Underground Injection Control – Class VI Permit Application for Mockingbird Carbon Storage Project Injection Wells No. 01, No. 02, No. 03, and No. 04

SECTION 4 – WELL CONSTRUCTION PLAN AND OPERATING CONDITIONS

Mockingbird Carbon Storage Project
Allen Parish, Louisiana
ExxonMobil Low Carbon Solutions Onshore Storage, LLC
April 2025

[redacted]

[redacted]

[redacted]

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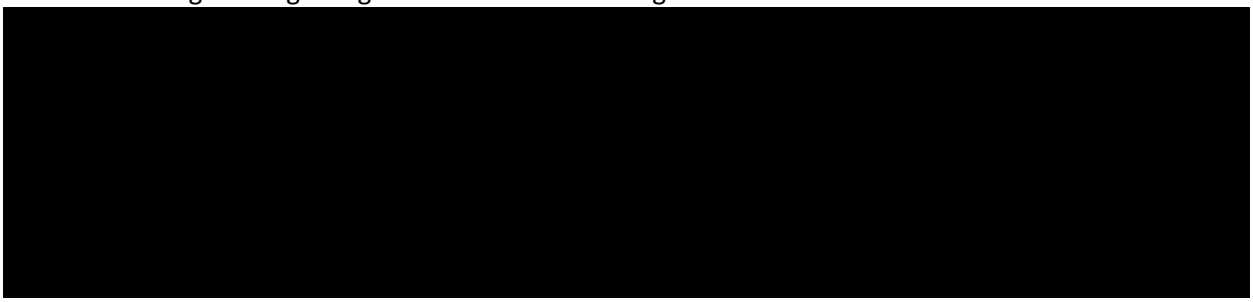


4.1 Well Construction Plan and Operating Conditions

ExxonMobil Low Carbon Solutions Onshore Storage, LLC (ExxonMobil) is undertaking the Mockingbird Carbon Storage (CS) (Mockingbird) Project in Allen Parish, Louisiana, to sequester CO_2 using four injection wells, Mockingbird INJ No. 01, No. 02, No. 03, and No. 04. This section contains information on the well construction and operating conditions in compliance with the requirements of the Louisiana Administrative Code, Title 43 (LAC43): XVII **§3607** and **§3617.A**.

This section provides a narrative with associated schematics and data summary tables that describe how ExxonMobil will construct the injection wells to meet the goals of LAC43: XVII **§3617.A**—specifically, to do the following:

1. Prevent the movement of fluids into or between underground sources of drinking water (USDWs) or into unauthorized zones (LAC43: XVII **§3617.A.1.a**).
2. Permit the use of appropriate testing devices and workover tools (LAC43: XVII **§3617.A.1.b**).
3. [redacted]

The engineering design is based on the collection of as much site-specific data as possible. This level of effort was undertaken to facilitate the permit-writing process, between conducting the pre-construction activities required by LAC43: XVII **§3607.C** and the pre-operational phase activities required by LAC43: XVII **§3619.A**.

4.2 Objectives

ExxonMobil developed the engineering design, pre-operational testing plan, and operating strategy for the injection wells to meet the following objectives:

- The injection well construction design, material specifications, and construction will be compatible with the composition of the CO_2 stream over the duration of the Mockingbird Project, to reduce the potential for endangerment of USDWs (LAC43: XVII **§3607.C.2.j** and **k**).

- The injection wells will undergo logging and testing prior to operation, to assess injection well and formation performance, and to update the operating strategy as necessary before the injection of CO_2 (LAC43: XVII **§3607.C.2.g** and **§3617.B**).

- The injection well operating strategy provides continuous injection and annulus monitoring systems for each injection well, to control injection pressure and trigger automatic shutoff devices, consistent with safe operating procedures (LAC43: XVII **§3607.C.2.f**, **h**, and **i**; **§3621**).

[redacted]

ExxonMobil assessed the corrosion-resistance properties of various metal alloys under the operating conditions expected on the proposed injection wells. [redacted]

[redacted]

[redacted]

4.4 Well Design and Construction

The engineering design parameters for the four proposed injection wells are based on the planned injection rates, injection volumes, fluid properties, and chemical properties of the injectate fluid. Injection well design [redacted]. The casing and cement were designed to have sufficient strength and material properties to withstand the pressure, temperature, and corrosive forces to which they will be exposed (LAC43: XVII **§3617.A.2.a**).

