2654 - Bottineau's Big Four Salted Townships

Application Details

Funding Opportunity:
1307-Outdoor Heritage Fund March 2020 - Round 16

Funding Opportunity Due Date: Mar 16, 2020 3:00 PM

Program Area: Outdoor Heritage Fund

Status: Under Review

Stage: Final Application

Initial Submit Date: Mar 13, 2020 3:27 PM

Initially Submitted By: Fintan Dooley

Last Submit Date: Mar 13, 2020 4:11 PM

Last Submitted By: Fintan Dooley

Contact Information

Primary Contact Information

Active User*: Yes

Type: External User

Name*: Mr. Fintan L
Salutation First Name Middle Name

Dooley
Last Name

Title: Coordinator of Salted Lands

Email*: findooley@gmail.com

Address*: 218 N 4th St

Bismarck North Dakota
City State/Province

58501
Postal Code/Zip

Phone*: 414-731-0520 Ext.
Phone
###-###-####

Fax: ###-###-####

Comments:

Organization Information

Status*: Approved

Name*: Salted Lands and Water Inc

Organization Type*: In-State Non-Profit

Tax Id: [redacted]

Organization Website: www.saltedlands.org

Address*: 218 N 4th St

Bismarck North Dakota
City State/Province

58501
Postal Code/Zip

Phone*: 414-731-0520 Ext.
###-###-####

Fax: ###-###-####

PeopleSoft Supplier ID:

Location Code:

Budget

Objective of Grant

Objective of Grant:

Embrace the owners of salted lands & reclaim the worst brine damaged acres in Ground Zero, Bottineau County. With the cooperation of veteran scientists & stewardship minded citizens and business owners we will inform all of the importance of reclamation and life after the oil patch.

Summary

Grant Request:	$30,697,052.00
Matching Funds:	$20,672,552.00
Total Project Costs:	$51,369,604.00
You must have at least 25% match	
Percentage of Match:	40.24%

Project Expenses

Project Expense Description	OHF Request	Match Share (Cash)	Match Share (In-Kind)	Match Share (Indirect)	Other Project Sponsor's Share	Total Each Project Expense
2 Monitoring Wells Per Site (100 wells)	$750,000.00	$750,000.00	$0.00	$0.00	$0.00	$1,500,000.00
Chemical Amendments	$75,000.00	$75,000.00	$0.00	$0.00	$0.00	$150,000.00
	$30,697,052.00	**$18,785,052.00**	**$204,500.00**	**$0.00**	**$1,683,000.00**	**$51,369,604.00**

Project Expense Description	OHF Request	Match Share (Cash)	Match Share (In-Kind)	Match Share (Indirect)	Other Project Sponsor's Share	Total Each Project Expense
Collapsed Tanks and Old Iron Debris	$750,000.00	$750,000.00	$0.00	$0.00	$0.00	$1,500,000.00
Contractor All-Maps	$50,000.00	$50,000.00	$0.00	$0.00	$0.00	$100,000.00
Contractor Soil Assessment	$75,000.00	$75,000.00	$0.00	$0.00	$0.00	$150,000.00
Cover Crop Seed	$25,000.00	$25,000.00	$0.00	$0.00	$0.00	$50,000.00
Disposal Well Access and Payment Per Barrel Down Well	$113,700.00	$113,700.00	$0.00	$0.00	$0.00	$227,400.00
Drain Tile	$500,000.00	$500,000.00	$0.00	$0.00	$0.00	$1,000,000.00
Ecological Planning, Finalize Remote Sensing & Salt Impacted Land Mapping and on Ground Calibration	$125,000.00	$125,000.00	$0.00	$0.00	$0.00	$250,000.00
Education	$0.00	$0.00	$100,000.00	$0.00	$0.00	$100,000.00
Engineering Planning of 50 Site Project	$75,000.00	$75,000.00	$0.00	$0.00	$0.00	$150,000.00
Equipment Rental/Ripper	$10,000.00	$10,000.00	$0.00	$0.00	$0.00	$20,000.00
Excess Salt Disposal to Approved Landfill	$75,000.00	$75,000.00	$0.00	$0.00	$0.00	$150,000.00
Gypsum Amendments	$262,500.00	$262,500.00	$0.00	$0.00	$0.00	$525,000.00
Irrigation/Pivots	$2,500,000.00	$2,500,000.00	$0.00	$0.00	$0.00	$5,000,000.00
Irrigation/Pipelines/Pivots	$400,000.00	$400,000.00	$0.00	$0.00	$0.00	$800,000.00
Irrigation/Pipelines/from River	$600,000.00	$600,000.00	$0.00	$0.00	$0.00	$1,200,000.00
Land Easements and Surveying	$2,304,000.00	$2,304,000.00	$0.00	$0.00	$0.00	$4,608,000.00
Landowner Rental	$10,800,000.00	$0.00	$0.00	$0.00	$0.00	$10,800,000.00
Leonardite Amendments	$50,000.00	$50,000.00	$0.00	$0.00	$0.00	$100,000.00
Legal Permits	$0.00	$0.00	$0.00	$0.00	$40,000.00	$40,000.00
Mapping Four Townships	$0.00	$0.00	$40,000.00	$0.00	$0.00	$40,000.00
Machine Rentals/Bobcat/Ect	$60,000.00	$60,000.00	$0.00	$0.00	$0.00	$120,000.00
Native Seed (Heavy Impact 30%)	$1,000,000.00	$1,000,000.00	$0.00	$0.00	$0.00	$2,000,000.00
Native Seed (Moderate Impact 30%)	$3,750,000.00	$3,750,000.00	$0.00	$0.00	$0.00	$7,500,000.00
Native Seed (Light Impact 40%)	$1,900,000.00	$1,900,000.00	$0.00	$0.00	$0.00	$3,800,000.00
	$30,697,052.00	**$18,785,052.00**	**$204,500.00**	**$0.00**	**$1,683,000.00**	**$51,369,604.00**

Project Expense Description	OHF Request	Match Share (Cash)	Match Share (In-Kind)	Match Share (Indirect)	Other Project Sponsor's Share	Total Each Project Expense
Repurpose an Active Oil Well for Disposal	$375,000.00	$375,000.00	$0.00	$0.00	$0.00	$750,000.00
Principal Agronomist	$0.00	$0.00	$0.00	$0.00	$350,000.00	$350,000.00
Principal Ecologist, Eco Toxicologist, and Scientists	$175,000.00	$175,000.00	$0.00	$0.00	$0.00	$350,000.00
Principal Agronomist II	$0.00	$0.00	$0.00	$0.00	$280,000.00	$280,000.00
Principal Scientists Sublette & Fisher	$0.00	$0.00	$0.00	$0.00	$210,000.00	$210,000.00
Salt Water Pipeline with Input Site by Site 12" dia by 8' deep	$570,240.00	$570,240.00	$0.00	$0.00	$0.00	$1,140,480.00
Salt Water Pipeline with Input Site by Site 8" dia by 8' deep	$506,880.00	$506,880.00	$0.00	$0.00	$0.00	$1,013,760.00
Salted Land - Accounting	$0.00	$0.00	$0.00	$0.00	$100,000.00	$100,000.00
Salted Land - Coordinator	$0.00	$0.00	$0.00	$0.00	$300,000.00	$300,000.00
Salted Land - Secretary	$0.00	$0.00	$0.00	$0.00	$150,000.00	$150,000.00
Supplies	$20,000.00	$0.00	$0.00	$0.00	$0.00	$20,000.00
Travel	$0.00	$0.00	$0.00	$0.00	$100,000.00	$100,000.00
Volunteer (Salted Land Board Member)	$0.00	$0.00	$55,000.00	$0.00	$0.00	$55,000.00
Contingency (10% of Subtotal)	$2,799,732.00	$1,707,732.00	$9,500.00	$0.00	$153,000.00	$4,669,964.00
	$30,697,052.00	**$18,785,052.00**	**$204,500.00**	**$0.00**	**$1,683,000.00**	**$51,369,604.00**

Budget Narrative

Budget Narrative:

The Council recognizes the unusual size of the 10 year plan. The request of the Outdoor Heritage Fund $30,797,052 is made hoping that we will receive partial funding. The significance of this endeavor is best expressed as an unblinking look at the cost of responsible stewardship in Bottineau County.

The hope for match share and other project sponsorship tallies up to $51 million.

We believe this unflinching budget proposal appropriately describes the necessary steps of the reclamation process. The budget reflects the insight of contractors, scientists, technicians who have undertaken these endeavors throughout their professional lives.

There is never been a more auspicious moment to apply the best science the best technology and recruit the most experienced reclamation minded individuals to serve the next generation of farmers.

This endeavor will restore the biosphere on a site by site basis who are at least 10 years.

With the oil price collapse of March of 2000 the men and women who serve in local enterprises need hope. They may, if they wish, increase their skills and apply their insight to the removal of geriatric oil facilities. Steward minded persons of all philosophies and faiths share the stewardship ethic that our project details.

Bid Attachments

Description	File Name	Type	Size	Upload Date
	No files attached.			

Match Funding

Match Amount	Funding Source	Match Type
$7,699,263.00	Commitments Pending	Cash
$7,699,263.00		

In-Kind

In-Kind Total: $204,500.00

Description

Directives

Major Directive*: Directive B
Choose One

Additional Directive: Directive B
Choose All That Apply

Type of Agency*: Tax-exempt, nonprofit corporation
Choose One

Abstract/Executive Summary

Abstract/Executive Summary*:

The $50 million 10 year project will initiate reclamation on brine impacted acres in Bottineau Townships, Bentinck, Hastings, Sherman, and Renville. The cost per acre reclaimed will average $1500. That price per acre will restore the most of the damaged agricultural acres of Bottineau County. Farmers participating in the project will be assisted in going free of lease so unproductive wells on surface acres can be plugged. Plumes of salt water continue to leach off well sites laterally and vertically. This project will focus on 50 sites graded on a 1-4 scale: 1 No Contamination Detected; 2 Slight Effect on Crop Production; 3 Moderate Effect On Salt Sensitive Cash Crops; 4 Serious Effect Nothing Grows.
In November, 2019 Salted Lands and Water Council engaged Applied Ecological Services to review 10 years of ortho-imagery to locate and categorize brine affected sites 1 to 4.In Summer 2020 Salted Lands and AES will undertake truthing and invite land owners to use QuickCapture (ArcGis App). That app allows dated photo uploads and geospatial location. When perfected the 1-4 grading and acre estimation will allow realistic high/low estimates reclamation cost to original condition using best available science and technology. See attached Karlene Fine's December 2013 letter to the Bottineau County Commission.

