Casper Carbon Storage Hub

Class VI Permit Application – Project Information

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
CCC	Casper Carbon Capture, LLC
N	North
No	Number
NPDES	National Pollutant Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
TBD	To be determined
USGS	United States Geologic Society
UIC	Underground Injection Control
W.S.	Wyoming Statute
W	West
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WY	Wyoming

1.0 PUBLIC NOTICE

In accordance with W.S. 35-11-313(f)(ii)(N), the applicant shall provide notice of the application for the geologic sequestration project proposed. Proof of notice is required to surface owners, mineral claimants, mineral owners, lessees, and other owners of record of subsurface interests that are located within one (1) mile of the proposed boundary of the geologic sequestration site (i.e, plume boundary). The publishing of notice of the application is required in a newspaper of general circulation in each county of the proposed operation at weekly intervals for four (4) consecutive weeks. **An affidavit of the notice shall be submitted to the Wyoming Department of Environmental Quality (WDEQ). Publishing of the notice may not occur more than 14 days following the submission of the permit application.**

Casper Carbon Capture, LLC (CCC) will ensure that notice is provided to the required parties within one mile of the plume boundary and will provide this proof of notice to the Administrator no more than 14 days following the submission of the permit application.

2.0 ACCESS FOR INSPECTIONS

Wyoming Statute (W.S.) 35-11-303 (a) states: "the administrator of the water quality division at the direction of the director: (i) may conduct on-site compliance inspections of all facilities and work during or following the completion of any construction, installation or modification for which a permit is issued under W.S. 35- 11-301 (a)(ii)."

As part of its application, the applicant shall certify under penalty of perjury that the applicant has secured and shall maintain permission for WDEQ personnel to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by W.S. § 6- 3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road. **A map of the access route(s) to the facility shall accompany the application.**

I, ________, *certify under penalty of perjury that CCC has secured and shall maintain permission for WDEQ personnel and their invitees to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by Wyoming Statute § 6-3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road.*

3.0 EXISTING ENVIRONMENTAL PERMITS

Within the AoR, a listing and status of all permits or construction approvals associated with the Casper Carbon Storage Hub received or applied for under any of the following programs or corresponding state programs is found in Table 1:

Table 1: Existing Environmental Permits		
RCRA – Hazardous Waste Management	Permit No.:	N/A ☒
UIC – Underground Injection of Fluids	Permit No.: Pending	N/A ☐
NPDES – Discharge of Surface Water	Permit No.:	N/A ☒
Prevention of Significant Deterioration – Air Emissions from Proposed Sources	Permit No.:	N/A ☒
Nonattainment Program under the Clean Air Act	Permit No.:	N/A ☒
National Emissions Standards for Hazardous Air Pollutants pre- construction approval under the Clean Air Act	Permit No.:	N/A ☒
Dredge and fill permitting program under section 404 of the Clean Water Act	Permit No.:	N/A ☒

4.0 OTHER PERMITS

Within the AoR, a list of other relevant permits associated with the geologic sequestration project that CCC is required to obtain (this excludes other Class VI wells and associated monitoring wells) is found in Table 2:

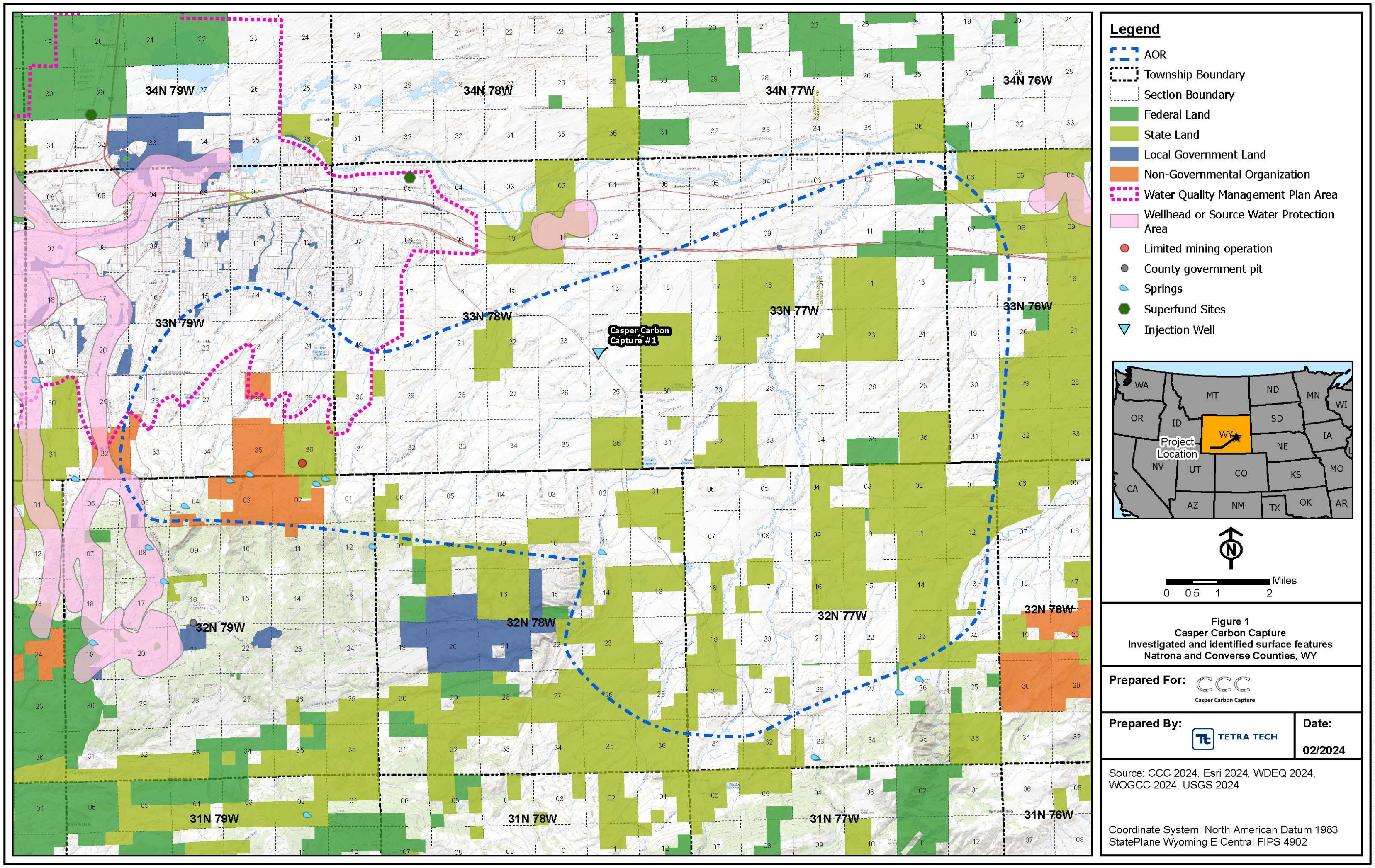
Table 2: Other Permits		
Right-of-Way Applications	Permit No.:	N/A ☒
Construction	Permit No.: TBD	N/A ☐
Road Use	Permit No.: TBD	N/A ☐
Pipeline	Permit No.:	N/A ☒
Water Crossing	Permit No.:	N/A ☒

5.0 INVESTIGATED AND IDENTIFIED SURFACE AND SUBSURFACE FEATURES

A map showing the injections well(s) for which a permit is sought and the applicable AoR consistent with Water Quality Rules, Chapter 24 Section 13. Within the AoR, the map shall list the number, or name and location of:

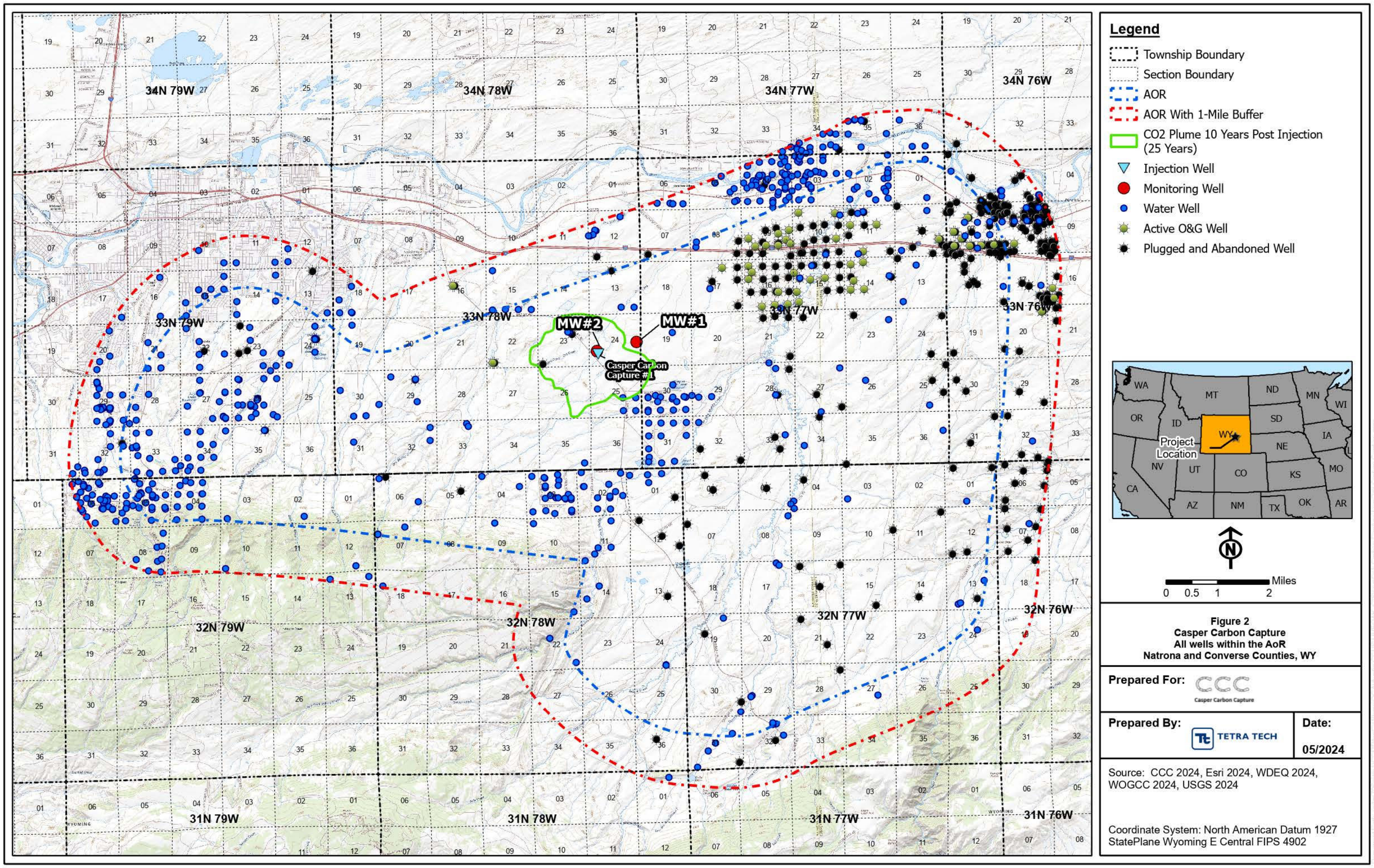
Table 3: Investigated and Identified Surface and Subsurface Features

Surface and Subsurface Features	Investigated and Identified (Figure Nos)	Investigated but Not Found in AoR
Producing (active Wells)	43 (Figure 2)	-
Abandoned Wells	182 (Figure 2)	-
Deep Stratigraphic Boreholes	-	X
Subsurface Cleanup Sites	-	X
Surface Bodies of Water	Figure 1	-
Other pertinent surface features, including structures intended for human occupancy.	Figure 1	-
Springs	6 (Figure 1)	-
Water Wells	454 (Figure 2)	-
Mines (surface and subsurface)	1 (Figure 1)	-
Quarries	-	X
Subsurface Structures (e.g., coal mines)	-	X
Location of Proposed Wells	Figure 2	-
Location of Proposed Cathodic Protection Boreholes	-	X
Any Existing Aboveground Facilities	-	X
Roads	Figure 1 and Figure 2	-
State Boundary Lines	-	X
Indian Boundary Lines	-	X
Known or Suspected Faults	Figure 3	-
Other Pertinent Surface Features	-	X
All water quality management plan areas, wellhead protection areas, and source water protection areas.	Figure 1	-



Not for Construction

Figure 1: Identified surface and subsurface features.



Not for Construction

Figure 2: All wells in the Area of Review.

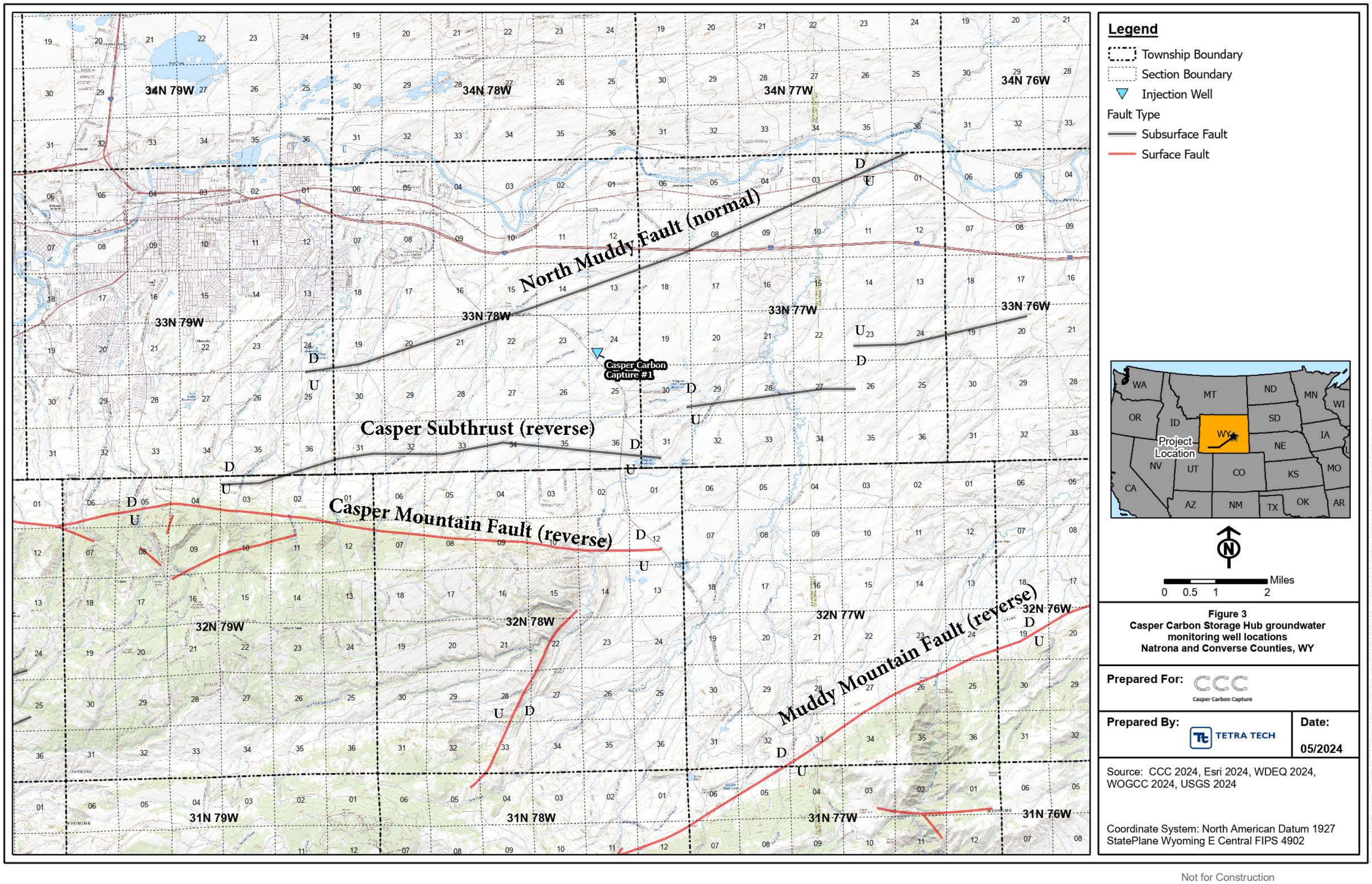


Figure 3: Orientation and extents of faults in the Project Area, with surface-breaching faults in red and subsurface faults mapped for this project in black.

6.0 TITLE OF CO_2

In accordance with W.S. 35-11-318, CCC shall have title to any carbon dioxide that they inject into and store underground or within a unit area, and shall hold title for any injected carbon dioxide until the department issues a certificate of project completion as specified in W.S. 35-11-319. During any time CCC holds title to carbon dioxide, CCC shall be liable for any damage the injected or stored carbon dioxide may cause, including damage caused by carbon dioxide that escapes or is released from where it is being stored underground.

Concerning the Permit Application for:	**Project Location:**
Casper Carbon Capture No. 1; Facility ID No: WYS-025-00487, UIC Class VI Permit Application No. 2024-0052v1.0 for Casper Carbon Capture, LLC pursuant to Wyoming Statute (35-11-313)(f)(ii)(N)	**Township 33 North, Range 78 West, 6th P.M.** Section 24: SW/4SW/4 Natrona County, Wyoming

AFFIDAVIT OF MAILING NOTICE

STATE OF TEXAS }
} §
COUNTY OF KENDALL }

Robert W. Hand, of lawful age, and being first duly sworn upon his oath, states and declares:

That he is the Vice President of Casper Carbon Capture, LLC;

That on the 11th day of July 2024, he caused a copy of the attached *Notice Letter*, referenced on Exhibit "A" to be deposited in the United States Mail, by postage prepaid certified mail at the address available and listed for each person described on Exhibit "B".

Affiant further hereby certifies and affirms that on the 11th day of July 2024, he caused a true and correct copy of the herein referenced documents to be sent via electronic mail, addressed as follows:

Wyoming Department of Environmental Quality
Water Quality Division
Attn: Lily Barkau, Groundwater, Section Manager

Robert W. Hand, Affiant

Subscribed and sworn to before me by Robert W. Hand, Vice President of Casper Carbon Capture, LLC on this 11 day of JULY, 2024.

Witness my hand and official seal.

Notary Public

ANDREA S. KIDD
Notary Public, State of Texas
Comm. Expires 11-06-2027
Notary ID 126314647

EXHIBIT "A"

CASPER CARBON CAPTURE, LLC

Date: 7/10/2024

To: Surface Owner, Mineral Claiment, Mineral Owner, Lessee or Other Owner of Record

Address Wyoming USA

Dear: Surface Owner, Mineral Claiment, Mineral Owner, Lessee or Other Owner of Record

The CASPER CARBON CAPTURE, LLC has submitted a Carbon Sequestration Underground Injection Control Program permit application for a Class VI well to the Wyoming Department of Environmental Quality on 7/01/2024. The purpose of this notice is to inform you that the application has been submitted and you have been identified as a surface owner, mineral claimant, mineral owner, lessees, or other owner of record of subsurface interest within one (1) mile of the proposed boundary of the geologic sequestration site. We are required by Wyoming Statute (35-11-313(f)(ii)(N) to provide a copy of the notice to you for your reference. The project is located in the SW Quarter of the SW Quarter of Section 24, Township 33 North, Range 78 West, of the 6th Principal Meridian, NATRONA COUNTY

A copy of the permit application may be accessed at https://deq.wyoming.gov/waterquality/groundwater/uic/class-vi/. For questions regarding the project, please get in touch with us at info@caspercarboncapture.com. If you have questions regarding the Class VI permitting process, please contact Graeme Finley, Senior Project Geologist, Water Quality Division, Wyoming Department of Environmental Quality at 307-473-3478 or graeme.finley@wyo.gov. Para Español, visite deq.wyoming.gov. Americans with Disabilities Act: special assistance or alternative formats will be made available upon request for individuals with disabilities. Please provide at least fourteen (14) days before the close of the public comment period for such requests.

Sincerely,

Robert W Hand

Robert W. Hand
Vice President
Casper Carbon Capture, LLC
713-951-0100

Exhibit "B"

Mineral And Surface Ownership for Area of Review

Description	Organization	Address	City	Region	Postal Code	Type of Interest	Comments
T33N-R78W Section 13: NWNW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Carey Minerals, LLC	2161 Coffeen Ave., Ste. 301	Sheridan	WY	82801	RI	
	Julia F. Carey					RI	No Address
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	J. M. Carey & Brother					RI	No Address
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 13: SESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: SWSE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: NW, N2SW, SWSW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: SESW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 15: SENE, NESE, S2SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 22: NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 23: S2NE, N2SE, SESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Ronald D Legerski and Jodi L Legerski, H/W	3640 Hat Six Rd	Casper	WY	82609	SI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

	Cole Creek Sheep Company	P.O. Box 2945	Casper	WY	82602	SI	
	Western Vista Credit Union	3207 Sparks Road	Cheyenne	WY	82001	MTGE	
T33N-R78W Section 23: SWSE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 26: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 25: S2SW, SWSE	Theresa Milne					25%	No address
	Gay Milne					75%	No address
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
	Gay Milne Revocable Living Trust 10/12/2024	5300 Hat Six Rd	Casper	WY	82609	SI	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
T33N-R78W Section 26: SESE	Theresa Milne					25%	No address
	Gay Milne					75%	No address
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 24: SWNW, W2SW	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI	
	Don S. & Katheryn Q Miller					MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: NWNW	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI	
	Don S. & Katheryn Q Miller					MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 26: E2SW, W2SE, NESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 25: S2NW, NWSW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 24: S2NE, SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

T33N-R78W Section 25: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: E2SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
	Marty Kamrath III and Martha Kamrath	10513 Goose Creek Rd	Casper	WY	82609	SI	
	On Q Financial, LLC	421 S Center St Suite 101	Casper	WY	82601	MTGE	
	David S & Ronda D Bullard Living Trust 3/19/2008	P.O. Box 2603	Casper	WY	82602	SI	
	Robert B Allaire Amy A Allaire	10628 Goose Creek Cir	Casper	WY	82609	SI	
	Goose Creek Ranch LLC	915 S McKinley St	Casper	WY	82601	SI	
	Mortgage Electronic Registration System, Inc.	P.O. Box 2026	Flint	MI	48501	MTGE	
	Richard E. Nurss II Donna M Nurss	10607 Goose Creek Cir	Casper	WY	82609	SI	
T33N-R78W Section 23: NWNE, N2NW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 24: N2N2	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 24: SENW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 25: NENW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: S2NE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI & MI	
T33N-R78W Section 34: E2NE, NESE	George E. Lilly and Stella M. Lilly					MI	No address
	Robert W. Patee					MI	No address
	William H. Brown Mineral Trust	P.O. Box 2680	Casper	WY	82602	MI	
	J. L. Gooder and Florance E. Gooder					MI	No address
	Jeanne Y. Stout					MI	No address

	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	SI	
T33N-R78W Section 34: W2NE, E2NW	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	MI & SI	
T33N-R78W Section 34: SESE	R. B. Blackmore					MI	
	Lyndon J. Hall					MI	
	Rulon B. Hall					MI	
	William B. Hall					MI	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI & MI	
T33N-R78W Section 35: E2NW, SWNW, NWSW	Thomas Miline Trust					75%	
	Theresa Milne					25%	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 35: NWNW	George E. Lilly and Stella M. Lilly					MI	No address
	Robert W. Patee					MI	No address
	William H. Brown Mineral Trust	P.O. Box 2680	Casper	WY	82602	MI	
	J. L. Gooder and Florance E. Gooder					MI	No address
	Jeanne Y. Stout					MI	No address
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	
T33N-R78W Section 35: SWSW, E2SW, SE	R. B. Blackmore					MI	the other 1/4 is under the assumption there was no reservations from Albert Bejiek and James A. Vodehnal or any of their heirs or devises. 169-327 is unreadeable. Title gets pretty cloudy after this. If there was no other reservations we are under the asumption that curent surface owner owns the remaining 1/4
	Lyndon J. Hall					MI	
	Rulon B. Hall					MI	
	William B. Hall					MI	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	

	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
	Erica K. Andren Reyes and Gilbert A. Reyes Wife and Husband	17909 Swans Creek Ln	Dumfries	VA	22026	SI	
	Heather J Adels and Brad Adels	8888 Week Creek Rd	Casper	WY	82609	SI	
	Wells Fargo Bank	101 North Phillips Ave	Sioux Falls	SD	57104	MTGE	
T33N-R77W Section 18: Lots 2, 3, E2NW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W Section 18: SWSW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	Oil and Gas
	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	Other minerals
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W Section 29: SW	Heidi Ann VonHelm and Kathryn Kay Beasley and Cory Craig Hamilton	11800 Clearfork Road	Casper	WY	82601	SI	
	Bonnie Milne					MI	
	LaVonnee Ramero					MI	
	M. John Bushmaker					MI	
	Ronda Flott					MI	
	Tom Bushmaker					MI	
	Connie Walters					MI	
	Dorma Barella, Marylee Milne and Betty Parish					MI	
	Frank L. Kimball	P.O. Box 100	Farson	WY	82932	MI	
	Merle A Kimball	2 Bromley Drive	Williamsburg,	VA	23185	MI	
	Marion A Slack	9230 Cisco Place	Tucson	AZ	85710	MI	
	James E. Kimball	P.O. Box 1055	Mayer	AZ	86333	MI	
	Patty Yvonne Kimball Slack	P.O. Box 51	Kinnear	WY	82516	MI	
	Rock Creek Ranch I LTD	100 Waugh, Suite 400	Houston	TX	77007	SI	
	State of Wyoming, Department of Heath Divison of Healthcare Financing/EqualityCare	6101 Yellowstone Road, Suite 210	Cheyenne	WY	82002	LIEN	
	Farm Credit Services of America, FLCA	5015 S 118th Street P.O. Box 2409	Omaha	NE	68103	MTGE	

T33N-R77W Section 30: S2	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	John Bolender and Christine S. Bolender	10955 Goose Creed Rd	Casper	WY	82609	SI	
	David S & Ronda D Bullard Living Trust 3/19/2008	P.O. Box 2603	Casper	WY	82602	SI	
	Goose Creek Ranch LLC	915 S McKinley St	Casper	WY	82601	SI	
	Mortgage Electronic Registration System, Inc.	P.O. Box 2026	Flint	MI	48501	MTGE	
	Pimentel 2007 Revocable Trust 2/27/2007	10748 Goose Creek Cir	Casper	WY	82609	SI	
	C Bar 6 LLC	10850 Goose Creek Cir	Casper	WY	82609	SI	
	David A Baxter Runge K Baxter	10868 Goose Creek Cir	Casper	WY	82609	SI	
	First Interstate Bank	104 S Wolcott	Casper	WY	82601	MTGE	
	Randy L Davis and Jesica C. Davis	P.O. Box 726	Casper	WY	82609	SI	
	Amerisave Mortgage Corporation	3525 Piedmont Rd NE, 8 Piedmont Center	Atlanta	GA	30305	MTGE	
	WyHY Federal Credit Union	P.O. Box 20050	Cheyenne	WY	82003	MTGE	
	Dean Rueter and Ingrid Rueter	10978 Goose Creek Cir	Casper	WY	82609	SI	
	Rocket Mortgage, LLC	1050 Woodward Ave	Detroit	MI	48226	MTGE	
	Colton Dillon and Danica Wilbanks	11088 Goose Creek Cir	Casper	WY	82609	SI	
	UBS Bank USA	P.O. Box 2026	Flint	MI	48501	MTGE	
	Cameron Smith Sheila Christy-Smith	11097 Goose Creek Cir	Casper	WY	82609	SI	
	Reliant Federal Credit Union	4015 Plaza Drive	Casper	WY	82604	MTGE	
	Lowell Horner and Nancy Horner	10857 Goose Creek Cir	Casper	WY	82609	SI	
	Richard E. Nurss II and Donna M Nurss	10607 Goose Creek Cir	Casper	WY	82609	SI	
	First Interstate Bank	P.O. Box 30198	Billings	MT	59166	MTGE	
	PacifiCorp	1407 WN Temple Suite 110	Salt Lake	UT	84116	EASE	
	The Bank of New York Mellon Trust Company, N.A.	531 W. Morse Blvd.	Winter Park	FL	32789	MTGE	
T33N-R77W Section 31: NENE	Bonnie Milne					MI	
	LaVonnee Pamero					MI	
	M. John Bushmaker					MI	
	Ronda Flott					MI	
	Tom Bushmaker					MI	
	Connie Walters					MI	
	and Betty Parish					MI	

	Frank L. Kimball	P.O. Box 100	Farson	WY	82932	MI
	Merle A Kimball	2 Bromley Drive	Williamsburg,	VA	23185	MI
	Marion A Slack	9230 Cisco Place	Tucson	AZ	85710	MI
	James E. Kimball	P.O. Box 1055	Mayer	AZ	86333	MI
	Patty Yvonne Kimball Slack	P.O. Box 51	Kinnear	WY	82516	MI
	Rock Creek Ranch I LTD	100 Waugh, Suite 400	Houston	TX	77007	SI
T33N-R78W Section 13: NE, NENW, S2NW, SW, N2SE, SWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI
T33N-R78W Section 14: S2NE, N2SE, SESE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI
T33N-R78W Section 15: N2N2, SWNE, S2NW, SW, NWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI
	Gail L Mahnke Living Trust 9/10/2008	5466 S Okeepa	Casper	WY	82604	SI
T33N-R78W Section 22: W2	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI
T33N-R78W Section 22: SE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI
	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	SI
T33N-R78W Section 23: NENE, W2	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI
	Ronald D Legerski and Jodi L Legerski, H/W	3640 Hat Six Rd	Casper	WY	82609	SI
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI
	Cole Creek Sheep Company	P.O. Box 2945	Casper	WY	82602	SI

	Western Vista Credit Union	3207 Sparks Road	Cheyenne	WY	82001	MTGE	
T33N-R78W Section 25: NESW, NWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Marty Kamrath III and Martha Kamrath	10513 Goose Creek Rd	Casper	WY	82609	SI	
	On Q Financial, LLC	421 S Center St Suite 101	Casper	WY	82601	MTGE	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 26: S2NE, NW, W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 27: E2, E2W2	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 27: NWNW	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R78W Section 27: SWNW, W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 35: NE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Milne K P Ranch Co	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 36: ALL	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 18: E2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W Section 19: ALL	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 20: W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

T33N-R77W Section 29: W2NW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R77W Section 30: N2	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 31: W2, SWNE, NWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	John Greer	P.O. Box 51874	Casper	WY	82605	SI	
	Karen J Buettner-Price	5770 Jul Ln	Casper	WY	82609	SI	
	Steven J Schulz	10750 Clearfork Rd	Casper	WY	82609	SI	
	Farm Credit Services of America, FLCA	5015 S 118th Street P.O. Box 2409	Omaha	NE	68103	MTGE	

Concerning the Permit Application for:	Project Location:
Casper Carbon Capture No. 1; Facility ID No: WYS-025-00487, UIC Class VI Permit Application No. 2024-0052v1.0 for Casper Carbon Capture, LLC pursuant to Wyoming Statute (35-11-313)(f)(ii)(N)	**Township 33 North, Range 78 West, 6th P.M.** Section 24: SW/4SW/4 Natrona County, Wyoming

AFFIDAVIT OF PUBLIC NOTICE

STATE OF TEXAS }
} §
COUNTY OF MONTGOMERY }

Jess D. Foshee, of lawful age, and being first duly sworn upon his oath, states and declares:

That he is the President of Casper Carbon Capture, LLC;

That on the 9th day of July 2024, he also caused a *Notice of Geologic Sequestration Project*, referenced on Exhibit "C" to be published weekly for four (4) consecutive weeks in the Casper Star-Tribune newspaper.

Affiant further hereby certifies and affirms that on the 12th day of July 2024, he caused a true and correct copy of the herein referenced documents to be sent via electronic mail, addressed as follows:

Wyoming Department of Environmental Quality
Water Quality Division
Attn: Lily Barkau, Groundwater, Section Manager
lily.barkau@wyo.gov

Jess D. Foshee, Affiant

Subscribed and sworn to before me by Jess D. Foshee, as President of Casper Carbon Capture, LLC on this 13 day of July, 2024.

Witness my hand and official seal.

WILLIAM SCOTT PARKS
Notary Public, State of Texas
Comm. Expires 07-23-2028
Notary ID 132584390

Notary Public
William Scott Parks

"Exhibit C"

Notice of Geologic Sequestration Project

Underground Injection Control Permit Application Submission

Wyoming Department of Environmental Quality

In accordance with Wyoming Statute, 35-11-313(f)(ii)(N), notice is being provided to inform the public that Casper Carbon Capture, LLC has submitted a UIC Class VI (Carbon Sequestration) Permit Application to the Wyoming Department of Environmental Quality for issuance of a permit for the Casper Carbon Storage Hub located in the SW Quarter of the SW Quarter of Section 24, Township 33 North, Range 78 West of the 6th Principal Meridian, Natrona County, WY.

Prior to permit issuance, WDEQ will hold a 60-day public comment period followed by a public hearing. A copy of the permit application may be accessed at https://deq.wyoming.gov/waterquality/groundwater/uic/class-vi/.

For questions regarding the project, please contact Jess Foshee at 713-951-0100. If you have questions regarding the Class VI permitting process, please contact Graeme Finley, Senior Project Geologist, Water Quality Division, Wyoming Department of Environmental Quality at 307-473-3478 or graeme.finley@wyo.gov.

Para Español, visite deq.wyoming.gov.

Americans with Disabilities Act: special assistance or alternative formats will be made available upon request for individuals with disabilities. Please provide at least fourteen (14) days before the close of the public comment period for such requests.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Site Characterization

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
2D	Two-Dimensional
3D	Three-Dimensional
AoR	Area of Review
API	American Petroleum Institute
bgs	Below Ground Surface
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
DPHI	Density Porosity
E	East
EPA	United States Environmental Protection Agency
ERRP	Emergency Remedial and Response Plan

°F	Fahrenheit
ft	Feet
GR	Gamma Ray
H_2O	Water
in	Inches
Kg/m^3	Kilograms per cubic meter
m/s^2	Meters per Second Squared
mD	Millidarcies
MMT	Million Metric Tonnes
MW	Monitoring Well
N	North
N/A	Not Applicable
NPHI	Neutron Porosity
OD	Outside Diameter
PNNL	Pacific Northwest National Laboratory
PRB	Powder River Basin
psi	Pounds per Square Inch
Qrt	Quarter
RNG	Range
RHOB	Bulk Density
RHOMA	Matrix Density
$scCO_2$	Supercritical Carbon Dioxide
SP	Spontaneous Potential
STOMP	Subsurface Transport Over Multiple Phases
TWN	Township
TD	Total Depth
TVD	True Vertical Depth
UIC	Underground Injection Control
USGS	U.S. Geological Survey
VSHALE	Shale Volume
W	West
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission

WSEO	Wyoming State Engineer’s Office
WY	Wyoming
Y/N	Yes/No

1.0 OVERVIEW OF PROJECT AREA GEOLOGY

1.1 EXECUTIVE SUMMARY

Casper Carbon Capture, LLC (CCC) proposes to construct and operate a Class VI Underground Injection Control (UIC) carbon sequestration well at the Casper Carbon Storage Hub in Natrona County, Wyoming, approximately 6 miles southeast of the city of Casper and 4.5 miles west of the Converse County border. The goal of the Casper Carbon Storage Hub is to permanently store CO_2 removed from the atmosphere via injection into a saline aquifer. The facility will be a commercial-scale carbon capture system that will be designed, constructed, and operated with the capability of storing CO_2 in deep geologic formations.

The hub site was chosen based on favorable geology, proximity to sources of CO_2, and the availability of usable surface and subsurface land ownership. The safely transported CO_2 will be injected into the Lower Sundance Formation and Crow Mountain Sandstone at a proposed total of 6 million metric tons (MMT) over a 15-year injection period (an average of 400,000 metric tons per year). The project expects to begin operations at an initial rate of 50,000 metric tons per year, ramping up by an additional approximate 50,000 metric tons per year, to a maximum rate of 750,000 tons per year.

The Casper Carbon Storage Hub is located on the southwestern margin of the Powder River Basin (PRB), which for more than 100 years has yielded extensive energy and mineral resources. The PRB accounts for more than half of Wyoming's oil production – more than any other basin in the state – and ranks second in natural gas production. Additionally, the development of coal and coal-bed methane resources remains active in more northern portions of the basin. Recently, increased interest in renewable energy and carbon emission reduction has shined a spotlight on the PRB as a potentially vast opportunity for geologic carbon sequestration (GCS). In addition to proximity to CO_2 emitters and infrastructure access, the basin offers many subsurface characteristics that are favorable for GCS:

- A thick column of sandstone, shale, and carbonate units that provide regionally extensive reservoirs and seals;
- Structural and stratigraphic traps at depths suitable for the permanent storage of injected CO_2;
- Saline aquifer storage potential in areas or formations that lack hydrocarbons;
- Depleted reservoir storage potential in previously developed oil and gas fields;
- Extensive data and subsurface knowledge generated over decades of oil and gas development to support GCS activity.

Tetra Tech, on behalf of CCC, has prepared this Site Characterization Form using a combination of regional and local studies, publicly available data, and purchased or licensed private data. The Site Characterization Form summarizes the geology of the planned well locations. In certain sections of this application, local data were not readily available, and regional data were substituted as a preliminary estimate. Site-specific data will be acquired as described in this form during the construction of the project.

The Casper Carbon Storage Hub is located in the southwestern PRB, adjacent to several important geologic features that define the basin margin. The surface geology, situated between the North Platte River and the northernmost extent of the Laramie Mountains, is characterized by low-grade pediments and exposed Upper Cretaceous bedrock that are cut by drainages trending northwest. Surficial sediments of Quaternary age overlie the bedrock and include landslide deposits, talus, terrace and riverbed alluvium, and eolian dunes. A topographic map of the project area, including the injection well location, monitoring well locations, facility and land boundaries, roads, and other surface features is shown in Figure 1.

The sedimentary section in this area preserves some 10,000 feet of Cambrian to Upper Cretaceous sandstone, shale, carbonate, and evaporite, deposited on a basement of Precambrian crystalline rocks. The stratigraphic record indicates deposition occurred in a variety of environments, including shelf to deep marine, fluvial-deltaic, coastal plain, strandplain, barrier island, and carbonate ramp settings. Well logs and other data from historical oil and gas exploration confirm the location contains porous and permeable geologic reservoirs with low-permeability seals, but no commercial hydrocarbons have been discovered.

The proposed storage complex utilizes geologic units previously studied for CO_2 sequestration potential by the U.S. Geological Survey (USGS) (Warwick & Corum, 2012) as shown in Figure 2 and Figure 3. The injection interval comprises a series of vertically contiguous stratigraphic units, listed from uppermost to lowermost:

- Lower Sundance Formation (including the Lak, Hulett, Stockade Beaver, and Canyon Springs members, or their stratigraphic equivalents of Jurassic age);
- Gypsum Spring Formation, or its stratigraphic equivalents of Jurassic/Triassic age; and
- Crow Mountain Sandstone (uppermost member of the Chugwater Group) or its stratigraphic equivalents of Triassic age.

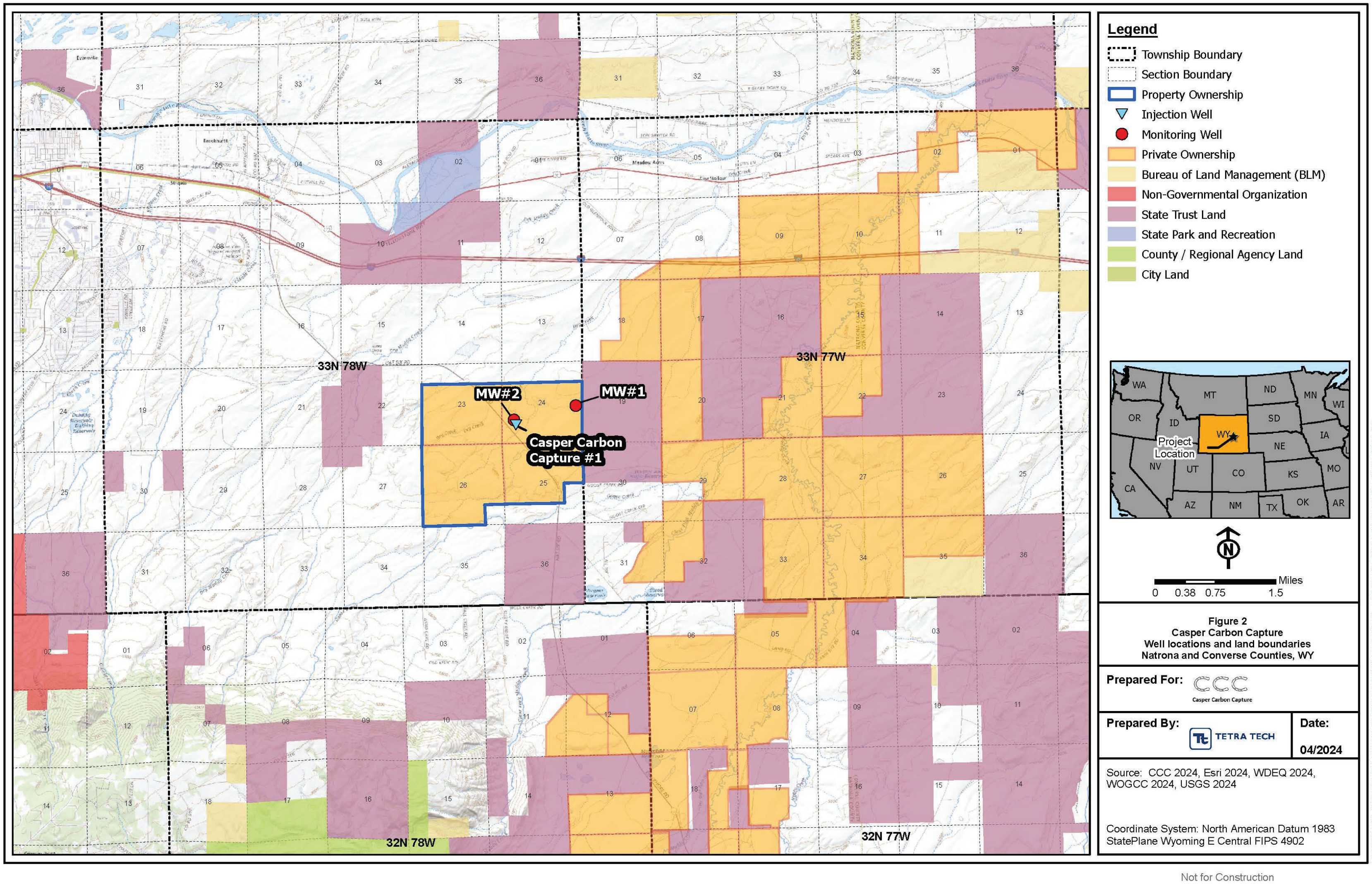


Figure 1: Topographic map of the project area, project area, including the injection well location, monitoring well locations, facility and land boundaries, roads, and other surface features.

This sand-rich interval extends from the basin margin at the Laramie-Casper Mountain fronts, where the sedimentary section has been overturned and fully eroded, and continues northward into the basin beyond the limits of the study area. The primary upper confining zone is defined as the Redwater Shale member of the Sundance formation and the immediately overlying Morrison Formation, both of Jurassic age. The lower confining zone comprises two additional members of the Chugwater Group, the Alcova Limestone and Red Peak Shale, underlying the Crow Mountain member; and the Goose Egg Formation, which underlies the Red Peak. As with the injection zone, the confining strata are continuous throughout the storage complex area.

A geologic prognosis based on the data evaluated for this project is provided in Table 1, showing projected depths and thicknesses of strata in the proposed injection well, Casper Carbon Capture #1. The injection zone is approximately 226 feet thick with a top depth of around 6,000 feet below ground surface. The upper confining zone is ~307 feet thick and the lower confining zone is ~1,000 feet thick. This provides sufficient vertical isolation between the injection zone and the underground sources of drinking water (USDWs) that are present above and below the injection zone.

The geology surrounding the project location has been subjected to large-scale deformation, most recently during the Laramide Orogeny (Late Cretaceous). Faults and associated uplifts exposed at the surface define the basin margin, including the basement-cored Laramie Mountains, Casper Mountain, and Casper Arch. The proposed storage complex is not intersected by any faults that are known to reach the surface. Some smaller-scale faults (e.g., "blind faults" that tip out in the subsurface) have been interpreted and mapped from seismic and well data. CCC selected an injection location that is away from these faults and has gentle formation dips to ensure injected CO_2 is permanently sequestered. Additional evaluation discussed later in this Site Characterization Form suggests the risks of leakage or fault reactivation in the area impacted by injection are low.

Based on available data, the injection zone is not a USDW; does not supply a public water system or contain a sufficient quantity of groundwater to supply a public water system; does not supply drinking water for human consumption; and is not known to contain fewer than 10,000 mg/L total dissolved solids. Site-specific data will be collected prior to injection to confirm the injection zone is not a USDW.

Table 1: Geologic Prognosis for Casper Carbon Capture #1 Showing Expected Formation Top Depths and Thicknesses				
Formation Top	**SSTVD (ft)**	**MD (ft)**	**Thickness (ft)**	**Lithology**
Alluvium / soil	5,314	-	12	Unconsolidated siltstone, sand, gravel
Mesaverde	5,302	12	608	Sandstone, shale
Cody	4,694	620	3,712	Shale, sandstone
Frontier	982	4,332	839	Shale, sandstone
Mowry	143	5,171	229	Shale (mudstone), sandstone
Muddy	-86	5,400	70	Siltstone
Skull Creek	-156	5,470	62	Shale (mudstone)
Dakota	-218	5,532	98	Shale (siltstone)
Lakota	-316	5,630	65	Sandstone, conglomerate
Morrison (UCZ)	-381	5,695	200	Shale (mudstone), sandstone
Redwater (UCZ)	-581	5,895	107	Shale (siltstone), limestone
Lower Sundance (IZ)	-688	6,002	106	Sandstone, siltstone, dolomitic limestone
Gypsum Spring (IZ)	-794	6,108	39	Siltstone, limestone
Crow Mountain (IZ)	-833	6,147	81	Sandstone, limestone
Alcova (LCZ)	-914	6,228	15	Limestone
Red Peak (LCZ)	-929	6,243	~600	Shale (siltstone, mudstone)
Goose Egg (LCZ)	-1,529	6,843	~400	Evaporites, shale

UCZ = upper confining zone unit, IZ = injection zone unit, LCZ = lower confining zone unit

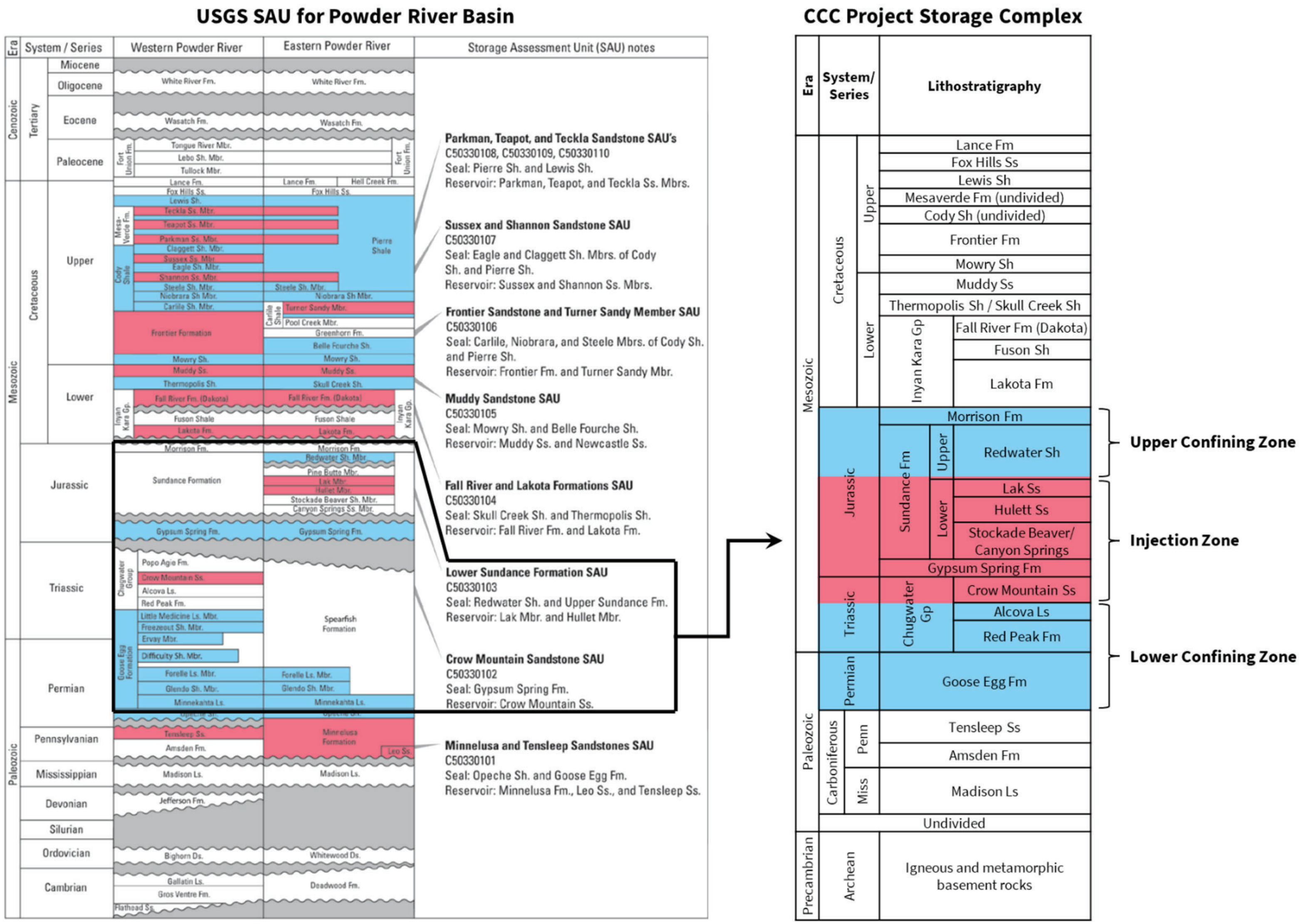


Figure 2: USGS stratigraphic column with storage assessment units (SAU) for the Powder River Basin (left) and the stratigraphic column defined for the Casper Carbon Storage Hub (right).

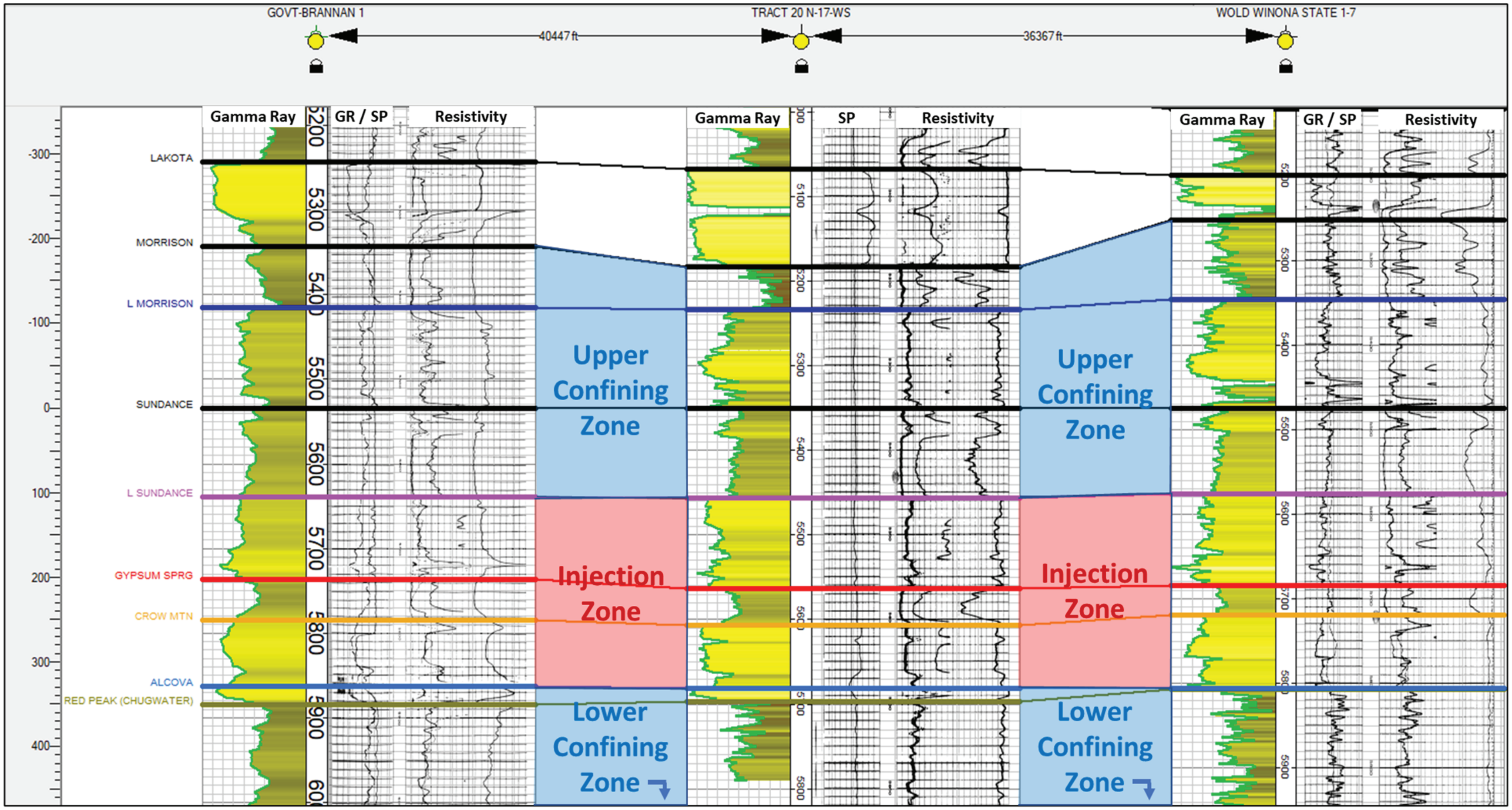


Figure 3: Cross section through key wells in the Project Area, showing details of the Sundance/Crow Mountain injection interval; the Upper Confining Zone (Sundance Redwater Shale Member and Morrison Fm) and the uppermost portion of the Lower Confining Zone (Chugwater Alcova and Red Peak Members).

1.2 REGIONAL STRUCTURE

The PRB is a large geologic structural basin extending from northeastern Wyoming to southeastern Montana. It contains a section of Phanerozoic sedimentary rocks that reaches a maximum total thickness of about 17,000 feet. Regional deformation began in the Upper Cretaceous during the Laramide Orogeny, producing a strongly asymmetric trough approximately 250 miles long and 100 miles wide (WSGS site) (Beikman, 1962; Warwick & Corum, 2012; Taboga K. G., 2013). Structural dips are steepest along the western margin, where near-vertical beds of Phanerozoic sedimentary strata are thrusted and exposed against Precambrian crystalline rocks.

Intensity of structural deformation varies widely, from steep-sided anticlines and synclines to low-amplitude deformation, reflecting a range of stress accommodation styles developed during Laramide tectonic activity. In the area of Casper Carbon Capture #1, faulting resulted in significant stratigraphic offset. Certain major fault zones are known to reach the surface in the vicinity of Casper Carbon Capture #1, notably the Casper Mountain Fault Zone and the Muddy Mountain Fault Zone, which are approximately 4 miles south-southwest and 9 miles southeast, respectively. These fault zones are dominated by large reverse faults with displacements exceeding 1,000 feet. Smaller synthetic and antithetic normal and reverse faults are developed off the major faults. Additional buried ("blind") fault zones are known from subsurface data and are thought to be genetically related to the outcropping faults. These blind faults, expected to be sealed at depth by cataclastic deformation and shale smear resulting from large displacements, establish structural, stratigraphic, and combination traps.

Evidence of such traps is seen throughout the PRB, which has been a prolific hydrocarbon province for more than 130 years. Notable fields near the project area include Brooks Ranch, Big Muddy, and Glenrock, all of which produce from Cretaceous reservoirs. Accumulations occur in structural closures, stratigraphic traps at permeability pinch-outs, buried topography, and combination traps (Anna, 2010). The Big Muddy Anticline, in the area of Big Muddy and Brooks Ranch fields, is the largest of these fold structures near the project location. The extent and general geometry of this anticline holds through the Mesozoic and likely most or all of the Paleozoic, as Laramide deformation occurred after the deposition and lithification of all preserved rock units in the area. Consequently, structural configurations can be confidently projected down section even where control data (i.e., well penetrations) are limited.

The structure of Casper Mountain, which is the nearest major surface geologic feature, is complex. This uplift is considered the northernmost extent of the Laramie Mountains, but it is detached and separated from the rest of the range by the Muddy Mountain Fault Zone.

Bounded on three sides by faults that truncate the sedimentary section and breach the ground surface, the structure is a breached doubly plunging anticline adjacent to the Casper Arch, which separates the Wind River Basin and PRB. The injection zone is situated between smaller scale faults in a relatively undeformed section northeast of Casper Mountain.

1.3 REGIONAL STRATIGRAPHY

The stratigraphic section of the project area extends, at depth, from Mississippian limestones deposited unconformably over Precambrian basement through Upper Cretaceous siliciclastics exposed and topped by Quaternary alluvium at the surface. Some localized Miocene rocks deposited unconformably on basement rocks are limited to outcrop areas, considered irrelevant to this evaluation, and are not discussed further.

Intervals of interest in the project area include the following:

- Cambrian to Paleozoic rocks, dominantly limestones, dolomites, and sandstones, deposited over Precambrian basement in transgressive marine to non-marine environments.
- Mesozoic shallow marine and terrestrial siliciclastics, carbonates, and evaporites.

Rock units (descriptions from Hunter, Ver Ploeg, & Boyd, 2005, and others as cited) from oldest to youngest include:

1.3.1 Undivided Igneous and Metamorphic Rocks (Archean)

Basement rocks underlying the Phanerozoic sedimentary section. Includes medium to very coarse-grained granite, gneiss and gneissic granite, and serpentinite intrusives. Exposed at top of Casper Mountain and other uplifted outcrops.

1.3.2 Flathead Sandstone (Cambrian)

Local distribution is poorly constrained, but likely occurs as thin to discontinuous quartz sandstone and conglomerate beds deposited unconformably over basement rocks.

1.3.3 Madison Limestone (Mississippian)

Regionally extensive cherty limestone and dolomite with karst at top; fossiliferous carbonate shelf deposits; an estimated 200-300 feet thick in the project area. A prolific freshwater aquifer in many parts of Wyoming, the Madison currently produces water for livestock, irrigation, and reservoir fill from two converted oil exploration wells (Govt Brannan #1, API 2505518; Govt Donley #1, API 2505485) within ~5 miles of the project location. Natural springs occur along Casper Mountain, from the “Casper Formation” or

"Aquifer" (Tensleep-Amsden) and Madison hydrologic units. Madison wells were previously used for industrial water production in Brooks Ranch and other nearby oil fields, and the city of Glenrock in Converse County sources public water supplies from Madison wells along the Laramie Mountain front. Additional details about Madison groundwater production are included in the hydrology and USDW sections of this application.

Based on available data, the Madison is considered the deepest USDW in the project area, warranting the submittal of an Injection Depth Waiver included with this permit application. Communication with the overlying injection zone is considered remote, as approximately 1,000 feet of low-permeability shale, limestone, and evaporites lies between the injection zone and the next permeable zone overlying the Madison (the Amsden Formation/Tensleep Sandstone).

1.3.4 Amsden Formation (Mississippian and Pennsylvanian)

Limestone and dolomite; shale, siltstone, and sandstone interbeds. The Amsden Formation records early Pennsylvanian transgression across a Mississippian carbonate shelf – i.e., the Madison Limestone (Anna, 2010). It is equivalent to the lower Minnelusa Formation of the eastern PRB and commonly includes the Upper Mississippian Darwin Sandstone at its base (Hunter, Ver Ploeg, & Boyd, 2005). The Amsden includes 125 feet to 330 feet of interbedded limestone, shale, dolomite, siltstone, and sandstone. Vertical communication with the underlying Madison and overlying Tensleep may be possible across permeable beds or natural fractures.

1.3.5 Tensleep Sandstone (Pennsylvanian)

The Tensleep Sandstone was deposited in a coastal dune environment on a prograding coastline. Its subsurface equivalents within the basin include the middle and upper Minnelusa Formation, which extends into the early Permian, and the Leo Sandstone. In regional hydrostratigraphy, the Tensleep and underlying Amsden/Madison are also grouped into the Casper Formation, exposed on and around Casper Mountain. Little is known about the characteristics of the Tensleep at the project location, but extensive published studies are available for Tensleep reservoirs in the Teapot Dome area some 25-30 miles to the north. Facies include medium to fine-grained massive sandstone, large-scale cross-bedded sandstone, and thin cherty limestone and dolomitic interbeds (Fryberger, S. G., 2013). Thickness is about 200 feet.

1.3.6 Goose Egg Formation (Permian-Triassic)

The Goose Egg Formation is regionally extensive and correlates in part to the Phosphoria Formation. Facies include bedded evaporites, mudstone red beds, siltstone, and thin sands (Anna, 2010). The Goose Egg provides a sealing caprock for the Tensleep reservoirs of Teapot Dome and other oil fields in Wyoming (Fryberger S. G., 2013) (Burk & Thomas, 1956). At some 400 feet thick in the study area, it is sandier, more gypsiferous, and more resistive on well logs than the overlying Chugwater Group. Together with the Chugwater, the Goose Egg comprises a lower confining zone for this project.

1.3.7 Chugwater Group (Triassic)

The basal unit of the Chugwater Group, the Red Peak Shale, comprises 600 feet of primarily low-permeability terrestrial deposits overlying the Goose Egg. Facies consist of red shale, siltstone, and fine-grained sandstone at the base, with algal limestones and mudstones higher in section. Overlying the Red Peak Shale is the Alcova Limestone (Bower, 1964; Lovelace, D. M., 2015), a thin, low-permeability carbonate that pinches out to the east of the project area; and the Crow Mountain Sandstone, a shallow marine or eolian quartzose sand (Warwick & Corum, 2012). The Chugwater below the Crow Mountain (i.e., Alcova and Red Peak) is designated as a lower confining zone for this project, along with the underlying Goose Egg Formation. The Crow Mountain is the basal reservoir unit of the injection zone for this project and sits an estimated 2,000 feet above the crystalline basement rock. The Chugwater correlates with the Spearfish Formation of the eastern PRB.

1.3.8 Gypsum Spring Formation (Jurassic)

The Gypsum Spring Formation is a shallow marine deposit containing gypsiferous beds, shales, and silts (Warwick & Corum, 2012). As a subordinate unit within the injection zone, the Gypsum Spring may provide some intraformational baffling of upward CO_2 movement. It is about 30 feet thick in the project area and grades into the overlying Sundance. Evidence of carbonate, likely intragranular cement, is seen locally on well logs at the base and top of the Gypsum Spring. Regionally, other recognized stratigraphic units such as the Stockade Beaver Shale and Canyon Springs Sandstone are likely correlative to or grade laterally into the Gypsum Spring.

1.3.9 Sundance Formation (Jurassic)

The Sundance Formation disconformably overlies the Gypsum Spring. Lithologies include calcareous and glauconitic sandstone and siltstone, shale, and limestone deposited in shelf-to-shoreface marine settings along a barrier island complex (Pipiringos, 1968; Uhlir, 1987; Johnson, E. A., 1992). The Sundance is divided into two units: the Lower Sundance, containing reservoir units including the Lak and Hulett sandstones or their stratigraphic equivalents; and the Upper Sundance, referred to here as the Redwater Shale. Thickly bedded siliciclastic cross-bedded sandstones and siltstones of the Lower Sundance comprise the injection zone for this project, along with the underlying Gypsum Spring and Crow Mountain. The Redwater Shale contains relatively impermeable marine mud and silt with minor sandstone and oolitic limestone (Warwick & Corum, 2012) and comprises part of the upper confining zone for this project, along with the overlying Morrison Formation. Total Sundance thickness is about 310-330 feet, containing more than 150 feet of net reservoir with clean sands having an average 15-20% porosity and average permeability of about 100 mD. Core analysis indicates the best developed sands can have porosity of more than 25% and permeability of ~1,000 mD.

1.3.10 Morrison Formation (Jurassic)

Overlying the Sundance is the Upper Jurassic Morrison Formation, comprising calcareous and bentonitic mudstones, shaly coastal plain deposits, and cross-bedded silty sandstones (Tank, R. W., 1956; Connely, M. V., 2002). These terrestrial facies were deposited in floodplain, lacustrine, and fluvial settings. The Morrison can further be divided into a lower unit (sandstone, siltstone, limestone, and shale) and an upper unit (shale). The Morrison will prevent upward movement of the injected CO_2 as part of upper confining zone for this project, along with the underlying Redwater Shale. Thickness is about 200 feet.

1.3.11 Dakota Formation, Fuson Shale, and Lakota Formation (Inyan Kara Group)

The Morrison Formation is overlain by the Lower Cretaceous Inyan Kara Group, which includes the Lakota Formation, Fuson Shale, and Fall River (Dakota) Formation (Anna, 2010; Warwick & Corum, 2012). Total thickness is about 150 feet. The basal unit, the Lakota, consists of cross-bedded chert pebble conglomerates of highly variable thickness in the project area, with deposition occurring in channels or on scour surfaces downcutting the underlying Morrison. The Fuson is a dark gray to black shale, while the overlying Dakota contains claystones, thin silty shales, and siltstones with scattered local oil production. The Lakota, dominated by mud-matrix conglomerate in the injection zone, can be locally productive as a brackish aquifer, but transmissivity and continuity is low owing to discontinuous permeability.

1.3.12 Skull Creek (Thermopolis) Shale and Muddy Sandstone (Lower Cretaceous)

This shale-sandstone package overlies the Dakota/Lakota section and is about 130 feet thick (Anna, 2010; Warwick & Corum, 2012). It includes fissile shale and fine- to-medium-grained sandstone. The Muddy, which is productive for oil in nearby Brooks Ranch Field, grades upward into the overlying Mowry Shale.

1.3.13 Mowry Shale (Upper Cretaceous)

The Mowry Shale is a regionally extensive, siliceous marine shale with high clay content, including bentontite layers, which provides a very low-permeability smear across faults through the overlying and underlying rocks (Surdam et al., 2010; Davies et al., 2015). It is about 230 feet thick in the project area.

1.3.14 Frontier Formation (Upper Cretaceous)

Conformably overlies the Mowry Shale and conformably underlies the Cody Shale. About 900 feet thick in the project area, the Frontier contains fine- to coarse-grained sandstone interbedded with dark siltstone and shale. Contact with the Mowry occurs at the "Clay Spur Bentonite." The Frontier is a high-water cut, oil-producing unit of the offset Brooks Ranch Field.

1.3.15 Cody Shale (Upper Cretaceous)

Calcareous marine shale with many bentonite layers and some sandstone that contains brackish groundwater in the project area (Anna, 2010; Warwick & Corum, 2012). Undivided in this report; locally present members of the Cody Shale include the Niobrara Formation and the Carlile Shale.

1.3.16 Mesaverde Formation (Upper Cretaceous)

Includes the Teapot and Parkman sandstones, which locally are potable freshwater aquifers. Forms the surface bedrock at the project location, where it is about 650-800 feet thick.

1.3.17 Lewis Shale (Upper Cretaceous)

Fully eroded at the project site but present as bedrock about 1 mile to the north. Comprises gray shale and sandstone hosting potable freshwater.

1.3.18 Fox Hills Sandstone (Upper Cretaceous)

Fully eroded at the project site but present as bedrock about 1.5 miles to the northwest. Upward-coarsening marine sandstone.

1.3.19 Surficial Deposits (Pleistocene / Holocene)

Includes landslide and alluvial fan deposits (pebbles, cobbles, boulders, and blocks) deposited downslope from elevated outcrops; alluvial and terrace deposits (clay, silt, sand, and gravel) concentrated in channels and stream valleys; windblown quartz sand (stabilized and mobile) forming dunes trending southwest-northeast to the north of the North Platte River.

1.4 REGIONAL CROSS SECTIONS

Regional dip and strike structural cross sections are located on Figure 4 and shown in Figure 5 and Figure 6. These lines are adapted from a large set of USGS structural cross sections covering the PRB to demonstrate alignment with previously published work. The selected data are highlighted on the map. The cross sections have a consistent vertical scale, are constructed with well logs, and show regional correlations of formations from the surface to the confining strata below the injection zone. Stratigraphic units, aquifers, and injection and confining zones are indicated.

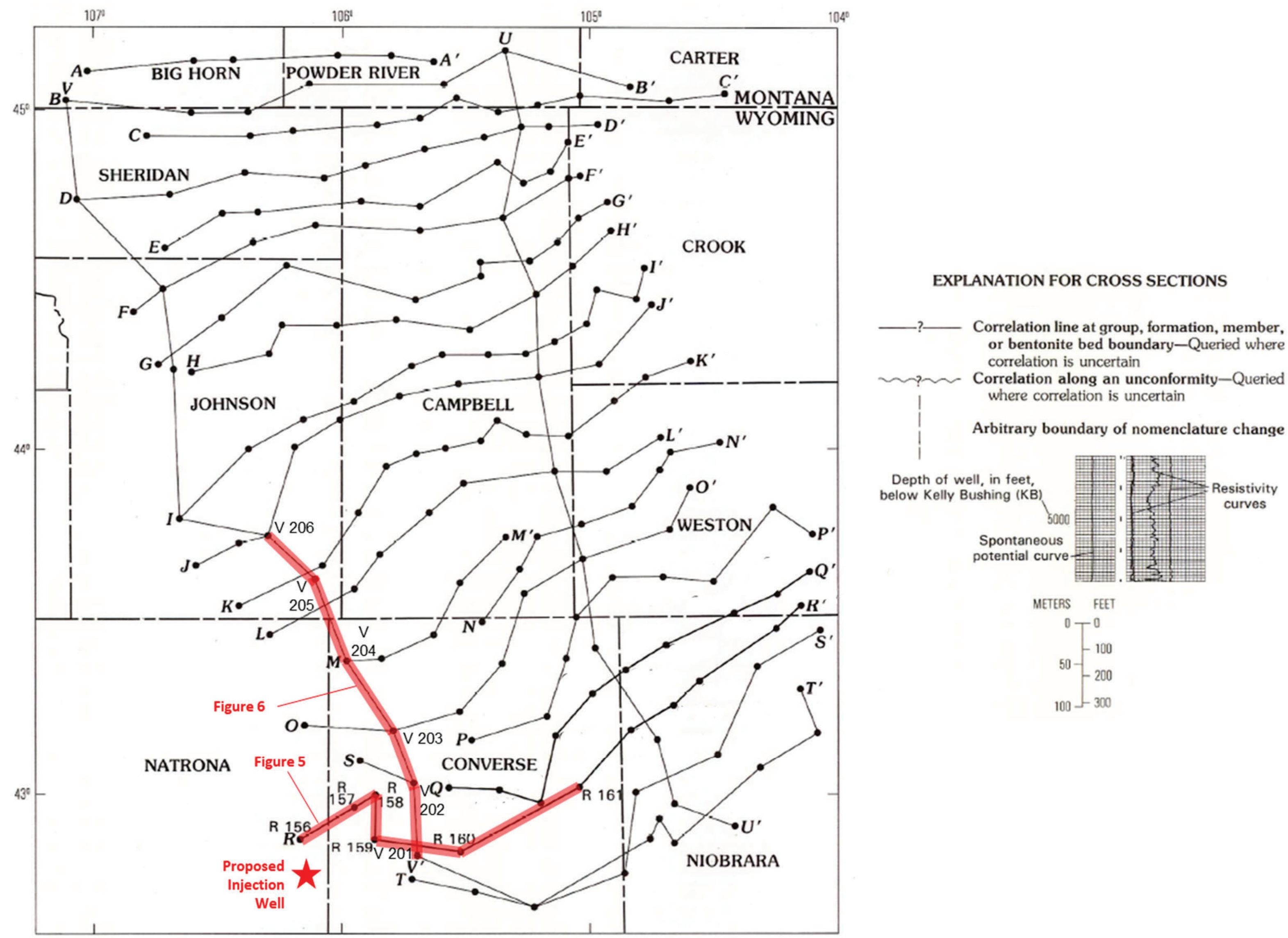


Figure 4: Regional cross-section map (after Fox, 1993).

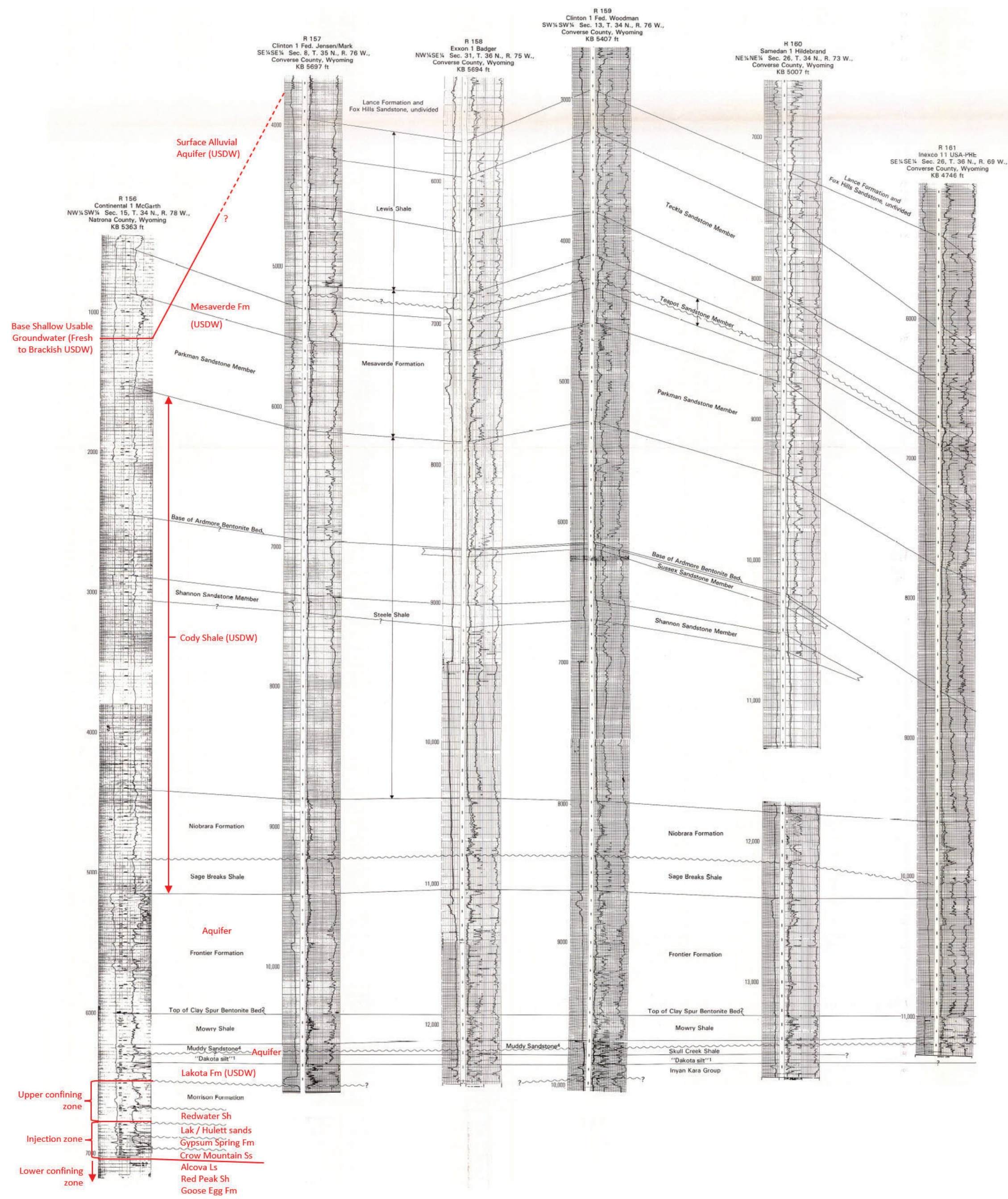


Figure 5: Regional cross-section (dip-oriented) of the Powder River Basin near the Project Area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

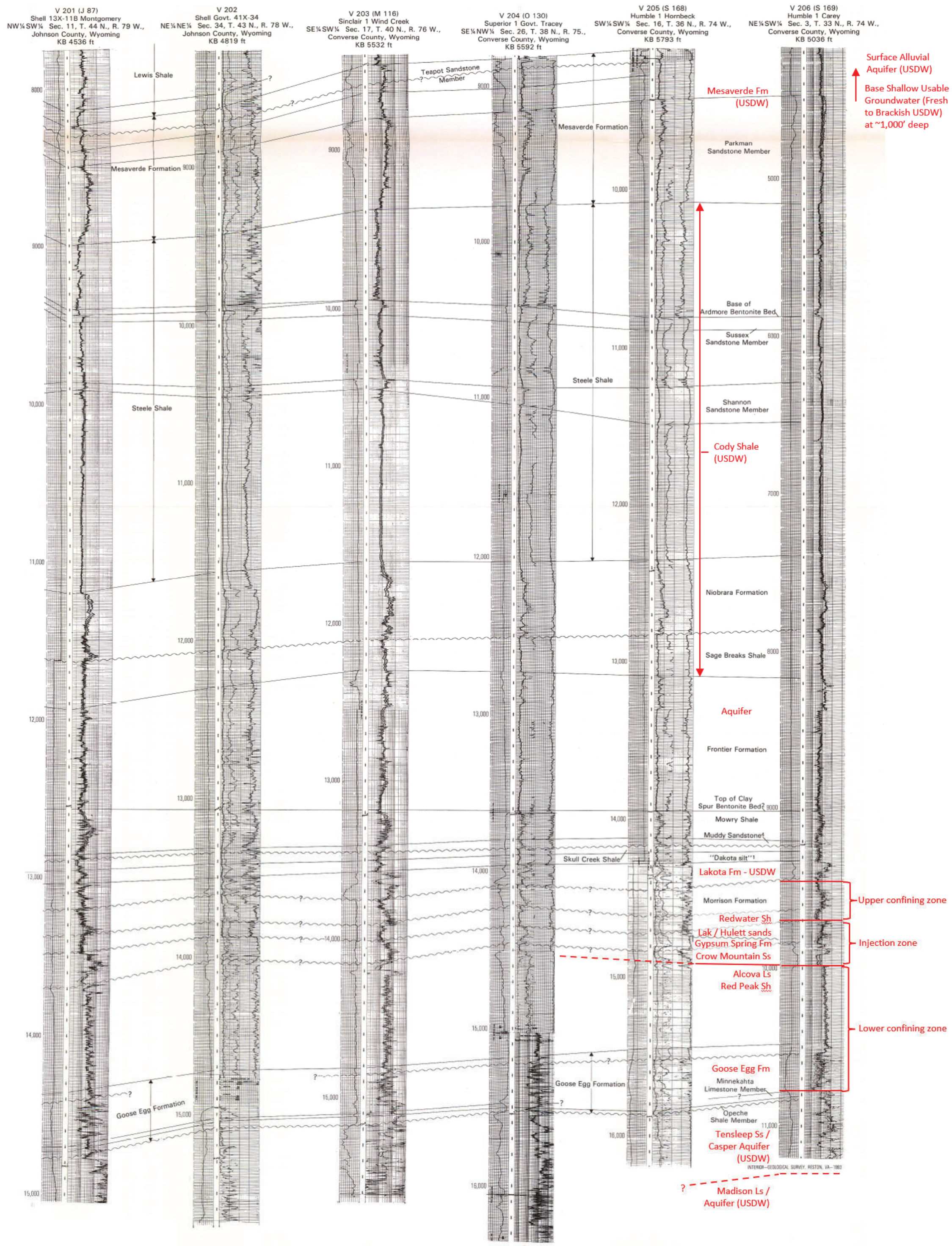


Figure 6: Regional cross-section (strike-oriented) of the Powder River Basin near the project area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

1.5 POTENTIAL MINERAL ZONES

Pursuant to WWQR, Chapter 8, Section 6(c)(ii), the discharge of waste will not degrade or decrease the availability of mineral resources, including oil and gas. Exploration drilling dating to the mid-20th century has demonstrated that no geologic zones in the area of Casper Carbon Capture #1 are prospective for commercial hydrocarbon production. There is no active exploration or production in the project area, and the nearest established production is in the Frontier Formation of Brooks Ranch Field ~3.5 miles to the northeast. The storage complex for this project is stratigraphically lower than the Frontier, and neither free-phase CO_2 nor pressure changes are expected to affect production at Brooks Ranch. Based on this information, no degradation or decrease in availability of mineral resources is expected to result from the project.

1.6 REGIONAL HYDROSTRATIGRAPHY

Major aquitards (confining zones) and major, marginal, and minor aquifers are defined in the Wyoming Statewide Framework Water Plan (http://waterplan.state.wy.us/basins/7basins.html). Zones of interest that are present or potentially present in the project area are listed below (adapted from Taboga, K. G., 2013) and noted, where penetrated, on Figure 5 and Figure 6:

1.6.1 Major Aquifers Above the Primary Upper Confining Zone

Quaternary alluvium
Fox Hills Formation
Clovery (including Dakota and Lakota Formations)

1.6.2 Major Aquifers Below the Primary Lower Confining Zone

Tensleep Sandstone
Madison Limestone
"Casper" aquifer or formation, generally including Tensleep and sometimes overlying/underlying rocks

1.6.3 Marginal Aquifer (Injection Zone)

Sundance Formation

1.6.4 Minor Aquifers Above the Primary Upper Confining Zone

Quaternary non-alluvial deposits

Mesaverde Formation
Frontier Formation

1.6.5 Minor Aquifers Below the Primary Lower Confining Zone

Flathead Sandstone (if present)

1.6.6 Major Aquitards Above the Primary Upper Confining Zone

Lewis Shale
Cody Shale
Mowry Shale
Skull Creek (Thermopolis Shale)

1.6.7 Major Aquitards Below the Primary Lower Confining Zone

Chugwater Group
Goose Egg Formation
Precambrian Basement

The primary USDWs in the project area are the Mesaverde Formation, Cody Shale, and Quaternary alluvium (assumed to typically be in hydraulic communication with the underlying Mesaverde and Cody aquifers). Additionally, the Lakota Formation produces from three known wells in the project vicinity for domestic, livestock, irrigation, and/or miscellaneous use. The Lakota is not a public water supply in the area. The Madison and Casper aquifers produce from two known wells in the project vicinity for livestock, irrigation, and/or miscellaneous use. The Madison was also produced for industrial use from a well in the nearby Brooks Ranch Oil Field, but the zone was later abandoned during a well recompletion. The Madison is a public water supply for the city of Douglas ~36 miles to the east of Casper Carbon Capture #1. Additional information about USDWs is provided in Section 1.8 Geology of USDWs.

1.7 REGIONAL GROUNDWATER FLOW

In the PRB, the regional groundwater flow is largely controlled by the terrain and geologic features. At higher elevations on the uplifted basin margins, aquifers are recharged by precipitation and usually reflect an influence of topography (Taboga, 2013). These aquifers are commonly unconfined and discharge at springs where the water table is higher than ground level. As groundwater flows downdip from the recharge areas, it becomes confined by overlying low-permeability rocks. Joints, fractures, or faults through a confining unit may permit flow from an underlying aquifer to reach the surface driven by the piezometric head present in an area. Groundwater flow within the deeper formations of the basin occurs mainly through permeable formations down-gradient (from higher to lower hydraulic pressure) and generally down-dip.

A variety of groundwater systems around the Casper area results in part from the structural configuration of the PRB margin, which allows older hydrogeologic units to recharge at surface outcrops before becoming confined toward the basin. Further compartmentalization of aquifers occurs along faults that sever the hydrogeologic units, as has been observed in the Madison aquifer on Casper Mountain, where five distinct groundwater compartments are documented (Stacy & Huntoon, 1994).

In the project area, groundwater flow generally occurs in two prevailing directions separated by the Casper Mountain Fault, which acts as an east-west barrier to flow. North of the fault, groundwater flow is generally to the north-northeast, in the direction of the structural dip; this trend moves groundwater away from Casper Mountain. On the south side of the Casper Mountain Fault, groundwater flow is to the south. On the eastern side of Casper Mountain, smaller-scale northeast-trending smaller faults and folds direct groundwater flow to the northeast, again away from the mountain front.

At Casper Mountain, recharge to the aquifers occurs by percolation of precipitation on the outcrop areas, by vertical leakage from overlying aquifers, and by vertical movement through faults and fractures. Fracturing has occurred primarily where rocks have been structurally deformed, e.g., on Casper Mountain (which is the uplifted hanging wall block of a reverse fault system), and within the highly dipping strata of the footwall block. These structurally deformed areas are all located to the south of the Casper Carbon Capture #1 site. Discharge occurs at springs where the level of the water table is higher than the ground surface. The nearest springs are 3.8 miles to the south-southeast of Casper Carbon Capture #1 (Wyoming Groundwater Atlas), located updip of the injection wells along the northeastern margin of the Casper Mountain outcrop.

Published potentiometric surface maps were utilized for the deeper aquifers found in the proposed Area of Review (AoR, see Form A-2 for more information). Figure 7 shows a regional potentiometric surface map of the Lower Cretaceous aquifers (Dakota/Lakota). The Lower Cretaceous water levels in the study area are shown to be at an elevation of approximately 4,400 feet. Figure 8 shows a potentiometric surface map of the Upper Paleozoic aquifers (Sundance/Casper). The Upper Paleozoic water levels in the study area are shown to be at an elevation of approximately 4,100 feet.

Figure 9 shows a potentiometric surface map of shallow aquifers created using Surfer (version 27.1.229, 03/07/2024) software. The surface was created by taking the available depth to water levels from the water wells within the AoR (see Form A-2 Appendix). To achieve more accurate results, wells with water depths less than 1 foot and greater than 150 feet were discarded.

Most of the moveable groundwater is believed to be contained in faulted and fractured zones (Wright Water Engineers, 1982). Previous studies of potential future groundwater production sites have focused on fracture-enhanced areas on the southern margin of Casper Mountain. The historical geologic targets for groundwater development are the Casper Aquifer, the Madison Limestone, and Cambrian-Mississippian sandstone, which are isolated from the injection zone by low-permeability rocks of the Goose Egg and Red Peak (Chugwater) shales.

1.8 GEOLOGY OF USDW FORMATIONS

Water production from groundwater wells around the project area primarily originates from alluvial aquifers or the shallow bedrock Mesaverde aquifer, some 5,000 feet or more above the injection zone and protected from upward migration of CO_2 by a primary confining zone (Redwater Shale and Morrison Formation) and multiple secondary confining zones (especially the Skull Creek Shale, Mowry Shale, and Cody Shale). Notably, all drinking water wells inside and within 1 mile of the anticipated AoR are shallow, not exceeding 1,000 ft in depth. Figure 10 shows all water wells within the AoR.

