Class VI Injection Well Application

Contains proprietary business information.

Attachment 01: Narrative

40 CFR 146.82(A)

Beargrass Project
Wabash County, Indiana

12 September 2024

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List of Acronyms

2D	two-dimensional
3D	three-dimensional
25Cr	25-Chrome
25Cr80	25-Chrome L80 Casing
ACZ	above confining zone
ADM	Archer Daniels Midland
Al	aluminium
AoR	Area of Review
APT	annulus pressure test
BAFL	Best Available Flood Hazard Layer
CAA	Clean Air Act
CCS	carbon capture and sequestration
CCS1	Illinois Basin–Decatur Project Injection Well drilled on ADM property
CCS2	ADM Illinois Industrial CCS Project CO_2 injection well
CMP	common midpoint
CO_2	carbon dioxide
CWA	Clean Water Act
DGS	Division of Geological Survey
DOE	Department of Energy
ECRB	Eastern Continental Rift Basin
EDX	Department of Energy Data eXchange
EGRP	Eastern Granite-Rhyolite Province
EPA	Environmental Protection Agency
EPSG	European Petroleum Survey Group
ERRP	Emergency and Remedial Response Plan
fbgl	feet below ground level
fbsl	feet below sea level
FEMA	Federal Emergency Management Agency
GSDT	Geologic Sequestration Data Tool
h	Thickness
IBDP	Illinois Basin–Decatur Project
IDNR	Indiana Division of Natural Resources
IEc	Industrial Economics
IL-ICCS	Illinois Industrial CCS Project (run by ADM)
IPaC	Information for Planning and Consultation
k	permeability
ktpa	kilotonnes per annum
MAIP	Maximum Allowable Injection Pressure
mD	millidarcy
MICP	mercury injection capillary pressure
Mpsi	mega psi
MRCSP	Midwest Regional Carbon Sequestration Partnership
ms	milliseconds
Mtpa	million tonnes per annum

Mw	moment magnitude
N/A	not applicable
NPDES	National Pollution Discharge Elimination System
NRI	Nationwide Rivers Inventory
O&G	oil and gas
ODNR	Ohio Department of Natural Resources
PBI	proprietary business information
pH	potential hydrogen
PISC	Post injection Site Care and Site Closure
PNM ACZ1	Beargrass Project Above Confining Zone Monitoring Well 1
PNM INJ1	Beargrass Project Injection Well 1
PNM OBS1	Beargrass Project Deep Observation Well 1
PNM USDW1	Beargrass Project USDW Monitoring Well 1
ppmv	parts per million volume
SRT	step rate test
TBD	to be determined
TD	total depth
TCS	total closure stress
TDS	total dissolved solids
UIC	Underground Injection Control
US	United States
USDW	underground source of drinking water
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
XRD	x-ray diffraction

1. Project Background and Contact Information [40 CFR 146.82(a)(1)]

1.1 Project Contact Information

Project Name: Beargrass

Project Operator: Vault GSL CCS Holdings LP

Project Contact: Jennifer Jacobs, Project Manager
Vault GSL CCS Holdings LP
1125-17th Street, Suite 1275
Denver, Colorado 80202
Email: jenn@vault4401.com
Phone: 713-930-4401

Project Location: Wabash County, Indiana

Beargrass Project Injection Well 1 (PNM INJ1) Location:
Latitude: 40.94407° N
Longitude: -85.77952° W

1.2 Project Background

The objective of the Beargrass Project is to permanently sequester carbon dioxide (CO_2). The area of review (AoR) and location of wells are shown in Figure 1 and Figure 2.

Vault GSL CCS Holdings LP will be the owner, operator, and permit holder for injection well PNM INJ1. Vault GSL CCS Holdings LP will also be the owner and operator of the transport pipeline. Neither an injection depth waiver nor an aquifer exemption expansion is being requested for this project. Based on the maximum anticipated annual volume of 359 kilotonnes per annum (ktpa) of CO_2 over a period of 12 years, the total mass of injected CO_2 is anticipated to be approximately 4.31 million tonnes (Mt).

The Mt. Simon Sandstone is of sufficient depth and temperature at the site to maintain the injected CO_2 in a supercritical state. The Mt. Simon Sandstone has served as a suitable injection interval for Class I, II and VI wells in the region for multiple decades. The primary confining zone is the Eau Claire Shale. Other strata including the Davis Formation, the Ancell Group, and the Maquoketa Group will serve as secondary confining zones.

Figure 1 and Figure 2 show the locations of the four primary wells associated with the project: Beargrass Project Deep Observation Well 1 (PNM OBS1), Beargrass Project USDW Monitoring Well 1 (PNM USDW1), Beargrass Project Above Confining Zone Monitoring Well 1 (PNM ACZ1), and PNM INJ1. Table 1 shows the coordinates, depth, and intended use for each well.

Within the AoR there are no State or Federal EPA approved subsurface clean-up sites, mines, quarries, and State, Tribal, or Territory boundaries. Surface bodies of water within the AoR include a perennial stream, Beargrass Creek, and an intermittent waterway, Staver Ditch. Information on oil and gas (O&G) wells and water wells within the AoR can be found in Section 4.1 of Attachment 02: AoR and Corrective Action Plan, (2024).

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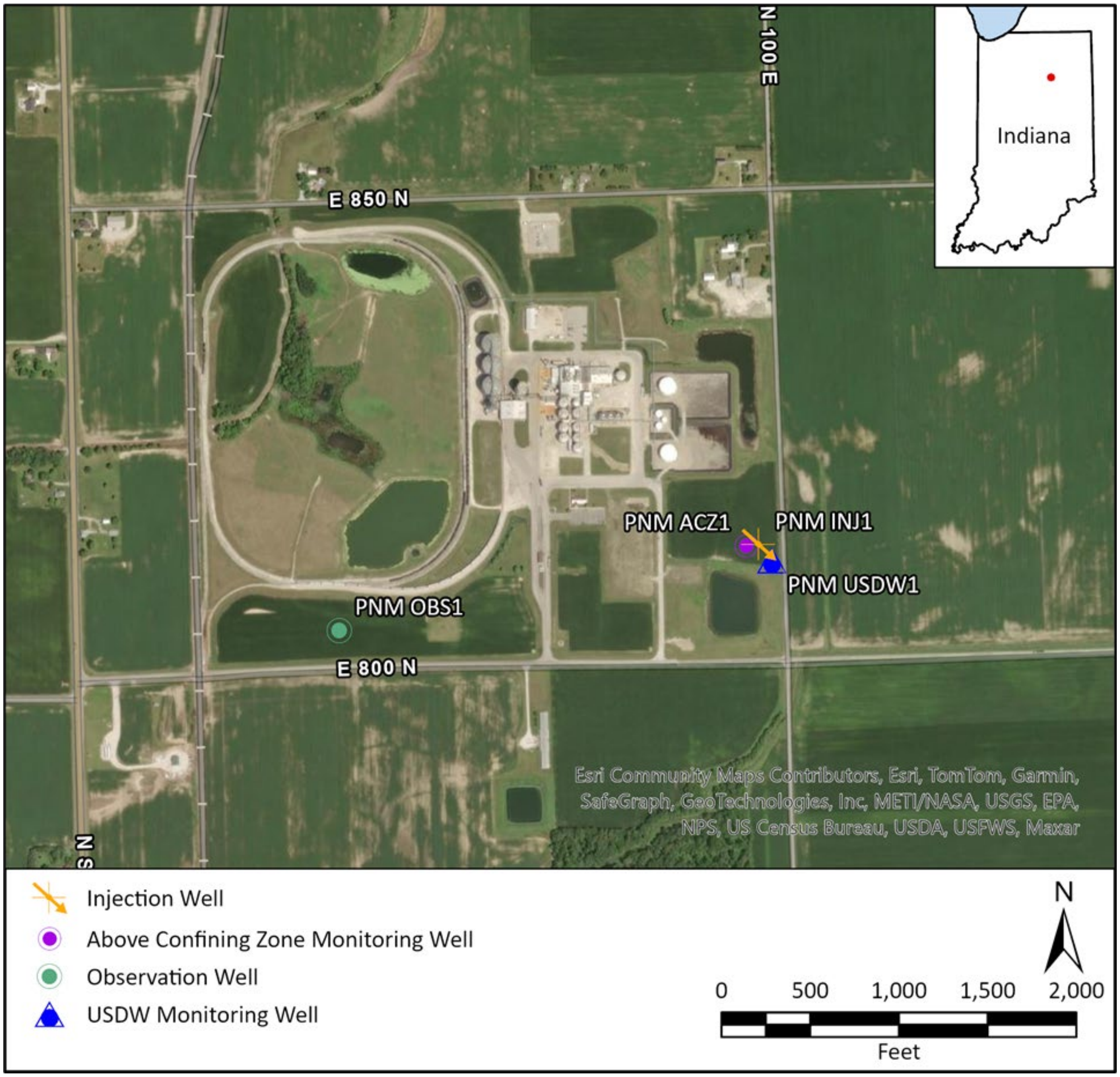

Figure 2: Proposed locations of PNM INJ1, PNM OBS1, PNM ACZ1 monitoring, and PNM USDW1 wells for the Beargrass Project. Map base adapted from Esri.

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The objective of the Beargrass Project is to effectively capture CO_2 produced at a nearby ethanol facility, and safely and permanently sequester approximately 4.31 Mt of CO_2 over 12 years in the Mt. Simon Sandstone. One well is expected to be required for injection of the project's intended mass flow rate of 359 ktpa of CO_2 into the Mt. Simon Sandstone. The Beargrass Project has been designed to operate for 12 years at a capacity of 359 ktpa of CO_2. This Underground Injection Control (UIC) Class VI application describes and supports this effort.

Project execution will begin with the drilling and completion of several wells including the CO_2 injection well (Figure 2, Table 1). Additional site-specific data will be collected as the wells are drilled and completed. The data gathered will be processed and analyzed to confirm or re-assess the project modeling efforts and current understanding. As necessary, additional data sets will be collected and analyzed.

1.3 Local, State, and Federal Emergency Contacts [40 CFR 146.82(a)(20)]

Table 2 provides emergency contact information in the event of an emergency at the project site.

Table 2: Local, state, and federal emergency contacts

Agency	Phone Number
Police or Fire Emergency	911
North Manchester Volunteer Fire Department	260-982-8212
Chester Township Fire Department	260-982-4957
Urbana Community Volunteer Fire Department	260-774-3648
Pleasant Township Fire Department (Laketon)	260-982-8745
Wabash County Sheriff's Department	866-288-3882 260-563-8891
North Manchester Police Department	260-982-8555
Indiana State Police District 16	800-382-0689 260-563-7535
Environmental services contractor to be determined (TBD)	TBD
UIC Program Director (Region 5)	312-353-7648
EPA Region 5 UIC Class VI Wells/Carbon Sequestration	312-353-3944
EPA National Response Center (24 hours)	800-424-8802
Indiana Department of Natural Resources	317-232-4200

1.4 Summary of Other Permits Required

Table 3 provides a summary of permits required for the Beargrass Project.

Table 3. Permits required for the Beargrass Project.

Program	Permit(s) Required
Hazardous Waste Management program under Resource Conservation and Recovery Act (RCRA)	Not applicable (N/A), non-hazardous waste
UIC program under Safe Drinking Water Act (SDWA)	Class VI UIC permit
National Pollutant Discharge Elimination System (NPDES) program under the Clean Water Act (CWA)	Stormwater pollution prevention plan (SWP3) prior to construction; NPDES program administered by state of Indiana.
Prevention of Significant Deterioration (PSD) program under Clean Air Act (CAA)	N/A, not a major source
Nonattainment program under CAA	N/A, Wabash County is in attainment for all criteria pollutants
National Emission Standards for Hazardous Air Pollutants (NESHAPS) Preconstruction approval under the CAA	N/A, non-hazardous pollutants
Ocean dumping permits under Marine Protection Research and Sanctuaries Act (MPRSA)	N/A, onshore project with no proposed ocean dumping
Section 404 of CWA.	N/A, activities outside of waters of the United States
State or Other relevant environmental permits including state permits. 40 CFR 144.31(e)(6)(ix)	
Indiana Department of Natural Resources (IDNR) Oil & Gas Resource Management	Carbon Sequestration Project Permit upon issuance of a UIC Class VI permit
Indiana Department of Environmental Management (IDEM) Office of Water Quality Construction Stormwater General Permit	SWP3 prior to land disturbance

1.5 List of Landowners Within the AoR

A list of names and addresses of all owners of record of land within the AoR of the Beargrass Project can be found in PBI Appendix A – List of Landowners Within the AoR.

2. Site Characterization [49 CFR 126.82(a)(2), (3), (5) and (6)]

Unless otherwise stated, all depths are in reference to feet below ground level (fbgl).

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

The Beargrass Project, located in northern Wabash County of north-central Indiana, is within the Arches Province which is a structural high extending beneath eastern Indiana, western Ohio, and central Kentucky (Figure 3). Three separate arches, the Kankakee, Cincinnati, and Findlay Arches, comprise the larger Arches Province, and the structural relief of the arches and associated platforms is the result of differential subsidence of the Illinois Basin to the west, the Michigan Basin to the north, and the Appalachian basin to the east. The Arches Province is comprised of Cambrian to Mississippian strata that reach a maximum thickness of over 5,000 feet in the Indiana portion of the province (Rupp, 1991).

The Mt. Simon Sandstone and the Arches Province have been the focus of research into geological carbon sequestration due to the intersection of reservoir thickness, permeability, and depth. Previously conducted simulation work on the Mt. Simon Sandstone in the Arches Province concluded that large-scale injection into the Mt. Simon Sandstone may be achieved in the region (Sminchak, 2012). The Mt. Simon Sandstone has served as a suitable injection interval in the province for Class I and II wells (BP Lima and AK Steel wells, Figure 3) for multiple decades, with the Eau Claire Shale acting as the confining zone (INEOS Nitriles, 2016; Cleveland-Cliffs Steel Corporation, 2021). In the adjacent Illinois Basin, the Mt. Simon Sandstone has been thoroughly investigated for carbon sequestration potential for over two decades through the Midwest Regional Carbon Sequestration Partnership's (MRCSP) Illinois Basin–Decatur Project (IBDP) (Wickstrom et al., 2005; Greenberg, 2021) and the CarbonSAFE program (Leetaru et al., 2019; Korose, 2022; Whittaker, 2022; Whittaker and Carman, 2022) funded by the United States (US) Department of Energy (DOE).

The Illinois Industrial Carbon Capture and Storage Project (IL-ICCS) is an active commercial carbon sequestration project taking place at the Archer Daniels Midland (ADM) ethanol facility in Decatur, IL, funded, in part, through the American Recovery and Reinvestment Act. The IBDP demonstration project also drilled an injection well (CCS1) on ADM property that has provided a rich source of data around carbon storage in the Mt. Simon Sandstone (Greenberg, 2021). The IBDP CCS1 and IL-ICCS CCS2 CO_2 injection wells are located approximately 170 miles west-southwest of the proposed location for the Beargrass Project (Figure 3).

The IL-ICCS Project storage complex uses the Cambrian Mt. Simon Sandstone as the injection zone and the overlying Eau Claire Shale as the confining zone (Figure 4, S. Gollakota and McDonald, 2014). These same formations are proposed as the storage complex for the Beargrass Project.

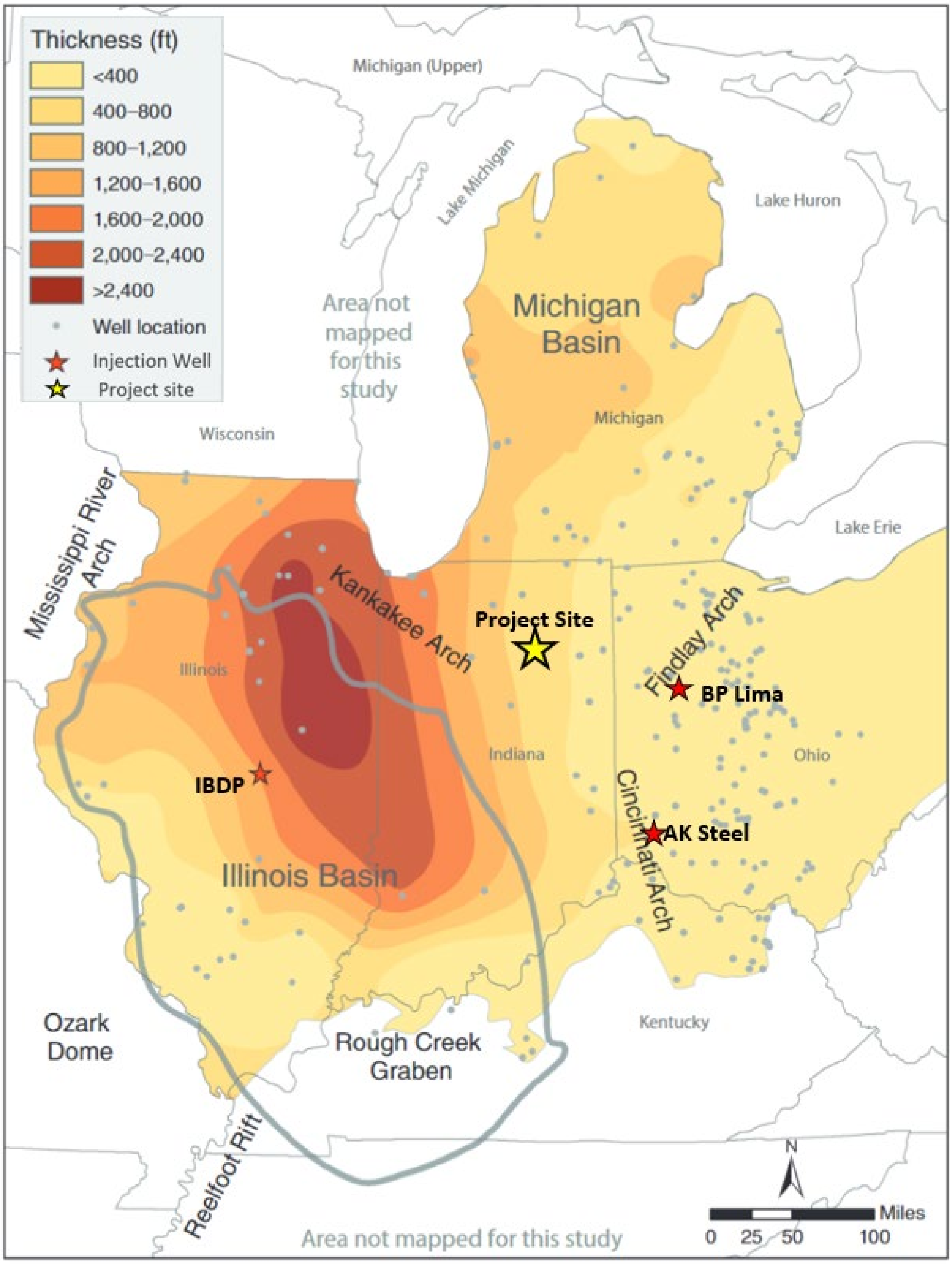

Figure 3: Mt. Simon Sandstone isopach map (feet) with major structural features of the Arches Province, the Illinois Basin extent, and the Beargrass Project site shown by the yellow star, The location of the IBDP and the IL-CCS Project, the AK Steel injection well, and the BP Lima injection well are shown by red stars. Modified from Medina and Rupp (2012).

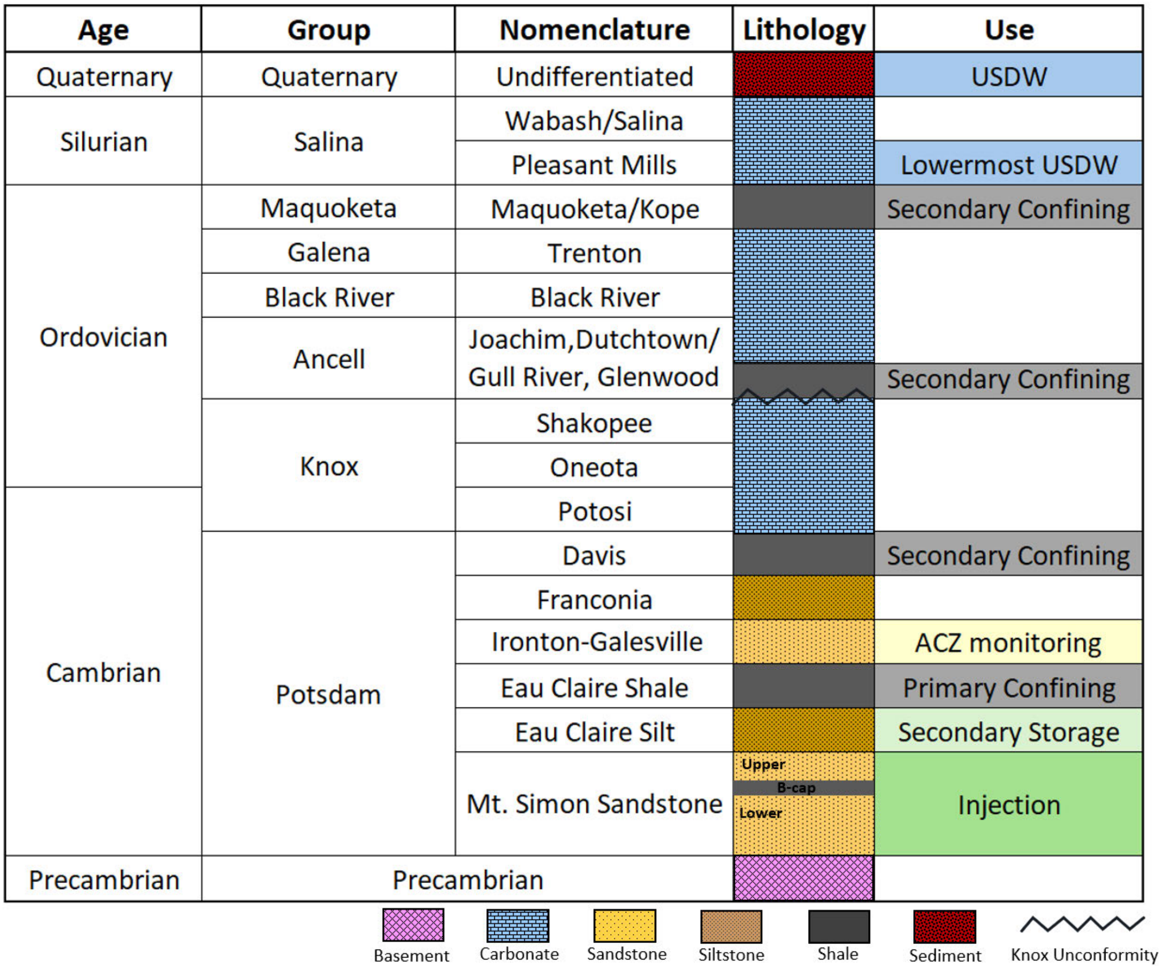

Figure 4: Beargrass Project site-specific stratigraphic column with age, nomenclature, generalized lithology, and zone of use.