The native fauna and the flora of the four townships have been devastated by 50 years of oil industry activity and modern farming which increasingly uses pesticides and herbicides. The project envisions restoration of soil fertility and with that the return of the native plants and animals, especially on sights which are consistently to wet to farm. After the 10 year period land owners will make their own decision whether they want to break up the restored wetlands and swales.

This project will utilize an array of soil science approaches and technological procedures to plug wells, remove surface debris, encrusted salt, abandoned equipment, radioactive tars and roads. The project will engage farmers and oil field service contractors to perform tillage, tile class 3 and 4 acres, install salt water receptacles, truck or pump salt water to disposal facilities. Soil amendments sourced from North Dakota will include manure, leonardite, gypsum, micro inoculant, and liquid calcium.

Project Duration

Project Duration*:

The project length will be 10 years. In years 1-3 will include engineering planning, removal of debris, truthing, electro conductivity assessment, deep tillage, incorporate amendments and establish salt tolerant cover crop. We will obtain water permits, water line rights of way and establish irrigation for moderately and heavily impacted acres.
During remaining years we will tile manage weeds, seed annual native plants, remove salt water and irrigate as needed and monitor to the project end.

Narrative

Narrative

Briefly summarize your organization's history, mission, current programs and activities. Include an overview of your organizational structure, including board, staff and volunteer involvement.

Organization Information*:

The Salt Contaminated Land Council 501(c)3 was created as a North Dakota non-profit educational entity. A website was created and is the repository of scientific articles, landowner testimonies, and news stories from the Williston Basin and other North American oil fields. The founder of the organization is Donald Nelson of Keene, North Dakota whose family has contended with the oil industry's adverse effects on his family farm and ranch since the 1950s. The Council has assisted Senator Rich Wardner and his Interim Transportation and Environment Committee bringing farmers to testify about legacy brine spills. The Council has held landowner seminars at the United Tribes, Bismarck State College and brought experts from Colorado, Louisiana, Oklahoma into the presence of citizens confounded by the continuing failure of the state to halt the leaching of salts into the waters of the State of North Dakota and across the surfaces of lands adjoining wells that no longer produce or are not commercially viable. The board and a committee of advisors include entrepreneurs, farmers, ranchers, scientists whose lives are focused on a successful integration of agriculture, ranching and oil production. The coordinator, Fintan Dooley, is an educator, a graduate of Lesley University in Boston, Massachusetts, University of North Dakota Law School, NDSU with a degree in Botany and Chemistry. He began his practice of natural resource law, especially Public Trust and Water Law in 1976.

Board members: Orion Gillette, is a policy and stewardship advisor to Mandan Hidatsa Arikara Allottees and Tribal Council. Cody Hatzenbuhler is an Agronomist and owner of Pan Ag. He will be the general contractor . He is involved in a significant best available technology salted lands reclamation project in Bottineau County. Austin Bitz is a contractor who's reclaiming wall board and selling the same to restore soil productivity. Judy Dooley has 15 years of experience in non-profit management.

Describe the proposed project identifying how the project will meet the specific directive(s) of the Outdoor Heritage Fund Program.

Identify project goals, strategies and benefits and your timetable for implementation. Include information about the need for the project and whether there is urgency for funding. Indicate if this is a new project or if it is replacing funding that is no longer available to your organization. Identify any innovative features or processes of your project.

Note: if your proposal provides funding to an individual, the names of the recipients must be reported to the Industrial Commission/Outdoor Heritage Fund. These names will be disclosed upon request.

If your project involves an extenuating circumstance to exempted activities please explain.

Purpose of Grant*:

Directive B this project will improve, maintain, and restore water quality, soil conditions, plant diversity, and animal systems and support other practices of stewardship which will enhance profitability of farming and ranching in the entire Williston Basin, especially in the conventional and about to be retired oil fields.

Relevance: This project will improve the sustainability and economic viability

The project will incentivize diversification of agricultural choices by restoring farm land productivity. This project will improve sustainability of farm communities. During the restoration cycle harvesting of cover crops will provide another source of income for farmers and create an opportunity for native grass seed sales for local businesses.

To assure what is sometimes called soil washing that is movement of salt from the plants root zone into the tiles an irrigation system must be established. It will typically be a rectangular water distribution array. The assurance of water to the full-season cover crops will allow soil washing and enhance the nutrition of the plants and improving water quality by removing brine which is typically brought into solution by excessive rainfall and thereafter water spreading by reason of the impermeability of the brine damaged land. This will improve the viability of small communities in these watersheds by reducing water treatment costs and potential for flooding and associated costs for communities.

Positive soil health and agronomic benefits of cover crops include: harvesting excess water, controlling erosion, building organic matter, fixing and sequestering nitrogen, avoiding or treating compaction from excessive traffic, controlling soil salinating, and additional benefits to wildlife and flood water reduction.

Impact: The project will embark upon complete reclamation of North Dakota?s Legacy salted lands. It will return unproductive acres to biological viability. Restore soil health, improve wildlife, carrying capacity and transition the failing oil well maintenance industry and pumping communities from financial decline to a higher level of skills. Local businesses will prosper.

Please list the counties that would be impacted by this project:

Counties*:	Bottineau
Is This Project Part of a Comprehensive Conservation Plan?*:	No
Does Your Project Involve an Extenuating Circumstance?*:	No

Provide a description of how you will manage and oversee the project to ensure it is carried out on schedule and in a manner that best ensures its objectives will be met. Include a brief background and work experience for those managing the project.

Management of Project*:

The Salted Lands and Water Council Coordinator, Fintan Dooley, with Soil Scientists Kerry Sublette, Bert Fisher, Marvin Nelson, Lance Loken and Ken Carlson. Together these close associates who have great familiarity with Bottineau County salted lands have more than a century of experience in reclamation. Corporately the most experienced project manager is Steve Apfelbaum, owner of Applied Ecological Services whose team has managed reclamation of thousands of mined acres in Montana, Wisconsin, Minnesota, Illinois, and Arkansas. Likewise, the AES group has been the primary designer and manager of thousands of miles of rivers and hundreds of acres of wetland restorations.

Both Sublette and Apfelbaum are willing to serve as co-project manager with Fintan Dooley. Kerry Sublette conducts reclamation seminars for corporate organizations in the United States and Internationally. We envision this project to involve a significant component of landowner education so that the vulnerable acres undergoing reclamation are not untimely returned to grazing or crop production. Dooley anticipates that the two experts will cooperate and assuming roles. Sublette is elderly and AES staff are not all elderly.

The same problem we address in Bottineau County has long been a distress to the farm and ranch lands of Oklahoma. For now we omit reference to west Texas, because its lands are typically desert like. The lessons learned by Sublette have been referenced before. Those insights will manifest in dealing with problems which will arise with completion of this project. Sublette's experience in engaging land owners to perform the work he diagnosis as necessary will result in a well-managed execution of the project.

One notable experience of Apfelbaum and his team involves the British Petroleum Disaster. Apfelbaum's group was engaged to find oil which washed ashore and were out of sight in the estuaries of the Gulf of Mexico. A second notable experience is Apfelbaum used the same technologies to help the several Ojibwa Tribes find rice beds which tribal members had rights to harvest off reservation because of United States Supreme Court decisions.

Apfelbaum is one of the planning team for the restoration of the parishes of the Louisiana Coast whose estuaries have been destroyed by Mississippi levies which have starved the coastal wetlands of regenerating mud. A similar problem has been caused by salt water intrusion permitted by the Corps of Engineers to enable oil production in the remotes of the Louisiana River Deltas.

We see the enterprise as a collaborative endeavor and maintain close relationships with an array of knowledgeable persons who serve on our team of advisors.

Indicate how the project will be funded or sustained in future years. Include information on the sustainability of this project after OHF funds have been expended and whether the sustainability will be in the form of ongoing management or additional funding from a different source.

Sustainability*:

Salted Land Council will seek matching funds from Bush Foundation, Bottineau County Commission Water board, municipalities which have businesses and residents employed in the servicing the gaging wells of Bottineau County, The North Dakota Association of Independent Bankers whose loan portfolios are devalued by salt water damage to surface acres, the Bottineau County and North Dakota Farm Bureau, the Bottineau County and North Dakota Farmers Union, Mandan Hidatsa Tribe, North West Landowner Association, ND Water Users, Dakota Resource Council, stewardship, faith based and environmental groups.

Indicate how the project will be affected if less funding is available than that requested.

Partial Funding*:

We will set up a go fund me account and approach private foundations.

If you are a successful recipient of Outdoor Heritage Fund dollars, how would you recognize the Outdoor Heritage Fund partnership? * There must be signage at the location of the project acknowledging OHF funding when appropriate. If there are provisions in that contract that your organization is unable to meet, please indicate below what those provisions would be.
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If you are a successful recipient of Outdoor Heritage Fund dollars, how would you recognize the Outdoor Heritage Fund partnership? * There must be signage at the location of the project acknowledging OHF funding when appropriate. If there are provisions in that contract that your organization is unable to meet, please indicate below what those provisions would be.

Partnership Recognition*:

We will publicly thank Outdoor Heritage Fund and our partners. We will post one thank you sign per Bottineau County oil field in which any of the 50 sites are located. We will purchase bill board space near Sterling Corners and the turn off highway 83 to Glenburn. We will mail a quarterly newsletter to zip codes for Glenburn, Mohall, Antler, Newburg describing our stewardship project and invite visits to our reclamation sites. The same newsletter will be utilized to invite farmers young and old to learn about the reclamation process its challenges and risks of failure. The primary educator will be Kerry Sublette. We will also publicly thank Outdoor Heritage by reconnecting with ABC News, Aljazeera, the New York Times, Rolling Stone, DeSmog, the Canadian Broadcasting Company, Prairie Public Television, local commercial television and radio stations who have interviewed us or joined us on tours.

