## Class VI UIC Area of Review and Corrective Action

This submission is for:

Project ID: R06-LA-0012

Project Name: Capio Sherburne CCS Well #1

Current Project Phase: Pre-Injection Prior to Construction

## Overview

Simulator Used for AoR delineation modeling: TOUGH2

Version Used: 2.0

Simulator Description/Documentation: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/PetraSimManual.pdf

Description of File Contents: Manual for modeling software

Total Simulation Time From Start of Injection: 100 yrs

Additional AoR Delineation Information: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/AREA--OF--REVIEW--AND--CORRECTIVE--ACTION--PLAN--2-----For--gsdt--module--1.pdf

Description of Information Submitted: Louisiana does not have primacy and will follow EPA submittals at this time

## Model Domain

Coordinate System: UTM

Horizontal Datum: NAD83

Coordinate System Units: m

Vertical Datum: Mean Sea Level

Describe Vertical Datum: Meters below mean sea level

Zone: N/A

Mesh Type: Hexahedral Cartesian

Domain Size in Global Units Specified Above

Hexahedral Cartesian

Domain Coordinates File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/AoRModeling_DomainCoordTemplate.xlsx

Angle of Inclination in X Direction: 0 Dips in the Direction of: increasing x

Angle of Inclination in Y Direction: 0 Dips in the Direction of: increasing y

Grid Size

Number of Nodes in x: 29 y: 29 z: 19

Grid Spacing: Variable

Grid File Format: ASCII file containing vertices and elements

Grid File Description: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4.xyz

Grid Data File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/mesh.csv

Faults Modeled: No

Caprock Modeled: Yes

Image File(s) for Model Domain Grid: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Vertical--Grid.JPG

https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Horizontal--Grid.JPG

Model Domain Comments: Image files for Model Domain Grid included in AoR document section 4.

## Processes Modeled by Simulator

Reservoir Conditions:

Supercritical $CO_2$ Conditions

Phases Modeled:

Aqueous Supercritical $CO_2$

Aqueous Phase:

Phase Compressibility: Compressible

Compressibility Value: 0 1/Pa

Phase Composition: Compositional

Aqueous Phase Components:

CO2 Water Salt

Supercritical CO2 Phase:

Phase Compressibility: Compressible

Phase Composition: Compositional

Supercritical CO2 Phase Components:

CO2 Water

Equation of State Description Including Reference: PRUESS_OLDEN_MORIES_September 2012 Tough 2 User guide Version 2 -

File with EOS Reference or Documentation: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/TOUGH2_V2_Users_Guide.pdf

Multifluid Flow Processes:

Advection Buoyancy

Non-wetting Fluid Trapping Mixed Wettability

Thermal Conditions: Isothermal

Heat Transport Processes:

Geochemistry Modeled: No

Geomechanical/Structural Deformations Modeled: No

## Rock Properties and Constitutive Relationships

Porosity/Permeability Model

Single Porosity

Porosity Distribution: Heterogeneous

Spatially Variable Porosity File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input.dat

File Describing how Porosity was Determined and Assigned to Numerical Model: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Rock--Property--Descriptions.txt

Image Files for Porosity Distributions: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Porosity--Distribution.JPG

Permeability Distribution: Heterogeneous

Spatially Variable Permeability File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----1.dat m**2

File Describing how Permeability was Determined and Assigned to Numerical Model: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Rock--Property--Descriptions-----1.txt

Image Files for Permeability Distributions: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Permeability--Distribution.JPG

Number of Rock Types Modeled: 4

Description of Rock Type Selection and Assignment: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Rock--Property--Descriptions-----2.txt

Rock Type Distribution Data File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----2.dat

Image Files for Rock Type Distribution: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Material--Distribution.JPG

### Rock Type #1

Rock Compressibility: Bulk

Rock Compressibility Distribution: Single Value

Compressibility Value: 0 1/Pa

Constitutive Relationships

Aqueous Saturation vs. Capillary Pressure: Functional Form

File Describing Functional Form Used for Aqueous Saturation vs Capillary Pressure: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--

