FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Big Sky Carbon Sequestration Partnership
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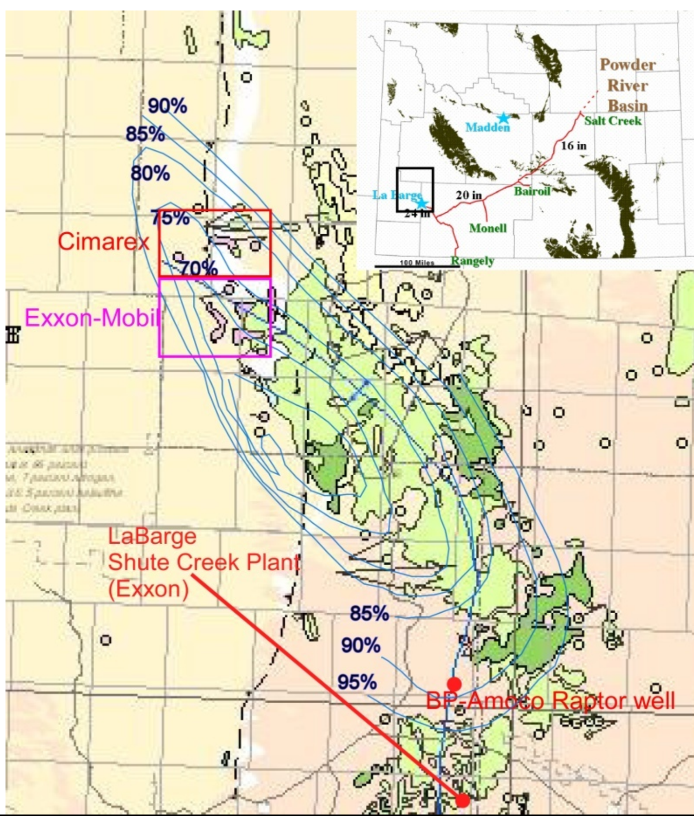
Principal Investigator	Lee Spangler
Field Test Information: Field Test Name	Phase III Saline Aquifer Large Volume
Test Location	Riley Ridge Field, Moxa Arch, southwestern Wyoming
Amount and Source of CO_2	Tons Source
Field Test Partners (Primary Sponsors)	University of Wyoming, Columbia, Cimarex Energy, Schlumberger, LANL, LLNL,

Summary of Field Test Site and Operations:

This project will perform a large volume sequestration test in the Triassic Nugget Sandstone Formation on the Moxa Arch. The test will inject 1million tons of CO2 a year for three years into the saline aquifer at depths of 12,000. The Nugget sandstone is equivalent to the Tensleep, Weber, and Navajo formations, which have been identified as regionally extensive sequestration targets in the western US. The carbon dioxide will be supplied by Cimarex Energy from their gas plant in the Riley Ridge Field. The Cimarex plant, scheduled for completion in 2008, will extract methane and helium from gas produced from the Madison Limestone at 18,000 feet. The produced gas is 75% carbon dioxide with accompanying methane, hydrogen sulfide and helium. The non-economic portion of the gas will be re-injected back into the deep Madison Limestone. The plant will produce approximately 1.5 million tons of high pressure CO_2 per year. The CO_2 for the project (92% CO_2 and 8% H_2S) will be diverted in a short lateral pipeline for injection into the Nugget Formation on Cimarex property. Information from the project will be used by Cimarex to evaluate the potential to establish a commercial sequestration facility.



The planned injection site occurs west of LaBarge, Wyoming and is east of the thrust belt that creates the LaBarge Platform and Moxa Arch geological features. Land ownership is a mix of public and private lands with the largest proportion of lands under management of the United States Department of Interior's Bureau of Land Management (BLM). United States Forest Service Lands occur to the west and most riparian areas are privately owned or comprise a segment of the "checkerboard" lands that are alternating private and public lands for 20 miles on each side of the Union Pacific Railroad Line that transects the state in a location roughly approximating US Highway 30. Figure 1 is a map of LaBarge, Wyoming.

