NORTH DAKOTA
BRINE EXTRACTION AND STORAGE TEST
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U.S. Department of Energy National Energy Technology Laboratory
Addressing the Nation’s Energy Needs Through Technology Innovation – 2019 Carbon Capture, Utilization, Storage, and Oil and Gas Technologies Integrated Review Meeting
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NORTH DAKOTA
BRINE TREATMENT AND STORAGE TEST
Because of a host of technical, social, regulatory, environmental, and economic factors, brine disposal tends to be more accessible and generally quicker, easier, and less costly to implement compared to dedicated CO$_2$ storage.
Brine extraction can enable dedicated CO$_2$ storage and improve the geologic CO$_2$ storage potential of a site.
TWO COMPLEMENTARY COMPONENTS

Active Reservoir Management (ARM) Test
• Reduce stress on sealing formation
• Geosteer injected fluids
• Divert pressure from leakage pathways
• Reduce area of review (AOR)
• Improve injectivity, capacity, and storage efficiency
• Validate monitoring techniques, and forecast model capabilities

Brine Treatment Test Bed
• Alternate source of water
• Reduced disposal volumes
• Salable products for beneficial use

Illustration modified from Lawrence Livermore National Laboratory https://str.llnl.gov/Dec10/aines.html
ACTIVE WATER DISPOSAL SITE AS A PROXY FOR DEDICATED CO₂ STORAGE
THE SITE
THE DESIGN (BALANCE)
BRINE TREATMENT TECHNOLOGY DEVELOPMENT AND TEST FACILITY

Enable development, testing, and advancement of commercially viable extracted and produced water treatment technologies that can meaningfully reduce brine disposal volumes and provide an alternate source of water and/or salable products for beneficial use.
• Permanent environmental enclosure
• Demonstration bay with concrete floor
• Integrated with ARM and SWD infrastructure
• Treatment rates up to 25 gpm (bench to pilot)
• Blending and pretreatment
• SCADA, energy/material and operability controls
ACCOMPLISHMENTS
ACTIVE RESERVOIR MANAGEMENT
ACCOMPLISHMENTS
ACTIVE RESERVOIR MANAGEMENT

- Drilling and completion (BEST-I1,BEST-E1)
- Tie in with SWD infrastructure
- SCADA, HSE, and operability systems installed/tested; fixes and modifications incorporated; full integration and shakedown
- Achieved target rate of 5000 bbl/day
- **Site is fully operational**
- Updated performance models
- Updated and initiated field implementation plan (FIP)
ACTIVE RESERVOIR MANAGEMENT
RESPONSE

- Pressure communication between the extraction well and two injection wells
  - Connectivity confirmed
  - Measurable and significant response
  - Pressure buildup in reservoir due to injection
  - Brine extraction slows pressure buildup.
ACCOMPLISHMENTS TO DATE

BRINE TREATMENT DEVELOPMENT FACILITY
ACCOMPLISHMENTS TO DATE
BRINE TREATMENT DEVELOPMENT FACILITY

• Design and build complete
• SCADA, HSE, and operability systems installed/tested; fixes and modifications incorporated; shakedown complete
• **Facility is fully operational.**
• First demonstration completed
  – MVR, August 2019
North Dakota water treatment test bed facility available for demonstration of produced water treatment technologies.

Enable development, pilot testing, and advancement of commercially viable extracted and produced water treatment technologies that can meaningfully reduce future disposal volumes and provide an alternate source of water and/or valuable products for beneficial use.

TEST BED FACILITY CAN REPLICATE EXTRACTED WATERS THAT ARE REPRESENTATIVE OF LOCATIONS/SOURCES THROUGHOUT THE UNITED STATES

SITE SPECIFICS
- historic STF building 50 x 40' x 15'
- 1ST decontaminated clay (accommodates west fractionation)
- 600 BBL reed power
- Tank farm
- Ferris Island oil, water treatment area, and control room
- 8 BBL sewer tank
- RV and trailer
- 350 BBL polymer tank
- Sedimentary water storage tank for decaolulation facility
- Flow test water tank for pilot use
- Pump treatment train moving up to 100 gpm
- Water day removal of decaolulation
- Capable of 20,000 gallons per day

FACILITY CAN BE READILY ADAPTED FOR USE WITH ALTERNATE FLUID COMPOSITIONS OR TREATMENT PROCESSES
- Alternative water source treated and injected
- Development well and water treatment can be modified to accommodate<br>
- Various influents
- Storage and treatment facility for decaolulation of water
- Test facility in existing technology (e.g., power plant, wastewater, coal mining)
- Gas dehydration and fractionation facility
- Cimarron field brine and mixed fluid facility
- Gas accumulation storage (2,000 gal) and treatment facility

CONTROL ROOM
- Fluent in English; fluent in Spanish
- Electrical engineer
- Energy and chemical engineer
- Gas dehydration, fuel, and water and gas treatment facility
- Process control engineer
- Facility management

This is a collaborative effort with Nuvera Environmental Solutions and the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL).

