PRE-OPERATIONAL TESTING PROGRAM
40 CFR 146.87

Facility Information

Facility Name:	Pelican Renewables, LLC
Well Names:	Rindge Tract CCS Well #1 Rindge Tract CCS Well #2
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Well Locations:	Rindge Tract Island, San Joaquin County, California 38.021507, -121.428926 (Well #1) 38.014567, -121.415405 (Well #2)

Introduction

The pre-operational testing program is limited to data collected during drilling and completion of the injection well for the purpose of ensuring conformance with the testing standards in 40 CFR 146.87 and the construction standards in 40 CFR 146.86. The testing program includes a combination of logs, surveys, cores, reservoir testing and integrity testing to provide site-specific subsurface data and to establish a baseline against which future measurements may be compared. Testing and monitoring activities, which will be conducted during the injection and post-injection phases are described in the Testing and Monitoring Plan of this application.

Notification of each step of the pre-operational testing plan will be provided to the UIC Program Director for witness opportunity. The schedule of activities will be provided a minimum of 30 days prior to the first test. Following all pre-operational testing, Pelican Renewables, LLC (Pelican) will provide a descriptive report prepared by knowledgeable analysts and include interpretations of each test result.

As discussed in the Site Characterization Narrative, existing site-specific geologic data are limited for the proposed sequestration complex. One of the injection wells will be initially treated as a stratigraphic test well for robust site-specific testing and data collection. Results of pre-operational testing will be used to confirm assumptions made through correlation of these currently available geologic data and therefore reduce uncertainty in the geologic characterization and model inputs. Pelican understands that if pre-operational data conflict with geologic characterization data and model inputs presented in this application, revisions to the AOR will be necessary prior to obtaining approval to initiate injection.

Pre-Injection Testing Plan – Injection Well

Deviation Surveys

Deviation surveys are the measurement of a borehole's departure from vertical. The injection well borehole will be drilled plumb and straight to optimize borehole to casing cement bond. A mechanical drift indicator will be centralized in the drill pipe and data collected at specified intervals. The deviation shall not be more than 0.5 of one degree between any two consecutive surveys, and not more than one degree over the entire well length. Any deviation from vertical greater than 0.5 of one degree will be corrected as drilling progresses. Drift indicator data and plots will be maintained by Pelican for the duration of drilling and supplied with the daily drilling logs. The tool will be inspected and disassembled, recalibrated, or tested as necessary. The requirements for a non-deviated hole may be modified if deviations result due to subsurface conditions and all reasonable care to avoid deviation has been exercised, the deviation will not materially affect the usefulness or performance of the well or further drilling operations, including setting of casings and future testing.

Mud Logging/Formation Samples and Testing

Formation samples will be collected at 10-foot intervals during pilot hole drilling of each injection well. Representative cutting samples will be collected for depth correlation and to provide an indication and classification of penetrated geological formations (lithology, mineralogy, thickness). Two representative samples of each 10-foot section will be collected and preserved in sample bags. All sample bags will be labeled with well identifier, date, time, and depth from which the sample was taken. Samples will be stored in a manner to prevent damage or loss. Residual cuttings and drilling fluids will be removed from the site and disposed of at an appropriate disposal site.

Fluid Samples and Testing

Pelican will collect representative formation water samples within the injection zone for geochemical analysis and characterization to: a) demonstrate compatibility of the formation fluids with injected CO_2; b) examine potential for geochemical interactions and resulting effects on storage capacity; c) verify that the injection zone (Mokelumne River Formation [MRF]) is not a USDW. Samples will be analyzed by a certified laboratory and parameters will include temperature, pH, and conductivity. Pelican will also measure reservoir pressure and static fluid level in the injection zone. Fluid samples will additionally be collected and tested for the Markley Formation to confirm that it is the lowermost USDW within the AOR, and for permeable units within the Nortonville and Domengine Formations to confirm that these units are not USDWs within the AOR.

Formation Samples and Analyses

Pelican will collect whole cores during the drilling of the stratigraphic test well (which will ultimately be converted to one of the Class VI injection wells) to characterize the injection zone (MRF) and confining zone (Capay/Meganos Formations) within the AOR. These data will allow

Pelican to confirm that the injection zone will support the proposed injection schedule and that the confining zone will be sufficient as a primary confining zone for the project. The borehole will extend into the lower confining zone (H&T Shale) to a sufficient depth to collect cores for analysis to confirm integrity.