The deepest water well within a 3-mile radius of the Casper Carbon Capture #1 is 1,000 feet, or approximately 4,695 feet above top of the Morrison Formation confining zone at the project location. Slightly saline to moderately saline waters (1,000-10,000 mg/L TDS) are estimated to be producible to depths of about 1,200 feet at the project location, in the Cody Shale. To confirm this base of the shallow USDW, well logs were reviewed to determine the depth to clean sand with deep resistivity greater than 2.0 ohm-m. There are also six springs located in the AoR.

Certain deeper aquifers at the project site are not used for public water supply but are considered USDWs owing to low total dissolved solids (TDS) project. These include the Lakota Formation (immediately overlying the upper confining zone), the Casper Aquifer (Tensleep and Amsden Formations, immediately underlying the lower confining zone), and the Madison Limestone, immediately underlying the Casper Aquifer. An injection depth waiver application has been prepared seeking approval to inject CO_2 above the Casper Aquifer.

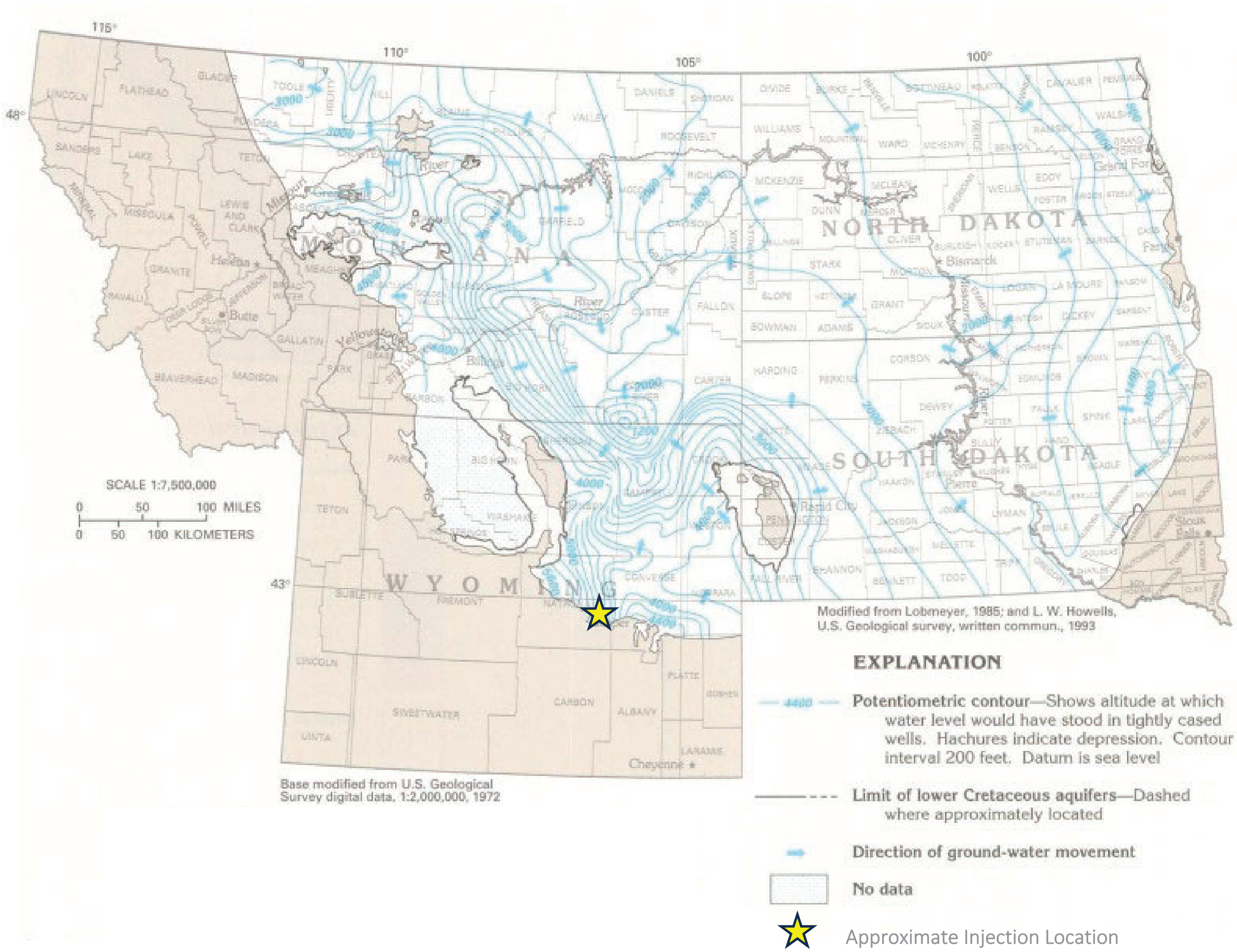


Figure 7: Potentiometric-surface map showing Lower Cretaceous Aquifers (modified from USGS Groundwater Atlas, 1996).

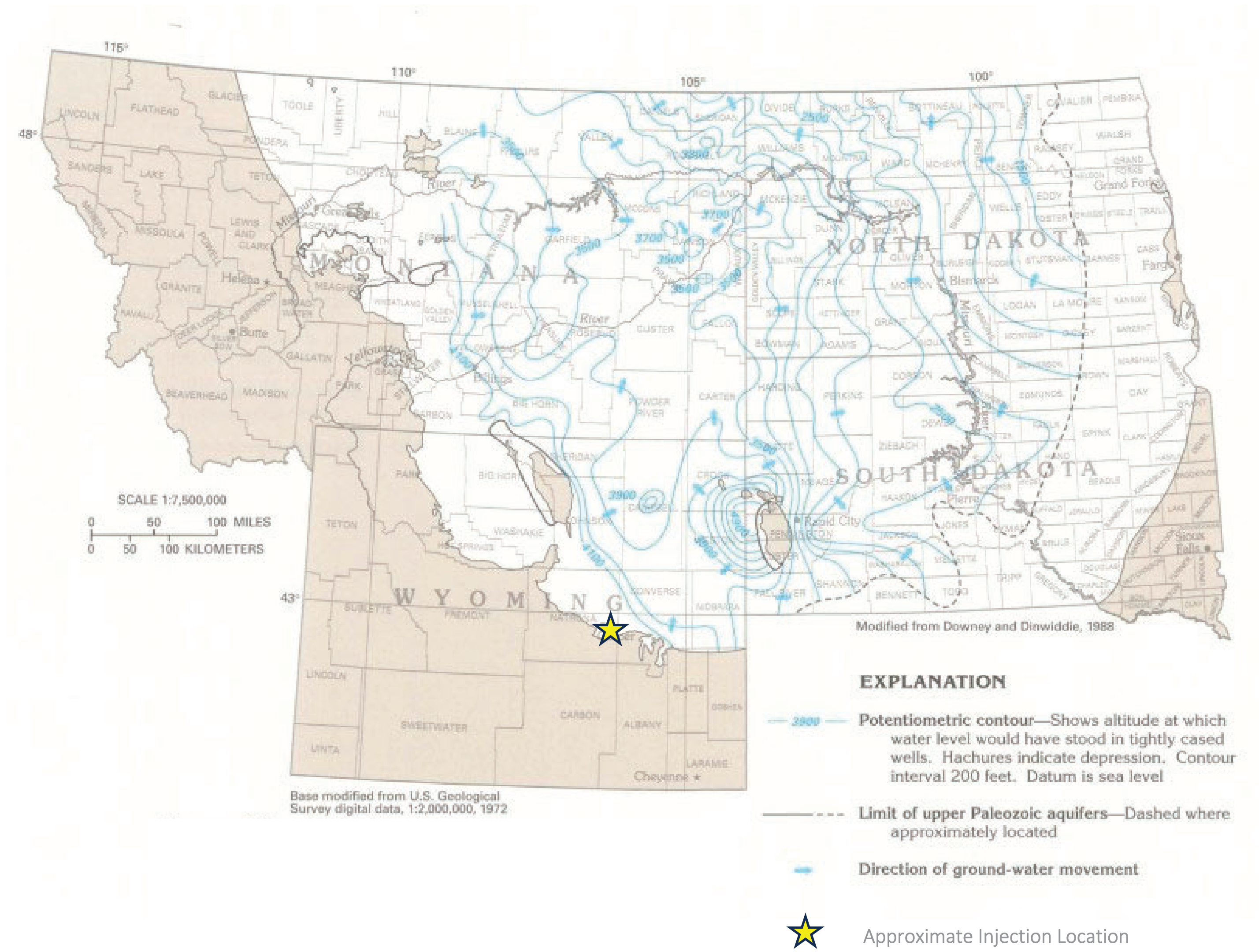


Figure 8: Potentiometric-surface map showing Upper Paleozoic Aquifers (modified from USGS Groundwater Atlas, 1996).

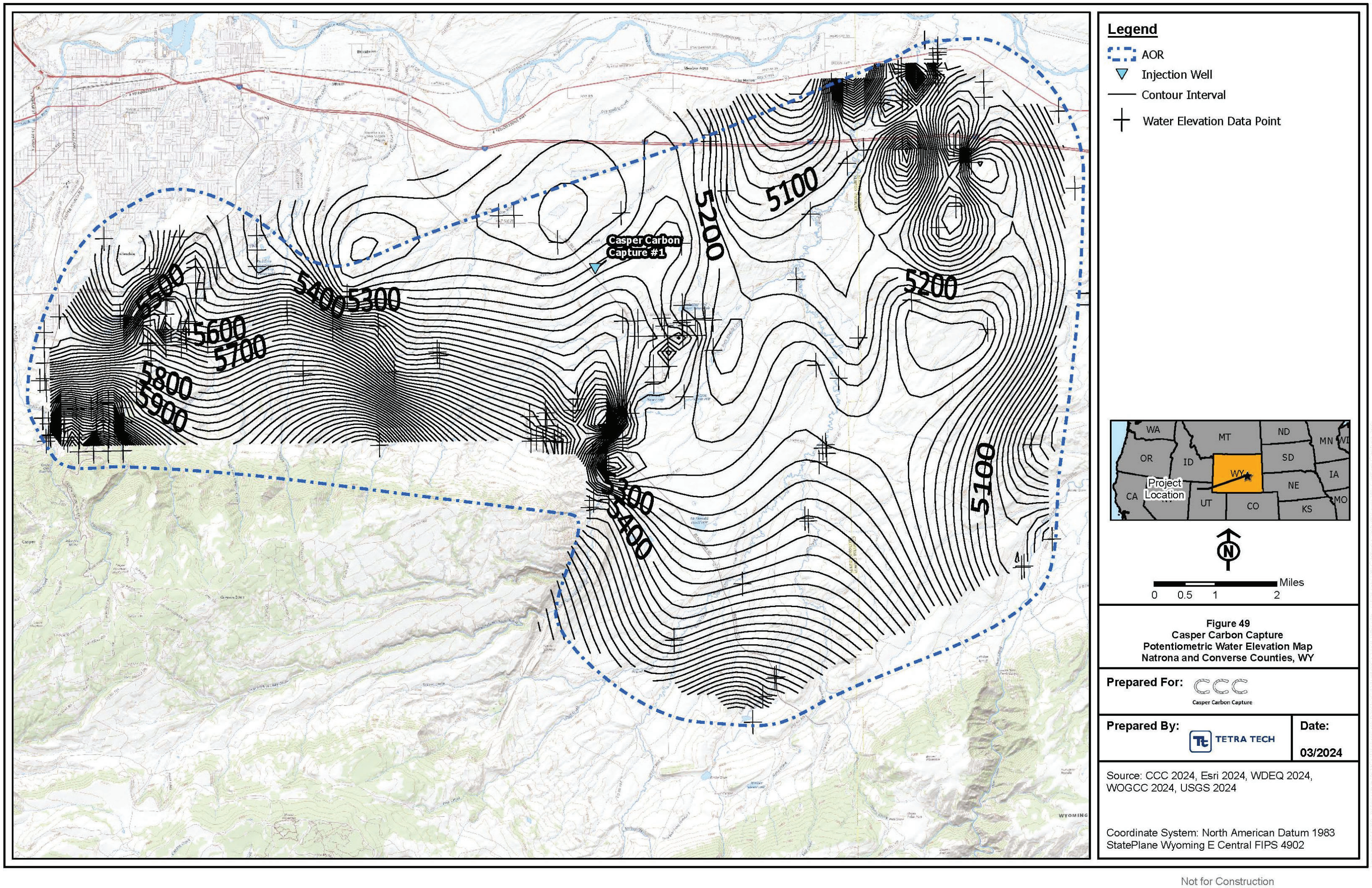


Figure 9: Potentiometric surface map for shallow aquifers within the AoR.

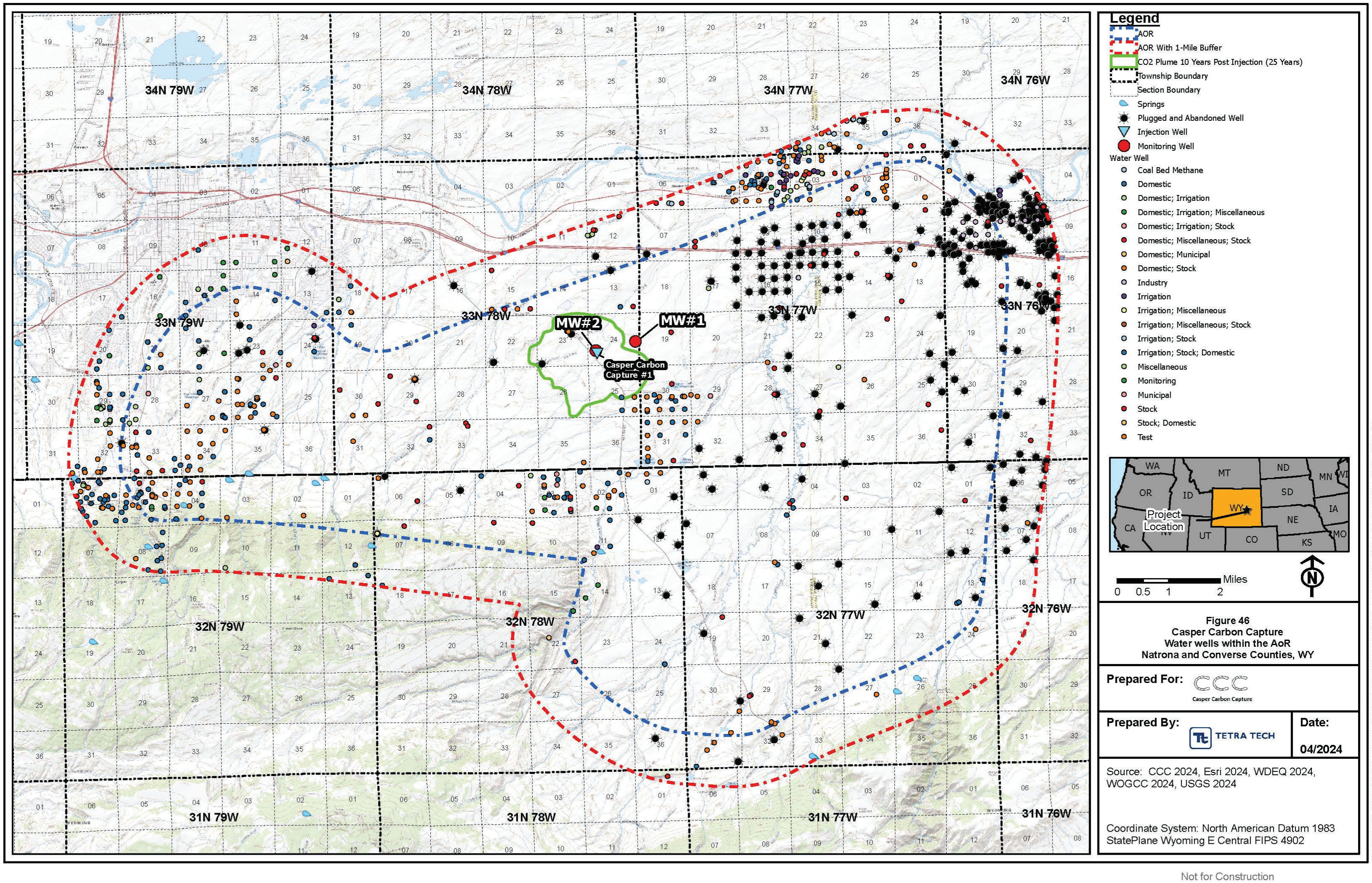


Figure 10: Water wells within the AoR.

1.8.1 Hydrostratigraphy at the Project Site

Figure 11 shows hydrostratigraphy and USDWs in the AoR, and Figure 12 shows the mapped extent of aquifers and confining units across the project area. Quaternary alluvial aquifers make up the shallowest USDW where present in the AoR. Below the Quaternary alluvium, the Mesaverde aquifer provides water for the majority of shallow water wells within the AoR. The Lakota formation is the deepest USDW that lies above the upper confining zone and proposed monitoring is discussed Form A-5 – Testing and Monitoring Plan. The Casper Aquifer lies beneath the lower confining zone. The Madison Aquifer underlies the Casper Aquifer and is the deepest USDW within the AoR.

Major Aquifers Above Confining Zone

The Quaternary alluvium, which is characterized by a mix of landslide and alluvial fan deposits, as well as windblown quartz sand, hosts aquifers with yields potentially over 1,000 gpm. These yields are influenced by factors like adjacent rivers, impacting transmissivity depending on the sediment's saturated thickness and size, ranging from 15 to 64,000 gpd/ft (Eisen et al., 1981). Water quality varies, with TDS often exceeding 1,000 mg/L, although areas near the North Platte River show lower TDS due to surface water impact.

At the project site, the Fox Hills Formation, a primarily upward-coarsening marine sandstone, is fully eroded but is present as bedrock approximately 1.5 miles to the northwest. Its transmissivities range from 100 to 2,000 gpd/ft, with specific capacities generally spanning 0.05 to 2 gpm/ft (Eisen et al., 1981). Although well yields can reach up to 350 gpm, these are typically associated with extended perforated intervals and significant drawdowns. Water quality varies significantly; outcrop waters contain 350 to 3,500 mg/L of TDS, displaying a variable major ion composition, while central basin waters have 1,000-3,500 mg/L TDS and are characterized by sodium bicarbonate-sulfate (Eisen et al., 1981).

The Lower Cretaceous Inyan Kara Group, encompassing the Lakota, Fuson Shale, and Dakota, has an approximate thickness of 150 ft. The Lakota, primarily a mud-matrix conglomerate in the project area, shows potential as a brackish aquifer with specific capacities ranging from 0.1 to 1 gpm/ft and yields generally under 50 gpm, though its low transmissivity and discontinuous permeability limit its productivity (Eisen et al., 1981). Similar to the Fox Hills Formation, TDS levels vary significantly, with outcrop waters ranging from 277 mg/L to 3,300 mg/L, while deeper basin waters exceed 10,000 mg/L, predominantly consisting of sodium chloride.

Era	System/ Series		Lithostratigraphy			Project Significance	Hydrostratigraphy
Quaternary Alluvium						USDW where present in AOR	Aquifer
Mesozoic	Cretaceous	Upper	Lance Fm			UDSW where present in AOR (not present over plume)	Aquifer
			Fox Hills Ss				
			Lewis Sh				Confining layer
			Mesaverde Fm (undivided)			USDW	Aquifer
			Cody Sh (undivided)			• Lowermost widely used USDW • Oil and gas production inside AOR	Confining layer with intraformational aquifers
			Frontier Fm			Oil production inside AOR	Aquifer
			Mowry Sh				Confining layer
		Lower	Muddy Ss			Oil production just outside AOR	Aquifer
			Thermopolis Sh / Skull Creek Sh				Confining layer
			Inyan Kara Gp		Fall River Fm (Dakota)	Lowermost oil and gas production inside AOR	Aquifer
					Fuson Sh		Confining layer
					Lakota Fm	• Lowermost USDW above storage complex • Limited oil production just outside AOR	Aquifer
	Jurassic		Morrison Fm			Upper Confining Zone	Confining layer
			Sundance Fm	Upper	Redwater Sh		
				Lower	Lak Ss	Injection Zone	Aquifer
					Hulett Ss		
					Stockade Beaver/ Canyon Springs		
			Gypsum Spring Fm				
	Triassic		Chugwater Gp		Crow Mountain Ss		
					Alcova Ls	Lower Confining Zone	Confining layer
					Red Peak Fm		
Paleozoic	Permian		Goose Egg Fm				
	Carboniferous	Penn	Tensleep Ss			Uppermost USDW below storage complex (Casper Aquifer)	Aquifer
			Amsden Fm				
		Miss	Madison Ls			Lowermost known USDW below storage complex	Aquifer
	Undivided						
Precambrian	Archean		Igneous and metamorphic basement rocks			Overthrusting and truncation of sedimentary section along mountain front	Confining layer

Figure 11: Site hydrostratigraphy with USDWs (in yellow).

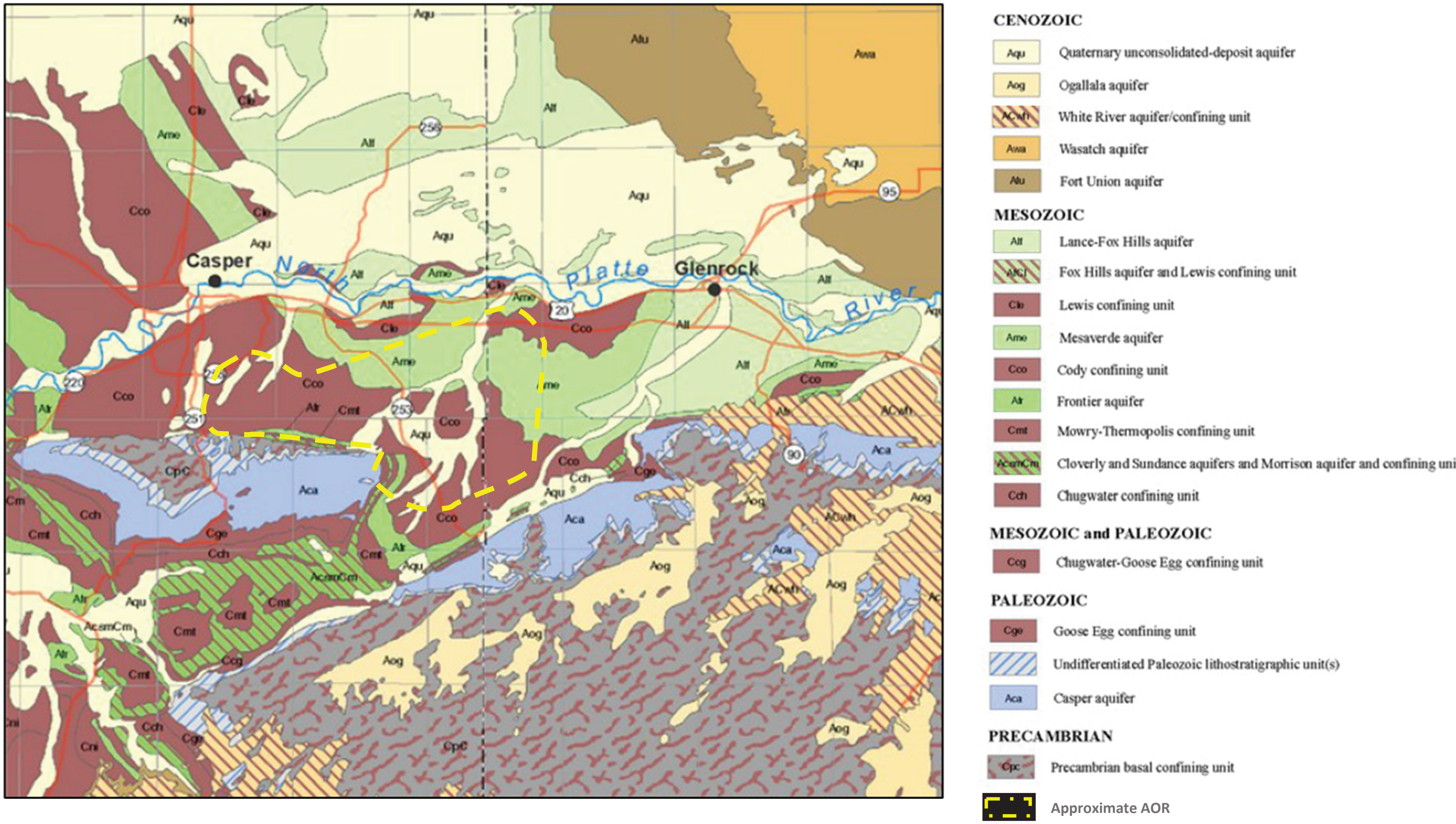


Figure 12: Areal map of USDWs (modified from Taboga et al., 2013).

Minor Aquifers Above Confining Zone

Minor Quaternary aquifers, characterized by diverse deposits from landslide and alluvial fans to windblown quartz sand, show significant potential with well yields exceeding 1,000 gpm in alluvial areas (Crist and Lowry, 1972). These aquifers exhibit a wide range of specific capacities, from 0.3 to 18 gpm/ft (Lowry and Cummings, 1966; Whitcomb and Morris, 1964), varying porosities between 28 to 45% (Whitcomb and Morris, 1964), and permeabilities up to 600 gpd/ft^2 (Eisen et al., 1981). Transmissivity values, crucial for understanding vertical and lateral USDW limits and groundwater flow, range from 15 to 350 gpd/ft, escalating up to 64,000 gpd/ft in some areas, with the saturated thickness playing a pivotal role (Davis and Rechard, 1977; Crist and Lowry, 1972) (Eisen et al., 1981).

The Mesaverde Formation, including the Teapot and Parkman sandstones, forms the surface bedrock at the project site, measuring approximately 650-800 ft thick and serving locally as potable freshwater aquifers.

The Frontier Formation, approximately 900 ft thick in the project area and composed of fine- to coarse-grained sandstone with interbedded dark siltstone and shale, is the geological unit overlying the Mowry Shale and beneath the Cody Shale. As an aquifer, it yields up to 10 gallons per minute (gpm) to flowing wells, with potential yields up to 50 gpm in regions north and west of Casper on the Casper arch, as documented by Crist and Lowry (1972). Reported permeabilities range from 0.1 to 9.0 gpd/ft^2, predominantly below 2 gpd/ft^2, with limited transmissivity, often less than 150 gpd/ft (Eisen et al., 1981). The Frontier Formation is not used as a source of drinking water within the AoR.

Major Aquitards Above Confining Zone

At the project site, Lewis Shale is completely eroded but exists as bedrock approximately one mile north, comprising gray shale and sandstone hosting low yields of potable freshwater.

Cody Shale with its Niobrara Formation and Carlile Shale members, typically contain brackish groundwater, as highlighted in studies by Anna (2010) and Warwick & Corum (2012). The deepest water well within a 3-mile radius of Caper Carbon Capture #1 descends 1,000 ft into the Cody Shale.

The Cody Shale is the uppermost aquitard at the project site. The Niobrara Formation and Carlile Shale members of the Cody Shale typically contain brackish groundwater, as highlighted in studies by Anna (2010) and Warwick & Corum (2012). The deepest water well within a 3-mile radius of Caper Carbon Capture #1 descends 1,000 ft into the Cody Shale.

The underlying Mowry Shale, a siliceous marine deposit with a high clay content and bentonite layers, is recognized for its exceptionally low permeability. With a thickness of approximately 230 ft in the project area, its aquifer yield in Natrona County ranges from flowing yields up to 2 gpm to pumped yields up to 10 gpm (Surdam et al., 2010, and Davies et al., 2015).

The Skull Creek Shale and Muddy Sandstone package, approximately 130 ft thick and comprising fissile shale and fine- to medium-grained sandstone, sits atop the Dakota/Lakota section (Anna, 2010; Warwick & Corum, 2012). Although the Muddy is productive for oil in the adjacent Brooks Ranch Field and transitions into the Mowry Shale above, there are no reported wells extracting water from Skull Creek Shale.

Major Aquifers Below Confining Zone

The Tensleep Sandstone and its subsurface equivalents, including the middle and upper Minnelusa Formation and the Leo Sandstone, are also known as the Casper Aquifer and are characterized by varied sedimentary structures and mineral compositions (Fryberger, S. G., 2013). While yields from these formations generally remain below 200 gpm (Eiesen et al., 1981), the Casper Aquifer in outcrop areas typically has low TDS under 500 mg/L, indicating freshwater quality predominantly of magnesium-calcium bicarbonate type (Whitcomb and others, 1966; Wyoming Water Planning Program, 1972). However, deeper regions in the east half of the basin show higher TDS levels (Eisen et. Al, 1981).

The underlying Madison Limestone is 200-300 feet thick in the project area and is characterized by cherty limestone and dolomite with karst features. It has historically supported various water needs, with yields varying from 600 gpm to 1,200 gpm and transmissivities ranging from 1,000 gpd/ft to more than 300,000 gpd/ft (Eisen et al., 1981). Water quality in the Madison aquifer varies significantly, with TDS near outcrops less than 600 mg/L, increasing basinward to over 3,000 mg/L, primarily comprising calcium-magnesium bicarbonate near the surface and sodium sulfate-chloride in deeper regions (Eisen et al., 1981). In nearby Brooks Ranch Oil Field, the Mississippian Madison Limestone was drilled as a non-saline industrial water source and produced ~3,000-8,000 mg/L TDS in the 1960s and 1970s.

Minor Aquifers Below Confining Zone

In the northern part of the basin, the Cambrian Flathead and Deadwood sandstone aquifers are known for their limited quality and yield of water, with minimal exploitation to date. The Flathead Sandstone is characterized by its tan to reddish hue, occasional conglomeratic nature, and layers interbedded with green shale and siltstone. Notably, a

USGS sample from Section 15 Township 57 Range 65 reveals that Flathead sandstone contains less than 0.4 µg/L of uranium, 14 pCi/L of radium-226, and a gross beta as cesium-137 of 19 pCi/L (Eisen et al., 1981). These sandstones are not known to be present in the project area.

Major Aquitards Below Confining Zone

The Chugwater Group, approximately 600 ft thick, includes the Red Peak and overlying Alcova Limestone, serving as the basal confining zone for this project (along with the Goose Egg Formation) beneath the Jurassic sandstones of the injection zone (Bower, 1964; Lovelace, D. M., 2015). Wells drilled into the Chugwater in Natrona County typically yield less than 20 gpm (Eisen et al., 1981). Spearfish Formation (Chugwater equivalent) wells in central Crook County reported specific capacities of 0.5 and 0.6 gpm/ft, with corresponding permeabilities and transmissivities, indicating its limited aquifer potential (Whitcomb and Morris, 1964). A Chugwater well in Natrona County exhibits mixed cation sulfate water with a TDS of 1,330 mg/L (Crist and Lowry, 1972).

The Goose Egg Formation, correlating partly with the Phosphoria Formation, comprises regionally extensive bedded evaporites, mudstone red beds, siltstone, and thin sands (Anna, 2010). This formation acts as a sealing caprock for Tensleep oil reservoirs in Wyoming (Fryberger S. G., 2013; Burk & Thomas, 1956). Crucially, the Permian Opeche Shale, the basal member of the Goose Egg, is considered an effective impervious barrier, isolating the Paleozoic section beneath it and influencing the vertical and lateral USDW limits (Trotter, 1963; Eisen et al., 1981).

Marginal Aquifer

The Sundance Formation, comprising calcareous and glauconitic sandstone, siltstone, shale, and limestone, is more than 300 feet thick and contains more than 150 feet of potential reservoir. Clean sands of the Sundance Formation have an average 15-20% porosity and permeability up to 1,000 mD, as detailed by Warwick & Corum (2012) and others. Its TDS often surpasses 1,000 mg/L (Eisen et al., 1981), with variations from sodium sulfate to sodium chloride brines, indicating diverse water qualities crucial for considering its designation as an USDW.

1.9 SURFACE AIR AND/OR SOIL GAS MONITORING DATA

At this phase of the project, no site-specific surface air or soil gas monitoring data was available for baseline reference. Baseline environmental data will be collected prior to injection and details for the planned baseline sampling are further described in Form A-5 Testing and Monitoring Plan.

2.0 STORAGE RESERVOIR GEOLOGY

2.1 DATA AND INFORMATION SOURCES

2.1.1 Existing Data

The geology of the PRB has been studied extensively owing to oil and gas exploration. Existing data were reviewed and curated to inform the site characterization, conceptual model development, and 3D modeling phases of this project.

Public sources of data, and a general summary of the information collected, included the following:

- WOGCC data site (http://pipeline.wyo.gov/legacywogcce.cfm) – Drilling and completion records, well header information (e.g., TD, important dates, location), formation tops, well logs, gas/water analyses, and core analysis reports.
- Wyoming Geological Survey – Bedrock and surficial geology maps, basin summaries, type logs.
- Wyoming State Engineer's Office – Water well records.

Published literature – Stratigraphy and lithology, structural geology, regional stress information, geochemistry, basin evolution, hydrocarbon exploration history, hydrology and groundwater characteristics.

Commercial, purchased, and/or licensed sources of data, and a general summary of the information collected, included the following:

- IHS Energy databases and platforms including Enerdeq and Kingdom – Drilling and completion records, well header information (e.g., TD, important dates, location), formation tops, well logs, drill stem tests, production histories, and drilling mud weights and temperatures. As the primary interpretation software for the project, Kingdom was used extensively to interpret and present well data, including stratigraphic correlations, construction of cross sections, structural mapping, well log digitization and editing, facies picks, and petrophysical calculations.
- Seismic clearinghouses – 2D seismic lines (selected segments were reprocessed for evaluation) and legacy oilfield structure maps in and around the project area.

2.1.2 Geophysical Well Logs

Approximately 200 wells with logs were reviewed and/or incorporated into geologic interpretations during the site characterization, conceptual model development, and 3D modeling phases of this project. Well logs were used for lithostratigraphic and structural control, petrophysical estimation of reservoir and geologic properties, or both, depending on well location, log depths, and log type. A complete list of these wells is provided in Form A-2 Appendix. Well logs used for detailed analysis (e.g., petrophysical reservoir property determination) are discussed further in the Form A-2 - AoR and Corrective Action Plan.

2.1.3 Core Sample Analyses

Approximately 15 wells with conventional core analysis through either the injection zone, confining zones, or overlying/underlying strata were used to establish general porosity and permeability trends for PRB reservoirs (Figure 13). A complete listing of wells with core data used for this project is provided in Form A-1 Appendix.

Only three wells with core data in the injection interval were located within the PRB. The most proximal two of these, SD3 SW 26 LOU 9 (API 4902521839) and Unit 59 (4901905826) from western PRB, were chosen as the core control well based on similarities in stratigraphy/facies and log-derived porosity compared with wells near the Casper Carbon Storage Hub. In SD3 SW 26 LOU 9, which has a full log suite, a high positive correlation between density log and core porosity was observed. The SD3 SW 26 LOU 9 also provides excellent vertical core coverage through the injection zone and includes grain density measurements that were used to calibrate density porosity (DPHI) calculations. However, while useful for initial site characterization, these control cores are too far (>40 miles north) to be considered as site-specific for this project. Core data collected at the Casper Carbon Storage Hub in a future drilling phase will eventually supplement or replace the SD3 SW 26 LOU 9 and Unit 59 in any geologic and plume model update.

2.1.4 Formation Temperature and Pressures

Formation temperatures were estimated from well logs (Table 2) and will be confirmed during a future drilling phase. Mean temperature was estimated at the projected mid-depth of the injection zone (6,089 feet below ground level [bgl]). An ambient temperature of 75 degrees F is added to the calculated temperature at depth.

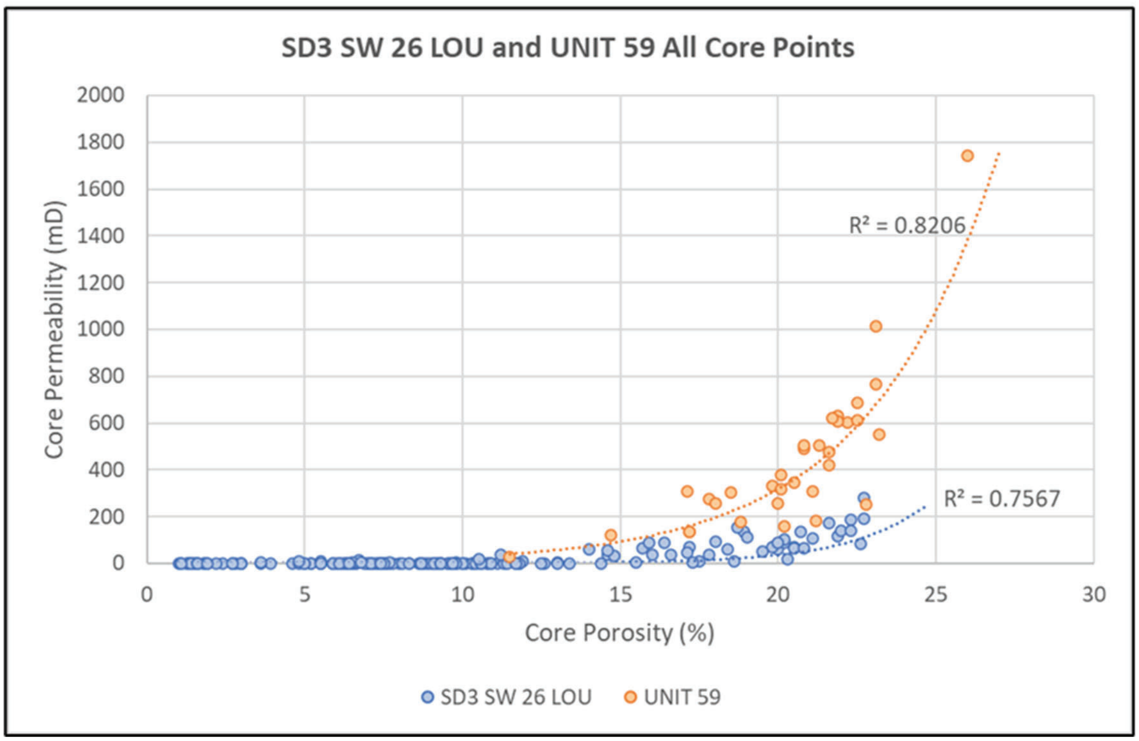


Figure 13: Porosity-permeability trends across selected PRB reservoirs (top); data from the two control core wells for the injection zone, showing good positive correlation (high r^2) between porosity and permeability.

Table 2: Temperature Measurements and Calculated Temperature Gradients[1]				
Formation	**Well Name**	**Test Depth, ft**	**Temperature, °F**	**Gradient, °F/ft**
Tensleep	PRATT RANCH 1	4,660	118	0.010
Dakota	NICOLAYSEN 1-23	5,714	124	0.009
Dakota	OCEANIC 1	5,756	110	0.005
Red Peak	LATHROP 54-33	5,774	120	0.012
Sundance	Casper Carbon Capture #1	6,115	142[1]	0.011
Tensleep	GOVT-BRANNAN 1	6,586	130	0.010
Dakota	HOTCHKISS FED A 1	6,610	157	0.014
Morrison	NICOLAYSEN 1	7,100	166	0.015

[1] Estimated at the expected midpoint of the injection zone using the average of calculated temperature gradients; to be confirmed with site-specific measurements.

Formation pressures were estimated from offset drilling mud weights and one near-offset drill stem test of the Sundance (WTR SUPPLY BLOCK-C 1, API 905299, ~9.5 miles to the southeast). A range of likely formation pressures was established by assuming a freshwater hydrostatic gradient for the low-side estimate (0.433 psi/ft) and, for the high-side estimate, the final hydrostatic pressure recorded during the referenced drill stem test (0.497 psi/ft). The midpoint of this range (0.433-0.497 psi/ft) is 0.465 psi/ft. Additionally, mud weights from near-offset wells were used to further constrain the upper end of the expected pressure gradient range. Estimates are shown in Table 3**.** Actual formation pressures will be confirmed during a future drilling phase.

The test depth and pressure for Casper Carbon Capture #1 shown in Table 3 was estimated using the midpoint pressure gradient (0.465 psi/ft) at the projected basal depth of the injection zone (6,228 ft). The mean pressure shown in Table 3 was estimated using the midpoint pressure gradient (0.465 psi/ft) at the projected mid-depth of the injection zone (6,115 ft).

Table 3: Formation Pressure Measurements and Calculated Pressure Gradients					
Formation	**Well Name**	**Test Depth, ft**	**Mud Weight, ppg**	**Pressure, psi**	**Gradient, psi/ft**
Dakota	NICOLAYSEN 1-23	5,714	9.4	2,794	0.489
Dakota	OCEANIC 1	5,756	9.3	2,786	0.484
Sundance	Casper Carbon Capture #1	6,228	N/A	2,896[1]	0.465
Dakota	HOTCHKISS FED A 1	6,610	9.2	3,160	0.478
Sundance	WTR SUPPLY BLOCK-C 1	6,944	N/A	3,452[2]	0.497
Morrison	NICOLAYSEN 1	7,100	9.3	3,436	0.484
Madison	WTR SUPPLY BLOCK-C 1	8,770	9.6	4,271	0.487

[1] Estimated at the expected base of the injection zone using the approximate midpoint of calculated pressure gradients; to be confirmed with site-specific measurements.

[2] Final hydrostatic pressure from a Sundance drill-stem test, assumed as high-side estimate of reservoir pressure.

2.1.5 Microfracture Tests

Microfracture tests were not available for the project area. Fracture pressures presented in Table 4 were estimated conservatively from offset drilling data, published data from diagnostic fracture injection tests from non-Sundance zones (Agarwal et al., 2019), and a near-offset Sundance drill stem test (WTR SUPPLY BLOCK-C 1, API 905299, ~9.5 miles to the southeast). Pressure estimates will be refined with site-specific data collected in a future drilling phase. Average pressures estimated at projected midpoint of the injection zone (6,115 feet bgl). The initial shut-in pressure gradient was calculated from the results of the referenced drill stem test.

Table 4: Description of Microfracture Tests									
		Breakdown Pressure		Propagation Pressure		Closure Pressure		Initial Shut-In Pressure	
Formation	Test Depth, ft	Gradient, psi/ft	Avg., psi	Gradient, psi/ft	Avg., psi	Gradient, psi/ft	Avg., psi	Gradient, psi/ft	Avg., psi
Sundance	6,115	0.7	4,281	0.65	3,975	0.6	3,669	0.39	2,712

2.1.6 Fluid Samples

Fluid samples from the injection zone are not available within the project area; obtaining fluid samples is one of the higher-priority objectives of future drilling and will be updated accordingly. Table 5 presents available water data from the Sundance Formation elsewhere in Wyoming, obtained from the USGS Produced Water Database. CCC will collect site-specific fluid samples during a later drilling phase and anticipates updating this data reporting at that time – the procedure for the receiving formation sampling plan is described in Form A-5 – Formation Fluid Sampling Plan.

Table 5: Fluid Sample Test and Corresponding Total Dissolved Solids (TDS) Values for Each Sample					
Formation	Test Depth, ft	TDS, mg/L	Latitude	Longitude	Distance (mi)
Sundance Lower	6,530-6,570	25,201	43.435	-106.204	43.27
Sundance Second Upper	2,842-2,847	23,860	43.406	-106.290	41.70
Sundance	3,008	21,158	43.404	-106.304	41.66
Sundance Third		20,836	43.402	-106.310	41.57
Sundance	2,828-2,870	20,597	43.395	-106.304	41.02
Sundance Second Lower	2,853-2,924	20,586	43.414	-106.299	42.26
Sundance Second	2,995	19,439	43.406	-106.299	41.75
Sundance		16,566	42.845	-106.739	29.20
Sundance		14,147	43.358	-106.260	38.18
Sundance Second		13,522	43.395	-106.310	41.11
Sundance	2,828-2,870	13,200	43.358	-106.260	38.18
Sundance Second		12,111	43.410	-106.291	41.95

Sundance Second	2,808-2,878	12,000	43.401	-106.290	41.33
Sundance		11,981	43.358	-106.260	38.18
Sundance Second		11,787	43.410	-106.173	41.47
Sundance Second		11,667	43.410	-106.173	41.47
Sundance Second	2,838-2,883	11,530	43.410	-106.290	41.95
Sundance Second	2,844	11,236	43.420	-106.290	42.63
Sundance Third	2,812-2,860	11,210	43.358	-106.260	38.18
Sundance Third	3,147-3,159	10,945	43.411	-106.278	41.93
Sundance Second	2,784-2,794	10,496	43.410	-106.298	41.99
Sundance	2,975-3,075	10,457	43.404	-106.287	41.54
Sundance		10,087	43.358	-106.260	38.18
Sundance Second		10,031	43.410	-106.303	42.05
Sundance	2,690	10,023	43.422	-106.292	42.81
Sundance Upper	2,620	8,498	43.422	-106.290	42.80
Sundance Third	3,200	8,189	43.406	-106.299	41.75
Sundance	3,340	8,085	43.358	-106.260	38.18
Sundance Third		7,959	43.410	-106.302	42.04
Sundance Second	2,949-2,997	7,644	43.382	-106.306	40.19
Sundance Second	2,949-2,997	7,275	43.382	-106.306	40.19
Sundance Second	2,828-2,836	7,098	43.406	-106.302	41.79
Sundance Second		6,979	43.400	-106.304	41.40
Sundance Second	2,808-2,818	6,662	43.409	-106.294	41.92
Sundance Second	2,746-2,756	6,313	43.412	-106.296	42.16
Sundance Second		6,122	42.475	-106.583	31.42
Sundance Second	2,853-2,924	5,746	43.406	-106.290	41.70
Sundance Third	2,842-2,847	5,534	43.414	-106.310	42.41
Sundance Canyon Springs	12,210-12,230	5,480	42.764	-105.012	58.57
Sundance Basal	1,290-1,370	5,282	43.231	-107.142	57.31
Sundance Canyon Springs Upper	12,160-12,170	4,882	42.764	-105.012	58.57
Sundance	1,436-1,494	4,832	42.846	-106.741	29.29
Sundance Second	2,754-2,764	4,704	43.403	-106.300	41.57

Sundance Basal	4,875-4,929	4,048	42.847	-105.975	9.98
Sundance Basal	4,077-4,090	4,015	42.720	-105.301	44.30
Sundance		3,880	42.851	-105.965	10.53
Sundance Canyon Springs		3,838	42.590	-106.550	24.77
Sundance Basal	4,077-4,090	3,826	42.720	-105.301	44.30
Sundance Basal	4,077-4,090	3,755	42.720	-105.301	44.30
Sundance	4,865-4,935	3,700	42.851	-105.965	10.53
Sundance	3,476-3,593	3,268	42.680	-105.276	46.04
Sundance	1,114-1,183	3,245	42.903	-106.644	25.11
Sundance Second	2,886-2,896	3,220	43.398	-106.314	41.33
Sundance	3,399-3,424	3,198	42.649	-106.660	27.50
Sundance Lower	4,357-4,385	3,073	42.724	-105.305	44.06
Sundance	4,357-4,385	3,064	42.724	-105.305	44.06
Crow Mountain	2,017-2,021	2,826	43.122	-106.622	31.65
Sundance		2,823	42.845	-106.739	29.20
Curtis	3,185-3,234	2,740	43.032	-106.964	43.27
Sundance	3,308-3,320	2,722	42.624	-106.639	27.29
Sundance		2,679	42.869	-106.781	31.49
Sundance	3,349-3,372	2,631	42.630	-106.636	26.99
Sundance	1,739-1,744	2,616	43.125	-106.625	31.90
Sundance	1,240-1,380	2,561	42.844	-106.741	29.30
Sundance	3,349-3,372	2,458	42.630	-106.636	26.99
Sundance	3,349-3,372	2,416	42.630	-106.636	26.99
Sundance	3,358-3,368	2,331	42.630	-106.636	26.99
Sundance	1,448	2,305	42.837	-106.729	28.64
Crow Mountain Tensleep	2,388-3,722	2,301	43.284	-106.786	45.37
Curtis		2,300	43.035	-106.969	43.60
Crow Mountain		2,300	43.036	-106.957	43.02
Sundance Lower	1045-1065	2,109	42.475	-106.583	31.42
Sundance Lower	1062-1078	2,104	42.475	-106.583	31.42
Sundance		2,081	42.858	-106.767	30.72
Sundance Lower	1,450	2,077	42.845	-106.755	30.02

Sundance		1,971	42.649	-106.660	27.50
Sundance Basal	1,479	1,911	42.846	-106.741	29.29
Sundance		1,837	42.631	-106.640	27.13
Sundance	3,376-3,381	1,822	42.627	-106.636	27.09
Sundance	3,249-3,382	1,788	42.627	-106.636	27.09
Sundance	3,398-3,410	1,744	42.624	-106.639	27.29
Sundance Basal	1,396-1,510	1,694	42.840	-106.734	28.90
Sundance		1,663	42.624	-106.639	27.29
Lakota Sundance		1,637	42.622	-106.642	27.49
Crow Mountain	2,548-2,570	1,435	43.171	-107.103	53.56
Sundance	6,657-6,944	1,167	42.784	-105.982	9.43
Sundance	3,038-3,478	1,070	42.627	-106.639	27.19

2.1.7 Seismic Survey

Existing, proprietary 2D seismic surveys were reviewed to evaluate the geologic structure, stratigraphic continuity, and faults in the project area. The locations of those 2D lines are shown in Figure 14. Selected segments of the reviewed 2D surveys were then licensed and reprocessed to support the geophysical evaluation.

Additionally, a proprietary set of subsurface structure contour maps was acquired and digitized to assist in mapping the subsurface. These legacy oilfield maps were originally built using single-fold seismic data and well data and consist of 2D contour sets on multiple stratigraphic horizons. The extent and a representative sample of these mapped areas are also shown in Figure 14.

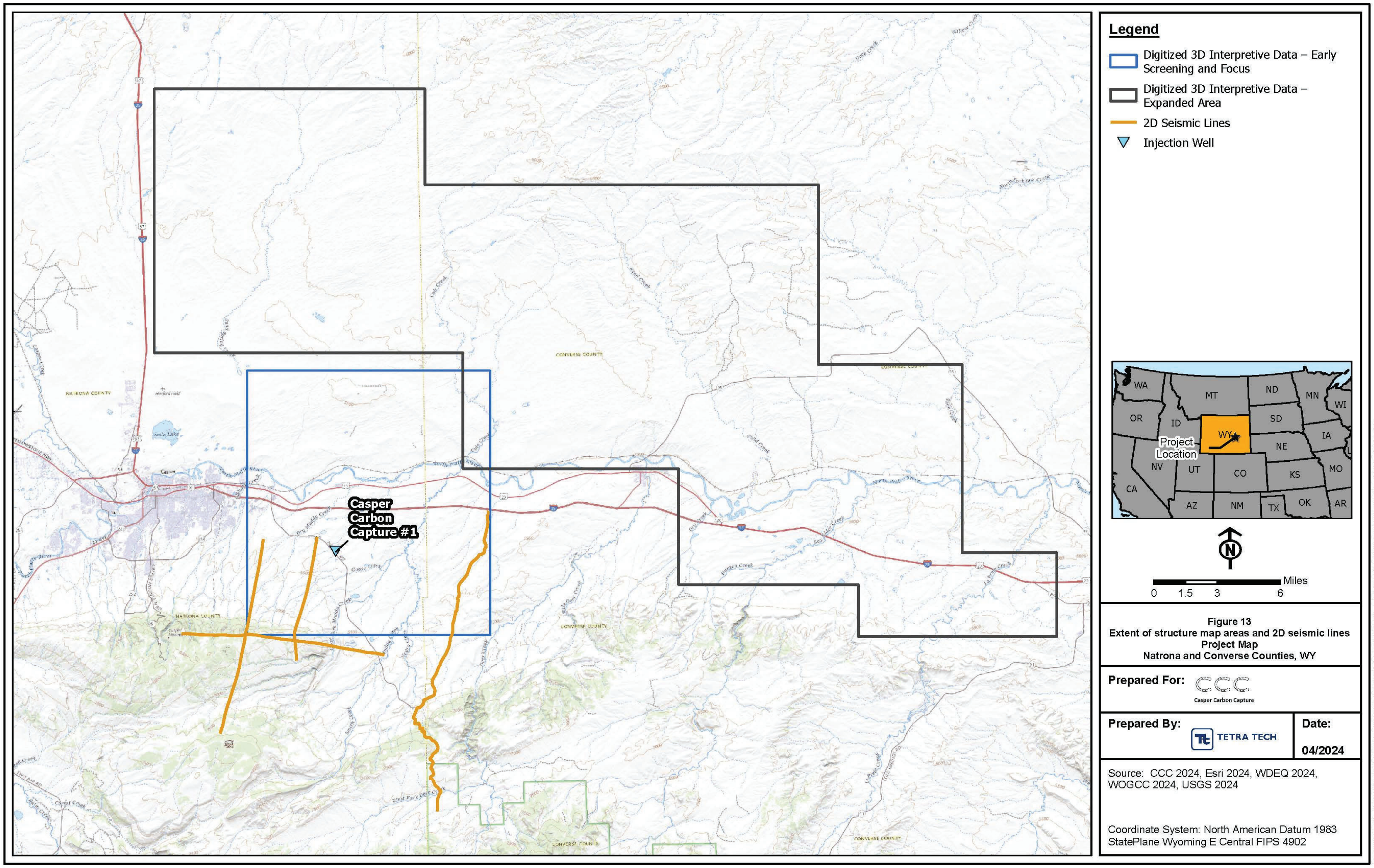


Figure 14: Seismic survey map.

2.2 INJECTION ZONE

The proposed storage reservoir or injection zone for this project is the Lower Sundance Formation (correlative to Lak and Hulett sands of eastern PRB) through the Crow Mountain Sandstone (Table 6). The Gypsum Spring, at only 39 feet thick, is included in the injection zone. As a shalier unit, the Gypsum Spring is expected to provide baffling between the Lower Sundance and underlying Crow Mountain, but not enough to prevent vertical movement of CO_2. In the project area, the Sundance disconformably overlies the Triassic Chugwater Group. The Alcova Limestone is the basal marker for the injection zone. All rocks above the Alcova and below the Redwater Shale are thereby assigned to the “Sundance” injection zone for this project.

The Sundance is a package of marine sandstone, siltstone, and shale of Jurassic age. These rocks were deposited in shelf to shoreface settings along a northwest-trending barrier island complex in the Sundance Sea. Distribution of facies is complex and variable, with intervals of cross-bedded, quartzose sandstones and finer-grained, laminated siltstones and mudstones. The sandstones represent nearshore deposition, and the mudstones and siltstones are shelf deposits. Bedded limestones include oolitic shoal and coquina deposits, reflecting relative sea level changes in a dynamic sedimentary environment. Cements include calcite and quartz.

Lateral facies changes at bed scale are difficult to constrain with well data, as few penetrations through the Sundance exist in the area. Substantial lateral heterogeneity in rock properties is seen on the 2D seismic data, probably as a result of depositional variability in the barrier island setting, but perhaps also because of diagenetic alteration or stresses. Despite such internal variability, the bulk Sundance interval has a fairly uniform thickness throughout the project area, with an average of 310-330 feet.

A conceptual facies framework was developed from legacy core and mud log descriptions obtained from commercial and public databases. In all, 14 wells with lithologic descriptions were studied, with facies types binned and upscaled into the most commonly occurring rock types (e.g., sandstone, siltstone, shale, and limestone). Facies or rock types were plotted on well log displays to visualize the distributions (Figure 15) and correlated across wells to develop a conceptual vertical zonation across the study area. These zonations are assumed to represent flow units assigned in later 3D modeling of the storage complex.

Sundance reservoir facies appear on logs and seismic to occur in stacks some 20-100 feet thick, separated by thinner, lower-permeability zones. It is likely that the best rocks for injection are concentrated in the lower half of the section, though CCC will update the model and flow units targeted for injection after collection of site-specific data. Based on current understanding, Casper Carbon Capture #1 will contain an estimated 226 feet of gross reservoir thickness at ~11-12% average porosity (yielding ~25 porosity-feet between the confining zones) and average permeability of about 140 millidarcies (mD), with exceptional intervals having 25% porosity or greater and permeability exceeding 1,000 mD. Additional minor storage is expected to be utilized at the base of the upper confining zone, as the CO_2 migrates upward and is trapped. The vertical distribution of these properties is illustrated in Figure 16.These estimates are constrained by seismic, well log, and core data and are summarized in Table 7. Additional detail is provided in Form A-2 - AoR and Corrective Action Plan. Estimated pressure and fracture data, to be confirmed with site-specific microfracture test results at a later data, are presented in Table 8.

Only six oil and gas wells were located within a 2.5-mile radius of Casper Carbon Capture #1. The deepest of these (7,100 feet) was drilled to the Morrison Formation, while the others were tests of the Dakota/Lakota (all above the Sundance). While this limits the number of artificial penetrations that can act as leakage pathways for injected CO_2, it also means that site-specific data through the storage complex is limited. Therefore, data and interpretations of rock properties were extrapolated or inferred from more distal locations. Information obtained from future drilling and data collection programs will be used to update these interpretations in the future.

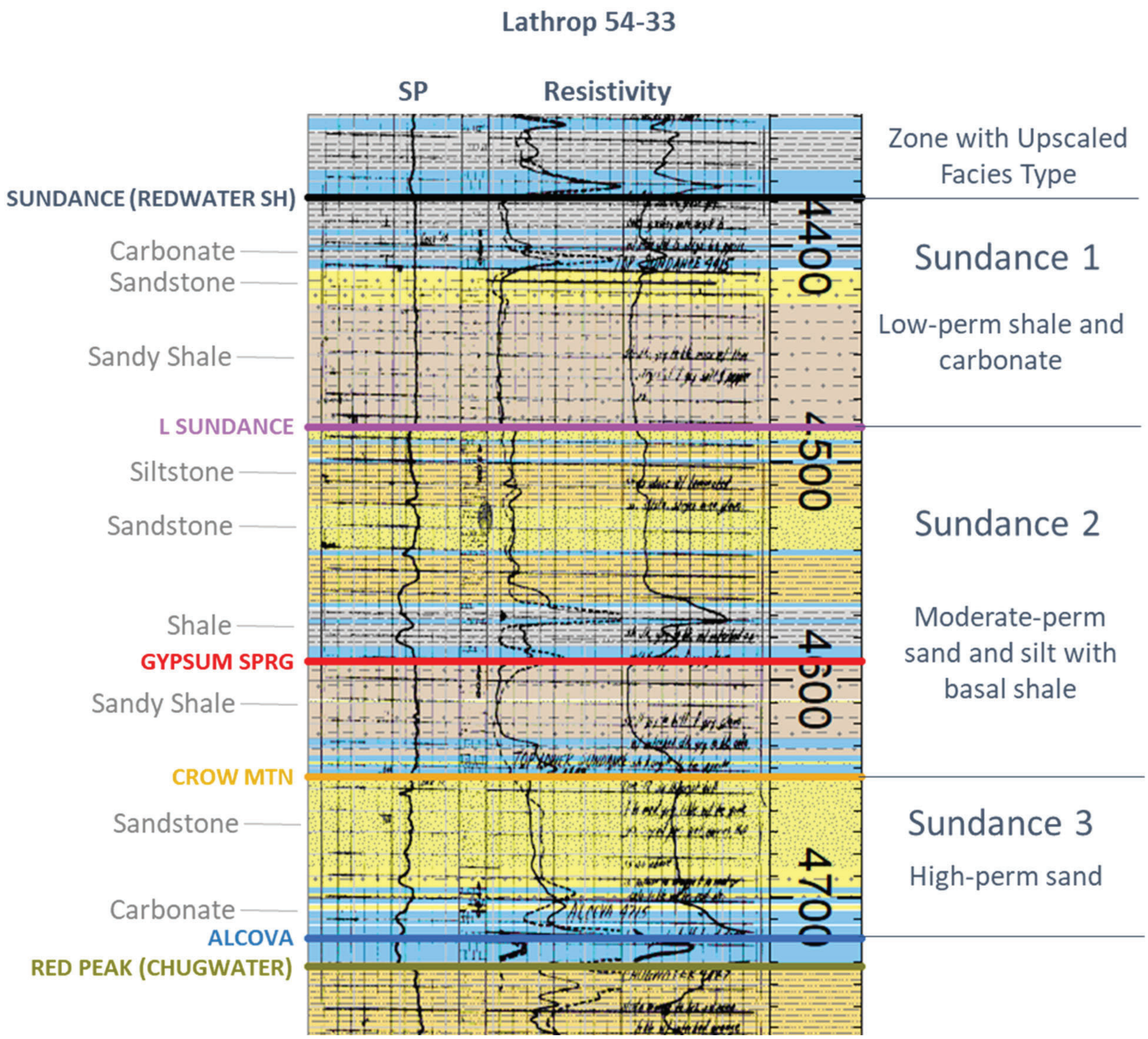


Figure 15: Facies model used to constrain property interpretations and distributions.

Table 6: Formations Comprising the CO_2 Storage Area				
Formation	**Purpose**	**Average Thickness at Project Site, ft**	**Average Depth at Project Site, SSTVD ft**	**Lithology**
Morrison	Upper Confining Zone	200	-381	Shale, carbonate, sandstone
Sundance Redwater Sh		107	-581	Glauconitic, calcareous shale
L Sundance through Crow Mtn	Injection Zone	226	-688	Sandstone with minor shale, carbonate, and evaporites
Alcova Ls, Red Peak Sh, Goose Egg Fm	Lower Confining Zone	1,000	-929	Limestone and red shale

Table 7: Porosity and Permeability							
Formation	**Porosity**	**Permeability**	**Laboratory Analysis**	**Model Property Distribution**			
				Layer	**Feet**	**Porosity, %**	**Perm, mD**
Morrison	4.59%	2.69 mD	N/A	1	73	0.1-15.0	0.001-33.6
				2	96	0.3-22.0	0.001-276
Sundance Redwater Sh	4.35%	9.14 mD	N/A	3	107	0.1-11.7	0.003-12.4
L Sundance through Gypsum Spring	8.59%	77.7 mD	2.8-26% porosity; < 0.01-1,745 mD permeability	4	106	3.0-15.9	0.014-44.6
Crow Mountain	15.7%	256 mD	10.5-23.1% porosity, 6.5-1,013 mD permeability	5	81	1.6-27.4	0.004-1,390
Alcova Ls and Red Peak Sh	5.00%	0.01 mD	1-3% porosity, 0.01—0.65 mD permeability (Alcova only)	6	30	5	0.01

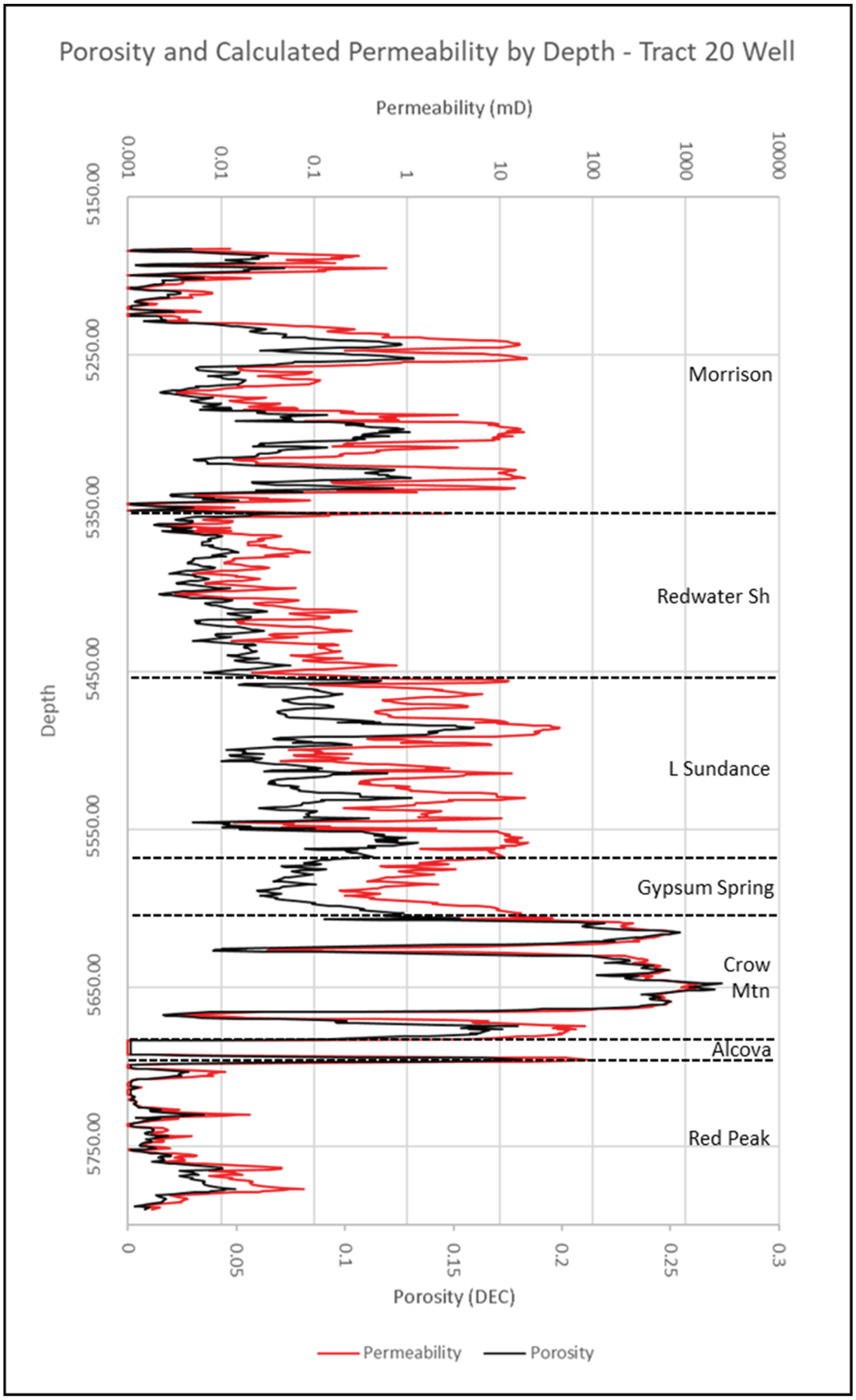


Figure 16: Vertical (depth) distribution of porosity and calculated permeability values from the near-offset Tract 20 well.

Table 8: Storage Reservoir Microfracture Results (Estimated)		
Depth, ft	6,228	
Pressure/Gradient	2,896 psi	0.465 psi/ft
Breakdown	4,281 psi	0.65 psi/ft
Fracture Propagation	3,975 psi	0.6 psi/ft
Closure	3,669 psi	0.39 psi/ft

Table 9: Average Minimum Stress of the Injection Formation as Determined by Horizontal Stress Test – NA to be Completed Following Collection of Site-Specific Data

Depth, ft	Average Propagation Pressure, psi	Reopening Pressure, psi	Closure Pressure, psi	Average Minimum Stress, psi

Table 10: Sample Parameters - NA to be Completed Following Collection of Site-Specific Data

Sample and Experimental Information	
Depth:	
Formation:	
Dry Bulk Density:	
Diameter:	
Rock Type:	
Porosity:	
Pore Fluids:	
Entered Length	

2.2.1 Mineralogy

No data were available for the injection zone from either X-ray diffraction (XRD, used for mineral identification) or X-ray fluorescence (XRF, used for chemical identification). Semi-quantitative estimates were developed from limited drilling sample descriptions, facies interpretations, and general inference as follows:

Sundance (shallow marine to supratidal deposition, tidal-shoreface-shelf)

- Silt and sand framework grains are dominantly quartz, perhaps with minor chert clasts and plagioclase feldspar; some intervals are limestone (dolomite and calcite, coquinas and oolites) and shale (mudstone/siltstone, limited claystone).
- Clays include intragranular illite and glauconite, plus authigenic kaolinite and chlorite. No smectite expected.
- Cements are quartz, calcite, and, to a lesser extent, dolomite.
- Sulfates (gypsum/anhydrite) and Fe-rich claystones may occur in minor amounts.
- TOC 0-2 wt%
- Of these constituents, we expect limited CO_2 brine reactivity with calcite and glauconite, and perhaps some adsorption effects from kaolinite. Detailed calculations on mineral interactions can be done after site-specific data are acquired.

Following the future collection and analysis of site-specific data, CCC will provide additional required figures showing laboratory-derived mineralogic characteristics and XRF data.

2.2.2 Mechanism of Geological Confinement

The geologic structure at the injection location is monoclinal, dipping to the northeast at about 100 feet per mile. A structure map on the top of the injection zone is shown in Figure 18, and an isopach map illustrating the thickness assumptions is shown in Figure 19. The structure map of the injection zone demonstrates the areal extent of the storage formation. Both maps were developed by CCC using well logs and seismic data to constrain formation top depths. Given the low dip of the formation at the injection location and the high degree of heterogeneity, the injection plume will have sufficient intraformational permeability baffles and an overall flat geometry that will moderate the migration of injected CO_2. This will allow the plume to reach a maximum extent, or stabilization, approximately 10 years after cessation of injection. Stabilization will be assisted by dissolution of CO_2 into formation brine and, following injection, residual trapping as displaced brine re-enters the pore space in the injection zone. Finally, chemical trapping via rock-brine-CO_2 interactions will provide minor to moderate additional confinement over longer time scales, especially after plume stabilization.

Further demonstration of the storage capacity of the injection zone within the project area was calculated using Subsurface Transport Over Multiple Phases (STOMP-CO_2) simulation. The modeling results demonstrated that the Sundance Formation had adequate thickness, porosity, permeability, and lateral extent to safely sequester the proposed mass of CO_2 within the CCC storage facility. The static model porosity and permeability values were derived from well log data in the Tract 20 well and then populated into the model using a randomizing function to re-create a property distribution, derived from the wells, within the 3D model space. Additional detail on model construction is provided in Form A-2 - AoR and Corrective Action Plan.

2.2.3 Geochemical Information

A quantitative geochemical analysis of the injection and confining zones (including water and rock geochemistry) was not available but will be obtained and provided following the collection of site-specific data.

2.2.4 Potential Geochemical Interactions

Glauconite and calcite are considered the most potentially reactive mineralogies in the confining and injection zones. Calcite may dissolve and become mobile when contacted by low-pH CO_2 or brine. Glauconite, a Fe/Ca/Mg-bearing aluminosilicate mineral, can theoretically react with CO_2, resulting in carbonate mineral precipitation and increased fluid pH, but this reaction potential is considered limited in reservoir environments. Likewise, dolomite and evaporate reaction potential is considered low, though this will be influenced by pressure, temperature, and other parameters.

Although these mineralogies are predicted to be present in the injection well, current data suggests reactions will be minimal, and current modeling does not include chemical processes. Data collected during a future drilling phase will be used to determine whether a model of geochemical interactions with the injected CO_2 will be needed. Should pre-operational testing indicate that geochemical reactions may be significant and should be accounted for, CCC will provide required figures showing change in fluid pH vs. time; dissolution and precipitation of minerals in the cap rock; and change in percent porosity of the cap rock.

Figure 17: Change in fluid pH vs. time – NA to be completed following collection of site-specific data

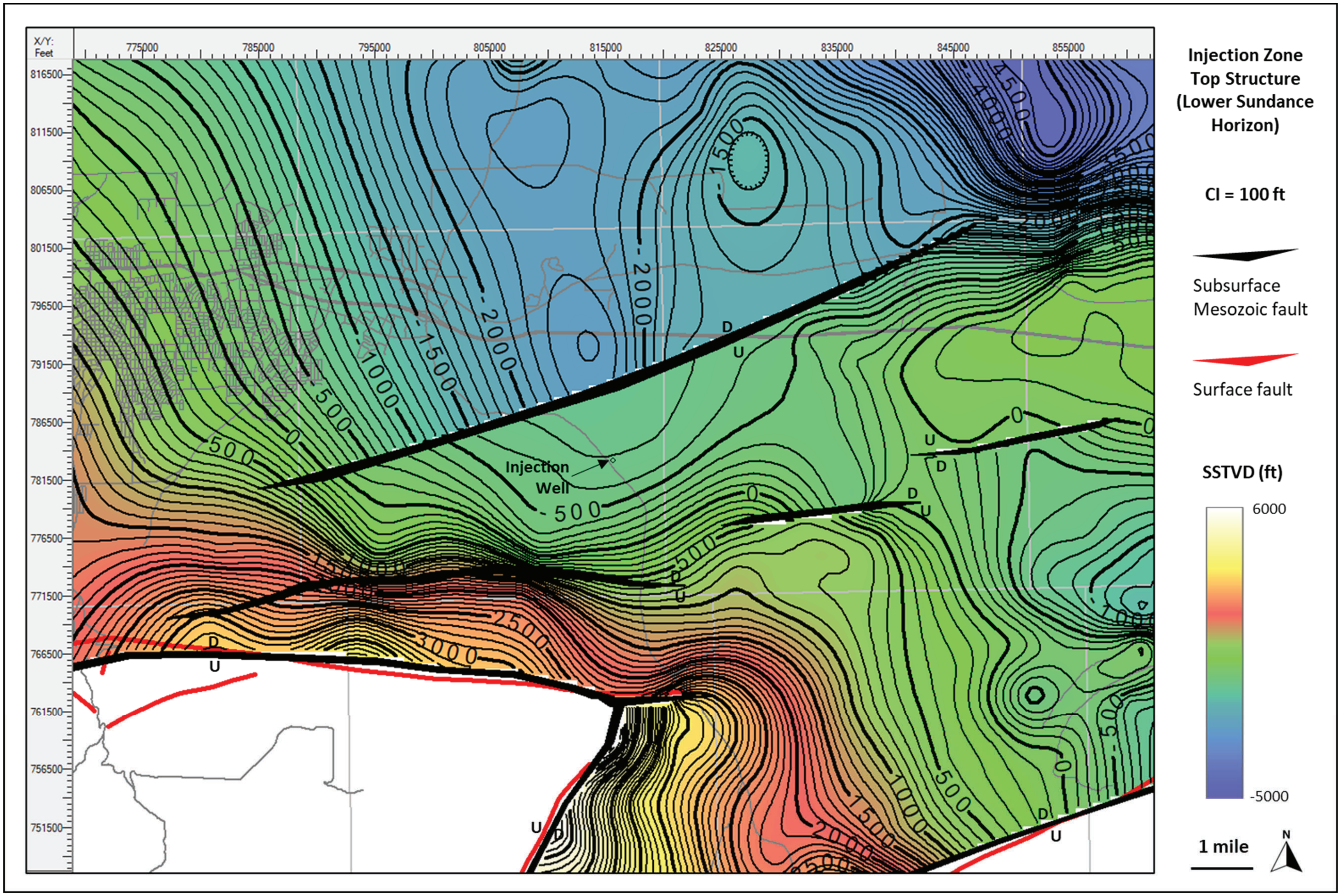


Figure 18: Structure map on the top of the injection zone.

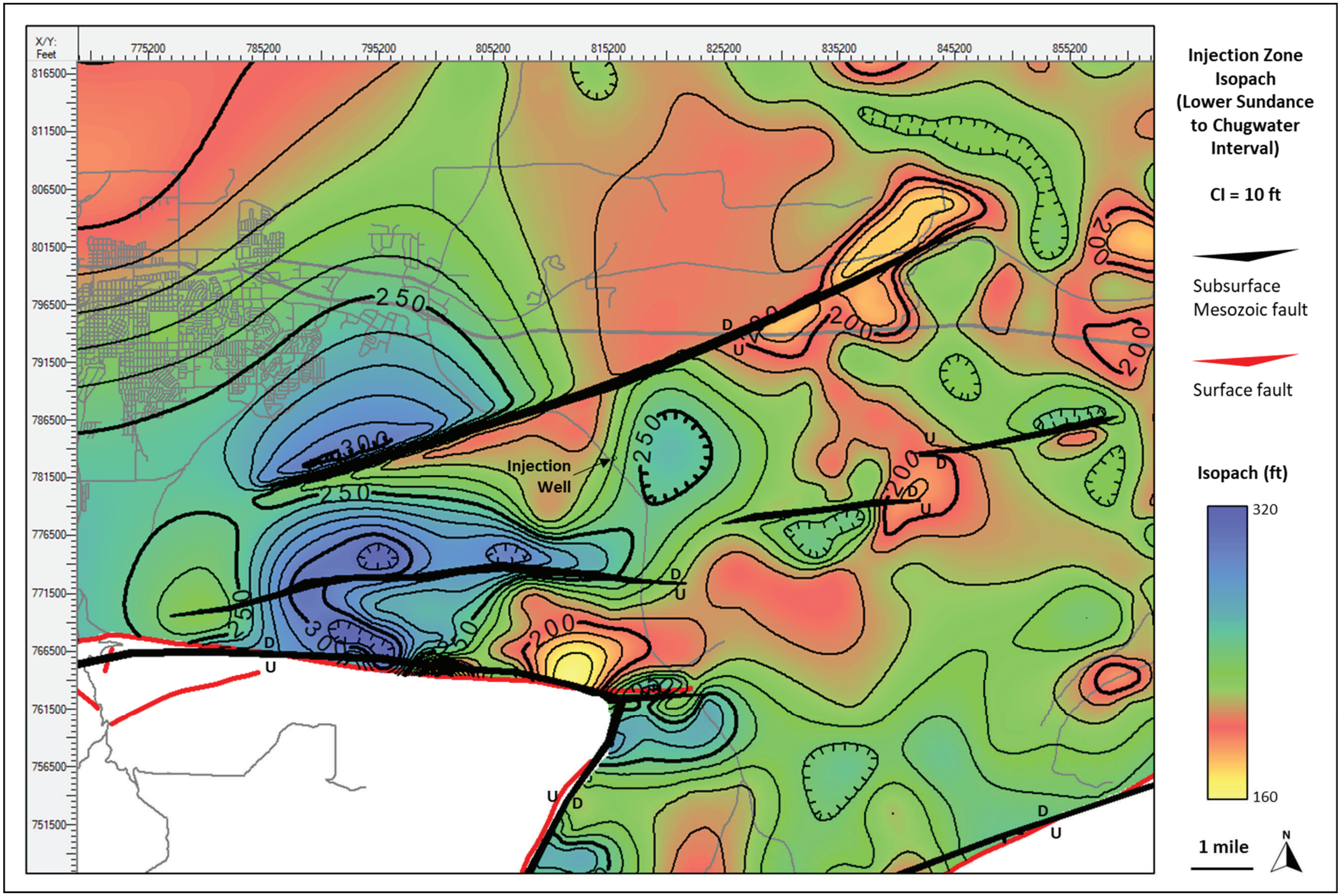


Figure 19: Isopach map of the injection zone.

The data presented in Table 11 represent a hypothetical composition estimate for major mineral constituents in the injection and confining zones, based on Casper Carbon Capture's evaluation of available mud logs, core descriptions, regional literature, and open-hole log responses to lithology throughout the project area.

Table 11: Geochemical Data

Depth, ft: 5,695-6,002 (Upper Confining Zone)		**Depth, ft: 6,002-6,228 (Injection Zone)**	
Mineral Data	**%**	**Mineral Data**	**%**
Quartz	10	Quartz	80
Clays and micas	60	Clays and micas	5
Calcite	15	Calcite	10
Dolomite	5	Dolomite	5
Glauconite	10	Glauconite	<1
Gypsum or anhydrite	N/A	Gypsum or anhydrite	<1

2.3 COMPATIBILITY OF THE CO_2 WITH SUBSURFACE FLUIDS AND MINERALS

Compatibility of the CO_2 with subsurface fluids and minerals will be analyzed with future drilling data. The expected stream composition is shown in Table 12.

Table 12: Expected CO_2 Stream Composition

Component	**ppmv**	**Mol%**
Carbon Dioxide, CO_2	984,885	98.489
Oxygen, O_2	20	0.00243
Nitrogen, N_2	90	0.00908
Total Hydrocarbons, (as CH_4)	0	0
Total Sulfur, as S	0	0
Water, H_2O	15,000	1.5
Other	1.1	0.00011

2.4 CONFINING ZONES

The injection interval is overlain and underlain by primary and secondary confining zones that will serve to prevent escape of the injected CO_2 vertically out of the injection zone. About 200 feet of top-sealing facies in the Morrison Formation and another 107 feet of the Redwater Shale will provide a competent barrier to movement of formation fluids and free-phase CO_2 out of the injection zone. Below the injection zone, the low-permeability units of the Chugwater group (Red Peak Shale, with Alcova Limestone at the top) will provide a lower confining zone for the CO_2 plume.

Table 13: Properties of Upper and Lower Confining Zones

Confining Zone Properties	Upper Confining Zone	Lower Confining Zone
Formation Name	Morrison-Redwater	Chugwater-Goose Egg
Lithology	Bentonitic claystone, siltstone, silty sandstone	Limestone, red shale, siltstone, fine-grained sandstone, mudstone
Formation Top Depth, ft	5,695	6,228
Thickness, ft	200	1,000
Porosity, % (core data)[1]	5 (estimated)	1 (estimated)
Permeability, mD (core data)[1]	2 (estimated)	0.5 (estimated)
Capillary Entry Pressure (GW), psi[1]	28	28
Depth below Lowest Identified USDW, ft	N/A	N/A

[1] To be confirmed with site-specific data

The primary upper confining zone is defined as the base of the uppermost unit of the Sundance Formation, the Redwater Shale, through the top of the Morrison Formation. Structure and isopach maps of the upper and lower confining zones are provided in Figure 20, Figure 21, Figure 22, and Figure 23. Because USDWs immediately overlie and underlie the upper and lower confining zones, respectively, no other confinement zone maps are applicable.

The Redwater Shale is glauconitic siltstone with minor amounts of fine green sandstone and clastic (oolitic) limestone. The presence of glauconite indicates deposition in a marine shelf environment. Horizontal permeability is interpreted as low based on a lack of SP log response across the interval, although thin streaks of permeability are occasionally seen, perhaps due to localized fractures. Mud logs and core description confirm the overall fine-grained and upward fining rock fabric, while a characteristic low amplitude sawtooth signature of gamma ray (GR) logs indicates a high degree of lamination.

The Redwater Shale is expected to contain greater than 50% clay or shale, interlayered with silt and very fine-grained sand, based on information from mud logs and regional published studies. Literature indicates that glauconite will likely be present, but the expected proportions of other clay species is not well constrained. Rock samples collected during future drilling will be evaluated for mineralogy to allow for additional assessment of the potential for chemical interaction with the injection stream and baffling capacity. Additionally, core data will be used to better characterize the porosity and permeability based on petrophysical evaluation of porosity logs and the permeability transform derived from sandy intervals of the Sundance.

The uppermost formation of the upper confining zone, the Morrison, is believed to have an average porosity of less than 5% and an average permeability of about 3 mD. The lower unit of the Morrison contains some sandstone with higher porosity and permeability; however, in some wells, bentonites with no apparent porosity on logs are present in this lower unit. The upper unit of the Morrison is considerably more shale-rich, and permeabilities on the order of 0.001-1 mD are expected. The interbedding of impermeable shales will provide additional confinement and protection of overlying USDWs in the unlikely event CO_2 migrates above the Redwater Shale. No site-specific values for capillary entry pressure were available for the project, so typical values for shales were used from published literature and will be updated upon collection of site-specific data.

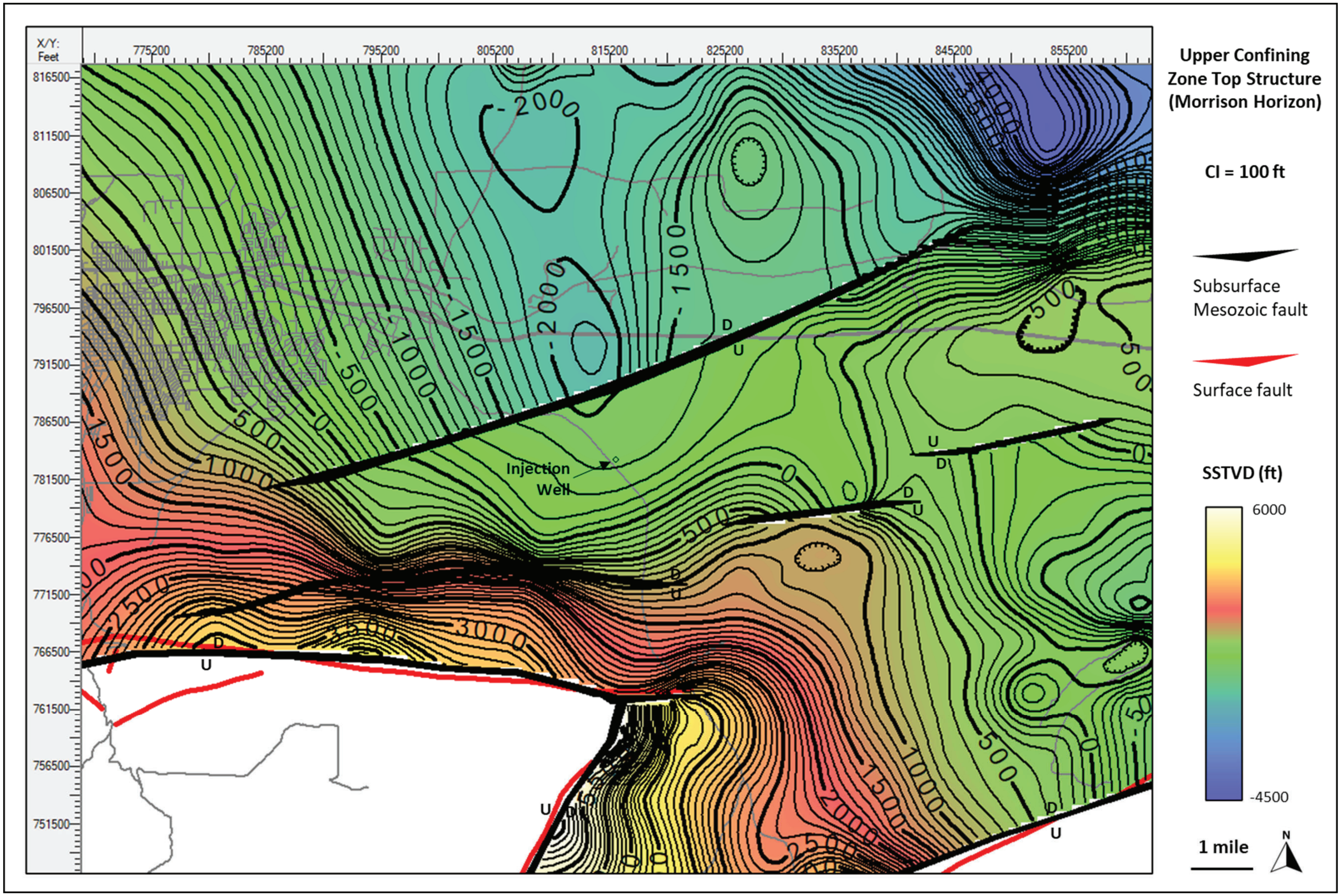


Figure 20: Structure map on the top of the upper confining zone.