Do you have any supporting documents, such as maps or letters of support that you would like to provide? If so, please provide them in a single file.

Supporting Documents*: Yes

If Yes, Please Provide Copies in a Single File: Supporting Documents for Outdoor Heritage Fund.pdf

Awarding of Grants - Review the appropriate sample contract for your organization. Sample Contract

Can You Meet All the Provisions of the Sample Contract?*: Yes

Tasks

Tasks

Task	Start Date	Completion Date
All-Mapping	07/01/2020	10/30/2020
Amendments	06/01/2021	10/15/2021
Education	07/01/2020	10/30/2023
Landowner Rental Rates	07/01/2020	10/30/2023
Reclamation	06/01/2021	10/30/2023
Seeding of cover crop	06/01/2021	07/15/2022
Soil testing	07/01/2020	10/15/2020

Description of Tasks

Please Describe Tasks:

Find the acres; Assess the acres condition via AES assessment via satellite, use drones infra-red mapping to be followed by EM surveys, test wells and soil sampling; Restoration will occur after: well plugging, site cleaning, road removal; deep tillage; Incorporation of Amendments

i. Manure
ii. Leonardite
iii. Gypsum
iv. Calcite

Cover crop seeding, weed control, replace cover crop w/Native salt tolerant forbes & grasses; Establish tiles, brine collection & irrigation wash soil; Manage & Monitor

Deliverables

Deliverables

Deliverable	Quantity	Unit of Measurement, if applicable
All-Mapping	50.000	3D software of site
QuickCapture	50.000	ArcGis App
Soil Sample	100.000	Take Soil Sample from 1 to 6 inches

Certification

Certification

Certification: No

Name: Fintan Dooley
First Name Last Name

Title: Salted Land and Water Council Coordinator
Title

Date: 03/13/2020

Internal Application Number

#/ID: 16-11

APPLIED ECOLOGICAL SERVICES
SPECIALISTS IN ECOLOGICAL SCIENCE, RESTORATION, MANAGEMENT, AND RESEARCH
17921 W SMITH ROAD • PO BOX 256 • BRODHEAD, WI 53520 • (608) 897-8641

Consulting Proposal

AES Project Information

Project Name: ND_Frac_Brine_Spill_Mine_Impacts
Project Number: 18-0215
Project Director: Steven I. Apfelbaum (email: Steve@appliedeco.com)
Project Manager: Fugui Wang (email: fugui.wang@appliedeco.com)

Fintan Dooley
Daryl Peterson
Salt Contaminated Land and Water Council
218 North 4th Street
Bismarck, ND, 58501
414-731-0520

October 29, 2019

Re: **Proposal for demonstrating a pilot approach to identify and quantify the acreage of land that is contaminated with oil field produced water (brine)**

Dear Mr. Dooley and Mr. Peterson,

Thank you so much for giving AES the opportunity to provide you and your organization a revised proposal, with our new understanding to the project scope. We look forward to working with you on this project. Please email or call me or Steve with any questions regarding this proposal.

Sincerely,

Dr. Fugui Wang

Senior Scientist – Remote Sensing | Ecological Modeling
Applied Ecological Services, Inc.
17921 Smith Road
Brodhead, WI 53520

Email: fugui.wang@appliedeco.com
Phone: 608-897-8641

Bottineau County, ND--- Demonstration Project---Identification and Quantification of Salt Contaminated Lands with Satellite Images and Field Verification

Project Understanding

We understand Salt Contaminated Land and Water Council (SCLWC), Inc is committed to demonstrating a pilot approach to identify and quantify the acreage of land that is contaminated with oil field produced water (brine). Four townships in Bottineau County, an area enclosed by the blue polygons in the map below (Figure 1), approximately144 square miles, were selected for this demonstration project. The demonstration project is designed to document the science, accuracy, and scalability of accurately mapping salt impacted lands, and evaluating the costs to scale this up to a larger area in a future phase.

We propose a concept of using multi-temporal satellite images to identify land cover changes, vegetation and soil stress and plant growth anomalies across the years, then to apply geospatial/statistical models, artificial intelligence classifier, and field data (soil EC/salinity measurements and vegetation/land condition observations) to model, filter, classify, and ultimately locate and accurately map the contaminated land, Using 10 meter on ground resolution satellite images from 2017, 2018, and 2019, we will do this evaluation and mapping over four townships in Bottineau County.

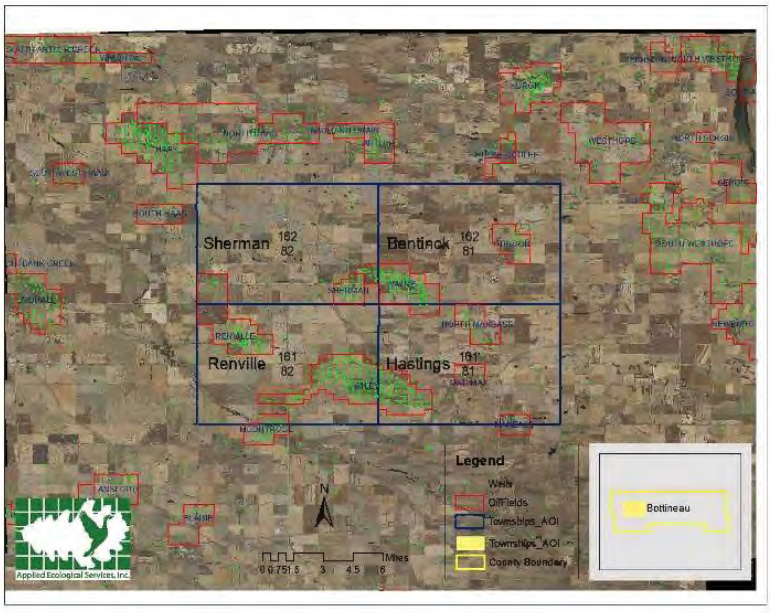

Figure 1. Four Townships in Bottineau County, ND comprise the focal area for this demonstration project.

Project Tasks:

Task 1. Project Management and Coordination
AES project director and manager will develop a project management plan to execute the project as required by items in the contract. This task will ensure AES fulfills the tasks and produces the quality of products within time and budgetary requirements by all stakeholders both from SCLWC and AES through planning, communication, QA/QC, and change request assessment.

Lump Sum: $1,750

Task 2. Geospatial Data Collection and Processing
Remotely sensed images planned to be collected for this project include radar images from satellite Sentinel-1 and multispectral images from satellite Sentinel-2 and aerial images acquired by National Agriculture Imagery Program (NAIP). The images will be processed to be useful for change detection and classification.

Deliverable: Radiometrical and geometrical corrected and normalized satellite images and aerial photos.

Lump Sum: $9,225

Task 3. Field Ground Truthing and Confirmation: This task will include one team of two persons to visit accessible contaminated sites in the entire area of interest.

Deliverable: Soil moisture and salinity measurements and vegetation condition observation and quantification at plot and field levels.
Lump Sum: $11,767 (if one person from SCLWC could help, then we propose only one of AES's employee to be in the field for a budget of $7,744)

Task 4. Interpret, Classify and Map*:* In general, this task involves deploying the technical methods to classify salt contaminated land and provide an accuracy assessment. The method includes four key steps of image segmentation, land cover classification, detection of anomalies of land cover over the three years of 2017, 2018, and 2019, and modeling and deriving salt contaminated fields for each of the year.

Deliverable: Maps of identified contaminated lands and summary of acres
Lump Sum: $13,525

Task 5. Report: AES will briefly report the findings in PowerPoint format and join a group discussion as follow up.
Lump Sum: $1,200

Table 1. Project Schedule and Budget Summary

Phase/Task	Year 1- MONTH 1	2	3	4	5	6	7	8	9	10	11	12	Estimated Cost
Task 1. Project Management and Coordination				x	x	x	x	x					$1,750
Task 2. Geospatial Data Collection and Processing				x	x								$9,225
Task 3. Field Confirmation and Ground Truthing						x	x						$7,744-$11,767
Task 4. Interpret, Classify and Map					x	x	x						$13,525
Task 5. Report:							x	x					$1,200
TOTAL													$33,444-37,467

COUNTY OFFICERS

County Auditor	Lisa Herbel
County Treasurer/MVD	Ann Monson
County Recorder	Helen Christenson
County Sheriff	Steve Watson
State's Attorney	A. Swain Benson
Clerk of Courts	Rhonda Langehaug
Tax Director/Zoning Adm.	Lisa Peterson
Social Services	Kelly Jensen
9-1-1 Coordinator	Terry Volk
Disaster Emergency	Richard Hummel
Veteran's Service Officer	Dwight Nahinurk
Road Supervisor	Ritchie Gimbel
Official Newspaper	Courant

BOTTINEAU COUNTY
NORTH DAKOTA

314 West Fifth Street
Bottineau, North Dakota 58318
Fax (701) 228-5181

COUNTY COMMISSIONERS

1ST District	LeRoy Rude Bottineau, ND 58318
2nd District	Jeff Beyer Bottineau, ND 58318
3rd District	Daniel Marquardt Bottineau, ND 58318
4th District	Lance Kjelshus Souris, ND 58783
5th District	Todd Streich Maxbass, ND 58760

November 7, 2013

NOV 2

Industrial Commission of ND
Jack Dalrymple, Chairman
Wayne Stenehjem, Attorney General
Doug Goehring, Agriculture Commissioner
State Capitol
14th Floor, Dept 405
600 E Boulevard Ave
Bismarck ND 58505-0840

The Bottineau County Commission is writing this letter to show our support for responsible oil development and express our appreciation of the prosperity and economic benefits the oil development brings to our county and citizens.