Figure 1 Map showing LaBarge location

The site has been subjected to significant oil and gas exploration and production beginning in the mid 1970's and continues to date. Oil, methane gas, helium and CO_2 are the principal products with a large CO_2 production facility supplying CO_2 to EOR operations in Colorado and Wyoming. This plant also has two acid gas disposal wells located at the facility and currently vents approximately 200 MMCF of CO_2 per day. Cimarex will be building a new gasification plant to strip methane, helium and a relatively pure stream of CO_2 (approximately 1.8 million tons/yr) from a CO_2 saturated Madison formation in the immediate vicinity. Cimarex intends to dispose of excess CO_2 back into the Madison formation or to provide the CO_2 to oil and gas operations pursuing EOR opportunities.

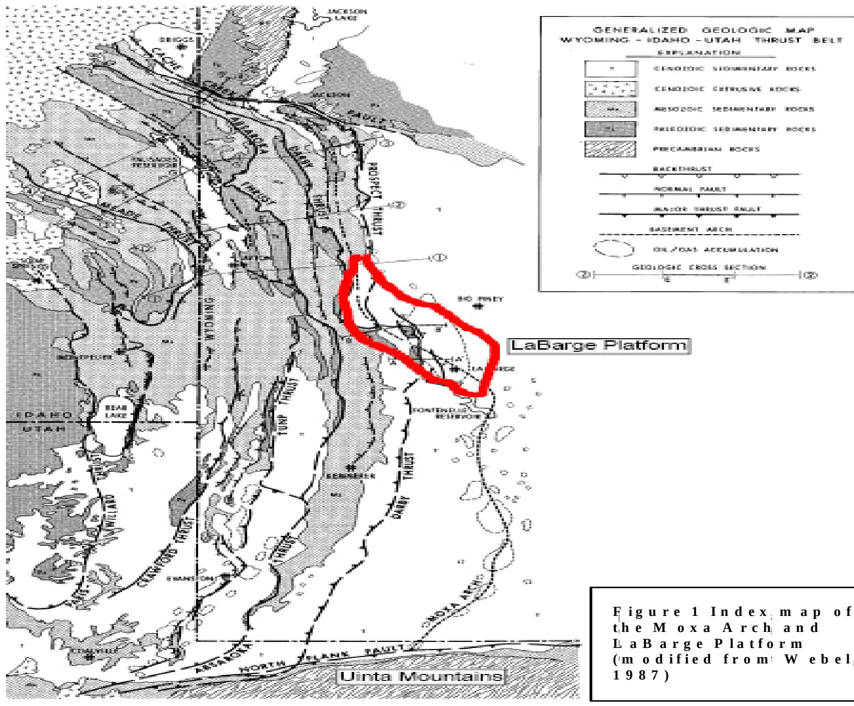


Figure 1 Index map of the Moxa Arch and LaBarge Platform (modified from Webel, 1987)

Description of Target Formation

The large volume injection will be located at the Riley Ridge Unit on the LaBarge Platform, southwest Wyoming. The LaBarge Platform encompasses a large structural closure at the northern limit of the Moxa Arch (Figure 2). The Moxa Arch is a large north-south trending anticline bound on the south by the Uinta Mountains and trending north for 120 miles before plunging beneath the leading edge thrust of the Wyoming Thrust Belt. The west flank of the anticline dips below the Wyoming Thrust Belt and the east flank is the western margin of the Green River Basin. The closure of the LaBarge Platform encompasses approximately 800 square miles on the northern region of the Moxa Arch (Figure 2; WGA, 1992). Three small, mature Nugget oil fields are present on the LaBarge Platform and produce from smaller anticlines superposed on the much larger structural feature. The Nugget Sandstone is a very extensive brine aquifer located on the LaBarge Platform and extending across the remainder of the Moxa Arch and into the Green River Basin as well. This saline aquifer of the Nugget Sandstone within the closure of the LaBarge Platform is the target of this Phase III project. The LaBarge Platform has the potential to store large volumes of CO_2 in the Nugget Formation and takes on even greater long-term significance, as the Nugget Formation on the remainder of the Moxa Arch and within the Green River Basin, is also a potential sequestration target of even greater volumetric significance. This Phase II activity, however, will focus on the static trap of the structurally closed LaBarge Platform.