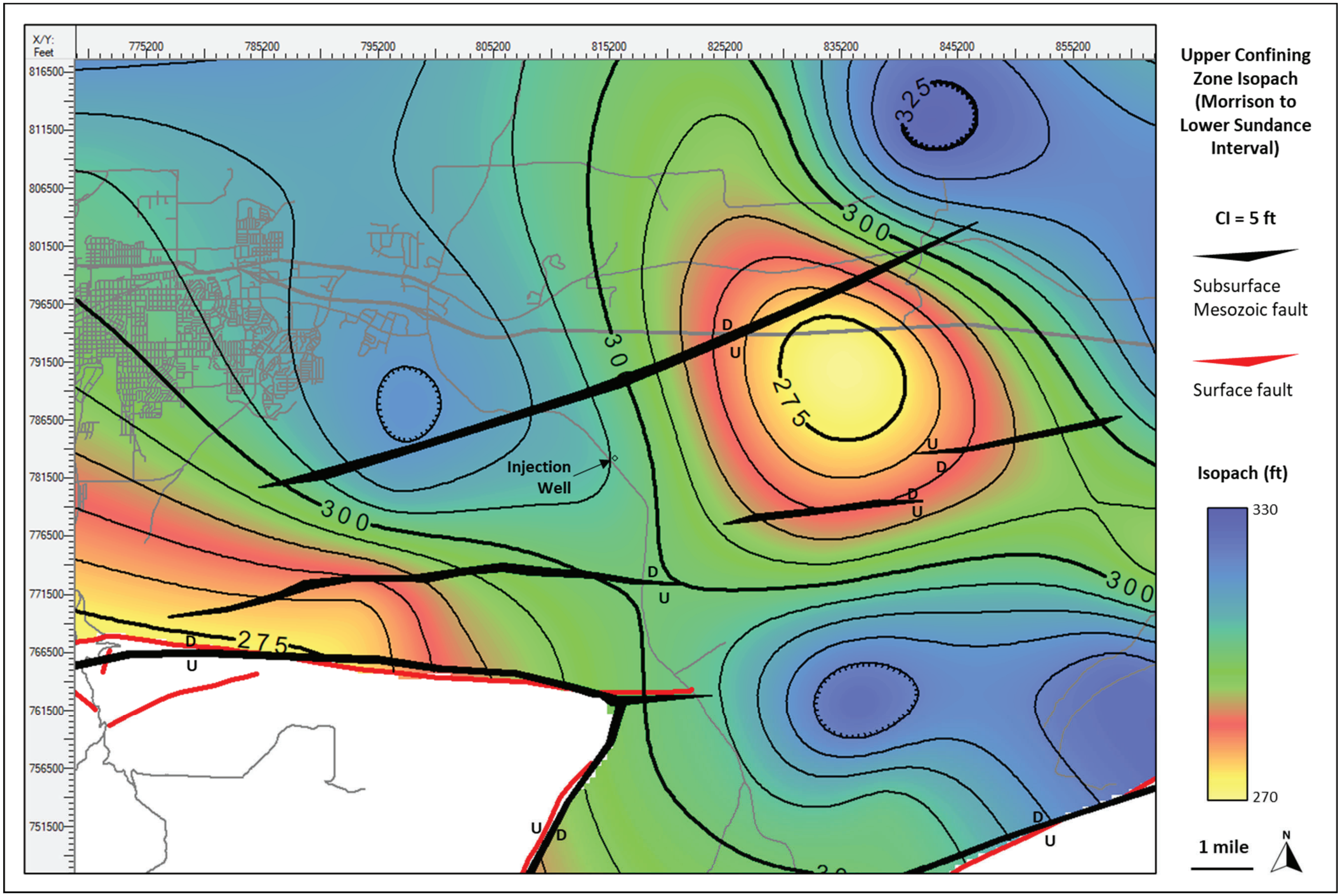


Figure 21: Isopach map of the upper confining zone.

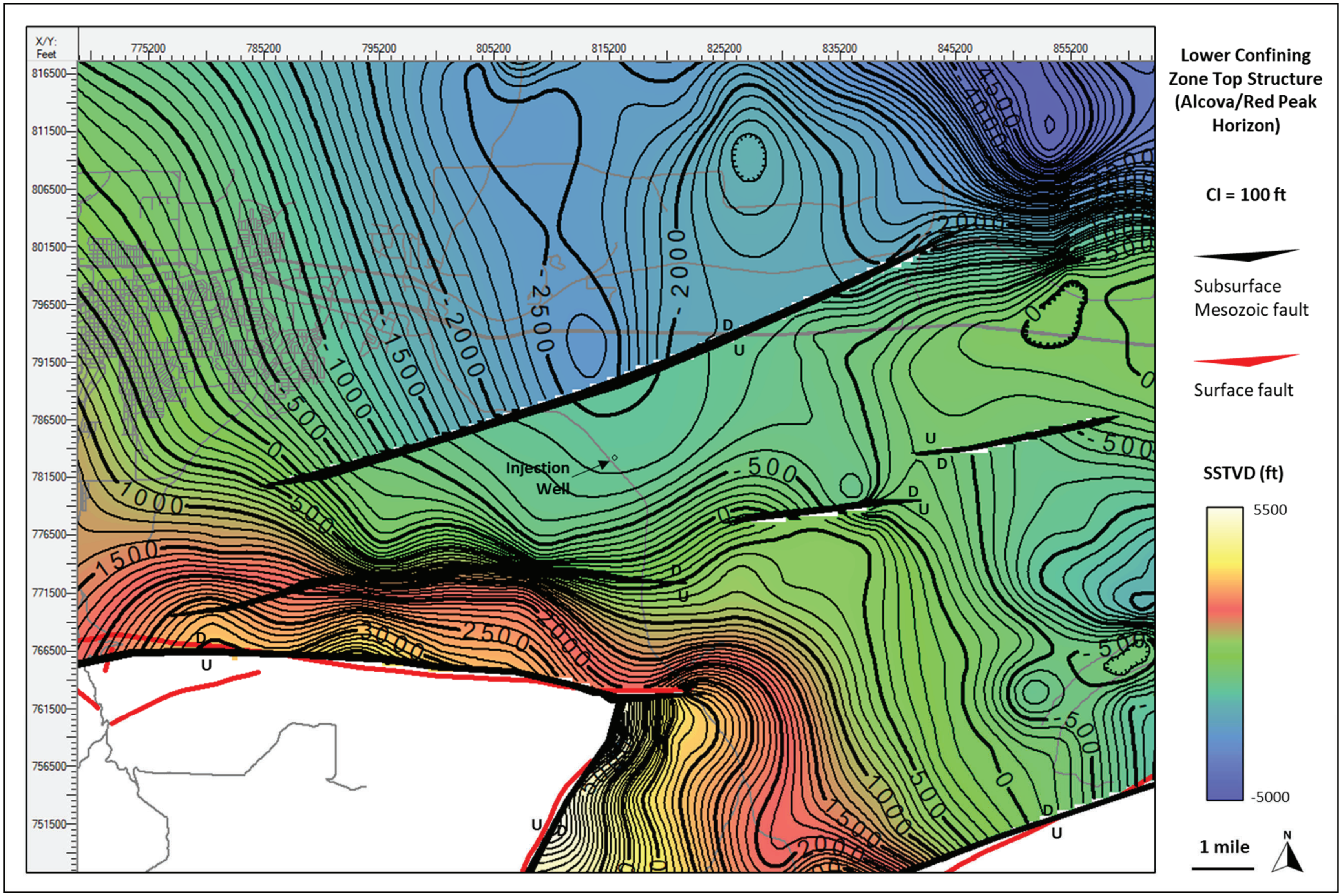


Figure 22: Structure map on the top of the lower confining zone.

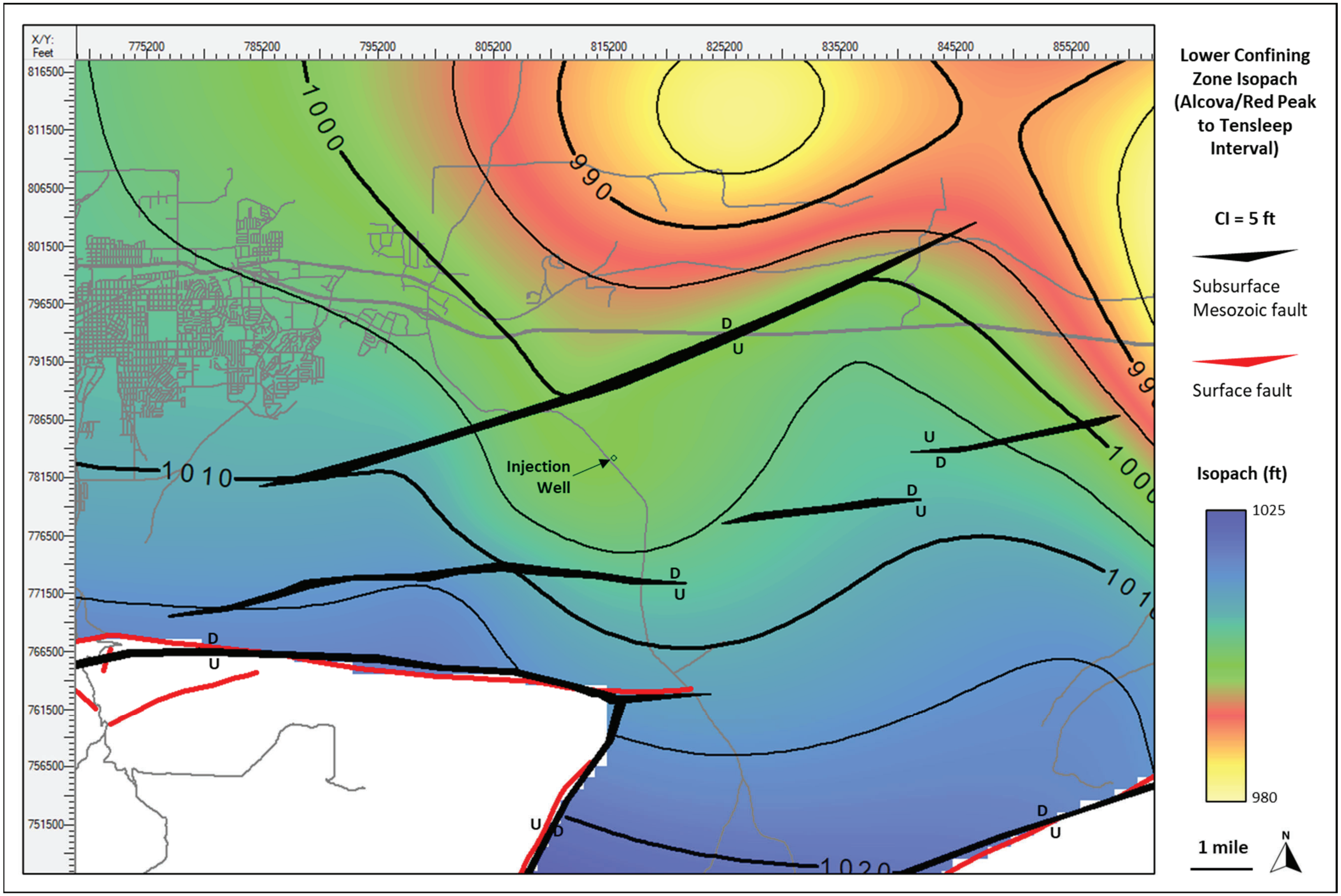


Figure 23: Isopach map of the lower confining zone.

The lower confining zone comprises two members of the Chugwater Group, the Alcova Limestone and the Red Peak Shale. The Red Peak Shale comprises 600 feet of primarily low-permeability terrestrial deposits overlying the Goose Egg Formation. Lithologies include red shale, siltstone, and fine-grained sandstone at the base, with algal limestones and mudstones higher in section. Overlying the Red Peak Shale is the Alcova Limestone (Bower, 1964; Lovelace, D. M., 2015), a thin, low-permeability carbonate layer that pinches out to the east of the project area. Similar to the Morrsion Formation, the lower confining zone is expected to average about 5% porosity and 0.01 mD permeability, though site-specific data is needed owing to a lack of available core data and reliable porosity log data through the Red Peak Shale. Estimated porosity and permeability for the lower confining zone are provided in Table 14.

2.4.1 Geomechanical Information

The team evaluated dipole sonic well log data in the project area to determine elastic properties of the confining zones. Poisson's ratio in shale-rich sections of the Morrison and in the Redwater Shale averages about 0.35 (range, 0.3-0.45), which is in the range for good sealing shales and suggests a low brittleness. The implication is that any existing fractures in the injection zone are likely to terminate at geomechanical boundaries in these shales, and that any new fractures initiated by CO_2 injection operations would not be able to propagate through the confining zone. The lower confining zone rocks have a computed Poisson's ratio of about 0.25. Additional log and core data collected from future drilling activities will be used to confirm these interpretations, including whether the fracture pressures of the confining zones are equal to or greater than that of the injection zone so that safe operational parameters are set.

2.4.2 Confining Zone Integrity

The Morrison and Chugwater have limited artificial penetrations that could create leakage pathways. A detailed list of penetrations within the AoR is provided in Form A-2 Appendix – All Wells in AoR. A discussion of seal integrity along faults is provided in the Faults, Fractures, and Seismic Activity section of this Site Characterization document.

2.4.3 Additional Overlying Confining Zones

Additional shale sections above the Morrison Formation will provide secondary containment for the CO_2 plume (Table 15). The most significant of these is the Mowry Shale, which provides a regional seal for Lower Cretaceous oil reservoirs throughout much of the PRB. The Mowry exhibits nanodarcy-scale permeability in multiple organic-rich layers and bentonites interspersed through a gross thickness of 230 feet (May, Socianu & Hankins, 2021). The Fuson

Shale, which sits between the Lakota and Dakota sands above the Morrison, is a dark shale with low apparent permeability that is inferred to provide minor secondary sealing.

Additionally, thick shaley sections of the overlying Frontier Formation and Cody Shales are expected to provide tertiary confinement for the CO_2 plume. Both contain sandstones that can produce either water and oil (Frontier) or only water (Cody) in the project area. The Cody is recognized as an aquitard (confining unit) in the regional hydrologic system but also contains an actively utilized USDW near its top in some areas around the project site. These formations exist above the expected lowermost USDW (Lakota) but will still contribute.

Table 14: Lower Confining Porosity and Permeability

Sample Depth, ft	Porosity %	Permeability, mD
Alcova	4.26	9.72
Red Peak	1.48	0.01
Range:	1-18	0.001-87.2

Table 15: Description of Zones of Confinement above the Immediate Upper Confining Zone

Name of Formation	Lithology	Formation Top Depth, ft	Thickness, ft	Depth below Lowest Identified USDW, ft
Fuson Shale	Dark to black shale	5,600	30	N/A
Mowry Shale (including Skull Creek Shale unit)	Clay-rich siliceous shale, organic-rich shale, bentonite	5,171	95	N/A
Frontier Formation	Fine- to coarse-grained sandstone interbedded with dark siltstone and shale; bentonite	4,332	1,363	N/A
Cody Shale	Calcareous shale with many bentonite layers and some sandstone	620	5,075	N/A

2.4.4 Mineralogy

No data were available for the upper or lower confining zones from either XRD (used for mineral identification) or XRF (used for chemical identification). Semi-quantitative estimates were developed from limited drilling sample descriptions, facies interpretations, and general inference as follows:

Morrison (terrestrial deposition, coastal plain)

- Minor limestone (calcite/dolomite)
- Silt and sand framework grains are dominantly quartz with lithic fragments (chert, quartz, mica, perhaps chlorite)
- Shale (bentonite, mudstone/siltstone, and claystone, some of it calcareous or Fe-rich)
- Clays dominated by illite, with kaolinite and some chlorite. Smectite and mixed-layer clay may occur toward the upper Morrison
- Cements are quartz and, to a lesser extent, dolomite and calcite
- TOC 1-5 wt%

Alcova Limestone

- Calcite and dolomite, minor evaporite

Chugwater (shale section)

- Fe-rich siltstone and claystone with illite and quartz

2.4.5 Geochemical Interaction

Smectite and calcite are considered the most potentially reactive mineralogies in the confining zones. Data collected from drilling Casper Carbon Capture #1 will be used to model geochemical interactions with the injected CO_2.

Figure 24: Dissolution and precipitation of minerals in the cap rock - NA to be completed following collection of site-specific Data, if applicable

Figure 25: Change in percent porosity of the cap rock - NA to be completed following collection of site-specific data, if applicable

2.4.6 Geomechanical Information

The team evaluated dipole sonic well log data in the project area to determine elastic properties of the confining zones. Poisson's ratio in shale-rich sections of the Chugwater averages about 0.23 (range, 0.2-0.3), which suggests a high brittleness. The implication is that any existing or new fractures in the injection zone may propagate through the Chugwater. However, given the buoyancy of CO_2, injection-related stresses are unlikely to cause downward fracture propagation, and so the risk of seal breach is considered low. Additional log and core data collected from Casper Carbon Capture #1 will be used to confirm these interpretations.

Table 16: Elastic Properties Measured at Different Confining Pressures[1]

Event	Conf., MPa	Diff., Mpa	E, Gpa	n	K, Gpa	G, Gpa	P, Gpa
Sundance	NA	NA	11	NA	27	NA	NA
Morrison	NA	NA	48	NA	44	NA	NA

[1]Elastic properties calculated from log data – to be updated with site specific data

2.4.7 Fracture Analysis

Fracture data was not available from core or image logs for the confining zones. Data collected from Casper Carbon Capture #1 will be used conduct a fracture analysis.

Figure 26: Borehole image analysis - NA to be completed following collection of site-specific data

Figure 27: Conductive fracture dip orientation injection zone - NA to be completed following collection of site-specific data, if applicable

Figure 28: Resistive fracture dip orientation injection zone - NA to be completed following collection of site-specific data, if applicable

Figure 29: Conductive fracture dip orientation cap rock - NA to be completed following collection of site-specific data, if applicable

Figure 30: Resistive fracture dip orientation cap rock - NA to be completed following collection of site-specific data, if applicable

2.4.8 Future Data Collection

Based on plans to collect and analyze fracture data during a future drilling phase, CCC anticipates providing the following figures at a later date:

- Borehole Image Analysis
- Conductive Fracture Dip Orientation Injection Formation
- Resistive Fracture Dip Orientation Injection Formation
- Conductive Fracture Dip Orientation Cap Rock
- resistive Fracture Dip Orientation Cap Rock

2.4.9 Stress, Ductility and Rock Strength, and Elastic Properties

Stress anisotropy and site-specific variance from regional stress orientations are expected given the relative proximity of the injection well to the thrusted mountain front. Dipole sonic data collected in Casper Carbon Capture #1 will be used to conduct stress analysis. Additionally, well logs and core samples collected during the drilling of Casper Carbon Capture #1 will be used to conduct a ductility and rock strength analysis. CCC anticipates providing data tables on stress, ductility and rock strength, and elastic properties following the collection of test drilling data.

2.4.10 Faults

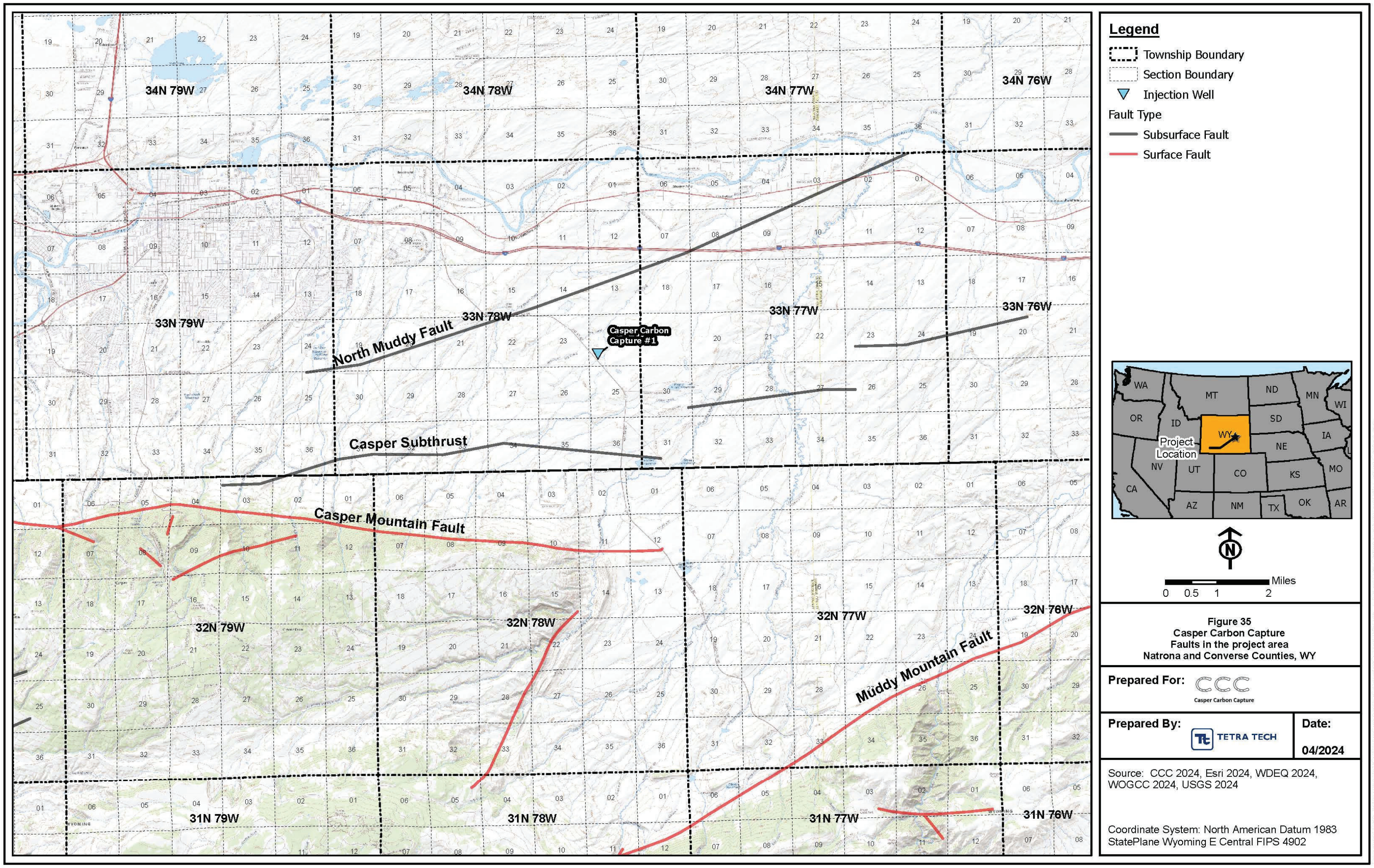
Certain faults of note were incorporated into the site characterization and model construction for this project (

Figure 31). The nearest faults intersecting the ground surface are oriented roughly east-west along the northern margin of Casper Mountain, about 3.7 miles southwest of the Casper Carbon Capture #1. This fault set ("Casper Mountain Fault") is interpreted as a high-angle reverse fault system based on geometries seen on seismic data and reported in previous publications). The entire sedimentary section is faulted, juxtaposing the strata against the uplifted crystalline basement core of Casper Mountain. These faults dip to the south, meaning their surface expression represents a minimum distance between the faults and Casper Carbon Capture #1 to the north. Based on the results of 3D plume modeling discussed further in the AoR and Corrective Action Plan, the injected CO_2 is not expected to reach any surface-breaching faults. Additional surface-breaching faults (the Muddy Fault system at the northern extent of the Laramie Mountains, and an unnamed fault defining the eastern margin of Casper Mountain) were included in the model but had no influence on the simulation, owing to distance from Casper Carbon Capture #1.

In the subsurface, four additional down-to-north faults were modeled to assess any effect on the injected CO_2. The first is a deeper and basinward imbricate to the Casper Mountain Fault ("Casper Subthrust," maximum vertical displacement ~800 feet); these two fault systems likely have a common displacement surface at depth. To the east-northeast of the Casper Subthrust, a pair of unnamed, northwest-trending synthetic faults occur in an en echelon pattern. Of this fault pair, the western tip of the western-most fault has minor contact with the late-stage plume, but this occurs in an area where fault displacement is negligible. Finally, to the north of Casper Carbon Capture #1 is the northwest-southeast-trending "North Muddy Fault" (maximum vertical displacement ~1,000 feet). These faults were mapped for this project from 2D seismic, well data, and legacy oilfield structure maps.

Based on modeling, the margin of the CO_2 plume is expected to come into contact with the Casper Subthrust and the North Muddy Fault between cessation of injection and plume stabilization. The western tip of the western-most en echelon fault also sees minor contact with the late-stage plume, but this occurs in an area where fault displacement is negligible (e.g, does not breach the confining zone).

Multiple lines of indirect evidence suggest these faults will be impermeable and will contain injected CO_2 and prevent leakage to surface or USDWs: 1) Velocity changes across faults observed in the reprocessed 2D seismic data are associated with the subsurface discontinuities, indicating pressure differentials exist across the faults; 2) The faults have large displacements in areas proximal to the modeled plume and pressure front, sufficient to entrain and smear low-permeability clays from shaly intervals (e.g., the Mowry Shale, the Morrison Shale, and others) along the fault zones (estimated shale gouge ratio of ; and 3) The presence of fault-bounded oil and gas accumulations at the nearby Brooks Ranch and Big Muddy fields demonstrates that fluid flow compartmentalization is present across structural features in the stratigraphic section. Due to licensing concerns, the seismic data has been excluded from this permit application, but is available to the WDEQ upon request.



Not for Construction

Figure 31: Orientation and extents of faults in the Project Area, with surface-breaching faults in red and subsurface faults mapped for this project in black.

2.4.11 Fractures

No information on fractures in the confining or injection zones was available for the project area; data needed to characterize fractures (e.g., borehole imaging, formation microresistivity imaging (FMI), and/or fracture finder (F logs. core samples) will be collected at the project site during a future drilling phase.To better understand the potential role of fractures in fluid flow, CCC evaluated the findings of published fracture studies in Paleozoic rocks within the PRB. Much of the relevant work in Wyoming has focused on the Tensleep or Madison intervals. Despite differences in depositional and lithologic characteristics, these rocks are considered to provide potential analogs for Sundance/Chugwater fracturing patterns owing to a common deformation history and the fact that all are situated between nonreservoir rocks of significantly contrasting lithologic (and, by extension, geomechanical) characteristics.

In their study of Wyoming Laramide thrust structures, Lorenz & Cooper (2011) found that Tensleep fractures developed in both fold hinge-normal (early) and hinge-parallel (late) orientations. Areas without significant folding (such as the Casper Carbon Capture #1 site) may contain only the early fractures. Most fractures described from Tensleep core are vertical; fracture distributions are strongly influenced by bedding and lithology, and termination of vertical fractures into bedding planes is common (Cooper & Lorenz, 2007-2010). Many fractures are open as a result of partial mineralization and favorable orientation relative to the local maximum horizontal stress direction.

Based on the prevailing offset fault strikes of ~70-110 degrees near the Casper Carbon Capture #1 site, at least one major fracture set within the injection zone is predicted to trend ~160-200 degrees. However, given the proximity of the site to the faulted and uplifted Laramie Mountains, it stands to reason that fractures of multiple generations and orientations are present in the subsurface. The effect of these fracture sets on subsurface fluid flow is not well understood, but certain mechanical stratigraphy concepts were applied to the conceptual site model. For the purposes of this initial site characterization, it was assumed that any open fractures are dominantly bed-normal and mechanically constrained at lithostratigraphic boundaries (i.e., terminating into shales and/or confining layers). The rationale underlying this assumption is rooted in the mechanical stratigraphy concept that fractures may terminate or redirect at bed boundaries and lithologic contacts as a result of ductility and rock strength contrasts – for example, fractures through a sandstone may not continue through an adjacent shale (Cooper & Lorenz, 2007-2010). Based on this assumption, any fractures present within the injection zone are not expected to not transmit injected fluids beyond the injection zone, and the initial simulation model does not account for potential flow along fractures within the reservoir. The conceptual and 3D models will be updated should site-specific data indicate that fractures are important to flow or may cause injected fluid to escape the storage complex.

2.4.12 Seismic Activity

The Casper area is seismically quiescent with no record of anthropogenic seismic events. A small number of distal natural earthquakes have been recorded in recent years on buried faults and fault segments. A summary of nearest events cataloged by the USGS is provided in Table 17. No earthquakes of magnitude 2.0 or greater have been recorded less than 14.9 miles from Casper Carbon Capture #1, and all recorded events fall outside the AoR (Table 17,

Figure 32).

Table 17: Summary of Earthquakes in Wyoming

Date	Magnitude, (M)	Depth, mi	Latitude	Longitude	City or Vicinity of Earthquake	Map Label	Distance to project, mi
2021-08-01	3.8	6.03	42.9946	-105.933	12 km NW of Rolling Hills WY	●	17.5
2020-07-22	3.2	21.4	42.9892	-106.004	16 km NW of Rolling Hills WY	●	14.9
2016-08-22	3.2	3.1	42.5857	-106.297	16 km S of Casper Mountain WY	●	16.8
2003-02-01	3.7	3.1	43.076	-106.179	11 km E of Antelope Hills, WY	●	18.3
1996-10-19	4.2	3.1	43.09	-106.056	21 km E of Antelope Hills, WY	●	20.2
1983-11-15	3.0	3.1	43.016	-105.955	15 km NW of Rolling Hills, WY	●	17.9

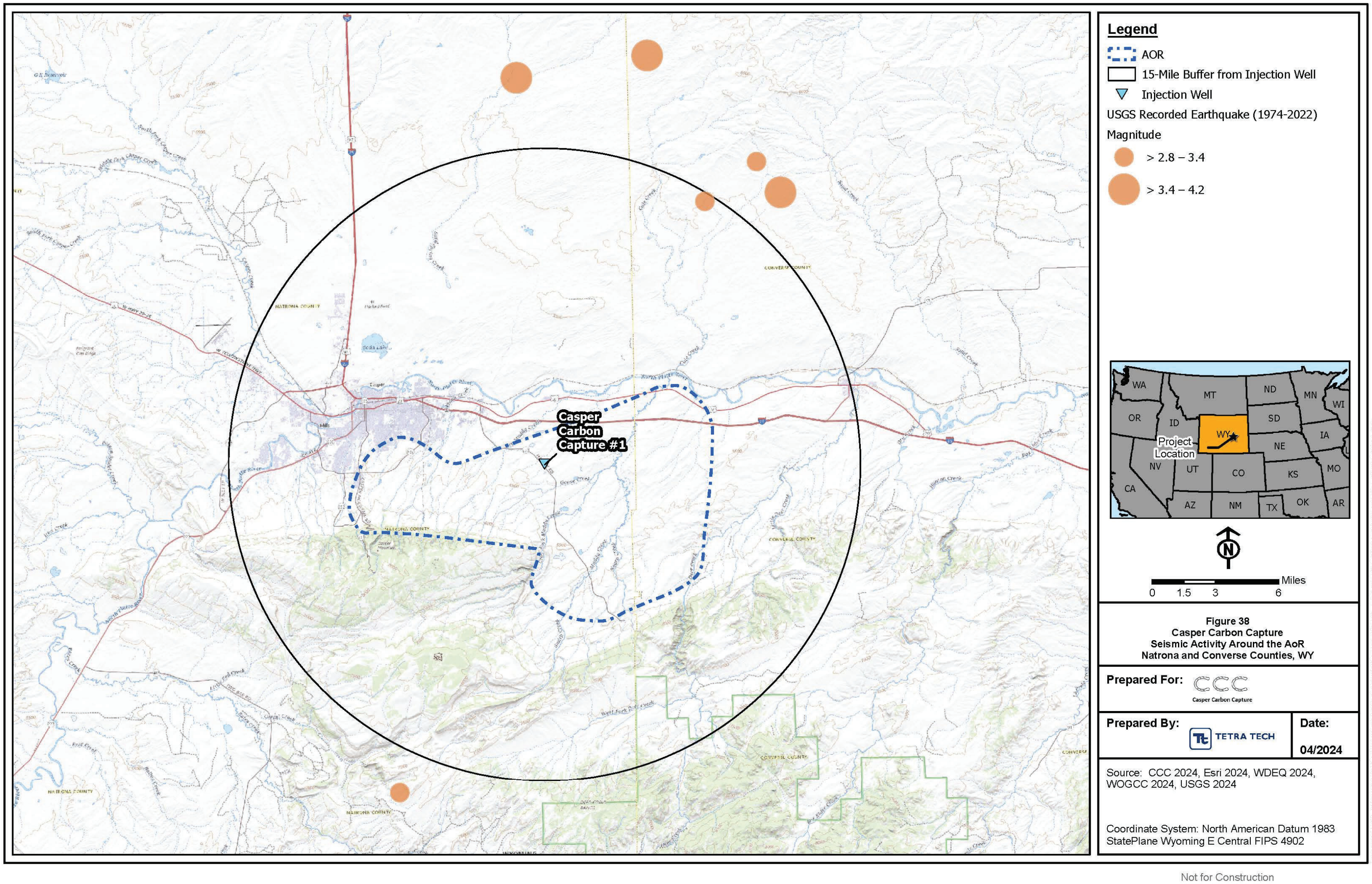


Figure 32: Seismic events in the Project Area.

3.0 REFERENCES

Anna, L. O. (2010*). Geologic assessment of undiscovered oil and gas in the Powder River Basin Province. In Total Petroleum Systems and Geologic Assessment of Oil and Gas Resources in the Powder River Basin Province, Wyoming and Montana: U.S. Geological Survey Series DDS–69–U* (p. 97 p.).

Asquith, G., & Krygowski, D. (2004). *Basic Well Log Analysis: AAPG Methods in Exploration Series 16.* Tula: American Association of Petroleum Geologists.

Beikman, H. M. (1962). *Geology of the Powder River Basin Wyoming and Montana with reference to subsurface disposal of radioactive wastes: Trace Elements Investigations Report 823.* U.S. Geological Survey.

Blackstone, Jr., D. L. (1996). *Structural geology of the Laramie Mountains, Southeastern Wyoming and Northeastern Colorado: Report of Investigations No. 51.* Wyoming State Geological Survey.

Bower, R. R. (1964). *Stratigraphy of Red Peak Formation, Alcova Limestone, and Crow Mountain Member of Popo Agie Formation (Triassic) of Central Wyoming (dissertation)*. University of Oklahoma.

Burk, C. A., & Thomas, H. D. (1956). *The Goose Egg Formation (Permo-Triassic) of Eastern Wyoming: Report of Investigations No. 6*. Geological Survey of Wyoming.

Connely, M. V. (2002). *Stratigraphy and Paleoecology of the Morrison Formation, Como Bluff, Wyoming (thesis).* Utah State University.

Cooper, S., & Lorenz, J. C. (2007-2010). *Tensleep Formation Fracture Study Compendium.* Enhanced Oil Recovery Institute, University of Wyoming.

Crist, M. A., and Lowry, M. E. (1972*). Ground-Water Resources of Natrona County, Wyoming,* https://doi.org/10.3133/wsp1897.

Davies, C., Purvis, S., Kenny, R., Fenton, J., Pandey, V., Geesaman, K., Trevino, R., Iwobi, C., Watford, M., & Bose, S. (2015*). Reservoir Quality and Stratigraphy of the Mowry and Muddy Interval of the Powder River Basin, Wyoming, USA.* First Break, v. 33, No. 12.

Davis, R. W., & Paul, A. R. (1977). Effects of Surface Mining Upon Shallow Aquifers in the Eastern Powder River Basin, Wyoming.

Finn, T. M. (2021*). Stratigraphic cross sections of the Mowry Shale and associated strata in the Wind River Basin, Wyoming: U.S. Geological Survey Scientific Investigations Map 3476, 1 sheet, 14-p.pamphlet*. U.S. Geological Survey.

Fox, J. E. (1993). *Stratigraphic cross sections M-M' through R-R', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Fox, J. E. (1993b). *Stratigraphic cross sections S-S' through V-V', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Friedmann, S. J., & Stamp, V. (2013). *Teapot Dome: Site characterization of a CO2-enhanced oil recovery site in Eastern Wyoming: UCRL-JRNL-217774.* Lawrence Livermore National Laboratory.

Fryberger, S. G. (2013). *Stratigraphic aspects of the Tensleep play of Wyoming.* University of Wyoming.

Fryberger, S. G., Jones, N., Johnson, M., & Chopping, C. (2016). *Stratigraphy, exploration, and EOR potential of the Tensleep/Casper Formations, SE Wyoming.* Enhanced Oil Recovery Institute, University of Wyoming.

Gregory, R. W. (1997). *Subsurface correlation of selected Late Cretaceous and older formations along the western margin of the Powder River Basin, Wyoming.* Wyoming State Geological Survey.

Hunter, J., Ver Ploeg, A. J., & Boyd, C. S. (2005). *Geologic Map of the Casper 30' x 60' Quadrangle, Natrona and Converse Counties, Central Wyoming.* Wyoming State Geological Survey.

Johnson, E. A. (1992). *Depositional History of Jurassic Rocks in the Area of the Powder River Basin, Northeastern Wyoming and Southeastern Montana.* In: Evolution of Sedimentary Basins – Powder River Basin, U.S. Geological Survey Bulletin 1917-J.

Lorenz, J. C., & Cooper, S. P. (2011). *Fracture Patterns in Laramide Thrust Structures, Wyoming.* Search and Discovery No. 40818.

Lovelace, D. M. (2015). *A New Age Constraint for the Early Triassic Alcova Limestone (Chugwater Group, Wyoming).* Palaeogeography Palaeoclimatology Palaeoecology 424.

Lowry, M. E., & Cummings, T. R. (1966). *Ground water resources of Sheridan County, Wyoming.* U.S. Geological Survey Water Supply Paper 1807.

Lynds, R. M., & Slattery, J. S. (2017*). Correlation of the Upper Cretaceous Strata of Wyoming, Open File Report 2017-3, 1 sheet.* Wyoming State Geological Survey.

May, J. A., Socianu, A. L., & Hankins, B. T. (2021). *The Mowry Shale of the Powder River Basin: A Multiscale Re-Evaluation of a Super Basin Source Rock and Emerging Unconventional Play.* AAPG Global Super Basins Leadership Conference.

Pipiringos, G. N. (1968). *Correlation and Nomenclature of Some Triassic and Jurassic Rocks in South-Central Wyoming.* U.S. Geological Survey Professional Paper 594-D.

Stacy, M. E., and Huntoon, P. W. (1994). Karstic Groundwater Circulation in the Fault- Severed Madison Aquifer in the Casper Mountain Area of Natrona County, Wyoming. Wyoming Resources Center, University of Wyoming.

Surdam, R. C., Zunsheng, J., Dr Bruin, R. H., & Bentley, R. D. (2010). *Shale Gas Potential of the Mowry Shale in Wyoming Laramide Basins. In: Challenges in Geologic Resource Development No. 9.* Wyoming State Geological Survey.

Taboga, K. G. (2013). *Platte River Basin Water Plan Update Groundwater Study Level 1 (2009-2013) Available Groundwater Determination Technical Memorandum*. Wyoming Water Development Commission.

Taboga, K. G., & Stafford, J. E. (2020*). Groundwater salinity in Wyoming: Open File Report 2020-6.* Wyoming State Geological Survey.

Tank, R. W. (1956). *Clay Mineralogy of Morrison Formation, Black Hills Area, Wyoming and South Dakota.* American Association of Petroleum Geologists Bulletin, v. 40, No. 5, p. 871–878.

Thornhill, J. T., et al. (1982). *Application of the Area of Review Concept.* Groundwater, vol. 20, no. 1, Jan. 1982, pp. 32–38, https://doi.org/10.1111/j.1745-6584.1982.tb01327.x.

Trotter, J. (1963). *The Minnelusa play of the northern Powder River Wyoming and adjacent areas.* In Guidebook, Wyo. Geol. Assoc. and Billings Geol. Soc. First Joint Field Conf. p. 117-122

Uhlir, D. M. (1987). *Sedimentology of the Sundance Formation, Northern Wyoming (dissertation).* Iowa State University.

Warwick, P., & Corum, M. (2012). *Geologic framework for the national assessment of carbon dioxide storage resources—Powder River Basin, Wyoming, Montana, South Dakota, and Nebraska, chap. B of Geologic framework for the national assessment of carbon.* U.S. Geological Survey.

Wenck Associates. (2016). *Platte River Basin Plan 2016 Update Volume 1.* Wyoming Water Development Commission.

Whitcomb, H. A. & Morros, D. R. (1964). *Ground-water Resources and Geology of northern and western Crook County, Wyoming.*

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Area of Review

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
2D	Two-Dimensional
3D	Three-Dimensional
AoR	Area of Review
API	American Petroleum Institute
bgs	Below Ground Surface
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
DPHI	Density Porosity
E	East
EPA	United States Environmental Protection Agency
ERRP	Emergency Remedial and Response Plan
°F	Fahrenheit
ft	Feet
GR	Gamma Ray
H_2O	Water
in	Inches
Kg/m^3	Kilograms per cubic meter
m/s^2	Meters per Second Squared
mD	Millidarcies
MMT	Million Metric Tonnes
MW	Monitoring Well
N	North
N/A	Not Applicable
NPHI	Neutron Porosity
OD	Outside Diameter

PNNL	Pacific Northwest National Laboratory
PRB	Powder River Basin
psi	Pounds per Square Inch
Qrt	Quarter
RNG	Range
RHOB	Bulk Density
RHOMA	Matrix Density
$scCO_2$	Supercritical Carbon Dioxide
SP	Spontaneous Potential
STOMP	Subsurface Transport Over Multiple Phases
TWN	Township
TD	Total Depth
TVD	True Vertical Depth
UIC	Underground Injection Control
USGS	U.S. Geological Survey
VSHALE	Shale Volume
W	West
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WSEO	Wyoming State Engineer’s Office
WY	Wyoming
Y/N	Yes/No

1.0 AREA OF REVIEW DELINEATION

This form describes how Casper Carbon Capture, LLC (CCC) determined the Area of Review (AoR) and evaluated any potential artificial penetrations that may require a Corrective Action Plan pursuant to Section 13 of Chapter 24 of the Wyoming Water Quality Rules. The predicted AoR was determined using computer modeling and simulation of reservoir properties and will encompass the larger extent of either the free-phase CO_2 plume (equal to or greater than 1% saturation) or the minimum pressure increase needed to lift formation brine into the lowermost underground source of drinking water (USDW), or critical pressure. The critical pressure was calculated using an equation provided by Thornhill et al. (1982). Until site-specific data is collected at the time of drilling Casper Carbon Capture #1, assumptions have been made to estimate a critical pressure of 21 psi. The assumptions and inputs for this analysis are detailed further in Section 2.5 of this form. This estimate of critical pressure will be updated when site-specific water sample, reservoir pressure, temperature, and formation depth measurements are taken in the stratigraphic well or Casper Carbon Capture #1 prior to injection. Based on these assumptions and the results of the reservoir modeling, the resultant AoR was delineated as approximately 72,000 acres (Figure 1).

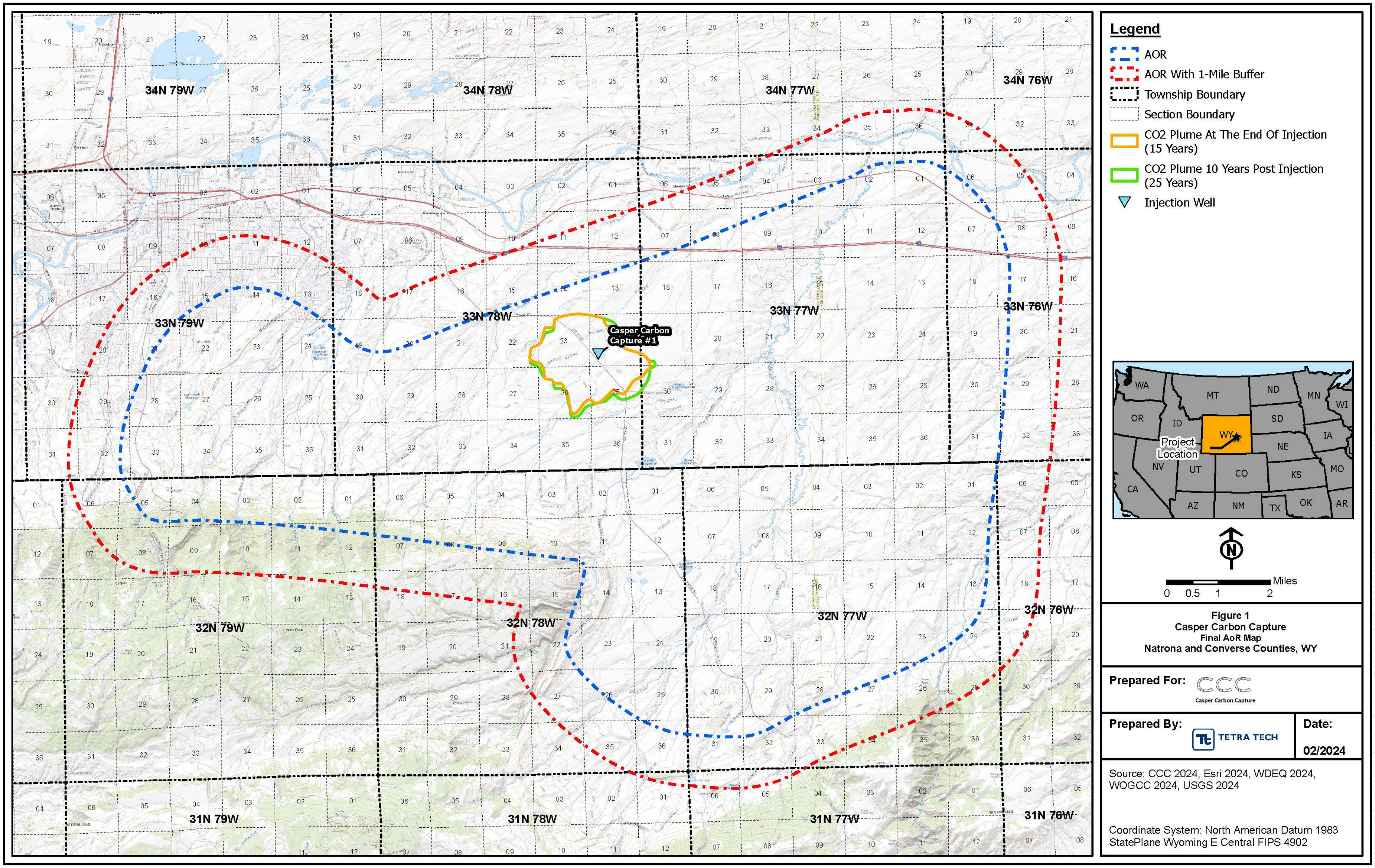
Due to the significant number of wells identified in the AoR, a list of all groundwater and oil and gas well penetrations within the AoR is given as an appendix to this Form. These wells, along with the stabilized plume are shown on Figure 2.

Figure 3 shows the pressure plume at the cessation of operations, after 15 years of injection. Reservoir pressure increases during the 15-year injection period as injection rate ramps up but dissipates rapidly within the first ten years of post-injection as the plume continues to expand. The pressure-based AoR is significantly larger than the free-phase CO_2 plume and is the basis for AoR delineation.

The critical pressure extent is used to help determine the pressure-based AoR and relies on inputs such as fluid density and reservoir pressure. Fluid density is a function of reservoir temperature, pressure, and salinity. Since no site-specific fluid samples or reservoir pressure measurements were available, the critical pressure extent will be updated once fluids are sampled during drilling.

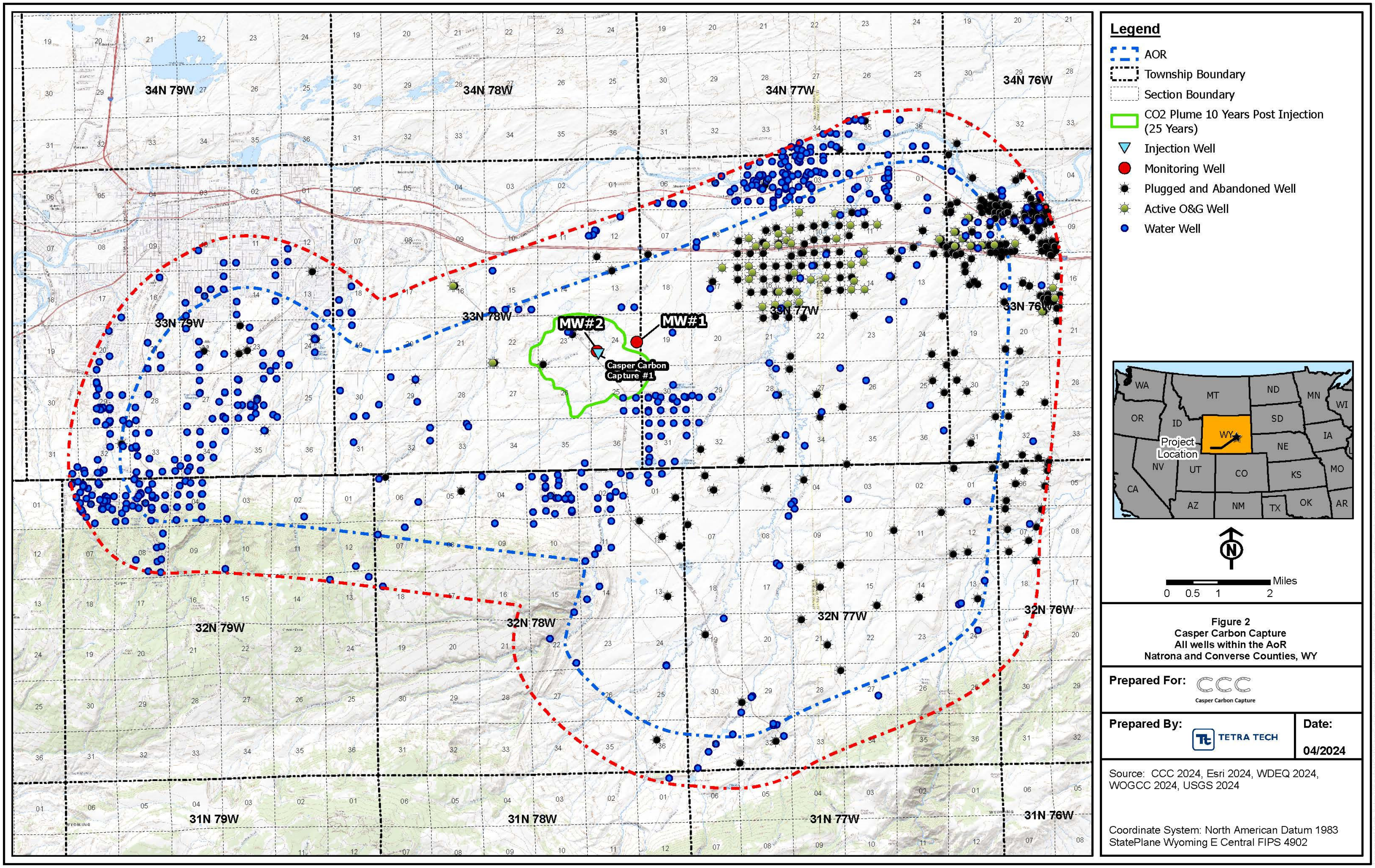
The proposed location of Casper Carbon Capture #1 is in township 33 north, range 78 west, section 24. The pressure front expected from the injection of CO_2 was delineated using modeling and fluid simulation software, and encompasses portions of townships 32 and 33 north, and ranges 76, 77, 78, and 79 west.

Regional cross-sections can be found in form A-1 that extend from the surface down through the lower confining zone. Figure 4Figure 4 and Figure 5Figure 5 are cross-sections of the AoR that were created during plume modeling. They show the Casper Carbon Capture #1 and Monitoring Well (MW) #s 1-2 in perpendicular directions. The model stratigraphically extends from the lower confining zone to above the lowermost USDW above the upper confining zone but does not extend stratigraphically to the surface or the basement as proper CO_2 confinement was shown.



Not for Construction

Figure 1: Final AoR map.



Not for Construction

Figure 2: All wells in the Area of Review.

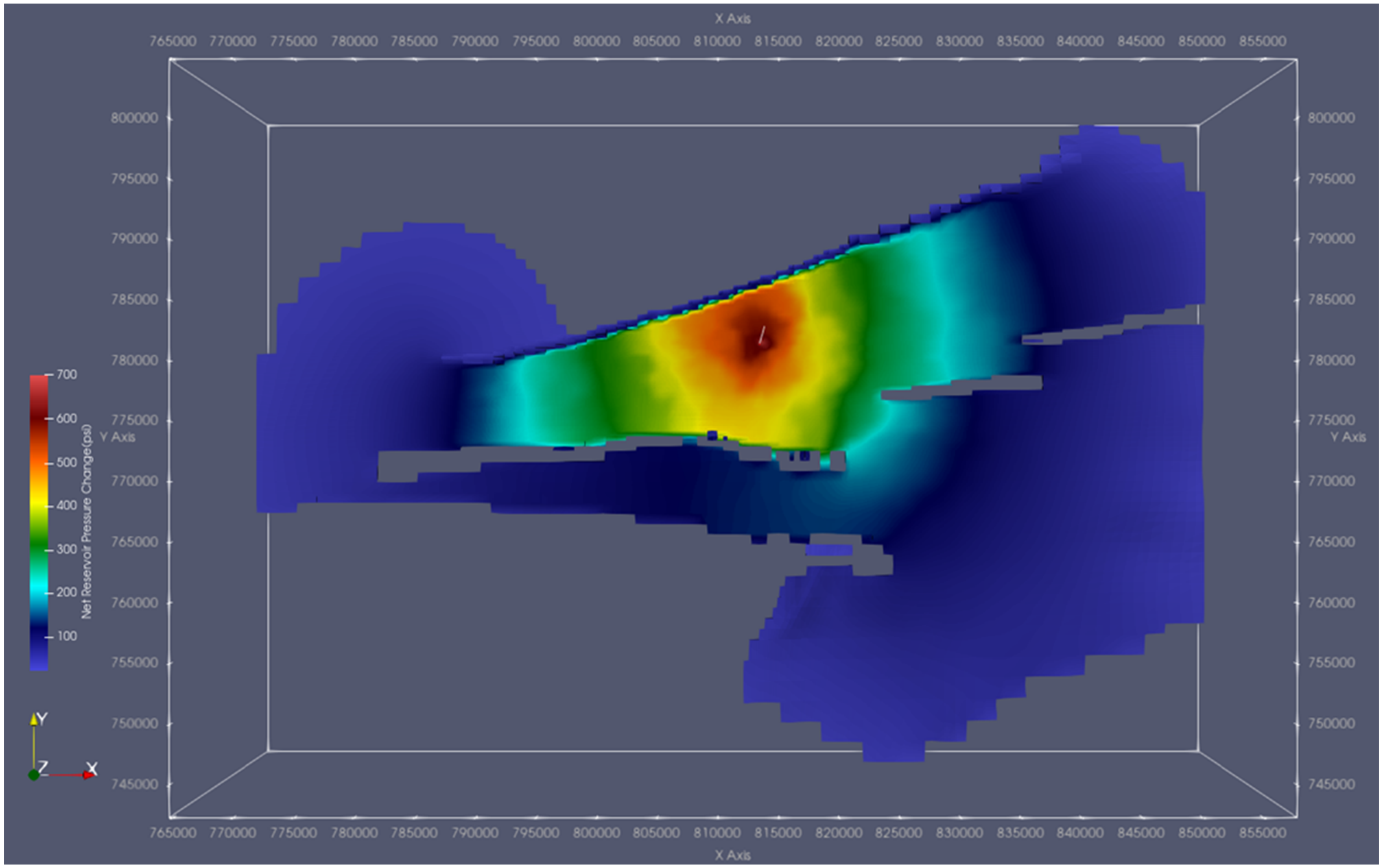


Figure 3: Area of Review – pressure map.

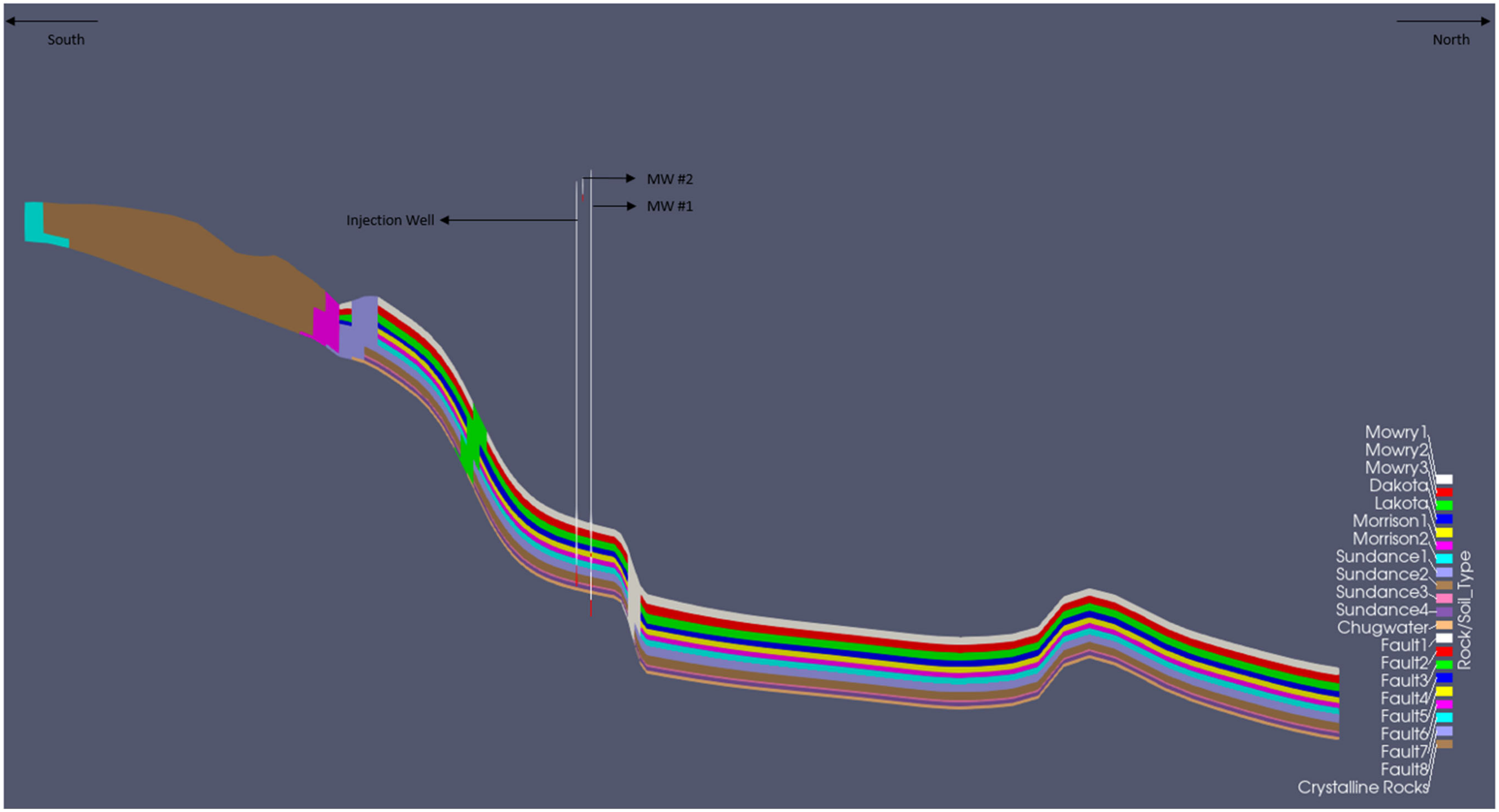


Figure 4: N-S Cross section of the AoR.

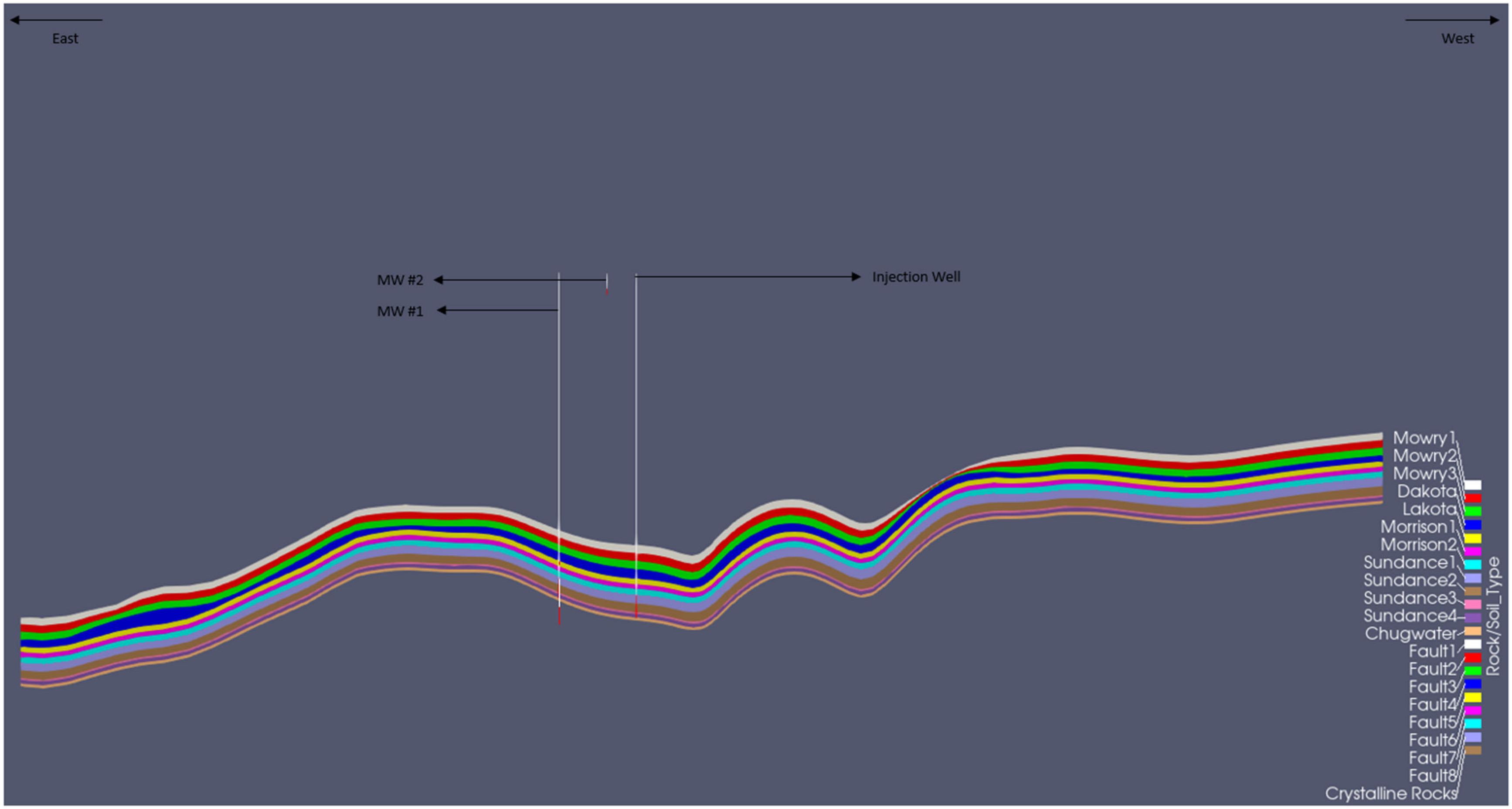


Figure 5: W-E Cross section of the AoR.

2.0 MODEL

2.1 COMPUTATIONAL MODEL

The CO_2 injection simulation conducted for this investigation was executed using the Subsurface Transport Over Multiple Phases (STOMP)-CO_2 simulator developed by Pacific Northwest National Laboratory (PNNL) (White et al. 2013; White and Oostrom 2006; White and Oostrom 2000). The STOMP-CO_2 simulator was extensively verified against other codes used for simulation of geologic disposal of CO_2 as part of the GeoSeq code intercomparison study (Pruess et al. 2002).

Partial differential conservation equations for fluid mass, energy, and salt mass compose the fundamental equations for STOMP-CO_2. Coefficients within the fundamental equations are related to the primary variables through a set of constitutive relationships. The salt transport equations are solved simultaneously with the component mass and energy conservation equations.

The solute and reactive species transport equations, including CO_2-brine thermodynamic property calculations and phase equilibrium, are solved sequentially after the coupled flow and transport equations. The fundamental coupled flow equations are solved using an integral volume finite-difference approach with the nonlinearities in the discretized equations resolved through Newton-Raphson iteration. The dominant nonlinear functions within the STOMP-CO_2 simulator are the relative permeability-saturation-capillary pressure (k-s-p) relationships. The STOMP-CO_2 simulator allows the user to specify these relationships through a large variety of popular and classic functions. Two-phase (gas-aqueous) k-s-p relationships can be specified with hysteretic or nonhysteretic functions or nonhysteretic tabular data. Entrapment of CO_2 with imbibing water conditions can be modeled with the hysteretic two-phase k-s-p functions. Two-phase k-s-p relationships span both saturated and unsaturated conditions. The aqueous phase is assumed to never completely disappear through extensions to the s-p function below the residual saturation and a vapor pressure lowering scheme. Supercritical CO_2 has the function of a gas in these two-phase k-s-p relationships. The model does not include geochemical reactions due to the lack of site-specific geochemistry data. The model also does not include heat transport processes, but instead assumes the reservoir temperature, based on the geothermal gradient specified in this Form.

The entrapment option available in STOMP-CO_2 was used to allow for entrapment of CO_2 when the aqueous phase is on an imbibition path (i.e., increasing aqueous saturation). Gas saturation can be free or trapped. The trapped gas is assumed to be in the form of aqueous occluded ganglia and immobile. The potential effective trapped gas saturation varies between zero and the effective maximum trapped gas saturation as a function of the historical minimum value of the apparent aqueous saturation.

For the range of temperature and pressure conditions present in deep saline reservoirs, four phases are possible: 1) water-rich liquid (aqueous), 2) CO_2-rich vapor (gas), 3) CO_2-rich liquid (liquid-CO_2), and 4) crystalline salt (precipitated salt). The equations of state express: 1) the existence of phases given the temperature, pressure, water, CO_2, and salt concentration; 2) the partitioning of components among existing phases; and 3) the density of the existing phases.

Thermodynamic properties for CO_2 are computed via interpolation from a property data table stored in an external file. The property table was developed from the equation of state for CO_2 published by Span and Wagner (1996). Phase equilibria calculations in STOMP-CO_2 use the formulations of Spycher et al. (2003) for temperatures below 100°C and Spycher and Pruess (2010) for temperatures above 100°C, with corrections for dissolved salt provided in Spycher and Pruess (2010). The Spycher formulations are based on the Redlich-Kwong equation of state with parameters fitted from published experimental data for CO_2-H_2O systems. Additional details regarding the equations of state used in STOMP-CO_2 can be found in the guide by White et al. (2013).

A well model is defined as a type of source term that extends over multiple grid cells, where the well diameter is smaller than the grid cell. A fully coupled well model in STOMP-CO_2 was used to simulate the injection of supercritical CO_2 (scCO_2) under a specified mass injection rate, subject to a maximum injection pressure limit. When the mass injection rate can be met without exceeding the specified maximum injection pressure limit, the well is considered to be flow controlled. Conversely, when the mass injection rate cannot be met without exceeding the specified pressure limit, the well is considered to be pressure controlled and the mass injection rate is determined based on the injection pressure. The well model assumes a constant pressure gradient within the well and calculates the injection pressure at each cell through which the well passes. The CO_2 injection rate is proportional to the pressure gradient between the well and surrounding formation in each grid cell. By fully integrating the well equations into the reservoir field equations, the numerical convergence of the nonlinear conservation and constitutive equations is greatly enhanced.

Input and output files for the computational model will be provided in a GEM-compatible format.

2.2 COMPUTATIONAL MODEL RESULTS

Figure 6 shows the predicted pressure increase (simulated pore pressure of the grid cell that contains the screen top) in the storage reservoir following the injection period. In the figure, the outermost boundaries are set at the pressure differential of 21 psi, which represents the estimated critical pressure. The timeframe for reservoir pressure decline below the critical pressure, or the pressure to lift formation fluids into the overlying USDW, is approximately 13 years. The maximum reservoir pressure increase is approximately 630 psi, which modeling simulations suggest is insufficient to move storage formation fluids through the low-permeability upper confining interval and into the above USDWs. Figure 7 shows the simulated CO_2 mass partitioning in the storage reservoir.

Figure 8 and Figure 9 show the predicted pressure plume following the cessation of injection. The extent of the pressure plume decreases significantly within the first 10 years after the cessation of injection, and by post-injection year 13 is less than half the extent it was upon final injection. The AoR delineation is based on this maximum pressure plume extent, as explained in Section 1.0. Figure 10 shows the extent of the injected free-phase CO_2 plume at the end of 15 years of injection, while Figure 11 shows the CO_2 plume after 10 years post-injection.

The model is a single computational model with multiple injection rate iterations. Open-flow boundaries were used in the model in an attempt to simulate the areal continuity of the target injection zone. Some uncertainty (primarily capillary pressure) exists due to a lack of site-specific data and will be included as part of the site-specific data collection effort and subsequent model re-evaluations.

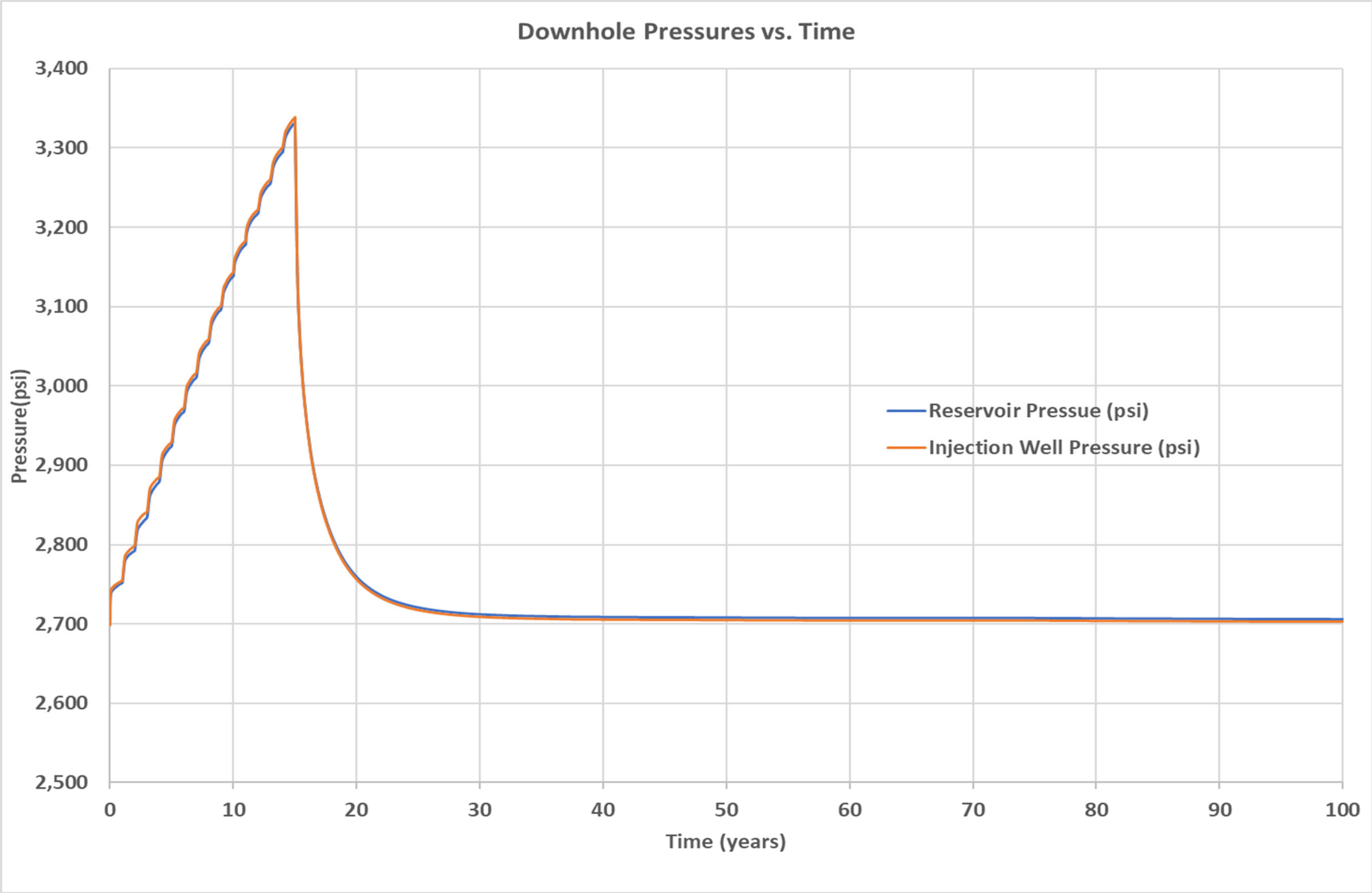


Figure 6: Predicted pressure increase in storage reservoir following injection period.

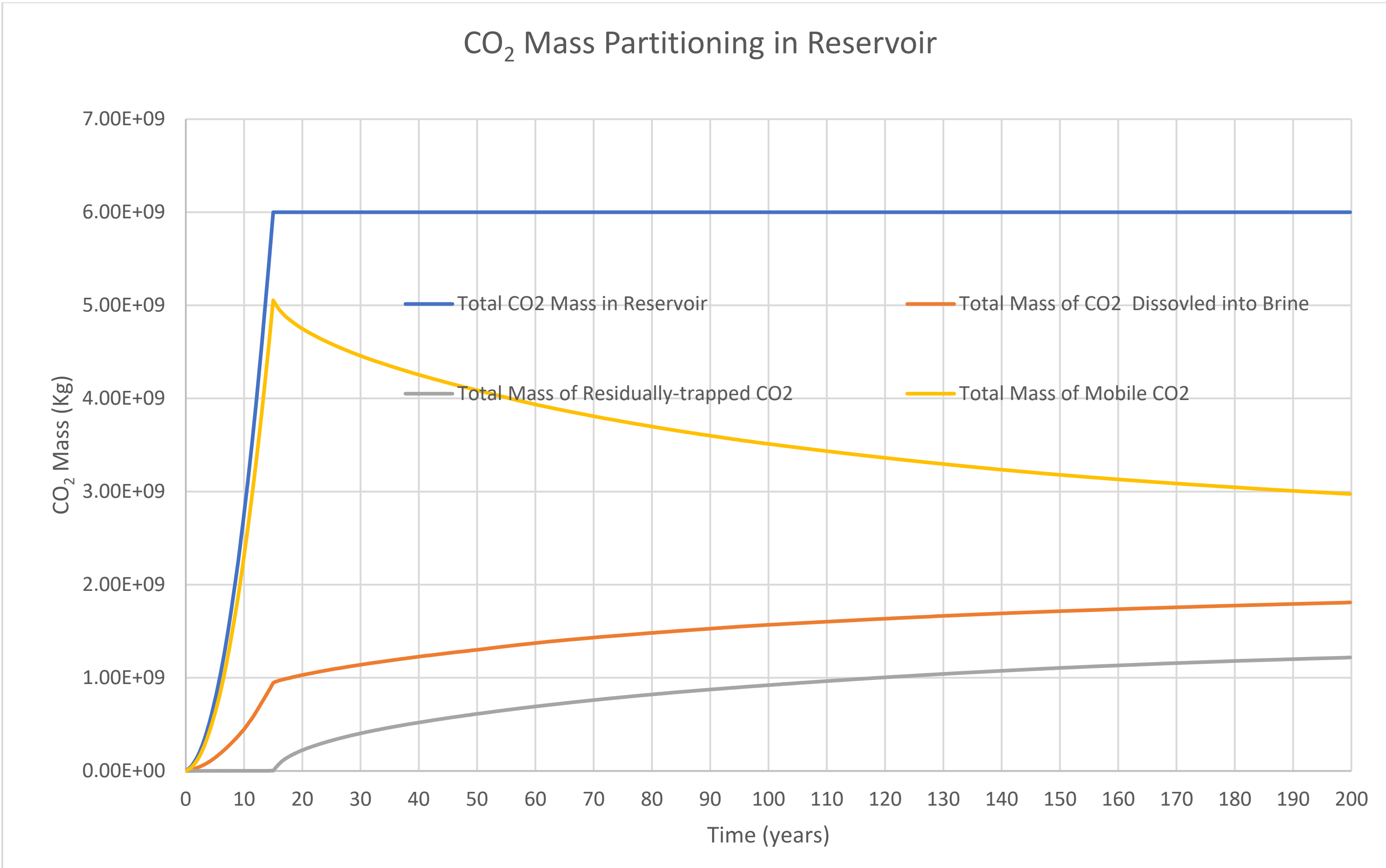


Figure 7: Simulated total injected, dissolved in brine, supercritical phase, and residually trapped CO_2.

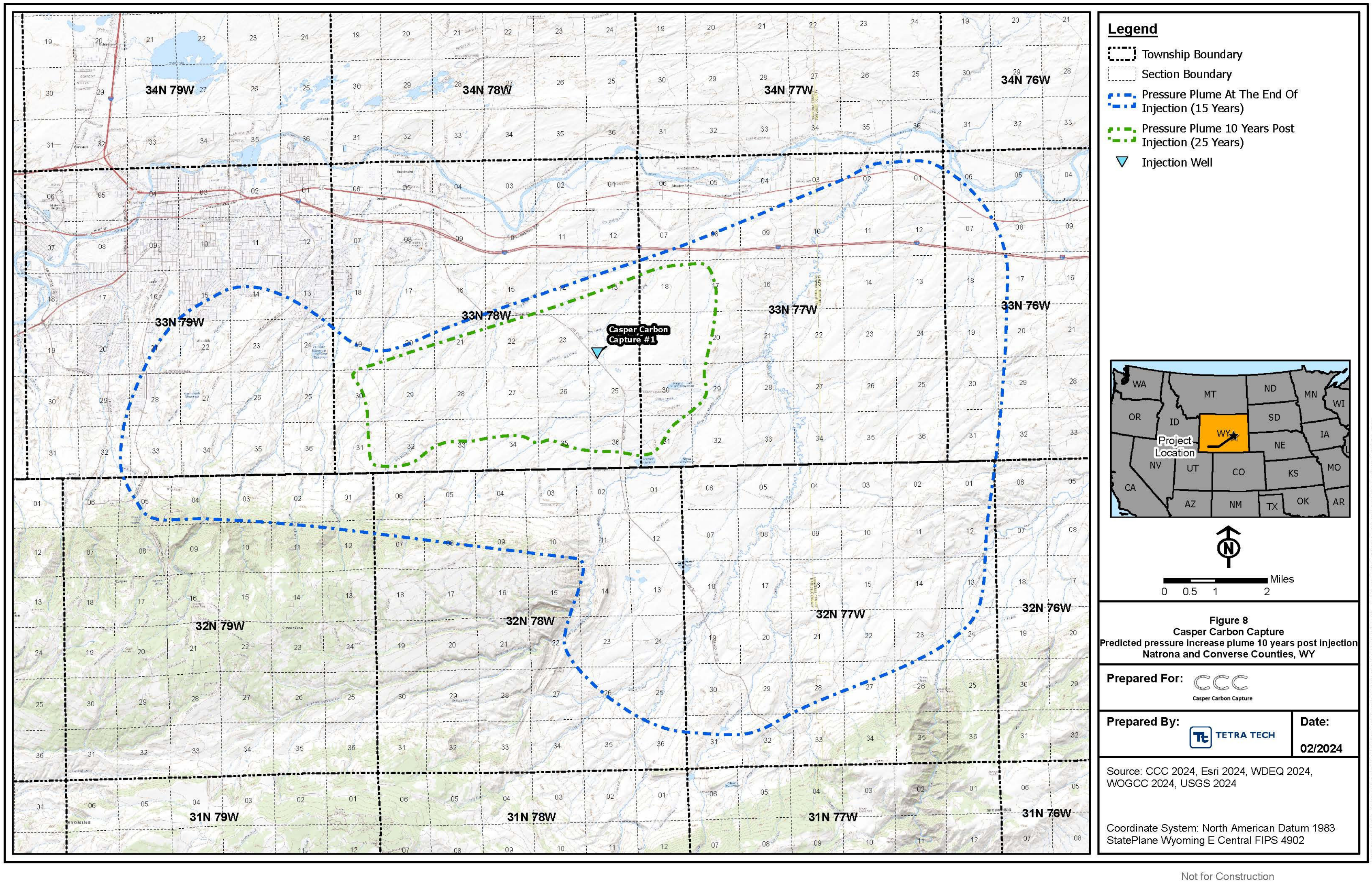


Figure 8: Predicted change in the extent of critical pressure in the storage reservoir after 10 years following cessation of CO_2 injection.

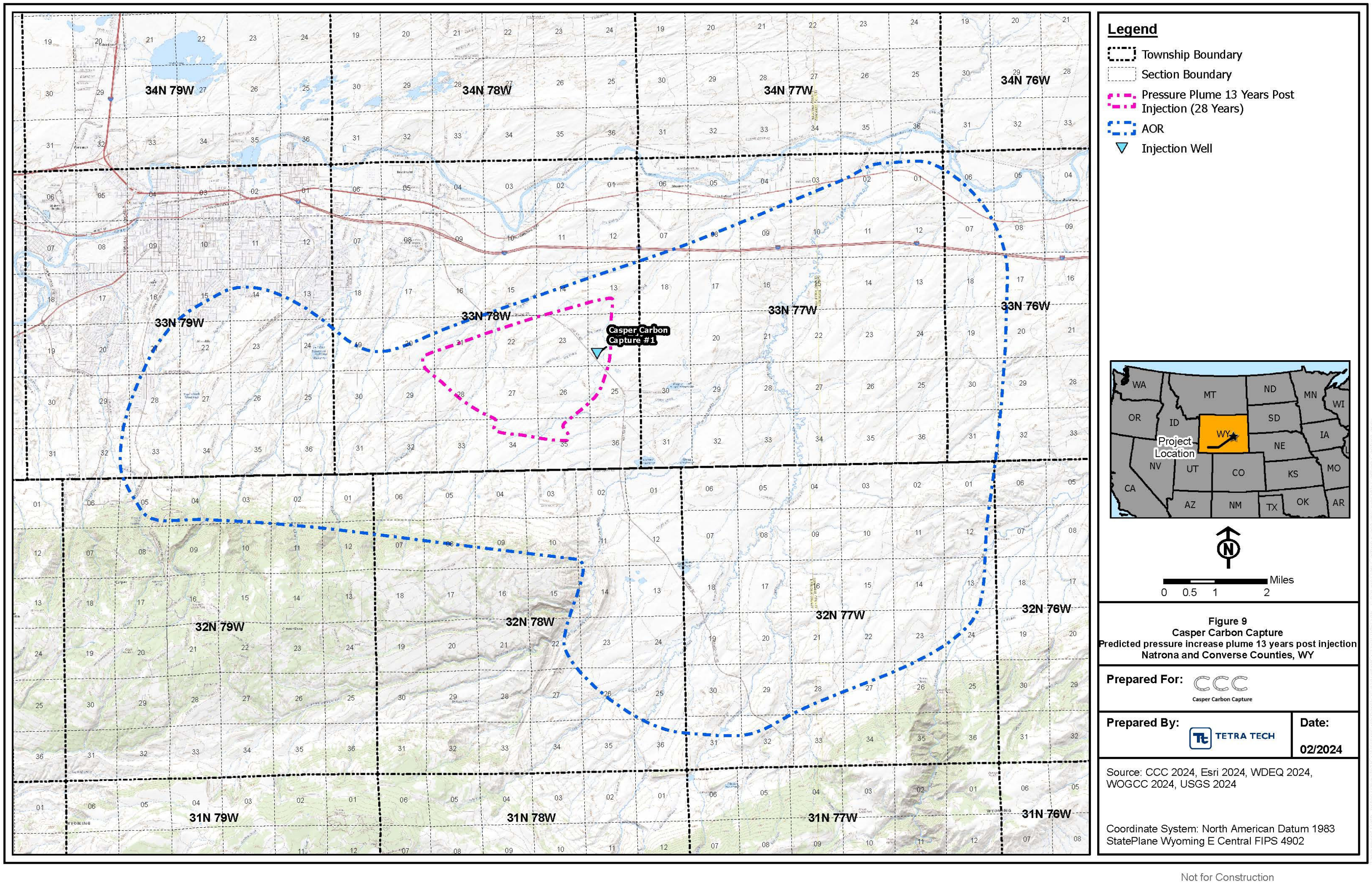
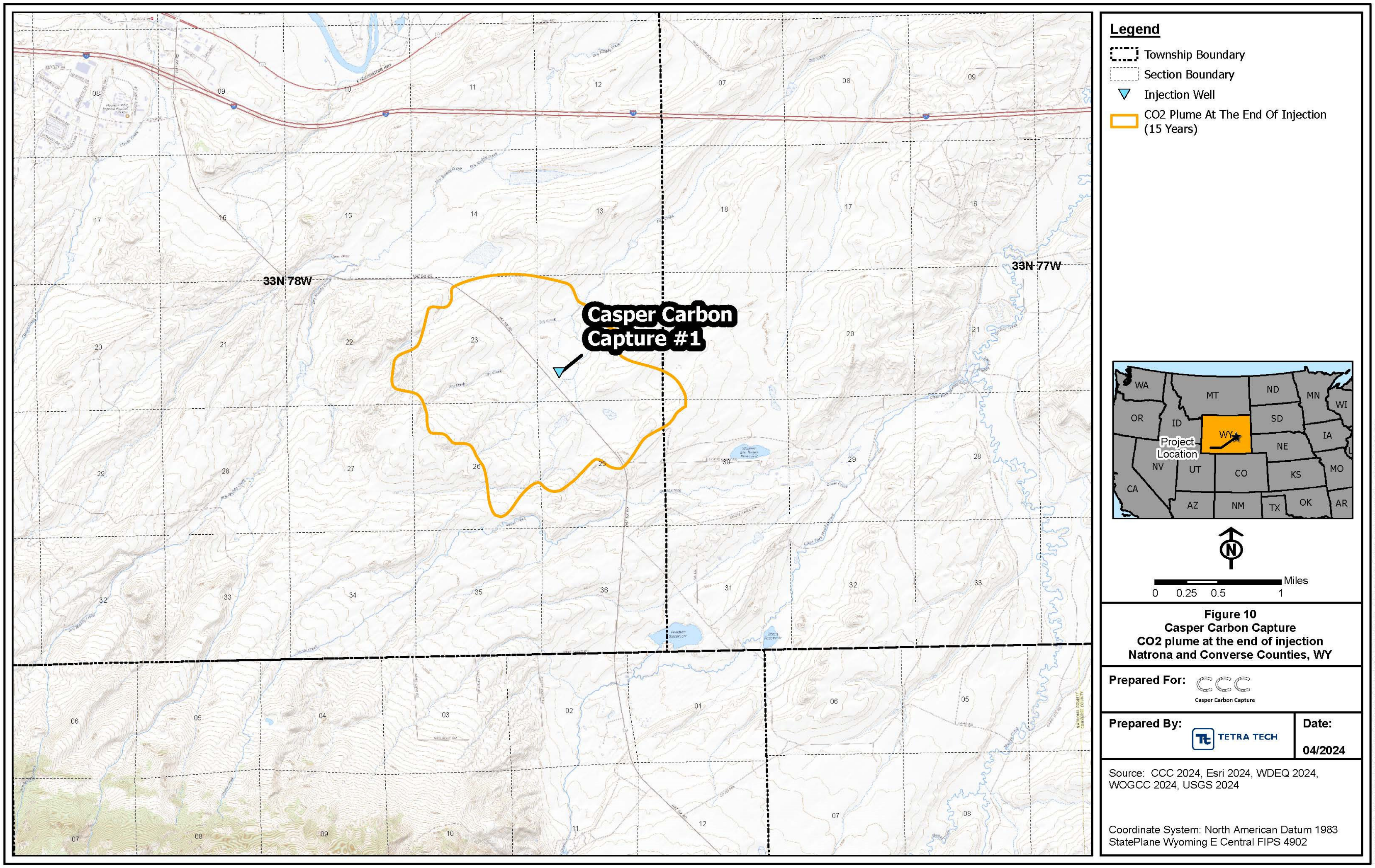


Figure 9: Predicted change in the pressure plume in the storage reservoir 13 after years following the cessation of CO_2 injection.



