New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

October 14, 2008

Arena Resources Inc
2130 W Bender
Hobbs, NM 88240

Reference: North Benson Queen Unit 016 30 015 10087
J-28-18S-30E Eddy County, New Mexico
2RP-226, 2RP-219, 2RP-249

Operator,

The New Mexico Oil Conservation Division District 2 Office (OCD) is in receipt of a remediation work plan (plan) dated September 22, 2008 for the remediation of a release of produced fluids that occurred at the above referenced facility. The plan was submitted on behalf of operator by ^{e}TECH Environmental & Safety Solutions, Inc.

The proposed method of soil washing to attain established remediation levels is approved with the following stipulations:

- Notify OCD 48 hours prior to commencement of activities including cell construction.
- Upon proposed excavation of south cell, contaminated materials to be stockpiled are to be placed on a liner. A perimeter berm shall be constructed and maintained around the contaminated soils to control water run-on and/or run-off.
- If a breach of any liner occurs, OCD shall be immediately notified.
- Contaminated soils shall be remediated so that residual contaminant concentrations are below established remediation action levels. Confirmation soil samples—to include but not limited to TPH, BTEX, and chloride constituents—will be required. In the event that soil action levels cannot practicably be attained, an alternate work plan will be required.
- Results of analytical data obtained through sampling shall be forwarded to OCD for approval **prior** to any backfilling activities.
- Upon satisfactory completion of the washing project and prior to backfilling, washing cell components (PVC piping, membranes, gravels, etc) shall be removed.
- Please notify OCD 48 hours prior to obtaining samples where analyses of samples obtained are to be submitted to OCD.
- Remediation requirements may be subject to change as site conditions warrant.
- Remediation actions are to be completed on or before December 15, 2008.
- Upon satisfactory completion of activities, please submit a closure report summarizing all actions taken and a Final Report Form C-141 for each release.

Remediation requirements may be subject to other federal, state, local laws and/or regulations. Additionally, please be advised that OCD approval does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that may pose a threat to ground water, surface water, human health or the environment.

Thank you for your attention to these matters. If I can be of assistance, you may reach me at the contact information listed below.

Respectfully,

Sherry Bonham
NMOCD District 2
1301 West Grand Avenue
Artesia, NM 88210
(505) 748-1283 Ext.109
sherry.bonham@state.nm.us

cc: Fred Holmes
^{e}TECH Environmental & Safety Solutions, Inc

Environmental & Safety Solutions, Inc.

Corrective Action Plan North Benson Queen Unit Tank Battery & Well No. 16 Produced Water Spills

Prepared For: Arena Resources, Inc.
2130 West Bender Blvd.
Hobbs, NM 88240

Prepared By:	**Etech Environmental & Safety Solutions, Inc.**
Date Prepared:	**September 22, 2008**
Project Number:	**094-1748 & 1749-000**

Table of Contents

Attachments

Introduction

On July 29, 2008 a release of produced water occurred at the Arena Resources, Inc (Arena) North Benson Queen Unit (NBQU) Well No. 16. On August 3, 2008, a second produced water release occurred at the NBQU Tank Battery. Before cleanup of the spills, a third release occurred on August 28, 2008 at the NBQU Tank Battery. Particulars on each spill are as follows:

Site: ....NBQU Well 16

Unit No: NMNM70993X

Latitude:..N32° 42' 56.300"

Longitude:...W103° 58' 26.600"

Quantity Released:............................125 BBLs.

Cause: Ruptured injection line.

Site: ....NBQU Tank Battery

Unit No: NMNM70993X

Latitude:..N32° 42' 57.100"

Longitude:...W103° 58" 17.900"

Quantity Released:............................580 BBLs.

Cause: Electrical storm shut down power to the facility. Sand tanks continued to send water to the water tank causing it to run over.

Site: ....NBQU Tank Battery

Unit No: NMNM70993X

Latitude:..N32° 42' 57.100"

Longitude:...W103° 58" 17.900"

Quantity Released:............................120 BBLs.

Cause: Lightning struck the north tank. A fire ensued causing the tank adjacent to the south to explode.

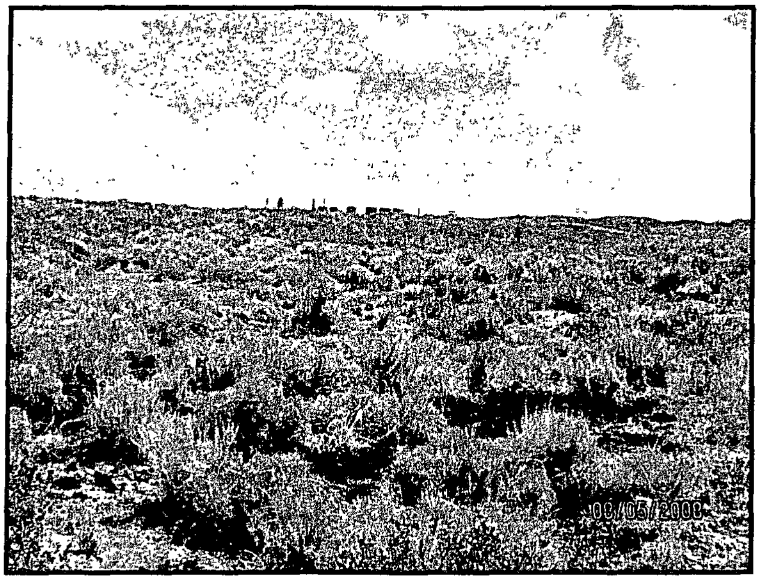
A site location map is provided in Attachment A. A copy of the spill reports is provided in Attachment B.

On August 4, 2008, Area contracted Etech Environmental & Safety Solutions, Inc. (Etech) to assess and remediate the spills. As both sites are in close proximity to each other, a single corrective action plan has been prepared to address mitigation of both sites and is provided in the following pages.

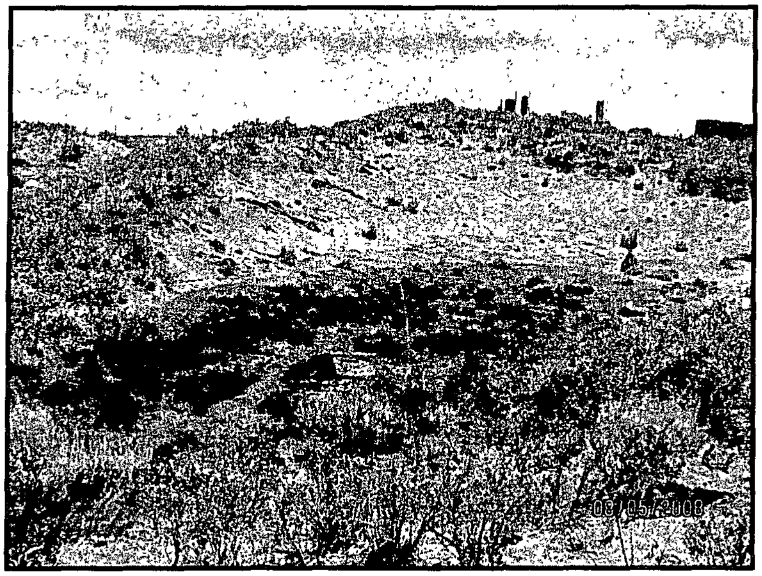
Assessment

NBQU Well 16

When the spill occurred, the release moved in a west and north direction following storm water pathways where the liquids eventually pooled. The first segment flowed west approximately 450 feet before pooling in an area approximately 30 feet in diameter. The other segment flowed northward approximately 150 feet before dividing and flowing around a large sand dune then converging and pooling in an area approximately 30 feet in diameter. The liquids eventually overfilled this area and pooled in a second area adjoining the northeast side of the first. This second area measured approximately 30 feet in diameter. Oil staining associated with the west segment was spotty and confined to the pooled area. The oil staining on the north segment appeared to be largely confined to the pooled areas and to a depth of the first ¼ inch of the surface. There was some spot staining observed in two areas along the spill pathway. Representations of the pooled areas are provided in Photographs 1 & 2 presented on the following page.

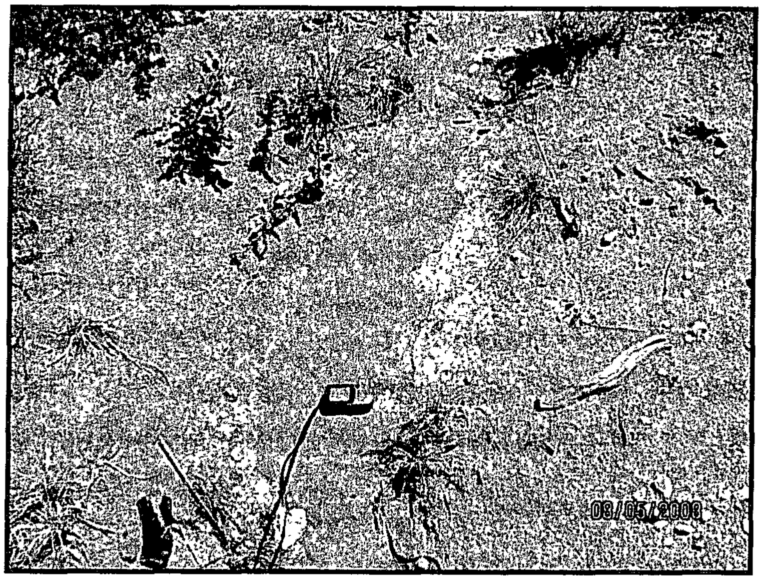


Photograph 1: View from the pooled are of the west segment looking east back towards the NBQU Tank Battery.

