# Underground Injection Control
# Carbon Sequestration
# Class VI Permit Application

## INJECTION AND MONITORING WELL PLUGGING PLAN
## 40 CFR 146.92(b)
## Section 9.0

## Four Corners Carbon Storage, LLC
## San Juan Basin, New Mexico Carbon Sequestration Project

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# INJECTION AND MONITORING WELL PLUGGING PLAN
# 40 CFR 146.92(b)

## San Juan Basin, New Mexico Carbon Sequestration Project – Injector 1

### Facility Information

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Injector 1

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Well location: San Juan County, New Mexico
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[1] North American Datum 1983

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **B** | |
| BHP | bottom hole pressure |
| BOP | blow out preventor |
| BPV | back-pressure valve |
| **C** | |
| CBL | cement bond log |
| CFR | Code of Federal Regulations |
| $CO_2$ | carbon dioxide |
| **F** | |
| Four Corners Carbon | Four Corners Carbon Storage, LLC |
| **M** | |
| MIT | mechanical integrity test |
| **N** | |
| NMAC | New Mexico Administrative Code |
| **P** | |
| PFO | pressure fall off |
| psi | pounds per square inch |
| **T** | |
| TD | total depth |
| **U** | |
| USIT | ultra sonic imaging tool |

# 9 INJECTION AND MONITORING WELL PLUGGING PLAN

Four Corners Carbon Storage, LLC (Four Corners Carbon) will conduct injection and monitoring[2] well plugging and abandonment according to the procedures below.

## 9.1 Planned Tests or Measures to Determine Bottom-Hole Reservoir Pressure [40 CFR 146.92(b)(1)]

Prior to commencing plugging operations, the bottomhole reservoir pressure will be measured using the real time downhole pressure gauge located near the packer. A fluid gradient calculation will be performed from the gauge to the pressure datum in [redacted]. If the permanent downhole gauge is not functioning at the end of injection, an electric line gauge will be run through the tubing to obtain down hole pressure at the datum [redacted] (or equivalent) will be run. The accuracy of the pressure gauges is guaranteed to be plus or minus 3.2 pounds per square inch (psi) or better. The well will be shut-in and static for a sufficient time to ensure the reservoir pressures are stabilized. The bottom hole pressure will be used to determine the specifications of the flush and buffering fluids.

## 9.2 Planned External Mechanical Integrity Test(s) [40 CFR 146.92(b)(2)]

Four Corners Carbon will conduct the tests listed in **Table 9.1** to verify external mechanical integrity prior to plugging the injection well as required by 40 CFR 146.92. This will apply to the injection and monitoring wells.

External mechanical integrity will be demonstrated through approved temperature and/or acoustic logging methods.

Table 9.1—Planned mechanical integrity tests performed within 12 months of plugging operations.

| Test Description | Location |
|---|---|
| Casing Pressure Test | The casing by tubing annulus will be pressure tested to 500 psi for 30 minutes and should show a drop no greater than 10% (40 CFR 146.8[b][2] & 19.15.25.13 New Mexico Administrative Code [NMAC]) |
| Temperature/acoustic log | Wireline convey a temperature survey down tubing (40 CFR 146.8[c][1]). A passed test shows no temperature anomalies which could indicate fluid or gas movement behind the casing. |
| [redacted] | After pulling tubing, log from the top perforation to surface. The logs will be evaluated and will be considered passing if the cement behind the long string is of sufficient quantity and quality to prevent fluid migration from any formation to any other formation. |

## 9.3 Information on Plugs

Four Corners Carbon will use the materials and methods noted in **Table 9.2** 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

[2] Four Corners Carbon plans to drill a monitoring well (Monitor 1) approximately [redacted] the Injector 1, within the area of review and plume boundary.

be compatible with the carbon dioxide ($CO_2$) stream. The cement formulation and required certification documents will be submitted to the relevant agencies with the well plugging plan. Four Corners Carbon will report the wet density and will retain duplicate samples of the cement used for each plug. **Table 9.3** and **Table 9.4** provide a summary of the cement plugs for the Injector 1 and Monitor 1 wells.

