FACTSHEET FOR SOUTHWEST PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Southwest Regional Partnership on Carbon Sequestration			
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Field Test Information: Field Test Name		Southwest Deep Saline Sequestration		
Test Location		Farnham Dome near Price, Utah		
Amount and Source of CO_2		**Tons** 2.9 Million tons	**Source** Farnham Dome (natural source)	
Field Test Partners (Primary Sponsors)		Savoy Energy, LLC		
		Pure Petroleum, LLC		
		Pacificorp Rocky Mountain Power Southern California Edison		

Summary of Field Test Site and Operations:

The SWP will accomplish a major sequestration deployment in the Farnham Dome in central Utah. This test will follow an injection schedule over 4 years, leading up to 900,000 tonnes (1 million U.S. tons) of CO_2 per year. The target formations for this deployment include deep Jurassic-, Triassic-, and Permian-aged sandstones in the Farnham Dome of Utah. These formations are also targets of potential commercial sequestration throughout the western United States. The SWP plans include a "dual completion" with injection in two different formations at the same time. By carrying out two tests in two different formations within the same stratigraphy, portability of science and engineering results can begin to be evaluated.

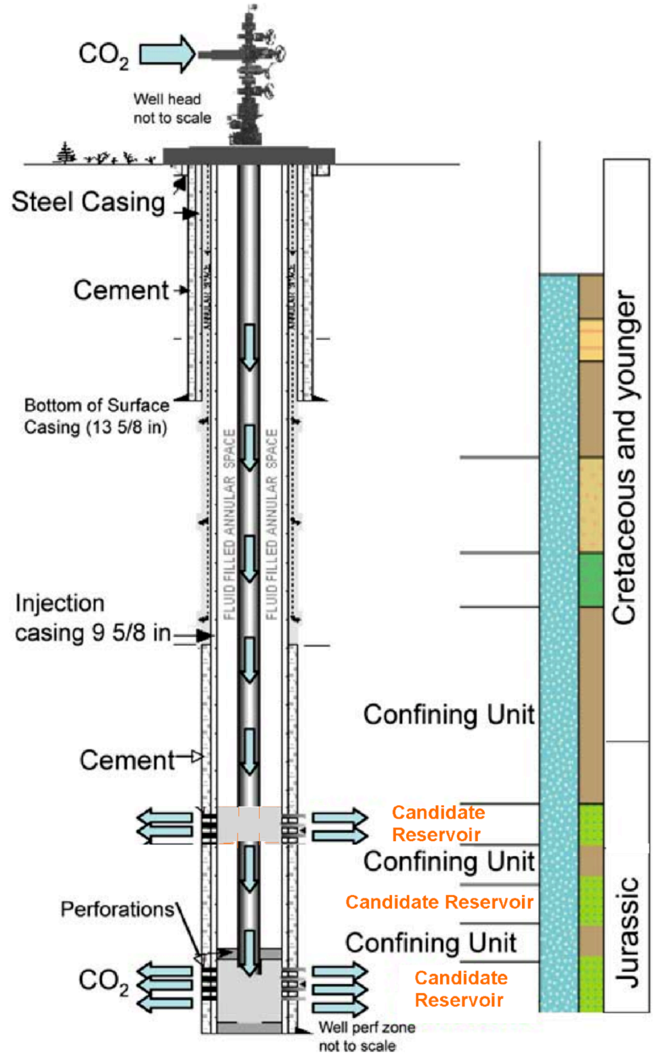

Figure 2. Schematic of injection well design.

Injection Site Description

The Farnham Dome injection site is located just southwest of the Uinta basin near Price, Utah, 120 miles south of Salt Lake City, in central Utah. Farnham Dome is an elongated surface anticline located along the northern plunge of the San Rafael uplift and the western edge of the Uinta basin.

Drilling along the crest of Farnham Dome in the 1920s and 1930s resulted in the discovery of significant deposits of CO_2 in the Jurassic Navajo Sandstone and small shows of CO_2 in Triassic, Permian, and Pennsylvanian reservoirs. Given that the more shallow Jurassic units hold significant CO_2, the deeper Triassic and Permian units appear promising with respect to large CO_2 capacities and low risk with respect to leakage. The area provides an excellent deployment test opportunity for analysis of high injection rates and high resolution monitoring of CO_2 in multiple rock layer horizons. These deep saline formations are major targets for commercial-scale sequestration associated with future coal-fired power plants planned for the area. Much of the Farnham Dome site falls under jurisdiction of the U.S. Bureau of Land Management.

Description of Geology

The target formations are deep saline units present throughout the Southwest Partnership region, as well as in many states outside the region. In all cases, the seal is the Morrison Formation, a thick (400 feet) shale/gypsum/siltstone of Jurassic age, also regionally present throughout the SWP states. The specific target formations are the Jurassic Wingate Formation and the Permian White Rim Formation, both sandstones. At the Farnham Dome and all other sites, the target units lie within a true "stacked" system—above the Morrison formation lies the Dakota formation, a Cretaceous-aged sandstone similar to the deep Triassic and Permian sands, and capped by the Pierre/Mancos shale, a very thick (1,500 feet to 5,000 feet) shale unit. The SWP has gathered porosity, permeability, mechanical, compositional, and geophysical data associated with these target formations and seals.

Source of CO_2

For the Farnham Dome deployment site, the sources of CO_2 include natural CO_2 from the Jurassic-aged Nugget Sandstone. A second potential source is a coalbed methane (CBM) production field northwest of Price, Utah; the CBM operation currently vents over 100,000 tons of CO_2 per year. A short pipeline would need to be added to facilitate injection of captured CO_2 into the deep saline reservoirs at Farnham Dome. All CO_2 captured will be 97 percent pure.

