**1.0 PROJECT NARRATIVE**
**40 CFR 146.82(a)**

## CASS SEQUESTRATION

### Facility Information

| | |
|---|---|
| Facility name: | Cass Sequestration |
| Facility contact: | Maureen Bennett<br>Cass Sequestration \| Senior Environmental Engineer<br>One Energy Plaza, 400 WCB Detroit, MI 48226<br>maureen.bennett@dteenergy.com \| 313-548-8154 |
| Well name: | [redacted] |
| Well location: | CASS COUNTY, INDIANA<br>[redacted] |

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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| ° | Degree |
| µm | Micrometer |
| $^{13}$CR | Corrosion-resistant chrome |
| 2D | Two-dimensional |
| 3D | Three-dimensional |
| ACZ | Above confining zone |
| AoR | Area of Review |
| Bbls | Barrels |
| BOP | Blowout preventor |
| BOPE | Blow out prevention equipment |
| BTC | Buttress threaded and coupled |
| C | Celsius |
| CBL-VDL | Cement bond log – variable density log |
| CCS | Carbon capture and storage |
| CFR | Code of Federal Regulations |
| $CO_2$ | Carbon dioxide |
| DAS | Distributed Acoustic Sensing |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| DRM | Dynamic Reservoir Model |
| DTS | Distributed Temperature Sensing |
| EOD | Environment of deposition |
| EPA | Environmental Protection Agency |
| ERRP | Emergency and Remedial Response Plan |
| F | Fahrenheit |
| FEMA AE | Federal Emergency Management Agency Adverse Effects |
| FMEA | Failure, Mode, Effect, Analysis |
| ft | Feet |
| FMI | Formation micro-imager |
| FO | Fiber optic |
| Gal | Gallon |
| GPM | Gallons per minute |
| ID | Identification |
| KCl | Potassium chloride |
| lb | Pound |
| LCM | Lost circulation material |
| LTC | Long threaded and coupled |
| MD | Measured depth |
| MDKB | Measured depth below Kelly Bushing |
| mD | Millidarcy |

| | |
|---|---|
| mg | Milligram |
| MI | Move-in |
| mi | Mile |
| MIT | Mechanical integrity test |
| mL | Milliliter |
| MMscf | Million standard cubic feet |
| Ms | Millisecond |
| mt | Metric tonne |
| mtpy | Metric tonnes per year |
| mtpd | Metric tonnes per day |
| MVA | Monitoring, Verification, and Accounting |
| N/A | Not applicable |
| NACE | National Association of Corrosion Engineers |
| NaCl | Sodium chloride |
| NELAP | National Environmental Laboratory Accreditation Program |
| NETL | National Energy Technology Laboratory |
| NMR | Nuclear magnetic resonance |
| ORP | Oxidation-reduction potential |
| P&A | Plug and abandonment |
| PFO | Pressure fall-off |
| PGA | Peak ground acceleration |
| PISC | Post-injection site closure |
| PM | Project Manager |
| PNC | Pulsed neutron capture |
| Poz | Pozzolan |
| ppg | Pounds per gallon |
| ppm | Parts per million |
| psi | Pounds per square inch |
| psig | Pounds per square inch gauge |
| QA | Quality assurance |
| QC | Quality control |
| QASP | Quality Assurance and Surveillance Plan |
| QR | Quality Representative |
| RPD | Relative percent difference |
| RPN | Risk Priority Number |
| RU | Rig up |
| SCADA | Supervisory Control and Data Acquisition |
| SEM | Static Earth Model |
| SF | Safety factor |
| SME | Subject matter expert |
| SOP | Standard operating procedures |
| SP | Spontaneous potential |
| SPCC | Spill Prevention, Control, and Countermeasure |
| SPF | Shots per foot |
| STC | Short threaded and coupled |
| STW | Stratigraphic Test Well |

| | |
|---|---|
| TBD | To be determined |
| TD | Total depth |
| TDS | Total dissolved solids |
| TVD | True vertical depth |
| TVDSS | True vertical depth sub sea |
| TW | Test Well |
| UIC | Underground Injection Control |
| USDW | Underground source of drinking water |
| USGS | United States Geological Survey |
| VSP | Vertical Seismic Profile |

## 1.0 Project Narrative

### 1.1 Project Background and Contact Information

The primary goal of the Cass Sequestration project is to sequester carbon dioxide ($CO_2$) produced by [redacted] utilizing a single Class VI injection well as further detailed in this document.

$CO_2$ will be captured onsite and transported via injection piping to the injection site for permanent geological sequestration. The project injection period is expected to run for 12 years with an average of 600,000 metric tonnes per year (mtpy) of $CO_2$. The capture and storage facilities will be operated by Cass Sequestration, LLC ("Cass Sequestration").

This permit application was prepared using site-specific data acquired from a stratigraphic test well (STW), Logansport #1, which was drilled within the Area of Review (AoR) (**Figure 1-1**) and will be converted to the injection well [redacted] during the construction phase of this project. Extensive [redacted] were performed (**Figure 1-2**). These data were incorporated into a geostatistical reservoir model (static earth model (SEM)) and used for dynamic reservoir simulation (Permit Section 2.0 – AoR and Corrective Action Plan) to address the key technical components of this permit application.

Within the AoR (**Figure 1-1**) there are [redacted] State and [redacted] Federal EPA approved clean-up sites. These sites were identified using both state and federal databases (indianamap.org and epa.gov, respectively) and the investigation into which locations are active subsurface cleanup sites is ongoing. There are known roads and railways within the AoR. There are no mines, State, Tribal, or Territorial boundaries within the AoR. The active Heidelberg Cement Plant Quarry is north of the injection well, within the AoR. Surface bodies of water include the [redacted], but no springs have been identified. There are [redacted] dry holes in the AoR, all of which do not penetrate the caprock. Aside from the planned injection and monitoring wells associated with this project, there are no other injection, producing, abandoned, plugged, or deep stratigraphic boreholes in the AoR. Additional information on these oil and gas wells and water wells can be found in Section 2.4 of Attachment 02: AoR and Corrective Action Plan. There are no known or suspected faults in the AoR.

[redacted]

Figure 1-1: Map of Cass Sequestration project showing injection well [redacted], In Zone (IZM-1) and Above Zone (AZM) monitor wells, conceptual location of seismicity stations and AoR. The satellite base image is unaltered and includes all required components of 40 CFR 146.82(a)(2). Components that are not shown are not present within the AoR.

[redacted]

Figure 1-2: Schematic summary illustrating data collected in the STW.

### 1.1.1 Project Goals

In this project, Cass Sequestration plans to:

- Construct a compression facility located at the [redacted]
- Build the infrastructure needed to transport $CO_2$ to the injection site
- Convert Logansport #1 to $CO_2$ injection service
- Monitor the subsurface for any potential impacts to the lowermost underground source of drinking water (USDW) above the injection interval
- Upon completion of the injection phase of the project, verify stability of the $CO_2$ plume and decline of storage formation pressure toward pre-injection levels, verify plume predictions made by the computational modeling, demonstrate non-endangerment of USDWs, safely plug all wells, and decommission associated infrastructure

### 1.1.2 Partners/Collaborators

Key partners and collaborators on this project are listed in **Table 1-1**.

[redacted]

Table 1-1: Key project partners and collaborators.

### 1.1.3 Overview of the Project Timeframe

The overall timeframe of the project, including well drilling, $CO_2$ injection, monitoring, and closure, is anticipated to be approximately [redacted] years. This includes:

- [redacted] for permit approval
- [redacted] for injection well drilling, pre-operational testing and issuance of authorization to inject
- 12 years of $CO_2$ injection and monitoring
- 5 years of post-injection site care (PISC) and monitoring (based on proposed alternative PISC timeframe.)

### 1.1.4 Proposed Injection Mass/Volume and $CO_2$ Source

The projected average annual injection rate for this project is 600,000 mtpy $CO_2$. The composition of the fermentation off-gas has been sampled and analyzed at the intended future capture point and found to have the composition across 3 samples as shown in **Table 1-2**. These samples are representative of the dry components of the anticipated injection stream.

[redacted]

Table 1-2: $CO_2$ Stream Composition.

Cass Sequestration has reached a commercial agreement with the $CO_2$ source provider that it will only accept $CO_2$ for injection that meets the specifications shown in **Table 1-3**. Prior to injection operations, the chemical and physical characteristics of the injectant will be confirmed using appropriate analytical methods (Section 7 – Testing and Monitoring Plan).

[redacted]

Table 1-3: Required $CO_2$ Stream Composition for sequestration.