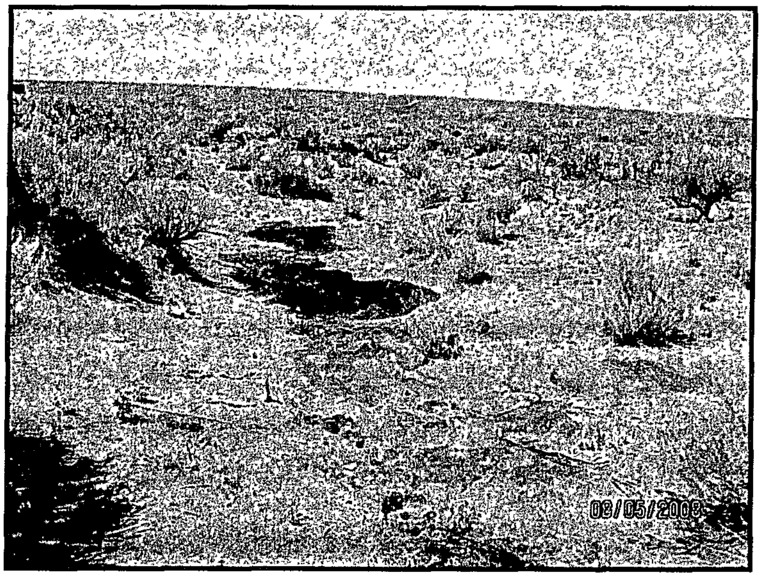


Photograph 2: View from the last pooled area on the north segment looking southeast. The NBQU Battery can be observed in the background.

The storm water pathways on the west segment are very narrow averaging of 12 inches in width. The pathways on the north segment range from 1-3 feet in width. No vegetation was observed in the majority of the bottoms of the pathways. Representations of the pathways are provided in Photographs 3 & 4 presented on the following page.



Photograph 3: Bottom of the storm water pathway on the west segment of the spill.

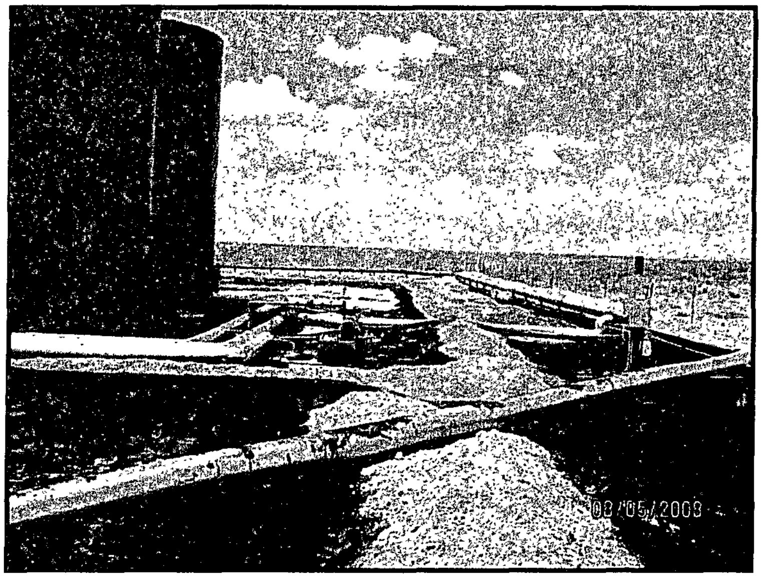


Photograph 4: Bottom of the storm water pathway on the north segment of the spill.

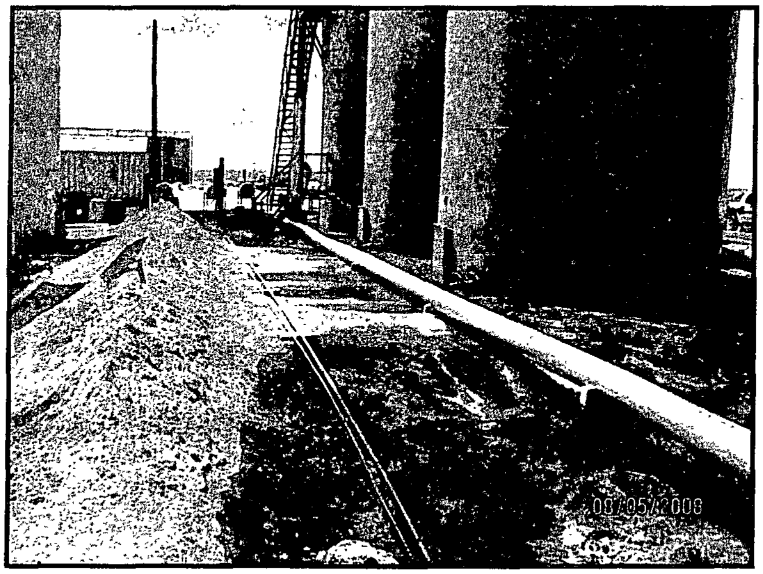
NBQU Battery

The majority of the produced water from the first release accumulated in the two (2) earthen bermed secondary containments located on the southeast side of the tank battery pad. Some of the liquids migrated outside of the east side of the southern containment flowing northward around the containment terminating underneath a transformer unit on the north side of the tank battery pad. All free liquids had been removed at the time of the assessment.

Arena reported that the north containment has a liner in place. The south containment does not. Also, the south containment is noted to be one of the original containments on the site which was built prior to the acquisition of the site by Arena. Hydrocarbon staining was prevalent across most of the bottom of both containments and in the surface soils. The staining in the soils outside of the containment appeared to be confined to the first ½ inch of surface soils. Representations of the pathways are provided in Photographs 5 & 6 presented below.

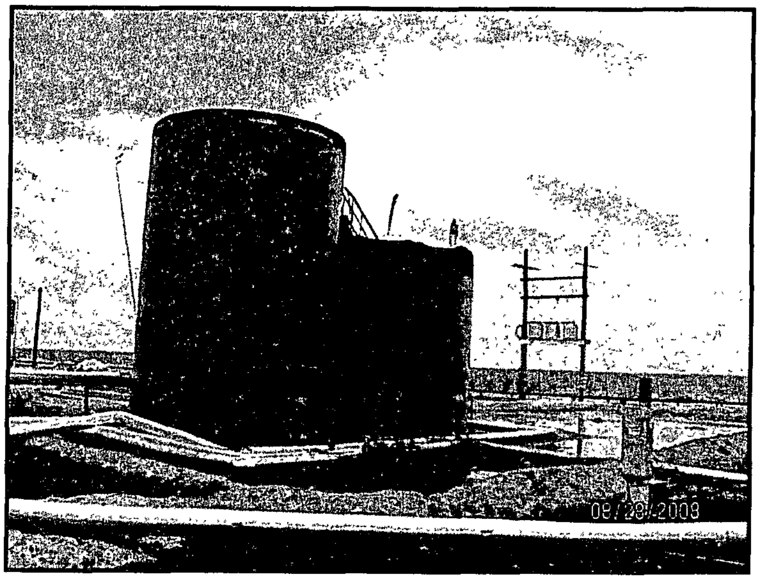


Photograph 5: View of the staining in the northern containment and adjoining area on the east side. A portion of the southern containment is in the foreground, lower right.

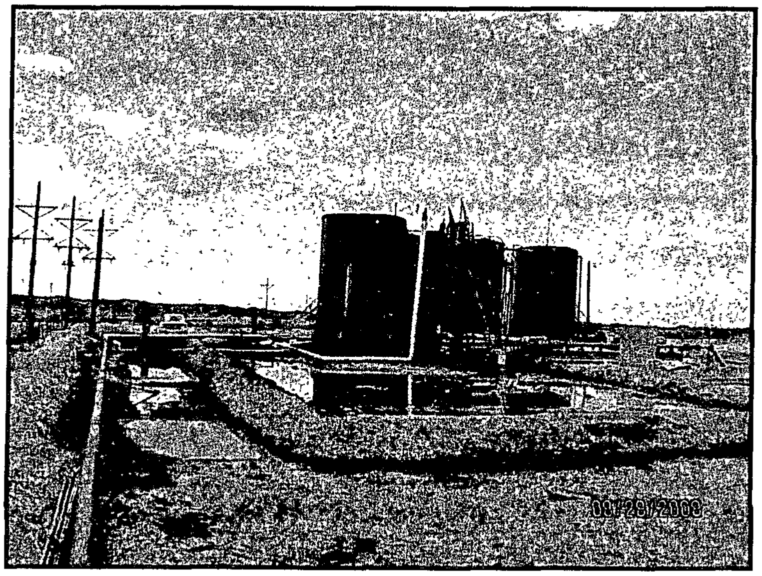


Photograph 6: View of the south side of the interior of the southern containment.

The second spill of produced water filled the containment located on the east side of the site. A breach of the east firewall occurred allowing some produced water to release along the east side of the containment and migrate northward. All fluids from the releases stayed within the confines of the tank battery pad. Photographs of this release event are provided in Photographs 7 & 8 presented on the following page:



Photograph 7: View from the southeast corner of the containment looking west northwest of the two tanks involved in the release.



Photograph 8: View from the northeast corner looking south of the facility following the release.

A site map showing the spill pathways and collection areas for both sites is provided in Attachment A.

Delineation Summary

Five (5) soil borings were advanced to an average depth of 2.5 feet along the spill pathway for the north and west spills. The purpose of these borings was to collect general information on the potential of the impact from the spill from the ruptured injection line. Since the same material was spilled at the tank battery and in the pooled areas, these sites were not sampled at the time of the assessment, but deferred until mitigation activities are performed. Samples from the soil borings were collected at specific intervals and subjected to laboratory analysis for chlorides. The results are presented below in Table 1.

