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**To:** Austin Nieman – Ameren Missouri **Project Number:** 23007-24DR

**CC:** Craig Giessman – Ameren Missouri  
Susan Knowles – Ameren Missouri

**From:** Mark Haddock, P.E., R.G., Jeff Ingram, R.G. **Email:** Jeff.Ingram@rocksmithgeo.com

**RE:** **Information supporting Private Wells West of the Meramec River are isolated from the Meramec Energy Center**

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## 1.0 INTRODUCTION

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On January 26, 2024, Ameren Missouri (Ameren) received a letter entitled “Ameren Missouri CCR Units Information Request” from Region 7 of the United States Environmental Protection Agency (USEPA). In this letter, the USEPA is seeking information on Ameren’s Coal Combustion Residual (CCR) management. Attached to the letter is a “List of Requested Information”, and this Technical Memorandum provides a response to section 3.e of the USEPA’s request, which states the following:

*“On page 7 of the CMA, Ameren concludes that public or private wells located on the opposite side of the Meramec River are isolated from the MEC. Provide any evidence and/or analysis to substantiate that claim.”*

## 2.0 INFORMATION PROVIDED IN CORRECTIVE MEASURES ASSESSMENT (CMA)

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A brief narrative on sitewide geology and hydrogeology was provided in the Corrective Measures Assessment (CMA) prepared by Haley and Aldrich (2019). The narrative explains that the MEC site lies on two distinctly different geological terrains: (1) the floodplain deposits of the Mississippi and Meramec River valleys and (2) older sedimentary bedrock formations. Specifically, the paragraph that discusses groundwater flow related to the Meramec River states the following:

*“Groundwater flow direction and gradient were estimated for downgradient CCR units monitoring wells using the USEPA’s On-line Tool for Site Assessment Calculation for Hydraulic Gradient (Magnitude and Direction) (USEPA, 2016). Results from this assessment indicate that while groundwater flow direction is variable, the overall net groundwater flow is from the bluffs towards the rivers. There are no users of Groundwater in the alluvial aquifer at MEC. All private and public wells recorded within a one-mile radius of the facility are upgradient of the facility or located on the opposite side of the Meramec River and are therefore isolated from the MEC. Horizontal gradients determined by CCR Rule compliance wells (not including background or MW-1) range from 0.0002 to 0.0005 ft/ft with an estimated net annual groundwater velocity of approximately 16 ft per year.”*

To date, no groundwater monitoring wells or groundwater modeling has been completed for the area across the Meramec River (west side) from the MEC.

### 3.0 GROUNDWATER FLOW

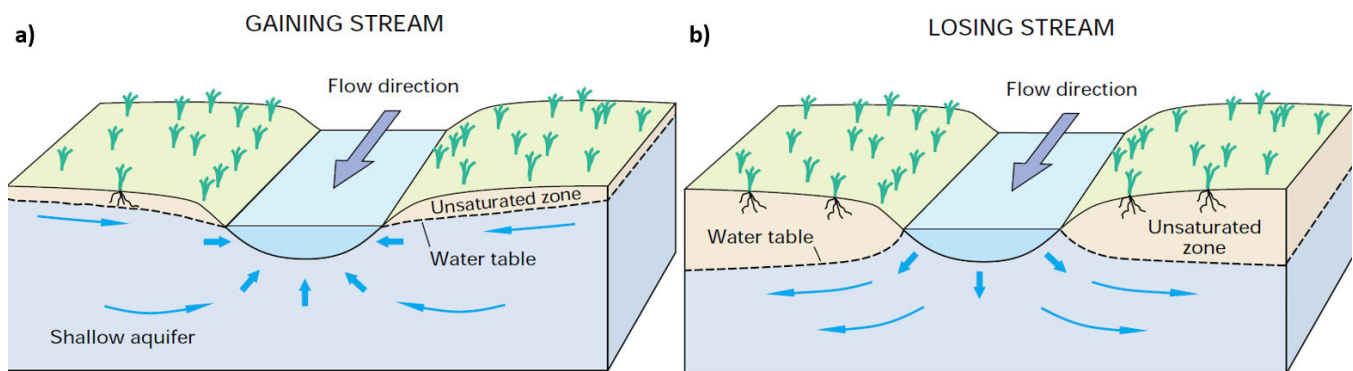
A primary principle of hydrogeology is the concept that groundwater flows from higher elevations and pressures to lower elevations and pressures. Together, the sum of water surface elevation and water pressure divided by the density of water is known as hydraulic head (Winter et al., 1998). Groundwater flows from high hydraulic head to low hydraulic head, and the change in head over the distance between two locations is known as hydraulic gradient, which drives groundwater flow rate and direction. Interaction between groundwater and surface water features is critical to groundwater movement, as explained below.