Injection Operations

For the Farnham Dome site in Utah, a minimal length of pipeline will be added in order to deliver the CO_2 for deep injection. Savoy Energy LLC, the field operator, is completing designs for necessary pipelines. Upon completion of the deployment phase test, this pipeline will be used to transport the captured CO_2 from the Farnham Dome site to the Uinta Basin enhanced oil recovery market.

Characterization Data

Because the Farnham Dome lies along the edge of the Uinta Basin, an active petroleum exploration area, the amount and quality of characterization data is fairly good.

Research Objectives:

SWP's overall goal is to validate the information and technology developed under the Characterization and Validation Phases relative to research and field activities, public outreach efforts, and regional characterization. Specific objectives include:

- Develop an overall methodology that optimizes engineering and planning for future commercial-scale sequestration projects
- Conduct successful large-scale CO_2 injection projects targeted at Jurassic and older sandstone formations
- Achieve a more thorough understanding of the science, technology, regulatory framework, risk factors, and public opinion issues associated with large-scale injection operations
- Validate MMV activities, modeling, and equipment operations.
- Refine capacity estimates of the target formation using results of the tests

Summary of Modeling and MMV Efforts:

The project will require extensive monitoring and simulation to determine if the storage operations are effective in trapping the injected CO_2 for millennia. Vertical seismic profiling and microgravity methods will be particularly utilized, given their proven ability to resolve the size of the CO_2 plume. Monitoring, mitigation and verification (MMV) techniques that will be used include repeat 3D seismic surveys, pressure monitoring, groundwater chemistry monitoring, pressure and fluid sample monitoring from other locations, soil gas sampling, and other methods. A variety of "in house" and commercial/public simulation tools will be used, including GEM, TOUGH2, TOUGHREACT, FEHM, CO_2-PENS, COMSOL, THRUST3D, MRKEOS and SWEOS.

Table 1 summarizes the monitoring approaches planned for the SWP Phase III deployment program.

Table 1. Monitoring options in the planning stages of SWP's Phase III deployment project.

Measurement technique	Measurement parameters	Application
Introduced and natural tracers	Travel time Partitioning of CO_2 into brine or oil Identification sources of CO_2	Tracing movement of CO_2 in the storage formation Quantifying solubility trapping Tracing leakage
Water composition	CO_2, HCO_3, CO_3^{2-} Major ions Trace elements Salinity	Quantifying solubility and mineral trapping Quantifying CO_2-water-rock interactions Detecting leakage into shallow groundwater aquifers
Subsurface pressure	Formation pressure Annulus pressure Groundwater aquifer pressure	Control of formation pressure below fracture gradient Wellbore and injection tubing condition Leakage out of the storage formation
Well logs	Brine salinity Sonic velocity CO_2 saturation	Tracking CO_2 movement in and above storage formation Tracking migration of brine into shallow aquifers Calibrating seismic velocities for 3D seismic surveys
Time-lapse 3D seismic imaging	P and S wave velocity Reflection horizons Seismic amplitude attenuation	Tracking CO_2 movement in and above storage formation
Vertical seismic profiling and crosswell seismic imaging	P and S wave velocity Reflection horizons Seismic amplitude attenuation	Detecting detailed distribution of CO_2 in the storage formation Detection leakage through faults and fractures
Passive seismic monitoring	Location, magnitude and source characteristics of seismic events	Development of microfractures in formation or caprock CO_2 migration pathways
Electrical and electromagnetic techniques	Formation conductivity Electromagnetic induction	Tracking movement of CO_2 in and above the storage formation Detecting migration of brine into shallow aquifers
Time-lapse gravity techniques	Density changes caused by fluid displacement	Detect CO_2 movement in or above storage formation CO_2 mass balance in the subsurface
Land surface deformation	Tilt Vertical and horizontal displacement using interferometry and GPS	Detect geomechanical effects on storage formation and caprock Locate CO_2 migration pathways
Visible and infrared imaging from satellite or planes	Hyperspectral imaging of land surface	Detect vegetative stress
CO_2 land surface flux monitoring using flux chambers or eddycovariance	CO_2 fluxes between the land surface and atmosphere atmosphere	Detect, locate and quantify CO_2 releases
Soil gas sampling	Soil gas composition Isotopic analysis of CO_2	Detect elevated levels of CO_2 Identify source of elevated soil gas CO_2 Evaluate ecosystem impacts

Accomplishments to Date:

- Site selection and cooperative agreement completed.
- Site characterization is under way, and general scoping calculations (using model simulations) are being carried out to design monitoring surveys (Table 1).
- Permitting and related activities are well underway

Summarize Target Sink Storage Opportunities and Benefits to the Region:
SWP's Characterization and Validation Phase analyses determined that the region's point sources emit approximately 320 million tonnes (350 million U.S. tons) of CO_2 per year, which for 100 years (assuming no change in emissions rate) translates to 32 billion tonnes (35 billion U.S. tons) total storage capacity needed. SWP's Characterization and Validation Phase analyses provide an initial minimum estimate of capacity of Jurassic saline reservoirs for just five selected basins in the Southwest region to exceed 18 billion tonnes (20 billion U.S. tons), well over the 50% criterion. During the Deployment Phase, SWP will continue to refine capacity estimates and evaluate injectivity and other critical factors relevant to regional storage goals.

Cost:

Total Field Project Cost:
$ 80,742,114

DOE Share: $ 64,895,992 80 %

Non-Doe Share: $ 15,846,122 20 %

Field Project Key Dates:

Baseline Completed: March, 2009

Drilling Operations Begin: March, 2009

Injection Operations Begin: June, 2009

MMV Events: June, 2009

Field Test Schedule and Milestones (Gantt Chart):
The generalized Gantt chart below provides the overall timeline for the SWP Phase III deployment program.