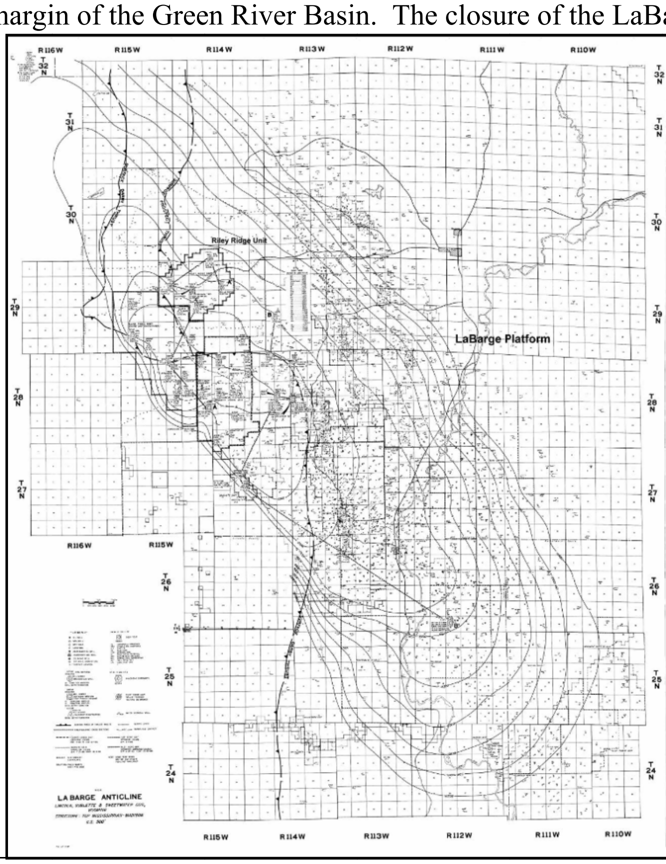


Figure 2 Structure contour map of the top Madison Formation (modified from WGA, 1992)

The Phase III sequestration target formation is the Nugget Sandstone (Figure 3). The Nugget Sandstone is a

Jurassic aged regional sheet sandstone that covers the entire southwestern area of the state of Wyoming. Total thickness of the Nugget Sandstone in the area of LaBarge is approximately 700 feet. It is equivalent to the Navajo Sandstone (Utah) and has similar properties to the Tensleep (Montana and Wyoming), Weber Sandstone (Wyoming, Colorado, and Utah, Quadrant Sandstone (Montana) and the Sundance Sandstone (Wyoming) and thus has important regional significance. The Nugget Sandstone was deposited as a series of sand dunes and interdunal deposits in an eolian depositional environment. The porous sandstones that are the injection target have an average thickness of greater than 200 feet, an average porosity of greater than 15 percent, and are highly permeable (Webel, 1977).