#### 3.1 Groundwater Flow at the MEC

The alluvial aquifer system underlying the MEC is an unconfined aquifer, in which groundwater elevation is the main component of hydraulic head and pressure is minimal in comparison. Groundwater flow within the alluvial aquifer is dynamic and is influenced by seasonal changes in the water level in the adjacent Mississippi and Meramec Rivers. A relatively flat alluvial plain is located between the rivers at the southern end of the MEC, while bedrock highs are located between the rivers at the north, upstream end of the MEC. A study conducted by the Missouri Department of Conservation (MDC) on the Meramec River watershed notes that, regionally, twenty-five percent of rainfall within the watershed drains as streamflow (MDC, 1998). Due to the location of the MEC at the confluence of the Mississippi and Meramec Rivers, nearby Meramec River water levels are sensitive to regional precipitation upgradient in the Meramec watershed. The study also notes that upland sandstone and carbonate bedrock deposits supply the Meramec River with groundwater baseflow that may emerge as localized springs. Under normal aquifer conditions at the MEC, groundwater flow in the alluvial aquifer has a southwest flow direction toward the Mississippi and Meramec Rivers. Groundwater elevation measurements from the monitoring well networks at the MEC are gathered no less than semi-annually, and potentiometric surface maps are generated from this data. Historically, potentiometric surface maps for the MEC indicate that both the Meramec and Mississippi river levels are lower than the groundwater levels measured onsite, with groundwater flowing from the bluffs to the rivers under typical conditions. The water table (groundwater potentiometric surface) typically follows changes in surface topography, especially in unconfined alluvial systems such as the area where the MEC is located.

Under these typical groundwater conditions, both the Meramec and Mississippi river levels are gaining streams. A representation of gaining and losing streams is shown below in **Figure 1a** (Winter et al., 1998):

**Figure 1 – Generalized Cross Sections of Gaining and Losing Streams**



With a gaining stream or river, groundwater flows from the alluvial aquifer into the river, as indicated by the diagram on the left side of the figure. Flow is directed from each riverbank towards the river, and groundwater beneath the riverbed is directed upward. A gaining river acts as a hydrogeologic boundary, with hydraulic gradients directing flow towards the river along each bank and in the prevailing downstream direction. For groundwater to travel from one side of a gaining stream to the other, it would need to move upgradient, which does not follow basic principles governing groundwater flow.

Using groundwater elevation data in the MEC monitoring wells, vertical hydraulic gradients were calculated for MW-9 (screened in shallow alluvium) and TP-1 (screened in deep alluvium), located west of the MEC and adjacent to the Meramec River. An upward component of flow is expected in locations adjacent to and beneath a

gaining stream, and as displayed in **Figure 2**, calculated vertical gradients between these wells, though they fluctuate, have been consistently upward since the wells were installed in 2018.

In the event of flooding of either the Meramec or Mississippi rivers, it is possible that river levels may temporarily be higher than local groundwater levels. Under this condition, these rivers continue to act as a hydrogeologic boundary for the shallow alluvial aquifer, though flow temporarily reverses or stagnates.

Estimated horizontal hydraulic gradients using wells within the MEC monitoring networks have historically ranged from 0.0002 to 0.004 feet/foot (Rocksmith, 2024). Additionally, groundwater flow directions at the MEC have been estimated with an average flow direction to the southwest (237 degrees azimuth).

## 4.0 PRIVATE WELLS ACROSS MERAMEC RIVER

As a part of the 2018 “*Human Health and Ecological Assessment of the Meramec Energy Center*” by Haley & Aldrich, Inc. (Haley & Aldrich), an evaluation of the Missouri Department of Natural Resources (MDNR) well databases was completed that identified 8 private wells within a 1-mile radius of the MEC. A review of the databases indicates that no new private or public wells have been installed within 1 mile of the MEC since 2018, as displayed on **Figure 3**.

There are three private wells located west of the Meramec River (across river from MEC) within 1 mile of the MEC, with the nearest well (#003741) located approximately 4,000 feet west of the surface impoundments along the western side of the MEC. The other private wells are located to the northwest of the MEC. Well logs are provided in **Attachment A**, and well construction details are summarized in **Table 1**, below.