The well design schematics are included in *Appendix D* (LAC43: XVII **§3607.C.2.j**).

4.4.1 Surface Conductor Pipe Design

The unconsolidated nature of the sediments in the upper subsurface soil requires the installation of a conductor pipe to establish and maintain borehole integrity. [redacted]

4.4.2 Surface Casing Design

The [redacted] Actual surface-casing setting depths will be determined based off of the openhole logs of the injection wells themselves. [redacted].

A summary of the surface casing design parameters for all four injection wells is presented in Tables 4-4 and 4-5. Tables 4-6 through 4-9 then present the surface casing cement-volume calculations for each well, respectively, followed by the surface casing centralizers design for all of the wells (Table 4-10).

Table 4-4 – Design for Surface Casing Completion for the Mockingbird Project Injection Wells

[redacted]

ID = inner diameter; kips = thousand pounds; lb/ft = pounds per foot; OD = outer diameter; psi = pounds per square inch

Table 4-5 – Surface Casing Design Calculations for the Injection Wells

[redacted]

Table 4-6 – Surface Casing Cement-Volume Calculations for Mockingbird INJ No. 01

[redacted]

Table 4-7 – Surface Casing Cement-Volume Calculations for Mockingbird INJ No. 02

[redacted]

Table 4-8 – Surface Casing Cement-Volume Calculations for Mockingbird INJ No. 03

[redacted]

Table 4-9 – Surface Casing Cement-Volume Calculations for Mockingbird INJ No. 04

[redacted]

Table 4-10 – Design for the Surface Casing Centralizers for the Injection Wells

[redacted]

4.4.3 Production Casing Design

[redacted]

The engineering and design parameters for the production casing are summarized in Tables 4-11 and 4-12. These depths will be updated based on the final logging of the injection wells.

Table 4-11 – Production Casing Specifications

[redacted]

Table 4-12 – Production Casing Design Calculations

[redacted]

Tables 4-13 to 4-16 show the production casing cement-volume calculations for each well.

Table 4-13 – Production Casing Cement-Volume Calculations for Mockingbird INJ No. 01

Table 4-14 – Production Casing Cement-Volume Calculations for Mockingbird INJ No. 02

Table 4-15 – Production Casing Cement-Volume Calculations for Mockingbird INJ No. 03

Table 4-16 – Production Casing Cement-Volume Calculations for Mockingbird INJ No. 04

Centralizer placement for [redacted] to promote a continuous, uniform column of cement throughout the production casing (LAC43: XVII **§3617.A.2.c**). The proposed placement of centralizers through the production casing is shown in Table 4-17.

Table 4-17 – Production Casing Centralizer Program for the Injection Wells

4.5 Completion Design and Equipment

The engineering design parameters for the four proposed injection wells are based on the planned injection rates, injection volumes, fluid properties, and chemical properties of the injectate fluid. [redacted] were selected to have sufficient strength and material properties to withstand the pressure, temperature, and corrosive forces to which they will be exposed (LAC43: XVII **§3617.A.4.a**).

The completion schematics are included in *Appendix D*

4.5.1 Injection Tubing Design

The production tubing will [redacted], installed with an injection packer. [redacted] or its equivalent in all sections where the CO_2

will contact the tubulars. A tubing design analysis was conducted that considered calculated pipe-friction losses, exit velocities, and compression requirements. Tables 4-18 and 4-19 provide the tubing design parameters and evaluation (LAC43: XVII **§3617.A.4.a**).

Table 4-18 – Tubing Specifications

[redacted]

Table 4-19 – Engineering Design Calculations for Tubing

[redacted]

4.5.2 Safety and Continuous Monitoring Device Design

The following safety and continuous monitoring devices were designed for installation in the injection wells (LAC43: XVII **§3625.A.2**).

