

9.0 POST-INJECTION SITE CARE AND SITE CLOSURE PLAN
40 CFR 146.93(a)

MARQUIS BIOCARBON PROJECT

Facility Information

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Well name: MCI CCS 3

Well location: PUTNAM COUNTY, ILLINOIS
S2 T32N R2W
Latitude: 41.27026520 N, Longitude: 89.30939322 W

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9.0 Post-Injection Site Care and Site Closure (PISC) Plan

9.1 Introduction

This Post-Injection Site Care and Site Closure (PISC) plan describes the activities that Marquis Carbon Injection LLC will perform to meet the requirements of 40 CFR 146.93. Upon cessation of injection, Marquis Carbon Injection LLC will evaluate its monitoring data and updated modeling results and either: (i) submit an amended post-injection site care and site closure plan, or (ii) demonstrate to the Director through monitoring data and modeling results that no amendment to the plan is needed. Marquis Carbon Injection LLC will monitor groundwater quality and track the position of the carbon dioxide (CO₂) plume and pressure front for 12 years after the cessation of injection, which is the anticipated timeline for CO₂ plume and pressure front stabilization, and will continue until the geologic sequestration project no longer poses an endangerment to USDWs and the demonstration described in Section 9.6 is submitted and approved by the Director.

9.2 Pre- and Post-Injection Pressure Differential [40 CFR 146.93(a)(2)(i)]

Based on the modeling of the pressure front as part of the area of review (AoR) delineation, pressure at the MCI CCS 3 well is expected to decrease to pre-injection levels (with less than 1% of pressure difference to pre-injection pressure) within 12 years of post-injection, as described below. Additional information on the projected post-injection pressure declines and differentials is presented in the permit application and the AoR and Corrective Action Plan (Permit Section 2).

Figure 9-1(a) shows the modeling results of pressure behavior during the 6-year injection phase of the project and a 50-year post-injection period. Refer to the AoR and Corrective Action Plan (Permit Section 2) for more information on the delineation of the AoR.

Figure 9-1(b) shows the pressure buildup during injection and post injection period. As **Figure 9-2** shows, the pre-injection pressure differential is equal to zero. The pressure differential reaches ~280 psi during injection. In the post injection phase, pressures at the injection wells decrease to pre-injection levels (with less than 1% of pressure difference to pre-injection pressure within 12 years of post-injection).

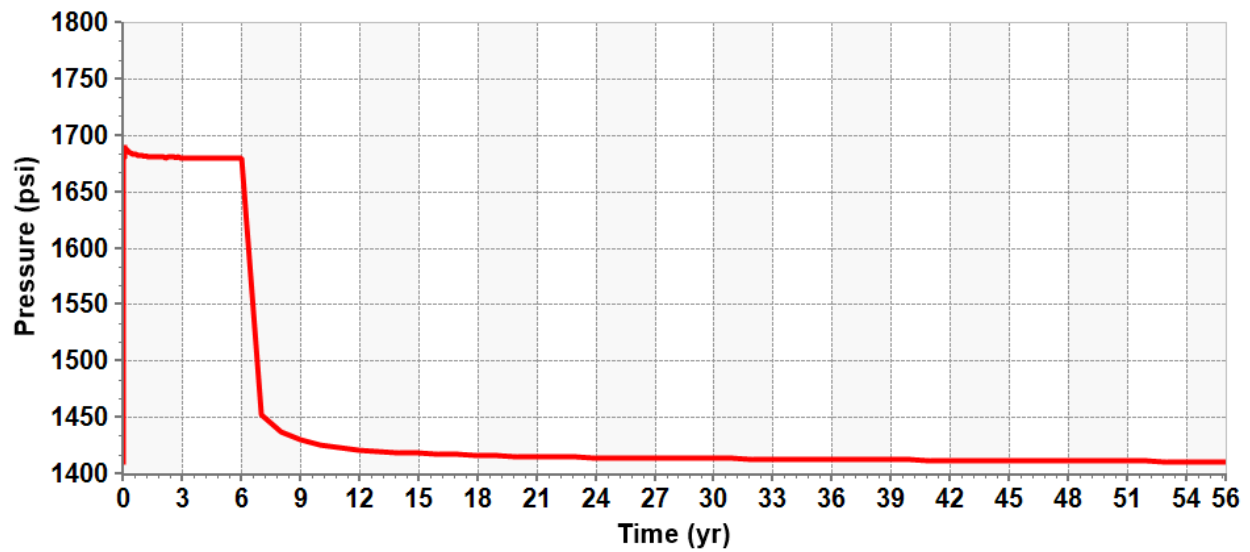


Figure 9-1(a): Pressure at Well Block/Cell Including Initial Time Step

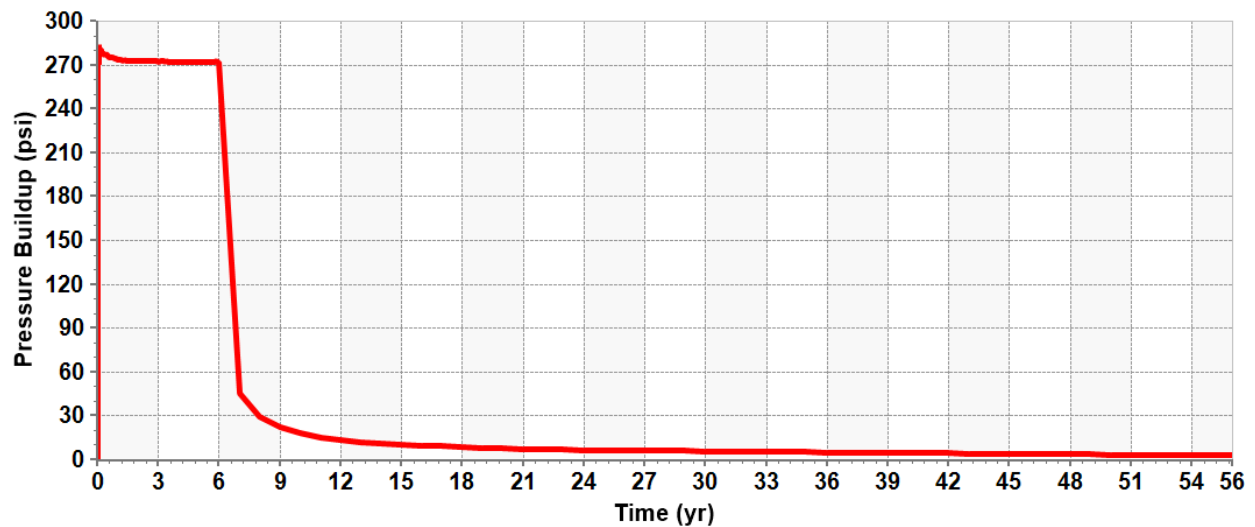


Figure 9-1 (b): Pressure Buildup at Injection Well Block/Cell Including Initial Time Step

9.3 Predicted Position of the CO₂ Plume and Associated Pressure Front at Site Closure (40 CFR 146.93(a)(2)(ii))

Figure 9-2 shows the predicted extent of the CO₂ plume at the end of the PISC timeframe that represents the maximum extent of the CO₂ plume in relation to the AoR. This map is based on the final AoR delineation modeling results submitted pursuant to 40 CFR §146.84.

Figure 9-3 shows the predicted extent of the CO₂ plume at the end of the injection phase and at 5, 10, and 50 years after the cessation of injection. The figures demonstrate the stability of the CO₂ plume during the PISC phase. **Figure 9-4** shows a map and cross section views of the pressure buildup around the MCI CCS 3 well during the injection phase. **Figure 9-5** reflects the pressure at 1, 5, and 10 years after the cessation of injection. The pressure front decreases rapidly after the injection period ends and decreases to differential of less than 1% of the pre-injection pressure within 12 years of post-injection.

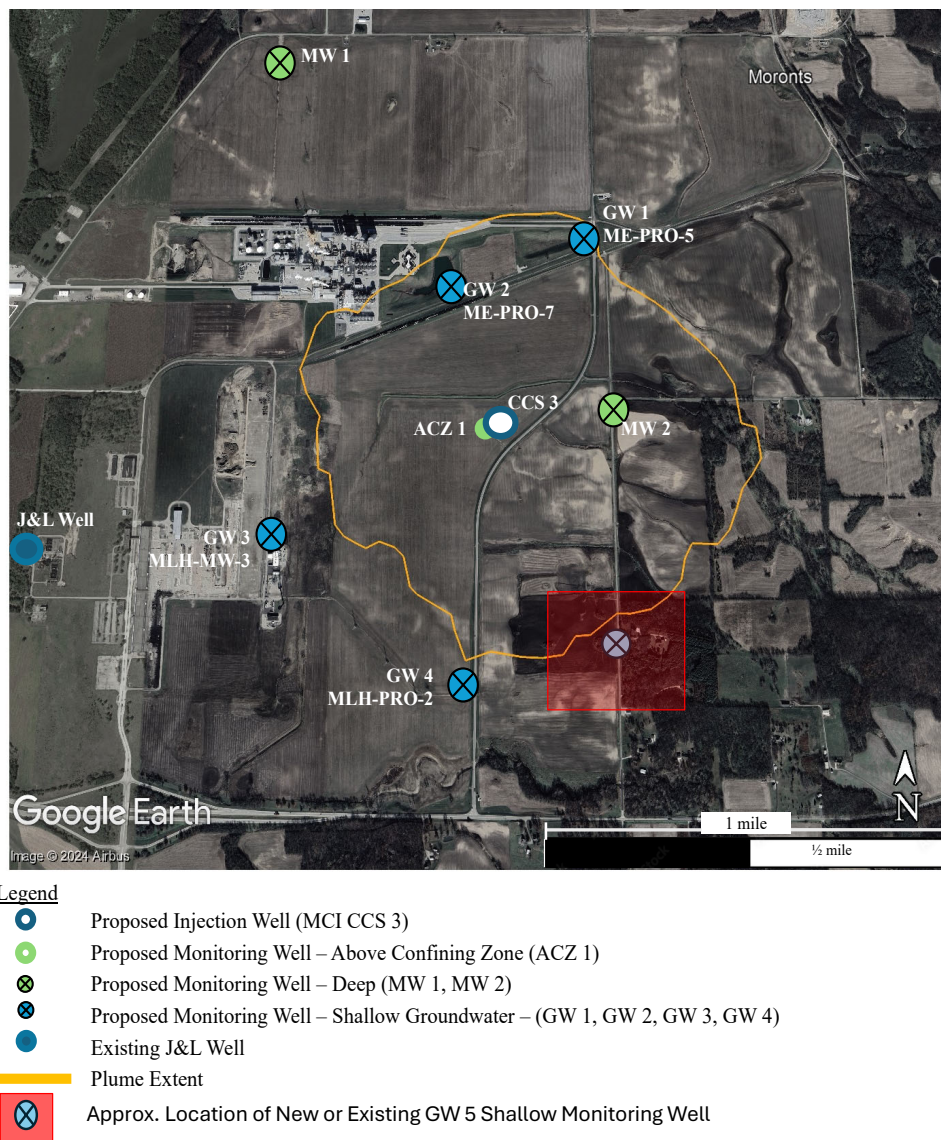


Figure 9-2: Map showing the modeled CO₂ plume footprint, and existing and proposed project wells within the AoR.