**Table 1 – Summary of Well Construction – Private Wells West of Meramec River within 1 mile of MEC**

Well ID	Ground Surface Elevation (FT MSL)	Year Well Installed	Depth of Casing (FT BGS)	Depth of Casing (FT MSL)	Static Water Level (FT BGS)	Static Water Level (FT MSL)	Screening Interval (FT BGS)	Screening Interval (FT MSL)
007100	450	1941	125	325	70	380	125 – 295	155 – 325
004756	554	1938	21	533	80	474	21 – 560	-6 – 533
003741	581	1936	32	549	145	436	32 – 510	71 – 549

Notes:

- 1) Static water levels are from drilling installation logs.
- 2) FT MSL – Feet Above Mean Sea Level.
- 3) FT BGS – Feet Below Ground Surface

As displayed in **Figure 3**, each of these wells are installed in the upland bluffs outside the lateral extent of the Mississippi and Meramec River Valleys’ alluvial deposits. These wells are screened in sedimentary bedrock, ranging from the Middle Mississippian Salem Formation to the Upper Ordovician Kimmswick Limestone. A generalized fence diagram (**Figure 4**) displays the closest private well to the site (#003741), the Meramec River and its associated alluvium, the MEC Plant, and the bedrock bluffs on either side of the river valley.

**Figure 5** displays bedrock groundwater elevation contours compiled from well records submitted to the Missouri Department of Natural Resources, publicly available using the department’s Geosciences Technical Resource Assessment Tool (GeoSTRAT)<sup>1</sup>. Displayed contours incorporate additional water level data from wells across the region and may be more representative of average bedrock groundwater elevations in the area. As shown in the figure, groundwater elevation contours west of the Meramec River indicate groundwater flow in the bedrock aquifer is to the southeast, showing these private wells are upgradient of the MEC.

There are no well records of any private wells screened in the alluvial aquifer west of the Meramec River. A review of property records and plat maps for Jefferson County<sup>2</sup> indicates that there is only one property listed as a

<sup>1</sup> MDNR GeoSTRAT data viewer available at:

<https://modnr.maps.arcgis.com/apps/webappviewer/index.html?id=3ac3a61da4af4834811503a24a3cb935>

<sup>2</sup> Jefferson County Property Viewer available at:

<https://jeffcomo.maps.arcgis.com/apps/webappviewer/index.html?id=efafd2634c3c494ab61f03bbcd759ec7>

dwelling opposite the Meramec River from the MEC. One additional property is classified with “other” occupancy status (this property appears to have structures for commercial purposes) at the confluence of the Meramec and Mississippi Rivers. Records for both properties indicate that their water supply is public (PWSD 10) from Jefferson County. The nearest private water wells detailed above are over 3,000 feet northwest of these properties and are screened in the bedrock aquifer, not the alluvial aquifer that the MEC CCR units overlie.

## 5.0 CLOSING

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Based on the evidence presented, the private water wells installed across the Meramec River west of the MEC are isolated from alluvial aquifer groundwater at the MEC. The Meramec River acts as a hydrogeologic boundary between both sides of the river. Furthermore, the private wells west of the Meramec River are located a significant distance from the MEC, hydraulically upgradient of the MEC, and are screened in the bedrock aquifer.