TABLE 1
SAMPLING EVENT No. 1
ANALYTICAL SUMMARY

Sample I.D.	Chlorides (Mg/Kg)		Sample I.D.	Chlorides (Mg/Kg)
BG – 1 (Background)	<100		SB3 – 1.5-2"	751
BG – 2 (Background)	<100		SB3 – 2.5-3'	1570
SB1 – 0-4"	7000		SB4 – 0-4"	242
SB1 – 1.5-2'	916		SB4 – 1.5-2'	3010
SB2 – 0-4"	107		SB5 – 0-4"	2290
SB2 – 2-2.5'	3920		SB5 – 1.5-2'	5220
SB3 – 0-4"	12500			

A second sampling event was conducted on August 28, 2008. During this sampling event, two (2) additional soil borings were conducted. The first (SB6) was advanced inside of the north containment where the third release occurred. The second soil boring (SB7) was conducted inside the southern containment on the east side. This site was selected as it was in the down-gradient side of the containment. Samples from the soil borings were collected at specific intervals and analyzed in-house for chlorides using EPA Methodology. The results are presented below in Table 2.

TABLE 2
SAMPLING EVENT No. 2
ANALYTICAL SUMMARY

Sample I.D.	Chlorides (Mg/Kg)		Sample I.D.	Chlorides (Mg/Kg)
SB6 – 4-6"	278		SB7 – 1.5'	1787
SB6 – 2'	119		SB7 – 2.5' – 3'	2779
SB6 – 3'	119		SB7 – 4 - 4.5'	2978
			SB7 – 5.5 – 6'	3573

Visual observations in the north containment revealed the area underneath the liner to be dry and no visible signs of hydrocarbon or chloride impacts. Soil samples in boring SB6 were very dry in the first 18 inches and slightly moist throughout the remainder on the boring. The area where SB7 was completed found some minor staining in the first 2-3 inches of surface soils. The soil in all samples collected was moist with a slight stagnant odor similar to produced water was noted.

Based upon the results of the analysis, it is concluded the chloride levels in the spill pathway and within the southern containment were found to be elevated and require corrective action. A copy of the analytical reports is provided in Attachment C.

Geologic & Hydrogeological Setting

A review of a soil resource report prepared by the United States Department of Agriculture, Natural Resource Conservation Service (NRCS) depicts the soils in the area to be Kermit Berino fine sands, 0-3 percent slopes. Typical profile of the soils is as follows:

0-17"	Fine sand
17-50"	Fine sandy loam
50-58"	Loamy sand

A review of the State of New Mexico, Engineers report for water wells in the area did not find any water wells in the section where the sites are located. A copy of the NRCS report is provided in Attachment D.

Remediation Scope of Work

Area of Impacted Soil for Remediation

Based upon visual inspection and a review of the analytical data, the area of impacted soil requiring active remediation includes the spill pathways and pooled areas from the spill at the NBQU 16 site and the areas within, as well as the area immediately adjacent to, the east and north of the containments at the NBQU Battery.

Proposed Soil Remediation – NBQU Well 16

The spill pathways, particularly to the west are quite narrow and have a relatively small surface area. These areas will be treated with granular calcium nitrate at a rate of 200 lbs per acre-foot and tilled into the soil at a depth of 6-8 inches. This reagent was selected as it has been very successful in treating spills of this type and dissolves very quickly into the soil providing a high level of calcium for ion exchange. This remediation approach to this area was selected because; 1.The areas are mostly void of vegetation due to storm water runoff and will likely never vegetate and, 2.This approach will provide the minimal amount of disturbance to the surrounding soil.

The pooled areas will be excavated until a chloride level of 500 mg/kg has been reached. The impacted soil will be transported to a remediation cell located at the NBQU Battery site. At this point, the bottom of the excavation will treated with calcium nitrate at a rate of 200 lbs. per acre. The area will then be graded to achieve a minimum of 3 feet of cover over the remaining impacted area.

Proposed Soil Remediation – NBQU Battery

The remediation of the site will occur in three phases. In Phase I, all impacted soils in the north containment will be removed until the levels of total petroleum hydrocarbons (TPH) and chlorides reach 5,000/500 mg/kg or less (respectively). The impacted soils will be treated on-site via soil washing in a cell constructed on this site.

In Phase II, the tanks and associated equipment in the southern containment will be removed and the permanently staged to the northern containment. Once this is done, the impacted soils will be treated on-site via soil washing and the area backfilled with clean soil to-grade. In Phase II any impacted soils from the spill outside of the containment will be will be treated on-site via soil washing as well.

Soil washing has been used for many years to remove inorganic contaminants such as salts and heavy metals from soils. The process is relatively simple where a given quantity of solvent, in this case clean fresh water, is passed over and percolate through the impacted soil removing the contaminants from the soil. The water would then be collected and either treated or, as in this case, disposed of. The rationale for selection of this approach is as follows:

1. The soils in this area are largely medium to coarse sand which is a perfect medium to wash salts from,
2. There is a readily available disposal method for the wash water (the saltwater disposal system), and

3. The clean soil will be used for backfilling the excavated areas. This is an ideal case of resource conservation which is one of the main aspects of the environmental regulations.

Diagrams showing the location, and general design, of the treatment cell are provided in Attachment E.

Sampling and Analysis

During the course of remediation activities, samples will be collected and analyzed on-site for TPH and chlorides. Once objectives have been reached, confirmation samples will be collected and sent to a third party laboratory for analysis.

Reclamation

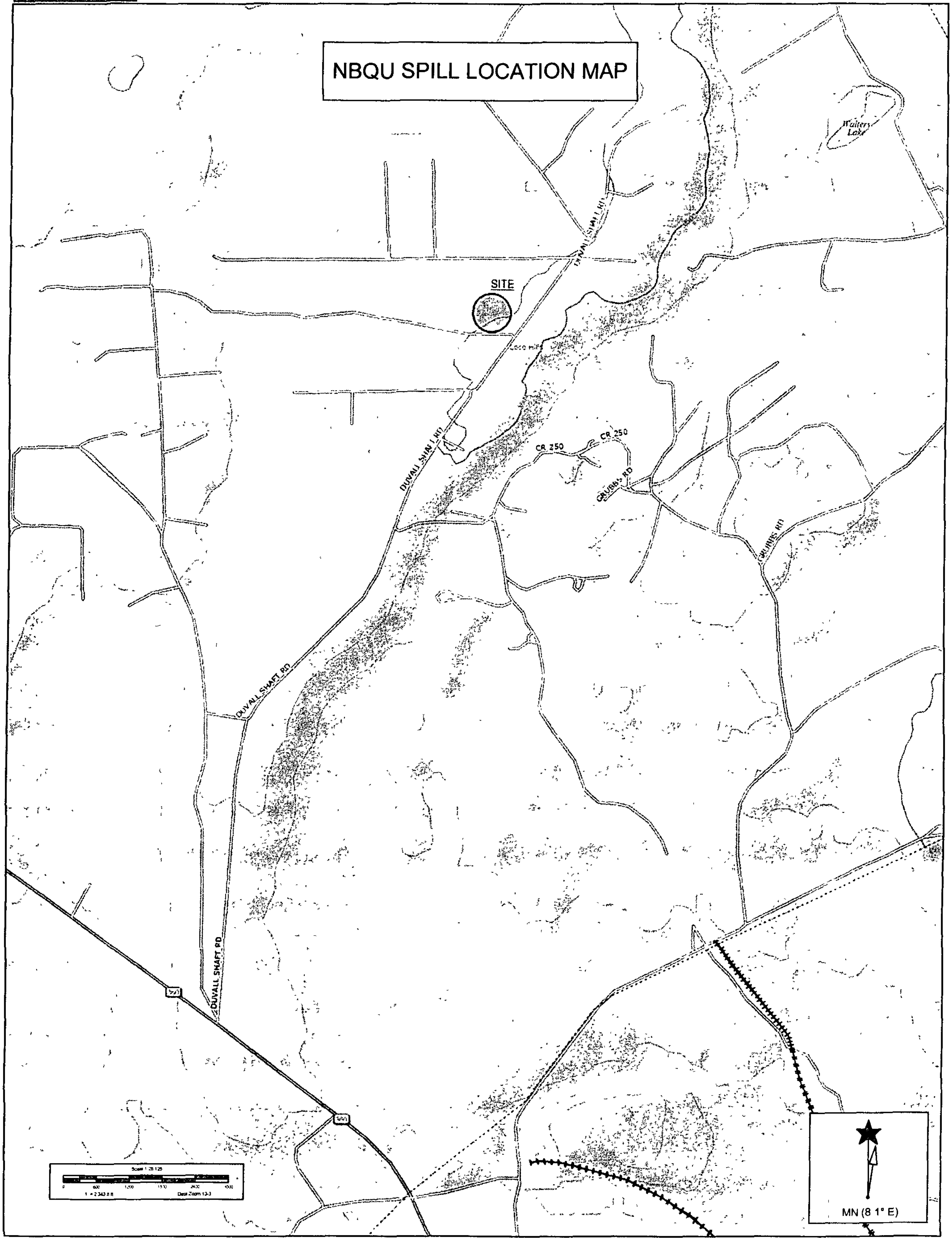
Once remediation activities are complete at the NBQU Well 16 site all disturbed areas will be seeded by broadcast with a mixture approved by the Department of Interior, Bureau of Land Management (BLM). The site will be monitored quarterly to ensure the site is revegetating properly.

