PRE-OPERATIONAL PLAN
40 CFR §146.82

Brown Pelican CO_2 Sequestration Project

CONTENTS

Facility name: Brown Pelican CO_2 Sequestration Project
BRP CCS1, BRP CCS2 and BRP CCS3 Wells

Facility contact: Caroline Huet, Carbon Certification Lead
5 Greenway Plaza, Houston, TX 77046
[redacted]

Well location: Penwell, Texas

[redacted]

1. Introduction / Purpose

The Brown Pelican CO_2 Sequestration Project (BRP Project or Project) includes participation of multidisciplinary teams from Occidental Oil & Gas Corporation (Oxy), parent company of Oxy Low Carbon Ventures (OLCV) consultants, and subcontractors. Each team will provide technical expertise and economic inputs to the Project to ensure a safe, successful, and efficient operation.

The testing activities described in this document are restricted to drilling, testing, and completing wells during the Pre-Injection phase. Testing and monitoring activities during the Injection and Post-Injection Site Care phases are described in the Testing and Monitoring Plan, along with other non-well related pre-injection baseline activities, such as geochemical monitoring.

The pre-injection operational testing plan described in this document is designed to meet the testing requirements of Title 40 of the U.S. Code of Federal Regulations Section §146.87 (40 CFR §146.87) and the well construction requirements of 40 CFR §146.86.

The pre-operational testing program will utilize a combination of open and cased hole logging, coring, fluid sampling, and formation hydrogeologic testing to determine and verify the depth, thickness, mineralogy, lithology, porosity, permeability, and geomechanical information of the Injection Zone, confining zones, and other relevant geological formations.

All pre-injection testing procedures for logging, sampling, and testing, as required by 40 CFR §146.87, will be submitted to the Underground Injection Control 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 BRP Project 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.

A table of the wells described in this document is shown below (Table 1). A summary of pre-operational data collected or planned for collection is presented in Table 2.

Table 1--Summary of wells drilled/planned for the BRP Project

Regulatory Well Name	Project Well Name	Anticipated Drill Date	Purpose	Latitude (NAD 27)	Longitude (NAD 27)
Shoe Bar 1	SLR1	2023*	Stratigraphic test well, converted to SLR/ACZ	31.76343602	-102.7034981
Shoe Bar 1AZ	ACZ1	2023*	Stratigraphic test well, converted to ACZ	31.76448869	-102.7305326
Shoe Bar 1USDW	USDW1	[redacted]	Monitor lowermost USDW	[redacted]	[redacted]
Shoe Bar 2SLR	SLR2	[redacted]	Monitor Injection Zone	[redacted]	[redacted]
Shoe Bar 3SLR	SLR3	[redacted]	Monitor Injection Zone	[redacted]	[redacted]
Shoe Bar 1CCS	BRP CCS1	[redacted]	CO_2 Injector	[redacted]	[redacted]
Shoe Bar 2CCS	BRP CCS2	[redacted]	CO_2 Injector	[redacted]	[redacted]
Shoe Bar 3CCS	BRP CCS3	[redacted]	CO_2 Injector	[redacted]	[redacted]
Shoe Bar 1WW	WW1	[redacted]	Brine water withdrawal	[redacted]	[redacted]
Shoe Bar 2WW	WW2	[redacted]	Brine water withdrawal	[redacted]	[redacted]
Shoe Bar 3WW	WW3	[redacted]	Brine water withdrawal	[redacted]	[redacted]
Shoe Bar 4WW	WW4	[redacted]	Brine water withdrawal	[redacted]	[redacted]

*Strat wells, already drilled

Table 2--Summary of data acquired or planned for wells in the BRP Project

	Basic Log Suite	Advanced Logging Suite	Core Acquisition	Formation Testing	Formation Fluid Sampling	Mechanical Integrity Testing	Plume Monitoring
	GR, SP, NPHI, RHOB, SGR, RES, PEF	[redacted]				Isoscanner/USIT /CBL-VDL	Pulsed Neutron Logging
Shoe Bar 1 (SLR1)	1	[redacted]					
Shoe Bar 1AZ (ACZ1)	1						
BRP CCS1	1	[redacted]				1	
BRP CCS2	1					1	
BRP CCS3	1					1	
USDW1	[redacted]						
SLR2							
SLR3							
WW1							
WW2							
WW3							
WW4							

Notes: Summary of logging, coring, MIT, formation testing and sampling in the wells at BRP Project. The numbers indicate the phase of the project the data will be acquired: 1 – During Construction, 2 – During Injection, 3 – During Post-Injection

1.1 Overview of Logging Suite(s)

A brief description of the logging tools that will be run during construction summarized in Table 2 is documented below.

- Basic log suite: A triple combo with spectral gamma ray will be the basic log suite that will be run in all the wells in the BRP Project. The measurements obtained include Gamma Ray (Total and Spectral), Spontaneous Potential (SP), Neutron Porosity (NPHI), Bulk Density (RHOB), Resistivity (RES), and Photoelectric Factor (PEF). The combination of these log measurements enables interpretation and quantification of key petrophysical properties such as porosity, mineralogy, fluid saturations with a high degree of resolution and accuracy.

