4.0 INJECTION WELL CONSTRUCTION PLAN

40 CFR 146.86

CASS SEQUESTRATION

Facility Information

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Well name:	[redacted]
Well location:	CASS COUNTY, INDIANA [redacted]

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4.0 Injection Well Construction Plan (40 CFR 146.86 (a)(1,2,3))

This section describes how the injection well [redacted] will be constructed near The [redacted] to meet the requirements of 40 CFR 146.86.

Figure 4-2 shows a base map of the project area and the location of the injection well, the Area of Review (AoR) and monitor wells.

The injection well has been initially drilled as a Stratigraphic Test Well (STW) and a comprehensive suite of [redacted] were acquired in October 2024. During the construction phase of this project, the STW will be converted to the injection well by final installation of the production casing string and other downhole components detailed in **Figure 4-2**.

The injection well will be vertical from surface to total depth (TD) and designed to prevent the movement of fluids into or between underground sources of drinking water (USDWs) or into any unauthorized zones, and to permit the use of appropriate testing devices and workover tools. The design also accommodates monitoring of the annulus space between the injection tubing and long string casing (40 CFR 146.86 (a)(1,2,3)). The proposed injection well diagram is shown in **Figure 4-2**. Additional safety systems related to the injection wellhead are noted in Permit Section 6.7.2 - Well Operations Plan. Specifically, an automatic surface shut-off system is planned upstream of the wellhead.

Table 4-1 details the depths of the geological formations of interest at the site based on the STW and available regional data (40 CFR 146.86 (b)(1)(i)). Refer to Permit Section 2 - Area of Review and Corrective Action Plan for further details on these formations.

The well design is described in detail in the following sections, including the drilling phase, materials to be used, and the design itself. Formation and casing depths for the injection well have been determined using data from the STW.

[redacted] The maximum injection volumes and pressures for this project are detailed in Permit Section 1.0 - Project Narrative and Permit Section 6.0 - Well Operation Plan. No oil or gas zones were encountered at this location.