Input-----3.dat

Aqueous Trapped Gas Modeled: No

Hysteresis other than non-wetting fluid trapping: No

Aqueous Relative Permeability: Functional Form

File Describing Functional Form Used for Aqueous Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----4.dat

Hysteresis other than non-wetting fluid trapping: No

Gas Relative Permeability: Functional Form

File Describing Functional Form Used for Gas Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----5.dat

Hysteresis other than non-wetting fluid trapping: No

Porosity and Permeability Reduction Due to Salt Precipitation

### Rock Type #2

Rock Compressibility: Bulk

Rock Compressibility Distribution: Single Value

Compressibility Value: 0 1/Pa

Constitutive Relationships

Aqueous Saturation vs. Capillary Pressure: Functional Form

File Describing Functional Form Used for Aqueous Saturation vs Capillary Pressure: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----6.dat

Aqueous Trapped Gas Modeled: No

Hysteresis other than non-wetting fluid trapping: No

Aqueous Relative Permeability: Functional Form

File Describing Functional Form Used for Aqueous Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----7.dat

Hysteresis other than non-wetting fluid trapping: No

Gas Relative Permeability: Functional Form

File Describing Functional Form Used for Gas Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----8.dat

Hysteresis other than non-wetting fluid trapping: No

Porosity and Permeability Reduction Due to Salt Precipitation

### Rock Type #3

Rock Compressibility: Bulk

Rock Compressibility Distribution: Single Value

Compressibility Value: 0 1/Pa

Constitutive Relationships

Aqueous Saturation vs. Capillary Pressure: Functional Form

File Describing Functional Form Used for Aqueous Saturation vs Capillary Pressure: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----9.dat

Aqueous Trapped Gas Modeled: No

Hysteresis other than non-wetting fluid trapping: No

Aqueous Relative Permeability: Functional Form

File Describing Functional Form Used for Aqueous Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----10.dat

Hysteresis other than non-wetting fluid trapping: No

Gas Relative Permeability: Functional Form

File Describing Functional Form Used for Gas Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----11.dat

Hysteresis other than non-wetting fluid trapping: No

Porosity and Permeability Reduction Due to Salt Precipitation

### Rock Type #4

Rock Compressibility: Bulk

Rock Compressibility Distribution: Single Value

Compressibility Value: 0 1/Pa

Constitutive Relationships

Aqueous Saturation vs. Capillary Pressure: Functional Form

File Describing Functional Form Used for Aqueous Saturation vs Capillary Pressure: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----12.dat

Aqueous Trapped Gas Modeled: No

Hysteresis other than non-wetting fluid trapping: No

Aqueous Relative Permeability: Functional Form

File Describing Functional Form Used for Aqueous Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----13.dat

Hysteresis other than non-wetting fluid trapping: No

Gas Relative Permeability: Functional Form

File Describing Functional Form Used for Gas Relative Permeability: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----14.dat

Hysteresis other than non-wetting fluid trapping: No

Porosity and Permeability Reduction Due to Salt Precipitation

Rock Properties Comments: Properties are described in AoR Document.

## Boundary Conditions

Attach Boundary Conditions Description File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4.sim

## Initial Conditions

Initial Phases in Domain: Aqueous

Initial Aqueous Pressure: Spatially Variable

Spatially Variable Initial Aqueous Pressure File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4_0.sim

Initial Temperature: Spatially Constant

Initial Temperature: 70 C

Initial Salinity: Spatially Constant

Initial Salinity: 0.04 mass fraction

## Operational Information

Number of Injection Wells: 1

### Injection Well #1

Well Direction: Vertical

Location: X: 4956 Model Units Y: 4246 Model Units

Wellbore Diameter: Constant

Wellbore Diameter: 17.5 in

Well Screen Interval Provided as: Multiple Intervals

Screened Interval File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----15.dat