Not for Construction

Figure 10: CO_2 plume at the end of 15 years of injection phase.

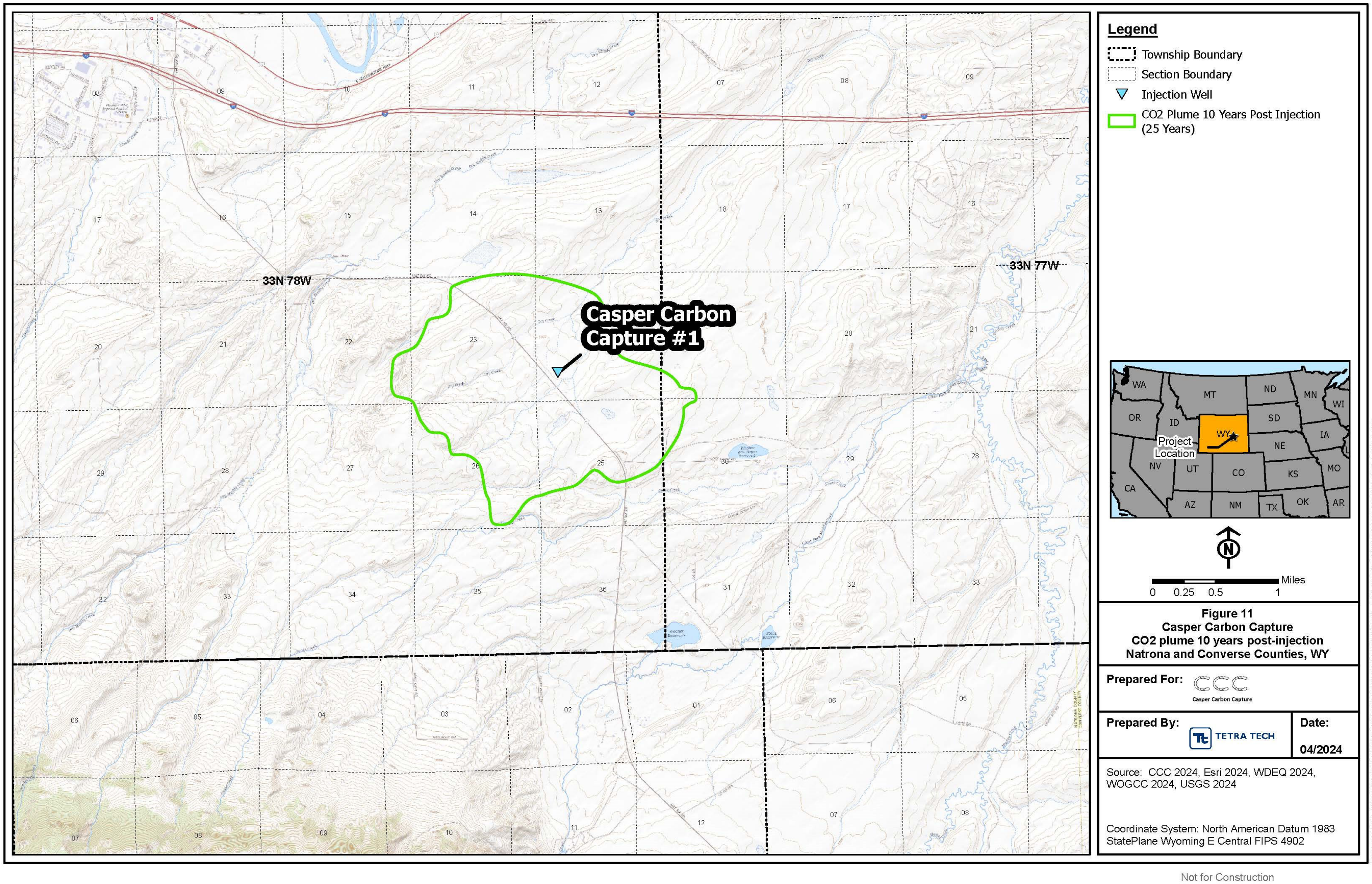


Figure 11: CO_2 plume 10 Years post injection model calibration and validation

2.3 MODEL CALIBRATION AND VALIDATION

At the time of this permit to construct is being developed, sufficient data for history-matching and model calibration were not available – there are no active injection or production wells for data available to history match to. The AoR model calibration is further discussed in section 4.0.

2.4 CONCEPTUAL SITE MODEL

A conceptual site model was constructed to represent specific geologic characteristics of the project location to the best degree possible. The conceptual model incorporates site-specific data and was used to develop attributes of the storage complex that populate the computational model.

The process of developing geologic model inputs involved two main phases: 1) construction of a set of 3D grids above, in, and below the storage complex (the structural-stratigraphic interpretation); and 2) estimation of the porosity, permeability, and other key rock attributes within the storage complex (the property interpretation).

Structural-Stratigraphic Framework

The 3D grids were constructed in IHS Kingdom (Kingdom version 2021, IHS Markit S&P Global, 64-bit) and later exported to the modeling software used for this project. The grids, which form the 3D framework of the model, each define a surface interpretated as the top of formations from the Mowry to the Chugwater. Additional underburden was not used in the model, as the model showed proper containment from the upper portion of the lower confining zone. The grids were built in the depth domain using formation tops picked on well logs API 4902522192 and API 4900927895 and refined by referencing 2D seismic and legacy structure maps. Additionally, some grids for which well top control was limited were further refined by projecting mapped thicknesses up and down from more densely drilled horizons.

The model grid is orthogonal, and used a variable grid spacing with coarser cell size away from the injection location to optimize computing time. Grid spacing is 112x112 feet near Casper Carbon Capture #1, and increases with distance. The furthest extent from Casper Carbon Capture #1 within the model uses a grid spacing of 500x500 feet.

Faults were handled in the model according to their specific characteristics. STOMP-CO_2 model grid cells directly intersected by or within 500 feet from a particular fault were assigned to a unique zone number, which allowed specification of unique porosity and permeability values for those grid cells, while the rest of model grid cells use the porosity/permeability values following stratigraphy/lithology.

Formation Correlations

Formations were correlated primarily using well top picks, correlated with regional markers, and compared to WOGCC records of geological markers for wells in the study area.

Log and Core-Derived Properties

To allow for improved quantitative analysis of discrete rock packages and properties, digitized raster log data was obtained from public and proprietary sources. Digitization was done using Kingdom and other standard software packages, and the digital data were edited to correct for gaps and erroneous or anomalous data points per standard log conditioning practices.

Porosity-permeability relationships were determined from a review of core analysis reports. Because available core for the Sundance was limited, core data from multiple permeable zones in the Powder River Basin (PRB) were analyzed together to develop an understanding of porosity-permeability relationships in potential reservoir rocks. In general, all porous zones assessed in this report follow a well-defined logarithmic permeability trend with a good best-fit power-law transform. Permeabilities were estimated using both this overall transform equation and formation-specific transforms derived from the core data.

Petrophysical Workflow

CCC evaluated well logs across the storage complex throughout the southwestern PRB and Casper Arch area to evaluate the suitability of the geology for CO_2 sequestration, to understand the horizontal and vertical changes in the geology, and to establish a set of geologic properties to be used in the 3D modeling of CO_2 injection.

Multiple iterations of the following log types were calculated from legacy data:

- **Normalized Gamma Ray (GR)** logs were generated to minimize variability in log response to similar lithology among different wells, remove drift resulting from different logging tools and borehole environments, and improve consistency for cross-section displays. Normalized GR was used to calculate shale volume, guide facies interpretations, and assist with correlation of geologic formations between well control.
- **Shale Volume (Vshale)** logs were created to visualize the horizontal and vertical distribution of shale across the project area. Normalized GR curves were used to calculate Vshale using a Kingdom workflow. Vshale was used to define the vertical zonation for the 3D STOMP model, which reflects geologic flow units believed to be present in the injection zone.

- **Bulk Density (RHOB)** logs were edited for poor borehole conditions, such as washout. Caliper and density correction logs were used to help identify zones with poor borehole conditions and thus, unreliable bulk density data. In the proposed injection zone, poor borehole is generally localized to the Redwater Shale (Sundance 1 in the model) and the Gypsum Spring (lower part of Sundance 2 in the model). To correct the bad bulk density data in these intervals, a transform equation for GR was developed to create a modeled RHOB curve segment. Additional minor editing using the transform was also applied to other intervals, including Crow Mountain (Sundance 3 in the model).
- **Density Porosity (DPHI)** logs were created using edited RHOB curves. This was originally done to improve consistency of the legacy porosity logs, which were run on different matrix density (RHOMA) values. As construction of the petrophysical model progressed, it became apparent that the lithologic heterogeneity justified the use of multiple RHOMA values throughout the injection zone. This resulted in DPHI logs with good match to core porosity (including a strong positive correlation in the core control well) and higher-confidence porosity estimates for difficult lithologies like shale and shaly sand without the use of a more complex petrophysical model (e.g., multi-mineral).
- **Permeability (K)** logs were created using a two-part transform derived from the control core wells. One transform was used for porosities under 10%, and another for porosities 10% and above. This allowed greater control than a single transform over permeability calculations on the low end of the range.

  Other well log types were used for additional characterization:

- **Spontaneous potential (SP) and resistivity** logs were used to identify permeable zones, generally indicated where SP deflects from a defined shale baseline and where the deep and shallow resistivity curves separate. This methodology is effective only when the salinity of the drilling fluid is different from that of the formation water. SP and resistivity were also used to discriminate intraformational lithology changes (e.g., a bed with no SP response and high resistivity may be interpreted as a low-permeability, low-porosity limestone, depending on information available from other well logs).
- **Neutron porosity (NPHI)** logs were used to distinguish high-clay from low-clay intervals and screen for potential hydrocarbon charge.
- **Caliper and Density Correction** logs were using to assess poor hole conditions, with a +/- 20% deviation from baseline used to flag potential bad hole and the need for further evaluation of the log data.
- **Mud/sample logs and core descriptions** were used to constrain facies log responses and estimate lithologies.

No saturation calculations were performed. Based on the lack of production, shows, and positive formation tests in the project area, pore space is assumed to be 100% water saturated.

The log-derived porosity estimates are assumed to represent total porosity of the rock, or a measure of all pores (connected, non-connected, clay-free, and clay-filled). CCC evaluated multiple methods for determining effective porosity, including Vshale corrections and the use of arbitrary porosity cutoffs, but these approaches introduced additional uncertainty to the porosity calculation. For instance, standard petrophysical workflows for effective porosity are sensitive to assumptions for clay content and permeability. This can be mitigated in future project phases via the collection of site-specific core, cuttings, and logs, allowing the optimization of the petrophysical model.

Seismic-Derived Properties

Seismic inversions were done for 2D seismic data discussed in the Site Characterization document attached to this permit application. HampsonRussell software (HRS-EA12.2, 11/2022) was used for the inversions, and properties were calibrated to sonic log data from Well API 49-009-05299. Specifically, porosity data derived from the inversions showed ranges of about 25% in the best-quality rock, with intervening low-porosity zones contributing to a bulk average of 20% in the gross. This is consistent with the log- and core-derived porosities used to populate the model. Additionally, the inversions show good top and bottom sealing facies above and below the Sundance with porosities of less than 5%.

General Approach to Property Upscaling

There are numerous challenges associated with determining property distribution within the Sundance:

- Heterogeneous depositional facies
- High glauconite content and lack of core data complicate log interpretation of porosity and permeability (i.e., how to define net reservoir)
- Shale volume for porosity corrections is difficult to constrain in mixed-lithology beds
- Permeability can be qualitatively inferred from spontaneous potential logs, but log responses are inconsistent.

Therefore, a total porosity-feet estimate was used to honor datasets at different scales (core, log, seismic). The porosity-feet estimate was sensitized to initial project estimates for the Sundance of 311 feet gross thickness, with 150 feet net thickness at 20% porosity, for an estimated total of ~31 porosity-feet in the storage reservoir. Further analysis constrained the storage capacity as follows:

- Log-based range, ~30-34 porosity-feet
- Seismic-based range, ~29-35 porosity-feet

Final petrophysical calculations yielded the following upscaled inputs to the geomodel:

- **Sundance 1** (Redwater Shale, basal member of the upper confining zone with minor storage capacity trapping upward-migrating CO_2)
    - 107 feet thick at 4.4% porosity = 4.7 porosity-feet
- **Sundance 2** (Lower Sundance through Gypsum Spring, injection zone members)
    - 145 feet thick at 8.6% porosity = 12.5 porosity-feet
- **Sundance 3** (Crow Mountain, basal injection zone member) 13.6 porosity-feet
    - 81 feet thick at 15.7% porosity = 12.7 porosity-feet
- **Total** – 29.9 porosity-feet

2.5 AOR DELINEATION

Movement of the injected CO_2 plume during and after the injection period is driven by the potential energy such as the lateral fluid pressure gradients from the injection intervals and the buoyant force of the injected CO_2. As the plume spreads out within the reservoir and CO_2 is trapped residually through the effects of relative permeability and dissolution, the potential energy of the buoyant CO_2 is gradually lost. Eventually, the buoyant force of the CO_2 is no longer able to overcome capillary entry pressure of the surrounding reservoir rock. At this point, the CO_2 plume ceases to move within the subsurface and becomes stabilized. The extent of the stabilized maximum size CO_2 plume is important for determining the project's AoR and the corresponding scale and scope of the project's monitoring and safety plans.

The CO_2 plume develops within more porous, permeable zones of the Sundance Formation, baffled by overlying low permeable, shaly zones. Due to the low-permeability layer at the top of the Sundance, most of the injected CO_2 is contained within the Sundance. The plume continues to move after the cessation of injection until plume stabilization occurs around year 13.

The AoR is defined as the region surrounding the Casper Carbon Storage Hub where USDWs may be endangered by CO_2 injection activity. The primary endangerment risk is due to the potential for vertical migration of CO_2 and/or formation fluids to a USDW from the storage reservoir. Therefore, the AoR encompasses the region overlying the extent of reservoir fluid pressure increase sufficient to drive formation fluids (e.g., brine) into a USDW, assuming pathways for this migration (e.g., abandoned wells or fractures) are present. The minimum pressure increase in the reservoir that results in a sustained flow of brine upward into an overlying drinking water aquifer is referred to as the “critical threshold pressure increase” and the resultant pressure as the “critical threshold pressure.” The U.S. Environmental Protection Agency (EPA) guidance for AoR delineation under the Underground Injection Control (UIC) Program for Class VI wells provides several methods for estimating the critical threshold pressure increase and the resulting critical threshold pressure. Determination of the critical pressure change threshold is calculated by the following Equation 1 (Thornhill et al., 1982):

$$P_c = P_u + \rho_i g(z_u - z_i) - P_i \qquad \text{Eq. (1)}$$

Where:

P_u =the initial pressure at the base of the USDW (Pa=kg/m·s2),

P_i =the initial pressure in the injection zone (Pa).

ρ_i =the density of the injection zone fluid (kg/m^3),

g =the acceleration of gravity (m/s^2),

z_u =the elevation of the base of the lowermost USDW (m),

z_i =the elevation of the top of the injection zone (m), and

$$P_c = 3582517.30 + (1007.21)(9.82)\big(-365.85 - (-1827.13)\big) - 17891688.46$$

$$144060.28 * 0.000145038 = 21\ psi$$

Using this conservatively estimated critical reservoir pressure increase (P_c) value of 21 psi as the cut-off value for the simulated pressure increase plume, we determine the maximum areal extent of the pressure increase plume with the pressure increase above 21 psi. Then the AoR, based on the maximum areal extent of the critical pressure increase, was determined by overlapping critical pressure increase plumes at various simulation times and finding the maximum area that encompassed all overlapping critical pressure increase plumes. Model parameters are shown in Table 1.

Another approach to delineate the AoR is based on the maximum extent of the simulated free-phase scCO_2 plume, which is also protective of the lowest USDW from proposed CO_2 injection. The final CO_2 plume is then determined by selecting the approach which gives larger areal extent in order to be more protective to the overlying USDW aquifers. As the AoR boundaries at the Casper Carbon Storage Hub defined by the two approaches overlap with each other, CCC defined the AoR that encompasses the maximum critical pressure boundary in order to be more conservative.

Table 1: Model Parameters for Multiphase Fluid Modeling of Geologic Sequestration			
Parameter	**Description**	**Dimensions**	**Variable Used**
Hydrogeologic Properties			
Intrinsic Permeability	Represents properties of the subsurface that impact the rate of fluid flow.	L^2/T	Milidarcy (mD)
Porosity	The relative volume of void space within a formation. Controls the volume of carbon dioxide that may be stored.	Dimensionless	(decimal/percentage)
Capillary Pressure	The pressure difference across the interface of two immiscible fluids (e.g., carbon dioxide and water).	M/LT^2	psi
Relative Permeability	Factor that determines the decrease in permeability for a fluid due to the presence of other immiscible fluids.	Dimensionless	decimal/percentage
Fluid Pressure	Force acting on a unit area, measure of the potential energy per volume of fluid.	M/LT^2	psi
Temperature	Measure of the internal energy of a fluid.	Temperature	°F
Formation Compressibility	Measure of the change in aquifer volume with a change in fluid pressure.	LT^2/M	psi^{-1}
Water Saturation	The percent of system void space occupied by aqueous fluids.	Dimensionless	decimal/percentage
Carbon Dioxide Saturation	The percent of system void space occupied by carbon dioxide.	Dimensionless	decimal/percentage
Storativity	The volume of fluid released from storage per unit decline in head per unit area of the formation.	Dimensionless	decimal/percentage
Fluid Properties			
Viscosity	Measure of the internal resistance to flow.	M/LT	Pa.s
Density	The mass of a fluid per unit volume.	M/L^3	kg/m^3
Composition	Molecular makeup, by volume or mass, of a fluid. Measurement of salinity, concentration of trace compounds.	Dimensionless	decimal/percentage
Fluid Compressibility	The change in volume of a fluid from a unit change in pressure.	LT^2/M	psi^{-1}

Chemical Properties			
Aqueous Diffusion Coefficient	The rate of chemical transport due to a concentration gradient.	L^2/T	(m^2s^{-1})
Aqueous Solubility	The maximum concentration of a chemical (e.g., carbon dioxide dissolved in the aqueous phase.	Dimensionless	decimal/percentage
Solubility in Carbon Dioxide	The maximum concentration of a chemical (e.g., water) dissolved in separate-phase carbon dioxide.	Dimensionless	decimal/percentage
Fluid injection and withdrawal rates			
Injection Rates	Injection rates at each well.	L^3/T	MMT/year
Withdrawal Rates	Any fluid withdrawal rates within model domain.	L^3/T	N/A
Boundary Conditions	Fluid pressures and/or flow rates at the edges of the model domain.	Varies	Aqueous initial condition with zero gas flux
Initial Conditions	Fluid pressures and/or flow rates within the domain at the beginning of the model run.	Varies	psi for pressure and °F for temperature
System Orientation and Simulation Controls			
Model Extent (domain)	The lateral extent of the model in all directions.	L	ft
Number of Model Layers	Model vertical discretization.	Dimensionless	Numerical value
Layer Thickness	Vertical extent of each model layer.	L	ft
Grid Cell Size	Lateral size of each model cell.	L^2	Ft^2
Model Timeframe	The complete duration of the model run.	T (year)	year
Time Step Size	The duration of each temporal interval during the model timeframe.	T	Increments from second to year

In-zone pressure and geochemical monitoring, as well as surface seismic methods, will be used to history match the progression of the pressure front and CO_2 plume in the subsurface. Casper Carbon Capture #1 and monitoring well locations and monitoring methods are discussed in the Testing and Monitoring Plan (Form A-5). Testing and monitoring results from these wells will help verify the extent and location of the delineated AoR.

2.6 CORRECTIVE ACTION EVALUATION

The proposed Corrective Action Plan is designed to protect and ensure that there is no endangerment to USDWs within and in proximity to the area of review. Once acquired, the site-specific data along with the proposed monitoring data, further discussed in the Testing and Monitoring Plan (Form A-5), will be used to validate and fine-tune the geologic and simulation models used to predict the plume and pressure front within the Sundance Formation. The basis for the preliminary plume and pressure front model are discussed in further detail in the conceptual model and simulation explanation to follow.

The identification and investigation of all potential leakage pathways has been completed. Because the AoR represents the critical pressure front, all wells within the AoR were evaluated for having the potential need for corrective action. Of the 679 penetrations within the AoR (see Appendix), 52 wells were determined to have the potential of penetrating the storage complex (Table 2). The critical pressures of the wells in Table 2 were calculated to determine if any of the wells have a critical pressure less than the that of the CO_2 plume (21 psi). These wells were then investigated based on publicly available well files from the WOGCC website, the State Engineer's Office (WSEO), and during a site visit to the WOGCC office. Based on this analysis, 51 of the 52 evaluated wells do not require corrective action. The Govt Brannan well was determined as the only well (Table 3) within the AoR requiring corrective action. Table 4 shows the Govt Brannan well evaluation.

CCC contends that plugging and abandonment activities of all other wells within the AoR have been conducted under the regulations of the WOGCC and the WSEO for plugging wells. These records used in conjunction with the critical pressure calculation conclude that leakage of CO_2 into neighboring USDWs through artificial penetrations within the AoR is unlikely, and no corrective action is currently necessary.

Table 2: Corrective Action Wells and other Borings							
Well Name	**API**	**Date Drilled**	**Latitude**	**Longitude**	**Depth (ft)**	**Date Plugged and Abandoned**	**Penetrates into the Confining Zone? (Y/N)**
NICOLAYSEN 1-23	2520296	09/16/1969	42.8159700	-106.1673700	5714	10/02/1969	N
OCEANIC #1	2505531	12/15/1960	42.8076900	-106.1787800	5756	12/29/1960	N
STATE 24247	2505564	09/17/1951	42.8234000	-106.1039700	5550	10/15/1951	N
STATE 1-A	2505493	06/15/1950	42.7697500	-106.1289500	3700	08/02/1950	N
STATE 1	2505500	04/05/1958	42.7799500	-106.1038000	4220	04/20/1958	N
BROOKS RANCH STATE	2523856	09/26/2012	42.8326340	-106.0977350	5444	02/20/2013	N
GOVT-BRANNAN 1	2505518	06/20/1953	42.8037700	-106.2274600	6980	06/24/1953	Y
LATHROP 54-33	2505512	10/22/1950	42.7863100	-106.0905100	4774	11/25/1950	Y
STATE LAND 1	2521092	09/07/1977	42.7561700	-106.1276900	2500	09/13/1977	N
BROOKS RANCH KL-1516	2523850	09/11/2012	42.8402290	-106.0876060	5280	01/14/2013	N
GOVT 1	2505516	06/04/1953	42.7918100	-106.0734000	4315	06/23/1953	N
UNIT C-037492 J-16	2505659	09/04/1957	42.8443600	-106.0833300	5350	09/24/1957	N
PRATT/WILSON 1	2505498	11/25/1956	42.7766100	-106.2394300	3089	12/12/1956	Y
GOVT 1	905328	08/15/1954	42.7945300	-106.0647800	4918	09/19/1954	N
UNIT PATENTED 0-14403	905575	12/18/1957	42.8308200	-106.0649000	4832	02/20/1958	N

BROOKS RANCH STATE	928911	10/24/2012	42.8298530	-106.0590070	4921	04/02/2013	N
BROOKS RANCH M-22	928509	10/24/2011	42.8350700	-106.0553000	5000	02/04/2012	N
COUNTRY CLUB 1	2560005	01/12/1959	42.8155200	-106.2651800	5120	01/25/1959	Y
LAMB 1	2510028	07/26/1958	42.7497700	-106.0818800	4024	08/11/1958	Y
TERRA STATE 6931 0-	921927	04/25/1981	42.8308000	-106.0453000	4848	05/06/1981	N
GEARY DOME 1	922075	02/04/1982	42.8668100	-106.0643800	6802	02/25/1982	N
MORGAN RICHARDSON	922701	09/20/1988	42.8742500	-106.0693600	6756	10/04/1988	N
FEDERAL 15-24	921337	01/08/1975	42.8089600	-106.0304000	5578	02/02/1978	Y
GOVT 12-1	905693	10/22/1958	42.8390700	-106.0368000	4626	11/16/1958	N
STATE-PETERSON 1	905220	06/07/1950	42.7596800	-106.0459500	4942	06/28/1950	Y
WALTON-FEDERAL 1-24	920020	10/14/1967	42.8196600	-106.0261000	4867	11/01/1967	Y
POOLE 5	905646	04/02/1951	42.8371900	-106.0291100	4558	04/23/1951	N
MULLEN FEE 4-35	921828	03/29/1981	42.8775600	-106.0604100	6950	04/18/1980	N
FEDERAL 21-1	906538	01/31/1966	42.7278100	-106.0718700	4200	02/10/1966	Y
USA-PAN AMERICAN-I 1	920076	04/22/1969	42.8856400	-106.0601800	7200	05/10/1969	Y
SIGNAL-FEDERAL 34-15	920183	02/28/1971	42.7386700	-106.0528100	4865	03/10/1971	Y
GOVT WINKLER 1	905296	12/05/1956	42.7838500	-106.0160100	5758	12/21/1956	Y
BROOKS RANCH 41-35	920136	07/10/1970	42.8784800	-106.0456100	7238	07/29/1970	Y

HUMPHREYS 2	905623	06/26/1949	42.8356100	-106.0146800	4485	07/1954	N
STATE 1	2505379	07/30/1952	42.7018000	-106.1374300	1584	08/18/1952	N
WHITESIDE NO 2	905797	07/15/1957	42.8447900	-106.0074300	4459	08/06/1957	N
GARDNER STATE 1	906042	08/25/1945	42.8521400	-106.0105300	4585	9/23/1945	N
UNION-STATE 22-12	920093	09/16/1969	42.7532600	-106.0178300	5493	10/04/1969	Y
STATE 1	906268	11/18/1951	42.8530600	-106.0068300	6617	03/20/1952	Y
HUMPHREY ST 0-1822 54	920156	10/22/1970	42.8396640	-105.9973030	4535	11/25/1970	N
HUMPHREY ST 0-1822 55	920208	08/13/1971	42.8452600	-105.9982200	4422	08/31/1971	N
HUMPHREY 48	905870	08/10/1946	42.8467700	-105.9981900	4374	09/09/1946	N
CABOT-FEDERAL 3-31	922559	11/03/1985	42.8787300	-106.0162900	9100	11/28/1985	Y
AE HUMPHREY 46	905885	03/08/1946	42.8468000	-105.9940100	4344	07/17/1946	N
STATE LOCKETT 1	920179	01/05/1971	42.7949300	-105.9875500	5550	01/05/1971	N
LOCKETT-STATE 1	921875	01/15/1981	42.8574700	-105.9973300	5030	02/15/1981	N
HUMPHREY 39A	905794	12/11/1926	42.8374500	-105.9877600	4359	07/10/1927	N
CRARY 36	905943	11/09/1946	42.8486300	-105.9916000	4337	12/01/1945	N
A E HUMPHREY 47	905881	04/23/1946	42.8468400	-105.9890900	4358	05/18/1946	N
STEPHENS 1	905221	06/13/1950	42.7649600	-105.9894400	5803	06/13/1950	Y
BAILEY 1	2505502	11/09/1955	42.7869100	-106.3399400	3820	01/24/1955	N

FESSENDEN 1	2505537	07/02/1955	42.8112800	-106.3534500	3082	06/15/1955	N

Table 3. Wells Identified for Corrective Action

Well Name	Spud Date	Surface Casing o.d., in	Surface Casing Seat, ft	Long-String Casing, o.d., in	Long-String Casing seat, ft	Hole Direction	TD, ft	TVD, ft	Status	Plug Date	TWN/ RNG	Qrt-Qrt	County	Corrective Action Needed
GOVT-BRANNAN	06/28/53	10-3/4	295	5-1/2	6,987	Vertical	7,844	7,844	Water Well	08/24/53	33N 78W Sec 29	NW NE	Natrona	Yes

Table 4. Evaluation for Corrective Action (GOVT BRANNAN)						
Cement Plugs				Formation		Cement Remarks
Interval, ft	Thickness, ft	Volume, sacks		Name	Estimated Top, ft	
Currently utilized as an active water well				Shannon	1,540	Halliburton Method
				Niobrara	2,915	Top of cement: 4,775’
				Carlisle	3,513	Bottom of cement: 5,020’
				1st Wall Creek	3,958	
				2nd Wall Creek	4,322	Top of cement: 5,615’
				Mowry	4,823	Bottom of cement: 5,850’
				Muddy	5,073	
				Dakota	5,173	
				Morrison	5,336	
				1st Sundance	5,637	
				2nd Sundance	5,698	
				Jelm	5,802	
				Alcova	5,856	
				Dinwoody	6,468	
				Phosphoria	6,533	
				Tensleep	6,865	

Corrective Action: The Govt Brannan well is currently active as a water well completed in the Madison and Lakota Formations. Per WSEO permit documents, the Sundance formation is not covered with cement in the casing annulus and is open to communication in both the Lakota and Madison. Corrective action will be needed, but due to insufficient public records, Casper Carbon Capture will collaborate with the operator to determine wellbore status and future corrective action.

Figure 12: Well schematic for corrective action – NA*

**To be completed after discussion with well Operator.*

2.7 PROTECTION OF USDWS

For this project, CO_2 is proposed to be injected into the Jurassic Sundance Formation, a siliciclastic cross-bedded sandstone with interbedded siltstones, located approximately 5,933 feet below ground surface (bgs) at Casper Carbon Capture #1. The Chugwater Group comprises the basal confining zone at a depth of approximately 6,267 bgs at Casper Carbon Capture #1 and will protect the first USDW (Casper Aquifer) below the injection zone. The primary protection against the migration of fluids from the injection zone into overlying USDWs is the upper confining zone, comprised of the Redwater Shale and the Morrison Formation, at a depth of 5,733 feet bgs and a thickness of 200 feet at the proposed Casper Carbon Capture #1 location. Across the AoR, the Redwater-Morrison confining zone provides approximately 180 to 265 feet of vertical separation of interbedded sandstones, siltstones, limestones, and impermeable shales between the Sundance and the next highest USDW, the Lakota Formation, providing sufficient isolation of the USDW from CO_2 injection activities.

3.0 AREA OF REVIEW AND CORRECTIVE ACTION PLAN

Pursuant to Section 13 of Chapter 24 of the WDEQ CCS Class VI Injection Wells and Facilities Underground and Injection Control Program, the AoR is defined as the subsurface three-dimensional extent of the carbon dioxide plume, associated pressure front, and displaced fluids, as well as the overlying formations, and surface area above that delineated region. The predicted AoRs (CO_2 plume and pressure-based) are delineated based on the reservoir modeling and will encompass the larger extent of either the plume-based or pressure-based results.

CO_2 plume based AoR is defined as the CO_2 plume front with the gas saturation greater than or equal to 0.01 (or 1%). To delineate the pressure front, the minimum or critical pressure (ΔPc) necessary to reverse flow direction between the lowermost USDW and the injection zone and thus cause fluid flow from the injection zone into the formation matrix of a USDW must be calculated is discussed in detail in Section 1.0, any uncertainties will be addressed once a water sample is acquired from the USDW in the drilling and construction of Casper Carbon Capture #1. Based on all available data to date, studies indicate that the Sundance Formation contains sufficient storage and geologic integrity for the injection of CO_2 over a 20-year period. Brine removal is not anticipated to be necessary during the operational or post-operational timeframes of this project, thus is not included in the computational model.

The AoR is delineated with three (3) primary purposes in mind. These are:

1. Identification of any subsurface geological features which may influence the ability to store sequestered gases for an indefinite length of time.
2. Identification of any artificial penetrations or manmade structures which may influence the ability to store sequestered gases for an indefinite length of time. Leakage along artificial penetrations was not included as part of the numerical simulation. Artificial penetrations were evaluated for the risk of leakage based on the calculated critical pressure, the pressure required to lift brine (or drilling fluids from an improperly completed well) out of the formation, and the pressure rise at each artificial penetration location, as determined by the model.
3. Identification of pore space rights impacted by the extent of the injection plume over the modeled time period.

The computational model uses anticipated operating data, including injection pressures, rates, and total volumes over the proposed life of the facility, as discussed in Form B-1.

4.0 REEVALUATION OF AOR AND CORRECTIVE ACTION PLAN

Prior to the injection operations, the new site-specific stratigraphy information, petrophysical properties measured from core samples of the newly drilled stratigraphic well and Casper Carbon Capture #1 will be incorporated into the numerical model to update and refine AoR delineation.

The AoR will be reevaluated at a minimum of every 2 years during operations, and every 5 years post injection (until site closure) as required by WDEQ Chapter 24 Section 13 (c). The AoR will be reevaluated prior to the next scheduled cycle if monitoring and operational data indicate a significant change in the areal and vertical extent of the predicted CO_2 plume and pressure front beyond the modeled CO_2 plume and pressure front.

During the injection operations, the operational and monitoring data will be used to further refine the distributions of reservoir petrophysical properties through inverse modeling techniques to allow better fittings between the model predictions and observed CO_2 plume spatial-temporal evolutions.

These data include:

1) the chemical and physical characteristics of the CO_2 injection stream based on sampling and analysis;

2) continuous monitoring of injection mass flow rate, pressure, temperature, and fluid volume;

3) measurements of pressure response at all site monitoring wells; and

4) CO_2 arrival and transport response at all site monitoring wells based on direct aqueous measurements and selected indirect monitoring method(s).

At that time when the AoR is reevaluated, CCC will either 1) submit the monitoring data and modeling results to demonstrate that no adjustment to the AoR is required, or 2) modify its Corrective Action, Emergency and Remedial Response and other plans to account for the revised AoR.

To the extent that the reevaluated AoR is different from the one identified in this supporting documentation, CCC will identify all active and abandoned wells that penetrate the confining zones in the reevaluated AoR and will perform corrective actions on those wells. As needed, CCC will revise all other plans, such as the Emergency and Remedial Response Plan (ERRP), to take into account the reevaluated AoR and will submit those plans to WDEQ for review and approval.

Note that seismic events are covered under the Emergency Response and Remediation Plan. A tiered approach for responding to seismic events will be based on magnitude and location. A notification procedure is provided in that plan.

5.0 REFERENCES

Anna, L. O. (2010). Geologic assessment of undiscovered oil and gas in the Powder River Basin Province. In *Total Petroleum Systems and Geologic Assessment of Oil and Gas Resources in the Powder River Basin Province, Wyoming and Montana: U.S. Geological Survey Series DDS–69–U* (p. 97 p.).

Bower, R. R. (1964). *Stratigraphy of Red Peak Formation, Alcova Limestone, and Crow Mountain* ..., shareok.org/bitstream/handle/11244/1786/6413321.PDF?sequence=1.

Burk, C. A., & Thomas, H. D. (1956). *The Goose Egg Formation (Permo-Triassic) of Eastern Wyoming: Report of Investigations No. 6.* Geological Survey of Wyoming.

Cramer, S.D. (1982). *The Solubility of Methane, Carbon Dioxide and Oxygen in Brines from 0 to 300 °C*, US Bureau of Mines, Report No. 8706, USA, 16 pp.

Crist, M. A., and Lowry, M. E. (1972). *Ground-Water Resources of Natrona County, Wyoming*, https://doi.org/10.3133/wsp1897.

Davies, Ceri, et al., (2015). *Reservoir quality and stratigraphy of the Mowry and muddy interval of the Powder River Basin, Wyoming, USA. First Break*, vol. 33, no. 12, 2015, https://doi.org/10.3997/1365-2397.33.12.83746.

Davis, R. W., and Paul A. R. (1977). *Effects of Surface Mining Upon Shallow Aquifers in the Eastern Powder River Basin, Wyoming*.

Eisen et al., (1981). *Occurrence and Characteristics of Groundwater in the Powder River Basin, Wyoming. U.S. Environmental Protection Agency*, vol. 1-B, 1981.

Fryberger, S. G. (2013). *Stratigraphic aspects of the Tensleep play of Wyoming*. University of Wyoming.

Hampson Russell. (2022). Version HRS-EA12.2

Hunter, J., Ver Ploeg, A. J., & Boyd, C. S. (2005). *Geologic Map of the Casper 30' x 60' Quadrangle, Natrona and Converse Counties, Central Wyoming*. Wyoming State Geological Survey.

Lovelace, D. M. and Doebbert, A.C. (2015). *A new age constraint for the Early Triassic Alcova Limestone (Chugwater Group), Wyoming. Palaeogeography, Palaeoclimatology, Palaeoecology* 424 (2015): 1-5.

Lowry, M. E., and Cummings, T. R. (1966). *Ground water resources of Sheridan County, Wyoming: U.S. Geological Survey* Water Supply Paper 1807.

Pruess, K., J Garcia, Kovscek, T., Oldenburg, C., Rutqvist, J., Steefel, C., and Xu, T. (2002). *Intercomparison of numerical Simulation Codes for Geologic Disposal of CO2*. LBNL-51813, Lawrence Berkeley National Laboratory, Berkeley, California.

Schlumberger. (1987). *Log Interpretation Principles/Applications*, Schlumberger Educational Services, Houston, Texas, p. 198.

Schlumberger. (1988). *Archie's Law: Electrical Conduction in Clean, Water-bearing Rock, The Technical Review, v. 36, n. 3*, Schlumberger Educational Services, Houston, Texas, pp. 4-13.

Stolper, K. (1994). *Calculate a More Accurate Water Salinity by Visually Estimating "m"*: Houston Geological Society Bulletin, September 1994, p. 34.

Span, R. and Wagner, W. (1996). *A New Equation of State for Carbon Dioxide Covering the Fluid Region from the Triple-Point Temperature to 1100 K at Pressures Up to 800 MPa.* J Phys Chem Ref Data 25:1509-1596.

Spycher N. and Pruess, K. (2010). *A Phase-Partitioning Model for CO2-Brine Mixtures at Elevated Temperatures and Pressures: Application to CO2-Enhanced Geothermal Systems. Transport in Porous Media* 82:173-196. doi:10.1007/s11242-009-9425-y.

Spycher N., Pruess, K., and Ennis-King, J. (2003). *CO2-H2O mixtures in geological sequestration of CO2. I. Assessment and calculation of mutual solubilities from 12 to 100°C and up to 600 bar.* Geochimica et Cosmoschimica Acta 67(16):3015-3031. doi:10.1016/s0016-7037(03)00273-4.

Stolper, K. (1994). *Calculate a More Accurate Water Saturation by Visually Estimating*.

Surdam, R.C., Jiao, Z., De Bruin, R.H., and Bentley, R.D. (2010). *Shale gas potential of the Mowry Shale in Wyoming Laramide Basins:* Wyoming State Geological Survey Challenges in Geologic Resource Development, no. 9.

Taucher et al. (2013). *Platte River Basin Water Plan Update Groundwater Study Level 1 (2009-2013) - Available Groundwater Determination Technical Memorandum*. Wyoming Water Development Commission.

Thornhill, J. T., et al. (1982). *Application of the area of review concept.* Groundwater, vol. 20, no. 1, Jan. 1982, pp. 32–38, https://doi.org/10.1111/j.1745-6584.1982.tb01327.x.

Trotter, J., (1963). *The Minnelusa play of the northern Powder River Wyoming and adjacent areas*. In Guidebook, Wyo. Geol. Assoc. and Billings Geol. Soc. First Joint Field Conf. p. 117-122

United States Environmental Protection Agency (2013). *Geologic Sequestration of Carbon Dioxide Underground Injection Control (UIC) Program Class VI Well Area of Review Evaluation and Corrective Action Guidance*. http://water.epa.gov/type/groundwater/uic/wells_sequestration.cfm

Warwick, P., & Corum, M. (2012). *Geologic framework for the national assessment of carbon dioxide storage resources—Powder River Basin, Wyoming, Montana, South Dakota, and Nebraska, chap. B of Geologic framework for the national assessment of carbon*. U.S. Geological Survey.

Whitcomb, H. A. (1965). *Ground-water resources and geology of Niobrara County, Wyoming, with a section on chemical quality of the Ground Water. USGS*, 1965. *1788*, https://doi.org/10.3133/wsp1788.

Whitcomb, H. A., Cummings, T. R., and McCullough, R. A. (1966). *Ground-water resources and geology of northern and central Johnson County, Wyoming:* U.S. Geological Survey Water Supply Paper 1806

Whitcomb, H. A. and Morris, D. A.R. (1964). *Ground-water resources and geology of northern and western Crook County, Wyoming.*

White, M.D., Watson D.J., Bacon D.H., White S.K., McGrail B.P., and Zhang Z.F. (2013). *STOMP Subsurface Transport over Multiple Phases STOMP-CO2 and -CO2e* Guide Version 1.1, PNNL-21268, Pacific Northwest National Laboratory, Richland, WA.

White, M.D. and Oostrom, M. (2006). *STOMP Subsurface Transport Over Multiple Phases, Version 4*: User's Guide. PNNL-15782, Pacific Northwest National Laboratory, Richland, Washington.

White, M.D., and Oostrom, M. (2000). *STOMP Subsurface Transport Over Multiple Phases: Theory Guide.* PNNL-12030, Pacific Northwest National Laboratory, Richland, Washington.

Whitehead, R L. (1996). *Segment 8 Atlas 730-I. Groundwater Atlas of the United States*, pubs.usgs.gov/ha/730i/report.pdf.

Wyoming. (1972). *Water Planning Program Report No. 10, Water & Related Land Resources of Northeastern Wyoming :* http://library.wrds.uwyo.edu/wwpp/No_10Water_and_Related_Land_Resources_of_Northeastern_Wyoming-1972.html

FORM A-2 APPENDIX – ALL WELLS IN AOR

Table: Area of Review Well Information						
Water Wells						
Permit Number	Status	Well Name	Uses	Total depth	Latitude	Longitude
111080	A	#5 KRO-1995	DOM_GW; STK	0	42.76877	-106.319
146096	A	NORTH 1	DOM_GW	40	42.77555	-106.314
146276	A	TRIPLE D.D.D.	DOM_GW	0	42.76519	-106.319
12218	A	MUDDY CREEK #18	STK	25	42.84909	-106.056
12221	A	OIL CORNER #21	STK	420	42.84572	-106.007
12222	A	CROMWELL #22	STK	400	42.84926	-106.031
12223	A	WHITE #23	DOM_GW; STK	400	42.83812	-106.041
12224	A	CORNELL #24	STK	125	42.82369	-106.041
12225	A	HAWKS WEST #25	STK	600	42.82753	-106.002
143360	A	MOSLEY #1	DOM_GW; STK	120	42.85268	-106.075
143977	A	PEIRCE #2	DOM_GW; STK	200	42.85941	-106.046
191494	A	ENL. PEIRCE #2	DOM_GW	0	42.85949	-106.046
194923	A	T42 LINDSEY #2	DOM_GW	40	42.73845	-106.021
176612	A	LINDSEY #1	DOM_GW	60	42.73875	-106.021
18489	A	JOHNSON HOUSE WELL #1 (DEEPENED)	DOM_GW	120	42.74499	-106.011
18493	A	WEST PASTURE #1	STK	290	42.76731	-106.018
116693	A	PEIRCE #1	DOM_GW; STK	200	42.85992	-106.046
164932	A	PEIRCE #3	DOM_GW; STK	480	42.8584	-106.047
166240	A	BIART #1	DOM_GW	640	42.85235	-106.051
167311	A	PEIRCE #4	DOM_GW; STK	560	42.85626	-106.046
167312	A	PEIRCE #5	DOM_GW; STK	320	42.85558	-106.047
167313	A	PEIRCE #6	DOM_GW; STK	360	42.85472	-106.047
16804	A	C Y #1	DOM_GW; STK	180	42.85288	-106.031
168598	A	PEIRCE #1A	DOM_GW; STK	0	42.85992	-106.046
168599	A	PEIRCE #2A	DOM_GW; STK	345	42.8585	-106.046
168817	A	LITTLE MUDDY #1	DOM_GW; STK	0	42.85992	-106.046
207398	A	LITTLE MUDDY #1	DOM_GW; STK	65	42.86086	-106.046
209728	A	FIDDLERS CREEK SUBDIVISION LOT #2 WELL #1	DOM_GW	60	42.85411	-106.053
210257	A	HOMESTEAD #1	STK	0	42.76849	-106.063

201391	A	PARKERTON MUDDY CREEK	DOM_GW; STK	70	42.84872	-106.058
201392	A	PARKERTON RANCH SW #1	DOM_GW; STK	380	42.83397	-106.036
204146	A	ALTMAN #4	MIS	0	42.8054	-106.065
204368	A	2 J LIVESTOCK WELL #1	STK	60	42.85553	-106.059
205566	A	FALLS RANCH SW-1	STK	60	42.85615	-106.058
205567	A	FALLS RANCH SW-4	STK	50	42.83727	-106.058
206451	A	WELL S23	STK	560	42.81875	-106.046
206452	A	WELL S14	STK	0	42.83101	-106.046
207300	A	S15-SW1	STK	60	42.84833	-106.064
25500	A	MANGUS #2	DOM_GW; STK	0	42.8527	-106.061
28116	A	HOUSE	DOM_GW; STK	305	42.80179	-106.056
30760	A	CROMWELL #1	DOM_GW; STK	180	42.85276	-106.046
63562	A	CROMWELL #3	DOM_GW; STK	0	42.85276	-106.046
63885	A	CROMWELL #2	DOM_GW	200	42.85992	-106.046
760	A	WHITESIDE 2 WELL #9	IND_GW	4459	42.84572	-106.007
515	A	WHITESIDE 3 WELL #4	IND_GW	3203	42.84203	-106.012
546	A	WHITESIDE 4 WELL #4	IND_GW	3217	42.84199	-106.017
547	A	WHITESIDE 3 WELL #7	IND_GW	3195	42.84206	-106.007
548	A	WHITESIDE 3 WELL #6	IND_GW	3208	42.84203	-106.012
549	A	WHITESIDE 2 WELL #7	IND_GW	3210	42.83836	-106.012
550	A	WHITESIDE 2 WELL #4	IND_GW	3190	42.84569	-106.012
551	A	WHITESIDE 2 WELL #3A	IND_GW	3210	42.84572	-106.007
552	A	WHITESIDE 1 WELL #2	IND_GW	3238	42.84566	-106.017
5598	A	BANNER #1 (DEEPENED)	STK	200	42.81592	-106.129
5599	A	BANNER #2	STK	125	42.79456	-106.031
5601	A	BANNER #4	STK	300	42.78727	-106.026
100044	A	ELAINE #1	DOM_GW; STK	40	42.78696	-106.139
101519	A	PARRISH 102	DOM_GW	30	42.77056	-106.177
101520	A	PARRISH 101	DOM_GW	0	42.7699	-106.178
101521	A	KRISTIN #1	DOM_GW; STK	34	42.79723	-106.295
102498	A	PATNIC #1	DOM_GW	0	42.82244	-106.315
102758	A	HUSKY STATE #1	DOM_GW	0	42.7906	-106.129
102759	A	HUSKY #1	DOM_GW	0	42.79419	-106.139
102760	A	HUSKY #2	DOM_GW	0	42.79782	-106.144
102842	A	ELLBOGEN #1	DOM_GW; STK	60	42.77555	-106.314
103403	A	JACKSON #1	DOM_GW; STK	0	42.77215	-106.328

103868	A	DUHADWAY #1	DOM_GW; STK	0	42.7936	-106.295
106158	A	GCSDL #1	DOM_GW; STK	30	42.79782	-106.144
106159	A	GCSDL #20	DOM_GW; STK	41	42.79418	-106.144
106410	A	ROGERS #1	DOM_GW	40	42.77555	-106.314
106798	A	HOOVER #1	DOM_GW; STK	12	42.7936	-106.295
106944	A	SIPLON #2	DOM_GW; STK	0	42.82262	-106.295
1071	A	HOLMAN #3	STK	0	42.77878	-106.334
115265	A	CHAPMAN #1	DOM_GW	0	42.72365	-106.168
115266	A	CHAPMAN #2	STK	0	42.72365	-106.168
11565	A	LAMB #1	DOM_GW; STK	60	42.75076	-106.091
115928	A	NELSON #2	DOM_GW	0	42.78335	-106.139
118302	A	STREET #1	DOM_GW	0	42.79059	-106.134
120145	A	CHAVEZ #1	DOM_GW	42	42.78335	-106.139
107471	A	CARRELL #3 (SPRING DEVELOPMENT)	DOM_GW	1	42.78994	-106.3
121262	A	Stilwell #1	DOM_GW; STK	0	42.79062	-106.124
123264	A	Carrell #5	DOM_GW	15	42.78994	-106.3
126674	A	DONNA & MAX #1	DOM_GW	30	42.77894	-106.31
126710	A	MORRIS #1	DOM_GW	40	42.79835	-106.136
128689	A	WILKISON #2	DOM_GW; STK	110	42.7903	-106.207
128690	A	WILKISON #3	DOM_GW; STK	0	42.7903	-106.207
128691	A	WILKISON #4	DOM_GW; STK	0	42.7903	-106.207
129089	A	SP-3A,B,C	MON	122	42.81167	-106.3
149791	A	HENTZEN # 1	DOM_GW	42	42.7978	-106.148
149996	A	JACKSON # 2	DOM_GW	80	42.77215	-106.328
150008	A	ZELLER # 1	DOM_GW; STK	0	42.7942	-106.134
152688	A	ZELLER #1	DOM_GW; STK	80	42.79419	-106.139
107472	A	CARRELL #4	DOM_GW	16	42.78994	-106.3
15322	A	ELKHORN #1	DOM_GW; STK	0	42.76529	-106.31
15323	A	EAST ELKHORN #2	DOM_GW; STK	0	42.7654	-106.3
153825	A	DIECAST #1	DOM_GW	0	42.77211	-106.333
153826	A	DUTTON #1	DOM_GW	47	42.77211	-106.333
155135	A	SHAWN #1	DOM_GW; STK	41.9	42.70898	-106.105
155239	A	CHAPUT #2	STK	0	42.76648	-106.169
155341	A	THOMAS #1	DOM_GW	0	42.80785	-106.325
15557	A	CREEL FORSBERG #1	STK	0	42.79023	-106.222
155833	A	DUFF #1	DOM_GW	0	42.7942	-106.124

156213	A	PETERSON #2	DOM_GW	55	42.7942	-106.124
159	A	MANOR HEIGHTS #1	DOM_GW	5058	42.82639	-106.281
159161	A	WISH #1	DOM_GW; STK	40	42.7697	-106.154
160858	A	KELLEN #1	DOM_GW	1380	42.76324	-106.154
161350	A	MILNE BARN #1	DOM_GW	0	42.77664	-106.15
162289	A	DUDLEY #1	DOM_GW	47	42.77363	-106.154
16470	A	B & L #2A	DOM_GW	267	42.76872	-106.324
1654	A	N-17-WS	IND_GW	7615	42.83074	-106.08
165587	A	ANDREN #1	DOM_GW; STK	55	42.77962	-106.163
165701	A	PATTERSON #2	DOM_GW	200	42.77215	-106.328
166	A	COUNTRY CLUB #1	IRR_GW	605	42.81913	-106.266
13098	A	AMERADA #1	STK	633	42.80462	-106.237
132335	A	HELEN #1	DOM_GW; STK	28	42.77021	-106.154
132373	A	WILSON #1	DOM_GW; STK	100	42.79782	-106.144
132983	A	KRISTIN #1	DOM_GW	0	42.78335	-106.139
133090	A	PODRAZIK # 1	DOM_GW; STK	50	42.77894	-106.31
134088	A	PODRAZIK # 2	DOM_GW; STK	31	42.77894	-106.31
135841	A	WELL # 2	DOM_GW	3	42.77215	-106.328
13698	A	STEWART #1	DOM_GW	0	42.78607	-106.334
138695	A	TWO C # 1	DOM_GW	29	42.77028	-106.149
138905	A	ERNEST # 1	DOM_GW; STK	0	42.78696	-106.139
138912	A	HAWK SPRINGS	DOM_GW	0	42.77891	-106.315
138990	A	EVON # 2	DOM_GW; STK	16	42.7936	-106.295
139083	A	GLIS # 1	DOM_GW	18	42.79723	-106.295
140947	A	TYLER SHAY # 1	DOM_GW	440	42.7942	-106.129
141495	A	STEPHENSON WELL # 1	DOM_GW	0	42.79418	-106.144
141658	A	NURSS # 1	DOM_GW; STK	640	42.79418	-106.144
141907	A	TYLER SHAY # 2	DOM_GW	0	42.7906	-106.129
143287	A	JOHNSON #1	DOM_GW	540	42.7942	-106.124
143420	A	NAROTSKY/STREET #1	DOM_GW	40	42.78697	-106.134
145175	A	KAHNER # 1	DOM_GW	16	42.79725	-106.29
145333	A	G.C.S.D. # 20	DOM_GW	40	42.7973	-106.129
147239	A	ELKHORN CREEK TRACT 2, WELL # 1	DOM_GW	51	42.78	-106.314
147407	A	CHAPAT #1	DOM_GW	50	42.75592	-106.154
14790	A	MIDDLETON #1	DOM_GW; STK	0	42.8115	-106.325
148818	A	LEAMAN # 1	DOM_GW	60	42.79419	-106.139

149197	A	GCR #9	DOM_GW; STK	60	42.7942	-106.134
149198	A	GCR #7	DOM_GW	60	42.7942	-106.129
10764	A	MILNE #3	IRR_GW; STK	0	42.77387	-106.139
107695	A	RUDKIN #3	DOM_GW	12	42.78994	-106.3
107792	A	SMOTHERS #3	DOM_GW	15	42.78994	-106.3
108893	A	FAITH #1	MIS	0	42.80784	-106.329
108894	A	JACKSON #1	DOM_GW	80	42.77215	-106.328
108974	A	#2 KRO-1998	DOM_GW; STK	0	42.76877	-106.319
108975	A	#3 KRO-1998	DOM_GW; STK	0	42.76877	-106.319
108976	A	#4 KRO-1998	DOM_GW; STK	101	42.76877	-106.319
109012	A	FCBO #1 WELL	DOM_GW; STK	0	42.78627	-106.305
110174	A	TAMARA #1	DOM_GW	137	42.77231	-106.309
110245	A	SHELBY #1	DOM_GW	16	42.79725	-106.29
110422	A	COLE CREEK HUSKY	DOM_GW	0	42.79416	-106.148
110707	A	#3 KRO-1998	DOM_GW; STK	0	42.76877	-106.319
110709	A	EVON #1	DOM_GW; STK	14	42.79908	-106.288
111659	A	Nelson #1	DOM_GW	40	42.78335	-106.139
112592	A	GCSD 1110	DOM_GW; STK	0	42.79782	-106.139
112593	A	GCSD #25	DOM_GW; STK	0	42.79775	-106.124
112594	A	GCSD #98	DOM_GW; STK	0	42.7978	-106.134
112595	A	GCSD #201	DOM_GW; STK	30	42.79778	-106.129
114592	A	OATES #1	DOM_GW	400	42.82327	-106.148
200836	A	WEBER	DOM_GW	0	42.76589	-106.168
201200	A	FALL CREEK HILL #2	DOM_GW	86	42.77093	-106.17
201212	A	HILL #1	DOM_GW	50	42.76969	-106.171
201277	A	LAR'S LEGACY 2013	DOM_GW	50	42.76992	-106.175
201450	A	CLEAR FORK NO. 1	DOM_GW	0	42.78701	-106.124
201451	A	HUDSON NO. 1	STK	45	42.73557	-106.111
201452	A	WEBEL NO. 1	DOM_GW; STK	50	42.80703	-106.092
201765	A	WALTER	DOM_GW; STK	0	42.79368	-106.251
201838	A	BURROUS 1	DOM_GW	20	42.77488	-106.173
202328	A	CLEAR FORK #1	DOM_GW	0	42.79061	-106.139
20273	A	ALLISON #1	DOM_GW; STK	80	42.79777	-106.119
203026	A	EAST ELKHORN WELL #1	DOM_GW; STK	0	42.80824	-106.276
203972	A	RM #3	DOM_GW	0	42.79354	-106.3
204102	A	ALTMAN #2	DOM_GW	50	42.768	-106.084

204103	A	ALTMAN #3	STK	360	42.79307	-106.073
204104	A	ALTMAN #1	STK	50	42.76726	-106.085
204250	A	CURRY #1	DOM_GW	0	42.80078	-106.3
204496	A	NICHOLATION	MIS	360	42.82814	-106.115
20452	A	KURZ'S 44	DOM_GW	0	42.80794	-106.31
204718	A	4903S1	DOM_GW	100	42.79417	-106.301
204719	A	4903S2	DOM_GW	40	42.79389	-106.301
204733	A	HAT SIX #2	TST	0	42.81651	-106.168
204904	A	HAT SIX #2	DOM_GW	500	42.81659	-106.169
205086	A	BUNKHOUSE WELL	DOM_GW	40	42.72256	-106.133
205565	A	HEADQUARTERS 1	DOM_GW	40	42.72253	-106.133
206246	A	FALLS RANCH SW-2	STK	40	42.82237	-106.088
206326	A	WELL S28	STK	0	42.79806	-106.09
206327	A	WELL S34	STK	50	42.83727	-106.07
206328	A	SW-3	STK	0	42.80536	-106.09
206612	A	WELL S15	STK	40	42.83418	-106.076
206613	A	WELL S33	STK	50	42.78678	-106.087
207299	A	S15-SW2	STK	50	42.78367	-106.079
207320	A	BEAR MOUNTAIN #2	DOM_GW; STK	50	42.78555	-106.336
208033	A	SWART #1	DOM_GW	0	42.76563	-106.175
208064	A	VANHOUTEN WELL #1	DOM_GW	0	42.7762	-106.203
208754	A	C BROKEN SPEAR #1	DOM_GW; STK	96	42.75407	-106.16
208756	A	HARLEY #34	DOM_GW	60	42.777	-106.165
208812	A	FORREST	DOM_GW; STK	0	42.7698	-106.159
208868	A	COW HOLLOW #2	STK	52	42.83983	-106.12
208977	A	BETTINGER #2	DOM_GW	60	42.777	-106.165
208983	A	DILLER #1	DOM_GW	55	42.77365	-106.33
209029	A	800 WEST FORK RD WSW	DOM_GW	80	42.77482	-106.318
209282	A	STAGHORN 6501	DOM_GW	70	42.77609	-106.316
28243	A	#1 KERR	DOM_GW	32	42.77008	-106.331
28244	A	#2 SIXBERRY	DOM_GW	25	42.77211	-106.333
28389	A	GIBBS #1	DOM_GW	52	42.81183	-106.266
29648	A	ERICKSEN #1	DOM_GW; STK	0	42.77215	-106.328
29710	A	REED #1	DOM_GW	120	42.78658	-106.222
30762	A	RACHOU #1	DOM_GW	340	42.77215	-106.328
30782	A	NASH #1	DOM_GW	80	42.77211	-106.333

309	A	B & L #1	DOM_GW	67	42.76872	-106.324
187815	A	DALTON #2	DOM_GW; STK	0	42.77836	-106.329
187816	A	DALTON #3	DOM_GW; STK	0	42.77836	-106.329
187817	A	DALTON #4	DOM_GW; STK	0	42.77829	-106.329
187818	A	DALTON #5	DOM_GW; STK	0	42.77157	-106.328
187819	A	DALTON #6	DOM_GW; STK	220	42.7714	-106.327
189906	A	IDE #5	DOM_GW	190	42.77285	-106.333
190170	A	MCMURRY TEXACO WELL	IRR_GW; MIS	1940	42.76038	-106.243
190171	A	MCMURRY AMERADA WELL	IRR_GW; MIS; STK	7844	42.80377	-106.227
190343	A	NELSON #4	DOM_GW; STK	0	42.77638	-106.134
190344	A	NELSON #5	DOM_GW; STK	0	42.77614	-106.139
190345	A	NELSON #6	DOM_GW; STK	28	42.77606	-106.146
190346	A	NELSON #7	DOM_GW; STK	0	42.77938	-106.134
190347	A	NELSON #8	DOM_GW; STK	0	42.781	-106.139
190718	A	COUGHLIN 2288	DOM_GW	200	42.78332	-106.334
191422	A	RUDE 2	DOM_GW	0	42.78214	-106.32
191791	A	WOODBURY #1	DOM_GW; STK	100	42.79672	-106.289
192245	A	18-1	DOM_GW	0	42.79719	-106.286
192624	A	NACHBAR #1	DOM_GW; STK	390	42.70297	-106.108
193695	A	GINA 29	DOM_GW	58	42.79786	-106.125
193875	A	BROWN # 1	DOM_GW	100	42.77562	-106.179
193960	A	COWBOYS WELL # 1	DOM_GW; STK	0	42.77301	-106.164
193961	A	COWBOYS WELL #2	DOM_GW; STK	0	42.77301	-106.164
193967	A	ZOBERTA 1	DOM_GW	0	42.76826	-106.324
194138	A	SPRING CREEK 18-1	DOM_GW	18	42.79865	-106.288
194734	A	BROWN #2	DOM_GW	100	42.77565	-106.179
195676	A	IVERSON #2	DOM_GW	54	42.79477	-106.289
196292	A	FALL CREEK HILL #1	DOM_GW	102	42.7698	-106.171
196293	A	FALL CREEK HILL #2	DOM_GW	86	42.76948	-106.169
196589	A	HILL #2	DOM_GW	44	42.79655	-106.135
196731	A	NORTH WELL	DOM_GW; STK	60	42.7982	-106.122
197594	A	LUCKY SPRING 7	DOM_GW	70	42.78031	-106.318
197942	A	ZADDOCK #1	DOM_GW	0	42.70531	-106.093
198165	A	DALTON #7	DOM_GW; STK	0	42.77177	-106.328
198594	A	ENL. BROKEN HEART #2	DOM_GW	0	42.76939	-106.169
198855	A	BROWN #3	DOM_GW	0	42.77284	-106.179

199268	A	EASTGATE-MUDDY #2	STK	320	42.79114	-106.208
199755	A	SCHUBERT #1	DOM_GW	60	42.7135	-106.101
199908	A	LOT 12 GOOSE CREEK NIC	DOM_GW	0	42.79372	-106.139
199918	A	RAUCHFUSS WELL #1	MIS	0	42.76814	-106.329
199954	A	SCHUBERT #2	STK	33	42.71319	-106.101
200143	A	KAHNER #2	DOM_GW	0	42.79685	-106.29
200312	A	SPRING CREEK 18-2	DOM_GW	38	42.79861	-106.288
200689	A	BEAR MOUNTAIN #2	DOM_GW; STK	0	42.78556	-106.334
200736	A	HAYGOOD #1	DOM_GW; STK	60	42.77153	-106.152
209878	A	FISH POND #1	DOM_GW; STK	0	42.73786	-106.168
210373	A	PURVIANCE #1	DOM_GW	0	42.80077	-106.31
212879	A	GHOST NO 1	DOM_GW	0	42.79721	-106.29
212892	A	HARDY WELL NO 2	DOM_GW	0	42.7723	-106.309
213237	A	WILSON 01	DOM_GW	0	42.80084	-106.3
214055	A	BILEK WELL	DOM_GW	0	42.76655	-106.154
215689	A	SCHRAGE 1	TST	0	42.76607	-106.183
215938	A	STAR NO 1	MIS	0	42.77612	-106.184
215980	A	GOOSE CREEK LOT 18 DOMESTIC WATER	DOM_GW	0	42.79781	-106.139
23361	A	GOODER #1	DOM_GW	50	42.77883	-106.324
23362	A	GOODER #2	STK	60	42.77883	-106.324
23927	A	G G N #1	DOM_GW; STK	100	42.82306	-106.188
167506	A	MALONE 1	DOM_GW	80	42.79656	-106.128
16807	A	ALTMAN WELL #1	DOM_GW	150	42.76599	-106.083
169428	A	CHAVEZ NO. 2	DOM_GW	0	42.78335	-106.139
169933	A	KELLEN #2	DOM_GW	0	42.75592	-106.154
169947	A	SLR 3	DOM_GW	50	42.75013	-106.09
171918	A	DUTTON #2	DOM_GW	0	42.77211	-106.333
172945	A	CARRELL #6	DOM_GW	100	42.79357	-106.3
173157	A	JACOBS #1	DOM_GW	0	42.77215	-106.328
173158	A	JACOBS #2	DOM_GW	0	42.77215	-106.328
173340	A	KAHNER #2	DOM_GW; STK	400	42.79827	-106.303
173341	A	KAHNER #1	DOM_GW; STK	100	42.79723	-106.294
173988	A	JEAN #1	DOM_GW; STK	0	42.76648	-106.169
176558	A	CLAYTON #1	DOM_GW	20	42.77211	-106.333
176699	A	PAULA #5	DOM_GW; STK	360	42.80667	-106.283
177216	A	ENL. NO. 1 KERR WELL	MIS	32	42.77541	-106.333

177993	A	KEN MILNE 1	DOM_GW; STK	0	42.78335	-106.139
179115	A	WHALEY #1	DOM_GW	25	42.77129	-106.334
181421	A	DUTTON #4	DOM_GW	100	42.77255	-106.333
181563	A	SWINNEY #1	DOM_GW	207	42.81164	-106.279
181762	A	IDE #2	DOM_GW	26	42.77681	-106.335
181763	A	IDE #3	DOM_GW	13	42.77675	-106.335
181788	A	DONNA #1	DOM_GW; STK	315	42.80436	-106.295
181789	A	JULIE #2	DOM_GW; STK	300	42.79436	-106.282
181809	A	EAST GATE RANCH TEST WELL	TST	0	42.79372	-106.246
182924	A	MCMURRY SIGNAL WELL	TST	0	42.77595	-106.242
183282	A	MCMURRY AMERADA WELL	TST	7844	42.80377	-106.227
184809	A	TANYA #1	STK	50	42.79688	-106.242
36774	A	STEWART #1	DOM_GW	40	42.77211	-106.333
37711	A	RAMSOUR #2	DOM_GW; STK	40	42.80086	-106.295
38100	A	ALLISON #2	DOM_GW; STK	70	42.79777	-106.119
39374	A	WINDLE #1	DOM_GW	16	42.81883	-106.315
40353	A	SPRING CREEK SEEP #1	DOM_GW; STK	-1	42.79001	-106.285
40354	A	DAIRY MEADOW SEEP #1	DOM_GW; STK	3	42.79362	-106.29
42192	A	1-4-32-79	DOM_GW	80	42.77231	-106.309
49606	A	E #1	DOM_GW	25	42.81902	-106.29
5600	A	BANNER #3	STK	300	42.80135	-106.129
56113	A	8-MILE	STK	400	42.82331	-106.144
56166	A	SIXBERRY SPRING #1	STK	18	42.77541	-106.333
56446	A	ENL SUSIE #1	DOM_GW; IRR_GW; STK	0	42.79783	-106.114
56519	A	BAILEY #1	DOM_GW	260	42.77215	-106.328
58074	A	BRUCE #2	DOM_GW	120	42.77215	-106.328
58331	A	MCDILL #2	DOM_GW	0	42.76868	-106.329
58332	A	MCDILL #3	DOM_GW	0	42.76868	-106.329
584	A	#2 H R N	MUN_GW	31	42.80058	-106.329
58952	A	BARTO #1	STK	400	42.82304	-106.193
59804	A	MRC2	MIS	120	42.79333	-106.334
5022	A	GGN #1	STK	130	42.82307	-106.183
5023	A	COW HOLLOW #1	STK	55	42.84139	-106.119
50932	A	BALDWIN #3	DOM_GW	0	42.78975	-106.329
510	A	MEABON	DOM_GW; IRR_GW; STK	-1	42.80819	-106.281

51939	A	HORAN #1	DOM_GW	200	42.77215	-106.328
52	A	HAT - SIX #1	IRR_GW	160	42.75572	-106.159
43393	A	BABB #1	DOM_GW	100	42.78607	-106.334
44030	A	BRUCE #1	DOM_GW	72	42.77215	-106.328
44031	A	PARDUE #1	DOM_GW	0	42.79333	-106.334
44432	A	CHES #1	DOM_GW; STK	0	42.82626	-106.295
462	A	PETERSON #1	DOM_GW; STK	20	42.80454	-106.285
47340	A	LEONARD #1	DOM_GW	97	42.77215	-106.328
48017	A	GALLES #2	DOM_GW	400	42.80072	-106.31
48309	A	GALLES #1	MIS	0	42.81158	-106.31
49390	A	MILLER #1	DOM_GW	18.5	42.81902	-106.29
49446	A	BALDWIN #1	DOM_GW; STK	0	42.78989	-106.31
49447	A	BALDWIN #2	DOM_GW; STK	0	42.78989	-106.31
4945	A	MHN #1	DOM_GW; STK	3	42.76877	-106.319
4946	A	MHN #2	DOM_GW; STK	3	42.76881	-106.314
4947	A	MHN #5	DOM_GW; STK	0	42.77555	-106.314
49473	A	STOVAL #1	DOM_GW	100	42.78971	-106.334
4948	A	MHN #6	DOM_GW; STK	3	42.77228	-106.314
4949	A	MHN #7	DOM_GW; STK	0	42.77228	-106.314
310	A	B & L #2	DOM_GW	117	42.76872	-106.324
32579	A	RAMSOUR #1	DOM_GW; STK	80	42.80449	-106.295
33253	A	HALL #ž	DOM_GW; STK	0	42.81158	-106.31
33926	A	MONTGOMERY SPRING #1	DOM_GW; STK	0	42.78246	-106.329
34594	A	MALONEY #1	DOM_GW	100	42.77215	-106.328
35281	A	DEER RUN #1	DOM_GW	60	42.77211	-106.333
77512	A	ENL B & L #2A	DOM_GW	267	42.76872	-106.324
77602	A	MOORE #1	DOM_GW	33	42.78263	-106.305
77660	A	OBG #13	MON	48.2	42.76669	-106.159
66872	A	WELS WELL #1	MIS	220	42.79693	-106.334
67773	A	HALL #1	DOM_GW	0	42.76868	-106.329
67781	A	FISCHERS HAT 6 #1	DOM_GW	0	42.77962	-106.163
67881	A	SILVER SAGE #1	DOM_GW	60	42.77978	-106.129
67882	A	SILVER SAGE #2	STK	0	42.77978	-106.129
68180	A	B J MILLER #1	DOM_GW; STK	0	42.77338	-106.179
68349	A	A. L. ULLRICH #1	DOM_GW; IRR_GW; STK	12	42.77645	-106.174

68350	A	JERON #1	DOM_GW; IRR_GW; STK	9	42.77342	-106.174
6846	A	KIMBALL SPRING IMPROVEMENT #1	DOM_GW; STK	3	42.76571	-106.271
69318	A	SHILLITO	DOM_GW	158	42.85268	-106.08
72015	A	MARTIN #1	DOM_GW	0	42.77215	-106.328
72168	A	SILVER SAGE #2	DOM_GW; STK	18	42.77978	-106.129
72250	A	APPALOOSA #1	DOM_GW; STK	1000	42.79059	-106.134
72252	A	GEIGER #1	DOM_GW	0	42.81538	-106.29
72511	A	NOONAN #1	DOM_GW	61	42.76885	-106.31
61923	A	MN#1	DOM_GW; STK	120	42.77219	-106.323
62297	A	BREWER TEST	MON	0	42.76868	-106.329
62298	A	HALL TEST	MON	0	42.76868	-106.329
62299	A	MCDILL TEST	MON	0	42.76868	-106.329
62577	A	HAT SIX #2	STK	0	42.76999	-106.169
62578	A	HAT SIX #3	STK	6	42.76277	-106.183
6260	A	CROSS #1	STK	100	42.78971	-106.334
6261	A	CROSS #2	STK	460	42.78971	-106.334
6262	A	CROSS #3	STK	150	42.78971	-106.334
63626	A	HOFFMAN #1	DOM_GW	80	42.79693	-106.334
64734	A	KNIGHT #1	DOM_GW	0	42.79368	-106.281
65894	A	JADE #1	DOM_GW	80	42.764	-106.086
66064	A	SCHREINER #1	DOM_GW	0	42.77974	-106.139
80472	A	GREEN VALLEY SPRING	DOM_GW; STK	0	42.78602	-106.339
80497	A	FCBO #1	DOM_GW	0	42.78627	-106.305
81149	A	HAT SIX OBSERVATION #1	MON	0	42.74505	-106.158
81150	A	HAT SIX OBSERVATION #2	MON	0	42.74146	-106.163
81151	A	HAT SIX #1	MON	0	42.74505	-106.158
81181	A	HAT SIX OBSERVATION #3	MON	0	42.73784	-106.168
81337	A	HEALTH SPRING	DOM_GW	6	42.75216	-106.164
82958	A	CHRISTMAN SPRING #1	DOM_GW; STK	0	42.78987	-106.315
82959	A	CHRISTMAN SPRING #2	DOM_GW; STK	7	42.79355	-106.305
82960	A	CHRISTMAN SPRING #3	DOM_GW; STK	7	42.78625	-106.31
83257	A	JULIE #1	DOM_GW; STK	0	42.70581	-106.093
8482	A	SWANSTROM NO. 1	DOM_GW; STK	58	42.79063	-106.119
84837	A	CARRELL #1	DOM_GW; STK	15	42.78994	-106.3
8504	A	BROTT #1	DOM_GW	40	42.77211	-106.333

8540	A	NASH #1	DOM_GW	0	42.77211	-106.333
85456	A	KINDER #1	MIS	0	42.80433	-106.31
92220	A	RUDKIN #2	DOM_GW	11	42.78994	-106.3
204496	A	NICHOLATION	MIS	360	42.82814	-106.115
3663	A	STURMAN WELL #7	STK	150	42.81572	-106.266
8566	A	ROBERT #1	DOM_GW; STK	0	42.79708	-106.315
85909	A	SPENCER #1 (SPRING DEV.)	STK	0	42.77332	-106.188
85910	A	SPENCER #2 SPRING	STK	6	42.76304	-106.198
85911	A	SPENCER #3	STK	20	42.7903	-106.207
85912	A	SPENCER #4 SPRING	STK	12	42.76938	-106.227
85913	A	SPENCER #5 SPRING	STK	2	42.76238	-106.232
85914	A	SPENCER #6 SPRING	STK	4	42.80456	-106.281
85915	A	SPENCER #7 SPRING	STK	10	42.79744	-106.227
85916	A	SPENCER #8	STK	16	42.81179	-106.286
85917	A	SPENCER #9	DOM_GW	21	42.81179	-106.286
86683	A	CARRELL #2	DOM_GW	18	42.78994	-106.3
86990	A	SMOTHERS #1	DOM_GW	15	42.78994	-106.3
87525	A	DACUS SPRING #1	DOM_GW	11.5	42.76881	-106.314
87529	A	EADES #1	STK	0	42.77559	-106.309
87530	A	EADES #2	DOM_GW	100	42.77559	-106.309
87885	A	RUDKIN #1	DOM_GW	12	42.78994	-106.3
89120	A	RUSSELL #1	DOM_GW; STK	40	42.79362	-106.29
898	A	HOLMAN #1	DOM_GW	100	42.78971	-106.334
89851	A	SHEPPARD - 4	DOM_GW; STK	330	42.77544	-106.328
899	A	HOLMAN #2	STK	460	42.78971	-106.334
89903	A	MOORE #2	DOM_GW	25	42.78263	-106.305
90122	A	BUFFALO LODGE "S"	DOM_GW; STK	0	42.76648	-106.169
90257	A	BUFFALO LODGE #1 TEST WELL	MON	0	42.76639	-106.178
90911	A	BRUNO #1	DOM_GW	0	42.79725	-106.29
91048	A	IVERSON #1	DOM_GW	41.4	42.79362	-106.29
91049	A	RUSSELL #2	DOM_GW; STK	40	42.79362	-106.29
91050	A	HOBART #1	DOM_GW	0	42.79725	-106.29
91133	A	DAVE'S #1	DOM_GW	0	42.81522	-106.31
91471	A	BAL-#1	DOM_GW	0	42.77211	-106.333
91866	A	SMOTHERS #2	DOM_GW	15	42.78994	-106.3
93087	A	SWANSTROM 31-A	DOM_GW; STK	110	42.78645	-106.251

93088	A	SWANSTROM 31-B	DOM_GW; STK	100	42.78645	-106.251
93574	A	HOBART #2	DOM_GW	0	42.79725	-106.29
94621	A	JUSTIN #1	DOM_GW; STK	20	42.79723	-106.295
94779	A	LACY #1	DOM_GW	40	42.77228	-106.314
94789	A	BROWN ROCK CORRAL WELL #7	STK	120	42.80094	-106.256
94963	A	MILLER #1	DOM_GW; STK	17	42.79362	-106.29
95153	A	PERKINS #1	DOM_GW; STK	35	42.76994	-106.174
96411	A	PAULA #1	DOM_GW; STK	25	42.80816	-106.285
96487	A	RIDGE ROAD #1	DOM_GW; STK	0	42.77891	-106.315
96488	A	RIDGE ROAD #2	DOM_GW; STK	0	42.7826	-106.31
96966	A	PARRISH 101 TEST	MON	30	42.7699	-106.178
96967	A	PARRISH 102 TEST	MON	30	42.7699	-106.178
96968	A	PARRISH 103 TEST	MON	0	42.7699	-106.178
97227	A	SPRING CREEK WEST #1	DOM_GW	168	42.80082	-106.3
97315	A	D'ELIA #1	DOM_GW	160	42.77887	-106.32
97715	A	RUSSELL #3	DOM_GW; STK	24	42.79362	-106.29
98	A	COUNTRY CLUB #1	MIS	5101	42.81548	-106.266
98726	A	WELL #D.D.D.	DOM_GW; STK	0	42.77224	-106.319
98837	A	FORSBERG #1	DOM_GW; STK	140	42.77555	-106.314
98981	A	N-INC LOT 1	DOM_GW	0	42.77555	-106.314
98982	A	N-INC LOT 3	DOM_GW	0	42.77555	-106.314
98983	A	N-INC LOT 4	DOM_GW	0	42.77555	-106.314
98984	A	N-INC LOT 5	DOM_GW	0	42.77555	-106.314
98985	A	N-INC LOT 6	DOM_GW	0	42.77555	-106.314
98986	A	N-INC LOT 9	DOM_GW	0	42.77555	-106.314
98987	A	N-INC LOT 10	DOM_GW	0	42.77555	-106.314
98988	A	N-INC LOT 11	DOM_GW	15	42.77228	-106.314
99151	A	WATTIS #2	DOM_GW; STK	0	42.79355	-106.305
99152	A	WATTIS #3	DOM_GW; STK	0	42.78257	-106.315
99205	A	#1 KRO-1995	DOM_GW	0	42.76877	-106.319
99572	A	PETERSON #1	DOM_GW; STK	0	42.8115	-106.325
59804	A	MRC 2	MIS	0	42.7923	-106.337

Active Oil and Gas Wells

API Number	WN	Company	Status	Total Depth	Latitude	Longitude
49-009-05534	O-22	UNIT STATE 0-16931	SI	4941	42.82739	-106.056
49-009-05578	N-19	UNIT PATENTED	PR	4035	42.83078	-106.07

49-009-05615	M-21	UNIT STATE 0-16931	SI	3958	42.83445	-106.061
49-009-05671	6	POOLE	PA	3317	42.84111	-106.027
49-009-05672	L-22	BROOKS RANCH	PR	3930	42.83807	-106.056
49-009-05684	5	WHITESIDES 4	PA	3245	42.8392	-106.015
49-009-05685	7	WHITESIDES-4	PA	3352	42.83914	-106.021
49-009-05686	11	WHITESIDES-3	PA	3227	42.83925	-106.011
49-009-05694	10	WHITESIDES 3	PA	3218	42.83931	-106.006
49-009-05717	8	WHITESIDES 4	PA	3307	42.84126	-106.018
49-009-05769	6	WHITESIDES-4	PA	3348	42.84315	-106.021
49-009-05821	J-21	BROOKS RANCH	PR	4140	42.84545	-106.061
49-009-05822	J-23	BROOKS RANCH	PR	4047	42.84553	-106.05
49-009-05879	3	WHITESIDE 1	PA	3268	42.84701	-106.016
49-009-28822	K-20	BROOKS RANCH	PR	4140	42.8418	-106.066
49-009-28869	I-20	BROOKS RANCH	PR	4572	42.84885	-106.066
49-009-28911	N0-2122	BROOKS RANCH STATE	PR	4921	42.82982	-106.06
49-009-29794	O-21	BROOKS RANCH STATE	PR	4315	42.82741	-106.061
49-009-28509	M-22	BROOKS RANCH	PR	5000	42.83504	-106.056
49-025-05563	P-15	UNIT	SI	4335	42.82347	-106.09
49-025-05583	N-13	UNIT	SI	4585	42.83076	-106.1
49-025-05584	N-17	UNIT PATENTED	PR	4141	42.83072	-106.08
49-025-05596	P-16	UNIT	PR	4235	42.82352	-106.085
49-025-05601	M-13	UNIT	SI	4480	42.83438	-106.1
49-025-05644	K-16	UNIT PATENTED	PR	4402	42.8416	-106.085
49-025-05659	J-16	UNIT C-037492	PR	5350	42.84433	-106.084
49-025-23761	K-13	BROOKS RANCH UNIT	PR	0	42.84221	-106.099
49-025-23762	P-17	BROOKS RANCH UNIT	PR	4270	42.82409	-106.081
49-025-23847	I-17	BROOKS RANCH UNIT	PR	4940	42.84927	-106.08
49-025-23848	N-18	BROOKS RANCH UNIT	PR	4121	42.83035	-106.076
49-025-23849	O-17	BROOKS RANCH	PR	4217	42.82699	-106.081
49-025-23850	KL-1516	BROOKS RANCH	PR	5280	42.8402	-106.088
49-025-23854	M-11	BROOKS RANCH STATE	PR	4600	42.83406	-106.11
49-025-23855	P-14	BROOKS RANCH STATE	PR	4555	42.82294	-106.095
49-025-23856	MN-1314	BROOKS RANCH STATE	PR	5444	42.8326	-106.098
49-025-23932	KL-1415	BROOKS RANCH UNIT	PR	4490	42.84023	-106.093
49-025-23933	KL-1314	BROOKS RANCH UNIT	PR	4500	42.83993	-106.097
49-025-23934	KL-1617	BROOKS RANCH UNIT	PR	4365	42.84055	-106.083

49-025-23972	JK-1516	BROOKS RANCH UNIT	PR	4615	42.84341	-106.088
49-025-60005	1	COUNTRY CLUB	PA	5120	42.81549	-106.266
49-025-21380	22-14	STATE	PA	5193	42.80825	-106.198
49-025-23043	1-16 H	BROOKS RANCH UNIT	PR	6557	42.82709	-106.088
49-025-22192	N-17	WS TRACT 20 FEE	AI	7615	42.83233	-106.082

Plugged and Abandoned Wells

API Number	WN	Company Name	Unit Lease	Total Depth	Latitude	Longitude
906089	3	MIDWEST OIL CORPORATION	WALKER	2455	42.85152	-106.02
906538	21-1	CONOCO INC	FEDERAL	4200	42.7278	-106.072
906557	1	ZIMMERMAN R E	FEDERAL	4007	42.72054	-106.067
905576	N-21	NAUTILUS EXPLORATION LLC	BROOKS RANCH	4006	42.83095	-106.061
905593	1-H-3	CONOCO INC	GOVT	3315	42.82919	-106.014
905613	M-20	NAUTILUS EXPLORATION LLC	M-20	3974	42.83445	-106.065
905623	2	CONOCO INC	HUMPHREYS	4485	42.8356	-106.015
905626	2	CONOCO INC	WHITESIDE	0	42.83595	-106.003
905645	1	CONOCO INC	WHITESIDE 3	1035	42.83732	-106.005
905648	14	CONOCO INC	HUMPHREY	3289	42.83736	-106.003
905673	L-20	NAUTILUS EXPLORATION LLC	BROOKS RANCH	4816	42.83808	-106.065
905693	1-12	CONOCO INC	GOVT	4626	42.83906	-106.037
905703	3	CONOCO INC	WHITESIDE 4	3325	42.83956	-106.022
905734	7	CONOCO INC	WHITESIDE NO 3	3195	42.84883	-106.008
905737	K-19	PENNECO EXPLORATION COMPANY OF WYO LLC	UNIT PATENTED	4150	42.84164	-106.07
905741	9	CONOCO INC	WHITESIDE 3	5031	42.84935	-106.008
905767	1	CONOCO INC	WHITESIDE 4	1300	42.84312	-106.014
905828	J-20	NAUTILUS EXPLORATION LLC	UNIT	4225	42.84548	-106.065
905879	3	CONOCO INC	WHITESIDE 1	3268	42.84704	-106.015
905891	1	KINNEY COASTAL OIL CO	FEE	1472	42.85065	-106.043
905161	1	EQUALITY OIL & DEVEL	STATE	2000	42.74403	-106.074
905164	1	YELLOWSTONE DRILLING	STATE	521	42.75011	-106.066
905220	1	WINKLER L W & SON	STATE-PETERSON	4942	42.75967	-106.046
905153	1	SKINNER CORPORATION	V R RANCH	5094	42.7401	-106.014
905276	1-1	CANADA SOUTHERN OIL	STATE	5800	42.77683	-106.023
905279	1	M K M OIL COMPANY	GOVT ANDERSON	6001	42.77672	-106.008
905536	O-19	NAUTILUS EXPLORATION LLC	UNIT W-077873	4195	42.82729	-106.07
905555	1	CONOCO INC	WHITESIDE	1288	42.82332	-106.002

