

**Wabash CarbonSAFE  
Subtask 7.1 – Pre-drilling Site Assessment  
Topical Report**

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WABASH CARBONSAFE

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## **EXECUTIVE SUMMARY**

The Wabash CarbonSAFE project will drill a stratigraphic test well at the Wabash Valley Resources facility near Terre Haute, Indiana. Lithologic, geomechanical, and geophysical data collected from samples testing and an extensive geophysical logging suite will be used to determine the feasibility for the geologic sequestration of 50 million metric tons or more of injected carbon dioxide. The primary target reservoir and caprock to be investigated for the Wabash CarbonSAFE project are the Mt. Simon Sandstone and Eau Claire Shale, respectively.

The project team has assessed the planned Wabash #1 drilling site using subsurface geologic data and analyses from both Illinois and Indiana. These data were used to generate geologic structure and isopach thickness maps for target reservoir and caprock layers which were incorporated into a detailed discussion of the nature of the Illinois Basin's Cambro-Ordovician carbon dioxide storage complex at the drilling site. Formation tops were prognosed for 19 lithologic units to aid drilling and coring procedures. Additional GIS analysis indicates that no known structural features will negatively impact the target storage reservoir or caprock, nor will protected and sensitive areas, groundwater resources, or existing resource development be negatively affected by Wabash #1 drilling activities.

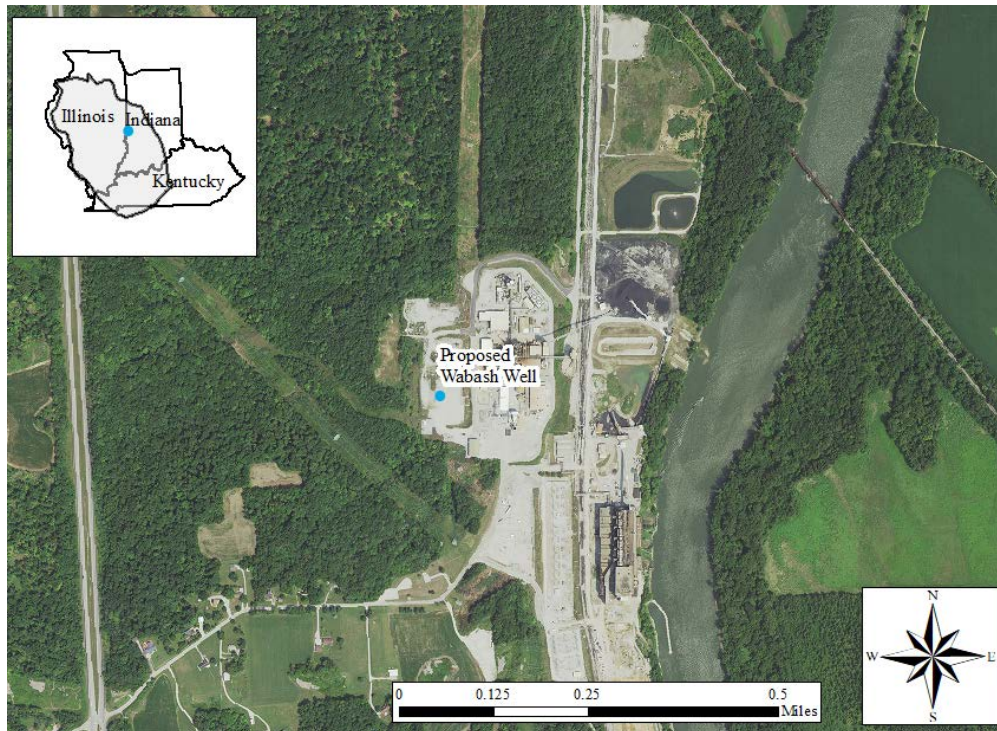
The Wabash #1 Geologic/Structure Test well drilling permit was awarded by Indiana Department of Natural Resources (IN-DNR) – Division of Oil and Gas on November 12<sup>th</sup>, 2019, and the well is expected to be drilled to a total depth of approximately 8,350 feet. Potential impacts on drilling progress include abandoned underground coal mines which mined the Springfield and Survant coals until 1964 and 1954, respectively, and a lost circulation zone in the Potosi Dolomite, which has been demonstrated to have intermittent cavernous porosity from karstification.

This document also details the coring and sampling program, proposed logging suite, and well testing program, all of which will be dynamically reviewed as drilling progresses.

## I. INTRODUCTION and SITE LOCATION

The Wabash CarbonSAFE project intends to drill a stratigraphic test well at the Wabash Valley Resources (WVR) facility near Terre Haute, Indiana, to determine the feasibility for the geologic sequestration of 50 million metric tons or more of injected CO<sub>2</sub>. This report includes project and site location description, geologic setting, storage complex assessment, well siting and protection of resources, drilling concerns and preliminary formation top prognosis, and planned logging and sampling programs, to characterize the regional and local context for the proposed Wabash #1 stratigraphic test well.

The proposed drill site is located at on the southwestern periphery of the Wabash Valley Resources anhydrous ammonia plant in Vigo County, Indiana, northwest of the city of Terre Haute (Figure 1). The facility is adjacent, to the north, to the Wabash River Generating Station, a coal-fired station that has been retired since 2016 and is currently being dismantled. The project area is in a rural setting, bounded on the east by the Wabash River, and the remainder bounded by wooded acreage with dispersed agricultural fields. The stratigraphic test well location is an existing lot in the southwest corner of the property, which will serve as the well pad for drilling and completion activities. The pre-drilling well location has been surveyed, and is located in T13N R9W, approximately 1,156 feet from the North line, and 387 feet from the East line, NE quarter, Section 32. Longitude and latitude coordinates in the NAD83 datum are: 87.427426, 39.531626. The Wabash #1 geologic/structure test well drilling permit was awarded by Indiana Department of Natural Resources (IN-DNR) on November 12<sup>th</sup>, 2019.



*Figure 1. Site of proposed Wabash #1 stratigraphic test well with inset map showing the site's location in the Illinois Basin.*

## II. GEOLOGIC SETTING

### Structural Features

The Mt. Simon Sandstone and Eau Claire Shale are the primary target reservoir and caprock to investigate with data collected from the Wabash #1 well. There are no known structural features (Figure 2) that would negatively impact the proposed storage reservoir(s). The La Salle Anticlinorium is approximately twenty miles west of the WVR site. Deep-seated faults in the Precambrian basement are observed on seismic profiles farther south in Lawrence and Crawford counties in Illinois, though none have been observed within a twenty-five-mile radius of the Wabash site (Nelson 1995). The nearest major regional fault is the Mt. Carmel Fault in south-central Indiana, which extends into the southern edge of Morgan County, IN, about fifty miles from the Wabash site. There is low risk of seismic activity impacting well integrity, the injection formation, or the seal at the proposed site (USGS 2018); in 1909 seismicity with a moment magnitude over 3.0 was recorded in Vigo County, IN (Gray and Steinmetz 2012).

