Class VI Injection Well Application

Attachment 08: Injection Well Plugging Plan
40 CFR 146.92(b)

Linden Project

3 April 2023

Prepared by:

Plan revision number: 1.0
Plan revision date: 3 April 2023

Project Information

Project Name: Linden

Project Operator: Vault Alliance CCS, LP

Project Contact: Sensitive, Confidential, or Privileged Information [redacted]

Linden Sassafras Hill Injection Well 1 (LSH INJ1) Location:

Latitude: 40.210756°
Longitude: -86.865219°

Table of Contents

List of Figures

List of Tables

List of Acronyms

BOP	blow out preventer
CO_2	carbon dioxide
CBL	cement bond log
LD	lay down
LSH INJ1	Linden Sassafras Hill Injection Well 1
MIT	mechanical integrity test
ND	nipple down
NU	nipple up
P&A	plugging and abandonment
PNL	pulsed neutron log
POOH	pull out of hole
PU	pick up
QASP	Quality Assurance and Surveillance Plan
RAT	radioactive tracer log
RIH	run in hole
RU	rig up
TD	total depth
VA	Vault Alliance CCS, LP

Vault Alliance CCS, LP (VA) will conduct Linden Sassafras Hill Injection Well 1 (LSH INJ1) plugging and abandonment (P&A) according to the following procedures at a time that is deemed appropriate after the cessation of injection.

1. Planned Tests or Measures to Determine Bottomhole Reservoir Pressure

As required by 40 CFR 146.92(b)(1), prior to any plugging operations, bottomhole pressure data from the bottomhole gauges set in LSH INJ1 will be used to determine the reservoir pressure and calculate an appropriate kill fluid weight. Should the gauges be inoperative, the bottomhole pressure will be obtained by conducting a static gradient survey using a memory pressure gauge run on slickline.

2. Planned External Mechanical Integrity Test(s)

VA will conduct at least one of the tests listed in Table 1 to verify external mechanical integrity prior to plugging the injection well as required by 40 CFR 146.92(a).

Following the operations to kill the well, testing of the external mechanical integrity will be performed. This testing will include one or more of the following:

- Temperature Log,
- Radioactive Tracer (RAT) Log,
- Cement Bong Log (CBL),
- Pulsed Neutron Log (PNL).

Prior to any field mobilization or operations, proper notification will be given to the agency. Within this notification, the specific logs and/or tests to be run to determine external mechanical integrity will be provided. The list above is an example of logs that would likely be run to confirm external mechanical integrity and should not be considered as a comprehensive or final list for this project.

Note the following:

i. Example procedures for the logging techniques provided above can be found in Attachment 05: Pre-operational Formation Testing Program, 2023 or Attachment 07: Testing and Monitoring, 2023 of this application.

ii. Specifications on the tools that will be used for this testing can also be found in the same sections as noted previously or in Attachment 11: QASP, 2023 of this application.

iii. Criteria for acceptable logging results can be found in Attachment 07: Testing and Monitoring, 2023 as well as in Attachment 11: QASP, 2023.

Table 1: Potential mechanical integrity tests to be run in LSH INJ1.

Test Description	Location
Temperature Log	Sensitive, Confidential, or Privileged Information
RAT Log	
CBL	
PNL	

3. Information on Plugs

VA will use the materials and methods noted in Table 2 to plug the injection well. The volume and depth of the plug or plugs will depend on the final geology and downhole conditions of the well as assessed during construction. The cement(s) formulated for plugging will be compatible with the carbon dioxide (CO_2) stream as outlined in Attachment 04: Injection Well Construction Plan, 2023. The cement formulation and required certification documents will be submitted to the agency with the well plugging plan. The owner or operator will report the wet density and will retain duplicate samples of the cement used for each plug.

The general plugging methodology is as follows:

- Sensitive, Confidential, or Privileged Information plugs to be used throughout the well,
- CO_2-resistant cement or CO_2-resistant resin will be used Sensitive, Confidential, or Privileged Information above the Eau Claire Formation,

Class A cement to be used Sensitive, Confidential above the Eau Claire Formation to surface.