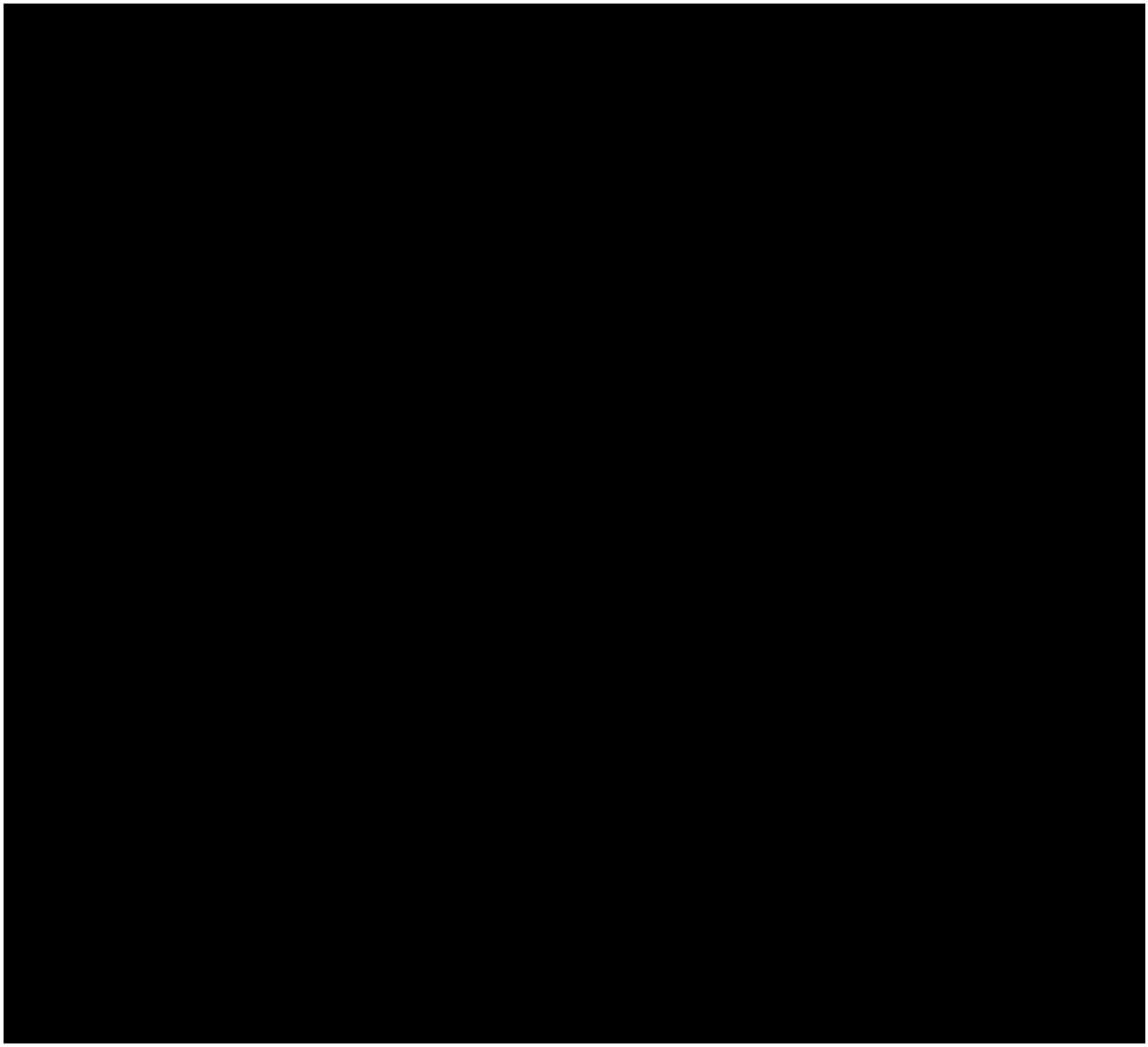

Table 4-1: Formations of interest and depths derived from data acquired in the STW.