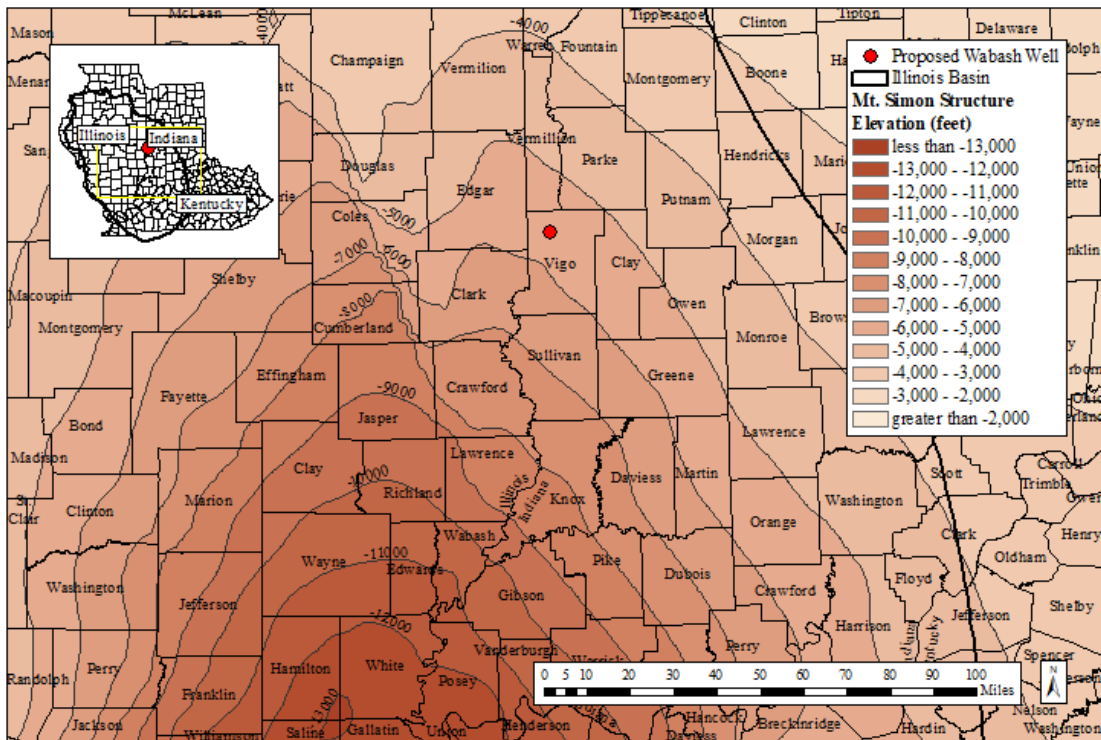


Figure 2. Structural map of the top of the Mt. Simon Sandstone formation.

### III. STORAGE COMPLEX ASSESSMENT

The Cambro-Ordovician storage complex (Figure 3) consists of multiple potential target reservoirs (Mt. Simon Sandstone, St. Peter Sandstone, Potosi Dolomite) overlain by multiple confining layer seals (Eau Claire Shale, Maquoketa Shale, New Albany Shale). This section describes key characteristics of those potential reservoirs and seals.

SYSTEM	GROUP	FORMATION	Storage Elements	
Ordovician	Maquoketa	Brainard	Secondary Seal	
		Ft. Atkinson		
		Scales		
	Galena	Kimmswick		
		Decorah		
	Plateville			
	Ansell	Joachim	Potential target	
		St. Peter		
	Cambrian	Knox	Shakoppee	Secondary Seal/Reservoir
			New Richmond	
			Oneota	
Gunter				
Eminence			Potential target	
Potosi				
Franconia				
Ironton-Galesville				
Eau Claire			Primary Seal	
Potsdam			Mt. Simon	Target reservoir
Precambrian				

St. Peter-Knox Storage Complex

Mt. Simon Storage Complex

**Cambro-Ordovician Storage Complex**

*Figure 3. Stratigraphic relationships of the primary reservoirs and seals in the Cambro-Ordovician storage complex in the Illinois Basin.*

## Reservoirs

### *St. Peter Sandstone*

The St. Peter Sandstone consists of fine to medium, well-sorted, well-rounded, frosted grains of weakly cemented or friable quartz sand. The St. Peter is generally pure quartz sand, extensively mined for silica sand where it occurs near surface and is a major Illinois aquifer. It is porous and permeable across most of Illinois and offers high reservoir potential for sequestration of CO<sub>2</sub> in the Illinois Basin, where it has been used for natural gas storage (Udegbunam et al., 1993). While the St. Peter's reservoir characteristics make it suitable as an alternative storage target, it is expected to be only around thirty feet thick at the Wabash site (Leetaru 2014).

### *Knox Group / Potosi Dolomite*

The Knox Dolomite Megagroup comprises the Cambrian, Lower Ordovician, and lowermost Middle Ordovician rocks of the Illinois Basin which overly the Mt. Simon Sandstone (Buschbach, 1975). In Vigo County, IN, the Knox Dolomite Megagroup is expected to be between 2,500 and 3,000 feet thick. The Knox Group is an attractive target for CO<sub>2</sub> sequestration as these strata are laterally extensive and contain beds of porous and permeable dolomites and sandstones with overlying tight shale and carbonate beds. Because of the previously described high porosity and permeability throughout members of the Knox Megagroup, most notably in the Potosi Dolomite, this group may be suitable as a potential secondary reservoir target.

### *Mt. Simon Sandstone*

The Mt. Simon Sandstone (Figure 4) has suitable properties for large-scale carbon storage: it is buried with pressures and temperatures maintaining CO<sub>2</sub> as supercritical, contains saline formation fluids, has a storage capacity of 12 to 172 GT in the Illinois Basin (US DOE, 2015), is overlain by numerous laterally extensive sealing formations, and has suitable petrophysical characteristics for injection. The Lower Mt. Simon is considered the best potential reservoir for carbon storage, with the highest quality reservoir found within an arkosic zone.

Lower Mt Simon well logs and regional trends indicate average porosity and permeability are 16.3% and 11.1 mD (Mehnert et al., 2014). The Hinton #7 well, located in the Manlove Natural Gas Storage Field, Champaign County, Illinois, has 215 feet of potential reservoir in the arkose zone with porosity and permeability values up to 25% and 600 mD. Lateral continuity of the high-quality reservoir in the Lower Mt. Simon is uncertain because of limited well control, but most wells within the southern half of the Mt. Simon depocenter that penetrate the Lower Mt. Simon show the occurrence of a porous zone.