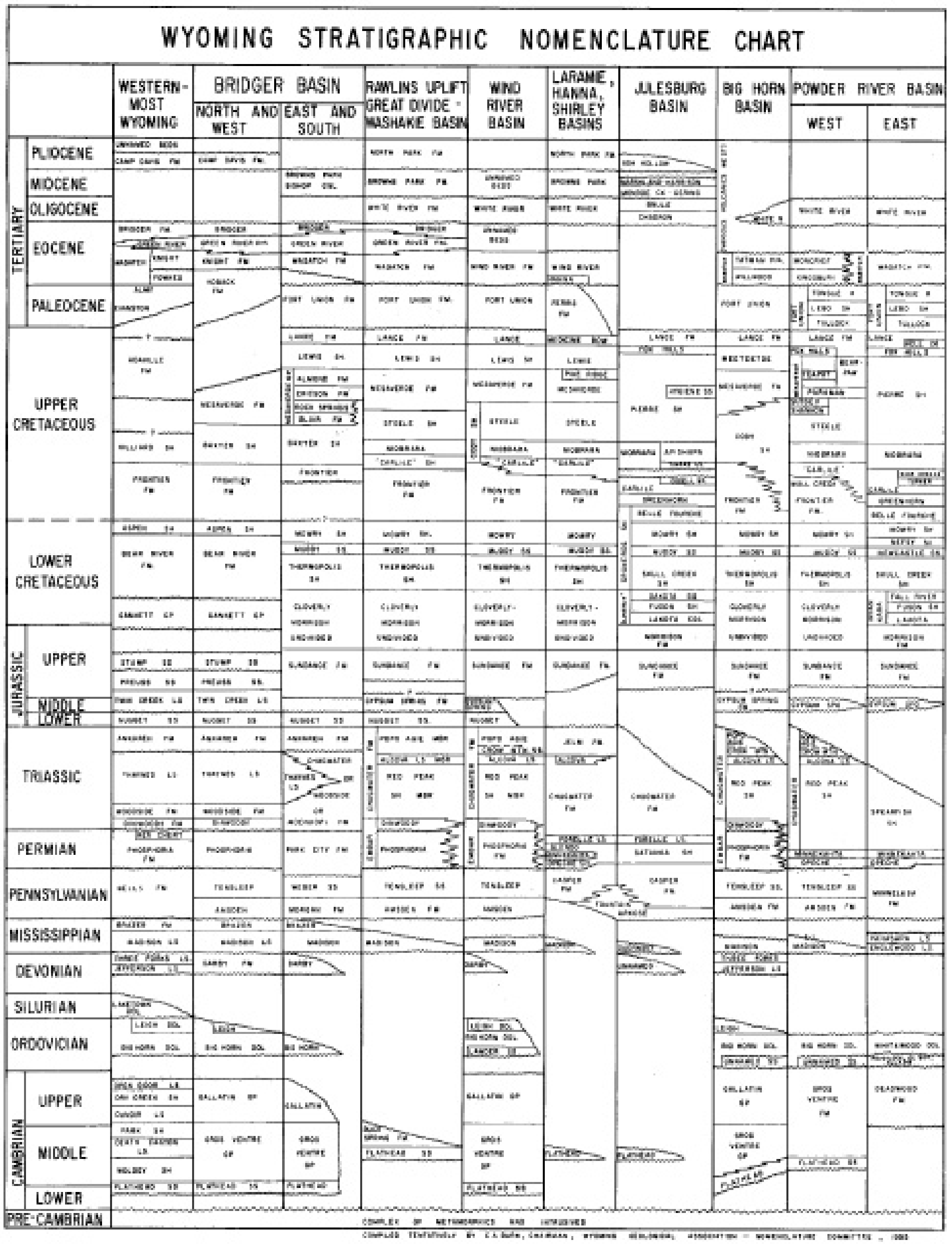


Figure 3 Wyoming Stratigraphy

The specific descriptions of the target formation characteristics are below:

- Current Data: Extensive well logs, cores, and seismic data exists both in the public and private domain. The Partnership is in negotiations for key private domain data.
- Depth, Temperature, and Pressure: 11,000 ft depth with 3850 psi pressure and 209°F temperature (reservoir conditions; Carlson, 1979; Golden, 1979; Webel, 1979)

