Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title: Study to determine the feasibility of developing salt caverns for hydrocarbon storage in Western North Dakota

Applicant: ATCO Energy Solutions Ltd.

Principal Investigator: Bob Armstrong

Date of Application: September 16, 2019

Amount of Request: $1,047,500

Total Amount of Proposed Project: $2,095,000

Duration of Project: 18-24 months

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ABSTRACT

Objective:

The objective of this study is to prove the viability of developing salt caverns in western North Dakota for hydrocarbon storage capable of supporting a large petrochemical industry.

A key requirement for petrochemical development is the availability of affordable large capacity hydrocarbon storage in the form of salt caverns.

In general, the salt formations across the state are very thin and too deep for the development of salt caverns. A preliminary review of available geological data from the State and other sources was conducted which identified salt formations in several locations that potentially meet requirements for the development of caverns.

Expected Results:

The study will produce the following results:

- Determine locations in western North Dakota that salt cavern development is viable
- Establish the maximum size of cavern that can be developed
- Establish a solution mining plan for developing caverns
- Develop a cost estimate for mining the caverns

The results and conclusions developed through the project will support the assessment of the suitability of western North Dakota as a location for petrochemical development.

Duration:

The study is expected to take between 18 to 24 months to complete.

Total Project Cost

Cost Estimate		
		Cost
Phase 1		
ATCO Analysis and Reporting	$	60,000
Geological Study	$	125,000
Geomechanical Study	$	100,000
Cavern Engineering	$	65,000
Sub Total	$	350,000
Phase 2		
ATCO Analysis and Reporting	$	170,000
Drilling and Core Collection	$	750,000
Update Geological Study & Seismic Analysis	$	465,000
Update Geomechanical Study & Core Testing	$	330,000
Update Cavern Engineering	$	30,000
Sub Total	$	1,745,000
Total	**$**	**2,095,000**

Participants:

The project will be conducted using various resources for the specific scopes, which include geological and geomechanical work, cavern engineering, and field services. Bids will be obtained for the specific services upon approval of the project. ATCO will direct the project work, conduct the overall compilation and analysis of the work, and generate the conclusions.

PROJECT DESCRIPTION

Objectives:

The Study to Assess the Feasibility of Developing Salt Caverns in Western North Dakota (the Study) will determine if and where salt caverns can be used for hydrocarbon storage to support the development of a petrochemical industry in the State, and at what cost. The study will determine the key geographic locations where the salt characteristics are suitable for such development and the capacity of potential caverns that could be developed.

Salt cavern storage of hydrocarbons is a key component for the operation of a petrochemical facility and will be a key consideration for investment. Caverns are used to store both the feedstock to the industry, such as ethane, propane, and butane, and the purity products produced**.**

Methodology:

ATCO will conduct the Study in two phases:

Phase 1) Geomechanical and a geological review of the study area using existing information.

Phase 2) Field study to obtain data and refine models.

The scope of work for each phase is as follows.

Phase 1 is anticipated to take approximately three to four months to complete and will include the following scope of work:

- Complete comprehensive review of all available well logs in the area of interest to identify key salt target locations
- Conduct preliminary geomechanical assessment of a theoretical salt cavern developed in the applicable salt formations using typical salt qualities
- Develop a preliminary salt cavern solution mining plan
- Identify potential brine disposal zones in the key target areas
- Identify subsequent activities to obtain detailed salt properties including composition and mechanical properties
- Identify subsequent activities to validate salt extents
- Develop preliminary cost estimate for mining a salt cavern

Phase 2 is anticipated to take approximately 15 - 20 months to complete and will include the following scope of work:

- Obtain and review seismic data to correlate with well logs to confirm salt zone extents
- Obtain a core sample from the applicable salt zone(s) (including cap and basement rocks)
- Obtain a core sample from the disposal zone

- Complete comprehensive testing of the salt and rock cores
- Develop a detailed salt cavern mining plan using observed salt properties
- Conduct a geomechnical assessment of the salt cavern using observed salt properties
- Refine the cavern development cost estimate based on Phase 2 findings

Anticipated Results:

It is expected that the results of this study will conclude it is possible to develop cost-effective large capacity hydrocarbon cavern storage in western North Dakota. The study will also conclude the maximum cavern size/capacity that can be developed, the expected cost of development, and a cavern mining plan.

Facilities:

No specific facilities are anticipated to be required for this Study. As part of Phase 2, ATCO plans to work with existing producer companies to obtain salt core samples by using wells already being drilled for oil production to avoid drilling a well specifically for core sampling.

Resources:

The Study will be conducted using ATCO employees and third-party consultants. Consultants planned to be engaged for the project include:

- Neset Consulting (geological services)
- RESPEC (geomechanical services)
- Lonquist (cavern engineering)
- Local contractors and producers for coring, drilling and related activities

Additional resources required for Phase 2 of the Study will be used to complete the acquisition of the salt and rock cores.