The Commissioners believe however, that positive actions must be taken to reclaim current sites and prevent future damage from oil field saltwater spills. These spills are happening at an alarming rate and are causing devastating damage to our prime farm and ranch land.

We are asking the Industrial Commission to assist our County with the positive actions to reclaim and protect our land, tax base, and the future of agricultural production and producers in Bottineau County.

We request that the Commission:

1. Require regulatory enforcement that holds violators fully accountable with real consequences for damaging the land that will sustain our rural prosperity for generations to come.
2. Use available resources to do an accounting of acres affected by oil field spills and inadequate reclamation of well sites.
3. Develop a plan to reclaim land to pre-exploration conditions so the land regains full productivity.

We look forward to working with your Commission and hearing from you soon.

Respectfully submitted,

Jeff Beyer,
Bottineau County Commissioner Chairman

COUNTY OFFICERS

County Auditor	Lisa Herbel
County Treasurer/MVD	Ann Monson
County Recorder	Helen Christenson
County Sheriff	Steve Watson
State's Attorney	A. Swain Benson
Clerk of Courts	Rhonda Langehaug
Tax Director/Zoning Adm.	Lisa Peterson
Social Services	Kelly Jensen
9-1-1 Coordinator	Terry Volk
Disaster Emergency	Richard Hummel
Veteran's Service Officer	Dwight Nahinurk
Road Supervisor	Ritchie Gimbel
Official Newspaper	Courant

BOTTINEAU COUNTY
NORTH DAKOTA

314 West Fifth Street
Bottineau, North Dakota 58318
Fax (701) 228-5181

COUNTY COMMISSIONERS

1ST District	LeRoy Rude Bottineau, ND 58318
2nd District	Jeff Beyer Bottineau, ND 58318
3rd District	Daniel Marquardt Bottineau, ND 58318
4th District	Lance Kjelshus Souris, ND 58783
5th District	Todd Streich Maxbass, ND 58760

December 5, 2013

Industrial Commission of ND
Jack Dalrymple, Chairman
Wayne Stenehjem, Attorney General
Doug Goehring, Agriculture Commissioner
State Capitol
14th Floor, Dept 405
600 E Boulevard Ave.
Bismarck, ND 58505-0840

The Bottineau County commission has established a committee to write a letter to your commission with concerns about salt water and oil spills within our County. A letter was sent to your commission on the 7th of November, listing the concerns that the County Commission has over this issue. Our committee was wondering if anything has or will be done about these concerns and if the County will receive any type of response from your Commission.

At the November Bottineau County Commission meeting members of the NW Landowners Association attended and brought these concerns to the County Commission and requested a letter of support. Also, at the meeting was a representative from the Farm Credit Bureau who was asked about obtaining a loan on any land with salt water damage. He said it would be hard to obtain a loan on that land, if not impossible.

Because of all the damage that is done by salt water spills, our committee feels that it is up to all of us to do whatever we can to protect the lands of North Dakota from the severe damage that salt water causes. We are in no way against oil production within the of State North Dakota, but would like to see stiffer enforcement of regulations that relate to oil production to help protect and preserve the lands of our fine State of North Dakota.

Looking forward again to your response

Best regards

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Bottineau County Commission Co-Chair
Lance Hjelshus

Northwest Landowners Association
Larry Peterson

Bottineau County Commission
LeRoy Rude

Northwest Landowners Association
~~Pete Artz~~

Bottineau County Emergency Manager
Rick Hummel

INDUSTRIAL COMMISSION OF NORTH DAKOTA

Jack Dalrymple
Governor

Wayne Stenehjem
Attorney General

Doug Goehring
Agriculture Commissioner

December 31, 2013

The Honorable Jeff Beyer, Chairman
The Honorable LeRoy Rude
The Honorable Daniel Marquardt
The Honorable Lance Kjelshus
The Honorable Todd Streich
Bottineau County Commissioners and
Larry Peterson
Pete Artz
Northwest Landowners Association and
Mr. Rick Hummel
Bottineau County Emergency Manager
314 West Fifth Street
Bottineau, North Dakota 58318

Dear Sirs:

This is in response to your recent letters regarding salt water and oil spills in Bottineau County. I am responding on behalf of the Industrial Commission.

The North Dakota Industrial Commission and the Oil and Gas Division are committed to the responsible stewardship of our State's mineral, land and water resources.

The statutory mission of the Oil and Gas Division is to encourage and promote the development, production and utilization of oil and gas in the State in such a manner as will prevent waste, maximize economic recovery, and fully protect the correlative rights of all owners to the end that landowners, the royalty owners, the producers and the general public realize possible good from these vital natural resources.

In keeping with that mission we recognize the potential for the detrimental effects that accidental spills and leaks can have on the State's precious land and water resources.

North Dakota has some of the most stringent spill reporting and reclamation requirements in the nation, which are evaluated and implemented on a case-by-case basis. Statutory changes were made during the 2011 and 2013 legislative sessions which resulted in the implementation of significant changes to the Industrial Commission's oil and gas rules and regulations. As you may know the 2013 proposed rules and regulations were just recently approved by the Industrial Commission and are now in the final stages of review under the Administrative Practices Act. It is the Commission's hope that these changes will become effective on April 1, 2014.

Karlene K. Fine, Executive Director and Secretary
State Capitol, 14th Floor - 600 E Boulevard Ave Dept 405 - Bismarck, ND 58505-0840

The 2011 revisions included changes to the North Dakota Administrative Code Sections:

43-02-03-19 – Site Construction
43-02-03-19.3 – Earthen Pits and Open Receptacles
43-02-03-28 – Safety Regulation
43-02-03-30.1 – Leak and Spill Cleanup

The 2013 proposed changes also impact a number of North Dakota Administrative Code Sections. Of particular interest are:

43-02-03-29 - Well and Lease Equipment (pipelines)
43-02-03-30 - Notification of fires, leaks, spills or blowouts

As you can see these revisions deal with the topics you are concerned about—spills, pipeline safety, reclamation, etc.

We continue to use our resources to respond to these situations, most effectively, on a case-by-case basis, recognizing that every case is unique, with different geographic, geologic and land-use considerations.

Statutes and rules currently exist that require impaired lands to be reclaimed to their original conditions and are based on sound scientific principles and engineering best practices. Plans for reclamation are and continue to be most effectively evaluated on a case-by-case basis.

Sincerely,

Karlene Fine
Executive Director and Secretary
North Dakota Industrial Commission

Leachate Generated by an Oil-and-Gas Brine Pond Site in North Dakota

by Edward C. Murphy[a], Alan E. Kehew[b], Gerald H. Groenewold[c], and William A. Beal[d]

ABSTRACT

Two unlined ponds were used for holding and evaporation of brines produced with oil and gas at a well site in north-central North Dakota. The brine-evaporation ponds were in use from 1959 up to the late 1970s when they were backfilled and leveled. Continued salt-water migration at this site since closure has decreased crop yields in surrounding fields and has killed trees in a shelterbelt within an area of approximately 10 acres.

An apparent resistivity survey delineated a 360,000-ft^2 area of extremely low resistivity. Isoconcentration maps indicate that a highly saline leachate plume extends laterally in a 500-foot radius around the ponds and vertically to a depth of 70 feet below the surface.

Ground-water recharge at this site is low because of the semiarid climate and the low hydraulic conductivity of the near-surface sediments and, as a result, very little flushing of the brine from the sediment beneath the ponds has occurred. Pore water within the unsaturated zone beneath the reclaimed ponds contains essentially the same ionic concentrations as that of brine impounded in these pits 10 to 25 years ago.

Based upon the results of this research, we estimate that brine leachate will continue to migrate at slow rates from this site for tens and possibly hundreds of years if no action is taken. The construction of a mound over the site and/or an infiltration gallery around the perimeter would minimize the spread of brine and make it possible to return this land to production in the foreseeable future.

INTRODUCTION

Brines typically are produced along with crude oil at oil-well sites. These brines are recognized as the major source of potential environmental contamination associated with oil production (Knox and Canter, 1980). The issue of how to properly dispose of oil-field brines has been considered in the State of North Dakota since oil production first began in 1951. North Dakota has benefited from the experiences of earlier oil-producing activities in other states and avoided problems such as the direct dumping of brines into streams which occurred in Illinois in the 1930s (Reed *et al.*, 1981).

As early as 1932, it was recognized in Kansas that brine-holding facilities were causing serious environmental problems (Grandone and Schmidt, 1943). However, clear documentation of the problems associated with surface brine disposal did not appear in the literature until the 1960s. Many of these 1960s studies document the decline in surface- and ground-water quality around producing oil fields (Krieger and Hendrickson, 1960; Shaw, 1966; and Boster, 1967). A number of studies over the last 20 years have focused upon the rate of movement of the brine plumes, the length of time needed for the natural restoration of water quality in a degraded aquifer, and the cost effectiveness of different methods of disposal-site and aquifer reclamation (Boster, 1967; Pettyjohn, 1973; Fryberger, 1972; Baker and Brendecke, 1983). The purpose of our study was to document brine migration within a unit of low hydraulic conductivity and to suggest methods of site reclamation.

Initially, salt water at North Dakota drilling sites was primarily disposed of in evaporation ponds and injection wells. These ponds were so

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Received April 1987, revised July 1987, and accepted July 1987.

Discussion open until July 1, 1988.