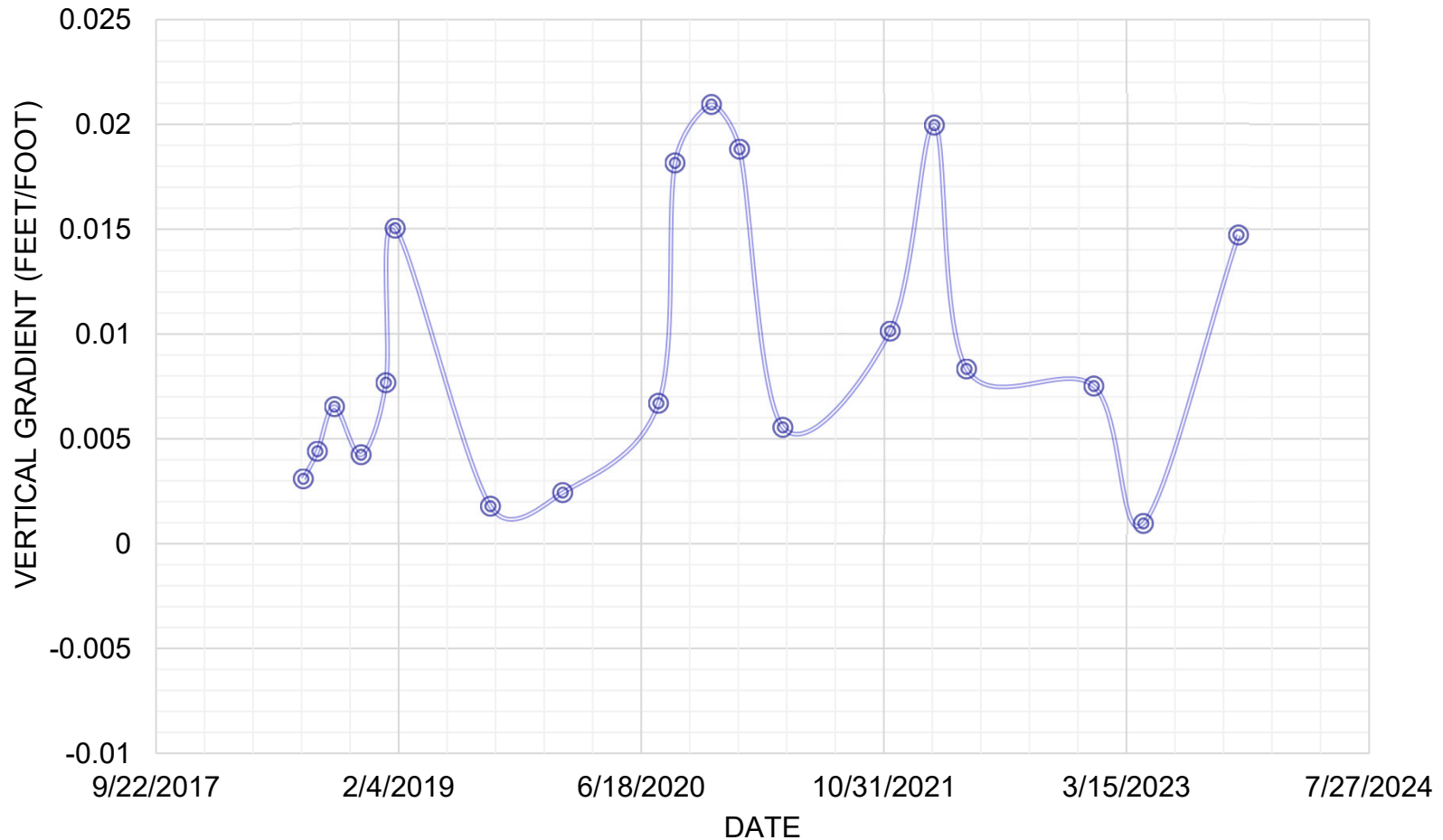
## 6.0 REFERENCES

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- Rocksmith Geoengineering, 2024. 2023 Annual Groundwater Monitoring and Corrective Action Report, Meramec Energy Center, St. Louis County, Missouri, USA.
- Haley & Aldrich, Inc., 2018. Report on Human Health and Ecological Assessment of the Meramec Energy Center, Ameren Missouri, St. Louis, Missouri.
- Haley & Aldrich, Inc., 2019. Corrective Measures Assessment, Ameren Missouri Meramec Energy Center, St. Louis County, Missouri.
- Missouri Department of Conservation, 1998. Meramec River Watershed and Inventory Assessment.
- Missouri Department of Natural Resources, 2023. Geosciences Technical Resource Assessment Tool (GeoSTRAT).
- Missouri Spatial Data Information Service (MSDIS), 2023. MSDIS Open Data Portal.
- Winter, T. C., J.W. Harvey, O.L. Franke, and W.A. Alley, 1998, Ground water and surface water: A single resource. United States Geological Survey Circular 1139, 79 pages, <https://pubs.er.usgs.gov/publication/cir1139k>.

