Plan revision number: Revision 1
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CLASS VI PERMIT APPLICATION NARRATIVE
40 CFR 146.82(A)

Jasper County Storage Facility

Permit Number: R06-TX-0004

June 2023

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LIST OF ACRONYMS

Acronym	Definition
ΔP_{crit}	critical pressure
µL/L	microliter per liter
1D	one-dimensional
3D	three-dimensional
AOD	Above Ordinance Datum
AoR	Area of Review
AP	Artificial penetration
APHA	American Public Health Association
API	American Petroleum Institute
APWD	annulus pressure while drilling
ASTM	American Society for Testing and Materials
BEG	University of Texas at Austin Bureau of Economic Geology
bgs	below ground surface
BOP	blowout preventer
BP	BP Carbon Solutions LLC
BRACS	Brackish Resources Aquifer Classification System
BTC	buttress threaded and coupled
BTU/ft.hr.F	British thermal unit per foot hour Fahrenheit
BUQW	base of useable quality water
C&CM	Crisis and Continuity Management
C&EA	Communications and External Affairs
CA	corrective action
CCS	carbon capture and storage
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COC	chain-of-custody
CWA	Clean Water Act
DAS	distributed acoustic sensing
DTS	distributed temperature sensing
ECD	equivalent circulating density
EDR	Environmental Data Resources
EOC	Emergency Operations Center
EoS	Equation of State
EPA	United States Environmental Protection Agency
ERRP	Emergency and Remedial Response Plan
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
ESS	equilibrium-specification-saturation
FIT	formation integrity test

Acronym	Definition
ft/day	feet per day
ft^2/day	square feet per day
ft^3/day	cubic feet per day
g/cm^3	grams per cubic centimeter
GAU	Groundwater Advisory Unit
GC-MS	gas chromatography mass spectrometry
[redacted]	
GIS	geographical information system
GR	gamma ray
GS	geological sequestration
GSDT	Geologic Sequestration Data Tool
GWB	Geochemist's Workbench
H_2O	water
HSE&C	Health, Safety, Environmental, and Carbon
IC	Incident Commander
ICS	Incident Command System
IMP	Incident Management Plan
IMT	Incident Management Team
IP	Individual Permit
IROC	Intelligence and Response Operations Center
IWOB	integrated weight on bit
km	kilometer
lbs/ft	pounds per foot
LWD	logging while drilling
M	magnitude
MCL	maximum contaminant level
mD	milliDarcy
MDT	Modular Formation Dynamic Tester
mg/L	milligrams per liter
Mg/kg	milligrams per kilogram
mi^2	square mile
MICP	mercury injection capillary pressure
MIT	mechanical integrity testing
Mpa	megaPascal
MSL	mean sea level
MS/MSD	matrix spike/matrix spike duplicate
MSRC	Marine Spill Response Corporation
MRT	multi-rate test
Mt	million metric tons
Mtpa	million metric tons per year
MWD	measurement while drilling
N/A	not applicable
n/r	not recorded
NACE	National Association of Corrosion Engineers
NaCl	sodium chloride
$NaClHCO_3$	sodium chloride bicarbonate
NAVD 88	North America Vertical Datum 1988
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NWI	National Wetlands Inventory
NWP	Nationwide Permit
P&A	plugging and abandonment

Acronym	**Definition**
PBR	Permits by Rule
PFO	pressure fall-off
PHREEQC	pH Redox Equilibrium (in C language)
PISC	post-injection site care
PQL	practical quantitation limits
ppf	pounds per foot
PPFG	pore pressure fracture gradient
ppm	parts per million
PR	Peng-Robinson
PRF	plutonic rock fragment
psi	pounds per square inch
psi/ft	pounds per square inch per foot
psig	pounds per square inch gauge
PTA	pressure transient analysis
PVT	pressure-volume-temperature
PVTX	pressure, volume, temperature, composition
QA	quality assurance
QA/QC	quality assurance/quality control
QASP	Quality Assurance Surveillance Plan
RCA	routine core analysis
RCRA	Resource Conservation and Recovery Act
RMS	root mean square
ROP	rate of penetration
RPD	relative percent difference
RRC	Railroad Commission of Texas
RST	Reservoir Saturation Tool
RSWC	rotary sidewall core
RT PPFG	real time pore pressure fracture gradient
SAPT	standard annulus pressure test
SCAL	special core analysis
SEM	scanning electron microscope
Site	Jasper County Storage Facility
SME	subject matter expert
SOP	standard operating procedure
SPWLA	Society of Petrophysicists and Well Log Analysts
SRF	sedimentary rock fragment
SRT	step rate test
t/d/well	tons per day per well
TAC	Texas Administrative Code
TBD	to be determined
TCEQ	Texas Commission on Environmental Quality
TD	total depth
TDLR	Texas Department of Licensing and Registration
TDS	total dissolved solids
TPDES	Texas Pollutant Discharge Elimination System
TVD	true vertical depth
TWDB	Texas Water Development Board
UIC	Underground Injection Control
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USCG	United States Coast Guard
USDW	underground source of drinking water

Acronym	**Definition**
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VLE	vapor-liquid equilibrium
VOC	volatile organic compound
VRF	volcanic rock fragment
VSH	volume shale
XRD	X-ray diffraction
XRF	X-ray fluorescence

CLASS VI PERMIT APPLICATION NARRATIVE
40 CFR 146.82(A)

Jasper County Storage Facility

1. FACILITY INFORMATION

Facility Name: Jasper County Storage Facility

Facility Contact: [redacted]
501 Westlake Park Blvd., Houston, Texas 77079
[redacted]

Well Location: Jasper County, TX

[redacted]

1.1 Project Background and Contact Information (40 CFR 146.82(a)(1))

BP Carbon Solutions LLC (BP) is submitting a Class VI Injection Well Permit application (Application) for the Jasper County Storage Facility (Site), a carbon capture and storage (CCS) project located in Jasper County, Texas. Geological storage of the carbon dioxide (CO_2) at the Site will be in strata of the Frio Formation. The supporting documentation associated with this Application was prepared in accordance with the U.S. Environmental Protection Agency's (EPA) Underground Injection Control (UIC) Program for Carbon Dioxide Geologic Sequestration Wells (The Geological Sequestration [GS] Rule, codified in Title 40 of the Code of Federal Regulations [40 CFR 146.81, et seq.]) and the EPA's provided templates and guidance documents. A summary of these documents and their respective appendices is as follows:

- Appendix A – Summary of Requirements Class VI Operating and Reporting Conditions
- Appendix B – Area of Review (AoR) and Corrective Action Plan
- Appendix C – Financial Assurance Demonstration
- Appendix D – Pre-Operational Testing
- Appendix E – Testing and Monitoring Plan and Quality Assurance and Surveillance Plan (QASP)
- Appendix F – Injection Well Plugging Plan
- Appendix G – Post-Injection Site Care and Site Closure Plan

- Appendix H – Emergency and Remedial Response Plan
- Appendix I – Stimulation Plan
- Appendix J – Injection Well Construction

[redacted]

[redacted] BP intends to construct access roads to the well pads and supporting infrastructure at the Site and to pipelines that transport the CO_2 from sources to the Site. **Figure 2.14** shows the general location of the Site, [redacted]

BP drilled an appraisal well (Well A469 #1) on December 1, 2021, to evaluate the geological formations at the Site and to provide site-specific data used in this Application. The well was permitted by the Railroad Commission of Texas (RRC) and assigned API 42-241-30913.

Development of the Site contemplates permitting and construction of injection well pads, associated infrastructure and equipment, and pipeline development. BP has developed a permitting matrix for current and potential permitting requirements for the Site. As specific permits and requirements are confirmed applicable or inapplicable, BP will provide the UIC Program Director with an updated list. Currently, aside from this Application, no other permits or construction approvals for the Site have been applied for or received under the programs listed in 40 CFR 144.31(e)(6). Permits and authorizations that may be required for the Site are summarized in **Table 1.1** below:

Table 1.1. Summary of Potential Permits and Authorizations Required for the Site

Permit or Approval	Project Phase	Authorizing Agency
Federal		
Section 404 of the Clean Water Act (CWA): Nationwide Permit (NWP) or Individual Permit (IP)	Pre-construction	United States Army Corps of Engineers (USACE) - Galveston District
Section 404 of the CWA: NWP 6	Pre-construction	USACE - Galveston District
Regional General Permit (SWG-1998-02413): Horizontal Directional Drill under Navigable Waters of the United States	Pre-construction	USACE - Galveston District
Section 10 of the Rivers and Harbors Act	Pre-construction	USACE - Galveston District
Jurisdictional Determination	Pre-construction	USACE - Galveston District
Compensatory Wetland Mitigation - Compliance with Section 404 of the CWA	Pre-construction	USACE - Galveston District
Section 408 of the CWA	Pre-construction	USACE - Galveston District
Real Estate Outgrant	Pre-construction	USACE - Galveston District

Permit or Approval	Project Phase	Authorizing Agency
National Environmental Policy Act	Pre-construction	The President's Council on Environmental Quality
Obstruction Evaluation / Airport Airspace Analysis	Pre-construction	Federal Aviation Administration
Compliance with The Endangered Species Act (ESA), Section 7 Consultation	Construction/ Operation	United States Fish and Wildlife Services (USFWS)
Compliance with the ESA, Section 10 Incidental Take Permit for Threatened and Endangered Species	Construction/ Operation	USFWS
Spill Prevention, and Control and Countermeasures Plan	Construction/ Operation	EPA
State Permits and Approvals		
Coastal Management Program Consistency Statement	Pre-construction	Texas General Land Office (GLO)
State Land Use Lease	Pre-construction	GLO
Stormwater Construction General Permit TXR150000	Pre-construction	Texas Commission on Environmental Quality (TCEQ)
Air - Case-By-Case Minor New Source Review Permit	Pre-construction	TCEQ
Air - Permits by Rule (PBR)106.472 Organic and Inorganic Liquid Loading and Unloading.	Construction	TCEQ
Air PBR 106.511 Portable and Emergency Engines and Turbines	Construction	TCEQ
Air - Prevention of Significant Deterioration Permit and/or Nonattainment New Source Review Permit	Pre-construction	TCEQ/EPA
Seismic Survey	Pre-construction	RRC
Pipeline Pre-construction Report	Pre-construction	RRC
Right of Way Permits (May include road construction-entrance, utility installations, and highway use permits)	Construction	Texas Department of Transportation
Drilling Completion Report	Construction	Texas Water Development Board (TWDB)
Water - Temporary Water Rights (TCEQ-20425)	Construction	TCEQ
Water - Temporary Water Rights (TCEQ-10202)	Construction	TCEQ
National Historic Preservation Act of 1966, as amended (16 United States Code [U.S.C.] 470 et seq.) Section 106 Review	Construction	Texas Historical Commission, also referred to as the State Historic Preservation Office
Threatened, Endangered, and other State-Protected Species Consultation	Construction	Texas Parks and Wildlife Department
401 Certification Discharge Dredged or Fill Material (submitted via a Tier I or Tier II Checklist/Questionnaire with USACE Section 404 permit application)	Construction	TCEQ
Water - Hydrostatic Test Water General Permit TXG670000	Construction	TCEQ/RRC
Air - Title V Site Operating Permit	Construction/ Operation	TCEQ/EPA

Permit or Approval	Project Phase	Authorizing Agency
Water - Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit TXR050000 or TPDES General Permit TXG11000	Operation	TCEQ
Water - CWA Section 402 - National Pollutant Discharge Elimination System (NPDES)/TPDES for Industrial Wastewater Discharges and Wastewater Treatment Evaluations	Operation	TCEQ
Waste - Industrial and Hazardous Waste Registration	Operation	TCEQ
Hazardous Materials Title 49 CFR Part 107, Subpart G (107.601-106.620)	Operation	TCEQ/TXDOT

A summary of the proposed operating conditions and routine shutdown procedures can be found in **Appendix A** - Summary of Requirements.

Neither an injection depth waiver nor an aquifer exemption expansion is being requested. At the time of this application, an alternative Post-Injection Site Care (PISC) and Site Closure Plan timeline is not proposed. There are no federally recognized Native American tribal lands or other federally owned territories within the AoR.

The contact for the project is [redacted] Mailing address: 501 Westlake Park Blvd., Houston, Texas 77079. [redacted]

The standard industrial classification code is 8999, Services, Not Elsewhere Classified.

BP has identified the following Texas contacts in accordance with 40 CFR 146.82(a)(20):

- RRC UIC Program: Bryce J. McKee, Phone: 512.463.2259
- TWDB: John Dupnik, Phone: 512.463.7847
- TCEQ: Bryan Smith, P.G., Phone: 512.239.6466

GSDT Submission - Project Background and Contact Information
GSDT Module: Project Information Tracking ***Tab(s):*** General Information tab; Facility Information and Owner/Operator Information tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Required project and facility details ***[40 CFR 146.82(a)(1)]***

2. SITE CHARACTERIZATION [40 CFR 146.82(A)(3, 5, AND 6) AND 40 CFR 146.83]

2.1 Regional Geology, Hydrogeology, and Local Structural Geology [40 CFR 146.82(a)(3)(vi)]

The U.S. Gulf Coast is a major petroleum-producing region of the United States. Sea-level oscillations had a major impact on sedimentation and the types of depositional environments that existed within the region. Additionally, fluctuations in clastic sediment supply associated with uplift and erosion of nearby mountain ranges, fluctuating channels and drainage systems, changes in basin structure, and salt tectonics greatly affected sedimentation within the region. The Gulf of Mexico Basin and surrounding region within the U.S. Gulf Coast were originally formed because of crustal extension and expansion of the seafloor associated with the breakup of Pangea during Mesozoic time (Sawyer et al., 1991, as cited in Galloway, 2008). The main depocenter of the Gulf Coast region, which is thought to underlie the southern Louisiana coastal plain and adjacent continental shelf, contains as much as 65,600 feet of rock that accumulated from the Jurassic through the Holocene.