6 Years after Start of Injection

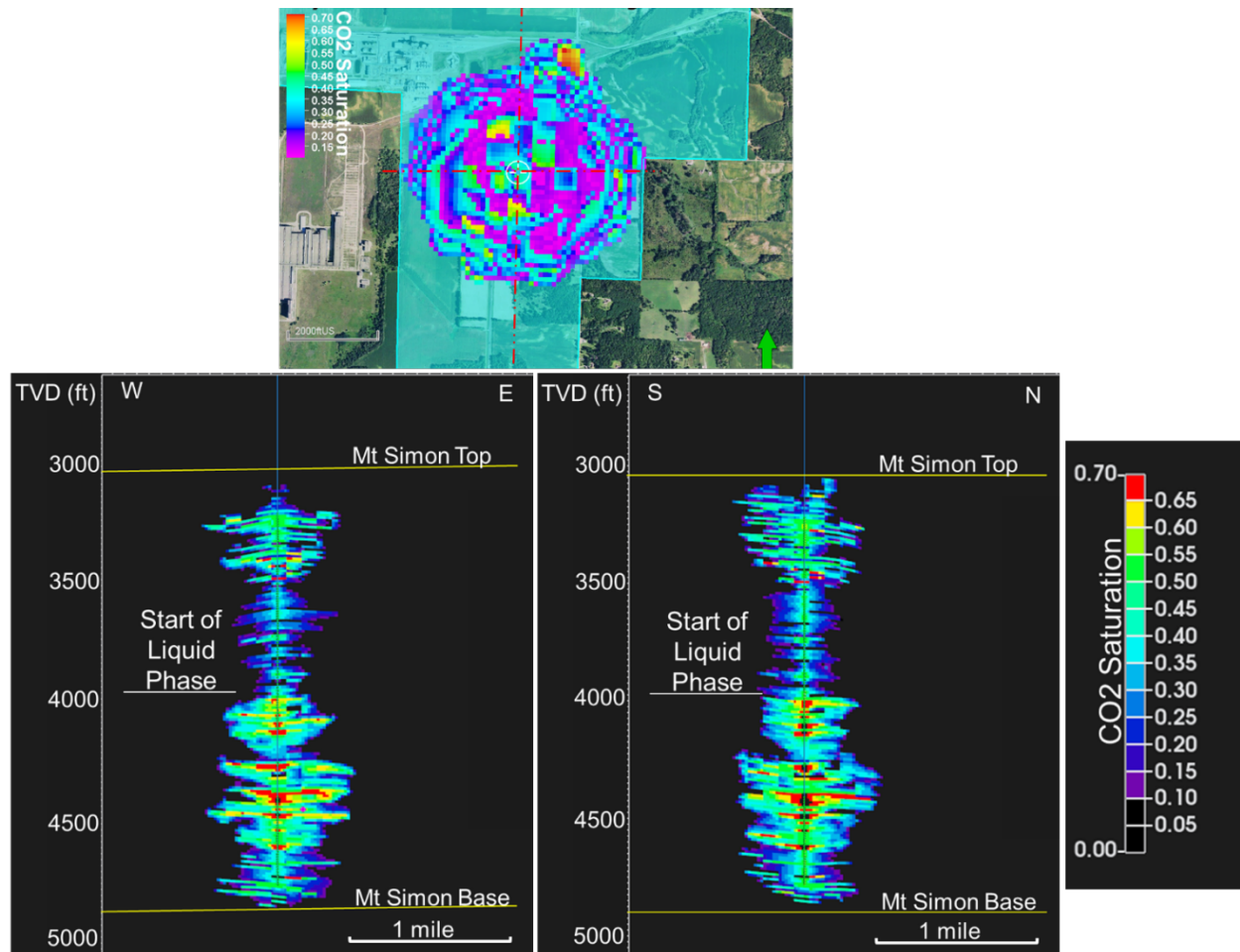


Figure 9-3: Plane view and cross-sections of the development of CO2 plume at end of 6-year injection, and at a) 5 years, b) 10 years, and c) 50 years post injection.

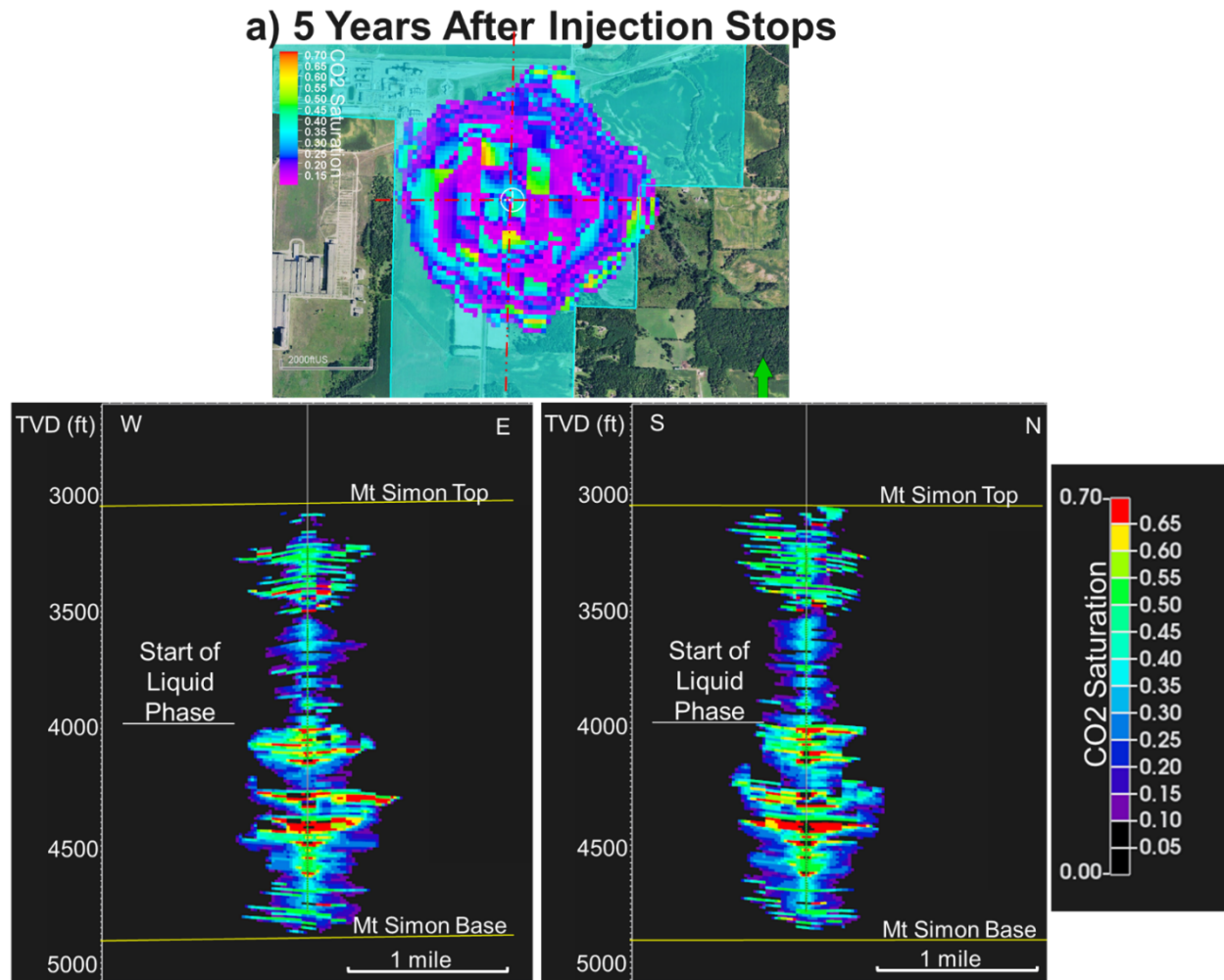


Figure 9-3(a): Plane view and cross-sections of the development of CO2 plume at end of 6-year injection, and at a) 5 years, b) 10 years, and c) 50 years post injection.

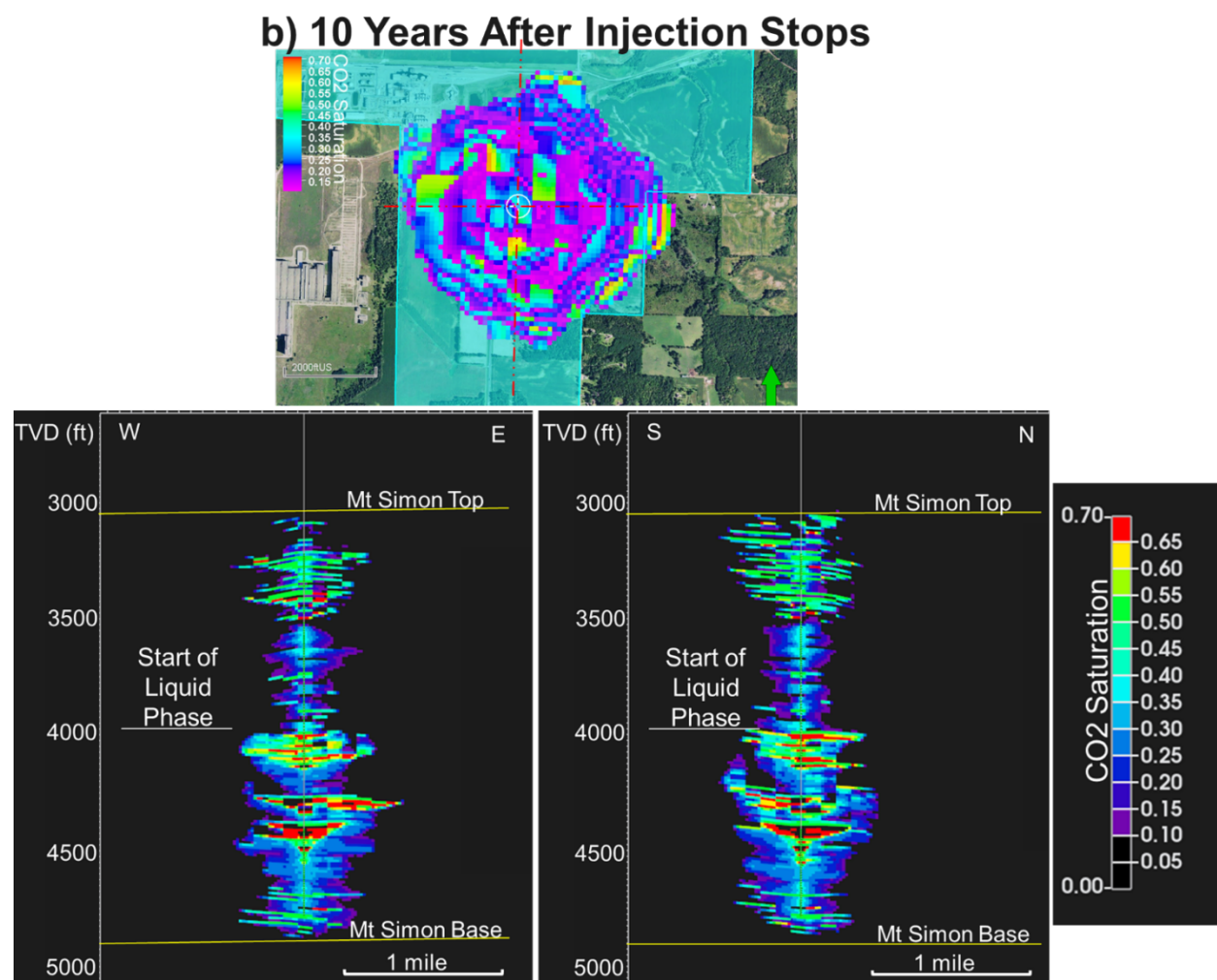


Figure 9-3(b): Plane view and cross-sections of the development of CO₂ plume at end of 6-year injection, and at a) 5 years, b) 10 years, and c) 50 years post injection.

