Form C-141   State of New Mexico

Page 3   Oil Conservation Division

Incident ID	NRM2020352997
District RP	
Facility ID	
Application ID	

Site Assessment/Characterization

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?	60 (ft bgs)
Did this release impact groundwater or surface water?	☐ Yes ☒ No
Are the lateral extents of the release within 300 feet of a continuously flowing watercourse or any other significant watercourse?	☐ Yes ☒ No
Are the lateral extents of the release within 200 feet of any lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark)?	☐ Yes ☒ No
Are the lateral extents of the release within 300 feet of an occupied permanent residence, school, hospital, institution, or church?	☐ Yes ☒ No
Are the lateral extents of the release within 500 horizontal feet of a spring or a private domestic fresh water well used by less than five households for domestic or stock watering purposes?	☐ Yes ☒ No
Are the lateral extents of the release within 1000 feet of any other fresh water well or spring?	☐ Yes ☒ No
Are the lateral extents of the release within incorporated municipal boundaries or within a defined municipal fresh water well field?	☐ Yes ☒ No
Are the lateral extents of the release within 300 feet of a wetland?	☐ Yes ☒ No
Are the lateral extents of the release overlying a subsurface mine?	☐ Yes ☒ No
Are the lateral extents of the release overlying an unstable area such as karst geology?	☐ Yes ☒ No
Are the lateral extents of the release within a 100-year floodplain?	☐ Yes ☒ No
Did the release impact areas **not** on an exploration, development, production, or storage site?	☒ Yes ☐ No

Attach a comprehensive report (electronic submittals in .pdf format are preferred) demonstrating the lateral and vertical extents of soil contamination associated with the release have been determined. Refer to 19.15.29.11 NMAC for specifics.
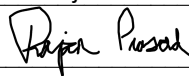
Characterization Report Checklist: *Each of the following items must be included in the report.*

☒ Scaled site map showing impacted area, surface features, subsurface features, delineation points, and monitoring wells.
☒ Field data
☒ Data table of soil contaminant concentration data
☒ Depth to water determination
☒ Determination of water sources and significant watercourses within ½-mile of the lateral extents of the release
NA Boring or excavation logs
☒ Photographs including date and GIS information
☒ Topographic/Aerial maps
☒ Laboratory data including chain of custody

If the site characterization report does not include completed efforts at remediation of the release, the report must include a proposed remediation plan. That plan must include the estimated volume of material to be remediated, the proposed remediation technique, proposed sampling plan and methods, anticipated timelines for beginning and completing the remediation. The closure criteria for a release are contained in Table 1 of 19.15.29.12 NMAC, however, use of the table is modified by site- and release-specific parameters.

Form C-141

Page 4

State of New Mexico

Oil Conservation Division

Incident ID	NRM2020352997
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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.

Printed Name: _____Rajan Prasad_____   Title: _____Vice President_____

Signature:_____   Date: 09/28/2020

email: _____rajan.prasad@hppcinc.com_____   Telephone: _____(432) 557-5067_____

OCD Only

Received by: _____Cristina Eads_____   Date: _____09/28/2020_____

Form C-141

Page 5

State of New Mexico

Oil Conservation Division

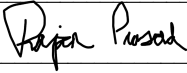| Incident ID	NRM2020352997
District RP	
Facility ID	
Application ID	

Remediation Plan

Remediation Plan Checklist: *Each of the following items must be included in the plan.*

☒ Detailed description of proposed remediation technique
☒ Scaled sitemap with GPS coordinates showing delineation points
☒ Estimated volume of material to be remediated
☒ Closure criteria is to Table 1 specifications subject to 19.15.29.12(C)(4) NMAC
☒ Proposed schedule for remediation (note if remediation plan timeline is more than 90 days OCD approval is required)

Deferral Requests Only: *Each of the following items must be confirmed as part of any request for deferral of remediation.*

☐ Contamination must be in areas immediately under or around production equipment where remediation could cause a major facility deconstruction.

☐ Extents of contamination must be fully delineated.

☐ Contamination does not cause an imminent risk to human health, the environment, or groundwater.

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.

Printed Name: _____Rajan Prasad_____ Title: _____Vice President_____

Signature: _____[signature]_____ Date: 09/28/2020

email: _____rajan.prasad@hppcinc.com_____ Telephone: _____(432) 557-5067_____

OCD Only

Received by: _Cristina Eads_ Date: 09/28/2020

☒ Approved ☐ Approved with Attached Conditions of Approval ☐ Denied ☐ Deferral Approved

Signature: _____[signature]_____ Date: 11/23/2020

General Information

NMOCD District:	District 1	Incident #	NRM2020352997
Landowner:	New Mexico State Lands Office		
Client:	HPPC Inc	Site Location:	Lea 946 State – Flowline
Date:	September 21, 2020	Project #:	20E-01925-001
Client Contact:	Rajan Prasad	Phone #:	(432) 557-5067
Vertex PM:	Natalie Gordon	Phone #:	(505) 506-0040

Objective

The objective of this environmental remediation work plan is to identify areas of exceedance for constituents of concern found during spill assessment and site characterization activities and propose appropriate remediation techniques to address the open release at Lea 946 State (hereafter referred to as "Lea Flowline"). This incident occurred on June 30, 2020, when a poly pipeline connected to the Lea 946 State #3 oil well ruptured. Approximately 3 barrels (bbls) of oil were released into pasture off-lease. The location and boundaries of this release are identified on Figure 1 (Attachment 1).

Initial site research and characterization have been completed and a closure criteria determination worksheet is included in Attachment 2. Using a 2019 New Mexico Office of the State Engineer-identified well located approximately 0.5 miles from the release site, depth to groundwater is determined to be approximately 60 feet below ground surface (bgs). The release at Lea Flowline is not subject to the requirements of Paragraph (4) of Subsection C of 19.15.29.12 *New Mexico Administrative Code* (NMAC) and the closure criteria for the site are determined to be associated with the following constituent concentration limits as determined by depth to groundwater.

Table 1. Closure Criteria for Soils Impacted by a Release		
Minimum depth below any point within the horizontal boundary of the release to groundwater less than 10,000 mg/L TDS[1]	**Constituent**	**Limit**
51 $\leq$ 100 feet	Chloride	10,000 mg/kg
	TPH[2] (GRO + DRO + MRO)	2,500 mg/kg
	GRO + DRO	1,000 mg/kg
	BTEX[3]	50 mg/kg
	Benzene	10 mg/kg

[1]Total Dissolved Solids (TDS)
[2]Total petroleum hydrocarbons (TPH) = gasoline range organics (GRO) + diesel range organics (DRO) + motor oil range organics (MRO)
[3]Benzene, toluene, ethyl benzene and xylenes (BTEX)

In addition to the Closure Criteria established in Table 1, further remediation will be required for the release in order to meet restoration and reclamation requirements associated with releases into undisturbed areas, as outlined in Paragraph (1) of Subsection D of 19.15.29.13 NMAC. This regulation requires a minimum of four feet of non-waste containing, uncontaminated, earthen material with chloride concentrations of less than 600 mg/kg, and levels of other contaminants that meet the most protective concentrations contained in 19.15.29.12 NMAC as shown in Table 2.

Table 2. Reclamation Criteria for Soils Impacted by a Release		
Minimum depth below any point within the horizontal boundary of the release to groundwater less than 10,000 mg/L TDS	Constituent	Limit
<u><</u>50 feet	Chloride	600 mg/kg
	TPH (GRO + DRO + MRO)	100 mg/kg
	BTEX	50 mg/kg
	Benzene	10 mg/kg

Site Assessment/Characterization

The Lea Flowline release characterization was completed on August 12, 2020. A total of 5 sample points were established across the release area (Attachment 1) and soil samples were collected from these locations at depths between the ground surface and 0.5 feet bgs. Initial characterization samples were field screened using an electrical conductivity (EC) meter to estimate the level of chloride in the soil and Petroflag to estimate the level of hydrocarbons. The results were then used to determine the horizontal extent of the release. The characterization soil samples were submitted to a laboratory for full analysis to support the in-field findings.

Typically, the same field screening method is used to determine the vertical extent of the release; however, at Lea Flowline, there is a layer of rock refusal at approximately 0.5 feet bgs that prevented soil sampling at deeper depths. Based on field screening and laboratory data from soil samples collected at this rock layer, chloride and hydrocarbons appear to have penetrated up to the rock layer and remained there. Additional sampling of the caprock itself is advised to demonstrate that contaminants have not permeated past the layer of refusal, and will be done at the time of remediation fieldwork.

The NM OCD requires full release delineation to the extent possible and has provided guidance specific to this situation, whereby remediation to the rock layer is required and full documentation should be conducted to demonstrate that everything possible was done to clean up contaminants. The NM OCD response regarding this remediation process is included as Attachment 3.

Data from the field screening and laboratory analyses have been compared to the above noted reclamation criteria results to establish the appropriate level of remediation required. Complete characterization field screening and laboratory results are presented in Table 3 (Attachment 4) and exceedances are identified in the table as bold with a grey background.

Proposed Remedial Activities

Vertex proposes areas identified with contaminant concentrations approaching, or above, reclamation criteria be remediated through excavation and removal of contaminated soil with the use of mechanical equipment, followed by in-situ treatment of the top layer of caprock with a mixture of an hydrocarbon treatment product, such as Soil Rx, and the chloride treatment product, SA-1000. Please see Rx and SA-1000 in-situ treatment product information for details (Attachment 5).

The proposed excavation will be guided by an onsite Vertex environmental technician, who will be conducting field screening during the excavation activities. Excavation depths will be to rock refusal, which is approximately 0.5 feet bgs, for the release area; approximately 45 cubic yards of contaminated soil are projected to be removed as part of the remediation. Contaminated soils should be removed from site immediately for disposal at an approved facility.