This summary focuses on the Eocene-aged Yegua Formation through to the Pleistocene-aged Beaumont Formation with the underburden rocks below the injection zone up to the Underground Sources of Drinking Water (USDW) reservoirs. **Figures 2.1, 2.2,** and **2.3** demonstrate the below descriptions of the Site.

During the Eocene, deltaic sediment input volumes generally decreased, but increased again during the Oligocene. A significant volume of clastic sediments continued to be deposited during the Oligocene, culminating with a significant transgression and subsequent regression that resulted in the deposition of the mud-dominated Anahuac Formation near the end of the Oligocene and into the early Miocene. Coarse clastic deposition resumed at the beginning of the Miocene and continued throughout. The underburden rock comprises the Eocene-aged Yegua and Jackson Formations and the Oligocene-aged Vicksburg Formation. The injection zone is defined by the Oligocene-aged Frio Formation, while the confining zone consists of the Late Oligocene-Early Miocene Anahuac Formation. Overburden rocks within the AoR belong to the Miocene-aged Fleming Formation and the Plio/Pleistocene-aged Goliad and Beaumont Formations.

The Anahuac Formation consists of mainly shaley sequences and represents a transgressive shale sequence bound at the top and bottom by regressive sand sequences. It is approximately 1,000 feet thick and is interbedded with multiple silt and shale beds with few sandy stringers

(**Figure 2.8**). Published regional work describes the Anahuac as having a range of porosities between 4% to 28% and permeabilities ranging from 0.1 millidarcy (mD) to 1,000 mD, with the higher end of reservoir properties belonging to sand stringers that are not expected to be in vertical communication. [redacted]

The Frio Formation can be interpreted as fluvio-deltaic sediments with distributary channels, interdistributary bayfills, and barrier bar facies. The Frio Formation is approximately 1,300 feet thick and consists of a series of alternating sand and shale sequences. The lower and upper parts of the Frio are interpreted to be wave-dominated deltaic deposits, while the middle Frio is inferred to be more fluvially influenced. Rock properties of the Frio are sufficient for injection. Expected permeabilities range from 10 mD to over 2,000 mD and porosities range from 10% to 38%.

The structural elements of the AoR comprise regionally extensive syndepositional fault systems (**Figure 2.7**) that are subparallel to the coast and generally dip towards the southeast. These normal growth faults were formed mainly by gravitational failure during rapid sediment loading along an unstable shelf margin and upper slope [redacted] The structural dip is to the south-southeast and is between 1 to 3 degrees.

Salt tectonics also play an important role in the structural development of the Gulf of Mexico. The salt originally formed as bedded evaporites during the Jurassic period and belong to the Louann Formation. Salt bodies, however, do not intrude nor have a major impact on the structure of our storage complex within the AoR.

Figure 2.4 is a map showing a 20-mile and 50-mile radius around the AoR.

[redacted]

[redacted]

[redacted]

[redacted]

2.1.1 Injection Zone

The injection zone for the Project is within the Frio Formation of the Oligocene Epoch and the Paleogene/Tertiary Period. The Frio Formation is considered a major pro-gradational wedge located in the Texas Gulf Coast Basin. The Frio Formation and the updip Anahuac Formation are centered in the Houston and Rio Grande Embayments.

The Frio Formation extends laterally throughout the coastal areas of Texas and Louisiana. The portion of the Frio Formation located within Texas follows the Gulf of Mexico coastline and extends longitudinally through the majority of the Gulf Coast Region. The Frio Formation ranges in thickness from less than 1,000 feet in southern Louisiana to nearly 9,000 feet in the coastal areas of Texas (Loucks et al., 1984). [redacted] Regionally the Frio can occur at depths ranging from surface to > 20,000 feet sub-sea. [redacted]

The Frio Formation is primarily composed of deltaic and marginal marine sandstone and shales. The Frio Formation is defined by fluvio-deltaic sediments with distributary channels, interdistributary bay fills, and barrier bar facies and consists of a series of alternating sand and shale sequences. The Frio Formation has been informally divided into upper, middle, and lower units. The lower and upper units of the Frio Formation are composed of wave-dominated deltaic deposits, while the middle unit is more fluvially influenced. The middle unit of the Frio Formation also includes the Hackberry Trend which is composed of shale and sandstone (Swanson et al., 2013). Further discussion on facies changes within the Frio Formation is available in **Section 2.5.**

The average porosity of the Frio Formation is 27%, and the average permeability is 685 mD. Porosity across the Frio Formation is reported to range between 10% and 38% while permeability is reported to range from 10 mD to over 2,000 mD (Loucks et al., 1984). [redacted]

The Frio Formation displays adequate deep-reservoir quality within the middle and upper Texas Gulf Coast and is expected to be sufficient for CO_2 injection. The Frio Formation is regionally overlain by the Anahuac Formation, which is the confining unit for the project.

2.1.2 Confining Zone

The confining zone for the Site is within the Anahuac Formation of the Upper Oligocene Epoch and the Paleogene/Tertiary Period. The Anahuac Formation is considered a transgressive marine shale sequence centered within the Rio Grande Embayment.

The Anahuac Formation extends throughout the coastal areas of Texas, Louisiana, and Mississippi. The portion of the Anahuac Formation located within Texas regionally overlays the Frio Formation and follows the entirety of the Gulf of Mexico coastline, extending longitudinally through the majority of the Gulf Coast Region. Regionally the average thickness of the Anahuac Formation ranges from 750 feet in Louisiana to 1,000 feet in Texas (John et al., 1992). [redacted]

[redacted]

The Anahuac Formation is primarily composed of light to dark green-gray calcareous shale interbedded with thin beds of sandstone and limestone. The Anahuac Formation is defined by transgressive marine shale sequences and is bound at the top and bottom of the unit by regressive sand sequences. Carbonate rocks, such as limestone, dominate the portion of the Anahuac Formation located within the eastern Gulf of Mexico (Swanson et al., 2013). Further discussion on facies changes within the Anahuac Formation is available in **Section 2.5.**

Porosity across the Anahuac Formation is expected to range between 4% and 28%, while permeability is expected to range from 0.1 mD to 1,000 mD with the higher end of reservoir properties belonging to sand stringers that are not expected to be in vertical communication. [redacted] Confining layers within the Anahuac Formation are dominated by shale and are structural or combination in nature, including faulted rollover anticlines and salt diapir-related traps (John et al., 1992).

2.1.3 Geologic History

The Gulf Coast is a major petroleum producing region of the United States. Prehistoric sea level oscillation significantly impacted the sedimentation and depositional environments that existed within the region. Additionally, fluctuations in clastic sediment supply associated with the uplift and erosion of nearby mountain ranges, fluctuations in channels and drainage systems, changes in basin structure, and salt tectonics affected the geological development of the region.

The Gulf of Mexico Basin and greater Gulf Coast were originally formed from crustal extension and seafloor expansion associated with the breakup of Pangea during the Mesozoic Era. The main depositional center in the Gulf Coast, which has been inferred to underlie the southern coastal plains of Louisiana and the adjacent continental shelf, potentially contains up to 65,600 feet of rock that accumulated from the Jurassic Period through the Quaternary Period (Holocene Epoch).

During the Tertiary Period, large quantities of sand and mud were deposited along the margins of the Gulf of Mexico. The depositional environment resulted in a series of pro-gradational wedges, beginning with the underlying Vicksburg Formation, Frio Formation, and regionally overlying Anahuac Formation. During the Eocene Epoch, input volumes of deltaic sediment generally decreased until the Oligocene Epoch, at which time volumes increased again. Significant volumes of clastic sediments continued to be deposited during the Oligocene Epoch, culminating in a significant transgressional and subsequent regressional sequence that resulted in the mud and shale-dominated Anahuac Formation (Swanson et al., 2013).

2.1.4 Geologic Setting

[redacted]

2.1.4.1 Beaumont and Goliad Formations

Younger stratigraphy of the Beaumont and Goliad Formations are most likely to be encountered at ground level. These rock units are comprised of Plio/Pleistocene and Late Miocene sediments that contain the water-bearing units in the Gulf Coast aquifer system in Texas. The Goliad sediments are interpreted as fluvial depositional systems with channel and inter-channel facies. The Beaumont is composed of clay-rich sediments transected by sandy fluvial and deltaic-distributary channels. [redacted]

2.1.4.2 Fleming Group

Stratigraphy representing the Fleming group is present above the Anahuac Formation and below the Beaumont and Goliad Formations. These rock units are comprised of Miocene-aged sediments consisting of interbedded sand and shale sediments deposited under fluvial-deltaic to shallow marine environments. The Fleming Group overlays the Anahuac Formation and includes the Lagarto and Oakville Formations. The Oakville and Lagarto Formations together compose a major fluvial-deltaic depositional episode in which the Oakville forms the lower pro-gradational part, and the Lagarto forms the upper retro-gradational part. In the onshore area, Oakville is generally sand-rich, whereas Lagarto is relatively more mud-rich.

[redacted]

2.1.4.4 Vicksburg, Jackson, and Yegua Formations

[redacted] The Vicksburg and Jackson Formations are predominantly shale/mud prone and are overlain by the Frio and underlain by the Yegua. The Eocene Yegua sediments are highly heterogeneous and were deposited within inner-neritic to outer-neritic paleowater depths. [redacted]

2.1.5 Geologic Features / Structural Geology

The series of pro-gradational wedges in the Gulf Coast Region, which includes the Vicksburg Formation, Frio Formation, and Anahuac Formation, are characterized by thickening upward sequences and gulfward dips. Regional structural dip is to the south/southeast and ranges between 1 to 3 degrees. Rapid sedimentation loading during deposition resulted in large growth fault systems near the downdip edge of each wedge. [redacted]

Three major structural areas are identified for the Frio Formation within Texas. These structural areas are defined as the Houston Embayment, San Marcos Arch and southward area towards the Rio Grande Embayment, and the Rio Grande Embayment. The Houston Embayment is characterized by salt diapirism and associated faulting. Salt tectonics were significant in the structural development of the Gulf of Mexico, with salt originally forming as bedded evaporites during the Jurassic Period.

The San Marcos Arch is characterized by linear belts of growth faults and associated shale ridges. The Rio Grande Embayment is characterized by large discontinuous belts of growth faults and deep-seated shale ridges. The regionally extensive depositional fault systems are subparallel to the coast and generally dip towards the south/southeast. These normal growth faults were formed from gravitational failure during the rapid sediment loading along the unstable gulf shelf margin and upper slopes.

Major deltaic progradation during the Oligocene Epoch created the Vicksburg Fault Zone which forms the updip limit of structural deformation within the Frio Formation. The Frio Fault Zone, located downdip from the Vicksburg Fault Zone, consists of 5 to 10 major normal faults spaced 3 to 6 miles apart with intervening rollover anticlines contained within a deep listric system. The observed faults display a range of approximately 500 to 1,000 feet of offset, and in some instances hold back material quantities of hydrocarbons (oil and gas). Thickening and displacement of sediments are more significant in the Frio Fault Zone than in the Vicksburg Fault Zone. Sediments during the Oligocene Epoch expanded and filled the offset space created from slip along the fault growths (Galloway et al., 1982).

[redacted]

2.1.6 Uncertainty

Subsurface geological interpretations come with uncertainties, and alternative interpretations were taken into consideration. **Section 2.5.5** discusses uncertainties in geological facies distribution and alternative interpretations considered for the geometries of the confining and injection zones. [redacted]

2.2 Maps and Cross-Sections of the AoR [40 CFR 146.82(a)(2), 146.82(a)(3)(i)]

[redacted] The following figures are provided as maps and cross-sections that represent the AoR:

- **Figure 2.5** shows a correlation between geologic (stratigraphic) and hydrogeologic units;

[redacted]

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[redacted]

Geologic (stratigraphic) units			Hydrogeologic units	Model layer
System	Series	Formation	Aquifers and confining units	
Quaternary	Holocene	Alluvium	Chicot aquifer	1
	Pleistocene	Beaumont Formation		
		Montgomery Formation		
		Bentley Formation		
		Willis Formation		
Tertiary	Pliocene	Goliad Sand	Evangeline aquifer	2
	Miocene	Fleming Formation	Burkeville confining unit	3
		Oakville Sandstone	Jasper aquifer	4
		Catahoula Sandstone		
		Anahuac Formation[1]	Catahoula confining system	
		Frio Formation[1]		

[1]Present only in subsurface.

Figure 2.5. Geologic and Hydrogeologic Unit Correlation

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

2.2.1 Project Area Map Narrative [40 CFR 146.82(a)(2), 40 CFR 146.84(c)(2)]

BP conducted an extensive search to identify the pertinent features within the AoR, which are depicted in the Project Area Map (**Figure 2.14**) in compliance 40 CFR 146.82(a)(2) and 40 CFR 146.84(c)(2). Searches were conducted for the following features:

a. State and federal subsurface cleanup sites;

b. Surface water bodies;

c. Springs;

d. Mines (surface and subsurface) and quarries;

e. Structures intended for human occupancy; and

f. Artificial penetrations (APs) including producing, abandoned, and plugged wells, Class I, II, III, IV, and V wells, dry holes, and stratigraphic boreholes.