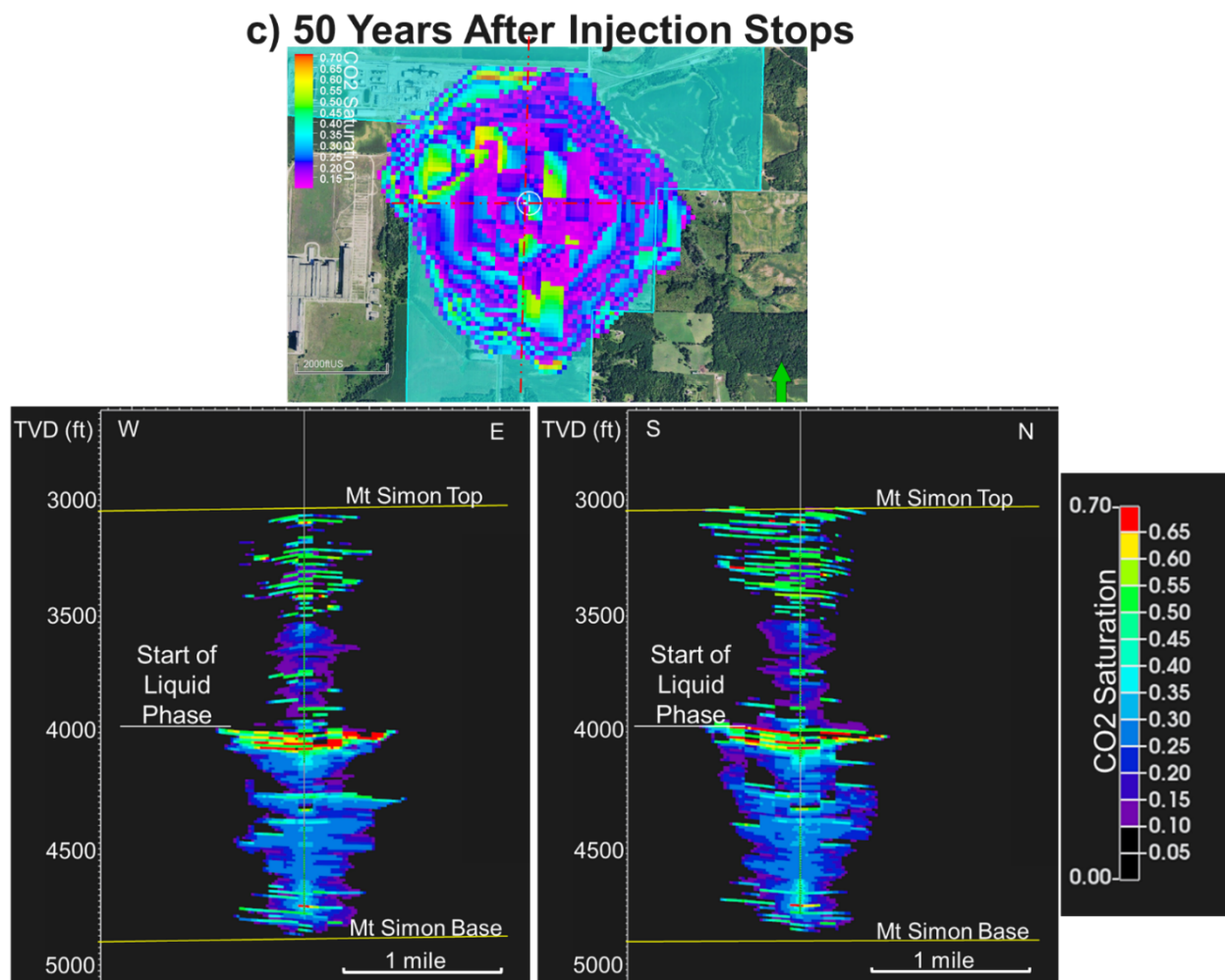
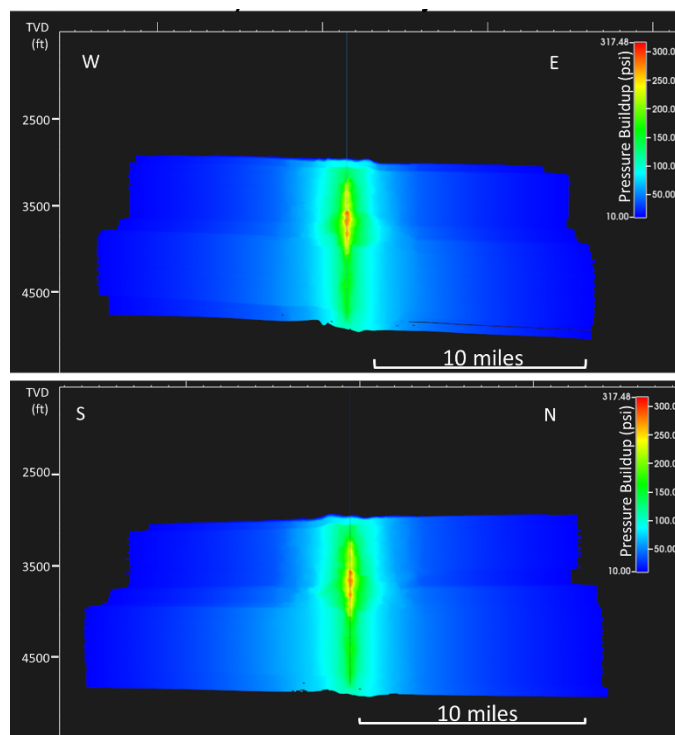


Figure 9-3(c): Plane view and cross-sections of the development of CO2 plume at end of 6-year injection, and at a) 5 years, b) 10 years, and c) 50 years post injection.

After 4 years of injection



After 6 years of injection

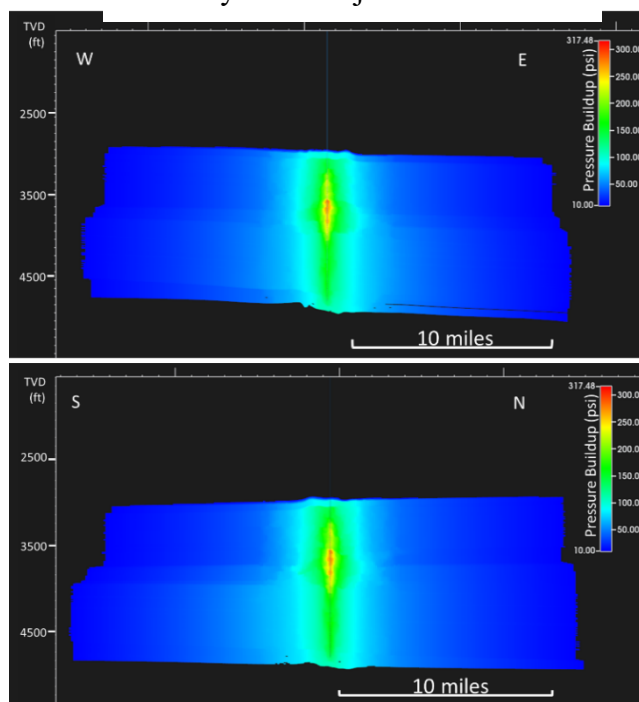


Figure 9-4: Predicted pressure plume development at years 4, and 6 of injection

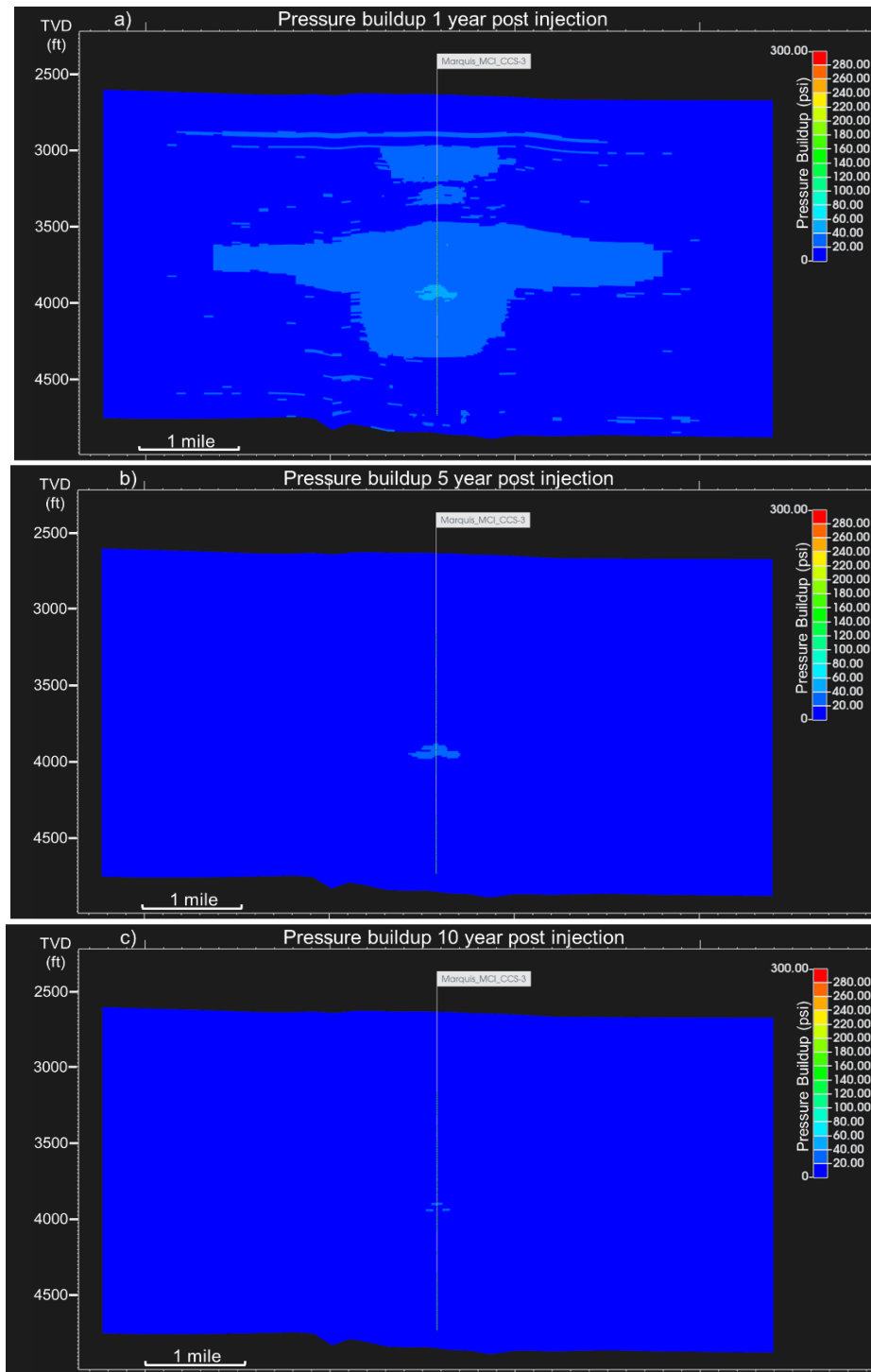


Figure 9-5: Predicted pressure plume development /dissipation at years 2, 5, and 10 post injection.

9.4 Post-Injection Monitoring Plan (40 CFR 146.93(a)(2), (a)(3), and (b)(1))

Performing groundwater monitoring, storage zone pressure monitoring, and geophysical monitoring as described in the following sections during the post-injection phase will meet the requirements of 40 CFR 146.93(b)(1). The results of all post-injection monitoring will be submitted semi-annually during the first year of the PISC and annually in subsequent years.

A quality assurance and surveillance plan (QASP) for all testing and monitoring activities during the injection and post-injection phases is provided in **Appendix 7.A** of the Testing and Monitoring Plan (Permit **Section 7**).

Table 9-1 summarizes the monitoring activities that will take place during the PISC phase of the project. Monitoring the well integrity of the MCI CCS 3 and MCI MW 2 wells will be conducted on a yearly basis using temperature measurements to ensure that there is no migration of CO₂ up the wellbores. In addition, the annular pressures and fluid volumes in the MCI CCS 3 well will be monitored on a continuous basis until the well is plugged and abandoned. Annular pressure in the deep monitoring well (MCI MW 2) will be monitored weekly until the well is plugged and abandoned. Refer to the Well Operations Plan and the Testing and Monitoring Plan for more information on the well integrity and operational monitoring plans (Permit **Sections 6 and 7**, respectively).