- Orientation: The LaBarge Platform is a structurally closed static trap.
- TDS Data / Fluid Chemistry: Chemical analyses of the Nugget Formation are available from the USGS oil field waters database. A search of the database found a total of 32 samples taken from the nearby Birch Creek, Hogsback, Tip Top and Big Piney oil fields over depths between 9432 and 11,033 feet. The total dissolved solids ranged from 72,033 to 108,740mg/L. The brine is composed primarily of NaCl with minor amounts of Ca, Mg and SO_4.
- Chemistry of Formation Water: Chemical analyses of the Nugget Formation are available from the USGS oil field waters database. A search of the database found a total of 32 samples taken from the nearby Birch Creek, Hogsback, Tip Top and Big Piney oil fields over depths between 9432 and 11,033 feet. The total dissolved solids ranged from 72,033 to 108,740mg/L. The brine is composed primarily of Na-Cl with minor amounts of Ca, Mg and SO_4.
- Plume Using rates of 1,000,000 tons/year and the reservoir rock properties at reservoir conditions previously stated, the plume of CO2 resulting from this injection will occupy a volume of reservoir rock as follows:
  Volume of CO2 injected/year = ρCO2 * Φ * A *H * (1-Swi) / 2000
  Rearranging this equation to solve for volume:

  A*H = (Volume of CO2 injected/year * 2000) / (ρCO2 * Φ * (1-Swi))
  A*H = (1,000,000tons/year * 2000 lbs/ton) / (38.89489lbs/ft3 * .15 * .8)
  A * H = 428,504,092ft3

  Assuming the plume occupied the entire 200 feet of reservoir thickness (minimum plume footprint), then the areal extent of the plume would be as follows:

  A = 428,504,092ft3 / 200feet
  A= 2,142,520 ft2 = 49 acres/year of injection.

  However, since the plume will tend to spread laterally along the overlying seal, computer modeling will be required to better estimate plume dimensions; the extent of surface area likely impacted by injection; and to determine optimum location for the injection and monitoring wells.

Research Objectives:

1) Evaluate the Nugget Sandstone saline aquifer responses to injection of commercial scale volume of supercritical CO_2 and derive the relevant economic information for future projects.
2) Track the post-injection migration and containment of the CO_2 in the Nugget Sandstone Formation to compare with pre-injection reservoir modeling predictions and serve as a basis to refine multiphase flow reactive-transport modeling of CO2 sequestration in saline aqiufers.
3) Evaluate the various MMV procedures used for their performance during deep sequestration. The depths in this project probably represent the deepest proposed, and may be used to help establish an economic basement for sequestration.

Summary of Modeling and MMV Efforts:
The monitoring activities will include extensive monitoring and simulations to ensure that the injected CO_2 remains contained in the target formation. The basic configuration of wells will include a single injection well with a minimum of four installed monitoring wells. Additional monitoring capacity will depend on existing wells if available within the plume dimensions.

In order to accomplish this goal the partnership will employ a team from MSU, LLNL, LANL, MSU and UW that will use an integrated approach. The fundamental direct monitoring methods employed will include soil gas surveys, geophysical detection of subsurface CO_2 (2- or 3-D seismic, single or multicomponent) and sampling of monitoring wells for tracers and for geochemical indicators of the presence of CO_2. Sampling of multiple vertical intervals is planned to allow detection of CO_2 in the target formation, the overlying seal interval and a shallow subsurface aquifer. Additional surface methodologies may include eddy-correlation towers, LIDAR and IR detection tools, and hyperspectral tools as well as traditional soil gas analysis.

Subsurface measurements will focus on borehole logs that provide physical and chemical information about the reservoir rocks and gases and fluids within the pore space. When measured between boreholes, and over time during and after CO_2 injection (time-lapse), gravity measurements and other borehole log measurements can be used to map changes in physical and chemical properties of rocks and fluids. Schlumberger Wireline Services will be contracted for the wireline logging for this project. Borehole gravity measurements will be contracted to Micro-g Lacoste. Lamont-Doherty Earth Observatory (LDEO) is experienced in supervising and supporting field logging operations, and will provide support for the analysis and interpretation of both conventional and unconventional wireline logs as well as borehole gravity measurements through its dedicated log analysis facility.