### 1.1.5 Injection Depth Waiver or Aquifer Exemption Requested

No injection depth waiver or aquifer exemption is being sought as part of this permit application.

### 1.1.6 Other Administrative Information

**Table 1-4** provides the administrative information for this Class VI injection well permit application as required by 40 CFR 144.31(e)(1 through 6).

| **Injection Well Information** | |
|---|---|
| **Well Name and Number** | [redacted] |
| **County** | Cass County, Indiana |
| **Latitude and Longitude** | [redacted] |
| **Applicant Information** | |
| **Name** | Cass Sequestration, LLC |
| **Address and Phone Number** | One Energy Plaza<br>400 WCB<br>Detroit MI 48226 |
| **Project point of contact** | Maureen Bennett<br>Senior Environmental Engineer<br>Phone: (313)-548-8154 |
| **SIC Code** | 4610 |
| **Ownership Status** | Private |
| **Status as federal, state, private, public, or other entity** | Private |
| **The injection well and AoR are not located on Tribal lands.** | |

| **Contacts for State, Federal, and Local Authorities Within AoR** | | |
|---|---|---|
| **Type** | **Agency Name** | **Phone Number** |
| Federal | UIC Class VI Program Director (Region 5) | 312-353-7648 |
| State | Indiana Department of Natural Resources | 317-232-4200 |
| Tribes | N/A - None in the AoR | - |
| Territories | N/A - None in the AoR | - |
| [redacted] | | |
| Local | Cass County Sheriffs Department | 574-722-6060 |
| Local | Indiana State Police | 800-552-8917 |

Table 1-4: General Class VI $CO_2$ injection well permit application information.

## 1.2 Site Characterization

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

The Cass Sequestration project is located southwest of the town of [redacted] (**Figure 1-3**). The present-day Illinois Basin and Michigan Basin were part of a large epicontinental sea during a period of sea-level rise in the Late Cambrian (Barnes et al., 2009; Medina et al., 2008). The primary sediment source was the Wisconsin Highlands with smaller local highlands creating secondary sediment sources. During the Cambrian period the depo-center for the Mt. Simon was located in northwestern Indiana and northeastern Illinois. The northwest-southeast trending [redacted] was uplifted after the Illinois Basin and Michigan Basin began to subside into the current configurations, most likely beginning in the early Ordovician (Howell and van der Pluijm, 1999; Hybza, 2019; Lovell, 2017).

Other structural features in the region, such as faults generally trend northeast-southwest, aligned with deepening of the Illinois Basin structure. The closest identified fault to the project site is the [redacted] which is [redacted] miles northwest of the site and trends northeast-southwest (**Figure 1-9** and **Figure 1-10**). Previous studies suggest the [redacted] penetrates the basement and Cambrian stratigraphic sections (see Section 1.2.3 Faults and Fractures) is a sealing, inactive, normal fault with offset documented in the Maquoketa Group and pinches out to the northeast and southwest (INDOT, 2021; Shaver and Austin, 1972). Newly acquired [redacted] data at the project site [redacted] (**Figure 1-11**). Additional information regarding detailed discussion of faults can be found in Section 1.2.3 - Faults and Fractures. The Precambrian basement in this part of the [redacted] area ranges in depth from [redacted] below the surface (Abert et al., 2016). The primary axis of the [redacted] trend in a northwest-southeast direction, with a gently dipping axis to the southeast. Regional dips off the arch are to the northeast into the Michigan Basin and southwest into the Illinois Basin. The sedimentary rocks in this area are primarily Paleozoic in age (Thompson et al., 2016).

The Mt. Simon formation (injection zone) is composed of detrital sediment, primarily sand-sized quartz and feldspar mineralogy (Cottingham, 1990; Droste and Patton, 1985; Lahann, 2012; Appendix A Section 5). The depth to the top of the Mt. Simon, at the proposed injection well is [redacted] measured depth from ground level, which corresponds to [redacted] true vertical depth (TVD) subsea. The Eau Claire formation (primary confining zone) is composed of low permeability fine sand, silt, and clay (Lahann et al. 2012) The depth of the Eau Claire at the proposed injection well is [redacted] measured depth from ground level, which corresponds to [redacted] true vertical depth (TVD) subsea. The stratigraphic column in **Figure 1-4** shows the study area's stratigraphic succession, highlighting the injection and confining zones.

[redacted]

Figure 1-3: Present day structural configuration of the adjacent basins and arches. Cass Sequestration location denoted with yellow star (modified from Oliver et al., 1989).

[redacted]

Figure 1-4: Cass Sequestration stratigraphic column and gamma ray log plot from the STW. Depths are measured from ground level.

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

Subsurface stratigraphy of the Cass Sequestration site is [redacted] (**Figure 1-5**). This was evaluated and confirmed through regional reports, regional and local cross sections and maps, and well correlations throughout the immediate site location and surrounding area. Regional structure and thickness maps for these units and further detail on data types used can be found in Section 1.2.4. Major geologic units and their stratigraphic relationships are depicted in the local cross section shown in **Figure 1-5**.

Based on regional reports and publications, the depth of lowest USDW (i.e. <10,000 ppm total dissolved solids (TDS) varies regionally across Indiana and Illinois (**Figure 1-6**; Rupp and Pennington, 1987; Lloyd and Lyke, 1995). [redacted] Another study across northern Illinois and Indiana shows the depth of the lowest USDW varies significantly across this area ranging, from Cambrian aged strata to Silurian-Devonian strata, and the likely transition at the project site location is in the Ordovician age formations, which includes the St. Peter (Lloyd and Lyke, 1995). [redacted] Pickett plot analysis of logs collected from the proposed injection well indicates the deepest USDW is the [redacted] (**Figure 1-7).** At the injection site, the [redacted] true vertical depth subsea (TVDSS), which is equivalent to [redacted] TVD (**Figure 1-4; Figure 1-5**), with a salinity of [redacted] TDS. STW data indicates the [redacted] above the base of the primary confining zone, the Eau Claire Formation, and is composed primarily of limestone and dolomite. Although there is regional variability in the deepest USDW, there is still sufficient offset of [redacted] between the base of the [redacted] and the top of the Eau Claire Formation, the project caprock. North of the site is the Teays River Valley, which is a large, Tertiary age incised valley system that trends west to east across northern Indiana (Bruns and Steen, 2003; **Figure 1-8**). In the deepest parts of the Teays Valley, subcrops of Ordovician age Maquoketa are reportedly encountered (Indiana Department of Natural Resources, 2003). Underlying the Maquoketa Group are the Trenton Formation, Black River Group, Joachim Dolomite, and Dutchtown Formation before the St. Peter Formation is encountered. This provides a suitable amount of intervening thickness between the St. Peter Formation and pathways to shallow drinking water sources.

[redacted]

Figure 1-5: Geologic cross section from west to east featuring the structural configuration of subsurface strata that contain the storage formation and confining zone, as well as the deepest USDW.

[redacted]

Figure 1-6: (Top) Indiana map of formations containing greater than 10,000 ppm TDS. Image modified from Rupp and Pennington, 1987. (Bottom) Image modified from Lloyd and Lyke (1995) showing transition to >10,000 ppm TDS and significant change in depth across northern Illinois and Indiana.

[redacted]

Figure 1-7: Calculated log salinity of the [redacted] from the STW. The [redacted] is calculated to be approximately [redacted]. This formation is the lowest freshwater formation (<10,000 ppm) by Pickett Plot analysis.

[redacted]

Figure 1-8: Location of the buried Teays Valley located north of the Cass Sequestration site denoted with yellow star.  Map modified from Bruns and Steen (2003).

A map of the AoR, including existing wells within the AoR and the proposed injection well is shown in **Figure 1-1**. The AoR for the Cass Sequestration site has a total of [redacted] known preexisting wellbores, including [redacted] Wells within the AoR were identified using well databases held by the Indiana Department of Natural Resources (2003), the Indiana Geologic and Water Survey (2024), and Enverus (2024). The groundwater wells within the AoR vary in depth from [redacted] and are mostly used for irrigation or domestic use. Records of well status have not been found from the state of Indiana. More information on the wells within the AoR can be found in Permit Section 2.4.1 - AoR and Corrective Action Plan. Consistent with 40 CFR 146.82(a)(2), this map also includes all required components.