[redacted]

4.5.2.2 Downhole Pressure and Temperature Gauge Design

[redacted]

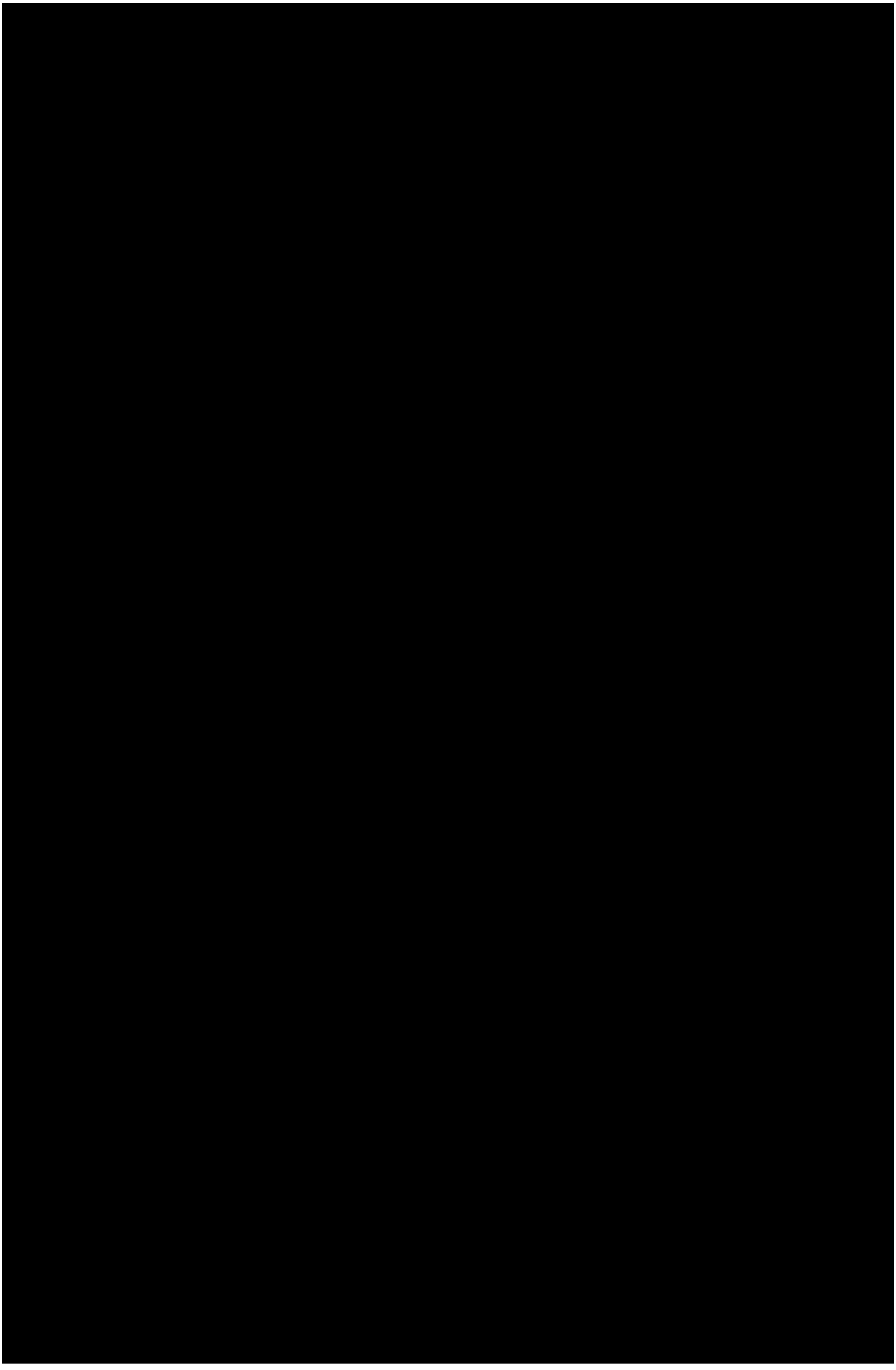
4.5.3 Injection Packer Design

[redacted]

4.5.4 Wellhead and Tree Equipment Design

[redacted]