Pulsed neutron capture (PNC) logging will continue in the MCI MW 2 well and the above confining zone (ACZ) monitoring well (MCI ACZ-1) in the second quarter of each year of the PISC phase. This will allow the project to continue to characterize the vertical plume development in the Mt. Simon Sandstone in the MCI MW 2 well and further verify that CO₂ is not migrating past the confining zone and into the ACZ aquifers, thereby endangering underground sources of drinking water (USDWs). Refer to the Testing and Monitoring Plan for more information on the PNC logging plans (Permit **Section 7**).

The project will continue to monitor pressures within the Mt. Simon Sandstone in the MCI MW 2 well and pressure at the top of the Mt. Simon Sandstone in the MCI CCS 3 well until it is abandoned. The pressure within the Mt. Simon Sandstone is expected to begin to dissipate once CO₂ injection ceases based on the computational modelling. The Mt. Simon Sandstone pressure measurements are expected to verify the pressure decrease, and the data will be used to history match the computational modelling in the PISC phase.

Table 9-1 Monitoring Activity	PISC Frequency	Location	Depth Range (ft, MD) (Note 1)
Assurance Monitoring:			
Shallow Groundwater Sampling (Note 2)	Annually	GW-1, 2, 3, 4 existing wells and GW-5 existing or new well within AoR	Shallower than 300 Feet below ground surface
Isotope Analysis	Annually	GW-1, 2, 3, 4 existing wells and GW-5 existing or new well within AoR	Shallower than 300 Feet below ground surface
Operational Monitoring:			
Annular Pressure	Continuous	MCI CCS 3 well	Surface and Downhole
Annular Fluid Volume Added	Continuous	MCI CCS 3 well	Wellhead Annulus Monitoring System (WAMS) Surface Skid
Annular Pressure	Weekly	MCI MW 1, MCI MW 2, and MCI ACZ 1 wells	Surface
Wellbore Temperature Profile (Storage Formation) Distributed Temperature Sensing (DTS) System - Fiber Optic	Annually	MCI CCS 3	0-3,100 (Upper Mt. Simon) On casing Outside Diameter (OD) to depth of injection packer
Monitoring Well Temperature Profile (Storage Formation) (DTS Fiber Optic)	Annually	MCI MW 1 well	0-3,100 (Upper Mt. Simon) On casing Outside Diameter (OD) to depth of injection packer
	Annually	MCI MW 2 well	
	Annually	ACZ 1 well	0-Total Depth
Verification Monitoring:			
Fluid Sampling			
Gunter Sandstone	Twice/year	MCI ACZ 1 well	2,118
Galesville Sandstone	Twice/year	MCI ACZ 1 well	2,635
Upper Mt. Simon Sandstone	Twice/year	MCI MW 2 well	3,225 (Note 3)
Isotope Analysis	Twice/year	MCI ACZ 1 well MCI MW 2 well	All samples
Pressure – Temperature Sensors			
Gunter Sandstone	Continuous	MCI ACZ 1 well	2,118

Table 9-1 Monitoring Activity	PISC Frequency	Location	Depth Range (ft, MD) (Note 1)
Galesville Sandstone	Continuous	MCI ACZ 1 well	2,635
Upper Mt. Simon Sandstone	Continuous	MCI MW 2 well	3,225
PNC Logging	Once/ year	MCI MW 2 well MCI ACZ 1 well	2,118 – Total Depth 2,118 – Total Depth
Microseismic Monitoring	Continuous	Surface stations	Surface (Note 4)
Time-lapse 3D Surface Seismic Data	Every 5 years and as required.	Surface	N/A
Corrosion Monitoring – multi-finger caliper logging or ultrasonic casing evaluation	6 years after start of post-closure period until well is closed/plugged	MCI CCS 3 - 25Cr Casing and Tubing	Downhole
Modeling of CO₂ Plume/AoR:			
Dynamic Modeling	Once Every 5 Years	Storage Formation	N/A
Notes: (1) All depths are estimates based on stratigraphic test well. Actual depths will be confirmed once wells are drilled, and installation plans are completed. (2) An evaluation and request were submitted to the Program Director to utilize existing shallow wells located within the AoR as part of the groundwater monitoring program. For establishing baseline, sampling of the deep wells will occur during well drilling and prior to start of injection. (3) The upper Mt. Simon at 3,225 ft is the location of the first perforation of the top most injection zone. Sampling frequency may be adjusted once model is updated post drilling to try and detect CO₂ fluid mixing front as it passes by the well. (4) Microseismic stations have been installed to collect background data. See Figure 7-10 which shows current location of stations. Stations may be relocated if necessary, and documentation showing basis for the change and new location will be retained in the facility records.			

Table 9-1: Summary of monitoring activities in the PISC phase of the project.

Pressures will also continue to be monitored in the Galesville Sandstone and the deepest USDW to confirm the continued containment of CO₂ within the storage formation (**Figure 9-6**). Fluid samples will be taken from the Galesville Sandstone and deepest USDW once a year for geochemical and isotopic analysis to further verify CO₂ containment. Shallow groundwater fluid samples will also be obtained each year from the shallow groundwater wells, MCI GW 1-5, for geochemical and isotopic analysis.

Microseismic activity is expected to return to background (pre-injection) levels once the injection phase of the project is complete and the associated pressure plume begins to dissipate. The microseismic monitoring would then be phased out in the first six to twelve months of the PISC phase. This will be evaluated in the first months of the PISC phase of the project, and no decisions will be made without consultation with the Underground Injection Control (UIC) Program Director (UIC Director).

The project proposes to acquire time-lapse three-dimensional (3D) surface seismic surveys in the PISC phase of the project. One will be acquired no more than 12 months prior to shutting down the well (pre-PISC). Then during the PISC, one will be acquired at 5 years post injection, and the final survey will be acquired in the final year of the PISC phase of the project. The objectives of these surveys include:

- Verification of continued CO₂ containment in the storage formation
- Demonstration of the stability of the CO₂ plume after the injection phase of the project
- Providing data for the calibration and verification of the computational modelling

The PISC data collected will be used to demonstrate non-endangerment of USDWs at the end of the PISC phase (Section 5.0).

Marquis companies own the land on which the injection, deep monitoring, and ACZ wells are located. Marquis also owns the land on which the shallow groundwater wells used for monitoring are located. The wells are on flat farmland, and there are no residential areas near the well locations. Access to the wells is not anticipated to be an issue for the PISC phase of the project.

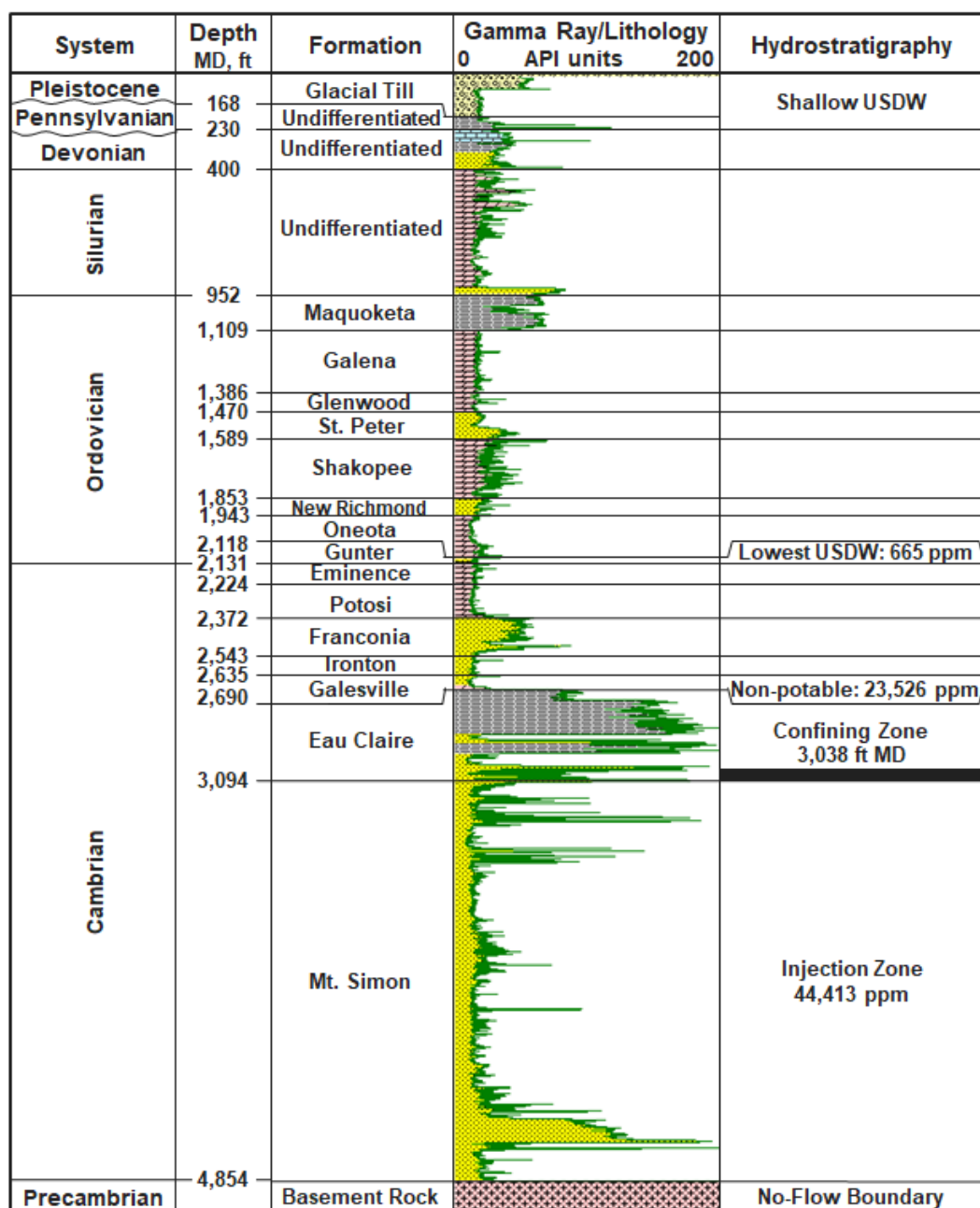


Figure 9-6 Revised: Stratigraphic column from MCI MW 1 well located at the Marquis BioCarbon Project site.

9.4.1 Monitoring Above the Confining Zone

The monitoring plan for the PISC is designed to be adaptive and respond to evolving project risks over time. At this point in the project, no phased monitoring has been planned for the MCI

ACZ 1 well; however, this may be assessed later as the project progresses. No changes will be made to the PISC without informing the UIC Director (40 CFR 146.93 (a)(3)).

Table 9-2 presents the analytes, locations and frequencies of monitoring in the proposed MCI ACZ 1 and groundwater monitoring wells. For fluid sampling, a bailer system, pump, or like method will be used to collect water samples to be analyzed for dissolved inorganic carbon, alkalinity, pH, isotopic parameters, and all other analytes Prior to sample collection the well will be swabbed to remove stagnant water and ensure representative water is collected from the formation. The fluid swabbed from the well will be monitored for field parameters, such as pH, specific conductance, and temperature, using a calibrated water quality meter (Horiba U-53, or similar). Once these parameters stabilize, it will be an indication that representative formation fluid is in the well at the time the sample is collected.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Shallow Groundwater	Groundwater geochemistry and stable isotopes	GW-1, 2, 3, 4 existing wells and GW-5 existing or new well within AoR	Within 300 Feet below ground surface	Q2/ year after injection ceases
Gunter Sandstone	Groundwater geochemistry and stable isotopes	MCI ACZ-1	~2,118 ft	Q2/ year after injection ceases
Galesville Sandstone	Groundwater geochemistry and stable isotopes	MCI ACZ-1	~2,635 ft, MD	Q2/ year after injection ceases
Galesville to Gunter Sandstones	PNC Logging	MCI ACZ-1	2,100 – 2,700 ft, MD	Q2/ year after injection ceases

Table 9- 2: Monitoring of ground water quality and geochemical changes above the confining zone.