[redacted]

[redacted]

2. <u>Stratigraphic Wells</u>

2.1 Overview of Stratigraphic Wells

The Shoe Bar 1 and Shoe Bar 1AZ stratigraphic wells were drilled in 2023 to provide site-specific characterization data for the BRP site. The Shoe Bar 1AZ is located within the proposed AoR, close to the locations in proposed Injector wells. Core data collected in the Shoe Bar 1AZ is representative of the subsurface at the locations of proposed future injectors BRP CCS1 and BRP CCS2, which will be located [redacted] Shoe Bar 1AZ (see additional details in Pre-Operational Plan Appendix A). The Shoe Bar 1 is located in the easternmost extent of the modeled AoR, approximately 1.5 miles East of Shoe Bar 1AZ.

The Project acquired a comprehensive suite of basic and advanced geophysical logs, whole core through the injection interval, sidewall cores, reservoir pressure data and fluid samples. After each well was constructed, the BRP team conducted [redacted] in the injection and confining intervals. Shoe Bar 1 will be recompleted as an Injection Zone Monitoring well (SLR). Shoe Bar 1AZ will be recompleted as an Above Confining Zone Monitoring (ACZ) well.

The following sections summarize the details of the logging and coring plans executed in the stratigraphic wells.

2.2 Logging Program in Stratigraphic Wells

The Shoe Bar 1 was drilled in January 2023. The well was planned with a 3-string casing design with the surface section (or surface string casing) at 0-1,800’ MD, intermediate section (or intermediate string casing) at 1,800-3,800' MD, and production section (or long string casing) at 3,800-6,550' MD.

Table 3 summarizes the data acquisition program conducted in the Shoe Bar 1.

Table 3--Data acquired in the Shoe Bar 1 Well

Method	Interval Section(s)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey [40 CFR §146.87 (a) (1)]	Every 100 ft while drilling as minimum, from surface to TD.	Define well trajectory, displacement, and tortuosity
Wireline- Spontaneous Potential – [40 CFR §146.87 (a) (2) (i)]	Intermediate, Production	Correlation log, volume of shale indicator, estimate salinity
Wireline – Caliper – [40 CFR §146.87 (a) (2) (i)]	Intermediate, Production	Identify borehole enlargement and calculate cement volume
Wireline –Resistivity – [40 CFR §146.87 (a) (3) (i)]	Intermediate, Production	Fluid identification, estimate salinity, correlation log
Wireline -Gamma ray – [40 CFR §146.87 (a) (3) (i)]	Intermediate, Production	Define stratigraphy, correlation log, shale indicator
[redacted]		
Mud Logging	Surface to TD (every 30 ft)	Identify lithology, hydrocarbon shows, gases composition

The Shoe Bar 1AZ was drilled in August 2023. This well is located in the AoR, [redacted]. The well was drilled with a 3-string casing design with the surface section at 0-1,800' MD, intermediate section at 1,800-3,910' MD, and production section at 3,910-6,725' MD. The BRP Project plans to convert this well to an ACZ well for use in future monitoring of the site.

Summarized below is the data acquisition program conducted in the Shoe Bar 1AZ.

Table 4--Data acquired in the Shoe Bar 1AZ well

Method	Interval Section(s)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey [40 CFR §146.87 (a) (1)]	Every 100 ft while drilling as minimum, from surface to TD	Define well trajectory, displacement, and tortuosity
Wireline- Spontaneous Potential – [40 CFR §146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Correlation log, volume of shale indicator, estimate salinity
Wireline –Resistivity – [40 CFR §146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Fluid identification, estimate salinity, correlation log
Wireline – Caliper – [40 CFR §146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Identify borehole enlargement and calculate cement volume
Wireline –Resistivity – [40 CFR §146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Fluid identification, estimate salinity, correlation log
Wireline – Caliper – [40 CFR 146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Identify borehole enlargement and calculate cement volume
Wireline -Gamma ray – [40 CFR §146.87 (a) (2) (i)], [40 CFR §146.87 (a) (3) (i)]	Surface, Intermediate, Production	Define stratigraphy, correlation log, shale indicator
[redacted]		
Mud Logging	Surface to TD (every 30 ft)	Identify lithology, hydrocarbon shows, gases composition

In addition to the open-hole logs, cased-hole logs were acquired over each section post-casing in both stratigraphic wells. The table below table summarizes the cased-hole data that was acquired.

Table 5--Cased-hole logs acquired

Method	Interval Section(s)	Purpose
Cased Hole Logs and surveys Before Injection		
Wireline - CBL-VDL-USIT-CCL – [40 CFR §146.87 (a)(2) (ii)], [40 CFR §146.87 (a)(3) (ii)]	Surface, Intermediate, Production	Cement bond, casing integrity. Validate external mechanical integrity
Annulus Pressure Test - Long string casing [40 CFR §146.87 (a)(4) (i)]	Annular between tubing and long string	Validate internal mechanical integrity between the tubing, long-string, and packer
[redacted]		

2.3 Coring Program

2.3.1 Whole and Sidewall Core Acquisition

The coring program for the Shoe Bar 1 and Shoe Bar 1AZ wells was designed to obtain full 4-in whole core from the Sequestration Zone, the Lower San Andres formation. The program collected 1.5-in diameter sidewall core plugs in the Grayburg and Upper San Andres formations, which are the Upper Confining Zones, and the Glorieta and Wichita-Albany formations, which are Lower Confining Zones. In addition, sidewall cores were also obtained to evaluate a prospective secondary sequestration zone, the Clearfork formation.

In Shoe Bar 1, the Project successfully achieved 100% recovery of [redacted] of whole core through the Lower San Andres and [redacted] sidewall cores from Grayburg, Upper San Andres, Glorieta, Clearfork, and Wichita-Albany formations.

In Shoe Bar 1AZ, the Project successfully achieved 100% recovery of [redacted] of whole core through the Lower San Andres and [redacted] sidewall cores from Grayburg, Upper San Andres, Glorieta, and Clearfork formations.

2.3.2 Core Analysis Program

The laboratory analysis of core acquired in Shoe Bar 1 and Shoe Bar 1AZ involved core slabbing, routine core analysis (RCA), petrographic analysis, and special core analysis (SCAL). Table 6 summarizes the program.

Table 6--Core Analysis Performed

Core	Test	Frequency
[redacted]		

*Core description: Detailed description of the slabbed core will assign core facies based on lithology, texture, biogenic structures, fossils, grain size trends, environment of deposition, and sedimentary structures.

[redacted]

2.4 Formation Fluid Characterization Program

2.4.1 Acquisition of Formation Fluid Samples

A Modular Formation Dynamics Tester (MDT) tool was utilized during the open-hole wireline logging runs to obtain representative samples of in-situ reservoir fluid. A MDT tool with pump-out module, Live Fluid Analyzer (LFA) module, and flow line resistivity measurement identifies and collects high-quality reservoir fluid samples suitable for laboratory analysis. Flowline resistivity measurements taken by the sensor on the MDT tool help discriminate between formation fluids and filtrate from muds. Equipping the MDT tool with a pump-out module makes it possible to sample fluid, while monitoring the flowline resistivity, by pumping filtrate-contaminated fluid into the mud column. Fluid removed from the formation is excluded from the sample chamber until an uncontaminated sample can be recovered.

The BRP Project utilized an MDT tool to acquire baseline reservoir fluid samples from three depths in the Lower San Andres in each of the two stratigraphic wells. These samples were transported under pressure to a third-party lab for comprehensive analysis including pH, conductivity, alkalinity, major cations, major anions, trace metals, dissolved gases, density, and TDS (Total Dissolved Solids) among others.

2.4.2 Analysis and Reporting

Table 7 indicates the analytical methods used to determine the measured parameters.

Table 7--Parameters and analytical methods for fluid analyses

Parameter	Analytical method
[redacted]	

3. <u>Injection Wells – Pre-Op Strategy</u>

The BRP Project will construct three new wells for CO_2 injection. An extensive suite of tests and logs will be acquired during drilling, casing installation, and post-casing installation in the injector wells in accordance with the testing required under 40 CFR §146.87(a), (b), (c), and (d).

3.1 Logging Program

The Project will plan and execute an extensive data acquisition program consisting of logs, surveys, and tests consistent with the data acquired in the stratigraphic test wells, shown in Table 4.

The table below shows the proposed logging and survey planned for injector wells.

Table 8--Proposed logging program for CO_2 injectors

Method	Interval Section(s)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey	Every 100 ft while drilling as minimum, from surface to TD	Define well trajectory, displacement, a tortuosity
Wireline - Spontaneous Potential	Intermediate, Production	Correlation log, volume of shale indicator, estimate salinity
Wireline - Resistivity	Intermediate, Production	Fluid identification, estimate salinity, correlation log
Wireline - Caliper	Intermediate, Production	Identify borehole enlargement and calculate cement volume
Wireline - Resistivity	Intermediate, Production	Fluid identification, estimate salinity, correlation log
Wireline - Gamma ray	Intermediate, Production	Define stratigraphy, correlation log, shale indicator
[redacted]		
Mud Logging	Surface to TD (every 30 ft)	Identify lithology, hydrocarbon shows, gases composition
Cased Hole Logs and surveys Before Injection		
Wireline - CBL-VDL-USIT (Casing inspection log)-CCL	Surface, Intermediate, Production	Cement bond, casing inspection log (USIT); Validate external mechanical integrity

Annulus Pressure Test - Long string casing	Annular between tubing and long string	Validate internal mechanical integrity between the tubing, long-string, and packer
[redacted]		
Wireline - Temperature Log	Surface, Intermediate, Production	Measure baseline temperature profile on the well from surface to top of perforation
[redacted]		

3.2 Coring Program

The Project will not collect whole core or sidewall cores in the CO_2 injector wells BRP CCS1 and BRP CCS2 wells, because representative core data were already acquired in the Shoe Bar 1AZ, [redacted]

The Project will collect up to [redacted] sidewall cores in the BRP CCS3 well, which is anticipated to have different rock properties than were encountered in the nearby Shoe Bar 1. The core depths will be finalized based on the petrophysical analysis of the triple combo logs run prior to the sidewall coring run. The project will plan to acquire [redacted] (subject to change) sidewall cores in each Confining Zone and [redacted] (subject to change) sidewall cores in the Injection Zone.

Table 9--Projected depths for rotary sidewall core sampling zones in well BRP CCS3

Well Name	Formation Top	Comment	Z [FT]	MD [FT]
CCS3	Grayburg	Upper Confining Zone	[redacted]	
CCS3	Upper San Andres	Upper Confining Zone		
CCS3	Lower San Andres (G4)	Injection Zone		
CCS3	Lower San Andres (G1)	Injection Zone		
CCS3	Lower San Andres (Holt)	Injection Zone		
CCS3	Glorieta	Lower Confining Zone		

Table 10--Core analysis plan for BRP CCS3

Core	Test	Frequency
[redacted]		

[redacted]

[redacted]

[redacted]

3.3 Well Mechanical Integrity Testing (MIT)

The BRP Project will conduct both internal and external mechanical integrity tests on all injection wells in the Project. Internal mechanical integrity refers to the absence of leaks in the casing by tubing annulus, the tubing, and the packer. External mechanical integrity refers to the absence of formation fluid or CO_2 movement through channels in the cement on the exterior of the casing.

Upon completion and installation of the downhole equipment in the wells, BRP will conduct an annular pressure test (APT) to verify internal mechanical integrity. The APT is a short-term pressure test (30 minutes) where the well is shut in and the fluid in the annulus is pressurized to a predetermined pressure and is monitored for leak off. BRP will use a test pressure of 500 psi for the MIT's. BRP will use a 5% decrease in pressure (test pressure x .05) from the stabilized test pressure during the duration of the test to determine if test is successful. If the annulus pressure decreases by ≥5%, the well will have failed the APT. If a well fails an APT, the test will be repeated. If the APT is again failed, the downhole equipment will be removed from the well and the source of the failure will be investigated. In general, the test procedure will be as follows:

1. Connect a high-resolution pressure transducer to the annulus casing valve and increase the annulus pressure to 500 psi and hold this pressure for 30 minutes.
2. At the conclusion of the 30-minute test the annulus pressure will be bled off to 0 psi and the pressure recording equipment will be removed from the casing valve.

Upon well completion, BRP will run cased hole logs to demonstrate external mechanical integrity of the casing and cement sheath prior to the start-up of operations. BRP will run Casing Inspection Logs (CIL) to evaluate casing integrity. In addition, BRP will acquire baseline temperature logs to demonstrate a lack of fluid movement through channels or communication paths through the tubing or annulus. [redacted]

3.4 Cement Logs

The BRP Project will collect noninvasive data to confirm the presence of an annular barrier and bond between casing and cement. Cement placement is a critical component of the well architecture for ensuring mechanical support of the casing, protection from fluid corrosion, and for isolation of permeable zones at different pressure regimes to prevent hydraulic communication. Tools such as Ultrasonic Imager tool (USIT) uses a single transducer mounted on an Ultrasonic Rotating Sub (USRS) on the bottom of the tool. The transmitter emits ultrasonic pulses between 200 and 700 kHz and measures the received ultrasonic waveforms reflected from the internal and external casing interfaces. The rate of decay of the waveforms received indicates the quality of the cement bond at the cement/casing interface, and the resonant frequency of the casing provides the casing wall thickness required for pipe inspection. Because the transducer is mounted on the rotating sub, the entire circumference of the casing is scanned. This 360° data coverage enables the evaluation of the quality of the cement bond as well as the determination of the internal and external casing condition. The very high angular and vertical resolutions can detect channels as narrow as 1.2 in. [3.05 cm]. Cement bond, thickness, internal and external radii, and self-explanatory maps are generated in real time at the wellsite.

[redacted]

3.5 Fracture Pressure

The fracture pressure of the Confining and Injection Zones is determined to understand injection pressure limit to maintain matrix flow. To determine the fracture pressure, a fracture is created and sustained for a small amount of time. The fracture pressure in the Injection Zone is determined through a mini-frac or Diagnostic Fracture Injection Test (DFIT). These tests will determine Instantaneous Shut-in Pressure (ISIP), the ISIP Gradient, and the Fracture Closure Pressure (FCP). These terms are defined as below and illustrated in Figure 1.

- Instantaneous Shut-In Pressure (ISIP) = Final Injection Pressure – friction pressure

- ISIP Gradient (or fracture gradient) = ISIP/formation depth
- Fracture Extension Pressure (FEP) = Minimum pressure need to develop and extend a fracture once it has been initiated
- Fracture Closure Pressure (FCP) = Minimum pressure needed to keep a fracture open; this is also the minimum horizontal formation stress
- Net Pressure (Δpnet) = Pressure in the fracture above fracture closure pressure

Following the drilling and logging of the injection well(s), an open hole wireline formation tester (such as MDT) mini-frac will be performed to determine the minimum horizontal stress of the formation intervals. The tester will be setup in a dual packer configuration to isolate ~[redacted] intervals for stress testing to determine the fracture initiation, fracture breakdown, and fracture propagation pressure. The proposed test intervals will be pre-screened to ensure no structural weaknesses (such as natural fractures) are present using a processed FMI log. The mini-frac operations will preferably occur from the deepest to shallowest depth interval following the procedure outlined below:

[redacted]

[redacted]

Mini-fracs will be performed in distinct porosity / permeability packages within the proposed Injection Zone and Upper and Lower Confining Zones. [redacted]

To perform a DFIT, the test zone will be perforated with a limited number of perforations to ensure fluid is injected over a small area. Fluid will then be injected down the tubing to apply pressure to the formation to induce a breakdown of the formation and establish a fracture. Pressure will be recorded on a surface gauge attached to the wellhead, and at a gauge at the end of the tubing. Once a fracture is created, a small volume of fluid will be pumped to extend the fracture before injection is terminated. To extend the fracture, the Δpnet needs to be above the FCP. The ISIP is the final pressure point when rate and pressure drop is zero, where net pressure is still present, and the fracture is open. At the ISIP, a fracture gradient is calculated at the depth of the fracture. Pressure decline is analyzed using G-function and root-time methods to determine fracture closure pressure.

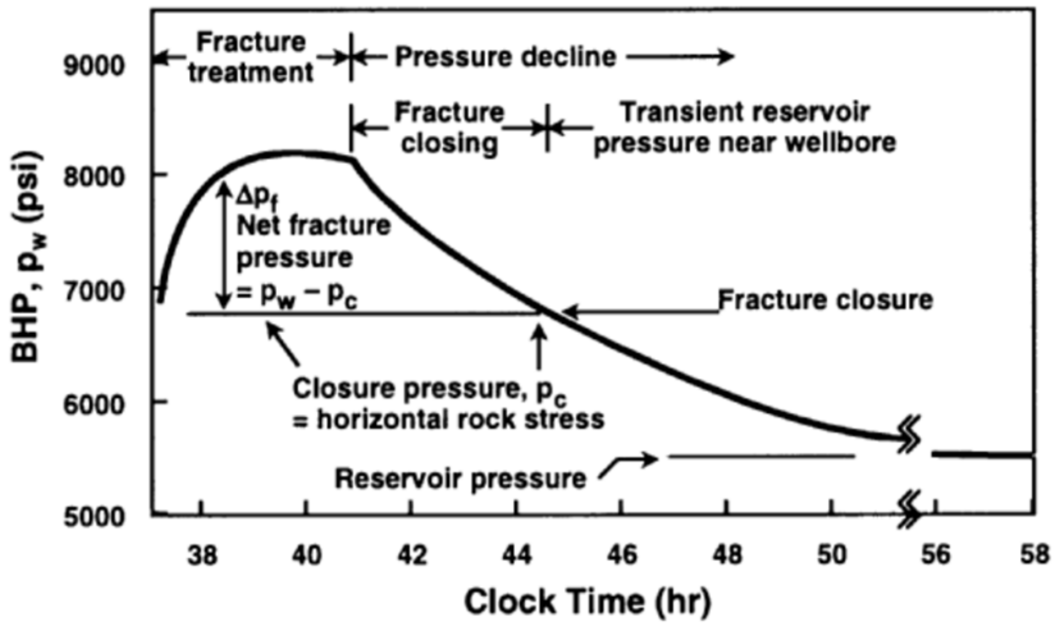

Figure 1: Well Injection Test (Talley, 1999)

3.6 Injection Well Testing

An injection test will be performed in the Lower San Andres after the injection well is complete, including perforation of the Injection Zone and installation of the injection tubing and packer. The pre-operation injectivity testing will serve as the baseline for future pressure fall-off testing. The purpose of conducting an injectivity test is to verify or establish the injection well operating parameters and constrain the inputs used for dynamic injection simulation modeling.

The injection testing will comprise of a period [redacted] of injection at constant rate [redacted] subject to a maximum bottom hole pressure limit (less or equal to 90% of the estimated fracture gradient for the perforated interval). This is followed by a shut-in/pressure fall off period [redacted] for monitoring. The injection period will be used to establish/monitor well injectivity performance and the fall off analysis will indicate the well/reservoir flow regime, average reservoir flow characteristics and the presence (if any) of reservoir baffles/boundaries/interwell interference. The tests will be planned to cover the entire perforated interval of the injector well. Injection profile logs may be run to further verify injection test results.

3.7 Pressure Fall-Off Testing

The main objectives for the pressure fall-off testing are to:

- Inform the expected rate and volume of CO_2 injectivity into the Lower San Andres formation.
- Identify potential baffles or barriers to subsurface flow.
- Verify or establish the maximum operation pressures of the well.
- Establish baseline reservoir performance for comparison with subsequent tests.

3.7.1 Test Activity Summary

The pre-injection test will be performed using brine or municipal water. There will be an injection period at constant rate followed by a zero-rate (shut-in) period for pressure monitoring (Figure 2).

[redacted]

The test will be conducted with the following considerations:

- The maximum injection pressure will be ≤90% of the estimated fracture pressure of the interval. The shut-in period will be sufficient to observe near-wellbore reservoir and boundary effects.
- Bottomhole pressure measurements will be recorded using the downhole pressure gauge near the perforations. A surface pressure gauge may also serve as a monitoring tool for tracking the test progress.
- Injection profile logs and other complementary data may be acquired during the test.
- Testing procedures will follow the EPA recommended methodology (EPA, 2002). The recommendations provided in these guidance documents will be followed to the extent possible. If BRP proposes a significantly different approach, the proposed operational changes will be reviewed with the UIC Program Director prior to initiation.

The following general procedure will be followed for pressure fall off testing:

1. Hook-up brine or municipal water to the well to prepare for injection.

2. Record static shut-in pressure at the downhole gauge.
3. [redacted]
7. End the pressure fall off test after confirmation of sufficient data acquisition.

Note: The injection rate schedule and the duration of the injection period and the pressure fall-off testing may be modified based on dynamic reservoir response.

3.7.2 Analysis and Reporting

Fall-off testing analysis allows for calculation of the following parameters: transmissivity, storage capability, skin factor, and well flowing and static pressures. A Cartesian plot of the pressure and temperature versus real time or elapsed time will be used to confirm pressure stabilization and look for anomalous data. A log-log diagnostic of the pressure and semilog derivative analysis will be performed for well/reservoir performance characterization (Petrowiki, 2016)

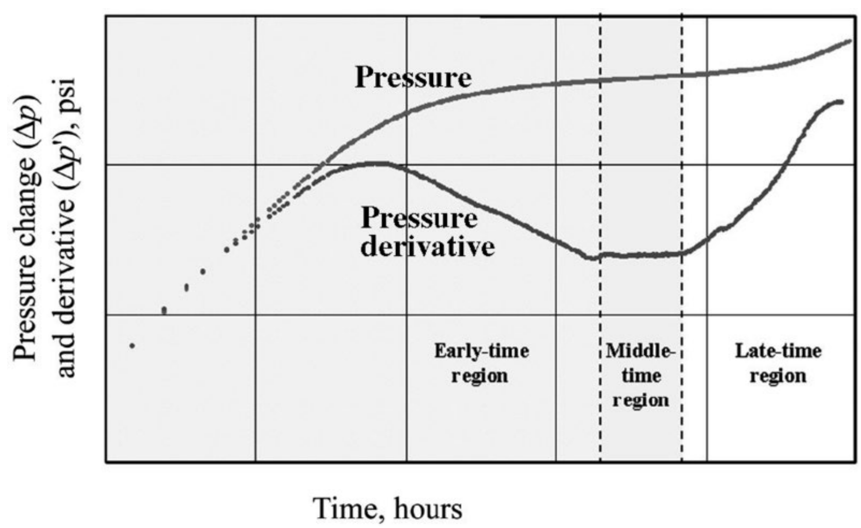

Figure 3. Pressure derivative analysis diagnostic chart (Petrowiki, 2016)

BRP will conduct the following data analysis, integration, and reporting:

- The results of the wireline logging program and the fracture pressure evaluation program will be integrated to support and corroborate the hydrogeologic properties.

- The fall-off testing report will be submitted no later than 60 days following the test and will include well schematic, gauge information, test information, rate/pressure data, reservoir parameters and summary of analysis.
- The testing will be repeated using carbon dioxide within the first 90 days following initiation of sequestration operations. This will allow for comparison to the baseline fluid-to-fluid test with the change in the injection fluid from brine water to carbon dioxide.
- The fall-off test will be performed annually at five-year intervals (within +/-3 months of the anniversary of the previous test), for the lifetime of injection operations. Periodic testing is expected to provide insight into the performance of sequestration site and potentially aid in interpreting the dimensions of the CO_2 plume, based on the expected lateral transition from supercritical CO_2 near the wellbore to native formation brine beyond the plume.
- A final pressure fall-off test will be run after the cessation of injection into the Injection Well.

3.8 Injection Wells Directional Survey

Wellbore deviation measurements will be conducted at periodic intervals while drilling the injection wells. Additionally, a final directional survey may be acquired from total depth to the surface to provide borehole inclination and azimuthal information.

3.9 Injection Wells Formation Pressure and Fluid Sampling

The BRP Project will utilize a formation testing tool (example: MDT) to quantify the reservoir pore pressure and collect fluids from selected intervals in the Injection Zone. The pore pressure testing, and fluid sampling procedure is outlined below:

1. Rig up formation testing tool.
2. Run in hole, for casing check, to above casing shoe.
3. Run in hole for depth correlation. Correlation should be recorded in the same direction as reference log (mostly log up)
4. Log depth correlation pass.
5. [redacted]

6. [redacted]
9. Pull out of hole to surface.

The fluid sample containers will be transported under pressure to a third-party lab for comprehensive analysis including pH, conductivity, alkalinity, major cations, major anions, trace metals, dissolved gases, density, and Total Dissolved Solids (TDS) among others. Based on data from the Shoe Bar 1 and Shoe Bar 1AZ, OLCV anticipates encountering [redacted] OLCV will collect fluid samples in each of these zones. The final sampling depths will be selected after reviewing logs for the specific Injector well.

4. SLR and ACZ Monitoring Wells – Pre-Op Strategy

The AoR for the BRP Project will be monitored by two In-Zone Monitoring wells (SLR), one Above Confining Zone Monitor well (ACZ). The Shoe Bar 1 stratigraphic test well will be converted to the SLR 1 monitor, and the Shoe Bar 1 AZ will be converted to the ACZ1 monitor well. The data collected in these wells is described earlier in the document. A USDW-level well will be drilled prior to the commencement of injection. One additional SLR will also be drilled prior to the commencement of injection. The need for additional monitoring wells will be considered during AoR re-evaluations, and at least every five years following commencement of injection. The locations and timing of monitor wells is discussed in the AoR and Corrective Action Plan.

4.1 Logging Program

4.1.1 Logs in SLR and ACZ monitoring wells

See Section 3 of this document for a description of the data collected in the Shoe Bar 1 (SLR 1) and Shoe Bar 1AZ (ACZ1) wells. Additional SLR wells will collect the log data listed in the table below.

Table 12--Logging program for SLR and ACZ monitoring wells

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey	Every 100 ft while drilling as minimum, from surface to TD	Define well trajectory, displacement, and tortuosity
Wireline - Spontaneous Potential	Production	Correlation log, volume of shale indicator, estimate salinity
Wireline - Gamma ray	Production	Define stratigraphy, correlation log, shale indicator
Wireline - Resistivity	Production	Fluid identification, estimate salinity, correlation log
Wireline – Caliper	Production	Identify borehole enlargement and calculate cement volume
[redacted]		
Mud Logging	Surface to TD (every 30 ft)	Identify lithology, hydrocarbon shows, gases composition
Cased Hole Logs and surveys Before Injection		
CBL-VDL-USIT-CCL	Surface, Intermediate, Production	Cement bond, casing integrity. Validate external mechanical integrity
Annulus Pressure Test – Long string casing	Annular between tubing and long string.	Validate internal mechanical integrity between the tubing, long string, and packer
[redacted]		

4.2 Coring Program

Whole core and sidewall cores were collected in the Shoe Bar 1 and Shoe Bar 1AZ wells. The Project does not intend to acquire any additional core in future monitoring wells.

4.3 Formation Fluid Characterization Program

4.3.1 Acquisition

The BRP project will utilize an MDT tool to acquire reservoir fluid samples from the zones being monitored in the SLR, ACZ, and USDW-level wells. For the SLR wells, the project will obtain fluid samples from the Lower San Andres (up to six samples, subject to change). For the ACZ wells, fluid samples will be acquired from the Yates ([redacted] samples, subject to change). The final sample acquisition depths in these monitoring wells will be determined based on the petrophysical analysis of the open hole logs run prior to the MDT logging run.

4.3.2 Analysis and Reporting

Following the acquisition of the fluid samples, they will be transported under pressure to a third-party lab for comprehensive analysis including pH, conductivity, alkalinity, major cations, major anions, trace metals, dissolved gases, density, and TDS (Total Dissolved Solids) among others.

The table below shows the analytical methods that will be used to determine the measured parameters.

Table 13--Fluid Analysis Methods.

Parameter	Analytical method
[redacted]	

4.4 Fracture Pressure

4.4.1 Confining zone

The fracture pressures of the Upper Confining Zone (Upper San Andres and Glorieta) and the Injection Zone (Lower San Andres) were estimated using mini-frac tests in the Shoe Bar 1 and Shoe Bar 1AZ wells. The fracture gradients are in the range of [redacted] The table below shows the summary information:

Table 14--Summary of Confining Zone Fracture Pressure Estimates

Well	Test	Zone	Formation	Measured Depth, ft	Fracture propagation pressure, psi	Fracture gradient, psi/ft
Shoe Bar 1	[redacted]	Upper confining zone	Upper San Andres	[redacted]	[redacted]	[redacted]
Shoe Bar 1	[redacted]	Lower confining zone	Glorieta	[redacted]	[redacted]	[redacted]
Shoe Bar 1AZ	[redacted]	Upper confining zone	Upper San Andres	[redacted]	[redacted]	[redacted]
Shoe Bar 1AZ	[redacted]	Lower Confining Zone	Glorieta	[redacted]	[redacted]	[redacted]

4.4.2 Injection Zone

The fracture pressure of the Injection Zone was estimated using Mini-frac (or Diagnostic Fracture Injection Test) and Step Rate Tests (SRT) performed in the Shoe Bar 1 and Shoe Bar 1AZ wells. The table below summarizes the results:

Table 15--Summary of Injection Zone Fracture Pressure Estimates

Well	Zone	Tested Interval Top Perf-Bottom Perf (MD, ft)	Initial Reservoir Pressure (psi)	Type of Test	Estimated Fracture Gradient (psi-ft)
Shoe Bar 1	Lower San Andres	[redacted]	[redacted]	[redacted]	[redacted]
Shoe Bar 1	Lower San Andres	[redacted]	[redacted]	[redacted]	[redacted]
Shoe Bar 1AZ	Lower San Andres	[redacted]	[redacted]	[redacted]	[redacted]
Shoe Bar 1AZ	Upper San Andres	[redacted]	[redacted]	[redacted]	[redacted]

4.5 Well Mechanical Integrity

4.5.1 Mechanical Integrity Testing (MIT)

The BRP Project will conduct both internal and external mechanical integrity tests on the two SLR wells and one ACZ monitoring well. Internal mechanical integrity refers to the absence of leaks in the casing by tubing annulus, the tubing, and the packer. External mechanical integrity refers to the absence of formation fluid or CO_2 movement through channels in the cement on the exterior of the casing.

Upon completion and installation of the downhole equipment in the wells, BRP will conduct an APT to verify internal mechanical integrity. The APT is a short-term pressure test (30 minutes) where the well is shut in and the fluid in the annulus is pressurized to a predetermined pressure and is monitored for leak off. BRP will use a test pressure of 500 psi for the MIT's. BRP will use a 5% decrease in pressure (test pressure x .05) from the stabilized test pressure during the duration of the test to determine if test is successful. If the annulus pressure decreases by ≥5%, the well will have failed the APT. If a well fails an APT, the test will be repeated. If the APT is again failed, the downhole equipment will be removed from the well and the source of the failure will be investigated. The proposed procedure will be as follows:

1. Connect a high-resolution pressure transducer to the annulus casing valve and increase the annulus pressure to 500 psi and hold this pressure for 30 minutes.
2. At the conclusion of the 30-minute test the annulus pressure will be bled off to 0 psi and the pressure recording equipment will be removed from the casing valve.

Upon well completion, BRP will run cased hole logs to demonstrate external mechanical integrity of the casing and cement sheath prior to the start-up of operations. BRP will acquire baseline temperature logs to demonstrate a lack of fluid movement through channels or communication paths through the tubing or annulus. BRP will also run an ultrasonic imaging tool (USIT) to provide further confidence that there are no channels in the cement sheath for formation fluids or CO_2 to migrate upwards in the well.

5. <u>USDW Monitoring Well</u>

Underground Source of Drinking Water (USDW) for the BRP project will also be monitored by a monitoring well drilled in the lower most USDW, the Dockum formation. Maps and additional stratigraphic details for the USDWs are included in the "Area of Review and Corrective Action Plan" document in section 2.2.8.

Two USDWs are present in the AoR, the Dockum and Pecos Valley aquifers. Baseline geochemical data for the Pecos Valley aquifer will be acquired from a water well close to the AoR and within the Shoe Bar Ranch property prior to the start of injection at BRP.

5.1 Logging Program

Table 16 shows the proposed logging and surveys planned for this well.