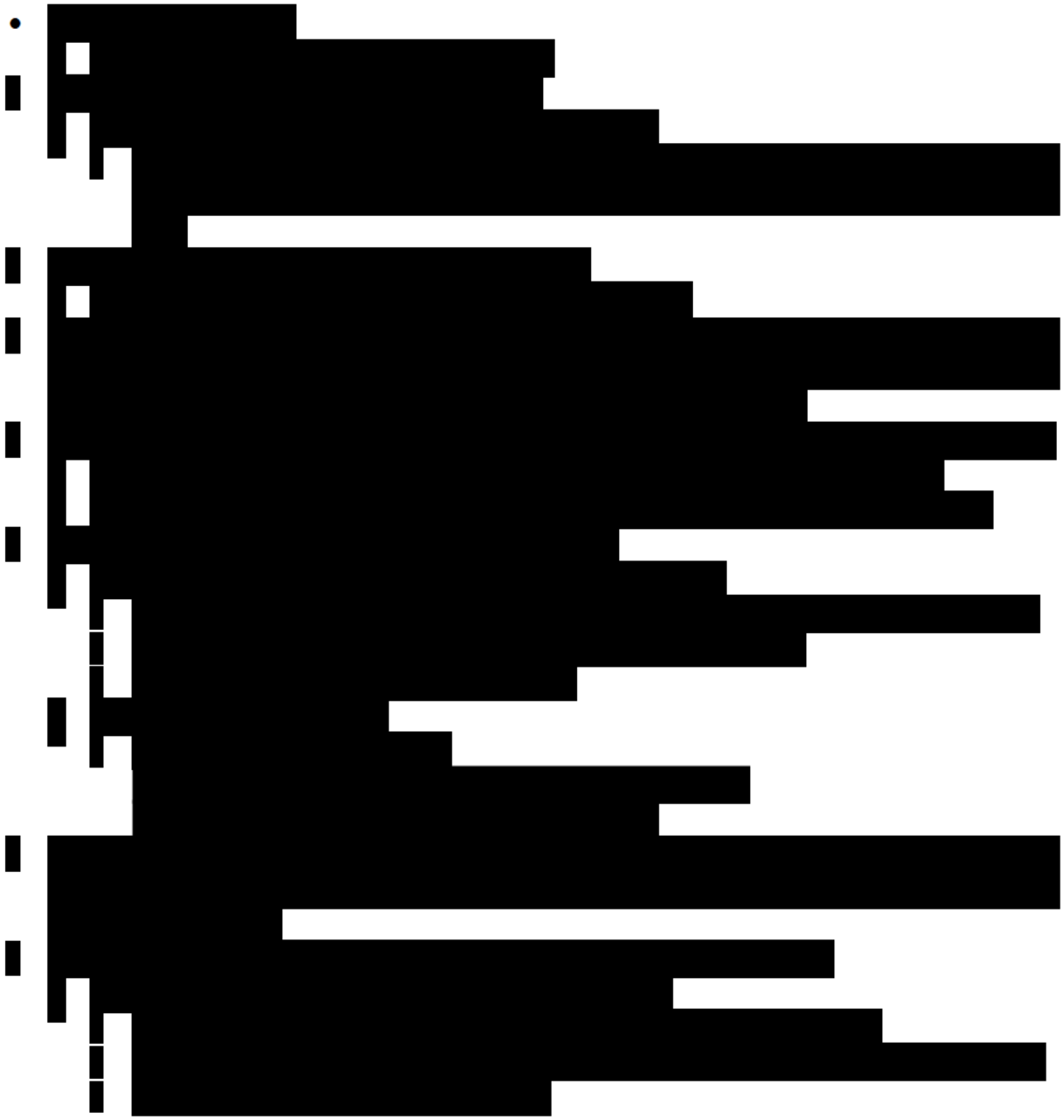
[redacted]



4.6 Well Drilling and Completion Design

4.6.1 Drilling and Completion Procedure for the Injection Wells

The proposed design summary and procedure for the Mockingbird Project injection wells is described below. The tables presented here and in *Appendix D* provide the well design and completion details for each injection well. The final completion depths and specifications listed in those tables and the *Appendix D* schematics may be modified based on actual formation depths and/or conditions encountered during drilling.



[redacted]

A detailed drilling and completion prognosis for each injection well is included in *Appendix D*.

4.7 Pre-Operational Testing Plan

The planned pre-operational sampling and testing program for the cores, well logs, and injection testing will be executed during the construction of the proposed injection wells. [redacted] Pursuant to LAC43: XVII **§3617.B.6**, ExxonMobil will provide at least a 72-hour notice to the Commissioner before performing any wireline logs, well tests, or reservoir tests.

4.7.1 Injection and Confining Zone Core Sampling

[redacted] Pre-operational coring activities will further verify the physical characteristics of the injection and confining zones.

4.7.2 Pre-Operation Logging Program

The following geophysical logs are planned for each proposed injection well. The openhole logging plan is detailed in Table 4-20, and the cased-hole logging plan in Table 4-21. [redacted]

4.7.3 Injection Zone Characterization

ExxonMobil will collect characterization data for the permitted injection zone, including formation fluid temperature, pH, specific conductivity, and formation pressure (LAC43: XVII **§3617.B.3**).