Table 9.2—Plugging details.

| Plug Information | Plug No. 1 | Plug No. 2 | Plug No. 3 |
|---|---|---|---|
| Diameter of boring or Casing in which plug will be placed (in) | [redacted] | [redacted] | [redacted] |
| Depth to bottom of tubing or retainer (ft) | [redacted] | [redacted] | [redacted] |
| Sacks of cement to be used | [redacted] | [redacted] | [redacted] |
| Slurry volume to be pumped (cu ft) | [redacted] | [redacted] | [redacted] |
| Slurry weight (lbm/gal) | [redacted] | [redacted] | [redacted] |
| Calculated top of plug (ft) | [redacted] | [redacted] | [redacted] |
| Bottom of plug (ft) | [redacted] | [redacted] | [redacted] |
| Type of cement or other material | [redacted] | [redacted] | [redacted] |

Table 9.3—Summary of cement plugs for the injection well.

| Cement Plug Number | Interval Range (ft) | | Thickness (ft) | Volume (cu-ft) | Note |
|---|---|---|---|---|---|
| 1 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] $CO_2$-resistant cement plug |
| 2 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] $CO_2$-resistant cement plug |
| 3 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] to cover base USDW and surface plug |

Table 9.4—Summary of Cement Plugs, Monitor 1.

| Cement Plug Number | Interval Range (ft) | | Thickness (ft) | Volume (cu-ft) | Note |
|---|---|---|---|---|---|
| 1 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] $O_2$-resistant cement plug |
| 2 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] $CO_2$-resistant cement |
| 3 | [redacted] | [redacted] | [redacted] | [redacted] | [redacted] o cover base USDW and surface plug |

## 9.4 Description of Plugging Procedures

This section provides an overview of the plugging and abandonment operations for Injector 1 and Monitor 1. The monitoring well (Monitor 1) will be plugged after the monitoring period. Four Corners Carbon may consider the conversion of Injector 1 to an in-zone monitoring well after the injection period. The Injector 1 well will be plugged either after the injection period or after it is utilized as a monitoring well. All wells will be plugged and abandoned under the requirements of New Mexico Oil Conservation Division, Rules 19.15.25**.** In addition to regulatory requirements, engineering and operational best practices will be applied during this program to prevent fluid migration and contamination of any underground storage of drinking water(s) (USDW). All materials used during this plugging operation will be compatible with $CO_2$ and $CO_2$-water mixtures. The procedure below outlines the plugging plan, including notification, the wellbore preparation, and the final plugging and abandonment procedure. After the abandonment operations, a notarized Subsequent Report of Abandonment (Form C-103) will be filed with the New Mexico Oil Conservation Division within 30 days of the plugging date, per the New Mexico Administrative Code, 19.15.7.14 (dated December 1, 2008)**.** Once the determination is made that the monitoring well is no longer needed, the well will be abandoned according to the same criteria as were applied to the injection well.

### *9.4.1 Pre-plugging Procedures*

Issue Notifications and Obtain Permits/Approval

- In compliance with 40 CFR 146.92(c), Four Corners Carbon will notify the Director of the regulatory agency at least 60 days before plugging the well, and provide an updated Injection Well Plugging Plan, if applicable (**Figure 9.1** and Table 9.3).
- Notify the New Mexico Administrator by filing a Notice of Intent to Plug (Form C-103) before plugging a well (19.15.25.9[A]). Provide a revised plugging plan that will capture changes and revisions that are not projected at the time of application.
- Notify the New Mexico Administrator at least 24 hours prior to commencing plugging operations (19.15.25.9[C]).

Procedure to Determine Reservoir Pressure

- Perform a pressure fall off (PFO) test within three months of final injection. The shut-in period for the PFO test will be determined by previous PFO tests or reservoir modeling. The gauge used for the PFO will be the downhole permanent gauge or a memory pressure gauge set in a gauge carrier by wireline in the nipple profile located in the tail pipe below the packer.
- If the injector is shut-in longer than three months from the time the PFO is performed, the reservoir pressure will be obtained within 1 month of commencing plugging. This will ensure an accurate pressure for designing the optimal fluids to be utilized in the abandonment procedure.