## Figures

# Upward Gradient at Monitoring Wells MW-9 and TP-1

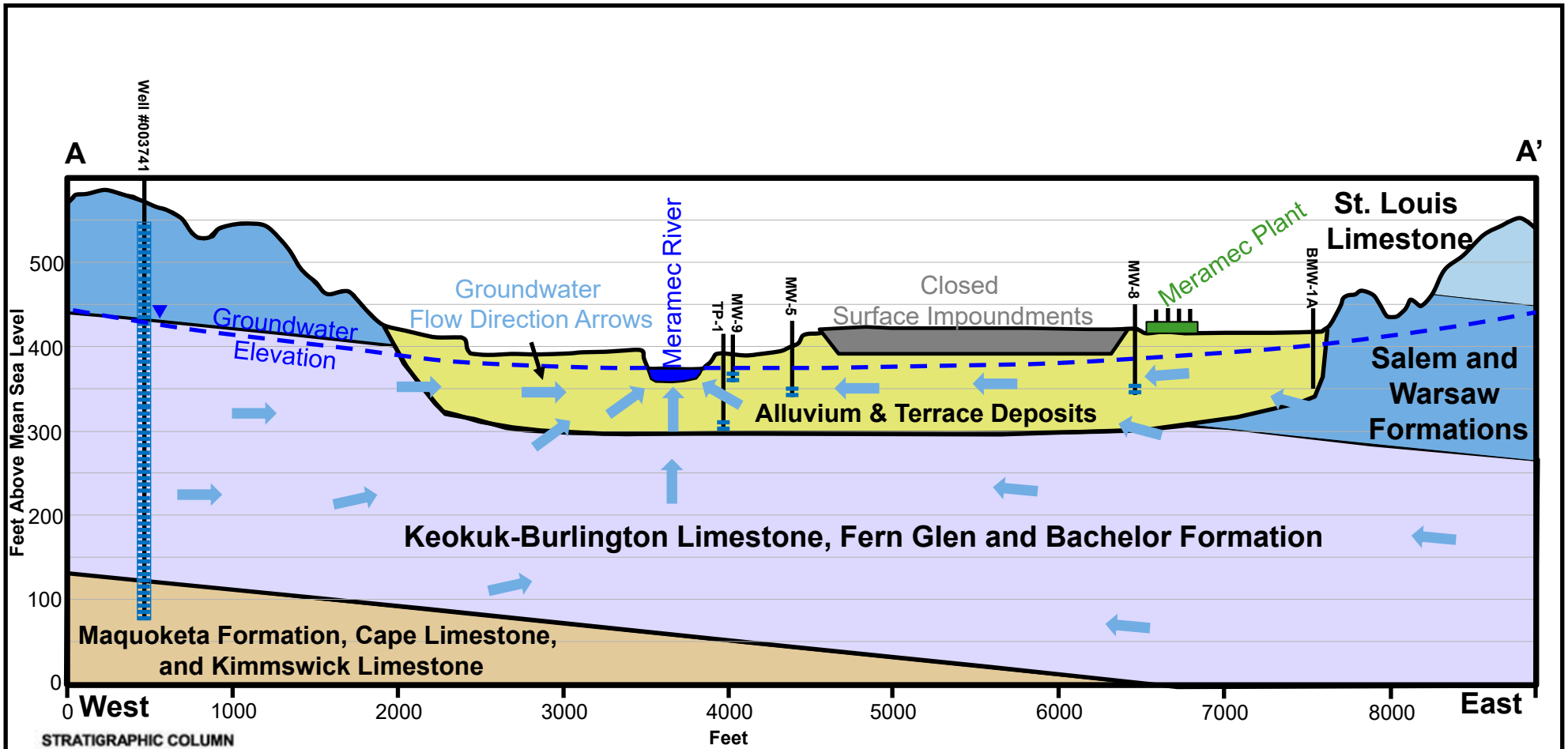


**Notes**

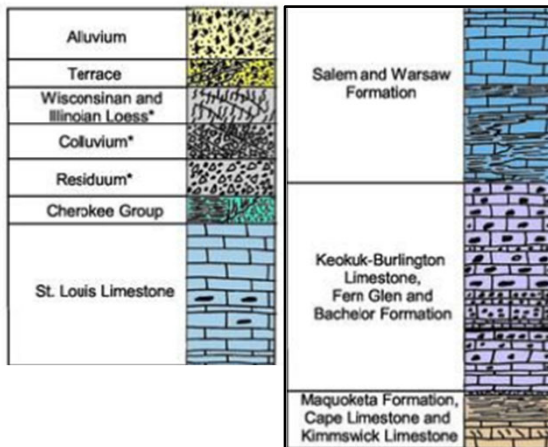
- 1) Values displayed indicate vertical gradient over time between monitoring well pair MW-9 (shallow) and TP-1 (deep). Values are calculated based on groundwater elevation measurements.
- 2) Vertical gradients displayed are positive, indicating there is an upward gradient from the deeper zones of the alluvial aquifer toward the shallow zone adjacent to the MEC and Meramec River.