905646	5	CONOCO INC	POOLE	4558	42.83718	-106.029
905658	1	CONOCO INC		1325	42.84369	-106.033
905671	6	CONOCO INC	POOLE	3317	42.84113	-106.026
905675	L-19	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4107	42.83804	-106.07
905686	11	CONOCO INC	WHITESIDES-3	3227	42.83928	-106.01
905694	10	CONOCO INC	WHITESIDES 3	3218	42.83933	-106.005
905710	3	CONOCO INC		3302	42.8397	-106.026
905717	8	CONOCO INC	WHITESIDES 4	3307	42.84128	-106.017
905746	2	CONOCO INC		2582	42.84369	-106.033
905758	K-21	NAUTILUS EXPLORATION LLC	BROOKS RANCH	4042	42.84263	-106.061
905774	4	CONOCO INC	WHITESIDE 3 PATENTED	3205	42.85049	-106.01
905795	5	CONOCO INC	GOVT	3211	42.83707	-106.019
905801	36	CONOCO INC	HUMPHREY	3168	42.83738	-106.001
905804	1	CONOCO INC	WHITESIDE	0	42.83733	-106.005
905811	34	CONOCO INC	HUMPHREY	3195	42.83773	-106.003
905860	3A	CONOCO INC	GOVT	3210	42.83931	-106.008
905954	I-22	NAUTILUS EXPLORATION LLC	BROOKS RANCH	4200	42.84914	-106.055
920034	14-1	BLACK COAL RESOURCES COMPANY	STATE 32-77	5032	42.74076	-106.037
920048	31-1	ANSCHUTZ CORPORATION	GOVT-75	5500	42.79114	-106.006
905296	1	TENNECO OIL COMPANY	GOVT WINKLER	5758	42.78384	-106.016
905535	0-20	NAUTILUS EXPLORATION LLC	UNIT STATE 0-22024	4135	42.82734	-106.065
905551	1-H-4	CONOCO INC	GOVT	1128	42.82837	-106.012
921337	15-24	MARMIK OIL COMPANY	FEDERAL	5578	42.80895	-106.03
960012	2	POWER TOOL	COFF	4524	42.8101	-106.002
905240	11	TRUE OIL LLC	STATE 1	5290	42.7645	-106.028
905341	1	TRUE OIL LLC	GOVT GLAZE	5433	42.79838	-106.017
905553	1-H-5	CONOCO INC	GOVT	0	42.82831	-106.016
905575	N-20	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4832	42.83081	-106.065
905585	1	WALLWAY M J	GOVT	3277	42.83195	-106.017
905599	1	WHEATLEY THOMAS F	GOVT	3265	42.8338	-106.017
905635	1	KINNEY COASTAL OIL CO	FEE	1472	42.83594	-106.043
905641	1	CONOCO INC	WHITESIDE 6	3315	42.83631	-106.003
905685	7	CONOCO INC	WHITESIDES-4	3352	42.83916	-106.02
905769	6	CONOCO INC	WHITESIDES-4	3348	42.84318	-106.02
905782	2	CONOCO INC	WHITESIDE 3	3217	42.85082	-106.023

905785	4	CONOCO INC	GOVT	3190	42.8367	-106.021
905809	8	CONOCO INC	GOVT	3207	42.83755	-106.005
905836	J-19	NAUTILUS EXPLORATION LLC	J-19	4292	42.84573	-106.07
920183	34-15	TRUE OIL LLC	SIGNAL-FEDERAL	4865	42.73866	-106.053
905867	13	CONOCO INC	HUMPHREY A E	3189	42.83943	-106.003
905915	31	CONOCO INC	CRARY	3200	42.8376	-106.003
922350	15-1	NANCE PETROLEUM CORPORATION	STATE	5660	42.75269	-106.023
921882	23-1	CENTURY OIL & GAS CORPORATION	CENTURY STATE	4200	42.82014	-106.06
2505440	1	CLAUSSEN DEAN R	STUCKENOFF	2377	42.74205	-106.132
2505485	1	TEXAS COMPANY	GOVT-DONLEY	1940	42.76045	-106.243
2505492	1	UNKNOWN		0	42.77193	-106.094
2505498	1	SIGNAL EXPLORATION INC	PRATT/WILSON	3089	42.7766	-106.239
2505509	1	MERRITT OIL CO	MERRITT OIL FEE	3550	42.77841	-106.063
2505516	1	CHICAGO CORPORATION THE	GOVT	4315	42.7918	-106.073
2505533	1	BENEDUM PAUL G	WEBEL-SCHULTE	4410	42.80898	-106.084
2505564	1-A	THE BRINKERHOFF COMPANY	STATE	5550	42.82339	-106.104
2505570	O-14	NAUTILUS EXPLORATION LLC	O-14	4483	42.8271	-106.094
2505571	O-13	NAUTILUS EXPLORATION LLC	UNIT	4625	42.82708	-106.099
2505598	M-14	NAUTILUS EXPLORATION LLC	UNIT	4500	42.83439	-106.094
2505630	L-18	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4160	42.83797	-106.075
2505636	K-17	NAUTILUS EXPLORATION LLC	UNIT C-037492	4290	42.84047	-106.078
2505643	K-18	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4217	42.84161	-106.075
2505664	5	NAUTILUS EXPLORATION LLC	USA-WARREN B LOOK	4607	42.84502	-106.089
2520227	1	CAPITOL DRILLING & SERVICE CO	BAILEY	2200	42.81266	-106.291
2509415	Q-14	NAUTILUS EXPLORATION LLC	Q-14	4530	42.81984	-106.094
2507114	L-17	NAUTILUS EXPLORATION LLC	BROOKS RANCH UNIT	1100	42.83798	-106.079
2505458	1	YELLOWSTONE PETROLEUM	ALICE	2342	42.76213	-106.124
2505493	1-A	YELLOWSTONE DRILLING	STATE	3700	42.76974	-106.129
2505494	1	SOUTHLAND ROYALTY COMPANY	PRATT RANCH	4660	42.77236	-106.211
2505500	1	MORTON-SHEPHERD & CAPERTON	STATE	4220	42.77994	-106.104
2505541	1	CASPER OIL & GAS SYNDICATE	CASPER	3551	42.81965	-106.294
2505543	1	CASPER OIL & GAS SYNDICATE	CASPER	3551	42.81262	-106.308
2505488	1-12	MORTON-SHEPHERD & CAPERTON	STATE	2520	42.76341	-106.143
2505495	1	CLARKE INTERESTS		3100	42.7742	-106.08
2505512	54-33	SEABOARD OIL	LATHROP	4774	42.7863	-106.09

2505518	1	AMERADA HESS CORPORATION	GOVT-BRANNAN	6980	42.80376	-106.227
2505519	1	MORTON & CAPERTON	GOVT	4036	42.79813	-106.075
2505554	Q-15	NAUTILUS EXPLORATION LLC	Q-15	4355	42.82024	-106.09
2505579	1	TRIGOOD OIL COMPANY	COLE CREEK SHEEP	4546	42.83026	-106.114
2505585	N-16	NAUTILUS EXPLORATION LLC	UNIT	4255	42.831	-106.084
2505592	17-1	NAUTILUS EXPLORATION LLC	STATE	4506	42.8341	-106.104
2505599	M-15	NAUTILUS EXPLORATION LLC	UNIT	4390	42.83436	-106.089
2505600	M-16	NAUTILUS EXPLORATION LLC	M-16	4322	42.83442	-106.084
2505568	O-16	NAUTILUS EXPLORATION LLC	O-16	4210	42.82716	-106.084
2505580	N-12	NAUTILUS EXPLORATION LLC	UNIT	4560	42.83072	-106.104
2505625	L-15	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4418	42.83801	-106.094
2505626	L-13	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4478	42.83802	-106.099
2505637	1	NAUTILUS EXPLORATION LLC	YOUNGMAN	4420	42.84071	-106.088
2505639	K-12	NAUTILUS EXPLORATION LLC	UNIT W-037492	4554	42.84161	-106.103
2505665	J-17	NAUTILUS EXPLORATION LLC	BROOKS RCH 2ND KF UT	4465	42.84507	-106.08
2505627	6	NAUTILUS EXPLORATION LLC	USA-WARREN B LOOK	4480	42.83801	-106.104
2505640	K-14	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4465	42.8411	-106.094
2505660	J-14	PENNECO EXPLORATION COMPANY OF WYO LLC	UNIT FEDERAL	4626	42.84443	-106.093
2520298	1	MCGEE GEORGE D	WALTER KEITH	3050	42.71198	-106.105
2509413	21-2	CONOCO INC	FEDERAL	3900	42.73498	-106.082
2509745	4	NAUTILUS EXPLORATION LLC	GOVT-LOOK	4282	42.83797	-106.08
2510028	1	MORTON-SHEPHERD & CAPERTON	LAMB	4024	42.74976	-106.082
2521380	22-14	BWAB INC	STATE	5193	42.80828	-106.197
2521412	1-33	WOLD OIL & GAS	NICOLAYSEN	3902	42.78297	-106.089
921354	25-9	MARMIK OIL COMPANY	FEDERAL	5323	42.79813	-106.026
2560005	1	CASPER COUNTRY CLUB	COUNTRY CLUB	5120	42.81551	-106.265
2560040	2	LANDER CORPORATION	LANDER	2200	42.79003	-106.285
2521233	28-2	CENTURY OIL & GAS CORPORATION	STUCKENHOFF	4270	42.79812	-106.089
2521232	28-1	CENTURY OIL & GAS CORPORATION	STUCKENHOFF FEE	4473	42.80538	-106.085
905328	1	NATURAL GAS & OIL CO	GOVT	4918	42.79452	-106.065
905904	40	CONOCO INC	CRARY	3267	42.84849	-106.01
905949	J-22	PENNECO EXPLORATION COMPANY OF WYO LLC	BROOKS RANCH	4025	42.84551	-106.055
905953	I-21	NAUTILUS EXPLORATION LLC	BROOKS RANCH	4298	42.8491	-106.06
905969	41	CONOCO INC	CRARY	3312	42.85004	-106.011

920020	24-1	WALTON PAUL T	WALTON-FEDERAL	4867	42.81965	-106.026
920093	22-12	SIGNAL EXPLORATION INC	UNION-STATE	5493	42.75325	-106.018
921292	25-1	PINTO PRODUCTIONS	FEDERAL	5395	42.8059	-106.025
921927	14-8	NAUTILUS EXPLORATION LLC	TERRA STATE 6931	4848	42.83079	-106.045
905807	41	CONOCO INC	HUMPHREY A E	3150	42.83754	-106.003
905605	1-H-1	CONOCO INC	GOVT	0	42.82919	-106.014
905614	M-19	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4025	42.83443	-106.07
905653	3	CONOCO INC	WHITESIDE 3	3258	42.8373	-106.005
905656	1-A	CONOCO INC		2811	42.83702	-106.024
905684	5	CONOCO INC	WHITESIDES 4	3245	42.83922	-106.014
905691	4	CONOCO INC		3318	42.83902	-106.024
905722	2	CONOCO INC	WHITESIDE 4	3170	42.84867	-106.023
905729	2-A	CONOCO INC		3280	42.84876	-106.024
905735	6	CONOCO INC	WHITESIDE 3	3208	42.84899	-106.022
905797	9	CONOCO INC	WHITESIDE NO 2	4459	42.84478	-106.007
905803	2	CONOCO INC	WHITESIDE 1	3238	42.83729	-106.005
905806	6	CONOCO INC	GOVT	3175	42.8373	-106.005
905810	7	CONOCO INC	GOVT	3210	42.83766	-106.022
905859	2A	CONOCO INC	GOVT	3210	42.83934	-106.005
905862	3	CONOCO INC	GOVT	3170	42.83933	-106.008
905871	1	CONOCO INC	GOVT	945	42.83952	-106.005
2511476	1	BLACKMORE R B	STATE	850	42.75889	-106.134
2505491	1	UNKNOWN		0	42.77172	-106.114
2505497	1	MORTON-SHEPHERD & CAPERTON	GOVT BLACKMORE	2800	42.77578	-106.118
2505502	1	WOLD OIL & GAS	BAILEY	3820	42.7869	-106.34
2505531	1	TRUE OIL LLC	OCEANIC	5756	42.80768	-106.179
2505538	1	MEABON ETAL		3500	42.8118	-106.295
2505551	Q-16	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4296	42.81992	-106.085
2505569	O-15	NAUTILUS EXPLORATION LLC	UNIT	4350	42.82711	-106.089
2505581	N-15	NAUTILUS EXPLORATION LLC	UNIT 0-14654	4365	42.83074	-106.089
2505582	N-14	NAUTILUS EXPLORATION LLC	UNIT 0-23521	4515	42.83076	-106.094
2505597	M-17	NAUTILUS EXPLORATION LLC	UNIT PATENTED	5077	42.83435	-106.08
2505602	M-18	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4100	42.83438	-106.075
2505623	L-16	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4296	42.83715	-106.083
2505629	L-14	NAUTILUS EXPLORATION LLC	UNIT PATENTED	4467	42.83801	-106.094
2506186	4	NAUTILUS EXPLORATION LLC	USA-W B LOOK	4282	42.83797	-106.08

922795	30-12	BURNETT OIL CO INC	BURNETT W-119724	5362	42.80159	-106.021
2520296	23-1	AMARILLO OIL	NICOLAYSEN	5714	42.81596	-106.167
2520493	22-19	TRUE OIL LLC	TRUE-STATE	2413	42.73117	-106.118
2521092	1	SAN JUAN EXPLORATION CO	STATE LAND	2500	42.75616	-106.128
2522379	1	DOMINION EXPLORATION & PRODUCTION INC	MILNE	3885	42.7832	-106.119
2505667	J-18	NAUTILUS EXPLORATION LLC	BROOKS RAN UT	4388	42.84543	-106.075
921355	25-7	MARMIK OIL COMPANY	FEDERAL	5385	42.80151	-106.03
921338	13-19	MARMIK OIL COMPANY	FEDERAL W-43688	5435	42.80924	-106.022
922840	11-Jan	NAUTILUS EXPLORATION LLC	FEDERAL C081299	4900	42.8381	-106.045
2521290	22-Jan	NAUTILUS EXPLORATION LLC	NICHOLS SCHULTE	4233	42.81975	-106.079
907176	5	CONOCO INC	WHITESIDE #2	3113	42.83709	-106.019
907177	6	CONOCO INC	WHITESIDE #2	3175	42.83725	-106.007
907173	31	CONOCO INC	WELL	3200	42.83739	-106.022
907175	4	CONOCO INC	WHITESIDE #2	3190	42.8367	-106.021

Springs

Latitude	Longitude
42.754	-106.157
42.777	-106.263
42.775	-106.266
42.778	-106.292
42.776	-106.299
42.769	-106.316

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AED	Automated External Defibrillator
AoR	Area of Review
bgs	Below Ground Surface
BLM	Bureau of Land Management
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
CPR	Cardiopulmonary Resuscitation
E3	Enhanced Environmental & Emergency Services
EMS	Emergency Medical Services
EPA	United States Environmental Protection Agency
ERRP	Emergency Remedial and Response Plan
FOT	Falloff Testing
HAZWOPER	Hazardous Waste Operations and Emergency Response
M	Magnitude
MIT	Mechanical Integrity Testing
NIMS ICS	National Incident Management System Incident Command System
P/T	Pressure/Temperature
PHMSA	Pipeline and Hazardous Materials Safety Administration
PPE	Personal Protective Equipment
PREP	Preparedness Response Exercise Program
T&M	Testing and Monitoring
UC	Unified Command
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water
USGS	U.S. Geological Survey
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WSEO	Wyoming State Engineer's Office

1.0 LOCAL RESOURCES AND INFRASTRUCTURE

The Casper Carbon Storage Hub was evaluated for impact to the local environment, population, and flora and fauna and selected to reduce potential impacts.

Resources in the Area of Review (AoR) that may be affected by an emergency event at the site include:

- The primary underground sources of drinking water (USDWs) for the area are the Alluvial, Mesaverde, and the Cody Shale aquifers, ranging from near-surface to approximately 1,200 bgs.
- There are multiple small, unnamed bodies of water in the area. Goose Creek is in the AoR to the South.
- Local agriculture, such as alfalfa and hay.
- Hat Six Hunter Management Area and Bureau of Land Management (BLM) land open to hunting.

Casper Storage Hub infrastructure that may be affected as a result of an emergency event at the site include:

- Oil and gas wells that have been identified in Appendix B of the permit application.
- Monitoring wells.
- Residential buildings near the town of Casper.
- Local roads and access roads.

2.0 POTENTIAL RISK SCENARIOS

There are several scenarios which may result in a potential risk to the site area. These include:

- Injection or monitoring (verification) well integrity failure;
- Injection well monitoring equipment failure (e.g., shut-off valve or pressure gauge, etc.);
- Fluid (e.g. brine) or CO_2 leakage to a USDW or the surface;
- A natural disaster (e.g., earthquake, tornado, lightning strike); or
- Induced or natural seismic event.

Each of these scenarios, including plans for detection and the appropriate emergency response are further detailed in Table 1 and Table 2.

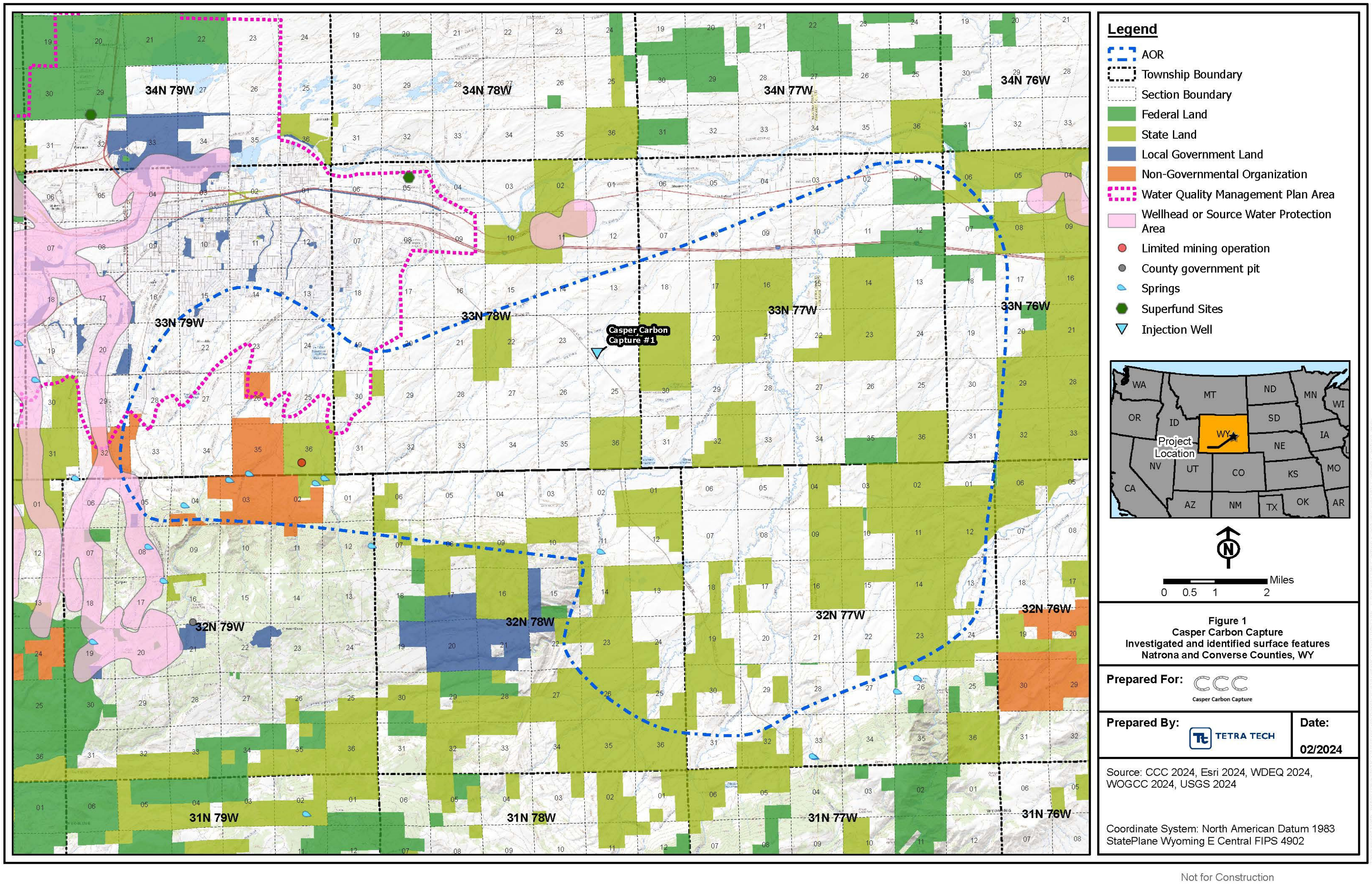


Figure 1: Site resources and infrastructure

3.0 IDENTIFICATION OF POTENTIAL EMERGENCY EVENTS

Table 1: Potential Project Emergency Events and Their Detection

Potential Emergency Events	Detection of Emergency Event
Well Integrity Failure	• Pressure response in the injection tubing and/or annulus. • Detection of CO_2 migration behind casing with external mechanical integrity assessment tools. • Anomalies in the results of any monitoring outlined in the Testing and Monitoring Plan or during the Post-Injection Site Care period may be cause for additional action to be taken to investigate potential leakage.
A monitoring system failure, such as a pressure, temperature, or flow indicating device on a well, equipment, or pipeline.	• Continuous monitoring and recording of well parameters (see Testing and Monitoring Plan).
A natural disaster (e.g., grass fire, landslide, tornado, lightning strike, earthquake).	• Weather forecast modeling, monitoring of public seismic arrays.
Fluid (e.g., brine) leakage to USDW or land surface.	• Elevated concentrations of indicator parameters in USDW samples. • Anomalies in the results of any monitoring outlined in the Testing and Monitoring Plan or during the Post-Injection Site Care period may be cause for additional action to be taken to investigate potential leakage.
CO_2 leakage to USDW or land surface.	• Elevated concentrations of indicator parameters in soil gas and groundwater samples. • Anomalies in the results of any monitoring outlined in the Testing and Monitoring Plan or during the Post-Injection Site Care period may be cause for additional samples to be taken to investigate potential leakage.
An induced seismic event.	• Utilize the public seismic monitoring array to detect induced or natural seismicity.

4.0 EMERGENCY RESPONSE ACTIONS

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response

Emergency Action	Determine Cause and Emergency Response	Severity	Timing of Event	Avoidance Measures	Detection Methods	Potential Response Action
Well Integrity Failure	Anomaly detected in injection tubing and/or casing annulus, continuous injection and annulus pressure & temperature monitoring, and other	Low - High	Injection Phase	Appropriate materials of construction and operating practices	Continuous Pressure/ Temperature (P/T) Gauges, Mechanical Integrity Testing (MIT)	• Verbally notify the Wyoming Department of Environmental Quality (WDEQ) Administrator within 24 hours of the emergency event • For a major (high severity) or serious emergency: ○ Initiate shutdown plan. ○ If contamination is detected, identify and implement appropriate remedial actions (in consultation with the WDEQ Administrator). • For a minor (low-medium severity) emergency: ○ Conduct assessment to determine whether there has been a loss of mechanical integrity. ○ If there has been a loss of mechanical integrity, initiate shutdown plan. • Casper Carbon Capture, LLC (CCC) may enact the following remedial actions to control the flow of injected CO_2 and/or associated reservoir fluids outside the permitted injection zone or USDW: ○ Cease injection of CO_2; ○ Pump heavy fluid into Casper Carbon Capture #1; ○ Perform workover operations on the well. • CCC will provide a written report to the WDEQ Administrator within 5 days that contains: ○ A description of the emergency event and its cause ○ The period of the emergency event, including exact dates and times, and, if the emergency event has not

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response						
Emergency Action	**Determine Cause and Emergency Response**	**Severity**	**Timing of Event**	**Avoidance Measures**	**Detection Methods**	**Potential Response Action**
						been controlled, the anticipated time it is expected to continue. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the emergency event.
Injection Well Monitoring Equipment Failure	Routine inspection and equipment checks	Low	Injection or Post-injection Phase	Proper Maintenance and Calibration of Equipment	P/T Gauges; Fluid samples	• Begin investigation into the source and extent of the problem and determine an appropriate course of action to repair and/or remediate the issue. • Determine severity of the event based on the information available within 24 hours of notification. • Verbally notify the WDEQ Administrator within 24 hours of the emergency event. • For a major or serious emergency: ○ Initiate shutdown plan. ○ Identify and, if necessary, implement appropriate remedial actions (in consultation with the WDEQ Administrator). • For a minor emergency: ○ Conduct assessment to determine whether there has been a loss of mechanical integrity. ○ If there has been a loss of mechanical integrity, initiate shutdown plan. • CCC will provide a written report to the WDEQ Administrator within 5 days that contains: ○ A description of the emergency event and its cause ○ The period of the emergency event, including exact dates and times, and, if the emergency event has not been controlled, the anticipated time it is expected to continue.

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response						
Emergency Action	**Determine Cause and Emergency Response**	**Severity**	**Timing of Event**	**Avoidance Measures**	**Detection Methods**	**Potential Response Action**
						Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the emergency event.
Fluid Leakage to USDW	Elevated concentration of indicator parameters in USDW monitoring wells	Medium - High	Injection or Post-Injection Phase	Proper monitoring according to the Testing and Monitoring(T&M) Plan; Propper Plugging of Injection Well	Direct and Indirect monitoring methods.	• Verbally notify the WDEQ Administrator within 24 hours of the emergency event. • For all emergencies (major, serious, minor): ○ Initiate shutdown plan. ○ Collect confirmation samples from USDW(s). ○ If the presence of indicator parameters is confirmed, develop (in consultation with the WDEQ Administrator) a case-specific work plan to: ▪ Install additional groundwater monitoring points near the affected groundwater well(s) to delineate the extent of impact; and ▪ Remediate unacceptable impacts to the affected USDW. ○ Arrange for an alternate potable water supply if the USDW was being utilized and drinking water standards for contaminants have been exceeded. ○ CCC will immediately enact the notification procedures described in Section 5.0 and 6.0. ○ Proceed with efforts to remediate USDW to mitigate any unsafe conditions (e.g., install system to intercept, extract, and dispose of brine or brine-contaminated water, and "pump and treat" the CO_2-laden water). ○ Continue groundwater remediation and monitoring (frequency to be determined by CCC and the WDEQ

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response						
Emergency Action	**Determine Cause and Emergency Response**	**Severity**	**Timing of Event**	**Avoidance Measures**	**Detection Methods**	**Potential Response Action**

						Administrator) until unacceptable adverse USDW impact has been fully addressed.
						• CCC will provide a written report to the WDEQ Administrator within 5 days that contains:
						  ○ A description of the emergency event and its cause
						  ○ The period of the emergency event, including exact dates and times, and, if the emergency event has not been controlled, the anticipated time it is expected to continue.
						  ○ Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the emergency event.
						Provide written notice to all surface owners, mineral claimants, mineral owners, lessees, and other owners of record of subsurface interests within thirty (30) days of discovering the leak

Fluid Leakage to Surface	Elevated concentrations of indicator parameters at soil vapor monitoring points.	High	Injection or Post-Injection Phase	Proper monitoring according to the T&M Plan; Propper Plugging of Injection Well	Direct and Indirect monitoring methods.	• Verbally notify the WDEQ Administrator within 24 hours of the emergency event.
						• For all emergencies (major, serious, minor):
						  ○ Initiate shutdown plan.
						  ○ If the presence of indicator parameters is confirmed, develop (in consultation with the WDEQ Administrator) a case-specific work plan to:
						    ▪ Install additional groundwater monitoring points near the affected groundwater well(s) to delineate the extent of impact; and
						    ▪ Remediate unacceptable impacts to the affected ground surface(s).

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response						
Emergency Action	**Determine Cause and Emergency Response**	**Severity**	**Timing of Event**	**Avoidance Measures**	**Detection Methods**	**Potential Response Action**
						○ CCC will immediately enact the notification procedures described in Section 5.0 and 6.0. ○ Proceed with efforts to remediate or mitigate any unsafe conditions. ○ Continue groundwater remediation and monitoring (frequency to be determined by CCC and the WDEQ Administrator) until unacceptable adverse surface impact has been fully addressed. • CCC will provide a report to the WDEQ Administrator within 5 days that contains: ○ A description of the emergency event and its cause ○ The period of the emergency event, including exact dates and times, and, if the emergency event has not been controlled, the anticipated time it is expected to continue. ○ Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the emergency event. • Provide written notice to all surface owners, mineral claimants, mineral owners, lessees, and other owners of record of subsurface interests within thirty (30) days of discovering the leak
Natural Disaster	Begin investigation into extent of the problem and determine an appropriate course of action	Low - High	Pre-Injection, Injection, or Post-Injection Phases	NA	Monitor emergency systems	• Verbally notify the WDEQ Administrator within 24 hours of emergency event. • For a major or serious emergency: ○ Initiate shutdown plan. ○ If contamination or endangerment of USDW is detected, CCC will identify and implement

Table 2: Actions Necessary to Determine Cause of Events and Appropriate Emergency Response						
Emergency Action	**Determine Cause and Emergency Response**	**Severity**	**Timing of Event**	**Avoidance Measures**	**Detection Methods**	**Potential Response Action**

	to repair and/or remediate any issues caused by or resulting from the disaster.					appropriate remedial actions (in consultation with the WDEQ Administrator).
						• For a minor emergency:
						  ○ Conduct assessment to determine whether there has been a loss of mechanical integrity.
						  ○ If there has been a loss of mechanical integrity, initiate shutdown plan.
						• CCC will provide a written report to the WDEQ Administrator within 5 days that contains:
						  ○ A description of the emergency event and its cause
						  ○ The period of the emergency event, including exact dates and times, and, if the emergency event has not been controlled, the anticipated time it is expected to continue.
						Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the emergency event.

Induced or Natural Seismic Event	Identify the epicenter, timing, frequency, and magnitude of the events. Determine whether there is a correlation between the event and injection activities.	Low - High	Pre-Injection, Injection, or Post-Injection Phases	Site characterization, geomechanical modeling, and seismic monitoring	Monitor seismic stations	• Determine if the event has impacted the mechanical integrity of the well and/or confining layers of the injection zone, and If warranted, stop CO_2 injection and/or depressurize surface facilities and implement appropriate remedial actions in consultation with the WDEQ Administrator.

Table 3 Seismic Monitoring System, for Seismic Events >M1.0 with an Epicenter within a 0.5-mile Radius of Casper Carbon Capture #1

Operating State	Threshold Condition[1,2]	Response Action
Green	Seismic events less than or equal to M1.5	1. Continue normal operation within permitted levels. Document the event for reporting to the WDEQ in semiannual reporting.
Yellow	Five (5) or more seismic events within a 30-day period having a magnitude greater than M1.5 but less than or equal to M2.0	1. Continue normal operation within permitted levels. 2. Initiate gradual shutdown of the well if it is determined to be appropriate. 3. Within 24 hours of the incident, notify the regulator of the operating status of the well. 4. Review seismic and operational data to determine location and magnitude of the seismic event. If the event falls within or near the extents of the plume, perform a falloff test (FOT) to determine if the storage complex has been compromised by the seismic event. 5. Document the event for semiannual reporting to the WDEQ in semiannual reports.
Orange	Seismic event greater than M1.5 and local observation or felt report	1. Continue normal operation within permitted levels. 2. Within 24 hours of the incident, notify the WDEQ Director of the operating status of the well. 3. Review seismic and operational data. 4. Report findings to the WDEQ Program Administrator and issue corrective actions.[3]
	Seismic event greater than M2.0 and no felt report	
Magenta	Seismic event greater than M2.0 and local observation report	1. Initiate rate reduction plan. 2. Vent CO_2 from injection equipment. 3. Within 24 hours of the incident, notify WDEQ Administrator, of the operating status of the well. 4. Limit access to wellhead to authorized personnel only. 5. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with WDEQ Administrator).

<table>
<tr><th colspan="3">Table 3 Seismic Monitoring System, for Seismic Events >M1.0 with an Epicenter within a 0.5-mile Radius of Casper Carbon Capture #1</th></tr>
<tr><th>Operating State</th><th>Threshold Condition[1,2]</th><th>Response Action</th></tr>
<tr><td></td><td></td><td>6. Determine if leaks to groundwater or surface water occurred.
7. If USDW contamination is detected:
a. Notify the WDEQ Administrator within 24 hours of determination.
8. Review seismic and operational data.
9. Report findings to the WDEQ and issue corrective actions.[3]</td></tr>
<tr><td rowspan="2">Red</td><td>Seismic event greater than M2.0, and local observation report, and confirmation of damage[4]</td><td rowspan="2">1. Initiate rate reduction plan.
2. Vent CO_2 from injection equipment.
3. Within 24 hours of the incident, notify WDEQ Administrator, of the operating status of the well.
4. Limit access to wellhead to authorized personnel only.
5. Communicate with facility personnel and local authorities to initiate evacuation plans, as necessary.
6. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with WDEQ Administrator).
7. Determine if leaks to groundwater or surface water occurred.
8. If USDW contamination is detected:
a. Notify the WDEQ Administrator within 24 hours of determination.
9. Review seismic and operational data.
10. Report findings to the WDEQ and issue corrective actions.[3]</td></tr>
<tr><td>Seismic event >M3.5</td></tr>
</table>

[1]Specified magnitudes refer to magnitudes determined by Casper Carbon Capture or USGS seismic monitoring stations or reported by USGS National Earthquake Information Center using the national seismic network.
[2]"Felt report" and "local observation and report" refer to events confirmed by local reports of felt ground motion or reported on the USGS "Did You Feel It?" reporting system.
[3]Reporting findings to the UIC Program Director and issuing corrective action will occur within 25 business days (five weeks) of change in operating state.
[4]Onset of damage is defined as cosmetic damage to structures, such as bricks dislodged from chimneys and parapet walls, broken windows, and fallen objects from walls, shelves, and cabinets.

5.0 RESPONSE PERSONNEL/EQUIPMENT AND TRAINING

CCC will utilize the flowchart below for internal reporting of emergency incidents:

CCC will ensure all personnel have the knowledge they need to conduct their job safely.

CCC will manage any incidents using a Unified Command (UC) structure in coordination with all applicable federal, state, and local agencies utilizing the National Incident Management System Incident Command System (NIMS ICS). The NIMS ICS is a standardized, on-scene, all-hazard management tool that is readily adaptable to incidents ranging from small to large. The Emergency Management Team and emergency management contractors have been trained, at a minimum, to the NIMS 300 Level. Figure 2 shows the UC structure that will be utilized with the NIMS ICS.

Hazardous Waste Operations and Emergency Response (HAZWOPER) Operations level training is required for personnel who are required to participate in the active response to an incident/emergency. The Training Program Administrator will certify personnel as HAZWOPER trained through the completion of comprehensive quarterly training, hands-on training, response drill participation, and applicable on-the-job experiences. Applicable personnel will possess biennial CPR/First Aid/AED Awareness Certifications and participate in hands-on response training in their area of operations through equipment deployment drills aligning with the Preparedness Response Exercise Program (PREP).

CCC will provide appropriate training as required by organizations with geographic and logistical jurisdiction at the Casper Carbon Storage Hub (e.g., PHMSA).

The Training Program Administrator will maintain documentation on the completion of all training elements and HAZWOPER certification for each trained employee.

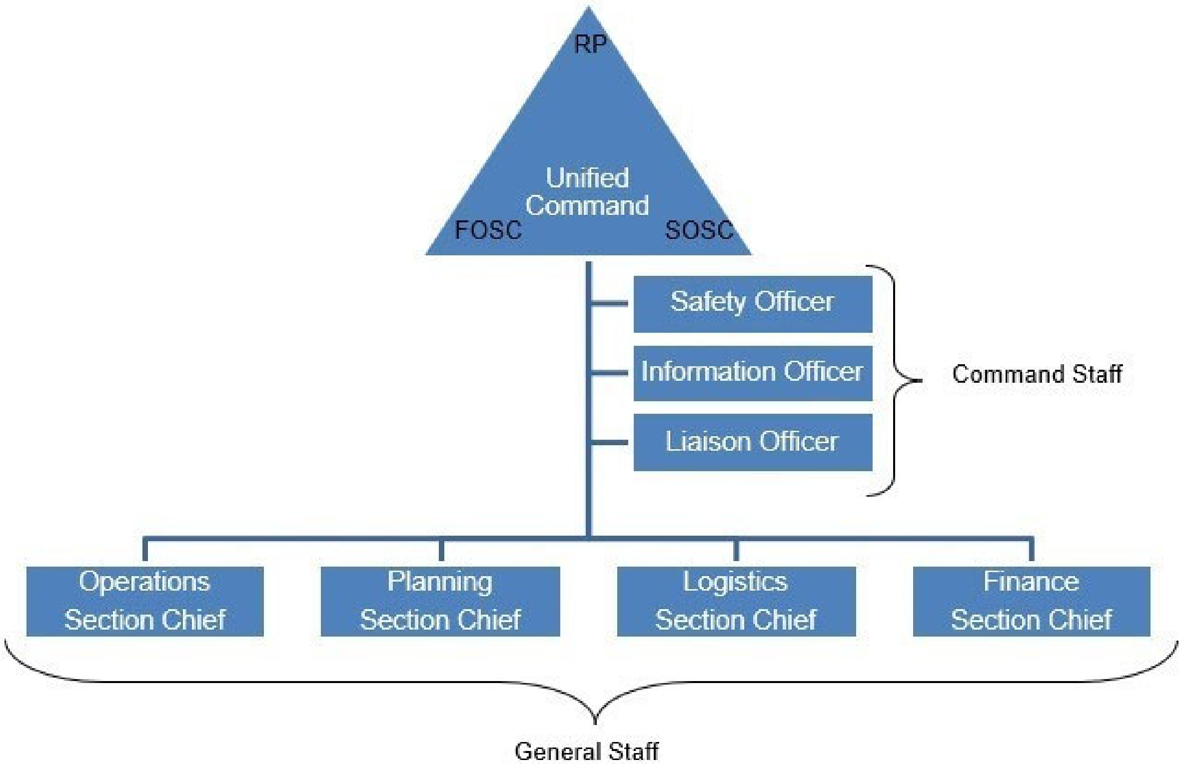


Figure 2: Unified Command Structure.

A site-specific emergency contact list will be developed and maintained during the life of the project. CCC will provide the current site-specific emergency contact list to the WDEQ Administrator.

Table 4: Emergency Contacts

Agency	Contact Information
Casper Police Department	(307) 235-8278
Natrona County Sheriff	(307) 235-9282
Converse County Sheriff	(307) 358-4700
Wyoming State Police	(307) 352-3100
Casper Fire-EMS Department	(307) 235-8222
Natrona Country Fire District Station 2 (Closest fire station to the project)	(307) 234-6694

Table 4: Emergency Contacts	
Agency	**Contact Information**
Natrona County Emergency Management Agency	(307) 235-9205
Converse County Emergency Management Agency	(307) 358 6880
Wyoming Department of Environmental Quality	(307) 777-6145
WDEQ Water Quality Division Director	Todd Parfitt; (307) 777-7937
WDEQ Water Quality Division Administrator	Jennifer Zygmunt; (307) 777-7937
Wyoming Oil and Gas Conservation Commission	(307) 234-7147
Wyoming Department of Environmental Quality – Spill Response Coordinator	(307) 777-5885
Enhanced Environmental & Emergency Services (E3)	(844) 833-0939
USEPA National Response Center (24 hours)	(800) 424-8802
Wyoming State Geological Survey	(307) 766-2286
Wyoming Game and Fish Department	(307) 777-4600
USEPA Region 8	(303) 312-6312

Equipment needed in the event of an emergency and remedial response will vary, depending on the emergency event. Response actions (cessation of injection, well shut-in, and evacuation) will generally not require specialized equipment to implement. Where specialized equipment (such as a drilling rig or logging equipment) is required, CCC shall be responsible for its procurement.

6.0 EMERGENCY COMMUNICATIONS PLAN

CCC will notify the USEPA, Natrona County Emergency Management Agency, WDEQ, and Wyoming Oil and Gas Conservation Commission (WOGCC) of any event that requires an emergency response and has potential to impact the public within 24 hours. The amount of information, timing, and communication method(s) will be appropriate to the event, its severity, its impact(s) to drinking water or other environmental resources, and any other impacts to the surrounding community. If an event has potential to impact a waterway, the National Response Center (NRC) will be contacted within 24 hours.

CCC will describe what happened, any impact(s) to the environment or other local resources, how the event was investigated, what responses were taken, and the status of the response. For long-term responses, (e.g., ongoing cleanups) CCC will provide periodic updates on the progress of the response action(s).

7.0 EMERGENCY REMEDIAL RESPONSE PLAN REVIEW AND UPDATES

The emergency and remedial response plan (ERRP) shall be reviewed and updated, as necessary, on the same schedule as the update to the AoR delineation. Amendments to the emergency and remedial response plan shall be submitted to the WDEQ Administrator as follows:

- In conjunction with the update to the AoR delineation
- At least once every two (2) years during injection operations
- At least once every five (5) years during the post-injection site care period;
- Within one (1) year of an AoR re-evaluation;
- Following any significant changes to the facility;
- Within 30 days, or other time prescribed by the WDEQ, following significant changes to the injection process or injection facility, or an emergency event; or
- As required by the WDEQ Administrator.

If the review indicates that no amendments to the ERRP are necessary, CCC will provide the WDEQ with the documentation supporting the “no amendment necessary” determination.

If the review indicates that amendments to the ERRP are necessary, amendments shall be made and submitted to the permitting agency for approval within 30 days, or another time prescribed by the Administrator, following an event that initiates the ERRP review procedure.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Financial Assurance Demonstration Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
ERRP	Emergency Remedial and Response Plan
FADP	Financial Assurance Demonstration Plan
mi	Miles
MNA	Monitored Natural Attenuation
N	North
NAD	North American Datum
PISC	Post-Injection Site Care
USDW	Underground Source of Drinking Water
USEPA	Environmental Protection Agency
W	West
WDEQ	Wyoming Department of Environmental Quality
WWQR	Wyoming Water Quality Rules

1.0 FINANCIAL ASSURANCE DEMONSTRATION PLAN

Casper Carbon Capture, LLC (CCC) is providing the Financial Assurance Demonstration Plan (FADP) for the Casper Carbon Storage Hub under Wyoming Department of Environmental Quality (WDEQ) Chapter 24, Section 26, which states:

The facility name, contact, and injection well location information are provided below:

Facility Name:	Casper Carbon Storage Hub
Facility Contact:	Jess Foshee
Injection Well Name:	Casper Carbon Capture #1
Injection Well Location:	42.8098, -106.1577 (NAD83) Natrona County Section 24, Township 33N, Range 78W

The FADP is prepared to account for the planned injection well in CCC's sequestration project in Natrona County, Wyoming with a ten-year post-injection site care period (PISC), or until criteria are met per the Wyoming Water Quality Rules. The FADP considers CCC facility permits and associated Class VI drilling permits to satisfy WDEQ regulations contained in Chapter 24 of the Water Quality Rules and Regulations.

At this time, CCC is continuing to evaluate different financial assurance mechanisms around the proposed injection well. The details in this FADP, along with supporting documentation, establish the strategy CCC will use to meet the financial responsibility requirements. This strategy sufficiently addresses the estimated costs associated with the corrective action plan, injection well-plugging program, post-injection site care, facility closure, Emergency and Remedial Response Plan (ERRP), and endangerment of underground sources of drinking water (USDWs).

The values included in the FADP are based on cost calculations from other Underground Injection Control projects, groundwater remediation projects, and publications. They are based on utilizing services conducted by multiple third-party service providers. These values are subject to change throughout the project life to account for inflation of costs and changes to the project that would impact the cost estimations, such as future improvements to monitoring and/or remediation technologies. If the cost estimates change, CCC will adjust the calculation in the financial assurance mechanism. Any adjustments will be submitted for approval by the WDEQ Administrator as required for the Certificate of Project W.S. §35-11-313(n).

Table 1 contains the FADP cost estimate, specifically the components and costs during the pre-injection phase and the first year of operation, while

Table 2: Financial Assurance Components - When Funded and Instruments

contains the financial assurance components and when they are expected to be funded. CCC will engage and coordinate with the WDEQ at the appropriate time to secure the financial assurance instruments at least 90 days prior to permit to construct approval.

Table 1: Financial Assurance Components and Costs: Pre-Injection and Year 1 of Injection

Financial Responsibility Element	Cost Estimate	Financial Assurance Required
A. Performing corrective action on other wells in the AoR that require corrective action under Chapter 24, Section 13	NA – All corrective action discussed in Form A-2 will be complete prior to project operation	No
B. Injection and monitoring well-plugging	$1,100,000	Yes
C. Operation and Maintenance During Testing and Monitoring – Injection Period		
(i) Pre-Injection Testing (Permitting and Site Characterization)	NA – All site characterization and permitting costs will be incurred prior to project operation	No
(ii) Operation and Maintenance During Testing and Monitoring	NA – All operation and monitoring costs will be incurred during to project operation, but will not impact the public	No
D. Emergency and Remedial Response	$24,500,000	Yes
E. PISC and Site Closure under Chapter 24, Section 24	$4,505,000	Yes
	Total:	**$30,105,000**

Table 2: Financial Assurance Components - When Funded and Instruments

Financial Responsibility Element	When Funded	Financial Assurance Instrument
A. Plugging the injection wells under Chapter 24, Section 23	Prior to Permit Construct	*WWQR Chapter 24, Section 26(c):* (i) Irrevocable Trust Funds with government backed securities, or (ii) Surety Bonds, or (iii) Irrevocable Letter of Credit, or (iv) Cash, or (v) Federally Insured Certificates of Deposit
B. PISC and Site Closure under Chapter 24, Section 24	Prior to Authorization to Inject	
C. Emergency and Remedial Response under Chapter 24, Section 25	Prior to Authorization to Inject	*WWQR Chapter 24, Section 26(c):* (vi) Irrevocable Trust Funds with government backed securities, or (vii) Surety Bonds, or (viii) Irrevocable Letter of Credit, or (ix) Cash, or (x) Federally Insured Certificates of Deposit. Permittees may also cover this as part of the public liability insurance

Note: Per WWQR Chapter 24 Section 26(b)(viii), CCC shall submit updated financial assurance cost estimates annually. The amounts shown in these tables are subject to change based on annual financial assurance updates.

1.1 CORRECTIVE ACTION ON WELLS IN AOR

The project approach for this calculation is to define the Area of Review (AoR), evaluate and identify both legacy and active wells within the AoR, and remediate any legacy wells that pose a leakage pathway risk, prior to first injection and project operation. It was determined that CCC has 1 well, the Govt. Brannan #1, that will need to be remediated. Since it is assumed this corrective action will be performed prior to first injection and no further remediation will be required upon commencement of injection, the Corrective Action estimate of $0 in 2024.

1.2 PLUGGING OF INJECTION WELL & MONITORING WELL

Calculations for the Project area assume only one Class VI injection well plugging and one monitoring well plugging. This represents a cost calculation of $1,100,000 in 2024.

1.3 EMERGENCY AND REMEDIAL RESPONSE (INCLUDING ENDANGERMENT TO USDWS)

Ranges of cost estimates for Emergency and Remedial Response activities associated with CO_2 leakage from the injection zone. The calculations are grounded in methodologies developed by Bielicki et al. *(2013)* and supplemented by information from the submitted Class VI permit for construction. Bielicki et al. *(2013)* provide a comprehensive framework in their research by outlining a case study, formulating cost narratives ranging from low to high, and identifying key factors influencing cost variations. This framework was refined to better fit the project context, particularly focusing on the costs associated with detecting and repairing leaks and the environmental remediation of USDW.

In formulating the cost estimates, extensive research was conducted on local hydrogeology and water systems within the AoR. This analysis concluded that the most expensive scenario would involve the unintended migration of CO_2 into the three deepest USDW formations: the Sussex Sands of the Cody Shales, Lakota, and Casper Formations. Per the Groundwater Atlas of Wyoming, the deepest operational groundwater wells within the AoR currently extract water from the Sussex Sands formation. It is assumed that a pump-and-treat strategy may be utilized for effective remediation. Conversely, as no existing domestic groundwater wells are drawing from the Lakota and Casper Formations within the AoR, this Financial Assurance Demonstration Plan intends to employ the Environmental Protection Agency (USEPA)-approved Monitored Natural Attenuation Approach (MNA) for their remediation. To project the remediation costs for Sussex Sands, integrated hydrogeological data from the work of Feathers et al. *(1981)* was utilized. This data was used to determine the volume of water requiring remediation. A conceptual remediation system design consisting of extraction wells, a treatment system, and injection wells was developed along with capital and operating costs. Additionally, monitoring expenses as outlined in the USEPA's guide for CCS project cost estimation *(USEPA, 2008)* were factored in.

For the Lakota and Casper Formations, the cost estimate was based on the methodology described in Estimating Cleanup Times Associated with Combining Source-Area Remediation with Monitored Natural Attenuation (U.S. Department of Defense, *(2008)*, which provides insights into cleanup durations when integrating source-area remediation with MNA. To ensure current relevance, adjusted costs reflect present-day values adjusting for inflation. The breakdown of the remediation costs for each formation is outlined in **Table 3: Remediation Cost Estimates.**

Table 4: Remediation Cost Estimates	
Remediation Component	**Estimated Cost**
Pump and Treat for Sussex Sands Aquifer	$ 11,679,510
MNA for Lakota Formation	$ 6,015,216
MNA for Casper Formation	$ 6,850,188
Grand Total	**$ 24,544,914**

1.4 UPDATES TO FINANCIAL ASSURANCE

During the active life of the sequestration project, CCC will adjust the cost estimate within 60 days before the anniversary date of the establishment of the financial instrument and provide this adjustment to the WDEQ Administrator. CCC will provide written updates of adjustments to the cost estimate within 60 days of any amendments to the AoR and corrective action plans, the injection well-plugging plan, the testing and monitoring plan, the post-injection site care and closure plan, and the emergency response plan.

1.5 REFERENCES

Bielicki, J.M., et al. (2013). *Causes and financial consequences of geologic CO2 storage reservoir leakage and interference with other subsurface resources.* International Journal of Greenhouse Gas Control, v. 20, pp. 272-282.

Feathers, R., Libra, and Stephenson, R. 1981 *Occurence and characteristics of groundwater in the Powder River Basin, Wyoming.* s.l. : Water Resources Research Institute, University of Wyoming, 1981.

U.S. Department of Defense. (2008). *Estimating Cleanup Times Associated with Combining Source-Area Remediation with Monitored Natural Attenuation.* s.l. : Environmental Security Technology Certification Program, 2008. ER-0436.

USEPA. (2008). *Geologic CO2 Sequestration Technology and Cost Analysis.* s.l. : Office of Water, 2008. EPA 816-B-08-009.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Testing and Monitoring Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
ACZ	Above Confining Zone
AoR	Area of Review
ASTM	American Society for Testing and Materials
BHP	Bottomhole Pressure
BHT	Bottomhole Temperature
$CaCO_3$	Calcium Carbonate
CCC	Casper Carbon Capture, LLC
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EM	Electromagnetic
ERRP	Emergency Remedial and Response Plan
ft	Feet
InSAR	Interferometric Synthetic-Aperture Radar
mg/L	Milligrams per Liter
MIT	Mechanical Integrity Testing
mS/cm	millisiemens per Centimeter
MW	Monitoring Well
N_2	Nitrogen

N/A	Not Applicable
NAD	North American Datum
No.	Number
O_2	Oxygen
P/T	Pressure/Temperature
pH	Potential of Hydrogen
psi	Pounds per Square Inch
QASP	Quality Assurance and Surveillance Program
SpC	Specific Conductivity
SU	Standard Units
TBD	To Be Determined
TD	Total Depth
USDW	Underground Source of Drinking Water
USGS	U.S. Geological Survey
VMP	Vapor Monitoring Point
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WWQR	Wyoming Water Quality Rules
WY	Wyoming

1.0 OVERVIEW OF MONITORING PROGRAM

This Testing and Monitoring Plan includes an analysis of the injected CO_2, periodic testing of Casper Carbon Capture #1, a corrosion-monitoring plan for the CO_2 injection well components, and a leak detection plan to monitor for potential movement of the CO_2 outside of the storage reservoir. This document discusses testing and monitoring prior to CO_2 injection (pre-operational baseline phase), during injection (operational), and during the post-operational monitoring time frames.

A combination of the above monitoring efforts will be used to verify that the geologic storage project is operating as permitted and is protecting underground sources of drinking water (USDWs). An overview of these individual monitoring activities is provided in Table 1. A regular assessment and adaptation of the monitoring program (i.e., a minimum of every 5 years) will be conducted to ensure that it remains appropriate for the site and is adequately tracking the injected CO_2. If needed, alterations to the monitoring program (i.e., technologies applied, frequency of testing, etc.) will be submitted for approval by the Wyoming Department of Environmental Quality (WDEQ) Administrator. This could include changes in sampling schedule or other aspects of the Testing and Monitoring Plan in response to changes in injection or annular pressure, as these changes may indicate a change in integrity of the injection well or storage complex. Results of pertinent analyses and data evaluations conducted as part of the monitoring program will be compiled and reported, as required.

Another goal of this monitoring program is to establish pre-injection baseline data for the storage complex, including baseline data for soil gas, shallow groundwater formations, and permeable formations above and below the confining zone. Once baseline samples are collected, threshold values will be established that would warrant further investigation for each sampling parameter.

In compliance with WDEQ Water Quality Rules Chapter 24 Section 20, the Quality Assurance and Surveillance Plan (QASP) was developed and is included as Form A-9.

Table 1: Overview of the Casper Carbon Storage Hub Monitoring Program					
Monitoring Type	**Device(s)**	**Testing and Monitoring Program**	**Min. Sampling Frequency**	**Target Structure/Project Area**	**Min. Recording Frequency**
Analysis of injected CO_2	In-line sampling/ Chromatography	Injection rate composition sampling	TBD	Wellhead	TBD
CO_2 flow line	CCC personnel	Surface leak detection and monitoring	TBD	Capture facility to the wellsite	TBD
Continuous recording of injection pressure, rate, and volume	P/T gauges, flowmeter	Continuous monitoring	Continuous	Surface-to-reservoir (Casper Carbon Capture #1)	Continuous
Well annulus pressure between tubing and casing	Pressure Gauge		Continuous		Continuous
Near-surface monitoring	MW/VMP	Shallow groundwater and soil gas sampling	See Table 6	Shallow USDW/Vadose Zone	See Table 6
Direct reservoir monitoring	Bottomhole P/T gauge	Pressure recording	Continuous	Storage reservoir	Continuous
Indirect reservoir monitoring	Seismic methods	A combination of one or more seismic methods	See Table 7	Area of the modeled CO_2 plume + buffer	See Table 7
External mechanical integrity	Wireline logging	Temperature log/survey, oxygen activation log, or noise log	See Table 7	Well infrastructure	See Table 7
Corrosion monitoring	Corrosion Coupons	Corrosion coupon monitoring	See Table 7	Capture facility to the wellsite	See Table 7

Casper Carbon Capture, LLC (CCC) will employ an adaptive management approach by completing periodic reviews of the Testing and Monitoring Plan and considering new and emerging technologies to continually optimize the monitoring strategy for the project. During each review, monitoring data and operational data will be analyzed, the Area of Review (AoR) will be reevaluated, and, if warranted, the Testing and Monitoring Plan will be adjusted accordingly within 1 year. The Testing and Monitoring plan will be reviewed in this manner at least once every 5 years, or within 1 year of a re-evaluation of the AoR, to decide whether an amendment is necessary. Should amendments to the testing and monitoring plan be necessary, they will be incorporated into the permit following approval by the WDEQ Administrator. Review and amendment are intended to ensure the proper monitoring of the storage performance is achieved and that the risk profile of the storage operations is addressed moving forward. Over time, monitoring methods and data collection may be supplemented or replaced as advanced techniques are developed.

Additional details of the individual efforts of the monitoring program are provided in the remainder of this document. Results of the testing and monitoring activities described below may trigger action according to the Emergency and Remedial Response Plan (ERRP).

2.0 ANALYSIS OF INJECTED CO_2 AND INJECTION WELL TESTING

2.1 CO_2 ANALYSIS

Per WDEQ Water Quality Rules Chapter 24 Section 20, analysis of the CO_2 stream is required with sufficient frequency to provide data representative of its chemical and physical characteristics. Based on the anticipated composition of the CO_2 stream, a list of parameters was identified for analysis (Table 2). Prior to injection, CCC will determine the chemical and physical characteristics of the CO_2 stream using appropriate analytical methods as described in the QASP. It is anticipated that the injected gas stream will be approximately 98% pure CO_2.

Samples of the CO_2 stream will be collected regularly for chemical analysis, including components listed in Table 2, and physical analysis (e.g. density, viscosity). Samples will be collected from the CO_2 flowline at a location where the flow is representative of injection conditions. Analytical techniques and laboratory methods that will be used to determine the chemical and physical characteristics of the CO_2 stream are described in the QASP.

The flow rate of CO_2 injected into Casper Carbon Capture #1 will be measured by a flowmeter installed at the wellhead, which will also be equipped with a continuously recording pressure gauge.

Table 2: Chemical Components Targeted for Characterization in Injected CO_2
CO_2
Carbon Monoxide (CO)
Nitrogen
Oxygen
Argon
Water

2.2 INJECTION WELL INTEGRITY TESTS

A pressure fall-off test, or other injectivity test, will be performed to obtain data on the injection zone characteristics including initial formation pressures and reservoir pressure buildup, permeability, and effective thickness/transmissibility (kh), injectivity, skin (formation damage/improvement) and wellbore storage effects. The pressure fall-off test will be conducted prior to initiation of CO_2 injection activities and at least once every 5 years thereafter. Prior to initial injection, an internal mechanical integrity test (MIT) will be run by pressure testing the inner annulus (i.e., the casing-tubing annulus above the packer) to an approved regulatory (WDEQ) test pressure. Additionally, at least once per year, CCC will perform an external mechanical integrity test to confirm the absence of significant fluid movement.

It is currently expected that the Falls Ranch #1 Monitoring Well will be outside of the free-phase CO_2 plume and mechanical integrity testing is not currently planned. If during the life of the project and AoR reevaluation process it is discovered that the monitoring well is expected to be within the plume, a revised Form A-5 – Testing and Monitoring Plan will be developed and submitted to the WDEQ for approval.

3.0 CORROSION MONITORING AND PREVENTION PLAN

CCC will ensure safe and reliable operations of injection well components through a corrosion monitoring and prevention plan. During the injection well operation, well materials will be monitored at least quarterly using the coupon method for loss of mass, loss of thickness, cracking, pitting, and other signs of corrosion to ensure the well components meet the minimum standards for material strength and performance.

Samples of materials used in the construction of Casper Carbon Capture #1 that may encounter the CO_2 stream will be included in the corrosion monitoring program by using well construction materials in a flow through loop or in-line monitoring point. The corrosion monitoring system will be located downstream of all process compression/dehydration/pumping equipment (i.e., at the beginning of the pipeline to the wellhead).

If a change of injectate composition is detected during gas sampling and/or continuous recording of operational parameters that indicates a potential for corrosion, CCC will implement a risk-based schedule for inspecting coupons based on the calculated corrosion rate.

The coupons will be handled and assessed for corrosion using the American Society for Testing and Materials (ASTM) G1-03 Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens (1999). The coupons will be photographed, visually inspected, dimensionally measured, and weighed. CCC will mitigate identified threats through changes in operating parameters and/or addition of corrosion inhibitors, as warranted.

Over the lifetime of the project, corrosion-preventing chemicals may be injected into the CO_2 stream based on the corrosion monitoring results. The specific corrosion inhibitor injected must be compatible with all equipment that will encounter the CO_2 stream throughout the project's lifetime and geochemical characteristics of the injection and confining zones. Periodic fluid sampling will be conducted at critical points in the system to determine the corrosion inhibitor's concentration and confirm that it is present at a sufficient level to prevent corrosion. For external corrosion on the wellhead, cathodic protection will be used to inhibit corrosion.

4.0 SURFACE LEAK DETECTION AND MONITORING PLAN

CCC will visually monitor surface components as part of routine inspection and maintenance of the Casper Carbon Storage Hub. Inspection records will be made available upon request. Any detected surface leaks will be immediately repaired.

5.0 SUBSURFACE LEAK DETECTION AND MONITORING PLAN

A pressure fall-off test, or other injection test, will be performed to obtain data on the injection zone characteristics including initial formation pressures and reservoir pressure buildup, permeability, and effective thickness/transmissibility (kh), injectivity, skin (formation damage/improvement) and wellbore storage effects. The pressure fall-off test will be conducted prior to initiation of CO_2 injection activities and at least once every 5 years thereafter to detect potential changes to reservoir conditions. Additionally, direct operational injection data (downhole pressure and temperature) will be used to monitor for changes in injection zone integrity.

CCC will monitor the immediate above (Lakota) and below (Tensleep) formations to detect for pressure and/or geochemical changes. Reservoir pressure increases and changes in geochemistry in either monitored formation may be indicative of a leak.

6.0 NEAR-SURFACE GROUNDWATER AND SOIL GAS SAMPLING AND MONITORING

Near-surface environments will be monitored for potential out-of-zone migration of CO_2. Vadose zone soil gas will be monitored within the AoR during the pre-operational, operational, and post-operational monitoring time frames. Two new soil vapor monitoring points (VMP) will be installed to monitor the vadose zone above the shallow aquifers. One VMP will be installed in the vicinity of Monitoring Well (MW) #s 1 and 2 (Figure 1), targeting the vadose zone above the Casper Carbon Storage Hub. MW #1 penetrates the injection zone outside of the modeled CO_2 plume, while MW #2 is in the vicinity of Casper Carbon Capture #1.

Form A-9, QASP, shows soil gas and fluid parameters that will be analyzed during the duration of the project, and details on the baseline monitoring for all methods are explained in Section 7.0. Monitoring frequencies are listed in Table 6.

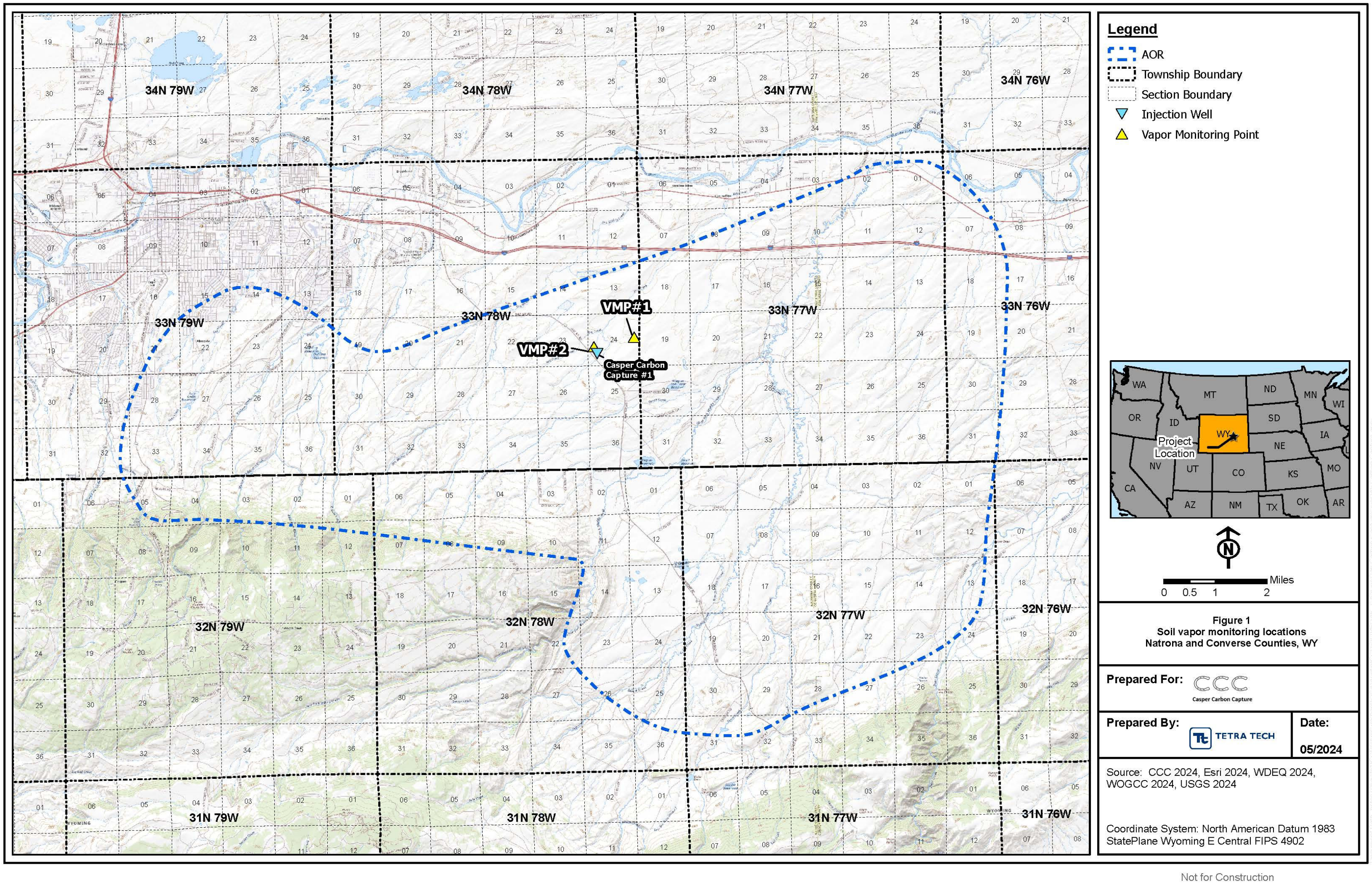
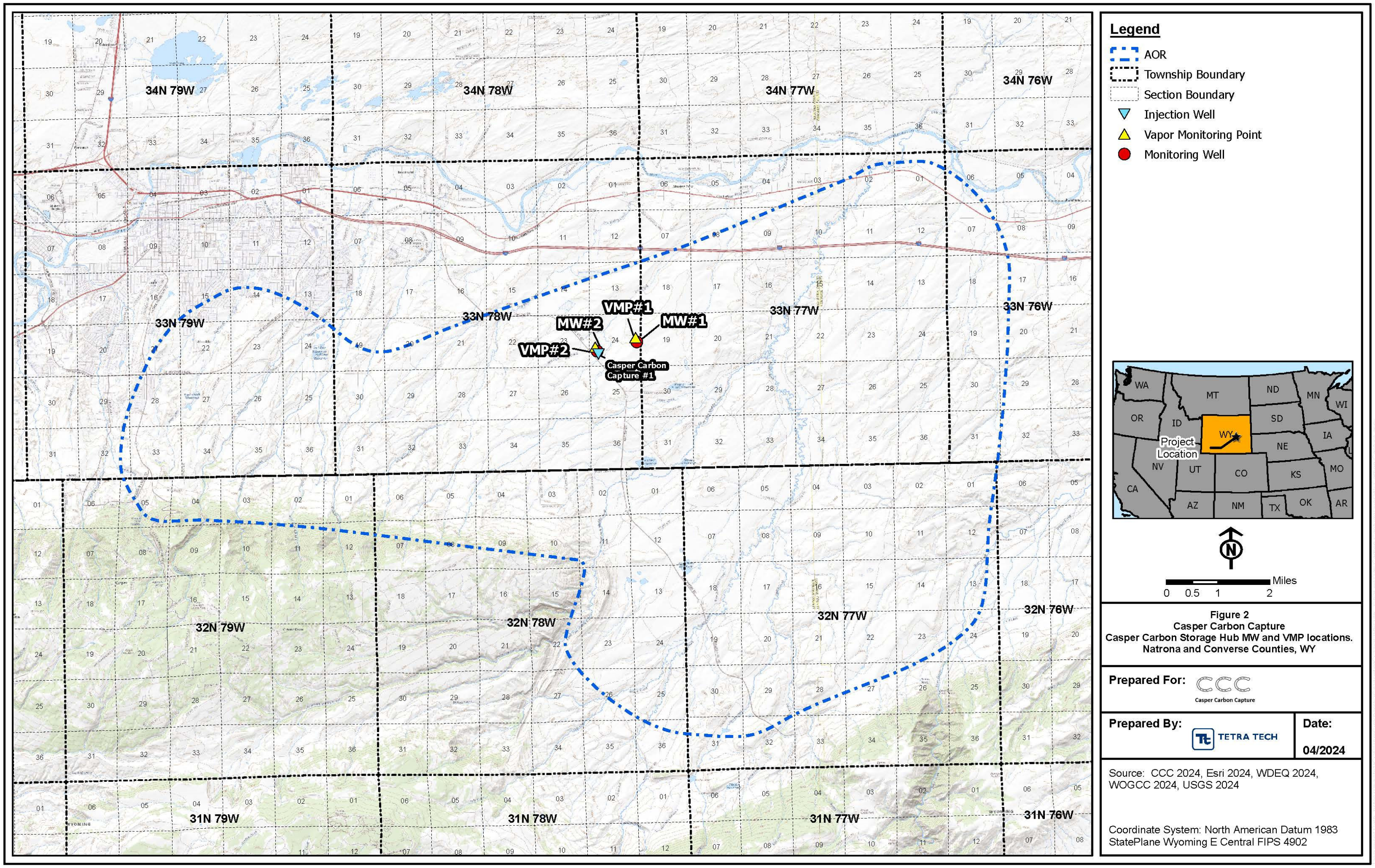


Figure 1: Casper Carbon Storage Hub soil vapor monitoring point locations.

7.0 COMPLETED BASELINE SAMPLING PROGRAM

The purpose of the Baseline Sampling Program is to establish pre-operational site conditions prior to CO_2 injection. The baseline data collection and analysis efforts in these environments will inform future monitoring for subsurface leaks, including during and after injection operations.

Where possible, baseline conditions should be established over multiple seasons to quantify the natural background variability of these systems and to establish action levels (threshold concentrations). These natural variations and external factors could trigger a false leakage signal if not characterized properly during baseline monitoring period. Figure 2 contains planned soil gas and monitoring well locations for the Casper Carbon Storage Hub.



Not for Construction

Figure 2: Casper Carbon Storage Hub MW and VMP locations.

7.1 GROUNDWATER BASELINE SAMPLING

The analytical results from the fluid monitoring performed during the baseline period will be used to establish the conditions prior to injection of CO_2. The baseline data will then be used to evaluate operational and/or post-injection data to evaluate if any significant changes in subsurface conditions might be from CO_2 leakage from the injection zone or possibly attributed to other sources. The locations of MWs are shown in Table 3 below.

Table 3: Proposed Monitoring Well Locations

Location	Approximate TD (ft)	Latitude	Longitude
Near-Surface Groundwater MWs			
MW#2	100	42.8111	-106.1580
ACZ/Underlying USDW MWs			
Falls Ranch #1	7,500	42.8134	-106.1429

Note: TD subject to change. Final depths will be determined during drilling operations.
Note: Coordinates are in NAD83 format

Baseline fluid sampling results will be presented in a manner similar to Table 4 below. Specifically, date, sample location, pH, and Specific Conductivity (SpC) will be reported. and site-specific maps and forms to be used by field samplers for each fluid monitoring event. Monitoring frequencies are listed in Table 6.

Table 4: Baseline Fluid Sampling Results (Example)									
Parameter	**pH (s.u.)**			**SpC, mS/cm**			**Alkalinity as $CaCO_3$, mg/L**		
Well No.	Date	Date	Date	Date	Date	Date	Date	Date	Date
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

7.2 SOIL GAS BASELINE SAMPLING

A process-based approach (see Table 5) will be employed by measuring N_2, O_2, CO_2 to determine whether they reflect natural atmosphere composition (78% N_2, 21% O_2, 0.04% CO_2) or a deviation. Soil temperature and moisture will also be monitored during the sample collection. To limit variability related to atmospheric and biological activity, samples will be acquired from the vadose zone near the top of shallowest aquifer.

Table 5: Baseline Soil Gas Sampling Results (Example)				
Parameter	**Date**	**CO_2 %**	**O_2 %**	**N_2 %**
Sample No.		TBD	TBD	TBD

The QASP shows soil gas and fluid parameters that will be analyzed during the duration of the project. Monitoring frequencies are listed in Table 6.

8.0 NEAR-SURFACE (GROUNDWATER AND SOIL GAS) MONITORING PLAN

To detect whether shallow USDWs are being impacted by operations, one new shallow groundwater monitoring well (MW #2) will be installed in the vicinity of Casper Carbon Capture #1. Monitoring locations are shown in Figure 3 and frequencies are listed in Table 6 below.

Table 6: Baseline (Pre-injection), Operational, and Post-operational Monitoring			
Monitoring Type	**Baseline (Pre-Injection)**	**Operational**	**Post-operational**
Soil Gas Monitoring			
Soil Vapor Monitoring Points	**Duration:** Up to 1 year	**Duration:** 15 years	**Duration:** 10 years or until plume stabilization
	Frequency: Quarterly events per well to establish seasonal baseline	**Frequency:** Annual sampling	**Frequency:** Every 5 years
Shallow Groundwater Wells			
Shallow Groundwater Wells	**Duration:** Up to 1 year	**Duration:** 15 years	**Duration:** 10 years or until plume stabilization
	Frequency: Quarterly events per well to establish seasonal baseline	**Frequency:** Annual sampling	**Frequency:** Every 5 years
Deep Monitoring Well			
Deep Monitoring Wells	**Duration:** Up to 1 year	**Duration:** 15 years	**Duration:** 10 years or until plume stabilization
	Frequency: Quarterly events to establish seasonal baseline. Deep monitoring well will monitor pressure and geochemistry.	**Frequency:** Annual sampling	**Frequency:** Every 5 years

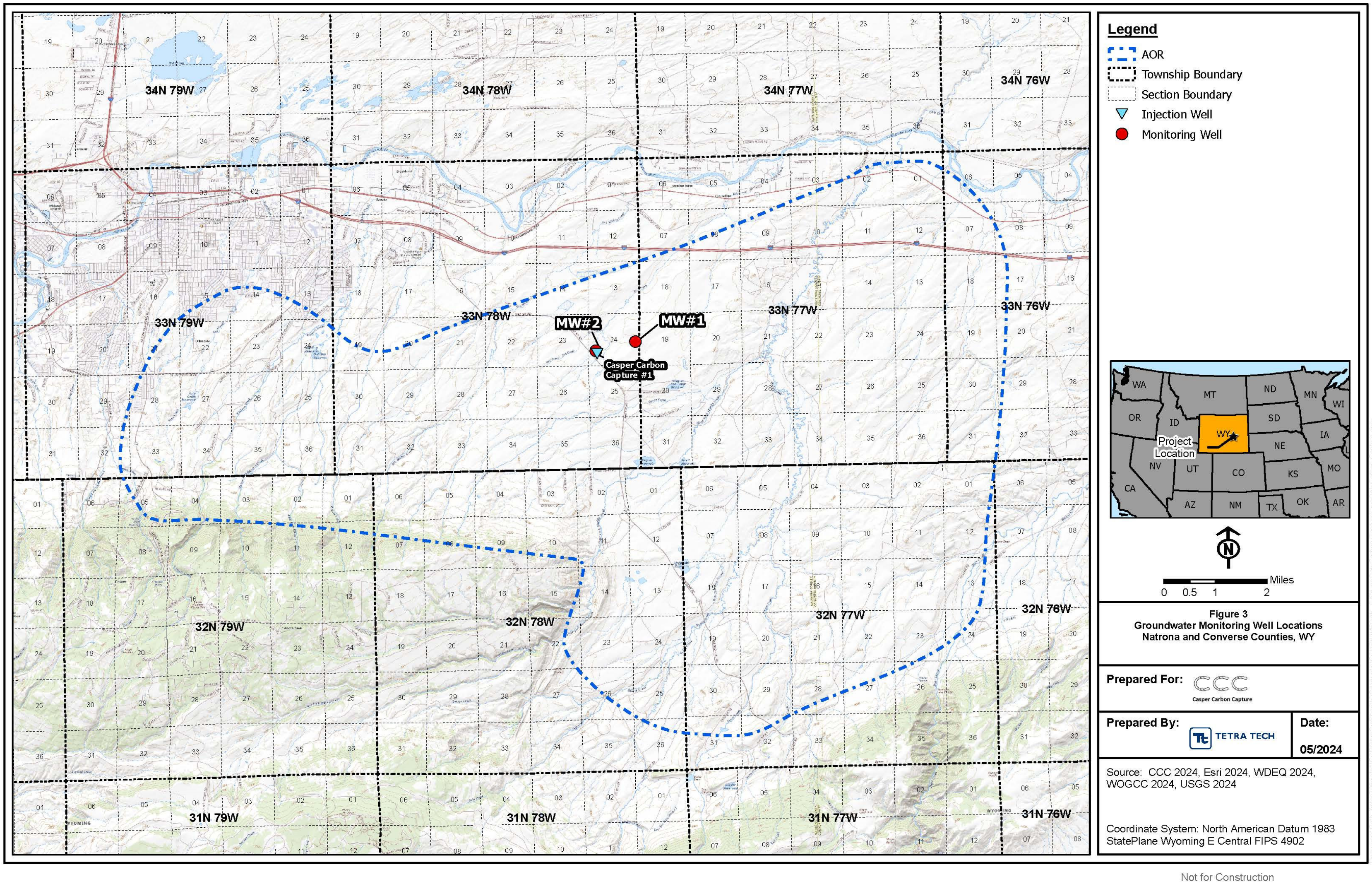


Figure 3: Casper Carbon Storage Hub groundwater monitoring well locations.

9.0 DEEP SUBSURFACE MONITORING OF FREE-PHASE CO_2 PLUME AND PRESSURE FRONT

CCC will implement direct and indirect methods to monitor the location, thickness, and distribution of the free-phase CO_2 plume (plume) and associated pressure (pressure) relative to the permitted storage reservoir. The time frame of these monitoring efforts will encompass the entire life cycle of the Casper Carbon Storage Hub, which includes the pre-operational (baseline), operational, and post-operational periods. The methods described in Table 7 will be used to characterize the plume and pressure within the AoR.

Figure 4 shows the simulated extent of the injected free-phase CO_2 plume at the end of 15 years of injection and after 10 years post-injection. Figure 5 contains plume saturation after 15 years of injection. Monitoring and operational data will be used to evaluate conformance between observations and history-matched simulation of CO_2 and pressure distribution relative to the pre-operational simulation result. If significant variance is observed, the monitoring and operational data will be used to calibrate the geologic model and associated simulations. The monitoring plan will be adapted to provide suitable characterization and calibration data as necessary to achieve such conformance. Subsequently, history-matched predictive simulation and model interpretations will in turn be used to inform adaptations to the monitoring program to demonstrate lateral and vertical containment of the injected CO_2 within the Casper Carbon Storage Hub.

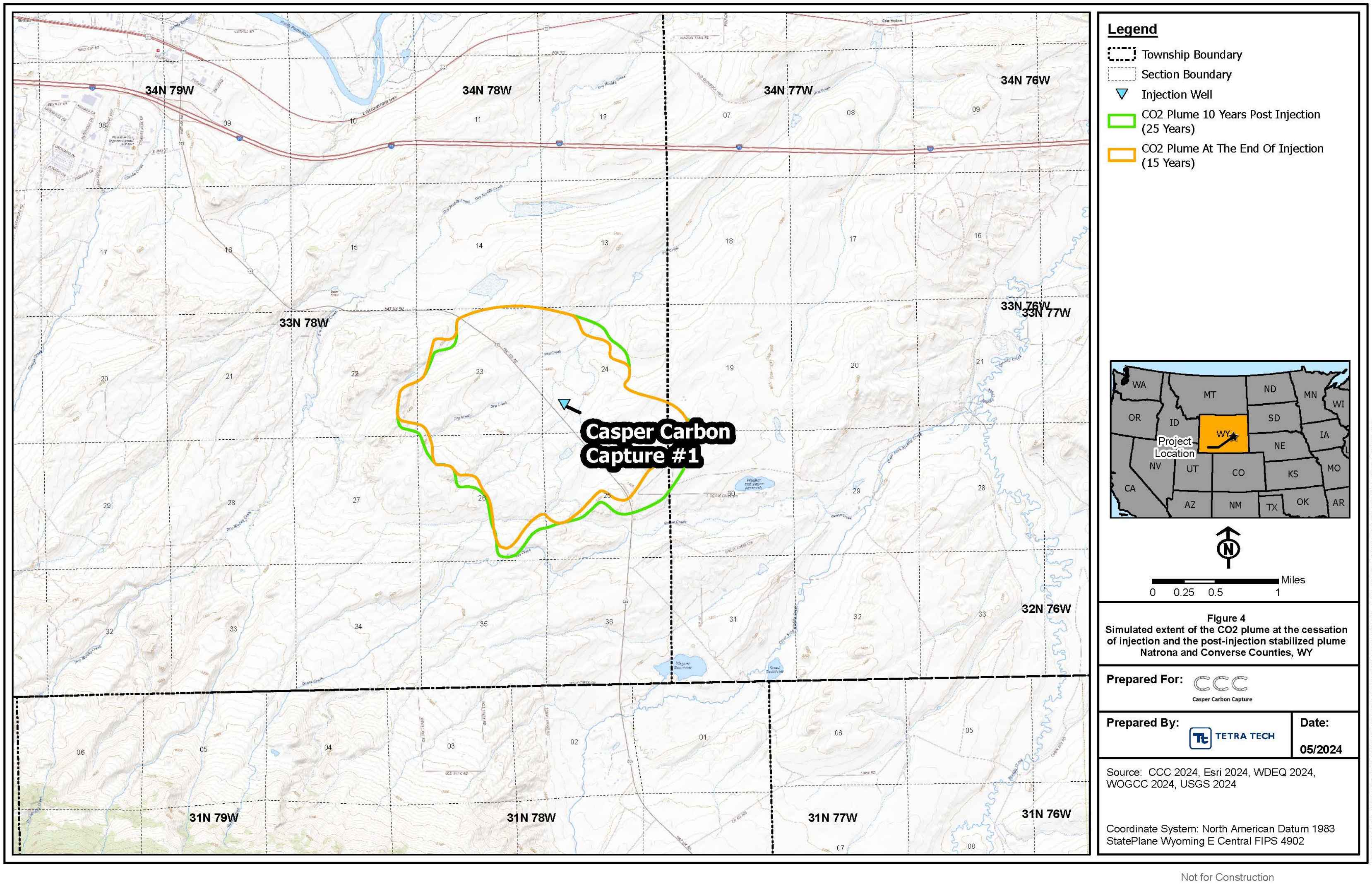


Figure 4: Simulated extent of the CO_2 plume at the cessation of injection and the post-injection stabilized plume.

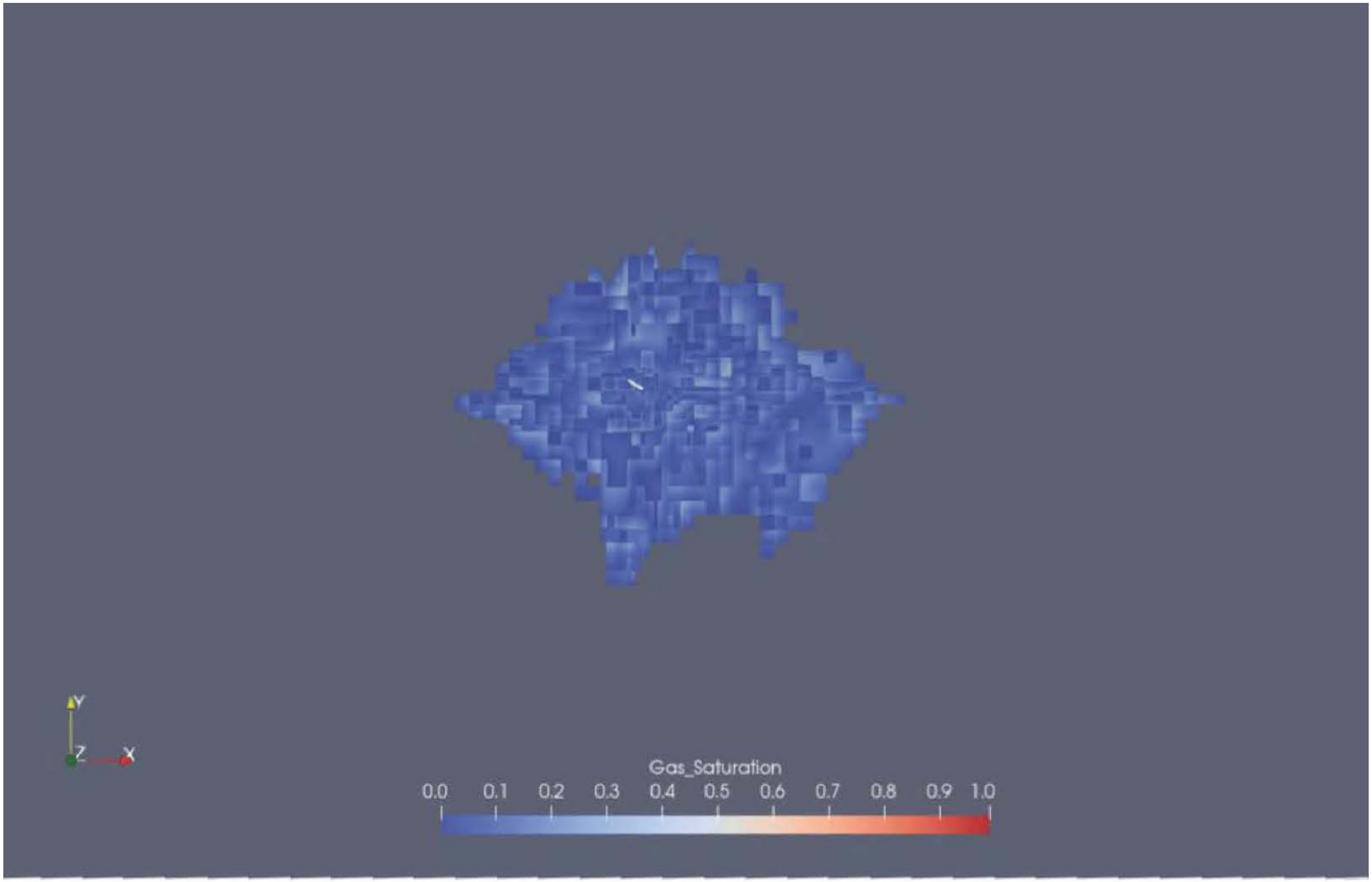


Figure 5: CO_2 plume saturation after 15 years of injection.

Table 7: Description of Monitoring Program			
Monitoring Type	**Baseline (Pre-Injection)**	**Operational**	**Post-operational**
Storage Reservoir Monitoring			
Monitoring During Well Operations - Flow Rates	N/A	**Duration:** 15 years **Frequency:** Continuous monitoring	**Duration:** 10 years or until plume stabilization **Frequency:** Continuous until well plugging. Casper Carbon Capture #1 may be converted to post-injection monitoring well
Monitoring During Well Operations - Volumes			
Monitoring During Well Operations - Surface Injection Pressure			
Monitoring During Well Operations - Surface Injectate Temperature			
Monitoring During Well Operations - Annulus Pressure			
Downhole Monitoring (Casper Carbon Capture #1)			
Downhole Pressure/Temperature gauge on tubing at packer (Casper Carbon Capture #1)	NA	**Duration:** 15 years **Frequency:** Continuous monitoring	**Duration:** 10 years or until plume stabilization **Frequency:** Continuous monitoring
Wireline Logging and Retrievable Data			

Table 7: Description of Monitoring Program			
Monitoring Type	**Baseline (Pre-Injection)**	**Operational**	**Post-operational**
Internal Mechanical Integrity: Tubing-Casing Annulus Pressure Test	**Duration:** NA **Frequency:** One test conducted prior to injection	NA	NA
External Mechanical Integrity	**Duration:** NA **Frequency:** One test conducted prior to injection	**Duration:** 15 years **Frequency:** Annually	**Duration:** 10 years or until plume stabilization **Frequency:** Annually until well plugging
Pressure Fall-Off Test	**Duration:** NA **Frequency:** Once after well construction/ before injection	**Duration:** 15 years **Frequency:** One continuous monitoring for 72 hours every 5 years	**Duration:** NA **Frequency:** One continuous monitoring for 72 hours prior to well plugging
Corrosion Monitoring	**Duration:** 1 year **Frequency:** Baseline measurement	**Duration:** 15 years **Frequency:** Quarterly	**Duration:** NA **Frequency:** None
Geophysical Monitoring			

Table 7: Description of Monitoring Program			
Monitoring Type	**Baseline (Pre-Injection)**	**Operational**	**Post-operational**
Indirect Plume Monitoring	**Duration:** NA **Frequency:** Baseline survey will be acquired prior to injection.	**Duration:** 15 years **Frequency:** Seismic methods will be utilized within the first 5 years of injection. The results will determine the timing, size and scale of future seismic methods.	**Duration:** 10 years or until plume stabilization **Frequency:** Upon final injection, indirect monitoring data will be acquired using seismic methods. Additional seismic methods will be utilized to evaluate CO_2 plume expansion post-injection. A final indirect plume monitoring will be performed using seismic methods to demonstrate CO_2 plume stabilization.