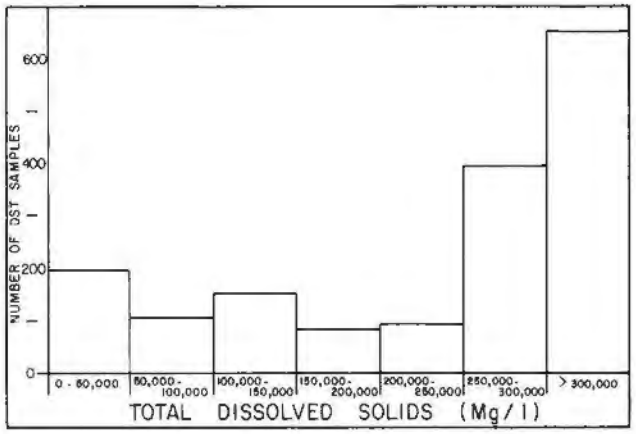


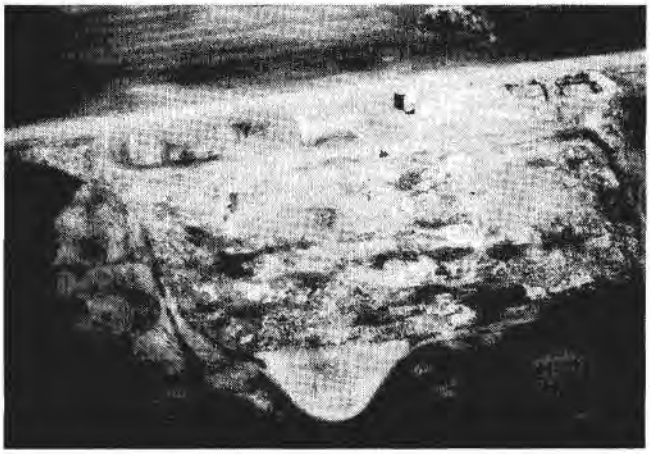
Fig. 1. Total dissolved solids concentration in Williston Basin brines.

named because it was believed that all of the salt water in these brine-holding ponds evaporated. The ponds were generally unlined, and ranged from dimensions of 45 × 60 feet up to 90 × 180 feet with depths of 4 to 9 feet. The ponds received brine at rates varying from ½ to 420 barrels per day.

The cumulative production of oil in North Dakota, during the period from 1951-1986, was 889,985,722 barrels. Salt-water production during this same period was 955,694,692 barrels. The ratio of crude oil-to-brine production varies significantly from well to well and will generally increase over the life of a given well. The chemistry of subsurface brines varies widely between and within geologic formations in the Williston Basin of North Dakota. However, chemical analyses of 1,956 oil-field drill-stem tests have demonstrated that the majority of brines within the Basin are characterized by TDS concentrations of greater than 250,000 mg/l; 12 percent of the brines contain less than 50,000 mg/l of TDS (Figure 1).

In 1969, the North Dakota Geological Survey began to require permits for all salt-water-handling facilities. During the period from 1969 to 1981, 206 permits for evaporation ponds were issued. The total number of evaporation ponds that operated within the State prior to 1969 is unknown. Brine-holding ponds are no longer allowed to operate within the State of North Dakota. Therefore, current environmental concern is no longer focused on active ponds, but rather is now focused on abandoned brine-holding ponds. Migration of brine from these abandoned ponds had been recognized as a potential source of soil degradation and surface- and subsurface-water contamination. The salt that remains in the pond sites after they have been leveled will generate leachates at a rate dependent upon the local precipitation, topography, and the hydraulic conductivity of the near-surface sediments.

In order to evaluate the long-term impacts of brine ponds, a reclaimed brine-holding pond site was chosen for study within the Wiley Field near the town of Maxbass in Bottineau County, North Dakota (Figure 2). This site was chosen because of obvious salt damage to crops and a shelterbelt adjacent to the pond site and because it was representative of many pond sites in North Dakota. The oil well at this site was drilled in 1959 and produced until 1970; it was later converted to a salt-water disposal well (Stratton SWD #1) by Phillips Petroleum in 1978. Two brine-holding ponds were located at this site from 1959 through at least 1976 (Kallestad, personal communication, 1986). The amount of brine that was disposed in these ponds during that 17-year period is not known.



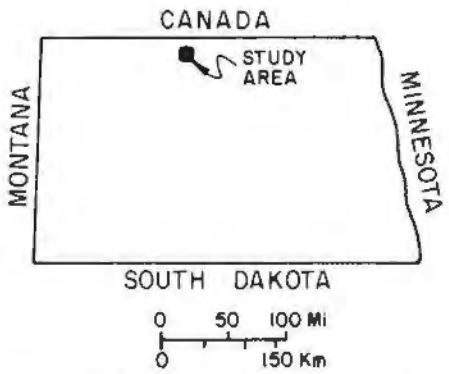


Fig. 2. Oblique aerial photograph of the study site and study site location map (photo taken June 1984 by John Foss).

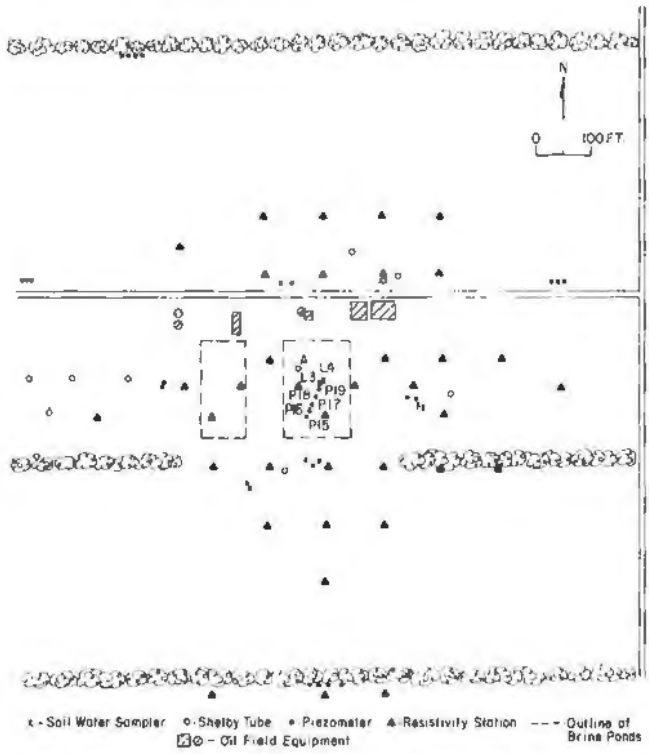


Fig. 3. Locations of earth resistivity survey stations, pore-water and ground-water sampling equipment, and Shelby-tube holes at the study site.

FIELD METHODS

An electrical earth resistivity survey, using the Wenner electrode configuration, was conducted at the Stratton SWD #1 site during June 1984. The Vertical Electrical Sounding method (VES), which was used at this site, involves a fixed center of the electrode array (resistivity station) and expansion of the electrodes about this point. Thirty-six resistivity stations were surveyed in and adjacent to the brine pits (Figure 3). Readings were taken at successive electrode spacings ("a") of 3, 5, 8, 10, 12, 16, 20, 24, 30, 40, 50, 60, 80, and 100 feet. The results of the earth resistivity survey were used to determine placement of the ground-water and pore-water monitoring instruments.

Shelby-tube sediment samples were taken using the North Dakota Geological Survey's truck-mounted, hollow-stem 8-inch auger. A total of 198 feet of Shelby-tube sediment core was retrieved from 10 holes drilled within and adjacent to the brine ponds (Figure 3). The maximum coring depth reached was 32.5 feet.

Eight pressure-vacuum lysimeters (soil-water samplers) (Soil Moisture Equipment Corp. Model 1920) were used to obtain water samples from the unsaturated zone. These were installed in pairs at depths of 4 and 9 feet. Twenty-eight piezometers were installed (Figure 3) to provide water samples from within the zone of saturation and to determine the elevation and gradient of the water table. Single well response tests (slug tests) were also performed to estimate the hydraulic conductivity of the sediment adjacent to the screened interval (Hvorslev, 1951). The piezometers were screened within four general zones: at depths less than 40 feet, between 40-55 feet, between 70-80 feet, and at 160 feet. One piezometer was installed in the Fox Hills Formation, which lies beneath the Pleistocene drift. Where possible, rotary-rig borings were drilled with air. When this proved difficult, fresh water was used and, where necessary, a bentonite mud fluid was used. In order to minimize the effects of the bentonite drilling mud, these piezometers were backwashed with fresh water injected by the drill-rig pumps until they flowed relatively clear water (approximately 20 minutes).

Water samples were collected on December 9, 1984, and June 12, 1985. The first set of samples was analyzed for both trace-metal and major-ion content, and the second set was analyzed only for majors. Temperature, pH, and electrical conductivity of the water samples were determined in the field at the time of sample collection. A minimum of two volumes of water was removed from each piezometer prior to sampling.

The ground-water and pore-water chemistry were determined by the Chemistry Department Laboratory of the North Dakota State University. Selected portions of the Shelby-tube sediment samples were also analyzed for major ion content by saturated paste extract at the North Dakota State University Land Reclamation Research Center Laboratory. The lab procedure used is described in Sandoval and Power (1977).

GEOLOGY AND GEOHYDROLOGY OF THE SITE

The Stratton SWD #1 site is situated upon approximately 220 feet of Pleistocene till which overlies the Cretaceous Fox Hills Formation (Figure 4). Surficial deposits in the area consist of Pleistocene sediments of Late Wisconsinan Age, including till, glaciofluvial, and glaciolacustrine units. Topographically, the site lies upon a low relief, hummocky till plain.