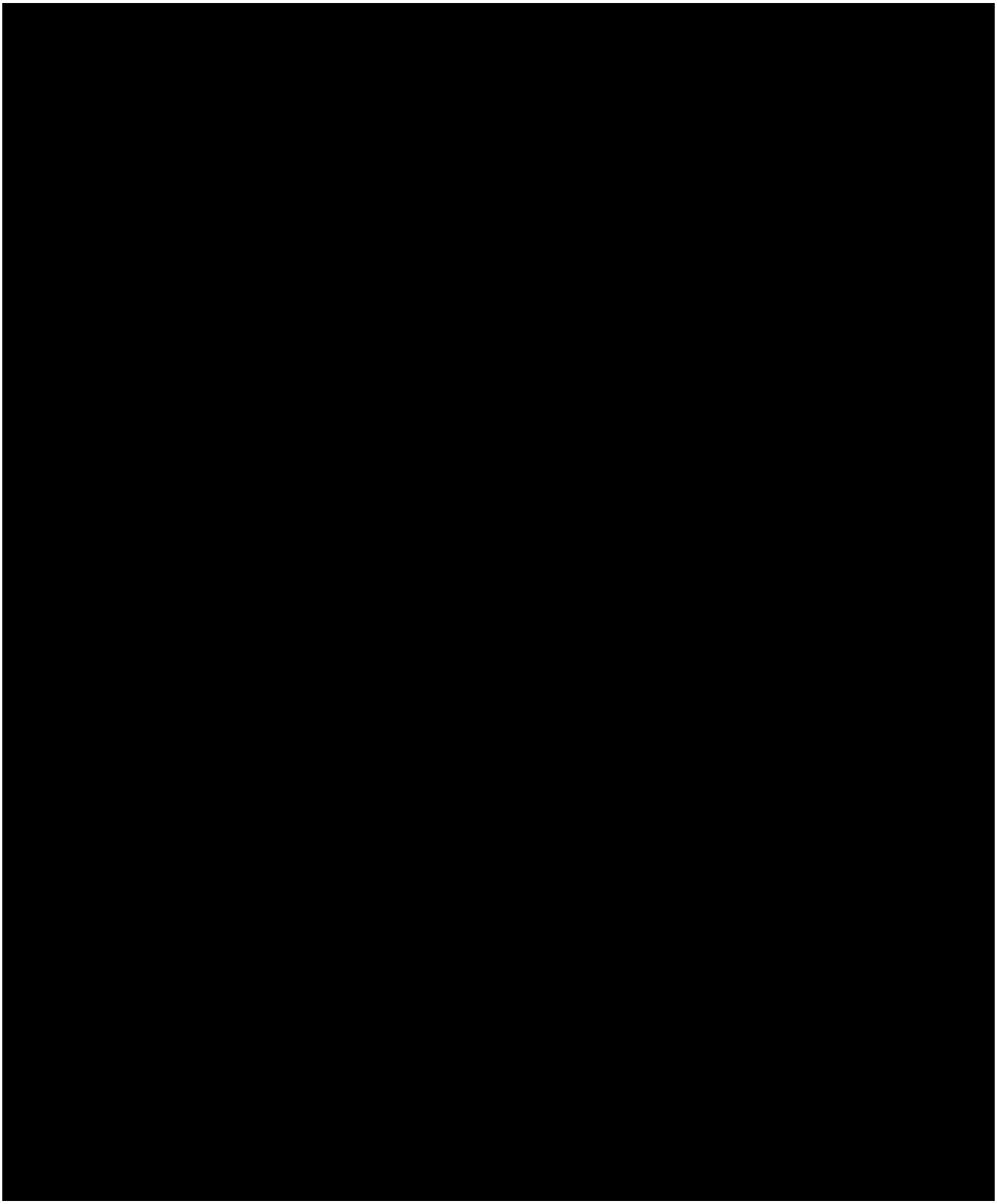

Figure 4-1: Map of Cass Sequestration project showing injection well [redacted], In Zone (IZM-1) and Above Zone (AZM-1) monitor wells, conceptual location of seismicity stations and AoR. The satellite base image is unaltered and includes all required components of 40 CFR 146.82(a)(2).