The Middle and Upper Mt. Simon generally demonstrate poorer reservoir properties than the Lower Mt. Simon. The Middle Mt. Simon is the tightest section of the Mt. Simon, with porosity below 10% and permeabilities below 10 mD. The Upper Mt. Simon has somewhat better reservoir properties with 10% porosity and permeabilities up to 220 mD. In certain thin tidal flat channel sands in the Upper Mt. Simon it is utilized for natural gas storage (Morse and Leetaru, 2005).

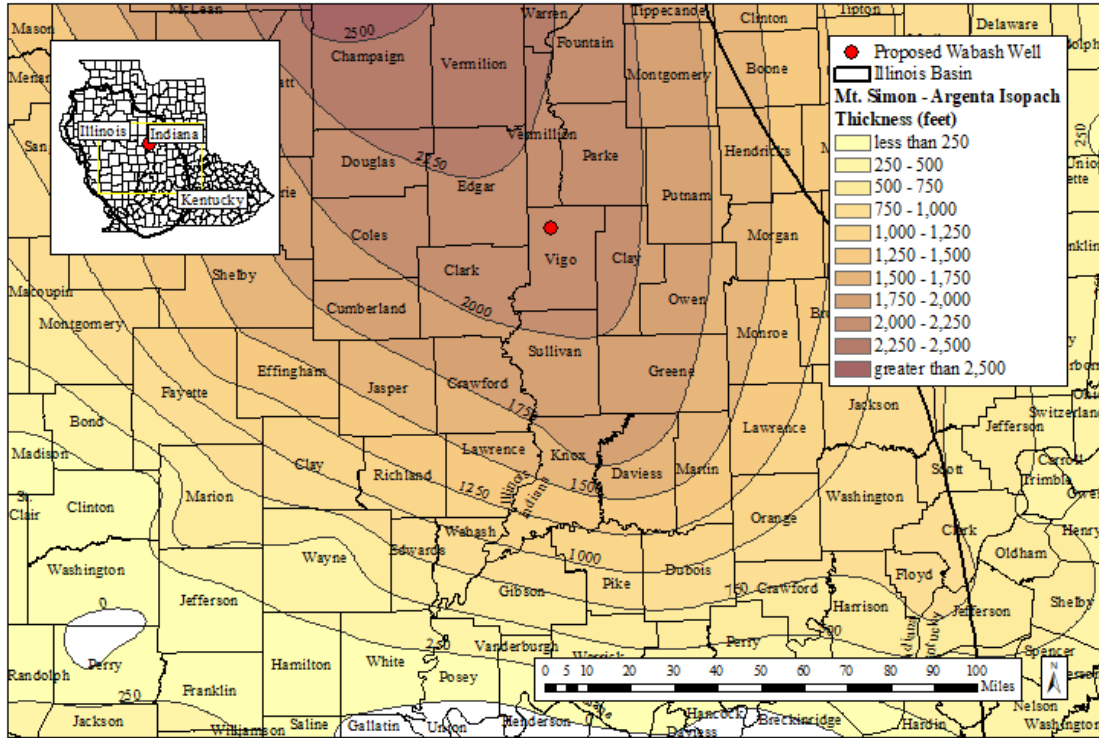


Figure 4. Regional thickness of combined Mt. Simon Sandstone and Argenta formations.

## Caprock Seals

### *New Albany Shale*

The Devonian-Mississippian New Albany Shale is another thick, impermeable, and laterally continuous shale formation which acts as a potential tertiary seal in Illinois Basin storage complex. The top of the New Albany Shale is anticipated to be 1,684 feet deep (measured depth, MD) and the formation is estimated to be about 100 feet thick at the Wabash drill site.

### *Maquoketa Shale*

The Ordovician Maquoketa Shale (Figure 5) is a laterally continuous impermeable confining layer which functions as a secondary seal in the Cambro-Ordovician storage complex in the Illinois Basin. Topical report DOE-FE0029445-11 evaluates the regional seal capacity of the Maquoketa, using a lithofacies model to define three main units (upper, middle, and lower) and quantify five distinct lithologies. The upper unit of the Maquoketa is dominated by dolomitic and calcitic shale and silty shale, the middle unit is dominated by limestone and muddy limestone, and the lower unit is dominated by dolomitic and calcitic shale, and occasionally contains minor amounts of muddy limestone and silty shale. The top of the Maquoketa is expected to be 2,500 feet deep and the formation is estimated to be 317 feet thick at the Wabash drill site.

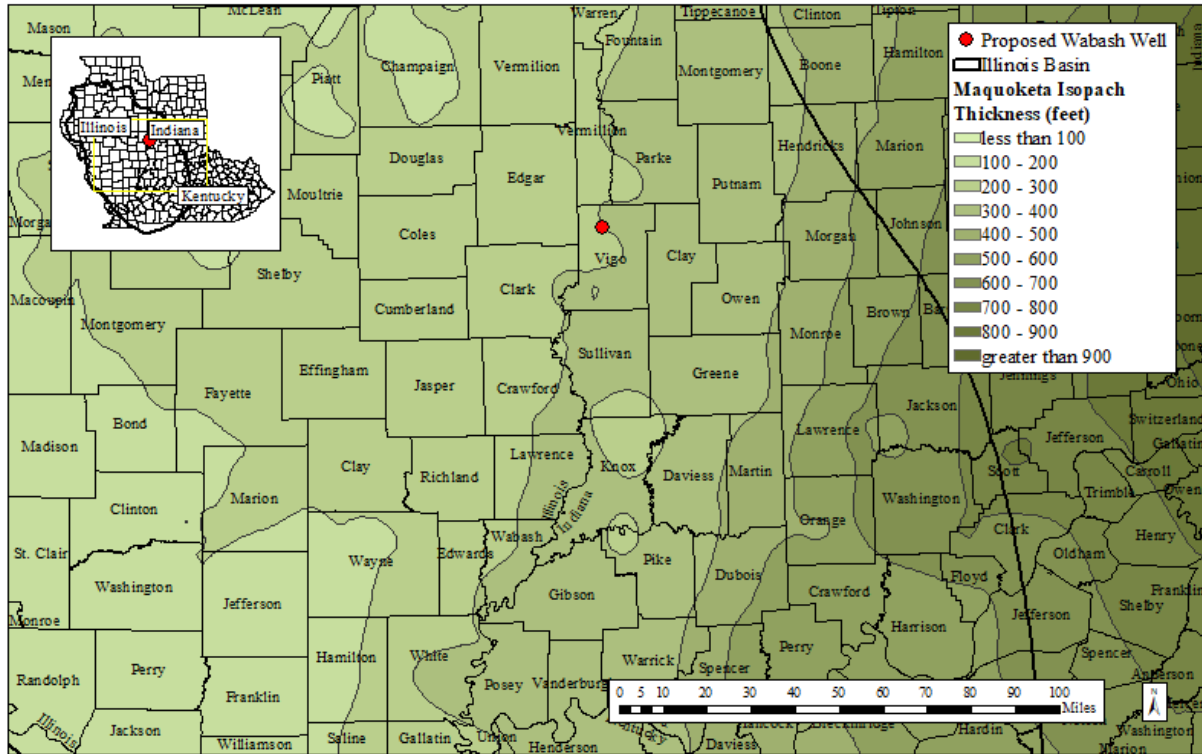


Figure 5. Regional thickness of Maquoketa shale formation.

