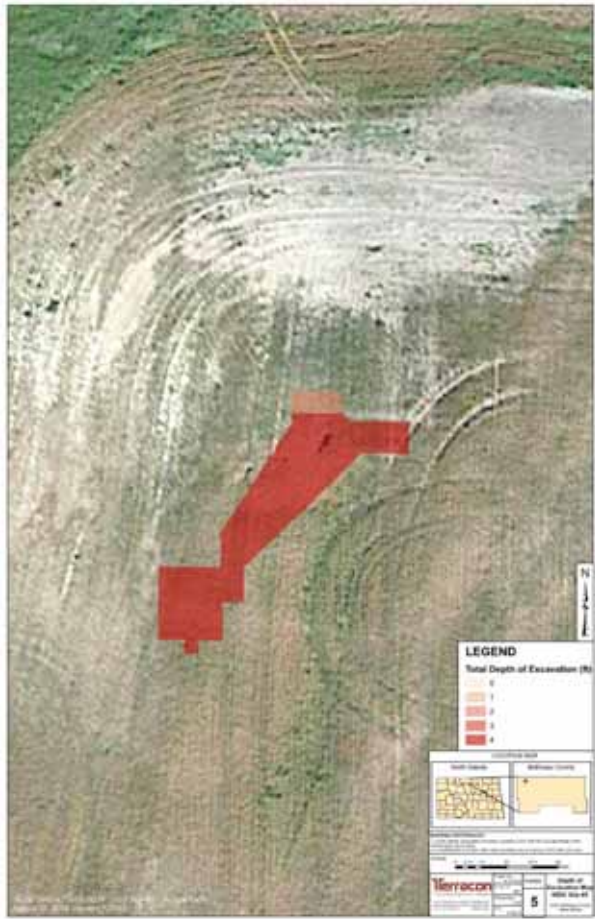
Site SW of Antler, ND - CAP



Field screening map.



Lab results map.



Area and total depth of excavation.



Terracon

Questions?

**RESPONSIVE.
RESOURCEFUL.
RELIABLE.**

Environmental



Facilities



Geotechnical



Materials