The Arches Province evolved contemporaneously with the basins that surround the structural high (Braile et al., 1986; Kolata and Nelson, 1990, 1997; Kolata et al., 2005). The Beargrass Project is located between the Kankakee and Findlay Arches in northcentral Indiana. Eustatic sea level fluctuations coupled with tectonics allowed for the accumulation of both marine and terrestrial sediments in the study area and surrounding basins. Paleozoic sedimentary strata of the Arches Province unconformably overlie the Precambrian basement, which is broadly composed of felsic intrusives and volcanics of the Eastern Granite-Rhyolite Province (EGRP) (Figure 5, Bradbury and Atherton, 1965; Bickford et al., 1986; Atekwana, 1996; Lidiak, 1996; Green, 2018). As previously stated, over 5,000 feet of Paleozoic sedimentary rock thickness exists in the Arches Province, which is relatively thin compared to that of surrounding basins. In contrast, up to 18,000 feet of Paleozoic strata accumulated in the Reelfoot Rift and Rough Creek Graben, which are significant features within the southern portion of the Illinois Basin related to processes linked to basin subsidence (Kolata and Nimz, 2010).

[redacted]

The Cambrian Mt. Simon Sandstone and Eau Claire Shale are among the oldest and deepest strata in Indiana and will serve as the injection and confining zones, respectively, for the Beargrass Project. The Eau Claire Silt is between the Mt. Simon Sandstone and the Eau Claire Shale and is a secondary storage interval (Figure 4). These transgressive clastic sediments were deposited in a near shore environment fed by drainage systems, and an erosional unconformity exists between the Mt. Simon Sandstone and the underlying Precambrian basement (Freeman, 1953; Janssens, 1973).

By late Cambrian, much of Indiana was covered by a shallow sea. This sea regressed in the Middle Ordovician creating the Knox Unconformity (Figure 4; Keith, 1984; McBride and Kolata, 1999). Indiana was near wave-base in the Middle Silurian and much sediment deposition during this time was diverted to the surrounding basins. During the Devonian, the sea regressed, and uplift occurred due to the Acadian Orogeny, allowing for non-deposition and erosion along the arches. Following this, sea level transgressed during the Devonian-Mississippian, depositing marine shales across the region. Uplift during the Pennsylvanian to Late Cretaceous separated the surrounding sedimentary basins from the Arches Province and eroded previously deposited sediment (Rupp, 1991; Kolata and Nimz, 2010).

Erosion and/or nondeposition prevailed along the arches throughout the Mesozoic and Cenozoic. During the Pleistocene Epoch, the region was covered by continental ice sheets that deposited hundreds of feet of glacial sediment in the region, some of which now serve as shallow groundwater aquifers.

2.2 Regional Stratigraphy

Figure 4 is a site-specific stratigraphic column for the Beargrass Project and will be referred to throughout this narrative.

Geophysical logs from regional wells were used in the static model (Figure 6). The regional continuity of the Paleozoic strata in the vicinity of the project site [40 CFR 146.82(a)(3)(i)] is demonstrated through cross sections of the site model (Figure 5 and Figure 7). Quaternary glacial sediments overlie the bedrock (Figure 4) and are discussed further in Section 2.9 *Hydrologic and Hydrogeologic Information*.

To develop a comprehensive understanding of the site-specific geology for this project, a database of publicly available geophysical well logs from Indiana, Illinois, Kentucky, and Ohio was compiled. The well logs were interpreted and used to develop a static model for the project site.

Within 50 miles of the Beargrass Project, nine wells penetrate the Precambrian basement, and 80 wells penetrate the Mt. Simon Sandstone, all of which were used to assess the site-specific geology. Figure 6 shows the closest wells to the Beargrass Project that penetrate the Mt. Simon Sandstone, the nearest of which is 1.5 miles southwest of the project site.

The Royal Center Gas Storage field began development in 1957 and is located approximately 35 miles to the west of the project site. This field utilizes a structural closure associated with the Royal Center Fault to store natural gas in both the Trenton Limestone and the Mt. Simon Sandstone (Figure 6; Keller, 1998).

[redacted]

[redacted]

2.2.1 Precambrian Basement Complex

The Precambrian basement complex that underlies the project site is comprised of granite, rhyolite, trachyte, and quartzite of the EGRP (Green, 2018). These basement rocks are of extensional tectonic origin (Figure 4) and contribute to the source of Early Cambrian siliciclastic strata (Bickford et al., 1986). Figure 8 shows that the Precambrian basement deepens from approximately 2,300 feet below sea level (fbsl) in the eastern portion of the map area to more than 3,100 fbsl in the western portion of the map.

A boundary between the EGRP and the Eastern Continental Rift Basin (ECRB; Figure 9) exists east of the project site. In portions of the Arches Province, the ECRB contains sandstones of the Middle Run Formation and intrabasinal volcanic rocks. The Middle Run Formation was first recognized in the Ohio Department of Natural Resources (ODNR), Division of Geological Survey (DGS) DGS #2627 core located in Warren County approximately 130 miles southeast of the project. Sediments of the Middle Run Formation were deposited in a rift-basin during the Late Precambrian, and seismic, magnetic, and gravity data suggest a genetic relationship between the Midcontinent Rift System and the Fort Wayne rift basin that contains the Middle Run Formation (Dickas et al., 1992; Drahovzal et al., 1992; Baranoski et al., 2009). This formation has been identified in portions of Ohio, Kentucky, and Indiana, but it is not expected at the Beargrass Project site. However, this is uncertain as the project site proximity to wells that penetrate the Middle Run Formation (Figure 9; Drahovzal et al., 1992).

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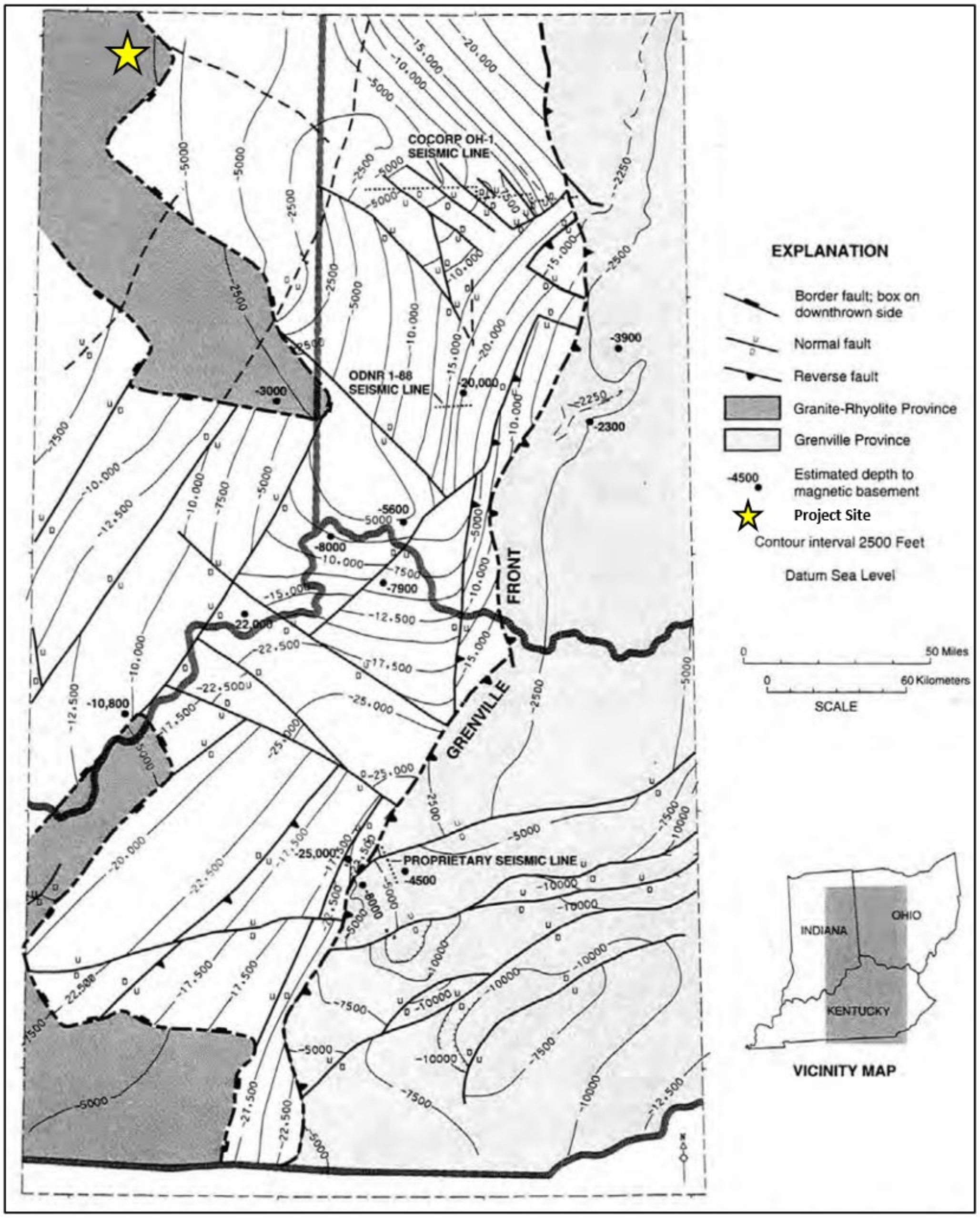

Figure 9: Elevation map of the Precambrian basement in the Arches Province and surrounding areas. Shaded areas indicate the EGRP, and border fault boundaries are shown. The Beargrass Project site is in the EGRP. This formation has been identified in portions of Ohio, Kentucky, and Indiana, but it is not expected at the Beargrass Project site. Modified from Drahovzal et al. (1992).

2.2.2 Mt. Simon Sandstone/Injection Zone (Cambrian)

The Potsdam Supergroup of the Cambro-Ordovician Sauk sequence unconformably overlies the Precambrian Basement and includes the Mt. Simon Sandstone, the Eau Claire Silt, the Eau Claire Shale, the Ironton-Galesville Sandstones, the Franconia Formation, and the Davis Formation (Figure 4 and Figure 5). Specific to this project, the Mt. Simon Sandstone is the target for the injection and sequestration zone, the Eau Claire Silt is a secondary storage zone, and the Eau Claire Shale (above the Eau Claire Silt) is the primary confining zone.

The Mt. Simon Sandstone is a transgressive terrestrial to shallow marine sequence that is a laterally extensive deposit throughout the Arches Province, the Illinois Basin, and the Michigan Basin (Janssens, 1973; Kolata and Nelson, 1990). It is thickest in northeastern and east-central Illinois and thins eastward into Indiana (Figure 3; Rupp, 1991; Leetaru and McBride, 2009). Mt. Simon Sandstone sedimentology was impacted by a wide range of depositional environments including shallow marine, deltaic, fluvial, eolian, and coastal (Janssens, 1973; Baranoski, 2007; Bowen et al., 2011; Saeed and Evans, 2012; Freiburg et al., 2016). Fine to coarse-grained, poorly sorted, quartz and arkosic sandstone primarily compose the Mt. Simon Sandstone in the Midwest (Bowen et al., 2011).

In Indiana, the Mt. Simon Sandstone is composed of a variety of lithofacies that include conglomerate, sandstone, and shale and porosity variations are related both to depositional heterogeneities and diagenesis (Bowen et al., 2011). In the Illinois Basin, the Mt. Simon Sandstone is subdivided into Lower, Middle, and Upper intervals, with the Lower Mt. Simon Sandstone containing an arkosic basal zone. Where the Mt. Simon Sandstone is thinner in northern Indiana, the "B-cap" (described below) is located near the top of the Mt. Simon Sandstone (Figure 4; Bowen et al., 2011). For this project, the B-cap separates the Lower Mt. Simon from the Upper Mt. Simon Sandstone, though it is important to note that these subdivisions are not necessarily the stratigraphic equivalent of the Lower and Upper Mt. Simon intervals in the Illinois Basin (Figure 4).

As previously mentioned, the Mt. Simon Sandstone has been the focus of numerous studies and served as the injection interval in the Arches Province for Class I and II wells for multiple decades, with the Eau Claire Shale acting as the confining zone (INEOS Nitriles, 2016; Cleveland-Cliffs Steel Corporation, 2021). The Mt. Simon Sandstone is also the injection interval in the adjacent Illinois Basin through a number of US DOE funded projects including the Regional Carbon Sequestration Partnerships' IBDP's CCS1 well (Greenberg, 2021) and the CarbonSAFE program (Leetaru et al., 2019; Korose, 2022; Whittaker and Carman, 2022).

Within the Mt. Simon Sandstone is a layer of interbedded mudstone and siltstone known as the "B-cap" that extends across much of northern Indiana and is interpreted to have been deposited in flood-plain to tidal environments (Bowen et al., 2011). The B-cap is a relatively fine-grained, lower porosity interval and is anticipated to exist at the Beargrass Project site. It is typically observed in the upper portion of the Mt. Simon Sandstone succession and, for this project, Mt. Simon Sandstone strata above B-cap are referred to as Upper Mt. Simon Sandstone and strata below, Lower Mt. Simon Sandstone (Figure 4).

The elevation map of the Mt. Simon Sandstone, which represents the top of the planned injection zone (Figure 10), shows the continuity of the unit across a wide region and that it deepens to the northeast and toward the Illinois Basin in the southwest. Figure 11 shows the thickness of the Mt. Simon Sandstone to be increasing from less than 300 feet in the east to nearly 1,000 feet in the west and northwest. In the area of the Beargrass Project the thickness Mt. Simon Sandstone is expected to be greater than 650 feet.

[redacted]

[redacted]

2.2.3 Eau Claire Shale /Primary Confining Zone (Cambrian)

For the purposes of this project, the Eau Claire Formation is divided into a basal Eau Claire Silt secondary storage interval that directly overlies the Mt. Simon Sandstone and a finer-grained Eau Claire Shale that will serve as the primary confining zone at the Beargrass Project site (Figure 4, Figure 5, and Figure 7). Regionally, the Eau Claire Formation is a thick succession of fine-grained strata present across much of Indiana and surrounding areas and deepens to the northwest (nearly 2,000 fbsl) and west (more than 1,600 fbsl; Figure 12). The Eau Claire Silt has some interbedded very fine-grained sandstone that forms a gradational contact with the underlying Mt. Simon Sandstone. The Eau Claire Silt is also sometimes referred to as the Elmhurst Member. The Eau Claire Silt is expected to be around [redacted] feet thick at the Beargrass Project site and considered to be a secondary storage zone (Figure 4). The regional thickness of the confining Eau Claire Shale above the Eau Claire Silt shows that the rock thickens from less than [redacted] feet in the north to more than [redacted] feet in the south (Figure 13). At the Beargrass Project site Eau Claire Shale confining zone is expected to be over [redacted] feet thick.

In core from the Class I UIC AK Steel well in southwestern Ohio (approximately 120 miles to the southeast; Figure 3), the Eau Claire Silt contains beds of silt and fine to medium-grained quartz sandstone, pyrite, and mica. The silt grades upward to a gray, micaceous, glauconitic shale with some slightly more calcareous beds (Cleveland-Cliffs Steel Corporation, 2021).

The BP Lima well is located over 80 miles southeast of the project site and is used as a Class I UIC well, with the Mt. Simon Sandstone serving as the injection zone and the Eau Claire Shale serving as the primary confining zone (INEOS Nitriles, 2016). At this well, the Eau Claire Silt secondary storage interval is approximately 150 feet thick and grades upwards into more than 300 feet of lower porosity shale of the confining zone (INEOS Nitriles, 2016). The Eau Claire Shale has been shown to be an effective seal for carbon storage in the IBDP and IL-ICCS projects 170 miles to the west in the Illinois Basin (Leetaru and Freiburg, 2014).

[redacted]

[redacted]

2.2.4 Ironton-Galesville Sandstones (ACZ Monitoring Zone), Franconia Formation, and Davis Formation (Secondary Confining Zone) (Cambrian)

The Eau Claire Shale is conformably overlain by the undifferentiated Ironton-Galesville Sandstones/Franconia Formation at the Beargrass project site. The Davis Formation is a sequence of shale, siltstone, limestone, and dolomite and is the upper unit of the Potsdam Supergroup. In north-central Indiana, Davis-equivalent rocks also include the Ironton-Galesville Sandstones and the Franconia Formation (Rupp, 1991). Due to the project site proximity to the facies transition in north-central Indiana and the thin and gradational nature of these rocks, the shaley unit at the top of the package is interpreted to be shale of the Davis Formation and the underlying rock are the undifferentiated Ironton-Galesville Sandstones/Franconia Formation. The Davis Formation will serve as a secondary confining zone and the Ironton-Galesville Sandstones will serve as the above confining zone (ACZ) monitoring interval for the Beargrass Project (Figure 4).

The Ironton-Galesville Sandstones are clean, fine to coarse-grained, were derived from pre-existing sedimentary rocks sourced from the northern Michigan Highlands and deposited on a broad, shallow shelf throughout the Arches Province and surrounding basins (Emrich, 1966). During this time, clastic deposition dominated northern Indiana and carbonate deposition increased southward. In southern and eastern Indiana, the Ironton Sandstone is medium to coarse-grained, poorly sorted silty sandstone that grades into a dolomitic shale. The underlying well-sorted Galesville Sandstone is slightly finer-grained than the Ironton Sandstone and only present in the northern portion of Indiana (Emrich, 1966).

The Ironton-Galesville Sandstones are overlain by the glauconitic and dolomitic fine-grained sandstones and siltstones of the Franconia Formation (Figure 4). The relatively coarser Ironton-Galesville Sandstones and Franconia Formation laterally grade into the Davis Formation south of the project site (Figure 4; Becker et al., 1978). In Indiana, the Franconia Formation grades from clastic facies in the north to dolomitic facies in the southern and eastern portions of the state. Vertically, the Franconia Formation includes some relatively pure, tight dolomite facies toward the top of the section and is not considered an ACZ monitoring zone for this project (Becker et al., 1978).

At the Beargrass Project site, the Davis Formation secondary confining zone contains four primary rock types: 1) gray oolitic dolomite, 2) yellowish-gray feldspathic siltstone, 3) dark gray calcareous shale, and 4) gray limestone with interbedded siltstone and sandstone. They are interpreted to have been deposited in a shallow marine environment (Becker et al., 1978).

2.2.5 Knox Supergroup (Potosi Dolomite/Oneota Dolomite/Shakopee Dolomite) (Cambro-Ordovician)

The Cambrian Potosi Dolomite conformably overlies the Davis Formation and is the basal unit of the Knox Supergroup in Indiana (Figure 4). It consists of crystalline gray-brown dolomite with thin shale and siltstone interbeds and glauconite and chert are locally present (Rupp, 1991). Drusy quartz sometimes covers the surfaces of small to large cavities within the rock, and portions of this formation have relatively high permeability (Willman et al., 1975). These intervals within the Potosi Dolomite that exhibit karst dissolution features can be zones of lost circulation in the Midwest (Droste and Patton, 1985).

The Ordovician Oneota Dolomite is the middle member of the Knox Supergroup and consists of crystalline, light gray to brownish gray cherty dolomite (Figure 4). Sandy and thin, green shaly beds occur with greater frequency at the base of the dolomite. The rock is interpreted to have been deposited in a peritidal environment and grades upward to the overlying finer-grained Shakopee Dolomite (Droste and Patton, 1985; Rupp, 1991).

In Indiana, the Shakopee Formation is the top interval of the Knox Supergroup and is composed of dolomite with interbedded shale and sandstone. Grain-size and content generally increases upward. Like the Oneota Dolomite, the Shakopee Dolomite is gray-brown and cherty. The chert occurs in discontinuous bands and isolated nodules (Willman et al., 1975; Droste and Patton, 1985; Rupp, 1991).

The transition from passive margin deposition to a convergent boundary created the Knox Unconformity and associated karst topography. The unconformity separates the passive margin Knox Supergroup carbonates from the unconformably overlying interbedded clastics and carbonates of the Ancell Group (Figure 4; Droste and Patton, 1985; Drahovzal et al., 1992).

2.2.6 Ancell Group (Joachim Dolomite and Dutchtown Formation/ Gull River/Glenwood Formation/Secondary Confining Zone) (Ordovician)

The Ancell Group can be differentiated into several members throughout in the Midwest, including the Joachim Dolomite and the undifferentiated Dutchtown Formation/Gull River/Glenwood Formation, and the relatively finer-grained basal interval is a secondary confining zone for the Beargrass Project (Figure 4). These rocks were deposited in a shallow sea that transgressed following the uplift associated with the Knox Unconformity and are generally composed of a range of upward coarsening-upward fine-grained clastic sediment with interbedded dolomite (Droste and Patton, 1985).

2.2.7 Black River Group (Ordovician)

The micritic to finely crystalline limestone of the Black River Group was deposited in subtidal to intertidal conditions (Drahovzal et al., 1992). This formation consists of lithographic limestone with sandstone, chert, and brown shales. Thin interbedded dolomite beds are present in the upper section of the Black River Group, while the lower section contains lenses of fine-grained brown dolomite. Bentonites at the top of the Black River Group are evidence that the Taconic Orogeny was increasing in intensity to the east (Drahovzal et al., 1992).

2.2.8 Trenton Limestone (Ordovician)

Deepening of the sea resulted in the deposition of the basal, subtidal, and open-shelf facies of the Ordovician Trenton Limestone. As a result of the subsidence of the proto-Appalachian Basin due to the Taconic Orogeny, the end of deposition of the basal Trenton facies is marked by a change in depositional strike. This caused shallowing of the sea to the northwest and the deposition of the thick platform carbonates facies of the Trenton Limestone.