### Eau Claire Shale

The Eau Claire Shale is a thick and continuous impermeable layer overlying the Mt. Simon Sandstone throughout the Illinois Basin (Figure 6). The Eau Claire is estimated to be 6,100 feet deep (MD) and around 900 feet thick at the WVR facility's Wabash #1 site. The Eau Claire consists of dolomite, dolomitic sandstone, siltstone, and shale, with regional variations in dominant lithology across the Basin. In east-central Illinois and west-central Indiana, the lowermost Eau Claire facies, directly overlies the Mt. Simon and is dominated by shale and tight siltstone.

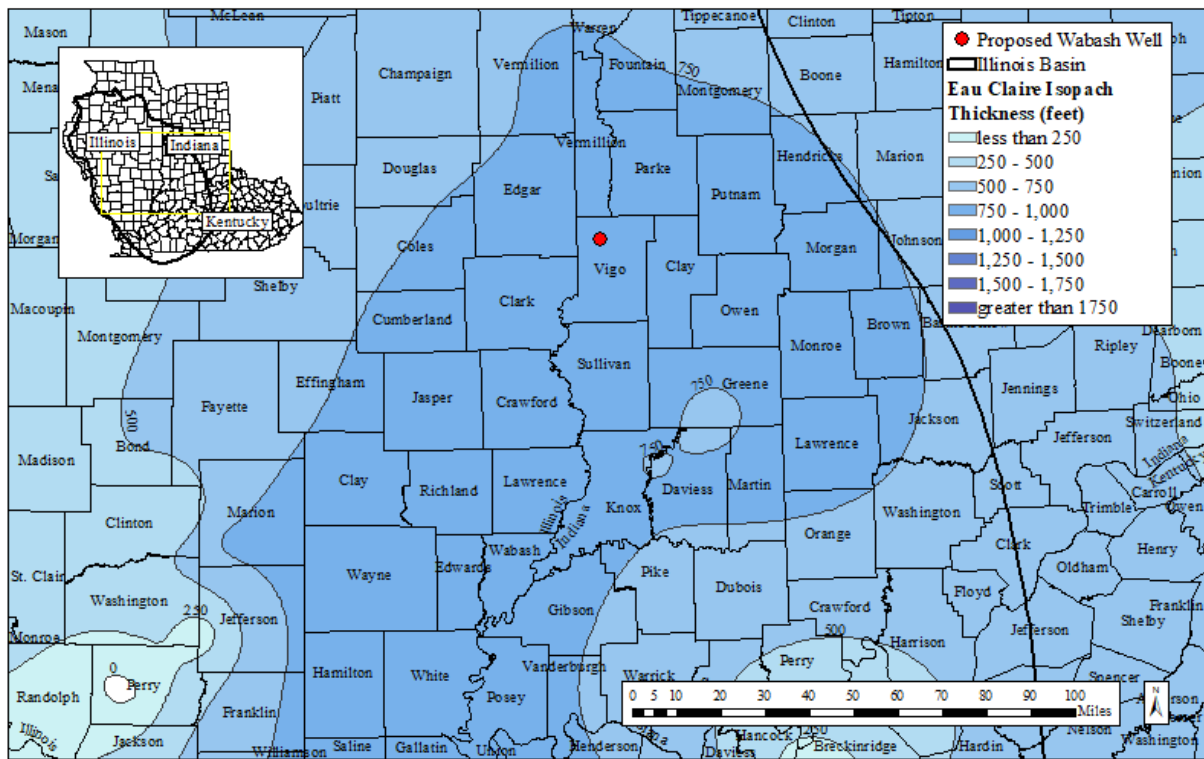


Figure 6. Regional thickness of the Eau Claire Shale.

## **IV. WELL SITING AND PROTECTION OF RESOURCES**

### **Protected and Sensitive Areas**

The Wabash #1 wellsite is located on an open industrial lot at the WVR plant. The site is approximately 0.3 miles west of the Wabash River floodplain. The Wabash site has been evaluated through the Indiana Natural Heritage Data Center and there are no endangered, threatened, or rare species, high quality natural communities, or natural areas documented within 0.5 mile of the project location. As required under Section 7 of the Endangered Species Act of 1973, further consultation with the U.S. Fish and Wildlife Service showed that the Indiana bat (endangered) and Northern long-eared bat (threatened) are listed for Vigo County, but that our proposed well drilling in a developed (industrial) area would have “no effect” on these federally listed species.

### **Groundwater**

Unconsolidated/surficial deposits above bedrock at the site are estimated to be up to approximately 50 feet thick. Indiana DNR Aquifer Systems Maps denote the Pennsylvanian Carbondale Group as the predominant bedrock aquifer system in the area, consisting primarily of shale and sandstone and including thin beds of limestone, clay, and coal, and ranging in thickness from 0 to 470 feet. thick and consists mostly of shale and sandstone, including thin beds of limestone, clay, and coal. (IndianaMap, Indiana DNR). In the absence of nearby underground sources of drinking water (USDW) data, the IN-DNR has recommended a protection of potential USDWs from surface down to sea level elevation plus an additional fifty feet; this equates to 587 feet MD from the surveyed ground surface elevation. During drilling, these zones will be protected behind surface and intermediate casing, and per IN-DNR requirements, a top cement plug from surface to 587 feet MD will be installed during well completion and abandonment.

The nearest residential well is approximately 0.3 miles to the southwest. The nearest Significant Groundwater Withdraw Wells are 1.5 miles to the southeast, at the Landing at Fort Harrison (Terre Haute). Data are per Indiana DNR Water Well Viewer and the U.S. EPA. The wellsite is not located in a wellhead or drinking water protection area, or above a sole source aquifer.