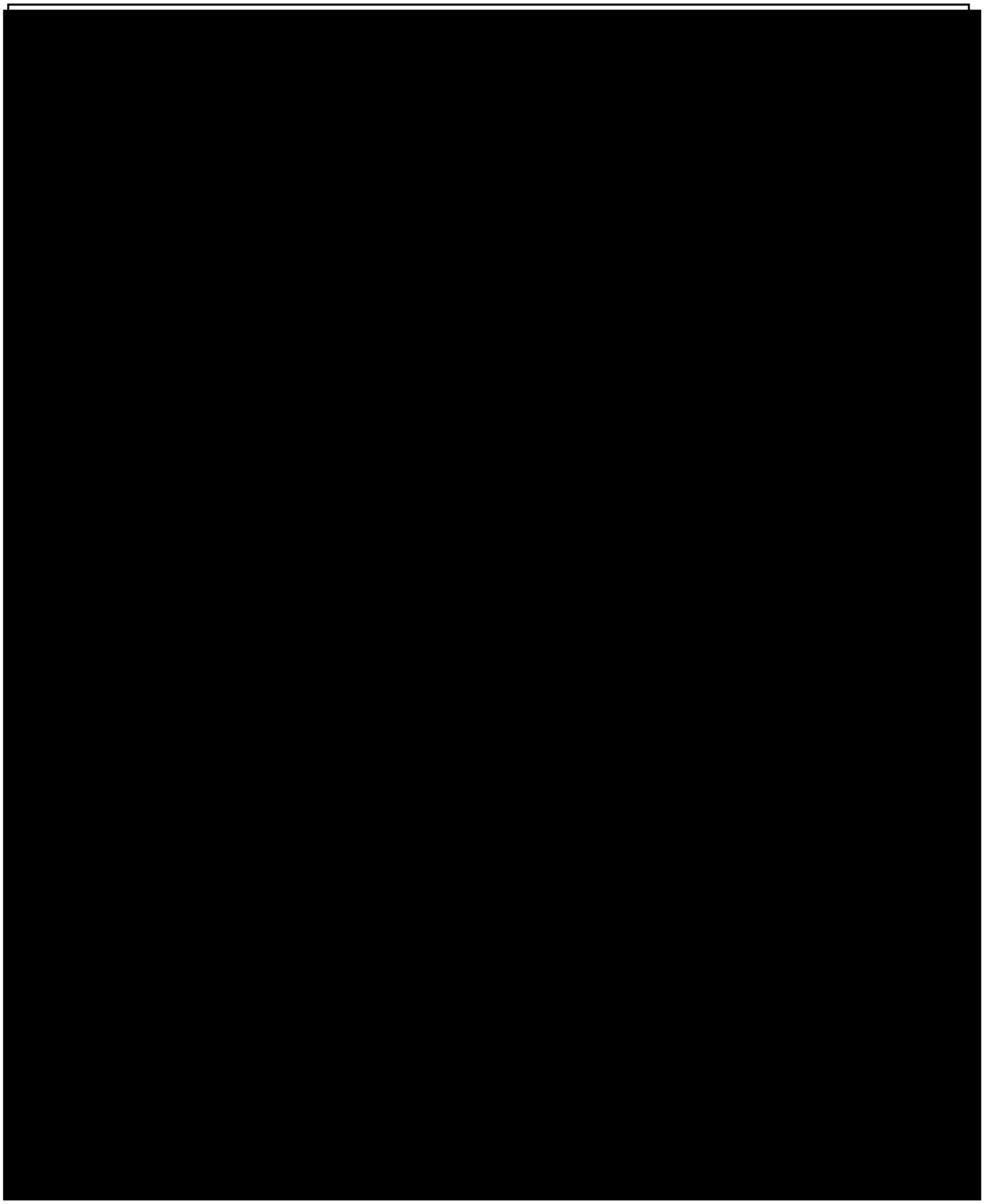
Procedure to Determine External Mechanical Integrity