CLIENT/PROJECT <b>AMEREN MISSOURI                  MERAMEC ENERGY CENTER</b>					TITLE <b>Upward Gradient at Monitoring Wells MW-9                  and TP-1</b>		
DRAWN GTM	CHECKED ANT	REVIEWED MNH	DATE 2024-02-28		Rev No. NA	JOB NO. 23007-24DR	FIGURE <b>2</b>





**STRATIGRAPHIC COLUMN**



**Notes**

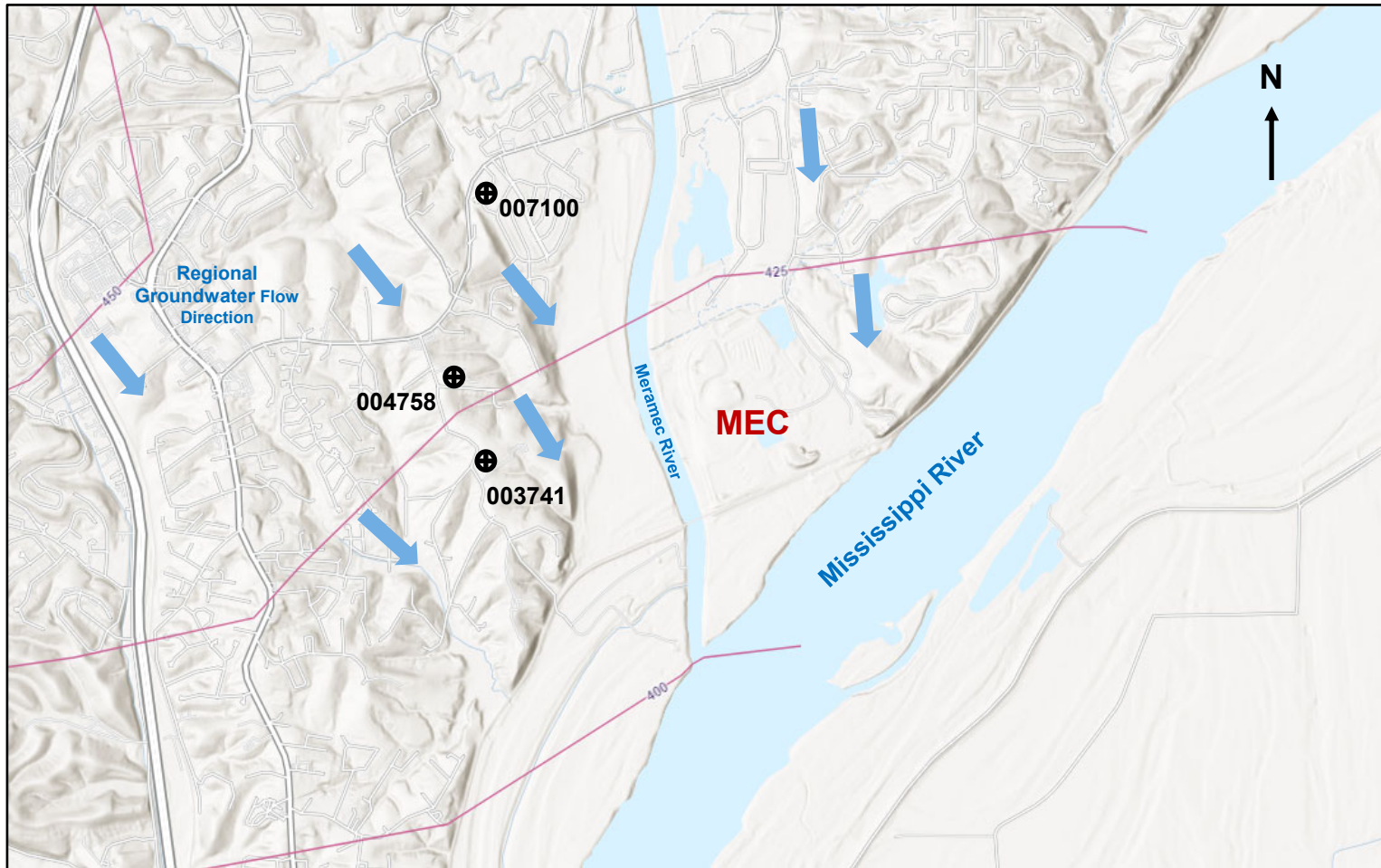
- 1) The location of the Fence Diagram is provided in **Figure 3**.
- 2) Geology, apparent dip, and stratigraphic column is from the 2002 Bedrock Geologic map of the Oakville 7 1/2' quadrangle, Missouri by Middendorf, M.A., and Brill, K.G.
- 3) Approximate distances and elevations given in feet and feet above mean sea level, respectively (5x vertical exaggeration).