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Mike Fluck, Project Manager, DOE NETL, (202) 586-3177

www.nuvera.org
www.undieerc.org
REGIONAL CHALLENGES

Technological:
• Very high salinity brines (100,000 to >300,000 mg/L TDS).
• Potential for fluid interactions, scaling, TENORM (technologically enhanced naturally occurring radioactive material) or biogenic gas in treated concentrate streams.

Logistical:
• Environmental conditions … Winter!

Economic:
• Geologic injection is cost-efficient and convenient.
• Freshwater is inexpensive and abundant.
• Limited demand for brine treatment (ahead of market).
CHALLENGES

Maintain an up-to-date risk register, mitigate risks where prudent, incorporate flexibility where possible, robust designs and contingency plans, be adaptive as conditions change.

- Extracted fluid temperature
- Injection rates/volumes in offset wells.
- Lessons from peers

Results from ARM field tests carry far reaching benefits that can positively impact commercial CCS implementation.

Large field tests have elevated risks and challenges.

Risk, cost, and objectives must be managed together.
Public/Private partnership is key

Committed partners, strong relationships, and full roster of experts.

Design phase provides opportunity to develop robust design that incorporates flexibility.

Communication is crucial.
SYNERGY OPPORTUNITIES

MONDAY

SUBSURFACE PLENARY

PLAINS AND NORTHWEST

1:30 PM
North Dakota Integrated Carbon Storage Complex Feasibility Study (E0029488)
• Wesley Peck, University of North Dakota Energy and Environmental Research Center (O'Dowd)

2:00 PM
Integrated Midcontinent Stacked Carbon Storage Hub (E0031623)
• Andrew Duguid, Battelle Memorial Institute (McNemar)

2:30 PM
Commercial-Scale Carbon Storage Complex Feasibility Study at Dry Fork Station, Wyoming (E0031624)
• Scott Quillian, University of Wyoming (O'Dowd)

3:00 PM
Developing and Validating Pressure Management and Plume Control Strategies in the Williston Basin Through a Brine Extraction and Storage Test (E0026160)
• John Homling, University of North Dakota Energy and Environmental Research Center (McNemar)

WEDNESDAY

SUBSURFACE BREAKOUT

GEOLOGIC STORAGE

Task 4: Active Reservoir Management (E19-0191)
• Thomas Buscheck, Lawrence Livermore National Laboratory (McNemar)

3:50 PM

TUESDAY

SUBSURFACE PLENARY

2:00 PM
Gulf Coast Field Demonstration at a Flagship Power Plant to Assess Optimal Reservoir Pressure Control, Plume Management and Produced Water Strategies (E0026140)
• Robert Trautz, Electric Power Research Institute Inc. (Hall)
Facility can be readily adapted for use with alternate fluid compositions or treatment processes.

• Alternate water sources trucked and offloaded at site.

• Pretreatment and conditioning can be modified to replicate broader influent specifications.

• Blending of additives to replicate target fluid chemistries.

• Application of cascade technologies (e.g., power/thermal supply, pretreatment/conditioning…).

• On-site SWD and waste handling.
NORTH DAKOTA BRINE TREATMENT FACILITY
POTENTIAL ADAPTATION FOR EXPANDED APPLICATION

- Oil and gas fluid conditioning (e.g., emulsion breaking, corrosion, scale inhibitors, fluid compatibility testing, etc.)
- Produced water treatment
- Electric power generation wastewater treatment
- Industrial and municipal waste and water treatment
- Mineral resource recovery
- Agricultural water treatment
- Geologic conditioning and homogenization as a means of water pretreatment
- Benchmarking the economic and technical limits of water treatment technologies (e.g., MVR)
- Collaboration with other federal, state, or industry groups
This material is based upon work supported by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under Award No. DE-FE0026160.
North Dakota water treatment test bed facility available for demonstration of produced water treatment technologies.
SITE EVENTS

STAKEHOLDER ENGAGEMENT AND COMMISSIONING

IEAGHG RISK AND MODELING NETWORK MEETING
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THANK YOU

Critical Challenges. Practical Solutions.
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BENEFIT TO THE PROGRAM