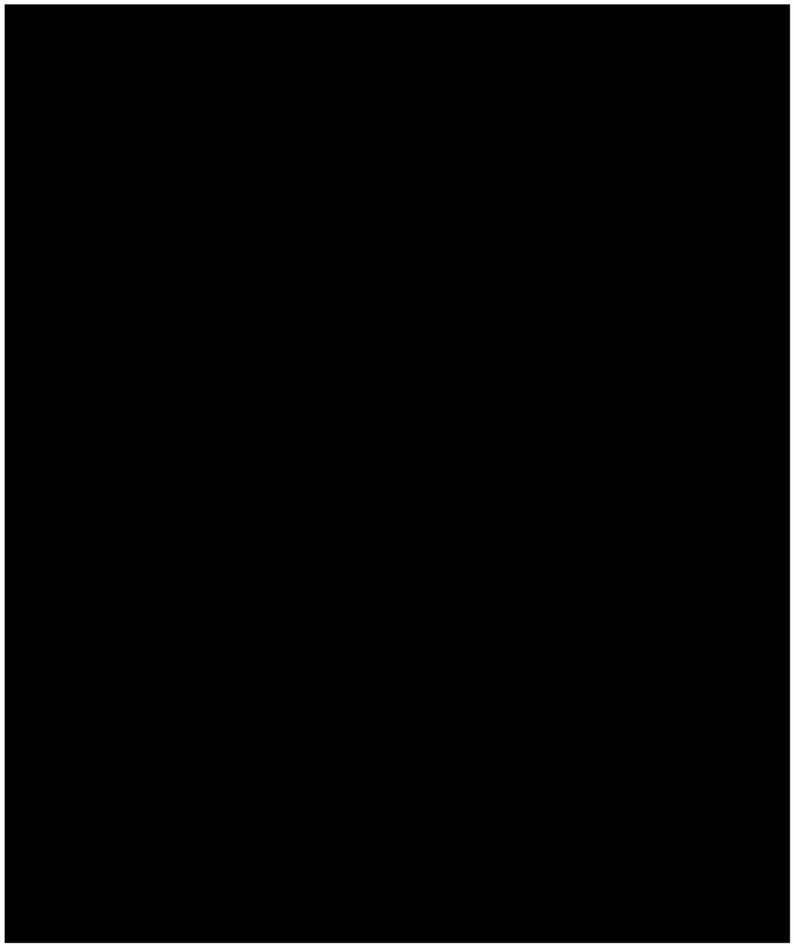
- Perform a temperature and or acoustic log survey via electric line with gauges run through tubing. This survey will be performed within 12 months of commencing plugging operations.
- With the well on gas injection, obtain baseline temperature data from the surface to the top perforation.
- Shut the well in at surface and log immediately from the top perforation to the base of USDW. Perform similar up-down passes at 30 minutes, 1-hour and 2-hour intervals after the well is shut in.
- Perform a tubing by long-string casing annular pressure test. This test will be performed within 12 months of commencing plugging operations.
- With wireline, set a plug in the tailpipe isolating the tubing from [redacted] and bleed off pressure in the tubing to zero psi at the wellhead.
- The annulus will be liquid filled and pressured up to 500 psi and held there for 30 minutes with no more than a 10% drop in pressure.
- Perform [redacted] Cement Bond Log (CBL) logging after the tubing is removed from the well during the early steps of the plug and abandonment program. These steps and logs are included as described in the Well Plugging and Abandonment Program below.

### *9.4.2 Injector 1—$CO_2$ Injection Well Plugging and Abandonment Program*

1. Perform the "Pre-plugging Procedure" described above.
2. Kill and flush the well.
   a) Determine the appropriate $CO_2$-compatible buffering fluid based on bottom hole pressure (BHP).
   b) Pump down tubing wellbore volume plus 50 barrels to flush buffer fluid into the formation. Run in hole with slickline and obtain a total depth (TD) tag.
   c) Set plug in XN nipple in the tailpipe.
   d) Run in hole with a tubing punch and punch just above the top of the floating seals.
   e) Circulate buffer fluid down tubing, taking returns up the annulus, filling the annulus with buffer fluid.
   f) Ensure well achieved static equilibrium.
2. Move in and rig up workover rig and equipment.
3. Install back-pressure valve (BPV) in the tubing hanger.
4. Nipple-down the wellhead.
5. Nipple-up the BOP.
6. Function test and pressure test the BOP.
7. Make up landing joint to tubing hanger or spear production tubing.
8. Pick up tubing hanger.
9. Pull out of hole laying down tubing.
10. Pick up work string and run in hole and mill and recover the permanent packer.
11. Pick up positive casing scraper with work string.
12. Run in hole with casing scraper to top perforation.
13. Pull out of hole racking back work string.
14. Rig up electric line, pressure control equipment, and logging tools.

15. Run [redacted] casing/cement inspection log and cement bond log from top perforation to surface.
    a) Evaluate logs and confirm wellbore integrity.
    b) If integrity cannot be confirmed, prepare, and submit a remediation plan for approval.
16. Isolate [redacted] and confining zone. Run in hole with a setting tool and cement retainer and set above the top perforation, but no higher than 50 feet (ft) above the top perforation.
17. Pump a corrosion-resistant cement plug through the cement retainer. The volume should be no less than the volume between the retainer and the deepest perforation plus 50% excess. Pull the tubing out of the retainer and place a plug of corrosion-resistant cement [redacted]) on top of the retainer of sufficient volume to reach the top of [redacted].
18. Pull out of hole to 200 ft above calculated top of cement and reverse circulate to clear cement from work string.
19. Wait on cement and run in is hole to tag top of cement.
20. Set surface casing shoe plug. Pull out of hole and lay a 500 ft of corrosion-resistant cement ([redacted]) balanced cement plug from 100 ft below the surface casing shoe.
21. Pull up hole 200 ft above calculated top of cement and circulate to clear work string.
22. Wait on cement.
23. Tag top of cement.
24. Set surface plug. Surface plug to also cover the USDW Pick up to 900 ft and circulate API Class H cement to surface.