Mass Rate of Injection: 1 MMT/yr

Total Mass of Injection: 7.5 MMT

Fracture Gradient: 0 other Specify Units: NA

Maximum Injection Pressure: 22 MPa Elevation Corresponding to Pressure: -2030 m

Description of How Fracture Gradient and Maximum Injection Pressure were Determined File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Injection--Pressure--Details.txt

Composition of Injectate: Pure CO2

Injection Schedule Provided as: Multiple Injection Periods

Injection Schedule File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4--TOUGH2--Input-----16.dat

Number of Production/Withdrawal Wells: 0

Operational Information Comments: For mass rate of injection, modeled 750,000 metric tons/yr for 2 years, followed by 1 million metric tons/year thereafter.

## Model Output/Results

Provide file name and corresponding spatial location for each file: The zip file contains all of the spatial locations at all times.

Time-Series File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Year--100.zip

Provide file name and corresponding variable and time stamp for each file: The output file contains all snapshots for all times.

Snapshot File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Capio--v5.4.out

Provide file name and corresponding description of surface for each file: None

Surface Flux File: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Flux.txt

## AoR Pressure Front Delineation

Lowermost USDW:

Name of Lowermost USDW: Jasper-equivalent aquifers

Water Density: 1.007 gm/cm^3 at Elevation: 2650 ft

Location of Measurement for Density: Test Well State Serial # 975895

Temperature: 107.5 F at Elevation: 2650 ft

Location of Measurement: Test Well State Serial # 975895

Pressure: 1155 psi at Elevation: 1650 ft

Location of Measurement: Test Well State Serial # 975895

Salinity: 10000 mg/L at Elevation: 2650 ft

Location of Measurement: Test Well State Serial # 975895

Elevation of bottom of USDW: 2650 ft

Injection Zone:

Name of Injection Zone: Miocene Sands (Sand 10 and Sand 11)

Water Density: 1.025 gm/cm^3 at Elevation: 5627 ft

Location of Measurement: Test Well State Serial # 975895

Temperature: 124.6 F at Elevation: 5627 ft

Location of Measurement: Test Well State Serial # 975895

Pressure: 2497 psi at Elevation: 5627 ft

Location of Measurement: Test Well State Serial # 975895

Salinity: 40000 mg/L at Elevation: 5627 ft

Location of Measurement: Test Well State Serial # 975895

Elevation of top of Injection Zone: 5627 ft

Method of Estimating Critical Pressure: Static Mass Balance

Assumptions: Hydrostatic Uniform Density

File Describing Critical Pressure Estimation: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/Critical--Pressure.txt

Estimated Critical Pressure: 3.1 MPa

Delineated AoR:

Shapefile or KML File Showing Delineated AoR: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/OilandGasWellsWithinPB_ExportForCharles.shp

AoR Pressure Front Delineation Comments: Described in AoR Document.

## Corrective Action

Corrective Action Comments: Described in AoR Document.

## Area of Review and Corrective Action Plan [40 CFR 146.82(a)(13) and 146.84(b) or applicable state requirements]

Are you making an Area of Review and Corrective Action Plan submission at this time?: Yes

Reason for Project Plan Submission: Permit application submission

Project Plan Upload

Attach the Area of Review and Corrective Action Plan: https://gsdt.pnnl.gov/alfresco/service/velo/getFile/no_wiki/shared/Submissions/R06-LA-0012/Phase1-PreConstruction/AoRModeling-12-13-2022-2213/03_CapioFidelis_AOR_and--CAP_--Redacted_V2.0.pdf

Appendices and Supporting Materials Upload

## Area of Review Reevaluation [40 CFR 146.84(e) or applicable state requirements]

Minimum fixed frequency of AoR reevaluation: 5 Years

Are you making an Area of Review reevaluation submission at this time?: No

Reevaluation Background

Reevaluation Materials

Please upload your amended AoR and Corrective Action Plan on the previous tab.

## Complete Submission

Authorized submission made by: Pete Hollis

For confirmation a read-only copy of your submission will be emailed to: michael.neese@fidelisinfra.com