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

Regional tectonic faulting within the Illinois Basin has been previously studied by many authors (Marshak et al., 2017; Collinson et al., 1988), focused on both Precambrian structures and the current structural configuration (**Figure 1-9**). The only documented nearby fault, the [redacted], is located approximately [redacted] miles northwest of the AoR (**Figure 1-10**) on the [redacted] (Nelson 1995). [redacted] Fault is a [redacted] with the [redacted] to the [redacted] (Mroz et al., 2016). This fault is thought to represent movement in the Mississippian and Pennsylvanian with offset as high as the Maquoketa Group (Melhorn and Smith, 1959; Shaver and Austin, 1972). The greatest offset is approximately [redacted] in the center of the fault and pinches out to the [redacted] (Shaver and Austin, 1972; Indiana Department of Transportation, 2021). Several wells were drilled in the structural trap on the upthrown side of the [redacted] for gas storage in the [redacted] and Mt Simon Formations (Enverus, 2024; Keller, 1998; Mroz et al., 1997; Mroz et al., 2016), which supports the dynamics of the fault as a sealing fault. The geometry of the field is reportedly complex, however acquired [redacted] (Mroz et al., 1997; Mroz et al., 2016).

[redacted] data were acquired in support of subsurface characterization and assessment of any potential faulting at the Cass Sequestration site. These data do not [redacted] the AoR and do not image the nearby [redacted] lines were acquired, with [redacted] lines oriented approximately [redacted], and [redacted] (**Figure 1-11**; **Table 1-5**). [redacted] from the STW well were used to create a [redacted]. Additionally, a [redacted] was collected to improve shallow velocity control and constrain velocities for time-to-depth conversion of the interpreted time horizons. The seismic data were used to confirm [redacted] **Figure 1-12** shows the Pre Stack Time Migration (PSTM) data from [redacted]. All data acquired in the STW is detailed in Permit Section 5.0 – Pre Operational Testing Plan - Appendix A.

Seismic data confirm the presence of a thick clastic section, likely Precambrian clastics, below the Mount Simon and above Precambrian crystalline basement which serves as a basal confining layer.

Additionally, the seismic data captures a deep dipping basement reflector, [redacted] (**Figure 1-12**).

[redacted] were acquired in the STW over the intervals of interest, including the Mt. Simon Formation storage intervals and the Eau Claire Formation confining zone. [redacted] were coupled with [redacted] observations to assess the presence of natural factures in the Mt. Simon and the Eau Claire Formations. [redacted] were observed as well as small scale fractures. Few [redacted] were interpreted; however no prolific fracture zones were observed in these intervals. [redacted] did not have significant aperture or extend up through the confining zone and are not anticipated to impact the integrity of the confining zone. These data can be found in Permit Section 5.0 – Pre Operational Testing Plan - Appendix A.

[redacted]

Figure 1-9: Present day fault map of the Illinois Basin. Cass Sequestration site is denoted with a pink dot (modified from Nelson, 1995).

[redacted]

Figure 1-10: Structural contours of the base of the Ironton Formation; Cass Sequestration site is denoted with a yellow star (based on interpretations from wells displayed on the map).

[redacted]

Figure 1-11: Map of the [redacted] data collected and used for subsurface interpretation at the Cass Sequestration site. The site location is denoted by the blue dot. Nearby wells penetrating the Mt Simon are denoted by the black dots. The SEM/DRM boundary is a [redacted] square for reference.

[redacted]

Table 1-5: Summary of 2D seismic data acquired by DTE Vantage within the AoR.

[redacted]

Figure 1-12: [redacted], associated horizon interpretation in time, and STW seismic-to-well tie. Refer to **Figure 1-11** for seismic line location.

### 1.2.4 Storage Formation and Confining Zone Details [40 CFR 146.82(a)(3)(iii)]

In addition to the site-specific data acquired in the STW, additional subsurface data were analyzed from regional wells where modern wireline log data exists, as well as historical log data from wells in proximity to the site (**Figure 1-13**). Well logs from [redacted] wells across the northern Indiana region were obtained, which provided multiple log types and the required spatial and depth coverage (**Table 1-6**). These were used to develop structural surfaces throughout the area. Of these wells, [redacted] had sufficient log data to provide regional and local measurements of in-situ physical rock properties, such as porosity, at depths that captured the target storage formation and confining zone formations. Additionally, the STW well was drilled within the AoR in October of 2024 to confirm storage and confining zone presence and properties. This well collected modern [redacted] that provided site-specific storage formation information such as formation depth and thickness (**Table 1-7**), as well as porosity and permeability. Further information regarding the data collected in this well is discussed in Section 1.2.5 Geomechanical and Petrophysical Information [40 CFR 146.82(a)(3)(iv)]. These datasets enabled the interpretation of crucial subsurface information regarding the lithology and properties of the storage formation and confining zone.

The [redacted] lines described above also contributed to understanding the storage and confining formations. The STW was used for a seismic-to-well tie to [redacted] leveraging the [redacted]

[redacted]

[redacted]

Table 1-6: Regional wells used in addition to STW at Cass Sequestration for subsurface characterization. The Coordinate Reference System is NAD83 Indiana State Plane, Eastern Zone, US Foot.

[redacted]

Figure 1-13: Map of the petrophysical wells used for subsurface interpretation at the Cass Sequestration site. The proposed injection well is denoted with a royal blue colored dot.

[redacted]

Table 1-7: Table of formation depths and thicknesses of confining and injection formations at the STW

*Confining Zone: Cambrian Eau Claire Formation*

Regional well data and [redacted] data collected at the project site indicate the confining zone at the site location is the regional and laterally extensive Cambrian Eau Claire Formation. The Eau Claire Formation was conformably deposited over the Mt. Simon Formation and is composed of fine sand, silt and clay, and dolomite (Lahann et al., 2012). [redacted] Depth and thickness across the AoR were determined using [redacted] data and by picking formation tops from digital well log data proximal to the site. These were gridded using a convergent interpolation algorithm from Schlumberger's Petrel® and contoured in TVDss. Maps of the top structural surface and the thickness of the Eau Claire Formation are presented in **Figure 1-14**.

Core description from the stratigraphic test well performed by [redacted] showed the Eau Claire to be thinly bedded heterogenous mix of [redacted] Analysis of regional well log data indicate the Eau Claire Formation has a relatively low porosity and permeability, [redacted]. This aligns with values measured in the stratigraphic test well with [redacted] (**Figure 1-15**). Additionally, [redacted] measurements were done on [redacted] samples from the Eau Claire formation. Results of the [redacted] testing are shown in **Table 1-8**. Threshold entry pressures seen in the testing reflect [redacted]. Duncan (2009) cites [redacted] as characteristic of good sealing formations, and [redacted] of the samples were [redacted]

[redacted]

Table 1-8: [redacted] results from nine Eau Claire and six Mt. Simon formation samples.

*Injection Zone: Mt. Simon Formation*

The Mt Simon formation was deposited in Early and Middle Cambrian time, during a period of greenhouse climate conditions. During this time, the Arches Region was located 20-30° south of the equator and the region was covered by an epicontinental sea. The primary sediment source was the Wisconsin Highlands to the northwest, transitioning from a terrestrial aeolian and fluvial environments to the northwest to near-shore and shallow marine environments to the southeast (Cohee, 1948; Catacosinos, 1973; Catacosinos et al., 2000; Droste and Shaver, 1983). A gradual, sustained rise in sea level deepened the seas to generate a thick sandstone covered by a mix of sand, silt and clay capped by a thick carbonate sequence in the Late Cambrian (Sargent, 1990; Medina and Rupp, 2012; Kolata and Nelson, 1991; Sloss, 1963; Leetaru et al., 2008).The top of the Mt. Simon Formation at the project site is [redacted] TVDss, which is equivalent to [redacted] measured depth, with a gross thickness of [redacted]. Maps of the top structural surface and the thickness of the Mt. Simon Formation are presented in **Figure 1-15**. At these depths, data from wireline logs indicate the pressure and temperature conditions are [redacted] (extrapolated from deeper Mt. Simon [redacted]), which are conditions that will [redacted] of the injected $CO_2$ at the site. The [redacted] variation in thickness across the project site demonstrates [redacted]

The Mt. Simon Formation is a heterogeneous formation composed mainly of terrigenous siliciclastic sediment that is primary composed of quartz sand with some silt and clays (Cottingham, 1990; Droste and Patton, 1985; Lahann, 2012; Appendix A Section 5). [redacted] from the STW indicate the Mt. Simon is predominately a medium [redacted] measurements were completed on [redacted] samples from the Mt. Simon formation with [redacted] the tests in the [redacted] Mt. Simon, and [redacted] in the proposed injection zone. Results of the [redacted] testing are shown in Table 1-8. [redacted]

[redacted]

Figure 1-14: Structural map showing True Vertical Depth Sub-Sea (ft) to the top of the Eau Claire Formation (left) and formation thickness map (right) at the Cass Sequestration site. Contour intervals are 50 ft and 20 ft, respectively. The black dots indicate wells with structural data for the Eau Claire and the black box indicates the Static Earth Model area.