Once the environmental technician confirms removal of contaminated soil such that sidewalls are below reclamation criteria as shown in Table 2, the exposed caprock will be sampled to depths of 1 to 1.5 feet using a rotary drill or other equipment, to verify that no liquids have permeated the rock. If the rock samples show that no contaminants have penetrated the

caprock, these samples may be used as confirmatory base samples. If the rock samples show that contaminants have penetrated the caprock, the rock will be excavated and/or treated with Soil Rx and/or SA-1000 prior to commencing confirmatory sampling.

Confirmatory Sampling

Five-point composite confirmatory samples will be collected from the base and sidewalls of the excavation in accordance with the sampling plan detailed in Attachment 6. The sampling plan is based on a non-parametric statistical sampling design, using the methods developed by Hahn and Meeker (1991), and was developed through the Visual Sample Plan (VSP) program. Sampling using VSP meets the Environmental Protection Agency's data quality assessment standards (DQAs) for composite sampling. This type of sampling approach is a variance from the alternative 200 square foot rule as described in Subparagraph (c) of Paragraph (1) of Subsection D of 19.15.29.12 NMAC. Please let this workplan serve as a formal variance request to the above-mentioned sampling method per the variance process outlined in Subsection A of 19.15.29.14 NMAC.

The need for a variance to the 200 square foot sampling method is based on the presence of a solid caprock existing just 0.5 feet below ground surface. Currently, the caprock acts as a protective barrier, preventing contaminants from filtering into the soil toward the water table. Obtaining valid confirmatory samples from this caprock is not only a difficult process, it is likely to weaken the caprock and create multiple pathways through the rock's protective, solid surface to the soil beneath.

Using the VSP program to design a statistical sampling plan allows for a sampling approach that provides high statistical confidence in proving that no contaminants of concern, above the closure and remediation requirements shown in Tables 1 and 2, remain in the release area. Statistically, the high level of confidence obtained by following the VSP sampling method in Attachment 6 is not significantly increased by collecting additional samples. For each additional sample collected over the VSP-recommended number, the incremental increase in confidence gets smaller but the risk of future contamination increases. Once the caprock is breached, contaminants from potential future releases may leak into the soils beneath the caprock. Having the protective nature of the caprock compromised with multiple holes could result in more widespread contamination during future release incidents. Subsequently, future remediation efforts would be incredibly destructive in having to remove the caprock partially or entirely to reach those contaminated soils, and would alter the landscape permanently and irreparably. Allowing use of the proposed sampling plan would allow for complete confirmatory sampling while providing better protection to the environment than would sampling every 200 square feet.

Regardless of the sampling method chosen, all confirmatory samples will be placed into laboratory-provided containers, preserved on ice and submitted to a National Environmental Laboratory Accreditation Program-approved laboratory for chemical analysis. Laboratory analyses will include Method 300.0 for chlorides, Method 8021B for volatile organics, including benzene and BTEX, and EPA Method 8015 for TPH, including MRO, DRO and GRO.

A GeoExplorer 7000 Series Trimble global positioning system (GPS) unit, or equivalent, will be used to map the approximate center of each of the five-point composite samples.

Post-Remediation

If not required prior to confirmatory sampling, following completion of confirmatory sampling, the surface of the caprock will be treated with Soil Rx to remediate any contamination remaining on the surface of the caprock, and to meet the requirements of NM OCD as outlined in their guidance email (Attachment 3).

Excavations will be backfilled with clean soil sourced locally and contoured to achieve erosion control, long-term stability and preservation of surface water flow patterns as outlined in Subsection A of 19.15.29.13 NMAC. Because the native soil at Lea

Flowline is not currently four feet deep, the depth of clean soil meeting Table 2 criteria will likely be limited to no more than six inches, as required to reconstruct existing grade.

Timeline for Completion

Remediation activities, as outlined in this workplan, are projected to be completed within 120 days of NM OCD notice of approval of the workplan and alternate sampling plan.

If there are any questions regarding this report, please contact Natalie Gordon at 505-506-0040.

Sincerely,

Natalie Gordon
PROJECT MANAGER

Attachments

Attachment 1: Figure 1 – Release Area and Field Screen Sample Points
Attachment 2: Closure Criteria Determination Worksheet and Documentation
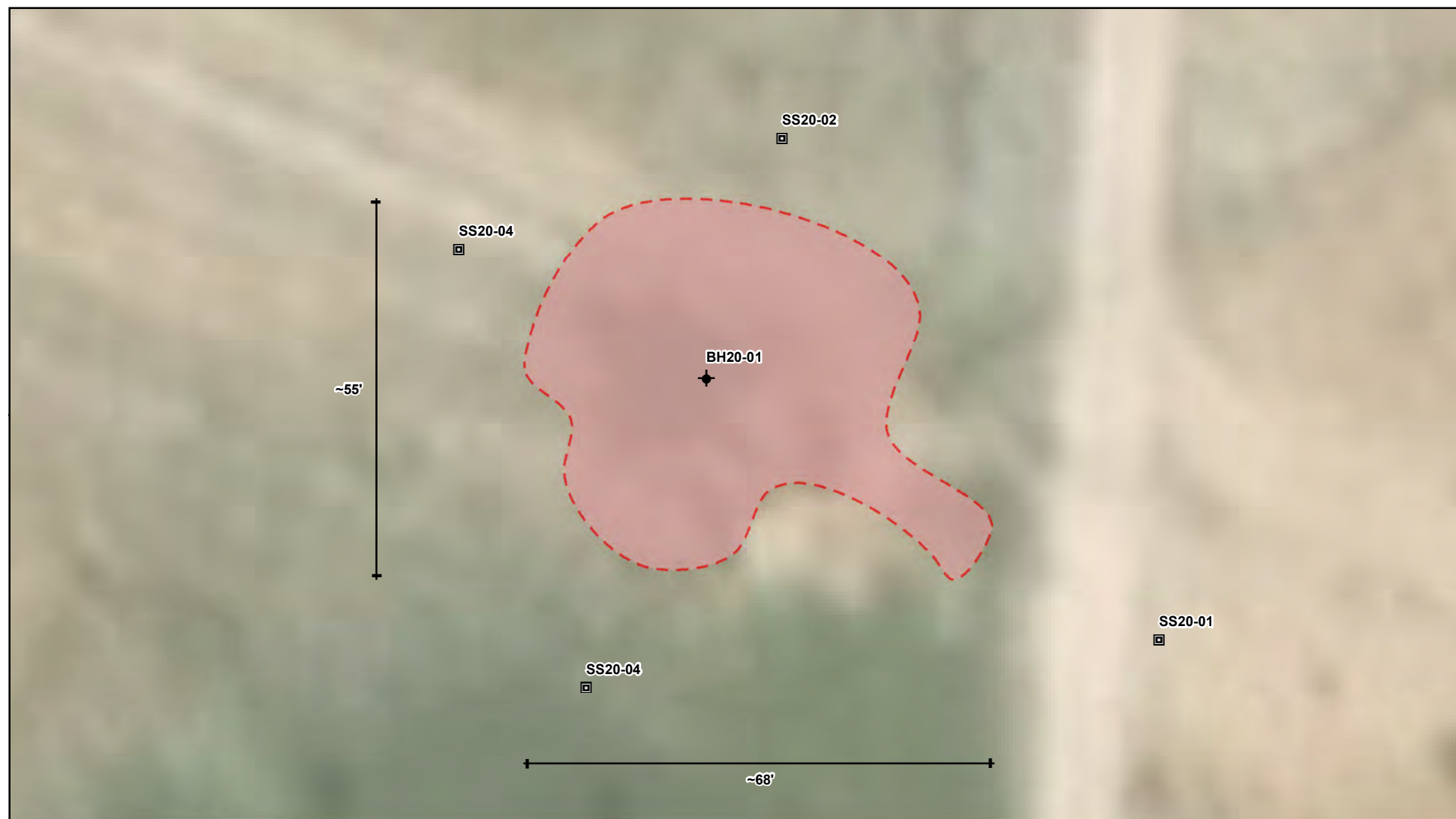Attachment 3: NM COD Guidance on Remediation of Soils on Solid Rock
Attachment 4: Table 3 – Release Characterization Sampling – Field Screen and Laboratory Data
Attachment 5: SA-1000 and Soil Rx Treatment Product Information
Attachment 6: Sampling to Compute a Nonparametric One-Sided Upper Tolerance Limit to Test that a Large Portion of a Room Surface Does Not Contain Contamination

ATTACHMENT 1

Initial Characterization Sampling and Site Schematic
Lea 946 State Flowline

FIGURE: **1**

HPPC Inc.

Legend:
- ◆ Borehole
- ▣ Surface Sample
- Approximate Spill Exent (~ 2,380 sq. ft.)

Labels on map: SS20-02, SS20-04, BH20-01, SS20-01, SS20-04

~55'   ~68'

0 10 20 Feet

NAD 1983 UTM Zone 13N
Date: Aug 17/20

Map Center:
Lat/Long: 32.780278, -103.434218

N

VERTEX

Document Path: G:\1-Projects_US PROJECTS\HPPC Inc\20E-01925\001 - Lea 946 State Flowline Leak\Figure 1 Site Schematic and Initial Characterization.mxd

Geospatial data presented in this figure may be derived from external sources and Vertex does not assume any liability for inaccuracies. This figure is intended for reference use only and is not certified for legal, survey, or engineering purposes.

Note: Background image from ESRI, 2019.

VERSATILITY. EXPERTISE.