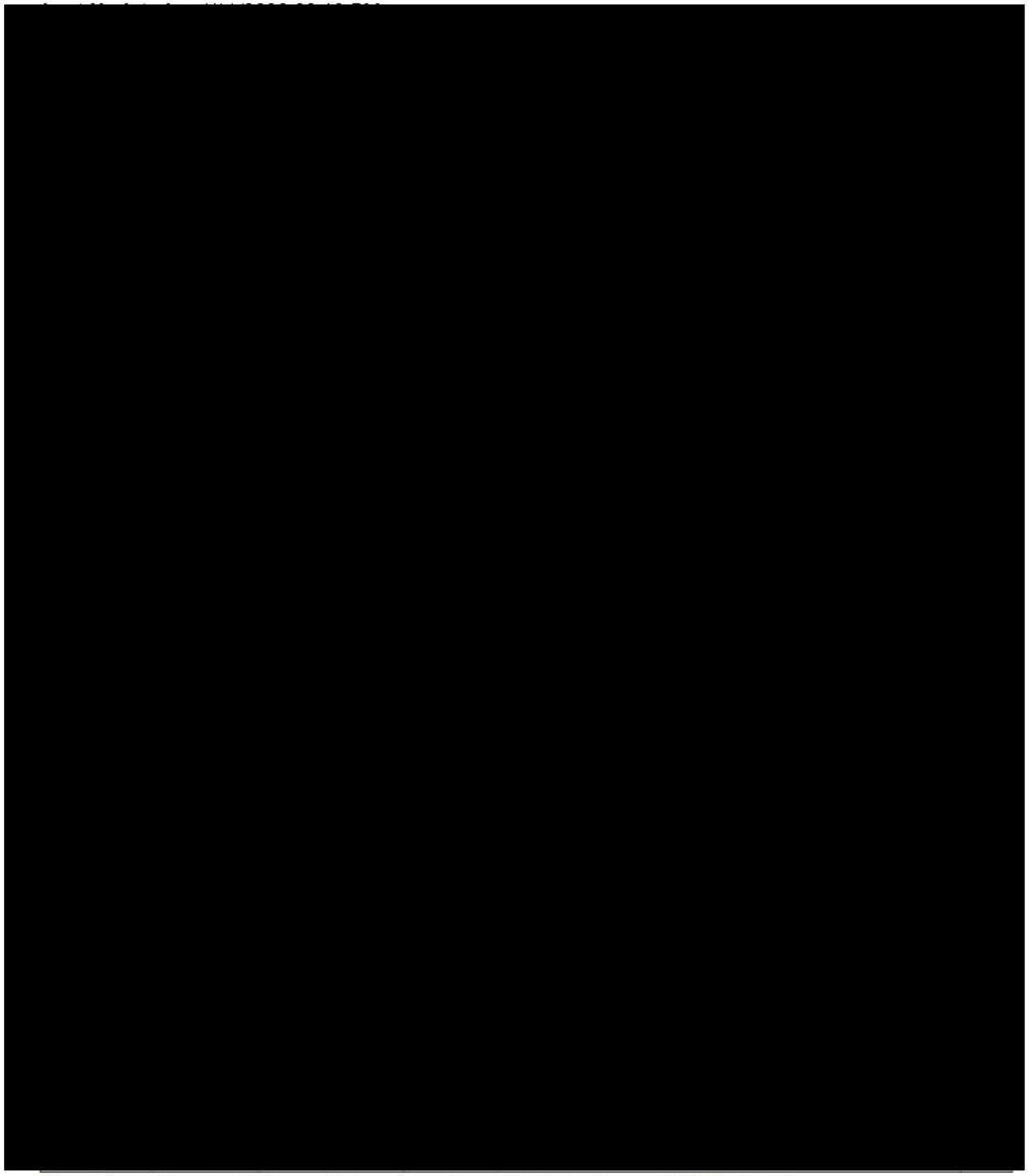


Figure 9.1—Proposed plug and abandon schematic, injection well (Injector 1).