[redacted]

Figure 1-15: Structural map showing True Vertical Depth Sub-Sea (ft) from the surface to the top of the Mt. Simon Formation (left) and formation thickness map (right) at the Cass Sequestration site. Contour intervals are 50 ft and 20 ft, respectively. The black dots indicate wells with structural data for the Mt Simon and the black box indicates the Static Earth Model area.

[redacted]

Figure 1-16: [redacted] of the Eau Claire Formation from the STW.

[redacted]

Figure 1-17: [redacted] of the Mt. Simon Formation from the STW.

Based on the mineralogical components and Folks (1974) classification scheme for sandstones, the Mt. Simon is classified as a sublitharenite (**Figure 1-18**). Samples from the STW in the Mt Simon injection interval analyzed with X-ray diffraction spectroscopy were composed of mostly [redacted] with variable amounts of [redacted] and [redacted], including [redacted] Detail of log and core data acquired in the STW can be found in Permit Section 5.0 – Pre Operational Testing Plan, Appendix A. Major minerals include quartz, potassium feldspar, and clays minerals, including mostly illite-mica with chlorite and mixed layer little/smectite.  A table summarizing these results is shown in **Table 1-9**.

[redacted]

Table 1-9: Summary of the mineralogical make-up of the Mt. Simon Formation from the proposed injection well.

[redacted]

Figure 1-18 Ternary diagram displaying the compositional make up of rock samples collected in the Mt. Simon Formation from the stratigraphic test well.

Current interpretations of the injection and confining zone at the site were confirmed by datasets acquired in the STW. Site-specific geologic core and special core analysis confirmed porosity and permeability, mineralogy, capillary pressure, and relative permeability (Section 2 – AoR and Corrective Action) as specified by 40 CFR 146.82(a)(3)(iii). [redacted] were collected in the Mt. Simon Formation and the Eau Claire Formation along with [redacted] of [redacted] in the Eau Claire to confirm reservoir and seal quality. [redacted] were attempted with [redacted] being recovered. [redacted] was conducted on these [redacted] samples by [redacted] and can be seen in **Table 1-10**. [redacted] testing was done on [redacted]. [redacted] measurements were done on [redacted], which was a composite of [redacted]. Additionally, [redacted] confirmed the maximum injection pressure, rock strength, and in-situ fluid pressure (see discussion in Permit Section 2.0 – AoR and Corrective Action Plan) as specified by 40 CFR 146.82(a)(3)(iv).

[redacted]

Table 1-10: [redacted] of the Eau Claire and Mt. Simon Formations collected at the STW. Samples in this table without a reported permeability were [redacted]

Analysis of regional well log data indicates porosity of the Mt. Simon ranges from [redacted] This range is similar to the values obtained from the STW [redacted] data in **Table 1-10** and well log data which averaged [redacted] in the Mt. Simon. The [redacted] plug permeability to air measurements in the Mt. Simon were [redacted].

To begin examining the volumetric storage potential of the site, screening calculations were completed. The Department of Energy (DOE)-National Energy Technology Laboratory (NETL) has put forward methods for static volumetric calculations (Peck et al., 2014). These methods are generalized, using site-specific data at a field-averaged scale, and so are mainly valuable as prospective and screening tools (the site-specific modeling described particularly in Permit Section 2.0: AoR and Corrective Action, is a more-detailed site-specific characterization).

Inputs for thickness and porosity were determined by calculating the average net thickness [redacted] and effective porosity values from the STW well log data for the Mt. Simon injection interval [redacted]. The input for the density of $CO_2$ was calculated using the same temperature and pressure gradients as the reservoir model, which were applied to the midpoint depth for the Mt. Simon Formation in the center of the AoR [redacted]. A storage efficiency factor of [redacted] based on the formation's clastic-fluvial depositional environment (Haeri, 2022) was used. Applying those values yielded an estimated storage capacity for the Mt. Simon Formation within the AoR is approximately [redacted] of $CO_2$ per square mile.

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

The strength of the confining zone, which serves as a metric for geomechanical integrity of the seal, was measured through laboratory testing of rock samples obtained from STW in the Eau Claire Formation. Details of laboratory tests can be found in Permit Section 5.0 – Pre-Operational Testing Plan, Appendix A. To assess rock compressive and tensile strength, [redacted] were conducted at [redacted]. These tests measure elastic parameters, peak compressive strength, and tensile strength. **Table 1-11** and **Table 1-12** present the elastic properties and peak strength (uniaxial and confined compressive strength) of rock samples under uniaxial and triaxial compressive tests. **Table 1-13** [redacted]

[redacted]

Table 1-11: Summary of rock mechanical properties for confining zone using uniaxial compressive test.

The data presented in **Table 1-11** and **Table 1-12** indicate that the Eau Claire Formation has an [redacted]

[redacted]

Table 1-12: Summary of rock mechanical properties for confining zone using triaxial compressive test.

[redacted]

Table 1-13: Summary of tensile strength of confining and injection zones using Brazilian test.

Triaxial tests were also conducted to assess the ductility of the confining formation. **Figure 1-19** shows that the confining formation exhibits high residual strength after failure [redacted]

According to these rock mechanics test results, the Eau Claire Formation can provide sealing capacity as the primary confining unit due to its measured compressive strength and tensile strength. Analysis of residual stresses after rock failure in the triaxial compressive test indicates rock ductility as well. Confining formations with higher ductility are more resistant to fracturing and fracture propagation.

[redacted]

Figure 1-19: Stress-strain plot for two [redacted]

[redacted]

Figure 1-20: Mohr Coulomb Failure Envelope for [redacted]

Petrophysical analysis was conducted to integrate available log and core data in the study area to determine the properties of the storage system at the proposed injection well, and calibrate log inputs used to populate the SEM**.** The wireline logs collected from the STW include [redacted] (**Figure 1-21**). Analyses on [redacted] In addition to the STW data, regional well log data were compiled, as detailed in Section 1.2.4. These logs were edited and normalized as part of the quality control procedure to eliminate erroneous data points, corrected for varying signal intensities, and to establish consistent readings between wells. A lithologic log representing the fraction of clay with depth ($V_{clay}$) was generated and integrated with core data and routine porosity logs to calculate refined porosity curves [redacted] permeability was validated with lab-measured permeability on the [redacted] (**Figure 1-21**).

In situ pressures were measured using the [redacted] wireline tool [redacted] of the formation face from the wellbore. Six of these measurements were done in the lower Mt. Simon. The [redacted] Additional discussion of in situ conditions is found in Section 2 – AoR and Corrective Action and a data can be found in Permit Section 5.0 – Pre-Operational Testing Plan, Appendix A.

[redacted]

Figure 1-21: Log plot of data acquired in the STW showing (left to right) [redacted]

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

The seismic history for the area was characterized using publicly available data from the United States Geological Survey (USGS, 2022). These data indicate that northern Indiana is relatively low levels of natural seismicity, with a history of low frequency and magnitude of earthquakes. Additionally, northern Indiana has relatively little faulting and is not seismically active. For more information on local structures and faults refer to Section 1.2.3. The absence of recorded natural earthquakes near the project site is consistent with the regional seismic hazard map published by the USGS (2022), which designates the area as a relatively low to moderate risk area for seismic activity (**Figure 1-22**). In the Cass County area, there have been 0 earthquakes in Cass County since 1931 with a 0.19% probability of a 5.0 earthquake [redacted] The USGS reports an expected 2-4 earthquakes to cause damage through shaking per 10,000 years in the Cass County area.