ATTACHMENT 2

Closure Criteria Worksheet			
Site Name: Lea 946 State			
Spill Coordinates:		X: 32.778542	Y: -103.436796
Site Specific Conditions		Value	Unit
1	Depth to Groundwater	**60**	feet
2	Within 300 feet of any continuously flowing watercourse or any other significant watercourse	270,705	feet
3	Within 200 feet of any lakebed, sinkhole or playa lake (measured from the ordinary high-water mark)	22,651	feet
4	Within 300 feet from an occupied residence, school, hospital, institution or church	2,904	feet
5	i) Within 500 feet of a spring or a private, domestic fresh water well used by less than five households for domestic or stock watering purposes, **or**	1,478	feet
	ii) Within 1000 feet of any fresh water well or spring	1,478	feet
6	Within incorporated municipal boundaries or within a defined municipal fresh water field covered under a municipal ordinance adopted pursuant to Section 3-27-3 NMSA 1978 as amended, unless the municipality specifically approves	No	(Y/N)
7	Within 300 feet of a wetland	1,900	feet
8	Within the area overlying a subsurface mine	No	(Y/N)
9	Within an unstable area (Karst Map)	Low	Critical High Medium Low
10	Within a 100-year Floodplain	Undetermined	year
NMAC 19.15.29.12 E (Table 1) Closure Criteria		51-100'	<50' 51-100' >100'

Lea 946 State Tank Overflow - Nearest OSE Wells

New Mexico Office of the State Engineer
Point of Diversion Summary

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest)   (NAD83 UTM in meters)

Well Tag	POD Number	Q64	Q16	Q4	Sec	Tws	Rng	X	Y
	L 10294		2	4	03	18S	35E	646209	3627419* 🌐

Driller License: 1235	**Driller Company:**	J & K DRILLING COMPANY	
Driller Name: EARL ELLISON			

Drill Start Date: 11/01/1992	**Drill Finish Date:** 11/02/1992	**Plug Date:**
Log File Date: 11/18/1992	**PCW Rcv Date:**	**Source:** Shallow
Pump Type:	**Pipe Discharge Size:**	**Estimated Yield:** 122 GPM
Casing Size: 6.00	**Depth Well:** 90 feet	**Depth Water:** 61 feet

Water Bearing Stratifications:	Top	Bottom	Description
	60	65	Other/Unknown
	65	85	Other/Unknown
	85	90	Other/Unknown

*UTM location was derived from PLSS - see Help

The data is furnished by the NMOSE/ISC and is accepted by the recipient with the expressed understanding that the OSE/ISC make no warranties, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the data.

8/10/20 2:30 PM   POINT OF DIVERSION SUMMARY

8/21/2020

New Mexico Office of the State Engineer
Point of Diversion Summary

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest)   (NAD83 UTM in meters)

Well Tag	POD Number	Q64	Q16	Q4	Sec	Tws	Rng	X	Y
	L 10404	4	4	4	34	17S	35E	646283	3628523*

x

Driller License:	1292	Driller Company:	BENTLE WATER WELL SERVICE
Driller Name:	BENTLE, BILLY L.		

Drill Start Date:	07/21/1994	Drill Finish Date:	07/24/1994	Plug Date:	
Log File Date:	08/09/1994	PCW Rcv Date:		Source:	Shallow
Pump Type:		Pipe Discharge Size:		Estimated Yield:	
Casing Size:	5.00	Depth Well:	115 feet	Depth Water:	115 feet

x

Casing Perforations:	Top	Bottom
	95	115

x

*UTM location was derived from PLSS - see Help

The data is furnished by the NMOSE/ISC and is accepted by the recipient with the expressed understanding that the OSE/ISC make no warranties, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the data.

8/21/20 9:09 PM   POINT OF DIVERSION SUMMARY

New Mexico Office of the State Engineer
Point of Diversion Summary

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest)   (NAD83 UTM in meters)

Well Tag	POD Number	Q64	Q16	Q4	Sec	Tws	Rng	X	Y
222AB	L 14712 POD1	1	3	2	02	18S	35E	647299	3627869

x

Driller License:	1044	**Driller Company:**	EADES WELL DRILLING & PUMP SERVICE
Driller Name:	EADES, ALANESL.G. HAYDENAS		

Drill Start Date:	07/18/2019	**Drill Finish Date:**	07/18/2019	**Plug Date:**	
Log File Date:	08/02/2019	**PCW Rcv Date:**		**Source:**	Artesian
Pump Type:		**Pipe Discharge Size:**		**Estimated Yield:**	24 GPM
Casing Size:	5.00	**Depth Well:**	190 feet	**Depth Water:**	60 feet

x

Water Bearing Stratifications:	Top	Bottom	Description
	60	130	Sandstone/Gravel/Conglomerate
	130	190	Sandstone/Gravel/Conglomerate

x

Casing Perforations:	Top	Bottom
	150	190

x

The data is furnished by the NMOSE/ISC and is accepted by the recipient with the expressed understanding that the OSE/ISC make no warranties, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the data.

8/21/20 9:07 PM   POINT OF DIVERSION SUMMARY

ATTACHMENT 3

Natalie Gordon

From:	Dhugal Hanton <vertexresourcegroupusa@gmail.com>
Sent:	Tuesday, May 12, 2020 4:30 PM
To:	Natalie Gordon
Subject:	Fwd: [EXT] Release characterization/delineation question

---------- Forwarded message ---------
From: **Hamlet, Robert, EMNRD** <Robert.Hamlet@state.nm.us>
Date: Tue, May 12, 2020 at 4:11 PM
Subject: RE: [EXT] Release characterization/delineation question
To: Dhugal Hanton <vertexresourcegroupusa@gmail.com>, Venegas, Victoria, EMNRD <Victoria.Venegas@state.nm.us>,
Bratcher, Mike, EMNRD <mike.bratcher@state.nm.us>, rmann@slo.state.nm.us <rmann@slo.state.nm.us>

Dhugal,

Rock Refusal (Remediation Process)

If rock refusal interferes with the remediation process, use a back-hoe/track-hoe to remove the rock. If the rock is immovable and target depth cannot be reached, use a hydrovac to clean the contaminated soil off of the rock surface and outline specific locations and steps taken on the Closure Report.

The OCD likes to see samples taken from the rock to see if the liquids have permeated the rock. This might consist of a 12-18" hole drilled with a rotary drill. If the drill sample doesn't show contaminants, spray the rock with Microblaze or other surfactants that will digest the organics (Get Approval by State/Federal Agency). At that point you've shown the OCD that you've done everything possible to clean up the contaminants.

Hopefully this helps.

Robert J Hamlet

State of New Mexico

Energy, Minerals, and Natural Resources

Oil Conservation Division

1

811 S. First St., Artesia NM 88210

(575) 748-1283

Robert.Hamlet@state.nm.us

From: Dhugal Hanton <vertexresourcegroupusa@gmail.com>
Sent: Tuesday, May 12, 2020 2:27 PM
To: Venegas, Victoria, EMNRD <Victoria.Venegas@state.nm.us>; Hamlet, Robert, EMNRD
<Robert.Hamlet@state.nm.us>; Bratcher, Mike, EMNRD <mike.bratcher@state.nm.us>; rmann@slo.state.nm.us
Subject: [EXT] Release characterization/delineation question

Hello District 2 and SLO reps,

I have a question regarding delineating a release vertically. When we try to vertically delineate a produced water release and hit a solid hardpan/refusal at approximately 1-2 feet below ground surface, are we supposed to try to drill or break through that rock layer? The soil collected and field screened/analyzed from immediately atop the refusal layer still shows chloride levels of greater than 10,000 mg/Kg so within closure criteria for the area, but NOT within reclamation standards of 600 mg/Kg for the off-pad portion.

Breaking through the solid layer opens a conduit for contamination to move deeper into the soil so it seems like a less-than-great idea. However, fully delineating the release is a necessity.

Please advise the OCD preferred method for handling this type of situation.

Thank you,

Natalie

Natalie Gordon
Project Manager

2

Vertex Resource Group Ltd.
213 S. Mesa Street
Carlsbad, NM 88220

P 575.725.5001 ext 709
C 505.506.0040
F

www.vertex.ca

3

ATTACHMENT 4

Client Name: HPPC, Inc
Site Name: Lea 946 State #2 - Flowline
NM OCD Tracking #: NRM2020352997
Project #: 20E-01925-001
Lab Report: 2008836

						Petroleum Hydrocarbons							
Sample Description			**Field Screening**			**Volatile**		**Extractable**					**Inorganic**
Sample ID	Depth (ft)	Sample Date	Volatile Organic Compounds (PID)	Extractable Organic Compounds (Petro Flag)	Inorganics (Electrical Conductivity)	Benzene	BTEX (Total)	Gasoline Range Organics (GRO)	Diesel Range Organics (DRO)	Motor Oil Range Organics (MRO)	(GRO + DRO)	Total Petroleum Hydrocarbons (TPH)	Chloride
			(ppm)	(ppm)	(ppm)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
SS20-01	0	August 12, 2020	-	159	<0	-	-	-	-	-	-	-	-
SS20-02	0	August 12, 2020	-	40	<0	<0.023	<0.210	<4.7	11	<46	11	11	<60
SS20-03	0	August 12, 2020	-	117	<0	-	-	-	-	-	-	-	-
SS20-04	0	August 12, 2020	-	48	<0	<0.024	<0.215	<4.8	<9.4	<47	<14.2	<61.2	<60
BH20-01	0	August 12, 2020	-	-	-	<0.120	<1.090	28	57,000	51,000	**57,028**	**108,028**	**980**
BH20-01	0.5	August 12, 2020	-	-	-	<0.120	2.930	240	16,000	10,000	**16,240**	**26,240**	**630**

Table 3. Release Characterization Sampling - Depth to Groundwater 51 ≤ 100 feet

"-" indicates not analyzed/assessed
Bold and shaded indicates exceedance outside of NM OCD Closure Criteria

VERTEX

ATTACHMENT 5

The Next Generation Treatment
SODIUM & HEAVY METALS IN SOIL AND WASTEWATER

Bio-Regen™ SA-1000
TURBO CHARGED REACTION

TIDWELL INDUSTRIES

Tidwell Industries is proud to introduce a revolutionary shift in the management and remediation of high sodium and metal contaminated soils and wastewater streams. SA-1000™ is the newest treatment that combines two, next generation, organic bio-polymers. This uniquely blended product possess the following properties and functions; optimal molecular mass, active functional groups, hydrophilic and hydrophobic sites, positively and negatively charged sites, non-ionic sites, and specific interactions between molecules themselves and organic/mineral compounds. The combination of these diverse properties and functions provide a product that utilizes multiple functions and mechanisms to detoxify, neutralize, bind, and convert a myriad of toxic metals to benign residual metals.