Table 9-3 identifies the initial groundwater parameters to be monitored and the analytical methods that will be used for the samples in the baseline analysis of the data. During the pre-injection and injection phases, the project will assess which subset of analytes are most responsive to interactions with CO₂, so the list of analytes will be reduced in the future (Permit Section 7). However, no changes will be implemented without consultation with the UIC Director.

Parameters	Analytical Methods	Alternate Analytical Method (Note 1)
Cations (Na, Ca, Mg, Ba, Sr, Fe, K)	ASTM D1976	EPA Method 6020
Cation (Sr)	ASTM D1976	EPA Method 6010
Anions (Cl, Br, SO ₄)	ASTM D4327	EPA Method 300
pH	ASTM D1293	Standard Method (SM) 4500H
Alkalinity	ASTM D3875	SM 2320B
Total Dissolved Solids (TDS)	ASTM D5907	SM 2540C
Density	ASTM D4052	SM 2710F
Dissolved Inorganic Carbon	ASTM D513-11	SM 5310C
Conductivity/Resistivity	ASTM D1125	SM 2510B
Stable Isotopes of C, O, and H	CRDS Laser H Isotope Ratio Mass Spectrometry (IRMS) for C	(Note 1)
Carbon-14	Accelerator Mass Spectrometry (AMS)	(Note 1)
Note: (1) If another alternative analytical method(s) is considered, prior approval will be obtained from the UIC Director.		

Table 9-3: Summary of analytical and field parameters for ground water samples.

A nationally certified laboratory will be selected for the groundwater sampling and analysis. The sampling and analytical measurements will be performed in accordance with project quality assurance requirements. Samples will be tracked using standard chain-of-custody forms. See the QASP for additional information (**Permit Section 7, Appendix 7.A**).

The results of the geochemical and isotope analysis will be delivered in the form of laboratory reports. If anomalous changes in the aqueous geochemistry are observed in the ACZ monitoring zones, new confirmation samples will be collected from the affected aquifer and sent for analysis to verify the changes.

If anomalous changes are confirmed (greater than 5% deviation from baseline values as described in the Testing and Monitoring Plan (Section 7.5), the frequency with which fluid samples are obtained from the ACZ aquifers for analysis will be increased. As a precautionary measure, the fluid sampling frequency for the shallow groundwater monitoring wells will also be increased in consultation with the UIC Director. If the injected CO₂ has a unique isotopic

signature from the existing isotopes in the overlying aquifers, a new round of samples will be collected for isotopic analysis from the affected aquifer. Confirmed anomalous changes may also trigger the need for additional well integrity testing in both the MCI MW 2 well and the MCI CCS 3 well to ensure that no well integrity issues have developed since the last set of external mechanical integrity tests. A combination of anomalous pressure, geochemical, and well integrity testing results may result in the decision to acquire a time-lapse surface seismic survey before the survey scheduled in year five of the PISC to determine the size of the leakage accumulation.

Table 9-5 presents information about the continuous monitoring devices to be used in the deepest USDW and the Galesville Sandstone. The pressure/temperature data will be stored as time stamped data pairs. Migration of CO₂ or brine into the MCI ACZ 1 well will likely first be identified through pressure changes in the aquifers. An increasing pressure trend in either aquifer would suggest that leakage across the confining layer is occurring. While any increasing trend in pressure or temperature will be evaluated, an increase in pressure or temperature greater than 5% above baseline values will warrant additional monitoring and inspections to rule out the possibility of fluid leakage out of the storage formation. Such an increase in pressure or temperature would initiate more frequent fluid sampling and analysis for geochemical parameters from the aquifer with the pressure/temperature increase. An increase in pressures or temperatures in the MCI ACZ 1 well may also trigger additional external well integrity investigations in the MCI CCS 3 or MCI MW 2 well.

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
Pressure	Pressure Gauge	Deepest USDW Galesville Sandstone	Every 1 min.	Every 1 min.
Temperature	Temperature Gauge	Deepest USDW Galesville Sandstone	Every 1 min.	Every 1 min.
Notes: • Sampling frequency refers to how often the monitoring device obtains data from the well for a particular parameter. For example, a recording device might sample a pressure transducer monitoring injection pressure once every two seconds and save this value in memory. • Recording frequency refers to how often the sampled information gets recorded to digital format (such as a computer hard drive). For example, the data from the injection pressure transducer might be recorded to a hard drive once every minute.				

Parameter	Device(s)	Location	Min. Sampling Frequency	Min. Recording Frequency
If system communication is lost for greater than 30 minutes, manual field monitoring of gauges will be conducted every 6 hours or twice per shift for both CO₂ surface injection pressure and annulus surface pressure. Logs will be maintained in the facility records				

Table 9-4: Sampling and recording frequencies for continuous monitoring in the MCI ACZ 1 well.

9.4.2 CO₂ Plume and Pressure Front Tracking (40 CFR 146.93(a)(2)(iii))

Direct and indirect methods will be employed to track the extent of the CO₂ plume and the presence or absence of elevated pressure.

Table 9-6 presents the direct and indirect methods that will be used to monitor the CO₂ plume including the activities, locations, and frequency of sampling.

Fluid sampling will be performed as described in Section B.2 of **Appendix 7.A** of the QASP; sample handling and custody will be performed as described in Section B.3 of the QASP; and quality control will be ensured using the methods described in Section B.5 of the QASP. Quality assurance procedures for seismic monitoring methods are presented in Section B.9 of the QASP (**Permit Section 7, Appendix 7.A**).

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Direct Plume Monitoring				
Galesville, Eau Claire Shale, and Mt. Simon Formations	Pulsed Neutron Logging	MCI MW 2 well	2,118 – TD	Q2/ Year
Indirect Plume Monitoring				
Galesville, Eau Claire Shale, and Mt. Simon Formations	Time-lapse 3D Surface Seismic Data	Over project AoR	Surface	Q2, Year 5 Q2, Year 10

Table 9-5: Post-injection phase CO₂ plume monitoring.

The PNC logs will be received as log ascii standard (LAS) files and interpreted products that can be imported into the static earth model (SEM). PNC logging will be used to monitor the distribution and saturation of CO₂ adjacent to the wellbore in the MCI MW 2 well. The PNC logs will be acquired through the Galesville Sandstone in the MCI MW 2 well to confirm the absence

of CO₂ accumulations along the wellbores above the confining layer. Technical details on PNC logging tools can be found in the QASP (**Permit Section 7, Appendix 7.A**).

Surface seismic data are delivered in a variety of formats including acquisition and processing reports and raw data files from a variety of points in the processing flow. In the context of time-lapse analysis, an assessment will be provided on the differences between the baseline and time-lapse surveys as well as data files that can be incorporated into the SEM. The injection of CO₂ and expansion of the plume is expected to change the acoustic impedance of the Mt. Simon Sandstone over time. These acoustic impedance changes will be used to track the CO₂ plume during the PISC phase of the project. The time-lapse surface seismic data will also be monitored for changes that may suggest that CO₂ has migrated past the confining layer.

Table 9-6 presents the direct methods that will be used to monitor the pressure front. The pressure/temperature sensors will be programmed to measure and record pressure and temperature readings every 60 seconds. The MCI CCS 3 pressure transducer will record data continuously on the distributed control system. The MCI MW 2 pressure transducer will monitor the pressure continuously, and the data will be downloaded on a quarterly basis. A pair of gauges will be placed in each zone to limit the possibility of data loss. The final monitoring interval in the upper Mt. Simon Sandstone will be determined after the MCI CCS 3 well has been drilled and well information has been reviewed (Pre-Operational Testing Program, Permit **Section 5**). A pressure transducer will also be set at the MCI CCS 3 well to measure the pressure fall-off at the top of the Mt. Simon Sandstone until the well is abandoned. The pressure/temperature data will be stored as time-stamped data pairs that can be used for history matching in the computational model.

Target Formation	Monitoring Activity	Monitoring Location(s)	Spatial Coverage	Frequency
Direct Pressure-Front Monitoring				
Upper Mt. Simon Sandstone	Pressure Monitoring	MCI MW 2	~3,225 ft, MD Exact TBD	Continuous
Top Mt. Simon Sandstone	Pressure Monitoring	MCI CCS 3 well	~3,100 ft, MD	Continuous
Indirect Pressure-Front Monitoring				
Eau Claire and Mt. Simon Formations, and Precambrian Basement	Microseismic Monitoring	5 Surface Stations	AoR	Continuous

Table 9-6: Post-injection phase pressure-front monitoring.

The results of the geochemical and isotope analysis, PNC logging, and time-lapse 3D surface seismic data will all be integrated to develop a comprehensive understanding of the CO₂ plume development over time. PNC logging and time-lapse 3D surface seismic data can be incorporated into the SEM for comparison to the computational modelling predictions at different points in time. Based on the current computational modelling results, the CO₂ plume is predicted to stabilize (**Figure 9-5**), and the pressure plume at the MCI CCS 3 well is expected to decrease to less than 1% of pressure difference to pre-injection pressure levels within 12 years of post-injection. A time-lapse 3D surface seismic survey will be acquired prior to shutdown of the injection well and prior to entering the PISC period. Thereafter, the surveys will be acquired during years 5 and 10 of the PISC phase to characterize the stabilization of the CO₂ plume. The pressure data from the MCI MW 2 and MCI CCS 3 wells will verify the decline in formation pressures predicted by the computational modelling.

The increase in pressure in a storage formation is one of the primary drivers for CO₂ and brine migration beyond the confining layer and potentially endangering USDWs. The rapid decrease in pressure in the Mt. Simon Sandstone coupled with the ACZ monitoring and absence of evidence for CO₂ migration beyond the confining layer will demonstrate the non-endangerment of USDWs within the AoR (Section 9.5). Plume stability will be reached when there is essentially no additional driving force to cause significant plume movement other than the natural buoyancy and geohydraulic flow, and equalization of the pressure to near pre-injection conditions will be one element in demonstrating non-endangerment.

9.4.3 Schedule for Submitting Post-Injection Monitoring Results (40 CFR 146.93(a)(2)(iv))

A report detailing all PISC monitoring data and results will be submitted to the EPA. In the first year of the PISC phase, reports will be submitted on a semi-annual basis. After the first year of the PISC phase, reports will be submitted annually. The reports will address the information and data generated during the reporting period (i.e., well-based monitoring data, sample analysis, and the results from updated site models). The initial Year 1 report will be submitted within eight months after the date that injection stops or alternatively on a date agreed upon with the UIC Director.

9.5 Alternative Post-Injection Site Care Timeframe (40 CFR 146.93(c))

Marquis Carbon Injection LLC will conduct post-injection monitoring for a twelve-year period following the cessation of injection operations. The 12 year post-injection site care timeframe is appropriate and ensures non-endangerment of USDWs at the end of the timeframe as demonstrated in sections 9.5.1 through 9.5.7 below.

9.5.1 Computational Modeling Results – 40 CFR 146.93(c)(1)(i)

Figure 9-3 shows the cross section of the predicted CO₂ plume extent and demonstrates the CO₂ plume stability during alternative PISC timeframe. **Figure 9-5** illustrates a cross section of the predicted pressure front during the post-injection period. The pressure front declines quickly during the post-injection period.

Figure 9-1 shows, the predicted pressure at the MCI CCS 3 well is expected to decrease to less than 1% of pressure difference to pre-injection pressure levels within 12 years of post-injection. Given the fast CO₂ plume stabilization and rapid pressure decrease in the Mt. Simon Sandstone predicted by the computational modeling, a 12-year PISC is appropriate to ensure USDW protection.

This was further supported by a sensitivity analysis to test the effects of varying several parameters including porosity and permeability in horizontal and vertical directions, well head temperature and flow rate relationships on the CO₂ plume shape and pressure behavior (**Figure 9-8**). High-high, high-low, low-high and low-low cases were runs to test porosity permeability relationships in addition to the base case. The summary of sensitivity cases is shown in **Figure 9-7**. The results of the sensitivity analysis indicate that the CO₂ plume shape is similar in all cases compared to the base case scenario (**Figure 9-8**). Details related to this sensitivity analysis are discussed further in AoR and Corrective Action Plan Section (Permit **Section 2.3**).

