8.0 INJECTION WELL PLUGGING PLAN

40 CFR 146.92

TEXAS CARBON STORAGE I

Facility Information

Facility name: [redacted]

Facility contact: Kim Do
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214-751-2568 | [redacted]

Well name: [redacted] #1

Well location: [redacted], TEXAS
Latitude: [redacted]
Longitude: [redacted]

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8.1 Plugging Plan for the [redacted] #1 Injection Well

The injection well plugging plan described in this section, details the methods and materials that will be used to plug and abandon the [redacted] #1 injection well in accordance with 40 CFR 146.92. The well construction details for this injection well are provided in the Injection Well Construction Plan (Permit Section 4) of this application, and includes the casing and cement used in the completion of the well. These details, along with requirements of the Texas Railroad Commission as well as any applicable requirements from the California Air Resources Board's Low Carbon Fuel Standard (LCFS) will be used to determine an appropriate approach to plugging the well to prevent migration of fluids upwards through the abandoned well. The Post-Injection Site Care and Closure (PISC) Plan (Permit Section 9) describes tests that will be performed prior to well abandonment to confirm the well has maintained mechanical integrity throughout the injection phase of the project.

Pursuant to the requirements of 40 CFR 146.92, specific data will be collected prior to plugging the injection well. The bottom-hole pressure will be determined and the mechanical integrity of the well casing will be confirmed prior to plugging and abandoning the well. The procedures that will be used to generate this data is described in the following sections.

8.2 Tests or Measures for Determining Bottom-Hole Reservoir Pressure

Bottom-hole pressure measurements will be used to determine several parameters including the pressure required to squeeze the cement from the well casing into the storage formation, the need for well control such as the weight of brine required to prevent the well from flowing, and the required blowout preventor (BOP) stack during the pre-abandoment workover activities. The bottom-hole reservoir pressure will also be used to confirm the blend of cement to be used to plug the well.

8.3 Planned External Mechanical Integrity Tests

External mechanical integrity tests (MITs) will be conducted prior to plugging the injection well as required by 40 CFR 146.92(a). The mechanical integrity of the well must be demonstrated after the injection phase of the project has been completed and prior to plugging the well to ensure conduits between the storage formation and the underground sources of drinking water (USDWs) have not developed. The external mechanical integrity will be evaluated using the fiber-optic Distributed Temperature Sensor (DTS) in the injection well (**Table 8-1**).

Test Description	Location
Temperature measurement (DTS)	[redacted] #1
Oxygen-Activation Log (Contingency)	[redacted] #1

Table 8-1: Planned Mechanical Integrity Tests.

Throughout the injection phase of the project, the external mechanical integrity of the injection well will be confirmed through regular temperature measurements in accordance with the Testing and Monitoring Plan (Permit Section 7). A final temperature measurement will be acquired over the entire [redacted] #1 well after the tubing has been pulled and prior to the plugging and abandonment process (40 CFR 146.92 (b)(2)). The temperature data will be evaluated for anomalies and compared to previous temperature measurements acquired during the pre-operational and injection phases of the project for any indications that the storage formation fluids have migrated outside of the storage formation.

The post-injection temperature data are expected to display a similar temperature gradient above the confining zone as the previous measurements. If a loss in external mechanical integrity is discovered, corrective action will be taken prior to proceeding to the plugging and abandonment. The response actions to such a situation are described in the Emergency and Remedial Response Plan (Permit Section 10).

8.4 Plugging Plan (40 CFR 146.92 (b))

A Notice of Intent to plug the well will be submitted to the EPA at least 60 days prior to the plugging operations (40 CFR 146.92 (c)). Section 8.5 details the pre-plugging procedures that will be completed prior to plugging the well, and Section 8.6 contains a detailed description of the plugging procedures.

After the the project has verified that there are no external well integrity issues, the well will be flushed with a buffer fluid to remove any fluids or particulates that may be present in the well (Section 8.6). The weight of the buffer fluid will be determined from the final reservoir pressure measurement and will be chemically compatible with the formation fluids and solids to reduce the potential of corrosion of the well materials. A minimum of three casing volumes will be circulated without exceeding the fracture pressure of the storage formation.