4.7.4 Fluid Characteristics and Downhole Conditions

During the construction of the injection wells, [redacted]

[redacted]

4.7.5 Injection and Confining Zone Formation Testing

[redacted] These tests are intended to confirm reservoir and operational parameters used in the permitting process and provide needed data on the geologic and hydrogeologic properties of subsurface formations. ExxonMobil will notify the Office of Conservation at least 72 hours before conduction the formation testing. [redacted]

[redacted]

4.8 Injection Well Operating Strategy

4.8.1 Overview of Injection Well Perforation and Completion Strategy

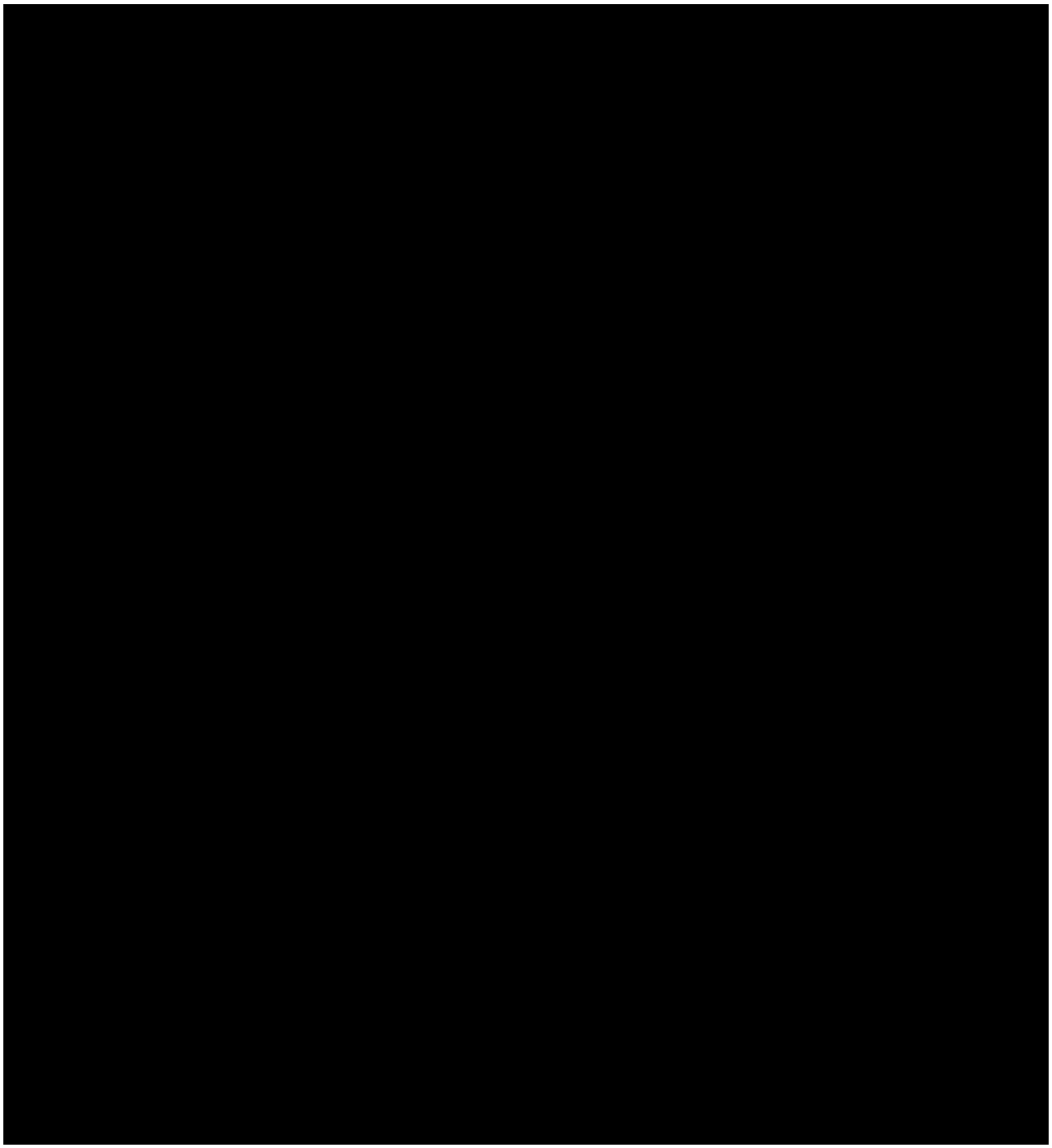
Upon permit approval, injection will start based on the stages and injection schedules referenced in Tables 4-23 through 4-26.