2.2.1.1. State and Federal Subsurface Cleanup Sites

State subsurface cleanup sites were searched within the AoR using the Industrial and Hazardous Waste Corrective Action Points layer from the TCEQ Environmental Systems Research Institute (ESRI) Geographic Information System (GIS) Data Hub, which included searches of the databases below:

- TCEQ Leaking Petroleum Storage Tank[1]
- TCEQ Landfills[2]
- TCEQ Groundwater Conservation Districts[3]

No State subsurface cleanup sites were identified in the search described above.

In addition to the searches performed above, an Area/Corridor Report was purchased from Environmental Data Resources (EDR) on August 18, 2023. The Area/Corridor Report identified environmental registrations within a defined project boundary, which was provided to EDR. The boundary included a quarter-mile offset from the AoR. The report contained a listing of State and Federal cleanup sites identified within and near the AoR by searching a range of County, State and Federal databases for sites, including the following: Lists for Federal National Priority List (NPL) (Superfund) sites; Federal Delisted NPL sites, Federal sites subject to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removals and CERCLA orders, Federal CERCLA sites with No Further Remedial Action Planned, Federal Resource Conservation and Recovery Act (RCRA) facilities undergoing corrective action, Federal RCRA transportation, storage, and disposal facilities, Federal RCRA generators, Federal institutional controls/engineering controls registries, Federal Emergency Response Notification System list, State and Tribal (Superfund) equivalent sites, State and Tribal landfills and solid waste disposal facilities, State and Tribal leaking storage tanks, State and Tribal registered storage tanks, State and Tribal institutional control/engineering control registries, State and Tribal voluntary cleanup sites, State and Tribal brownfield sites, local brownfield lists, local lists of landfill/solid waste disposal sites, local hazardous waste/contaminated sites, local lists of registered storage tanks,

[1] https://gis-tceq.opendata.arcgis.com/datasets/TCEQ::lpst-points/explore?location=30.216820%2C-93.996604%2C10.65&showTable=true
[2] https://gis-tceq.opendata.arcgis.com/datasets/TCEQ::landfills/explore?location=30.340981%2C-93.778136%2C12.00&showTable=true
[3] https://gis-tceq.opendata.arcgis.com/datasets/TCEQ::groundwater-conservation-districts/explore?showTable=true

local land records, records of emergency release reports, County records, and other databases. The report was reviewed for records related to subsurface cleanup sites within the AoR.

Two subsurface cleanup sites were identified with registrations inside the AoR:

- Westrock Texas LP, 1913 FM 105, Evadale, TX 77615, US EPA RCRA Corrective Actions Sites (CORRACTS), US EPA 2020 Corrective Action Baseline List (2020 COR ACTION), status: open
- Double S & S Service Center, 320 Main St., Buna, TX 77612, Leaking Petroleum Storage Tank, status: open with site assessment

The identified registrations and their relation to the Site are depicted in **Figure 2.14**.

2.2.1.2. Surface Water Bodies

Surface water bodies within the AoR were identified using the National Hydrography Dataset (NHD) Flowing Water and NHD Water Bodies GIS layers from the United States Geological Survey (USGS) National Hydrography Dataset, the River Basins GIS layer from the Texas Water Development Board, Texas Tech University Center for Geospatial Data for Texas, the Texas National Wetlands Inventory (NWI) geodatabase from the U.S. Fish & Wildlife Service, and the Surface Water Segments database from the TCEQ ESRI GIS Data Hub. These resources can be found at the websites listed below.

- USGS NHD Best Resolution – Texas[4]
- Texas Tech University Center for Geospatial Technology[5]
- U.S. Fish & Wildlife Service NWI Texas Geodatabase[6]
- TCEQ Surface Water: Line Segments[7]
- GIS Data | Texas Water Development Board[8]

A number of surface water bodies within the AoR were identified by the search. Identified surface water bodies within the AoR include but are not limited to Tenmile Creek and Gum Slough. Surface water bodies are depicted on **Figure 2.14**.

2.2.1.3. Springs

The AoR was assessed for springs using Data Basin's publicly available Springs of Texas dataset:

- Data Basin Springs of Texas[9]

No springs were identified within the AoR.

[4] https://www.sciencebase.gov/catalog/item/61f8b8edd34e622189c3293f
[5] https://www.depts.ttu.edu/geospatial/center/TexasGISData.html
[6] https://www.fws.gov/program/national-wetlands-inventory/download-state-wetlands-data
[7] https://gis-tceq.opendata.arcgis.com/datasets/TCEQ::segments-line/explore?location=30.301545%2C-93.974762%2C11.57&showTable=true
[8] https://www.twdb.texas.gov/mapping/gisdata.asp
[9] https://databasin.org/datasets/2400de0b78284e0fa44083e78824ff24/

2.2.1.4. Mines & Quarries

The AoR was assessed for mines and quarries using the Prospect & Mine Related Features and the Mineral Resources data layer from the following USGS GIS sources:

- USGS Mine Related Features[10]
- USGS Mineral Resources[11]

No mines or quarries were identified within the AoR. Historical aerial photographs were also reviewed, and no mines or quarries were identified within the AoR in the search.

Within the Area/Corridor Report purchased from EDR, multiple mining and quarry regulatory databases were reviewed to identify registrations within the AoR. The databases searched included the following: Uranium Mill Tailings Sites, Lead Smelter Sites, U.S. Mines (Mines Master Index File, Ferrous and Nonferrous Metals Mines Database Listing, Active Mines & Mineral Plants Database Listing), Mines Violations (Mine Safety and Health Administration Violation Assessment Data), and Abandoned Mines.

No mines or quarries were identified within the AoR in the search.

2.2.1.5. Structures Intended for Human Occupancy

The AoR was searched for structures intended for human occupancy using the Hardin County and Orange County Properties layer of land parcels from the Texas Natural Resources Information System (TNRIS) data hub, the Jasper County Properties parcels layer of the Jasper County Appraisal District, the U.S. Census GIS dataset of Texas Population Areas and the Public Schools K-12 dataset from the Texas Tech University Center for Geospatial Technology, and the USGS U.S. Hospitals ArcGIS dataset.

- TNRIS DataHub Land Parcels[12]
- Jasper County Appraisal District Parcel Data Download[13]
- Texas Tech University Center for Geospatial Technology[14]
- USA Hospitals - Overview[15]

Numerous structures intended for human occupancy were identified in this search, primarily residential houses. Structures intended for human occupancy in the AoR are depicted on **Figure 2.14**.

2.2.1.6. Artificial Penetrations (APs)

In accordance with 40 CFR 146.82(a)(4) and 40 CFR 146.84(c)(2), a search was conducted to identify and evaluate all APs, including water wells; producing, abandoned, and plugged wells;

[10] https://mrdata.usgs.gov/usmin/
[11] https://mrdata.usgs.gov/mrds/
[12] https://data.tnris.org/collection/?c=55eb0be8-6d05-4536-bf75-45f1dd31dd94
[13] https://jaspercad.org/Links/
[14] https://www.depts.ttu.edu/geospatial/center/TexasGISData.html
[15] https://www.arcgis.com/home/item.html?id=f114757725a24d8d9ce203f61eaf8f75

Class I, II, III, IV, and V wells; dry holes; and stratigraphic boreholes. To identify all APs, the following searches were conducted:

- BP searched the TWDB and RRC databases, as well as Enverus, a private subscription-based service, using geographic attributes such as county and state-level files to identify APs. Then using ArcGIS, the AoR was overlaid against the identified AP locations, the Select by Location function was performed, and the wells that fell within the AoR were selected and exported as a list.
- An EDR DataMap™ Well Search Report, purchased on August 18, 2023, provided a listing of the attributes and location coordinates of the oil and gas wells and water wells located within the AoR that are registered with local, state, and federal databases. An accompanying base map depicting the location of each well was included with the report. Each well in the EDR DataMap™ Well Search Report was cross-referenced against the wells identified through the TWDB and RRC databases.
- To identify UIC Class I, III, IV, and V injection wells, the TCEQ Central File Room online records were examined. Cities and zip codes within the counties of the AoR were identified to search the TCEQ database for UIC permits. UIC permits within those city, zip code, and county locations were then cross-referenced for geographical location against the AoR. No UIC Class I, III, IV, or V wells in the AoR were identified during this search.
- Class II injection wells were identified through the RRC records search and the EDR DataMap™ Well Search Report and are further discussed below and in Section 6 of the Area of Review and Corrective Action Plan (**Appendix B**).

All APs identified through these methods were combined to create a comprehensive list of APs within the AoR. All APs are depicted in **Figure 2.14** with a unique identifying number that corresponds to an AP listed in Attachment 4 of the Area of Review and Corrective Action Plan (**Appendix B**).

Once the APs were identified, an exhaustive AP records search was performed and included reviewing databases, reports, maps, logs, and other documents from federal, state, local, and private entities that have information on wells or boreholes in the AoR. The RRC, TCEQ, Texas Department of Licensing and Regulation (TDLR), TWDB, University of Texas at Austin Bureau of Economic Geology (BEG), USGS, Enverus, and TGS were researched. Limited historical aerial images were also reviewed to support the search. A description of the searches conducted, and the results of those searches, are described below.

RRC

Online research queries within the RRC database and the RRC GIS Viewer were utilized to search the RRC well files (websites listed below). Personnel performed in-person records searches at the RRC Central Records office in Austin to retrieve non-digital data files, including microfilm. Well records for which an online digital record and/or API number was not available required a manual search of RRC Central Records. For these records, a research request was sent to and completed by the RRC Research Team. Currently, there are three outstanding research requests. One request, submitted on September 14th, 2023, includes a records request for five wells, plus four locations that were indicated as permitted, cancelled, or abandoned and for which no evidence has been identified that the well was drilled. A second request, submitted on October 4th, 2023, includes two wells. The third request includes six locations that were indicated as cancelled, abandoned, or expired. The timeline for the requests was estimated to be eight to ten weeks for a researcher to be assigned, plus additional time for the researcher to research and send the records. This permit application will be amended with the records requested from RRC Central Records once they are received.

The online RRC resources that were searched included:

- RRC Public GIS Viewer (Map)[16]
- RRC Resources & Research Center[17]
- RRC Online Research Queries[18]
- RRC Imaged Records[19]

Well records were found and have been uploaded as Supporting Documentation under the Corrective Action tab of the Area of Review and Corrective Action reporting module in the Geologic Sequestration Data Tool (GSDT).

TCEQ

The TCEQ was contacted via telephone and email to verify the appropriate search methods for obtaining AP records and for assistance with the search. It was concluded that no digital (hard copy) records for wells in the AoR could be found in the TCEQ's databases or Central Records. In addition, each of the links below were followed and all potentially relevant documents were reviewed. No relevant documents were found with the TCEQ.

- TCEQ Access Records from our Central File Room[20]
  - Contacted the TCEQ Central File Room by telephone and email. The Central File Room Team directed the inquiry to the Drinking Water Inventory and Protection Team in the Water Supply Division. The list of wells was provided to this team who searched for the well records, including for any wells in proximity to the ones identified. Both the Central File Room team and the Drinking Water Inventory and Protection Team verified that these wells are not in their databases or hard copy files.
- TCEQ Central Registry Query [21]
  - Searched for Jasper & Orange County water wells on TCEQ's Central Registry Query pages including customer search, regulated entity search, program ID search and document search. No relevant documents were found.

[16] https://www.rrc.texas.gov/resource-center/research/gis-viewer/
[17] https://www.rrc.texas.gov/resource-center/
[18] https://www.rrc.texas.gov/resource-center/research/research-queries/
[19] https://www.rrc.texas.gov/resource-center/research/research-queries/imaged-records/
[20] https://www.tceq.texas.gov/agency/data/records-services/fileroom.html
[21] https://www15.tceq.texas.gov/crpub/

- TCEQ Look Up Data and Records Online[22]
    - Searched the water well database raw files and "Water Well Report Viewer". Within the "Water Well Report Viewer", examined the reports listed below. No relevant documents were found.
        - Jasper & Orange County Data and Information Management System Reports
        - Jasper & Orange County Legacy Maps
        - Jasper & Orange County Maps and Photos
        - Jasper & Orange County Not Plotted Water Wells
        - Jasper & Orange County Plotted Water Wells
        - Jasper & Orange County Plugging Reports
        - Jasper & Orange County State Water Well Reports
        - Jasper & Orange County Undesirable Reports
- TCEQ Records Online[23]
    - Searched for listed Jasper & Orange County water wells on TCEQ's "Records Online" database. No relevant documents were found.
- TCEQ GIS[24]
    - Conducted searches within the GIS Data Hub, which includes Groundwater Conservation District data. No relevant documents were found. This also links back to the "Water Well Report Viewer", which was previously exhaustively examined.
- TCEQ Finding Information about Water Wells in Texas[25]
    - The link above directs to the "Water Well Report Viewer", which was previously exhaustively examined. It also directs to the TWDB.

TWDB

The TWDB was contacted via telephone and email to assist with the search. The agency confirmed that no hard copy files exist, and the web viewer has all files associated with the wells.