10.0 ABOVE CONFINING ZONE

WDEQ Water Quality Rules Chapter 24 Section 20 (iv) requires periodic monitoring of the groundwater above the confining zones. CCC plans to monitor subsurface pressure of the first permeable zone above the confining zone using the stratigraphic test well, converted into a monitoring well, as shown in Figure 2 and geochemical changes using the groundwater monitoring well. The Lakota formation has been established as a permeable formation for monitoring above the confining zone. As such, the Falls Ranch #1 will monitor both the Lakota formation and the Tensleep formation, a deep aquifer (Casper) below the injection zone, to ensure that a CO_2 leakage pathway does not exist through the upper confining zone or between the Sundance and the Tensleep formations. As this well will be completed into multiple zones, it will monitor the above confining zone (ACZ) and Casper Aquifer through annular pressure only. Monitoring frequencies are listed in Table 6.

The groundwater monitoring well will monitor above the confining zone, in the near subsurface, for changes in pressure and geochemistry. Samples will be analyzed for the parameters presented in Table 4. Changes to these parameters may trigger an increase in sampling frequency and/or analytes to confirm the possibility of a leak.

11.0 DIRECT MONITORING METHODS

Casper Carbon Capture #1 will be equipped with downhole gauges to monitor bottom hole pressure (BHP) and bottom hole temperature (BHT). The BHP/BHT data will be used to update the results of the numerical simulation over the life of the project, as well as detect possible changes in injection one integrity.

12.0 INDIRECT MONITORING METHODS

Indirect monitoring methods will be used to track the extent of the CO_2 plume and the associated pressure front. To demonstrate conformance between the reservoir model simulation and site performance, seismic methods will be utilized to monitor the extent of the CO_2 plume within the first 5 years of CO_2 injection. The collected indirect monitoring data will provide confirmation of the simulation predictions and confirm the extents of the CO_2 plume within the AoR. Through the operational phase of the project, the indirect monitoring plan will be adapted based on updated simulations of the predicted extents of the CO_2 plume. At the end of the operational phase, indirect monitoring data will be acquired and utilized during the post-injection period to confirm the stabilization of the plume. To complement the seismic methods and, as improved time-lapse monitoring technologies emerge (e.g., borehole seismic, gravity, electromagnetic [EM], Interferometric Synthetic Aperture Radar [InSAR]), the monitoring plan will be reevaluated at least every 5 years to determine if modifications to the plan would improve the ability to characterize the migrating CO_2 plume. If some of these methods do not yield representative field data, they may be discontinued after approval from WDEQ and only those methods that yield valid and representative data will be continued.

At the conclusion of the operating phase of the project, the monitoring program will provide an assessment of the long-term containment and stability of the injected CO_2 in the storage complex. Monitoring of the storage complex will continue following the cessation of CO_2 injection for 10 years as further described in the Post Injection Site Care and Site Closure document, or until the Administrator deems no further monitoring is necessary.

13.0 REPORTING AND NOTICE REQUIREMENTS

Monitoring reporting and notifications will meet the requirements and timelines of Wyoming Water Quality Rules (WWQR) Chapter 24 Section 22. Reporting will include a minimum of the following:

- Semi-annual reports shall be submitted to the Administrator within 30 days following the end of the period covered in the report and shall contain:
  - Any changes to the physical, chemical, and other relevant characteristics of the carbon dioxide stream from the proposed operating data;
  - Monthly average, maximum, and minimum values for injection pressure, flow rate and volume, and annular pressure;
  - A description of any event that exceeds operating parameters for annulus pressure or injection pressure as specified in the permit;
  - A description of any event that triggers a shutdown device required pursuant to Section 18(g) of WWQR Chapter 24, and the response taken;
  - The monthly volume of the carbon dioxide stream injected over the reporting period and project cumulatively;
  - Monthly annulus fluid volume added; and
  - The results of monitoring required by WWQR Chapter 24 Section 20.

- Reports, within thirty (30) days, the results of:
  - Periodic tests of mechanical integrity;
  - Any other test of Casper Carbon Capture #1 conducted by CCC if required by the Administrator; and
  - Any well workover.

- Reports, within twenty-four (24) hours of:
  - Any evidence that the injected carbon dioxide stream or associated pressure front may cause an endangerment to a USDW;
  - Any noncompliance with a permit condition, or malfunction of the injection system, which may cause fluid migration into or between USDWs;
  - Any triggering of a Shut-off system, either down-hole or at the surface;
  - Any release of carbon dioxide to the atmosphere or biosphere indicated by the surface air or soil gas monitoring or other monitoring technology required by WWQR Chapter 24 Section 20(b)(ix); and
  - And failure to maintain mechanical integrity.

- CCC shall notify the Administrator in writing thirty (30) days in advance of:
  - Any planned well workover;
  - Any planned stimulation activities;
  - Any other planned test of Casper Carbon Capture #1.

CCC shall submit all required reports, submittals, and notifications in a format approved by the Administrator. CCC shall submit a written report to the Administrator of all remedial work concerning the failure of equipment or operational procedures that resulted in a violation of a permit condition at the completion of the remedial work. For any aborted or curtailed operation, CCC shall submit to the Administrator a complete report within 30 days of complete termination of the discharge or associated activity.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Post-Injection Site Care and Facility Closure Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
ACZ	Above Confining Zone
AED	Automated External Defibrillator
AoR	Area of Review
BHP	Bottomhole Pressure
BHT	Bottomhole Temperature
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
EM	Electromagnetic
EPA	United States Environmental Protection Agency
InSAR	Interferometric synthetic aperture radar
MW	Monitoring Well
P/T	Pressure/Temperature
pH	Potential of Hydrogen
PISC	Post-Injection Site and Facility Care
psi	Pounds per Square Inch
QASP	Quality Assurance and Surveillance Program
TBD	To be Determined
USDW	Underground Source of Drinking Water
USGS	U.S. Geological Survey
VMP	Vapor Monitoring Point
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WY	Wyoming

1.0 NON-ENDANGERMENT DEMONSTRATION CRITERIA

This PISC Plan describes the activities that Casper Carbon Capture, LLC (CCC) will perform to meet the requirements of the Class VI Injection Wells and Facilities Underground Injection Control Program in the Wyoming Department of Environmental Quality (WDEQ) Water Quality Rules and Regulations, Chapter 24, Section 24. A minimum Post-Injection Site and Facility Closure (PISC) timeframe of 10 years is planned to monitor groundwater quality and track the position of the CO_2 plume and pressure, or until stabilization is demonstrated. It is expected that within or near this timeframe, sufficient evidence will be provided that post-injection reservoir pressure has trended back to initial reservoir pressure and the free-phase CO_2 plume has stabilized. However, if alongside collaboration with the WDEQ, it is determined that additional monitoring beyond the initial 10-year PISC period will be required, CCC will continue working with the WDEQ to determine the appropriate modification(s) to the PISC plan to confirm stabilization for final closure of the site. Following approval for site closure, CCC will plug all monitoring wells, restore the site to its original condition, and submit a site closure report and associated documentation. The PISC will be updated on the same schedule as updates to the Area of Review (AoR) delineation.

2.0 RECLAMATION, MONITORING, AND REMEDIATION

Two monitoring wells (MWs) and two soil vapor monitoring points (VMPs) will be installed, as shown in Figure 1 and in the Testing and Monitoring Plan. Sampling procedures are described in Form A-9 - Quality Assurance and Surveillance Program (QASP).

CCC will implement direct and indirect methods to monitor the location, thickness, and distribution of the free-phase CO_2 plume and associated pressure relative to the permitted storage reservoir during the post-operational period. Anticipated areal coverage of the indirect methods are shown in Figure 2, although the survey area may be reduced/expanded to more accurately track CO_2 plume extent.

Post-injection reclamation will occur at the end of the post-injection site care period. Reclamation activities will include decommissioning surface equipment, plugging monitoring wells, restoring the site, and preparing and submitting site closure reports. The WDEQ Administrator will be notified, in writing, at least 120 days before filing a request for site closure. A revised site closure plan will be submitted if any changes have been made to the original site closure plan. After site closure is authorized, site closure activities will be completed.

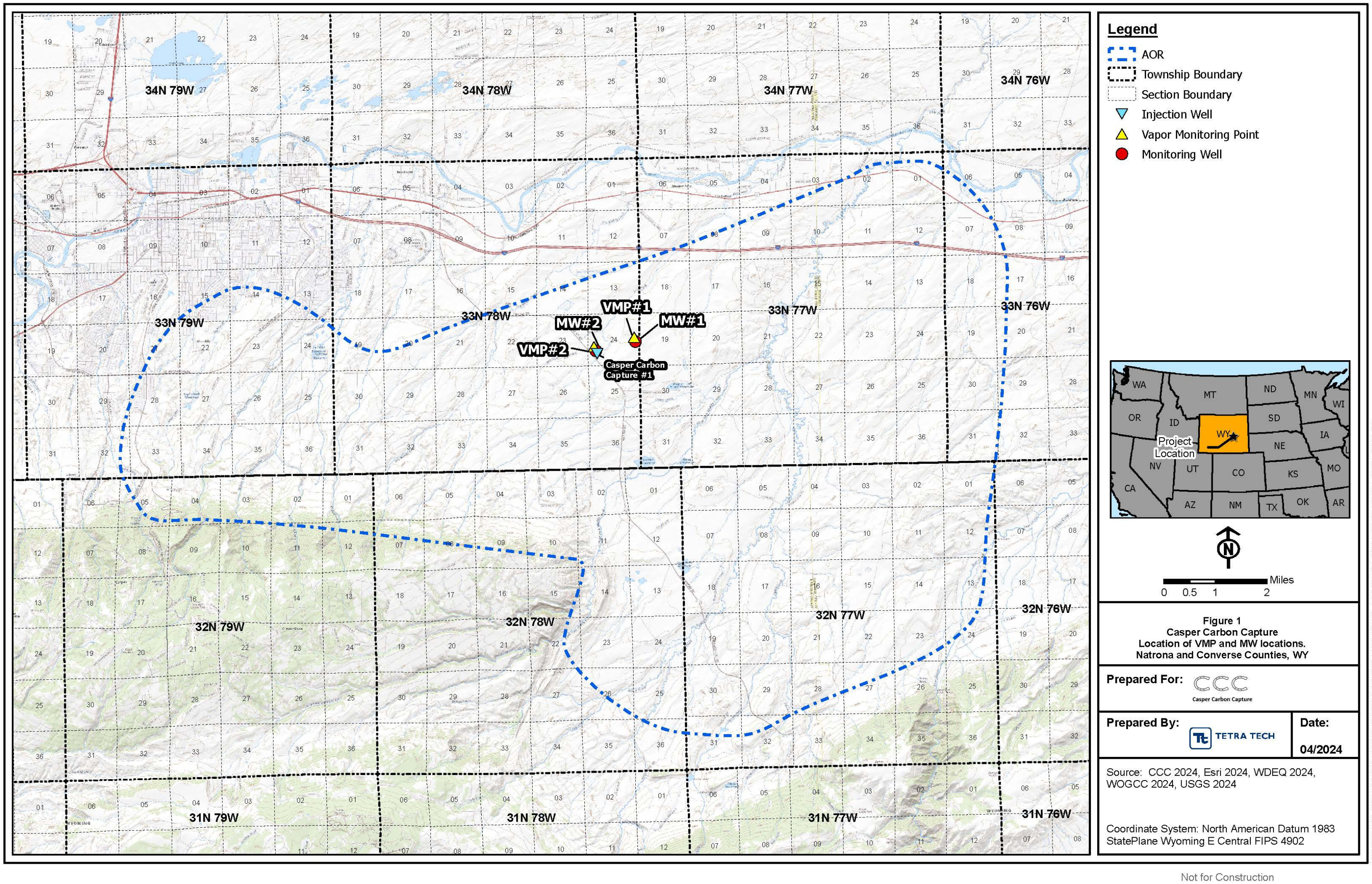


Figure 1: Location of soil gas and groundwater well sampling locations.

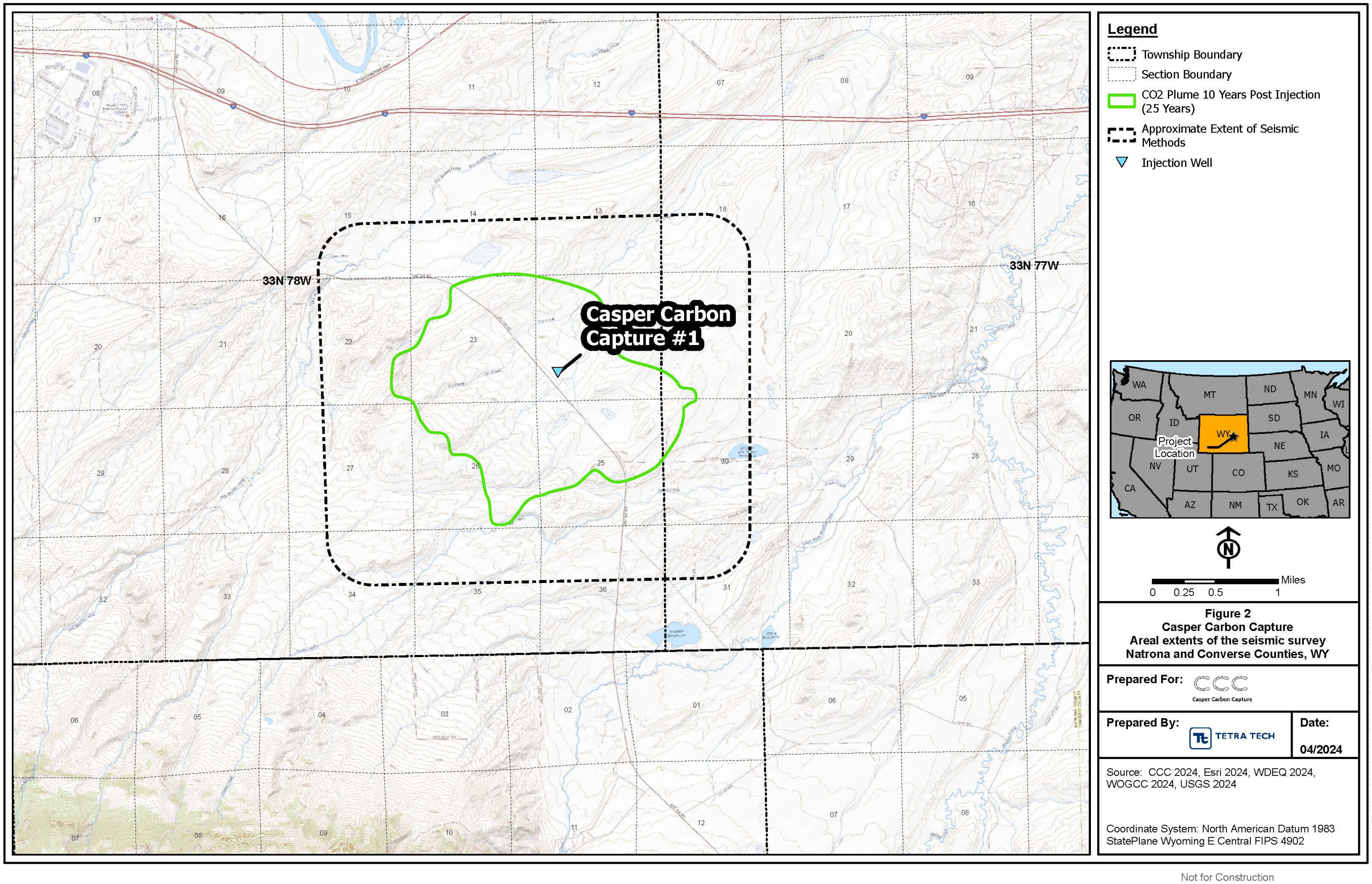


Figure 2: Areal extent of monitoring surveys proposed during the PISC timeframe.

3.0 PRE- AND POST-INJECTION PRESSURE DIFFERENTIAL

The proposed injection target is into Sundance Formation, utilizing the Redwater Shale and Morrison Formation as the upper confining zone. The nearest underground sources of drinking water (USDWs) are the Casper Aquifer (approximately 1,000 feet below) and the Lakota Formation (approximately 300 feet above). The deepest groundwater well within a 3-mile radius of Casper Carbon Capture #1 is 1,000 feet deep, or approximately 4,695 feet above the depth of the shallowest upper confining zone at the injection site. Characterization of the confining zones and potential conduits for fluid movement can be found in the Site Characterization (Form A-1), and USDWs are included in the AoR Delineation and Corrective Action Plan (Form A-2). Monitoring efforts to these USDWs are discussed in the Testing and Monitoring Plan (Form A-5).

Figure 3 shows the predicted pressure increase (simulated pore pressure of the grid cell that contains the screen top) in the storage reservoir following the injection period. The pressure increase required to lift formation brine into the overlying USDW, or critical pressure, was estimated for the project to be 21 psi. The timeframe for reservoir pressure to decline below the critical pressure is approximately 13 years. In other words, after 13 years of the post-injection period, the reservoir pressure will have decreased below a value that would displace fluids into and endanger a USDW. The maximum reservoir pressure increase is approximately 630 psi, which modeling simulations suggest is insufficient to move storage formation fluids through the low-permeability upper confining interval and into the above USDWs. The PISC plan will be updated on the same schedule as AoR delineation.

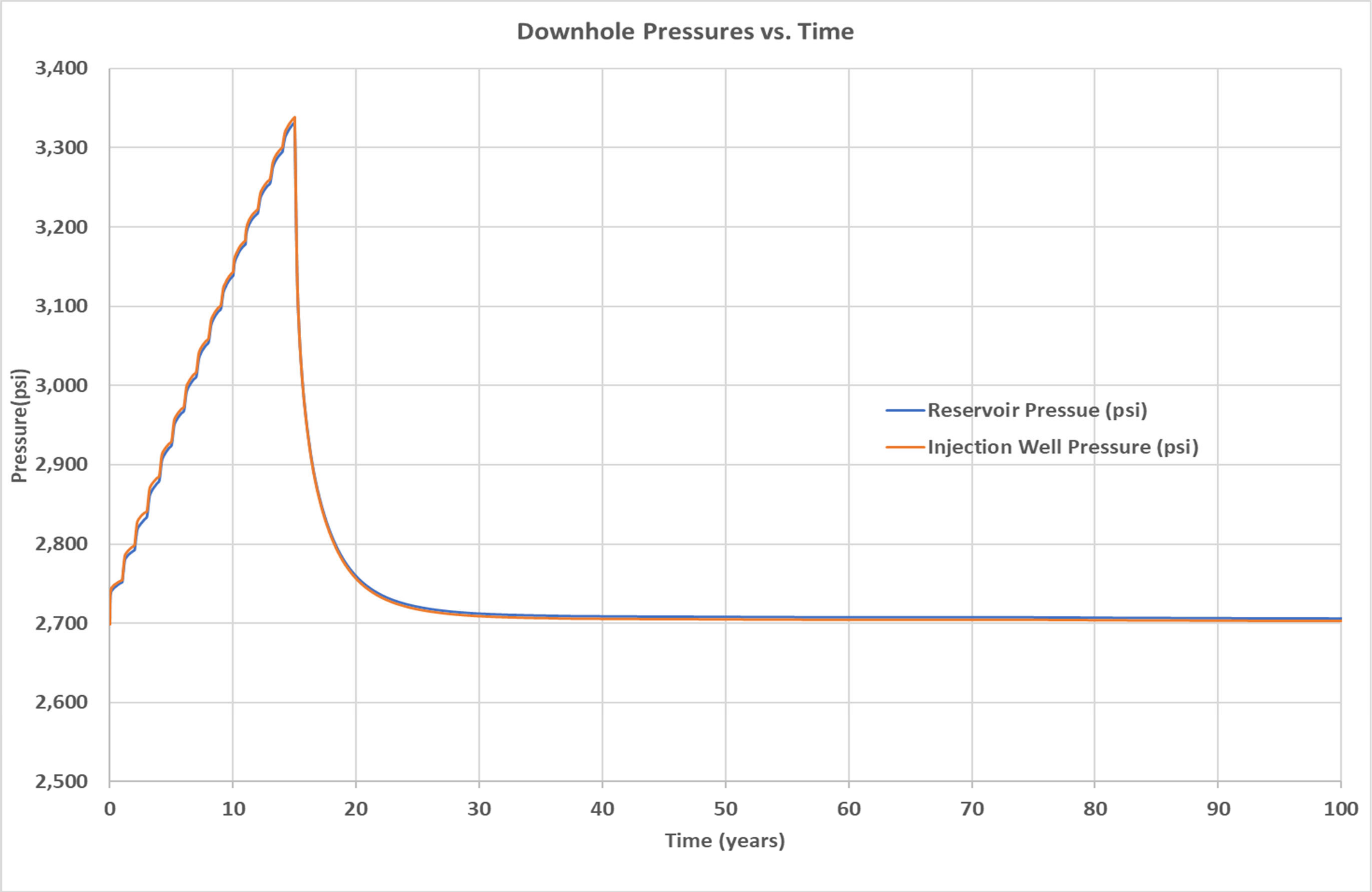


Figure 3: Predicted pressure increase in storage reservoir during and after the injection period.

4.0 PREDICTED EXTENT OF CO_2 PLUME AND ASSOCIATED PRESSURE FRONT AT SITE CLOSURE

Even after injection stops, CO_2 can continue moving in the pore space due to buoyancy and other motive forces until these motive forces dissipate or it encounters a low permeability barrier or capillary entry forces are greater than the forces driving the CO_2 to move.

During the post-injection phase for the Casper Carbon Storage Hub, the movement of the free phase CO_2 plume continues after the cessation of injection, but movement slows down significantly after year 10 and is expected to stabilize.

Figure 4 and Figure 5 show the predicted pressure plume following the cessation of injection. The maximum pressure differential (approximately 650 psi) of the project occurs at the injection site and at the end of the injection period. The extent of the pressure plume decreases significantly within the first 10 years after the cessation of injection, and by post-injection year 13 is less than half the extent it was upon final injection. As pressure increase trends back to 0 between years 13 and 14, no additional figures showing pressure increase beyond year 13 are necessary. The AoR delineation is based on this maximum pressure plume extent, as explained in Form A-2.

Similarly, the free-phase CO_2 plume is expected to stabilize, and movement is expected to cease around 10 years after the post-injection period. Between the 10-year and 25-year post injection marks, the free-phase CO_2 plume area only increases by 3.2%, or an average of 0.32% per year. Over the required 3 years to demonstrate plume stabilization, CCC expects that this rate of movement is estimated to be less than 1% and considered stabilized.

Figure 6 shows the simulated CO_2 mass partitioning in the storage reservoir. A description of the site-specific processes that will result in CO_2 trapping including immobilization by capillary trapping, dissolution, and mineralization is provided in form A-2.

Table 1: Plume Area Over Time During PISC

Time from First Injection	15 Years	25 Years	35 Years	50 Years
Area	1,668 Acres	1,848 Acres	1,907 Acres	1,947 Acres
% Change	-	10.78%	3.22%	2.08%

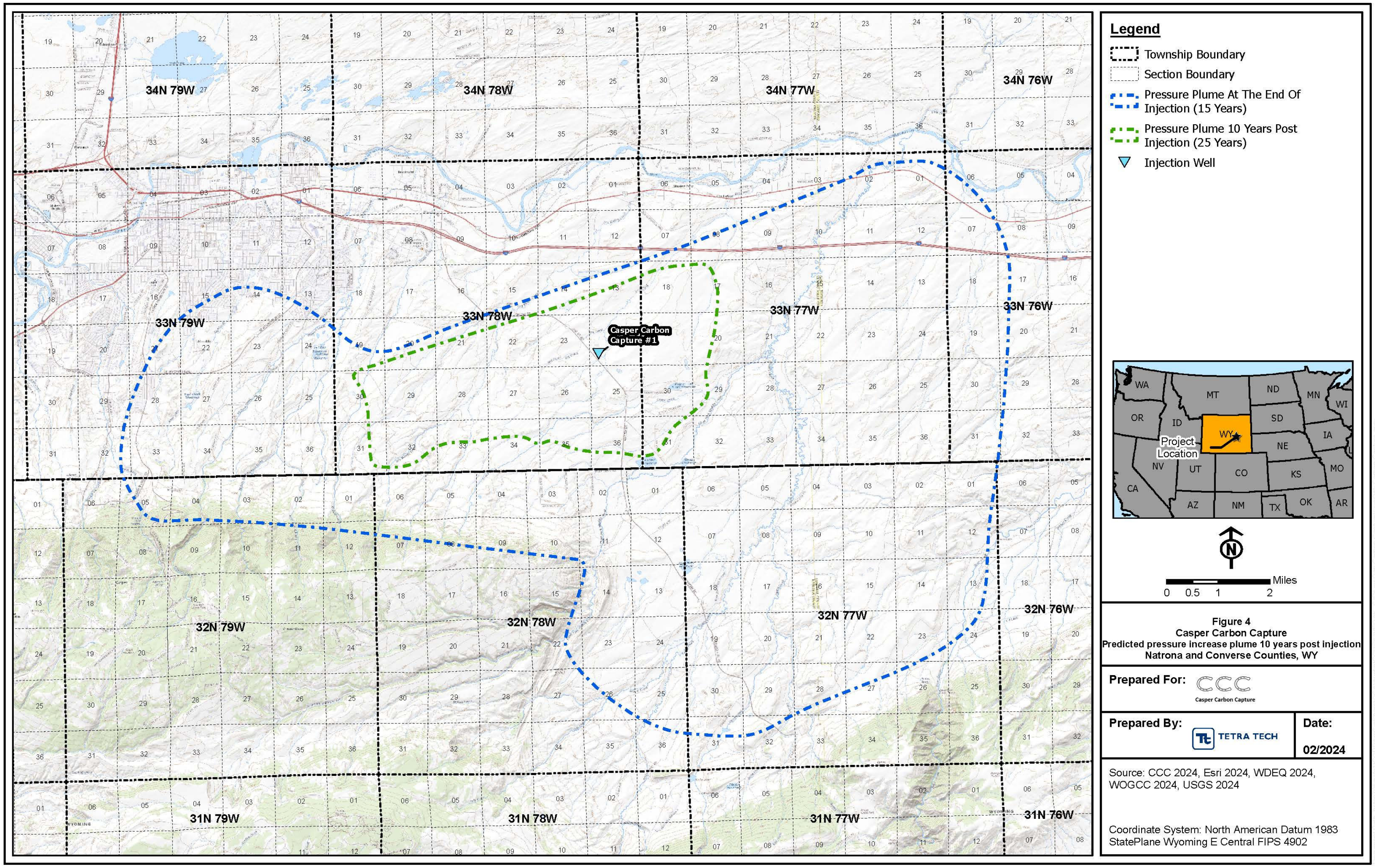


Figure 4: Predicted change in the extent of critical pressure in the storage reservoir after 10 years following cessation of CO_2 injection.

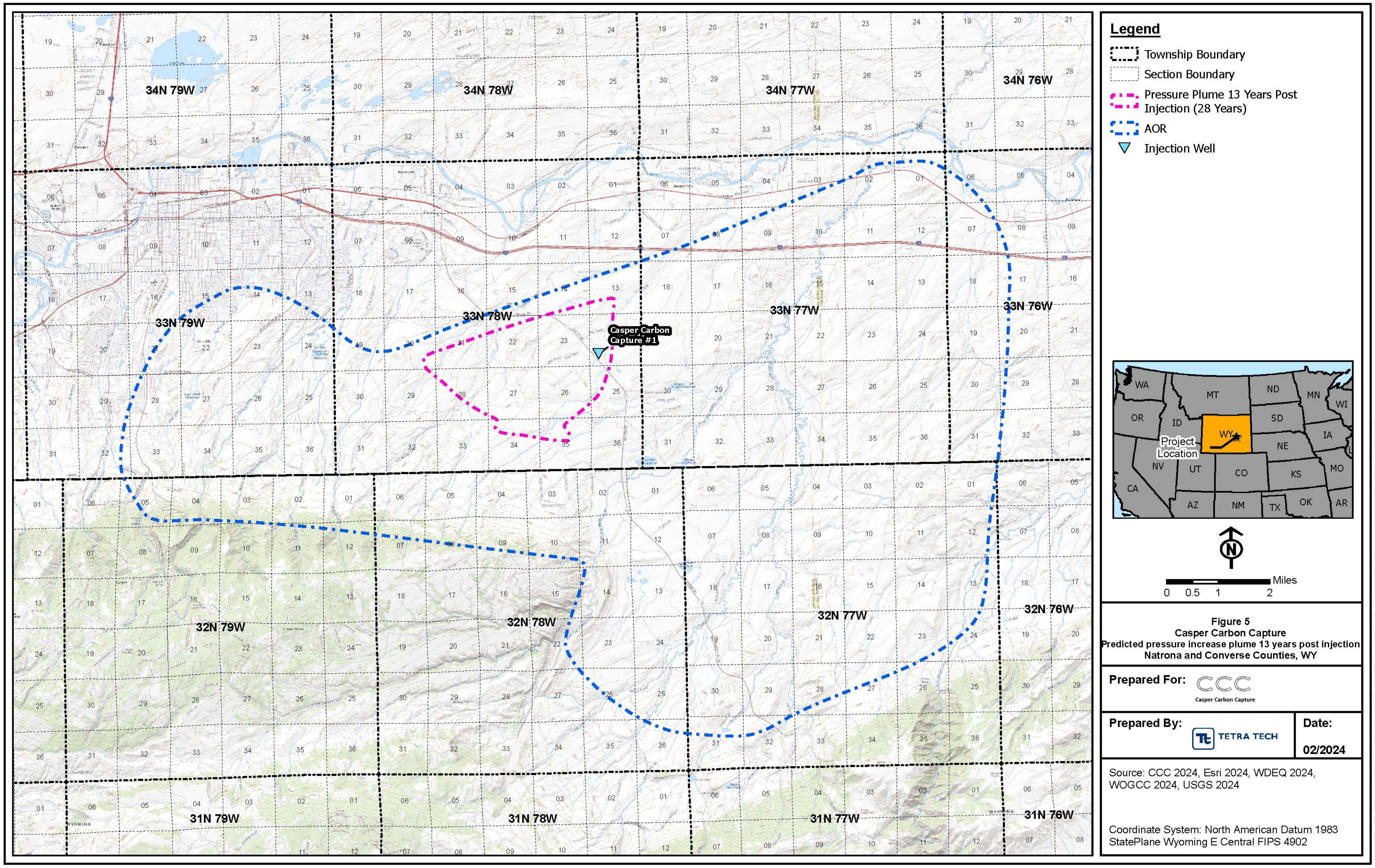


Figure 5: Predicted change in the pressure plume in the storage reservoir 13 after years following the cessation of CO_2 injection.

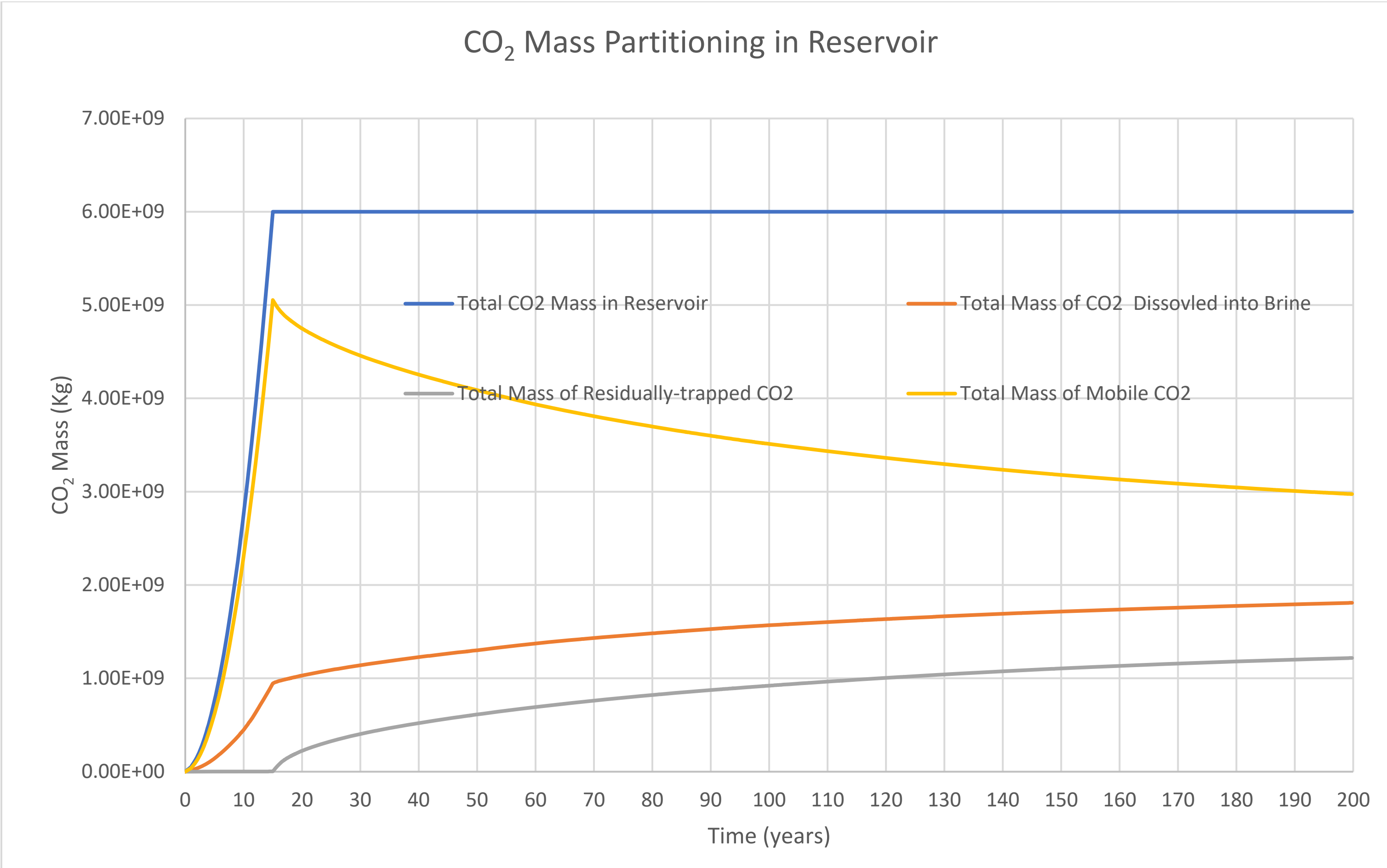


Figure 6: Simulated total injected, dissolved in brine, supercritical phase, and residually trapped CO_2.

5.0 POST-INJECTION MONITORING PLAN

A brief description and duration of the current post-injection monitoring plan for each method and the frequency of data sampling are shown in Table 2. Sampling and recording frequencies for continuous monitoring are provided in Table 3.

Table 2: Summary of Post-injection Site Care-Monitoring Program

Type of Monitoring	Frequency	Spatial Coverage	Comments
Near Surface Monitoring			
Shallow Groundwater Well	**Duration:** 10 years after injection or until plume stabilization. **Frequency:** Every 5 Years	See Figure 1	Sampling of shallow groundwater monitoring well
Soil VMPs	**Duration:** 10 years after injection or until plume stabilization. **Frequency:** Every 5 Years	See Figure 1	Sampling of soil VMPs
Storage Reservoir Monitoring			
Casper Carbon Capture #1	**Duration:** 10 years after injection or until plume stabilization. **Frequency:** Every 5 Years	Injection Zone	Sampling of Storage Complex Monitoring Wells
Downhole Monitoring (Casper Carbon Capture #1)			
Downhole Pressure and Temperature Gauges	**Duration:** 10 years after injection our until plume stabilization. **Frequency:** Continuous	Injection Zone	
Geophysical Monitoring			
Indirect Reservoir Monitoring	Upon final injection, indirect monitoring data will be acquired using seismic methods. Additional seismic methods will be utilized to evaluate CO_2 plume expansion post-injection. A final indirect plume monitoring will be performed using seismic methods to demonstrate CO_2 plume stabilization.	See Figure 2	Indirect monitoring data will be acquired using seismic methods.

A QASP for all testing and monitoring activities during the injection and post-injection phases is provided as Form A-9.

Continuous monitoring sampling and recording frequencies are listed in Table 3.

Table 3: Sampling and Recording Frequencies for Continuous Monitoring				
Parameter	**Device(s)**	**Location**	**Min. Sampling Frequency**	**Min. Recording Frequency**
Flow Rate	Flowmeter	Wellhead	TBD	TBD
Injection Volume	Calculated	Wellhead	TBD	TBD
Injection Pressure	Pressure Gauge	Wellhead	TBD	TBD
Injection Temperature	Temperature Gauge	Wellhead	TBD	TBD
Packer Fluid Volume	Flowmeter	Surface	TBD	TBD
Downhole P/T	P/T gauge	Casper Carbon Capture #1	TBD	TBD

5.1 GROUNDWATER AND SOIL GAS MONITORING

Two monitoring wells and two soil VMPs will be installed, as shown Figure 1. Sampling procedures are described in the QASP. Analytical parameters for groundwater samples are shown in Table 4. The duration of the post-injection monitoring period and the frequency of data sampling are shown in Table 2.

CCC plans to monitor subsurface pressure and geochemical changes using the stratigraphic test well as a converted monitoring well. The Lakota formation has been established as a permeable formation for monitoring above the confining zone. As such, the Falls Ranch #1 will monitor both the Lakota formation and the Tensleep formation, a deep aquifer (Casper) below the injection zone, to ensure that a CO_2 leakage pathway does not exist through the upper confining zone or between the Sundance and the Tensleep formations. As this well will be completed into multiple zones, it will monitor the above confining zone (ACZ) pressure via annular pressure monitoring and pressure and geochemistry of the Casper Aquifer. An initial fluid sample will be collected from the injection zone to obtain baseline fluid chemistry from the injection formation. Parameters to be tested are shown in Table 5. Details of the proposed plugging and abandonment of the deep monitoring well, the Falls Ranch #1, can be found in Form B – Permit to Construct.

Near-surface environments will be monitored for potential out-of-zone migration of CO_2. One VMP will be installed in the vicinity of Monitoring Well (MW) #s 1 and 2, targeting the vadose zone above the Casper Carbon Storage Hub. The Falls Ranch #1 penetrates the injection zone outside of the modeled CO_2 plume, while MW #2 is in the vicinity of Casper Carbon Capture #1.

Table 4: Summary of Analytical and Field Parameters for Ground Water Samples

Parameters	Analytical Methods
Mesaverde Formation	
pH	Field water quality meter
Conductivity	Field water quality meter
Temperature	Field water quality meter

Table 5: Summary of Analytical and Field Parameters for Fluid Sampling in the Injection Zone – NA, to be completed when site specific fluid samples are taken

Parameters	Analytical Methods
Alkalinity, as Bicarbonate (HCO_3^-)	NA
Alkalinity, as Carbonate (CO_3^{2-})	NA
Alkalinity, as Hydroxide (OH^-)	NA
Boron	NA
Barium	NA
Bromide	NA

Table 5: Summary of Analytical and Field Parameters for Fluid Sampling in the Injection Zone – NA, to be completed when site specific fluid samples are taken	
Parameters	**Analytical Methods**
Dissolved Inorganic Carbon (DIC)	NA
Dissolved Organic Carbon (DOC)	NA
Calcium	NA
Chloride	NA
Iron	NA
Potassium	NA
Lithium	NA
Magnesium	NA
Sodium	NA
Lead	NA
Sulfate	NA
Strontium	NA
Zinc	NA
TDS	NA
pH	NA
Conductivity	NA
Temperature	NA

Note: Analytical Methods to be determined prior to sample collection

5.2 MONITORING OF CO_2 PLUME AND PRESSURE FRONT

CCC will implement direct and indirect methods to monitor the location, thickness, and distribution of the free-phase CO_2 plume and associated pressure relative to the permitted storage reservoir during the post-operational period.

For the post-injection monitoring period, Casper Carbon Capture #1 may be converted into a monitoring well. Casper Carbon Capture #1 will be equipped with P/T gauges to internally monitor BHP and BHT.

Indirect monitoring methods will also track the extent of CO_2 plume within the storage reservoir and can be accomplished by performing one or more seismic methods.

To demonstrate conformance between the reservoir model simulation and site performance, seismic methods will be utilized encompassing the entirety of the free phase CO_2 plume, plus some buffer. This indirect monitoring data will be collected at the end of injection, at least one time during the PISC period, and at the end of the expected PISC period. Anticipated areal coverage of the seismic methods are shown in Figure 2, although the survey area may be reduced/expanded to more accurately track CO_2 plume extent. To complement the current monitoring approach and as improved monitoring technologies emerge (e.g., borehole seismic, gravity, EM, InSAR, etc.), the monitoring plan will be reevaluated at least every 5 years to determine if modifications to the plan would improve the ability to characterize the migrating CO_2 plume are commercially available and are proven methods.

The predicted extent of the CO_2 plume at site closure is shown in Figure 7. The predicted pressure plume at closure is not shown in this figure, as the pressure is anticipated to have stabilized below critical pressure. Table 6 demonstrates post-injection plume monitoring. Monitoring wells will be plugged, and restoration activities will be performed upon authorization of site closure.

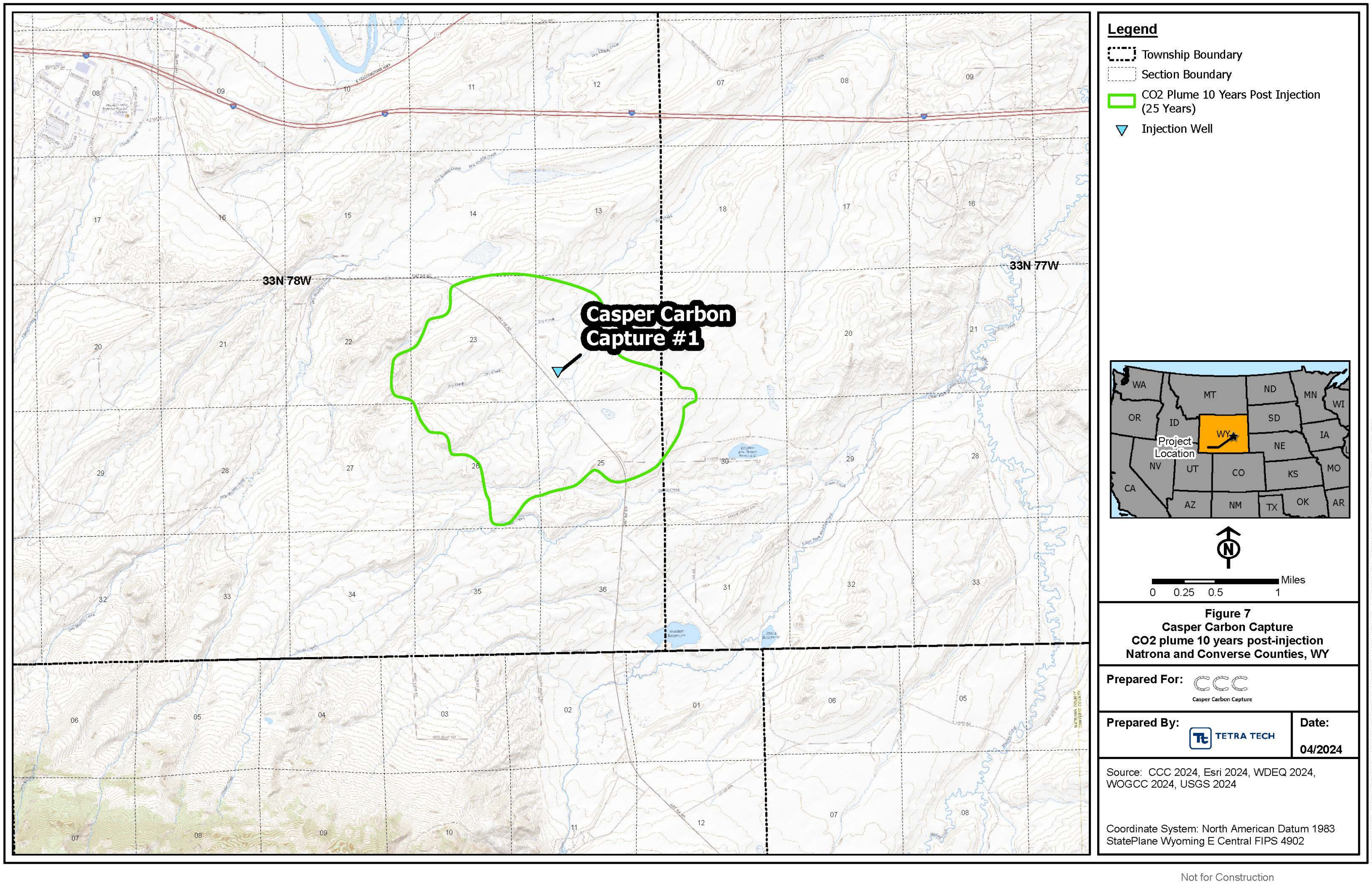


Figure 7: Predicted extent of CO_2 plume at site closure.

Table 6: Post-injection Phase Plume Monitoring				
Target Formation	**Monitoring Activity**	**Monitoring Location(s)**	**Spatial Coverage**	**Frequency**
Direct Plume Monitoring				
Sundance Formation	Downhole P/T Gauges	Casper Carbon Capture #1	Injection Zone	Continuous
Indirect Plume Monitoring				
Storage Complex	Seismic Methods	Casper Carbon Storage Hub	See Figure 2	Upon final injection, post-injection, and to confirm plume stabilization.

5.3 SCHEDULE FOR SUBMITTING POST-INJECTION MONITORING RESULTS

Per WDEQ Chapter 24, Section 22, all post-injection site care monitoring data and monitoring results collected using the methods described above will be submitted to the WDEQ in reports submitted on an annual basis. CCC may propose for an alternative shorter PISC timeframe if at any point of the project CCC can demonstrate, based on monitoring and other site-specific data, that the project does not pose an endangerment to any USDWs.

A site closure report will be submitted to the WDEQ within 90 days of site closure. The site closure report will include the following information:

- Documentation of injection and monitoring well-plugging.
- A copy of a survey plat indicating injection well and monitoring well locations that has been submitted to both the local zoning authority designated by the WDEQ Director and to the USEPA Regional Administrator.
- Documentation of appropriate notification and information to the State, local and tribal authorities that have authority over drilling activities to enable them to impose appropriate conditions on subsequent drilling activities that may penetrate the injection and confining zones.

- Proof that CCC has published notice of the application for site closure, including a mechanism to request a public hearing, in a newspaper of general circulation in each county of the proposed operation at weekly intervals for four (4) consecutive weeks; and that CCC has mailed notice of the application for site closure to all surface owners, mineral claimants, mineral owners, lessees, and other owners of record of subsurface interests that are located within one (1) mile of the proposed boundary of the geologic sequestration site.
- Records of the nature, composition, and volume of the CO_2 stream.

In association with site closure, a record of notation on the Casper Carbon Storage Hub property deed will be added to provide any potential purchaser of the property with the following information:

- The fact that land has been used to sequester CO_2.
- The name of the State agency, local authority, or Tribe with which the survey plat was filed, as well as the address of the Environmental Protection Agency (EPA) regional office to which it was submitted.

The volume of fluid injected, the injection zone or zones into which it was injected, and the period over which injection occurred.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Formation Fluid Sampling Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
Bbls	Barrels
C	Celsius
e.g.	Exempli gratia (for example)
KB	Kelly Bushing
KCl	Potassium Chloride
Ft	Feet
pH	Potential of Hydrogen
TD	Total Depth

1.0 PROPOSED FORMATION FLUID TESTING PROGRAM

Available water samples of expected USDWs are available in Form A-8 – USDW Analysis Plan. After running casing to total depth (TD) and cementing to surface, general procedures for Sundance swabbing and sampling are as follows.

1. Circulate well to displace drilling mud with clean fluid (2% KCl or other)
2. Perforate Sundance Formation from XXXX-XXXX ft KB, sampling depths to be determined based on site-specific data and WDEQ approval.
3. TIH with the work string, seating nipple, packer and one tail joint.
4. Set the packer within 100' of the top of the proposed injection zone.
5. Pressure test annulus to ensure isolation above and below the packer
6. Rig-up sand line and swab cups to swab well.
7. Swab XX bbls to evacuate tubing volume and casing volume below packer, evacuation volume to be determined based on actual Sundance depth and TD of the well.
8. Continue swabbing while monitoring and documenting volume and field parameters (pH, conductivity, temperature) on each swab run using calibrated meter.
9. Once sufficient volume (e.g., 3 casing volumes min.) has been produced from the well and field parameters have stabilized, collect samples from same swab run (1 full set and at least 1 duplicate set) per specific laboratory procedures for required analyte list. General guidelines for stabilized parameters: pH +/- 0.2 units, temp within 1 deg C, conductivity +/-10%.
10. Use clean buckets, equipment & nitrile gloves for transferring fluid into bottle sets.
11. Pack labeled bottles into cooler with ice, complete chain of custody paperwork and deliver to the lab within designated hold time per lab specs for required analyte list.

Table 1: Formation Water Chemistry from Injection Formation

Formation Water Chemistry from Injection Formation	
Parameter	**Results, mg/L**
Alkalinity, as Bicarbonate (HCO_3^-)	
Alkalinity, as Carbonate (CO_3^{2-})	
Alkalinity, as Hydroxide (OH^-)	
Boron	
Barium	
Bromide	
Dissolved Inorganic Carbon (DIC)	
Dissolved Organic Carbon (DOC)	
Calcium	
Chloride	
Iron	
Potassium	
Lithium	
Magnesium	
Sodium	
Lead	
Sulfate	
Strontium	
Zinc	
TDS	

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Underground Source of Drinking Water Analysis Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
E	East
Fm	Formation
ft	Feet
Gp	Group
gpd	Gallons per Day
gpm	Gallons per Minute
KB	Kelly Bushing
Ls	Limestone
m	Meters
mg/L	Milligrams per Liter
mi	Miles
N	North
NE	Northeast
NW	Northwest
pCi/L	Picocuries per Liter
R	Range
S	South
SE	Southeast
Sec.	Section
Sh	Shale
Ss	Sandstone
SW	Southwest
T	Township
TDS	Total Dissolved Solids
Ug/L	Microgram per Liter
USDW	Underground Source of Drinking Water
W	West

1.0 REGIONAL GEOLOGIC OVERVIEW OF USDWS

Major aquitards (confining zones) and major, marginal, and minor aquifers are defined in the Wyoming Statewide Framework Water Plan (http://waterplan.state.wy.us/basins/7basins.html). Zones of interest that are present or potentially present in the project area are listed below (adapted from Taboga K. G., 2013) and noted, where penetrated, on Figure 2 and Figure 3:

Major Aquifers Above the Primary Upper Confining Zone

Quaternary alluvium
Fox Hills Formation
Clovery (including Dakota and Lakota Formations)

Major Aquifers Below the Primary Lower Confining Zone

Tensleep Sandstone
Madison Limestone
"Casper" aquifer or formation, generally including Tensleep and sometimes overlying/underlying rocks

Marginal Aquifer (Injection Zone)

Sundance Formation

Minor Aquifers Above the Primary Upper Confining Zone

Quaternary non-alluvial deposits
Mesaverde Formation
Frontier Formation

Minor Aquifers Below the Primary Lower Confining Zone

Flathead Sandstone (if present)

Major Aquitards Above the Primary Upper Confining Zone

Lewis Shale
Cody Shale
Mowry Shale
Skull Creek (Thermopolis Shale)

Major Aquitards Below the Primary Lower Confining Zone

Chugwater Group

Goose Egg Formation
Precambrian Basement

Figure 1 shows the locations of the cross-sections shown in Figure 2 and Figure 3. Figure 4 is an areal map showing the surface extents of underground sources of drinking water (USDWs) in the region.

The primary USDWs in the project area are the Mesaverde Formation, Cody Shale, and Quaternary alluvium (assumed to typically be in hydraulic communication with the underlying Mesaverde and Cody). The Mesaverde aquifer and Cody confining unit outcrop throughout much of the study area; however, stratigraphically lower units outcrop near the southern Area of Review (AoR) boundary. Additionally, the Lakota Formation, immediately overlying the upper confining zone produces from three known wells in the project vicinity for domestic, livestock, irrigation, and/or miscellaneous use. The Lakota is not a public water supply in the area. The Casper Aquifer, immediately underlying the lower confining zone, and the Madison Limestone, immediately underlying the Casper Aquifer, produce groundwater from two known wells in the project vicinity for livestock, irrigation, and/or miscellaneous use. The Madison was also produced for industrial use from a well in the nearby Brooks Ranch Oil Field, but the zone was later abandoned during a well recompletion. The Madison is a public water supply for the city of Douglas ~36 miles to the east of Casper Carbon Capture #1. Additional information about USDWs is provided in Form A-2 Section 1.8 Geology of USDWs.

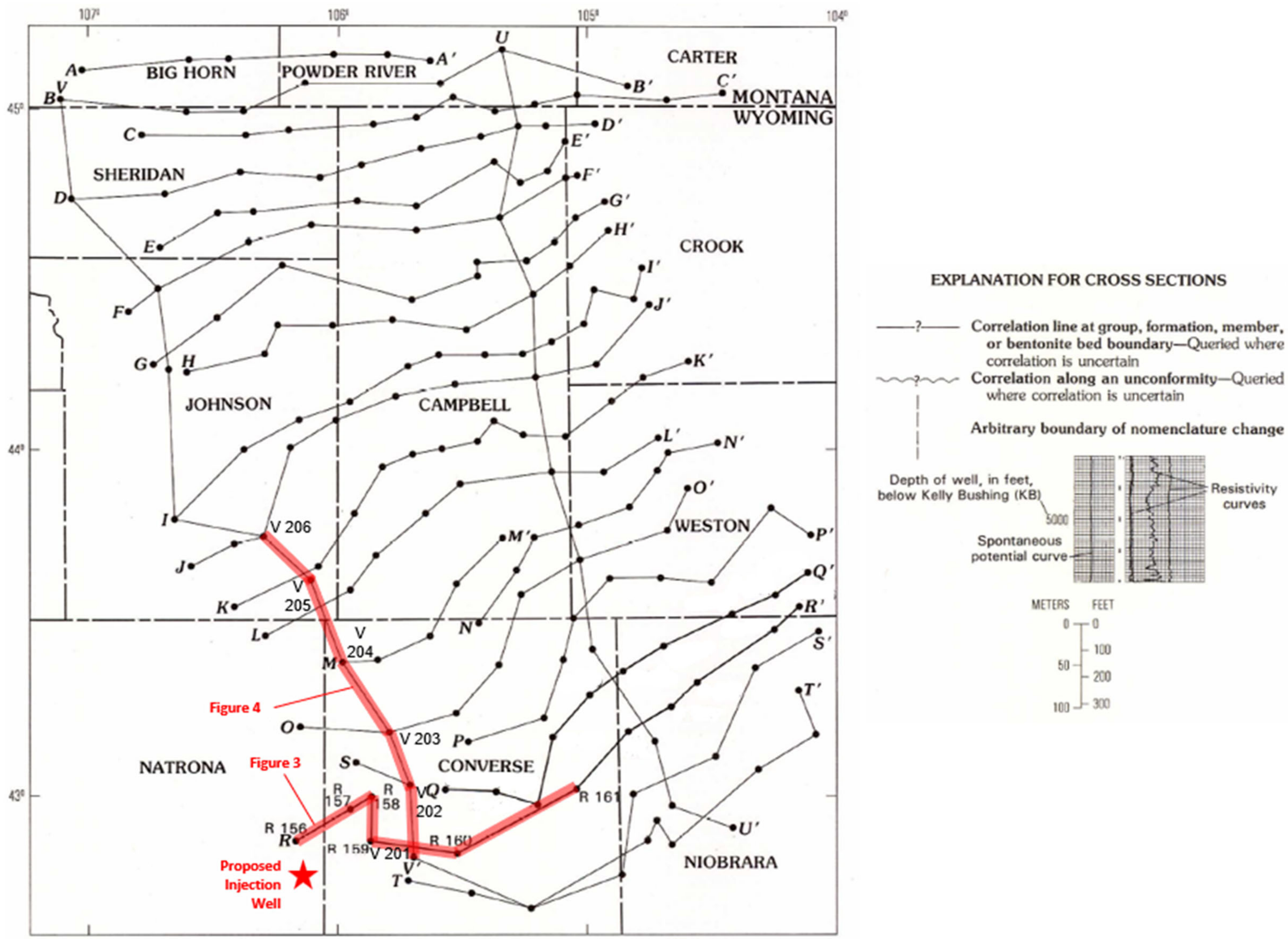


Figure 1: Regional cross-section map (after Fox, 1993).

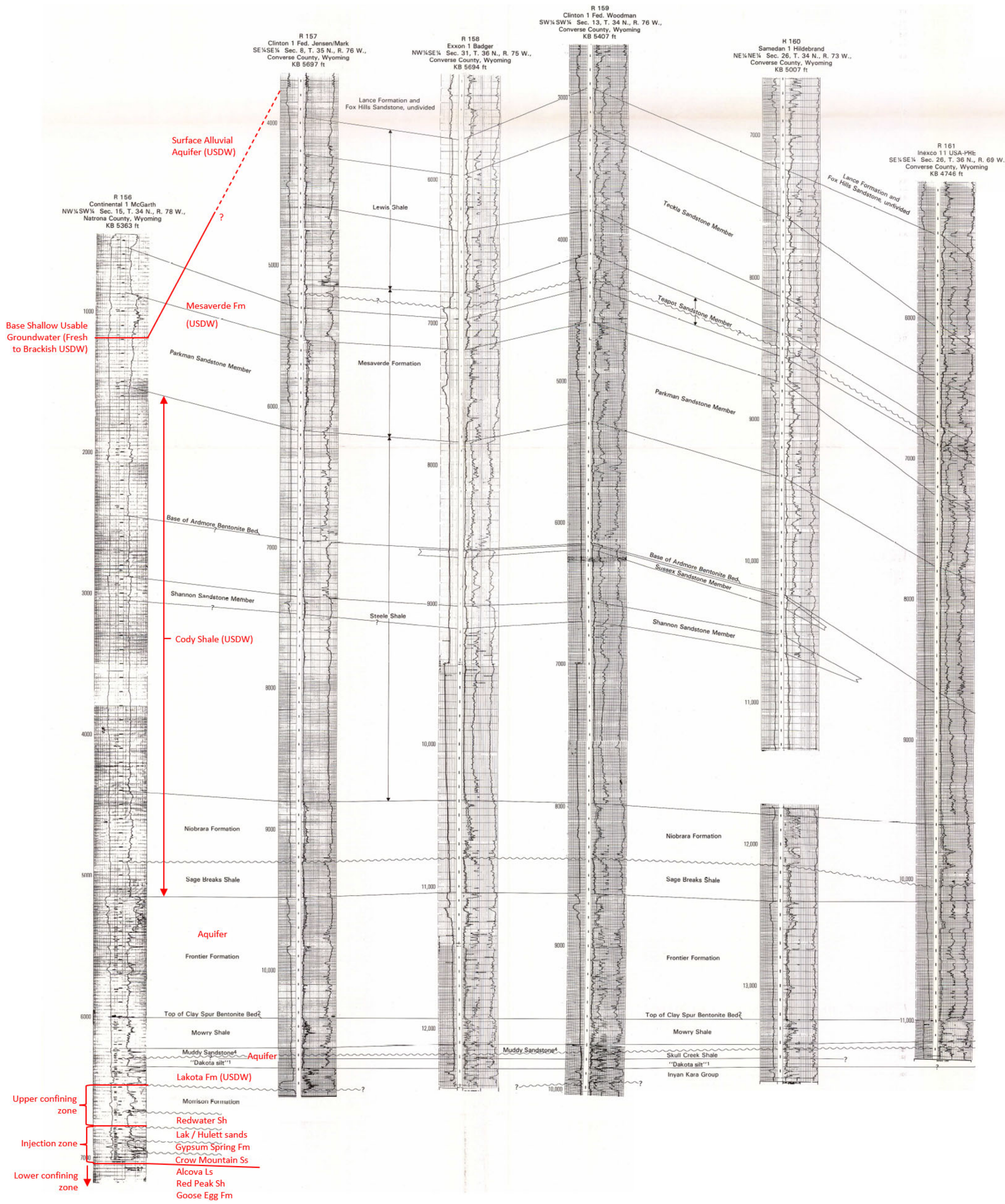


Figure 2: Regional cross-section (dip-oriented) of the Powder River Basin near the Project Area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

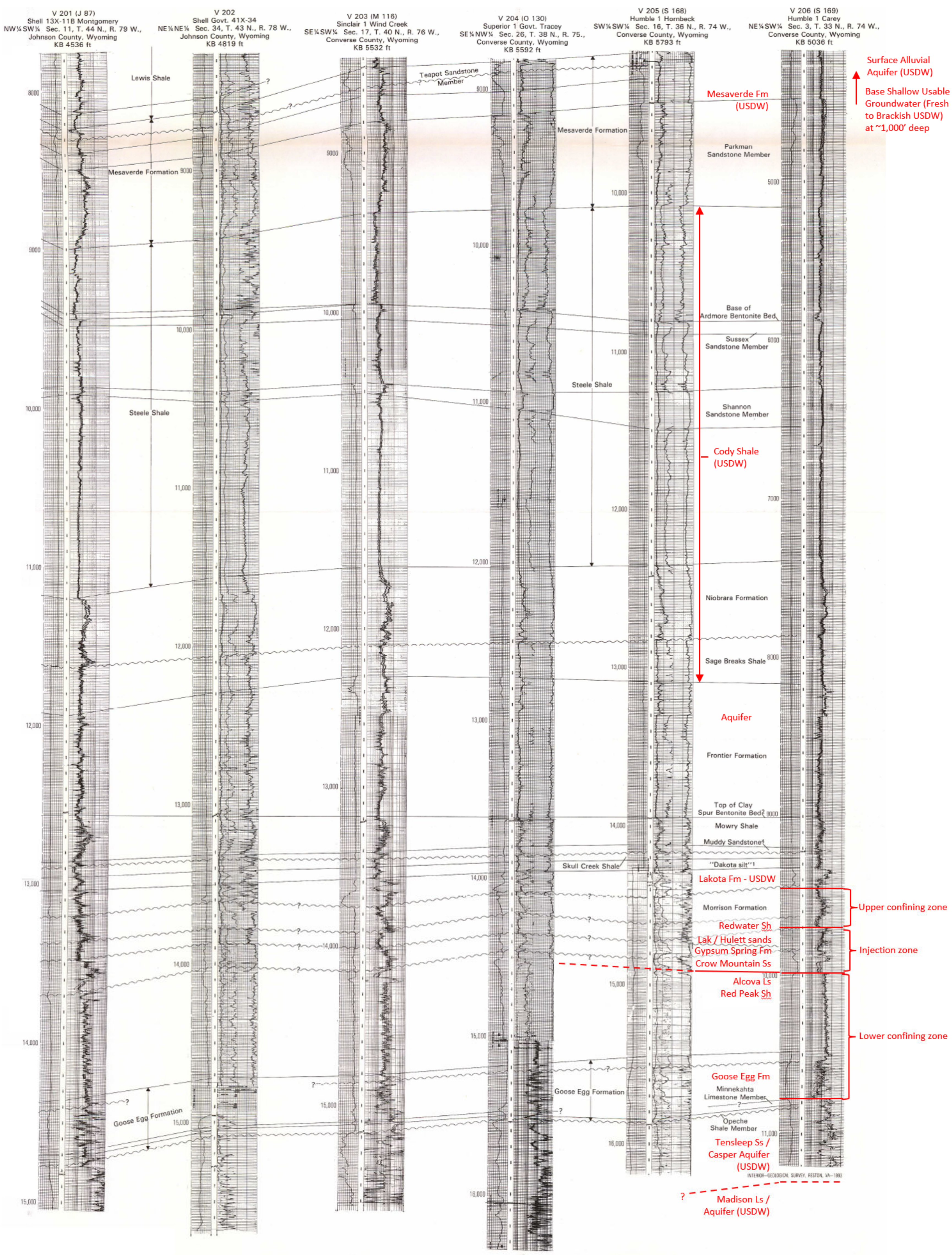


Figure 3: Regional cross-section (strike-oriented) of the Powder River Basin near the project area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

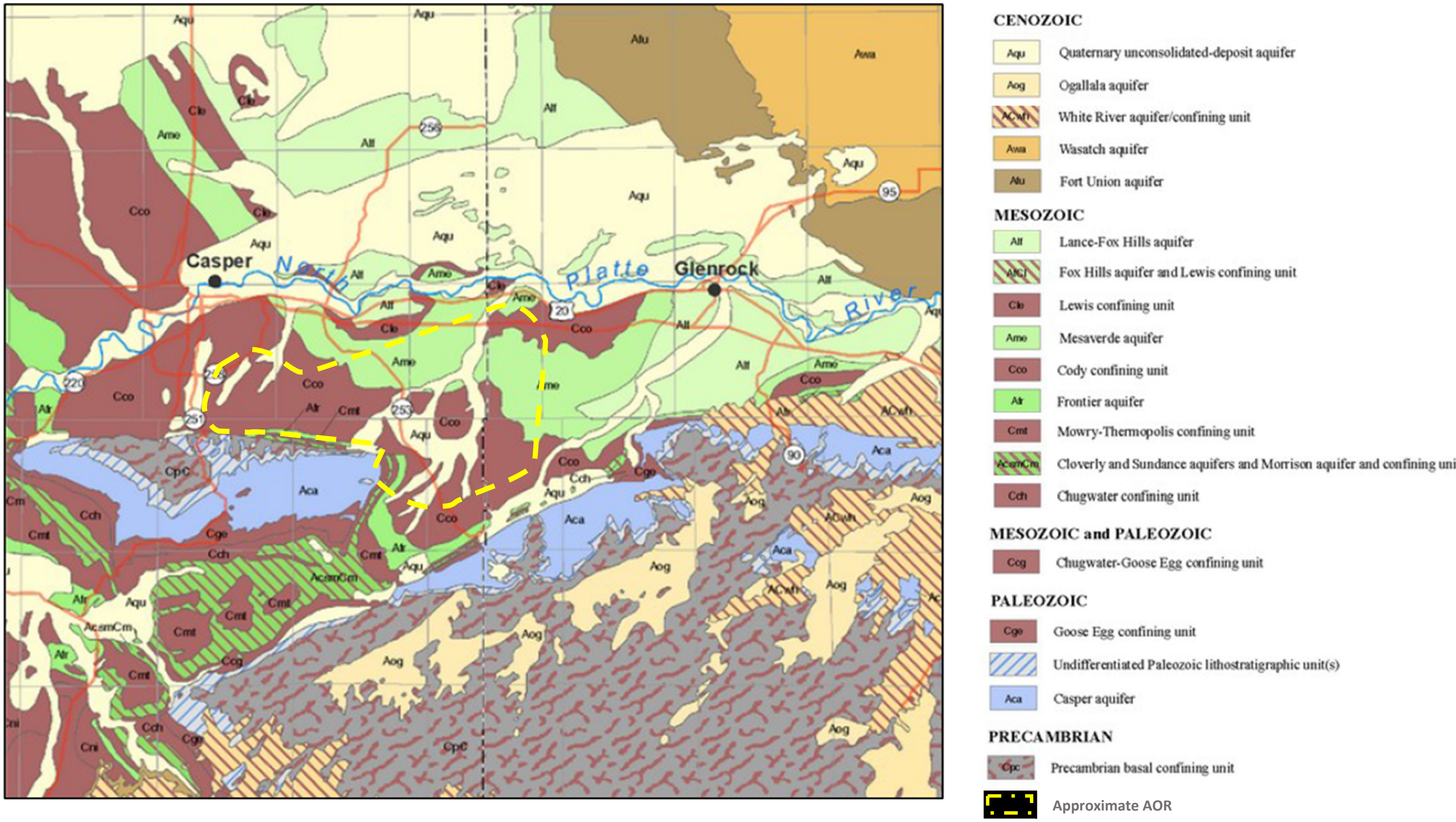


Figure 4: Areal map of USDWs (modified from Taboga et al., 2013).

2.0 GEOLOGY OF USDW AND AQUIFERS WITHIN THE PROJECT AREA

In the Powder River Basin (PRB), the regional groundwater flow is largely controlled by the terrain and geologic features. At higher elevations on the uplifted basin margins, aquifers are recharged by precipitation and usually reflect an influence of topography (Taboga, 2013). These aquifers are commonly unconfined and discharge at springs where the water table is higher than ground level. As groundwater flows downdip from the recharge areas, it becomes confined by overlying low-permeability rocks. Joints, fractures, or faults through a confining unit may permit flow from an underlying aquifer to reach the surface driven by the piezometric head present in an area. Groundwater flow within the deeper formations of the basin occurs mainly through permeable formations down-gradient (from higher to lower hydraulic pressure) and generally down-dip.

A variety of groundwater systems around the Casper area results in part from the structural configuration of the PRB margin, which allows older hydrogeologic units to recharge at surface outcrops before becoming confined toward the basin. Further compartmentalization of aquifers occurs along faults that sever the hydrogeologic units, as has been observed in the Madison aquifer on Casper Mountain, where five distinct groundwater compartments are documented (Stacy & Huntoon, 1994).

In the project area, groundwater flow generally occurs in two prevailing directions separated by the Casper Mountain Fault, which acts as an east-west barrier to flow. North of the fault, groundwater flow is generally to the north-northeast, in the direction of the structural dip; this trend moves groundwater away from Casper Mountain. On the south side of the Casper Mountain Fault, groundwater flow is to the south. On the eastern side of Casper Mountain, smaller-scale northeast-trending smaller faults and folds direct groundwater flow to the northeast, again away from the mountain front.

At Casper Mountain, recharge to the aquifers occurs by percolation of precipitation on the outcrop areas, by vertical leakage from overlying aquifers, and by vertical movement through faults and fractures. Fracturing has occurred primarily where rocks have been structurally deformed, e.g., on Casper Mountain (which is the uplifted hanging wall block of a reverse fault system), and within the highly dipping strata of the footwall block. These structurally deformed areas are all located to the south of the Casper Carbon Capture #1 site. Discharge occurs at springs where the level of the water table is higher than the ground surface. The nearest springs are 3.8 miles to the south-southeast of Casper Carbon Capture #1 (Wyoming Groundwater

Atlas), located updip of the injection wells along the northeastern margin of the Casper Mountain outcrop.

Most of the moveable groundwater is believed to be contained in faulted and fractured zones (Wright Water Engineers, 1982). Previous studies of potential future groundwater production sites have focused on fracture-enhanced areas on the southern margin of Casper Mountain. The historical geologic targets for groundwater development are the Casper Aquifer, the Madison Limestone, and Cambrian-Mississippian sandstone, which are isolated from the injection zone by low-permeability rocks of the Goose Egg and Red Peak (Chugwater) shales.

Water production from groundwater wells around the project area primarily originates from alluvial aquifers or the shallow bedrock Mesaverde aquifer, some 5,000 feet or more above the injection zone and protected from upward migration of CO_2 by a primary confining zone (Redwater Shale and Morrison Formation) and multiple secondary confining zones (especially the Skull Creek Shale, Mowry Shale, and Cody Shale). Notably, all drinking water wells inside and within 1 mile of the anticipated AoR are shallow, not exceeding 1,000 ft in depth.

The deepest water well within a 3-mile radius of the Casper Carbon Capture #1 is 1,000 feet, or approximately 4,695 feet above top of the Morrison Formation confining zone at the project location. Slightly saline to moderately saline waters (1,000-10,000 mg/L TDS) are estimated to be producible to depths of about 1,200 feet at the project location, in the Cody Shale. To confirm this base of the shallow USDW, well logs were reviewed to determine the depth to clean sand with deep resistivity greater than 2.0 ohm-m. There are also six springs located in the AoR.

Certain deeper aquifers at the project site are not used for public water supply but are considered USDWs owing to low total dissolved solids (TDS) project. These include the Lakota Formation (immediately overlying the upper confining zone), the Casper Aquifer (Tensleep and Amsden Formations, immediately underlying the lower confining zone), and the Madison Limestone, immediately underlying the Casper Aquifer. An injection depth waiver application has been prepared seeking approval to inject CO_2 above the Casper Aquifer.

Figure 5Error! Reference source not found. shows hydrostratigraphy and USDWs in the AoR, Quaternary alluvial aquifers make up the shallowest USDW where present in the AoR. Below the Quaternary alluvium, the Mesaverde aquifer provides water for the majority of shallow water wells within the AoR. The Lakota formation is the deepest USDW that lies above the upper confining zone and proposed monitoring is discussed in Form A-5 - Testing and

Monitoring Plan. The Casper Aquifer lies beneath the lower confining zone. The Madison Aquifer underlies the Casper Aquifer and is the deepest USDW within the AoR.

Major Aquifers Above Confining Zone

The Quaternary alluvium, which is characterized by a mix of landslide and alluvial fan deposits, as well as windblown quartz sand, hosts aquifers with yields potentially over 1,000 gpm. These yields are influenced by factors like adjacent rivers, impacting transmissivity depending on the sediment's saturated thickness and size, ranging from 15 to 64,000 gpd/ft (Eisen et al., 1981). Water quality varies, with TDS often exceeding 1,000 mg/L, although areas near the North Platte River show lower TDS due to surface water impact.

At the project site, the Fox Hills Formation, a primarily upward-coarsening marine sandstone, is fully eroded but is present as bedrock approximately 1.5 miles to the northwest. Its transmissivities range from 100 to 2,000 gpd/ft, with specific capacities generally spanning 0.05 to 2 gpm/ft (Eisen et al., 1981). Although well yields can reach up to 350 gpm, these are typically associated with extended perforated intervals and significant drawdowns. Water quality varies significantly; outcrop waters contain 350 to 3,500 mg/L of TDS, displaying a variable major ion composition, while central basin waters have 1,000-3,500 mg/L TDS and are characterized by sodium bicarbonate-sulfate (Eisen et al., 1981).

Era	System/ Series		Group	Lithostratigraphy	Project Significance	Hydrostratigraphy
				Quaternary Alluvium	USDW where present in AOR	Aquifer
Mesozoic	Cretaceous	Upper		Lance Fm	UDSW where present in AOR (not present over plume)	Aquifer
				Fox Hills Ss		
				Lewis Sh		Confining layer
				Mesaverde Fm (undivided)	USDW	Aquifer
				Cody Sh (undivided)	• Lowermost widely used USDW • Oil and gas production inside AOR	Confining layer with intraformational aquifers
				Frontier Fm	Oil production inside AOR	Aquifer
				Mowry Sh		Confining layer
		Lower		Muddy Ss	Oil production just outside AOR	Aquifer
				Thermopolis Sh / Skull Creek Sh		Confining layer
			Inyan Kara Gp	Fall River Fm (Dakota)	Lowermost oil and gas production inside AOR	Aquifer
				Fuson Sh		Confining layer
				Lakota Fm	• Lowermost USDW above storage complex • Limited oil production just outside AOR	Aquifer
	Jurassic			Morrison Fm	Upper Confining Zone	Confining layer
		Upper	Sundance Fm	Redwater Sh		
		Lower		Lak Ss	Injection Zone	Aquifer
				Hulett Ss		
				Stockade Beaver/ Canyon Springs		
				Gypsum Spring Fm		
	Triassic		Chugwater Gp	Crow Mountain Ss		
				Alcova Ls	Lower Confining Zone	Confining layer
				Red Peak Fm		
Paleozoic	Permian			Goose Egg Fm		
	Carboniferous	Penn		Tensleep Ss	Uppermost USDW below storage complex (Casper Aquifer)	Aquifer
				Amsden Fm		
		Miss		Madison Ls	Lowermost known USDW below storage complex	Aquifer
	Undivided					
Precambrian	Archean			Igneous and metamorphic basement rocks	Overthrusting and truncation of sedimentary section along mountain front	Confining layer

Figure 5: Site hydrostratigraphy with USDWs (in yellow).

The Lower Cretaceous Inyan Kara Group, encompassing the Lakota, Fuson Shale, and Dakota, has an approximate thickness of 150 ft. The Lakota, primarily a mud-matrix conglomerate in the project area, shows potential as a brackish aquifer with specific capacities ranging from 0.1 to 1 gpm/ft and yields generally under 50 gpm, though its low transmissivity and discontinuous permeability limit its productivity (Eisen et al., 1981). Similar to the Fox Hills Formation, TDS levels vary significantly, with outcrop waters ranging from 277 mg/L to 3,300 mg/L, while deeper basin waters exceed 10,000 mg/L, predominantly consisting of sodium chloride.

Minor Aquifers Above Confining Zone

Minor Quaternary aquifers, characterized by diverse deposits from landslide and alluvial fans to windblown quartz sand, show significant potential with well yields exceeding 1,000 gpm in alluvial areas (Crist and Lowry, 1972). These aquifers exhibit a wide range of specific capacities, from 0.3 to 18 gpm/ft (Lowry and Cummings, 1966; Whitcomb and Morris, 1964), varying porosities between 28 to 45% (Whitcomb and Morris, 1964), and permeabilities up to 600 gpd/ft^2 (Eisen et al., 1981). Transmissivity values, crucial for understanding vertical and lateral USDW limits and groundwater flow, range from 15 to 350 gpd/ft, escalating up to 64,000 gpd/ft in some areas, with the saturated thickness playing a pivotal role (Davis and Rechard, 1977; Crist and Lowry, 1972) (Eisen et al., 1981).

The Mesaverde Formation, including the Teapot and Parkman sandstones, forms the surface bedrock at the project site, measuring approximately 650-800 ft thick and serving locally as potable freshwater aquifers.

The Frontier Formation, approximately 900 ft thick in the project area and composed of fine- to coarse-grained sandstone with interbedded dark siltstone and shale, is the geological unit overlying the Mowry Shale and beneath the Cody Shale. As an aquifer, it yields up to 10 gallons per minute (gpm) to flowing wells, with potential yields up to 50 gpm in regions north and west of Casper on the Casper arch, as documented by Crist and Lowry (1972). Reported permeabilities range from 0.1 to 9.0 gpd/ft^2, predominantly below 2 gpd/ft^2, with limited transmissivity, often less than 150 gpd/ft (Eisen et al., 1981). The Frontier Formation is not used as a source of drinking water within the AoR.

Major Aquitards Above Confining Zone

At the project site, Lewis Shale is completely eroded but exists as bedrock approximately one mile north, comprising gray shale and sandstone hosting low yields of potable freshwater.

Cody Shale with its Niobrara Formation and Carlile Shale members, typically contain brackish groundwater, as highlighted in studies by Anna (2010) and Warwick & Corum (2012). The deepest water well within a 3-mile radius of Caper Carbon Capture #1 descends 1,000 ft into the Cody Shale.

The Cody Shale is the uppermost aquitard at the project site. The Niobrara Formation and Carlile Shale members of the Cody Shale typically contain brackish groundwater, as highlighted in studies by Anna (2010) and Warwick & Corum (2012). The deepest water well within a 3-mile radius of Caper Carbon Capture #1 descends 1,000 ft into the Cody Shale.

The underlying Mowry Shale, a siliceous marine deposit with a high clay content and bentonite layers, is recognized for its exceptionally low permeability. With a thickness of approximately 230 ft in the project area, its aquifer yield in Natrona County ranges from flowing yields up to 2 gpm to pumped yields up to 10 gpm (Surdam et al., 2010, and Davies et al., 2015).

The Skull Creek Shale and Muddy Sandstone package, approximately 130 ft thick and comprising fissile shale and fine- to medium-grained sandstone, sits atop the Dakota/Lakota section (Anna, 2010; Warwick & Corum, 2012). Although the Muddy is productive for oil in the adjacent Brooks Ranch Field and transitions into the Mowry Shale above, there are no reported wells extracting water from Skull Creek Shale.

Major Aquifers Below Confining Zone

The Tensleep Sandstone and its subsurface equivalents, including the middle and upper Minnelusa Formation and the Leo Sandstone, are also known as the Casper Aquifer and are characterized by varied sedimentary structures and mineral compositions (Fryberger, S. G., 2013). While yields from these formations generally remain below 200 gpm (Eiesen et al., 1981), the Casper Aquifer in outcrop areas typically has low TDS under 500 mg/L, indicating freshwater quality predominantly of magnesium-calcium bicarbonate type (Whitcomb and others, 1966; Wyoming Water Planning Program, 1972). However, deeper regions in the east half of the basin show higher TDS levels (Eisen et. al, 1981).

The underlying Madison Limestone is 200-300 feet thick in the project area and is characterized by cherty limestone and dolomite with karst features. It has historically supported various water needs, with yields varying from 600 gpm to 1,200 gpm and transmissivities ranging from 1,000 gpd/ft to more than 300,000 gpd/ft (Eisen et al., 1981). Water quality in the Madison aquifer varies significantly, with TDS near outcrops less than 600 mg/L, increasing basinward to over 3,000 mg/L, primarily comprising calcium-magnesium bicarbonate near the surface and sodium sulfate-chloride in deeper regions

(Eisen et al., 1981). In nearby Brooks Ranch Oil Field, the Mississippian Madison Limestone was drilled as a non-saline industrial water source and produced ~3,000-8,000 mg/L TDS in the 1960s and 1970s.

Minor Aquifers Below Confining Zone

In the northern part of the basin, the Cambrian Flathead and Deadwood sandstone aquifers are known for their limited quality and yield of water, with minimal exploitation to date. The Flathead Sandstone is characterized by its tan to reddish hue, occasional conglomeratic nature, and layers interbedded with green shale and siltstone. Notably, a USGS sample from Section 15 Township 57 Range 65 reveals that Flathead sandstone contains less than 0.4 µg/L of uranium, 14 pCi/L of radium-226, and a gross beta as cesium-137 of 19 pCi/L (Eisen et al., 1981). These sandstones are not known to be present in the project area.

Major Aquitards Below Confining Zone

The Chugwater Group, approximately 600 ft thick, includes the Red Peak and overlying Alcova Limestone, serving as the basal confining zone for this project (along with the Goose Egg Formation) beneath the Jurassic sandstones of the injection zone (Bower, 1964; Lovelace, D. M., 2015). Wells drilled into the Chugwater in Natrona County typically yield less than 20 gpm (Eisen et al., 1981). Spearfish Formation (Chugwater equivalent) wells in central Crook County reported specific capacities of 0.5 and 0.6 gpm/ft, with corresponding permeabilities and transmissivities, indicating its limited aquifer potential (Whitcomb and Morris, 1964). A Chugwater well in Natrona County exhibits mixed cation sulfate water with a TDS of 1,330 mg/L (Crist and Lowry, 1972).

The Goose Egg Formation, correlating partly with the Phosphoria Formation, comprises regionally extensive bedded evaporites, mudstone red beds, siltstone, and thin sands (Anna, 2010). This formation acts as a sealing caprock for Tensleep oil reservoirs in Wyoming (Fryberger S. G., 2013; Burk & Thomas, 1956). Crucially, the Permian Opeche Shale, the basal member of the Goose Egg, is considered an effective impervious barrier, isolating the Paleozoic section beneath it and influencing the vertical and lateral USDW limits (Trotter, 1963; Eisen et al., 1981).

Marginal Aquifer

The Sundance Formation, comprising calcareous and glauconitic sandstone, siltstone, shale, and limestone, is more than 300 feet thick and contains more than 150 feet of potential reservoir. Clean sands of the Sundance Formation have an average 15-20% porosity and permeability up to 1,000 mD, as detailed by Warwick & Corum (2012) and others. Its TDS often surpasses 1,000 mg/L (Eisen et al., 1981), with variations from sodium sulfate to sodium chloride brines, indicating diverse water qualities crucial for considering its designation as an USDW.

3.0 USDW DETERMINATION

3.1 GEOCHEMICAL INFORMATION OF INJECTION ZONE (RECEIVING FORMATION)

Fluid samples from the injection zone are not available within the project area; obtaining fluid samples is one of the higher-priority objectives of future drilling and will be updated accordingly. Table 1 presents available water data from the Sundance Formation elsewhere in Wyoming, obtained from the United States Geological Society (USGS) Produced Water Database.