Table 2: Plugging details for LSH INJ1

Plug Information	Plug #1	Plug #2	Plug #3	Plug #4	Plug #5	Plug #6	Plug #7	Plug #8	Plug #9	Plug #10	Plug #11	Plug #12
Diameter of boring in which plug will be placed (inches)	Sensitive, Confidential, or Privileged Information											
Depth to bottom of tubing or drill pipe (feet)												
Sacks of cement to be used (each plug)												
Slurry volume to be pumped ($feet^3$, bbl.)												
Slurry weight (pounds/gallon)												
Calculated top of plug (feet)												
Bottom of plug (feet)												
Type of cement or other material	Sensitive, Confidential, or Privileged Information											
Method of emplacement (e.g., balance method, retainer method, or two-plug method												
*EverCRETE is a mark of slb, WellLock™ is a trademark of Halliburton, Both are CO_2 resistant												

4. Narrative Description of Plugging Procedures

4.1. Notifications, Permits, and Inspections

In compliance with 40 CFR 146.92(c), VA will notify the regulatory agency at least 60 days before plugging the LSH INJ1 well and provide updated information, if applicable.

4.2. Plugging Procedures

In compliance with 40 CFR 146.92, the following will be done:

1. The regulatory agency will be notified at least 60 days before any field activity begins with an updated plugging plan.
2. Move in the workover rig and rig up (RU) on LSH INJ1.
3. CO_2 pipelines will be marked and noted with the rig supervisor and facility manager.
4. Hold safety meeting with all available rig crew, contractors, and facility personnel.
5. Based on the calculated kill fluid weight needed from the bottomhole pressure survey, kill the well.
    a. It is anticipated that approximately Sensitive, Confidential, or Privileged Information will be appropriate. This weight is subject to change based on the result of the bottomhole pressure survey. It is noted that regardless of the results of the pressure survey, Sensitive, Confidential, or Pri [redacted] will be the minimum fluid weight.
6. Ensure that rig pump or another suitable pump is rigged up to the well. Pressure test all lines to minimum 2,500 psi. Perform annulus pressure test.
7. Fill tubing and cased hole volume with kill brine. Monitor tubing pressure to ensure the well is dead.
8. Once the casing and tubing are dead, nipple down (ND) the well head.
9. Nipple up (NU) and test blow out preventers (BOPs).
10. Latch onto and remove tubing hanger from wellhead.
11. Lay down (LD) tubing hanger.
12. Latch onto injection string.
13. Unlatch from packer
    a. Note that, at this time, the well is likely to u-tube. Ensure rig pump is connected to the top side, close the BOPs, and slowly circulate out the annulus fluid while maintaining a full column of fluid (as feasible).
14. Pull out of hole (POOH) with tubing and LD same.
    a. Fill hole as necessary.
15. Pick up (PU) work string with packer pulling tool and run in hole (RIH).
16. Latch onto Packer and remove same.

17. POOH with work string and packer. LD same.
18. RIH with open end work string.
19. Tag bottom. Note tag depth.
20. Pump plug #1.
    a. Pump [redacted] off bottom.
    b. Target height of plug should be [redacted].
    Plug volume should be as detailed in Table 2.
    c. Slowly pull out of hole if necessary while pumping plug.
21. Target top of hole should be approximately [redacted]. Trip work string out to approximately [redacted]. Wait at [redacted] for approximately two hours.
    a. Wait time is dependent on hardening time for cement.
    b. Wet samples of cement should be taken.
22. RIH and tag top of cement. Note top of cement. Ensure cement top has not moved.
23. Repeat steps 20 through 22 plugs 2 and 3.
    a. Note that cement used in plugs one through three will be CO_2 resistant.
    b. Target top of plug three to be [redacted]. This depth is approximately [redacted] above the top of the Eau Claire Formation.
24. Flush wellbore with brine.
25. RIH with work string and tag top of cement. Note top of cement.
26. Pump plug # 4.
    a. [redacted].
    b. Target height of plugs should be [redacted]. Plug volume should be as detailed in Table 2. Plug to be pumped as balance plug.
    c. Slowly pull out of hole as necessary while pumping plug.
27. Trip out work string to [redacted] projected top with cement. Wait two hours.
    a. Wait time is dependent on hardening time for cement.
    b. Wet samples of cement should be taken.
28. RIH and tag top with cement. Note top of cement.
29. Pump remaining [redacted] plugs by repeating steps 24 through 27.
30. Ensure cement is to surface. Fill from surface if necessary.
31. ND BOPs.
32. Rig down rig. All casing should be cut to a minimum of three feet below ground level and have a plate with well information welded on top.
33. Fill and level the ground as necessary.