- TWDB Submitted Drillers Reports[26]
    - Conducted searches of GIS viewers and databases accessed from this website: Groundwater Data Viewer (Interactive Map), Groundwater Database Report and Downloads, Submitted Drillers Report Database Reports and Downloads. Well data sheets and attachments were found and are included with the well records.

[22] https://www.tceq.texas.gov/agency/data/lookup-data
[23] https://records.tceq.texas.gov/cs/idcplg?IdcService=TCEQ_SEARCH
[24] https://www.tceq.texas.gov/gis
[25] https://www.tceq.texas.gov/drinkingwater/SWAP/wells.html
[26] http://www.twdb.texas.gov/groundwater/data/drillersdb.asp

- TWDB BRACS Database[27]
  - The Brackish Resources Aquifer Classification System (BRACS) database was utilized to match API numbers with TWDB numbers for wells which may have been converted from an oil/gas well to a water well or vice versa. Resistivity and spontaneous potential logs were found for some wells.

TDLR

The TDLR was contacted via telephone and email to assist with the search of these records. The agency responded that they did not have any hard copy files and sent the following website links in response to the request for files:

- TWDB Submitted Drillers Reports
- TCEQ Finding Information about Water Wells in Texas

Both websites were searched for records as described in the TCEQ and TWDB sections above. The TDLR website (https://www.tdlr.texas.gov/wwd/wwd.htm) contains a link for the Texas Well Reporting System, which directs to the TWDB Submitted Drillers Reports Database for wells drilled after 2002. This website was researched as described in the TWDB section above.

BEG

The BEG was contacted via telephone and email to verify the appropriate search methods for obtaining AP records and/or for assistance with the search. The Continuum database (website below) was searched, and any relevant files were purchased if the file was not found by other sources. Although there are hard copy paper records that have not been catalogued at the BEG, it was reviewed and confirmed by BEG staff that no other files are available for the wells in the AoR.

- BEG Geologic Data Continuum[28]
  - Conducted search within the Continuum database. Logs were found and purchased as applicable.

USGS

A subset of wells in the AoR was identified in the EDR DataMap™ Well Search Report as USGS wells. Records for these wells were located by searching the USGS website below by county. Date drilled was not available in the digital records for these wells. An email request was submitted to the USGS for this information as well as any other available records. The request is pending, and this permit application will be amended with the records requested once received.

- USGS Site Inventory[29]
  - Conducted records search for wells in Jasper County. A description of the wells, including location coordinates and total depth, was available.

Private Databases

Two private subscription-based services were searched for AP records: Enverus and TGS. Enverus stores any publicly available well record including permit information, drilling,

[27] https://www.twdb.texas.gov/groundwater/bracs/database.asp
[28] https://coastal.beg.utexas.edu/continuum/#!/
[29] https://waterdata.usgs.gov/nwis/inventory?state_cd=tx&format=station_list&group_key=county_cd&list_of_search_criteria=state_cd

completions, and production-related information and records, as well as raster logs. For the Enverus search, the Prism and DrillingInfo dashboards were utilized to search for well information and any relevant information was saved for the well record as applicable.

TGS stores well data including raster logs and directional surveys. For the TGS search, the R360 platform was utilized to search for well information and any relevant logs were saved for the well record as applicable.

2.3 Faults and Fractures [40 CFR 146.82(a)(3)(ii)]

2.3.1 Evidence for Faults and Fractures

The series of pro-gradational wedges in the Gulf Coast Region (**Figures 2.6a** and **2.6b**), which includes the Vicksburg Formation, Frio Formation, and Anahuac Formation, are characterized by thickening upward sequences and gulfward dips. Regional structural dip is to the south/southeast and ranges between 1 to 3 degrees (shown on **Figures 2.8, 2.9,** and **2.10**). Rapid sedimentation loading during deposition resulted in large growth fault systems near the downdip edge of each wedge. [redacted]

[redacted] These normal growth faults were formed mainly by gravitational failure during rapid sediment loading along an unstable shelf margin and upper slope. [redacted] Three major structural areas are identified for the Frio Formation within Texas. These structural areas are defined as the Houston Embayment; San Marcos Arch and southward area towards the Rio Grande Embayment; and the Rio Grande Embayment. The Houston Embayment is characterized by salt diapirism and associated faulting. Salt tectonics were significant in the structural development of the Gulf of Mexico, with salt originally forming as bedded evaporites during the Jurassic Period.

The San Marcos Arch is characterized by linear belts of growth faults and associated shale ridges. The Rio Grande Embayment is characterized by large discontinuous belts of growth faults and deep-seated shale ridges. The regionally extensive depositional fault systems are subparallel to the coast and generally dip towards the south/southeast. These normal growth faults were formed from gravitational failure during the rapid sediment loading along the unstable gulf shelf margin and upper slopes.

Major deltaic progradation during the Oligocene Epoch created the Vicksburg Fault Zone, which forms the updip limit of structural deformation within the Frio Formation. The Frio Fault Zone, located downdip from the Vicksburg Fault Zone, consists of 5 to 10 major normal faults spaced 3 to 6 miles apart with intervening rollover anticlines contained within a deep listric system. The observed faults display a range of approximately 500 to 1,000 feet of offset, and in some instances hold back material quantities of hydrocarbons (oil and gas). Thickening and displacement of sediments are more significant in the Frio Fault Zone than in the Vicksburg

Fault Zone. Sediments during the Oligocene Epoch expanded and filled the offset space created from slip along the fault growths (Galloway et al., 1982).

The overall structure is a gently dipping monocline with low structural dip between 1 and 3 degrees. The Frio Formation (injection zone) is a more sand-prone interval, which is overlain by the mainly shaley Anahuac Formation, which makes up the confining zone. [redacted]

2.3.2 Faults and Fractures in the AoR

[redacted]

2.3.3 Uncertainty

[redacted]

2.4 Injection and Confining Zone Details [40 CFR 146.82(a)(3)(iii)]

2.4.1 Injection Zone

2.4.1.1 Minerology and Petrology

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

2.4.1.2 Thickness, Porosity, and Permeability

The Frio Formation is approximately 1,000 to 1,300 feet thick and consists of a series of alternating sand and shale sequences. [redacted] These observations are consistent with regional thickness maps, which show the total thickness of the Frio Formation and the overlying Anahuac Formation as approximately 2,300 feet.

Porosity across the Frio Formation is heterogenous and is expected to range between 10% to 38% (Swanson et al., 2013). Permeability across the Frio Formation is heterogenous and is expected to range from 10 mD to over 2,000 mD (Loucks et al., 1984). [redacted]

[redacted] Sandstone texture (grain size and sorting) is expected to vary depending on the sedimentary facies present. Well-sorted, coarse-grained sandstones will perform better with porosity and permeability compared to poorly sorted, fine-grained sandstones.

2.4.1.3 Geochemical Compatibility

[redacted]

[redacted]

[redacted]

The available reactive surface area is also a primary controlling factor in the forecasts of fluid-rock reactivity. [redacted] The extent of low pH fluids is governed by the size and geometry of the free phase CO_2 plume and the volume of brine into which said phase comes into contact. The increase in density results in a quasi-static zone of CO_2-saturated brine and may also collapse under gravity, allowing for the exchange with unsaturated brine and additional contact with remaining free-phase CO_2. This alters the equilibrium between the fluid and solid phases, promoting further reactivity. [redacted]

2.4.2 Confining Zone

2.4.2.1 Minerology and Petrology

The confining zone of the A469 #1 well is defined as the Anahuac Formation, described as an extensive transgressive marine shale, which overlies the Frio Formation in Eastern Texas (Swanson et al., 2013). The Anahuac Formation is comprised of deltaic and slope sandstones and shales within the area of investigation. [redacted].

[redacted]

[redacted]

[redacted]

[redacted]

2.4.2.2. Thickness, Porosity, and Permeability

The Anahuac Formation is approximately [redacted] These observations are consistent with regional thickness maps which show the total thickness of the Frio Formation and the overlying Anahuac Formation as approximately 2,300 feet (**Figure 2.8**).

Porosity across the Anahuac Formation is heterogenous and is expected to range between 4% and 28%. Permeability across the Anahuac Formation is heterogenous and is expected to range from 0.1 mD to 1,000 mD, with the higher end of reservoir properties belonging to sand stringers that are not expected to be in vertical communication. [redacted] Confining layers within the Anahuac Formation are dominated by shale and are structural or combination in nature, including faulted rollover anticlines and salt diapir-related traps (John et al., 1992) [redacted]

2.4.2.3 Geochemical Compatibility

Diagenetic cements are not common in the Anahuac Formation. [redacted]

2.4.3 Methods

[redacted]

[redacted]

Additional porosity and permeability data collected from core and logs during pre-operational testing will be used to update the porosity and permeability relationship and property distribution in the static model.

[redacted] Fluid sample data will be used to understand water chemistry, establish baseline water quality in confining and injection zones, provide geochemical information on solids and fluids to identify potential interactions that could affect injectivity or mobilize trace elements, and assess compatibility of the CO_2 stream with fluids and minerals in the injection and confining zones.

[redacted]

[redacted] Core data was used to characterize the geomechanical properties of the confining zone to demonstrate the integrity of the confining zone and set safe operational parameters. It will be used to provide information on mineralogy, petrology, and lithologies of the injection and confining zones.

2.4.4 Supporting Data for Confining and Injection Zones

2.4.4.1 Seismic Data

[redacted]

[redacted]

[redacted]

Figure 2.13 Map ID	[redacted]	Resistivity	Density	Gamma Ray	Sonic	Neutron	SP	Frio Well Tie	Checkshot
1		YES	YES	YES	YES	NO	YES	NO	NO
2		YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO
3		YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO
4		YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO
5		YES	YES	NO	YES	NO	NO	NO	NO
6		YES	YES	YES	YES	YES	YES	NO	NO
7		YES	PSEUDO	YES	YES	YES	YES	YES – Frio PseudoDensity	NO
8		YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO
9		YES	YES	NO	YES	YES	YES	NO	NO
10		YES	NO	YES	NO	NO	NO	NO	NO
11		YES	YES	YES	NO	YES	YES	NO	NO
12		YES	YES	YES	NO	YES	NO	YES – Frio Tie	NO
13		YES	YES	YES	YES	YES	YES	NO	NO
14		YES	PSEUDO	YES	YES	YES	YES	YES – Frio PseudoDensity	NO
15		YES	NO	YES	NO	NO	NO	NO	NO
16		YES	YES	YES	YES	YES	NO	YES – Frio Tie	NO
17		YES	YES	YES	NO	NO	YES	NO	NO
18		YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO

Figure 2.13 Map ID	[redacted]	**Resistivity**	**Density**	**Gamma Ray**	**Sonic**	**Neutron**	**SP**	**Frio Well Tie**	**Checkshot**
19	[redacted]	YES	YES	NO	NO	NO	NO	NO	NO
20	[redacted]	YES	NO	YES	YES	NO	NO	NO	NO
21	[redacted]	YES	PSEUDO	NO	YES	NO	YES	YES – Frio PseudoDensity	NO
22	[redacted]	YES	YES	YES	YES	YES	YES	NO	NO
23	[redacted]	YES	NO	NO	YES	NO	YES	NO	NO
24	[redacted]	YES	PSEUDO	YES	YES	NO	YES	YES – Frio PseudoDensity	NO
25	[redacted]	YES	NO	NO	YES	NO	YES	NO	NO
26	[redacted]	YES	NO	NO	YES	NO	YES	NO	NO
27	[redacted]	YES	NO	YES	NO	YES	YES	NO	NO
28	[redacted]	YES	YES	YES	YES	YES	YES	NO	NO
29	[redacted]	YES	YES	YES	YES	YES	YES	YES – outside model boundary	NO
30	[redacted]	YES	YES	YES	YES	YES	YES	YES – outside model boundary	NO
31	[redacted]	YES	NO	YES	NO	NO	YES	NO	YES – outside model boundary
32	[redacted]	YES	YES	YES	YES	YES	YES	YES – Frio Tie	YES – outside model boundary
33	[redacted]	YES	YES	NO	YES	YES	YES	YES – outside model boundary	NO

2.5 Geomechanical and Petrophysical Information [40 CFR 146.82(a)(3)(iv)]

2.5.1 Structure and Mechanism of Geologic Confinement

2.5.1.1 Core Testing

[redacted]

[redacted] and part of those rock samples is being preserved and used for geomechanical analyses.

[redacted]

2.5.1.2 Fractures, Ductility, Rock Strength, In-Situ Stress Field, Pore Pressure, Hydraulic Gradient, Fracture Gradient

[redacted]

[redacted]

The in-situ stress had been estimated pre-drill through offset well data and regional information. [redacted]

[redacted]

[redacted]

Formation pressure data were collected across the confining zone, the permeable units above, and the underlying reservoir. A wireline conveyed, repeat formation tester tool was used to collect pressure and fluid data. [redacted]

Increases in CO_2 saturation that indicate movement of CO_2 into or above the confining zone, and/or unexpected changes in fluid constituent concentrations that indicate movement of CO_2 or brines into or above the confining zone, will trigger a new evaluation of the AoR unless changes are found to be related to well integrity, which would be investigated and addressed.

2.5.2 AoR Reservoir Model

[redacted] It can be used to simulate enhanced oil recovery (low salinity, miscible/immiscible displacement, chemical or non-steam-based thermal recovery), unconventional reservoirs, and long-term CO_2 injection. [redacted]

[redacted]

2.5.3 Capillary Pressure

[redacted]

[redacted]

[redacted] Lithostatic pressure only becomes a significant constraint on compressibility at greater depths.