Case #	Case Name	Altered Parameter	Value of Altered Parameter
0	Base Case	None	Average Porosity: 7.9%, Average Horizontal Permeability: 64.22 mD
1	High Porosity High Permeability “High High case”	Porosity/Permeability Transform	Average Porosity: 8.7%, Average Horizontal Permeability: 169.2 mD
2	High Porosity Low Permeability “High Low case”		Average Porosity: 8.7%, Average Horizontal Permeability: 31.5 mD
3	Low Porosity High Permeability “Low High case”		Average Porosity: 6.9%, Average Horizontal Permeability: 111.1 mD
4	Low Porosity Low Permeability “Low Low case”		Average Porosity: 6.9%, Average Horizontal Permeability: 19.8 mD
5	High Vertical Permeability	Vertical to Horizontal Permeability Ratio	0.7%-50% based on flow facies type
6	Low Vertical Permeability		0.1%-0.4% based on flow facies type
7	93.2 °F Wellhead Temperature	Wellhead Temperature	93.2 °F
8	115 °F Wellhead Temperature		115 °F
9	Reduced Rate to 600,000 tonnes/year	CO ₂ Injection Rate	600,000 tonnes/year

Figure 9-7: Summary of Sensitivity Cases

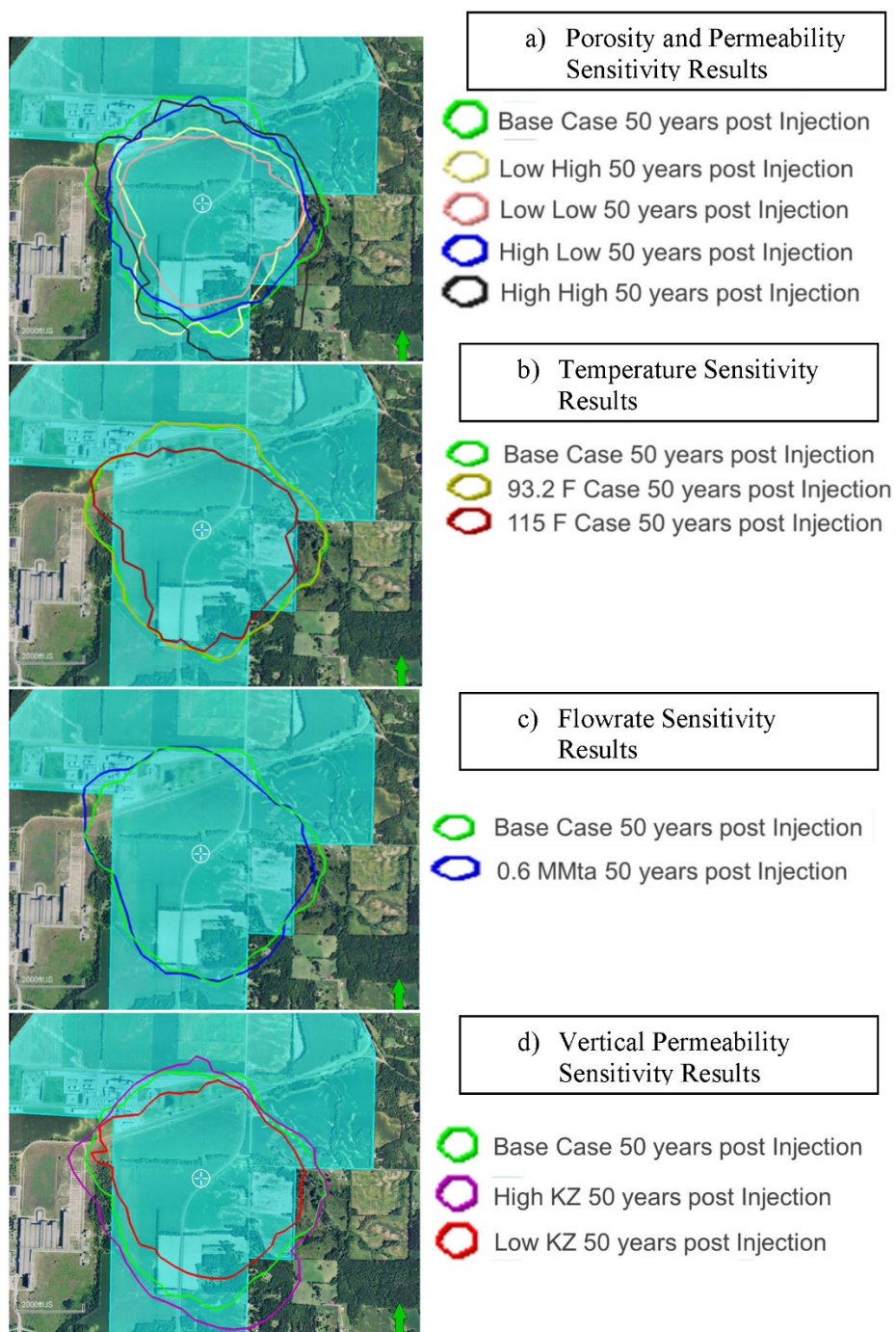


Figure 9-8: Results from Sensitivity Analyses. Figures 2 miles x 2 miles.

9.5.2 Predicted Timeframe for Pressure Decline – 40 CFR 146.93(c)(1)(ii)

Figures 9-5 shows the cross section of the pressure front during the post injection phase. Additional plots and figures showing the pressure front during the injection period, can be found in the AoR and Corrective Action Plan Section (Permit Section 2). The maximum spatial extent of the pressure front occurs at the end of the injection period.

Figure 9-1(a) and **Figure 9-1(b)** show the predicted pressure buildup and decline at the MCI CCS 3 well through the injection phase and for 50 years of the post-injection period. The pressure declines immediately following cessation of injection and is predicted to be heterogenous between the MCI CCS 3 and MCI MW 2 wells. The details related to sensitivity analysis can be found in the AoR and Corrective Action Plan Section (Permit Section 2). A comparison of the pressure time series from the sensitivity analysis demonstrates that the pressure buildup during the injection phase and rapid decline during the PISC phase is similar to the base case scenario for different porosity permeability relationships (**Figure 9-8**).

Continuous pressure measurements will be acquired from the Mt. Simon Sandstone through the injection and PISC phases of the project (Testing and Monitoring Plan, Permit Section 7). The pressure data obtained during the injection phase of the project will be used to update the computational modelling every six months as per the reporting requirements in 40 CFR 146.91. Pressure data acquired during the PISC phase of the project are expected to verify the rapid decline in pressure in the Mt. Simon Sandstone predicted by the computational modelling.

9.5.3 Predicted Rate of Plume Migration – 40 CFR 146.93(c)(1)(iii)

Figure 9-3 shows that the cross section of the CO₂ plume remains relatively stable from the end of the injection period to year 12 of the PISC phase and beyond. Additional figures illustrating the predicted CO₂ plume expansion during the injection period are provided in the AoR and Corrective Action Plan Section (Permit Section 2). The overall CO₂ plume extent was utilized to define the AoR. The details related to sensitivity analysis are presented in the AoR and Corrective Action Plan Section (Permit Section 2.3). The results from the sensitivity analysis show that the CO₂ plume shape remains a similar size and shape for the different modeled porosity permeability relationships (**Figure 9-7**).

9.5.4 Site-Specific Trapping Processes – 40 CFR 146.93(c)(1)(iv)-(vi)

The computational modeling assessed the residual and solubility trapping process during the injection phase and for a 50-year post-injection period. Mineralization of CO₂ has not been included due to a much longer period (hundreds of years) for its impact. The CO₂ solubility in brine was modeled as a phase equilibrium process, which is computed by the equality of fugacity in the gas and aqueous phase (Li and Nghiem, 1986). The fugacity of gaseous components soluble in the aqueous phase was calculated using Henry's Law. The Henry constant is a

function of pressure at each time step, temperature, and salinity in the model according to Harvey's correlation (Harvey,1996). This correlation is applicable up to 150 °C (302 °F) and 700 bar (10,152 psi). Initial Pressure, temperature, and salinity are listed and described in **Section 2.1.7** (Initial Conditions) of Area of Review and Corrective Action Plan. Pressure at each time step is estimated in the model during CO₂ injection and post injection period as an input to calculate Henry constant and solubility. Duan and Sun (2003) developed a thermodynamic model for the solubility of CO₂ in pure water and aqueous solutions. Razipectchikolae et al., 2013 shows the CMG solubility model using Henry's law is in good agreement with the Duan and Sun model under different pressure and temperature conditions. The amount of CO₂ residually trapped in the aquifer due to relative permeability hysteresis is determined by the Land Model (Land, 1968). Linear Land's equation is used in the simulator for modeling hysteresis in relative permeability (CMG-GEM,2022, Land, 1968). The input parameters that control the amount of trapped gas are the relative permeability curves to estimate Land model's parameters depending on CO₂ saturation at each time step (relative permeability curve provided in **Section 2.1.4** (Constitutive Relationships and Other Rock Properties) of Area of Review and Corrective Action Plan, and maximum residual gas saturation. As mentioned, one of the parameters that controls the amount of trapped gas by relative permeability hysteresis is the maximum residual gas saturation, which is a function of the formation pore structure (Raziperchikolae et al., 2013). Values of 0.3 - 0.4 are typical for maximum residual gas saturation (CMG-GEM,2022, Burnside, 2014). In this model, maximum residual gas saturation of 0.3 was used. Due to the thickness and permeability variations of the Mt. Simon Sandstone, significant amounts of CO₂ can be residually trapped. Residual CO₂ trapping increases during the post-injection time period.

Figure 9-9 shows the moles of dissolved CO₂, the moles of trapped CO₂, and the moles of free CO₂ as a percentage of total CO₂ moles injected during the injection and post-injection periods.

As the CO₂ becomes immobilized through solubility and residual trapping, the risk of CO₂ migration out of the storage formation decreases. Ultimately, this will serve to demonstrate the non-endangerment of USDWs. Mineralization is unlikely to play a significant role as a major trapping mechanism for the project.

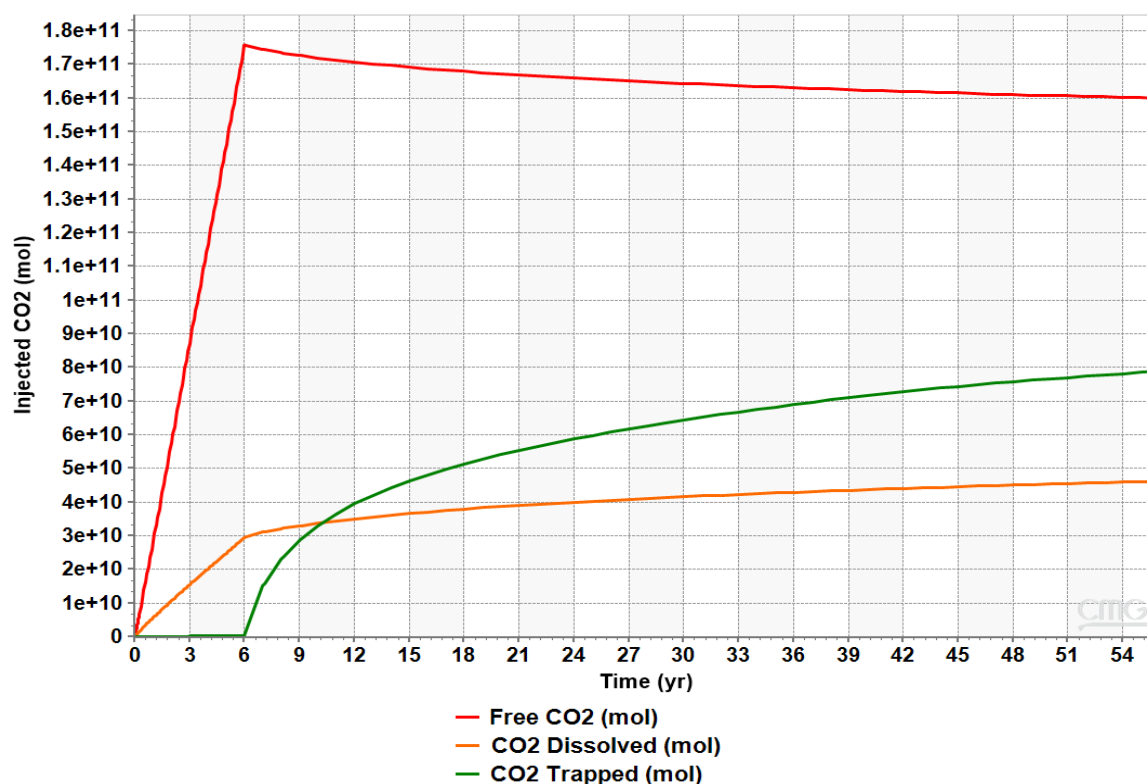


Figure 9-9: CO₂ dissolved in brine, CO₂ residually trapped in brine during injection, and free CO₂ as a percentage of total CO₂ moles injected during the injection and post-injection periods.