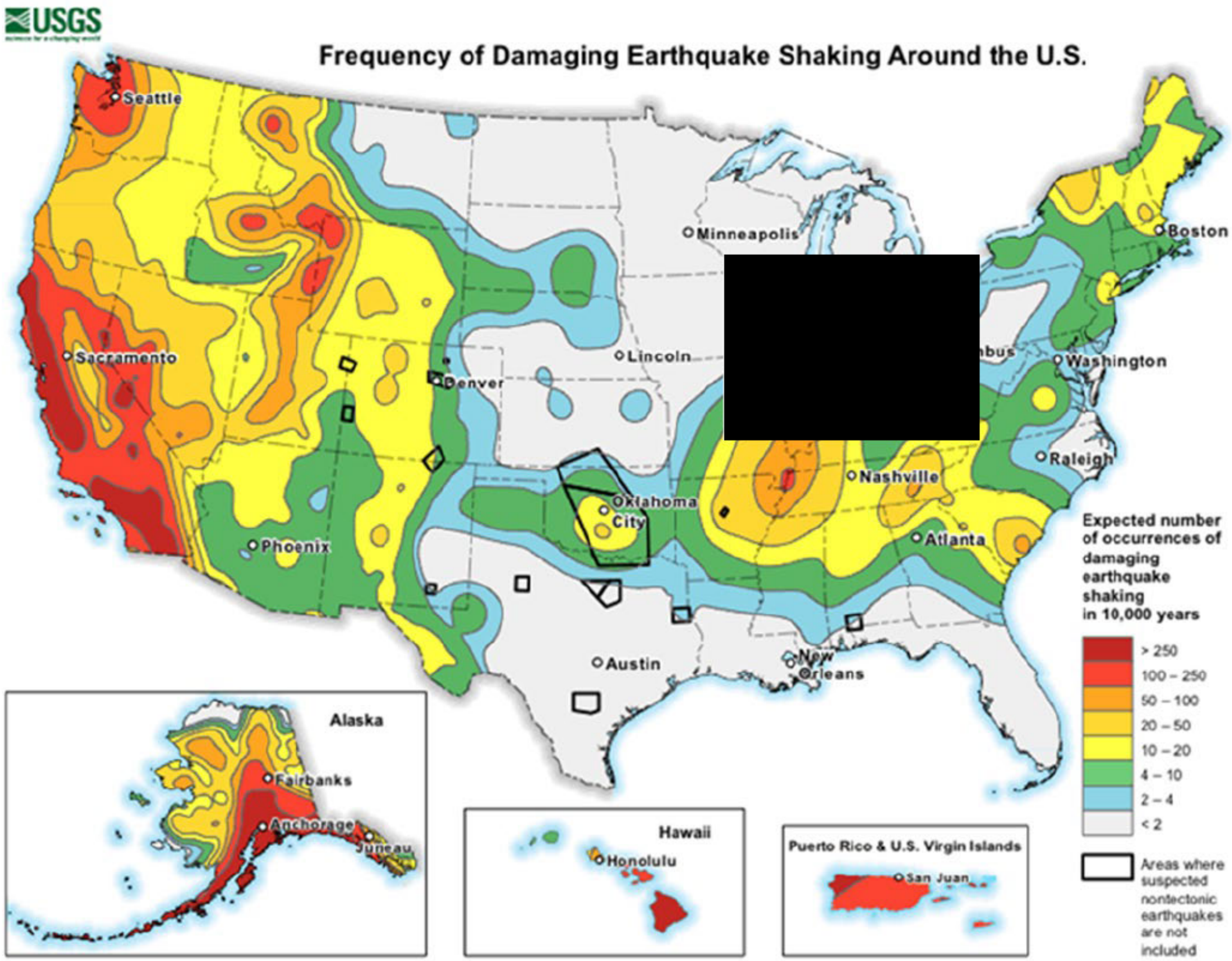



Figure 1-22: USGS regional seismic hazard map for the United States shows a low to moderate hazard for northern Indiana with an expected 2-4 earthquakes to cause damage through shaking per 10,000 years. Project site denoted by yellow star. (USGS, 2022).

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

An assessment of the local hydraulic and hydrogeologic conditions at the Cass Sequestration site has been completed including a review of the hydrostratigraphy, groundwater flow direction (**Figure 1-23**), and salinity of shallow and deep aquifers in the [redacted] area.

The primary USDW within the AoR is from unconsolidated Quaternary glacial sediments, where present, and the shallow Silurian-Devonian bedrock aquifers (Lloyd and Lyke, 1995; Rupp and Pennington, 1987). A 2008 Indiana Department of Natural Resources groundwater mapping study of Cass County identified seven unconsolidated glacial aquifer systems throughout the county (Unterreiner, 2008). These include the Till Venner, Bluffton/Iroquois/Kankakee/Tipton/Warsaw Till Subsystem, the Iroquis/Kankakee/Tipton/Warsaw Complex, Natural Lakes and Moraines, Wabash River and Tributaries Outwash, and the Wabash River and Tributaries Outwash Subsystem. These shallow aquifers are unconsolidated sediments deposited by glacial activities including glacial meltwater and post-glacial precipitation and are associated with the advancement of at least three glacial systems in Cass County (Unterreiner, 2008). [redacted] (Gillies, 1981). The shallow aquifers receive recharge from precipitation and discharge to local rivers and streams from the upper zones. The lower zones flow beneath local rivers and streams to discharge at larger regional discharge points. In the area of [redacted], the primary groundwater movement is toward the Wabash River within the Wabash River Basin. The average potentiometric surface is 600 to 1,100 feet above sea level with a hydraulic gradient of up to 50 feet per mile. The Teays Valley has unique transmissivity values compared to surrounding aquifers, ranging from 3,000 to 40,000 square feet per day while other aquifers outside of the Teays Valley having transmissivity up to 500 square feet per day (Gillies, 1981). Water in most shallow aquifers in this area is considered hard water with calcium magnesium bicarbonate and large concentrations of iron, with dissolved solids typically ranges from 250-750 mg/L (Gillies, 1981).

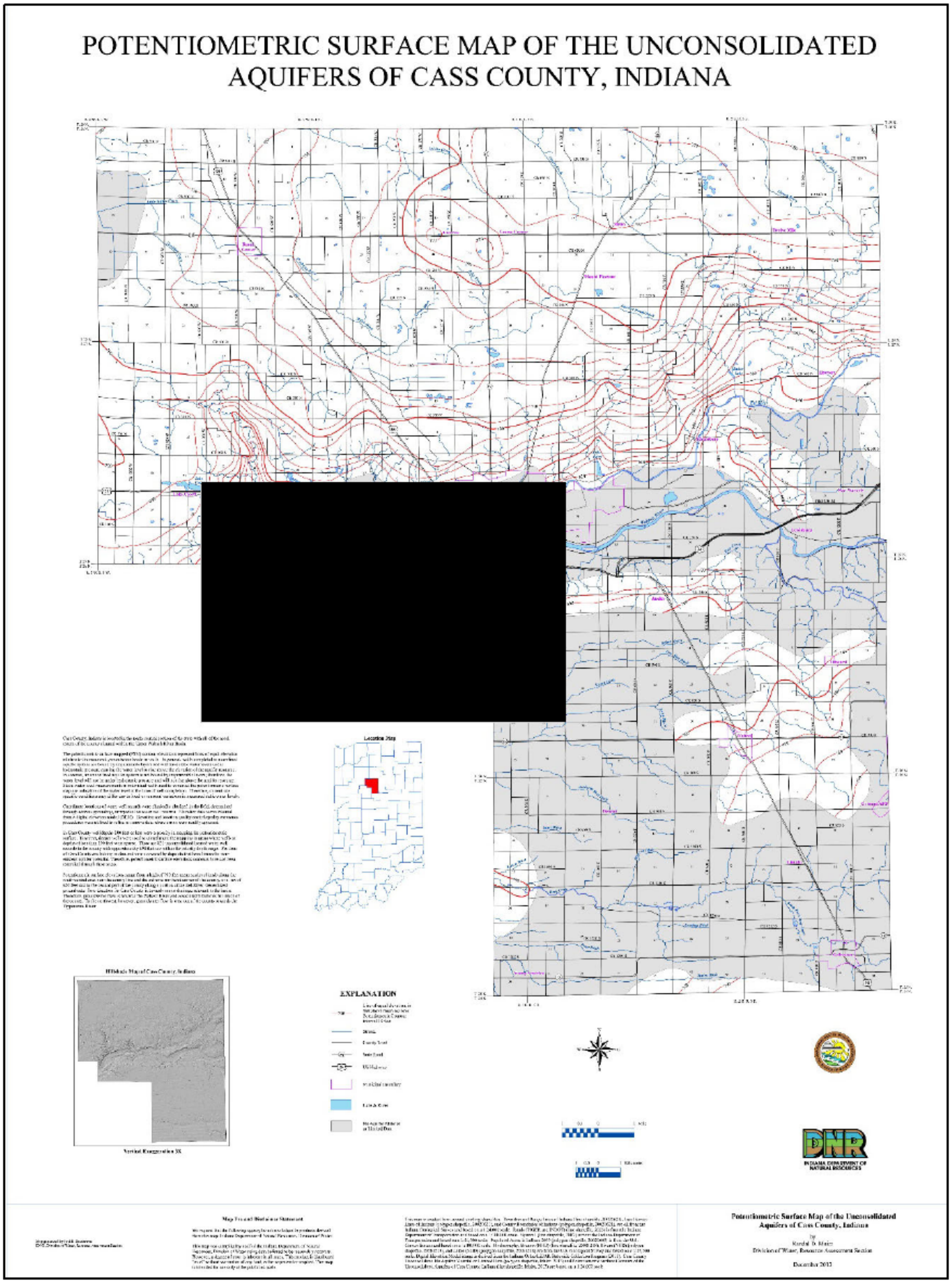
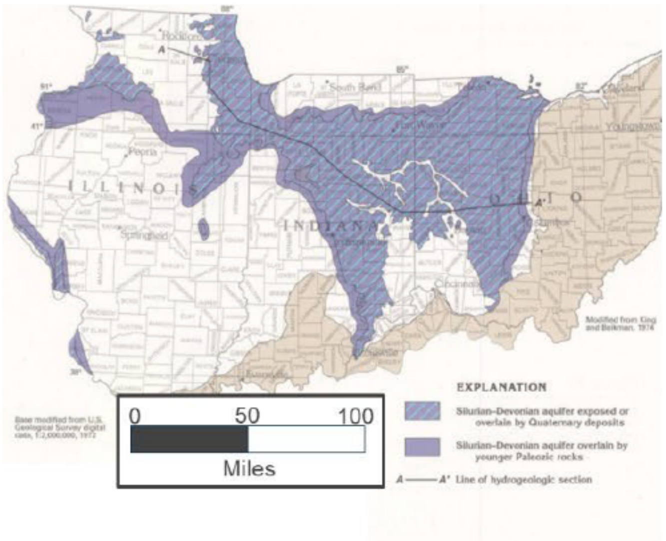