Other subsurface methodologies may be employed depending on specific site conditions and costs. These include downhole methods such as electrical resistance tomography, crosswell tomography, passive seismics, and sparse array seismics that can be used to address storage feasibility, in-situ probes that can provide point location measurements of state functions (pressure and temperature), and syn-injection tracers to track the disposition of injected CO_2.

A team from MSU, UW, LLNL and LANL will develop and refine the MMV plan and implement the MMV program for Phase III activities in southwestern Wyoming. The following steps will be performed to fulfill this effort:

1. Obtain preliminary data feeds from CO_2-PENS site-specific model.
2. Obtain preliminary data feeds from site-specific process models (reservoir, atmospheric, etc.)
3. Write the MMV plan. This plan will include:
    a. Measurement parameters and metrics
    b. Definition of compromising activities
    c. Identification of the types and positions of test equipment and specifications
    d. Specifications for timing of activities
4. Develop data visualization and analysis methods to support MMV data collection, interpretation, and storage.
5. Determine pre-injection background conditions.
6. Advise data collection and conduct data analysis on processed data.
7. Perform isotope and colloid analysis on sample aliquots.
8. Determine short and long-term impact on reservoir rock properties and water quality.
9. Produce final report on MMV methods effectiveness and transferability to other locations.

Natural and induced tracers, including SF_6, SF_5-CF_3, and the noble gas isotopes ^{124}Xe, ^{78}Kr and ^{3}He, will be used to monitor the movement of injected CO_2 in the reservoir and to identify any induced chemical effects. BSCSP will inject known volumes of these tracer gases concurrently with CO_2 in a continuous or pulse mode. U-tubes sampling systems installed in the monitoring wells or other downhole sampling devices will be used to retrieve fluid samples from the reservoir. A pre-injection survey will establish the background concentrations of these tracers in the reservoir fluids and will serve as a baseline for the subsequent injection phase. Tracers will be analyzed using a traditional gas chromatograph and/or a newly developed GC system, which is capable of continuously measuring both tracers on water samples. High frequency sampling is anticipated during the first several months of the injection phase and then one sampling campaign approximately every 6 months during the monitoring and closure phase.

Accomplishments to Date:
This work is currently in the proposal phase and subject to approval by DOE/NETL as part of the Phase III continuation application.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

This project will provide the basis for a rigorous economic evaluation of deep sequestration and provide critical information to determine if commercialization is viable in the area. This area is the endpoint for a State-wide CO_2 pipeline infrastructure and the Nugget Sandstone on the Moxa Arch is projected to be able to store in excess of 10GT, about 100 years of current Wyoming carbon dioxide emissions from power plants. The nearby Rock Springs uplift is estimated to have a storage capacity of 26GT that will supplement the Moxa storage. On a regional scale, the Nugget is equivalent to other major eolian saline aquifers being considered as sequestration targets including the Tensleep, Weber, and Navajo formations that could be used for storage of regional emissions.

This project will also be able to test our current MMV technology on a much deeper target than current projects. For comparison, the Sleipner, Weyburn and In Salah are sequestering and monitoring CO_2 injection at depths of 300, 4950, 6000, respectively. Other planned large volume sequestration sites such as the Gorgon gas field in Australia are similar in depth.

