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PROPOSED PRE-OPERATIONAL TESTING

Bluebonnet Sequestration Project

1.0 Facility Information

Facility name: Bluebonnet Sequestration Project
Bluebonnet CCS 1 Well

Facility contact: [redacted], Project Manager
5 Greenway Plaza Houston, TX 77046
[redacted]

Well location: Winnie, Chambers County, Texas
[redacted] (North American Datum 1927)

The testing activities at the Bluebonnet CCS 1 described in this attachment are restricted to the pre-injection phase. Testing and monitoring activities during the injection and post-injection phases are described in the Testing and Monitoring Plan, along with other non-well related pre-injection baseline activities such as geochemical monitoring.

The Bluebonnet Sequestration Hub will construct a new well for injection, Bluebonnet CCS 1, [redacted].

The Bluebonnet Sequestration Hub LLC drilled the Encanto 01 stratigraphic well in 2022, [redacted] miles to the [redacted] of the proposed Bluebonnet CCS 1 and acquired advanced geophysical logs as well as [redacted] ft of full core and [redacted] of SWC. The Project also performed a step rate test in the prospect reservoir and leak off test on the proposed confining zone. The results and summary of the data acquisition program for Encanto 01 are shown in Appendix C in the AOR attachment. Encanto 01 stratigraphic well was temporarily abandoned and will be re-completed as In Zone Monitoring well for the project.

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2.0 Pre-Injection Test Plan – Injection Well Bluebonnet CCS 1

The following tests and logs will be conducted during drilling, casing installation, and after casing installation in the Bluebonnet CCS 1 in accordance with the testing required under 40 CFR 146.87(a), (b), (c), and (d).

The Bluebonnet CCS 1 well testing program includes a combination of advanced logging, sidewall coring, and formation hydrogeologic testing. This program is complemented with an extensive data acquisition program in the stratigraphic well as well as in the proposed monitoring wells. The pre-operational testing program will determine or verify the depth, thickness, mineralogy, lithology, porosity, and permeability information of the injection zone, overlying confining zone, and other relevant geologic formations. Salinity of formation fluids will also be determined. Table POT-1 lists the logs, tests, and surveys proposed for the Bluebonnet CCS 1 well to comply with 40 CFR 146.87 (a).

Table POT-1—Logs, Test and Surveys for Bluebonnet CCS 1 [(40 CFR 146.87 (a))]

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
[redacted] [40 CFR 146.87 (a) (1)]	[redacted]	Define well trajectory, displacement and tortuosity.
[redacted] [40 CFR 146.87 (a) (2) (i)]	[redacted]	Correlation log, volume of shale indicator, estimate salinity
[redacted] [40 CFR 146.87 (a) (2) (i)]	[redacted]	Fluid identification, estimate salinity, correlation log
[redacted] [40 CFR 146.87 (a) (2) (i)]	[redacted]	Identify borehole enlargement and calculate cement volume.
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Fluid identification, estimate salinity, correlation log
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Identify borehole enlargement and calculate cement volume.
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Define stratigraphy, correlation log, shale indicator
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Estimate porosity, pore size distribution, permeability index
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Estimate mechanical properties, validation of velocity model, well tie to seismic
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Define uranium rich formation, clay indicator

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[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Estimate porosity, mineralogical characterization.
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Identify fracture, structural information, minimum stress orientation
[redacted] [40 CFR 146.87 (a) (3) (i)]	[redacted]	Identify mineralogy.
Wireline - Formation pressure measurement – Long String	[redacted]	Measure formation pressure
Mud Logging	[redacted]	Identify lithology, hydrocarbon shows, gases composition.
Cased Hole Logs and surveys Before Injection		
[redacted] [40 CFR 146.87 (a)(2) (ii)]	[redacted]	Cement bond, casing integrity. Validate external mechanical integrity
[redacted] [40 CFR 146.87 (a)(3) (ii)]	[redacted]	Cement bond, casing integrity. Validate external mechanical integrity
[redacted] [40 CFR 146.87 (a)(4) (i)]	[redacted]	Validate internal mechanical integrity between the tubing, long-string and packer.
[redacted] [40 CFR 146.87 (a)(4) (ii)]	[redacted]	CO_2 saturation, baseline for monitoring
[redacted] [40 CFR 146.87 (a)(4) (iv)]	[redacted]	Wall thickness, corrosion, ovality of tubulars. Validate external mechanical integrity. Baseline for monitoring.
[redacted] [40 CFR 146.87 (a)(4) (iii)]	[redacted]	Measure temperature profile on the well from surface to top of perforation. Define baseline for monitoring mechanical integrity.