Figure 1-23: Potentiometric surface map of the unconsolidated aquifers in Cass County, Indiana. The project site is denoted with the yellow star (modified from DNR, Maier, 2013).

The Silurian-Devonian bedrock aquifer system is also present throughout Cass County and is primarily composed of consolidated carbonates with some interbedded shales (**Figure 1-24**) (Lloyd and Lyke, 1995). Locally, the Silurian-Devonian aquifer has had multiple names applied but has been applied regionally to the same system that stretches across Illinois, Iowa, Wisconsin, Minnesota, Indiana, and Ohio, and is therefore used in this report. The Silurian rocks are the predominant rock system due to significant erosion of the Devonian formations. Freshwater is generally found between the ground surface and 500 feet below ground level, and the base of the freshwater coincides with the base of the Silurian formations with the top of Ordovician age rocks acting as a lower sealing boundary (**Figure 1-24** and **Figure 1-25**). The Silurian-Devonian aquifer is overlain by unconsolidated sediment that often acts as the surficial aquifer system. The Silurian-Devonian aquifer system is most commonly used for potable water where it is overlain by at least 200 feet of unconsolidated sediment. Groundwater moves under confined conditions through fractures, along bedding planes, and through solution cavities in the dolomite. Water recharge is typically from the surficial aquifer but does have a reversed gradient in some parts of the aquifer system where the surface aquifer receives recharge from the Silurian-Devonian aquifer. Wells in the Silurian-Devonian aquifer produce 5 gpm to more than 1,000 gpm of hard water with $CaCO_3$ range of 340 to 2,200 ppm and other dissolved solids and iron greater than established US EPA maximum contaminant level. Water quality is typically classified as a calcium magnesium bicarbonate in recharge areas and a calcium magnesium sulfate at discharge areas (Lloyd and Lyke, 1995).



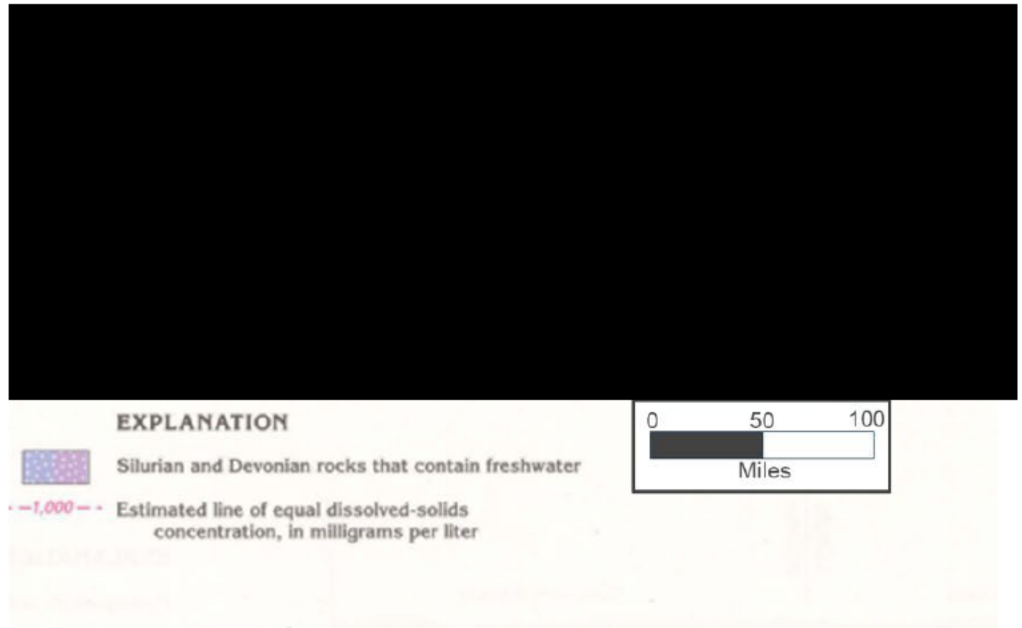




Figure 1-24: Silurian-Devonian aquifer system. The Cass Sequestration site is denoted with a red dot and a vertical line (modified from Lloyd and Lyke, 1995).

[redacted]

Figure 1-25: Cross section illustrates the presence and thickness of the USDWs at the site location. The Cass Sequestration site is denoted with the yellow star (cross section generated from local well data and interpretations).

### 1.2.8 Geochemistry [40 CFR 146.82(a)(6)]

Site-specific data (fluid and log analysis) were integrated to assess geochemistry of the storage system and compare to regional geochemical data (see section 1.2.2). [redacted] Results of the geochemical analysis of major cations and anions, trace metals, and general geochemical properties (i.e., pH, TDS, alkalinity, etc.) are shown in **Table 1-14** and **Table 1-15**. A description of the data acquired as part of the fluid sampling is given in Permit Section 5.0 – Pre-Operational Testing Plan, Appendix A. These analyses have been or will be used to determine:

- Baseline geochemical data for the project site to evaluate any migration of $CO_2$ and brine waters at the site
- Baseline geochemical equilibrium conditions to evaluate the saturation relationship between the dissolved and solid-phase minerals at the site.

[redacted]

Table 1-14: Site-specific Mt Simon fluid geochemistry physical properties.

[redacted]

Table 1-15: Site-specific Mt Simon fluid geochemistry Anions and Cations.

In addition to [redacted] to estimate the geochemistry of the storage system. Pickett plots, also known as the resistivity-porosity method, are a graphical solution to Archie's water saturation equation and are a cross-plot of deep resistivity versus porosity on a log-log scale (**Figure 1-26**). Formation water resistivity is a function of salinity and temperature, so in saline aquifers where the formation is fully saturated, Pickett plots can be used to determine formation salinity (U.S. EPA, 1988; Pickett, 1973). The red and blue lines represent lines of equal water saturation, with the red line drawn through the fully water-saturated reservoir log derived data. The red line is extrapolated to Total Porosity = 1 and the intercept indicates a resistivity of the water in the formation (Rw) at in-situ formation temperature. The Rw is converted to salinity in parts per million (ppm) using an industry standard chart within the petrophysical software (U.S. EPA, 1988). The slope of these lines is the m-exponent (cementation factor), and the n-exponent (saturation exponent) and a-factor (lithology coefficient) are standard inputs into the Archie equation. [redacted]

[redacted]

Figure 1-26: Calculated log salinity of the Mt. Simon intervals from the STW. [redacted]

In addition to the analysis described above, these data will be used as baseline geochemical data for the project site to evaluate any migration of $CO_2$ and brine waters at the site throughout the injection phase. It will also provide input to assess the compatibility of both the $CO_2$ stream and injection well construction materials with storage formation fluids (40 CFR 146.82(c)(3)).