CLIENT/PROJECT <b>AMEREN MISSOURI</b> <b>MERAMEC ENERGY CENTER</b>				
DRAWN JSI	CHECKED GTM	REVIEWED MNH	DATE 2024-02-28	




TITLE <b>Generalized Fence Diagram of Meramec River Valley Near MEC</b>		
Rev No. NA	JOB NO. 23007-24DR	FIGURE <b>4</b>





Notes

- 1) Bedrock groundwater elevation contours determined from Well Driller Reports submitted to the Missouri department of Natural Resources (MDNR).
- 2) Data accessed using the MDNR Geosciences Technical Resource Assessment Tool (GeoSTRAT).
- 3) Groundwater elevations are shown in feet above mean sea level (feet MSL).
- 4) Private wells within one mile of the Meramec Energy Center (MEC) west of the Meramec River are indicated on map.

CLIENT/PROJECT <b>AMEREN MISSOURI MERAMEC ENERGY CENTER</b>				
DRAWN GTM	CHECKED JSI	REVIEWED MNH	DATE 2024-03-07	



TITLE <b>Regional Groundwater Elevations and Flow Directions in Bedrock based on MDNR GeoSTRAT Database</b>		
Rev No. NA	JOB NO. 23007-24DR	FIGURE <b>5</b>

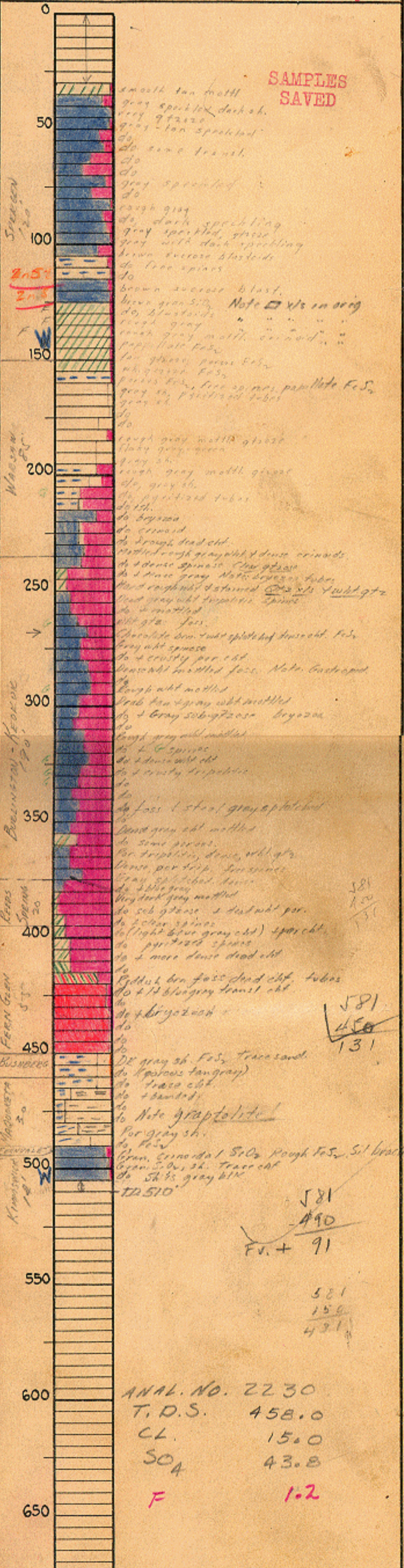
# Attachment A

## Private Well Boring Logs

MO SURVEY NO <b>3741</b>		OWNER <b>FRED DORNSEIF JR.</b>	
COUNTY <b>Jefferson</b>	FARM <b>FEE</b>	WELL NO <b>1</b>	
T <b>42</b>	R <b>6E</b>	DRILLER <b>Theo. Flamm</b>	
DATE <b>7-28-36 to 8-22-36</b>			
ELEVATION <b>581 (P.A.)</b>		PRODUCTION	
SAMPLES STUDIED <b>Grohskopf</b>			