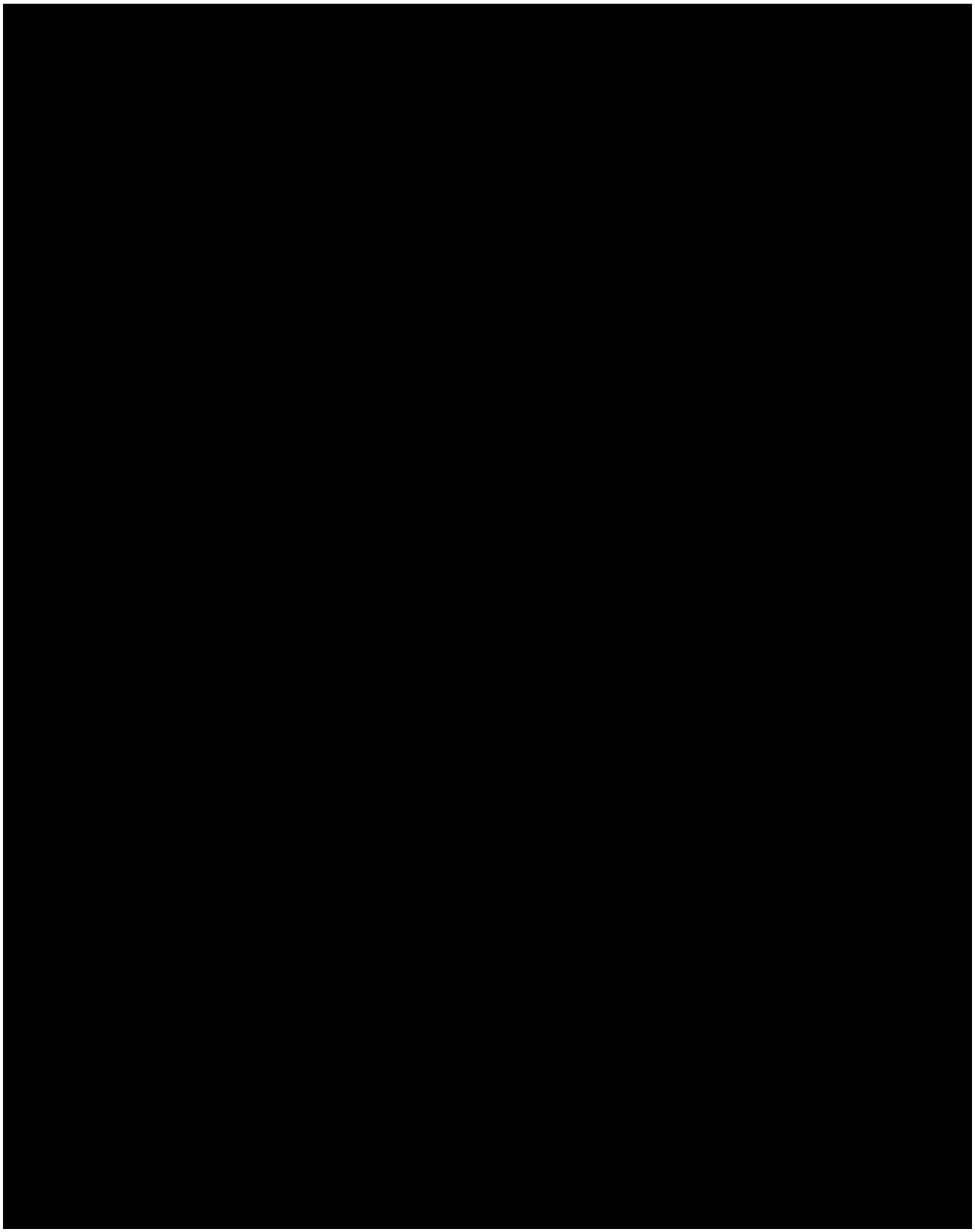
### *9.4.4 Monitor 1—Monitoring Well Plugging and Abandonment Program*