The Trenton Limestone exists throughout the subsurface of Indiana except in the southeastern part of the state, where the limestone interval is truncated so that the rock is entirely calcarenite and calcarenitic limestone. The Trenton Limestone also becomes increasingly dolomitic in northern Indiana. Near faults and highly fractured areas, the Trenton Limestone is completely dolomitized and may have both fracture and vuggy porosity (Gray, 1972; Droste and Shaver, 1983; Sullivan, 1995).

The Trenton Gas Field is located south of the Beargrass Project site in east-central Indiana. This field was explored and developed between 1889 and 1910 and was the largest natural gas discovery in Indiana at that time. Reservoir porosity occurs in dolomitized vuggy and fractured rock. By 1910, the Trenton Gas Field was depleted partially due to wasteful production methods (IDNR).

2.2.9 Maquoketa Group/Secondary Confining Zone (Ordovician)

The shale and carbonates of the Maquoketa Group are a clastic wedge that exists across Indiana, most of the Arches Province and the Illinois Basin and conformably overlies the Trenton Limestone at the Beargrass Project site (Figure 4). Silurian strata locally truncate the upper portion of the Maquoketa Group, which thins westward across Indiana. Within the Maquoketa Group, the Kope Formation is the lower basal shale overlying the Trenton Limestone in eastern Indiana and is the equivalent to the Utica Shale in the Appalachian Basin (Gutstadt, 1958). The carbonate content is greatest in the upper part of the group (DuBois, 1945; Gutstadt, 1958), and it will serve as a secondary confining zone for this project.

2.2.10 Silurian System/Lowermost USDW (Pleasant Mills Formation, Wabash Formation, Salina Group)

The Silurian Pleasant Mills Formation and the Wabash Formation/Salina Group comprise the Silurian System strata at the Beargrass Project site and unconformably overly the Maquoketa Group. The Pleasant Mills Formation, a limestone, is the basal Silurian unit and is the lowermost underground source of drinking water (USDW) at the project site (Figure 4; Fitzwater and Dunkman, 2007). During the Silurian, a shallow sea transgressed across the Arches Province, depositing carbonates and evaporites. This, in conjunction with the subsidence of the surrounding basins, allowed prominent shelf-edge carbonate banks to develop in Indiana. At the end of the Silurian, eustatic fluctuations, cratonic uplift, and local tectonic events caused sea level to regress. This ended sedimentation, exposing, and eroding the Silurian strata for millions of years (Mikulic et al., 2010).

2.3 Regional Structure

The region around and including Indiana (Figure 3) has been affected by three major tectonic episodes during the Phanerozoic Eon, including Rodinia-related rifting; widespread compressional (reverse) faulting during the assembly of the supercontinent Pangea in the late Paleozoic; and extensional (normal) faulting during the Mesozoic related to Pangea's breakup (Drahovzal et al., 1992; Denny et al., 2020).

Major structural features in Indiana consist of the Kankakee Arch, the Cincinnati Arch, the eastern portion of the Illinois Basin, and the southern portion of the Michigan Basin (Figure 3). The Cincinnati Arch is a broad uplift that separates the Illinois Basin to the west and the Appalachian Basin to the east. At the Indiana/Ohio boundary, the Cincinnati Arch bifurcates into two separate arches: the Kankakee Arch to the west and the Findlay Arch to the east, and this region of the Midwest is called the Arches Province. The project site is located within the Arches Province in the area where the Cincinnati Arch splits into the two separate arches and is on the crest of the Kankakee Arch (Figure 3).

The Kankakee Arch extends across northern Illinois and northern Indiana and separates the Michigan Basin to the northeast from the Illinois Basin to the southwest. The arch crest is broad, flat, and up to 75 miles wide.

The closest mapped structural features to the Beargrass Project site are the normal, northeast-trending Royal Center, Sharpsville, Fortville, and Auglaize Faults (22 miles northwest, 36 miles south-southwest, 39 miles south-southeast, and 71 miles southeast, respectively (Figure 14; Gray and Steinmetz, 2015). As previously mentioned in Section 2.2 *Regional Stratigraphy*, the Royal Center Gas Storage is located approximately 35 miles to the west of the project site field and began development in 1957. This field utilizes a structural closure associated with the Royal Center Fault to store natural gas in both the Trenton Limestone and the Mt. Simon Sandstone (Figure 6; Wickstrom et al., 1993; Mroz et al., 1997). The Fortville Fault is a northeast-trending normal fault that extends for nearly 50 miles in central Indiana (Indiana Department of

Transportation, 2021). The hanging-wall is on the southeast of the fault and up to 80 feet of displacement is observed in Trenton Gas Field wells.

The Auglaize Fault is mapped to terminate in western Ohio (though this is speculative due to data constraints) and is associated with the Eastern Continental Rift Basin basement (rift-fill volcanics and sediments) and is not exposed at the surface. Offset along this feature is also questionable and is not interpreted to have been active during the Paleozoic (Wickstrom et al., 1993; Baranoski et al., 2009).

The Wabash Valley Fault System in southwestern Indiana is approximately 150 miles southwest of the site and is composed of high-angle normal faults that die out with depth (Nelson, 1995; Leetaru and McBride, 2009). The Kentland Impact Structure is 85 miles west of the site and is a circular dome and an associated deformed area that is approximately eight miles in diameter. This deeply eroded structure is characterized by shatter cones, deformed bedrock, localized faults, and vertical contacts among normally horizontal strata.

High density two-dimensional (2D) seismic data acquired specifically for the Beargrass Project indicates there are no significant structural features identified within the project's AoR that would impact CO_2 sequestration and containment. The 2D seismic data is discussed in detail in Section 2.5 *Faults and Fractures*. The structural features listed above are significantly removed from the Beargrass Project site and are not considered impactful to carbon sequestration operations.

[redacted]

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

[redacted]

[redacted]

The Mt. Simon Sandstone is the injection zone, the Eau Claire Silt is the secondary storage zone, the Eau Claire Shale is the confining zone, and all extend laterally beyond the AoR limits. This is demonstrated by the regional thickness maps (Figure 11 and Figure 13), the cross section shown in Figure 5, as well as the 2D seismic data discussed below (Figure 16; Figure 17; Figure 18; Figure 19; Figure 20; and Figure 21).

Strata of the Mt. Simon Sandstone and Eau Claire Shale are of consistent thickness with no evidence of stratigraphic pinch-out within the AoR. [redacted] Additionally, there is no indication that structural trapping by faults or domes could occur within the AoR.

2D seismic data (Figure 16, Figure 17, Figure 18, Figure 19, Figure 20, and Figure 21) acquired specifically for the Beargrass Project, and discussed in Section 2.5 *Faults and Fractures*, also indicate the Mt. Simon Sandstone, Eau Claire Silt, and Eau Claire Shale strata are laterally continuous and there are no structural features in the AoR that will impact storage and containment. The ductile nature of the Eau Claire Shale and lack of structural features indicate the confining zone has excellent characteristics for CO_2 sequestration at the Beargrass Project site. There are no potential geologic conduits for injection zone fluids to migrate out of the Mt. Simon Sandstone injection zone in the AoR of the Beargrass Project.

The base of the Pleasant Mills Formation/top of the Maquoketa Group is the lowermost USDW present within the AoR. The top of the lowermost USDW is prognosed at [redacted] feet depth, and its base is more than [redacted] feet above the top of the Eau Claire Shale confining zone at the Beargrass Project site. There are no structural features or faults observed to intersect the Silurian strata in the AoR. As described in Section 2.1 *Regional Geology, Hydrogeology, and Local Structural Geology,* there are several secondary confining zones between the Eau Claire Shale and the Silurian strata in the AoR.

There are four O&G wells within the Beargrass Project AoR (Figure 15) according to the Indiana Department of Natural Resources public database (Indiana DNR). The latest water well data search indicates that 31 shallow groundwater wells are located within the Beargrass AoR; all are less than 360 feet deep (Figure 15, Indiana DNR, Division of Water).

There are no existing wells in the AoR that penetrate the confining strata of the Eau Claire Shale at the Beargrass Project site.

2.5 Faults and Fractures [40 CFR 146.82(A)(3)(ii)]

A high density 2D seismic program conducted in March 2024 that acquired and processed [redacted] miles of seismic data at the Beargrass Project site to provide information regarding subsurface structure and stratigraphy (Figure 16). Lines were acquired around the project site to enable accurate delineation of subsurface features. A vibrator truck operating on county roads with a 4-120Hz broad band sweep of 24 second duration acquired these data. Source spacing of 80 feet and receiver spacing of 40 feet were used to enable high density processing to identify both shallow and deep subsurface features. Long offsets were obtained to enable potential inversion work to identify any lithological changes at target.

The Hudson #1 well (API UWI 13169290240000), drilled approximately 625 feet north of Line B, was used to generate a synthetic seismogram to tie and correlate the well data to the seismic data (Figure 17). Since the Hudson #1 well is located close to one of the project seismic lines, the resulting stratigraphic correlation and interpretation has a high degree of certainty.

Line A and Line B are west-east 2D seismic lines (Figure 18 and Figure 19), and Line C and Line D are south-north 2D lines (Figure 20 and Figure 21), all of which are within the Beargrass Project AoR (Figure 16).

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

2.5.1 Impact on Containment and Tectonic Stability

Previously collected seismic data associated with CO_2 sequestration projects in Indiana and the adjacent Illinois Basin suggest that minor faults in the Precambrian and Mt. Simon Sandstone strata are not expected to act as conduits through the confining zone (Greenberg, 2021) and that they present negligible endangerment to USDWs.

A future baseline three-dimensional (3D) surface seismic survey will be conducted at the Beargrass Project site prior to injection. This survey will evaluate injection and confining zone properties, map Precambrian basement topography as well as any subsurface structural features or faults that may potentially be present and assess their potential impact to storage or containment. The 3D surface seismic survey will be designed to obtain full fold data over the predicted extent of the CO_2 plume after 12 years of injection and 50-year post injection site care (PISC) period (Attachment 06: Testing and Monitoring, 2024).

The data gathered during the pre-operational phase of the project will be used for geomechanical modeling to evaluate the influence of regional stresses on any minor faults identified in the 3D surface seismic data. The Pre-operational Testing Program details the geophysical log and core data that will be acquired to evaluate the nature of any identifiable fractures and their impact on long-term integrity of the confining zone (Attachment 05: Pre-operational Testing Program, 2024).

The Mt. Simon Sandstone contains numerous small offset faults that die out in the lowermost part of the injection zone just above the Precambrian Basement. Faults originating in the Precambrian basement and terminating in the basal units of the Mt. Simon Sandstone have not been active since Cambrian time and thickness changes in the Cambrian-aged Mt. Simon Sandstone may be related to interpreted syn-depositional fault movement along the basement-involved faults. Additionally, within the AOR, one fault identified on Line A transects the Mt. Simon Sandstone and dies out in the lowermost part of the Eau Claire Silt. This fault does not transect the Eau Claire Shale primary confining zone and will not impact containment. At the Beargrass Project site, the thickness of strata overlying the Mt. Simon Sandstone does not change, which suggests there has been little active faulting since early Cambrian time.

In the area of the Beargrass Project in Indiana, earthquakes above M 2.5 are rare. See 662.8 *Seismic History* for further details.

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

2.6.1 Injection Zone and Confining Zone Extent and Thickness

The Mt. Simon Sandstone is the injection zone for the Beargrass Project. The overlying Eau Claire Silt provides additional storage capacity as a secondary sequestration zone (section 2.2 *Regional Stratigraphy*) although direct injection will not be performed into this unit.

Computational modeling indicates most of the injected CO_2 will remain in the Mt. Simon Sandstone as described in Attachment 02: AoR and Corrective Action Plan (2024)

The Eau Claire Shale above the Eau Claire Silt is the confining zone for the Beargrass Project (Figure 4). Regional characteristics of the injection and confining zones are also described in Section 2.2 *Regional Stratigraphy*.

Available public data were collected and integrated to develop site-specific subsurface maps, petrophysical relationships, and a static model of the Beargrass Project site. Geophysical well logs and 2D seismic data were used to generate thickness maps for the Mt. Simon Sandstone injection interval (Figure 22), the Eau Claire Silt secondary sequestration zone (Figure 23), and the Eau Claire Shale primary confining zone (Figure 24).

Within the Beargrass Project AoR, there are minor elevation variations as well as thickness changes in the Mt. Simon Sandstone injection zone that are related to topography of the Precambrian Basement and some associated Precambrian faults in that die out in the Lower Mt. Simon Sandstone. Thickness and elevation of the Eau Claire Silt secondary storage zone and the Eau Claire Shale primary confining zone are relatively consistent across the AoR. [redacted]

CO_2 plume development is controlled dominantly by reservoir characteristics related to depositional and diagenetic processes and sedimentological heterogeneities within the injection zone, with basement topography and related thickness variations are expected to have less of an influence on CO_2 plume development at this site. The fine-grained, low porosity B-cap unit within the Mt. Simon Sandstone will act as a baffle to vertical migration of CO_2 into the Upper Mt. Simon Sandstone beds. The Eau Claire Shale primary confining zone will provide a thick, laterally extensive barrier to prevent upward migration of injection zone fluids over time.

2.6.2 Porosity and Permeability

Public log and core information from four wells (Pfeil, Hudson #1, Shady Lane, and Leuenberger) surrounding the Indiana project site provide significant data for petrophysical characterization of the injection and confining zones at the Beargrass Project site (Figure 25). These wells are variously located at gas storage sites, stratigraphic test wells, and hydrocarbon wells and include data such as well logs, core, and fluid injection data from the Mt. Simon Sandstone, Eau Claire Silt, and Eau Claire Shale.

The Hudson #1 well is approximately 1.5 miles southwest of the Beargrass Project site (Figure 25 and Figure 26) and represents the closest analog for the injection and confining zones. The Pfeil well located approximately 35 miles west of the site in the Royal Center Gas Storage

Project also serves as a geologic analog for the storage system (Figure 6, Figure 25, and Figure 27). These wells are discussed in more detail in section 2.7.2 *Petrophysics*.

[redacted]

2.6.3 Mt. Simon Sandstone

[redacted]

Reservoir quality of both the Upper and Lower Mt. Simon Sandstone is similar in northern Indiana. Bowen et al., (2011) states that reservoir quality does not have a simple relationship with depth and varies both laterally and vertically depending on depositional facies, mineralogy, and diagenesis. Enhanced reservoir quality in the Mt. Simon Sandstone is often observed through depositional heterogeneities and secondary porosity development resulting from diagenetic dissolution of feldspar grains (Leetaru and McBride, 2009; Bowen et al., 2011; Medina and Rupp, 2012; Freiburg et al., 2016; Leetaru et al., 2019). Primary depositional flow barriers within the Mt. Simon Sandstone consist of isolated overbank and tidal mudstones including the B-cap.

Bowen et al. (2011) concluded that porosity types in the Mt. Simon Sandstone range from intergranular porosity, elongate and oversized pores, fracture porosity, and dissolution porosity. In contrast, quartz and feldspar overgrowth cement, iron-bearing illitic clays, kaolinite, and iron oxides greatly reduce porosity in the Mt. Simon Sandstone. Sminchak (2012) examined geophysical well logs, rock samples, drilling logs, and geotechnical tests collected from the Mt. Simon Sandstone in the Arches Province, with a focus on porosity and permeability analyses and concluded that large-scale injection of CO_2 into the Mt. Simon Sandstone in the Arches Province is possible with proper design, operation, and monitoring.

[redacted]

[redacted]

[redacted]

Additional site-specific information regarding the injection zone will be acquired when the project wells are drilled through the pre-operational testing program and will include, but are not limited to, well logging, fluid sampling, and core acquisition and analysis (Attachment 05: Pre-operational Testing Program, 2024).

The baseline 3D surface seismic data will be calibrated to the well data and used for inversion analysis. This will allow the project to characterize variations in injection zone porosity and lithology away from the project wells over the imaging area of the 3D surface seismic data volume.

2.6.4 Eau Claire Shale

[redacted]

Sminchak (2012) compiled data on depositional fabrics, mineralogy, and petrophysical characteristics to assess the sealing potential of the Eau Claire Shale in the Arches Province. More than 300 porosity and permeability core data points were evaluated and many of the tests were below detection limits for permeability. This study determined that the Eau Claire Shale will act as an effective confining interval in the Arches Province. As the Eau Claire Shale regionally exhibits effective seal characteristics, it is expected to be a thick, competent confining zone for the underlying Mt. Simon Sandstone injection zone at the Beargrass Project site.

Well logs, core analyses, and seismic data collected as part of the pre-operational testing program will be used to further characterize the porosity and permeability of the confining zone (Attachment 05: Pre-operational Testing Program, 2024). Capillary pressure and permeability will be measured as part of the Eau Claire Shale core analysis.

2.6.5 Davis Formation

The shale of the Davis Formation is a thin, fine-grained unit at the top of the Cambrian Potsdam Supergroup in north-central Indiana and will serve as a secondary confining zone for the Beargrass Project (Figure 4). This shale is laterally gradational with the Franconia Formation and Ironton-Galesville Sandstones in portions of northern Indiana. At the nearby Hudson #1 well, the Davis Formation is 93 feet thick and has average porosity and permeability of 0.5% and 0 mD.

2.6.6 Ancell Group

The Ancell Group will serve as a secondary confining zone and unconformably overlies the Knox Group (Figure 4). This rock was deposited in a shallow sea that transgressed following the uplift associated with the Knox Unconformity and is generally composed of a range of upward coarsening-upward fine-grained clastic sediment with interbedded dolomite (Droste and Patton, 1985). The finer-grained clastics at the base of the Ancell Group are approximately 45 feet thick at the Beargrass Project site.

2.6.7 Maquoketa Group

The Maquoketa Group is approximately 268 feet thick at the Beargrass Project site and regionally serves as a seal for hydrocarbons in the underlying Trenton Limestone. Young (1992) indicates the Maquoketa Group is a low permeability groundwater-confining unit throughout the Midwest. Core from Kentucky reveals that the Maquoketa Group is a black, fissile shale dominated by clay minerals and has both sufficiently low permeability and high compressive strength to serve as secondary confining zone for an underlying CO_2 injection zone. In the adjacent Illinois Basin, the Maquoketa Group contains higher fractions of quartz and carbonate minerals relative to clays and is thinly laminated with low effective porosity (<3%) and permeability (<9.86 x10 $^{-12}$ cm^2 [1 mD] (Zaluski, 2014).

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

2.7.1 Geomechanics

A 27-layer geomechanical model was constructed to test the integrity of the confining zone at the Beargrass Project site. Average values of Young's Modulus, Poisson's Ratio, and bulk compressibility were calculated for the Eau Claire Shale, the Eau Claire Silt, and the Mt. Simon Sandstone using data from the BP Lima well (Figure 3 and Figure 28; Table 5). Average values of total closure stress (TCS) and pore pressure used in the geomechanical model are shown in Table 6. The large difference between the TCS and the pore pressure indicates that there is a sufficient buffer that will allow a significant injection rate to occur without opening existing fractures.

Figure 28 is a log with the calculated geomechanics properties calculated on 0.5-foot intervals and calibrated with geomechanical data from well tests. The geomechanical properties derived from the calibrated sonic and density logs include Vp/Vs ratio, Biot's constant, bulk and shear moduli, Poisson's ratio, and Young's Modulus. The calculated values of TCS were compared to actual values from well tests from the BP Lima wells and were found to be in good agreement. These geomechanical data were then used to model the Eau Claire Shale confining zone integrity with an anticipated injection rate of 359 ktpa into the Mt. Simon Sandstone.

Shales are ductile and can accommodate high levels of strain without brittle failure. Mechanical tests using core from the Eau Claire shale collected at the BP Lima wells demonstrate a low Young's modulus and a high Poisson's ratio which indicate a ductile shale. This core data and well test data informed the log calculations of the geomechanical properties shown in Figure 29. These geomechanical data were used to model the Eau Claire Shale confining zone integrity at the Aster Project site with an anticipated injection rate of 359 ktpa into the Mt Simon Sandstone. Applying the pressure gradient resulting from this analysis to Aster Project site indicates a pore pressure of 1,103 psi in the Eau Claire Shale (Table 5). Although estimates of in situ pressures in the confining zone are provided at BP Lima, site specific data on pressure in the Eau Claire Formation will be obtained as part of the Pre-operational Testing.

[redacted]

[redacted]

[redacted]

During the pre-operational phase of the project, a variety of site-specific data from the confining and injection zones will be acquired in the project wells to support further geomechanical modeling (Attachment 05: Pre-operational Testing Program, 2024). These data include:

- Caliper, sonic, and image logs,
- Triaxial testing to establish geomechanical parameters such as rock strength, Young's Modulus, Poisson's Ratio, and fracture gradient,
- SRT.

2.7.2 Petrophysics

Petrophysical analysis of the Mt. Simon Sandstone, the Eau Claire Silt, and the Eau Claire Shale was performed using four wells in the general region of the Beargrass Project site (Figure 25 and Table 7). The petrophysical analyses were completed to evaluate the characteristics of the confining and injection zones (Figure 29, Figure 30, Figure 31, Figure 32, and Figure 33). For the analyses, log ASCII standard files and routine core analyses data were acquired from the Indiana Geological & Water Survey, the Illinois State Geological Survey, and the Ohio State Geological Survey. Geophysical well logs, core plugs, and well test data were used to calibrate the petrophysical calculations to derive effective porosity and permeability (Figure 30 and Figure 31). These analyses will be re-visited once the project acquires site-specific well logs and core data in the project wells (Attachment 05: Pre-operational Testing Program, 2024).

Table 7: Well logs used for petrophysical analysis. Log abbreviations can be found at the beginning of this document.

Well Name	UWI	Well Logs
Shady Lane	13053537870000	Gamma ray, spontaneous potential, density, density sandstone porosity, neutron sandstone porosity, photoelectric factor, density correction, deep resistivity, deep resistivity, medium resistivity, density limestone porosity, neutron limestone porosity, density dolomite porosity, neutron dolomite porosity
Pfeil	13049700400000	Gamma ray, deep resistivity, neutron porosity, core porosity, core permeability
Leuenberger	13003702210000	Gamma ray, caliper, neutron sandstone porosity, medium resistivity, neutron limestone porosity, neutron porosity, core porosity, core permeability
Hudson #1	13169290240000	Gamma ray, spontaneous potential, sonic, deep resistivity, deep resistivity, neutron porosity

Core and log data were also calibrated to well test data that is publicly available from the BP Lima well in western Ohio (Figure 3). Cross plots and histograms were made using these data which enabled more thorough analysis of wells without core data (Figure 29, Figure 30, and Figure 31). These results were incorporated into the development of a static geologic model (Attachment 02: AoR and Corrective Action Plan, 2024).