Note that the procedure presented above assumes that no contingencies are necessary. Cement volumes, pumping pressures and weights are subject to change based on geologic and field conditions. This plan will be updated following the drilling and completion of LSH INJ1.

All materials and equipment to be used in this procedure are to be cement resistant [redacted] above the Eau Claire Formation.

Any contingency plans that are necessary will be provided for as part of the formal procedure submitted 60 days before any field activities.

Following the completion of field activities, a report detailing the procedures and process followed to plug this well will be submitted to the agency. This report will be submitted within 60 days of the completion of plugging.

Figure 1 displays the theoretical plugging schematic for LSH INJ1.

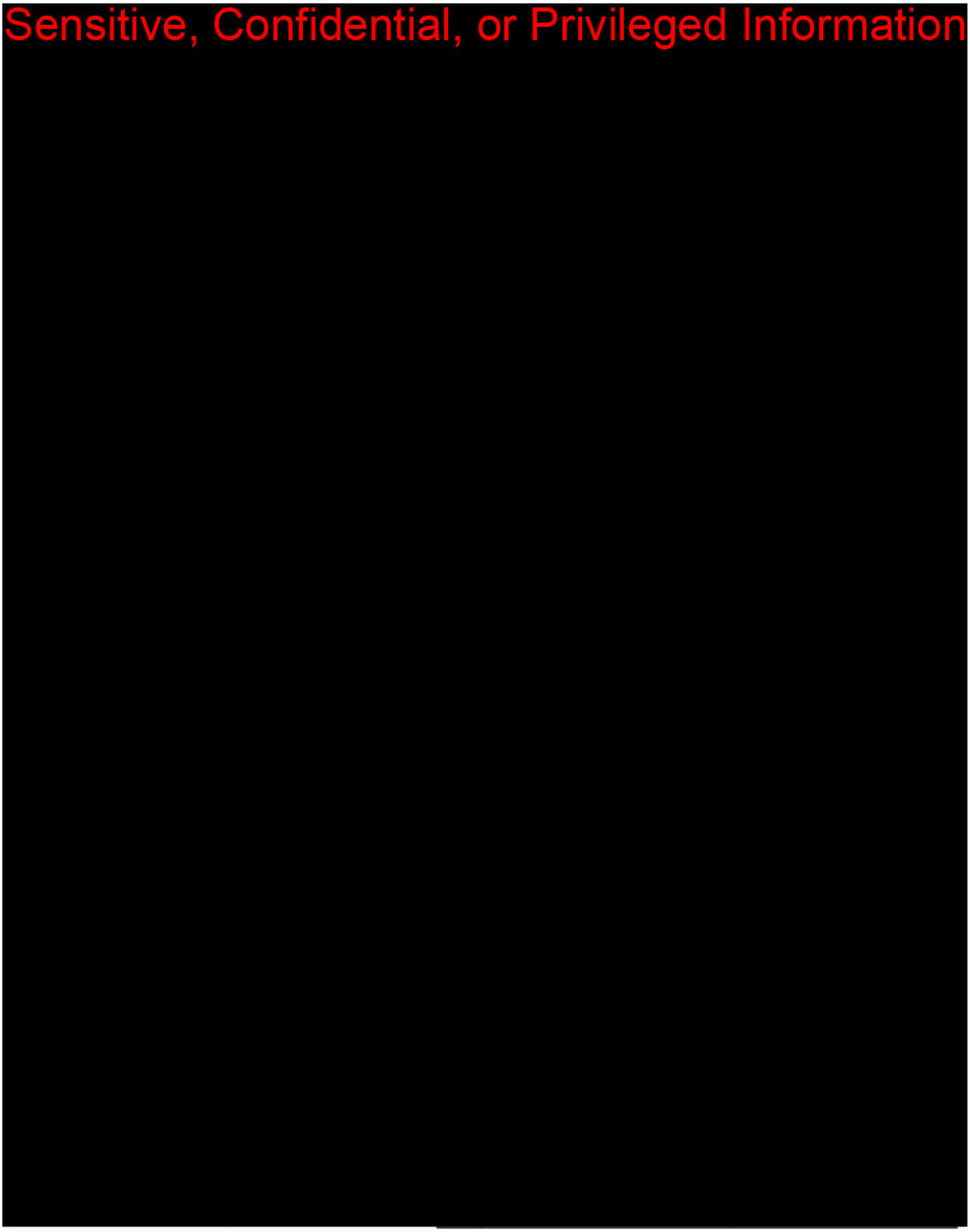

Figure 1: LSH INJ1 plugging schematic.