Cost:

Total Field Project Cost: $110,443,505

DOE Share:$41,627,108 38%

Non-Doe Share:$68,816,397 62%

Field Project Key Dates:

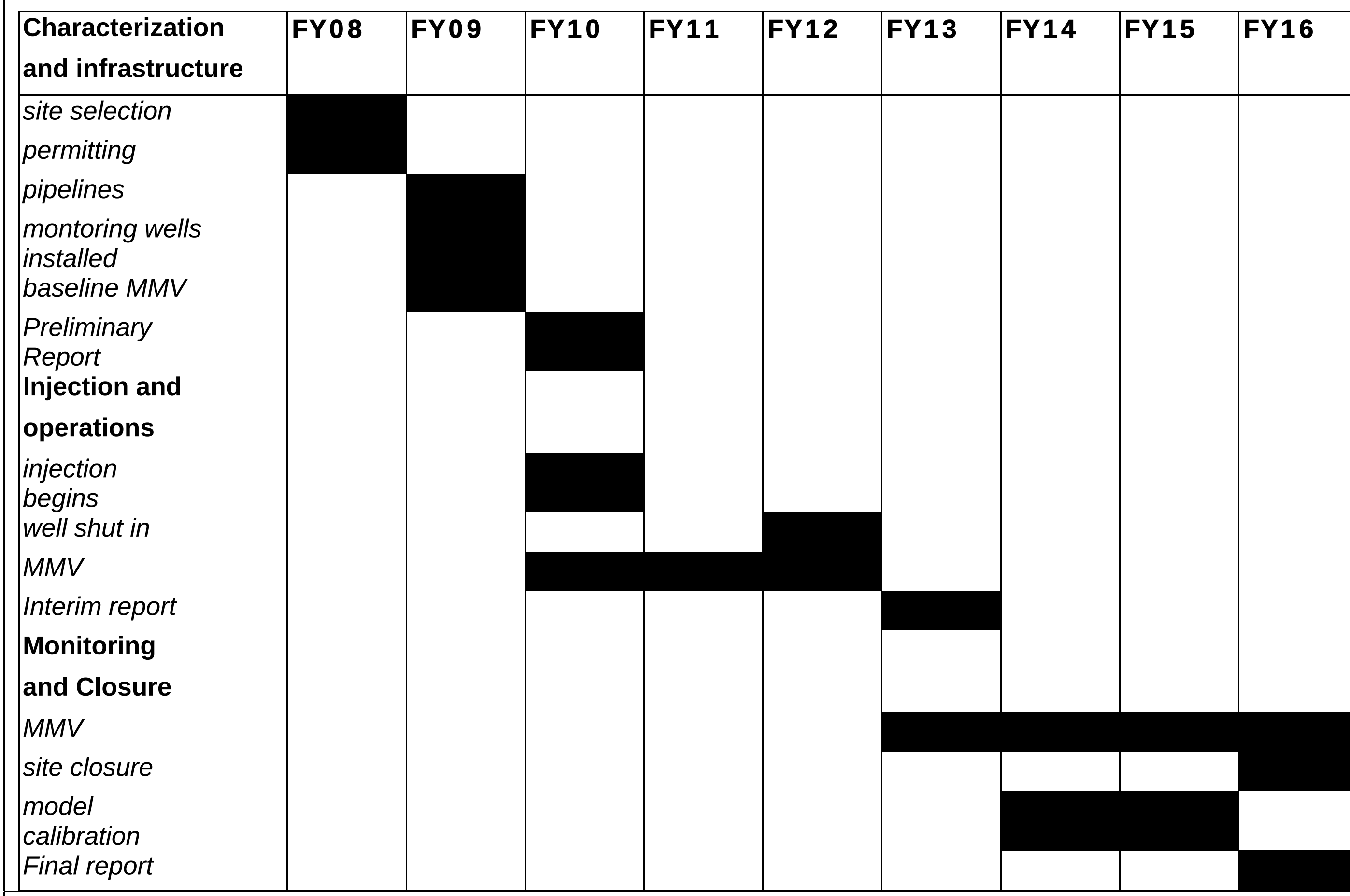
Baseline Completed: NA

Drilling Operations Begin:NA

Injection Operations Begin:NA

MMV Events: NA

Field Test Schedule and Milestones (Gantt Chart):



Additional Information: