ATTACHMENT I: PRE-OPERATIONAL TESTING PLAN
40 CFR 146.87
CTV VI

Document Version History

Version	Revision Date	File Name	Description of Change
1	7/31/2024	Att I Pre-Operational Testing Plan_v1	Original Submission

1. Facility Information

Facility Name: CTV VI

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Well Location(s): Claimed as PBI

2. Testing Summary

Carbon Terra Vault Holdings, LLC (CTV) plans to drill seven new injection wells:

- Claimed as PBI
- Claimed as PBI
- Claimed as PBI

Pre-operational formation testing will include a suite of logging, coring, geohydrologic testing, and other activities during the drilling and completion of these injection wells, as detailed in this plan.

Electrical logging will support reservoir rock and fluid properties characterization. Formation pressure testing will determine current reservoir pressure and permeability. The other pre-operational tests will confirm the depth, thickness, mineralogy, lithology, porosity, permeability, and geomechanical attributes of the Confining Zone and Injection Zone as defined in **Attachment A: Narrative Report** (**Attachment A**).

Methods for tests will be consistent with U.S. Environmental Protection Agency (EPA) standards (U.S. EPA, 2013) and testing methods listed in **Attachment C: Testing and Monitoring Plan** (**Attachment C**). Well-specific construction and plugging (CP) plans (**Attachments G1 through G7**) are submitted for each individual well. This Pre-Operational Testing Plan summarizes planned pre-operational testing activities, schedule, and reporting to EPA.

3. Schedule and Reporting

Results of testing will be documented in a report submitted to EPA after new well drilling and testing activities have been completed but before carbon dioxide (CO_2) injection commences.

CTV will notify the Director at least 30 days prior to conducting any testing.

4. Injection Well Testing

Wireline logging of the injection wells will consist of conventional and advanced open-hole logs of the surface, intermediate, and injection hole sections. Cement bond logs (CBLs) will be run on the surface, intermediate, and injection casing sections to verify cement integrity and zonal isolation. A pulsed neutron capture log will be run on the injection hole to provide a baseline water-to-gas saturation to support saturation and injection modeling over the life of the project.

All tests listed in the following subsections will be performed for new injection wells.

4.1 Wireline Logs Prior to Running Casing

The following logs will be run for the following hole sections:

- Surface, intermediate and long-string:
  - Deviation checks
  - Spontaneous Potential
  - Dual Induction Laterolog
  - Gamma Ray Log
  - Caliper Log
- Intermediate and long-string only:
  - Image Log
  - Compensated Neutron Log
  - Formation Density Log
  - Mud Log

4.2 Wireline Logs after Running Casing

The following will be conducted for surface, intermediate and long-string sections:

- Cement Bond Log
- Casing Inspection Log

4.3 Additional Injection Well Testing

Additional injection well testing will include the following:

- Internal mechanical integrity/standard annulus pressure test (SAPTs) on all injection wells, configured with tubing and a packer (**Attachment C**).
- Internal mechanical integrity/standard casing pressure test (SCPTs) on in-zone monitoring wells that penetrate the Confining Zone (**Attachment C**). External mechanical integrity test (MIT) consisting of (at least one of) oxygen activation log, noise log, and/or temperature log. **Attachment C** lists testing methods that may be used for MIT on injection and monitoring wells associated with the project.
- Pressure fall-off testing as described in **Attachment C**.

5. Coring Program

Several whole and sidewall cores will be taken from at least one newly drilled injection well in the Area of Review (AoR) to evaluate fluid and rock properties and to calibrate against open-hole logs. The objective of the coring is to determine the nature of sand reservoir containers and their transitions to shales. Cores will be taken across sealing interfaces and across the Injection Zones. Targets include the Injection and Confining Zones as defined in **Attachment A**.