Table 16--Logs collected in the USDW-level well

Method	Interval (ft)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey	Every 100 ft while drilling as minimum, from surface to TD	Define trajectory, displacement, and tortuosity
Wireline – Spectral gamma ray	Surface to TD	Define uranium rich formation, clay indicator
Wireline- Spontaneous Potential	Surface to TD	Correlation log, volume of shale indicator, estimate salinity
Wireline –Resistivity	Surface to TD	Fluid identification, estimate salinity, correlation log
Wireline – Density / Neutron	Surface to TD	Estimate porosity, mineralogical characterization
Wireline – Caliper	Surface to TD	Identify borehole enlargement and calculate cement volume

5.2 Formation Fluid Characterization Program

5.2.1 Acquisition

The Project will monitor the chemical composition of the fluids and dissolved gases in this lower most USDW. Baseline samples will be collected on a quarterly basis, for approximately one year prior to the start of injection. These samples will be collected by a qualified environmental monitoring and service provider and overseen by Oxy or OLCV personnel.

5.2.2 Analysis and Reporting

Table 17 includes the analysis that will be performed by the qualified environmental service provider and verified by Oxy or OLCV personnel.

Table 17--USDW Geochemical Analysis Plan.

Analysis	Sampling
[redacted]	

5.3 Well Mechanical Integrity

Per Texas Water Development Board, mechanical integrity testing is not required for the USDW monitoring well.

6. Water Withdrawal Wells

BRP Project will drill four water withdrawal wells for pressure management. The project will plan and execute a data acquisition program consisting of logs (including baseline fluid sampling) and surveys.

6.1 Logging Program

The table below shows the proposed logging and surveys for the water withdrawal wells.

Table 18--Proposed logging, survey, and sampling program for water withdrawal wells

Method	Interval Section(s)	Purpose
Open Hole Logs, Surveys and Sampling During Construction		
Deviation survey	Every 100 ft while drilling as minimum, from surface to TD	Define well trajectory, displacement, and tortuosity
Wireline- Spontaneous Potential	Production	Correlation log, volume of shale indicator, estimate salinity
Wireline – Resistivity	Production	Fluid identification, estimate salinity, correlation log
Wireline – Caliper	Production	Identify borehole enlargement and calculate cement volume
Wireline -Gamma ray	Production	Define stratigraphy, correlation log, shale indicator
[redacted]		
Cased Hole Logs		
Wireline - CBL-VDL-USIT-CCL	Surface, Intermediate, Production	Cement bond, casing integrity. Validate external mechanical integrity
Wireline – Temperature Log	Surface, Intermediate, Production	Measure baseline temperature profile on the well
Annulus Pressure Test - Long string casing	Annular between tubing and long string	Validate internal mechanical integrity between the tubing, long-string, and packer
[redacted]		

6.2 Formation Fluid Characterization Program

The BRP project will utilize an MDT tool to acquire reservoir fluid samples in the water withdrawal wells during construction to capture baseline fluid properties and chemistry.

6.3 Well Mechanical Integrity

The BRP Project will conduct both internal and external mechanical integrity tests on four water withdrawal wells. Internal mechanical integrity refers to the absence of leaks in the casing by tubing annulus, the tubing, and the packer. External mechanical integrity refers to the absence of formation fluid or CO_2 movement through channels in the cement on the exterior of the casing.

Upon the completion of drilling of the four water withdrawal wells and prior to perforating, BRP will conduct an APT to verify internal mechanical integrity. The APT is a short-term pressure test (30 minutes) where the well is shut in and the fluid in the annulus is pressurized to a predetermined pressure and is monitored for leak off. BRP will use a test pressure of 500 psi for the MIT's. BRP will use a 5% decrease in pressure (test pressure x .05) from the stabilized test pressure during the duration of the test to determine if test is successful. If the annulus pressure decreases by ≥5%, the well will have failed the APT. If a well fails an APT, the test will be repeated. If the APT is again failed, the downhole equipment will be removed from the well and the source of the failure will be investigated. The proposed procedure will be as follows:

1. Connect a high-resolution pressure transducer to the annulus casing valve and increase the annulus pressure to 500 psi and hold this pressure for 30 minutes.
2. At the conclusion of the 30-minute test the annulus pressure will be bled off to 0 psi and the pressure recording equipment will be removed from the casing valve.

Upon the completion of drilling, BRP will run cased hole logs to demonstrate external mechanical integrity of the casing and cement sheath prior to the start-up of operations. BRP will acquire baseline temperature logs to demonstrate a lack of fluid movement through channels or communication paths through the tubing or annulus. BRP will also run an ultrasonic imaging tool (USIT) to provide further confidence that there are no channels in the cement sheath for formation fluids or CO_2 to migrate upwards in the well.

7. <u>References</u>

Talley, G. R., Swindell, T. M., Waters, G. A., and K. G. Nolte. 1999. Field Application of After-Closure Analysis of Fracture Calibration Tests. Paper presented at the SPE Mid-Continent Operations Symposium, Oklahoma City, Oklahoma, March 1999. doi: https://doi.org/10.2118/52220-MS

EPA. 2002. UIC Pressure Falloff Testing Guideline, EPA Region 6, 2 Aug. 2002. https://www.epa.gov/sites/default/files/2015-07/documents/guideline.pdf. Accessed 30 Oct. 2023.

Petrowiki. 2016. Diagnostic Plots. Society of Petroleum Engineers. petrowiki.spe.org/Diagnostic_plots.