[redacted] The measurements are still in progress; data will be incorporated into future AoR modeling as appropriate.

2.5.4 Facies Changes – Conceptual Model

[redacted]

Frio intra-reservoir heterolithics and mudrocks

[redacted]

[redacted]

2.5.5 Facies Changes - Uncertainties

[redacted]

Interpolation between known data points will be used for potential depositional environments based on the core description. In addition to the core description, the offset well logs, seismic data, and injectivity test results within the AoR will be incorporated to determine if the subsurface heterogeneity is being appropriately represented in alternate methods. [redacted]

[redacted]

Items such as the nature of stratal surfaces and reservoir architectural styles (for instance, linear versus clinoform or compound clinoform) geometries will also be explored to ensure that a full range of scenarios are being considered.

2.6 Seismic History [40 CFR 146.82(a)(3)(v)]

2.6.1 Seismic Activity and Collected Data

[redacted] Seismic activity within the Gulf Coast Region is well researched, allowing for a confident description of natural seismicity risk surrounding the Site. The history of seismic activity in the region is documented beginning in the late 1800s (Reagor et al., 1988). Additionally, the Texas Seismological Network and Seismology Research (also known as "TexNet") began operation in 2017 and is part of the Bureau of Economic Geology. TexNet consists of more than 150 seismic monitoring stations and can reliably record seismic events of less than one magnitude and greater across the state of Texas (Savvaidis et al., 2019). [redacted]

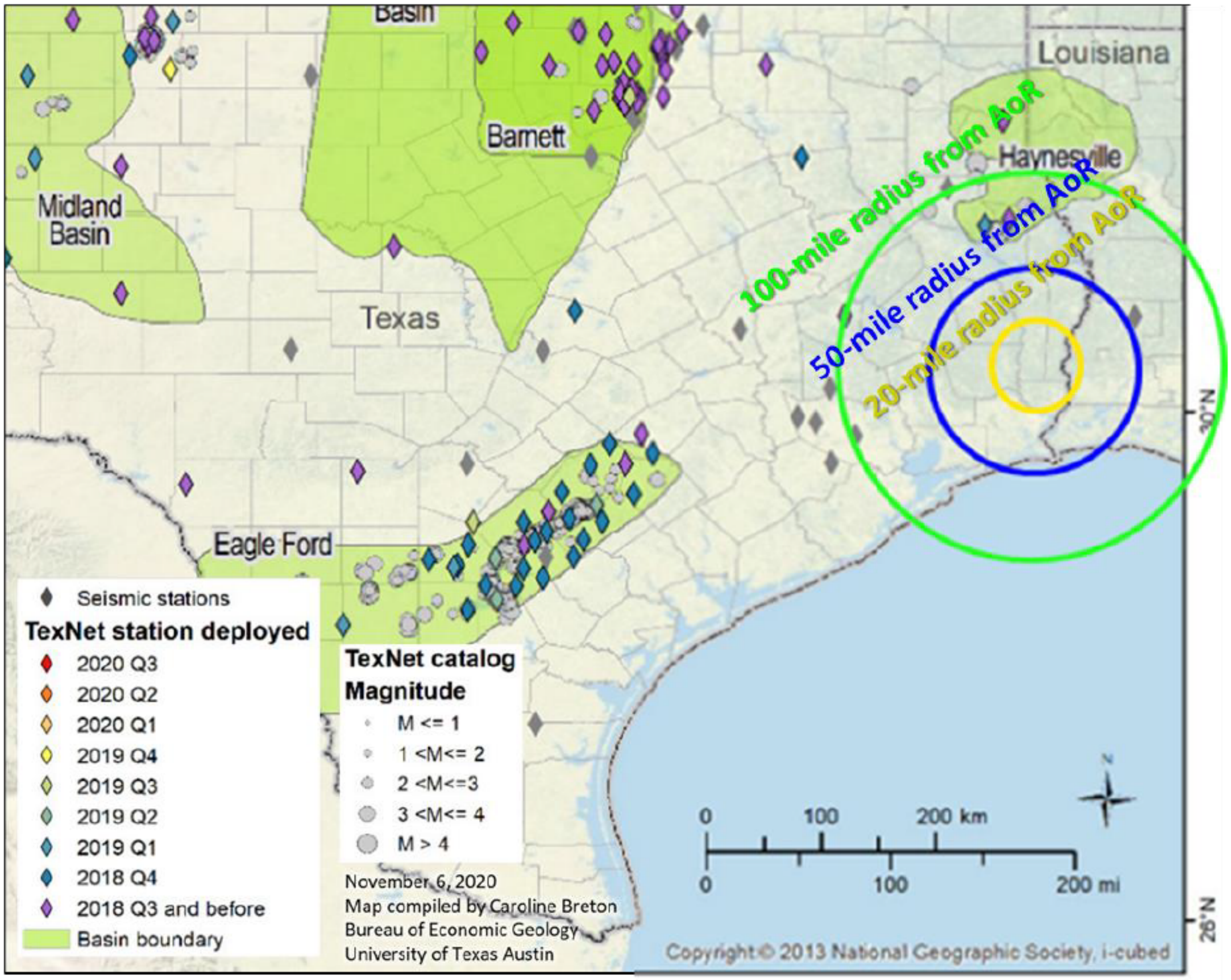

Figure 2.24. Historical Seismic Activity

The USGS publishes national seismic hazard maps based on the determined estimations of location and sizes of future earthquakes (**Figure 2.25**). The seismic hazard maps are used to inform seismic-design regulations for building and transportation infrastructure, government disaster management and mitigation strategies, and insurance rates. The available maps include more than 100 years of global earthquake observations, widely accepted seismology-based principles, and the best available data, methods, and models for seismic hazard assessment (Petersen et al., 2014).

Analysis of the most recent and real time data from TexNet supports the estimates identified in the 2014 USGS seismic hazard maps. [redacted]

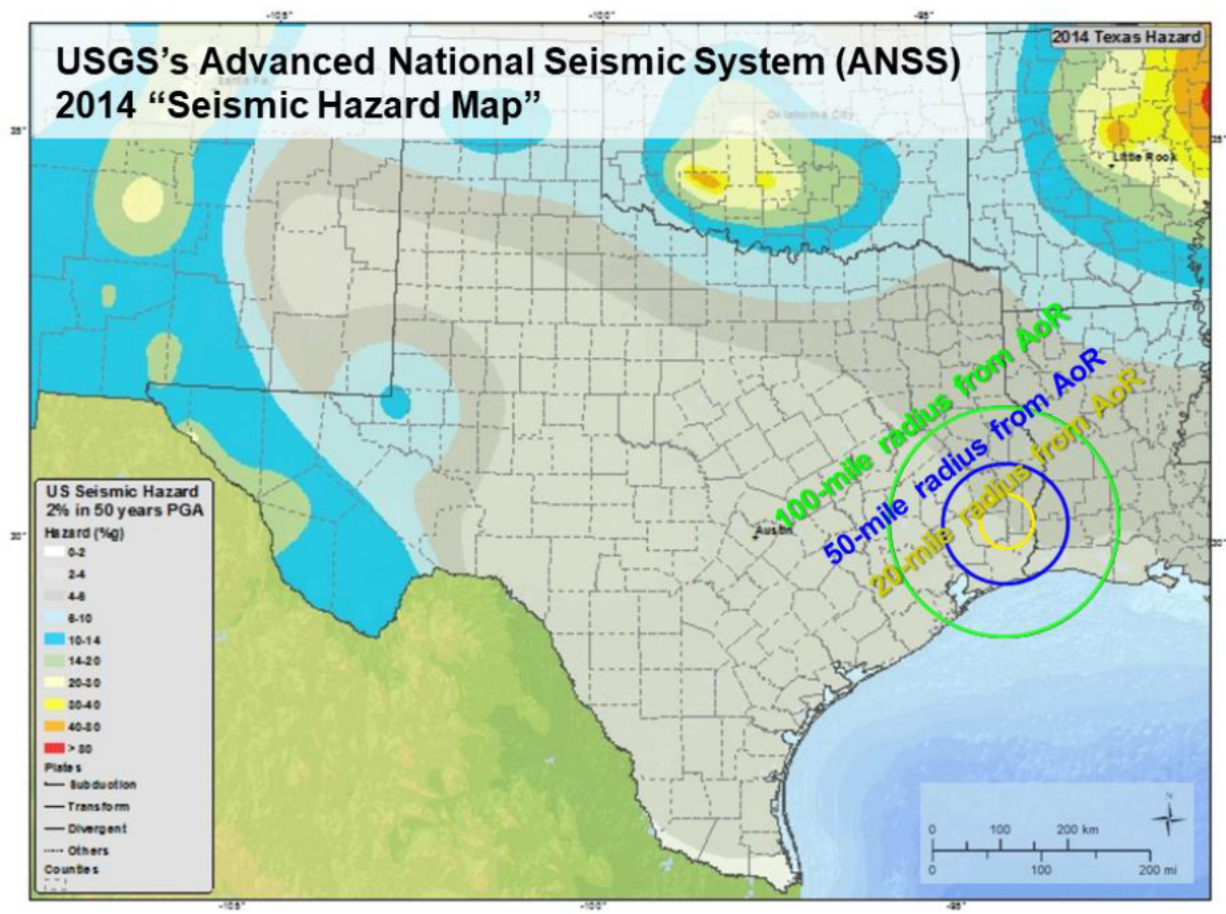

Figure 2.25. USGS Seismic Hazard Map

[redacted] This change is a reflection of the improved methodology for decoupling induced seismicity from the natural seismic hazard analysis (Petersen et al., 2014).

2.6.2 Risk of Induced Seismic Activity

[redacted]

Therefore, injection activity is unlikely to induce seismic activity or pose a threat to carbon dioxide containment at the Site.

[redacted]

2.7 Hydrologic and Hydrogeologic Information [40 CFR 146.82(a)(3)(vi), 146.82(a)(5)]

2.7.1 Major Hydrologic Units

Data related to major hydrologic units is provided in publications by Kasmarek 2013, Kasmarek and Strom 2002, and Wesselman 1967, as referenced in **Section 2.11**.

2.7.1.1 Chicot Aquifer

The Chicot aquifer is comprised of Willis Sand, Lissie Formation, Beaumont Clay, and Quaternary Alluvium (**Figure 2.5**). The basis for the separation of the Evangeline aquifer from the overlying Chicot is the differences in lithology and permeability. No continuous clay separation exists between the two aquifers. The Chicot aquifer contains only fresh water in Jasper and Newton Counties. The approximate thickness of the sands in the Chicot aquifer is more than 400 feet in the southern part of Newton County. The sands of the Chicot are generally more permeable than those of the Evangeline and Jasper aquifers, and the electric logs show a thick, high-resistivity sand at the base of the Chicot.

2.7.1.1.1 Vertical and Lateral Limits of the Chicot Aquifer

The updip limit of the Chicot aquifer is an undulating boundary approximately parallel to the coast and extending as far north as Lavaca, Colorado, Austin, Waller, Grimes, Montgomery, San Jacinto, Polk, Tyler, Jasper, and Newton Counties. To the southeast, the freshwater portion of the aquifer extends beneath the Gulf of Mexico. The altitude of the top of the Chicot aquifer approximates the land-surface altitude and ranges from the North American Vertical Datum of 1988 (NAVD 88, “datum”) at the coast to as high as 445 feet above datum at its updip limit. The altitude of the base of the Chicot aquifer ranges from greater than 1,500 feet below datum southeast of the coast to more than 420 feet above datum in the outcrop area and varies locally because of numerous salt domes in the study area.

2.7.1.1.2 Direction of Water Movement in the Chicot Aquifer

[redacted]

On the basis of sand thickness of 225 feet and an average permeability of 187.15 ft/day, the composite transmissivity of the center positioned aquifer in Orange County, Texas (approximately equivalent to the Chicot aquifer) was computed to be approximately 41,441.08 ft2/day. The transmissivity of the Chicot aquifer is higher in southeastern Newton County where the sand thickness is more than 400 feet (Wesselman, 1967).

The coefficients of storage determined in Orange County ranged from approximately 0.00047 to 0.063 and averaged 0.0067. The coefficients of storage are expected to be larger in Jasper and Newton Counties than in Orange County.

The measured specific capacities of eight wells in the Chicot aquifer in Orange County and one well in Jasper County ranged from 1,270 to 5,698 ft^3/day/ft drawdown. Specific capacities as large as 12,743.5 ft3/day/ft drawdown have been reported (Well T2-62-34-20l) (Wesselman, 1967).

2.7.1.2 Evangeline Aquifer

The Evangeline aquifer includes all the sediments between the Burkeville aquiclude and the Chicot aquifer. It is comprised of the Goliad Sand and sands at the top of the Lagarto and Oakville Formations and is equivalent to the "heavily pumped layer" in the Houston district (Wood and Gabrysch, 1965). The aquifer contains fresh water to depths of more than 1,500 feet below sea level in an area near the southern boundaries of Jasper and Newton Counties. The downdip limit of fresh water in the aquifer is located within Orange County. The estimated thickness of fresh-water sands in the Evangeline aquifer is more than 500 feet in the southern parts of Jasper and Newton Counties.