The till at this site is a mixture of clay, silt, sand, pebbles, cobbles, and boulders. The mean grain-size percentages of 66 till samples from this site are: sand 35.6%, silt 37.9%, and clay 26.5%. Numerous sand and gravel zones, with thicknesses

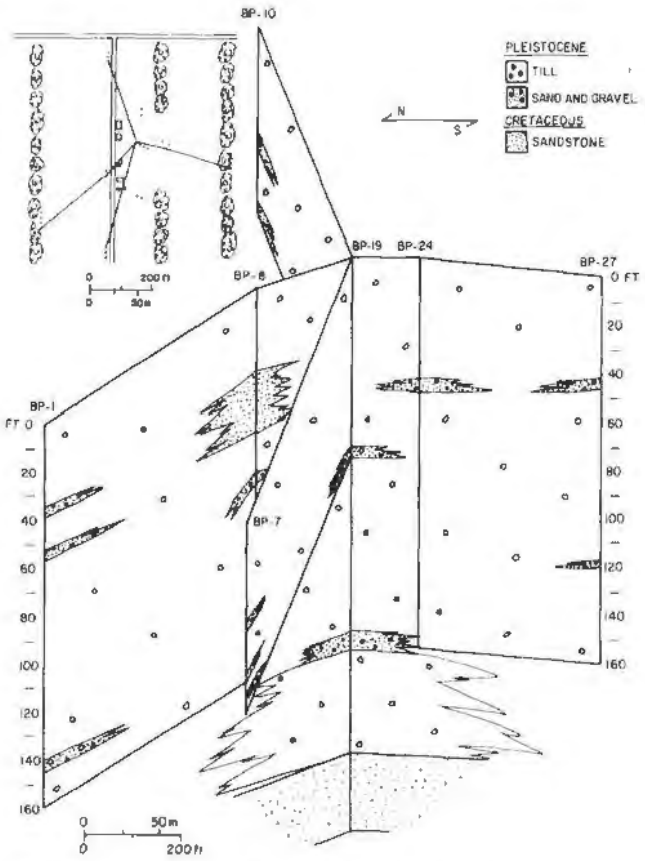


Fig. 4. Geologic fence diagram of the study site.

of 5-15 feet, were encountered within the till. These zones could not be traced between boreholes and therefore appear to be discontinuous lenses (Figure 4).

Glacial drift in the vicinity of the study site is an aquitard and, therefore, there are no farm wells completed within either the till or the discontinuous sand and gravel lenses. However, numerous unconfined and confined aquifers occur in surficial or buried glaciofluvial deposits throughout the region. The Stratton well (SWD #1) is situated near the northern extent of one of these major glaciofluvial aquifers (Randich and Kuzniar, 1984), although this aquifer was not encountered during our drilling project. The underlying Fox Hills Formation is the most extensive bedrock aquifer system in north-central North Dakota and commonly is the only aquifer system that yields sufficient quantities of water for domestic or stock use (Randich and Kuzniar, 1984).

The water table, which lies at a depth of approximately 17 feet is mounded below the brine ponds to within 10 feet of the surface. Mound boundaries may extend as far as 500 feet beyond the ponds and may be affecting the water levels in all of the shallow piezometers. It is difficult to determine the direction of ground-water flow in the study area due to the local effects of the ground-water mound.

The slug-test results gave a range of hydraulic-conductivity values of 1.6 to 3.2 × 10^{-6} ft/s with a mean of 2.4 × 10^{-6} ft/s for the glacial drift. Sediment-core observations indicate that the till is highly fractured. Presumably, these fractures have a significant effect upon the bulk hydraulic conductivity of the till unit.

APPARENT RESISTIVITY

An area of low resistivity measuring approximately 360,000 ft² was delineated at all of the "a" spacings down to 100 feet around and beneath the brine ponds (Figure 5). The resistivity values increase radially from the pits.

The ratio of depth-to-electrode spacing using the Wenner electrode configuration is approximately 1:1 for an isotropic, homogeneous medium. Electrode spacing and depth of current penetration are sometimes considered to be equal, especially for electrode spacings of less than 100 feet (Soiltest, 1968). However, the presence of sedimentary layers with greatly differing resistivities and/or saline pore water has been shown to distort the electrical field and reduce the depth of current penetration (Reed *et al.*, 1981). In this study, the current may have been concentrated in

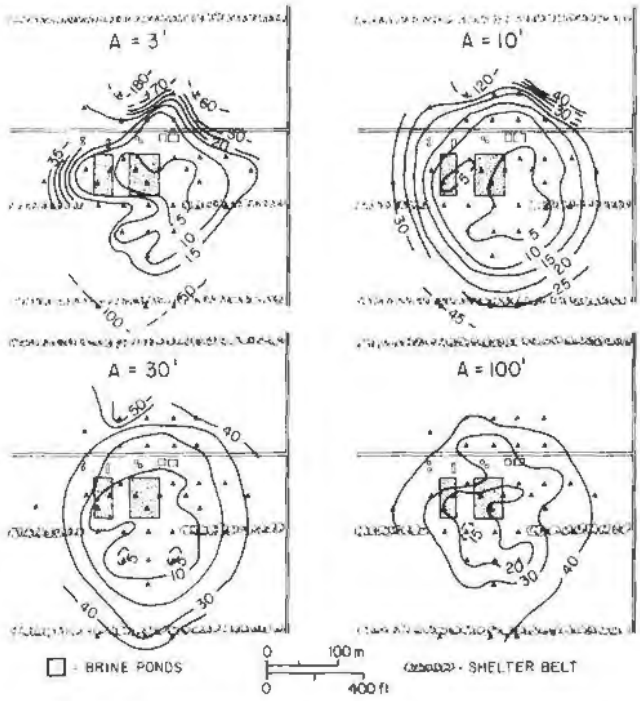


Fig. 5. Apparent isoresistivity maps (ohm-ft) of the study site for electrode spacings of 3, 10, 30, and 100 feet.

Table 1. Chemical Composition (mg/l) of Brine from Wiley Field and Selected Lysimeters (L-3 and -4) and Piezometers (P-15 to -19) at the Study Site. The Interval Is the Depth of the Lysimeters or the Depths of the Piezometer Screen. Piezometer and Lysimeter Data from Samples Taken on 6/12/85

Well or Sample	Interval (ft)	Temp °C	pH	TDS	Ca	Mg	Na	K	HCO_3	SO_4	Cl
Wiley High	-	20	7.1	268,036	5,510	2,310	96,823	-	440	3,634	163,000
Wiley Low	-	20	5.3	21,287	1,348	302	6,141	-	82	1,102	10,250
Mean	-	20	6.3	182,414	4,338	1,298	64,535	-	227	2,132	109,686
L-3	4		6.5	214,470	5,597	1,923	60,766	1,652	212	759	119,920
L-4	9		6.6	100,590	2,542	2,082	32,143	403	412	1,263	67,760
P-15	25-35		6.5	127,490	5,517	1,546	35,764	621	222	1,895	75,390
P-16	35-40		6.8	50,010	3,727	588	8,008	146	343	2,040	20,871
P-17	76-81		7.4	2,670	86	172	445	12	465	1,112	158
P-18	156-161		7.6	2,590	91	146	467	11	469	682	579
P-19	215-220		8.0	3,290	22	34	1,118	9	560	6	1,512

the zone of lowest resistivity which is the highly concentrated brine in the near-surface. This hypothesis was supported by the failure of two-thirds of the apparent resistivity soundings to be interpreted by the resistivity program developed by Zohdy and Bisdorf (1975). This program calculates layer thicknesses and resistivities but cannot interpret VES curves that exceed a slope of 45°. Interpreted resistivity data could be obtained by this program for only 11 of the 36 resistivity stations. These stations are all located along the edges of the grid, which indicates that the current at the interior stations was greatly affected by the near-surface brine. Therefore, the interpreted resistivity data were not useful in our study. Although evidence suggests that at least a portion of the current is not reaching a depth equal to the electrode spacing, the results of the apparent resistivity survey were useful in delineating the lateral extent of brine movement and guiding the placement of ground-water instrumentation.

GROUND-WATER CHEMISTRY

Unsaturated zone water at a depth of 4 feet below the reclaimed brine-pond surface (L-4, Table 1) is chemically very similar to the mean concenttations of brines produced from the Wiley Field (Table 1). The exception to this is the generally lower sulfate concentrations in the pore water at the site in comparison to the brine. This may be the result of removal of sulfate from the aqueous system by the precipitation of gypsum ($CaSO_4 \cdot 2H_2O$) in the unsaturated zone. Large concentrations of gypsum crystals were observed in Shelby-tube sediment cores from the unsaturated zone. A parallel reduction in the calcium concentrations within this same interval is not evident. This is assumed to be due to the release of Ca^{++} by cation exchange as Na^{+} is adsorbed onto the smectitic clays.

Pore water at a depth of 4 feet in the reclaimed pond has essentially the same chemistry as that of the brines disposed of in the pond 10 to 25 years ago (Figure 6). Apparently, minimal

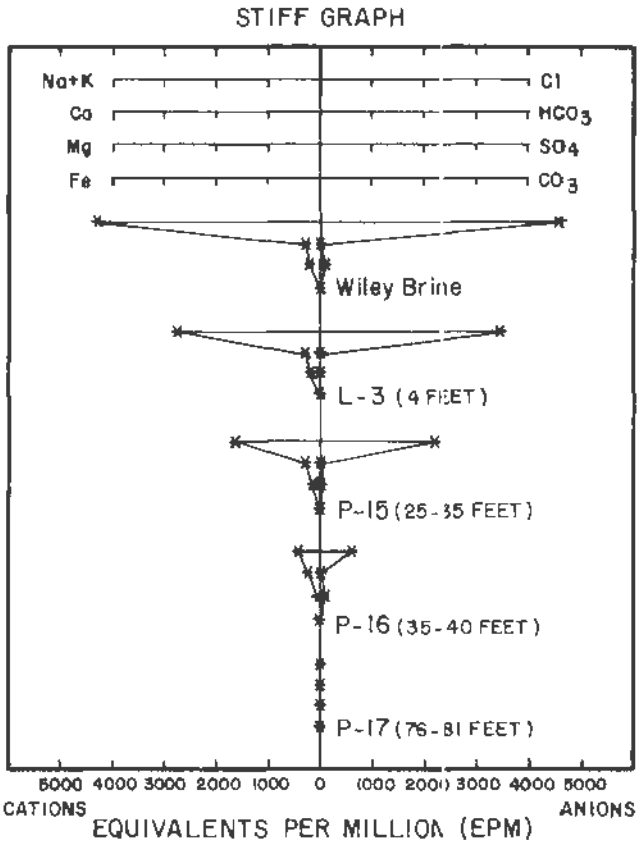


Fig. 6. Stiff diagrams of a Wiley Field brine (Wiley) and pore water (L-3) and ground water (P-15, P-16, and P-17) beneath the brine ponds.

flushing has occurred in the shallow subsurface at the site. The semiarid climate in this region generally results in few major recharge events per year (Rehm *et al.*, 1982). In addition, this water is restricted from moving through the subsurface by the reduction of sediment permeability as a result of the exchange of sodium from the brine to the clays.