Also to be considered, though not expected due to interbeds in the Mt. Simon, is the chance for caprock reactivity related to $CO_2$ filled fluid interactions with the Eau Claire. [redacted] The lower Eau Claire [redacted] appear more [redacted] with the [redacted]

Nonetheless, this should be considered/investigated in further detail especially in conjunction with the sedimentological framework. For example, does the degree of heterogeneity negate any potential reactivity in terms of connectivity and tortuosity of any developing flow pathway. [redacted]

Neufelder et al., 2012 continues by saying there are two caveats related to the effectiveness of the Eau Claire seal. The first is related to the faulting or lack thereof, potentially providing conduits to the more reactive cement or lithology (in our case, there is no evidence of faulting across the Eau Claire formation). The second caveat is referencing any ancient fracture zones that might be filled with carbonate cement. Again, as sampled in this location, fracture zones have not been observed.

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

No surface air and/or soil gas data have been or are planned to be collected at the site.

### 1.2.10 Site Suitability [40 CFR 146.83]

An extensive set of subsurface data has been analyzed at the Cass Sequestration site to support the evaluation of site suitability. Site-specific well logs from the STW were integrated with regional wells to create maps and cross sections to confirm the lateral extent of the storage formation and confining zones, as well as the absence of faulting at the site location and surrounding area that would impact the integrity of the storage formation and confining zones. This analysis of the suggests the containment risk is low, and although secondary confinements zones are present, none are necessary for USDW protection. Except the STW, which will be converted to the injection well during the construction phase, there are no deep wellbore penetrations into the confining zone above the storage formation (refer to Permit Section 2.4.2 - Wells Penetrating the Confining Zone).

The Cass Sequestration site is suitable for $CO_2$ sequestration due to the favorable properties of the storage and confining formations. The Eau Claire confining zone is primarily composed of silts and shales with an average log measured porosity of [redacted] and permeabilities of [redacted]. The Mt. Simon storage formation is primarily composed of sandstone with an average log measured porosity of [redacted] (**Table 1-9** and **Figure 1-21**). The mineralogy of the Mt Simon is predominantly [redacted], with varying amounts of [redacted] (**Figure 1-18**). Although neither the $CO_2$ stream nor formation waters are expected to be highly corrosive, the injection well materials that come in contact with the $CO_2$ stream and/or reservoir brines will be constructed of corrosion-resistant materials (Permit Section 4 – Injection Well Construction Plan). For example, the casing string across the reservoir and caprock, packer, and deep portions of the tubing will be constructed of corrosion-resistant materials or coatings. The thickness and porosity of the Mt. Simon storage formation make the site optimal for $CO_2$ sequestration with a large $CO_2$ storage capacity. Based on the DOE-NETL methods for static volumetric calculations, the estimated storage capacity for the Mt. Simon Formation within the AoR is approximately [redacted] of $CO_2$ per $mi^2$. With a total AoR area of approximately [redacted], the Mt. Simon Formation provides more than enough storage capacity to accommodate the target injection volumes.

## 1.3 Permit Section 2.0: AoR and Corrective Action

This Area of Review (AoR) and Corrective Action Plan describes the computational modeling performed by Cass Sequestration to derive the AoR and the corrective actions to be taken in response to changes in the AoR, in compliance with 40 CFR 146.84.

Computational modeling at the Cass Sequestration project location has been completed to delineate the plume size and shape, area of pressure buildup, and AoR for injected carbon dioxide ($CO_2$). A Static Earth Model (SEM) named Clymers_SEM was prepared using the Schlumberger Petrel® modeling software. The SEM is a three-dimensional (3D) geocellular model that represents petrophysical properties within the stratigraphic formations intended for $CO_2$ storage, as well as the overlying confining layer. This type of model offers the best options for quantifying, visualizing, and simulating dynamic behavior through the subsurface geology at the site. By integrating multiple data types, the model represents the spatial distribution of available pore space and flow potential (permeability), enabling a data-driven estimation of $CO_2$ storage capacity. The SEM serves as the framework (in terms of delineating zones, surfaces, porosity, and permeability) for dynamic simulation of $CO_2$ injection.

Computational dynamic reservoir modeling to simulate $CO_2$ injection into the injection zone was completed using the 3D multiphase flow simulator CMG-GEM (Computer Modelling Group, 2024). In addition to the geological framework and associated properties of the SEM, parameters such as relative permeability, initial reservoir conditions, phase behavior, and well completion were added to the dynamic model for simulation. CMG-GEM is an equation-of-state based compositional simulator that models the transport and phase behavior of brine and $CO_2$ during the injection and post-injection stages of a project.

The [redacted] injection well has a modeled average injection rate of 600,000 mtpy for a 12-year injection period. In the model, the well is completed over an [redacted] vertical section of the Mt. Simon formation [redacted]

The deepest USDW is identified as the [redacted] aquifer, based on Pickett Plot analysis of log data acquired in the STW. Pressure in the storage formation is found using a regression of pressure and depth measurements in the STW. Brine density was directly measured on formation fluid samples from the STW. [redacted] These data were used to calculate the critical pressure increase threshold to be [redacted]

Figure 1-27 shows the $CO_2$ saturation in map view and in vertical cross section view at the end of the 12 year injection period and the AoR.

[redacted]

Figure 1-27: Base Case $CO_2$ plume after 12 years of injection. The AoR outline is shown in black.

## 1.4 Permit Section 3.0: Financial Responsibility

The Financial Responsibility Plan is submitted as Section 3.0 to meet the requirements of 40 CFR 146.82(a)(14) and 146.85.

## 1.5 Permit Section 4.0: Injection Well Construction

### 1.5.1 Construction Procedures

The injection well has been initially drilled as a Stratigraphic Test Well (STW) and a comprehensive suite of wireline logs, core, fluid samples and reservoir testing were acquired in October 2024. During the construction phase of this project, the STW will be converted to the injection well by final installation of the production casing string and other downhole components.

The injection well will be vertical from surface to total depth (TD) and designed to prevent the movement of fluids into or between underground sources of drinking water (USDWs) or into any unauthorized zones, and to permit the use of appropriate testing devices and workover tools. The design also accommodates monitoring of the annulus space between the injection tubing and long string casing (40 CFR 146.86 (a)(1,2,3)).

No completion stimulation beyond an acid-wash to clean up near wellbore drilling mud and cement invasion is planned at this time. The maximum injection volumes and pressures for this project are detailed in Permit Section 1.0 - Project Narrative and Permit Section 6.0 - Well Operation Plan. No oil or gas zones were encountered at this location.

The proposed injection well design is shown in Error! Reference source not found. of Permit Section 4.0 – Injection Well Construction Plan.

### 1.5.2 Casing and Cementing

The well was designed using carbon steel for the casing and tubulars that are not expected to be in contact with a mixture of the injectant and formation waters. That is, the conductor, surface and second surface casing sections are all carbon steel. The cementing of the surface strings have also been circulated back to the surface. The deep casing string will be constructed with corrosion-resistant chrome [redacted] from the reservoir through the confining zone and carbon steel from above the confining zone to surface. The lower section of the wellbore is expected to have intermittent exposure to $CO_2$-formation water mixed fluids, especially in the initial phases of injection and intermittently when well workovers are performed throughout the project. Since the expected water content of the injectant stream will be greater than [redacted] parts per million (ppm), the injection tubing string and flow-wetted injection tree components will be composed of corrosion-resistant materials or coatings.

All selected casing and tubing grades and weights will be adequate for handling anticipated stress loads and pressures throughout the life of the project. The downhole tubulars were analyzed to ensure their ability to withstand the anticipated loads they may undergo. This analysis reviewed loads during installation, drilling, injection, workover, and subsequent abandonment. Additionally, effects due to cyclical loading, temperature, and exposure to wellbore fluids were also assessed. A summary of the proposed injection rate and maximum pressure of the $CO_2$ stream, and annular pressure is found in Permit Section 6.0 – Well Operations Plan (**Table 6-1** and Section 6.4). The planned annular pressure is designed to maintain positive differential on the annulus to ensure any tubing leak would result in annular fluid leaking into the tubing rather than $CO_2$ escaping into the annulus. The targeted differential is [redacted] psi with planned maximum of [redacted] psi. **Table 1-** summarizes the casing program for the injection well.

[redacted]

Table 1-16: Casing details.

The deepest USDW has been confirmed from analysis with wireline logs in the STW. Surface casing is set through all active drinking water depths, and the second surface and production casings will provide additional layers of protection to the USDW.

The cemented casing strings [redacted] for the proposed injection well will all be cemented back to surface. [redacted]

[redacted]

Table 1-17: Summary of cement types and corresponding casing strings.