2.7.1.2.1 Vertical and Lateral Limits of the Evangeline Aquifer

The updip limit of the Evangeline aquifer is an undulating boundary approximately parallel to the coast and extending as far north as Lavaca, Fayette, Austin, Washington, Grimes, Montgomery, Walker, San Jacinto, Polk, Tyler, Jasper, and Newton Counties, Texas. The downdip limit of freshwater is approximately coincident with the coast. The altitude of the top of the Evangeline aquifer ranges from more than 1,440 feet below datum to as much as 469 feet above datum at its updip limit. The altitude of the base of the Evangeline aquifer ranges from more than 5,300 feet below datum at the coast to 430 feet above datum in the outcrop area and varies locally due to numerous salt domes. The base of the Evangeline aquifer transgresses the stratigraphic boundary between the Goliad Sand and the Fleming Formation.

2.7.1.2.2 Direction of Water Movement in the Evangeline Aquifer

[redacted]

The maximum thickness of sands containing fresh water in the Evangeline aquifer is more than 500 feet in the southern parts of Jasper and Newton Counties. [redacted]

[redacted] Because the wells in the area are not screened through the entire thickness of the water-bearing sands, the specific capacities of these 12 wells are less than the maximum that could be developed.

2.7.1.3 Burkeville Aquiclude

The Jasper and Evangeline aquifers are separated by the Burkeville aquiclude, a clay bed that is usually 200 to 300 feet thick. This clay bed, which contains minor amounts of sand in places, crops out in the vicinity of Burkeville and is named the Burkeville aquiclude.

2.7.1.3.1 Vertical and Lateral Limits of the Burkeville Aquiclude

The updip limit of the Burkeville confining unit is an undulating boundary approximately parallel to the coast and extending as far north as Lavaca, Fayette, Austin, Washington, Grimes, Montgomery, Walker, San Jacinto, Polk, Tyler, Jasper, and Newton Counties, Texas. The Burkeville confining unit lies stratigraphically below the Evangeline aquifer and above the Jasper aquifer. This confining unit restricts flow between the Evangeline and Jasper aquifers because of its relatively large percentage of silt and clay compared to the adjacent aquifers.

Southeast of the downdip limit of freshwater, this unit is considered a no-flow unit that prevents diffuse upward migration of saline water from the Jasper aquifer. In updip areas of the Burkeville confining unit, the sediments are slightly more transmissive and thus able to supply small quantities of water for domestic use. In the outcrop area, the altitude of the top of the Burkeville confining unit is equal to the land-surface altitude, and in the subcrop area, the top of the Burkeville confining unit is coincident with the base of the Evangeline aquifer. The altitude of the base of the Burkeville confining unit is coincident with the top of the Jasper aquifer and varies locally due to the numerous salt domes in the area.

2.7.1.4 Jasper Aquifer

The Jasper aquifer includes the sediments between the upper clay bed of the Catahoula Sandstone and the Lagarto and Oakville clay unit. The aquifer consists of about 50% sand. The aquifer is the principal aquifer in Jasper and Newton Counties in terms of storage, availability, quality of water, and potential for development. The Jasper aquifer contains fresh water to depths of more than 3,000 feet below sea level in the area east of Kirbyville. In most of the northern half of the Jasper and Newton Counties, all the sands in the aquifer contain fresh water; but in the southern half, sands containing fresh water overlie and inter tongue with those containing slightly saline water.

2.7.1.4.1 Vertical and Lateral Limit of the Jasper Aquifer

The updip limit of the Jasper aquifer is an undulating boundary approximately parallel to the coast and extending as far north as Lavaca, Gonzales, Fayette, Washington, Brazos, Grimes, Walker, Trinity, Polk, Tyler, Angelina, Jasper, Newton, and Sabine Counties, Texas. The altitude of the top of the Jasper aquifer ranges from less than 2,800 feet below datum to about 900 feet above datum at its updip limit. The altitude of the base of the freshwater portion of the Jasper aquifer ranges from about 3,800 ft below datum near the downdip limit of freshwater to about 500 feet above datum in the outcrop area and varies locally due to numerous salt domes. The base of the Jasper aquifer in updip areas transgresses the stratigraphic boundary between the Fleming Formation and the Catahoula Sandstone.

The Jasper aquifer is underlain by the Catahoula confining system, which is composed mostly of clay or tuff. The Catahoula confining system impedes substantial exchange of water between the Jasper aquifer and underlying units.

2.7.1.4.2 Direction of Water Movement in the Jasper Aquifer

The transmissivity from aquifer tests on 11 wells that penetrate the Jasper aquifer in Jasper and Newton Counties, Texas, ranged from 1,069.45 ft^2/day at well PR-62-25-60l to 14,036.49 ft^2/day at well T2-62-l0-309. Coefficients of storage determined from three tests ranged from 0.00038 to 0.0012. The hydraulic conductivity determined from the tests ranged from 37.03 to 101.60 ft/day and averaged 72.86 ft/day.

In the northern portion of the report area where the sands are 550 feet thick, the transmissivity of the entire thickness of the aquifer is approximately 40,104.27 ft^2/day. With one exception (well T2-62-26-203), the aquifer tests that hydraulic conductivity was based upon are located updip from the 500-foot contour in the northern part of Jasper County. The hydraulic conductivity will likely be less downdip as observed in the 63.9 ft/day well T2-62-26-203.

The largest specific capacity observed in a well in the Jasper aquifer was 7584.5 ft/day/ft in well PR- 62-0l-406 (163 feet of screen) (Wesselman, 1967).

2.7.2 Minor Hydrologic Units

2.7.2.1 Catahoula Sandstone

The basal unit of the Gulf Coast Aquifer system is the Catahoula confining system, which comprises the Catahoula Sandstone and, downdip, the Anahuac and Frio Formations. The Catahoula Sandstone is overlain by younger fresh-water sands in much of Jasper and Newton Counties. Electric logs of oil tests in Jasper and Newton Counties indicate that 700 feet is the maximum thickness for the Catahoula in the area where it contains fresh or slightly saline water. According to these logs, the thickness of individual sand beds is up to 60 feet and a total of approximately 230 feet of sand is the maximum observed on an individual log. In most of the area in Jasper County where the Catahoula contains fresh water, sands containing slightly and moderately saline water are interbedded with those containing fresh water. In places in the extreme northwestern extension of Jasper County, fresh water is not available in the Catahoula Sandstone.

2.7.2.2 Jackson Group

Available electric logs and well data indicate that the Jackson Group contains fresh or slightly saline water in one locality in Jasper and Newton Counties. In the northwestern part of Jasper County, a flowing well, 986 feet deep, produces fresh water with traces of oil and gas. Logs of nearby oil tests indicate that individual fresh-water-bearing sands as much as 20 feet thick occur at depths from 710 to 935 feet below ground surface. The maximum sand thickness shown on one log is 40 feet. Areas in northwestern Jasper County that have sandy beds in the Jackson Group are generally the sources of fresh groundwater.

2.7.2.3 Yegua Formation

The Yegua Formation is not a source of fresh water in either Jasper or Newton County. However, it contains small quantities of slightly to moderately saline water in the extreme northern parts of both counties (Wesselman, 1967).

2.7.3 Regional Groundwater Flow

Recharge groundwater enters the system in topographically high updip outcrops of the hydrogeologic units in the northwestern parts. Groundwater then flows relatively short distances, discharging into topographically lower areas to features such as streams, or flows longer distances southeastward through deeper zones, where it is discharged by diffuse-upward leakage in topographically low areas along coastal areas.

An appreciable amount of the precipitation that infiltrates the subsurface (total recharge) in the relatively topographically high outcrop areas of the hydrogeologic units joins local flow systems. Thus, much of the total precipitation enters from and exits to the shallow subsurface by streams and in topographically low areas. A proportionally smaller amount of the total recharge joins intermediate flow systems, and an even smaller amount of the total recharge joins regional flow systems.

The natural groundwater-flow system has been altered in places (the Houston area, for example) by decades of substantial and concentrated withdrawals in the Chicot and Evangeline aquifers. By 1977, water levels had declined to as much as 250 feet and 350 feet below datum in the Chicot and Evangeline aquifers, respectively. Because the Chicot and Evangeline aquifers are hydraulically connected, in these areas, withdrawals have increased vertical head gradients and have induced downward flow from local and intermediate flow systems into the regional flow system, thus capturing some flow that would have discharged naturally (Kasmarek, 2013).

The Burkeville confining unit lies stratigraphically below the Evangeline aquifer. This unit is considered a no-flow basal unit in the Houston area that restricts the upward movement of more dense saline water from depth (Kasmarek and Strom, 2002).

Near the coast and at depth, saline water is present. The saline water causes less-dense freshwater that has not been captured and discharged by wells to be redirected upward as diffuse leakage to shallow zones of the aquifer system and ultimately to be discharged to coastal water bodies (Kasmarek and Robinson, 2004).

2.7.4 Aquifers Serving as Potential Sources of Drinking Water

Groundwater from the Gulf Coast aquifer system, which includes the Chicot aquifer in rocks of Holocene and Pleistocene age, the Evangeline aquifer in rocks of Pliocene and Miocene age, and the Jasper aquifer in rocks of Miocene age, is an important resource along the northeastern Gulf Coast of Texas.

These aquifers supply most of the water used for industrial, municipal, agricultural, and commercial purposes for an approximately 25,000-square-mile (mi^2) area that includes the Beaumont, Houston, Huntsville, and Port Arthur metropolitan areas. The Houston metropolitan area encompasses about 2,500 mi^2 and had an estimated population of 2.3 million in 2022 by the United States Census Bureau. Water use in the Houston metropolitan area is projected to be about 1.2 billion gallons per day by 2030 (Turner Collie and Braden, Inc., 1996 as cited in Kasmarek and Robinson, 2004).

[redacted]

[redacted]

[redacted]

2.8 Geochemistry [40 CFR 146.82(a)(6)]

The PR cubic EoS is used in all coupled flow and geochemical simulations and standalone geochemical models. The main function of the EoS is to appropriately model the non-ideal behavior of CO_2 in the supercritical state. Although providing a more simplistic treatment, cubic EoS provide for a common platform across tools, can account for liquids in the system, and are less specific than some forms that only deal with gaseous properties and/or pure gas mixtures.

The EoS calculates the fugacity of CO_2 in the gas/dense phase in combination with Henry's Law that is used to calculate fugacity in the aqueous phase. This facilitates solubility calculations of CO_2 in aqueous solutions under non-ideal, non-isothermal conditions.

Example PR EoS formulation:

p = RT/Vm - b - aA/V 2 + 2bV - b2

Where:

p - pressure (absolute)
Vm - molar volume (1 mole of gas or liquid)
R - ideal gas constant (8.3144621 Joule per mole kelvin)
T - absolute temperature (kelvin)
Tc - critical temperature
pc - critical pressure
Tr= T/Tc
A= (1 + k(1-Tr0.5))2
b = 0.07780RTc/pc
a = 0.45724 R2 Tc2/pc
k = 0.37464 + 1.54226w - 0.26992w2

[redacted] A combination of XRD and X-ray fluorescence (XRF) data in conjunction with brine sample analyses was used to characterize the mineral composition and the elemental distributions in the solid media phases.

[redacted]

[redacted]

2.8.1 Groundwater Monitoring

[redacted]

BP has not drilled shallow wells for the collection of USDW data. Publicly available and accessible data obtained from the TWDB has been utilized to understand the geochemical baseline of the local (Chicot, Evangeline, and Jasper) aquifers prior to CO_2 injection activity.

Data for above-confining-zone aquifers was derived from the TWDB database and is shown on **Table 2.5** below.

Consistent pressure data was not reported in the older well reports and neither were sample and preservation methods, analytical methods, or quality assurance/quality control (QA/QC) used (excluding standard charge balance). For the reviewed wells, from 2001 onwards, reports on the analytical methods are more consistent and were identified in well reports. Inductively Coupled Plasma (ICP), ICP Mass Spectrometry (ICP-MS), titration, and ion chromatography are listed as the analytical methods.

For wells with significant geochemical data available (e.g., major/minor ions, pH, and TDS), the majority are reported as being charge balanced (i.e., water is electrically neutral; therefore, in theory the cation charge of any given water sample should equal the anion charge). However, no error margin is stated, so it is unknown if the error margin is less than 5%. Well data reported as "charge unbalanced" is also present within the TWDB reports. Generally, these are due to a lack of full major/minor ion chemistry/reported laboratory errors when calculating or the charge balance is not recorded for samples collected prior to 1990. For this study, 92 samples were selected for analysis (**Table 2.5**). Data that contained major and minor ions and were reported as charge balanced were utilized and included data classified as unbalanced if the data collected were consistent with previous sampling campaigns and/or charge balancing errors were not reported and the data was deemed as good or high quality.

Table 2.5 lists the data used in this study, which includes state well number, aquifer code, well depth, date, whether the data are classed as charge balanced, and the latitude and longitude of the well. Most data are obtained from the Jasper aquifer. Of the information provided, 52 samples are classified as good quality with the relevant major/minor ion chemistry, followed by 24 samples from the Chicot and 11 from the Evangeline aquifers. BP plans to undertake a thorough geochemical baseline sampling campaign prior to injection, in which balanced ions/cations, trace elements, temperature, specific conductance, and pressure are recorded, along with sample preservation, analytical, and QA/QC methods.