9.5.5 Confining Zone Characterization – 40 CFR 146.93(c)(1)(vii)

The Eau Claire Formation is the primary confining unit for the project. The base of the Eau Claire Formation is comprised of the sandy Elmhurst Member where some CO₂ mobility is possible over time. However, the Eau Claire Formation from the top of the Eau Claire Shale down to the upper Elmhurst shale has known thick and continuous shale intervals which have been confirmed as having good sealing capacity with core analysis (Permit **Section 5**). The Pre-Operational Testing Plan details the characterization that has been and will be completed for the Eau Claire Shale (Permit **Section 5**). This included assessing the mineralogy, geomechanics, and capillary pressure within the Eau Claire Shale at the MCI MW 1 well. These characteristics will be confirmed at the MCI CCS 3 well as described in Permit **Section 5**.

The properties of the Eau Claire Formation were distributed within a static reservoir model and then imported into the computational model. Data from the MCI CCS 3 well will serve to confirm and augment the models. **Figure 9-3** shows the cross section of the plume map at the

end of the injection period and for Years 5 and 10 of the PISC phase. Additional figures illustrating the CO₂ plume behavior during a 50-year post-injection period have been included in the AoR and Corrective Action Plan Section (Permit **Section 2**). Computational modeling results show that there would be no CO₂ penetration into the Eau Claire Shale during the injection and post-injection modeling period due to the low permeability of the Eau Claire Shale.

9.5.6 Assessment of Fluid Movement Potential – 40 CFR 146.93(c)(1)(viii)-(ix)

There is no evidence of geological conduits within the AoR. For purposes of the Marquis BioCarbon Project, a tabulation of all wells within the AoR were identified using well databases held by the Illinois State Geologic Survey (ISGS). Available well information indicates approximately 3,085 well records identified within the 29-mile diameter AoR. Except for one well (J&L well), there were a few other wells that penetrated into the top of the Eau Claire, but those other wells did not penetrate through the confining layer. Those other wells identified in the AoR that terminate in the top of the Eau Claire unit have been identified and logs included in **Appendix V**. As detailed in the well logs, since those wells did not fully penetrate the cap rock and were properly sealed, these wells have not been identified as potential leakage pathways, and no corrective action is required.

The only well that penetrates the confining zone in the AoR, but outside the CO₂ plume area, is the waste pickling liquor well, WPL-1, known as the J&L Well. The J&L well is located at a former ArcelorMittal steel plant, and the well was certified closed under the supervision of Illinois EPA in 2013. See **Appendix W**. The Closure Report submitted to the Illinois EPA with the well plugging documentation and logs were reviewed by the project team. The well was plugged in a manner to avoid any leakage into a USDW. The plugging conducted in accordance with 35 Illinois Administrative Code 730.131 should withstand the pressure from the injected CO₂ so no additional corrective action is proposed under the PISC.

The MCI CCS 3 well, MCI MW 1 and MCI MW 2 wells that penetrate through the Eau Claire confining layer will be constructed or completed according to the USEPA Class VI regulations. Additionally, several measures will be incorporated in the well design to ensure protection of the USDWs at the site following the injection period (Injection Well Construction Plan, Permit Section 4). The long casing string, tubing, and packer will be constructed of corrosion-resistant alloys (25Cr) across the injection reservoir and confining zone to reduce the chances of casing degradation over the long term for MCI CCS 3, MCI MW 1, and MCI MW 2. Additionally, for MCI CCS 3 and MCI MW 2, the long string casing above the Eau Claire caprock to the surface will be constructed with 13Cr versus carbon steel. Similarly, a CO₂-resistant cement will be pumped behind the deep string casing across the injection reservoir and confining zone. Following completion of the injection phase of the project and monitoring efforts, all wells will be plugged and abandoned according to the EPA Class VI guidelines, including the use of CO₂-resistant cement across the storage formation (Injection Well Plugging Plan, Permit Section 8).

All sensitivity modeling of vertical permeability shows that CO₂ does not migrate into the lower Elmhurst.

During the injection and PISC phases of the project, the well integrity of the MCI CCS 3 and MCI MW 2 wells will be monitored through several internal and external monitoring techniques (Section 9.3, Permit Section 7). Annular pressures and fluid volumes will be monitored in the MCI CCS 3 well on a continuous basis until the MCI CCS 3 well is abandoned. Annular pressures in the MCI MW 2 well will be monitored weekly for deviation from a baseline during and post injection. Temperature logging is the primary external mechanical integrity test that will be used to monitor the MCI CCS 3 and MCI MW 2 wells on an annual basis.

9.5.7 Location of USDWs – 40 CFR 146.93(c)(1)(x)

At the Marquis BioCarbon Project site, the Mt. Simon Sandstone is not considered a USDW based on salinity samples acquired from MCI MW 1 with total dissolved solids (TDS) concentrations greater than 10,000 milligrams per liter (mg/L) or 10,000 parts per million (ppm). The lowermost USDW is defined locally as the Gunter Sandstone of the Prairie du Chien Group (Knox Supergroup). At the MCI MW 1 well, the base of the Gunter Sandstone is 914 feet (ft) above the top of the Mt. Simon. USDWs in the project site range from the Gunter Sandstone (deepest USDW) to shallow, near-surface glacial till aquifers.

9.6 Non-Endangerment Demonstration Criteria

Prior to approval of the end of the post-injection phase, Marquis Carbon Injection LLC will submit a demonstration of non-endangerment of USDWs to the UIC Director, per 40 CFR 146.93(b)(2) and (3).

The owner or operator will issue a report to the UIC Director. This report will make a demonstration of USDW non-endangerment based on the evaluation of the site monitoring data used in conjunction with the project's computational model. The report will detail how the non-endangerment demonstration evaluation uses site-specific conditions to confirm and demonstrate non-endangerment. The report will include all relevant monitoring data and interpretations upon which the non-endangerment demonstration is based, model documentation and all supporting data, and any other information necessary for the UIC Director to review the analysis. The report will include the following sections:

9.6.1 Introduction and Overview

A summary of relevant background information will be provided, including the operational history of the injection project, the date of the non-endangerment demonstration relative to the post-injection period outlined in this PISC and Site Closure Plan, and a general overview of how monitoring and modeling results will be used together to support a demonstration of USDW non-

endangerment.

9.6.2 Summary of Existing Monitoring Data

A summary of all previous monitoring data collected at the site, pursuant to the Testing and Monitoring Plan (Permit Section 7) and this PISC and Site Closure Plan, including data collected during the injection and post-injection phases of the project, will be submitted to help demonstrate non-endangerment. Data submittals will be in a format acceptable to the UIC Director [40 CFR 146.91(e)], and will include a narrative explanation of monitoring activities, including the dates of all monitoring events, changes to the monitoring program over time, and an explanation of all monitoring infrastructure that has existed at the site. Data will be compared with baseline data collected during site characterization [40 CFR 146.82(a)(6) and 146.87(d)(3)].

9.6.3 Summary of Computational Modeling History

The results of computational modeling used for AoR delineation and for demonstration of an alternative PISC timeframe will be compared to the monitoring data collected during the injection and PISC phases of the project. The monitoring data used to update and calibrate the computational modeling and to demonstrate non-endangerment of USDWs will include:

- Pressure monitoring data from the Mt. Simon Sandstone, Galesville Sandstone, and the deepest USDW;
- Microseismic data;
- PNC logs that characterize CO₂ saturations and vertical plume development along the well bores; and
- Time-lapse 3D seismic data.

Data generated during the PISC period will be used to help show that the computational model accurately represents the storage site and can be used as a proxy to determine the CO₂ and pressure plume's properties and size. Marquis Carbon Injection LLC will demonstrate this degree of accuracy by comparing the monitoring data obtained during the PISC period against the model's predicted properties such as plume location, rate of movement, and pressure decay. The validation of the computational model with the large volume of available data will be a significant element to support the non-endangerment demonstration. The validation of the computational modeling results over the areas and zones where monitoring data have been collected will help to ensure confidence in those areas of the model where surface infrastructure precludes the collection of time-lapse 3D surface seismic data or the installation of monitoring wells.

9.6.4 Evaluation of Reservoir Pressure

During the PISC phase, the computational modeling predicts that the pressure in the Mt. Simon

Sandstone will steadily decrease toward the pre-injection static pressure. One of the primary forces driving CO₂ or brine migration out of the storage formation is a pressure increase in the storage formation.

Figure 9-1(a) and **Figure 9-1(b)** illustrate the rapid decrease in pressure back to pre-injection levels in the Mt. Simon Sandstone once the injection phase of the project ends; and pressure decline toward pre-injection levels is one factor indicative of USDW non-endangerment.

Post-injection the project will monitor pressure in the Mt. Simon Sandstone in the MCI MW 2 well and at the top of the Mt. Simon Sandstone in the MCI CCS 3 well with downhole pressure gauges (**Table 9-6**). The measured pressure will be compared to the pressure predicted by the computational model. Agreement between the actual and the predicted values will help validate the accuracy of the model and further demonstrate non-endangerment.

9.6.5 Evaluation of CO₂ Plume

During the injection and PISC phases of the project, the extent of the CO₂ plume will be evaluated by PNC logging in the MCI MW 2 well and time-lapse 3D surface seismic surveys.

PNC logging will be used to monitor the distribution and saturation of CO₂ adjacent to the wellbore in the MCI MW 2 well. The PNC logging results can be compared against the model's predicted plume vertical extent at a specific point location at a specified time interval. A good correlation between the two data sets will help provide strong evidence in validating the model's ability to model the CO₂ plume. Time-lapse 3D surface seismic data will be acquired at longer time intervals to track the development of the CO₂ plume over a larger spatial extent. Both data types will be used to verify the computational model's ability to predict the CO₂ behavior in the PISC phase of the project and support a demonstration of non-endangerment of USDWs at the end of the project.

9.6.6 Evaluation of Emergencies or Other Events

Mobilized brine from the storage formation may also pose a risk to USDWs. The geochemical data collected from the MCI ACZ 1 well will be used to demonstrate that the storage formation fluids have not migrated above the confining formation during the injection or PISC phases of the project. If these fluids have not migrated beyond the confining zone during the injection or PISC phases of the project, then they are not anticipated to pose a risk to USDWs after the PISC phase. To demonstrate non-endangerment, results of the fluid sampling in the deepest USDW from the injection and PISC phases will be compared to the pre-injection baseline samples. This comparison will support a demonstration that no significant changes in the fluid properties of the overlying formations have occurred and that storage formation fluids have not moved through the confining layer, and therefore the CO₂ and/or brine would not represent an endangerment to any USDWs.