Techniques to Be Used, Their Availability and Capability:

The main techniques to be used for the study in Phase 1 will be an analytical review of existing data, computer modeling, and computer simulations.

A geological consulting team will collect and review existing well files, core samples and seismic information. With the expected outcome of determining, the boundaries of the salt formation that can be developed in the target area, thickness of the salt formation, brine disposal zone, and salt characteristics.

Geomechanical consultant will develop a single axisymmetric model of a cavern using typical rock and salt properties of the area. The model will be used in a computer simulation the cavern over a 30-year time span to predict the stability of the surrounding salt, casing strain of the well, and cavern growth and closer.

Results from geological work and geomechanical work will be used to determine if development of caverns is possible and if the project should move forward with Phase 2.

Phase 2 of the study will focus on the field work and will utilize modern drilling techniques to obtain actual core samples of the salt formation and disposal formation including samples of the cap rock and basement rock adjacent each formation. Wireline tools will be used to collect detailed formation logs.

Core samples taken from the well will be sent to the lab for testing to determine physical properties of sample. Properties of each zone will be fed back into the computer models and new simulations will be run. The properties will also be used in the development of the cavern mining plan.

All techniques will be performed by third party resources that are identified in the Resource section and are readily available.

Environmental and Economic Impacts while Project is Underway:

No environmental impacts are expected during the Study. As the field drilling and core collection portion of the study aim to use existing drilling activities, no incremental drilling waste is anticipated for core sampling.

It is expected that the project will have a positive economic impact as the intent is to use (where possible) local contractors and consultants.

Ultimate Technological and Economic Impacts:

There is potential for a large economic impact for the State of North Dakota. Proving that it is possible to develop salt cavern storage will help serve industries that require large volume hydrocarbon storage.

Why the Project is Needed:

Understanding the viability of developing commercial salt caverns in western North Dakota is very important in the ability of North Dakota to attract value-add investment by the petrochemical industry. Salt cavern storage for feedstock and purity products is a fundamental component of the petrochemical value chain.

Information obtained from the results of the study will be used in the overall assessment of petrochemical processing feasibility and selection of the location for new, value-add investment in western North Dakota.

STANDARDS OF SUCCESS

The measurable project deliverables will include a completed study on salt cavern viability for value-add development in western North Dakota, including a core sample. Success will include the study being completed on time and on budget.

Results from this study will develop baseline information that will lead to other projects in western North Dakota which create significant value to the state. The information and knowledge that will be generated will directly support new, value-added industry investment in North Dakota and can be used by the State and by private investors to support development of petrochemical and other industry development within the state. The value to the state of viable salt cavern storage will be that the state can attract new value-add industrial development, in particular petrochemical investment. Petrochemical investment will preserve existing oil and gas jobs by preventing curtailment due to pipeline constraints or flaring restrictions, create new jobs in value-add industries which have invested and require salt cavern storage for hydrocarbon products, support continued or increased oil production royalties, increase tax revenues from economic growth and expand the economy in the area around these developments. The size of resulting investment has the potential to increase economic activity through direct jobs and indirect jobs related to new population in the area.

Natural gas production in North Dakota is projected to rise by 30% or more by 2022 (currently at 2.9 Bcf per day) at the same time the gas to oil ratio is also increasing. This production will continue to push development of NGL infrastructure such as takeaway capacity, gas-processing plants, and fractionators, which all leads to the demand for storage of NGLs.

Petrochemical investment can support alleviation of flaring by consuming more natural gas and ethane in state and can improve oil production by creating a market for associated natural gas liquids currently being rejected and taking up pipeline capacity, which positively affect ultimate recovery of ND's existing oil and gas pools. By enabling the continued production of oil, results can preserve existing jobs and production levels which could otherwise be curtailed from pipeline limits and can create new jobs.

NGL storage is a requirement of the petrochemical industry with salt cavern storage being the most attractive option assuming the required geological conditions exist. Market potential for oil, natural gas and associated byproducts would be significantly increased should salt cavern storage be viable in North Dakota.

The potential that commercial use will be made of the project's results is significant. Commercial uses include development of salt cavern storage facilities required to support petrochemical investment in the State. Should salt cavern storage be viable in north west North Dakota, the potential that salt cavern development to support petrochemical investment occurs is high. Without this information, investment is improbable. Storage of additional hydrocarbons or commodities can also be stored attracting other investment should it be viable. The private sector would make immediate use of the results in investment decisions, in particular petrochemical, midstream, pipeline and producer investments. Other industries requiring hydrocarbon or other energy storage may also make use of the results.

The project/study will also enhance the research, development and marketing of North Dakota's oil and gas resources by better understanding the marketability of the salt formations which will enable the State to market to and attract new industries which require large scale storage availability. The public sector can make additional use of the project's results by improving understanding of the State's geology and natural resources. These results can be immediately used for economic development and by the state's industrial commission to attract value-add investment to the state.

Overall the results of this study, if positive, can directly support value-add investment in western North Dakota which in turn can support flaring reduction and mitigation of pipeline heat content limitation when exporting natural gas.