The high ion concentrations in the pore water may also result from the original evaporative concentration of salts at the base of the pond. Although salt was observed macroscopically throughout the sediment cores, it did not occur in a concentrated layer in the unsaturated zone. These sediments may have become supersaturated with salts because of the evaporation of the brine and now constitute a source of leachate when fresh water infiltrates from the surface.

Chemical analyses of ground-water samples from the study site define a brine-generated leachate plume that extends laterally beneath an area of 250,000 ft^2 around the brine ponds. This plume extends down to a depth of approximately 70 feet (Figure 7). An area of high chloride that occurs at a depth of 160 feet beneath the pond

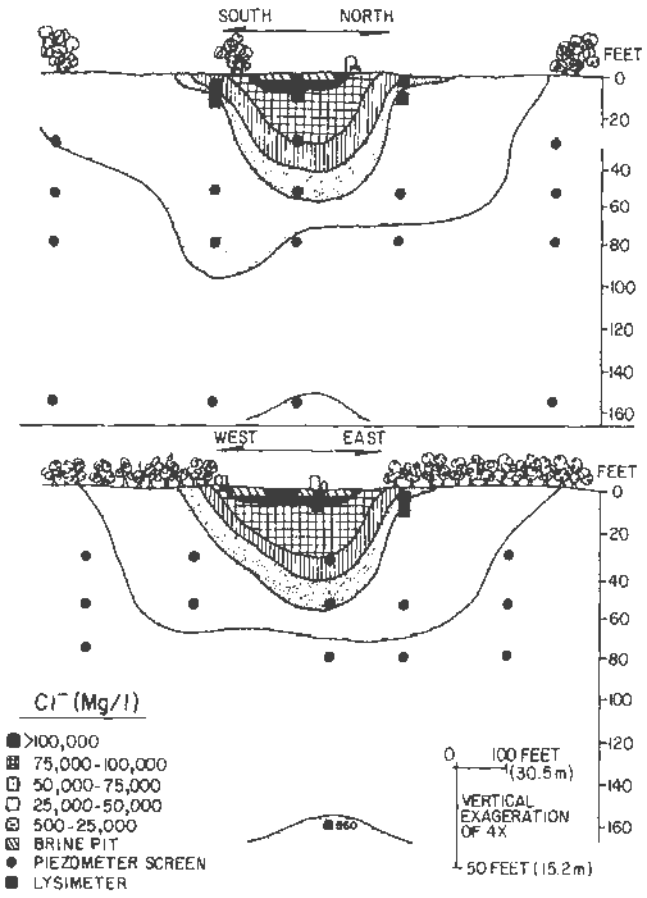


Fig. 7. Profiles of chloride concentrations at the study site.

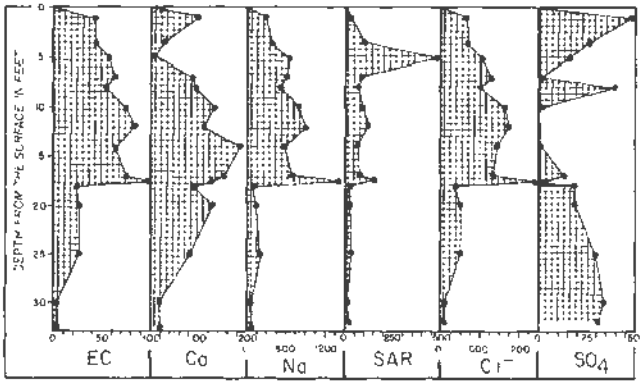


Fig. 8. Ionic concentration profiles from sediment samples beneath the brine ponds (Shelby Tube Hole #A).

appears to be the result of upward leakage from the Fox Hills Formation. The Fox Hills Aquifer in this area contains naturally occurring Cl$^-$ concentrations of up to 4000 mg/l in this area (Kuznair and Randich, 1982).

The movement of salts in the subsurface is further documented by analysis of sediment from beneath one of the brine ponds (Hole No. A, Figure 3). A sharp decrease in the Na^+ and Cl^- ion concentrations occurs at a depth of 18 feet (Figure 8). This depth corresponds to the color contact between oxidized and unoxidized till and is assumed to represent the water-table position prior to mounding caused by fluid disposal in the ponds.

This reduction in Na^+ and Cl^- ion concentrations may be due to the initial greater movement of leachate through the unsaturated zone. The alternate wetting and drying in this zone promotes greater fracture permeability in contrast to below the water table where the expansion of saturated smectitic clays decreases fracture permeability and reduces leachate movement.

DISCUSSION

A major question at this site is how long, and to what depth, the reclaimed brine ponds will impact subsurface water. Powell *et al.* (1963) documented widespread contamination of shallow aquifers by brine-evaporation ponds in Alabama. A study of these same areas 10 years after the closure of the ponds documented rapid cleansing of the impacted aquifers (Powell *et al.*, 1973). The same environmental conditions which had created rapid and widespread migration by brines at these sites, i.e., high annual precipitation, shallow water table, and permeable sediments, also contributed to the rapid water-quality improvement of the aquifers.

In contrast, the semiarid climate (15-19

inches of annual precipitation) and low hydraulic conductivity of the sediments at the Stratton SWD #1 site have resulted in limited movement of brine leachate in the shallow subsurface. The results of the earth resistivity surveys and ground-water chemistry indicate that the brine contamination is restricted to the till aquitard and has not affected any usable ground-water supply. The minimal flushing that has occurred at this site indicates that the amount of salt remaining at the site today is not significantly different from the amount at the time of pond abandonment.

The horizontal component of leachate migration is seven times that of the vertical component (500 vs. 70 feet) (Figure 7). It is this lateral surface and near-surface component of brine migration which is of most concern at this site. Salt migration is causing soil sterility, decreasing crop yields, and the death of trees in a shelterbelt within a 250,000-ft^2 area around the ponds. Interpretation of aerial photographs of this and other brine ponds taken over the last 25 years has documented the gradual lateral spread of brine in the plant-growth horizon from these sites over time (Foss *et al.*, 1985).

The heavily concentrated brine in the shallow subsurface within the reclaimed brine ponds at the study site is evidence that little dilution has occurred over the last 10 years. If no remedial action is taken, this site will continue to generate highly saline leachate for tens and possibly hundreds of years. The area of brine contamination will continue to grow slowly as ground water flows laterally away from the water-table mound and runoff flows freely from the site.

The study site is typical of many sites situated upon drift in the glaciated portion of North Dakota. The results from this study can be applied to leveled brine ponds situated in drift and other low permeable sediments throughout the oil-producing states.

RECOMMENDATIONS

The key to controlling or limiting the near-surface spread of brine at this site is to control infiltration in and out of the immediate pond areas. This can be done by either mounding soil above the old ponds or constructing an infiltration gallery around the site. Mounding the site is the least expensive method and would minimize the spread of brine from the area. Precautions would have to be taken to prevent capillary rise from bringing salts up through the mound. The construction of an infiltration gallery with a sump pump and the periodic use of artificial irrigation with $CaCO_3$ or $CaCl_2$ around the site would have an initial cost of between $20,000 to $30,000. This method is costly but would lead to the eventual flushing of brine from the shallow subsurface and make it possible to return this land to crop production in the foreseeable future. The land which has been taken out of production due to brine contamination is capable of generating gross annual revenue of $1250.00 (based upon 25 bushels of wheat to the acre and a $2.50 per bushel price). The cost of this remedial action is not extravagant when you consider that a jury in Oklahoma awarded a landowner $4,000,000 in damages ($2,000,000 in actual damages) from a brine pond that had been abandoned for 25 years (Hall, pers. comm., 1987).

As we have previously discussed, we predict that the area of brine contamination at the Stratton SWD #1, and at other brine ponds in similar geologic settings, will continue to spread. Therefore, as time goes by, these sites will become more expensive to reclaim. We are currently searching for sources of funding to enable us to implement our suggested methods of reclamation at both the study site and an additional brine pond. We plan to monitor the local ground-water and pore-water conditions over an extended period of time following reclamation.

We hope to use the information obtained from this study, and any future studies, to encourage oil companies to voluntarily reclaim the abandoned brine pond sites in North Dakota. It is in the companies' best interests to reclaim these sites because of the increasing tendency of juries to award huge sums of money to landowners for damages resulting from improperly reclaimed brine ponds in Oklahoma and other oil-producing states (Hall, 1986).

ACKNOWLEDGMENTS

This study was funded by a two-year grant (No. 5850-4138-6671) from the North Dakota Water Resources Research Institute through the North Dakota Mining and Mineral Resources Research Institute. This research was also supported in part by U.S. Bureau of Mines Grant No. G1164138. The study took place on land owned by North Dakota State University. The North Dakota Geological Survey provided vehicle and equipment support. Dr. Eugene C. Doll and Dr. Nyle C. Wollenhaupt performed analyses on sediment samples at the Land Reclamation Research Center in Mandan, North Dakota. Dr. John E. Foss, University of Tennessee, provided the aerial photograph of the site.

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Support of House Bill 1347

- By: Claude Sem
- On: ??, 2015

Good Morning Chairman Porter and members of the House Natural Resources Committee.

My name is Claude Sem, and I am here today to testify in support of House Bill 1347. I am the Chief Executive Officer of Farm Credit Services of North Dakota, but I am here today to testify as an individual in support of this bill. Farm Credit Services of North Dakota (FCSND) lends money to farmers and ranchers in Northwest North Dakota. Farm Credit has approximately 55% of the market share on real estate financing in its territory.

Much of that real estate lies in the oil rich Bakken region of North Dakota which is subject to possible contamination from well sites and pipelines. Farm real estate values have increased significantly the last several years and this has caused us to look closely at the increasing risk of financing land in a market where we begin to question whether those values will be sustained. A contamination of the land due to an oil or saltwater spill increases the risk of financing land that may be subject to such events.