Section 9.4.6 describes the quality of the well construction for the wells that penetrate the confining zone for this project. The Well Construction Plan and the Well Plugging Plan are presented in Permit Sections 4 and 8, respectively.

9.7 Site Closure Plan

Marquis Carbon Injection LLC will conduct site closure activities to meet the requirements of 40 CFR 146.93(e) as described below. Marquis Carbon Injection LLC will submit a final Site Closure Plan and notify the permitting agency at least 120 days prior of its intent to close the site. Once the permitting agency has approved closure of the site, Marquis Carbon Injection LLC will plug or transfer to another permit the MCI MW 1, MCI MW 2, and MCI ACZ 1 wells and submit a site closure report to EPA. The activities, as described below, represent the planned activities based on information provided to EPA. The actual site closure plan may employ different methods and procedures. A final Site Closure Plan will be submitted to the UIC Director for approval with the notification of the intent to close the site.

9.7.1 Plugging Monitoring Wells

Prior to plugging the wells, the external integrity of each well will be confirmed by running a temperature log over the entire length of the casing (total depth [TD] to surface). The temperature log will be acquired just before plugging the well and will be compared to previously run temperature logs to ensure that no deflections have developed that may indicate a problem with external well integrity. In addition, PNC logs will be run in the wells following the injection period to confirm that CO₂ has not migrated out of the injection zone.

The Well Plugging Plan for the MCI CCS 3 well can be found in Permit **Section 8**. The same approach that was used to plug the MCI CCS 3 well will be used to plug the MCI MW 1, MCI MW 2, and MCI ACZ 1 wells. Plugging and abandonment of the MCI MW 1, MCI MW 2, and MCI ACZ 1 wells will meet all requirements set forth by the Class VI regulations. The perforated zone of the well will be plugged using a retainer method and the upper portions of the well will be cemented with a balance method. In addition, the portion of the casing within the storage formation in the deep MCI MW 1 and MCI MW 2 well and the upper portion of MCI MW 2 will be plugged using CO₂-resistant cement. All the wells will have the casing cut off 5 ft below grade and a steel cap will be welded to the top of the deep casing string. The cap will have the well identification (ID) number and the date of plugging and abandonment inscribed on it. The following provides a detailed plan for plugging the MCI MW 1, MCI MW 2, and MCI ACZ 1 wells at the Marquis BioCarbon Project site.

1. Conduct and document a safety meeting.
2. Move-in (MI) rig and ancillary equipment onto well site and rig up (RU). Nipple up and test blow out preventors (BOPs), pressure test equipment and ensure proper operation.

3. Check wellhead tubing and casing pressures.
4. Record bottom-hole pressure from downhole gauge (if final pressure has not already been determined) and calculate kill fluid density.
5. Fill tubing with kill weight brine as determined by the final pressure measurement. Inject two tubing volumes of kill weight brine. Monitor tubing and casing pressure for 1 hour.
6. If the well is not dead or the pressure cannot be bled off the tubing, rig up slickline and set plug in lower profile nipple below packer. Unstab the tubing and circulate tubing and annulus with kill weight fluid until well is dead.
7. Release packer and pull out of hole with tubing laying it down. NOTE: Ensure that the well is over-balanced so there is no backflow due to formation pressure and there are always at least two well control barriers in place.
8. Trip into hole with work string with 5-1/2-inch cement retainer to approximately 100 ft above the top perforation, set retainer to cement the perforated portion of the well, and prepare for cement plugging operations. Pump the specified number of sacks of cement through the retainer while maintaining bottom-hole pressure below fracture pressure. If it appears that the injection pressure will exceed the fracture pressure and the total amount of cement has not been pumped into the injection zone, cement pumping will cease. After allowing the pressure to reduce to an acceptable level, cement pumping will be attempted again. A rapid increase in pressure on the tubing would indicate that the perforations have been sealed with cement, and no additional cement will be added to the zone or plug.
9. If a second perforated zone is present in the well, repeat Step 8 for upper perforated zone.
10. Trip tubing string out of well and remove stinger from end of tubing.
11. Trip tubing string to a depth of approximately 300 ft and prepare to set second cement plug. Pump 12 sacks of Class A cement (slurry weight of 15.9 pounds per gallon [lb/gal]) using a balance method to cement between a depth of 200 and 300 ft.
12. Trip tubing string to a depth of 100 ft and prepare to set third cement plug. Pump approximately 12 sacks of Class A cement to fill the casing from a depth of 100 ft to near surface.
13. Cut the casing string off at 5 ft below grade and weld a steel plate, (with well ID, permit number, and date of abandonment on it) to the casing strings.
14. Backfill the excavation.
15. Rig down and move off service rig and any remaining equipment.

Table 9-7, Table 9-8, and Table 9-9 provide the methods that will be used to set the plugs in each of the monitoring wells, and **Table 9-10, Table 9-11, and Table 9-12** provide the materials that will be used during the plugging process. The volume of the casing to be cemented was calculated using the inside diameter of the casing string, and the length of the casing to be cemented. Note that an additional 10% volume was used when calculating the cement needed to cement the perforated zones.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
<u>Perforated Interval</u>	<u>Various between 3,165–4,050</u>	<u>Mt. Simon Sandstone</u>	<u>Retainer</u>	<u>CO₂-Resistant</u>	<u>132 sacks</u>
<u>5-1/2-in. Casing Column</u>	<u>~200-300</u>	<u>Pennsylvanian</u>	<u>Balance</u>	<u>Class A</u>	<u>12 sacks</u>
<u>5-1/2-in. Casing Column</u>	<u>~0-100</u>	<u>Pleistocene Drift</u>	<u>Balance</u>	<u>Class A</u>	<u>12 sacks</u>

Table 9-7: Intervals to be plugged and methods used when plugging the MCI MW 1 well.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Perforated Interval	Various between 3,165–4,050	Mt. Simon Sandstone	Retainer	CO ₂ -Resistant	132 sacks
5-1/2-in. Casing Column	~200-300	Pennsylvanian	Balance	<u>CO₂-Resistant</u>	<u>13 sacks</u>
5-1/2-in. Casing Column	~0-100	Pleistocene Drift	Balance	<u>CO₂-Resistant</u>	<u>13 sacks</u>

Table 9-8: Intervals to be plugged and methods used when plugging the MCI MW 2 well.

Zone of Interest	Cemented Depth (ft, MD)	Formation	Plugging Method	Plug Description	
				Type	Quantity
Galesville Perforated Interval	2,409-2,579	Galesville Sandstone	Retainer	Class A	37 sacks
Deepest USDW Interval	1,321-1,466	Deepest USDW	Retainer	Class A	33 sacks
5-1/2-in. Casing Column	~200-300	Pennsylvanian	Balance	Class A	12 sacks
5-1/2-in. Casing Column	~0-100	Pleistocene Drift	Balance	Class A	12 sacks

Table 9-9: Intervals to be plugged and methods used when plugging the MCI ACZ 1 well.

Plug Information	Plug #1	Plug #2	Plug #3
Diameter of boring in which plug will be placed (in.)	4.892	4.892	4.892
Depth to bottom of tubing or drill pipe (ft, MD)	~3,065	~300	~100
Sacks of cement to be used (each plug)	132	12	12
Slurry volume to be pumped (ft ³)	142	13.1	13.1
Slurry weight (lb./gal)	15.2	15.9	15.9
Slurry Yield (ft ³ /sack)	1.07	1.18	1.18
Calculated top of plug (ft, MD)	~3,065	~200	~0
Bottom of plug (ft, MD)	~4,050	~300	~100
Type of cement or other material	CO ₂ - Resistant	Class A	Class A
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Balance	Balance

Table 9-10: Materials used for plugging the MCI MW 1 well.

Plug Information	Plug #1	Plug #2	Plug #3
<u>Diameter of boring in which plug will be placed (in.)</u>	<u>4.892</u>	<u>4.892</u>	<u>4.892</u>
<u>Depth to bottom of tubing or drill pipe (ft, MD)</u>	<u>~3,065</u>	<u>~300</u>	<u>~100</u>
<u>Sacks of cement to be used (each plug)</u>	<u>132</u>	<u>13</u>	<u>13</u>
<u>Slurry volume to be pumped (ft³)</u>	<u>142</u>	<u>13.9</u>	<u>13.9</u>
<u>Slurry weight (lb./gal)</u>	<u>15.2</u>	<u>15.2</u>	<u>15.2</u>
<u>Slurry Yield (ft³/sack)</u>	<u>1.07</u>	<u>1.07</u>	<u>1.07</u>
<u>Calculated top of plug (ft, MD)</u>	<u>~3,065</u>	<u>~200</u>	<u>~0</u>
<u>Bottom of plug (ft, MD)</u>	<u>~4,050</u>	<u>~300</u>	<u>~100</u>
<u>Type of cement or other material</u>	<u>CO₂- Resistant</u>	<u>CO₂- Resistant</u>	<u>CO₂- Resistant</u>
<u>Method of emplacement (e.g., balance method, retainer method, or two-plug method)</u>	<u>Retainer</u>	<u>Balance</u>	<u>Balance</u>

Table 9-11: Materials used for plugging the MCI MW 2 well.

Plug Information	Plug #1	Plug#2	Plug #3	Plug #4
Diameter of boring in which plug will be placed (in.)	<u>6.276</u>	<u>6.276</u>	<u>6.276</u>	<u>6.276</u>
Depth to bottom of tubing or drill pipe (ft)	~2,309	~1,221	~300	~100
Sacks of cement to be used (each plug)	<u>54</u>	<u>50</u>	<u>18</u>	<u>18</u>
Slurry volume to be pumped (ft ³)	<u>58</u>	<u>53</u>	<u>21.5</u>	<u>21.5</u>
Slurry weight (lb./gal)	15.2	15.2	15.9	15.9
Slurry Yield (ft ³ /sack)	1.07	1.07	1.18	1.18
Calculated top of plug (ft)	~2,309	~1,221	~200	0
Bottom of plug (ft)	~2,579	~1,466	~300	~100
Type of cement or other material	CO ₂ -Resistant	CO ₂ -Resistant	Class A	Class A
Method of emplacement (e.g., balance method, retainer method, or two-plug method)	Retainer	Retainer	Balance	Balance

Table 9-12: Materials used for plugging the MCI ACZ 1 well.

Following the plugging and abandonment of the monitoring wells, the above ground infrastructure, such as wellheads, monitoring equipment, etc., will be removed, and the area around the wells will be regraded to follow the natural topography of the surrounding area (currently agricultural fields). The ground will be replanted with either native vegetation or be converted back to agricultural land.

9.7.2 Site Closure Report

A site closure report will be prepared and submitted within 90 days following site closure, documenting the following:

- Plugging of the monitoring wells (and the MCI CCS 3 well if it has not previously been plugged).
- Location of sealed MCI CCS 3 well on a plat of survey that has been submitted to the local zoning authority.
- Notifications to state and local authorities as required by 40 CFR 146.93(f)(2).
- Records regarding the nature, composition, and volume of the injected CO₂, and post-injection monitoring records.
- Groundwater monitoring wells may be converted to use as groundwater wells as appropriate.

Marquis Carbon Injection LLC will record a notation to the property's deed on which the MCI CCS 3 well was located that will indicate the following:

- That the property was used for CO₂ sequestration;
- The name of the local agency to which a plat of survey with MCI CCS 3 well location was submitted;
- The volume of fluid injected
- The formation into which the fluid was injected; and
- The period over which the injection occurred.

The site closure report will be submitted to the Director in electronic format and maintained by the owner or operator for a period of 10 years following site closure. Additionally, the owner or operator will maintain the records collected during the post-injection period for a period of 10 years after which these records will be delivered to the UIC Director.

9.7.3 Quality Assurance and Surveillance Plan (QASP)

The QASP is presented in the **Appendix 7.A** of the Testing and Monitoring Plan (Permit Section 7.0).

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