Pre-processing work on the raw log data, including depth shifting, unit conversion, and synthetic log generation, was performed prior to the petrophysical calculations. Gamma, neutron porosity, sonic, photo-electric, and density logs were used to derive the petrophysical properties for the four wells, which included:

- Effective Porosity
- Permeability
- Mineralogy (where data quality was reliable)
    - Volume Shale (VSH_V)
    - Volume Quartz (Quartz_V)
    - Volume Limestone (Limestone_V)
    - Volume Dolomite (Dolomite_V)
    - Volume Sphalerite (Sphalerite_V)
    - Precambrian (Basalt_V)
    - Bound Water (BVW_V)

Table 8 and Table 9 summarize petrophysical values determined from geophysical well logs and calibrated using data from core and reservoir testing for the Mt. Simon Sandstone, the Eau Claire Silt, and the Eau Claire Shale. Of the wells evaluated that have data throughout the entire Mt. Simon Sandstone interval, the Shady Lane well has the highest Mt. Simon Sandstone average porosity and permeability values, though it is important to note that this well does not penetrate the entire thickness of the Lower Mt. Simon Sandstone. The Hudson #1 well, closest to the Beargrass Project site, indicates porosity values in both Upper and Lower Mt. Simon Sandstone intervals that average near 11% and permeability values around 29 mD. The Pfeil and Leuenberger wells have relatively lower values (Table 8 and Table 9).

Facies modeling was performed on the four petrophysical wells and is reported in Section 1.1.1 of Attachment 02: AoR and Corrective Action Plan (2024). Effective porosity (PHIE) and mineralogy logs were used to define three porosity cutoffs for sandstone (relatively higher porosity), siltstone, and shale facies (relatively lower porosity). Individual variograms for each facies were developed and the facies were then each distributed throughout the static model.

For the four petrophysical wells, effective porosity/permeability cross plots (Figure 29), effective porosity histograms (Figure 30), and permeability histograms (Figure 31) indicate that the Upper and Lower Mt. Simon Sandstone intervals have the highest porosity and permeability values. The petrophysical and core data show that the Mt. Simon Sandstone is primarily composed of quartz sandstone with some thin interbedded shale and siltstone layers and demonstrates that the Lower and Upper Mt. Simon Sandstone intervals have similar reservoir quality.

The Eau Claire Shale primary confining zone above the Eau Claire Silt has significantly lower effective porosity and permeability values and higher shale content compared to the underlying Mt. Simon Sandstone (Figure 30, Figure 31, Figure 32 and Figure 33; Attachment 02: AoR and Corrective Action Plan, 2024).

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

Based on Federal Emergency Management Agency (FEMA) classification the Beargrass Project site has a very small probability of experiencing damaging earthquake effects. The site is more than 300 miles northeast of the Strongest Shaking Zone E associated with the New Madrid Seismic Zone (Figure 34).

The site is also approximately 70 miles northwest of the Moderate Shaking Zone associated with the Anna Seismic Zone in western Ohio. It is hypothesized that this seismic zone is associated with the Eastern Continental Rift Zone (Figure 34; Dart and Hansen, 2008).

All earthquakes since 1800 having a magnitude of 2.5 or greater and within a 100-mile radius of the Beargrass Project site are shown in Figure 35 and listed in Table 10 (USGS, 2024). The largest earthquake within this 100-mile radius occurred in 1937 approximately 85 miles southeast with a magnitude of 5.4 moment magnitude (Mw). The most recent earthquake occurred on 9 December 2023, approximately 95 miles southeast from the project site near Jackson Center, Ohio and had a magnitude of 2.9 Mw. No earthquakes have been recorded with an epicenter within the project AoR.

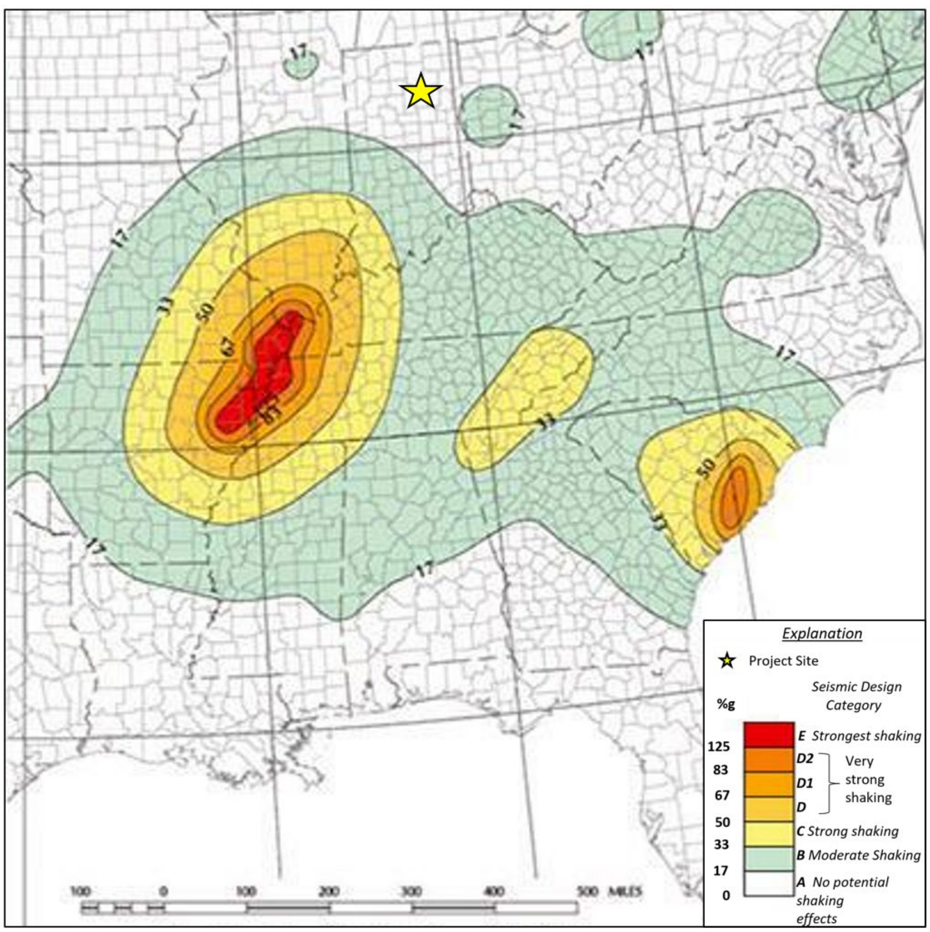

Figure 34: FEMA Earthquake Hazard Map shows that the project site (yellow star) is located in the lowest earthquake hazard category A. The New Madrid Seismic Zone is in Zone E.

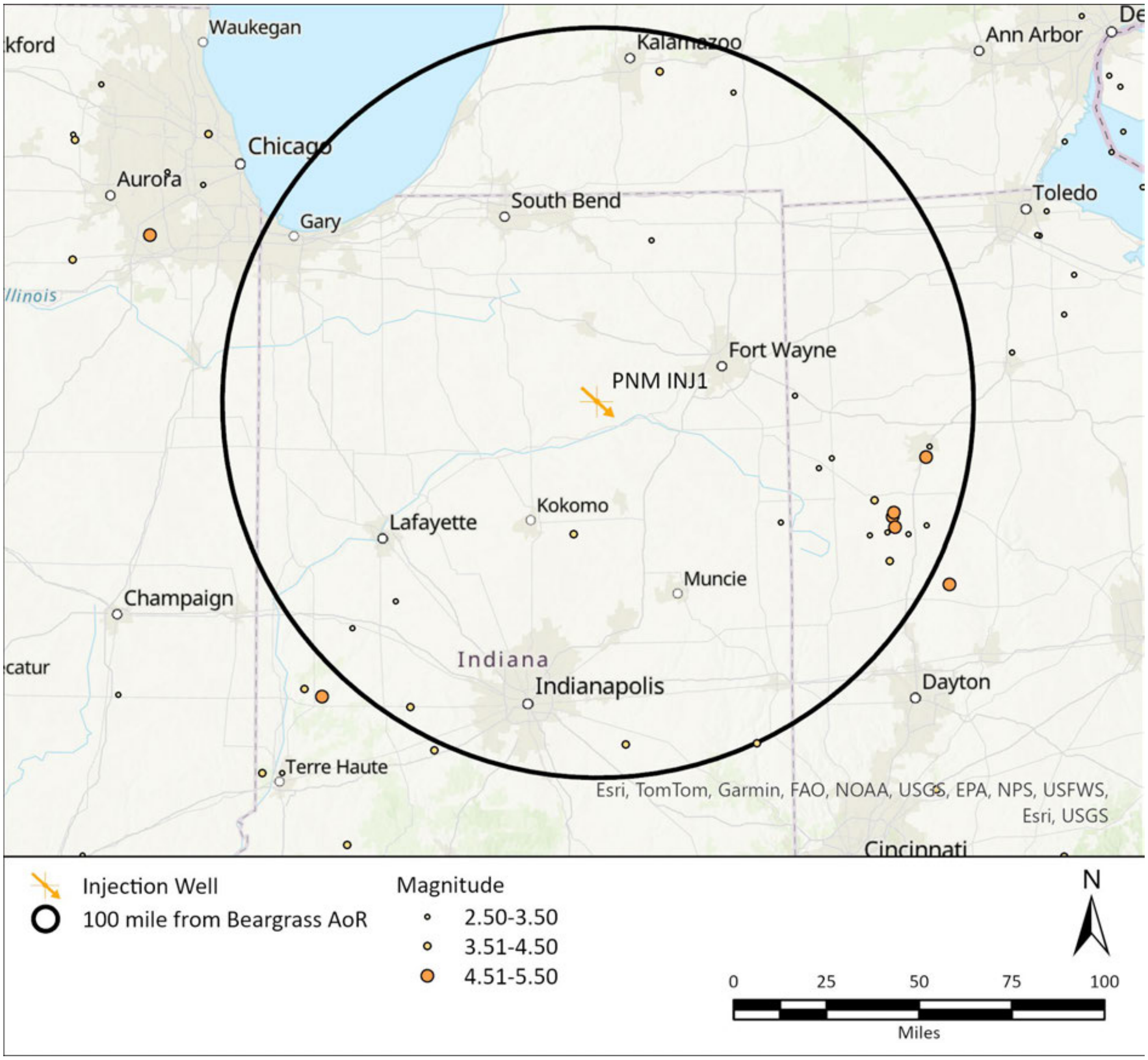

Figure 35: Map of earthquake epicenters with 2.5 or greater magnitude that occurred between 1 January 1800 to 28 June 2024 within 100 miles (black circle) of the Beargrass Project AoR (USGS).

Table 10: Events 2.5 or greater magnitude from 1 January 1800 to 28 June 2024 with epicenters within 100 miles (USGS).

Date	Latitude	Longitude	Depth	Magnitude	Place
12/09/2023	40.4322	-84.1084	6.79	2.9	5 km W of Jackson Center, Ohio
10/31/2023	40.1745	-86.8227	6.13	2.5	7 km ESE of Linden, Indiana
06/30/2015	42.1464	-85.0459	5.00	3.3	5 km NNE of Burlington, Michigan
06/12/2015	40.9550	-84.7620	5.00	2.6	6 km NW of Convoy, Ohio
05/02/2015	42.2357	-85.4285	4.48	4.2	5 km S of Galesburg, Michigan
01/26/2012	41.5760	-85.4900	4.70	3.0	5 km NE of Topeka, Indiana
12/30/2010	40.4300	-85.9140	5.00	3.8	6 km SE of Greentown, Indiana
09/30/2008	40.4100	-84.3100	5.00	2.8	5 km SW of Kettlersville, Ohio
08/15/2006	40.7100	-84.1100	5.00	2.5	3 km NE of Fort Shawnee, Ohio
05/12/2006	40.7400	-84.0800	5.00	2.8	2 km E of Lima, Ohio
09/12/2004	39.6043	-85.6615	2.40	3.8	4 km NW of Manilla, Indiana
01/30/2004	40.6700	-84.6500	5.00	2.5	2 km S of Rockford, Ohio
04/14/2000	39.7600	-86.7500	5.00	3.6	4 km NW of Heritage Lake, Indiana
04/04/1994	40.4000	-84.4000	5.00	2.9	2 km WNW of Minster, Ohio
12/17/1990	40.0680	-87.0440	10.00	3.2	Illinois-Indiana border region
04/17/1990	40.4600	-84.8520	5.00	3.0	8 km NW of Fort Recovery, Ohio
07/12/1986	40.5370	-84.3710	10.00	4.5	1 km ESE of Saint Marys, Ohio
06/17/1977	40.7070	-84.5820	5.00	3.2	5 km ENE of Rockford, Ohio
03/09/1937	40.4700	-84.2800	3.00	5.4	3 km NNW of Kettlersville, Ohio
03/02/1937	40.4880	-84.2730	2.00	5.0	3 km E of New Knoxville, Ohio
09/20/1931	40.4290	-84.2700	5.00	4.7	1 km SSW of Kettlersville, Ohio
09/30/1930	40.3000	-84.3000	0.00	4.2	5 km E of Newport, Ohio
09/19/1884	40.7000	-84.1000	0.00	4.8	Near Lima, Ohio
02/09/1882	40.4000	-84.2000	0.00	3.1	Near Anna, Ohio

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

The following sections provide information regarding available drinking water resources and delineation of the lowermost USDW. The lowermost USDW at the Beargrass Project site is the base of the Silurian Pleasant Mills Formation directly overlying the Maquoketa Group (Figure 4). Shallower USDW sources occur in the unconsolidated glacial sediments overlying the Silurian System bedrock. Water well, monitoring well, and dry well records were collected for the project AoR from the Indiana Department of Natural Resources, Division of Water (Indiana DNR, Division of Water). A total of 31 shallow water wells are located within the AoR. Attachment 02: AoR and Corrective Action Plan, (2024) includes a detailed discussion of the number and locations of the shallow groundwater wells within the AoR.

2.9.1 Near Surface Aquifers

The study site is located near the Beargrass Creek, which is a tributary of the Eel River, and the Eel River is part of the larger Upper Wabash River Watershed. This in turn is part of the greater Wabash River Watershed that drains rural, agricultural land and communities across much of Indiana and flows southwestward into the Ohio River (Figure 36).

During the Pleistocene Epoch, Indiana experienced several glacial intervals, and glacial sediments were deposited on top the Paleozoic bedrock throughout much of the state. These glacial deposits affect surface hydrology and aquifers in the region with up to 500 feet of till and valley fill sediment in areas of the state. The Beargrass Project AoR is within glacial deposits composed of till, drift, loam, and outwash associated with both Pre-Wisconsinan and Wisconsinan glaciations. At the project site there are 100-200 feet of unconsolidated glacial loam till of the Trafalgar and Lagro Formations and other associated Wisconsinan outwash deposits (Figure 37 and Figure 38) that overlie the Wabash Group of the Silurian System bedrock (Figure 39).

The site is near the boundary of the Warsaw Moraine and Bluffton Till Plain physiographic provinces and these areas have flat to gently rolling topography created by glaciers. The average ground elevation within the AoR is approximately 770 feet above mean sea level.

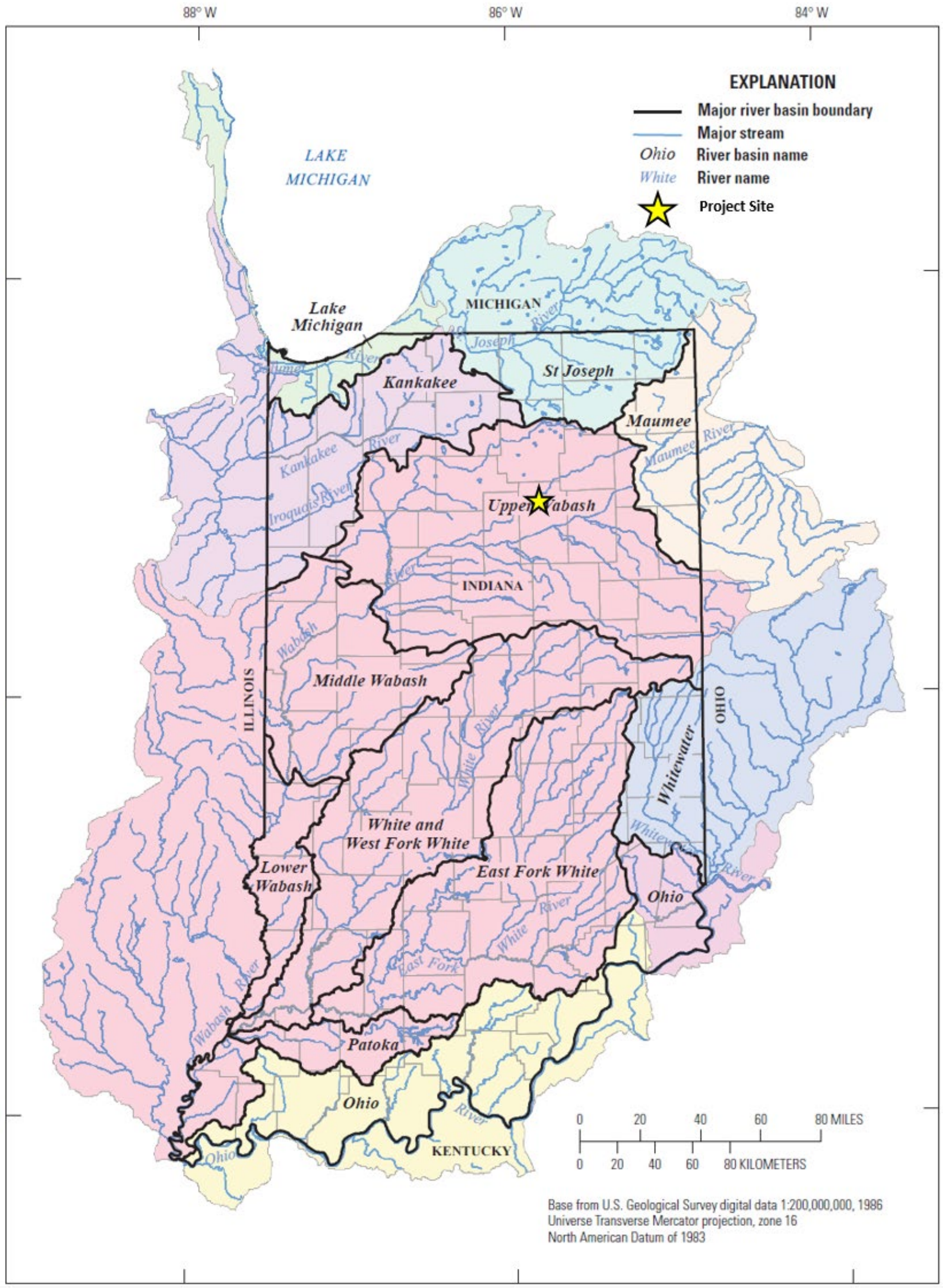

Figure 36: Map of the Wabash River Watershed with cities and EPA Toxics Release Inventory sample locations along the river. HUC = hydrologic unit code. From Stone and Latimer (2018).

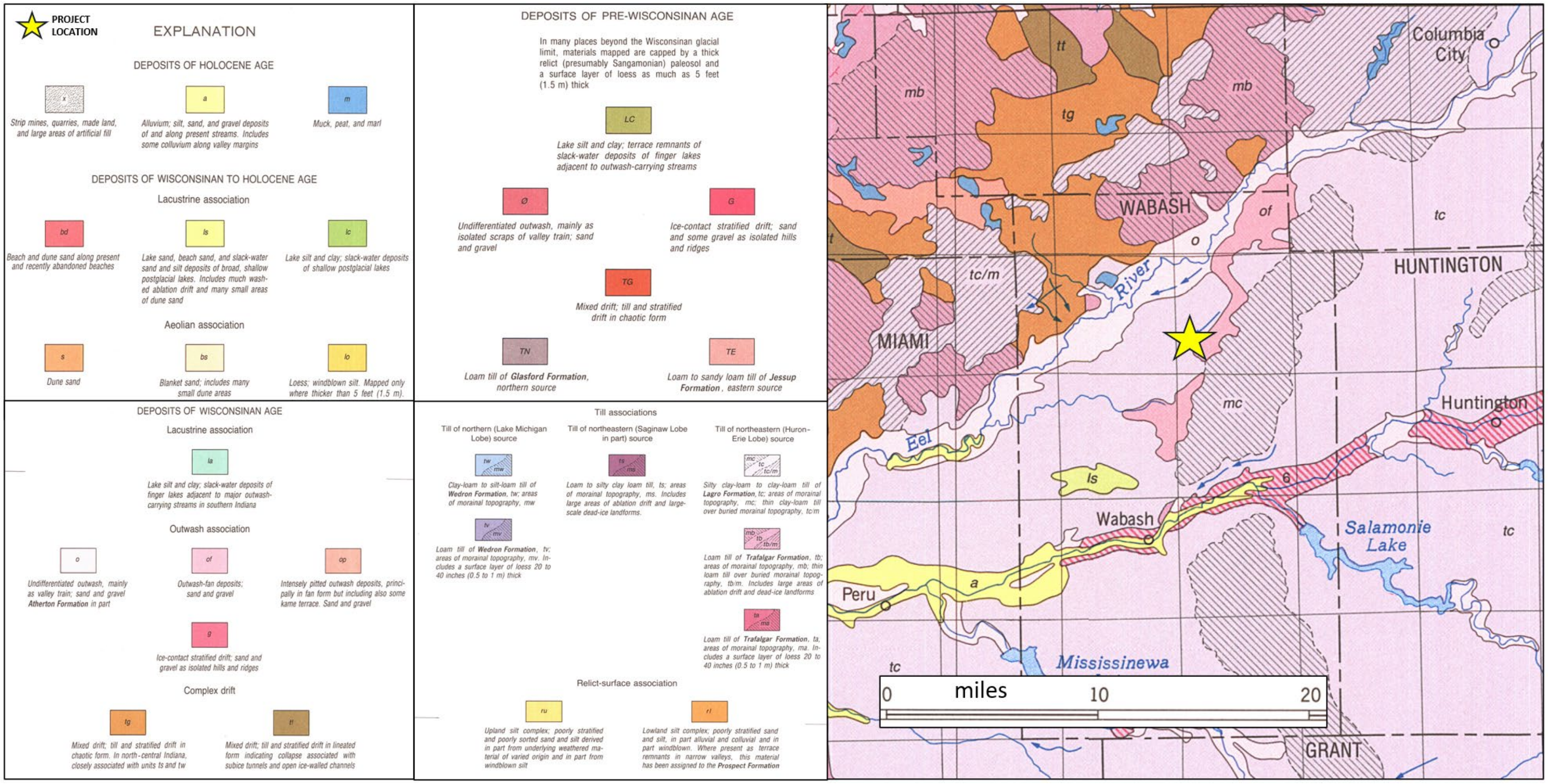

Figure 37: Map of Indiana glacial deposits shows that the Beargrass Project site is located on glacial deposits composed till, drift, loam, sand, and gravel associated with the Wisconsinan glaciation. Modified from Gray (1989).