Table 1: Water Quality of the Receiving Formation

Well Name (API#)	Distance from proposed injection well	Formation	Test Depth, ft	TDS, mg/L	Latitude	Longitude
49025089310000	43.27	Sundance Lower	6,530-6,570	25,201	43.435	-106.204
49025079460000	41.70	Sundance Second Upper	2,842-2,847	23,860	43.406	-106.290
49025078470000	41.66	Sundance	3,008	21,158	43.404	-106.304
	41.57	Sundance Third	NA	20,836	43.402	-106.310
49025074180000	41.02	Sundance	2,828-2,870	20,597	43.395	-106.304
49025083070000	42.26	Sundance Second Lower	2,853-2,924	20,586	43.414	-106.299
49025079490000	41.75	Sundance Second	2,995	19,439	43.406	-106.299

NA	29.20	Sundance	NA	16,566	42.845	-106.739
NA	38.18	Sundance	NA	14,147	43.358	-106.260
NA	41.11	Sundance Second	NA	13,522	43.395	-106.310
NA	38.18	Sundance	2,828-2,870	13,200	43.358	-106.260
NA	41.95	Sundance Second	NA	12,111	43.410	-106.291
NA	41.33	Sundance Second	2,808-2,878	12,000	43.401	-106.290
NA	38.18	Sundance	NA	11,981	43.358	-106.260
NA	41.47	Sundance Second	NA	11,787	43.410	-106.173
NA	41.47	Sundance Second	NA	11,667	43.410	-106.173
49025081300000	41.95	Sundance Second	2,838-2,883	11,530	43.410	-106.290
49025085270000	42.63	Sundance Second	2,844	11,236	43.420	-106.290
NA	38.18	Sundance Third	2,812-2,860	11,210	43.358	-106.260
49025081670000	41.93	Sundance Third	3,147-3,159	10,945	43.411	-106.278
49025081270000	41.99	Sundance Second	2,784-2,794	10,496	43.410	-106.298
49025078750000	41.54	Sundance	2,975-3,075	10,457	43.404	-106.287
NA	38.18	Sundance	NA	10,087	43.358	-106.260
49025081340000	42.05	Sundance Second	NA	10,031	43.410	-106.303
49025085910000	42.81	Sundance	2,690	10,023	43.422	-106.292
49025085990000	42.80	Sundance Upper	2,620	8,498	43.422	-106.290
49025079490000	41.75	Sundance Third	3,200	8,189	43.406	-106.299
NA	38.18	Sundance	3,340	8,085	43.358	-106.260

NA	42.04	Sundance Third	NA	7,959	43.410	-106.302
49025070630000	40.19	Sundance Second	2,949-2,997	7,644	43.382	-106.306
49025070630000	40.19	Sundance Second	2,949-2,997	7,275	43.382	-106.306
49025079470000	41.79	Sundance Second	2,828-2,836	7,098	43.406	-106.302
49025051630000	41.40	Sundance Second	NA	6,979	43.400	-106.304
49025080800000	41.92	Sundance Second	2,808-2,818	6,662	43.409	-106.294
49025082270000	42.16	Sundance Second	2,746-2,756	6,313	43.412	-106.296
NA	31.42	Sundance Second	NA	6,122	42.475	-106.583
49025079460000	41.70	Sundance Second	2,853-2,924	5,746	43.406	-106.290
NA	42.41	Sundance Third	2,842-2,847	5,534	43.414	-106.310
NA	58.57	Sundance Canyon Springs	12,210-12,230	5,480	42.764	-105.012
49025062640000	57.31	Sundance Basal	1,290-1,370	5,282	43.231	-107.142
NA	58.57	Sundance Canyon Springs Upper	12,160-12,170	4,882	42.764	-105.012
NA	29.29	Sundance	1,436-1,494	4,832	42.846	-106.741
49025078150000	41.57	Sundance Second	2,754-2,764	4,704	43.403	-106.300
49009058760000	9.98	Sundance Basal	4,875-4,929	4,048	42.847	-105.975
49009050730000	44.30	Sundance Basal	4,077-4,090	4,015	42.720	-105.301

NA	10.53	Sundance	NA	3,880	42.851	-105.965
49009058760000	24.77	Sundance Canyon Springs	NA	3,838	42.590	-106.550
49025095860000	44.30	Sundance Basal	4,077-4,090	3,826	42.720	-105.301
49009050730000	44.30	Sundance Basal	4,077-4,090	3,755	42.720	-105.301
49009050730000	10.53	Sundance	4,865-4,935	3,700	42.851	-105.965
NA	46.04	Sundance	3,476-3,593	3,268	42.680	-105.276
49009050490000	25.11	Sundance	1,114-1,183	3,245	42.903	-106.644
49025058230000	41.33	Sundance Second	2,886-2,896	3,220	43.398	-106.314
49025077400000	27.50	Sundance	3,399-3,424	3,198	42.649	-106.660
NA	44.06	Sundance Lower	4,357-4,385	3,073	42.724	-105.305
49009051150000	44.06	Sundance	4,357-4,385	3,064	42.724	-105.305
49009051150000	31.65	Crow Mountain	2,017-2,021	2,826	43.122	-106.622
49025060740000	29.20	Sundance	NA	2,823	42.845	-106.739
NA	43.27	Curtis	3,185-3,234	2,740	43.032	-106.964
49025059890000	27.29	Sundance	3,308-3,320	2,722	42.624	-106.639
49025052870000	31.49	Sundance	NA	2,679	42.869	-106.781
NA	26.99	Sundance	3,349-3,372	2,631	42.630	-106.636
49025053030000	31.90	Sundance	1,739-1,744	2,616	43.125	-106.625
49025060880000	29.30	Sundance	1,240-1,380	2,561	42.844	-106.741

49025056580000	26.99	Sundance	3,349-3,372	2,458	42.630	-106.636
49025053030000	26.99	Sundance	3,349-3,372	2,416	42.630	-106.636
49025053030000	26.99	Sundance	3,358-3,368	2,331	42.630	-106.636
49025053030000	28.64	Sundance	1,448	2,305	42.837	-106.729
49025056210000	45.37	Crow Mountain Tensleep	2,388-3,722	2,301	43.284	-106.786
49025203330000	43.60	Curtis	NA	2,300	43.035	-106.969
49025059960000	43.02	Crow Mountain	NA	2,300	43.036	-106.957
NA	31.42	Sundance Lower	1045-1065	2,109	42.475	-106.583
NA	31.42	Sundance Lower	1062-1078	2,104	42.475	-106.583
49025057340000	30.72	Sundance	NA	2,081	42.858	-106.767
NA	30.02	Sundance Lower	1,450	2,077	42.845	-106.755
NA	27.50	Sundance	NA	1,971	42.649	-106.660
NA	29.29	Sundance Basal	1,479	1,911	42.846	-106.741
NA	27.13	Sundance	NA	1,837	42.631	-106.640
49025052960000	27.09	Sundance	3,376-3,381	1,822	42.627	-106.636
49025052960000	27.09	Sundance	3,249-3,382	1,788	42.627	-106.636
49025052870000	27.29	Sundance	3,398-3,410	1,744	42.624	-106.639
49025056350000	28.90	Sundance Basal	1,396-1,510	1,694	42.840	-106.734
49025052870000	27.29	Sundance	NA	1,663	42.624	-106.639
NA	27.49	Lakota Sundance	NA	1,637	42.622	-106.642

49025061510000	53.56	Crow Mountain	2,548-2,570	1,435	43.171	-107.103
49009052990000	9.43	Sundance	6,657-6,944	1,167	42.784	-105.982
49025052990000	27.19	Sundance	3,038-3,478	1,070	42.627	-106.639

3.2 GEOCHEMICAL INFORMATION OF LOWERMOST USDW (ABOVE THE INJECTION ZONE)

The Lakota is the lowermost USDW above the injection zone. It produces from at least three wells in the vicinity of the project area for non-public uses. Data on water quality and yield are limited, with available data from the two closest wells shown in Table 2**.**

Table 2: Water Quality of the Lowermost USDW (above the injection zone)

Well Name (API#)	Distance from Casper Carbon Capture #1	Formation Name	Depth of sample, ft	Date of Sample Collection	Constituent	Concentration (mg/L)
McMurry Amerada (Govt Brannan #1, 490250551)	3.6 miles	Lakota	5,260-5,310	2007	TDS	2,800 (calculated)
Casper County Club #1 (4902560005)	5.5 miles	Lakota	5,008-5,101	1/26/59	TDS	1,10

3.3 OTHER AQUIFERS

The Casper Aquifer is the uppermost USDW below the injection zone. It produces from at least one wells in the vicinity of the project area for non-public uses. Data on water quality and yield are limited, with available data from the known well shown in Table 3**.** The Casper Aquifer also likely contributes to spring discharge on the Casper Mountain margin. It has been explored as a potential public water supply at locations south of Casper Mountain Fault, which hydraulically severs this aquifer along an east-west trend.

Table 3: Water Quality of the Uppermost USDW (below the injection zone)						
Well Name (API#)	**Distance from Casper Carbon Capture #1**	**Formation Name**	**Depth of sample, ft**	**Date of Sample Collection**	**Constituent**	**Concentration (mg/L)**
McMurry Amerada (Govt Brannan #1, 490250551)	3.6 miles	Casper/Madison	6,935-7,844	2007	TDS	3,240

4.0 PROPOSED FLUID TESTING PROGRAM

Information for this is included within the form "Class VI Permit Application – Proposed Formation Fluid Testing Program" (Form A-7).

5.0 REFERENCES

Anna, L. O. (2010). Geologic assessment of undiscovered oil and gas in the Powder River Basin Province. In *Total Petroleum Systems and Geologic Assessment of Oil and Gas Resources in the Powder River Basin Province, Wyoming and Montana: U.S. Geological Survey Series DDS–69–U* (p. 97 p.).

Bower, R. R. (1964). *Stratigraphy of Red Peak Formation, Alcova Limestone, and Crow Mountain Member of Popo Agie Formation (Triassic) of Central Wyoming (dissertation)*. University of Oklahoma.

Burk, C. A., & Thomas, H. D. (1956). *The Goose Egg Formation (Permo-Triassic) of Eastern Wyoming: Report of Investigations No. 6*. Geological Survey of Wyoming.

Crist, M. A., and Lowry, M. E. (1972). *Ground-Water Resources of Natrona County, Wyoming*, https://doi.org/10.3133/wsp1897.

Davies, C., Purvis, S., Kenny, R., Fenton, J., Pandey, V., Geesaman, K., Trevino, R., Iwobi, C., Watford, M., & Bose, S. (2015). *Reservoir Quality and Stratigraphy of the Mowry and Muddy Interval of the Powder River Basin, Wyoming, USA*. First Break, v. 33, No. 12.

Eisen et al., (1981). *Occurrence and Characteristics of Groundwater in the Powder River Basin, Wyoming. U.S. Environmental Protection Agency*, vol. 1-B, 1981.

Fox, J. E. (1993). *Stratigraphic cross sections M-M' through R-R', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Fox, J. E. (1993b). *Stratigraphic cross sections S-S' through V-V', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Fryberger, S. G. (2013). *Stratigraphic aspects of the Tensleep play of Wyoming*. University of Wyoming.

Lovelace, D. M. (2015). *A New Age Constraint for the Early Triassic Alcova Limestone (Chugwater Group, Wyoming).* Palaeogeography Palaeoclimatology Palaeoecology 424.

Stacy, M. E., Huntoon, P.W. (1994). *Karstic Groundwater Circulation in the Fault-Severed Madison Aquifer in the Casper Mountain Area of Natrona County, Wyoming*. Wyoming Water Resources Center.

Surdam, R. C., Zunsheng, J., Dr Bruin, R. H., & Bentley, R. D. (2010). *Shale Gas Potential of the Mowry Shale in Wyoming Laramide Basins. In: Challenges in Geologic Resource Development No. 9*. Wyoming State Geological Survey.

Taboga, K. G. (2013). *Platte River Basin Water Plan Update Groundwater Study Level 1 (2009-2013) - Available Groundwater Determination Technical Memorandum*. Wyoming Water Development Commission.

Taucher et al. (2013). *Platte River Basin Water Plan Update Groundwater Study Level 1 (2009-2013) - Available Groundwater Determination Technical Memorandum*. Wyoming Water Development Commission.

Trotter, J., (1963). *The Minnelusa play of the northern Powder River Wyoming and adjacent areas*. In Guidebook, Wyo. Geol. Assoc. and Billings Geol. Soc. First Joint Field Conf. p. 117-122

Warwick, P., & Corum, M. (2012). *Geologic framework for the national assessment of carbon dioxide storage resources—Powder River Basin, Wyoming, Montana, South Dakota, and Nebraska, chap. B of Geologic framework for the national assessment of carbon*. U.S. Geological Survey.

Whitcomb, H. A., Cummings, T. R., and McCullough, R. A. (1966). *Ground*-water *Resources and Geology of Northern and Central Johnson County, Wyoming:* U.S. Geological Survey Water Supply Paper 1806

Whitcomb, H. A. and Morris, D. A.R. (1964). *Ground-water Resources and Geology of Northern and Western Crook County, Wyoming.*

Wyoming State Water Plan, waterplan.state.wy.us/basins/7basins.html. Accessed 13 May 2024.

Wyoming. Water Planning Program, Water & Related Land Resources of Northeastern Wyoming : a Report, 1972

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Quality Assurance and Surveillance Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
ASTM	American Society for Testing and Materials
BHP	Bottomhole Pressure
°C	Degrees Celsius
CBL	Cement Bond Log
CCC	Casper Carbon Capture, LLC
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
dP	Differential Pressure
EPA	United States Environmental Protection Agency
°F	Fahrenheit
FD	Field Duplicate
ft	Feet
ft/hr	Feet per Hour
FS	Full Scale
GC	Gas Chromatography
H_2S	Hydrogen Sulfide
HID	Helium Ionization Detector
IA	Inner Annulus
ID	Identification
in	Inches
lb	Pound
mS/cm	millisiemens per Centimeter
MS/MSD	Matrix Spike/ Matrix Spike Duplicate
N_2	Nitrogen
N/A	Not Applicable
NAPL	Non-Aqueous Phase Liquids
NTU	Nephelometric Turbidity Units

O_2	Oxygen
pH	Potential of Hydrogen
ppmv	Parts per Million Volume
psi	Pounds per Square Inch
QA/QC	Quality Assurance/Quality Control
QASP	Quality Assurance and Surveillance Program
RPD	Relative Percent Difference
SOP	Standard Operating Procedures
SU	Standard Units
TCD	Thermal Conductivity Detector
USEPA	United States Environmental Protection Agency
VMP	Vapor Monitoring Point
VOC	Volatile Organic Compounds
WDEQ	Wyoming Department of Environmental Quality

1.0 OVERVIEW

The Testing and Monitoring Plan (Form A-5) includes plans developed by Casper Carbon Capture, LLC (CCC) for CO_2 Injectate Analysis, Injection Well Integrity Testing, Corrosion Monitoring, and Subsurface Monitoring at the Casper Carbon Storage Hub. This Quality Assurance and Surveillance Plan (QASP) fulfills the Wyoming Department of Environmental Quality (WDEQ) Water Quality Rules Chapter 24, Section 20 requirement, and provides the quality assurance and surveillance procedures to accompany the Testing and Monitoring Plan.

2.0 MONITORING AND ANALYSIS OF INJECTED CO_2

Prior to injection, CCC will determine the chemical and physical characteristics of the CO_2 that has been captured for storage using appropriate analytical methods. The CO_2 stream will be regularly sampled for analysis of the gases shown in Table 1. Samples of the CO_2 stream will be collected from the CO_2 pipeline at a location where the conditions are representative of injection conditions.

Equipment used for field sampling (if applicable) and laboratory analysis will be calibrated, serviced, inspected, and maintained according to the manufacturer's recommendations. Sampling and analysis may be performed by either CCC staff or selected 3rd party service providers.

If abnormal compositional gas values for CO_2 are received during the testing period, sampling procedures will be verified, locations will be resampled, and the new samples will be submitted to the lab for confirmatory analysis.

Table 1: Analytical parameters and methods for CO_2 stream analysis

Analytical Parameter	Analytical Method	Detection Limit	Typical Precision/Accuracy
CO_2	GC/TCD[1**]	1 ppm to 100%	+- 1% of full scale
Carbon Monoxide	GC/TCD[1**]	1 ppm to 100%	+- 1% of full scale
Nitrogen	GC/TCD[1**]	1 ppm to 100%	+- 1% of full scale
Oxygen	GC/TCD[1**]	1 ppm to 100%	+- 1% of full scale
Argon	GC/TCD[1**]	1 ppm to 100%	+- 1% of full scale
Water	GC/HID[2**]	1 ppm to 100%	+- 10%

Table 1: Analytical parameters and methods for CO_2 stream analysis			
Analytical Parameter	**Analytical Method**	**Detection Limit**	**Typical Precision/Accuracy**
[1] GC/TCD - Gas Chromatography with a thermal conductivity detector [2] GC/HID - Gas Chromatography with helium ionization detector **The listed analytical methods, detection limits and precision and accuracy may be revised based on input from the laboratories selected to do the work.			

3.0 CORROSION MONITORING

3.1 CORROSION MONITORING

CCC will monitor Casper Carbon Capture #1 and the flowline system for corrosion using corrosion coupons installed in the surface flowline near the injection point. Corrosion coupons are representative samples of the tubing, casing, and flowline materials that are installed, and can be easily removed and analyzed over time for signs of corrosion.

Coupons will be sampled and analyzed quarterly, per WDEQ Ch. 24, Section 20 (b)(iii)(A), until the cessation of injection. If a change of injection stream conditions is detected during gas sampling and/or continuous recording of operational parameters that indicates a potential threat to mechanical integrity through wall loss, CCC will implement a schedule for inspecting corrosion coupons based on the calculated corrosion rate and calculated remaining life.

Corrosion Coupons will be installed, prepared, and analyzed using American Society for Testing and Materials (ASTM) G1-03, Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens (ASTM 2011). This process includes visually inspecting the coupons for evidence of corrosion (e.g., discoloration, pitting), measuring the weight and size (thickness, width, length) of the coupons, and calculating the corrosion rate based on weight loss during the exposure period divided by the duration (i.e., weight loss method). Quality assurance and quality control measures specified in the ASTM method will be followed.

3.2 CORROSION PREVENTION

Any corrosion-preventing chemicals injected into the CO_2 stream will be compatible with all equipment that will encounter the CO_2 stream throughout the project's lifetime and geochemical characteristics of the injection and confining zones. Periodic fluid sampling will be conducted at critical points in the system to determine the corrosion inhibitor's concentration and confirm that it is present at sufficient level to prevent corrosion.

4.0 SOIL GAS MONITORING

Soil gas monitoring directly measures the characteristics of the vapors in soil and can provide information that can be an indicator of CO_2 releases as well as an indirect indicator of both chemical and biological processes occurring in the unsaturated and saturated zones. Two soil VMPs will be installed to monitor soil vapor above the soil – groundwater interface of the shallowest aquifer in the vadose zone, as detailed in the Testing and Monitoring Plan.

4.1 SAMPLING AND ANALYSIS PROTOCOL

Samples will be collected in a manner consistent with the media being sampled and the analytes of interest, and consistent with United States Environmental Protection Agency (USEPA) Technical Procedures.

Prior to sample collection at the soil vapor monitoring point (VMP) locations, a handheld monometer will be used to measure if there is negative pressure in the well, followed by a leak detection procedure to ensure the sample train is not leaking. Once the leak detection procedure has confirmed no leaks in the sample train, a minimum of one casing and filter pack volume will be purged to ensure a representative sample is collected. The handheld multi-gas meter shall be calibrated daily prior to sampling according to the manufacturer's recommendations.

Soil gas samples will be collected using an approved laboratory supplied container for fixed gases. It is assumed that this will include Tedlar bags and / or summa canisters for fixed gases. Samples will be labeled with a unique sample ID, sampler name, and date & time of collection. This data will be recorded on a field data sheet along with Location ID, weather conditions, barometric pressure and handheld meter reading for the vacuum and gases listed above. Samples will be packed and handled according to the method-specific instructions and shipped to the laboratory with chain-of-custody documentation.

The soil gas sampling methods will be reviewed and modified as necessary, to be consistent with applicable regulatory requirements and standard industry practices, once the VMPs have been designed and installed.

Field meters including the handheld multigas meter shall be calibrated daily prior to sampling according to the manufacturer's recommendations. Sampling personnel shall receive training on the use of meters and equipment as well as the sampling techniques from experienced personnel.

Sampling will be conducted by CCC personnel or a qualified contractor following established Standard Operating Procedure (SOPs) for the Casper Carbon Storage Hub. Field personnel will receive training in the use of meters, equipment and sampling techniques from personnel experienced in the use of the equipment.

Sample analysis shall be performed by a certified laboratory using USEPA approved methods, where applicable, or other approved standards.

Table 2 summarizes the planned parameters for baseline soil vapor measurements, with analytical methods, typical reporting limits, and the field quality control (QC) requirements.

Table 2: Fixed Gases for Compositional Analysis

Parameters	Method	Typical Detection Limit	QC Requirements
FIELD MEASUREMENTS:			
Well Casing Pressure / Sample Train Pressure	Handheld monometer	Varies by meter	Calibration as per manufacturer recommendations
Purge gases: CO_2, H_2S, O_2, VOCs	Multi-gas meter (such as RAE Systems PGM 54)	Varies by meter and gas	
LABORATORY ANALYSES:			
Fixed Gases (H_2, N_2, O_2, CO, CO_2, and CH_4) by Method EPA 3C Modified	EPA 3C Modified	50 to 100 ppmV (analyte dependent)	Field duplicates at 10% or 1 per event if less than 10 samples are collected.

4.2 QUALITY CONTROL

Quality control for soil gas sampling shall be maintained by following CCC's approved sampling SOPs, using pre-prepared field data sheet templates, adhering to laboratory recommendations for sample handling and preservation, and implementing a field QC sampling program as needed. Field data sheets will be archived as part of the Casper Carbon Storage Hub QC record.

5.0 SUB-SURFACE FLUID MONITORING

Sub-surface fluid monitoring encompasses sampling of shallow and deep fluid to ensure that injected CO_2 is properly contained in the storage complex.

5.1 SAMPLING AND ANALYSIS PROTOCOL

Upon arriving at each sampling point, the sampler will inspect the fluid monitoring well, concrete pad, protective barriers, lock, and well cap, if applicable. Upon completion of monitoring well inspections and before setting up to begin sampling, the sampler will gauge the depth to water and the total depth of each monitoring well with a water level meter. The depth measurements will be collected from a notch filed into the north side of the monitoring well casing during monitoring well installation to provide a consistent reference point for depth to water datum. The water level meter will be decontaminated with a phosphate-free detergent solution before and after use in each monitoring well. The results of the depth to water will be recorded on the field sampling sheet or in the field book to the nearest hundredth of a foot and observations will be recorded as to the presence of non-aqueous phase liquids (NAPL), odors, organic compounds, or any other relevant observations.

Low-flow sampling techniques will be utilized to purge and sample each monitoring well, where possible, using a peristaltic pump, bladder pump, or submersible pump, as appropriate, with new disposable tubing in accordance with Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures by the EPA. Whether a portable or permanent pump will be used, the pump intake will be placed near the center of the screened interval in each monitoring well. Where low-flow sampling is conducted, purging will be initiated with a flow rate of between 100 to 500 milliliters per minute (ml/min) in an attempt to keep well drawdown below 4 inches. Where permanent submersible pumps are utilized, low-flow purging and sampling will attempt to be conducted, however, this may not be possible. When not possible, wells will be purged at the lowest possible flow rate.

During purging, fluid quality parameters including temperature, pH, and SC will be recorded every three to five minutes in addition to monitoring well drawdown and purging flow rate. Field parameters will be monitored for stabilization for the following ranges in three consecutive measurements:

- ±4 inches for water level change;
- ±0.1 units for pH;
- ±3% for specific conductance;

Once field parameters have stabilized at each monitoring well, groundwater samples will be collected into laboratory provide containers. If the turbidity is measured as greater than 10 Nephelometric Turbidity Units (NTUs) after field parameter stabilization, fluid samples may be field filtered prior to filling sample containers based on laboratory guidance for each analytical method.

As is indicated in *Geologic Sequestration of Carbon Dioxide Underground Injection Control Program Class VI Well Testing and Monitoring Guidance, March 2013,* special sampling procedures may need to be designed and implemented for deep wells.

Field fluid sampling will be conducted by CCC personnel or a qualified contractor following established SOPs for the Casper Carbon Storage Hub. If necessary, additional sample analysis shall be performed by a certified laboratory using WDEQ approved methods or other approved standards. Contracted laboratories may be audited by CCC or a designated third-party to improve QC if it is determined to be necessary.

All field equipment will be maintained, stored, serviced, and calibrated according to the manufacturer's instructions. Field meters will be calibrated daily prior to sampling. Spare parts and equipment that may be needed will be kept on hand during sampling activities. Equipment that fails to calibrate shall be replaced or serviced and returned to proper working order prior to use in the field.

Laboratory equipment, maintenance, inspection, and calibration shall be the responsibility of the laboratory performing the analysis and conducted according to method-specific protocols and laboratory QA procedures.

Table 3 shows the planned parameters for baseline fluid measurements, with detailed analysis methods, range, accuracy, and the QC requirements. Modification of the parameters is possible depending on the chemical makeup of the CO_2 injection stream.

Table 3: Analytic Methods and Parameters for Fluid Monitoring

Parameter	Analysis Method	Typical Reporting Limit (or Range)	Field QC Requirements
FIELD MEASUREMENTS:			
pH	Field water quality meter	2 to 12 SU	Factory calibration and user calibration per manufacturer's instructions
Conductivity		0 to 200 mS/cm	
Temperature		-5 to 50° C	
LABORATORY ANALYSES:			
N/A			

Notes: The listed analytical methods and/or reporting limits may be revised based on input from the laboratories selected to do the work.
Field duplicates to be collected at rate of 10% (1 for every 10 samples) or 1 per event if less than 10 samples are collected.
MS/MSDs to be collected at a rate of 5% (1 for every 20 samples) or 1 per event if less than 20 samples are collected.
Field blanks and equipment blanks will be collected as per Section 5.2 of this QASP.

5.2 QUALITY ASSURANCE/QUALITY CONTROL PROTOCOLS

Quality control for fluid sampling shall be maintained by following CCC approved sampling SOPs, using pre-prepared field data sheet templates, adhering to laboratory recommendations for sample handling and preservation, and implementing a field QC sampling program as described below. Field data sheets will be archived as part of Casper Carbon Storage Hub QC record.

A field QA/QC sampling program will be used to evaluate the quality of the sampling effort. The program utilizes the regular inclusion of field and equipment blanks, field duplicates, and matrix spikes to assess whether there are potential impacts to the quality of results due to field techniques and conditions, sample handling, or laboratory QC.

Field and equipment blanks are used to determine whether contamination has been introduced by ambient air (field blanks) or by contaminated equipment (equipment blanks). Field blanks are collected by pouring deionized water directly into a sampling container at the sampling location. New nitrile gloves are worn during collection and care taken during containerization not to introduce contamination into the sample. One field blank will be included for each sampling event.

Equipment blanks are collected by pouring deionized water over and through sampling equipment, collecting the rinsate, labeling it as a regular sample, and submitting with the other samples for analysis. The presence of target analytes in an equipment blank indicates a quality issue due to equipment decontamination procedures. One equipment blank will be included for each sampling event for which decontaminated equipment was used for sampling.

Field duplicates assess sampling and laboratory precision. A field duplicate (FD) is obtained by filling two sample containers from the same collected sample volume. Precision will be determined by calculating the relative percent difference (RPD) between the parent sample's results and the field duplicate's results. One FD will be collected for every 10 field samples. At least one FD will be collected for each sampling event.

For QA/QC, field duplicate fluid samples will be collected at a ratio of one (1) field duplicate sample for every 10 primary samples. Duplicate samples will be submitted along with the primary samples for laboratory analyses listed with redacted sample locations and false collection times in chain-of-custody documentation. The redacted sample locations and false collection times will prevent the analytical laboratory from having knowledge of the parent-duplicate sample pairs to maintain integrity throughout the QA/QC process. Upon receipt of analytical data, RPDs will be calculated between primary and duplicate sample results to check the precision of the laboratory analyses.

6.0 STORAGE RESERVOIR MONITORING

Storage Reservoir Monitoring consists of injectate pressure and temperature gauges, an injection flowmeter, and downhole pressure and temperature gauges. Injection pressure and temperature will be continuously measured at the surface via real-time P/T instruments installed at the wellhead. Example technical specifications for pressure and temperature instruments are shown in Table 4 and Table 5.

Table 4: Example of technical specifications for surface pressure gauges

Parameter	Typical Value
Calibrated Working Pressure Range	0 – 3,000 PSI
Pressure Accuracy	<0.075%
Pressure Resolution	0.1 PSI
Type of Sensor	Rosemount 2088 or Equivalent

Table 5: Example of technical specifications for surface temperature gauges

Parameter	Value
Calibrated Working Temperature Range	0° to 150° F
Temperature Accuracy	+/-1.44° F @ 212° F per IEC60751 Class B
Temperature Resolution	0.1° F
Type of Sensor	Rosemount 214C RTD or Equivalent

The flow rate of CO_2 injected into Casper Carbon Capture #1 will be measured by a flowmeter at the surface. Example technical specifications for a flowmeter are given in Table 6.

Table 6: Example of technical specifications for a flowmeter

Parameter	Value
Standard Accuracy	±0.5% of rate
Repeatability	±0.1% or better
Flow Ranges	10:1 and greater
Standard Beta Ratios	0.45 to 0.85
Head Loss	Varies with beta ratio and dP

Downhole pressure and temperature gauges will be deployed at Casper Carbon Capture #1 on the tubing, the casing, or via fiber-optic cables to monitor real-time bottomhole conditions of the injection zone. The gauges or cables will be selected to comply with CO_2 service conditions, and the data will be integrated into the communications system and the surveillance platform. Table 7 shows an example of technical specifications for downhole gauges.

Table 7: Example of technical specifications for downhole P/T sensors

Parameter	Typical Value
Pressure - Range of Sensor (psi)	0 to 10,000
Pressure - Accuracy (% FS) (psi)	0.015 (1.5)
Pressure - Typical Accuracy (% FS) (psi)	0.012 (1.2)
Pressure - Achievable Resolution (psi/sec)	<0.006
Pressure - Maximum Drift at Maximum Pressure and Temperature (% FS/ Year) (psi)	0.02 (2.0)
Temperature – Accuracy of Sensor (°C)	0.5
Temperature - Typical Accuracy (°C)	0.15
Temperature - Achievable Resolution (°C/sec)	<0.005
Temperature - Repeatability (°C)	<0.01
Temperature – Max Operating Temperature (°C)	150

For all data streams collected during continuous monitoring, the device's transmitter sends data to a hardwired or wireless communication system used to centralize and visualize monitoring data. The communication system is equipped with both battery back-up and storage back-up to protect against power or data interruptions.

7.0 WIRELINE LOGGING AND INTEGRITY TESTING

Activities discussed in this section are executed infrequently, and generally by specialized contractors with proven technologies and experience in the oil and gas industry. Calibration and QC of the tools will follow specific protocols and procedures based on the provider.

7.1 CEMENT BOND LOG (CBL)

To successfully demonstrate that the well has sound well integrity, a CBL will be run prior to injection to confirm that there is good cement to formation and cement to casing bonding and that there are no channels or poor cement bonding behind the pipe/casing that may lead to upward flow of the injection stream out of the injection zone and potentially endanger overlying USDWs.

CCC will follow best industry and service company practices while performing the CBL.

7.2 EXTERNAL MECHANICAL INTEGRITY LOGGING

CCC will use either a temperature log, noise log, or oxygen-activation log to evaluate external mechanical integrity and detect the inflow or outflow of injection or reservoir fluids. Table 8 gives example temperature logging specifications, although CCC may alternatively perform an oxygen activation log or noise log. CCC will provide the WDEQ with logging specifications prior to performing alternative logging methods.

Table 8: Example Temperature tool specifications

Logging Type	MCG Temperature Tool[1]
Logging Speed	3,600 ft/hr
Depth of Investigation	24 in.
Vertical Resolution	1 ft.
Accuracy	+/- 3%
Temperature Range	320° F
Pressure Rating	15,000 psi
Outside Diameter	2.25 in.
Length	8.7 ft.
Weight	64 lb.

[1]MCG Temperature Tool - Weatherford

7.3 INJECTION ZONE PRESSURE FALL-OFF TEST

The injection zone pressure fall-off test will be performed in Casper Carbon Capture #1 prior to the initiation of CO_2 injection activities, once every five years thereafter, and prior to well plugging to demonstrate injectivity of the storage reservoir. Specifically, the objective of the periodic pressure fall-off testing is to determine whether any significant changes in the near-wellbore conditions (permeability, k; transmissibility, kh; skin factor; wellbore storage effects, WBS) have occurred that may adversely affect well/reservoir performance. Pressure data will be recorded for the pressure fall-off test both downhole and at the wellhead using the Bottom Hole Pressure (BHP) and wellhead pressure gauges, respectively.

Controlled pressure fall-off tests are conducted by terminating injection for a designed period/duration of time. The pressure fall-off test is then started with shutting in the well by closing the surface wellhead valve(s) and maintaining continuous monitoring of the surface and downhole pressure recovery within the well/test interval system during the fall-off/recovery period.

No specialized sample/data-handling procedures are required. Electronic sensor data (e.g., pressure data) will be recorded on data loggers. All electronic data and field records will be transferred and stored on secure servers at the conclusion of each test.

A commercial software program will be used for analyzing pressure fall-off tests. Significant changes in well and reservoir property characteristics (as determined from pressure fall-off analysis), compared to those used in site computational modeling and Area of Review (AoR) delineation, may signify a reevaluation of the AoR.

All field equipment will be visually inspected and tested prior to use. Pressure gauges that are used to conduct fall-off tests will be calibrated in accordance with manufacturer recommendations.

7.4 ANNULAR PRESSURE

Annular pressure testing is used to validate mechanical integrity in the system. Tests will be performed prior to first injection, when tubing and packer are pulled for workover, or when the monitoring systems indicate a potential mechanical integrity issue.

To start the test, the well is shut in to stabilize the pressures (injectors). The testing equipment is connected to the annular valves, and surface lines are tested to 1,500 psi above the testing pressure. CCC must ensure there are no surface leaks from the pumping unit to the wellhead valve. Any air in the system is bled. If needed, the annular is completed with packer fluid and corrosion inhibitor (it should require minimum amount if so). Initial tubing and casing pressure are recorded. The well will be tested to 1,000 psi or as prescribed by WDEQ in the Inner Annulus (IA – between the tubing and casing above the packer), and the pressure should not decrease more than 10% in 30 minutes or by a threshold amount over a period of time required by WDEQ and be stable. Tubing and casing pressure is monitored continuously. Final tubing and casing pressure are recorded, and pressure and volume are bled.

If the pressure decreases more than 10%, the pressure is bled, the surface connection tested, and the test repeated. If there is an indication of mechanical failure, CCC will conduct diagnostics and prepare a plan to repair the well and discuss it with the director.

Surface gauges should be calibrated according to manufacturer recommendations and should have a pressure range which will allow the test pressure to be near the midrange of the gauge. Additionally, the gauge must be of sufficient accuracy and scale to allow an accurate reading of a 10% change. The test results will be documented and stored in the centralized database of the project for reporting and documentation.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Stimulation Plan

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
WDEQ	Wyoming Department of Environmental Quality
WWQR	Wyoming Water Quality Rules

1.0 PROPOSED STIMULATION PROGRAM

The need for stimulation to enhance the injectivity potential of the Sundance Formation will be determined once the data acquired from the planned stratigraphic well and injection well is available and has been evaluated (i.e., results of geophysical logs, electric logs, core analysis, hydrogeologic testing). Stimulation may involve, but is not limited to, flowing fluids into or out of the well, increasing or connecting pore spaces in the injection formation, or other activities that are intended to allow the injectate to move more readily into the injection formation.

If it is determined that stimulation is warranted, a stimulation plan will be developed and submitted to the Wyoming Department of Environmental Quality (WDEQ) for review and approval 30 days before anticipated start of stimulation, per Wyoming Water Quality Rules (WWQR) Chapter 24, Section 10.

1.0 CERTIFICATION

All applications for permits, reports, or information submitted to the Administrator shall be signed by a responsible corporate officer.

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations."	
Signature	**Printed Name** Jess Foshee
Title Chief Executive Officer	**Date** 06/26/2024

2.0 CARBON DIOXIDE STREAM EXCLUSION

The definition of the "carbon dioxide stream" means carbon dioxide, plus associated substances derived from the source materials and any processing, and any substances added to the stream to enable or improve the injection process. Within Chapter 24, the term "carbon dioxide stream" does not include any carbon dioxide stream that meets the definition of a hazardous waste under 40 CFR 261.3. Any Class VI UIC well owner or operator, who claims that a carbon dioxide stream is excluded under paragraph (h) of 40 CFR 261.4 must have an authorized representative (as defined in WWQR Chapter 24 Section 2(mm)) sign a certification statement worded as follows:

"I certify under penalty of law that the carbon dioxide stream that I am claiming to be excluded under 40 CR 261.4(h) has not been mixed with, or otherwise co-injected with, hazardous waste at the UIC Class VI permitted facility, and that injection of the carbon dioxide stream is in compliance with the applicable requirements for UIC Class VI wells, including the applicable requirements in WWQR Chapter 24."	
Signature	**Printed Name** Jess Foshee
Title Chief Executive Officer	**Date** 06/26/2024

3.0 CERTIFICATION OF PROFESSIONAL GEOLOGIST:

Sections of permit applications that represent geologic work shall be sealed, signed, and dated by a licensed professional geologist as required by W.S. § 33-41-115.

The geologic interpretations, cross-sections, maps, and hydrologic studies that are included in this application (Forms A, A-1, A-2, A-3, A-4, A-5, A-6, A-8, A-9, B-1 – Section 1, 2, 3, 4, & 5, and E) were all completed under the responsible charge or direct supervision of the licensee, who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Geology.

The seal appearing on this document was authorized by Keith S. Thompson on June 28, 2024.

Signature of Professional Geologist

Keith S. Thompson

Printed Name of Professional Geologist

June 28, 2024 PG-2454

Date P.G. Number (SEAL)

PROFESSIONAL GEOLOGIST
KEITH S. THOMPSON
PG-2454
WYOMING

4.0 CERTIFICATION OF PROFESSIONAL ENGINEER:

Section of permit applications that represent engineering work shall be sealed, signed, and dated by a licensed professional engineer as required by W.S. § 33-29-601.

The Engineering Designs, Plans, and Specifications that are included in this application (Forms A, A-1, A-2, A-3, A-4, A-5, A-6, A-8, A-9, B-1 – Section 1, 2, 3, 4, & 5, and E) were all completed under the responsible charge or direct supervision of the licensee who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Engineering.

Signature of Professional Engineer

William J. Zahniser

Printed Name of Professional Engineer

June 28, 2024 WY-12912

Date P.E. Number (SEAL)

Professional Engineer (Environmental)
WILLIAM J. ZAHNISER
12912
Date 6/28/24
WYOMING

3.0 CERTIFICATION OF PROFESSIONAL GEOLOGIST:

Sections of permit applications that represent geologic work shall be sealed, signed, and dated by a licensed professional geologist as required by W.S. § 33-41-115.

The geologic interpretations, cross-sections, maps, and hydrologic studies that are included in this application (Forms A-7, A-10, B-1 – Section 6 & 7, and B-01) were all completed under the responsible charge or direct supervision of the licensee, who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Geology.

Wes Jones	WY - 3861
Printed Name of Professional Geologist	*P.G. Number (SEAL)*
	6/26/2024
Signature of Professional Geologist	Date Signed

4.0 CERTIFICATION OF PROFESSIONAL ENGINEER:

Section of permit applications that represent engineering work shall be sealed, signed, and dated by a licensed professional engineer as required by W.S. § 33-29-601.

The Engineering Designs, Plans, and Specifications that are included in this application (Forms A-7, A-10, B-1 – Section 6 & 7, and B-01) were all completed under the responsible charge or direct supervision of the licensee who has reviewed this work and certifies that it is prepared according to the highest standards of Professional Engineering.

Lewis Wandke	WY - 15731
Printed Name of Professional Engineer	*P.E. Number (SEAL)*
	6/26/2024
Signature of Professional Engineer	Date Signed

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Permit to Construct

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
AoR	Area of Review
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BHA	Bottomhole Assembly
BOP	Blowout Preventors
CBL	Cement Bond Log
CCC	Casper Carbon Capture, LLC
CCL	Casing Collar Locator
Ch.	Chapter
CO_2	Carbon Dioxide
CRA	Corrosion Resistant Alloys
DTS	Distributed Temperature Sensing
DST	Drill Stem Test
DV	Differential Valve
FADP	Financial Assurance Demonstration Plan
Fm	Formation
FMI	Fracture Finder
FOT	Falloff Testing
ft	Feet
gal	Gallons
GCS	Geologic Carbon Sequestration
GL	Ground Level
GR	Gamma Ray
ID	Identification
In.	Inches
KB	Kelly Bushing
lb	Pound
Ls	Limestone
MD	Measured Depth
MI	Mechanical Integrity

MIT	Mechanical Integrity Testing
MMT	Million Metric Tons
MW	Monitoring Well
MWD	Measurement Well Drilling
N	North
N/A	Not Applicable
NAD	North American Datum
ND	Nipple Down
NE	Northeast
NMR	Nuclear Magnetic Resonance
No.	Number
NU	Nipple Up
NW	Northwest
OA	Oxygen Activation
OD	Outer Diameter
PBTD	Plug Back Total Depth
P&A	Plugging and Abandoning
pH	Potential of Hydrogen
PISC	Post-Injection Site Care
PMI	Positive Material Identification
PRB	Powder River Basin
psi	Pounds per Square Inch
Qrt	Quarter
R	Range
RD	Rig Down
RES	Resistivity
RHOB	Bulk Density
RU	Rig Up
SE	Southeast
SF	Fatigue Strength
Sec.	Section
SGCA	Sage Grouse Core Area
SGEO	Governors Executive Order

Sh	Shale
SP	Spontaneous Potential
Ss	Sandstone
SW	Southwest
T	Township
TBD	To Be Determined
TD	Total Depth
Temp	Termperature
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
W	West
WGFD	Wyoming Game and Fish Department
WOC	Wait on cement
WOGCC	Wyoming Oil and Gas Conservation Commission
WWQR	Wyoming Water Quality Rules
WY	Wyoming

Facility Name: Casper Carbon Storage Hub	**Facility ID No.:** TBD
Injection Well Name: Casper Carbon Capture #1	**Monitoring Well Name:** Falls Ranch #1
UIC Class VI Permit No.: TBD	

1.0 GENERAL INFORMATION

1.1 WYOMING CONSERVATION EXECUTIVE ORDERS 2019-3 AND 2020-1

a. Sage Grouse

Pursuant to the requirements of the Governor's Executive Order 2019-3 (SGEO), applicants for new Underground Injection Control (UIC) permits must determine if any part of the project falls within a Greater Sage-Grouse Core Area (SGCA) before applying. If any part of the project falls within an SGCA, the first point of contact for addressing sage-grouse issues is the Wyoming Game and Fish Department (WGFD). Please coordinate with the WGFD and obtain written confirmation of consistency with the Executive Order prior to applying for a UIC permit and submit this documentation as part of the application package. For more information, contact the Wyoming Game and Fish: Wyoming Game and Fish Department Habitat Protection Program (307) 777- 4506 or wgfd.hpp@wyo.gov.

Note that the application shall be returned without processing until a letter confirming consistency with the Executive Order has been obtained. Additional information and maps of SGCAs are available at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management.

Check one of the following, as applicable to the project:

☐ Some part, or all, of my project falls within an SGCA and I have contacted the WGFD for a SGEO review. A letter from the WGFD confirming consistency with the Executive Order is attached.

☐ Some part, or all, of my project falls within an SGCA and I have contacted the WGFD for a SGEO review. It does not comply with the SGEO. I have valid and existing rights related to this permit. I have committed to the following recommendations that will minimize the impact on the sage grouse.

☒ By checking this box, I certify that I have reviewed the SGCAs available online and determined that no portion of my project falls within an SGCA. (No additional requirements apply.)

b. Migration Corridors

Pursuant to the requirements of the Governor's Executive Order 2020-1, applicants for new UIC permits must determine if any part of the project falls within a Migration Corridor designated under the Executive Order before applying. If any part of the project falls within a Migration Corridor, you must consult with the WGFD. Please coordinate with the WGFD and obtain written confirmation of consistency with the Executive Order prior to applying for a UIC permit and submit this documentation as part of the application package. For more information, contact the Wyoming Game and Fish: Wyoming Game and Fish Department Habitat Protection Program (307) 777-4506 or wgfd.hpp@wyo.gov. Note that the application shall be returned without processing until a letter confirming consistency with the Executive Order has been obtained.

Please also visit the WGFD's Management Page for more information and a map of designated Migration Corridors:
https://sites.google.com/view/wywildlifemigrationadvisorygrp/home?fbclid=IwAR3y_HEQxOo4HckAVKz RzT5kdLaOsyiV0vt9NJOtzNu45b_WK0vESwTWVzY#h.bc90kvcpohnu.

Check one of the following, as applicable to the project:

☐ Some part, or all, of my project falls within the area described and I have contacted the WGFD for consultation. A letter from the WGFD confirming consistency with the Executive Order is attached.

☒ By checking this box, I certify that I have reviewed the Migration Corridors information available online and determined that no portion of my project falls within a Migration Corridor. *(No additional requirements apply.)*

1.2 STANDARD INDUSTRIAL CLASSIFICATION CODES

List in descending order of significance the four (4) digit "Standard Industrial Classification Manual" which best describes your facility in terms of the principal products or services you produce or provide. Also, specify each classification in words.	1st	7389 / Business services, not elsewhere classified
	2nd	Code/Name
	3rd	Code/Name
	4th	Code/Name

1.3 WATER QUALITY MANAGEMENT PLAN, WELLHEAD PROTECTION AREA, SOURCE WATER PROTECTION AREA

Is the Geologic Sequestration Project within a state-approved water quality management plan area?	YES ☐	NO ☒
Is the Geologic Sequestration Project within a state-approved wellhead protection area?	YES ☐	NO ☒
Is the Geologic Sequestration Project within a state-approved source water protection area?	YES ☐	NO ☒

1.4 MINERAL AND SURFACE OWNERSHIP FOR AREA OF REVIEW

Table 1: Mineral Ownership - Included as Form B Appendix

Name	Lease Number	Township	Range	Section	Qrt Qrt	Mailing Address
See Form B Appendix						

Table 2: Surface Ownership – Included as Form B Appendix

Name	Lease Number	Township	Range	Section	Qrt Qrt	Mailing Address
See Form B Appendix						

Per W.S. 35-11-313(f)(ii)(N), the applicant shall provide notice of the application for the proposed geologic sequestration project. Proof of notice is required to surface owners, mineral claimants, mineral owners, lessees, and other owners of record of subsurface interests that are located within one (1) mile of the proposed boundary of the geologic sequestration site (i.e., CO_2 plume). The affidavit is to be submitted along with the above Mineral and Surface Ownership tables. Copies of the letters sent are not necessary.

Table 3: Historic or Archeological Site						
Name of Site	**Site Description**	**Township**	**Range**	**Section**	**Qrt Qrt**	**State or Fed?**
NA						

1.5 ACCESS FOR INSPECTIONS

Wyoming Statute (W.S.) 35-11-303 (a) states: "the administrator of the water quality division at the direction of the director: (i) may conduct on-site compliance inspections of all facilities and work during or following the completion of any construction, installation or modification for which a permit is issued under W.S. 35-11-301 (a)(ii)."

As part of its application, the applicant shall certify under penalty of perjury that the applicant has secured and shall maintain permission for Wyoming Department of Environmental Quality (WDEQ) personnel to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by W.S. § 6- 3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road. A map of the access route(s) to the facility shall accompany the application.

I, [signature], certify under penalty of perjury that the applicant has secured and shall maintain permission for WDEQ personnel and their invitees to access the permitted facility, including (i) permission to access the land where the facility is located, (ii) permission to collect resource data as defined by Wyoming Statute § 6-3-414, and (iii) permission to enter and cross all properties necessary to access the facility if the facility cannot be directly accessed from a public road.

2.0 CLASS VI WELL

Casper Carbon Capture, LLC (CCC) proposes to construct and operate a Class VI Underground Injection Control carbon sequestration well in Natrona County, Wyoming, approximately six miles southeast of Casper, Wyoming, and 4.5 miles west of the Converse County border (Figure 1). The goal of the Casper Carbon Storage Hub is to permanently store CO_2 removed from the atmosphere. The facility will be a commercial-scale carbon capture system that will be designed, constructed, and operated with the capability of storing CO_2 into deep geologic formations. The site was chosen based on the geology, the proximity to emitting sources of CO_2, and the availability of usable surface and subsurface landownership. The safely transported CO_2 will be injected into the Sundance Formation and Crow Mountain Sandstone at a proposed total of 6 million metric tons (MMT) over a 15-year injection period (an average of 400,000 metric tons per year). The project expects to begin operations at an initial rate of 50,000 metric tons per year, ramping up by an additional approximate 50,000 metric tons per year, to a maximum rate of 750,000 tons per year.

The Casper Carbon Storage Hub is located on the southwestern margin of the Powder River Basin (PRB), which for more than 100 years has yielded extensive energy and mineral resources. The PRB accounts for more than half of Wyoming's oil production – more than any other basin in the state – and ranks second in natural gas production. Additionally, the development of coal and coal-bed methane resources remains active in more northern portions of the basin.

Recently, increased interest in renewable energy and carbon emission reduction has shined a spotlight on the PRB as a potentially vast opportunity for geologic carbon sequestration (GCS). In addition to proximity to CO_2 emitters and infrastructure access, the basin offers many subsurface characteristics that are favorable for GCS:

- A thick column of sandstone, shale, and carbonate units that provide regionally extensive reservoirs and seals;
- Structural and stratigraphic traps at depths suitable for the permanent storage of injected CO_2;
- Saline aquifer storage potential in areas or formations that lack hydrocarbons;
- Depleted reservoir storage potential in previously developed oil and gas fields;
- Extensive data and subsurface knowledge generated over decades of oil and gas development to support GCS activity.

Casper Carbon Capture has prepared this Class VI application using a combination of regional and local studies, publicly available data, and purchased or licensed private data. In certain sections of this application, local data was not readily available. Regional data was substituted as a preliminary estimate and site-specific data will be acquired during the construction of the project.

The application summarizes the geology of the planned well locations, the evaluation of the qualities required to permanently contain the sequestered CO_2 and outlines the engineering design and safety requirements of the constructed wells. The application will also discuss the future plans for additional data collection and planned monitoring system, which will be used to analyze the movement of the actual injectate plume with that predicted by reservoir modeling and simulation.

This application has been developed to meet all the requirements of the WDEQ Water Quality Rules Chapter 24. Once the permit has been issued, per the requirements of Chapter 24 Section 13(c) the permit will be updated every two years thereafter for the active injection life of the well.

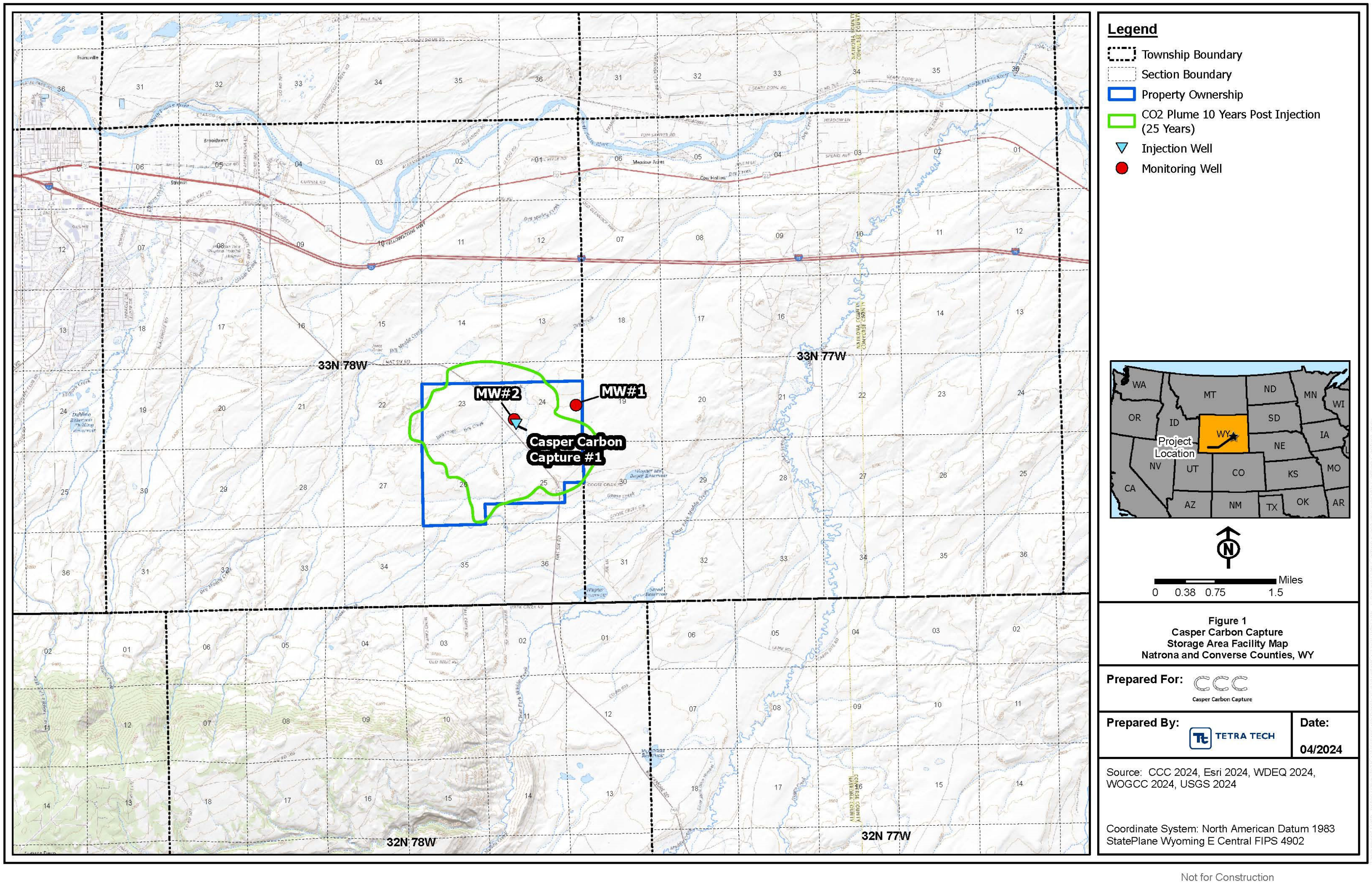


Figure 1: Project map.

3.0 SITE CHARACTERIZATION INFORMATION

Regional dip and strike structural cross sections are located on Figure 2 and shown in Figure 3 and Figure 4. These lines are adapted from a large set of United States Geologic Society (USGS) structural cross sections covering the PRB to demonstrate alignment with previously published work. The selected data are highlighted on the map. The cross sections have a consistent vertical scale, are constructed with well logs, and show regional correlations of formations from the surface to the confining strata below the injection zone. Stratigraphic units, aquifers, and injection and confining zones are indicated.

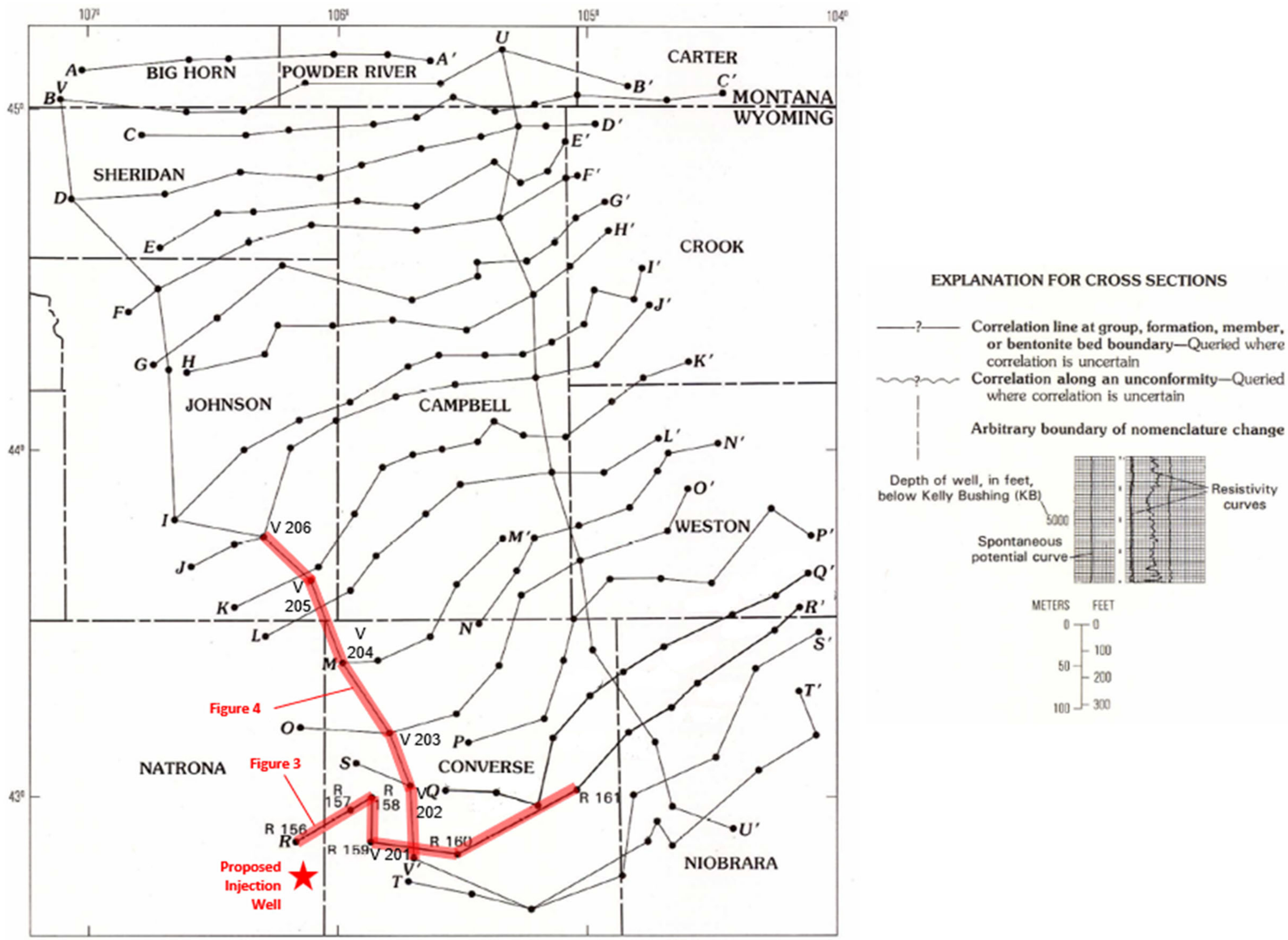


Figure 2: cross-section map (after Fox, 1993).

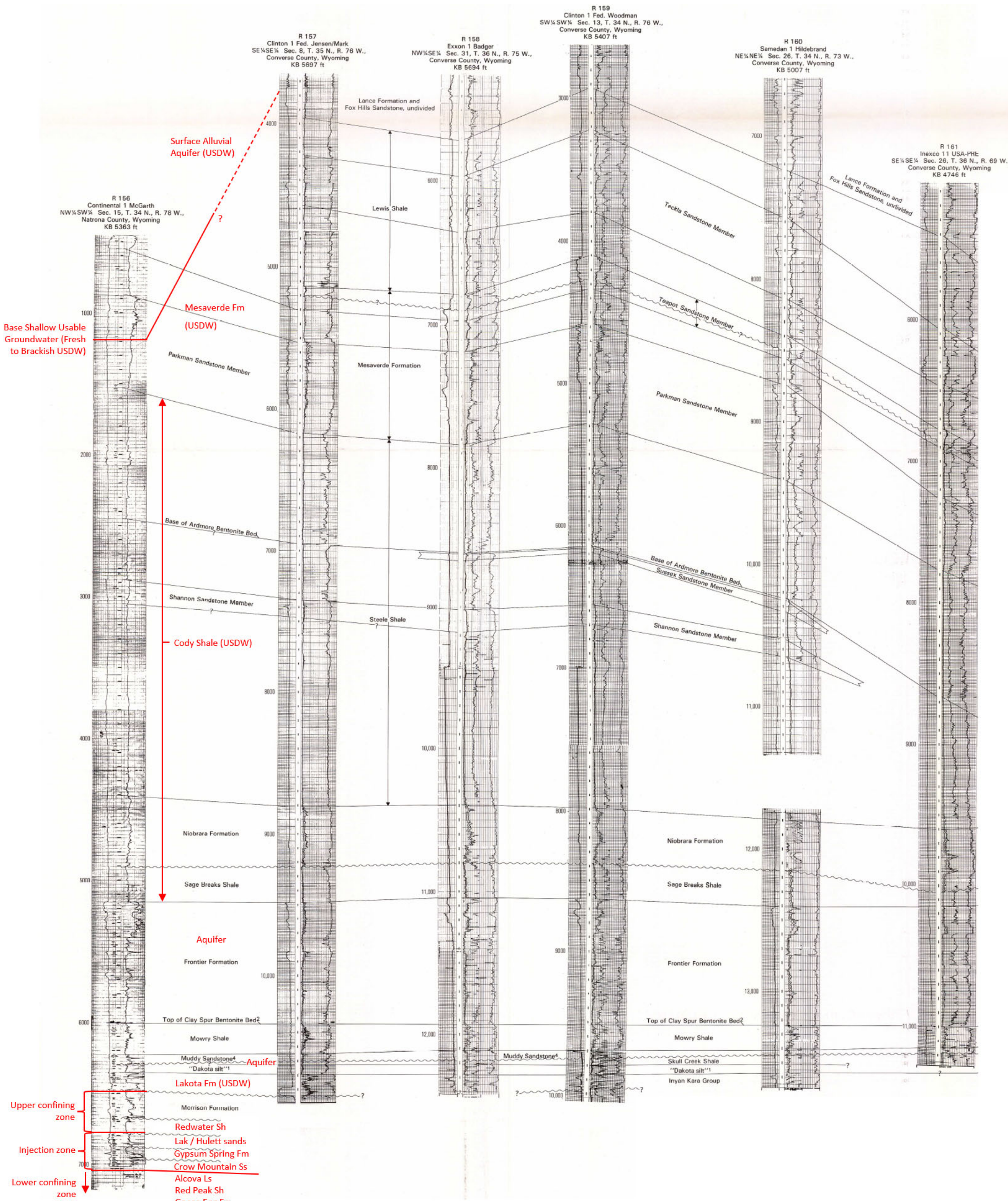


Figure 3: Cross-section (dip-oriented) of the Powder River Basin near the Project Area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

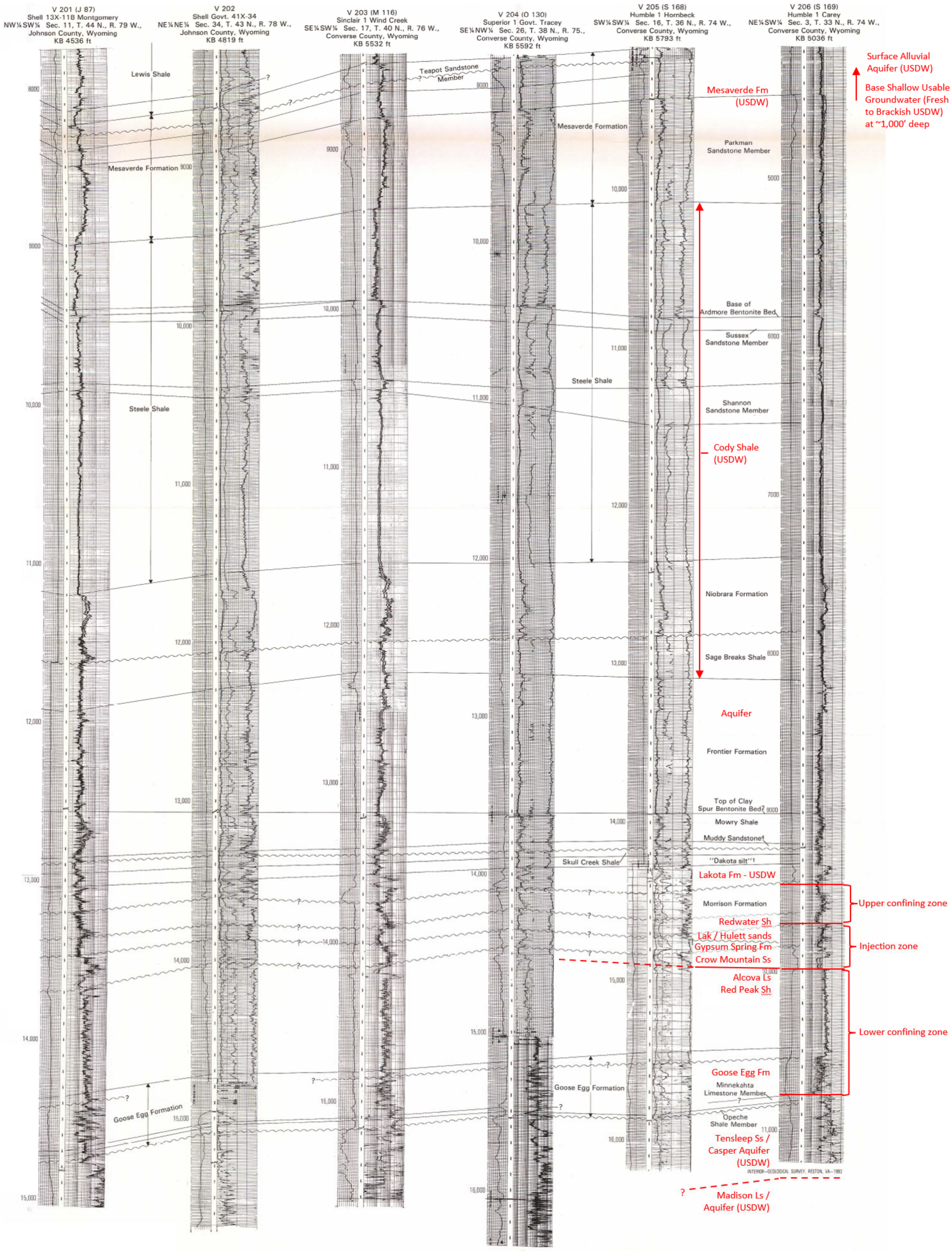


Figure 4: Cross-section (strike-oriented) of the Powder River Basin near the project area. Annotations in red are specific to the Casper Carbon Storage Hub (after Fox, 1993).

Is storage reservoir information different than what is provided in the Project Site Characterization Section?

☐ **Yes (complete only the applicable sections)** ☒ **No (go to next Section 4.0)**

4.0 AREA OF REVIEW

Is Area of Review (AoR) information different than what is provided in the Project AoR Section?

☐ **Yes (complete only the applicable sections)** ☒ **No (go to next red bolded question)**

Is AoR Model information different than what is provided in the Project AoR Model Section?

☐ **Yes (complete only the applicable sections)** ☒ **No (go to next red bolded question)**

Is AoR Corrective Action information different than what is provided in the Project AoR Corrective Action Section?

☐ **Yes (complete only the applicable sections)** ☒ **No (go to next red bolded question)**

Is AoR Corrective Action Plan different than what is provided in the Project AoR Corrective Action Plan Section?

☐ **Yes (complete only the applicable sections)** ☒ **No (go to Section 5.0)**

5.0 FINANCIAL ASSURANCE

The Financial Assurance Demonstration Plan (FADP) is prepared to account for the planned injection well in CCC's sequestration project in Natrona County, Wyoming with a ten-year post-injection site care period (PISC), or until criteria are met per the Wyoming Water Quality Rules. The FADP considers CCC facility permits and associated Class VI drilling permits to satisfy WDEQ regulations contained in Chapter 24 of the Water Quality Rules and Regulations.

Table 4 contains a financial assurance summary for the Casper Carbon Storage Hub.

Table 4: Financial Assurance Summary		
Financial Responsibility Element	**Cost Estimate**	**When Funded**
A. Injection and monitoring well-plugging	$1,100,000.00	Prior to construction
Total Cost Prior to Well Construction:		**$1,100,000**

6.0 WELL CONSTRUCTION, WELL CASING AND CEMENTING PROGRAM

6.1 CO_2 INJECTION WELL CASING AND CEMENTING PROGRAMS

6.1.1 Injection Zone Information

The proposed injection well, Casper Carbon Capture #1, will target the Sundance Injection Zone and will be drilled to a TD of approximately 6,343 feet, or approximately 100 feet into the Underlying Chugwater Formation, which composes the upper portion of the lower confining zone. Actual well depth will be refined based on site-specific conditions encountered during drilling. Table 5 contains Injection Well Information.

Table 5: Injection Well Information (referenced below ground surface in feet)			
Well Name	**Injection Zone Formation Name**	**Injection Well Total Depth, ft**	**Injection Zone Depth, ft**
Casper Carbon Capture #1	L Sundance through Crow Mtn	6,343	6,002

6.1.2 Casing Design

The surface casing depth and specifications for Casper Carbon Capture #1 have been selected and designed to protect the lowermost underground source of drinking water (USDW). The long string protection casing and injection tubing are designed to satisfy installation requirements, and to suit the existing subsurface geologic, formation fluid, and injected fluid environment. Procedures to install casing, tubing, and packer in the well are described in the construction plans (Section 6.0). Note that wellbore construction elements are subject to change based on vendor and material availability and operational constraints. CCC will provide WDEQ with a final construction procedure prior to installation Table 6 contains casing program details while Table 7 details casing properties.

Table 6: Casper Carbon Capture #1 Casing Program								
Section	**Hole Size, in.**	**Outside Diameter (inches)**	**Weight (lb/ft.)**	**Grade (API)**	**Connection**	**Top Depth, ft**	**Bottom Depth, ft**	**Objective**
Conductor	20	16	N/A	N/A	Welded	0	100	
Surface	12.25	9.625	36	K-55	LTC	0	1,000	
Protection	8.75	7	26	N-80	LTC	0	5,000	
Protection	8.75	7	26	CRA	TBD	5,000	6,343	

Table 7: Casper Carbon Capture #1 Casing Properties									
Outside Diameter (inches)	**Grade (API)**	**Weight (lb/ft.)**	**Connection**	**Inside Diameter (inches)**	**Drift, in.**	**Burst Strength (psi)**	**Collapse Strength (psi)**	**Yield Strength, 1000 lb**	
								Body	**Connection**
16	N/A	N/A	Welded	15.5	TBD	N/A	N/A	N/A	N/A
9.625	K-55	36	LTC	8.921	TBD	3,520	2,020	564	489
7	N-80	26	LTC	6.276	TBD	7,240	5,410	604	519
7	CRA	26	TBD	6.276	TBD	7,240	5,410	604	519

Minimum Casing Design Factors

Based on typical industry standards, the following minimum casing design factors would be used:

Collapse	1.05
Tensile	1.45
Burst	1.10

Surface Casing Design Factors based on the following:

Collapse: 3.07 SF: Based on: External Gradient of 0.81 psi/ft; Internal Gradient of 0.2 psi/ft

Tensile: 3.58 SF: Based on 100,000 pounds of overpull

Burst: 1.67 SF: Based on: External Gradient of 0.20 psi/ft; Internal Gradient of 0.81 psi/ft

Protection Casing Design Factors based on the following:

Collapse: 1.30 SF: Based on: External Gradient of 0.81 psi/ft; Internal Gradient of 0.2 psi/ft

Tensile: 1.95 SF: Based on 100,000 pounds of overpull

Burst: 1.35 Sf: Based on: External Gradient of 0.20 psi/ft; Internal Gradient of 0.81 psi/ft

All strings of casing and tubing will be certified as new with mill test reports and verification via third party positive material identification (PMI) if needed.

All tubular goods will be shipped with thread protectors and loaded onto trucks using suitable stripping between layers. All tubular goods will be offloaded at the site using a forklift to protect from damage while handling. Threads will be cleaned and new thread compound will be installed prior to installation.

6.1.3 Injection Well Construction Procedure

Upon preparation of the site and mobilization of required equipment, 16-inch conductor casing will be driven or set to a depth of approximately 100 feet. The cementing program will be determined based on field conditions, but at a minimum will consist of a mixture of Type IL standard cement with additives or a suitable equivalent. Excess cement (minimum of 25% of the calculated volume) will be available and may be used based on measured hole conditions.

Site-specific conditions will be used to further refine cement volume. Standard site health and safety procedures will be implemented during the well installation, including daily and task-specific safety meetings.

A 12 1/4-inch borehole will then be drilled out of conductor casing to a depth of approximately 1,000 feet, well below the base of the lowermost USDW above the injection zone. Confirmation of the base of the lowermost USDW (Lakota Formation) will be conducted via geophysical well logging. After the openhole logging/testing program is completed, the hole will be conditioned and 9 5/8-inch 36 lb/ft K-55 LTC (or suitable equivalent) casing will be installed from surface to a depth of approximately 1,000 feet. The cementing program will be determined based on field conditions, but at a minimum will consist of a mixture of ASTM Type 1LCI standard cement with additives or a suitable equivalent. Excess cement (minimum of 75% of the calculated volume) will be available and may be used based on measured hole conditions. It is anticipated that a float shoe will be used with a float collar located one joint off bottom, and that centralizers will be placed at a minimum of one every third joint depending on hole condition. Other than cement volume that may be modified based on well conditions encountered at the time of cementing, advanced notice will be provided to WDEQ if cement plans are changed.

After the surface casing string has been cemented and the recommended wait on cement (WOC) time (based on blend-specific lab reports) has elapsed, the remaining cement will be drilled out of the surface casing shoe and an 8 3/4-inch hole will then be drilled to approximately 6,343 feet, into the Chugwater Formation. One approximately 100-foot core section will be collected from the Morrison/Sundance Redwater, one approximately 100-foot core will be collected from the Lower Sundance, and one 100-foot core will collected from the top of the Chugwater. Additional sidewall cores may be collected after reviewing open hole logs. A cement bond log (CBL) will be conducted over the surface casing interval to demonstrate cement integrity behind the casing. Openhole logging will be completed from the base of the surface casing to the TD of the 8 3/4-inch hole.

It is projected after the first phase of the deep openhole logging program is complete, the hole will be conditioned and 7-inch, 26 lb/ft, L-80 LT&C (long threaded and coupling) long-string protection casing, or suitable equivalent, will be installed to a depth of approximately 6,343 feet with approximately 1,350 feet of corrosion resistant alloys (CRA) material casing on bottom. The cementing program for the protection casing will be determined based on field conditions but is projected to consist of a mixture of Class G standard cement lead and a Glass G with latex additives tail, or suitable equivalents. A minimum of 150 sacks of CO_2 resistant cement will be displaced above the shoe. A differential valve (DV) tool will be placed at approximately 5,000 feet, through which the second stage of cement will be pumped. Excess cement (minimum of 25% of the calculated volume) will be available and may be used based on measured hole conditions. It is anticipated that a float shoe will be used, with a float collar one joint up from the bottom, and that centralizers are to be placed a minimum of one every third joint based on hole conditions.

No over-pressured zones are anticipated during drilling of the Casper Carbon Capture #1 well. If under-pressured zones are encountered, lost-circulation materials will be utilized to control fluid loss as necessary based on well conditions. Fresh water will be trucked to the site using local oilfield suppliers or a pre-existing water well located on the property will be used to supply water during drilling and testing of this well. Water-based mud will be used as the drilling fluid and will be held in on-site tanks with no in-ground pits.

Injection Well Cementing Procedures

The following general cementing procedures have been designed for the installation of Casper Carbon Capture #1. The procedures may be modified slightly during field operations as warranted based on the downhole conditions encountered.

The surface casing will be cemented in a single stage. A float shoe will be run on bottom with a float collar one joint off bottom. A plug will be dropped behind the cement and displaced to the float collar while circulating cement back to surface. The cement will be allowed to set and develop compressive strength per service company recommendations.

The protection casing will be cemented using a two-stage method. A float shoe will be run on bottom with a float collar one or two shoe joints off bottom. A plug will be dropped behind the first stage cement and displaced to the float collar. An opening device will be dropped to open the stage tool (unless a hydraulic tool is used), located at approximately 5,000 feet. Mud will then be circulated through the long-string casing annulus above the stage tool by pumping through the stage tool. Returns will be observed to determine if cement from the first stage is recovered. The second stage cement will then be pumped after sufficient WOC time for the first stage. A plug will be dropped behind the second stage cement and displaced to the stage tool while circulating cement back to the surface. The plug will be pumped to close the stage tool.

Any casing shoe tests will be run at values conservatively estimated to be below fracture pressure. As noted by Bourgouyne et al. (1991), the exact amount of compressive strength needed before drilling activities can continue is difficult to determine, but a value of 500 psi is commonly used in field practice. Compressive strengths that exceed projected test pressures for the proposed cement blends over the range of temperatures will be provided by the cement vendors prior to drilling.

Table 8 contains cementing program details.

Table 8: Casper Carbon Capture #1 Cementing Program						
Casing	**Stage 1**		**Stage 2**		**Excess %**	**Volume, sacks**
	Slurry	**Interval (ft)**	**Slurry**	**Interval (ft)**		
Conductor	Grout	0 - 100	N/A	N/A	20	TBD
Surface	ASTM Type 1LCI or equivalent (est. 15.6 ppg)	0 – 1,000	N/A	N/A	75	TBD
Long-String	CO_2-resistant (est. 15.6 ppg)	5,000 - 6,343	Class G or equivalent (est. 13.5 ppg)	0 - 5,000	25	TBD

Casing and cement or other materials used in the construction of Casper Carbon Capture #1 shall have sufficient structural strength and designed for the life of the well [Ch24 Section14(b)].

The proposed completion diagram is presented in the attached Figure 5.

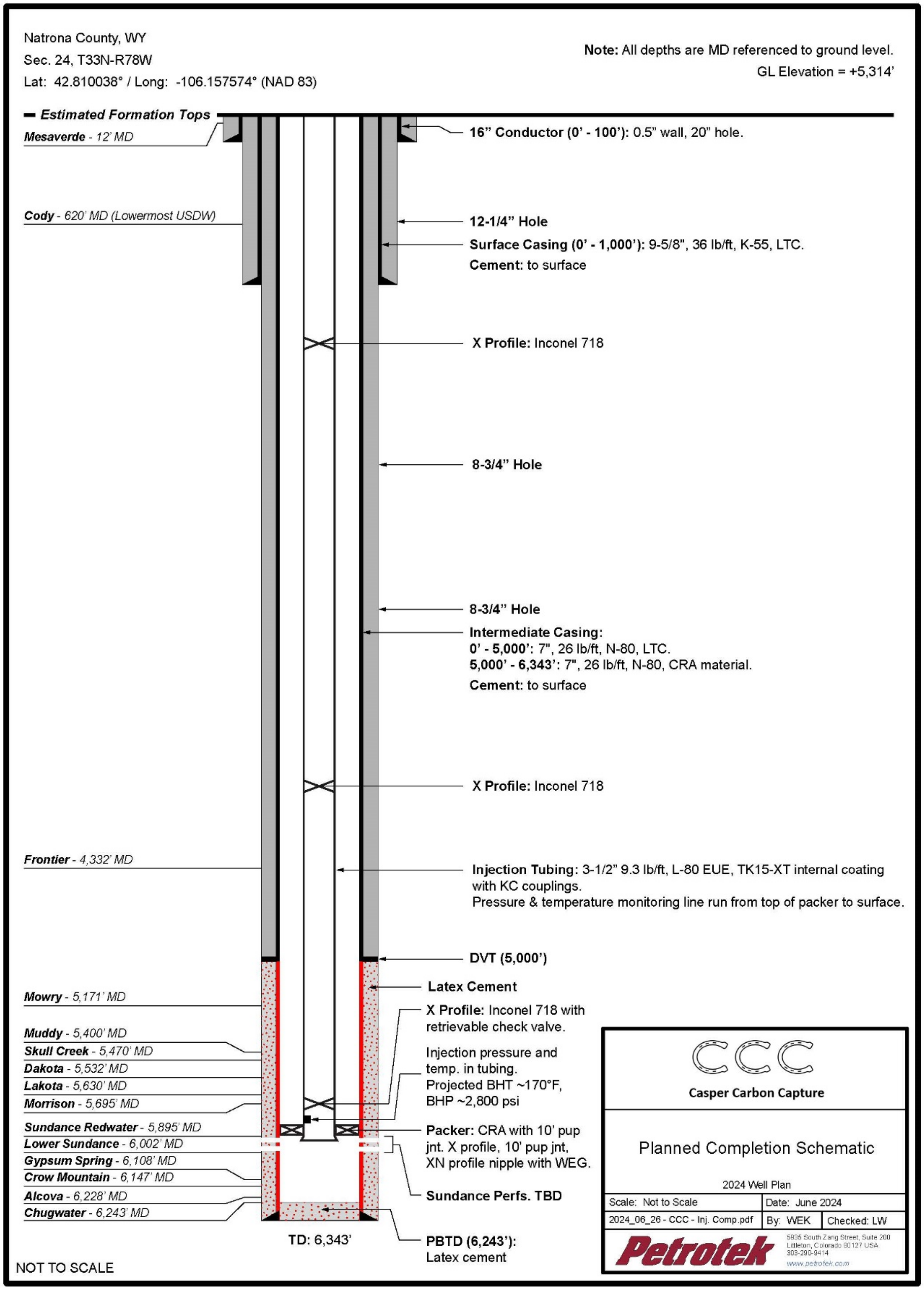


Figure 5. Proposed Injection Well Schematic

6.1.4 Monitoring Well Casing and Cementing Programs

Table 9: Falls Ranch #1 Monitoring Well Casing Program								
Section	**Hole Size, in.**	**O.D. (inches)**	**Weight (lb/ft.)**	**Grade (API)**	**Connection**	**Top Depth, ft**	**Bottom Depth, ft**	**Objective**
Conductor	20	16	N/A	N/A	Welded	0	100	
Surface	12.25	9.625	36	K-55	LTC	0	1,000	
Protection	8.75	7	26	N-80	LTC	0	6,350	

Table 10: Falls Ranch #1 Monitoring Well Casing Properties									
O.D., in	**Grade (API)**	**Weight (lb/ft.)**	**Connection**	**I.D., in**	**Drift, in.**	**Burst (psi)**	**Collapse (psi)**	**Yield Strength, 1000 lb**	
								Body	**Connection**
16	N/A	N/A	Welded	15.5	TBD	N/A	N/A	N/A	N/A
9.625	K-55	36	LTC	8.921	TBD	3,520	2,020	564	489
7	N-80	26	LTC	6.276	TBD	7,240	5,410	604	519

Table 11: Falls Ranch #1 Monitoring Well Cementing Program						
Casing	Stage 1		Stage 2		Excess %	Volume, sacks
	Slurry	Interval (ft)	Slurry	Interval (ft)		
Conductor	Grout	0 – 100	N/A	N/A	20	TBD
Surface	ASTM Type 1LCI or equivalent (est. 15.6 ppg)	0 – 1,000	N/A	N/A	75	TBD
Long-String	Class G or equivalent (est. 15.6 ppg)	5,000 – 6,350	Class G or equivalent (est. 15.6 ppg)	0 – 5,000	25	TBD

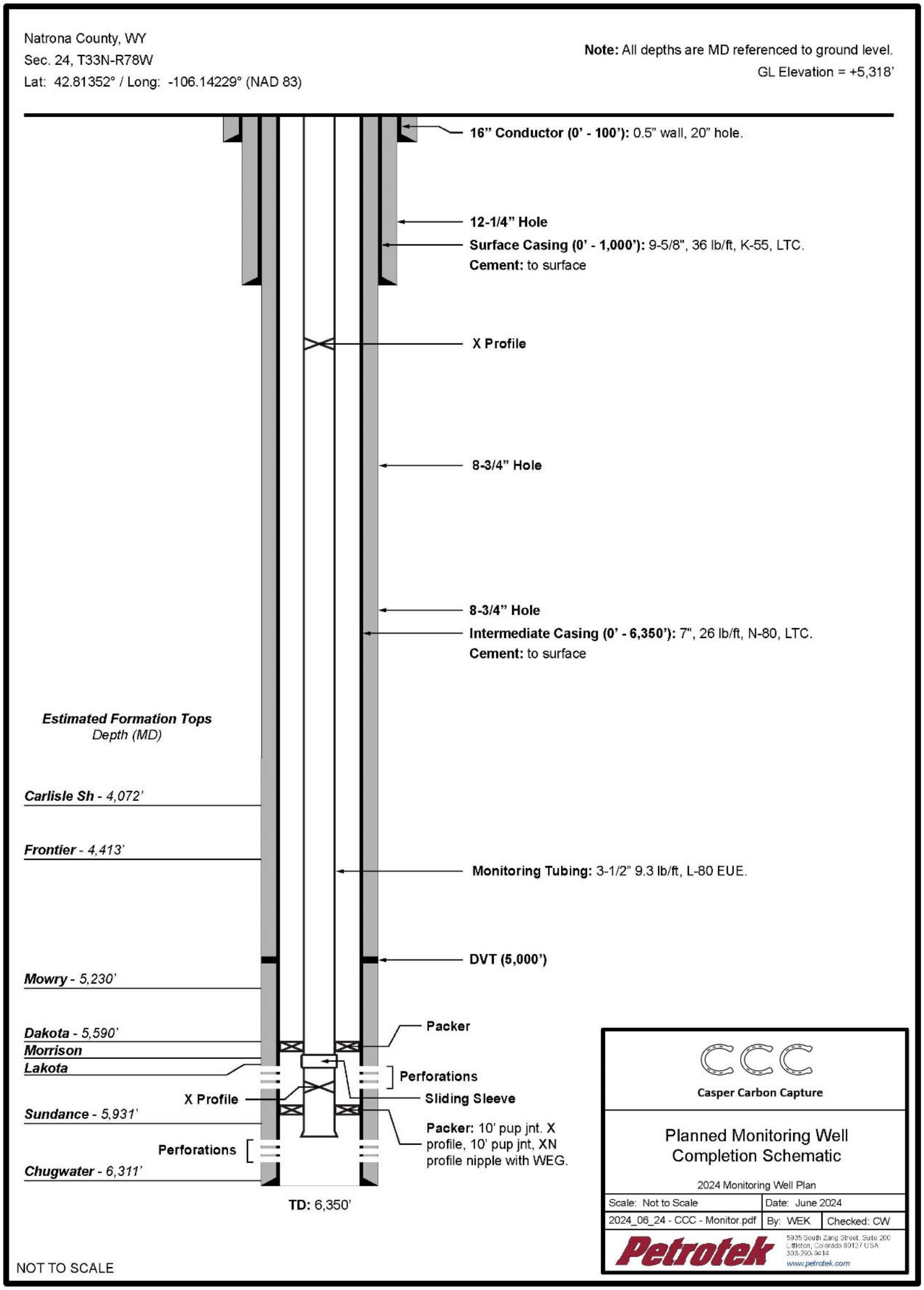


Figure 6: Proposed Monitoring Well Schematic

6.2 INJECTION WELL TUBING AND PACKER

The Casper Carbon Capture #1 tubing will consist of 3 1/2-inch outside diameter (OD), 9.3 lb/ft, L-80 tubing with TK15XT coating, utilizing Tuboscope KC couplings, or suitable equivalent. The tubing size and weight, as well as the internal coating material, are chosen for their strength and durability in the environment of a carbon sequestration injection well. Tubing specifications are provided in Table 12.

A polish bore receptable packer constructed of corrosion-resistant materials to ensure it can withstand the specific conditions of the injection well environment will be installed within 100 feet of the injection zone in a casing section with good cement isolation per Ch24 Section 14(c). The tubing will be landed in the packer with a seal bore assembly that is also built from corrosion resistant materials as well as elastomer seals that are appropriate for the service. The seal bore can be removed from the well with the tubing if needed for maintenance and repair. Proposed packer specifications are provided in Table 12.

In addition to the tubing and Polish Bore Receptacle packer, other components that may be included in the injection well design include a check valve to control the flow of CO_2 and a monitoring system to track the operational parameters such as bottom hole pressure and bottom hole temperature, of the injection well. All of these components work together to ensure the safe and effective sequestration of CO_2 in the subsurface.

Table 12: Tubing and Packer Details

Material	**Setting Depth Interval and Units**	**Tensile Strength**	**Burst strength (psi)**	**Collapse strength (psi)**	**Material** (e.g., weight/ grade/ connection)	**Outside Diameter (inches)**	**Inside Diameter (inches)**
Injection tubing	0-6,000	N/A	10,160	10,540	9.3 lb/ft / Lined L80 / EUE	3.5	2.992
Retrievable/ Seal Bore Packer	Approx. 6,000	N/A	N/A	N/A	23-29 lb/ft	6.000	2.347

6.3 MATERIAL COMPATIBILITY

The casing and tubular selections are based on American Petroleum Institute standards, historical materials performance, and professional recommendations from vendors. Casing, cement, tubing and packers shall meet or exceed the standards specified in WDEQ Ch24, Section 14 (b)(i) and (c)(i). The casings to be used in the construction of the well are designed for the life expectancy of the well. The casings proposed for Casper Carbon Capture #1 are rated to have sufficient structural strength for the design life of the well including the maximum pressures and tensile stress which may be experienced at any point along the length of casing or tubing.