Whole cores will be collected in core barrels of approximately four inches in diameter and ten or more feet in length, outfitted with a core bit appropriate for the formations. The depths of the intervals to be cored will be selected based on evaluation of rock cuttings and will be analyzed by a laboratory specializing in core analyses. Analyses will include fluid saturation, porosity, grain density, sieve analysis, horizontal and vertical permeability, x-ray diffraction, CT scan, acoustic velocity, compressive strength testing, steady state permeability, mercury injection capillary pressure, resistivity, and fracture pressure. Core handling procedures will be conducted in accordance with the "Sample Examination Manual," Methods in Exploration Series published by the American Association of Petroleum Geologists, or equivalent. The core analyses will be provided to the UIC Program Director.

Solid phase data collected from cores will be used for the following site characterization activities within the AOR:

- Mokelumne River Formation – Injection Zone
    - Characterize porosity, permeability, relative permeability, and capillary pressure and verify these parameters support injectivity of CO_2
    - Characterize solid phase assemblage and degree of mineral precipitation, compatibility with injected CO_2, and potential for geochemical interactions and effects on storage capacity
    - Characterize geomechanical properties including ductility, rock strength brittleness, and pore pressure
- Capay/Meganos Formations – Upper Confining Zone
    - Characterize porosity, permeability, relative permeability, and capillary pressure and verify these parameters support confinement of CO_2 and formation fluids
    - Characterize solid phase assemblage and potential for geochemical interactions with injected CO_2 that may affect integrity
    - Characterize geomechanical properties including ductility, rock strength brittleness, and pore pressure
- H&T Shale – Lower Confining Zone
    - Characterize porosity, permeability, relative permeability, and capillary pressure and verify these parameters support confinement of CO_2 and formation fluids
    - Characterize solid phase assemblage and potential for geochemical interactions with injected CO_2 that may affect integrity
    - Characterize geomechanical properties including ductility, rock strength brittleness, and pore pressure

Geophysical Logging

Pelican will conduct open borehole logging throughout drilling and completion of each injection well to provide in situ subsurface geologic and hydrologic information to total depth. Cased

borehole logging will also provide information on well integrity and cement bonding. Logging will be conducted in the surface and long string boreholes, but will not be conducted in the large-diameter conductor borehole. The logging program is provided below in Table 6-1.

Table 6-1. Logging Program

Interval	Section	Log
Conductor[1]	Open borehole	None
	Cased Hole	None
Surface[1]	Open Borehole	Gamma ray[2], formation density[2], neutron porosity[2], resistivity[3], spontaneous potential[3], caliper[3], casing inspection[2]
	Cased Hole	Cement bond[3], variable density[3], temperature[3]
Long String[1]	Open Borehole	Gamma ray[3], formation density[2], neutron porosity[2], resistivity[3], spontaneous potential[3], caliper[3], fracture finder[3], spectral gamma[2], dipole sonic shear[2], acoustic-based image[2], nuclear magnetic resonance[2], elemental capture spectroscopy[2]
	Cased Hole	Cement bond[3], variable density[3], temperature[3], casing inspection[3]

(1) Approximate depths and casing sizes provided in well construction details section of the application
(2) Optional logs of which one or more may be run across the selected interval
(3) Required logs under 40 CFR 146.87

Geophysical logs will be performed by a company licensed and experienced in the performance of such logs and interpretation will be performed by a qualified geophysical log analyst. Logs and interpretations will be provided to the UIC Program Director.

Permanent Fiber Optic Monitoring System

Downhole deployment of fiber optic provides temperature, strain, and acoustic data measurements at high spatial and temporal resolutions with full wellbore coverage. The data is used for reservoir characterization based on reflection and refraction seismic, CO_2 plume detection with time-lapse VSP, detection and location of micro seismic events, well integrity and leak detection. The cable is to be permanently attached to the casing using cross-coupling clamps that both protect and secure the cable in place. Mid-joint clamps with extra mass are installed at intervals within the planned perforation zone. These clamps are used to locate the cable position around the long string casing prior to the perforation process. On the surface, the cable will be positioned through the casing hanger and out of the wellhead to a surface enclosure. The enclosure is used to host and protect the optical splices connecting the downhole cable to the surface cable, which is routed to a data acquisition room.

Demonstration of Mechanical Integrity and Reservoir Tests

Below is a summary of mechanical integrity tests (MITs) and pressure fall-off tests (FOTs) to be performed in the injection well prior to operation. The purpose of the MIT is to confirm casing integrity (internal MIT) and of the cement seal (external MIT). FOTs and injectivity tests provide information on hydrologic reservoir properties used to determine the pressure build up at the

wellbore and real-time storage capacity. A list of the tests and testing frequency is provided in Table 6-2.