SA-1000™

SA-1000™ is a convenient, cost effective, liquid treatment product derived from and naturally occurring organic substrate. Our proprietary and patented manufacturing process unleashes unparalleled performance that address most of the potential effects that excess sodium and heavy metals will have in all soil and wastewater applications.

Product Benefits:
- SA-1000™ adsorbs and coordinates sodium cations and chlorine anions which allow excessive amounts of salt to become more mobile in terms of sodium cations and chloride anions that have a natural ability to flush through the soil or precipitate out of water. Any sodium residue creates a new mineral formation resulting in sodium, chlorine, cation and anion conversion into physically and mechanically bound status, thus eliminating salt toxicity resulting in desalination and salt toxicity reduction/ elimination.
- SA-1000™ will naturally stimulate toxic organic and mineral pollutants decomposition into neutral compounds such as converting Chromium VI to Chromium III.
- SA-1000™, with an abundance of hydroxyl and phenolic groups, provides these functional groups that are key to the metal complexation resulting in the binding of various metals.
- SA-1000™ is immediately soluble and active compared to gypsum applications. See results within a couple weeks.
- In soil, SA-1000™ creates fresh soil organic matter that results in increased CEC, better water holding capacity, and soil porosity/structure that results in healthy, active soil for re-use.
- SA-1000™ is a chemically, biologically and geologically active material.
- Cost effective low dose rates for either injection or mechanical applications.

For additional information and specific application rates for your project, contact an authorized Tidwell Industries representative.

SA-1000 PERFORMANCE CASE STUDY

The remediation and management of waste tailings from the metals refinery industry is a growing challenge with increased regulations towards heavy metals, salts, and other related contaminants. In an effort to demonstrate the real world performance of SA-1000 and the direct impact it has on metals and salts, Tidwell Industries received a sample of stainless steel slag directly from a refinery to treat.

TRIAL OUTLINE:

The slag sample was crushed and screened to a homogenous material with all large clumps removed. An equal amount of processed slag was added to two clean plastic dishes. One dish was treated with SA-1000 (Right Photo Below), wheat seed was added to each dish and mixed into the slag, and each dish watered. Each dish received equal amounts of water daily to aid in normal seed germination for five days.

The photo below shows plant germination after 5 days. After 10 days, the treated sample continued to grow while the untreated dish with limited initial germination all died. The trial was abandoned after 30 days with the treated sample plants remained healthy for the entire time.

SUMMARY:

This study has demonstrated the performance of SA-1000 and its ability to reduce/eliminate salt and metals toxicity while providing a valuable organic structure which will sustain growth. Additionally, this study has laid the foundation for a large scale pilot study for the treatment of refinery tailings. The new pilot study will include pre and post material metals and sodium testing and replicate the ability of the tailings to support various plants from seed.

Tidwell Industries is seeking additional tailing remediation locations as well as salt and/or metal contaminated soil sites for additional performance pilot studies. Contact Steve Tidwell at steve@tidwellind.com or Call (361) 200 - 0011.
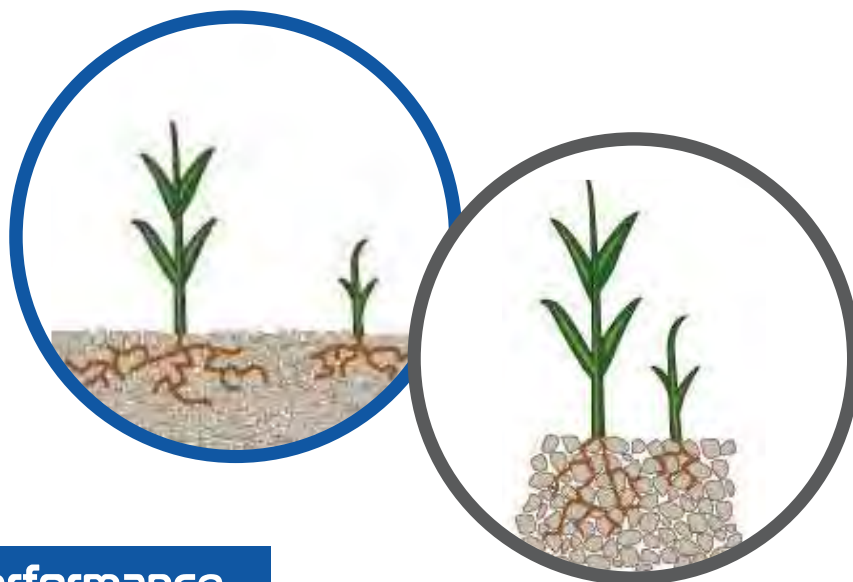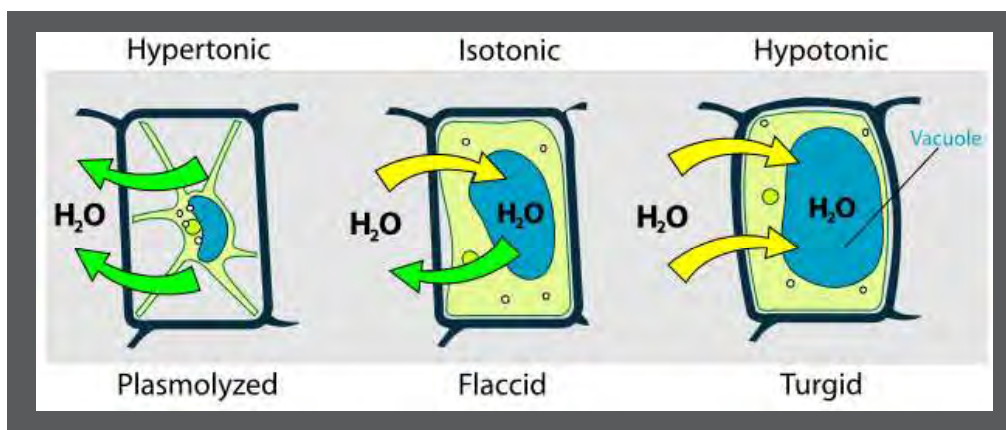
HOW SA-1000 WORKS
THE EFFECTS OF SODIUM & CHLORIDES ON SOIL

Sodium & Chlorides Impact Soil Structure, Increase Compaction, Limit Moisture Movement, Reduce Nutrient Availability, & Reduce Beneficial Bacteria

Things That Impact Product Performance

- Soil Structure
- Total Contaminant Loading
- Moisture
- Application Process
- Rate of Application Versus Results Required
- Additional Chemical Treatments
- Expectations or Regulatory Requirements
- Testing Methods

Produced Water Spill Clean-Up -1
LOCATION: WESTERN OKLAHOMA – DISPOSAL STATION
CONTAMINANT: PRODUCED WATER (BRINE)
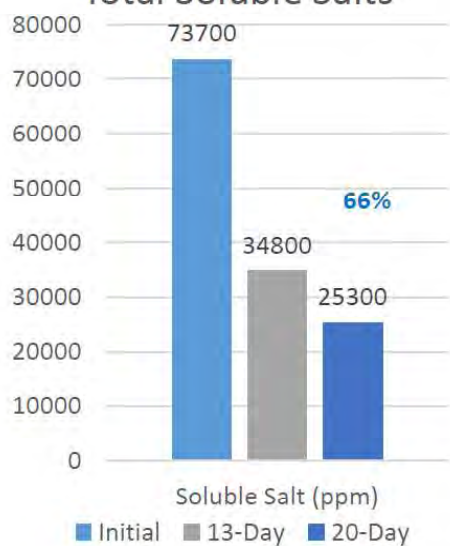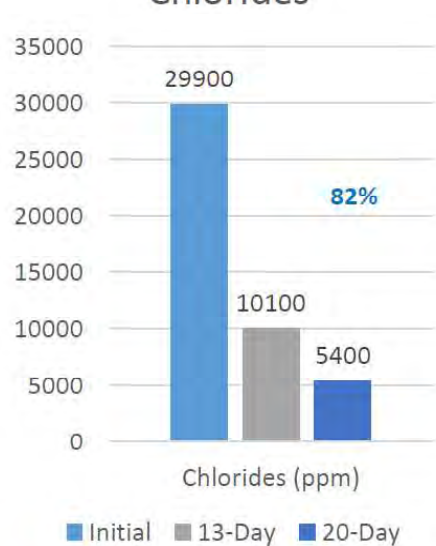IMPACT AREA: MEDIUM SPILL AREA
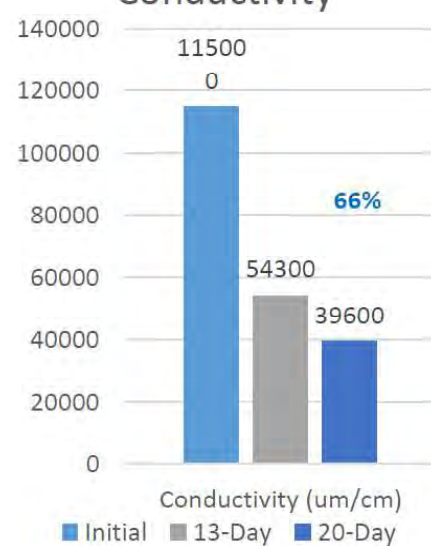
Application Day

13 Days After Application

Total Soluble Salts
- 73700
- 34800
- 25300
- **66%**

Soluble Salt (ppm)
■ Initial ■ 13-Day ■ 20-Day

Chlorides
- 29900
- 10100
- 5400
- **82%**

Chlorides (ppm)
■ Initial ■ 13-Day ■ 20-Day

Conductivity
- 115000
- 54300
- 39600
- **66%**

Conductivity (um/cm)
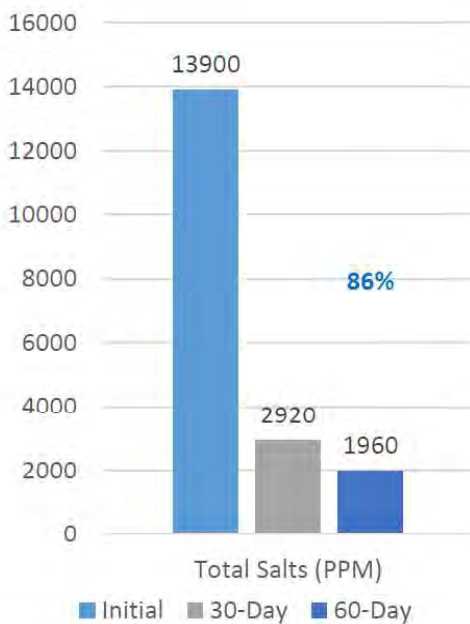■ Initial ■ 13-Day ■ 20-Day