Reporting

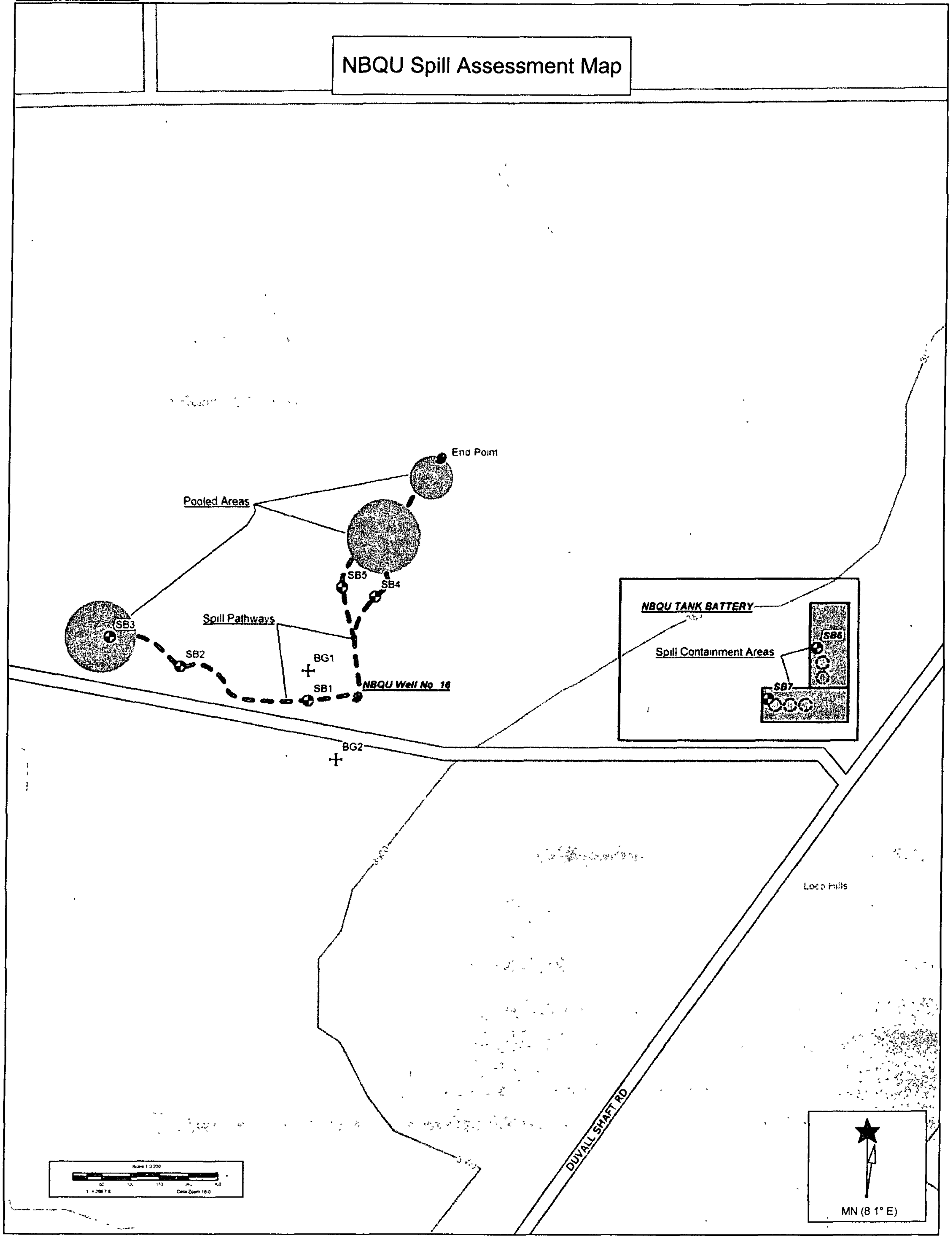
At the conclusion of all remediation activities, a report will be prepared documenting all remediation activities and the results of all analyses.

Attachment A
Site Maps

NBQU SPILL LOCATION MAP



NBQU Spill Assessment Map



Attachment B
Spill Reports

NBQU #16

Form NM 3162-1
(Revised - August 2004)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management
New Mexico State Office

REPORT OF THE UNDESIRABLE EVENT

DATE OF OCCURRENCE/DISCOVERY: 7-29-08 TIME OF OCCURRENCE: 8:00 pm

DATE REPORTED TO BLM: 8-4-08 TIME REPORTED: 10:00 am

BLM OFFICE REPORTED TO: (FIELD/DISTRICT/OTHER) Carlsbad

LOCATION: (¼ ¼) NW SE SECTION 28 T. 18S R. 30E MERIDIAN

COUNTY: Eddy STATE: NM WELL NAME NBQU #16

OPERATOR: COMPANY NAME Arena Resources PHONE NO. 575-738-1739
CONTACT PERSON'S NAME Tony Tucker

SURFACE OWNER: BLM MINERAL OWNER: BLM
(FEDERAL/INDIAN/FEE/STATE)

Unit ~~LEASE~~ NO.: NMNM70993X RIGHT-OF-WAY NO.:

UNIT NAME / COMMUNITIZATION AGREEMENT NO.: North Benson Queen Unit

TYPE OF EVENT, CIRCLE APPROPRIATE ITEM (S):

BLOWOUT, FIRE, FATALITY, INJURY, PROPERTY DAMAGE, OIL SPILL, [✓ SALTWATER SPILL], OIL AND SALTWATER SPILL, TOXIC FLUID SPILL, HAZARDOUS MATERIAL SPILL, UNCONTROLLED FLOW OF WELLBORE FLUIDS, OTHER (SPECIFY):

CAUSE OF EVENT: Ruptured Injection Line

HazMat Notified: (for spills)

Law Enforcement Notified: (for thefts)

CAUSE AND EXTENT OF PERSONAL INJURIES/CAUSE OF DEATH(S): N/A

Safety Officer Notified:

EFFECTS OF EVENT: Water soaked into the sand at the location

ACTION TAKEN TO CONTROL EVENT: Shut In, repaired line

LENGTH OF TIME TO CONTROL BLOWOUT OR FIRE:

VOLUMES DISCHARGED: OIL WATER 125 bbls GAS

OTHER AGENCIES NOTIFIED: nmocd

ACTION TAKEN OR TO BE TAKEN TO PREVENT RECURRENCE:

FINAL INVESTIGATION:

TEAM NAME(S)

FIELD INSPECTION DATE

SUMMARY OF RESULTS OF INSPECTION

RESOURCE LOSS WAS (CIRCLE ITEM): AVOIDABLE UNAVOIDABLE

DATE OF MEMO NOTIFYING MINEALS MANAGEMENT SSERVICE THAT LOSS WAS AVOIDABLE:

DATE/TIME/PERSON NOTIFIED:

STATE OFFICE

WASHINGTON OFFICE

SUMMARY OF RESULTS OF RECLAMATION/CORRECTIVE ACTION:

REMARKS:

SIGNATURE OF AUTHORIZED OFFICER

DATE: TITLE:

NBQU Battery

Form NM 3162-1
(Revised - August 2004)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management
New Mexico State Office

REPORT OF THE UNDESIRABLE EVENT

DATE OF OCCURRENCE/DISCOVERY: 8.3.08 TIME OF OCCURRENCE: 8:20 Am

DATE REPORTED TO BLM: 8.4.08 TIME REPORTED: 10:00 Am

BLM OFFICE REPORTED TO: (FIELD/DISTRICT/OTHER) Carlsbad

LOCATION: (¼ ¼) NW SE SECTION 28 T. 18S R. 30E MERIDIAN

COUNTY: Eddy STATE: NM WELL NAME NBQU Battery

OPERATOR: COMPANY NAME Arena Resources Inc PHONE NO. 575-738-1739
CONTACT PERSON'S NAME Tony Tucker

SURFACE OWNER: BLM MINERAL OWNER: BLM
(FEDERAL/INDIAN/FEE/STATE)

Unit ~~LEASE~~ NO.: NMNM70993X RIGHT-OF-WAY NO.:

UNIT NAME / COMMUNITIZATION AGREEMENT NO.: North Benson Queen Unit

TYPE OF EVENT, CIRCLE APPROPRIATE ITEM (S):

BLOWOUT, FIRE, FATALITY, INJURY, PROPERTY DAMAGE, OIL SPILL, [✓ SALTWATER SPILL], OIL AND SALTWATER SPILL, TOXIC FLUID SPILL, HAZARDOUS MATERIAL SPILL, UNCONTROLLED FLOW OF WELLBORE FLUIDS, OTHER (SPECIFY):

CAUSE OF EVENT: Electrical storm shut down power, the sand tanks continued to Send water to the water tank causing it to run over.

HazMat Notified: (for spills)

Law Enforcement Notified: (for thefts)

CAUSE AND EXTENT OF PERSONAL INJURIES/CAUSE OF DEATH(S): N/A

Safety Officer Notified:

EFFECTS OF EVENT: It was contained inside the firewall at the battery.