Table 6-2. Pre-Operational Testing Schedule

Class VI Rule Citation	Rule Description	Test Description	Program Period
40 CFR 146.89(a)(1)	MIT - Internal	Standard Annulus Pressure Test(2)	Prior to operation, annually, following corrective action
40 CFR 146.87(a)(4)	MIT - External	Temperature Log(2)	Prior to operation, annually, following corrective action
40 CFR 146.87(a)(4)	MIT - External	Fiber Optic Monitoring System(1)	Prior to operation, annually, following corrective action
40 CFR 146.87(a)(4)	MIT - External	Casing Inspection Log(1)	Prior to operation, following corrective action
40 CFR 146.87(e)(1)	Reservoir Test	FOT(2)	Prior to operation, every five years
40 CFR 146.87(e)(1)	Reservoir Test	Injectivity or Pump Test(1)	Prior to operation

(1) Optional tests of which one or more may be conducted
(2) Required tests under 40 CFR 146.87

MITs and FOTs will be conducted through wireline deployment and will be performed using experienced and licensed personnel and with furnished equipment that is appropriate and adequate to complete all testing phases. Wellhead equipment will be furnished with a stripper head (wireline packoff) assembly and used to conduct the geophysical log(s). The stripper head assembly will be securely attached to the wellhead to prevent flow from the well at the pressures observed. The stripper head assembly will be sized to accommodate the width and length of the longest geophysical tool used for conducting the tests and surveys. The wellhead will be furnished with bleed and isolation valves so the stripper head assembly can be shut-in and isolated from the wellhead equipment. The assembly will include a pressure gauge and appurtenances for monitoring the pressure in the well during the tests.

Internal Mechanical Integrity

Internal mechanical integrity will be performed to confirm the well's ability to maintain pressure in the fluid-filled annular space between the tubing and casing. As described in EPA's guidance for standard annulus pressure tests, the annular space will be pressurized and pressure readings will be recorded for a minimum of one hour. Internal mechanical integrity will be confirmed if the pressure gain or loss does not exceed 3% of the initial test pressure.

External Mechanical Integrity

External mechanical integrity will be performed to confirm that there are no external influences on the cemented long string casing. While fiber optic will sense downhole acoustic changes, temperature logs may also be used to identify fluid movement through the confining zone adjacent to the well borehole and can identify casing leaks. Noise logs or radioactive tracer surveys (RTSs) may be used if anomalies are identified in the temperature logs.

Fall-Off Testing

Hydrologic characteristics of the storage reservoir can be determined by conducting fall-off testing. This test measures the relative time lapse between pressure fall-off in a stressed reservoir against the ambient formation pressure.

Injection or Pump Testing

Injection testing provides hydrogeologic characteristics of the injection zone and validates the numerical modeling used to estimate the lateral extents of the Area of Review. Freshwater will be injected into the well at a constant and measured rate. The injectivity test may be conducted as a constant rate test or at incrementally increasing rates (step-rate testing) to determine the pressure response within the injection interval. Data obtained from step-rate testing will be used to validate the calculations of formation fracture pressure at the top of the injection zone (conservatively correlative to the base of the confining zone).

Pre-Injection Testing Plan – Deep Monitoring Wells

Pre-operational testing for the deep monitoring wells will include the following tests, described in more detail above:

- Deviation surveys
- Mud logging/formation samples and testing
- Whole core samples within the confining zone and, if possible, upper injection zone – one well only
- Geophysical logging (cement bond logs and casing inspection logs only)
- Internal and external mechanical integrity testing

Pre-Injection Fault Characterization

As discussed in the Site Characterization Narrative (Section 2), listric slump faults were interpreted within the Meganos Formation, which is part of the Upper Confining Zone. In addition, one basement fault was identified that extends up into the Meganos sequence in an area where the injection zone was eroded away by the Meganos Gorge. Existing data to thoroughly assess the sealing capacity of these faults are not available and interpretations of these faults were made solely from review of the 3D seismic volume. The presence of hydrocarbons both within the region and RTI and as noted in the 3D seismic volume provide some evidence of sealing along interpreted faults. However, this does not account for pressure or other subsurface changes due to injection operations. During pre-operational testing, Pelican will collect permeability and capillary pressure data from the MRF and Meganos section and static pressure data. Pelican will collect pressure data and cores from the Meganos as specified in a preceding section. Following geophysical and mud logging and other data collection that may provide evidence of sealing, Pelican will review these

data in conjunction with further review of the 3D seismic volume. Methods utilized by Pelican for gathering evidence of fault sealing may include:

- Evaluating whether the faults juxtapose conductive and non-conductive units on either side using an Allan chart;
- Evaluating the potential risk for leakage based on capillary pressure and permeability estimates for sediments in the Capay/Meganos collected along the faults;
- Evaluating the presence of catalysis in hand samples during drilling or in collected cores or thin sections;
- Evaluating the presence of diagenetic sealing.

Pelican will provide these lines of evidence within the updated Site Characterization Narrative and AOR and Corrective Action Plan following pre-operational testing to demonstrate the sealing capacity of the faults.