Produced Water Spill Clean-Up -2

LOCATION: CENTRAL OKLAHOMA –STORAGE TANK LEAK
CONTAMINANT: PRODUCED WATER (BRINE)
IMPACT AREA: 1.58 ACRES BY 18" DEEP
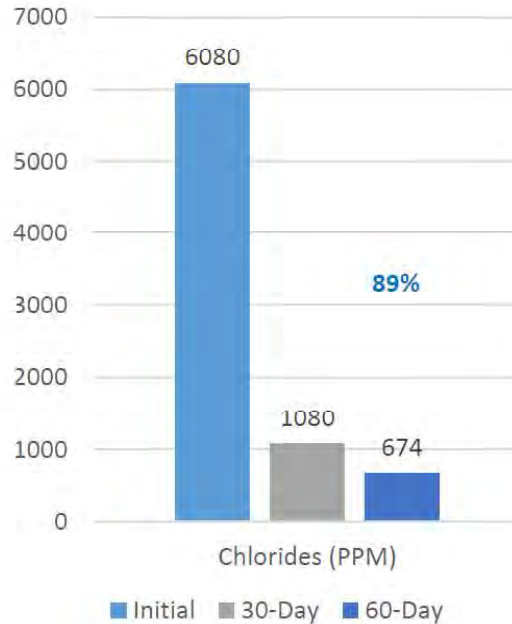

Total Soluble Salts

- 13900 — Initial
- 2920 — 30-Day
- 1960 — 60-Day
- 86%

Total Salts (PPM)
■ Initial ■ 30-Day ■ 60-Day

Chlorides

- 6080 — Initial
- 1080 — 30-Day
- 674 — 60-Day
- 89%

Chlorides (PPM)
■ Initial ■ 30-Day ■ 60-Day

Conductivity

- 21545 — Initial
- 4536 — 30-Day
- 1235 — 60-Day
- 94%

Conductivity (um/cm)
■ Initial ■ 30-day ■ 60-Day

Produced Water Spill Clean-Up -3

LOCATION: WESTERN OKLAHOMA – DISPOSAL STATION
CONTAMINANT: PRODUCED WATER (BRINE)
IMPACT AREA: SMALL SPILL AREA

Application Day　　　　　　　**13 Days After Application**

Total Soluble Salts — Soluble Salt (ppm): Initial 16200, 8-Day 7010, 15-Day 9730 — 40%

Chlorides — Chlorides (ppm): Initial 1960, 8-Day 656, 15-Day 118 — 94%

Conductivity — Conductivity (um/cm): Initial 25300, 8-Day 11000, 15-Day 15200 — 40%

REVERSING THE EFFECTS OF
SODIUM & BICARBONATES
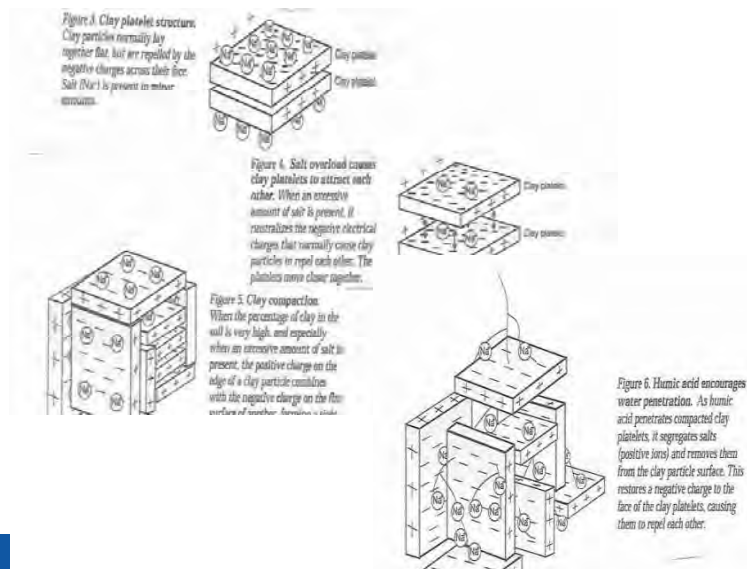
| July 13, 2015 | August 13, 2015 | September 12, 2015 |

This is the result of years of effluent water use and the effects it has on traditional sand based greens.

SALTS & CHLORIDES REMEDIATION

The remediation of salts and chlorides is not a process of consumption but rather a process of binding, buffering, immobilization, detoxification, filtering, or conversion into a non-toxic soil mineral. This is accomplished in a variety of both cationic and anionic processes and reactions. The following information will provide some additional information that will assist in how some of these processes occur and a foundation on what these potential contaminants do in soil.

Impact of Salt/Chloride on Soil

There are three major impacts on soil and plants when salt water spills occur.

- Soil particles are dispersed which destroys aggregation
- Osmotic potential reduces the plants ability to up take water
- Ionic balance of the soil solution is impacted reducing nutrient absorption.

Impact of sodium on soil & plants.

The Na+ ion of sodium chloride causes the dispersion of the soil. Due to the large number of Na+ ions available, the Na+ ions are able to exchange with a sufficient number of the Ca++ and Mg++ ions. The Na+ ion is a large ion therefore weakening the normal soil aggregate stability. The major impact of a salt water spill is the destruction of the soil aggregates by dispersion. Dispersion will occur when more than 15% of the cation exchange capacity sites on clays are occupied by sodium ions and when the total EC in the soil solution is low. The potential dispersion of a soil can be determined by the exchangeable sodium percentage (ESP).

Soil dispersion results in:
- Loss of soil structure
- Loss of pore structure
- Reduced air and water movement
- Reduced bioactivity
- Reduced nutrient transfer
- Increased water run-off and erosion of soil

Due to the major impact of the Na+ ion in the soil root zone, the remediation process is focused on restoring the soil aggregation. When the soil aggregation is restored the secondary impact due to osmotic pressure will also be reduced.

In the remediation process it is very important to treat the soil as soon as possible. Rain on the spill site before gypsum is added will increase the rate of soil dispersion.

As the salt (NaCl) concentration in the water solution increases, the change in osmotic potential makes the roots work harder to take in water. The amount of water intake by a plant will directly affect plant growth. As rain fall events occur salt in the water solution will be diluted. In most cases the first year rain fall (12-14 inches of rain) will significantly reduce the salt concentration in the soil solution.

Impact of chloride on soil & plants

Depending on the chloride concentration in the spill event, direct chloride toxicity can occur at high levels of Cl- ions. Sensitivity to the Cl– ion will depend on the plant species. The Cl– ion in the soil water solution is usually flushed below the root zone by the first year of rain fall.

The Cl– ion, due to its negative charge, moves rapidly out of the root zone through the negatively charged soil aggregates. Chloride concentration does not have a direct impact on soil structure except for being one of the ions which increases the osmotic potential in the soil solution.

The term "chloride" does not refer to any specific compound but is a category of substances that are either present in the soil or groundwater or are added to drilling muds or hydro-fracturing fluids to facilitate development of a gas/oil well. The most common chlorides of interest include sodium chloride, calcium chloride, magnesium chloride, ammonium chloride, potassium chloride, and barium chloride. Therefore the remediation of "Chlorides" may encompass a variety of compounds that can respond differently to treatments due to a variety of variables and conditions. It is also known that within any remediation of salts and chlorides that a variety of charges and reactions are required due to the fact that Cations migrate to negative charges and anions migrate to positive charges. Therefore, multiple charges of treatment products will be required to react appropriately with the different charges of the various components in the soil and water.

PROPER SITE CHARACTERIZATION AND ANALYTICAL DATA FOR MAXIMUM PERFORMANCE RESULTS:

Basic sodium and chloride testing will ONLY provide one small piece of the puzzle.........what is the level of loading! Understanding the makeup and use of the site, soil structure, and analytics that detail the impact of the sodium/chloride to the specific site are all critical to development of an effective remediation process that can yield maximum results in the shortest period of time. Without a complete site picture, the remediation process will, in most cases, will not perform to the required expectations resulting in retreatment, additional time, and additional expense that can be avoided with proper testing and investigation of the site.

Required site testing:

(the best method for overall site analysis is composite soil sampling)

- pH
- Bicarbonate Alkalinity
- Carbonate Alkalinity
- Electrical Conductivity (EC)
- Total Soluble Salts (TSS)
- Calcium
- Potassium
- Magnesium
- Sodium
- Chloride (Anions)
- Nitrate as N (Anions)
- Sulfate as SO4 (Anions)
- Cation Exchange Capacity (CEC)
- Exchangeable Sodium Percentage (ESP)
- Sodium Absorption Ration (SAR)
- Soil Texture Analysis (Sand, Silt, Clay)

Required site specific information:

- General topography of site
- Site accessibility
- Principal site use (Pasture, Agricultural, Stabilization)
- Regulatory Standard
- Surface/Groundwater impact or influence (location of creeks, rivers, ponds and depth to groundwater if known)
- Age/Volume of Spill
- Makeup of the water spilled (Produced Water, Frack Water, Hydrocarbon present, Metals, other potential remediation concerns presented by spill, MAY REQUIRE ADDITIONAL TESTING DATA)
- Depth of contamination (Soil Texture Testing at incremental depths may be required)
- Depth to groundwater, type & potential water uses

Frequent work within a general geographic area may limit the amount of information required for all sites through experience though it is not uncommon for soil structure to vary significantly from location to location. Due to the relatively low cost for all tests, establishing a consistent testing regime will insure consistent results and a portfolio of proven reference data for replicatable results and success.

SA-1000 TECHNICAL
MECHANISMS
(SALTS/CHLORIDES)

- The bio-polymers that makeup SA-1000 are chemically, biologically and geologically active material. In other terms, PEB is a nonspecific material that provides a positive impact to many, if not all, soil compounds (organic and mineral matter, soil bacteria, plant, etc.); organic pollutant (oil hydrocarbon and others); mineral toxicant (heavy metals, salts, etc.); soil function and properties (water holding capacity, porosity and density, CEC, EC, etc.) as well as plant growth / development processes. These are caused by PEB which is a poly fractional organic-mineral composition and colloidal origin (PEB contains molecules with different molecular mass); biopolymer or polyelectrolyte nature (PEB molecules are biologically synthesized molecules – biopolymer, while at the same time these polymers - molecules are electrolyte – or rather a polyelectrolyte); volumetric structure (three dimensional molecules with ability to conformational changes – ability to change their shapes) , its functional groups and a number of local positively and negatively charged active centers – negatively charged centers located primarily on the outer/external edges and positively charged centers located primarily in the inner/internal sites of these molecules. This unique molecular structure allows SA-1000 to be effective on both sodium cations and chloride anions.

- It is well known that soil particles bear negative electrical charges and this results in cations (positively charged ions) absorption on their surfaces. Note: Soil particles form a soil "skeleton" that means they are not available for moving through soil profile (in most cases). These cations form thin or thick hydrated layer around each soil particle. This electrically charged layer is called a "Double Electrical Layer". This property primarily causes soil Cation Exchange Capacity (CEC). There is primarily hydrogen, calcium, magnesium, sodium; potassium and some other cations are present in this layer. Depending on makeup of the soil, the type of cations that dominates various soils could vary significantly. According to modern agro chemistry the best cation is calcium. If sodium cations dominate in this layer and the layer is thick, the sodium cations can move into soil pore solution due to diffusion, in this case, soil gets toxic for plant and soil bacteria (due to several mechanisms including high osmotic pressure). However, most sodium cations are strongly bound with soil particles and even soil washing with plenty of water does not remove any significant amount of sodium. That is why sodium removal is possible through ions exchange mechanisms: usually calcium (calcium sulfate – bio-available calcium) is used to replace sodium by calcium and sodium is available for removal from soil due to rainfall, natural diffusion processes, etc. If soil has high CEC (for example, black soil; clay; clay loam), soil can accumulate high levels of sodium without detectable sodium toxicity to plants because sodium cations are strongly bound and sit in "double electric layer". Soil with low CEC cannot absorb high levels of sodium that is why in "light" soil (sandy soil; sandy clay; etc.) even a small amount of sodium results in great toxicity for plant/soil bacteria. Tidewell PEB's increase CEC because activated bio-polymers have many active functional groups which have increased ions exchange capacity. The greater CEC, the greater the amount of sodium is absorbed and the lower its toxicity. Our PEB is the real molecular solution with dominated mass around 27,000 Daltons up to 100,000 Daltons. Therefore, with a sodium cation mass being 23 D (chlorine ion 36 D) a single PEB molecule is greater/heavier than a sodium ion by 1,174 times. The greater/heavier the molecules, the less mobile they are. Once sodium ions are absorbed by the PEB molecule, it makes sodium ions less mobile and respectively less toxic. It is possible to say roughly, that each PEB molecule works like a soil "particle" which forms a "Double electrical layer" with sodium resulting in reduced sodium mobility/toxicity.

- Our PEB molecules are volumetric: meaning three dimensions. Sodium ions can travel inside volumetric molecules and interact with their negatively charged sites. This can be described in terms of "sodium coordination".

  Note: It can be explained in very simple terms. - For example, the Moon is coordinated by the Earth (due to gravity) and this doesn't allow the Moon travel freely. But if the Moon gets extra energy, it can leave the Earth because there are no other forces or bonds which keep them together.

- In the soil or waste water PEB molecules absorb and coordinate sodium cations on negatively charged external surfaces and chlorides anions on the positively charged centers. Due to "diffusion" by water, chlorides ions have a significantly greater concentration on the inside portion of the molecule, while the sodium ions are captured in greater concentration on the outside of the PEB molecules rather than in the surrounding water. In soil this results in lowering sodium and chlorides concentration in soil pore solution and greater concentration around solid phase. The lower sodium and chlorides content in soil pore solution, the less salt toxicity to the plants. Though this process of absorption and coordination still binds sodium and chlorides ions, they still remain mobile and soluble without the inhibiting effects to the soil, water, and the environment trying to survive in it.

  Note: PEB molecules interaction with calcium, magnesium and two others with greater valent cations resulting in PEB molecules coagulation and precipitation. Calcium, magnesium, etc. make conformational changes or in other terms change PEB molecules shapes to more spherical which include sodium and chloride inside such spheres. This is the sodium and chlorides occlusion that results in less mobility/toxicity of these ions.

- Solid phase formation in soil or sediment formation in waste water due to PEB coagulation by calcium, magnesium, etc. significantly changes the mechanisms of sodium and chlorides diffusion in solid-liquid media. Sodium and chlorides distribution between liquid phase (water) and solid phase (coagulated PEB in soil and sediment in waste water) results in greater sodium and chlorides content in solid phase. This difference can be detected by sodium and chlorides content determination in liquid phase before and after PEB application. Liquid phase electro conductivity can be read also before and after PEB application. Electro conductivity reduction is more than expected.

  Note: without solid phase or sediment formation a PEB application could result in electro conductivity increase due to its electrolytic nature. Sodium and chlorides diffusion in solid phase and sediment is still great because they are not strongly bound; they are just absorbed and coordinated. This diffusion allows sodium and chlorides leaving the top soil into deeper layers. This results in top soil desalination. If this sediment in waste water is located on the surface of native ground (loam, sandy loam, etc.) it can result in sodium and chlorides diffusion to deeper layers and salt content reduction in waste water.

  Note: PEB molecules which were coagulated to sediment are not mobile. They can catch sodium in the same manner as it does cationic resins in case of sodium prevalent content over calcium, magnesium, etc. In this case sodium replaces calcium, magnesium, etc. and calcium chloride, magnesium chlorides content can increase while lowering sodium chloride concentration in water.

- As previously stated, PEB is a biologically active product which catalyzes the processes of new soil organic matter formation due to fresh organic matter and organic residue humification into colloidal PEB and primarily to Humus. Freshly formed colloidal PEB is negatively charged in wet soil having a high CEC that results in sodium ions absorption and protons H+ release. Protons replace sodium and form H+ Cl- . So, original NaCl turns to H+ Cl- . Protons and chlorides are very mobile which results in rapid filtering and movement from the soil top layer. Freshly formed colloidal PEB can absorb and keep protons and chlorides "mechanically" bound thus reducing or eliminating chlorides toxicity.

  Note: PEB also acts as a biologically active product in soil. First of all, PEB stimulates autotroph group of bacteria which use mineral compounds such as ammonia/ammonium; sulfur; iron, etc. as energy source. This group of bacteria can utilize carbon dioxide as carbon source. But carbon dioxide is a gas and not available for this bacteria. Carbon dioxide dissolution in soil pore solution or waste water results in bicarbonate formation. Bicarbonate in soil or waste water is rapidly available for autotroph and they turn bicarbonate into bacterial organic matter. If soil is contaminated, for example by sodium bicarbonates, bicarbonates consumption by bacteria results in free sodium ions release and their absorption by soil negatively charged particles – CEC or leaching from soil in form of sodium hydroxide (NaOH). So, PEB is most effective for soil which is contaminated by bicarbonates – sodium bicarbonate, magnesium bicarbonate, etc.

- PEB acts as effective bio stimulator for plant and soil native microbiology. PEB can be applied by mixing into the soil or as foliar spray. PEB molecules regulate soil and plant's cells osmotic pressure. It is known, that the higher salt content in water, the greater the osmosis pressure and greater the salt toxicity will be to the plants. High osmosis pressure makes water unavailable for plant resulting in their drying and death. PEB molecules reduce osmosis pressure making water available for plant.

- As we also stated, PEB is geologically active product. It means that PEB catalyzes the process of new soil mineral formation acting as a "matrix" which collects dissolved cations (primarily magnesium, calcium) and anions (primarily hydroxyl groups, silicates) into new clayey minerals. Sodium and chlorides are "mechanically" occluded between mineral's crystals and lose their mobility and toxicity to plants. These processes in soil a reasonable period of time and result are detectable in several weeks: sodium and chlorides reduction while soil clay mineral content may increase.

FAQ – BIO-REGEN SA-1000
FOR SALT REMEDIATION

What is SA-1000?

Tidwell Industries SA-1000 is a new management tool for remediation of high sodium and metal contaminated soils and wastewater streams. SA-1000 is an advanced treatment product combing two, next generation, Polyelectrolyte Enhanced Organic Bio-Polymers (PEB) with bio-available calcium. This uniquely blended product possess the following properties and functions; optimal molecular mass, active functional groups, hydrophilic and hydrophobic sites, positively and negatively charged sites, non-ionic sites, and specific interactions between molecules themselves and organic/mineral compounds. The combination of these diverse properties and functions provide a product that utilizes multiple functions and mechanisms to detoxify, neutralize and bind, salts and chlorides with the added ability to convert a myriad of toxic metals to benign residual metals.

What is Tidwell's Polyelectrolyte Enhanced Biopolymer (PEB)?

The foundation of SA-1000 is an advanced blend of two Polyelectrolyte Enhanced Biopolymer (PEB) that are derived from very stable, organic compounds found in brown and oxidized black coal. Our proprietary processing technology purifies and unleashes the vast potential of these massive molecular formulas.