ACTION TAKEN TO CONTROL EVENT:

LENGTH OF TIME TO CONTROL BLOWOUT OR FIRE:

VOLUMES DISCHARGED: OIL WATER 580 bbls GAS

OTHER AGENCIES NOTIFIED: nmocd

ACTION TAKEN OR TO BE TAKEN TO PREVENT RECURRENCE:

FINAL INVESTIGATION:
TEAM NAME(S)

FIELD INSPECTION DATE

SUMMARY OF RESULTS OF INSPECTION

RESOURCE LOSS WAS (CIRCLE ITEM): AVOIDABLE UNAVOIDABLE

DATE OF MEMO NOTIFYING MINEALS MANAGEMENT SSERVICE THAT LOSS WAS AVOIDABLE:

DATE/TIME/PERSON NOTIFIED:

STATE OFFICE

WASHINGTON OFFICE

SUMMARY OF RESULTS OF RECLAMATION/CORRECTIVE ACTION:

REMARKS:

SIGNATURE OF AUTHORIZED OFFICER

DATE: TITLE:

Form NM 3162-1
(Revised - August 2004)

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Land Management
New Mexico State Office

REPORT OF THE UNDESIRABLE EVENT

DATE OF OCCURRENCE/DISCOVERY: 8·28·08 TIME OF OCCURRENCE: 1:00 Am

DATE REPORTED TO BLM: 8·28·08 TIME REPORTED: 10:50 Am

BLM OFFICE REPORTED TO: (FIELD/DISTRICT/OTHER) Carlsbad

LOCATION: (¼ ¼) NWSE SECTION 28 T. 18S R. 30E MERIDIAN

COUNTY: Eddy STATE: nm WELL NAME NBQU Battery Injection Facilit

OPERATOR: COMPANY NAME Arena Resources Inc. PHONE NO. 575-738-1739
CONTACT PERSON'S NAME Tony Tucker

SURFACE OWNER: BLm MINERAL OWNER: BLm
(FEDERAL/INDIAN/FEE/STATE)

Unit ~~LEASE~~ NO.: nmnm 70993K RIGHT-OF-WAY NO.:

UNIT NAME / COMMUNITIZATION AGREEMENT NO.: North Benson Queen Unit

TYPE OF EVENT, CIRCLE APPROPRIATE ITEM (S):

BLOWOUT, FIRE, FATALITY, INJURY, PROPERTY DAMAGE, OIL SPILL, [✓ SALTWATER SPILL,] OIL AND SALTWATER SPILL, TOXIC FLUID SPILL, HAZARDOUS MATERIAL SPILL, UNCONTROLLED FLOW OF WELLBORE FLUIDS, OTHER (SPECIFY):

CAUSE OF EVENT: Lighting struck north tank - fire ran into other Causing South tank Causing it to blow

HazMat Notified: (for spills)

Law Enforcement Notified: (for thefts)

CAUSE AND EXTENT OF PERSONAL INJURIES/CAUSE OF DEATH(S): N/A

Safety Officer Notified:

EFFECTS OF EVENT: The spill stay containd inside the firewall at the battery

ACTION TAKEN TO CONTROL EVENT:

LENGTH OF TIME TO CONTROL BLOWOUT OR FIRE:

VOLUMES DISCHARGED: OIL WATER 120 GAS

OTHER AGENCIES NOTIFIED: NMOCD

ACTION TAKEN OR TO BE TAKEN TO PREVENT RECURRENCE:

FINAL INVESTIGATION:

TEAM NAME(S)

FIELD INSPECTION DATE

SUMMARY OF RESULTS OF INSPECTION

RESOURCE LOSS WAS (CIRCLE ITEM): AVOIDABLE UNAVOIDABLE

DATE OF MEMO NOTIFYING MINEALS MANAGEMENT SSERVICE THAT LOSS WAS AVOIDABLE:

DATE/TIME/PERSON NOTIFIED:

STATE OFFICE

WASHINGTON OFFICE

SUMMARY OF RESULTS OF RECLAMATION/CORRECTIVE ACTION:

REMARKS:

SIGNATURE OF AUTHORIZED OFFICER

DATE: TITLE:

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised October 10, 2003

Submit 2 Copies to appropriate District Office in accordance with Rule 116 on back side of form

Release Notification and Corrective Action

OPERATOR

☒ Initial Report ☐ Final Report

Name of Company Arena Resources Inc	Contact Tony Tucker
Address 2130 W. Bender Hobbs, NM 88240	Telephone No. 575-738-1739
Facility Name NBQU Battery	Facility Type Production Battery

Surface Owner BLM	Mineral Owner BLM	Lease No. 33129

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
J	28	18S	30E	1743	SL	784	EL	EDDY

Latitude__________ **Longitude**__________

NATURE OF RELEASE

Type of Release Produced Water	Volume of Release 120	Volume Recovered 120
Source of Release Produced Water Tank Blew Up	Date and Hour of Occurrence 8-28-08 1:00 AM	Date and Hour of Discovery
Was Immediate Notice Given? ☒ Yes ☐ No ☐ Not Required	If YES, To Whom? Mike Bratcher	
By Whom? Colleen Robinson	Date and Hour 8-28-08 11:00 AM	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*

Describe Cause of Problem and Remedial Action Taken.*

Lighting struck the north tank, the fire ran into the line to the South Tank causing it to blow

Describe Area Affected and Cleanup Action Taken.*

The spill stay contained inside the firewall at the battery

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD 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 NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD 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.

Signature: C Robinson	OIL CONSERVATION DIVISION	
Printed Name: Colleen Robinson	Approved by District Supervisor:	
Title: Compliance Analyst	Approval Date:	Expiration Date:
E-mail Address: crobinson@arenaresourcesinc.com	Conditions of Approval:	Attached ☐
Date: 8-29-08 Phone: 575-738-1739		

Attach Additional Sheets If Necessary

Attachment C
Analytical Reports

Summary Report

Fred Holmes
Etech Environmental Safety

P.O. Box 8469
Midland, TX, 79708

Report Date: August 8, 2008

Work Order: 8080651

Project Location: TX
Project Name: North Benson Queen Unit #016
Project Number: 094-1748-000

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
169722	Benson 016 BG - 1	soil	2008-08-05	11:05	2008-08-06
169723	Benson 016 BG - 2	soil	2008-08-05	11:20	2008-08-06
169724	Benson 016 SB1 0-4	soil	2008-08-05	11:45	2008-08-06
169725	Benson 016 SB1 1.5-2'	soil	2008-08-05	12:00	2008-08-06
169726	Benson 016 SB2 0-4 in.	soil	2008-08-05	12:20	2008-08-06
169727	Benson 016 SB2 2-2.5'	soil	2008-08-05	12:30	2008-08-06
169728	Benson 016 SB3 0-4 in.	soil	2008-08-05	12:55	2008-08-06
169729	Benson 016 SB3 1.5-2'	soil	2008-08-05	13:05	2008-08-06
169730	Benson 016 SB3 2.5-3'	soil	2008-08-05	13:15	2008-08-06
169731	Benson 016 SB4 0-4 in.	soil	2008-08-05	13:50	2008-08-06
169732	Benson 016 SB4 1.5-2'	soil	2008-08-05	14:00	2008-08-06
169733	Benson 016 SB5 0-4 in.	soil	2008-08-05	14:25	2008-08-06
169734	Benson 016 SB5 1.5-2'	soil	2008-08-05	14:30	2008-08-06

Sample: 169722 - Benson 016 BG - 1

Param	Flag	Result	Units	RL
Chloride		<100	mg/Kg	2.00

Sample: 169723 - Benson 016 BG - 2

Param	Flag	Result	Units	RL
Chloride		<100	mg/Kg	2.00

Sample: 169724 - Benson 016 SB1 0-4

Param	Flag	Result	Units	RL
Chloride		**7000**	mg/Kg	2.00

Sample: 169725 - Benson 016 SB1 1.5-2'

Param	Flag	Result	Units	RL
Chloride		**916**	mg/Kg	2.00

Sample: 169726 - Benson 016 SB2 0-4 in.

Param	Flag	Result	Units	RL
Chloride		**107**	mg/Kg	2.00

Sample: 169727 - Benson 016 SB2 2-2.5'

Param	Flag	Result	Units	RL
Chloride		**3920**	mg/Kg	2.00

Sample: 169728 - Benson 016 SB3 0-4 in.

Param	Flag	Result	Units	RL
Chloride		**12500**	mg/Kg	2.00

Sample: 169729 - Benson 016 SB3 1.5-2'

Param	Flag	Result	Units	RL
Chloride		**751**	mg/Kg	2.00

Sample: 169730 - Benson 016 SB3 2.5-3'

Param	Flag	Result	Units	RL
Chloride		**1570**	mg/Kg	2.00

Sample: 169731 - Benson 016 SB4 0-4 in.

Param	Flag	Result	Units	RL
Chloride		**242**	mg/Kg	2.00

Sample: 169732 - Benson 016 SB4 1.5-2'

Param	Flag	Result	Units	RL
Chloride		**3010**	mg/Kg	2.00

Sample: 169733 - Benson 016 SB5 0-4 in.

Param	Flag	Result	Units	RL
Chloride		**2290**	mg/Kg	2.00

Sample: 169734 - Benson 016 SB5 1.5-2'

Param	Flag	Result	Units	RL
Chloride		**5220**	mg/Kg	2.00

Field Analysis Sheet

Date: 8/28/2008 **Client:** Arena Resources

Site: NBQ Inj. Facility **Project Number:** 094-1749-000

Technican: Johnny Titsworth **Contaminant:** Chlorides

Sample ID	Milliliters of Sample Used	Dilution	AgNO3 0.028(N)	Result (mg/kg)	Notations
SB-6 4"-6"	10	4	0.700	277.928	
SB-6 2'	10	4	0.300	119.112	
SB-6 3'	10	4	0.300	119.112	
	1	2		0	
SB-7 1.5'	10	4	4.500	1786.68	
SB-7 2.5'-3'	10	4	7.000	2779.28	
SB-7 4'-4.5'	10	4	7.500	2977.8	
SB-7 5.5'-6'	10	4	9.000	3573.36	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
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	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	
	1	2		0	

