

8.0 INJECTION WELL PLUGGING PLAN
40 CFR 146.92

CASS SEQUESTRATION

Facility Information

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Well name: [REDACTED]

Well location: CASS COUNTY, INDIANA
[REDACTED] [REDACTED]

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8.0 Injection Well Plugging Plan

8.1 Plugging Plan for the Logansport INJ-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] injection well in accordance with 40 CFR 146.92. The well construction details for this injection well are provided in Permit Section 4 - Injection Well Construction Plan of this application, and includes the casing and cement used in the completion of the well. These details will be used to determine an appropriate approach to plugging the well to prevent migration of fluids upwards through the abandoned well. Permit Section 9 - Post-Injection Site Care and Closure (PISC) 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 measured from pressure and temperature gauges conveyed on the injection tubing 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-abandonment 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]
Oxygen-Activation Log (Contingency)	[REDACTED]

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 Permit Section 7 - Testing and Monitoring Plan. A final temperature measurement will be acquired over the entire [REDACTED] 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. If temperature data indicate anomalies or data collected with the [REDACTED] fails, an oxygen-activation log will be used as a secondary method to assess the external mechanical integrity.

The post-injection temperature data is 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 Permit Section 10 - Emergency and Remedial Response Plan.

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 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 displaced 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** presents the intervals that will be plugged as well as the materials and methods that will be used to plug the intervals. [REDACTED]

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 [REDACTED] ft plug of CO₂ resistant cement.

In addition, a cement plug will be placed within the long-string casing string at the casing shoe of the surface and second surface strings. [REDACTED] will be placed over the surface and second surface casing shoe depths using a balance method (Section 8.6). Approximately [REDACTED] sacks of [REDACTED] cement will be used for each of these plugs. A surface plug from [REDACTED] ft to surface will be placed using approximately [REDACTED] sacks of [REDACTED] cement.

After the top cement plug has been set, the casing sections will be cut off approximately [REDACTED] 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 methods and materials described in the preceding paragraphs 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)). **Figure 8-1** shows the well schematic of the injection well after plugging and abandonment.

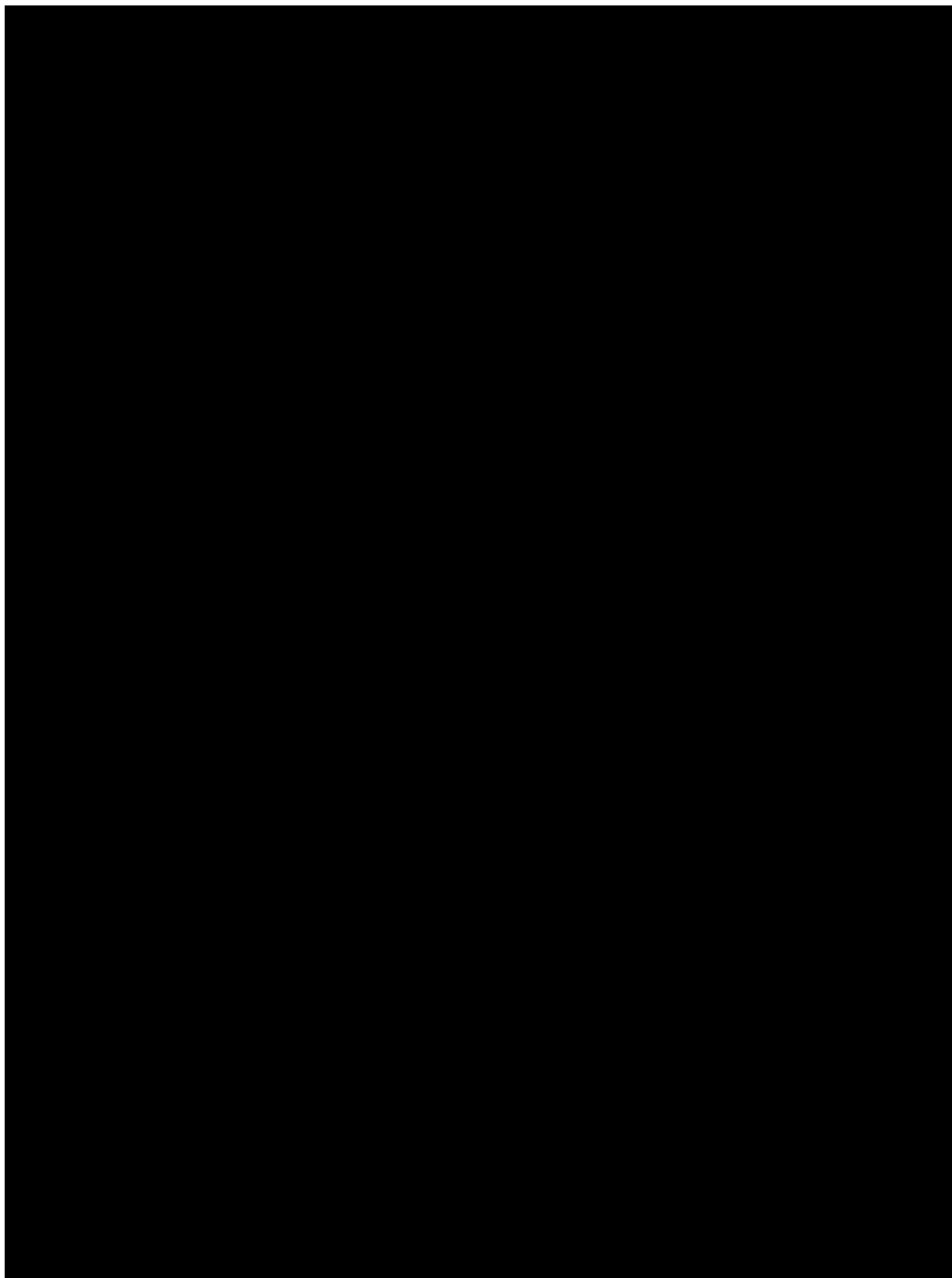


Figure 8-1: Well schematic of the injection well after plugging and abandonment



Table 8-2: Intervals to be plugged and materials/methods used. (40 CFR 146.92 (b)(3 – 6)).

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 CO₂-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 CO₂ resistant cement on top of retainer.
10. Trip tubing string out of well and remove stinger from end of tubing.
11. Trip tubing string to second surface casing shoe and prepare to set cement plug. Pump CO₂ resistant cement using a balance method to cement [REDACTED] ft across casing shoe.
12. Trip tubing string to surface casing shoe and prepare to set cement plug. Pump Class A cement using a balance method to cement [REDACTED] ft across casing shoe.
13. Trip tubing string to a depth of [REDACTED] ft and prepare to set cement plug. Pump Class A cement to fill the casing from a depth of [REDACTED] ft to surface.
14. Cut the casing string off at [REDACTED] ft below grade and weld a steel plate, (with well ID, permit number, and date of abandonment on it) to the casing strings.
15. Backfill the excavation.
16. 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)).