### 1.5.3 Completion Strategy

[redacted]

## 1.6 Permit Section 5.0: Pre-Operational Logging and Testing

The pre-operational formation testing plan describes how Cass Sequestration will meet the testing requirements of 40 CFR 146.87 and well construction requirements of 40 CFR 146.86.

At the Cass Sequestration site, a stratigraphic test well (STW), Logansport #1 test well [redacted] was drilled at the proposed injection well location to provide the site-specific subsurface data required by 40 CFR 146.87 and to support subsequent geostatistical model building and $CO_2$ injection simulation. The well was spudded on October 2nd 2024, and reached a total depth of [redacted] on October 24th 2024. After all required data had been acquired, the well was shut-in, secured, and the rig was released on October 30th, 2024. The STW was drilled and completed in such a way that it can be converted to the injection well.

Data collected in the STW includes extensive [redacted] which has been incorporated into the static earth and dynamic models (Permit Section 2 – AoR and Corrective Action Plan) from which the AoR is derived.

Upon conversion of the STW to an injection well, the production casing will be cemented and logs will be acquired to evaluate cement quality and provide baseline data for external well integrity. Cement quality will be evaluated through a CBL-VDL log. If further investigation becomes necessary an advanced ultrasonic logging tool will be run.

[redacted] will be completed after the STW has been converted to the injection well. Upon completion, prior to operation, the injection well will [redacted] characteristics of the injection zone.

### 1.7 Permit Section 6.0: Well Operations

The Well Operations Plan describes the steps Cass Sequestration will take to ensure that injection pressure does not exceed 90 percent of the fracture pressure of the storage formation to reduce that risk that injection does not initiate new fractures or propagate existing fractures in the storage area. No injection will occur between the outermost casing protecting underground sources of drinking water (USDWs) and the well bore in accordance with 40 CFR 146.88 (b). The injection well construction is detailed in Permit Section 4 – Injection Well Construction Plan which addresses 40 CFR 146.88 (c).

The Well Operations Plan describes the source of the carbon dioxide ($CO_2$) that will be delivered to the storage site, its chemical and physical properties, and flow rate at the piping outlet. In addition, this section provides the monitoring that will be performed on the injection well to confirm mechanical integrity (40 CFR 146.89).

### 1.8 Permit Section 7.0: Testing and Monitoring

The Testing and Monitoring Plan describes how Cass Sequestration will monitor the Cass Sequestration site pursuant to 40 CFR 146.90.

The Testing and Monitoring Plan has been developed to reduce the risks associated with carbon dioxide ($CO_2$) injection into the deep geologic subsurface at this site. Goals of the monitoring strategy include:

- Protecting underground sources of drinking water (USDWs),
- Ensuring that the injection well is operating as planned,
- Providing data to validate and calibrate the geological and dynamic models used to predict the distribution of $CO_2$ within the injection zone,
- Supporting data for Area of Review (AoR) re-evaluations over the course of the project at a minimum of every 5 years,
- Meeting the regulatory requirements of 40 CFR 146.90.

The Testing and Monitoring Plan will be adaptive over time; the plan will be adjusted to respond:

- As project risks evolve over the course of the project
- If significant differences between the monitoring data and predicted dynamic modeling results are identified
- If key monitoring techniques indicate anomalous results related to well integrity or the loss of containment

[redacted]

[redacted] The AZM well will be adjacent to the location of the injection well to monitor the aquifers above the upper confining formation. **Figure 7-1** in Permit Section 7.0 – Testing & Monitoring Plan**,** illustrates the AoR at the end of the Post Injection Site Care (PISC) period, the conceptual location of the IZM and AZM well, and the conceptual location of seismicity stations.

The Testing and Monitoring Plan will utilize several direct and indirect monitoring technologies throughout the injection and PISC phases that can be categorized in three ways:

- Operational monitoring - continuous activities of the injection operations – pressures, temperatures, injection rates
- Assurance monitoring – activities to confirm $CO_2$ containment beneath the confining formation. These include injection well integrity, above zone monitoring and groundwater monitoring
- Verification monitoring – activities to confirm the projected development of both the pressure plume and $CO_2$ plume over time. These include direct in zone monitoring and indirect plume monitoring

The general schedule and spatial extent for the monitoring activities in the baseline and injection phases of the project are shown in **Table 1-18**.

[redacted]

[redacted]

Table 1-18: General schedule and spatial extent for the testing and monitoring activities for Cass Sequestration.

### 1.9 Permit Section 8.0: Injection Well Plugging

The injection well plugging plan described in this section details the methods and materials that will be used to plug and abandon the [redacted] injection well in accordance with 40 CFR 146.92. Pursuant to the requirements of 40 CFR 146.92, specific data will be collected prior to plugging the injection well. The bottom-hole pressure will be determined, and the mechanical integrity of the well casing will be confirmed prior to plugging and abandoning the well.

A Notice of Intent to plug the well will be submitted to the EPA at least 60 days prior to the plugging operations (40 CFR 146.92 (c)).

After the project has verified that there are no external well integrity issues, the well will be flushed with a buffer fluid to remove any fluids or particulates that may be present in the well (Section 8.6). The weight of the buffer fluid will be determined from the final reservoir pressure measurement and will be chemically compatible with the formation fluids and solids to reduce the potential of corrosion of the well materials. A minimum of three casing volumes will be displaced without exceeding the fracture pressure of the storage formation.

The injection well casing will be plugged with cement to ensure that it does not provide a conduit outside the storage formation. Error! Reference source not found. presents the intervals that will be plugged as well as the materials and methods that will be used to plug the intervals.

[redacted]

Table 1-19: Intervals to be plugged and materials/methods used. (40 CFR 146.92 (b)(3 – 6)).

## 1.10 Permit Section 9.0: Post-Injection Site Care (PISC) and Site Closure

This Post-Injection Site Care and Site Closure (PISC) plan describes the activities that Cass Sequestration will perform to meet the requirements of 40 CFR 146.93.

At the end of the injection period, Cass Sequestration will either submit an amended PISC plan or demonstrate to the Director through monitoring data and modeling results that no amendment to the plan is needed.

Cass Sequestration will monitor groundwater quality and track the position of the carbon dioxide ($CO_2$) plume and pressure front for five years after the end of injection which is the [redacted] Underground Sources of Drinking Water (USDW) and the Non-Endangerment Demonstration criteria are satisfied.

Pressure behavior of the storage system in response to injection at the proposed [redacted] injection well has been modeled as part of the Area of Review (AoR) delineation (Permit Section 2 - Area of Review and Corrective Action Plan). The modeling indicated that [redacted] The pre-injection pressure at the gridblock of the topmost completion in the injection interval [redacted] The pressure time series data shown in **Figure 1-28** indicates that the pressure decreases to this threshold after [redacted] years post injection and continue to drop thereafter, supporting the alternative PISC timeframe of 5 years.

[redacted]

Figure 1-28: Pressure time-series data over 12 years injection period followed by post-injection decrease over a 100 year PISC at the gridblock of the topmost completion in the injection interval. Pre injection pressure and critical pressure threshold shown in black dashed.

### 1.11 Permit Section 10.0: Emergency and Remedial Response

Cass Sequestration will operate the Cass Sequestration project, inclusive of the capture plant, pressure lines and injection well.

This Emergency and Remedial Response Plan (ERRP) describes response actions that Cass Sequestration will take to address events that have the potential to cause movement of the injection fluid or formation fluid in a manner that may endanger an underground source of drinking water (USDW) during the construction, operation, or post-injection site care periods of injection well [redacted], in accordance with 40 CFR 146.94. This plan additionally describes the local resources and infrastructure within the Area of Review (AoR).

This plan complements the existing [redacted] Emergency Action Plan.

An emergency shutdown of the injection well will be triggered if Cass Sequestration obtains evidence that the injected carbon dioxide ($CO_2$) stream and/or associated pressure front may cause endangerment to a USDW. In an emergency shutdown situation Cass Sequestration will perform the following actions:

1. Immediately cease injection and initiate shutdown plan for the injection well.
2. Take all steps reasonably necessary to identify and characterize any release.
3. Notify the permitting agency/EPA Region 5 UIC Program Director of the emergency event within 24 hours.
4. Implement applicable portions of the ERRP.

If a serious or major emergency shutdown should occur, $CO_2$ injection will only resume with the consent of the UIC Program Director. If Cass Sequestration can demonstrate that the injection operation will not endanger USDWs, the UIC Program Director may allow the resumption of injection prior to remediation.

If a minor emergency shutdown of the $CO_2$ injection system is required, the operator will complete the shutdown in a stepwise approach to prevent over-pressure situations and/or damage to the equipment.

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