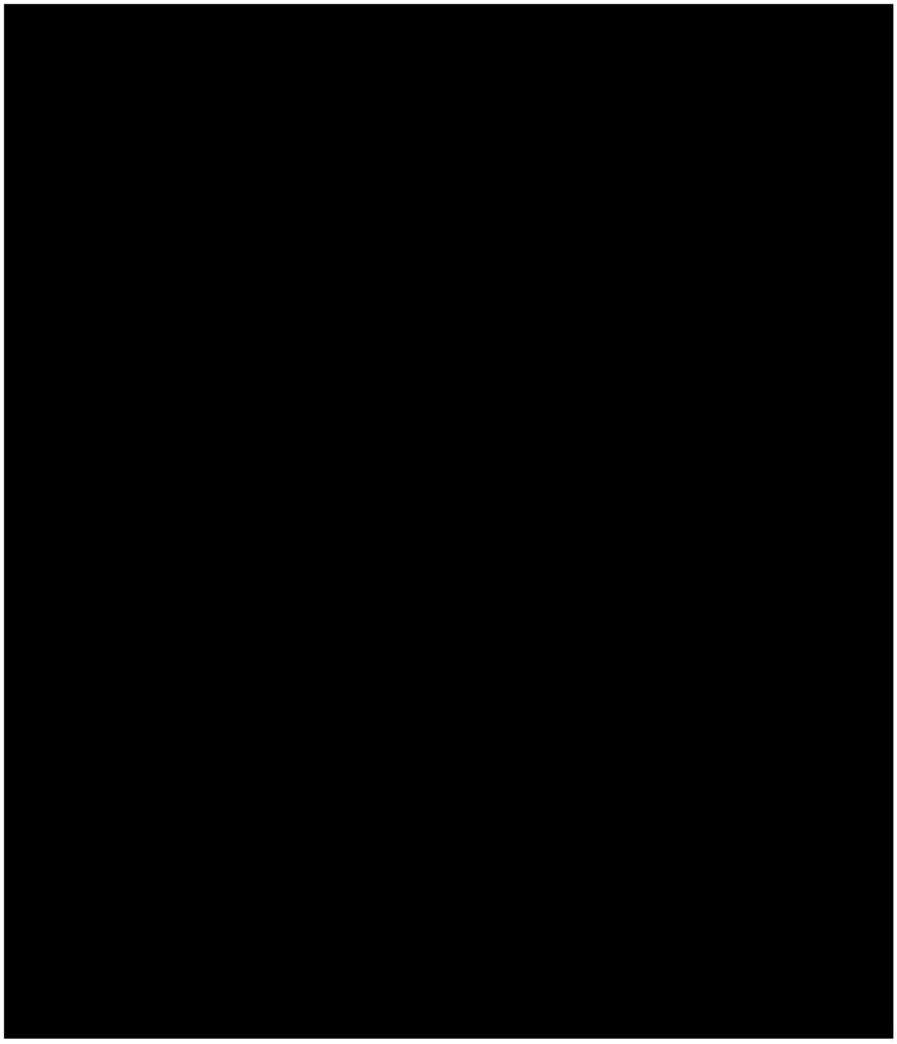
As part of the site closure activities, the Monitor 1 monitoring well will be abandoned. Four Corners Carbon intends to plug and abandon this well under the requirements of New Mexico OCD Rule 19.15.25. In addition to regulatory requirements, normal and customary engineering and operational practices will be applied during this program to prevent fluid migration and contamination of any USDWs. All materials used during this plugging operation will be compatible with $CO_2$ and $CO_2$-water mixtures. The procedure outlines the plugging plan, including notification, the wellbore preparation, and the final plugging and abandonment procedure (**Figure 9.2** and **Table 9.4**). After the abandonment operations, a notarized Subsequent Report of Abandonment (Form C-103) will be filed with the Division and provided to the Director within 30 days of the plugging date, per the NMAC 19.15.7.14 (dated 2008 December 1).

**Monitor 1—Monitoring Well Abandonment Program**

1. Shut in Monitor 1.
   a) Obtain temperature survey log to confirm external mechanical integrity (MIT).
   b) Obtain bottom hole reservoir pressure by running either a memory gauge on wireline or real time gauge on electric line.
   c) Pressure test down the casing by tubing annulus to 500 psi for 30 minutes with no drop more than 10% (40 CFR 146.8[b][2] and New Mexico Administrative Code 19.15.25.13).
2. Move in and rig up workover rig and equipment.
3. Install back pressure valve in the tubing hanger.
3. Nipple-down the wellhead.
4. Nipple-up the BOP.
5. Function test and pressure test the BOP.
6. Make up landing joint to tubing hanger or spear production tubing.
7. Pick up tubing hanger.
8. Pull out of hole laying down tubing.
9. Pick up work string and run in hole and mill and recover the permanent packer.
10. Pick up positive casing scraper with work string.
11. Run in hole with casing scraper to well total depth and displace fluid in well with buffering fluid.
12. Pull out of hole racking back work string.
13. Rig up electric line, pressure control equipment, and logging tools.
14. Run [redacted] casing/cement inspection log and cement bond log from top perforation to surface.
15. Isolate [redacted]a and confining zone. Run in hole with a setting tool and cement retainer and set above the top perforation but no higher than 50-ft above the top perforation.
16. Pump a corrosion-resistant cement plug through the cement retainer. The volume should be no less than the volume between the retainer and the deepest perforation plus 50% excess. Sting out of the retainer and place a plug of corrosion-resistant cement ([redacted]) on top of the retainer of sufficient volume to reach the top o[redacted].
17. Pull out of hole to 20-ft above calculated top of cement and reverse circulate to clear cement from work string.