F = (ml $AgNO_3$)(N)(35450)/ml. sample used

Soil Sample Volume: 10 Grams

Deionized Water Volume = 20 ml

Attachment D
Soil Report

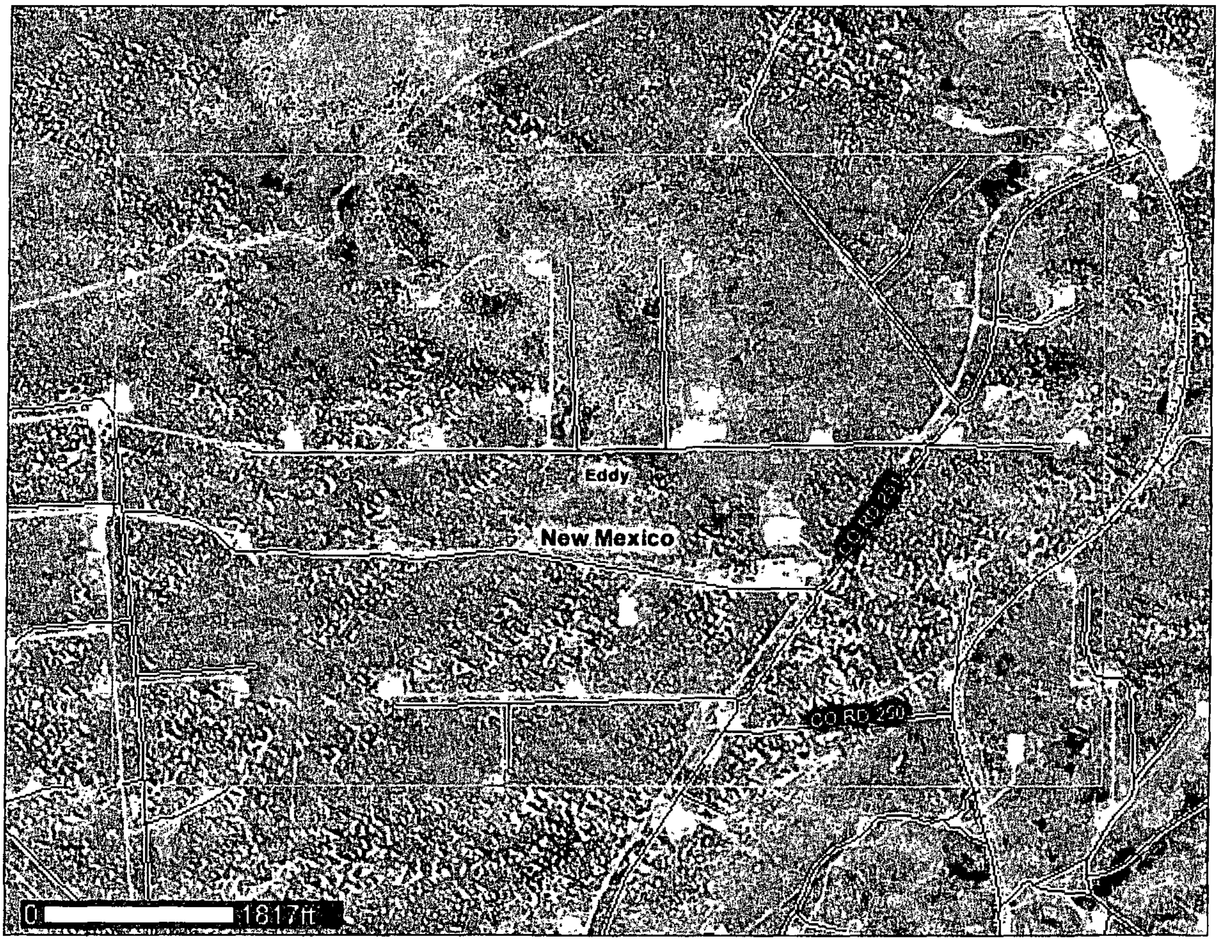
USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Eddy Area, New Mexico

Arena - North Benson Queen



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

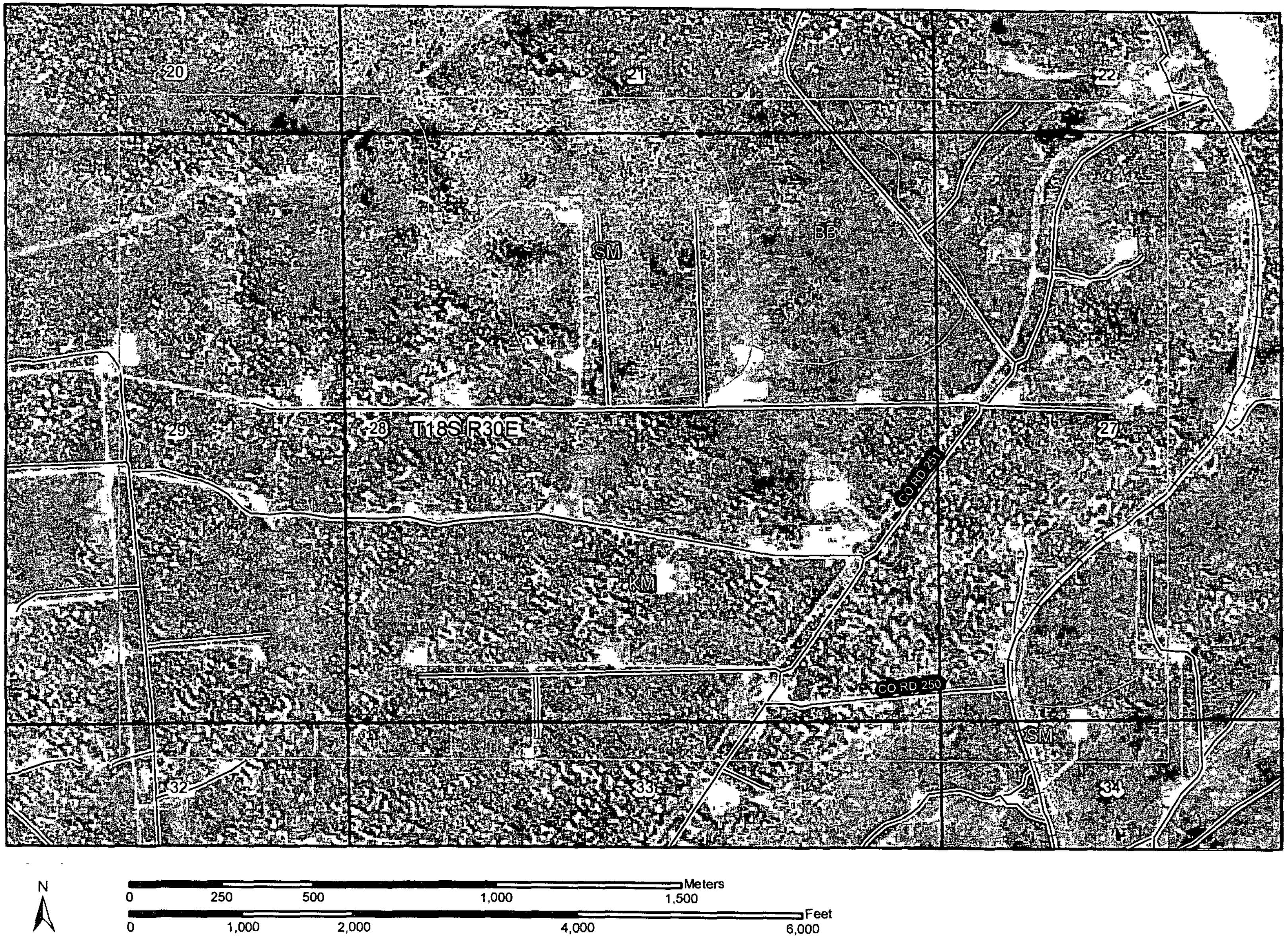
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


20
21
22
SM
BB
29
28
T18S R30E
27
CO RD 251
KM
CO RD 250
SM
32
33
34
N
0
250
500
1,000
1,500
Meters
0
1,000
2,000
4,000
6,000
Feet

Custom Soil Resource Report
Legend

MAP LEGEND

Area of Interest (AOI)
☐ Area of Interest (AOI)

Soils
☐ Soil Map Units

Special Point Features
- ∪ Blowout
- ⊠ Borrow Pit
- ⋇ Clay Spot
- ◆ Closed Depression
- ✕ Gravel Pit
- ∴ Gravelly Spot
- Ⓐ Landfill
- ⋏ Lava Flow
- ⚲ Marsh
- ⚒ Mine or Quarry
- ◎ Miscellaneous Water
- ◉ Perennial Water
- ∨ Rock Outcrop
- + Saline Spot
- ∵ Sandy Spot
- ≡ Severely Eroded Spot
- ◇ Sinkhole
- ⟩ Slide or Slip
- ø Sodic Spot
- ≡ Spoil Area
- ○ Stony Spot
- ⚇ Very Stony Spot
- ▼ Wet Spot
- ▲ Other

Special Line Features
- ∼ Gully
- ... Short Steep Slope
- ∼ Other

Political Features

Public Land Survey
- ☐ Township and Range
- ☐ Section

Municipalities
- ○ Cities
- ☐ Urban Areas

Water Features
- ▨ Oceans
- ∼ Streams and Canals

Transportation
- +++ Rails

Roads
- ∼ Interstate Highways
- ∼ US Routes
- ∼ State Highways
- ∼ Local Roads
- ∼ Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Eddy Area, New Mexico
Survey Area Data: Version 6, Jan 28, 2007

Date(s) aerial images were photographed: 11/1/1997

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Eddy Area, New Mexico (NM614)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BB	Berino complex, 0 to 3 percent slopes, eroded	91.0	7.2%
KM	Kermit-Berino fine sands, 0 to 3 percent slopes	1,004.0	79.0%
SM	Simona-Bippus complex, 0 to 5 percent slopes	175.2	13.8%
Totals for Area of Interest (AOI)		1,270.2	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Eddy Area, New Mexico Version date:1/28/2007 7:42:44 PM

BB—Berino complex, 0 to 3 percent slopes, eroded

Map Unit Setting

Elevation: 3,000 to 4,200 feet
Mean annual precipitation: 10 to 15 inches
Mean annual air temperature: 60 to 64 degrees F
Frost-free period: 200 to 220 days

Map Unit Composition

Berino and similar soils: 60 percent
Pajarito and similar soils: 25 percent

Description of Berino

Setting

Landform: Fan piedmonts, plains
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Loamy Sand (R042XC003NM)

Typical profile

0 to 17 inches: Fine sand
17 to 58 inches: Sandy clay loam
58 to 60 inches: Loamy sand

Description of Pajarito

Setting

Landform: Interdunes, plains, dunes
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex

Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 7e
Ecological site: Loamy Sand (R042XC003NM)

Typical profile

0 to 9 inches: Loamy fine sand
9 to 72 inches: Fine sandy loam

KM—Kermit-Berino fine sands, 0 to 3 percent slopes

Map Unit Setting

Elevation: 3,100 to 4,200 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 60 to 64 degrees F
Frost-free period: 190 to 230 days

Map Unit Composition

Kermit and similar soils: 50 percent
Berino and similar soils: 35 percent

Description of Kermit

Setting

Landform: Alluvial fans, plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.0 mmhos/cm)

Sodium adsorption ratio, maximum: 1.0
Available water capacity: Low (about 3.1 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Deep Sand (R042XC005NM)

Typical profile

0 to 7 inches: Fine sand
7 to 60 inches: Fine sand

Description of Berino

Setting

Landform: Fan piedmonts, plains
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability (nonirrigated): 7e
Ecological site: Loamy Sand (R042XC003NM)

Typical profile

0 to 17 inches: Fine sand
17 to 50 inches: Fine sandy loam
50 to 58 inches: Loamy sand

SM—Simona-Bippus complex, 0 to 5 percent slopes

Map Unit Setting

Elevation: 3,000 to 4,200 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 60 to 64 degrees F
Frost-free period: 200 to 220 days

Map Unit Composition

Simona and similar soils: 55 percent
Bippus and similar soils: 30 percent

Description of Simona

Setting

Landform: Alluvial fans, plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Mixed alluvium and/or eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 7 to 20 inches to petrocalcic
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Very low (about 2.1 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Ecological site: Shallow Sandy (R042XC002NM)

Typical profile

0 to 19 inches: Gravelly fine sandy loam
19 to 23 inches: Indurated

Description of Bippus

Setting

Landform: Alluvial fans, flood plains
Landform position (three-dimensional): Rise, talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 1.0
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 3e

Ecological site: Bottomland (R042XC017NM)

Typical profile

0 to 37 inches: Silty clay loam
37 to 60 inches: Clay loam

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Land Classifications

This folder contains a collection of tabular reports that present a variety of soil groupings. The reports (tables) include all selected map units and components for each map unit. Land classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Taxonomic Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2003). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. This table shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Alfisols.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udalfs (*Ud*, meaning humid, plus *alfs*, from Alfisols).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludalfs (*Hapl*, meaning minimal horizonation, plus *udalfs*, the suborder of the Alfisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, active, mesic Typic Hapludalfs.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

References:
Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.
Soil Survey Staff. 2003. Keys to soil taxonomy. 9th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. (The soils in a given survey area may have been classified according to earlier editions of this publication.)

Report—Taxonomic Classification of the Soils

[An asterisk by the soil name indicates a taxadjunct to the series]

Taxonomic Classification of the Soils– Eddy Area, New Mexico

Soil name	Family or higher taxonomic classification
Berino	Fine-loamy, mixed, thermic Typic Haplargids
Bippus	Fine-silty, mixed, superactive, thermic Cumulic Haplustolls
Kermit	Siliceous, thermic Typic Torripsamments
Pajarito	Coarse-loamy, mixed, thermic Typic Camborthids
Simona	Loamy, mixed, thermic, shallow Typic Paleorthids

Soil Chemical Properties

This folder contains a collection of tabular reports that present soil chemical properties. The reports (tables) include all selected map units and components for each map unit. Soil chemical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil chemical properties include pH, cation exchange capacity, calcium carbonate, gypsum, and electrical conductivity.

Chemical Soil Properties

This table shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable bases that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Effective cation-exchange capacity refers to the sum of extractable bases plus aluminum expressed in terms of milliequivalents per 100 grams of soil. It is determined for soils that have pH of less than 5.5.

Soil reaction is a measure of acidity or alkalinity. It is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity and aeration, and a general degradation of soil structure.

Chemical Soil Properties– Eddy Area, New Mexico								
Map symbol and soil name	**Depth**	**Cation-exchange capacity**	**Effective cation-exchange capacity**	**Soil reaction**	**Calcium carbonate**	**Gypsum**	**Salinity**	**Sodium adsorption ratio**
	In	*meq/100g*	*meq/100g*	*pH*	*Pct*	*Pct*	*mmhos/cm*	
BB—Berino complex, 0 to 3 percent slopes, eroded								
Berino	0-17	3.0-7.0	—	6.6-7.3	0	0	0.0-2.0	0-1
	17-58	7.0-20	—	6.6-7.8	0	0	2.0-4.0	0-1
	58-60	0.0-1.0	—	7.9-8.4	15-40	0	2.0-4.0	0-1
Pajarito	0-9	3.0-9.0	—	7.4-8.4	0-5	0	0.0-1.0	0-1
	9-72	6.0-10	—	7.9-8.4	15-40	0	0.0-1.0	0-1
KM—Kermit-Berino fine sands, 0 to 3 percent slopes								
Kermit	0-7	1.0-1.0	—	6.6-7.3	0	0	0.0-1.0	0-1
	7-60	1.0-1.0	—	6.6-7.3	0	0	0.0-1.0	0-1
Berino	0-17	3.0-7.0	—	6.6-7.3	0	0	0.0-1.0	0-1
	17-50	7.0-20	—	6.6-7.3	0	0	2.0-4.0	0-1
	50-58	0.0-1.0	—	7.9-8.4	15-40	0	2.0-4.0	0-1
SM—Simona-Bippus complex, 0 to 5 percent slopes								
Simona	0-19	7.0-15	—	7.4-7.8	0-15	0	0.0-2.0	0-1
	19-23	—	—	—	—	—	—	—
Bippus	0-37	6.0-15	—	7.4-8.4	0-15	0	0.0-2.0	0-1
	37-60	8.0-20	—	7.9-8.4	15-40	0	0.0-2.0	0-1

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Engineering Properties– Eddy Area, New Mexico

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
BB—Berino complex, 0 to 3 percent slopes, eroded												
Berino	0-17	Fine sand	SM	A-2	0	0	95-100	95-100	50-95	10-35	0-0	NP
	17-58	Sandy clay loam	CL, CL-ML, SC, SC-SM	A-4, A-6	0	0	95-100	95-100	65-80	35-60	20-35	5-15
	58-60	Loamy sand	SM	A-2	0	0	95-100	95-100	55-75	15-25	0-0	NP
Pajarito	0-9	Loamy fine sand	SM	A-2	0	0	100	100	85-100	25-35	0-0	NP
	9-72	Fine sandy loam	SM	A-2, A-4	0	0	90-100	85-100	60-100	25-45	15-20	NP-5
KM—Kermit-Berino fine sands, 0 to 3 percent slopes												
Kermit	0-7	Fine sand	SM	A-2, A-3	0	0	100	100	85-100	5-15	0-0	NP
	7-60	Fine sand	SP, SP-SM	A-3	0	0	90-100	75-100	60-80	0-10	0-0	NP
Berino	0-17	Fine sand	SM	A-2	0	0	95-100	95-100	50-95	10-35	0-0	NP
	17-50	Sandy clay loam, fine sandy loam	CL, CL-ML, SC, SC-SM	A-4, A-6	0	0	95-100	95-100	65-80	35-60	20-35	5-15
	50-58	Loamy sand	SM	A-2	0	0	95-100	95-100	55-75	15-25	0-0	NP

Engineering Properties– Eddy Area, New Mexico

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
SM—Simona-Bippus complex, 0 to 5 percent slopes												
Simona	0-19	Gravelly fine sandy loam	GM, SM	A-2, A-4	0	0-10	60-80	55-75	50-70	30-50	20-25	NP-5
	19-23	Indurated	—	—	—	—	—	—	—	—	—	—
Bippus	0-37	Silty clay loam	CL, CL-ML, SC, SC-SM	A-2-4, A-4	0	0	100	95-100	80-98	30-60	18-25	4-10
	37-60	Clay loam	CL, SC, SC-SM	A-4, A-6	0	0	100	95-100	85-98	36-75	22-40	7-20

Physical Soil Properties

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates in the table are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity (Ksat) is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion.

There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Physical Soil Properties– Eddy Area, New Mexico														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
BB—Berino complex, 0 to 3 percent slopes, eroded														
Berino	0-17	—	—	5-10	1.55-1.65	14.11-42.34	0.09-0.11	0.0-2.9	0.3-0.6	.17	.17	4	2	134
	17-58	—	—	20-35	1.20-1.30	4.23-14.11	0.13-0.17	3.0-5.9	0.2-0.3	.32	.32			
	58-60	—	—	0-10	1.40-1.50	14.11-42.34	0.06-0.08	0.0-2.9	0.1-0.2	.17	.17			
Pajarito	0-9	—	—	5-12	1.40-1.50	14.11-42.34	0.09-0.11	0.0-2.9	0.4-0.7	.17	.17	5	2	134
	9-72	—	—	15-20	1.45-1.55	14.11-42.34	0.13-0.15	0.0-2.9	0.2-0.3	.24	.24			
KM—Kermit-Berino fine sands, 0 to 3 percent slopes														
Kermit	0-7	—	—	2-8	1.40-1.50	141.14-141.14	0.05-0.07	0.0-2.9	0.1-0.2	.17	.17	5	1	220
	7-60	—	—	2-8	1.40-1.50	141.14-141.14	0.04-0.06	0.0-2.9	0.0-0.2	.15	.15			
Berino	0-17	—	—	5-10	1.55-1.65	14.11-42.34	0.09-0.11	0.0-2.9	0.3-0.6	.17	.17	4	2	134
	17-50	—	—	18-35	1.20-1.30	4.23-14.11	0.13-0.17	3.0-5.9	0.2-0.5	.32	.32			
	50-58	—	—	0-10	1.40-1.50	14.11-42.34	0.06-0.08	0.0-2.9	0.1-0.3	.17	.17			
SM—Simona-Bippus complex, 0 to 5 percent slopes														
Simona	0-19	—	—	15-20	1.45-1.55	14.11-42.34	0.09-0.12	0.0-2.9	0.4-0.7	.15	.28	1	4	86
	19-23	—	—	—	—	0.00-0.42	—	—	—					
Bippus	0-37	—	—	27-35	1.45-1.65	14.11-42.34	0.11-0.15	0.0-2.9	1.0-3.0	.24	.24	5	3	86
	37-60	—	—	27-35	1.40-1.65	4.23-14.11	0.14-0.20	3.0-5.9	0.2-0.5	.28	.28			