This project is expected to result in the development of engineering strategies/approaches to quantitatively affect changes in differential formation pressure and to monitor, predict, and manage differential pressure plume movement in the subsurface for future CO₂ saline storage projects. Additionally, the brine treatment technology evaluation is expected to provide valuable information on the ability to produce water for beneficial use. The results derived from implementation of the project will provide a significant contribution to the U.S. Department of Energy’s (DOE’s) Carbon Storage Program goals. Specifically, this project will support Goals 1 and 2 by validating technologies that will improve reservoir storage efficiency, ensure containment effectiveness, and/or ensure storage permanence by controlling injected fluid plumes in a representative CO₂ storage target. Geologic characterization of the target horizons will provide fundamental data to improve storage coefficients related to the respective depositional environments investigated, directly contributing to Goal 3. In addition, this project will support Goal 4 by producing information that will be useful for inclusion in DOE best practices manuals.
PROJECT OVERVIEW
GOALS AND OBJECTIVES

• Confirm efficacy of ARM for commercial scale CCUS
  – Managing injection performance and formation pressure
  – Model, predict, monitor and validate movement of fluids and pressure
  – Generate results that enable evaluation and adoption of concept at compatible CCUS sites.

• Implement and operate a development facility for brine treatment technologies applicable to ARM for CCUS

Three development stages over 71 months
1. Site preparation and construction
2. Site operations for ARM and brine treatment technology testing and development
3. Project closeout/decommissioning and data processing/reporting
Gantt Chart, Deliverables, and Milestones

Deliverables

Milestones (M)

D1 — Updated PMP
D2 — Field Implementation Plan (FIP) Finalized
D3 — Water Treatment Technology Selection Process Summary
D4 — Preliminary Schedule of Technologies
D5 — Vol. 1 — ARM Engineering and Evaluation Summary
D6 — Vol. 2 — Technology Evaluation Report
D7 — Data Submission to EISX
D8 — Lessons Learned Document
M1 — Project Kickoff Meeting
M2 — Permit to Drill Submitted
M3 — Water Treatment Test Bed Permit Received
M4 — Staff Water Treatment Facilities Construction
M5 — Permit to Drill Planned
M6 — Staff Site Preparation
M7 — First Treatment Technology Selected
M8 — Test Installation Complete
M9 — Surface Installation Complete
M10 — Water Treatment Facilities Complete
M11 — Intake Stage 1 of Experimental Scenario
M12 — Intake Collection of Operational Data
M13 — Water Treatment Test Bed Fully Operational
M14 — Intake Stage 2 of Experimental Scenario
M15 — Final Treatment Technology Evaluated
M16 — Completion of ARM Operations
M17 — Conduct Repeat ETEM Survey
M18 — Completion of Water Treatment Technology Demonstration
M19 — ARM Site Decommissioning/Disposal Completed
M20 — Water Treatment Test Bed Decommissioning/Disposal Completed

Note: The contract was signed for Phase I from May 31, 2016, to September 6, 2016.

Red line indicates the end of the 5 year program.
ORGANIZATION CHART

Senior Oversight
Ed Stedman
John Harju
Charles Gorecki

Project Advisors
Jim Sorensen
Wes Peck
Larry Pekot

Lead Organization
Energy & Environmental Research Center (EERC)

Principal Investigator (PI)
John Hamling
Assistant PI
Ryan Klapperich

Project Partners
U.S. Department of Energy
Nuverra Environmental Solutions
Schlumberger Carbon Services
Computer Modelling Group Ltd.

Host Site Operator
Nuverra Environmental Solutions

Cost-Share Providers
Schlumberger Carbon Services
Computer Modelling Group Ltd.

Task 1
Project Management, Planning, and Reporting
Lead
John Hamling

Task 2
ARM Site Preparation
Lead
Lonny Jacobson

Task 3
Test Bed Site Preparation
Lead
Lonny Jacobson

Task 4
ARM Operations
Lead
Ryan Klapperich

Task 5
Test Bed Treatment Operations
Lead
Marc Kurz

Task 6
ARM Data Processing/Project Closeout
Lead
Lonny Jacobson

Task 7
Test Bed Data Processing/Project Closeout
Lead
Marc Kurz
BIBLIOGRAPHY


- Test bed operational June 2019
- ARM FIP Initiated
- Seeking technologies for testing at ND Brine Treatment Test Bed User Facility.
- First technology selected and scheduled for testing

2019

- Seek and schedule technologies for testing at ND Brine Treatment Test Bed User Facility.
- Preferred operations in spring, summer, or fall
- Update and continue ARM FIP, data collection, and interpretation

2020

- Operations currently planned through September 2021
- Generate results that enable evaluation and adoption of concept at compatible CCUS sites

2021

North Dakota Brine Treatment Facility and ARM Test Operating Time Frame