REMARKS **32 ft of 6 1/4" csg  
Water at 145 & 505**

S.W.L. 145 F-1.20 ✓

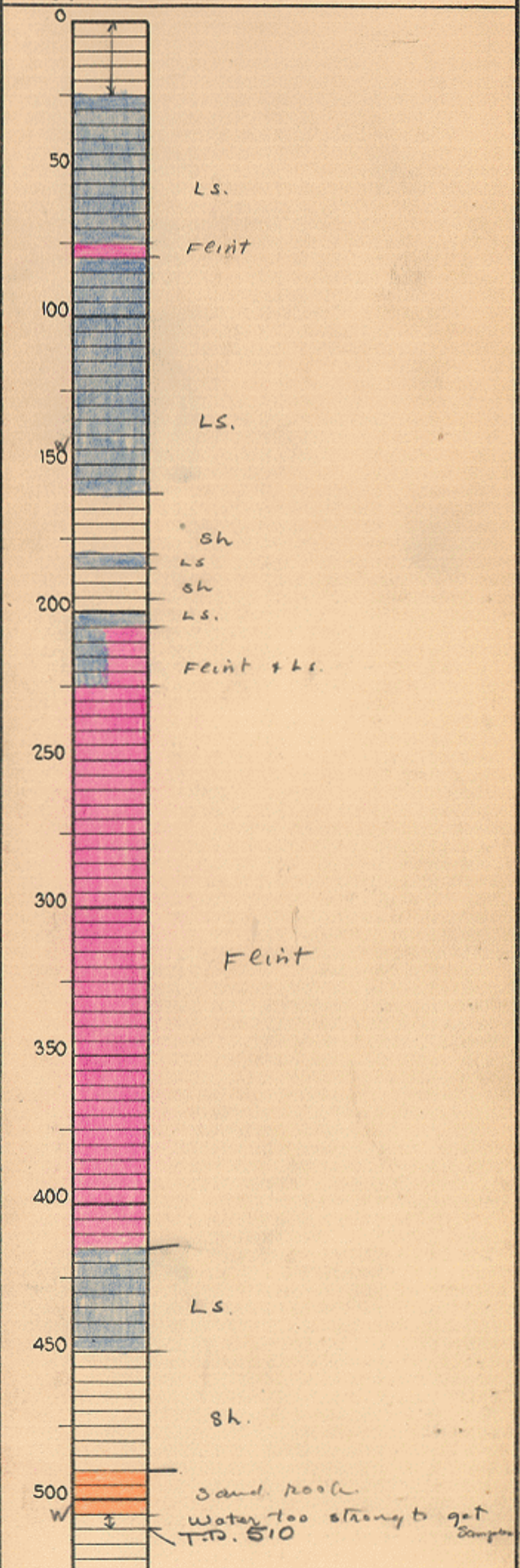


MO SURVEY NO <b>3741</b>		OWNER <b>Fred Darnsief Jr.</b>	
COUNTY <b>Jefferson</b>	FARM	WELL NO <b>1</b>	
T <b>42</b>	R <b>6E</b>	DRILLER <b>Theo. Flamm</b>	
DATE <b>8/28/36</b>			
ELEVATION		PRODUCTION	
SAMPLES STUDIED <b>D.L.</b>			

REMARKS **32' 6 1/4"**

S.W.L. 145

DRILLER'S LOG



CHEMICAL WATER ANALYSIS			
PARTS PER MILLION			
T.D.S.	458.0	Alk	290.0
Na	96.8	Cl	15.0
Mg	14.7	SO4	43.8
Ca	27.1	HCO3	353.6
Hard.	128.0	Fe	1.15
Analyst		Mo. G. S.	
Date		12-7-36	
Remarks			



MISSOURI BUREAU OF GEOLOGY & MINES, ROLLA, MO.

MO SURVEY NO <b>7100</b>	OWNER <b>JOHN H FLAMM</b>	
COUNTY <b>Jefferson</b>	FARM	WELL NO

T <b>43</b>	R <b>6E</b>	DRILLER <b>A Mall for T. Flamm</b>
		DATE <b>Feb 1941</b>

	33		
©			

ELEVATION <b>450 (VAN LED)</b>	PRODUCTION <b>15 G.P.M.</b>
SAMPLES STUDIED <b>Grohskept</b>	

Index 54 \* 139

REMARKS **125 ft of 6 1/4" casing**  
**On Route "VV" on E side of road just below quarry**  
**SWL 70**      **W. at 130, 260**      ✓

Warsaw  
Burlington - Keokuk