PEB is a highly reactive long-chain molecule providing a purified carbon source available with various concentrations of fulvic acids, highly reaction functional groups, high CEC potential, and low ash and ballast. SA-1000 contains a combination of negatively charged molecules for reactions with positively charged Na and a new generation of non-ionic molecules for negatively charged chlorides. This unique combination with the addition of calcium creates a complete remediation tool for salts, chlorides and metals. PEB is an all-natural, highly soluble, liquid concentrate that is safe and easy to use for both soil and aqueous application

Why is the PEB important to the salt remediation process?

PEB naturally binds, adsorbs, and coordinates sodium cations and chlorine anions which allow excessive amounts of salts/chlorides to become more mobile in terms of sodium cations and chloride anions, which eliminates the salt's/chlorides ability to bind to soil particles, especially clay. This reaction allows sodium/chlorides to be safely leached and naturally filtered through the soil profile. Any sodium/chloride residue creates a new mineral formation resulting in sodium, chloride, cation and anion conversion into physically and mechanically bound status, thus eliminating salt toxicity resulting in desalination and salt toxicity reduction/elimination. This process also improves the growing profile by reversing negative osmotic pressure, reducing electrical conductivity, increasing soluble organic matter allowing proper nutrient and moisture retention, percolation, and uptake, therefore allowing new plants to establish and regenerate soil back to a healthy and productive state. In aqueous solutions, the reactions are similar, resulting in the precipitation of most of the sodium, chlorides and metals with the remaining soluble forms being neutralized into non-toxic forms.

How does SA-1000 work?

SA-1000 possesses several beneficial characteristics that buffers the treatment environment, creates a foundation for maximum biological, geological and chemical reactions, is both hydrophobic and hydrophilic, and is designed to work effectively in both soil and aqueous environments. Through these various reactions with contaminants, SA-1000 attracts various contaminants, reverses their negative impact in their environment and reduces/or eliminates the harmful impact through the following processes:

- SA-1000 adsorbs and coordinates sodium cations and chlorine anions which allow excessive amounts of salt to become more mobile in terms of sodium cations and chloride anions that have a natural ability to safely filter through the soil or precipitate out of water. Any sodium residue creates a new mineral formation resulting in sodium, chlorine, cation and anion conversion into physically and mechanically bound status, thus eliminating salt toxicity resulting in desalination and salt toxicity reduction/ elimination.
- SA-1000 with bio-available calcium is immediately soluble and active compared to gypsum applications. See results within a couple weeks.
- In soil, SA-1000 creates fresh soil organic matter that results in increased CEC, reduced Electrical Conductivity (EC), better water holding capacity through osmotic pressure reduction, and soil porosity/structure that results in healthy, active soil for re-use.
- SA-1000 will naturally stimulate toxic organic and mineral pollutants decomposition into neutral soil mineral compounds such as converting Chromium VI to Chromium III which is accomplished by an abundance of hydroxyl and phenol groups. These functional groups are key to the metal complexation resulting in the binding of various metals which protects the environment.

How does SA-1000 improve the soil condition?

When frack/production water or drilling muds are accidentally released onto healthy soils, the results on vegetation are immediate, with devastating results. The impact of the sodium increases compaction through interactions with clay particles, reduces the ability for moisture to naturally penetrate the soils, dramatically increases Electrical Conductivity (EC), and limits natural nutrient conversion and availability to plants resulting in certain death.

Treatment of soils with SA-1000 creates fresh soil organic matter that results in healthy, active soil for re-use. SA-1000 will increase CEC while reducing electrical conductivity, improve water holding capacity by reducing the osmotic pressure, and soil porosity/structure by releasing the sodium for the clay and reversing the charge of the clay particles forcing them apart. SA-1000 helps safely regenerate soil affected by salts/chlorides/metals and promotes improved soil structure for healthy, productive use of the site.

How quickly will SA-1000 work and when can you expect desired results?

In most of our project sites, the application of SA-1000 resulted in a reduction in excess of 75% of Total Soluble Salts and over 80% reduction in chlorides within 30 days after application. While results may vary from one project site to the next, it is important to evaluate results after a minimum of six months. At such time SA-1000 full impact would be realized in terms of improving the soil structure.

In most cases, the speed in which the product will work is impacted by a variety of variables. The most important factor is accurate soil analysis the clearly defines the level of contamination and soil structure/type. This information will insure proper application dosage of the treatment for the desired results. Other critical factors include soil moisture after application (Limited or no rainfall will slow analytical results), proper dosing rate and application, and the establishment of accurate expectations. A reasonable expectation is to see significant results in 30 days if the recommended dosage is used.

Once SA-1000 is applied is it safe to apply seed and any other required nutrients?

Yes, the impact of SA-1000 is almost immediate in terms of detoxifying and buffering the soil structure. If desired, you may apply seed & required nutrients to the treated soil immediately after the application of SA-1000. With the proper moisture level & rain fall, germination may be seen in as little as 2 weeks

Why is the PEB important to the salt remediation process?

PEB naturally binds, adsorbs, and coordinates sodium cations and chlorine anions which allow excessive amounts of salts/chlorides to become more mobile in terms of sodium cations and chloride anions, which eliminates the salt's/chlorides ability to bind to soil particles, especially clay. This reaction allows sodium/chlorides to be safely leached and naturally filtered through the soil profile. Any sodium/chloride residue creates a new mineral formation resulting in sodium, chloride, cation and anion conversion into physically and mechanically bound status, thus eliminating salt toxicity resulting in desalination and salt toxicity reduction/elimination. This process also improves the growing profile by reversing negative osmotic pressure, reducing electrical conductivity, increasing soluble organic matter allowing proper nutrient and moisture retention, percolation, and uptake, therefore allowing new plants to establish and regenerate soil back to a healthy and productive state. In aqueous solutions, the reactions are similar, resulting in the precipitation of most of the sodium, chlorides and metals with the remaining soluble forms being neutralized into non-toxic forms.

TIDWELL
INDUSTRIES

Tidwell Industries is a complete solution for oil-spill cleanup. Our ground-breaking patented technology is redefining oil cleanup methods. We make the entire process quick and easy so that we do not disrupt your ability to use the location. All of our products are non-toxic products, easily applied, and rapidly absorbs spills from water, soil, and all hard surfaces.

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📠 Fax: (361) 200-0012

Soil RX "The Hydrocarbon Solution"

TIDWELL
INDUSTRIES

Product Overview

Soil Rx utilizes a new approach to solving soil and water hydrocarbon contamination problems. Specifically formulated for safe, effective and environmentally friendly applications, Soil Rx utilizes a blend of Polyelectrolyte Enhanced Bio-Polymers, highly concentrated live, hydrocarbon-oxidizing bacteria, and a readily biodegradable natural amino acid complex consisting of a nutrient-rich extract with a broad-spectrum package of identifiable amino acids and other proteins. This triple action product works together synergistically to degrade hydrocarbons with minimal use of equipment, labor and cost. Soil Rx is a low-cost liquid, making it an easy-to-use, cost effective means to eliminate hydrocarbon contamination problems within various types of industry. Soil Rx is an excellent product to remediate hydrocarbons in soil and water. It is effective on gasoline, jet fuels, diesel fuels, grease, tar, motor oils, crude oils, organic solvents, etc.

Application Methods

Soil Rx is a liquid concentrate that must be diluted prior to use. Soil Rx can be sprayed after dilution using standard spray application equipment including but not limited to hand sprayers, mechanical sprayers, water trucks, fire or emergency response equipment, pressure washers, aerial spray equipment, soil injection, well injection, wastewater injection, etc.

Soils Applications: Mix and saturate diluted mixture with contaminated soils thoroughly for maximum performance. For shallow/surface contamination, drench affected areas with enough dilution to fully saturate the soil using normal spray equipment or water trucks. For general contamination less than two feet, contaminated soil may require tilling or excavation to properly mix concentrate/water dilution into soils. For deeper contamination greater than two feet, product application can be applied through boring-n-pour method, soil injection, or on-site soil land farming and/or bio-piling.

Water Applications: For contaminated water such as marshes, shore- lines and open water with floating hydrocarbons, apply dilution directly to the contaminated areas using appropriate spray equipment or water cannons. For wastewater systems, contact Tidwell Industries directly for appropriate treatment methods.

Application Rates

Soil Rx must be diluted using 1 part concentrate to 10 parts clean water prior to use. Product can be diluted up to 100 parts water as directed for specific applications. Application rates are determined by level of contamination, area of application, and speed required for cleanup. Specific application rates are determined prior to sale by the manufacturer and/or distributor.

Soil: Standard application rate for contaminated soil is one gallon (5 liters) 10:1 diluted product per cubic yard (meter) of soil.

Water: Normal application rate for water applications is three gallons (12 liters) 10:1 diluted product per 1000 sq. feet (93 sq. meters) of contaminated surface area. Wastewater systems will receive application rates between 5 and 100 PPM of the average GPD or system volume.

Technical Information

Soil Rx contains naturally occurring, single-celled, hydrocarbon-oxidizing microorganisms; a biodegradable natural amino acid complex consisting of a nutrient-rich extract with a broad-spectrum package of identifiable amino acids, coenzymes, and other proteins in a blend of organic bio-polymers.

Product Effectiveness: The effectiveness and "speed" of this product is determined by several factors.

In general, these factors are:

Temperature: Optimum performance temperatures range from 40°F (5°C) to 98°F (36°C).

pH: Maximum performance range is 5 – 9, acceptable range is 4 – 10.

Soil Moisture: Optimum soil moisture is 15% to 20% moisture content.

Remediation Speed: Factors that influence speed of process include type, level, depth, and age of contaminants as well as method of applications, regulatory standards, and urgency.

Performance Tips: Various strategies may be used to maximize performance like application rate & frequency, the addition of aeration, and method of application.

Shelf Life: Properly stored unopened containers have a shelf life of 2 years, 1 year after opening.

Benefits

- Cost Effective In-Situ Method
- No Dig-N-Dump Costs for Contaminated Soils "Green" Remediation Technology
- Significant Labor & Application Cost Savings
- Can be Used Through Multiple Application Methods

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ATTACHMENT 6

Grid cell sampling for achieving high confidence of discovering unacceptable grid cells if they exist

Summary
This report summarizes the sampling design developed by VSP based on inputs provided by the VSP user.