18. Wait on cement and run in hole to tag top of cement.
19. Set surface casing shoe plug. Pull out of hole and lay a 500 ft of corrosion-resistant cement [redacted]) balanced cement plug from 100 ft below the surface casing shoe.
20. Pull up hole 200 ft above calculated top of cement and circulate to clear work string.
21. Wait on cement.
22. Tag top of cement.
23. Set USDW and surface plug. Pick up to 750 ft and circulate Class H cement to surface.





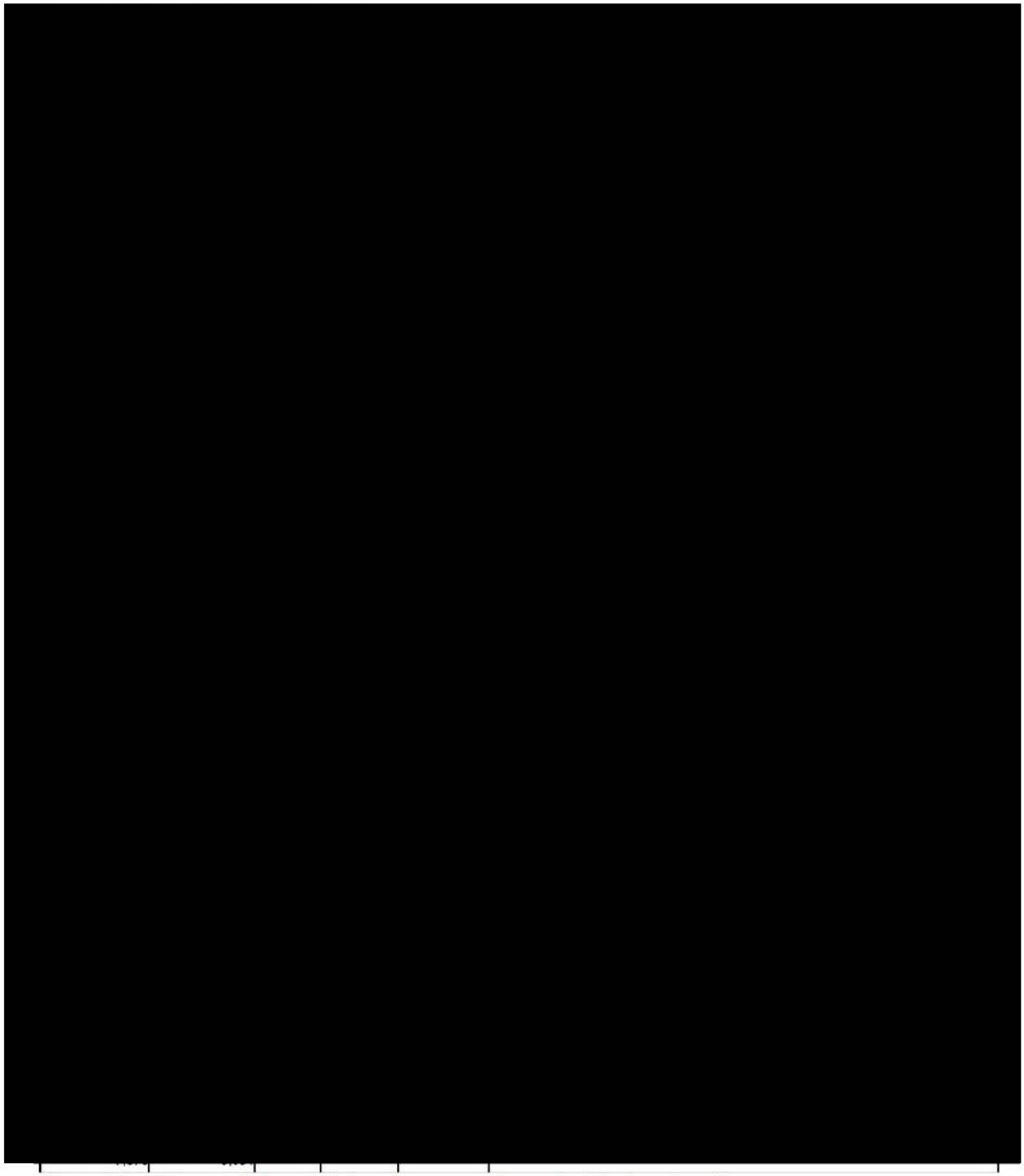


Figure 9.2—Proposed plug and abandonment schematic, Monitor 1 well.