The injection well casing will be plugged with cement to ensure that it does not provide a conduit outside the storage formation. **Table 8-2** and **Table 8-3** present the intervals that will be plugged as well as the materials and methods that will be used to plug the intervals. The cement volume required for each plug was calculated using the inside diameter of the deep casing string, the length of the zone to be plugged, and the yield of the cement slurry (1.18 ft^3/sack for Class A or G or H and 1.07 ft^3/sack for the CO_2-resistant cement). The storage formation will be plugged using CO_2-resistant cement with a retainer/squeeze method or other method approved by the UIC Director. A cement retainer will be set in the injection casing a minimum of 100 ft above the top perforation. These depths will be re-evaluated after the injection well has been drilled and

precise formation depths have been established. CO_2-resistant cement will be used to plug the storage formation; this will include a 20% excess volume to be squeezed into the storage formation. It requires approximately 0.2 sack of cement to seal one foot of hole, and this value may be used to estimate the amount of cement needed for different perforation scenarios.

The pressure used to squeeze the cement will be determined from the bottom-hole pressure data measured before beginning the plugging and abandonment process. The injection pressure of the cement will not exceed 90% of the fracture pressure of the storage formation. Once the squeeze volume of cement has been pumped through the retainer or calculated bottom hole pressure has reached maximum allowable pressure, the tubing stinger will be pulled out of the retainer and any remaining volume of cement will be spotted on top of the retainer.

The cement retainer will be capped with at minimum a 100 ft plug of CO_2 resistant cement. The cement stage tool (DV tool) will also be covered by a minimum of a 100 ft plug of CO_2 resistant cement.

In addition, a cement plug will be placed within the production casing string at the casing shoe of the surface strings. One hundred-foot-thick plugs will be placed over the surface and intermediate casing shoe depths using a balance method (Section 8.6). Approximately 20 sacks of Class C cement will be used for each of these plugs. A surface plug from 500 ft to surface will be placed using approximately 100 sacks of Class C cement.

After the top cement plug has been set, the casing sections will be cut off approximately 5 ft below grade, and a steel cap will be welded to the top of the deep casing string. The cap will have the well identification (ID) number, the UIC Class VI permit number, and the date of plug and abandonment inscribed on it. The area around the wells will be regraded to follow the natural topography of the surrounding area (currently agricultural fields) unless the surface owner desires the well pad be left in place. The ground will be replanted with either native vegetation or be converted back to agricultural land, as warranted relative to the surface owner's desire.

The methods and materials described in the preceding paragraph are based upon current understanding of the geology at the site and current well designs. If necessary, the plans will be updated to reflect latest well designs. The new designs, materials, and methods will be described in the Notice of Intent to Plug submitted at least 60 days prior to the plugging of the well (40 CFR 146.92 (c)).

After the completion of the plugging activities, a plugging report will be submitted to the UIC Director describing the methods and tests that were performed on the well during plugging. This report will be submitted to the UIC Director within 60 days of completing the plugging activities (40 CFR 146.92 (d)).

Description	Cemented Interval (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Open Hole Interval	[redacted]	[redacted]	Retainer	CO_2-Resistant	300 sacks
On cement retainer	[redacted]		Balance	CO_2-Resistant	26 sacks
At cement stage tool	[redacted]		Balance	CO_2-Resistant	26 sacks
Intermediate Casing Shoe	[redacted]		Balance	Class C	22 sacks
Surface Casing Shoe	[redacted]		Balance	Class C	22 sacks
Surface	Surface - 500		Balance	Class C	110 sacks

Table 8-2: Intervals to be plugged and materials/methods used (40 CFR 146.92 (b)(2 – 4)).

Plug Information	Plug #1	Plug #2	Plug #3	Plug #4	Plug #5	Plug #6
Diameter of boring in which plug will be placed (in.)	6.125	6.875	6.875	6.875	6.875	6.875
Depth to bottom of tubing or drill pipe (MD,ft)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	100
Sacks of cement to be used (each plug)	300*	26	26	22	22	110
Slurry volume to be pumped (ft^3)	321*	28	28	20	20	100
Slurry weight (lb./gal)	15.2	15.2	15.2	14.8	14.8	14.8
Slurry Yield (ft^3/sack)	1.07	1.07	1.07	1.33	1.33	1.33
Calculated top of plug (ft)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Surface
Bottom of plug (ft)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	500
Type of cement or other material	CO_2-Resistant	CO_2-Resistant	CO_2-Resistant	Class C	Class C	Class C
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Balance	Balance	Balance	Balance	Balance

* Estimated - calculated based on estimated open hole interval

Table 8-3: Information on proposed well plugs.