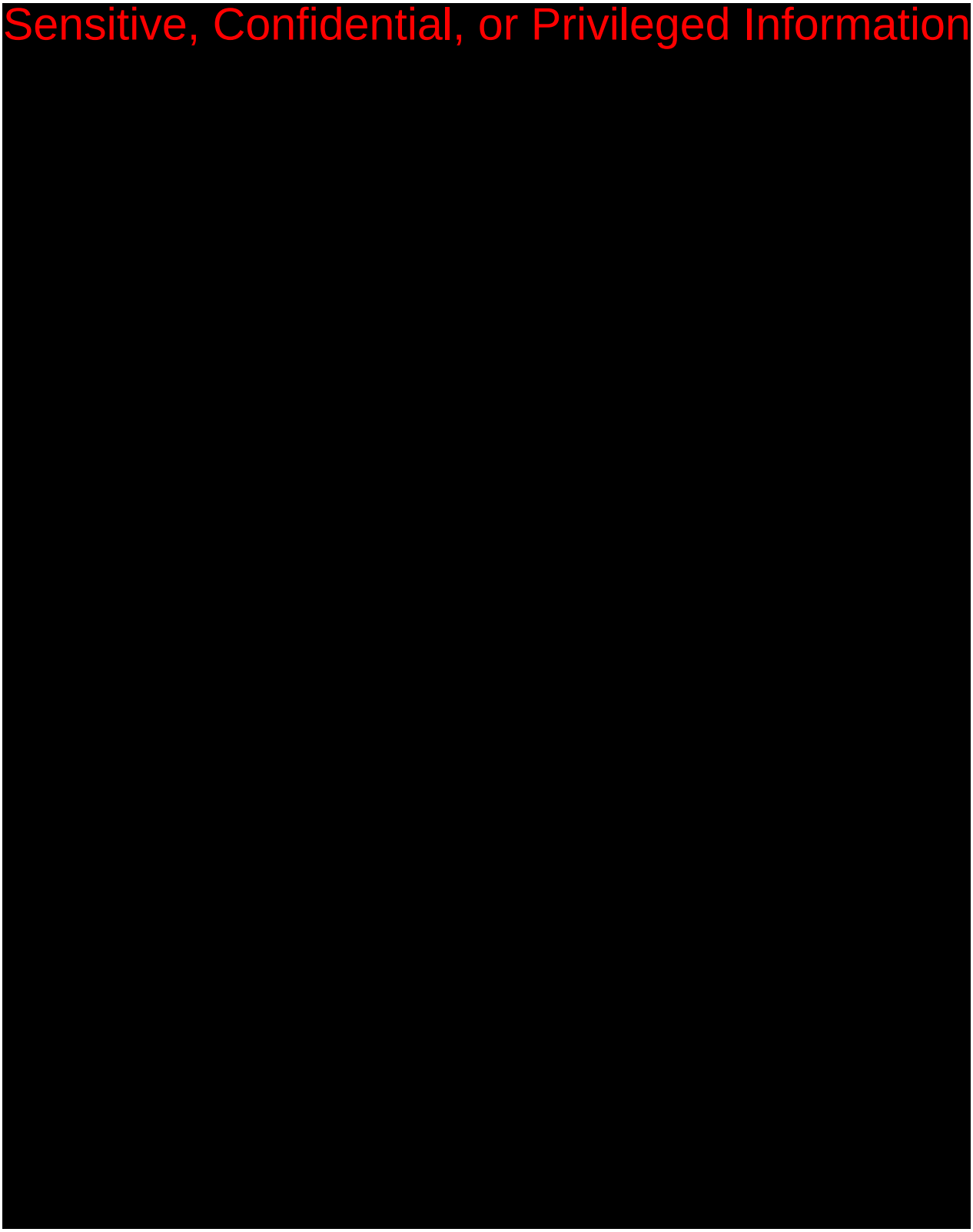

Figure 2: LSH INJ1 with intermediate contingency plugging schematic.

5. References

Attachment 04: Injection Well Construction Plan, 2023: Linden.

Attachment 05: Pre-operational Formation Testing Program, 2023: Linden.

Attachment 07: Testing and Monitoring, 2023: Linden.

Attachment 11: QASP, 2023: Linden.