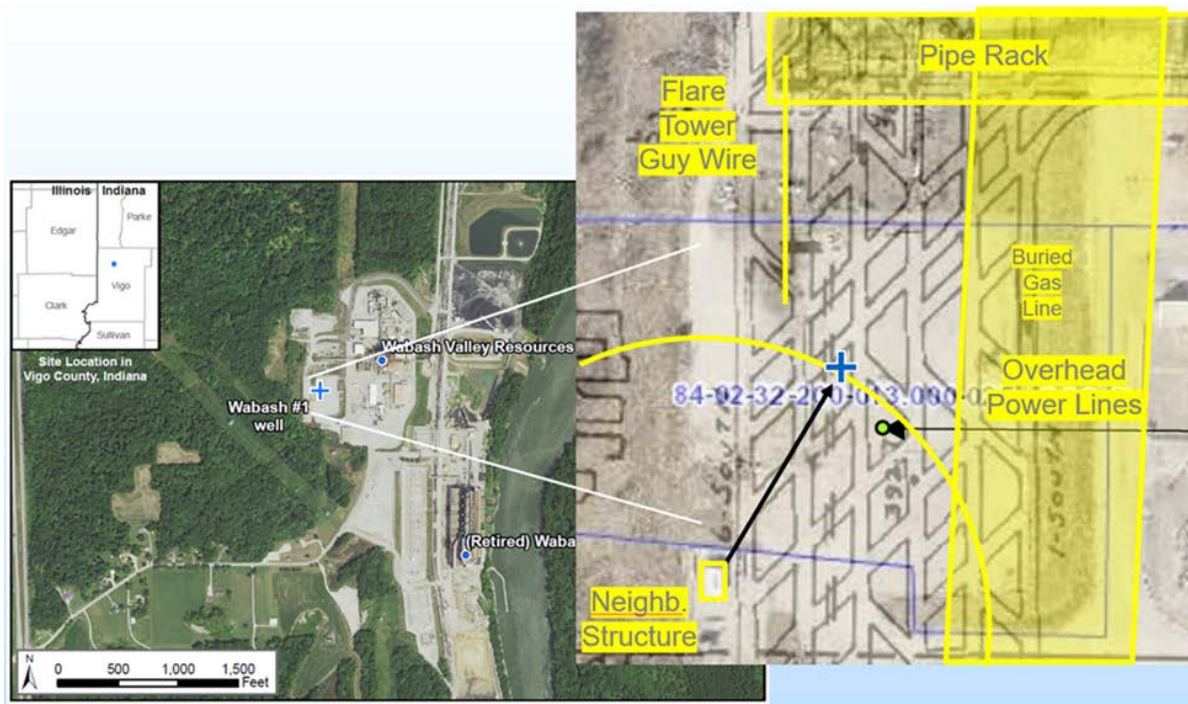
### **Existing Resource Development**

The Springfield and Survant Coals were underground-mined in the immediate vicinity of the wellsite until 1964 and 1954, respectively (Viking and Saxton Mines), and slope or shaft entrances (now sealed) were located near the Wabash plant site. Although the mines have been abandoned, per IN-DNR requirements, a notice of intent to drill the Wabash #1 test well was given to the owners of the coal beneath the WVR site in order to assure that that no mineable coal interests would be affected by the Wabash #1 test well.

Small clusters of currently or formerly producing oil and gas wells exist (New Goshen gas field, Sandford gas field, and Terre Haute oil field), respectively ranging from approximately 3 to 4.5 miles away from the drilling site. Of these fields, only Sandford Gas Field is currently active, producing from Pennsylvanian coal seams up to 628 feet deep. Wells in the New Goshen and Terre Haute fields are plugged. Although other scattered dry holes or structure tests were drilled in the general area, none are deep enough to have penetrated our primary target reservoir and seal. All coal and oil and gas activities have occurred well above the secondary seal (Maquoketa) and thousands of feet above the proposed storage complex.

### **Well Siting**

In addition to the presence of abandoned coal mines (discussed further in Drilling Prognosis section of this report), site access and well drilling/logistics decisions considered the well location’s proximity to surface features such as neighboring properties or structures, high-voltage power lines, and on-site industrial equipment or WVR plant infrastructure (Figure 7). Per IN-DNR – Division of Oil and Gas geologic/structure test well permitting regulations, the well is required to be located 200 feet or greater from a neighboring gas-handling building off the southwest corner of the open lot at the WVR site. An underground survey was also conducted of the drilling location, and the results indicated no underground obstructions at the well location. A buried natural gas service line to WVR runs along the eastern-most edge of the industrial lot, beneath and parallel to the overhead power lines.



**Figure 7.** Aerial and zoomed-in view of the WVR plant site showing the well location on the south lot (blue '+'), and the proximity of industrial site infrastructure and selected surface and subsurface features that affected the location selection.

### Deep Well Penetrations

The deepest well near to the Wabash site which penetrates the Upper Mt. Simon is the Newport Chemical Plant #WD-1 (Table 1), located approximately 22 miles north. It has fair reservoir quality and was used as a disposal well that accepted millions of gallons of wastewater. This well penetrated the top 900 feet of the Mt. Simon, so the Lower Mt. Simon remains unexplored in the local Wabash area. All deep wells (that penetrate the Maquoketa or Knox formations above the Mt. Simon) within ten miles of the site are listed in Appendix A.

*Table 1. Nearest wells to the proposed site which penetrate selected formations*

<b>API</b>	<b>Well Name</b>	<b>Latitude (DD)</b>	<b>Longitude (DD)</b>	<b>Distance (miles)</b>	<b>Total Depth (ft)</b>	<b>State</b>	<b>County</b>	<b>Penetration</b>
124289	Lovelace	39.559684	-87.387565	3	3160	IN	Vigo	St. Peter
124283	Biglow & Millikin	39.527835	-87.311665	6	3490	IN	Vigo	Knox
157501	Summers	39.616094	-87.048861	22	4668	IN	Parke	Eau Claire
125110	Newport	39.85023	-87.422848	21	6164	IN	Vermillion	Mt. Simon
117407	Pensinger	39.2612274	-87.0925092	26	6,751	IN	Clay	Mt. Simon
120192399601	Hinton	40.263803	-88.412651	72	6,550	IL	Champaign	Argenta
164778	Duke	38.7997551	-87.2531572	51	10,050	IN	Knox	Precambrian

## **V. DRILLING PROGNOSIS**

The Wabash #1 well is expected to be drilled from surface to a depth of ~8,350 feet (Appendix B). A generalized stratigraphic column is shown in Figure 8, while the measured depths and subsea elevations of prognosed formation tops expected to be encountered in the Wabash #1 well are listed in Table 2, as based on regional structural correlation and/or nearest well data. Figure 9 illustrates a regional structural cross section from available deep well data, showing the deep stratigraphic trends below the St. Peter Sandstone. A discussion of potential lost circulation zones that may be encountered during drilling is presented before a summary of the primary target reservoir and caprock.

**Table 2.** Formation tops for proposed drilling site, prognosed from structural correlation and nearby well data. Measured depth (MD) and subsea elevation (SS) are in feet. (See also the Lost Circulation Zone section of the report, below).