The long string section of Bluebonnet CCS 01 will be drilled with [redacted] in order to ensure well stability while drilling, logging, and cementing. Therefore, spontaneous potential logs will not be possible to acquire, However, the project is proposing additional new generation logs to improve reservoir and confining zone characterizations as described in the table above.

The project will not collect full core while drilling the long string section in Bluebonnet CCS 01, only side wall cores, as allowed by the hole condition. The Bluebonnet Sequestration Hub, LLC will also collect water samples in the injection zone as shown in table POT-2.

As part of the data acquisition program for the Bluebonnet Site, the project acquired reservoir pressure and water samples in 2022 for the above confining zones and overburden in Encanto-01 stratigraphic well. The project is also planning to acquire additional water samples and pressure in the reservoir, above confining zone, and overburden in the Bluebonnet IZM 01 and Bluebonnet IZM 02. This data will complement the proposed acquisition for the Bluebonnet CCS 01.

Table POT-2—Sidewall cores and water sampling for Bluebonnet CCS 1 (40 CFR 146.87 (b))

Method	Interval (ft)	Samples	Purpose
[redacted]			

The Bluebonnet Sequestration Hub, LLC will record the fluid temperature and reservoir pressure obtained from the wireline tool while taking the water samples. The project also plans to install downhole gauges that will allow us to determine original pressure and temperature at top of the perforations.

The project will send the water samples to a third-party lab for a complete analysis including pH, conductivity, major cations, major anions, trace metals, dissolved gases, density, and TDS among others. Table POT-3 shows the analytics to be characterized in the reservoir samples defined as minimum by the project **(40 CFR 146.87 (d)(3))**.

Table POT-3—Analyses and Methods for Water Samples Testing in reservoir, above confining zone and overburden

Parameter	Analytical Method
[redacted]	

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The static fluid level of the injection zones will be determined during the step rate test and fall off test **(40 CFR 146.87 (c)).** [redacted]

From **40 CFR 146.87 (d)**, at minimum, the owner or operator must determine or calculate the following information concerning the injection and confining zones:

1) Fracture pressure
2) Other physical and chemical characteristics of the injection and confining zones

The acquired data in the proposed Bluebonnet CCS 1 injection well includes formation testing/logging, rotary sidewall core sampling and analyses, and hydrogeologic testing to determine the physical and chemical characteristics of the injection and confining zones. This data will allow calibration of the data acquired in the 2022 Encanto 01 Stratigraphic Test well during the initial site characterization and further serves as a baseline prior to commencing CO_2 injection. The combined knowledge from these two wells will strengthen the static subsurface and dynamic operational testing interpretation and increase confidence in the injection and confining zone characteristics prior to CO_2 injection.

(1) Fracture pressure / fracture gradient

- [redacted]: fracture gradient [redacted] psi/ft was determined from a step rate test with downhole gauges in the Encanto 01 Stratigraphic Test well. In the simulation model, we assigned a conservative fracture pressure gradient of [redacted] psi/ft to ensure that CO_2 injection will not propagate fractures in the injection zone.
- [redacted]: fracture gradient [redacted] psi/ft was determined from a leak-off test in the Encanto 01 Stratigraphic Test well.

(2a) Physical characteristics

- Well logging – Open hole wireline logs were run to obtain in-situ, stratigraphic, physical, and geomechanical information in confining and storage zones. This data was obtained from surface to [redacted] in a [redacted] mud system and in the main hole from casing point to TD at [redacted] in an [redacted] system. Well logging interpretation (porosity, permeability, lithology) will be calibrated to measurements acquired in cores, rotary side wall cores, and formation testing.
- Core sampling & analyses.
  - Frio injection and Anahuac confining zone: core data provides critical information about stratigraphic relationships, depositional environments, lithology, sedimentary structures, diagenetic features, facies, contacts, rock fabrics, textural maturity, distribution of grain sizes, varying degrees of sorting, bedding and laminations, elements, minerals, matrix porosity and permeability, fractures or solution features, capillary pressures, pore throat sizes, and shapes through which the injected CO_2 will migrate in the injection zone and in contrast be confined by the overlying low-permeability confining zone.