[redacted]

[redacted]

[redacted]

The modal frequencies of the Chicot, Evangeline and Jasper aquifers were calculated to represent their geochemical composition and a combined mode of the data is presented on **Table 2.6** [redacted]. This average value does not take into account all wells and includes those that were reported via the TWDB. [redacted] Modal data for the Jasper, Chicot, and Evangeline aquifers are similar. However, the range of data for each aquifer is broad. In order to best represent the mode and ranges of data, both are used in the **Figure 2.29** plots to show variations between wells/depths/aquifers.

2.8.2 Modal Data for Chicot, Evangeline, and Jasper

[redacted]

The Chicot, Evangeline and Jasper aquifers have similar modal values for major/minor ion chemistry, with these plotted in a piper diagram below **(Figure 2.28)**. [redacted]

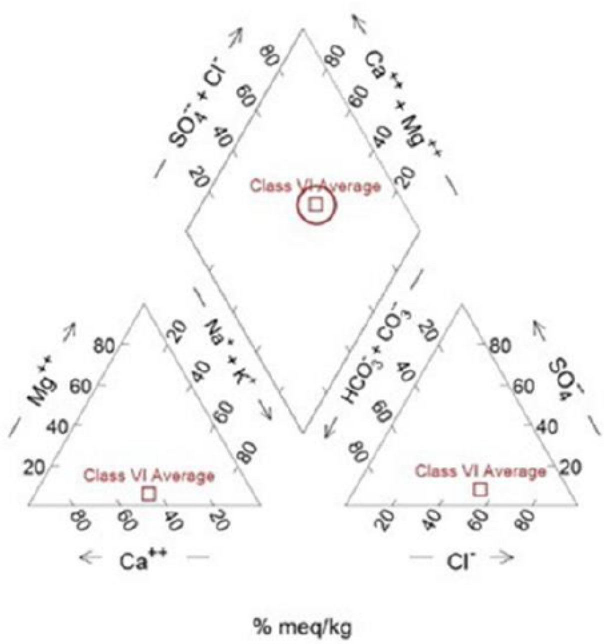

Figure 2.28. Comparison of Groundwater Compositions Between the Injection Zone and Overlying Aquifers

[redacted]

While the modal values are consistent, there is a range of major/minor ion values for the Chicot, Evangeline, and Jasper aquifers. **Figure 2.29** shows sodium vs depth and with chloride vs depth. [redacted]

[redacted]

[redacted] This data, and additional data collected by BP for the purpose of groundwater monitoring, will be used to understand metal concentrations within aquifers of interest during CO_2 injection activities. The metals are plotted on **Figure 2.30.**

[redacted]

The samples subjected to modal frequency analysis come from varying depths and different regions within Jasper County with differing land usage and covering a 30+ year time span.

Reservoir injection conditions are simulated under non-isothermal conditions. [redacted]

2.8.2.1 Groundwater Well Data to Be Collected/Analyzed from New Monitoring Wells

Samples will be collected with an appropriate method to provide for representative analysis as described in the Testing and Monitoring Plan (**Appendix E**). Laboratory results will be tabulated, including duplicates and blanks, for QA purposes and a narrative interpreting the results will be prepared.

2.8.3 Geochemical Modeling

BP also performed geochemical modeling to determine the geochemical effects upon CO_2 containment and near well-bore processes (salt-drop out). The full discussion, results, and conclusions can be found in the Geochemical Modeling and Simulation Results in **Attachment 1**. Geochemical simulations are conducted at a range of scales and the tools are selected based on conceptual model considerations. [redacted]

Prior to undertaking the simulation work, conceptual models were created to aid in thinking and designing test case scenarios. **Figure 2.31** shows three of these conceptual models, based upon assumption of both free phase and CO_2 saturated brine plume migration, both spatially and vertically. [redacted]

[redacted]

The combination of conceptual models, equilibrium-based geochemical simulations (including reaction path models), mineralogical and petrographic data provided for a thorough assessment of fluid-fluid and fluid-rock interactions. [redacted]

[redacted]

2.8.3.1 PHREEQC and GWB Equilibrium-Speciation-Saturation Modeling

[redacted]

2.8.3.2 Mineral Compositional Data

BP used detailed petrography and quantitative X-ray diffraction obtained from the appraisal well to determine the mineral composition of the reservoir and confining zone. [redacted] **Table 2.7** shows the XRD analysis for plug samples recovered from the appraisal well, including both zones. [redacted]

[redacted]

Textural relationships are defined with a combination of core descriptions, petrography, and SEM. [redacted] A more detailed explanation of the petrographic analysis is presented in **Sections 2.4.1.1 and 2.4.2.1**. Clay typing and bulk elemental and mineral compositions are defined using electron microprobe and XRD analysis. Clay morphology, the habits of mineral overgrowths and the nature of pore filling cements are key factors in understanding the impacts of reactive fluids on the rock mass.

[redacted]

[redacted]

[redacted]

2.8.3.3 Geochemical Model Narrative Interpretation

The integrated conceptual modeling, and multi-level simulation approach adopted, provided an effective method for understanding the impacts of CO_2 injection on both reservoir and confining zone units[redacted]

[redacted]

2.8.4 CO_2 Stream Compatibility

Prior to undertaking geochemical simulation work, conceptual models were created by BP to aid in designing test case scenarios to geochemically model. [redacted]

[redacted] The resulting low vertical intrinsic permeability, imparted by flat-lying and gently dipping stratal surfaces and bedding planes, limits vertical migration of low-density fluids and preferentially directs flow horizontally. This is partly a consequence of maintaining CO_2 in dense phase that reduces the buoyancy pressure by a factor of up to four compared with gaseous CO_2. The intrinsic permeability in the vertical plane influences the relative permeability drainage cycles by limiting water saturation, which, therefore, reduces the CO_2 mobility. These aspects of reservoir physics control the fluid-rock contact relationships and the potential for fluid-rock reactivity.

There are both physical and chemical interactions between free phase CO_2 and the reservoir media. The potential for each is controlled by the H_2O saturation state of the CO_2. The intention is to inject dehydrated CO_2 to minimize infrastructure corrosion, which results in brine desiccation at the injection sand face and the near well zone of the reservoir. If dehydrated CO_2 were to contact clay rich sediments, the bound water in the clays would vaporize causing mineral desiccation and shrinkage. The solubility of H_2O in CO_2 is an approximate order of magnitude lower than the solubility of CO_2 into brine where the saturation limit is reached rapidly. [redacted] Most framework siliciclastic minerals (e.g., quartz and feldspars) are resistant to low acidity brines. The resistance is generally congruent to matrix clays. However, other phylosilicates (e.g., chlorite) readily dissolve. The reactive behavior and concomitant changes in mineral composition and structure at the interface between the reservoir and confining zones commonly limits the vertical movement of CO_2 in siliciclastic depositional systems (e.g., clay swelling and incongruent dissolution of feldspars to clays that occludes pore space by increasing matrix volume).

[redacted]

2.8.5 Experimental Modeling

[redacted]

[redacted]

2.8.5.1 Experimental Solids

Material for the experimental program will be gathered from whole core samples defined by rock typing analysis [redacted]

2.8.5.2 Experimental Impurities

[redacted]

2.8.5.3 Experimental Rock Sample

Porosity and permeability were obtained from routine core analysis conducted on whole core and rotary sidewall core samples. [redacted]

2.8.5.4 Geochemical Reaction

Experimental results will be provided subsequent to completion of the program that is scheduled for mid-2024.

2.9 Identifying the Risk of Contaminant Mobilization

[redacted]

[redacted]

Elevated manganese is generally abundant within the earth's crust as manganese oxides and/or as impurities within iron oxides, silicates, and carbonates. Thus, manganese commonly coexists with iron in groundwater at concentrations of iron often at higher concentrations than manganese [redacted]

[redacted]

[redacted] These components, along with the major ions listed above, should be the focus of a shallow monitoring program undertaken by BP.

XRF data obtained from side wall plugs are presented on **Table 2.9**. This data has been used in conjunction with fluid data to understand the risk of groundwater contamination, resulting from the potential mobilization of metals and/or other hazardous elements pre-, post- and during CO_2 injection. [redacted]

[redacted]

[redacted]

Figure 2.35 shows XRF compared to depth of sample [redacted] It is also reported that clays within the Frio Formation are within proximity to alter VRFs (**Figure 2.17**), with clays being a potential source for these trace elements.

[redacted]

[redacted]

[redacted] Rubidium does occur within nature, and readily substitutes for potassium within rock forming minerals and is, therefore, fairly widespread. It can be found within magmatic, pegmatitic and zeolitic deposits. This is also true of yttrium – yttrium, a rare earth element found within almost all rare earth minerals and uranium ores.

[redacted] Nd is commonly found within granitic, gneissic and pegmatitic rocks, which are generally present in most drainage basins.

[redacted] The mobilization of these trace elements is largely a function of pH. The drop in pH is related to saturation of host brines with CO_2, which spatially limited by CO_2 plume geometry and extent. [redacted] BP is committed to undertaking thorough petrographic analysis plus SEM EDS and QEMSCAN (or equivalent) to define contaminant availability under CO_2 injection conditions.

[redacted] A combination of XRD and XRF data in conjunction with brine sample analyses were used to characterize the mineral composition and the elemental distributions in the solid media phases.

The groundwater Testing and Monitoring Plan (**Appendix E**) will consist of shallow wells penetrating potable aquifers and deep wells targeting the base of the lowermost USDW and permeable units above the confining zone. Details of the spatial distribution and depth of the wells and the sampling and analysis program are detailed in **Appendix E**.

[redacted]

2.10 Site Suitability [40 CFR 146.83]

BP has thoroughly analyzed the geology, hydrogeology, geochemistry, and subsurface characteristics at and in the vicinity of the Site. Through the drilling and development appraisal well A469 #1, and analysis of associated data, BP has demonstrated, throughout this Application that the geologic systems present at the Site consist of appropriate and protective injection and confining zones.

In particular, the site-specific data from the appraisal well, as well as BP's additional research, field work, and modeling have confirmed that:

[redacted]

The Site meets the suitability requirements set forth at 40 CFR 146.83.

2.11 References for Site Characterization

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Wood, L.A., and Gabrysch, R.K., 1965, Analog model study of ground water in the Houston district, Texas, Texas Water Commission Bulletin 6508.

2.12 Other Information (Including Surface Air and/or Soil Gas Data, if Applicable)

BP plans to work with the University of Texas at Austin Bureau of Economic Geology's Gulf Coast Carbon Center to assess the need for and utility of surface air and/or soil gas monitoring at the Site.

3. AOR AND CORRECTIVE ACTION [40 CFR 146.84]

BP has prepared the AoR and Corrective Action Plan (**Appendix B)** in accordance with 40 CFR 146.82(a)(13) and 146.84(b). Detailed documentation regarding the computational modeling [40 CFR 146.84(c)] is submitted to the Geologic Sequestration Data Tool (GSDT) AoR and Corrective Action Module. This includes:

- Model Domain
- Processes Modeled
- Rock Properties
- Boundary Conditions
- Initial Conditions
- Operational Information
- Model Output, and
- AoR Pressure Front Delineation.

The AoR and Corrective Action Plan provide a summary of the results of the modeling and AoR. Wells identified for corrective action are detailed with this plan. The AoR and Corrective Action can be found in **Appendix B**.

AoR and Corrective Action GSDT Submissions
GSDT Module: AoR and Corrective Action

Tab(s): All applicable tabs

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

- ☒ Tabulation of all wells within AoR that penetrate confining zone ***[40 CFR 146.82(a)(4)]***
- ☒ AoR and Corrective Action Plan ***[40 CFR 146.82(a)(13) and 146.84(b)]***
- ☒ Computational modeling details ***[40 CFR 146.84(c)]***

4. FINANCIAL RESPONSIBILITY [40 CFR 146.85]

The financial responsibility demonstration can be found in **Appendix C** and includes a description of the potential financial mechanisms and cost estimates that will be used for costs associated with corrective action, injection well plugging, post-injection site care and site closure, and emergency and remedial response for the Site, as required by 40 CFR 146.82(a)(14) and 40 CFR 146.85.

The Site will be owned and operated by BP, which will be responsible for financial assurance for the facility.

Financial Responsibility GSDT Submissions

GSDT Module: Financial Responsibility Demonstration
Tab(s): Cost Estimate tab and all applicable financial instrument tabs

Please use the checkbox(es) to verify the following information was submitted to the GSDT:

- ☒ Demonstration of financial responsibility ***[40 CFR 146.82(a)(14) and 146.85]***

5. INJECTION WELL CONSTRUCTION [40 CFR 146.86]

Construction of the injection wells will meet the requirements of 40 CFR 146.82(a)(12) and 40 CFR 146.86. The procedures and specifications [redacted] are described in **Appendix J** - Injection Well Construction as required in 40 CFR 146.86(a).

Each injection well has the following documentation and details provided:

- Injection well operating conditions (**Appendix A** – Summary of Requirements);
- Injection well construction details including open hole diameters and intervals, casing specifications, tubing specifications, packer specification, and construction diagrams (**Appendix J** – Injection Well Construction); and
- Proposed Stimulation Program (40 CFR 146.82(a)(9)) (**Appendix I** – Stimulation Program).

5.1. Proposed Stimulation Program [40 CFR 146.82(a)(9)]

At this time, no stimulation program is planned for the proposed injection wells. If a stimulation program is deemed warranted, the program will be detailed in **Appendix I** and will operate in compliance with applicable regulations.