5.1 Proposed Core Analyses

The following testing and analyses are proposed for the core samples:

- Porosity
- Permeability to air
- Saturations
- Grain density, to calibrate porosity logs
- Gamma ray, to correlate to open-hole logs
- Core descriptions

5.2 Proposed Special Core Analysis

The following special testing and analyses are proposed for the core samples:

- Capillary pressure on select plugs to determine pore throats and relate water saturations to permeability (K) and porosity (φ)
- X-ray diffractograms (XRD) to determine clay mineralogy and validate petrophysical clay volume calculations
- CO_2 to water relative permeability

- Geomechanical measurements of Injection and Confining Zones
  - Triaxial compressive tests to determine static and dynamic mechanical properties (Young's modulus, Poisson's ratio) and failure criteria (unconfined compressive strength, friction angle)
- Pore compressibility
- Thin section and scanning electron microscopy (SEM) analyses

6. Additional Pre-Operational Testing

Additional pre-operational testing will address hydrologic and hydrogeologic information, geochemistry and geochemical data, seismic history and risk, facies changes in the Injection or Confining Zones, CO_2 stream compatibility with subsurface fluids and minerals, Confining Zone integrity, and injection well construction.

6.1 Hydrologic and Hydrogeologic Information

Groundwater sample collection and analysis will be conducted during well construction to establish the depth of the lowermost underground source of drinking water (USDW) within the AoR (analytes and testing methods in **Attachment C**).

6.2 Geochemistry/Geochemical Data

Baseline geochemistry of the USDW and the Injection Zone will be characterized for all parameters (and monitoring locations and methods) described in **Attachment C** to (1) confirm the inputs to the geochemical modeling and (2) establish a baseline for operational monitoring.

6.3 Seismic History and Seismic Risk

Seismic history and seismic risk will be evaluated in order to (1) establish pressure in the Injection Zone (anticipated testing methods: pressure gauge measurement) and (2) continue to establish baseline seismicity using methods listed in **Attachment A** and **Attachment C**.

6.4 Facies Changes in the Injection or Confining Zones

Testing will confirm the thickness of the formations that make up the Injection Zone at the location of the injection wells to provide additional information on their suitability for injection, including facies changes that could facilitate preferential flow (anticipated testing methods: cores and well logging data, see Sections 4 and 5 of this plan).

6.5 CO_2 Stream Compatibility with Subsurface Fluids and Minerals

The CO_2 stream will be evaluated to confirm the composition of the CO_2 injectate as part of baseline sampling and to provide verification that it will not react with the formation matrix (anticipated testing methods: injectate analysis and core testing, geochemical modeling).

Properties of the CO_2 stream will be analyzed for consistency with the AoR delineation model inputs (anticipated testing methods: various geochemical analyses) and to confirm that the analytes for the injectate and ground water quality monitoring are appropriate based on the results of the geochemical modeling evaluation (anticipated testing methods: various geochemical analyses).

6.6 Injection and Confining Zone Integrity

Testing will be performed to evaluate the fracture pressure of both the Injection and Confining Zones. Methods will include site-specific step rate testing (SRT) in the Injection Zone in at least one well within the project AoR. SRT procedures will follow U.S. EPA (1999). Confining Zone integrity will be tested or calculated using a diagnostic fracture injection test (DFIT) or will be calculated using a combination of logs and core.

6.7 Injection Well Construction

Following pre-construction measurement of the composition, properties, and corrosiveness of the injectate, review well construction materials and cement in the context of the results of these tests (anticipated testing methods: various geochemical analyses).

6.8 Reservoir Modeling

AoR delineation modeling (see **Attachment B**) will be revised based on newly collected data during the pre-operational period. Grid inputs will be revised as necessary to reflect any heterogeneities identified and reduce uncertainty.

References

U.S. Environmental Protection Agency (U.S. EPA). 1999. Step-Rate Test Procedure. January 12, 1999.

U.S. EPA. 2013. Underground Injection Control (UIC) Program Class Six Well Testing and Monitoring Guidance. Office of Water (4606M). EPA 816-R-13-001. March 2013.