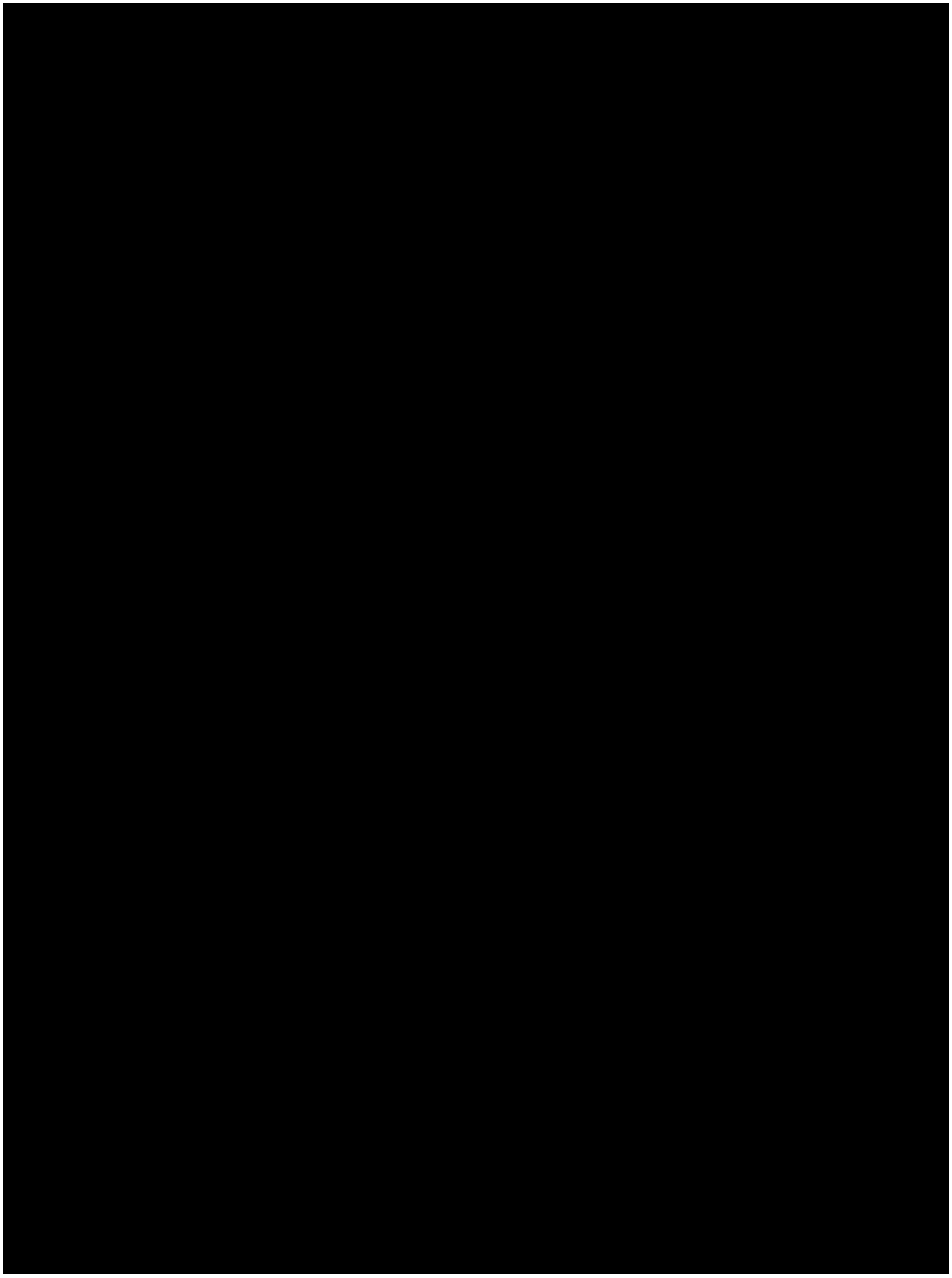

Figure 4-2: [redacted] injection well schematic.

4.1 Casing and Cementing (40 CFR 146.86 (b))

The proposed injection well design is shown in **Figure 4-1**. The lithology of the storage formation and confining zones are shown with the injection depth, hole sizes and casing sizes and depths. Additional discussion of these items is found below.

4.1.1 Corrosiveness of the CO_2 Stream and Formation Fluids (40 CFR 146.86 (b)(1)(v)(vi))

The chemical and physical characteristics of the injectant are detailed in Permit Section 6.0 – Well Operations.

The corrosivity of the injection stream should be limited given the quantities of constituents other than CO_2 in the injection stream. As detailed in the Permit Section 5.0 - Pre-Operational Testing Plan, we will confirm this assertion.

Table 4-2 presents the basic properties of the Mt Simon formation waters measured in the STW to assess the corrosivity. The pH, conductivity, and total dissolved solids (TDS) data represent analytical results from a commercial laboratory and the temperature value is the temperature measured at the mid-point of the formation through wireline logging at the STW (40 CFR 146.86 (b)(1)(vi)).

Table 4-2: Chemical parameters of Mt Simon brine to be used for corrosivity assessment.

4.1.2 Casing/Tubing

The well was designed using carbon steel for the casing and tubulars that are not expected to be in contact with a mixture of the injectant and formation waters. That is, the conductor, surface and second surface casing sections are all carbon steel. The cementing of the surface strings have also been circulated back to the surface. The deep casing string will be constructed with corrosion-resistant chrome from the reservoir through the confining zone and carbon steel from above the confining zone to surface. The lower section of the wellbore is expected to have intermittent exposure to CO_2-formation water mixed fluids, especially in the initial phases of injection and intermittently when well workovers are performed throughout the project. Since the expected water content of the injectant stream will be greater than parts per million (ppm), the injection tubing string and flow-wetted injection tree components will be composed of corrosion-resistant materials or coatings.

All selected casing and tubing grades and weights will be adequate for handling anticipated stress loads and pressures throughout the life of the project. The downhole tubulars were analyzed to ensure their ability to withstand the anticipated loads they may undergo. This analysis reviewed loads during installation, drilling, injection, workover, and subsequent abandonment. Additionally, effects due to cyclical loading, temperature, and exposure to wellbore fluids were also assessed. A summary of the proposed injection rate and maximum pressure of the CO_2 stream, and annular pressure is found in Permit Section 6.0 – Well Operations Plan (Table 6-1 and Section 6.4). The planned annular pressure is designed to maintain positive differential on the annulus to ensure any tubing leak would result in annular fluid leaking into the tubing rather than CO_2 escaping into the annulus. The targeted differential is [redacted] psi with planned maximum of [redacted] psi.