Soil Qualities and Features

This folder contains tabular reports that present various soil qualities and features. The reports (tables) include all selected map units and components for each map unit. Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil Features– Eddy Area, New Mexico									
Map symbol and soil name	**Restrictive Layer**				**Subsidence**		**Potential for frost action**	**Risk of corrosion**	
	Kind	**Depth to top**	**Thickness**	**Hardness**	**Initial**	**Total**		**Uncoated steel**	**Concrete**
		In	*In*		*In*	*In*			
BB—Berino complex, 0 to 3 percent slopes, eroded									
Berino		—	—		—	—	Low	High	Low
Pajarito		—	—		—	—	Low	High	Low
KM—Kermit-Berino fine sands, 0 to 3 percent slopes									
Kermit		—	—		—	—	Low	Moderate	Low
Berino		—	—		—	—	Low	High	Low
SM—Simona-Bippus complex, 0 to 5 percent slopes									
Simona	Petrocalcic	7-20	4-17	Indurated	—	—	Low	High	Low
Bippus		—	—		—	—	Low	Moderate	Low

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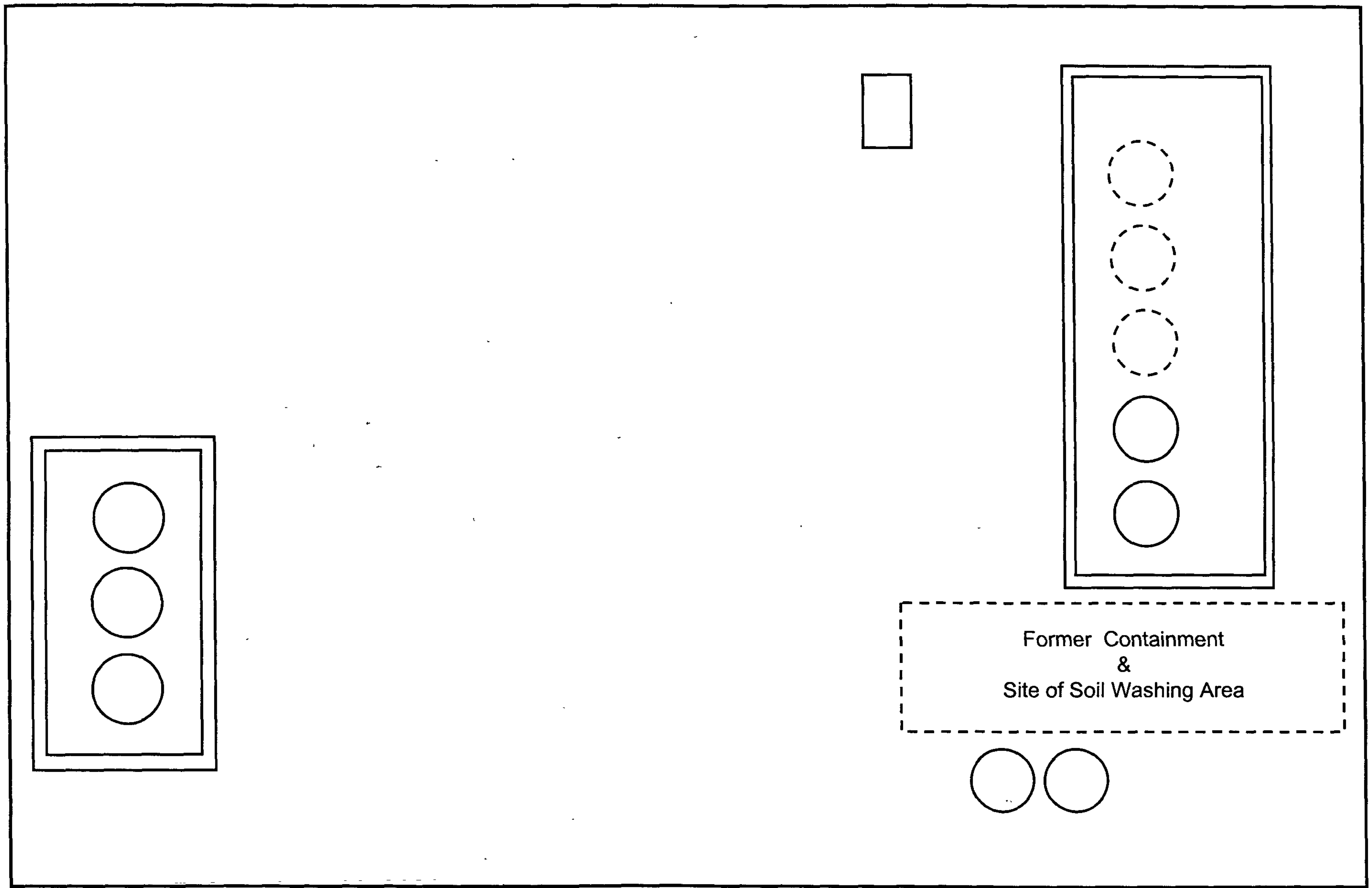
Attachment E
Remediation System Diagrams



Client: Arena Resources, Inc.

Fig. 1: Site Layout

Date: 09/09/08

Facility: North Benson Queen Unit Injection Facility

Scale: None

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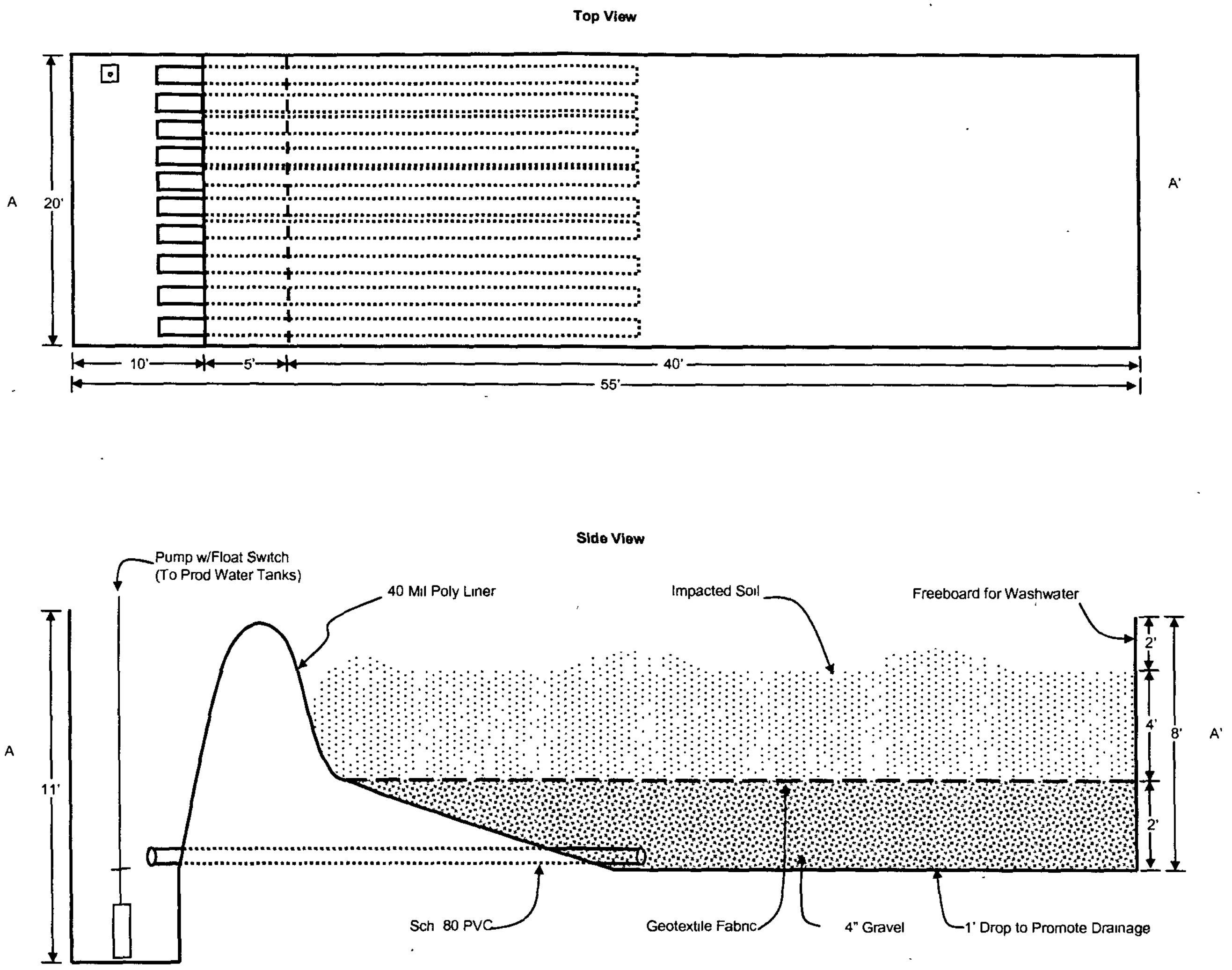

Client: Arena Resources, Inc.

Fig. 2: Soil Washing Diagram

Date: 09/09/08

Facility: North Benson Queen Unit Injection Facility

Scale: None

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