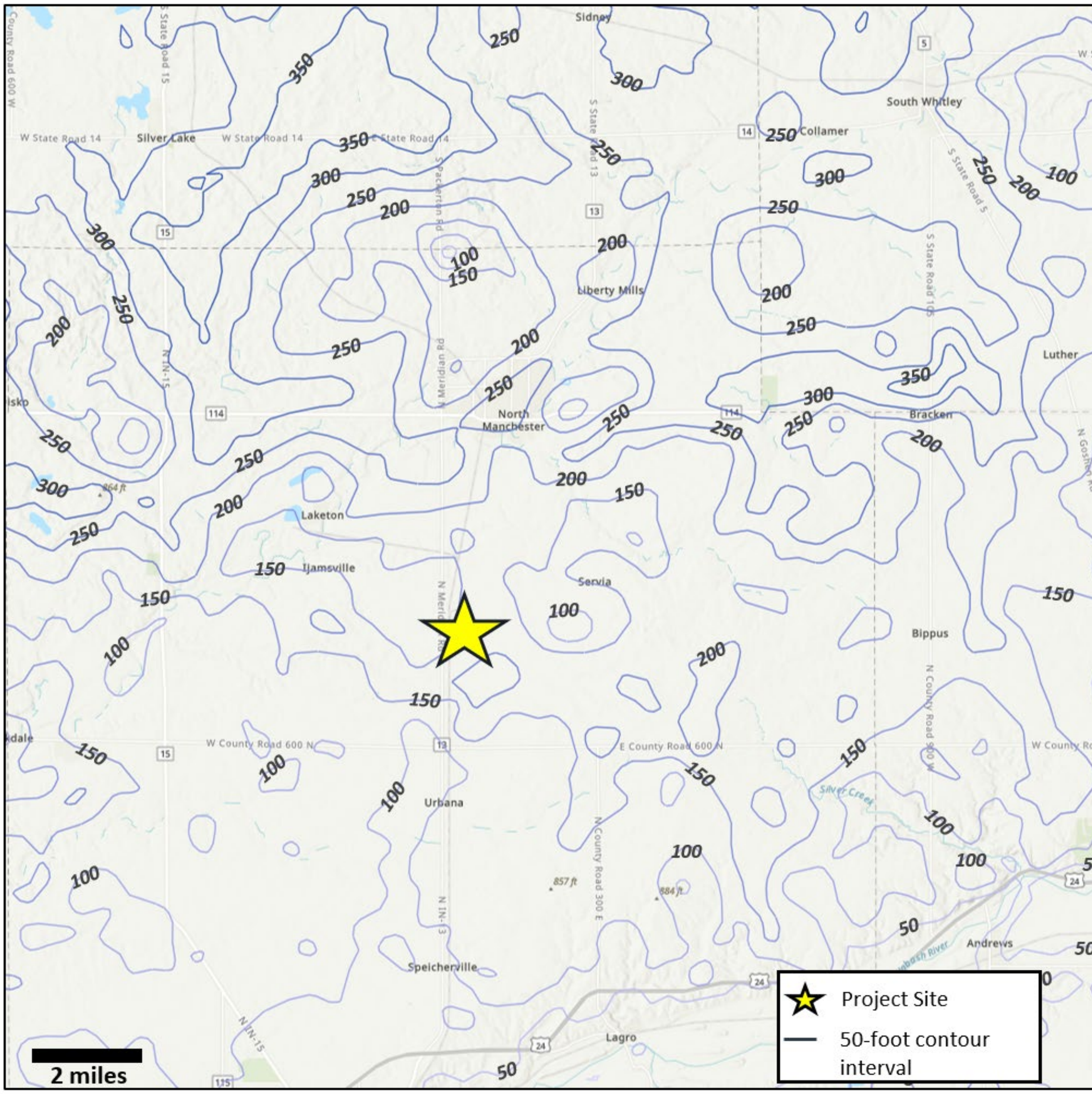

Figure 38: Map of glacial drift thickness in feet. At the project site, 100-200 feet of glacial drift are expected. Modified from (Indiana Geographic Information Office, 2024).

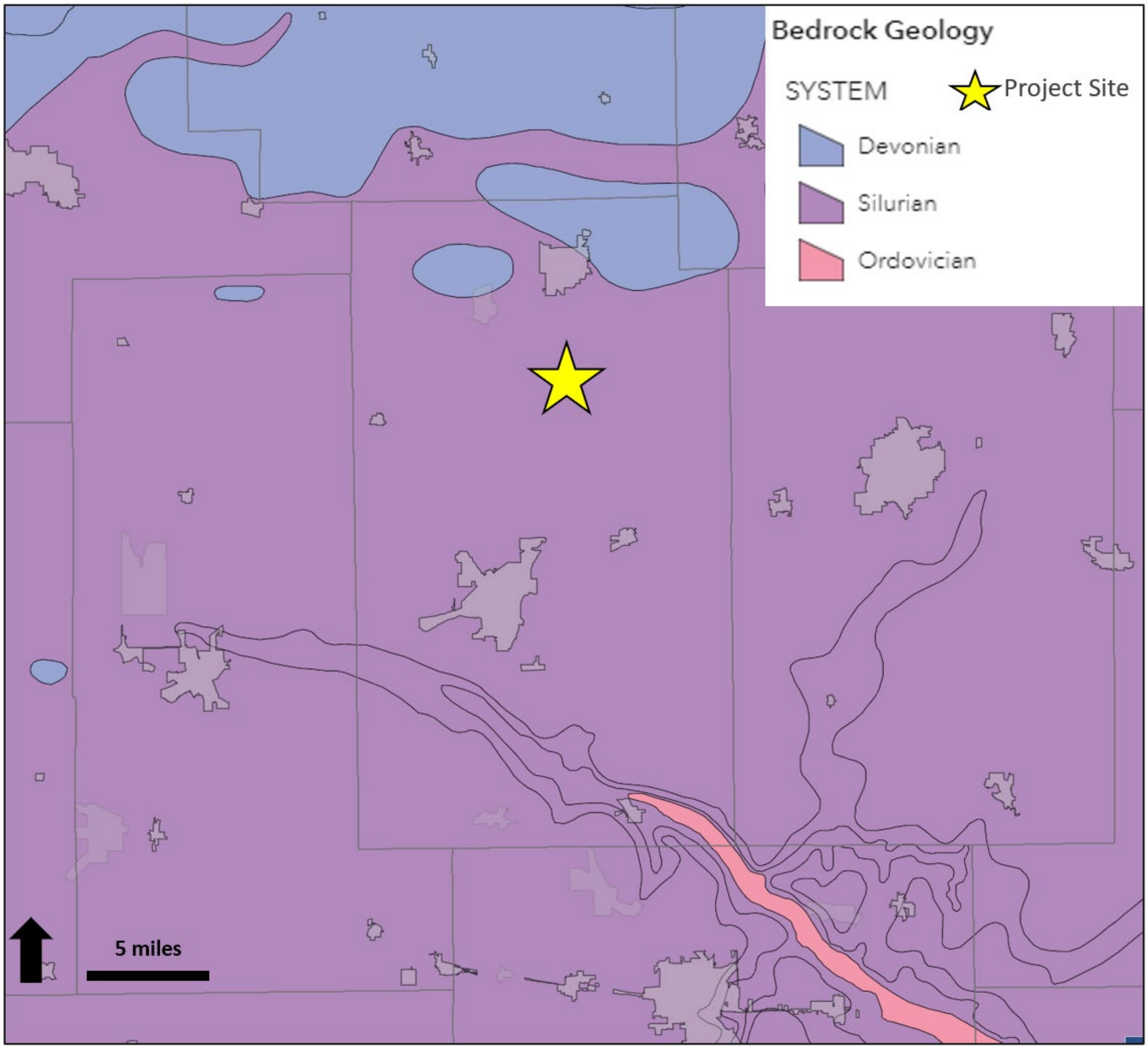

Figure 39: Bedrock geology underlying unconsolidated glacial drift. The Project site, indicated by the yellow star, is located above Silurian Wabash Formation bedrock. Modified from Indiana Geographic Information Office (2024).

2.9.2 Local Hydrology

There are several sources of groundwater in northern Wabash County:

1) The consolidated Silurian Carbonate Aquifer System,
2) The unconsolidated aquifer systems of various tills associated with the Bluffton Till and Complex Aquifer, and
3) Unconsolidated outwash sand and gravel of the White River and Tributaries Aquifer (Figure 40, Figure 41, and Figure 42, Fitzwater and Dunkman, 2007a).

Extracted groundwater is primarily used for public supply, and other uses include agriculture, industry, and energy/mining. Specifically, the area within and surrounding the Beargrass Project site utilizes the unconsolidated Pleistocene aquifers and Silurian carbonate bedrock (Figure 40, Figure 41, and Figure 42; Fitzwater and Dunkman, 2007a; Fitzwater and Dunkman, 2007b). Devonian carbonates are a primary groundwater source in southern Wabash County, but as the Devonian bedrock near the project site is thin to non-existent, it is not a significant groundwater source in northern Wabash County (Figure 40; Fitzwater and Dunkman, 2007a; Fitzwater and Dunkman, 2007b).

The thickness of the unconsolidated glacial deposits tends to be variable across Wabash County and bedrock is exposed at or near the surface along portions of the Wabash River and its tributaries. Approximately half of the reported water wells in Wabash County produce from unconsolidated glacial aquifers (Fitzwater and Dunkman, 2007a). Till veneer deposits have limited groundwater resources in the county, whereas the White River and Tributary outwash aquifer and the Bluffton Till and Complex Aquifer System meet the needs of domestic and high-capacity groundwater users (Figure 41). The primary unconsolidated aquifers surrounding the Beargrass Project site are till veneer, till and outwash deposits associated with the Bluffton Aquifer System, and White River and Tributary outwash deposits (Fitzwater and Dunkman, 2007b). Approximately 100 to 200 feet of unconsolidated deposits are predicted at the site (Figure 38).

The project site is underlain by approximately 160 feet of carbonates of the Silurian Wabash Formation (Figure 40 and Figure 42). Wells completed in Silurian carbonates generally meet the needs of both domestic and high-capacity users in Wabash County. These wells may have depths up to 500 feet, but are typically between 100-200 feet, and dissolution features and complex fracture patterns have been described in some well records (Fitzwater and Dunkman, 2007a). This system is primarily used where glacial deposits are relatively thin or primarily composed of till veneer. In Wabash County groundwater in the Silurian carbonate aquifer is recharged by percolation of precipitation through overlying glacial deposits. Regional groundwater flow in the Silurian aquifer is down-dip to the west (Fenelon et al., 1994; 40 CFR 146.82(a)(5)). Locally, groundwater flow can be directed toward registered groundwater withdrawal facilities within Madison County (Dean, 2010a).

As stated in Section 2.2 *Regional Stratigraphy*, the Maquoketa Group consists mostly of organic-rich black shale and organic-poor gray shale with minor amounts of dolomite and quartz sandstone. Wells completed in the shale typically have little to no yield in western Indiana, and this shale is not considered a groundwater source in Wabash County (Fitzwater and Dunkman, 2007a). As such, the base the Silurian Pleasant Mills Formation/top of the Maquoketa Group is considered the lowermost USDW for the Beargrass Project.

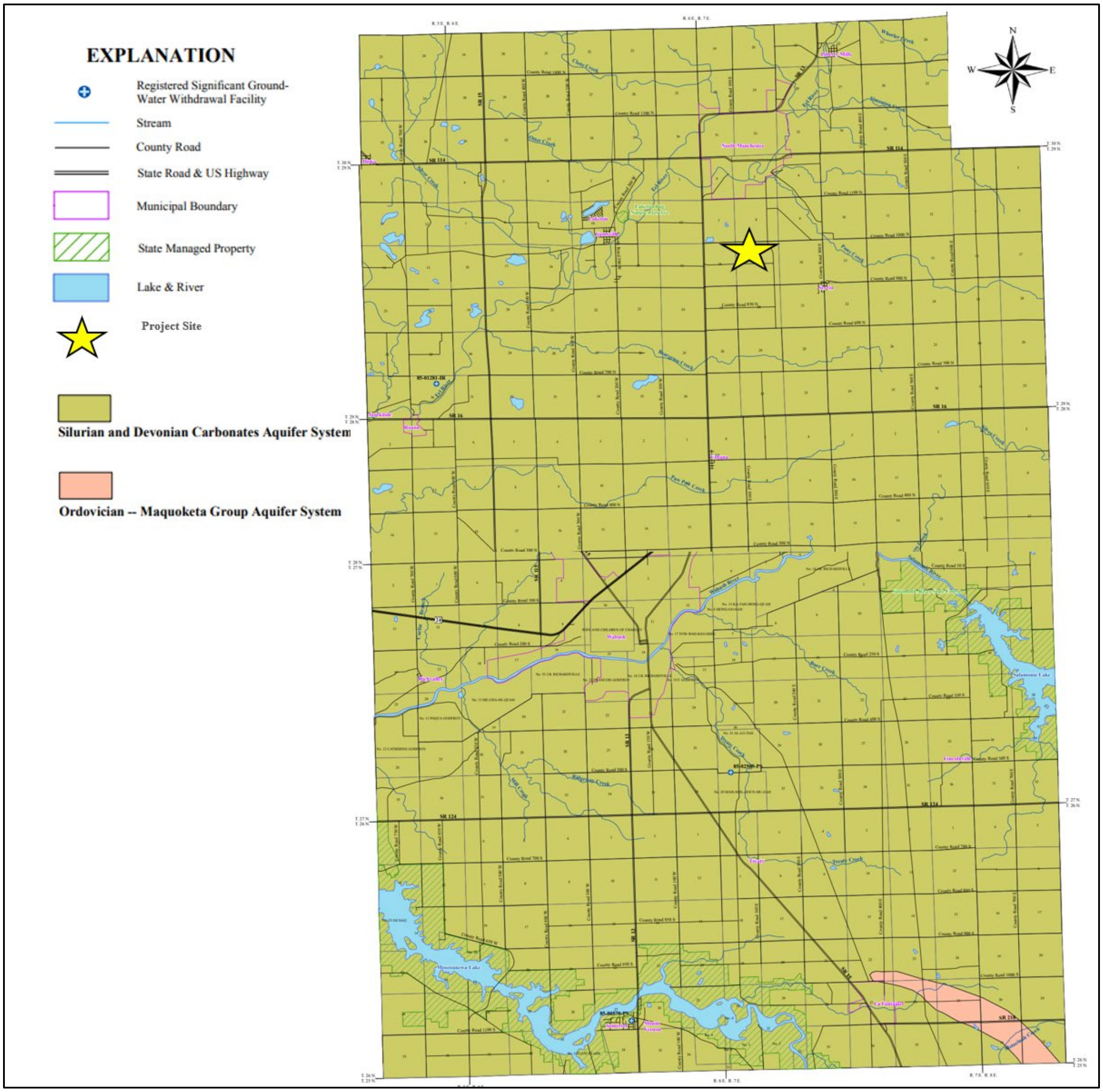

Figure 40: Bedrock aquifer map of Wabash County. Modified from Fitzwater and Dunkman (2007a).

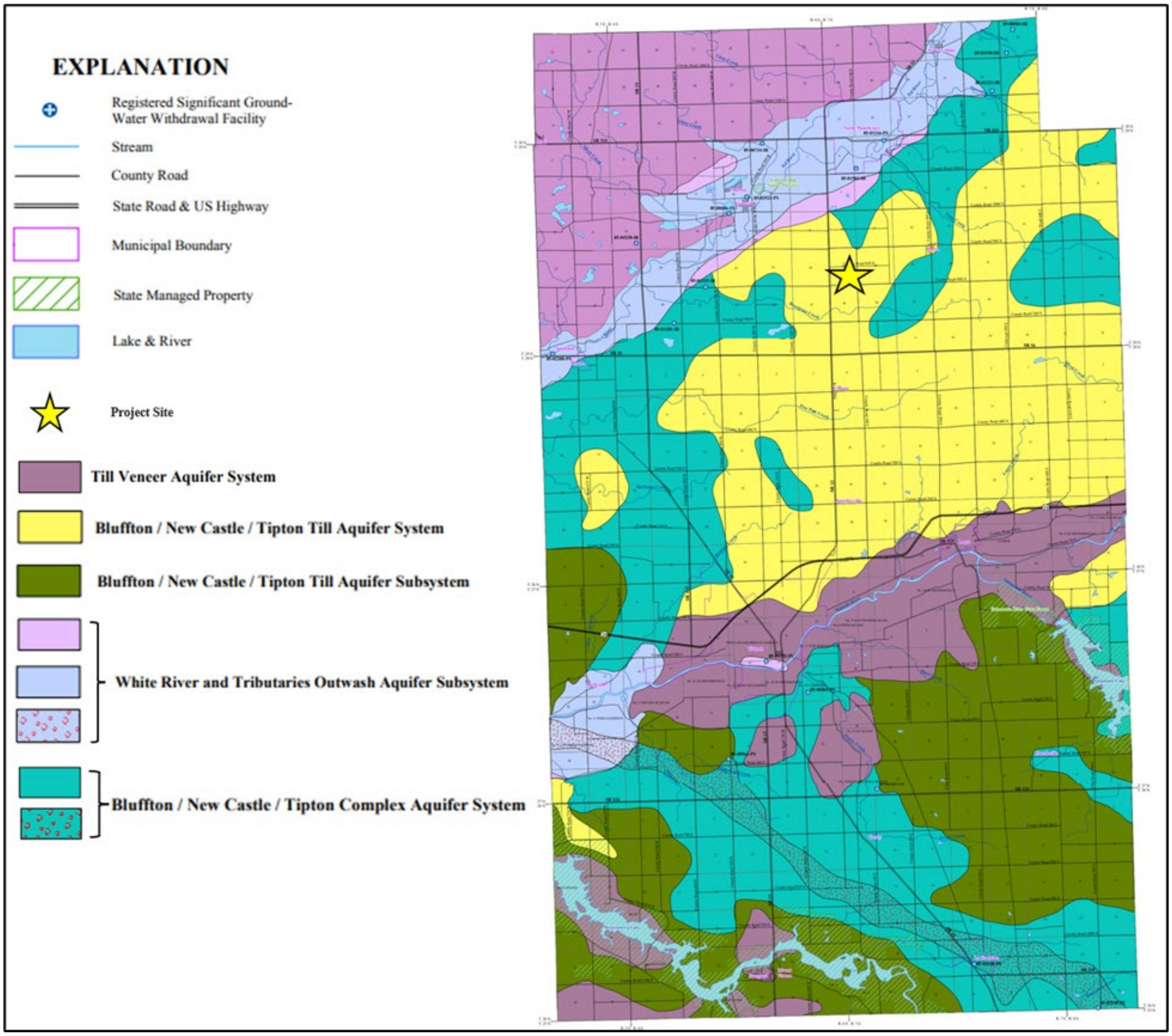

Figure 41: Unconsolidated aquifer map of northern Wabash County. Modified from Fitzwater and Dunkman (2007b).

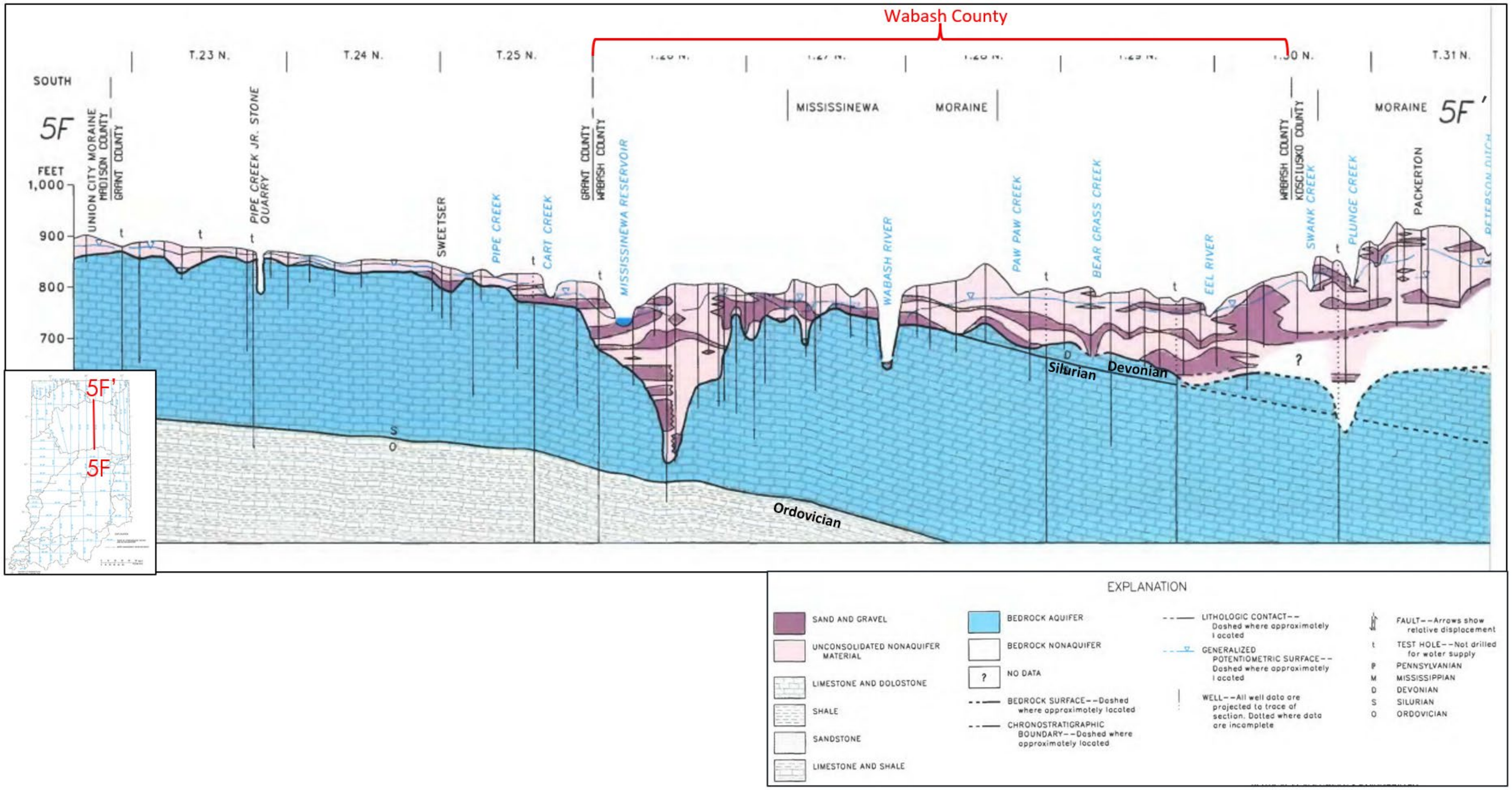

Figure 42: South-north hydrogeologic cross section through Wabash and surrounding counties showing the base of the Silurian strata (Pleasant Mills Formation)/top of the Ordovician strata (Maquoketa Group) as the lowermost USDW (Fenelon et al., 1994).