CCC will monitor for any potential corrosion using well construction material coupons placed in a flow loop for all materials exposed to the injection stream per Wyoming Water Quality Rules (WWQR) 20(b)iii(B) as further detailed in Form A-5.

6.4 WELLHEAD DESIGN AND SHUT-OFF SYSTEM INFORMATION

The wellhead will be pressure rated to withstand maximum injection pressures for the life of the project. Wetted components of the wellhead with be CRA materials that are corrosion resistant to the injectate, or standard well head materials that are internally coated to protect from corrosion. The outer surface of each wellhead will be protected at all times with protective paint as a corrosion preventative. A final wellhead configuration will be provided to WDEQ upon submittal of a finalized drilling and completion report.

CCC will utilize either surface or downhole shut-off valves or a combination of both. For a surface shut-off system, a wellhead shutdown valve would potentially be installed on the injection line connection for emergency conditions. For a downhole shut-off system, check valve(s) will be set in a profile nipple(s) in the injection tubing before operation. If the shut-off system is triggered at any time during project operation, CCC will investigate as expeditiously as possible the cause of the valve triggering.

6.4.1 Logging, Sampling and Testing Prior to Injection Operations

Chapter 24, Section 17 specifies that "During the drilling and construction of a Class VI injection well, the owner or operator shall run appropriate logs, surveys, and tests to determine or verify the depth, thickness, porosity, permeability, lithology, and salinity of any formation fluids in all relevant geologic formations to ensure the well meets the construction requirements of Section 14 of this Chapter and to establish accurate baseline data against which future measurements may be compared. The owner or operator shall submit to the Administrator a descriptive report prepared by a knowledgeable log analyst that includes an interpretation of the results of the logs and tests" Requirements set forth in Section 17 including logging and tests, as described below.

6.5 DEVIATION CHECKS

As addressed in Chapter 24 Section 17 (a)(i), deviation checks will be performed. The Casper Carbon Capture #1 wellbore is planned to be vertical with less than 3 degrees of inclination. Deviation checks are planned to be performed at a minimum of every 300 feet measured depth (MD) in the event a measurement well drilling (MWD) system is not in the bottomhole assembly (BHA).

6.6 PLANNED LOGGING PROGRAM

The logging program will include logging requirements specified at Ch24 Section 17(a)(ii) and includes logging to be conducted before and upon installation of the surface and long string casings. Required logs are described below and in Table 13 and the table will be updated based on actual data from the injection well.

Figure 7: Cement Evaluation Log – NA, to be completed after drilling of injection well

6.6.1 Openhole Logs

The surface section openhole logs will include, at a minimum, GR, SP, RES, and caliper logs. Depending on the mud type, SP may not be run effectively if freshwater is used as drilling fluid. GR will be run regardless and provide the primary log for lithologic correlations.

Openhole logs will be obtained over the entire interval, from the base of the surface casing to TD of the well (prior to installation of the protection casing) and will include, at a minimum, GR, SP, RES, caliper, RHOB, and neutron porosity. Depending on the mud type, SP may not be run effectively if freshwater used as drilling fluid. GR will be run regardless and provide the primary log for lithologic correlations. In addition, FMI, nuclear magnetic resonance (NMR), and dipole sonic logs will be run from TD to above the confining zone (approximately 6,350 to 5,000 feet) to provide additional site characterization data for the injection and confining zones.

6.6.2 Cased Hole Logs

Cased hole logs will be obtained for the surface casing and protection casing and will include a CBL and temperature log. Logging of the protection section CBL may occur at the end of drilling operations or during completions, depending on scheduling and tool availability. In addition, a casing inspection log of the protection casing will be run near the end of the drilling operations, or during the completion operations, to establish a baseline measurement of the casing and help evaluate initial mechanical integrity prior to injection activities.

Table 13: Proposed Logging Program for Casper Carbon Capture #1

Hole Section	Log Run Title	Log Type (Openhole or Cased Hole)	Comments
Surface (0-1,000')	GR, SP[1], RES, Caliper	Openhole	
Surface (0-1,000')	Cement Bond Log	Cased Hole	
Surface (0-1,000')	Temperature Log	Cased Hole	
Protection (1,000-6,350')	GR, SP[1], RES, Caliper	Openhole	
Protection (1,000-6,350')	RHOB, Neutron Porosity	Openhole	
Protection (5,000-6,350')	Dipole Sonic	Openhole	Section TD to above Confining Zone
Protection (5,000-6,350')	Nuclear Magnetic Resonance	Openhole	Section TD to above Confining Zone
Protection (5,000-6,350')	Fracture Finder (FMI)	Openhole	Section TD to above Confining Zone
Protection (0-6,350')	Radial Cement Bond Log or Ultrasonic Cement Bond Log	Cased Hole	
Protection (0-6,350')	Temperature Log	Cased Hole	
Protection (0-6,350')	Casing Inspection Log	Cased Hole	

[1]SP run if wellbore conditions allow. GR to be utilized for primary lithology correlation.

6.7 CORING PROGRAM

Collection of whole core is planned in Casper Carbon Capture #1. Approximately 100 feet of the confining zone will be cored, approximately 100 feet of the injection zone will be cored, and approximately 100 feet of the lower confining zone will be cored to characterize these intervals. Sidewall coring may be conducted if whole cores cannot be collected, or if it is determined that additional characterization is needed.

6.8 WELL TESTING

Formation falloff tests (FOT) will be performed at Casper Carbon Capture #1 in the injection zone formation(s) (Sundance). Step-rate tests will be performed on the injection zone (Sundance), and fluid samples will be collected from the injection zone to satisfy requirements at Chapter 24, Section 17(d). Due to the expected low permeability of the confining zone(s) no fluid sample is planned to be collected from the confining zone(s). Step-rate testing of the confining zone(s) is not planned at this time, based on the multitude of core analyses that will be performed to further determine confining and injection zone characteristics, such as geomechanical information of the injection and confining zones. The step-rate test in the injection zone, in conjunction with core and log data collected at Casper Carbon Capture #1, will provide the full complement of data necessary for site-specific geologic characterization. Geophysical logs and core from Casper Carbon Capture #1 will also be used to confirm the site-specific fracture pressure calculation.

6.9 WELL FLUID AND CUTTINGS SAMPLING

Mud logging, which collects formation cuttings from the mud returns at surface, will be performed during drilling activities and included in subsequent reporting. Cuttings reporting will be included from beneath the conductor casing to the well TD. Cutting sampling frequency and analysis will be determined prior to drilling activities based on vendor and equipment capabilities.

A mud log reporting the cuttings from the well will be included in the sample collection.

Fluid sampling will be conducted in the Sundance injection zone by means of perforation and swabbing. Swabbing will be conducted until pH, conductivity, and specific gravity have stabilized, at which point a fluid sample will be collected and sample data submitted to WDEQ per Ch 24, section 17, (b)(i)(C).

A drill stem test (DST) may be used as an alternate test method to obtain fluid samples if well conditions are deemed suitable. Results of well logging, coring, and formation fluid sampling shall be presented in a detailed report prepared by a log analyst.

6.10 FALLOFF TEST

Testing shall include that which is necessary to determine fracture pressures of the injection and confining zones and to verify hydrogeologic and geomechanical characteristics of the injection zone (Ch24 Section 17 (c)). Proposed testing is described below.

A pressure FOT consists of injecting fluid into a well at a constant rate for a period of time, followed by shut-in of the well and monitoring the pressure decline. The pressure change is analyzed using pressure transient analysis, a technique based on the mathematical relationships between flow rate, pressure, and time. The information from these analyses helps evaluate injection capacity, reservoir properties, and skin factor. Combined with other geologic and fluid property data, it can also be used to derive permeability, reservoir boundary shape and distance, and reservoir pressures. Prior to injection, a pressure FOT is planned at Casper Carbon Capture #1, as described below, to meet the requirements of Ch 24, Section 17(d). Table 14 presents the proposed testing program for Casper Carbon Capture #1.

Table 14: Casper Carbon Capture #1 Formation Test Plan

Class VI Rule	Test Description	Schedule	Comments
Ch 24, Section 17(d)	Injectivity and FOT	At completion of Casper Carbon Capture #1	
	Confining Zone Sampling	Not Planned	
Ch 24, Section 17(b)(ii)	Injection Zone Sampling	At completion of Casper Carbon Capture #1	

For initial testing, the continuous injection period should be a minimum of 12 hours at approximately half the maximum allowable rate, based on a fracture pressure calculation.

The FOT must be targeted for a length of time sufficient such that the pressure is no longer dominated by wellbore storage or skin effects and enough data points lie within the infinite-acting period, such that the semi-log straight line is developed for analysis. The FOT shut-in period will be a period sufficient time to allow adequate pressure transient data to be collected to calculate the average reservoir pressure. Pressure sensors used for this pressure FOT will be downhole gauges of a type that meets or exceeds ASME B 40.1 Class 2A (0.5% accuracy across full range) with a range of at least 0-10,000 psi. A general data collection procedure is outlined below. Note that specific procedures for the FOT are included, as required in the reporting requirements in Section 17(d).

1. For FOT, record injection flow data at typical operating conditions (constant rate, plus or minus 10%). Rate versus time data will be recorded during the injection period. Cumulative injection volume will also be recorded. Continue injection for a minimum of approximately 12 hours. Note that significant rate variations may require more complicated analysis techniques.
2. Rig-up downhole memory pressure gauge and run in well to a depth approved by WDEQ.
3. For pressure transient falloff, obtain final stabilized injection pressure for a minimum of one hour. Ensure that the injectate temperature has stabilized.
4. Cease injection and monitor pressure falloff. Continue monitoring pressure for a minimum of 12 hours. Wellbore pressure gradients will be obtained to establish fluid gradient.
5. Stop test data acquisition, rig-down and release equipment.

6.11 MECHANICAL INTEGRITY

Mechanical Integrity Testing (MIT) will be completed during the completion activities. A description of the planned MIT is included in

Table 15: Casper Carbon Capture #1 Mechanical Integrity Testing Plan

. The MIT generalized procedures are included below. Specific procedures will be developed at the time of testing and will be included in notices provided to WDEQ.

Table 15: Casper Carbon Capture #1 Mechanical Integrity Testing Plan			
Class VI Rule	**Test Description**	**Schedule**	**Comments**
Ch, 24 Section 17.a(iv)(A)	Internal MIT (Annulus Pressure Test)	Completion	
Ch. 24 Section 17.a(iv)(B) and (C)	External MIT (OA Log or Temp Log)	Completion	
Ch. 24, Section 17.a(iv)(D)	Casing Inspection Log	Drilling or Completion	Also included in logging program

6.12 INTERNAL MECHANICAL INTEGRITY

An annulus pressure test (APT) is the proposed test to evaluate initial internal mechanical integrity (MI). The initial test will be performed after Casper Carbon Capture #1 is fully constructed and all well logs have been obtained. The annulus will be completely filled with fluid or gas, as discussed in well construction. A general procedure to test the annulus is provided below.

1. Shut-in well for a period of 12-36 hours to ensure thermal equilibrium.
2. After stabilization, pressure up the annulus to approximately 100 psi over the expected maximum surface injection pressure. Isolate the annulus so only the annulus of the well is being tested. Monitor the pressure for a period of 1 hour at 10-minute increments. Pressure change within ± 10% from the original test pressure is required for demonstration of MI.
3. Rig-down any annulus equipment and return well to original configuration and operating status provided a good pressure test.

6.13 EXTERNAL MECHANICAL INTEGRITY

External MITs will consist of an oxygen activation (OA) log or a static temperature log depending on equipment availability. The initial test will be performed after Casper Carbon Capture #1 is fully constructed and completed following the completion activities. Generalized procedures are included below.

Temperature Log

1. A temperature log with GR and casing collar locator (CCL) will be obtained prior to injection activities to establish baseline conditions and to identify any potential local temperature anomalies that may exist.
2. Shut-in the well for a minimum of 24 hours, targeting 36 hours of shut in time, if allowable, based on operational needs.
3. Rig-up wireline company and perform temperature log from surface to TD.
4. Pull temperature tool out of hole. If anomalies are present, re-log well at least eight hours after initial pass to re-establish static conditions. If none are identified, rig-down wireline company.

A baseline log will be collected prior to injection and will be obtained thereafter as described in the Testing and Monitoring plan. Per *USEPA Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Well Testing and Monitoring Guidance dated March 2013*, a temperature log is evaluated by comparing the relative differences of the log to a baseline log; if the log comparison shows little relative differences of the temperature log to the baseline log, it is considered a successful demonstration of MI. After enough time has passed to minimize near-wellbore temperature effects, anomalies may be revealed as only inconsistencies between logs. If needed, more than one log can be run to confirm or refute an anomaly, as the temperature anomaly should become more prevalent as the well returns to the natural geothermal gradient.

OA Log

1. Rig-up wireline company and run logging tool into the injection zone.
2. Conduct a short baseline GR Log and CCL near the top of the injection zone prior to taking the stationary readings with the OA tool. Verify calibration of the OA tool.
3. All stationary readings will be taken with the well injecting fluid near maximum allowable rate, or as the average of recent flow rates allow, with minimal rate and pressure fluctuations.
4. Bottomhole cement checks will include stationary readings to be taken near the base of the Sundance, Morrison, and Mowry.
5. Flow behind casing checks will be conducted near the top of confining zone and immediately above the injection zone.
6. If a false positive regarding flow is suspected, move uphole or downhole to rerun the log. Per *USEPA Geologic Sequestration of Carbon Dioxide: UIC Program Class VI Well Testing and Monitoring Guidance dated March 2013*, another option is to vary injection rate to (25, 50, and/or 75%of maximum rate) to determine false positive.
7. If significant flow is indicated by the OA Log at a station, move uphole or downhole as necessary and take additional stationary readings to determine the area of fluid migration.
8. Pull OA tool out of hole and rig down wireline equipment.

An OA test is considered passing when no upward-flow is detected out of the injection zone. To minimize the potential of false positives, checks near the same depth will be performed on any anomalous log response as outlined in the procedure above. Threshold velocities for false positives will be determined based on the vendor's logging equipment.

7.0 PLUGGING PLAN

Class VI injection well plugging is detailed in Ch 24, Section 23 of the WDEQ regulations, and requires the following for well plugging and abandonment:

- Prior to the well plugging, the owner or operator must flush each Class VI injection well with a buffer fluid, determine bottomhole reservoir pressure, and perform a final external mechanical integrity test [see Chapter 24 Section 23(a)].
- Injection Well plugging plan. The owner or operator of a Class VI well must prepare, maintain, and comply with a plan…that is approved by the Administrator…that must include the following [see Chapter 24 Section 23(b)]:
    - (1) Appropriate tests or measures for determining bottomhole reservoir pressure;
    - (2) Appropriate testing methods to ensure external mechanical integrity as specified in Ch24, Section 19;
    - (3) The type and number of plugs to be used;
    - (4) The placement of each plug, including the elevation of the top and bottom of each plug;
    - (5) The type and grade and quantity of material, suitable for use with the CO_2 stream, to be used in plugging; and
    - (6) A description of the method of placement of the plugs.

Notification of at least 60 days prior to the well plugging is required under Ch24, Section 23 (d) at which time a revised well plugging plan must be provided, if applicable. A well plugging report is required under Ch24, Section 23 (e), to be submitted to the director within 60 days after well plugging; the report must be certified as accurate by the owner/operator and by the person who performed the plugging operation.

7.1 CO2 INJECTION WELL PLUGGING AND ABANDONMENT PROGRAM

Injection well plugging and abandonment will be conducted according to the procedures provided in this section.

Upon completion of the active injection phase of the project, or at the end of the life of the Class VI well, Casper Carbon Capture #1 will be plugged and abandoned to meet the requirements of Ch24, Section 23. The plugging procedures and materials are designed and will be implemented to prevent fluid movement between stratigraphic intervals, to resist the corrosive aspects of CO_2/water mixtures, and to protect any USDW. Information collected from annual testing, or information derived during plugging operations may necessitate the need for revisions to this Plugging and Abandonment (P&A) Plan. Significant revisions will be submitted to the UIC Program Director.

Summary

After injection has ceased, Casper Carbon Capture #1 will be flushed with a buffer fluid composed of inhibited fresh water. A minimum of three tubing volumes will be injected without exceeding maximum bottomhole injection pressure, as specified by permit. Bottomhole pressure measurements will be made using wireline or slickline conveyed tools, and the well will be logged, and pressured to evaluate Part II external mechanical integrity prior to plugging. If a loss of mechanical integrity is discovered, the agency will be consulted regarding findings, and Casper Carbon Capture #1 will be repaired as necessary to allow abandonment consistent with regulatory requirements prior to proceeding with the plugging operations.

A detailed plugging procedure is provided below. Proposed well construction and completion activities (detailed in Section 6.0) are designed to bring cement to surface on all casing strings. It is not anticipated that any of the casing will be retrievable at abandonment.

After the injection is terminated permanently, the injection tubing and packer will be removed. After the tubing and packer are removed, the casing will be circulated clean or fluids will be displaced into the injection interval, and the balanced-plug placement method will be used to plug the well by cementing the long-string protection casing to surface.

If a permanent packer is installed in the well bore, the tubing will be removed and the packer will be cemented in place by the balanced-plug method. If a retrievable packer is used and the packer cannot be released, a tubing cutter will be used to cut off the tubing above the packer, and the packer will be left in the well. The well will be flushed, and the cement retainer method will be used for plugging the injection formation below the abandoned packer.

All of the casing strings will be cut off at least four feet below the surface, below the plow line. A blanking plate with the required permit information will be welded to the top of the cutoff casing at the conclusion of the abandonment process.

Table 16 contains a summary of the plugging and abandoning plan.

Table 16: Summary of P&A Plan for Injection Well					
Cement Plug Number	**Interval Range, ft**		**Thickness, ft**	**Volume, sacks**	**Note**
1	6,000	6,343	343	78	Class G with Latex or Equivalent
2	5,000	6,000	1,000	222	Class G with Latex or Equivalent
3-7	Surface	1,000	1,000	224	Class G neat or equivalent
	1,000	2,000	1,000	224	
	2,000	3,000	1,000	224	
	3,000	4,000	1,000	224	
	4,000	5,000	1,000	224	

Planned Tests or Measures to Determine Bottom-hole Reservoir Pressure

CCC will record static bottomhole formation pressure using a down hole pressure gauge.

Planned External Mechanical Integrity Test(s)

CCC will conduct at least one of the tests in to verify external mechanical integrity prior to plugging Casper Carbon Capture #1, as required in Ch24 Section 23(b)(ii) and in compliance with Ch24 Section 19(c).

Table 17: External MIT Methods	
Test Type	**Means of Testing**
Temperature Log	Along wellbore using DTS or wireline well log
Noise Log	Wireline Well Log
Oxygen Activation Log	Wireline Well Log
Radioactive Tracer Log	Wireline Well Log

Information on Cement Plugs

The cement(s) formulated for plugging will be compatible with the CO_2 stream that has historically been injected into the well at the conclusion of the well life. The cement formulation and required certification documents will be submitted with the notice to plug the well. CCC will report the wet density of the cement and will retain duplicate samples of the cement used for each plug. Figure 8 presents a typical plugging schematic. Table 16 provides details of the cement plugs to be used and may change based on final well construction [Ch24 Section 23(b)(iii-v)].

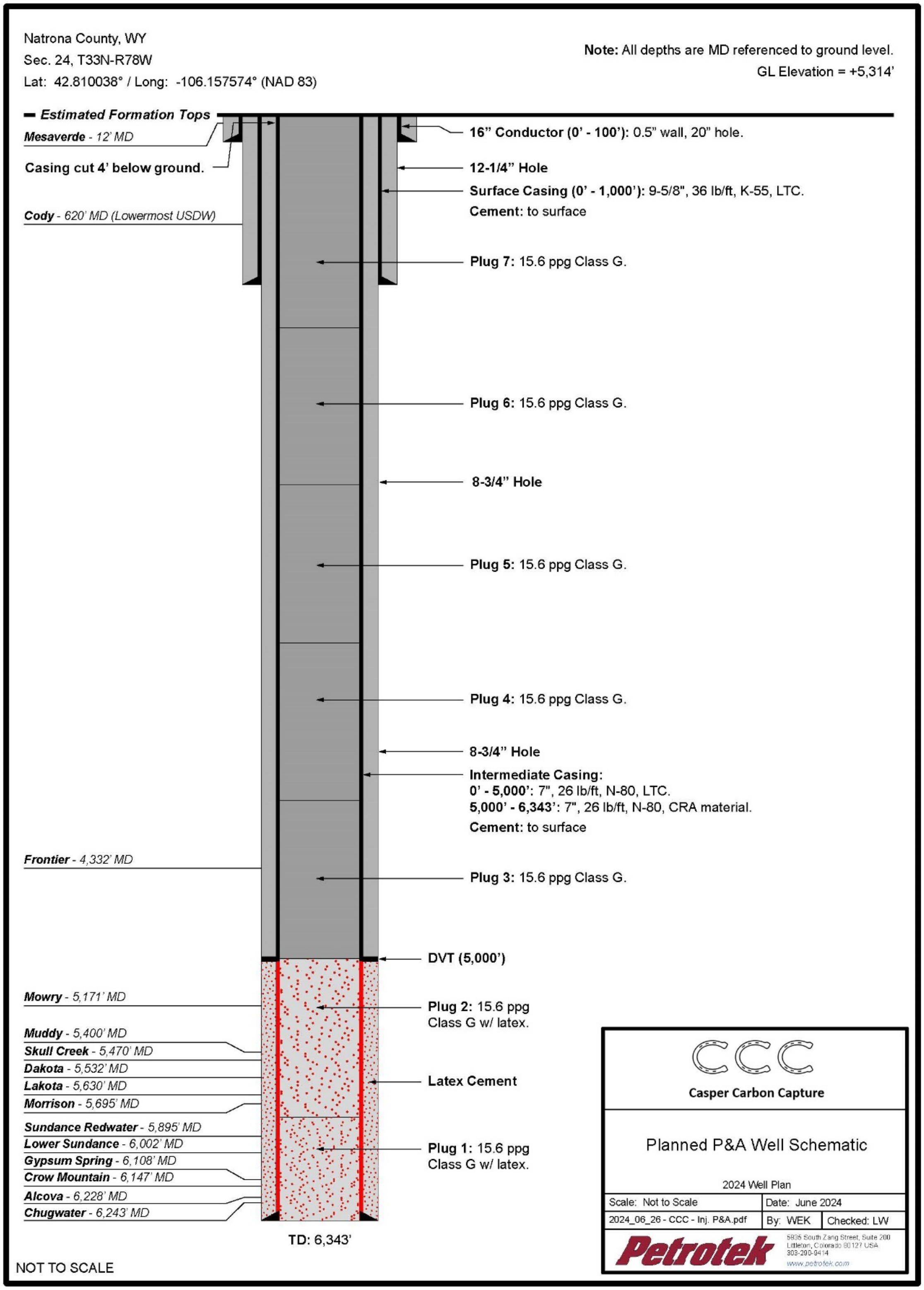


Figure 8: Injection Well Plugging Schematic

7.2 NARRATIVE DESCRIPTION OF PLUGGING PROCEDURES

The following details the proposed procedures for well plugging and abandonment [Ch24 Section 23 (b)(vi)].

1. In compliance with Ch24 Section 23(d), notify the regulatory agency at least 60 days before plugging the well and provide updated plugging plan, if applicable.
2. Conduct and document a safety meeting specifying requirements based on conditions noted at the well prior to plugging mobilization.
3. Move-in rig onto well and rig up (RU). All CO_2 pipelines will be marked and noted with rig supervisor prior to field work.
4. Confirm the mechanical integrity of the well by performing one of the permitted external mechanical integrity tests.
5. RU wireline or slickline equipment and required pressure control, and run-in well to datum depth to record bottomhole pressure using down hole gauge. Rig down (RD) slickline.
6. Test the pump and lines to a minimum of 2,500 psi. Fill tubing with inhibited fresh water or kill fluid.
7. Nipple down (ND) tree, nipple up (NU) Blow Out Preventors (BOPs), and perform a function test. After testing BOPs, pick up tubing string and unset packer. Verify that well is dead. During this process, annulus fluid may be bullheaded into the formation, or circulated out of the well, and annulus may be filled with kill fluid.
8. **Contingency:** If unable to unset packer, RU electric line and make cut on tubing string just above packer. Note: Cut must be made above packer, at least five-ten feet MD. If problems are noted, update cement remediation plan (if needed) and execute prior to plugging operations.
9. Pull out of hole with tubing laying it down.
10. TIH with work string and tag TD.
11. The lower section of the well from above the top of the confining zone at approximately 5,000 feet to plug back total depth (PBTD) will be plugged using CO_2 resistant cement which. This initial stage of plugging will be accomplished by placing an estimated two balanced plugs in the casing. Actual cement volume will depend upon PBTD and wellbore fill that determine total plug length. Top depth of the plugs will be verified by setting the work string down onto the plug after the cement is set. Wait on cement for a minimum of 20 hours prior to proceeding with the second stage of plugging above the confining zone to surface.
12. After the first stage of cementing is complete, circulate the well and ensure it is in balance. Tag cement to verify depth and place work string just above the top of

cement. For plugging of long-string protection casing above the confining zone, mix and spot balanced plug in 7-inch casing. Pull out of plug and reverse circulate work string.

13. Repeat this operation until cement reaches the surface. Lay down work string while pulling from well. At the end of the day if cement is not at surface, pull approximately 10 stands and rack back in derrick, and reverse tubing before shutting down for night.
14. Once plugs have brought cement to surface, pull work string from well and shut-in for 12 hours.
15. ND BOPs and cut all casing strings below plow line (minimum four feet below ground level, or per local policies/standards and CCC requirements).
16. If cement is not to surface, top off cement.
17. Lay down all work string, etc. Rig down all equipment and move out. Clean cellar to where a plate can be welded onto casing stub with the well name onto the lowest casing string at four feet, or as per permitting agency directive.

The procedures described above are subject to modification during execution, as necessary, to ensure implementation of a plugging operation that protects worker safety and effectively protects USDWs. Any significant modifications due to unforeseen circumstances will be reported to the agency during field operations and documented in the plugging report. Completed plugging forms, records, and lab information will be supplied to the regulatory agency as required by permit. The plugging report will be certified as accurate by CCC and the plugging contractor and shall be submitted to the agency within 60 days after plugging is completed.

7.3 MONITORING WELL PLUGGING AND ABANDONMENT PROGRAM

Upon completion of the post-injection monitoring phase of the project, or at the end of the life of the overall Class VI project, the Falls Ranch #1 will be plugged and abandoned to meet the requirements of Ch24, Section 23. The plugging procedures and materials are designed and will be implemented to prevent fluid movement between stratigraphic intervals and to protect any USDW and the P&A Diagram for the monitoring well is shown in . Information collected from annual testing, or information derived during plugging operations may necessitate the need for revisions to this Plugging and Abandonment (P&A) Plan. Significant revisions will be submitted to the UIC Program Director.

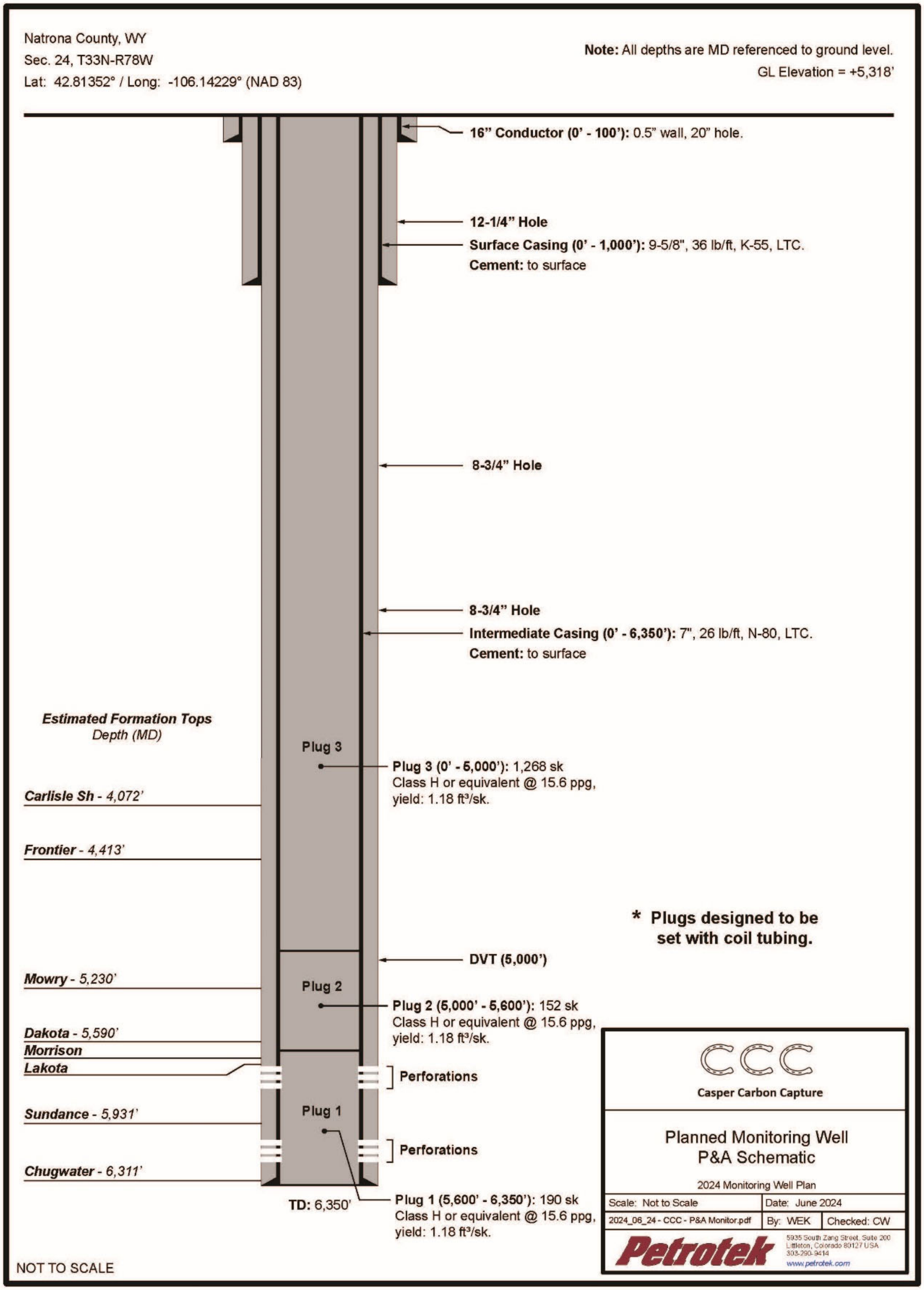


Figure 9: Monitoring Well Plugging Schematic

Table 18: Summary of P&A Plan for Monitoring Well					
Cement Plug Number	Interval Range, ft		Thickness, ft	Volume, sacks	Note
1	5,600	6,350	750	190	Class G neat or equivalent
2	5,000	5,600	600	152	Class G neat or equivalent
3	Surface	5,000	5,000	1,268	Class G neat or equivalent

8.0 PRE- AND POST-INJECTION PRESSURE DIFFERENTIAL

Is PISC different than what is provided in the Project PISC?

☐ **Yes (complete only the applicable sections)** ☒ **No (you are finished with this form)**

9.0 REFERENCES

Bourgouyne, A.T., Chenevert, M.E., Millheim, K.K., Young Jr., F.S. (1991). *Applied Drilling Engineering*, SPE Textbook Series

Fox, J. E. (1993). *Stratigraphic cross sections M-M' through R-R', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Fox, J. E. (1993b). *Stratigraphic cross sections S-S' through V-V', showing electric logs of Upper Cretaceous and Older Rocks, Power River Basin, Montana and Wyoming.* U.S. Geological Survey.

Mineral And Surface Ownership for Area of Review							
Description	Organization	Address	City	Region	Postal Code	Type of Interest	Comments
T33N-R78W Section 13: NWNW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Carey Minerals, LLC	2161 Coffeen Ave., Ste. 301	Sheridan	WY	82801	RI	
	Julia F. Carey					RI	No Address
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	J. M. Carey & Brother					RI	No Address
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 13: SESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: SWSE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: NW, N2SW, SWSW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 14: SESW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 15: SENE, NESE, S2SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 22: NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 23: S2NE, N2SE, SESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Ronald D Legerski and Jodi L Legerski, H/W	3640 Hat Six Rd	Casper	WY	82609	SI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

	Cole Creek Sheep Company	P.O. Box 2945	Casper	WY	82602	SI	
	Western Vista Credit Union	3207 Sparks Road	Cheyenne	WY	82001	MTGE	
T33N-R78W Section 23: SWSE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 26: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 25: S2SW, SWSE	Theresa Milne					25%	No address
	Gay Milne					75%	No address
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
	Gay Milne Revocable Living Trust 10/12/2024	5300 Hat Six Rd	Casper	WY	82609	SI	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
T33N-R78W Section 26: SESE	Theresa Milne					25%	No address
	Gay Milne					75%	No address
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 24: SWNW, W2SW	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI	
	Don S. & Katheryn Q Miller					MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: NWNW	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI	
	Don S. & Katheryn Q Miller					MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 26: E2SW, W2SE, NESE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	MI & SI	
T33N-R78W Section 25: S2NW, NWSW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 24: S2NE, SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

T33N-R78W Section 25: N2NE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: E2SE	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
	Marty Kamrath III and Martha Kamrath	10513 Goose Creek Rd	Casper	WY	82609	SI	
	On Q Financial, LLC	421 S Center St Suite 101	Casper	WY	82601	MTGE	
	David S & Ronda D Bullard Living Trust 3/19/2008	P.O. Box 2603	Casper	WY	82602	SI	
	Robert B Allaire Amy A Allaire	10628 Goose Creek Cir	Casper	WY	82609	SI	
	Goose Creek Ranch LLC	915 S McKinley St	Casper	WY	82601	SI	
	Mortgage Electronic Registration System, Inc.	P.O. Box 2026	Flint	MI	48501	MTGE	
	Richard E. Nurss II Donna M Nurss	10607 Goose Creek Cir	Casper	WY	82609	SI	
T33N-R78W Section 23: NWNE, N2NW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 24: N2N2	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 24: SENW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W Section 25: NENW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 25: S2NE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI & MI	
T33N-R78W Section 34: E2NE, NESE	George E. Lilly and Stella M. Lilly					MI	No address
	Robert W. Patee					MI	No address
	William H. Brown Mineral Trust	P.O. Box 2680	Casper	WY	82602	MI	
	J. L. Gooder and Florance E. Gooder					MI	No address
	Jeanne Y. Stout					MI	No address

	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	SI	
T33N-R78W Section 34: W2NE, E2NW	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	MI & SI	
T33N-R78W Section 34: SESE	R. B. Blackmore					MI	
	Lyndon J. Hall					MI	
	Rulon B. Hall					MI	
	William B. Hall					MI	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI & MI	
T33N-R78W Section 35: E2NW, SWNW, NWSW	Thomas Miline Trust					75%	
	Theresa Milne					25%	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	
	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 35: NWNW	George E. Lilly and Stella M. Lilly					MI	No address
	Robert W. Patee					MI	No address
	William H. Brown Mineral Trust	P.O. Box 2680	Casper	WY	82602	MI	
	J. L. Gooder and Florance E. Gooder					MI	No address
	Jeanne Y. Stout					MI	No address
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	
T33N-R78W Section 35: SWSW, E2SW, SE	R. B. Blackmore					MI	the other 1/4 is under the assumption there was no reservations from Albert Bejiek and James A. Vodehnal or any of their heirs or devises. 169-327 is unreadeable. Title gets pretty cloudy after this. If there was no other reservations we are under the asumption that curent surface owner owns the remaining 1/4
	Lyndon J. Hall					MI	
	Rulon B. Hall					MI	
	William B. Hall					MI	
	Raymond C Martin and Susanne M. Martin, H/W	7914 Feather Springs Dr	Houston	TX	77095	SI	

	Milne K P Ranch Company	1531 E Burlington Ave	Casper	WY	82601	SI	
	Erica K. Andren Reyes and Gilbert A. Reyes Wife and Husband	17909 Swans Creek Ln	Dumfries	VA	22026	SI	
	Heather J Adels and Brad Adels	8888 Week Creek Rd	Casper	WY	82609	SI	
	Wells Fargo Bank	101 North Phillips Ave	Sioux Falls	SD	57104	MTGE	
T33N-R77W	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
Section 18: Lots 2, 3, E2NW	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	Oil and Gas
Section 18: SWSW	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	Other minerals
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W Section 29: SW	Heidi Ann VonHelm and Kathryn Kay Beasley and Cory Craig Hamilton	11800 Clearfork Road	Casper	WY	82601	SI	
	Bonnie Milne					MI	
	LaVonnee Ramero					MI	
	M. John Bushmaker					MI	
	Ronda Flott					MI	
	Tom Bushmaker					MI	
	Connie Walters					MI	
	Dorma Barella, Marylee Milne and Betty Parish					MI	
	Frank L. Kimball	P.O. Box 100	Farson	WY	82932	MI	
	Merle A Kimball	2 Bromley Drive	Williamsburg,	VA	23185	MI	
	Marion A Slack	9230 Cisco Place	Tucson	AZ	85710	MI	
	James E. Kimball	P.O. Box 1055	Mayer	AZ	86333	MI	
	Patty Yvonne Kimball Slack	P.O. Box 51	Kinnear	WY	82516	MI	
	Rock Creek Ranch I LTD	100 Waugh, Suite 400	Houston	TX	77007	SI	
	State of Wyoming, Department of Heath Divison of Healthcare Financing/EqualityCare	6101 Yellowstone Road, Suite 210	Cheyenne	WY	82002	LIEN	
	Farm Credit Services of America, FLCA	5015 S 118th Street P.O. Box 2409	Omaha	NE	68103	MTGE	

T33N-R77W Section 30: S2	GJK Mineral Trust	10 Red Fox Lane	Englewood	CO	80111	MI	
	John Bolender and Christine S. Bolender	10955 Goose Creed Rd	Casper	WY	82609	SI	
	David S & Ronda D Bullard Living Trust 3/19/2008	P.O. Box 2603	Casper	WY	82602	SI	
	Goose Creek Ranch LLC	915 S McKinley St	Casper	WY	82601	SI	
	Mortgage Electronic Registration System, Inc.	P.O. Box 2026	Flint	MI	48501	MTGE	
	Pimentel 2007 Revocable Trust 2/27/2007	10748 Goose Creek Cir	Casper	WY	82609	SI	
	C Bar 6 LLC	10850 Goose Creek Cir	Casper	WY	82609	SI	
	David A Baxter Runge K Baxter	10868 Goose Creek Cir	Casper	WY	82609	SI	
	First Interstate Bank	104 S Wolcott	Casper	WY	82601	MTGE	
	Randy L Davis and Jesica C. Davis	P.O. Box 726	Casper	WY	82609	SI	
	Amerisave Mortgage Corporation	3525 Piedmont Rd NE, 8 Piedmont Center	Atlanta	GA	30305	MTGE	
	WyHY Federal Credit Union	P.O. Box 20050	Cheyenne	WY	82003	MTGE	
	Dean Rueter and Ingrid Rueter	10978 Goose Creek Cir	Casper	WY	82609	SI	
	Rocket Mortgage, LLC	1050 Woodward Ave	Detroit	MI	48226	MTGE	
	Colton Dillon and Danica Wilbanks	11088 Goose Creek Cir	Casper	WY	82609	SI	
	UBS Bank USA	P.O. Box 2026	Flint	MI	48501	MTGE	
	Cameron Smith Sheila Christy-Smith	11097 Goose Creek Cir	Casper	WY	82609	SI	
	Reliant Federal Credit Union	4015 Plaza Drive	Casper	WY	82604	MTGE	
	Lowell Horner and Nancy Horner	10857 Goose Creek Cir	Casper	WY	82609	SI	
	Richard E. Nurss II and Donna M Nurss	10607 Goose Creek Cir	Casper	WY	82609	SI	
	First Interstate Bank	P.O. Box 30198	Billings	MT	59166	MTGE	
	PacifiCorp	1407 WN Temple Suite 110	Salt Lake	UT	84116	EASE	
	The Bank of New York Mellon Trust Company, N.A.	531 W. Morse Blvd.	Winter Park	FL	32789	MTGE	
T33N-R77W Section 31: NENE	Bonnie Milne					MI	
	LaVonnee Ramero					MI	
	M. John Bushmaker					MI	
	Ronda Flott					MI	
	Tom Bushmaker					MI	
	Connie Walters					MI	
	and Betty Parish					MI	

	Frank L. Kimball	P.O. Box 100	Farson	WY	82932	MI	
	Merle A Kimball	2 Bromley Drive	Williamsburg,	VA	23185	MI	
	Marion A Slack	9230 Cisco Place	Tucson	AZ	85710	MI	
	James E. Kimball	P.O. Box 1055	Mayer	AZ	86333	MI	
	Patty Yvonne Kimball Slack	P.O. Box 51	Kinnear	WY	82516	MI	
	Rock Creek Ranch I LTD	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
Section 13: NE, NENW, S2NW, SW, N2SE, SWSE	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
Section 14: S2NE, N2SE, SESE	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R78W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
Section 15: N2N2, SWNE, S2NW, SW, NWSE	Gail L Mahnke Living Trust 9/10/2008	5466 S Okeepa	Casper	WY	82604	SI	
T33N-R78W Section 22: W2	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R78W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
Section 22: SE	Eastgate Ranch, LLC	2400 Claude Creek Rd	Casper	WY	82609	SI	
T33N-R78W	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
Section 23: NENE, W2	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
	Ronald D Legerski and Jodi L Legerski, H/W	3640 Hat Six Rd	Casper	WY	82609	SI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
	Cole Creek Sheep Company	P.O. Box 2945	Casper	WY	82602	SI	

	Western Vista Credit Union	3207 Sparks Road	Cheyenne	WY	82001	MTGE	
T33N-R78W Section 25: NESW, NWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Marty Kamrath III and Martha Kamrath	10513 Goose Creek Rd	Casper	WY	82609	SI	
	On Q Financial, LLC	421 S Center St Suite 101	Casper	WY	82601	MTGE	
	Nicole Nelson	5440 S. Poplar St	Casper	WY	82601	SI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 26: S2NE, NW, W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 27: E2, E2W2	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 27: NWNW	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R78W Section 27: SWNW, W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R78W Section 35: NE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Milne K P Ranch Co	1531 E Burlington Ave	Casper	WY	82601	SI	
T33N-R78W Section 36: ALL	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 18: E2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
	KRO Ventures LLC	10 Red Fox Lane	Englewood	CO	80111	SI	
T33N-R77W Section 19: ALL	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 20: W2SW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	

T33N-R77W Section 29: W2NW	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	Falls Ranch Limited Partnership	100 Waugh, Suite 400	Houston	TX	77007	SI	
T33N-R77W Section 30: N2	Wyoming State Land and Investments	122 W 25th St Bldg. 1W	Cheyenne	WY	82002	MI & SI	
T33N-R77W Section 31: W2, SWNE, NWSE	Bureau of Land Management	5353 Yellowstone Rd	Cheyenne	WY	82009	MI	
	John Greer	P.O. Box 51874	Casper	WY	82605	SI	
	Karen J Buettner-Price	5770 Jul Ln	Casper	WY	82609	SI	
	Steven J Schulz	10750 Clearfork Rd	Casper	WY	82609	SI	
	Farm Credit Services of America, FLCA	5015 S 118th Street P.O. Box 2409	Omaha	NE	68103	MTGE	

Casper Carbon Storage Hub

Class VI Permit Application – Proposed Injection Well Operations

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
DP	Differential Pressure
EDTA	Ethylene Diamine Tetra-Acetic Acid
EGMBE	Ethylene Glycol MonoButyl Ether
°F	Fahrenheit
FOT	Falloff Testing
ft	Feet
Gal	Gallon
GL	Ground Level
GLDA	Glutanic Acid-NN-Diacetic Acid
HEDTA	Hydroxyl Ethylene Diamine Triacetic Acid
Lat	Latitude
lb	Pound
Long	Longitude
MASIP	Maximum Allowable Surface Injection Pressure
max	Maximum
MD	Measured Depth
min	Minutes
MMT	Million Metric Tons
mT	Metric Tons
N	North
N/A	Not Applicable
NAD	North American Datum
NTA	Nitrilotriacetic Acid
PBTD	Plug Back Total Depth
PPE	Personal Protective Equipment
ppg	Pounds per Gallon
psi	Pounds per Square Inch
psig	Pounds per Square Inch (Gauge)
R	Range

Sec	Section
SRT	Step Rate Test
T	Township
TBD	To Be Determined
THPS	Tetrakis (hydroxymethyl) Phosphonium Sulfate
TMAC	Tetramethylammonium Chloride
USDW	Underground Source of Drinking Water
USEPA	United States Environmental Protection Agency
W	West
WDEQ	Wyoming Department of Environmental Quality
WY	Wyoming

1.0 INJECTION WELL OPERATIONS

Casper Carbon Capture, LLC (CCC) proposes to construct and operate a Class VI Underground Injection Control carbon sequestration well in Natrona County, Wyoming, approximately six miles southeast of Casper, Wyoming, and 4.5 miles west of the Converse County border. The goal of the Casper Carbon Storage Hub is to permanently store CO_2 removed from the atmosphere. The facility will be a commercial-scale carbon capture system that will be designed, constructed, and operated with the capability of storing CO_2 into deep geologic formations. The site was chosen based on the geology, the proximity to emitting sources of CO_2, and the availability of usable surface and subsurface landownership. The safely transported CO_2 will be injected into the Sundance Formation and Crow Mountain Sandstone at a proposed total of 6 million metric tons (MMT) over a 15-year injection period (an average of 400,000 metric tons per year).

The Class VI injection well Casper Carbon Capture #1 will receive a maximum of 750,000 metric tons (mT) of CO_2 annually, collected via direct air capture. The CO_2 capture and injection systems are designed to operate continuously, with the exception of downtime for maintenance and required testing and inspections.

The maximum average daily injection rate will be approximately 2,060 mT $CO_{2;}$ with an average daily rate equal to approximately 1,096 mT. There is no storage capacity for CO_2 at the surface, so it will not accumulate when injection is not active.

The maximum allowable surface injection pressure (MASIP) is to be determined based on as-built well depth and fracture pressure that will be determined by the Step Rate Test. The MASIP is estimated to not exceed 1,753 psi with 6.5 pounds per gallon (ppg) average CO_2 density; pressures to be confirmed after testing.

Except during stimulation and formation testing during completion, CCC will ensure that injection pressure does not exceed 90% of the fracture pressure of the injection zone(s) to ensure that the injection does not initiate new fractures in the injection zone(s) and to prevent compromising the confining zones.

The project expects to begin operations at an initial rate of 50,000 metric tons per year, ramping up by an additional 50,000 metric tons per year, to a maximum rate of 750,000 metric tons per year. The total mass of CO_2 to be injected into well Casper Carbon Capture #1 is estimated to be no more than 6,000,000 mT over a 15-year duration.

Formation suitability for CO_2 storage will be assessed based on data collected while drilling and completing the well. Such information will include the following:

- Porosity and permeability evaluation from open hole logs;

- Porosity and permeability measurement on core samples;
- Sampling, analysis, and testing reservoir water;
- Potential compatibility testing on formation samples with CO_2 and reservoir water, and;
- Reservoir evaluation through Step-Rate Testing (SRT) and Falloff Testing (FOT).

Results from modeling the above information at the proposed injection rates will be provided to the Wyoming Department of Environmental Quality (WDEQ). Table 1 includes Injection Well Operating Conditions.

The well bore equipment that is exposed to the CO_2 injection stream will be constructed from corrosion resistant alloys or steel that is coated with CO_2 resistant materials on the exposed surfaces.

Table 1: Injection Well Operating Conditions

Item	Values	Description/Comments
Injected Volume		
Total Injected Volume	6,000,000 mT	
Injection Duration to Reach Total Injected Volume	15 years	
Injection Rates		
Proposed Average Injection Rate	1,096 mT/day	Based on a 15-yr injection schedule starting at 0.05 million metric tons/yr and increasing up to 0.75 million metric tons/yr, using 365 operating days per year
Calculated Maximum Daily CO_2 Injection Rate	2,060 mT[1]/day	
Pressure		
Formation Fracture Pressure at Top Perforation	Estimated 4,201 psi, to be confirmed by testing	Based on Fracture Pressure Gradient = 0.7 psi/ft at the top of the Sundance injection interval estimated 6,002 feet

Table 1: Injection Well Operating Conditions		
Average Operating Surface Injection Pressure	Estimated 1,200 psi, to be confirmed by testing.	
Surface Maximum Injection Pressure	Estimated 1,753 psi, to be confirmed by testing	Based on 90% of fracture pressure using an average 6.5 lb/gal CO_2 density – to be confirmed
Average Operating Bottom Hole Pressure	Estimated 3,000 psi, to be confirmed by testing	
Maximum Bottomhole Pressure	Estimated 3,781 psi, to be confirmed by testing.	Based on 90% of fracture gradient assuming 0.7 psi/ft fracture gradient
Annulus Pressure	Estimated 1,300 to 1,850 psig to be confirmed after testing	Minimum 100 psig above injection pressure, not to exceed 80% of casing burst pressure at the packer depth
Annulus Tubing-Casing Differential Pressure (DP)	Minimum 100 psig differential	Highest operating pressure will be under 80% of the casing burst rating at the packer depth

[1]*Average daily value; actual injection rate will vary dependent upon surface facility efficiency as well as maintenance and planned downtime, not to exceed 750,000 mT/yr*

The conditioned CO_2 stream will be delivered to the well as a relatively pure liquid under pressure. The typical estimated composition of the stream is presented in Table 2 – these projected values will be updated at a later date when results from laboratory analyses are available.

Table 2: CO_2 Stream Characteristics		
Parameter	**Estimated Value[1]**	**Units[2]**
Pressure	>1,200	psig
Temperature	TBD	°F
Phase	Liquid/supercritical	N/A
CO_2	98.488	%
Water	1.5	%
Oxygen	0.002	%
Nitrogen	0.009	%

[1] These estimated values are good faith estimates based on design work. Actual values will depend on conditions in the Class VI Injection Permit and analytical testing during actual operation.

[2] The percentages listed are equivalent gas phase mole percentage.

1.1 PROPOSED COMPLETION PROCEDURE TO CONDUCT OPERATIONS

After the drilling rig is released and adequate time has elapsed for cement to cure, a completion rig will be mobilized to drill out the DV tool and clean the hole to the proposed plug back total depth (PBTD), which will be near the top of the Chugwater Formation, approximately 6,243 feet. The 7-inch casing will be pressure tested and cement bond logging will be performed and evaluated on the casing. The well bore will be cleaned out and displaced with compatible fluids and perforated in the Sundance injection intervals selected from log analysis. A test packer and work string will be run into the well and set above the perforated interval to swab formation fluid to assess water quality. Swabbing will be performed until conductivity and pH stabilize based on field measurements. Samples will be collected for analysis at a qualified laboratory.

After water samples are collected, pressure gages will be installed in the well to record actual down hole pressures while performing the SRT followed by FOT.

Rates and times for the SRT may be adjusted based on fluid entry observations while swabbing. A preliminary proposed SRT schedule is presented in Table 3.

Table 3: Preliminary Step Rate Test							
Step	**Rate**	**Time (min)**	**Volume**	**Cumulative Volume**	**Max Tubing Pressure**	**Casing Pressure**	**Comments**
0	0.50	30	15	15			
1	0.75	30	22.5	37.5			
2	1.00	30	30	67.5			
3	1.50	30	45	112.5			
4	2.00	30	60	172.5			
5	2.50	30	75	247.5			
6	3.00	30	90	337.5			
7	4.00	30	120	457.5			
8	5.00	30	150	607.5			
9	6.50	30	195	802.5			
10	8.00	30	240	1,042.5			

Surface pressures will be recorded after pumping ceases until stable trends are established. Bottom hole pressure will be recorded for at least 12 hours prior to resuming test work.

Pressure FOT will be conducted using approved methods and in accordance with WDEQ Rules and Regulations Chapter 24, Section 10. For the first test, the minimum duration of injection and falloff will be calculated according to the equations on page A-4 of the "UIC Pressure Falloff Testing Guideline" (USEPA Region 6, August 2002), or the equivalent equations in subsequent editions. Durations for subsequent tests will be longer than wellbore storage and skin effects and sufficient for persuasive analysis and accurate estimates of transmissivity. Tests will be analyzed by using commonly accepted methods to obtain transmissivity, permeability, and skin factor and to identify reservoir heterogeneity and boundaries. The test method chosen will be justified by a review of relevant assumptions and actual well and aquifer conditions. Along with the analysis and interpretation, plots of injection rate, pressure, and the pressure derivative versus time on appropriate graphs will be submitted. Digital data, results, analyses, and interpretations for the FOT will be submitted to the WDEQ in approximately 30 days after completing the field work.

After initial evaluation on the injection zone, including the above SRT and FOT analysis, is incorporated with core testing and open hole log evaluation, CCC may propose to utilize hydraulic fracturing methods to stimulate the injection interval(s). Such stimulation may include water-based fluids with gelling agents, friction reducers, and appropriate chemical additives to minimize negative formation interactions with the fluids. Stimulation would likely include proppant in the form of sand at concentrations ranging from one to six ppg through portions of the stimulation treatment to prop fractures open as the fluid leaks off. Prior to executing such a treatment, CCC will submit a complete stimulation plan with details regarding fluid system components, proposed fluid rates and pressure limits to the WDEQ. The fracturing proposal will include fracturing design modeling cases to demonstrate the proposed stimulation will not create fractures that would compromise the integrity of the upper or lower confining zones. Stimulation would be conducted after review and approval by the WDEQ.

After the above water sample collection, formation testing, and any stimulation, the test packer and work string will be removed and the well cleaned out to install Injection equipment.

An injection string consisting of a corrosion resistant section of tail pipe, a corrosion resistant mechanical packer, and tubing string with profile nipples for placement of down hole check valves will be installed as shown in Figure 1. The tubing string will be either corrosion resistant metal or standard carbon steel tubulars with an internal liner that is suitable for CO_2 injection service.

The annulus will be filled with fresh water treated with corrosion inhibitor chemical(s) and the well will be tested for internal mechanical integrity. A corrosion resistant well head tree will be installed and then logging will be performed with temperature and radioactive tracer tools to confirm external mechanical integrity to confine the injected CO_2 into the intended injection interval(s).

The proposed completion diagram is presented in the attached Figure 1.

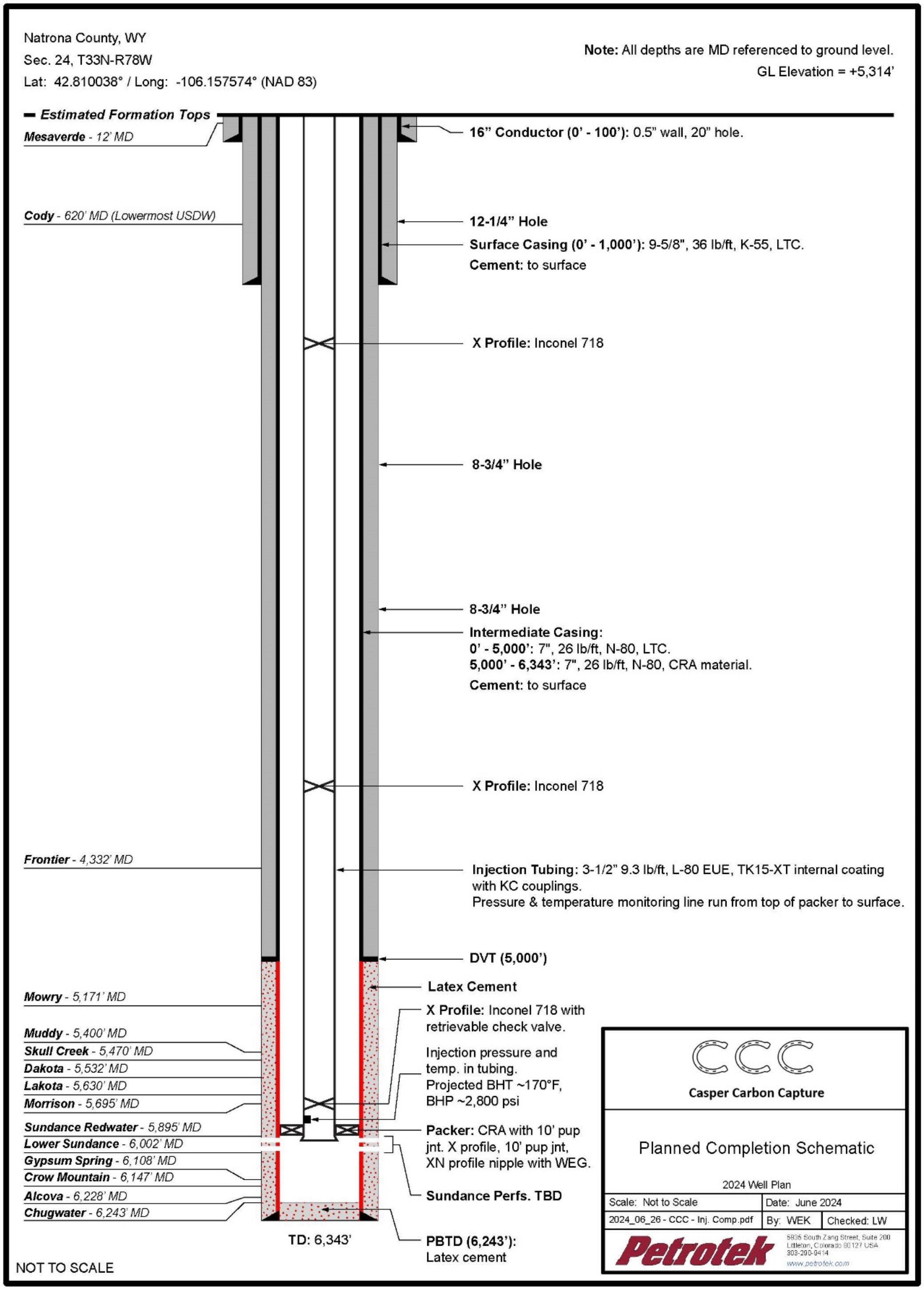


Figure 1. Proposed well schematic

1.2 ROUTINE WELL MAINTENANCE PROCEDURES

This section outlines critical elements pertaining to the well maintenance options, and specifically provides a description of well maintenance options that might be used to remediate plugging and optimize injectivity during the operating life of the well.

Impediments to optimum injection capacity can be associated with native and induced flow-restricting materials, such as: clay fragments, mineral scales, metallic sulfide or oxide particulates, relative permeability blockages, oil emulsions, and other materials carried into the injection intervals, or precipitated by injected CO_2 reaction with formation minerals, or formation brine dehydration. When injection monitoring or analyses indicate a flow restriction that is either within the wellbore or in the near-wellbore injection formation interval(s), CCC will provide specific proposed remedial actions with as much prior notice as possible. When the specific procedures are known, additional information may include a description of what is expected to be achieved; a description of the stimulation fluids, additives, placement methods to be used, and the step-by-step procedures that will be employed.

When remedial stimulation based on declining well performance is required, and to further develop the optimal stimulation procedures, CCC may propose the following:

- Conduct logging operations, such as caliper, temperature, flow profile (with mechanical or differential temperature measurement tools), or tracer-injection logs; and/or,
- Collecting bottom hole samples with sampling equipment conveyed into the well bore by wireline, slickline, or coiled tubing, with follow-up analytical testing, as appropriate for the sample and treatments under consideration.

Prior to performing remediation operations, CCC will provide notification to WDEQ that will include the proposed operational tasks and method(s) that will be implemented to conduct the remediation and the detailed chemical formulation (final selections and volumes) for stimulation when chemical stimulation is proposed.

The following section presents a discussion of chemical and mechanical stimulations that may be used in Casper Carbon Capture #1. Additionally, a discussion is provided regarding determinations and steps proposed to ensure that any proposed stimulation activities will not impact any confining zones.

1.3 CHEMICAL STIMULATION METHODS

Chemical remediation methods include Bullhead stimulation (no chemical treatment fluid recovery), matrix treatment with fluid recovery, or direct chemical injection with the CO_2 injectate. The following sections describe these methods and the fluids that may be used as part of the described methods.

1.3.1 Bullhead Treatment

Bullhead treatment is a maintenance method whereby fluids are injected to enhance injectivity or solubilize flow restrictions, with no fluid recovery. It can be accomplished in injection wells by pumping treatment fluids into an injection formation and ultimately displacing the treatment fluids or flushing them out of the wellbore and into the formation with no recovery back to surface. The chemical stimulant may be preceded by volumes of treated water or other fluids and subsequently followed by enough treated water to displace the stimulation chemicals into the injection zone. For the purpose of these proposed methods, treatment is conducted below the permitted bottom hole pressures which are below 90% of the established fracture initiation pressures so that no new fractures are created. The displacement may be in stages to allow the stimulation chemicals time to soak at the targeted depth. Variations for delivering the chemical treatment to the targeted intervals include the methods below.

- Pumping the chemicals and stimulants down the injection tubing. Site equipment or temporary pumping equipment may be used for injection.
- Placing the chemicals and stimulants at or near the targeted interval(s) by running coiled tubing inside of the injection tubing and pumping the chemicals through the coiled tubing. This option may also include using various nozzles on the coiled tubing string to jet water or chemicals at specific perforated intervals to enhance the chemical contact and mechanical washing.

1.3.2 Matrix Treatment with Fluid Recovery

Matrix treatment involves the injection of fluids to solubilize flow restrictions, utilizing reverse flow to recover spent chemicals, solubilized fines, and other materials. Chemicals are pumped into the formation with complete or partial recovery achieved by flowing fluids back out of the well bore. This method is preferred when the treatment is expected to mobilize a significant mass of particulates or solid materials that need to be removed from the formation porosity to optimize injection. The chemicals may be preceded by volumes of treated water and may be followed by additional volumes of treated water. In some cases where significant solids are present, initial treatment steps may involve attempts to recover solids from the well and near wellbore porosity by backflowing, jetting with coiled tubing, swabbing, or otherwise producing the well so that less treatment chemical is then required to address immobile plugging materials.

The same methods of placement listed in the Bullhead Treatment bullets above, would be options for matrix treatment with the addition of fluid recovery. The principal recovery method would be to utilize the previously injected CO_2 as the energy source to flow the spent chemicals and flush water back out of the well. This would require installing temporary separation equipment at surface to flow the well back under controlled conditions and remove the particulate laden spent treatment fluids prior to venting the CO_2.

If extensive fluid volumes are used, the well may be amenable to recovering fluid by the following methods:

- Swabbing of the well to recover the fluids that have been pumped down the injection string or a work string; or,
- Jetting fluids out with nitrogen gas or CO_2 gas when working with coiled tubing or a work string.

1.3.3 Direct Chemical Injection with the Carbon Dioxide Injection

The introduction of solubilizing or scale prevention agents in a fluid system carried by the CO_2 injection fluid may be used to solubilize or prevent formation of materials that would impede injection flow paths. This method could be implemented on either a continuous or batch basis.

Direct chemical injection with the CO_2 injection would be appropriate when it is necessary to dissolve minor amounts of particulates or to introduce scale inhibitors into the injection intervals. Chemicals are typically not recovered.

1.3.4 Description of Fluid System Components that may be Proposed for Chemical Stimulation

Proposed chemical stimulation formulations may contain a variety of primary fluids and additives to address different conditions that might be encountered. When new well completion or remediation requirements are identified and vendors are selected, specific fluid details, including concentrations and volumes, will be provided to WDEQ for approval prior to initiating treatment. Treatment chemicals and additives may include one or more of the following chemical agents, categories, or suitable equivalents:

1. Inorganic acid solutions such as:
    - hydrochloric acid, and/or
    - hydrofluoric acid in combination with hydrochloric acid.

2. Inorganic basic solutions such as:
    - sodium hydroxide,
    - ammonium solutions and conjugal salts thereof, and/or
    - sodium hypochlorite solutions.
3. Oxidizing agents such as:
    - Sodium hypochlorite solutions,
    - Chlorine dioxide solutions,
    - Sodium chlorite solutions, and/or
    - Sodium chlorate solutions.
4. Organic acids such as:
    - Citric acid,
    - Acetic acid,
    - Formic acid, and/or
    - Sulfamic acid.
5. Combinations of inorganic and organic acids listed above.
6. Alternating stages of inorganic and/or organic acids and oxidizers listed above.
7. Chelating agents – as a direct treatment chemical or in combination with inorganic and/or organic acids listed above, such as:
    - Citric acid and salts thereof,
    - Acetic acid and salts thereof,
    - Nitrilotriacetic acid (NTA),
    - Ethylene diamine tetra-acetic acid (EDTA),
    - Hydroxyl ethylene diamine triacetic acid (HEDTA),
    - Glutamic acid-N,N-diacetic acid (GLDA), and/or
    - Tetrakis(hydroxymethyl)phosphonium sulfate (THPS).
8. Acid inhibitors – particularly in common with acids listed in items 1 and 4 above. There are numerous commonly utilized chemical additives applied to minimize the corrosion of metal well components. Some general categories are:
    - Quaternary amine compounds,
    - Imadazoline compounds,
    - Pyridine compounds, and/or

- many others.

9. Surfactants, in common with mineral and organic acids, and bases, listed above;
10. Organic solvents to mitigate hydrocarbon contamination that could inhibit acid penetration, such as:
    - Xylene,
    - Toluene,
    - Naphtha or naphtha in combination with various aromatic compound blends, and
    - Terpenes.
11. Mutual solvents to enhance the dispersion and effectiveness of any organic solvents that are applied, such as:
    - Ethylene Glycol MonoButyl Ether (EGMBE), and/or
    - Various alcohols.
12. Scale inhibitors to reduce scale formation from reactions with the fluids introduced during the stimulation or from the subsequent CO_2 injection. There are many specifically-designed scale inhibitors that might be applied depending on the expected scaling potential. The two primary general categories are:
    - Polymeric – typically long chain polymers with carboxylic or acrylic functional groups, and
    - Phosphonate – organic phosphorous bearing compounds that are specifically designed and fabricated to prevent scale formation.
13. Clay stabilizers – salts or chemicals specifically applied to prevent the native clays in the formation from fragmenting and releasing pore-blocking particulates. Examples include:
    - Inorganic salts – particularly potassium chloride, sodium chloride, calcium chloride, ammonium chloride, and magnesium chloride; but other salts may be used;
    - Temporary clay stabilizers – typically organic amine-type compounds with relatively low molecular weight intended to bind with ion-exchange sites on the clays to prevent the clays from fragmenting. Examples include:
      - Tetramethylammonium chloride (TMAC),
      - Choline chloride, and/or
      - Other substances that are utilized to stabilize clays to prevent damage through ion-exchange induced clay fragmentation.

- Permanent clay stabilizers – typically long chain cationic or nonionic polymers that bridge across multiple ion-exchange sites on the clay structure to provide longer term fragmentation prevention. There are many polymeric chemistries applied for this purpose, with polyamines being one common example.

14. Diverting agents – materials used to temporarily block-off intervals that retain high injectivity so that stimulation chemicals are focused into intervals that are less permeable or more impaired. These might include:
    - Rock salt – conveyed into the well bore as a slurry with the salt crystals suspended in salt brine. The salt brine may be treated with gelling agents such as guar polymer or xanthan gum to produce higher viscosity and salt carrying capacity.
    - Water soluble solids with low acid solubility, such as benzoic acid flakes, encapsulated citric acid, or other bridging agents that can be dissolved after stimulation chemical placement is completed by flushing with water or injected CO_2.
    - Polymeric substances that are formulated to provide temporary restrictions and then "break down" or dissolve with time and temperature.
15. Biologic control agents, or biocides. When large volumes of flush water are used before or after a chemical stimulation, treatment of the fluids to prevent contaminating the well bore with undesirable microbes may be appropriate. Numerous chemical alternatives are available as USEPA registered biocides and may be used as additives to reduce undesirable biological activity. A few examples are:
    - Quaternary amine compounds,
    - Sodium hypochlorite,
    - Chlorine dioxide,
    - Dazomet, and/or
    - Other alternatives, depending on the anticipated microbial control requirement and confirmation that the biocidal agent(s) are compatible with the proposed chemical stimulation.
16. Water, with or without additives from the above lists, as a pre-flush or post-treatment flush, or as a stand-alone treatment if precipitated salts from formation brine dehydration are suspected to be the primary injection restriction source.

1.4 MECHANICAL STIMULATION METHODS

In addition to chemical stimulation, mechanical stimulation of the well may be pursued independently, or in concert with the chemical methods described earlier in this section.

Mechanical methods that might be used include propellant stimulant and backflow methods, as described below.

1.4.1 Propellant Stimulation

Propellant stimulation may be used to induce or enhance flow paths in the injection interval, with flow paths confined to approximately the height of the propellant gun. When analytical data indicate that flow restriction extends past the wellbore face or the initial perforation channel to moderate depths into the formation, (e.g. 5 to 15 feet), direct propellant stimulation may be proposed to create flow paths through the damaged or restricted formation section. Various studies and modeling efforts have been performed by private and governmental agencies to confirm that propellant stimulations create or stimulate flow paths into the targeted formation intervals with nominal vertical growth, verifying that there is no risk of confinement layer breach when gun depths are restricted to appropriate distances below the top of the injection zone (Schmidt et al. [1980], Enhanced Energetics [undated], and Natural Resources Agency of California [2019]; provided in Appendix 8-1)

Deployment for propellant stimulation is commonly done with conventional electric line, coiled tubing e-line, and/or jointed tubing conveyance methods. Any of these methods may be proposed depending upon the scope of the stimulation and well operating conditions. When performing remedial work, the stimulation may be performed with the well full of liquid kill-weight fluid, or with the well full of injected CO_2.

1.4.2 Backflow

To backflow a CO_2 injector, safety issues associated with a controlled CO_2 release from the wellhead to the atmosphere will be addressed, and the wellhead area prepared for operations. Preparations will include assessment of appropriate limits/safe operating practices for: wellhead temperature and pressure, weather, and air quality monitoring; communications; PPE; and suitable exclusion areas.

After equipment is tested and necessary monitoring is enabled, valves at the wellhead will be opened to allow CO_2 to be produced from the well, thereby reversing flow direction from the injection reservoir downhole. Controlled CO_2 production will be monitored to ensure safe production operations, and to allow the calculation of the volume of CO_2 produced. At the end of the prescribed production period, valves will be closed slowly in stages to manage temperature effects and minimize the potential for shocks to the well from instantaneous shut-in.

Backflow may be utilized in conjunction with other chemical or mechanical stimulation methods. The process may require additional equipment connected to the well head for controlling the backflow, as well as capturing recovered liquids or solids.

Well backflow operations may be followed by mechanical methods of solids removal from the rathole, such as jetting with coiled tubing, that will also be detailed in the prior notification.

1.4.3 Determination that Maintenance activities will not Interfere with Containment

Maintenance treatments of the permitted injection zone will take place at depths below the top of the permitted injection zone such that activities will not impact the confining zone. Mechanical operations, such as propellant stimulation, will be vertically separated from the casing at the top of the permitted injection zone by a minimum of 10 feet. Chemical additives will be injected below the base of the confining zone and are not expected to penetrate the rock matrix above the base of the confining zone formations. This will be accomplished by injecting limited treatment volumes at controlled pressures.

Routine chemical maintenance treatments will be conducted at sustained bottom hole pressures that remain below 90% of the established fracture initiation pressures for the well/interval being stimulated. This practice will satisfy the requirement that "In no case may injection pressure initiate fractures in the confining zones(s) or cause movement of injection or formation fluids that endangers a USDW".

Maintenance chemical treatments will be conducted in a manner to ensure that chemical treatments are isolated to the injection interval. For example:

- When treating through either the injection tubulars or a work string, the annular pressure will be monitored to confirm that chemicals are contained below the upper packer, or other down hole isolation tools.
- All chemical treatments will be selected for chemical compatibility with the placement method. For example, mineral acids will be treated with chemical inhibitors to prevent any significant corrosion damage to the tubing string that conveys the chemical. In addition, chemical systems will be selected to avoid damage to the downhole packer sealing elements and other seals within the injection system that might be exposed to the chemicals.

Propellant stimulations will only be utilized well below the top of the injection zone. Established studies indicate that propellant stimulations have only nominal height growth above the propellant tool depth so restricting the use of propellant well below the top of the injection interval will assure that no fractures are created into the confining zone.

1.5 REFERENCES

The following references for stimulation procedures are provided in Appendix 8.1:

Schmidt, R.A., et al. (1980). *In Situ Evaluation of Several Tailored-Pulse Well-Shooting Concepts*, Society of Petroleum Engineers (SPE) publication 8934.

Enhanced Energetics. (2020). *Kraken-enhance Perforating Flow Performance Tests*, API RP19B Section 4 Test Results.

Enhanced Energetics. (undated). GasGun – Vertical Containment – Sandia Study.

Natural Resources Agency of California, Department of Conservation, Division of Oil, Gas, & Geothermal Resources. (2019). Well Stimulation Determination letter dated 4/12/2019.

2.0 PROPOSED PROCEDURE FOR MONITORING WELL OPERATIONS

Monitoring wells that may encounter the subsurface CO_2 plume will be constructed from comparable corrosion resistant materials as Casper Carbon Capture #1.

Monitoring wells will be equipped with tubing and annulus pressure recording devices comparable to Casper Carbon Capture #1.

Fluid samples will be collected from the monitored intervals every 12 months.

Down hole pressures will be measured when retrieving fluid samples.

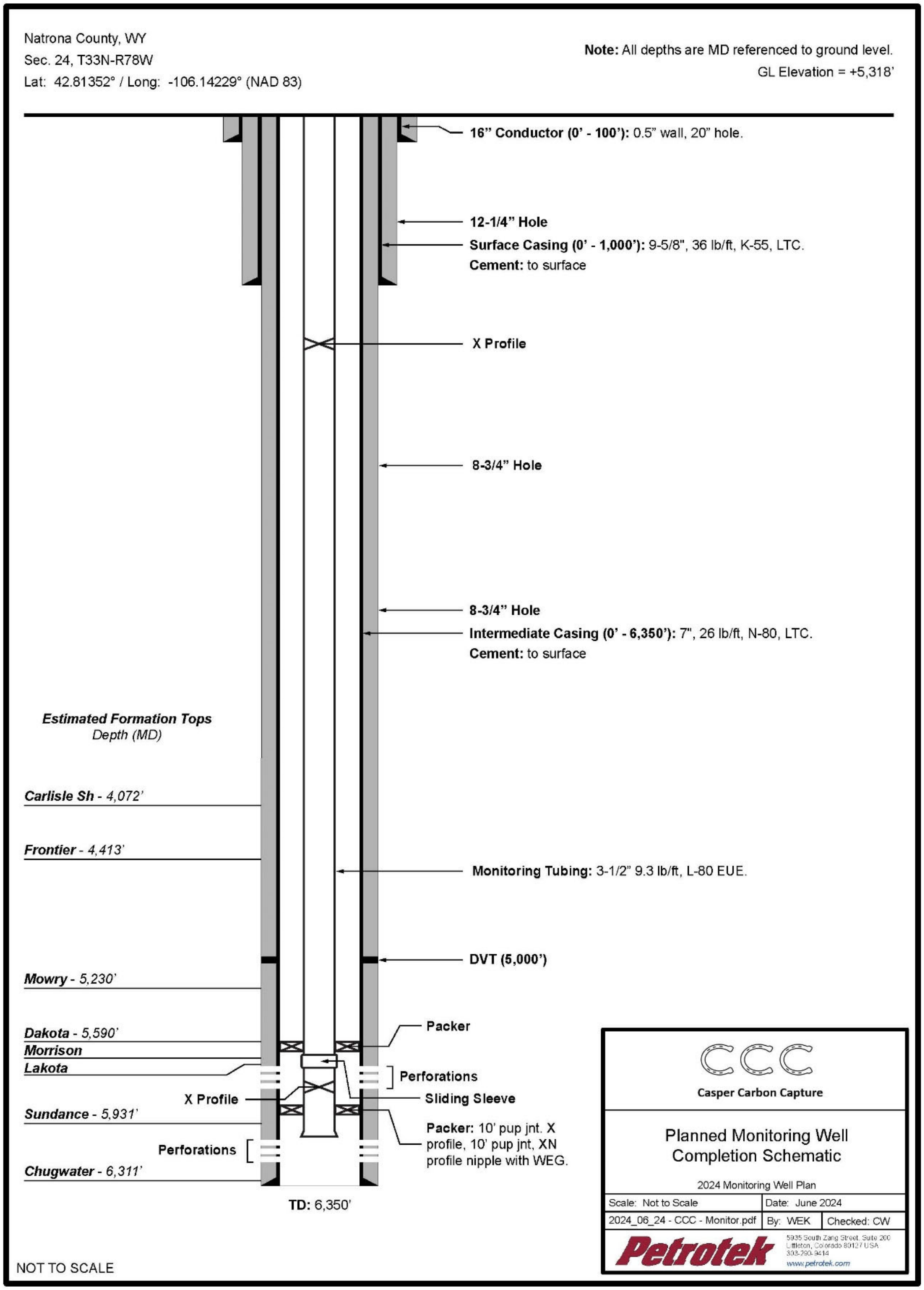


Figure 2. Planned Monitoring Well Schematic

3.0 OPERATING ANNULAR PRESSURE

The annulus between the tubing and the long-string protection casing will be filled with fresh water treated with corrosion inhibitor chemical(s). Other than during times of well workover (maintenance) or annulus maintenance, CCC will maintain an annulus pressure at least 100 psi greater than the operating tubing injection pressure.

Annular and tubing pressures are measured and recorded digitally using pressure transducers located at the wellhead and on the injection pumps. Annular pressure is maintained by an annulus tank filled with inhibited water and pressurized with nitrogen. The annulus tank is calibrated to keep pressures within permit limits. A certified gauge is onsite that is used against the pressure transducers to verify calibrations. The gauges are sensitive to 0.25% change. As a back-up, the manual gauges on the wellhead tree are also used to compare to the digital gauges during daily readings.

CASPER CARBON CAPTURE, LLC

Casper Carbon Storage Hub

Class VI Permit Application – Injection Depth Waiver Report

Casper Carbon Capture, LLC, Natrona County, Wyoming

Casper Carbon Capture

June 2024

FINAL

TABLE OF CONTENTS

ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
2D	Two dimensional
3D	Three dimensional
AoR	Area of Review
CCC	Casper Carbon Capture, LLC
CO_2	Carbon Dioxide
FMI	Formation Microresistivity Imaging
mD	Millidarcies
mg/L	Milligrams per Liter
MNA	Monitored Natural Attenuation
TDS	Total Dissolved Solids
USDW	Underground Source of Drinking Water
WDEQ	Wyoming Department of Environmental Quality
WWQR	Wyoming Water Quality Rights

1.0 OVERVIEW

Casper Carbon Capture, LLC (CCC) proposes to construct and operate a Class VI Underground Injection Control carbon sequestration well in Natrona County, Wyoming, approximately six miles southeast of Casper, Wyoming, and 4.5 miles west of the Converse County border. The site was chosen based on the geology, the proximity to emitting sources of CO_2, and the availability of usable surface and subsurface landownership. The proposed Casper Carbon Storage Hub utilizes the lower Sundance formation and Crow Mountain Sandstone as the proposed injection zone, overlying the lower confining zone consisting of the Alcova Limestone, Red Peak Formation, and Goose Egg Formation. The upper confining zone consists of the uppermost unit of the Sundance Formation, the Redwater Shale, through the top of the Morrison Formation.

Underlying the lower confining zone is the Casper Aquifer, consisting of the Tensleep Sandstone and Amsden Formation, and the Madison Limestone. As such, CCC is seeking a waiver of the requirement to inject below the lowermost underground source of drinking water (USDW), per Wyoming Department of Environmental Quality (WDEQ) Ch 24, Section 15.

2.0 INJECTION ZONE CHARACTERIZATION

The proposed storage reservoir for this project is the Lower Sundance Formation (correlative to Lak and Hulett sands of the eastern Powder River Basin) through the Crow Mountain Sandstone, which is detailed in Form A-1 of the Permit. Sundance deposition was extensive throughout Wyoming, and the limits are well beyond the area studied for this project. The injection zone is separated from the Casper Aquifer and the Lakota Formation by the lower and upper confining zones, respectively. As shown in Form A-2, the Sundance Formation does not outcrop within the Area of Review (AoR), with the closest outcrop being to the south on Casper Mountain.

The storage reservoir contains some internal variability, although it maintains a fairly uniform thickness of around 310 feet throughout the project area. The clean sands of the Sundance Formation have an average 15-20% porosity and permeability up to 1,000 millidarcies (mD). Its total dissolved solids (TDS) often surpasses 1,000 mg/L (see Form A-1), with variations from sodium sulfate to sodium chloride brines, indicating diverse water qualities crucial for considering its designation as a USDW.

As detailed in Form A-1, Casper Carbon Capture #1 will contain an estimated 226 feet of gross reservoir thickness at ~11-12% average porosity (yielding ~25 porosity-feet between the confining zones) and average permeability of about 140 MD, with exceptional intervals having 25% porosity or greater and permeability exceeding 1,000 mD. Additional minor storage is expected to be utilized at the base of the upper confining zone, as the CO_2 migrates upward and is trapped. These estimates are constrained by seismic, well log, and core data and are summarized in Form A-1.

3.0 CONFINING ZONE CHARACTERIZATION

The storage reservoir is bound above by the upper confining zone (Redwater Shale and Morrison Formation), and below by the lower confining zone (Goose Egg Formation and lower Chugwater Group), as shown in Figure 2 of Form A-1 of the Permit. Both the upper and lower confining zones are considered to be laterally continuous throughout the AoR. Overall thickness of the upper confining zone is estimated to be 200 feet, with 5% porosity and permeability measuring 2 mD, while the lower confining zone is estimated to be 1,000 feet thick, with 1% porosity and permeability measuring 0.5 mD (see Form A-1).

Fracture data (e.g., image logs) was not available for the confining zones. Data collected from Casper Carbon Capture #1 will be used conduct a fracture analysis. Subsurface fractures are not expected to exist through the confining zone. As with the injection zone, the confining strata are continuous throughout the storage complex area.

4.0 REGIONAL FAULT CHARACTERIZATION

The nearest faults intersecting the ground surface are oriented roughly east-west along the northern margin of Casper Mountain, about 3.7 miles southwest of Casper Carbon Capture #1. Based on the results of 3D plume modeling, the injected CO_2 is not expected to reach any surface-breaching faults. Additional surface-breaching faults (the Muddy Fault system at the northern extent of the Laramie Mountains, and an unnamed fault defining the eastern margin of Casper Mountain) were included in the model but had no influence on the simulation, owing to distance from Casper Carbon Capture #1.

In the subsurface, four additional down-to-north faults were modeled to assess any effect on the injected CO_2. These faults were mapped for this project from 2D seismic, well data, and legacy oilfield structure maps. Multiple lines of evidence suggest these faults will be impermeable and will contain injected CO_2 and prevent leakage to surface or USDWs.

5.0 REGIONAL FRACTURE CHARACTERIZATION

No information on fractures in the project area was available; data needed to characterize fractures (e.g., borehole imaging and/or formation microresistivity imaging (FMI) logs, core samples) will be collected at the Casper Carbon Storage Hub during a future drilling phase. Additional regional fracture characterization is given in Form A-1 of the Permit Application.

6.0 COMPUTER MODELING

Form A-2 of the Permit contains results from computer modeling, in accordance with Wyoming Water Quality Rules (WWQR) Chapter 24, Section 13, demonstrating that USDWs above and below the injection zone will not be endangered as a result of fluid movement.

7.0 TESTING AND MONITORING

Form A-5 of the Permit contains the Testing and Monitoring Plan tailored to this geologic sequestration project, which includes an analysis of the injected CO_2, periodic testing of Casper Carbon Capture #1, a corrosion-monitoring plan for the CO_2 injection well components, and a leak detection plan to monitor for potential movement of the CO_2 outside of the storage reservoir. The plan discusses testing and monitoring plans prior to CO_2 injection (pre-operational baseline phase), during injection (operational), and during the post-operational monitoring time frames A combination of these monitoring efforts will be used to verify that the Casper Carbon Storage Hub is operating as permitted and is protecting USDWs above and below the injection zone.

8.0 PUBLIC WATER SUPPLY

USDWs above the confining zone include the Quaternary Alluvium Aquifer, Mesaverde Aquifer, Cody Shale, and the Lakota Formation. The Casper Aquifer and Madison Aquifer are two deep USDWs that exist below the lower confining zone. The Lakota is not a public water supply withinin the AoR. The Madison and Casper aquifers produce from two known wells in the project vicinity for livestock, irrigation, and/or miscellaneous use. These aquifers are described in Form A-2 of this Permit application, which also describes the created model that simulates CO_2 plume and pressure movement. This model shows the plumes successfully constrained by the storage complex.

454 water wells exist within the AoR (see Form A-2). These wells are sourced from shallow aquifers, with the deepest water well installed to a depth of 1,000 feet. Public water supplies

are not expected to be affected by this sequestration project, due to: 1) multiple confining layers between the storage reservoir and these shallow aquifers; and 2) model results indicating no leakage from the storage reservoir.

9.0 SITING, CONSTRUCTION, AND OPERATION

Form B of the Permit application details the Well Casing and Cementing Program. All new wells (Injection and Monitoring) for the Casper Carbon Storage Hub are designed to ensure isolation of the injection zone. The integrity of the upper and lower confining zones is discussed in Section 3.0 of this Waiver, and the suitability of the injection zone is found in Section 2.0. The Emergency and Remedial Response Plan is presented in Form A-3 of the Permit application, while the Demonstration of Financial Responsibility is contained in Form A-4.

10.0 COMMUNITY DRINKING WATER NEEDS

The majority of the population of Natrona County belongs to the city of Casper, Wyoming. The City of Casper receives its water supply via a combination of alluvial groundwater and surface water. Water supply within the AoR is provided in section 8.0 of this waiver. CCC is unaware of any planned additional use of deeper aquifers within the AoR.

11.0 LOCAL WATER, HYDOCARBON, AND MINERAL EXPLOITATION

Pursuant to WWQR Chapter 8, Section 6(c)(ii), the discharge of waste will not degrade or decrease the availability of mineral resources, including oil and gas. Exploration drilling dating to the mid-20th century has demonstrated that no geologic zones in the area of Casper Carbon Capture #1 are prospective for commercial hydrocarbon production.

There is no active exploration or production in the project area, and the nearest established production is in the Frontier Formation of Brooks Ranch Field ~3.5 miles to the northeast. The storage complex for this project is stratigraphically lower than the Frontier, and neither free-phase CO_2 nor pressure changes are expected to affect production at Brooks Ranch. Based on this information, no future penetrations into or through the injection zone are anticipated, suggesting no degradation or decrease in availability of mineral resources is expected to result from the project (See Form A-1 of the Permit application).

12.0 CONTAMINATION PLAN

Form A-3 of the Permit application contains the proposed plan for treating the deep USDW formation waters in the event of contamination related to this Class VI Injection activity. This approach consists of pump and treat and/or a Monitored Natural Attenuation (MNA).