Table 4-3 summarizes the casing program for the injection well. All casing strings will be cemented to the surface and any changes to the final well design will be discussed with the UIC Director or representative. **Table 4-** details the minimum recommended tubulars and descriptions of key loads that were assessed. The design is robust, meeting industry accepted minimum safety factors with significant margin. API [redacted] The expected maximum applied external pressures acting on the casing strings from the formations have been applied in the calculations of the casing safety factors.

The deepest USDW has been confirmed from analysis with wireline logs in the STW. Surface casing is set through all active drinking water depths, and the second surface and production casings will provide additional layers of protection to the USDW.

[redacted]

Table 4-3: Casing details.

Table 4-4: Tubular performance details.

4.1.3 Tubular Stress Conditions (40 CFR 146.86 (c))

Surface

The surface casing was the first string of casing installed by the drilling rig during the STW drilling.

Second Surface

The second surface casing was installed to isolate the lower aquifers designated as USDWs

[redacted]

Long String

The long string is the final casing string that will be installed and will be exposed to installation and injection load cases. [redacted]

[redacted]

Injection Tubing

The injection tubing will be the final string of tubulars installed. [redacted]

4.1.4 Cement (40 CFR 146.86 (b))

The cemented casing strings [redacted] for the proposed injection well will all be cemented back to surface. The surface and second surface strings will be cemented using [redacted] The injection string will be installed using a CO_2 resistant cement system as the tail mix in the storage formation and confining formation with [redacted] cement back to surface. **Table 4-5** gives a summary of the cement types, sacks, weight and yield to be used for each casing string.

Additives may change slightly based on laboratory testing. Volumes may be adjusted based on expected hole enlargement during drilling operations.

[redacted]

Table 4-5: Injection well cement program including type, sacks, weight, and yield

[redacted] cements have a [redacted] component with reduced carbon emissions but maintain near equivalent performance specs to [redacted] cements. All casing strings will be cemented to the surface.

4.1.5 Downhole Completion Equipment (40 CFR 146.86 (a) (2,3)

Completion equipment will exceed the ratings of the injection tubing and will be suitable for the downhole conditions. Completion equipment will be designed such that a profile plug can be set and the tubing released from the on-off tool for workover activities.

[redacted]

[redacted]

[redacted]

4.1.6 Completion Strategy

[redacted]

4.1.7 Wellhead Design

The injection wellhead design is shown below in **Figure 4-3**. The injection well tree will be constructed with CO_2 resistant materials/coatings on all surfaces to be in contact with the injection stream. The design has dual master valves for redundancy and a crown valve to allow rigup of wireline even under pressured situations.