Wabash Proposed Well – Prognosed Formation Tops		
Formation	Measured Depth (feet)	Subsea elevation (feet)
Ground Level	0	537
Springfield Coal (mined in immediate area)	150	387
Survant Coal (mined in immediate area)	265	272
Miss.-Penn. Unconformity	787	-250
Paint Creek (not present)	-	-
Aux Vases Sandstone (not present?)	-	-
St Louis Limestone	800	-263
Chouteau/Rockford Limestone	1,678	-1,141
New Albany Shale	1,684	-1,147
Maquoketa Shale	2,500	-1,963
Trenton Limestone	2,817	-2,280
St. Peter Sandstone	3,332	-2,795
Shakopee Dolomite (Knox)	3,457	-2,920
Oneota Dolomite	3,969	-3,432
Eminence Dolomite	4,199	-3,662
Potosi Dolomite	4,559	-4,022
Franconia Dolomite	4,878	-4,341
Ironton-Galesville	5,087	-4,550
Eau Claire	5,187	-4,650
Mount Simon Sandstone	6,092	-5,555
Precambrian	8,242	-7,705

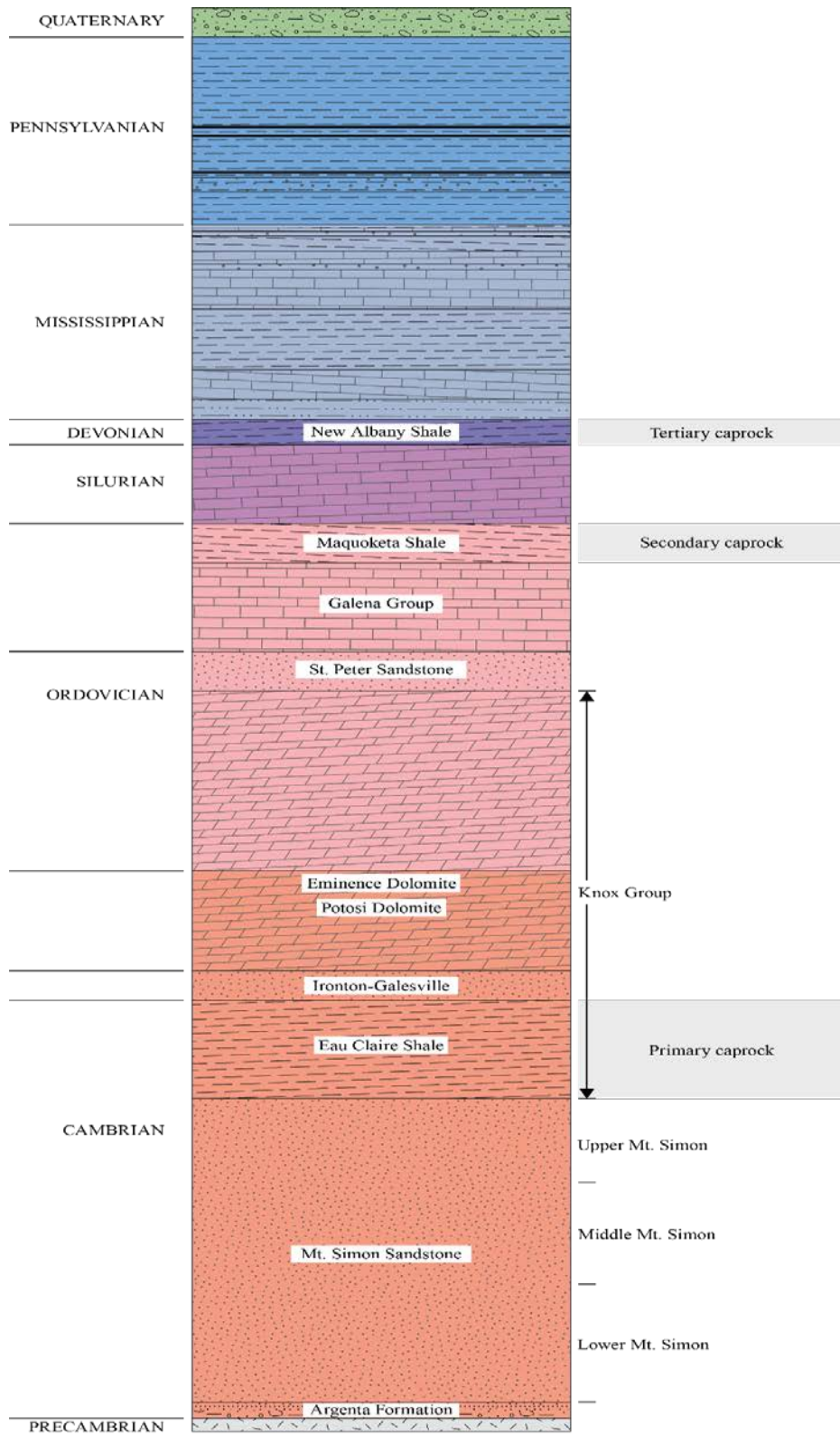


Figure 8. Generalized regional stratigraphic column

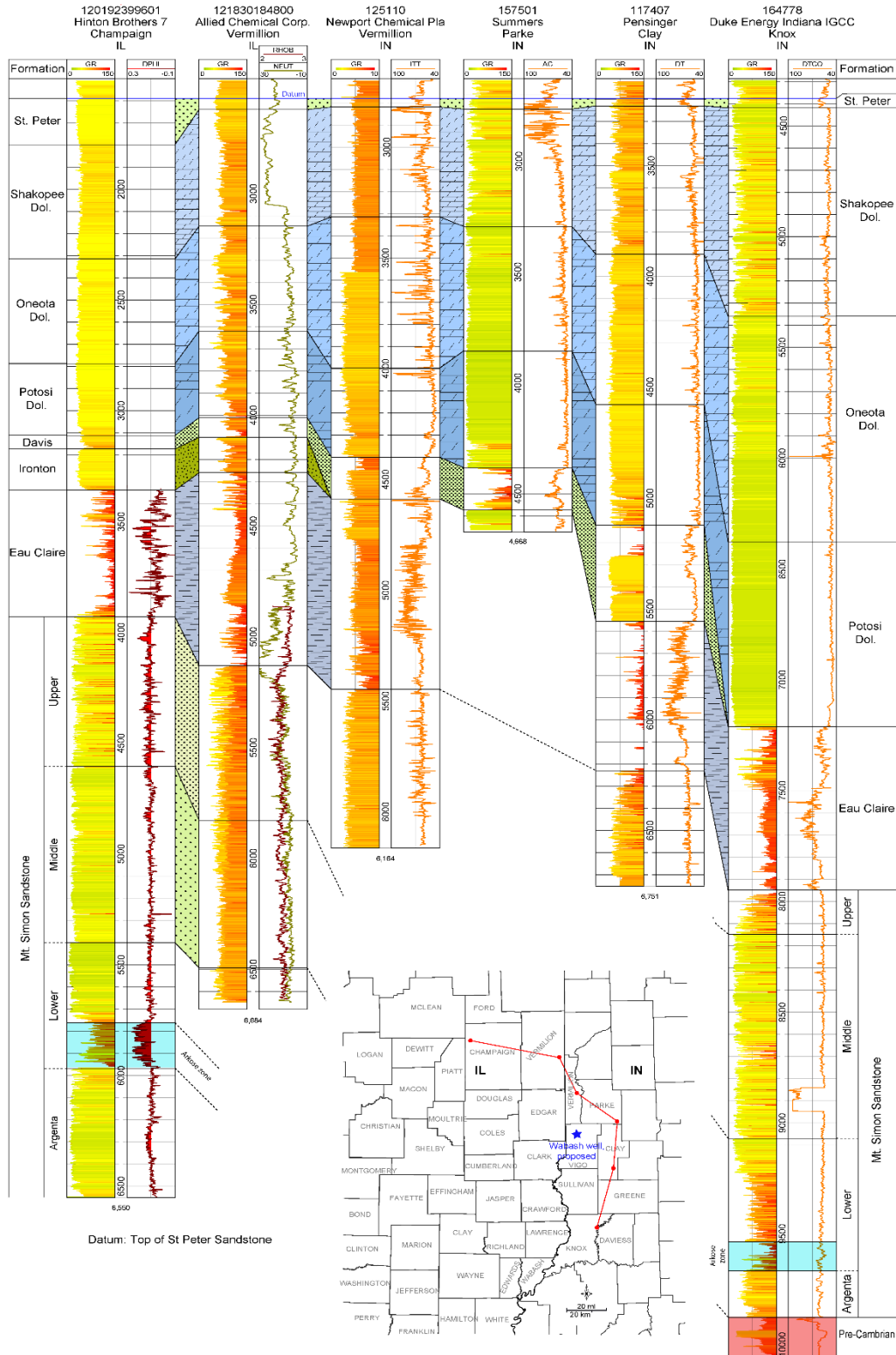


Figure 9. Structural cross section using deep wells near the Wabash #1 drill site; datum: Top of St. Peter Sandstone.

## **Abandoned Underground Coal Mines**

The Springfield and Survant Coals were underground-mined in the immediate vicinity of the proposed wellsite until 1964 and 1954, respectively (Viking and Saxton Mines), and slope or shaft entrances (now sealed) were located near the Wabash plant site. From the best available mine maps, only the Springfield Coal was mined directly beneath the open surface lot where the well is located. The well location is expected to be on a pillar of in-place coal within the Springfield mine (Figure 7). However, only drilling will verify the accuracy of the in-mine surveying and mapping, and/or later georeferencing of the mine map images. The Wabash #1 drillers will be prepared to encounter an approximately 5-foot thick mine void, and potential loss of drilling mud, in the case of an inaccurate coal map. Nearby in-mine elevation measurements (assumed tops) of the Springfield and Survant Coals are 387 and 272 feet above sea level, respectively, which equate to approximate measured depths from the ground surface of 150 and 265 feet (Table 2).

## **Lost Circulation Zone**

A zone of lost circulation is expected to be encountered in the Potosi Dolomite, a formation with the larger Knox Megagroup. The Potosi is characterized by up to 7 feet thick vuggy intervals, brecciated zones, and cavernous porosity that suggest a paleokarst environment (Freiburg and Leetaru, 2012), and may be a viable storage target as reservoir modeling in zones of cavernous porosity suggests that it could contain approximately 90 million tonnes of CO<sub>2</sub> from a single injection well (Will et al., 2014). Deep wells drilled throughout the Illinois Basin have demonstrated the Potosi's lost circulation zone and excellent reservoir properties:

- The cavernous porosity of the Potosi was encountered during drilling of both the Illinois Basin – Decatur Project (IBDP) and Illinois Industrial Carbon Capture and Storage (IL-ICCS) project wells in Macon County, IL: the considerable volume of lost drilling fluid forced well engineers to plug the zone with cement and drill through the plug.