The hypergeometric model used in this design requires that each sample result be categorized as a binary outcome, such as 1) the presence or absence of a particular quality, 2) a sample result being acceptable or unacceptable as defined by an action level threshold, 3) contamination being detected or not detected, etc. This statistical model presented here is an alternative interpretation of the same hypergeometric model used in Compliance Sampling (Schilling and Neubauer 2009) and Accept on zero attribute compliance sampling (AOZ-ACS) (Squeglia, 1994; Bowen and Bennett, 1988). Instead of using a test of hypothesis as the basis for the sampling design, the discovery sampling model consists of calculating the probability that at least one of the grid cells in the random sample will be unacceptable, if the percentage of the population that is unacceptable is at least P x 100%.

The following table summarizes the sampling design.   Figures that show the grid cell placement are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Achieve high certainty unacceptable grid cells will be detected if they are present
Type of Sampling Design	Square grid cells
Formula for calculating the achieved confidence level	Hypergeometric model with Jaech approximation (described below)
Number of selected sample areas	1
Sampling surface area	2522.03 ft^2
Grid cell side length	1 feet
Sample placement method	Random grid cell sampling
Possible number of grid cells [a]	2522
Actual possible number of grid cells on map [b]	2522
Desired minimum percentage of sampling area that is acceptable	85%
Achieved confidence that unacceptable grid cells will be detected.	72.9%
Number of sampled grid cells[c]	8
Actual number of grid cells on map marked for sampling [d]	8
Area to be sampled (Area under the grid cells)	8.00 ft^2
Total cost of sampling [e]	$TBD

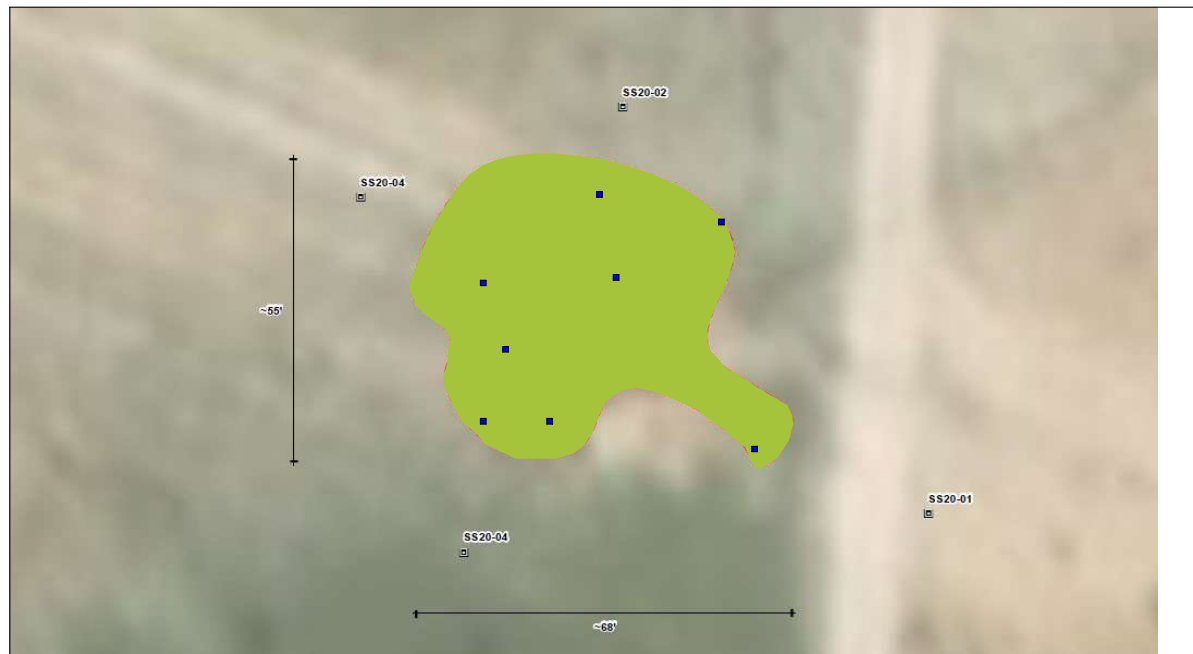[a] This is the total number of grid cells (*N*) used to calculate how many grid cells must be sampled (*n*).
[b] The actual possible number of grid cells on the map may differ from the number used in calculations due to 1) rounding effects of room surface areas, 2) manually entering the number of grid cells, or 3) selecting or unselecting sample areas.
[c] This is the number of grid cells to be sampled as determined by the VSP user (*n*)
[d] The actual number of grid cells to be sampled on the map may differ from the calculated number (*n*) due to 1) rounding effects of room surface areas, or 2) selecting or unselecting sample areas.
[e] See the Cost of Sampling section for an explanation of the costs presented here.

Grid Unit Placement

Primary Sampling Objective
The primary objective of the sampling design in this decision area is to discover, with high probability, the presence of unacceptable grid cells if they exist.

Selected Sampling Approach
The sampling approach was grid cell sampling using a compliance sampling method based on the hypergeometric distribution. The population size is determined by dividing the decision area surfaces into non-overlapping, equal-size grid cells of specified size that correspond to the sampling methodology, i.e., 1 feet x 1 feet. It also requires that each sample result be categorized as a binary outcome, such as 1) the presence or absence of a particular quality, 2) a sample result being acceptable or unacceptable as defined by an action level threshold, 3) contamination being detected or not detected, etc.

The size of the grid cell should correspond to the "footprint" of the sampling methodology (e.g. the area sampled by a swab, wipe, or vacuum). If more than one sampling methodology is to be employed in a decision area, the size of the grid cell should be chosen to match the sampling methodology with the smallest sampling area. Samples taken using methodologies that cover larger areas should be located in a consistent fashion, i.e. the sample is centered on the smaller grid cell, or the upper-left corners of the larger sample is aligned with the upper-left corner of the assigned grid cell, etc. While this approach to multiple sampling methodologies is conservative, it ensures that the desired confidence level is preserved.

VSP offers options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, random grid cell sampling was chosen. Locating the grid cells randomly provides data that are separated by varying distances, providing good information about the spatial structure of the potential contamination. Knowledge of the spatial structure is useful for geostatistical analysis. However, it may not ensure that all portions of the site are equally represented.

Decision Rule
If 8 of the 2522 grid cells are selected using random sampling, you will be 72.875% confident that if at least 15% of the grid cells in the decision area are unacceptable, you will discover at least one unacceptable grid cell.

In addition, if all 8 grid cells are identified as acceptable, then you will be 72.875% confident that at least 85% of the grid cells in the decision area are acceptable.

Table of Inputs and Outputs

Symbol	Description	Value
Inputs		
N	Total number of grid cells	2522
P	The smallest hypothetical fraction of unacceptable grid cells that we wish to discover	0.15
V	The smallest hypothetical (and possibly fractional) number of unacceptable grid cells that we wish to discover, defined as *V=PN*	378.3
P	The smallest whole number of hypothetical unacceptable grid cells, defined as *V=ceiling(PN)*	379
n	Number of randomly selected grid cells that will be measured or inspected	8
Outputs		
C	Achieved confidence that at least one unacceptable grid cell will be sampled, given that at least *P* x 100% of the sample area is unacceptable	0.72875

Calculating the Confidence

The method discussed here is an alternative interpretation of the same hypergeometric model used in Compliance Sampling (Schilling and Neubauer 2009) and Accept on zero attribute compliance sampling (AOZ-ACS) (Squeglia, 1994; Bowen and Bennett, 1988). Instead of using a test of hypothesis as the basis for the sampling design, the discovery sampling model consists of calculating the probability that at least one of the grid cells in the random sample will be unacceptable, if the percentage of the population that is unacceptable is at least *P*x100%.

The achieved confidence is given by:

$$g(n, N, U) = \begin{cases} 1 - \dfrac{\Gamma(N-U+1)\Gamma(N-n+1)}{\Gamma(N-U-n+1)\Gamma(N+1)} & \text{if } n < N - U + 1 \\ 1 & \text{otherwise} \end{cases}$$

where

$$\Gamma(x) = \int_0^\infty e^{-t} t^{x-1} dt$$

is the gamma function.

Interpreting Sample Results

If no unacceptable grid cells are observed in the sample, then we may also conclude with Cx100% confidence that at least (1-P)x100% of the grid cells in the decision area are acceptable.

Assumptions that Underlie Compliance Sampling

1. The size of the grid cell has been determined to be appropriate for the measurement (inspection) method to be performed. For example, an appropriate grid cell size might be a 10cm by 10cm surface area.
2. The total number of grid cells in the decision area, *N*, is known.
3. All *N* grid cells are the same size.
4. *n* of the *N* grid cells are selected using random sampling.
5. The *n* selected grid cells are representative of the total population of *N* grid cells.
6. Each of the *n* grid cells are measured or inspected using an approved method.
7. Each sample is correctly classified as being acceptable or unacceptable (no false positives or false negatives).

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of sample areas and grid cells. Based on the numbers of grid cells determined above, the estimated total cost of sampling this site is $1,108.00. Note: these costs are for the sampling effort only, and do not include any cleanup or follow-up investigations. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Cost / Unit**	**Units**	**Total**
Collection costs	$1.00 / grid unit	8 grid units	$8.00
Setup costs	$100.00 / area	1 areas	$100.00
Fixed planning and validation costs			$1,000.00

Total cost		**$1,108.00**

References

Bowen, M.W. and C.A. Bennett. 1988. *Statistical Methods for Nuclear Material Management*, NUREG/CR-4604, U.S. Nuclear Regulatory Commission, Washington, DC

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Schilling, E.G. and D.V. Neubauer. 2009. *Acceptance Sampling in Quality Control, 2nd ed.* CRC Press, Taylor & Francis Group, NY.

Squeglia, N.L. 1994, *Zero Acceptance Number Sampling Plans*. ASQ Quality Press, Milwaukee, WI.

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