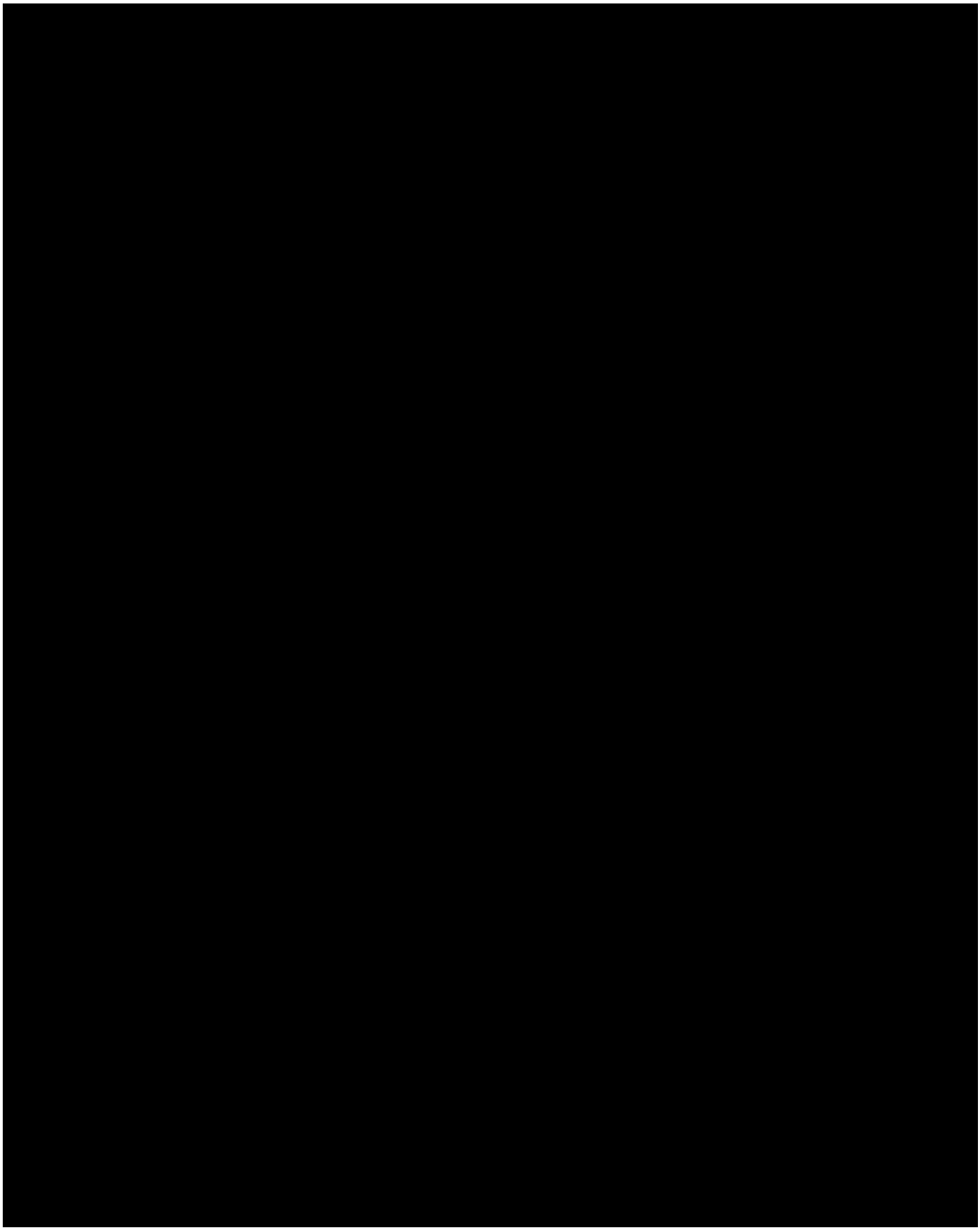

Figure 4-3: [redacted] wellhead design.

4.2 Drilling Contingencies

As noted in the previous section, the setting depths for the surface and second surface casing strings were designed to provide maximum protection for USDWs. The main sources of drinking water in the area are the shallow aquifers above [redacted] MD which provide water to the local municipality in the region. [redacted]

4.3 Annular Fluid System

This section discusses the injection tubing-casing annular fluid system to be used in the injection well after drilling and casing. The injection tubing-casing annular fluid will be a dilute salt solution such as potassium chloride (KCl), sodium chloride (NaCl), or similar. The fluid will be mixed on site from dry salt and good quality (clean) fresh water, or it will be acquired pre-mixed. The fluid will also be filtered to ensure that solids do not interfere with the packer or other components of the annular protection system. The likely density of the annular fluid will be approximately 9.2 ppg. The final choice of the type of fluid will depend on availability and wellbore conditions.

The annulus fluid will contain additives and inhibitors including: a corrosion inhibitor, biocide (prevent growth of harmful bacteria), and an oxygen scavenger. Example additives and inhibitors are listed below along with approximate mix rates:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

Actual products and suppliers will be determined closer to project execution.

4.4 Stimulation Program

No stimulation program is planned in the injection well. [redacted]

4.5 Demonstration of Mechanical Integrity

Pressure testing and logging will be performed to confirm the casing was installed correctly and cemented adequately.

Refer to Permit Section 5.0 - Pre-Operational Testing Plan and Permit Section 7.0 - Testing and Monitoring Plan for additional details on the demonstration of mechanical integrity.