- A deep waste disposal well (API 125110) was drilled at Newport Chemical Plant in Vermillion County, IN, in 1960, 900 feet into the Mt. Simon. The lost circulation in the Knox and Potosi was predicted and encountered during drilling from 2,800 feet to 4,000 feet. The zone was not considered for waste storage. Unlike at the Macon County IBDP and IL-ICCS wells, after several such zones were encountered, lost circulation was satisfactorily controlled by the addition of circulation materials directly to the drilling mud, albeit at added cost (Hundley 1963).
- A chemical waste disposal project at Tuscola, Douglas County, IL, has injected over 50 million tonnes of CO<sub>2</sub> equivalent of liquid chemical waste into the Potosi through the Cabot-Tuscola #2 well (Leetaru, 2014a).

## **Primary Target Reservoir and Caprock**

The primary characterization target for this project is the Mt. Simon Sandstone (Figure 2), estimated to be from approximately 6,092 to 8,242 feet deep (Table 2, Figure 4); we intend to drill completely through the Mt. Simon and into the underlying Precambrian basement rocks in order to fully evaluate the reservoir quality of the Mt. Simon and to understand the controls of the basement on this quality. The Eau Claire Shale directly overlies the Mt Simon and is the thickest primary sealing unit for the reservoir with an estimated depth of approximately 5,187 to 6,092 feet. Based on previous drilling experiences in the Illinois Basin, a significant zone of lost circulation is expected to be encountered in the Potosi Dolomite, of the Knox Megagroup, between 4,559 and 4,878 feet in depth (Table 2), with potential minor lost

circulation encountered throughout the Knox Megagroup dolomites. A detailed discussion of the regional geological setting of the drilling site location is provided in the Geologic Setting section.

## VI. DATA COLLECTION

The Wabash #1 geologic/structure test well will allow the Wabash CarbonSAFE team to evaluate reservoir potential for long-term storage of CO<sub>2</sub> focusing mainly on the Cambrian Mt. Simon Sandstone and its primary and secondary sealing units. In addition, we will investigate hydrocarbon potential throughout the stratigraphic column and drill into the Precambrian basement for general scientific knowledge about the deep Illinois Basin. Extensive data collection and testing will be performed using the well. Details of these investigations are provided below.

### Coring and Sampling Program

Core will be taken from the Maquoketa Group (secondary seal, 60 ft.), the Eau Claire Formation (primary seal, +/-60 ft.) contact with the Upper Mt Simon Sandstone (potential reservoir, +/-60 ft.), and the Lower Mt Simon Sandstone (potential reservoir target, 240 ft.) In case of unsuccessful core recovery, well cuttings will be available as contingency. The coring and sampling program is summarized in Table 3, and detailed as follows:

1. One section of 3-1/2" whole core will be collected from the following interval using a 7-7/8" PDC core head and 5-3/4" barrel:

- 60 ft. unsleeved from the Maquoketa Shale ± 2,550 - 2,610 ft. depth.