5.2. Construction Procedures [40 CFR 146.82(a)(12)]

The construction of [redacted] will be performed following industry best practices. All materials used in the construction of the wells will conform to American Petroleum Institute (API) and National Association of Corrosion Engineers (NACE) standards. Injection well construction details can be found in **Appendix J**.

To appropriately drill the wells and protect underground sources of drinking water (USDWs), construction will follow the guidelines outlined in the Pre-Operational Testing Program (**Appendix D**), which includes details on the following:

- Deviation Checks [40 CFR 146.87(a)(1)];
- Tests and Logs During Drilling [40 CFR 146.87(a)];
- Tests and Logs Before, During, and After Casing Installation [40 CFR 146.87(a)(2)-(3)]; and
- Demonstration of Mechanical Integrity [40 CFR 146.87(a)(4)].

5.3 Injection Well Details

[redacted] The depth intervals will be based on site-specific geology, with the general diameters, casing, tubing, and packer specifications as detailed in **Appendix J**. BP will provide the UIC Program Director with supplemented Construction Details for each injection well in a final injection well construction plan prior to each well's installation.

6. PRE-OPERATIONAL LOGGING AND TESTING [40 CFR 146.87]

The Pre-Operational Logging and Testing Plan in accordance with 40 CFR 146.82(a)(8) and 146.87 is designed to gather confining layer and reservoir data to confirm BP's understanding of subsurface conditions, in addition to providing initial conditions data to understand pre-injection site conditions.

The Pre-Operational Testing Program can be found in **Appendix D**.

Pre-Operational Logging and Testing GSDT Submissions
GSDT Module: Pre-Operational Testing ***Tab(s):*** Welcome tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:
☒ Proposed pre-operational testing program ***[40 CFR 146.82(a)(8) and 146.87]***

7. WELL OPERATION [40 CFR 146.82(A)(7) AND (10) AND 40 CFR 146.88]

The following operational procedures and operating conditions are proposed to meet the requirements of 40 CFR 146.82(a)(7) and (10) and ensure compliance with the requirements in 40 CFR 146.88 for operation of the injection wells.

7.1 Operational Procedures [40 CFR 146.82(a)(7) and (10)]

The operating conditions proposed are based on the average steady state condition for operation of the injection wells. Actual operating conditions may vary due to throughputs and routine plant maintenance outages. Further information on the proposed operational conditions can be found in the AoR and CA Plan (**Appendix B**).

BP will gather pre-operational data prior to injection in accordance with 40 CFR 146.82(a)(8) and described in the Pre-Operational Testing Plan (**Appendix D)**. Parameters described in these plans may change based on the logging and testing data.

7.2 Proposed CO_2 Stream [40 CFR 146.82(a)(7)(iii) and (iv)]

7.2.1 Carbon Dioxide Stream Analysis

The CO_2 stream delivered to the injection wells will be derived from [redacted] The corrosive attributes of CO_2-rich fluids have been assessed, which included a detailed assessment on the influence of impurities. This assessment was completed through an established literature review, dedicated laboratory experimentation, and computational modeling performed both internally and collaboratively via participation in joint industry programs.

[redacted] Other trace impurities will be treated to levels required by the corrosion monitoring plan. Generally, this treatment will occur [redacted] Specification limits for impurities are driven by requirements of the transportation pipeline, which are generally more stringent than injection well requirements due to material selection (i.e., pipeline metallurgy). Therefore, the composition of the injected fluid presents no significant concerns regarding its interactions with subsurface fluids or suitability of the well materials.

BP will analyze the CO_2 stream during the operation period to yield data representative of its chemical and physical characteristics and to meet the requirements of 40 CFR 146.90(a). Sampling will take place both on a continuous and intermittent basis via online gas analysis and routine spot sampling, respectively. Analysis of the CO_2 stream will be monitored closely to assess risks to flow assurance and mechanical integrity of both the CO_2 pipeline and the injection well, as well as any impact on fluid behavior in the subsurface. Sample points will be located at the receipt point(s) of CO_2 stream(s) into the pipeline network to assess the quality of the CO_2 stream prior to transportation and injection. Sampling frequency is subject to further assessment and approval from the UIC Program Director but will occur quarterly at a minimum for the initial phases of Site operation.

BP will analyze the CO_2 for specific constituents utilizing detailed analytical methods as described in **Table 2** in the Testing and Monitoring Plan (**Appendix E**). The specific analytical methods employed and frequency of sampling will vary based on criticality to operations and the analyzers implemented for continuous monitoring.

The volume of CO_2 injected will be calculated from the mass flow rate obtained from the mass flow meter installed on the injection line. Flow rate is measured on a mass basis (kilograms/hour). The downhole pressure and temperature data will be used to perform the injectate density calculation.

7.2.2 Carbon Dioxide Stream in the AoR Model [40 CFR 146.82(a)(7)(i) and (ii)]

[redacted]

[redacted] This allows the salinity (among the other aqueous properties) to adjust during and after injection.

Table 7.1 provides the proposed operational parameters and conditions of the injection wells in accordance with 40 CFR 146.82(a)(7)(i)-(ii). The average annual injection rate is the rate of injection used for AoR modeling and represents the maximum injection volume for any given year. The maximum instantaneous injection rate will be utilized in the event of well maintenance to preserve the average annual injection rate. It will honor the maximum injection pressure for safe operating conditions, as well as any other surface conditions.

[redacted]

7.3 Stimulation Plan

In accordance with 40 CFR 146.82(a)(9), a stimulation plan may be developed for the Site (**Appendix I**). However, at the time of this submittal, a stimulation plan has not been proposed.

8. TESTING AND MONITORING [40 CFR 146.90]

The Testing and Monitoring Plan was developed in accordance with 40 CFR 146.82(a)(15) and 146.90 and is provided in **Appendix E**. Testing and monitoring in accordance with this plan will demonstrate that the Site is operating as anticipated, that the sequestered CO_2 plume and pressure front are moving as predicted, and that the CO_2 plume does not endanger any USDWs.

The Testing and Monitoring Plan will be reviewed at a minimum of every five years and will be adjusted to reflect any changes to the Site conditions over time. The amended plan will be sent to the UIC Program Director for approval in accordance with 40 CFR 146.90.

Testing and Monitoring GSDT Submissions
GSDT Module: Project Plan Submissions

Tab(s): Testing and Monitoring tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:
☒ Testing and Monitoring Plan ***[40 CFR 146.82(a)(15) and 146.90]***

9. INJECTION WELL PLUGGING [40 CFR 146.92]

The Injection Well Plugging Plan was developed in accordance with 40 CFR 146.82(a)(16) and 40 CFR 146.92(b) and is provided in **Appendix F**. Prior to injection well plugging, the mechanical integrity of each well will be tested to confirm no pathways have been established between the injection zone and USDWs or ground surface. Well logs will also be completed and compared to the pre-injection and operational phases. Following the injection well plugging, all tubing and packers will be removed.

Injection Well Plugging GSDT Submissions

GSDT Module: Project Plan Submissions
Tab(s): Injection Well Plugging tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:
☒ Injection Well Plugging Plan ***[40 CFR 146.82(a)(16) and 146.92(b)]***

10. POST-INJECTION SITE CARE (PISC) AND SITE CLOSURE [40 CFR 146.93]

The PISC and Site Closure Plan was developed in accordance with 40 CFR 146.82(a)(17) and 146.93(a) and is provided as **Appendix G**. The plan describes activities for monitoring groundwater quality and tracking the position of the CO_2 plume and pressure front, following termination of the injection operations. Post-injection monitoring will continue for at least 50 years or until BP's demonstration of non-endangerment of USDWs has been approved by the UIC Program Director pursuant to 40 CFR 146.93(b)(3). Following the approval for site closure, BP will plug all monitoring wells, restore the Site to its initial condition, and submit a site closure report and associated documentation.

BP has not requested an alternative PISC timeframe in this application. Pursuant to 40 CFR 146.93(c)(1), BP may request, and the UIC Program Director may approve, an alternative PISC timeframe if appropriate in the future.

PISC and Site Closure GSDT Submissions

GSDT Module: Project Plan Submissions
Tab(s): PISC and Site Closure tab

Please use the checkbox(es) to verify the following information was submitted to the GSDT:
☒ PISC and Site Closure Plan ***[40 CFR 146.82(a)(17) and 146.93(a)]***

PISC and Site Closure GSDT Submissions
GSDT Module: Alternative PISC Timeframe Demonstration ***Tab(s):*** All tabs (only if an alternative PISC timeframe is requested) Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☐ Alternative PISC timeframe demonstration ***[40 CFR 146.82(a)(18) and 146.93(c)]***

11. EMERGENCY AND REMEDIAL RESPONSE [40 CFR 146.94]

The Emergency and Remedial Response Plan (ERRP) is designed to meet the requirements of 40 CFR 146.82(a)(19) and 146.94(a) and is provided as **Appendix H**. BP has outlined in this application steps to prevent impacts to USDWs, the environment, and human health. The ERRP details actions to be taken if an emergency event occurs at the Site. Furthermore, the ERRP demonstrates the process and response to emergencies to ensure protection of USDWs, health and safety, and the surrounding environment.

Emergency and Remedial Response GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** Emergency and Remedial Response tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Emergency and Remedial Response Plan ***[40 CFR 146.82(a)(19) and 146.94(a)]***

12. INJECTION DEPTH WAIVER AND AQUIFER EXEMPTION EXPANSION [40 CFR 146.82(D) AND 146.95(A)] AND [40 CFR 146.4(D) AND 144.7(D)]

No Injection Depth Waiver or Aquifer Exemption Expansion is being requested by BP at this time.

Injection Depth Waiver and Aquifer Exemption Expansion GSDT Submissions
GSDT Module: Injection Depth Waivers and Aquifer Exemption Expansions ***Tab(s):*** All applicable tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☐ Injection Depth Waiver supplemental report ***[40 CFR 146.82(d) and 146.95(a)]*** ☐ Aquifer exemption expansion request and data ***[40 CFR 146.4(d) and 144.7(d)]***

13. OPTIONAL ADDITIONAL PROJECT INFORMATION [40 CFR 144.4]

Various Federal laws may apply to the issuance of a Class VI permit. If applicable, BP will follow the procedures of relevant laws, including those listed below. For the items below, please see **Table 1.1** for a full list of potential applicable environmental permits and requirements for the Site.

13.1 Wild and Scenic Rivers Act

The Wild and Scenic Rivers Act, 16 U.S.C. 1273 et seq. states that "certain selected rivers which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."

In accordance with the Wild and Scenic Rivers Act, the presence of national wild and scenic rivers will be determined within the areas that may be impacted by activities associated with the Site. Based on the location of the Site, the Wild and Scenic River Act is not applicable.

13.2 National Historic Preservation Act

The National Historic Preservation Act of 1966, 16 U.S.C. 470, et seq. states that "it shall be policy … to use measures, including financial and technical assistance, to foster conditions under which our modern society and our prehistoric and historic resources can exist in productive harmony and fulfil the social, economic, and other requirements of present and future generations."

In accordance with the National Historic Preservation Act, the presence of properties listed or eligible for listing in the National Register of Historic Places will be determined within the areas that may be impacted by activities associated with the Site. In the instance a historic property is identified, additional procedures and policies may be implemented, including historic and/or cultural resource surveys.

13.3 Endangered Species Act

The Endangered Species Act, 16 U.S.C. 1451 et seq. states that "the purposes … are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as my be appropriate to achieve the purposes of the treaties and conventions set forth…"

In accordance with the Endangered Species Act, the presence of endangered or threatened species will be determined within the areas that may be impacted by activities associated with the Site. In the instance an endangered or threatened species is identified, additional procedures and policies may be implemented, including endangered or threatened species surveys and/or biological assessments. If required, proper permits and authorizations will be acquired prior to construction and operation of the Site.

13.4 Coastal Zone Management Act

The Coastal Zone Management Act, 16 U.S.C 1451 et seq. states that "it is the national policy to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations;" and, "the protection of natural resources, including wetlands, flood plains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone." Based on the location of the Site, the Coastal Zone Management Act is not applicable.

13.5 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act,16 U.S.C. 661et seq., requires the Regional Administrator, before issuing a permit proposing or authorizing the impoundment (with certain exemptions), diversion, or other control or modification of any body of water, to consult with the appropriate State agency exercising jurisdiction over wildlife resources to conserve these resources.

In accordance with the Fish and Wildlife Coordination Act, the presence of these types of streams or other bodies of water will be determined within the areas that may be impacted by activities associated with the Site. If required, proper permits and authorizations will be acquired prior to construction and operation of the Site.

13.6 Environmental Justice

EPA considers environmental justice in its review of Class VI injection well permit applications. Environmental Justice is defined in Executive Order 14096[30] (Revitalizing Our Nation's Commitment to Environmental Justice for All) as the "just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people: (i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and (ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices."

In consultation with EPA, BP will assess the potential environmental, climate, and socioeconomic burdens to communities affected by its proposed Class VI injection well permit through the utilization of EPA's EJSCREEN, the Council on Environmental Quality's Climate and Economic Justice Screening Tool, the U.S. Department of Energy's Energy Justice Dashboard and/or any other relevant tools. After assessing the burdens and engaging with the communities, BP will determine what measures could be implemented to mitigate these burdens and increase the benefits to these communities.

[30] https://www.federalregister.gov/documents/2023/04/26/2023-08955/revitalizing-our-nations-commitment-to-environmental-justice-for-all

ATTACHMENT 1
GEOCHEMICAL MODELING AND SIMULATION RESULTS