Farm Credit is concerned about taking security in any property that has or potentially has hazardous material on the premises, such as from a saltwater spill or oil spill. In fact, we would be cautious of even taking collateral near the hazardous or potentially hazardous site. It is and has been the policy of FCSND to not take security in property that is or potentially will be environmentally damaged. FCS discourages credit applications on property that is contaminated and would, and will, deny approval if credit was requested.

I am offering this testimony because I think it's important for folks to know that farmers who have spills on their land don't just have land taken out of production and potential contamination; they also will have difficulty with financing at a time when they could really need it. It is my feeling that the provisions of HB 1347 which would first help prevent a hazardous land spill and secondly provide for clean-up, would be beneficial to North Dakota landowners.

Thank you.
Claude Sem

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MEMORANDUM

To: Fintan Dooley

From: Fugui Wang, Steven I. Apfelbaum

Date: March 1, 2020

Re: Update on Salt Spill Identification Effectiveness

AES has completed the analysis of the remote sensing methods and process to identify and map salt spills. The next step in the process is to field confirm the severity of representative salt spills that are mapped and then to classify the salt impacts in each spill location as to severity and reclamation investment needs.

The following is the summary of the process and findings:

1. A representative number of known salt spill locations were sampled by Darrell Peterson and others using electrical conductivity field measurement equipment **(see Figures 1 and 2**) and these known locations were used to automate the training of the computer modeling to predict other locations with salt spills.

2. A map of the entire project area was created using the computer modeling and training location spectral signatures to project and map other salt spill locations across the entire project area. The total number of predicted (and known) spill locations in the project area is 3,861 acres (4.2%) (**see Figure 3**) out of the total 92,155 acres of land.

3. Using the well head locations and known reported salt spills, the computer modeling accuracy was evaluated. The modeling was able to map a total of 1,873 individual sites in the entire AOI. In this application, the term “site” does not represent one site per spill, but an individual enclosed area. Many sites could be contaminated from a single spill. These mapped sites were identified as highly probable spill locations (locations where the spectral signature of the vegetation and soil system is aligned with known spill signatures) of unreported salt spills.

Summary

Using the project area as a test, the methods of remote sensing, computer modeling using known salt spill locations, and projecting the model findings over the larger area is highly efficient and effective at identifying and mapping salt impacted lands and vegetation systems.

The recommended next step in the project is to field confirm the severity of representative salt spills that are mapped and then to classify the salt impacts in each spill location as to severity and reclamation investment needs.

Figure 1: Known Salt Spills Locations

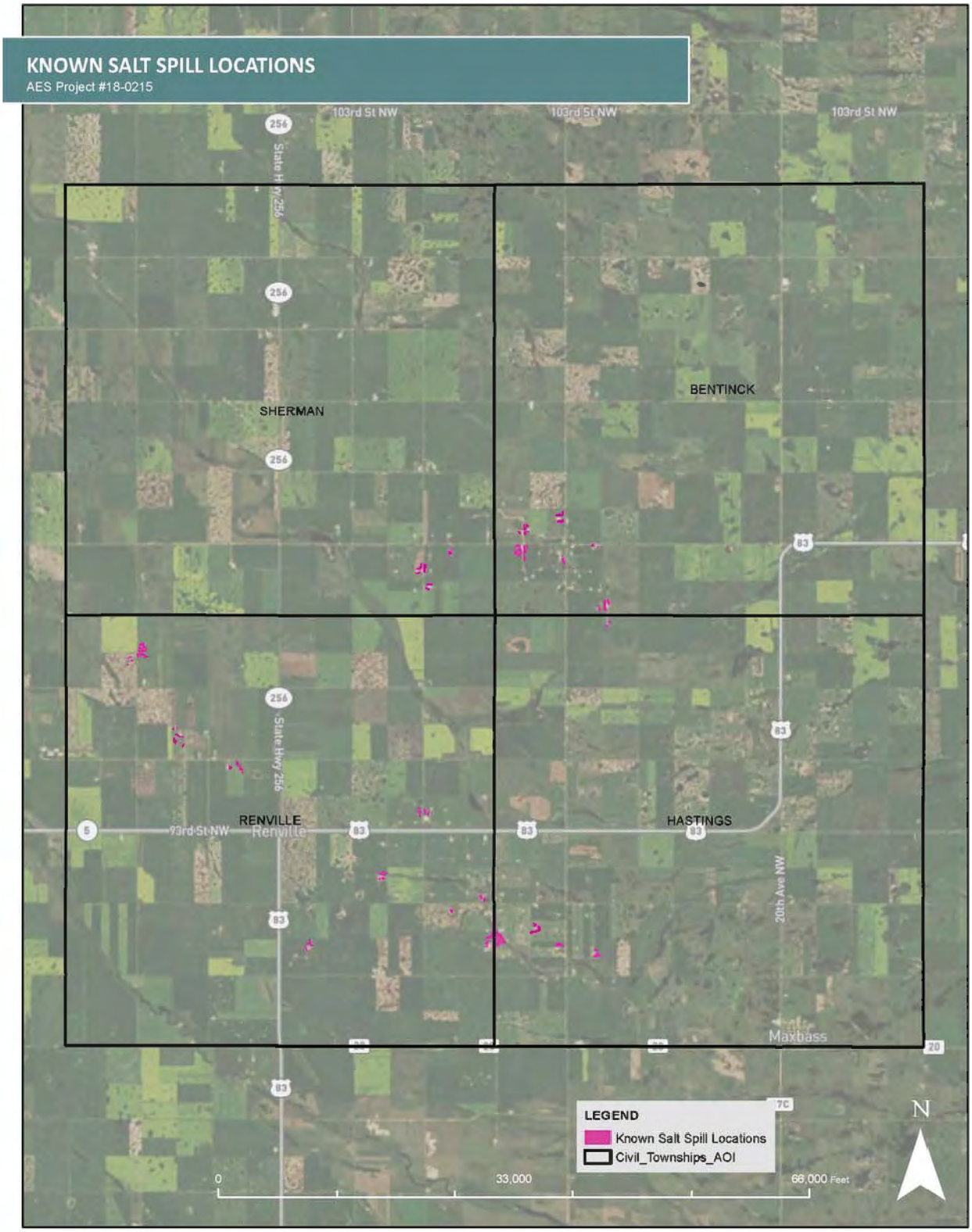

Figure 2: Electrical Conductivity Test Locations

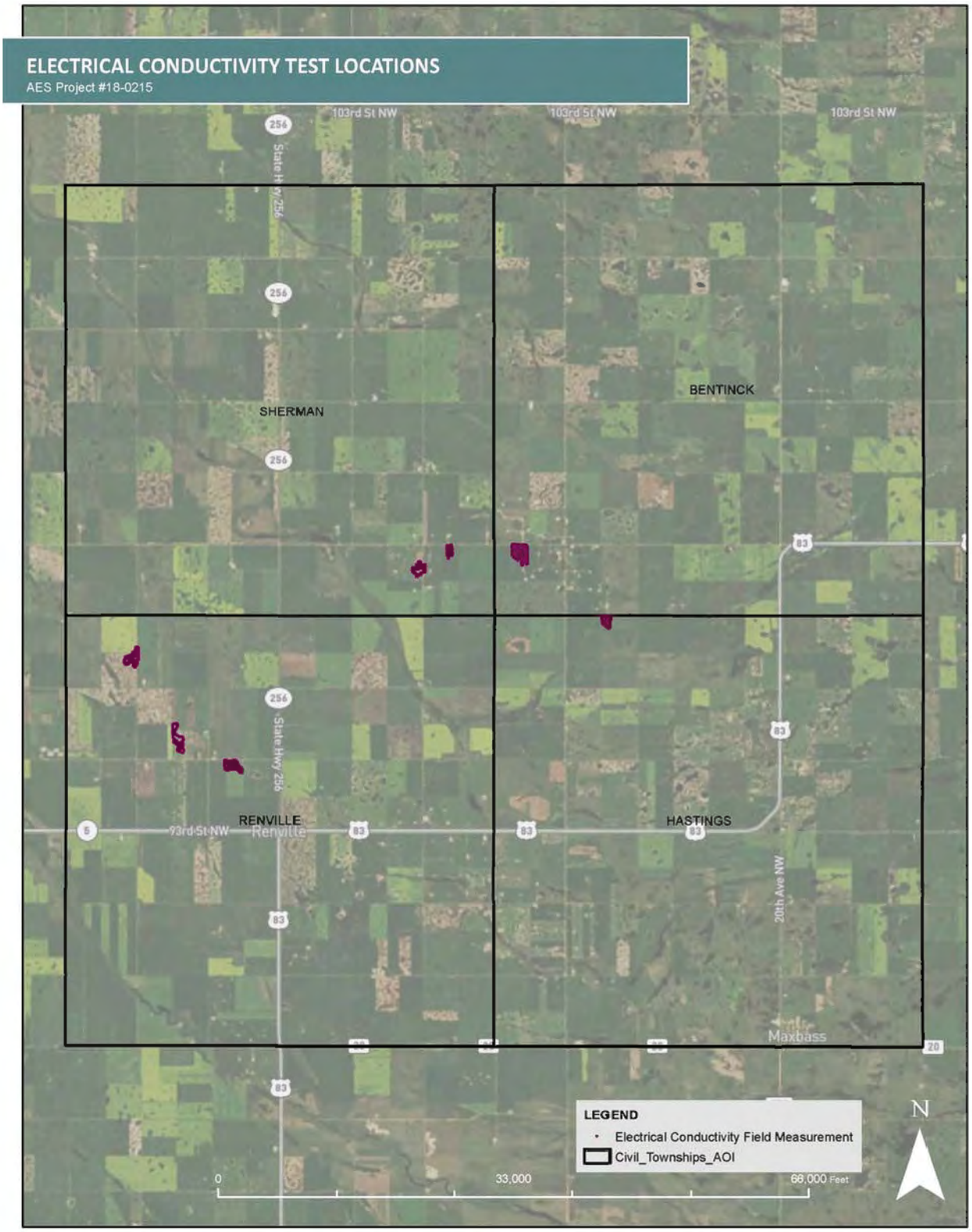

Figure 3: Predicted Salt Contaminated Lands