- Laboratory analyses of the acquired cores in the Encanto 01 Stratigraphic Test well are currently well underway and will be reported once completed, interpreted, and integrated with the other data sets, such as logs and well tests.

(2b) Chemical characteristics

- Well logging – [redacted]
- Core sampling & analyses.
  - [redacted]: Based on the elemental and mineral composition derived from logs and core data, [redacted]
  - Laboratory analyses of the acquired cores in the Encanto 01 Stratigraphic Test well are currently well underway and will be reported once completed, interpreted, and integrated with the other data sets, such as logs and well tests.

Upon completion and prior to injection, the Bluebonnet Sequestration Hub, LLC will conduct the test in table POT-4 to verify hydrogeologic characteristics of the injection zone.

Table POT-4—Summary of Pre-Injection Testing to evaluate reservoir condition.

Method	Comments
[redacted]	

3.0 Pre-Injection Test Plan – Deep Monitoring Wells

3.1 [redacted]

[redacted] will be new wells drilled as part of the Project. Table POT-5 shows the proposed logging, survey, and mud log sampling for these wells. Table POT-6 shows the proposed water sampling in the reservoir and in the above confining zone.

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Table POT-5—Logging, survey and sampling for [redacted]

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
[redacted]		
Cased Hole Logs and surveys Before Injection		
[redacted]		

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[redacted]

Original pressure in the reservoir will be measured with a downhole gauge installed in the tubing ported to the reservoir below the packer.

Table POT-6—Water sampling for [redacted]

Method	Interval (ft)	Samples	Purpose
[redacted]			

Table POT-3 shows the analytics to be characterized in the reservoir and above confining zone samples defined as minimum by the project.

3.2 [redacted]

As described in the previous section, the Encanto 01 stratigraphic well will be re-completed as [redacted] monitoring well. Additional to the data acquired previously during the stratigraphic campaign, the well will be tested for mechanical integrity after the recompletion. Pulse neutron baseline will be acquired as well. Table POT-7 shows the logs and test will be performed during and after the recompletion of the well.

Table POT-7—Cased hole logs for [redacted]

Cased Hole Logs during and after recompletion as In Zone monitoring well		
Method	**Interval (ft)**	**Purpose**
[redacted]		

Original pressure in the reservoir will be measured with a downhole gauge installed in the tubing ported to the reservoir below the packer.

4.0 Pre-Injection Test Plan – Above-Confining-Zone Well – [redacted]

[redacted] will be a new well drilled as part of the Project. Table POT-8 shows the proposed logging, survey, and mud log sampling for this well. This well will be completed with a [redacted] This system is described in the QASP attachment and the frequency and testing required is described in the Testing and Monitoring Plan Attachment. Table POC-8 shows the proposed logging, survey and mud log sampling for this well.

Table POT-8—Logging, survey and sampling for [redacted]

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
[redacted]		

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[redacted]

Cased Hole Logs and surveys Before Injection
[redacted]

The original pressure in the above confining zone will be measured with a downhole gauge installed in the tubing ported to the reservoir below the packer.

5.0 Pre-Injection Test Plan – USDW Monitoring Wells

[redacted] will be shallow wells drilled in the USDW section to monitor ground water. Table POT-9 shows the proposed logging and survey for these wells. These wells are described in the Testing and Monitoring Plan Attachment, as well as the frequency and testing required. Table POC-8 shows the proposed logging and survey for this well.

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Table POT-9—Logging, survey and sampling for USDW monitoring wells

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
[redacted]		

Notes:

Details for the tests and procedures are described in the QASP attachment to this permit.

All pre-injection testing procedures for logging, sampling, and testing, as required by 40 CFR 146.87, will be submitted to the Director for review. The results of the testing activities will be documented in a report and submitted to the US Environmental Protection Agency (EPA) after the well drilling and testing activities have been completed, but before the start of CO_2 injection operations.

The Bluebonnet Sequestration Hub, LLC will notify the EPA at least 30 days prior to conducting the test and provide a detailed description of the testing procedure. Notice and the opportunity to witness these tests/logs shall be provided to the EPA at least 48 hours in advance of a given test/log.