Two sections of 4-1/2" whole core will be collected from the following intervals using an 8-3/4" PDC core head and 6-3/4" core barrel:

- 120 ft. sleeved from the Eau Claire – Upper Mt. Simon contact ± 6,070 - 6,190 ft.
- 240 ft. sleeved from the Lower Mt. Simon Sandstone ± 8,010 - 8,250 ft.

2. Rotary sidewall core (RSCW) and cutting samples will be collected from the Eau Claire to the Precambrian basement as detailed in Table 3.

*Table 3. Proposed depths and amounts of whole core and rotary sidewall core.*

Formation Name	Whole Core intervals in ft., and diameter (in.)	Whole Core sleeving	Number of RSWC (1 inch)	Cuttings interval, ft.
1000'				10'
New Albany				10'
Silurian				5'
Maquoketa	60 (3½")	Unsleeved		5'
Trenton				10'
St. Peter				5'
Knox				10'
Eau Claire	~60 (4¼")	Sleeved	10	5'
Upper Mt. Simon	~60 (4¼")	Sleeved	10	5'
Middle Mt. Simon			10	5'
Lower Mt. Simon	240 (4¼")	Sleeved	20	5'
Argenta			10	5'
Basement			10	5'

**Proposed Logging Suite**

An extensive suite of geophysical logs will be collected from the well bore (Appendix B) immediately after drilling to evaluate CO<sub>2</sub> storage potential, hydrocarbon potential, and general lithological and petrophysical characteristics of the sedimentary column (Table 4).

*Table 4. Proposed logging suite for the Wabash CarbonSAFE stratigraphic test well at the WVR facility*

**Intermediate Open Hole Logging Run: Surface Casing to TD**

<u>Logging Run</u>	<u>Logging Tools</u>	<u>Interval</u>
<b>Triple Combo</b>	GR, Caliper, SP, Resistivity, Density, Neutron	Correlation, Porosity, Saturations, Hole Size
<b>Dipole Sonic</b>	Sonic compressional and shear	Porosity, Mechanical Properties,
<b>Formation Images</b>	Formation Micro-Imager borehole images	Structure, Env. Deposition, Fractures
<b>Elemental Spectroscopy</b>	Elemental Capture Spectroscopy	Lithology, Evaluation of Secondary Reservoirs and Containment
<b>Natural Gamma Ray Spectroscopy</b>	Spectral GR	Clay Minerals
<b>Magnetic Resonance</b>	Magnetic Resonance	Porosity, free and bound fluids, Permeability
<b>Dielectric Scanner</b>	Dielectric Tool	EOR Evaluation

**Intermediate Cased Hole Logging Run**

<u>Logging Run</u>	<u>Logging tools</u>	<u>Interval</u>
<b>CBL/VDL, GR, CCL</b>	Cement Bond Log, Gamma Ray, Casing Collar Locator	TD to Surface

**Production Open Hole Logging Run: Intermediate Casing to TD**

<u>Logging Run</u>	<u>Logging tools</u>	<u>Interval</u>
<b>Triple Combo</b>	GR, Caliper, SP, Resistivity, Density, Neutron	Correlation, Porosity, Saturations, Hole Size, Resistive Anisotropy
<b>Dipole Sonic</b>	Sonic compressional and shear	Porosity, Mechanical Properties,

<b>Formation Images</b>	Formation Micro-Imager borehole images	Structure, Env. Deposition, Fractures
<b>Magnetic Resonance</b>	Magnetic Resonance	Porosity, free and bound fluids, Permeability
<b>Elemental Spectroscopy</b>	Elemental Capture Spectroscopy	Lithology
<b>Natural Gamma Ray Spectroscopy</b>	Spectral GR	Clay Minerals
<b>Sidewall Cores</b>	Sidewall Coring Tool	Porosity, Permeability
<b>Temperature</b>	Temperature Log	Geothermal Gradient
<b>VSP</b>	Vertical Seismic Profile	Tie in to 2D regional profile

### **Well Testing Program**

Following drilling the project team will analyze the drilling, coring and logging results to identify specific zones for well testing. If the Mt Simon Sandstone, or other formations, do not indicate sufficient reservoir quality for CO<sub>2</sub> storage, testing may not be conducted.

It is anticipated that testing will take place within one year of completion of drilling. The pre-drilling well testing plan is as follows:

- **Reservoir Limit Test – Mt Simon Sandstone.** This test includes pumping from one or more intervals within the Mt Simon Sandstone to establish broad reservoir characteristics and determine whether vertical and horizontal limits can be detected.
- **Step rate tests –** Step rate tests involve injection of water into the formation to determine parting pressures of strata and establish fracture gradients needed for guidelines for injection pressures during CO<sub>2</sub> storage and for geomechanical measurements. The tests will be performed in the Eau Claire, Mt Simon, and Precambrian formations.
- **Vertical Interference Testing.** The team will evaluate the potential for conducting vertical interference testing during the step rate tests in the Mt Simon and Eau Claire formations. The performance and success of these tests depends on the vertical spacing of the intervals being tested, intervening lithologies, and wellbore integrity.

## **Contributions**

This report was prepared with contributions from Zohreh Askari, Damon Garner, Charles Monson, Daniel Byers, Hannes Leetaru, James Damico, and Steve Whittaker, at the Illinois State Geological Survey; Kevin Ellett and Cristian Medina at the Indiana Geological and Water Survey; Nick Malkewicz at Projeo Corp.; Donald Vereide and Bill Armstrong at Geostock Sandia.

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## VIII. APPENDICES

### *Appendix A*

*Locations and well information for wells within ten miles of the proposed stratigraphic test well drill site which penetrate the Maquoketa or Knox formations.*

<b>API</b>	<b>Lat. (DD)</b>	<b>Long. (DD)</b>	<b>TD (ft)</b>	<b>TD Formation (ft)</b>	<b>LAS Availability</b>
166909	39.47124	-87.4017	3561	Knox	
124283	39.52784	-87.3117	3490	Knox	
124289	39.55968	-87.3876	3160	St. Peter	
157261	39.56867	-87.268	3000	St. Peter	
124214	39.46217	-87.4183	2980	Trenton	
124049	39.40416	-87.3893	2933	Trenton	Y
166365	39.46422	-87.2916	2760	Trenton	
124985	39.63516	-87.398	2577	Black River	Y
124981	39.64009	-87.4525	2566	Trenton	
124943	39.65123	-87.3288	2466	Trenton	
123994	39.40683	-87.3986	1950	Muscatatuck	Y
124039	39.40427	-87.387	1803	Muscatatuck	Y