2.9.3 Determination of Lowermost USDW

A USDW is defined by the EPA as an aquifer that (40 CFR 146.3):

- Supplies any public water system,
- Contains a sufficient quantity of groundwater to supply a public water system; and
    - Currently supplies drinking water for human consumption, or
    - Contains fewer than 10,000 mg/l total dissolved solids (TDS),
- Which is not an exempted aquifer.

At the Beargrass Project site, the Pleasant Mills Formation of the Silurian Salina Group is the lowermost USDW. For the purposes of this project, the lowermost USDW will be mapped as the top of the Upper Ordovician Maquoketa Group/base of the Pleasant Mills Formation.

The incorporated town of North Manchester is approximately three miles north of the Beargrass Project site and five wells supply the town with drinking water (Wessler Engineering, 2022). These wells are completed in the unconsolidated Quaternary aquifers of northern Wabash County described in Section 2.9.2 *Local Hydrology*. Schrader et al. (2002) presented analyses of groundwater in northern Madison County (approximately 40 miles south of the Beargrass Project site) from both unconsolidated Quaternary aquifers and the Silurian bedrock aquifer. Generally, the bedrock aquifers have higher TDS values compared to the overlying unconsolidated deposits, and TDS values vary based on the bedrock mineralogy and groundwater residence times. TDS values from the unconsolidated and bedrock aquifers in northern Madison County range between 500-800 mg/L (Schrader et al., 2002). Wabash County and Madison County share the same Quaternary and Silurian aquifer systems, and salinity values at the Beargrass Project site are expected to be similar to those in northern Madison County.

The St. Peter Sandstone is a potable aquifer in northwestern Indiana. However, this formation does not exist at the Beargrass Project site. The Mt. Simon Sandstone is considered a ‘high capacity’ aquifer system in Wisconsin, Iowa, and northern Illinois, where it is relatively shallow and accessed for groundwater withdrawal. However, TDS in the Mt. Simon Sandstone increases southward throughout Indiana, and it is not suitable as a drinking or agricultural water source in the east-central portion of the state (Mehnert and Weberling, 2014). Based on regional data, the Mt. Simon Sandstone injection and storage zone formation water TDS is expected to be about 125,000 mg/L at the Beargrass Project site (Figure 43).

Hydraulic flow simulations and modeling by Gupta (1993) show that in central Indiana regional groundwater flow in the Mt. Simon Sandstone is westward towards regions of lower hydraulic head; 40 CFR 146.82(a)(5). This flow is influenced by the broad-scale arches as described in Section 2.1 *Regional Geology, Hydrogeology, and Local Structural Geology* toward the center of the Illinois Basin to the west (Lloyd and Lyke, 1995; Gupta, 1993).

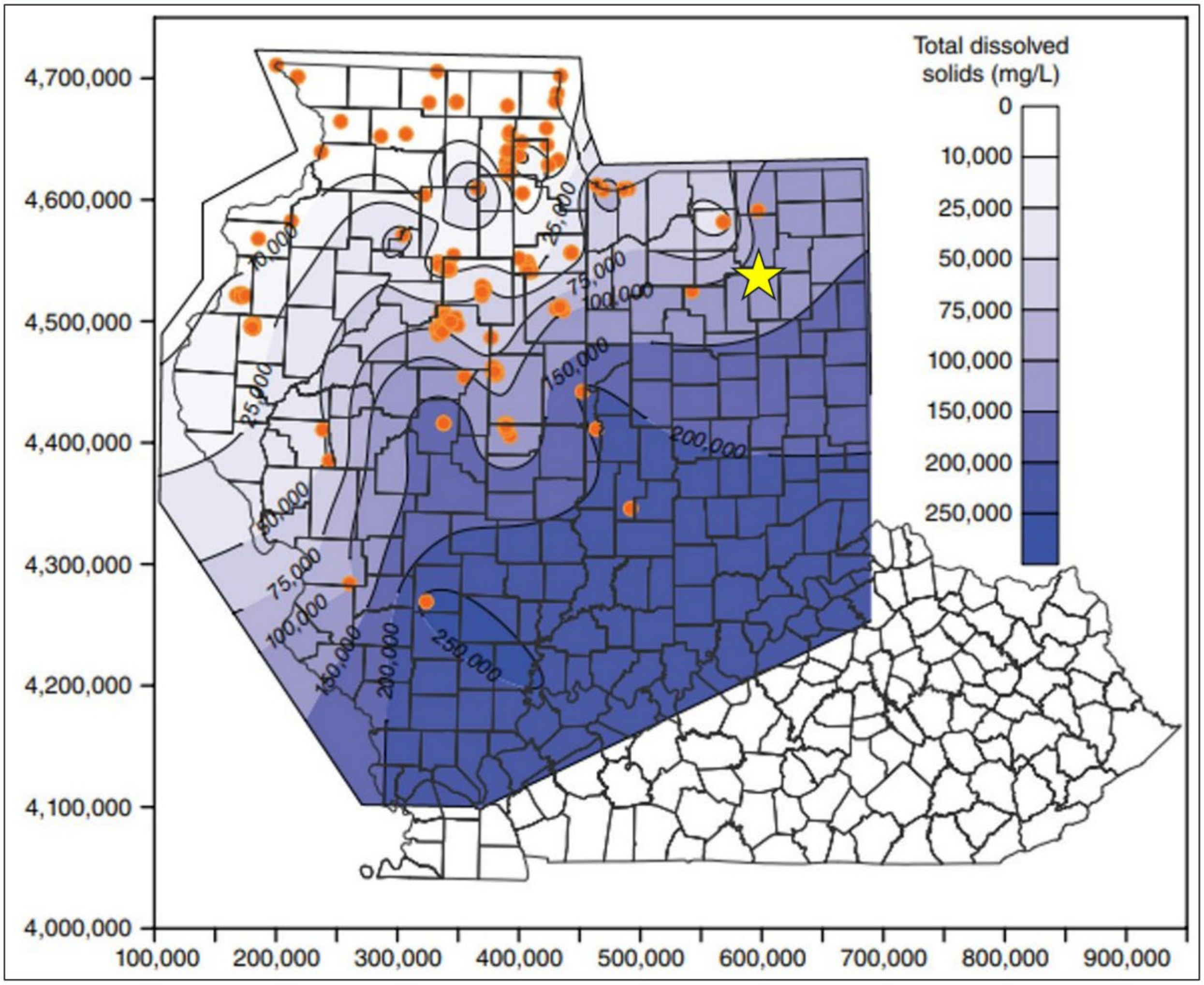

Figure 43: Map of TDS concentration contours in the Mt. Simon Sandstone formation brine. The project site is represented with a yellow star and sample locations are shown by orange circles Modified from Mehnert and Weberling (2014).

2.9.4 Topographic Description

[redacted]

The site has an elevation of approximately 770 feet above sea level. It is part of the Bluffton Till Plain, which in turn is part of the larger Central Till Plain Physiographic Province of Indiana. This region is characterized by generally flat or gently sloping topography with glacial deposits overlying bedrock (Section 2.9.2 *Local Hydrology*).

The land within the project AoR is considered an area of minimal flood hazard as established by FEMA. The nearest FEMA Zone A flood hazard risk (1% chance of annual flooding) is more than 3.1 miles northwest of the project site along the Eel River (FEMA).

Indiana DNR has developed a Best Available Flood Hazard Layer (BAFL) with additional studies reviewed and approved by the Division of Water. Although the data has not been submitted to FEMA for inclusion in the Flood Insurance Rate Maps or National Flood Hazard Layer, the data is useful for planning and development purposes. The BAFL indicates a Zone A flood hazard risk along a portion of Staver Ditch and along Beargrass Creek and its tributary with the project AoR (Figure 44).

[redacted]

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

2.10.1 Data Sources, Analyses

There has been extensive research into the regional understanding of the geochemistry of fluids and lithology of strata within the Arches Province and surrounding areas from numerous studies by Saeed and Evans (2012), Sminchak (2012), and the Illinois State Geological Survey as well as detailed work at carbon capture and sequestration (CCS) projects in the Illinois Basin including the IBDP (Greenberg et al., 2022), IL-ICCS (Gollakota and McDonald, 2014; Whittaker and Carman, 2022), and CarbonSAFE Illinois – Macon County (Whittaker and Carman, 2022). Although local variations will exist, there is confidence in the bulk lithology and mineralogy of rock and geochemistry of formation fluids in injection zone and confining zone in the Beargrass Project AoR. Formation fluids, full-diameter rock core, and side-wall core samples have been collected and analyzed by the projects identified above.

The Pre-operational Formation Testing Program details the data that will be acquired in the Beargrass Project PNM OBS1 and PNM INJ1 that may be used to support future geochemical evaluation (Attachment 05: Pre-operational Testing Program, 2024). The mineralogy of the injection zone and confining zone will be determined through a combination of core analysis and well logging. Well log data will also be acquired through the lowermost USDW and above confining zone (ACZ) monitoring zone to assist in establishing the mineralogy of these formations. Fluid samples will also be collected and analyzed from Silurian strata above the Maquoketa Group (Pleasant Mills, the lowermost USDW), the above confining zone interval (Ironton-Galesville Sandstones) and the injection zone (Mt. Simon Sandstone).

The Testing and Monitoring Plan details the parameters and analytes that will be used to establish baseline conditions for these formations as well as during the injection phase of the project (Attachment 06: Testing and Monitoring, 2024). The aqueous geochemistry data gathered during the pre-operational phase of the project will also be used to support any future geochemical modeling work. Geochemical modeling will likely focus on reactions in the injection zone and any reactions in the confining zone that may impact long-term containment and endangerment of USDWs.

2.10.2 Fluid Geochemistry

Many fluid samples have been collected from the Mt. Simon Sandstone in the Midwest, (Locke et al., 2013). To fulfill the requirements for UIC Class I or VI permits for the IBDP and IL-ICCS projects, the Illinois State Geological Survey has collected fluid samples since 2011 from the Mt. Simon Sandstone from these sites at Decatur, IL about 170 miles west-southwest of the Beargrass Project site. Mt. Simon Sandstone fluids are of the Na-Ca-Cl type with Cl/Br ratios typically ranging 165±15 (Panno et al., 2013). The general range of TDS measured for fluids from Mt. Simon Sandstone at the Decatur, IL, sites is from 150,000 - 200,000 mg/L and the salinity at the Beargrass Project site is expected to be slightly lower around 125,000 mg/L (Figure 44).

2.10.3 Solid-Phase Geochemistry

The mineralogy of the Mt. Simon Sandstone has been regionally characterized in the Midwest Region by numerous studies (Bowen et al., 2011; Saeed and Evans, 2012; Carroll et al., 2013; Freiburg et al., 2014; Davila et al., 2020; Shao et al., 2020) that indicate it is dominated by quartz with lesser amounts of feldspar, authigenic clay, and detrital clay minerals. The clay-sized fraction of minerals usually present in the Mt. Simon Sandstone are a small percentage (1–3% by volume). In Indiana, the formation is primarily quartz arenite (up to 95%). Some intervals of the Mt. Simon Sandstone contain abundant detrital and early authigenic K-feldspar (up to 40% by volume), clay minerals (illite, kaolinite, and chlorite up to 3% by volume), and iron oxide (up to 2% by volume). Trace detrital grains include zircon, rutile, and chromite. The distribution of the mineral components of the Mt. Simon Sandstone across the Arches Province and the Illinois Basin is consistent (Bowen et al., 2011; Freiburg et al., 2014).

2.10.4 Geochemical Reactions and Modeling

The Mt. Simon Sandstone mineralogy is similar in the Arches Province and the Illinois Basin (Bowen et al., 2011; Saeed and Evans, 2012; Carroll et al., 2013; Freiburg et al., 2014; Davila et al., 2020; Shao et al., 2020) and regional fluid chemistry trends within the Mt. Simon Sandstone have been documented (Locke et al., 2013; (Locke et al., 2013; Panno et al., 2013). As such, laboratory batch studies on geochemical reactions conducted using samples from the IBDP site 170 miles west of the Beargrass Project site can be used as an analog. These studies use Mt. Simon Sandstone, Eau Claire Silt, and Eau Claire Shale samples collected at the IBDP wells near Decatur to investigate the geochemical interaction of rock, brine, and CO_2 (Carroll et al., 2013; Yoksoulian et al., 2014). The experiments were conducted under relevant reservoir conditions to identify the reaction mechanisms, kinetics, and solid-phase products that are likely to occur when rock and brine are exposed to injected CO_2. The results of batch studies were also used to constrain the conceptual geochemical model, calibrate mean parameter values, and quantify parameter uncertainty in reactive-transport simulations.

The batch reactor experiments with Mt. Simon Sandstone generally indicated that limited dissolution of rock minerals occurs (Carroll et al., 2013; Yoksoulian et al., 2014; Shao et al., 2020). A decrease of potential hydrogen (pH) occurs quickly in these experiments after CO_2 is introduced because of its dissolution into the brine and dissociation of carbonic acid. Reaction of the Mt. Simon Sandstone can be characterized by an increase in dissolved silicon (Si) and aluminium (Al) after the reaction, suggesting the dissolution of aluminosilicate minerals, such as feldspar and clay minerals.

The amount of mineral dissolution is limited, however, as the mass of Al that dissolved from the solid phase into aqueous phase accounted for less than 0.3% of total Al in the rock samples. The liquid to solid ratios in batch experiments were much higher than aquifer conditions suggesting that under aquifer conditions less than 0.002% of Al would be mobilized. Results from x-ray diffraction (XRD) analyses indicated the bulk mineral composition remained unchanged for all sandstone samples after reaction (one to four months), indicating that the influence of rock-brine-CO_2 interaction on bulk rock composition was negligible.

Batch experiments introducing CO_2 to crushed Eau Claire Shale indicated mineral dissolution from Eau Claire samples were more significant than Mt. Simon Sandstone samples (Carroll et al., 2013; Shao et al., 2020). This is likely, in part, due to the processing of rock samples to small fragments that increased the reactive surface area, thus accelerating mineral dissolution of Eau Claire rock. The Eau Claire Shale, however, is a highly laminated, fissile shale to silty shale with the shaliest section near the base (above the Eau Claire Silt) and advective flow from the Mt. Simon Sandstone into the Eau Claire Silt is expected to be insignificant (Roy et al., 2014). Modeling of ionic diffusion into the Eau Claire Silt and Eau Claire Shale has also shown this to be insignificant (Roy et al., 2014).

Numerical simulations with PHREEQC 2.17.0 geochemical code (Carroll et al., 2013) suggested that the geochemical alteration of the Mt. Simon Sandstone, Eau Claire Silt, and Eau Claire Shale can be modeled by incongruent dissolution of annite, illite, potassium (K)-feldspar, and formation of montmorillonite, amorphous silica, and kaolinite. However, the formation of these secondary minerals was not confirmed with available characterization techniques.

Potential geochemical reactions at the Beargrass Project site were also modeled using Computer Modelling Group (CMG) Generalized Equation Model (GEM). A 24 layer model was constructed, and the four main expected mineral components and their percentages used in the model are based on Mt. Simon Sandstone core from the IBDP Verification Well #1 (Leetaru and Freiburg, 2014):

- Quartz (70 %).
- K-feldspar (20%).
- Illite (5%); and
- Illite-smectite (5%).

The modeling results indicate that K-feldspar precipitates and smectite dissolves over the 12-year injection period (Figure 45). There is little reaction with quartz or illite. A very small amount of mineralization is predicted to occur in this timeframe (0.02% of injected CO_2) and any change (reduction) in porosity is negligible during the injection period.

[redacted]

The geochemical modeling also predicted the main CO_2 trapping mechanisms. Figure 46 displays the evolution of the main trapping mechanisms during injection, PISC, and post-PISC periods. Initially, a large percentage of the CO_2 is structurally trapped. As the fluids gravity segregate, the amount of residual (immobile) gas increases. Dissolution of CO_2 into brine also begins at a slow rate. Dissociation of dissolved CO_2 into aqueous ions also occurs but only accounts for a small percentage of the trapping. Mineralization is a slow process that generally takes hundreds or thousands of years to become a significant trapping mechanism. Table 11 indicates the trapping mechanisms and percentage of CO_2 trapped 100-year post-injection at the Beargrass Project site.

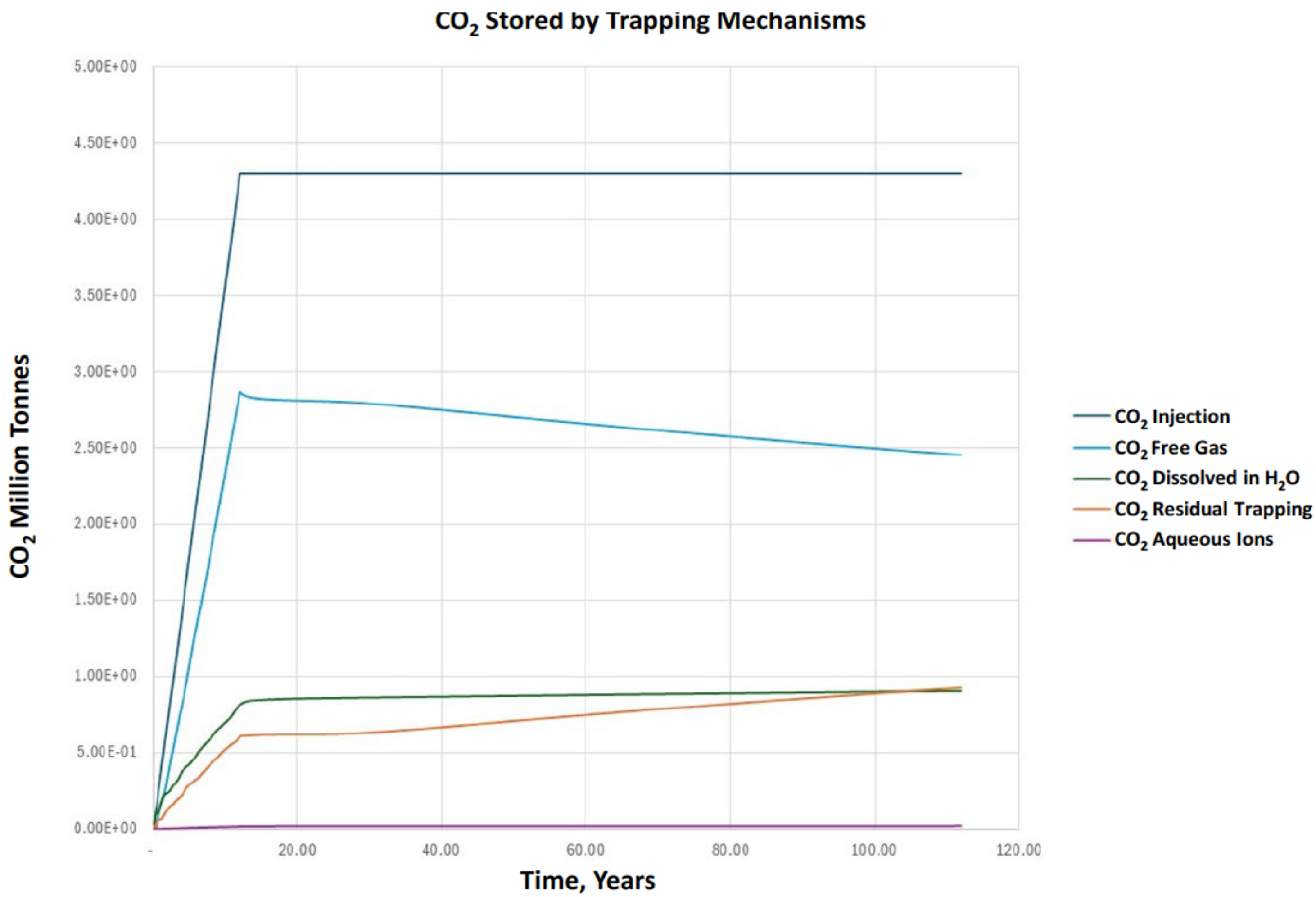

Figure 46: Graph of the relationships and evolution of CO_2 trapping mechanism during the 12-year injection period, 50-year PISC, and a 50-years post-PISC period at the Beargrass Project site

[redacted]

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

Attachment 05: Pre-operational Testing Program, (2024) presents the data that will be collected in order to determine and verify the depth, thickness, mineralogy, lithology, porosity, permeability, and geomechanical information of the injection zone, confining zone, and other relevant geologic formations via petrophysical logging and analysis, and core acquisition and testing (Attachment 05: Pre-operational Testing Program, 2024). In addition, baseline 3D surface seismic data will be acquired during the pre-injection phase of the project to assist in characterizing injection zone and confining zone rock properties away from the project wells.