8.5 Detailed Pre-Plugging Procedure (40 CFR 146.92 (c))

1. Notify EPA 60 days in advance of plugging via letter of intent, and 48 hours prior to commencing field operations. Ensure proper notifications and permits are in place and given to all regulatory agencies for rig move-in.

2. Ensure all permits for plug and abandonment (P&A) procedure and work plan have been approved and work authorized by the EPA, or its primacy designee.

3. Ensure that advance pre-site inspection has been performed and the rig company has visited the site and is capable of transporting rig, tanks and ancillary equipment to perform P&A operations. Remediate any findings from pre-site inspection. Notify all key third parties of expected work scope, and ensure third-party contracts for work are in place prior to move in.

4. Provide on-site all copies of permits prior to initiating operations. Monitor and ensure all permit conditions of approval have been met.

5. Confirm all necessary forms for the owner are on the location, i.e., permits, safety meetings, trip sheets, etc.

8.6 Detailed Plugging and Abandonment Procedure (Post-Injection) (40 CFR 146.92 (c))

1. Conduct and document a safety meeting each morning before work effort begins and/or any crew/tour change, or any additional service provider crews arrive.

2. Conduct Bottom Hole Pressures and Mechanical Integrity Tests. See Sections 8.2 and 8.3.

3. Move-in (MI) rig and ancillary equipment onto injection well site and rig up (RU). Nipple up and test BOPs, pressure test equipment and ensure proper operation.

4. Check wellhead tubing and casing pressures.

5. Record bottom-hole pressure from downhole gauge (if final pressure has not already been determined) and calculate kill fluid density.

6. Fill tubing with kill weight brine as determined by the final pressure measurement. Flush two tubing volumes of kill weight brine. Monitor tubing and casing pressure for 1 hour. Release from packer with tubing string and circulate one hole volume with kill weight brine.

   If the well is not dead or the pressure cannot be bled off of tubing, RU slickline and set plug in lower profile nipple below packer. Pick up on tubing to remove tubing seals from packer and circulate tubing and annulus with kill weight fluid.

7. Release packer and pull out of hole with injection tubing laying it down. Ensure that the well is over-balanced so there is no backflow due to formation pressure and there are at least two well control barriers in place at all times.

8. Trip into hole with work string and 7 inch cement retainer and set retainer to cement the perforated or open hole portion of the well, and prepare for cement plugging operations. Pump required number of sacks of CO_2-resistant cement through the retainer while maintaining bottom-hole pressure below fracture pressure. Once the squeeze volume of cement has been pumped through the retainer or calculated bottom hole pressure has reached maximum allowable pressure, the tubing stinger will be pulled out of the retainer and any remaining volume of cement will be spotted on top of the retainer.

9. Spot required number of sacks of CO_2 resistant cement on top of retainer.

10. Trip tubing string out of well and remove stinger from end of tubing.

11. Trip tubing to 50 ft below DV tool and prepare to set cement plug. Pump CO_2 resistant cement to leave 100 ft cement plug across DV tool.

12. Trip tubing string to intermediate casing shoe and prepare to set cement plug. Pump Class C cement using a balance method to cement 100 ft across casing shoe.

13. Trip tubing string to surface casing shoe and prepare to set cement plug. Pump Class C cement using a balance method to cement 100 ft across casing shoe.

14. Trip tubing string to a depth of 500 ft and prepare to set cement plug. Pump Class C cement to fill the casing from a depth of 500 ft to surface.

15. Cut the casing string off at 5 ft below grade and weld a steel plate, (with well ID, permit number, and date of abandonment on it) to the casing strings.

16. Backfill the excavation.

17. Rig down and move off service rig and any remaining equipment (i.e. deadmen anchors).

The procedures described above are subject to modification during execution as necessary to ensure a plugging operation that protects worker safety and is effective to protect USDWs. Any significant modifications due to unforeseen circumstances will be described in the Plugging Report. The Plugging Report will be submitted to the EPA, or its primacy designee within 60 days after plugging is completed (40 CFR 146.92 (d)).