[redacted]

4.8.2 Injection Rate and Pressure

Table 4-27 provides the proposed operations for the injection wells, including injection rate and pressure by well. [redacted] Both the maximum and average injection rates are predicted to result in reservoir pressure rises that are below 90% of the critical fracture pressure, shown in Table 4-27. Both the injection rates and pressures are within the operating window of the injection wells.

[redacted]



4.8.3 Annulus Pressure

The annulus pressure will be adjusted to exceed the wellhead injection pressure, [redacted] (LAC43: XVII **§3621.A.3** and **4**).

4.8.4 Well Stimulation Procedures

Well Stimulation may be necessary in some cases to achieve the desire injectivity of the Class VI injection well. ExxonMobil is not proposing a stimulation program upon initial completion. However, if injection impairment is observed during the life of the well, ExxonMobil will

develop a specific plan to address the cause of the impairment. Potential causes for injection reduction are:

- Formation damage (e.g., fines migration, scaling, debris in injection stream)
- Geochemical reactions due to fluid / reservoir incompatibility
- Salt precipitation due to in situ brine vaporization
- Reservoir compartmentalization or facies variation
- Shale swelling
- Others

Because a stimulation plan is case specific and would be designed to address certain issues causing injectivity impairment, ExxonMobil, in accordance with LAC43: XVII **§3621.A.9**, will provide an advance notice of the proposed stimulation procedures in detail to the UIC Program Director in writing at least 30 days prior to implementation is a stimulation plan is required. The stimulation plan will include:

- Stimulation design to ensure the treatment will not interfere with containment
- Stimulation fluids detail (e.g., volumes, concentrations, additives)
- Stimulation fluid / well material compatibility analysis
- Well Integrity analysis (e.g., casing / tubing stress analysis)
- Stimulation procedure

Pursuant to LAC43: XVII **§3607.C.2.h**, the stimulation fluids will be an acid, most likely HCl, or a water-based fluid treated as needed with the necessary chemicals and/or additives to achieve the desired results. Any stimulation would not interfere with the containment of the project. A high-level procedure is as follows and, as mentioned in the paragraph above, a case-specific stimulation plan procedure along with a detailed description of fluids to be used will be provided to the UIC Program Director should a stimulation become necessary:

1. Determine compatibility of stimulation chemicals with well materials, reservoir rock, and fluids.
2. Develop stimulation plan based on the injection impairment cause
3. Provide work procedure and stimulation program to the UIC Program Director in writing at least 30-days prior to the planned date for start of the work (LAC43: XVII **§3621.A.9**).
4. Prepare wellsite and mobilize equipment
5. Shut-in and isolate the well from the CO2 injection system. Allow the pressures to stabilize
6. Rig up the stimulation equipment.
7. Prepare the well for stimulation.
8. Perform the stimulation treatment as per approved plan.
9. Flush the wellbore with treated water and prepare the well to return to normal operation
10. Rig down and return the well back to injection

4.8.5 Operational Reporting Plan

During the operational phase of the Mockingbird Project, ExxonMobil will, within 24 hours, report to the Commissioner any confirmed endangerment to USDWs, pursuant to the requirements in LAC43: XVII **§3621.A.7.b.iii**, **§3629.A.1.c**, and **§3623.A.2.c**—including the following:

- Evidence that the CO_2 plume or pressure front may endanger one or more USDWs
- The noncompliance situation as it relates to a permit condition
- Apparent malfunction of the injection system
- Triggering of a shutoff system or a loss of mechanical integrity
- A release of CO_2 to the atmosphere or biosphere

ExxonMobil will cease injection and take all steps reasonably necessary to determine whether there may have been a release of CO_2 to an unauthorized zone, in the event that there is a loss of mechanical integrity (LAC43: XVII **§3621.A.7.b.ii**).

Appendix D – Well Construction Schematics and Procedures:

- Appendix D1: Well Design and Completion Schematics for Injection Wells
- Appendix D2: Drilling and Completion Prognosis for Injection Wells

Appendix D – Well Construction Plan and Operating Conditions

- See Section 0 – Application Narrative for PE Stamp Cover Page

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- See Section 0 – Application Narrative for PE Stamp Cover Page