Currently, the project does not plan to acquire baseline atmospheric or soil gas data nor are there plans to pursue atmospheric or soil gas monitoring during the injection phase of the project.

2.12 Site Suitability [40 CFR 146.83]

2.12.1 Summary

The Mt. Simon Sandstone at the Beargrass Project site meets all requirements necessary to serve as a competent injection zone and can sequester 359 ktpa of CO_2 over a 12-year period (approximately 4.3 Mt total), as evident through geologic evaluation, static modeling, and computational modeling results. The Eau Claire Shale at the project site has sufficient thickness, continuity, and low porosity and permeability to be a competent confining zone for the proposed volume of CO_2. Class I UIC wells in the Arches Province, as well as the IBDP and ongoing commercial IL-ICCS projects in Illinois (Figure 3), provide significant data that supports that the Mt. Simon Sandstone/Eau Claire Silt/Eau Claire Shale storage complex are highly suitable for long-term carbon sequestration.

Table 12 summarizes the properties of the Mt. Simon Sandstone that contribute to its suitability as an injection zone.

[redacted]

CO_2 plume development will likely be controlled by heterogeneities within the injection zone, and these heterogeneities will be characterized using a combination of well log, core, and 3D surface seismic data (Attachment 05: Pre-operational Testing Program, 2024). The AoR and Corrective Action Plan includes discussion of the capacity estimates for the injection zone (Attachment 02: AoR and Corrective Action Plan, 2024).

There are no wells that penetrate the confining zone within the AoR. The closest well is the Hudson #1 well, which is about 0.2 miles outside of the AoR (Indiana DNR).

FEMA classifies the project site to have a very small probability of experiencing damaging earthquake effects and a low probability of experiencing annual flooding.

2.12.2 Primary Seal

[redacted]

2.12.3 Lowermost USDW

The base of the Silurian Pleasant Mills Formation overlying the Ordovician Maquoketa Group is the lowermost USDW at the project site and is expected to be more than 1,800 feet above the top of the Eau Claire Shale confining zone.

2.12.4 Secondary Confinement Strata

There are several secondary confining beds between the lowermost USDW and the Eau Claire Shale primary confining zone, including the Davis Formation, the base of the Ancell Group, and the Maquoketa Group, to prevent fluids from reaching the lowermost USDW should they migrate past the primary confining zone.

2.12.5 Structural Integrity

2D seismic data acquired for the project indicate there are no faults or fractures, or other natural conduits, which can be identified that would allow injection zone fluid migration beyond the primary confining zone.

2.12.6 Capacity and Storage

The AoR and Corrective Action Plan show that the Mt. Simon Sandstone at the Beargrass Project site storage location has the capacity and hydrogeologic characteristics necessary to store 359 ktpa of CO_2 over a period of 12-years (4.31 Mt total).

Computational modeling was used to simulate multiphase (brine and CO_2) flow in the subsurface and considered the injection zone geologic and hydrogeologic characteristics. The computational modeling included one injection well at the project site and resulting AoR. Significant CO_2 trapping mechanisms modeled include structural/stratigraphic trapping, residual phase trapping, and solubility trapping. The model showed that in the post-injection phase and beyond, the pressure front dissipates rapidly, and the CO_2 plume stabilizes and remains confined to the injection zone (Attachment 02: AoR and Corrective Action Plan, 2024).

2.12.7 Injection Zone and Compatibility with the Injectate

Studies using laboratory experiments and reactive transport modeling of the Mt. Simon Sandstone from the adjacent Illinois Basin suggest that there is minimal reactivity of the rock with brine and CO_2. Experiments using Mt. Simon Sandstone core samples suggest minor dissolution of aluminosilicate minerals such as feldspar and clay minerals may occur, but the bulk of the mineralogy (i.e., quartz) is effectively inert. Results from XRD analyses indicated the bulk mineral composition remained unchanged for all sandstone samples after reaction and indicates that the influence of rock-brine-CO_2 interaction on bulk rock composition was negligible. Computational modeling indicates that smectite dissolution and K-feldspar precipitation may occur in the first 100 years of the project, but it would take hundreds of years to see any impact of mineral trapping.

The well casing, tubing, and cement used through the confining zone and injection zone will be CO_2 resistant (Attachment 04: Injection Well Construction Plan, 2024).

3. AoR and Corrective Action

Computational modeling has delineated the AoR for the Beargrass Project shown in Figure 1.

The AoR and Corrective Action module (Attachment 02: AoR and Corrective Action Plan, 2024) provides a detailed summary of the modeling parameters used to define the AoR and identify wells that may require corrective action. After a thorough review of all identified wells in the region, it has been determined that there are four wells within the AoR, none of which penetrate the confining zone [40 CFR 146.82(c)(2)]. The Hudson #1 well is 0.2 mi outside of the AoR and does penetrate the confining zone. During AoR re-evaluations, the position of the Hudson #1 well will be assessed and the requirement for corrective action will be addressed according to the results of the re-evaluation.

Further detail on the corrective action(s) is provided in the AoR and Corrective Action document (Attachment 02: AoR and Corrective Action Plan, 2024).

AoR and Corrective Action GSDT Submissions
GSDT Module: AoR and Corrective Action ***Tab(s):*** All applicable tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Tabulation of all wells within AoR that penetrate confining zone ***[40 CFR 146.82(a)(4)]*** ☒ AoR and Corrective Action Plan *[40 CFR 146.82(a)(13) and 146.84(b)]* ☒ Computational modeling details ***[40 CFR 146.84(c)]***

4. Financial Responsibility

The financial assurance estimation for the project was divided into four components:

1) Corrective Action,
2) Injection Well Plugging and Abandonment,
3) Post Injection Site Care and Closure, and
4) the Emergency and Remedial Response Plan (ERRP).

[redacted]

Internal estimates and external vendor quotes were used to assemble the estimates for the first three components. All appropriate quotes that were provided from vendors are provided with the submittal documentation. The cost estimate for the ERRP was developed in tandem with Industrial Economics (IEc). Their full report is provided with the Financial Assurance Plan (Attachment 03: Financial Assurance Plan, 2024).

Financial Responsibility GSDT Submissions
GSDT Module: Financial Responsibility Demonstration ***Tab(s):*** Cost Estimate tab and all applicable financial instrument tabs Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Demonstration of financial responsibility ***[40 CFR 146.82(a)(14) and 146.85]***

5. Injection Well Construction

The injection well (PNM INJ1) proposed in this application will be constructed as a new well will terminate in the Precambrian basement. The Mt. Simon Sandstone, the targeted injection zone for the project, is a thick sandstone which directly overlies the Precambrian basement. The Eau Claire Shale, which overlies the Mt. Simon Sandstone, is approximately 278 feet thick and serves as the primary confining zone for the project.

Vault GSL CCS Holdings LP plans to drill the deep monitoring well (PNM OBS1) into the Precambrian basement. PNM INJ1 will also be drilled into the Precambrian basement in order to identify the depth to the top of the basement. PNM INJ1 will also be used to collect most of the pre-operational testing data for the project.

Vault GSL CCS Holdings LP intends to use materials for the construction (casing, cement, etc.) that are verified by independent third-party sources as suitable for the worst-case corrosive and operational loading expected to occur during the life of the project (AMPP, 2023). This suitability is discussed further in Section 5.5 *Construction Material Suitability.* All work will be performed in accordance with guidance documents, approved work plans, and reporting timelines as required by the EPA. PNM INJ1 will be constructed with multiple casing strings. Each string will be smaller in diameter than the previous string and cemented to surface to provide multiple layers of protection for USDWs.

The wellhead will use appropriately sized components and materials of construction based on the build of the wellbore. The wellhead will vary depending on whether the intermediate casing contingency section is needed or not. Following installation of the long string casing and cement, the casing shoe will be drilled out and the well will be drilled out to the basement to collect characterization data. Once the basement characterization data has been collected, the open hole sections of both wells will be plugged back to the injection zone using CO_2-resistant cement. This will be performed as part of the completion of the well.

This section of the document summarizes the methods and materials to be used for the construction of the injection well. Schematics of the well that illustrate its construction and wellhead are provided in Attachment 04: Injection Well Construction Plan (2024). Please note that these schematics are not meant to portray final products and are subject to change pending availability of materials listed and the completion of well installation.

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

It is not anticipated that an initial stimulation will need to be performed on the well after its completion.

Intermediate stimulations during the life of the project may be required based on well conditions and performance. For instance, near-wellbore salt precipitation may cause a reduction in well performance. The requirements and methods of stimulation will be identified through the evaluation of well performance over time. The necessary notification will be provided to the EPA prior to any field mobilization. Within this notification, detail on the proposed procedure, equipment, and chemicals to be used will be provided.

A list of some of the common remediation techniques that may be deployed in the future has been listed below. Note this list is not exhaustive and additional technologies or treatments may be used.

- Matrix acid stimulation,
- Coil tubing chemical stimulation,
- Coil tubing mechanical stimulation,
- Coil tubing stimulation with a salt water flush,
- Perforations.

All treatments will be performed at pressures under the fracture pressure of the Mt. Simon Sandstone in order to prevent the development of fractures and to ensure that containment is maintained. Calculations to determine safe working pressures during stimulation operations will be determined prior to any work and be strictly enforced while stimulation operations are carried out.

Potential additives to stimulations may include, but are not limited to, dilute concentration hydrochloric (HCl) acid, dilute mud acid (HCl and hydrofluoric acids), citric acid, scale reducer, defoamers, or saline solution (potassium chloride or other non-reactive mineral solution). Prior to the use of any acids, additives, or other stimulation fluid, analysis of the drill cuttings and/or core will be performed to ensure compatibility between any solutions and the Mt. Simon Sandstone.

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

Multiple strings of carbon steel and 25-Chrome (25Cr), specifically 25-Chrome L80 (25Cr80), casing will be installed and cemented in place to protect the USDWs and other strata overlying the injection zone. Fluids will be injected into the Mt. Simon Sandstone using internally coated carbon steel tubing landed in a nickel or chrome-coated packer. The Mt. Simon Sandstone will be accessed for injection through [redacted] within the Lower Mt. Simon Sandstone.

The injection well is designed such that monitoring equipment is located in a manner that makes it easily accessible and retrievable should failure occur. Downhole gauges are currently planned to be landed in a mandrel above the packer. The lines from these gauges will be run back up the casing-tubing annulus through a port in the wellhead. This mandrel and port will be properly rated for the anticipated pressure loading to be experienced downhole and at the wellhead.

Table 13 provides a summary of the open hole sections of the injection well construction Vault GSL CCS Holdings LP may elect to utilize an intermediate hole section and intermediate casing in order to mitigate the potential for lost circulation pending operational results from drilling PNM OBS1.

[redacted]

A high-level procedure is provided below. A detailed procedure will be provided prior to any field activities.

[redacted]

Should a lost circulation zone be encountered while drilling, all attempts will be made to successfully cure the loss circulation. Should those efforts be unsuccessful, a contingency intermediate casing string will be installed. These efforts would take place between steps 6 and 7 above. Further details on the casing and cementing for this string are provided in Section 5.3 *Casing and Cementing*. Schematics for the design are provided in Attachment 04: Injection Well Construction Plan (2024).

Specifications on the tools, equipment, casing, cement, and other things are provided in more detail in the following sections. All materials of construction are designed to API standards and are intentionally chosen to maximize protection from corrosive loading. Each item is suitably rated for the corrosive and pressure loading it will experience.

5.3 Casing and Cementing

5.3.1 Casing

Table 14 and Table 15 display the safety factors and safety factor loads based on the proposed well design. It is noted that a standard 80% derating factor for new pipe is applied prior to any analyses. This implies there is an additional 1.20 safety factor on top of those displayed in Table 14. The safety factor is determined by dividing the pipe rating by the calculated load. Additionally, material and specification derating based on tensile loading has also been considered for the collapse analysis. For purposes of this application, three scenarios were considered for the casing analysis.

The burst analysis scenario considers the impact of the plug bump and preset holding pressure following the full pumping of cement. Note that the preset holding pressure is typically 500 psi over the hydrostatic pressure required to pump the cement or 80% of the burst rating of the pipe, whichever is less.

The collapse analysis scenario considers the impact of having a full column of cement on the annulus side of the casing following the bleed off of pressure utilized to hold the plug in place following the full pumping of cement. Note that this analysis includes the derating of the collapse rating of the pipe when in tension.

The tensile analysis scenario considers the impact of a 100,000-pound overpull on the casing string. Overpull is defined as the pulling weight less the weight of the pipe. Note that this scenario will typically occur prior to any cement being pumped and hydrostatic differences in fluid have not been considered.

The tubing burst analysis consisted of analyzing the burst loading during injection operations at the surface, where the tubing-annulus differential is at its greatest. The point that was utilized for the analysis was the Maximum Allowable Injection Pressure (MAIP) at surface. Details on the determination of this pressure are provided in Section 7.1.1.

The tubing collapse analysis consisted of estimating the collapse loading during a modeled annulus pressure test (APT), which will be run during static (in this case 0 wellhead pressure) conditions at 1,500 psi on the annulus. In this scenario the maximum collapse load will be experienced at the packer.

The tensile analysis on the tubing was performed in a similar manner as the casing, with the exception of the analyzed tensile load being a 75,000-pound overpull.

The resulting safety factor from these analyses are presented in Table 15. In addition to these analyses, operational, cyclic, and temperature loading analyses were performed. These are discussed in greater detail in Section 5.5 *Construction Material Suitability*.

Table 16 displays the setting depths and specifications of the casing to be used for the well. All casing conforms with API specifications. Table 17 shows the design parameters of the casing and tubing to be used for the well.

Details on the cement program are provided in Section 5.3.2 *Cementing*. All cement used will conform with API standards. Corrosion resistant cement will be used from the bottom of the long string casing in the Mt. Simon Sandstone to above the top of the Eau Claire Shale.

Mechanical integrity will be demonstrated as part of the initial completion, and as needed during injection operations as discussed in Attachment 05: Pre-operational Formation Testing Program, (2024) and Attachment 06: Testing and Monitoring, (2024).

All materials for the construction will be suitable for the anticipated loading and are not anticipated to decrease in suitability over time.

Table 14: Casing safety factors for design.

Burst	Collapse	Tensile
1.2	1.2	1.5

[redacted]

[redacted]

[redacted]

5.3.2 Cementing

Table 18 provides a summary of the cement systems that will be used on the casing strings during the injection well construction. This table also provides details on the systems for the contingency intermediate string. All cement systems used will conform with API standards where applicable. Note that the excess cement pumped is subject to change pending field results.

Cement will be pumped with the following excess:

- Surface: 100% open-hole excess
- Intermediate (contingency): 50% open-hole excess
- Long string: 30% open-hole excess

Vault GSL CCS Holdings LP plans to use CO_2-resistant cement for the lower portion of the long string section. One CO_2 resistant option is EverCRETE from SLB. These systems are stable in extreme acidic conditions, highly resistant to the CO_2 stream and formation fluids in the Mt. Simon Sandstone, and of sufficient quality to maintain integrity over the design life of the injection well. Note that if the EverCRETE system is not used, an equivalent alternative will be.

[redacted]

The surface casing cement system will provide the required isolation of the lowermost USDW from the drilling process for the remainder of the well installation and serve as an additional layer of protection to prevent contamination from the CO_2 or formation fluids from the Mt. Simon Sandstone. The lowermost USDW is currently anticipated to be the Pleasant Mills Formation, with the base considered to be the top of the directly underlying Maquoketa Group.

The intermediate casing cement system, if used, will provide isolation from any potential lost circulation zone, and serve as an additional layer of protection to prevent upward migration of CO_2 or injection zone fluids.

The long string cement system will provide the primary isolation for injected CO_2 or injection zone fluids from formations above the injection zone.

The quality of the bond between the cement, casing, and borehole for all hole sections, will be verified by the cased hole logs that will be run after each string of casing is cemented in place (Attachment 05: Pre-operational Testing Program, 2024).

5.4 Tubing and Packer Specifications

The tubing will be internally coated 4-inch L80 pipe designed for CO_2 service. An example of a CO_2 service coating is National Oilwell Varco (NOV) Tuboscope™, TK-15XT, which is used in CO_2 floods for enhanced oil recovery. Material specifications and suitability for use were determined from material provided by NOV (*Tuboscope Coatings Spec Sheet*, 2022).

The injection packer will use CO_2 resistant materials for the CO_2-wet surfaces. An example of this type of packer is the Baker Hughes' Signature F™ Injection packer system. The packer can be used with either a retrievable or permanent configuration and will be made of 25Cr or a nickel alloy to resist corrosion effects of the CO_2 stream (Baker Hughes, 2021).

Tubing and packer setting depths and materials of construction are detailed in Table 19.

[redacted]

5.5 Construction Material Suitability

This section discusses the application of the design ratings to ensure the suitability of the construction materials for this project in addition to the analysis performed in Section 5.3.

Consistent with Section 5.3 *Casing and Cementing*, all tubulars have been derated to 80% of their initial ratings. All comparative evaluations detailed in this section are in reference to these derated values.

The injection packer to be used will have a differential rating of 10,000 psi and a max load rating of 80,000 pound-force.

5.5.1 Temperature

[redacted]

5.5.2 Injection Pressure

[redacted]

[redacted]

5.5.3 Annulus Pressure

[redacted]

5.5.4 Formation Pressure

[redacted]

[redacted]

5.5.5 Tensile Loading

[redacted]

5.5.6 Cyclic Loading

[redacted]

5.5.7 Corrosion Loading

[redacted]

5.5.8 Operational Considerations

Permanent downhole gauges will be used to monitor pressure and temperature at the packer. These gauges will be located in a gauge mandrel above the packer and will transmit data through a wire that is run up the annulus to the surface SCADA system. This mandrel and port will be properly rated for the anticipated pressure loading to be experienced downhole and at the wellhead.

Tubulars have been designed such that logging tools and other equipment that are needed for routine annual monitoring will be able to pass through with no restrictions.

6. Pre-operational Logging and Testing

Details on the Pre-operation Testing Program are provided in the relevant section of this permit application (Attachment 05: Pre-operational Testing Program, 2024).

Pre-Operational Logging and Testing GSDT Submissions
GSDT Module: Pre-Operational Testing ***Tab(s):*** Welcome tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ Proposed pre-operational testing program ***[40 CFR 146.82(a)(8) and 146.87]***

7. Well Operation

This section is meant to provide a brief overview of the well operation conditions. The operational parameters for PNM INJ1 provided in Table 20 will be monitored continuously.

[redacted]

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

Table 21 displays the parameters that will be used during injection operations. Details on the methods of calculations and inputs for these values are provided in Section 7.1.1 *Determination of Maximum Injection Pressure*. Values provided in this table are designed to stay below the critical fracture pressure and manage the pressure loading experienced during operations in order to protect equipment. It is not anticipated that significant deviation from these values will occur during the life of the project.

[redacted]

7.1.1 Determination of Maximum Injection Pressure

[redacted]

[redacted]

The annular pressure operations will be performed as follows:

1. When the well is started up, annulus pressure will be allowed to rise to 500 psi. At this point, the pressure will be bled off until the pressure reaches 100 psi.
2. This process will be repeated until the annulus liquid comes to thermal equilibrium.
3. Pressure will then be monitored as the injection operations continue. Pressure will be allowed to fluctuate freely during steady state injection.
4. Pressure alarm set points will be at:
    a. 1,250 psi for the high alarm
    b. 1,500 psi for the high-high emergency shut down
    c. 0 psi for the low alarm
    d. -5 psi for the low-low emergency shut down.
5. Should a high or low alarm occur, the occurrence will be noted in daily logs.
6. Should a shut-down event occur, the well will be shut-in, and the cause of the shut-down event will be investigated by the operator.

This method of monitoring annulus pressure will allow for detection of the following potential problems:

- A tubing to casing leak,
- A packer leak,
- A casing to formation leak,
- A wellhead leak.

Any time the annulus is blown down and fluid is removed, the volume of fluid removed from the annulus will be measured.

7.1.3 Potential Future Variation in Operational Parameters

Beargrass Project does not anticipate any variations from the current operational parameters outlined in Section 7.1. Should variations occur which would necessitate any changes to those parameters, EPA Region 5 would be consulted prior to making any such changes.

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

The CO_2 injection stream will be sourced from an ethanol production facility located in Wabash County, Indiana and is anticipated to have the fluid composition as shown in Table 22.

Vault GSL CCS Holdings LP will analyze the CO_2 stream during the injection phase of the project to provide data representative of its chemical characteristics and to meet the requirements of 40 CFR 146.90 (a). Details on the testing and monitoring of the CO_2 stream are provided in Attachment 06: Testing and Monitoring (2024). Additional details on technical standards, QA/QC policy, sample collection and storage policies, and analytical methods are provided in Attachment 10: Quality Assurance and Surveillance Plan, (2024).

The CO_2 stream produced from an ethanol production facility will be of high purity based on the nature of the ethanol fermentation process. The CO_2 stream from ethanol fermentation typically exceeds 99 % CO_2 (mole basis), with minor impurities including common atmospheric gases (ex: O_2, N_2) and H_2O. The stream will be dehydrated to a low water content prior to entering the flowline for injection.

Quarterly sampling and analysis of the CO_2 injection stream will be performed to track the composition of the stream.

[redacted]

8. Testing and Monitoring

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

This section is meant to provide a brief overview of the Testing and Monitoring Plan. Further details on this plan are provided in Attachment 06: Testing and Monitoring (2024).

The Beargrass Project uses a risk-based Testing and Monitoring Plan that includes operational, verification, and assurance monitoring components that meet the regulatory requirements of 40 CFR 146.90. This Testing and Monitoring Plan is based on experience gained from other approved Class VI projects, as well as geologic evaluation and computational modeling.

Goals of the monitoring strategy include, but are not limited to:

- Fulfillment of the regulatory requirements of 40 CFR 146.90,
- Protection of USDWs,
- Risk mitigation over the life of the project,
- Confirmation that PNM INJ is operating as planned while maintaining mechanical integrity,
- Acquisition of data to validate and calibrate the models used to predict the distribution of carbon dioxide (CO_2) within the injection zone, and
- Support AoR re-evaluations over the course of the project.