BACKGROUND/QUALIFICIATIONS

ATCO owns and operates 10 existing natural gas and natural gas liquids (NGL) salt caverns and one depleted reservoir natural gas storage facility in Alberta, Canada. Through these assets, ATCO has developed experience with underground storage of hydrocarbons and has established relationships with consultants who are experts in specific aspects of underground storage.

Bob Armstrong is the principal investigator for the project. He is the Manager, Projects and Development for ATCO Energy Solutions Ltd. and is a Mechanical Engineer registered with the Association of Engineers and Geoscientists of Alberta. Bob has over 20 years of experience with design and operations of natural gas and NGL infrastructure including responsibility for underground natural gas storage and salt cavern development.

MANAGEMENT

The study will be managed using the principles of the Project Management Institute. Baseline scope, schedule and cost will be established for each scope of work and for the overall project. Regular status meetings will be held to assess performance to the project baseline and action will be taken to ensure that the project remains on track to meet its deliverables. Any changes to the project scope, schedule or cost will be managed through a Change Management Process.

Upon completion of the Phase 1 deliverables, the geological and geomechanical results will be assessed by ATCO. Pending the results of Phase 1 and a positive outlook for the need for cavern development, ATCO will proceed with Phase 2 of the study.

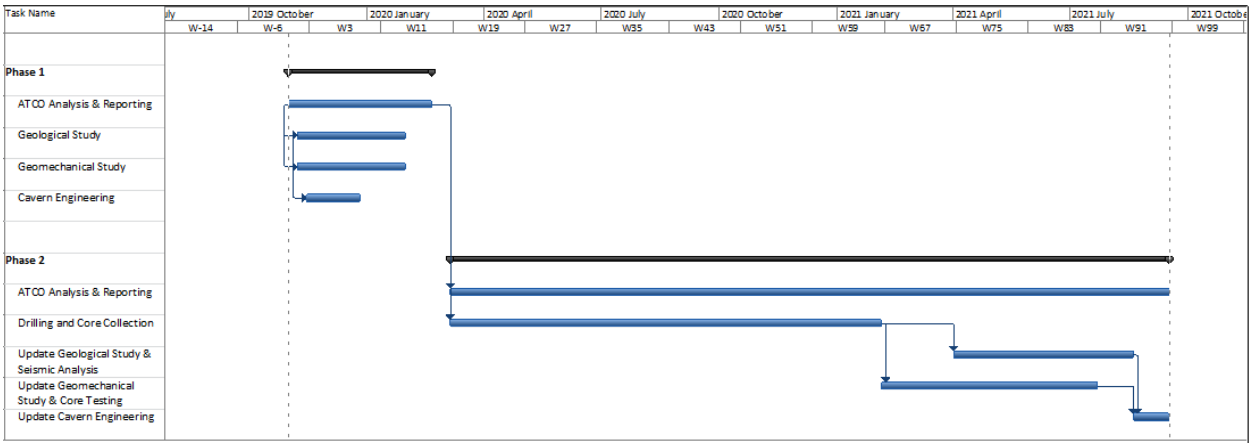
TIMETABLE

The anticipated duration of each phase of the project is as follows:

Phase 1: 3-4 months

Phase 2: 15-20 months

The project will follow the approximate schedule shown below.



An interim report will be submitted upon completion of Phase 1 of the study. A final report will be submitted upon completion of Phase 2 of the study.

BUDGET

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Phase 1				
ATCO Analysis and Reporting	$ 30,000		$ 30,000	
Geological Study	$ 62,500	$ 62,500		
Geomechanical Study	$ 50,000	$ 50,000		
Cavern Engineering	$ 32,500	$ 32,500		
Phase 1 Total	**$ 175,000**	**$ 145,000**	**$ 30,000**	
Phase 2				
ATCO Analysis and Reporting	$ 85,000		$ 85,000	
Drilling and Core Collection	$ 375,000	$ 375,000		
Update Geological Study & Seismic Analysis	$ 232,500	$ 232,500		
Update Geomechanical Study & Core Testing	$165,000	$165,000		
Update Cavern Engineering	$ 15,000	$ 15,000		
Phase 2 Total	**$ 872,500**	**$ 787,500**	**$ 85,000**	
Total	**$ 1,047,500**	**$ 932,500**	**$115,000**	

CONFIDENTIAL INFORMATION

ATCO requests that all information, results and conclusions generated through completion of this study be kept confidential for a period of five years from completion of Phase 2 of the study.

The extended confidentiality period is requested due to the integrated nature of the information that will be developed through the study, the very long lead time required to develop subsequent projects, and the criticality of confidentiality during that period.

PATENTS/RIGHTS TO TECHNICAL DATA

ATCO does not request to reserve any patents/rights to the technical data generated by the study, but reserves the right to use the results for its further works.

STATUS OF ONGOING PROJECTS (IF ANY)

ATCO has not received any previous funding from the Commission.