The Testing and Monitoring Plan will be adaptive over time, and is subject to alteration should one of the following potential scenarios occur:

- Project risks evolve over the course of the project outside of those envisioned at the beginning of the project,
- Significant differences between the monitoring data and predicted computational modeling results are identified,
- Key monitoring techniques indicate anomalous results related to well integrity or the loss of containment.

The monitoring activities fall within three categories based on project objectives: operational, verification, and assurance monitoring.

- ***Operational monitoring*** focuses on day-to-day injection operations such as system performance.

- ***Verification monitoring*** confirms that the injected CO_2 remains contained within the selected storage zone. The CO_2 plume and pressure front development are tracked over time to provide data for model calibration. Integration of verification monitoring data into project models allows the project to demonstrate conformance between the computational modeling and the testing and monitoring data collected during the operations and post injection phases of the project's lifecycle.

- ***Assurance monitoring*** is performed at surface and near-surface (i.e., soil, shallow groundwater, USDWs, etc.) to monitor for any changes from baseline sample data that might indicate CO_2 or injection zone fluid migration towards surface.

The three monitoring categories encompass:

- Well operations,
- Containment,
- Non-endangerment of USDWs,
- Capacity,
- Injectivity,
- Injection pressure, and
- Conformance.

Table 23 provides of summary of the general monitoring strategy with subcategories.

[redacted]

9. Injection Well Plugging

During the PISC period, the injection well will be permanently plugged and abandoned (Attachment 08: Post-injection Site Care and Site Closure, 2024). Details on the methods of these operations are provided in Attachment 08: Injection Well Plugging Plan (2024). The methods and procedures presented in the attachment are consistent with industry standards and the requirements detailed in 40 CFR 146.92. All materials to be used for the plugging and abandonment are suitable for the anticipated corrosive loading below the top of the Eau Claire Shale. Above the top of the Eau Claire Shale, the materials are standard construction materials and will conform to the API specifications.

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

10. Post-injection Site Care and Closure

The requested documents listed below have been included in the file submission (Attachment 08: Post-injection Site Care and Site Closure, 2024). These documents address the rule requirements for the EPA citations. The Beargrass Project is not requesting an alternative PISC timeframe.

PISC and Site Closure GSDT Submissions
GSDT Module: Project Plan Submissions ***Tab(s):*** PISC and Site Closure tab Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☒ PISC and Site Closure Plan [40 CFR 146.82(a)(17) and 146.93(a)]
GSDT Module: Alternative PISC Timeframe Demonstration ***Tab(s):*** All tabs (only if an alternative PISC timeframe is requested) Please use the checkbox(es) to verify the following information was submitted to the GSDT: ☐ Alternative PISC timeframe demonstration ***[40 CFR 146.82(a)(18) and 146.93(c)]***

11. Emergency and Remedial Response

The requested documents listed below have been included in the file submission (Attachment 09: Emergency and Remedial Response Plan, 2024). These documents address the rule requirements for the above EPA citations.

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

12. Injection Depth Waiver and Aquifer Exemption Expansion

The Beargrass Project does not intend to apply for a Depth Waiver or Aquifer Exemption. As such, no supplemental documents have been filed.

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

13. Optional Additional Project Information

A review of the National Wild and Scenic River System database indicates that no designated wild and scenic rivers exist in Indiana. The Beargrass Project, located in northern Wabash County, Indiana, will not impact any designated wild and scenic rivers (National Information Services Center and National Park Service, 2023; National Wild and Scenic Rivers System.).

A review of Nationwide Rivers Inventory (NRI) river segments was undertaken because NRI river segments are potential candidates for inclusion in the National Wild and Scenic River System. No NRI rivers are present in Wabash County so the Beargrass Project will not have an impact to NRI rivers (National Park Service).

Indiana's Scenic River System has designated three streams for inclusion in the Natural, Scenic and Recreational River System. None of the Indiana Scenic River System streams occur within Wabash County, so no impacts to Scenic River System streams will occur (Indiana DNR, State Parks, 2022).

There are no National Register Historic Districts or National Register Historic Sites within the Beargrass Project AoR. The nearest historic district and historic sites are located over two miles north of the AoR (National Park Service).

Indiana Historic Sites and Structures Inventory (IHSSI) County Survey Program identifies five historic structures within the Beargrass Project AoR. However, the structures are not listed on the Indiana Register of Historic Sites and Structures and are over 0.4 miles from the proposed project wells. The project will not impact these historic structures. The Cemetery Registry indicates a historic cemetery located within the AoR, over a mile from the project wells. It is not expected that the cemetery will be impacted by the project (Indiana DNR, Historic Preservation & Archaeology, 2021).

The Beargrass Project well sites will be located on private land previously disturbed by agriculture. A desktop review indicates no known archaeological sites or previously conducted surveys within the AoR (Atwell, 2024).

On July 12, 2024, a US Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) system review identified threatened or endangered, candidate, or proposed species that may be affected by the Beargrass Project (Table 24).

Table 24: Threatened, endangered, candidate, or proposed species that may be affected by the Beargrass Project (USFWS, 2024).

Name	Federal Status	Critical Habitat
Indiana Bat	Endangered	Proposed location does not overlap critical habitat.
Northern Long-eared Bat	Endangered	No critical habitat designated.
Whooping Crane	Experimental non-essential	No critical habitat designated.
Rabbitsfoot	Threatened	Proposed location does not overlap critical habitat.
Salamander Mussel	Proposed Endangered	Proposed location does not overlap critical habitat.
Monarch Butterfly	Candidate	No critical habitat designated.

The IPaC information page for the Northern Long-eared Bat indicates the species only needs to be considered for projects that include wind turbine operations. The AoR does not overlap critical habitat for identified species so potential effects to habitat are not expected to be analyzed (USFWS, 2024).

The Bald Eagle, identified as not a Bird of Conservation Concern Vulnerable (Non-BCC Vulnerable), is likely present in the AoR. The Bald Eagle is protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Migratory birds identified as Birds of Conservation Concern (BCC) that may be present in the AoR include the Chimney Swift, Lesser

Yellowlegs, Prothonotary Warbler, Red-headed Woodpecker, and the Wood Thrush (USFWS, 2024).

Within the Beargrass Project AoR there is potential to encounter threatened or endangered flora or fauna for Wabash County. The Indiana County Endangered, Threatened, and Rare Species List for Wabash County includes the flora and fauna listed in Table 25. State special concern, state significant, and state rare species also exist within Wabash County but are not included in this discussion (IDNR, 2024). Habitat assessments may be needed to identify potentially suitable habitat for state-listed species within the AoR.

The Beargrass Project is located inland Indiana, far from coastal zones, therefore project activities will not affect any coastal zones.

Table 25: Wabash County, Indiana listed threatened and endangered species (IDNR, 2024)

Species Name	Common Name	State Status
Mollusk: Bivalvia (Mussels)		
Cyprogenia stegaria	fanshell	State endangered (SE)
Epioblasma rangiana	northern riffleshell	SE
Epioblasma triquetra	snuffbox	SE
Obovaria subrotunda	round hickorynut	SE
Pleurobema clava	clubshell	SE
Theliderma cylindrica	rabbitsfoot	SE
Villosa fabalis	rayed bean	SE
Insect: Lepidoptera (Butterflies & Moths)		
Calephelis muticum	swamp metalmark	State threatened (ST)
Euphyes bimacula	Two-spotted Skipper	ST
Poanes viator	Big Broad-winged Skipper	ST
Speyeria idalia	Regal Fritillary	SE
Fish		
Clinostomus elongatus	Redside Dace	SE
Moxostoma valenciennesi	Greater Redhorse	SE
Reptile		
Emydoidea blandingii	Blanding's turtle	SE
Sistrurus catenatus	eastern massasauga	SE
Bird		
Chlidonias niger	Black Tern	SE
Circus hudsonius	Northern Harrier	SE
Lanius ludovicianus	loggerhead shrike	SE
Setophaga cerulea	Cerulean Warbler	SE
Tyto alba	Barn Owl	SE
Mammal		
Myotis sodalis	Indiana myotis	SE
Vascular Plant		
Anticlea elegans var. glaucus	white camas	ST
Carex flava	yellow sedge	ST
Carex lupuliformis	false hop sedge	ST
Carex viridistellata	green star sedge	SE
Cypripedium candidum	small white lady's-slipper	ST
Cypripedium parviflorum var. makasin	small yellow lady's-slipper	ST
Cypripedium reginae	showy lady's-slipper	ST
Erysimum capitatum	prairie-rocket wallflower	SE
Geum fragarioides	barren strawberry	ST
Larix laricina	tamarack	ST
Lathyrus venosus	smooth veiny pea	SE
Minuartia michauxii var. michauxii	Michaux's stitchwort	ST
Platanthera psycodes	small purple-fringe orchid	ST
Schizachne purpurascens	purple oat	SE

14. References

AMPP, 2023, Guideline for Materials Selection and Corrosion Control for CO2 Transport and Injection, AMPP Guide 21532–2023.

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Attachment 02: AoR and Corrective Action Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 03: Financial Assurance Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 04: Injection Well Construction Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 05: Pre-operational Testing Program, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 06: Testing and Monitoring, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 07: Injection Well Plugging Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 08: Post-injection Site Care and Site Closure, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 09: Emergency and Remedial Response Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

Attachment 10: Quality Assurance and Surveillance Plan, 2024, Underground Injection Control Class VI Permit Application: Beargrass Project.

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15. PBI Appendix A – List of Landowners Within the AoR

Parcel ID	Owner	Address	City	Zip
85-07-18-400-011.000-001	Arnett Kernie & Rhoda	331 E 950 N	North Manchester	46962
85-07-29-100-001.000-001	Beauchamp Homestead Properties LLC	1385 E 800 N	North Manchester	46962
85-07-30-200-003.000-001	Beauchamp Homestead Properties LLC	800 N	North Manchester	46962
85-07-20-100-002.000-001	Beery Leland H & Angilee M	E 850 N	North Manchester	46962
85-07-20-100-013.000-001	Beery Leland H & Angilee M	900 N	North Manchester	46962
85-07-19-100-001.000-001	Behny Ronald Gene & Lynne Carol	N State Road 13	North Manchester	46962
85-06-24-200-004.000-012	Behny Ronald Gene Trust	8902 N State Road 13	North Manchester	46962
85-06-24-200-005.000-012	Behny Ronald Gene Trust	8700 N St Rd 13	North Manchester	46962
85-07-18-300-028.000-001	Bennett William & Beccylyn	331 E 950 N Lot 249	North Manchester	46962
85-06-25-400-009.000-010	Biehl Eldon E & Martha J L / E 1 / 2 & Biehl Larry	72 W 700 N	North Manchester	46962
85-06-25-400-006.000-010	Biehl Family Farm LLC	348 W 700n	North Manchester	46962
85-07-29-200-006.000-001	Brubaker Alan L & Monica	1863 E 800 N	North Manchester	46962
85-07-29-200-007.000-001	Brubaker Alan L & Monica	800 N	North Manchester	46962
85-07-29-200-002.000-001	Brubaker Alan L & Monica A	800 N	North Manchester	46962
85-07-29-200-009.000-001	Brubaker Boyd & Brad Brubaker T/C	800 N	North Manchester	46962
85-07-19-200-013.000-001	Creekside Farms Inc	850 N	North Manchester	46962
85-07-30-300-004.000-001	Custer Kenneth E & Barbara R Rev Liv Trust 1/2 Ea	7257 N State Road 13	North Manchester	46962
85-07-30-400-007.000-001	Custer Kenneth Eugene	7257 N State Road 13	North Manchester	46962
85-06-25-100-001.000-010	Dale Farms Inc	800 W	North Manchester	46962
85-06-24-400-017.000-012	Dale Farms Inc	376 W 800 N	North Manchester	46962
85-06-25-400-010.000-010	Dale-Niccum Land Partnership	N State Road 13	North Manchester	46962
85-07-20-200-018.000-001	Dingess Oscar D & Kathy M	1633 E 900 N	North Manchester	46962
85-07-17-400-010.000-001	Dodson Devin & Amanda	1568 E 900 N	North Manchester	46962
85-06-24-400-010.000-012	Eakright Kevin L & Courtney L	8370 N State Road 13	North Manchester	46962
85-06-13-400-013.000-012	Egner Isaac J	22 W 900 N	North Manchester	46962
85-07-19-300-008.000-001	Flora Shane M	8479 N State Road 13	North Manchester	46962

Parcel ID	Owner	Address	City	Zip
85-07-28-100-009.000-001	Graves Tim & Shelley	7863 N 200 E	North Manchester	46962
85-07-20-300-016.000-001	Greer William Allen & Susan B	1329 E 850 N	North Manchester	46962
85-07-20-300-007.000-001	Grossman Rex E & Sheila M	E 850 N	North Manchester	46962
85-07-20-300-008.000-001	Grossman Rex E & Sheila M	E 850 N	North Manchester	46962
85-07-20-300-017.000-001	Grossman Steven Michael & Kassi Jo	E 850 N	North Manchester	46962
85-06-24-200-018.000-012	Harp Development LLC	8652 N State Rd 13	North Manchester	46962
85-07-19-300-019.000-001	Haupert Daniel D & Roxanne	N State Road 13	North Manchester	46962
85-07-19-300-009.000-001	Haupert Daniel D & Roxanne	State Road 13	North Manchester	46962
85-07-20-100-012.000-001	Haupert Farms Inc	E 850 N	North Manchester	46962
85-07-18-400-012.000-001	Haupert Farms Inc	E 900 N	North Manchester	46962
85-07-19-200-003.000-001	Haupert Farms Inc	900 N	North Manchester	46962
85-06-25-200-003.000-010	Haupert Farms Inc	N State Road 13	North Manchester	46962
85-07-30-100-001.000-001	Haupert Farms Inc.	State Road 13	North Manchester	46962
85-06-24-400-008.000-012	Haupert Livestock Enterprises	N State Road 13	North Manchester	46962
85-07-19-300-018.000-001	Haupert Livestock Enterprises Inc	N State Road 13	North Manchester	46962
85-06-24-200-019.000-012	Haupert Livestock Enterprises Inc	N State Road 13	North Manchester	46962
85-07-32-100-015.000-001	Haupert Steven E	150 E	North Manchester	46962
85-07-19-300-020.000-001	Haupert Steven E & Kathy J	N State Road 13	North Manchester	46962
85-07-19-400-016.000-001	Heartland Rural Electric Membership Corporation	E 850 N	North Manchester	46962
85-07-30-100-008.000-001	High View Farm	800 N	North Manchester	46962
85-07-19-300-016.000-001	Indiana State Of	N State Road 13	North Manchester	46962
85-07-19-300-017.000-001	Indiana State Of	N State Road 13	North Manchester	46962
85-07-30-400-008.000-001	Indiana State Of	State Road 13	North Manchester	46962
85-06-25-400-012.000-010	Indiana State Of	N State Road 13	North Manchester	46962
85-06-25-400-011.000-010	Indiana State Of	W 700 N	North Manchester	46962
85-06-24-400-019.000-012	Indiana State Of	N State Road 13	North Manchester	46962

Parcel ID	Owner	Address	City	Zip
85-06-24-400-020.000-012	Indiana State Of	N State Road 13	North Manchester	46962
85-06-24-400-021.000-012	Indiana State Of	N State Road 13	North Manchester	46962
85-07-20-400-010.000-001	Isbell Ronald L & Carolyn A	8158 N 180 E	North Manchester	46962
85-07-17-300-032.000-001	Leffel Joshua T & Melissa S	1412 E 900 N	North Manchester	46962
85-07-19-400-011.000-001	Lewis Seth L & Laura D	8448 N 100 E	North Manchester	46962
85-07-20-400-009.000-001	Lewis Sharon	8461 N 180 E	North Manchester	46962
85-07-17-300-009.000-001	Lyons Family LP	E 900 N	North Manchester	46962
85-07-18-400-015.000-001	Lyons Family LP	E 900 N	North Manchester	46962
85-07-17-300-022.000-001	Lyons Family LP	E 950 N	North Manchester	46962
85-07-30-200-006.000-001	Manchester Veal LLC	437 E 800 N	North Manchester	46962
85-07-30-100-002.000-001	Manchester Veal LLC	State Road 13	North Manchester	46962
85-07-19-200-007.000-001	Marshall Allen Kent & Teresa	260 E 850 N	North Manchester	46962
85-07-19-300-021.000-001	Marshall Allen Kent & Teresa	N State Road 13	North Manchester	46962
85-06-24-400-011.000-012	Mc Nall Timmy C & Loretta D	8222 N State Road 13	North Manchester	46962
85-07-18-400-013.000-001	Meeks Cody L & Rileigh	331 E 900 N	North Manchester	46962
85-06-25-200-005.000-010	Nesler Joel C & Jennifer Ann	7806 N State Road 13	North Manchester	46962
85-06-25-200-006.000-010	Niccum Ryan	N State Road 13	North Manchester	46962
85-06-25-400-013.000-010	Niccum Ryan	N State Road 13	North Manchester	46962
85-06-25-400-007.000-010	Niccum Ryan & Stephanie L	7504 N State Road 13	North Manchester	46962
85-07-30-100-005.000-001	North Central Cooperative Inc	31 E 800 N	North Manchester	46962
85-07-20-100-015.000-001	North Manchester Ethanol LLC	1118 E 850 N	North Manchester	46962
85-07-19-200-005.000-001	North Manchester Ethanol LLC	544 E 850 N	North Manchester	46962
85-07-19-200-004.000-001	North Manchester Ethanol LLC	720 E 850 N	North Manchester	46962
85-07-21-300-009.000-001	Oldfather Family Revocable Trust	E 180 N	North Manchester	46962
85-07-20-400-011.000-001	Oldfather Family Revocable Trust	E 800 N	North Manchester	46962
85-07-21-300-010.000-001	Oldfather Family Revocable Trust	E 800 N	North Manchester	46962

Parcel ID	Owner	Address	City	Zip
85-07-20-400-017.000-001	Oldfather Family Revocable Trust	N 180 E	North Manchester	46962
85-07-20-200-005.000-001	Perry Jeffrey L & Virginia	8829 N 180 E	North Manchester	46962
85-07-32-100-001.000-001	Personett & Sons Land Co Inc	E 700 N	North Manchester	46962
85-07-31-200-003.000-001	Personett & Sons Land Co Inc	700 N	North Manchester	46962
85-07-19-400-015.000-001	Poet Biorefining-North Manchester LLC	868 E 800 N	North Manchester	46962
85-07-19-200-002.000-001	Randall David A & Sally	601 E 900 N	North Manchester	46962
85-07-20-200-006.000-001	Reahard Alice	8653 N 180 E	North Manchester	46962
85-07-21-100-002.000-001	Reahard Alice	N 180 E	North Manchester	46962
85-07-20-200-003.000-001	Reed Credit Trust 1/2 Int Anderson Shirley A Trust	E 850 N	North Manchester	46962
85-07-20-200-004.000-001	Reed Michael J & J Edward T/C 1/2 & Anderson S Tru	E 900 N	North Manchester	46962
85-07-21-100-001.000-001	Reed Michael J & J Edward T/C 1/2 & Anderson S Tru	E 900 N	North Manchester	46962
85-07-17-400-016.000-001	Runkel Billy D & Jeanne L Trustees Family Trust	E 900 N	North Manchester	46962
85-07-17-400-018.000-001	Runkel Billy D & Jeanne L Trustees Family Trust	N 180 E	North Manchester	46962
85-07-29-400-004.000-001	Runkel Farms	1586 E 700 N	North Manchester	46962
85-07-29-300-003.000-001	Runkel Farms	E 700 N	North Manchester	46962
85-07-17-300-031.000-001	Runkel Farms	1152 E 900 N	North Manchester	46962
85-07-29-400-005.000-001	Runkel Farms	700 N	North Manchester	46962
85-07-32-200-016.000-001	Runkel Farms	700 N	North Manchester	46962
85-07-20-200-020.000-001	Runkel Farms Partnership In Partnership Gary L & S	180 E	North Manchester	46962
85-07-31-200-010.000-001	Runkel Richard	700 N	North Manchester	46962
85-07-31-200-002.000-001	Runkel Richard L & Carolyn	721 E 700 N Lot 1	North Manchester	46962
85-07-32-100-009.000-001	Sarll Benjamin J & Cecilia K	1123 E 700 N	North Manchester	46962
85-06-24-400-009.000-012	Schmalzried Eugene E	200 W 800 N	North Manchester	46962
85-07-20-200-019.000-001	Shepherd Jake & Virgie M	1579 E 900 N	North Manchester	46962
85-06-13-400-023.000-012	Singleton Tyler & Shailea	9124 N State Rd 13	North Manchester	46962
85-07-29-200-008.000-001	Southline LLC	7496 N 200 E	North Manchester	46962

Parcel ID	Owner	Address	City	Zip
85-06-24-200-006.000-012	Speicher Bobbi & Melanie Macgregor T/C	State Road 13	North Manchester	46962
85-07-17-400-017.000-001	Stephan Wayne A & Diana	1852 E 900 N	North Manchester	46962
85-07-28-300-003.000-001	Vawter Ruth E L / Est Then: Angia & Jamie Vawter 1	200 E	North Manchester	46962
85-07-29-300-004.000-001	Vawter Zachary R	1128 E 700 N	North Manchester	46962
85-07-19-300-014.000-001	Vetor Larry & Marilyn	8181 N State Road 13	North Manchester	46962
85-07-30-100-009.000-001	Wabash County Commissioners	800 N	North Manchester	46962
85-07-19-300-015.000-001	Wabash County Commissioners	N State Road 13	North Manchester	46962
85-06-25-200-004.000-010	Wabash County Commissioners	800 N	North Manchester	46962
85-06-24-400-018.000-012	Wabash County Commissioners	W 800 N	North Manchester	46962
85-07-19-200-012.000-001	Warren Susan D	695 E 900 N	North Manchester	46962
85-07-28-100-001.000-001	Whitacre Family Farm LLC	200 E	North Manchester	46962
85-06-13-400-012.000-012	Winger Billy J	900 N	North Manchester	46962
85-07-18-300-010.000-001	Winger Billy Joe	N State Road 13	North Manchester	46962
85-07-31-100-001.000-001	Wolf Kelly L & Kaye Ellen Lauer Wolf	N State Road 13	North Manchester	46962

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