

APPENDIX A – HYDRAULIC CONDUCTIVITY MODIFICATIONS IN THE SUMTER COUNTY REGION

HYDRAULIC CONDUCTIVITY MODIFICATIONS IN THE SUMTER COUNTY REGION

The Central Springs Model (CSM) version 1.0 groundwater flow model and the subsequent model documentation report were completed jointly by the St. Johns River Water Management District (SJRWMD) and Southwest Florida Water Management District (SWFWMD) in February 2024 (Sun et. al. 2024). During stakeholder review, Vikus Water and Andreyev Engineering submitted comments on behalf of Village Center Community Development District; North Sumter County Utility Dependent District; Wildwood Utility Dependent District; Gibson Place Utility Company, LLC; Gibson Place Water Conservation Authority, LLC; Middleton Utility Company, LLC; Middleton Water Conservation Authority, LLC; Blue Goose Utility Company, LLC; and Blue Goose Water Conservation Authority, LLC (referred to collectively as “The Villages”).

Among the comments, stakeholders stated that available aquifer performance testing (APT) data in the vicinity of The Villages in Sumter County was not adequately utilized and the calibration for the Upper Floridan Aquifer (UFA) and Lower Floridan Aquifer (LFA) in the area needed to be improved using the monitoring data submitted by The Villages. The stakeholders suggested that the same aquifer characteristics that were used in the expanded and recalibrated Northern District Model version 5.0 (NDM5), including UFA and LFA horizontal permeability and Middle Confining Unit (MCU) vertical permeability, should be utilized in the CSM to obtain a reasonable calibration in the southern portion of The Villages (Vikus Water 2023; Andreyev Engineering, Inc. 2023). The model development team determined it was appropriate to address these issues in the upcoming CSM v1.1 modeling effort.

This memo documents the process and extent of hydraulic parameter modification in Northern Sumter County in the CSM version 1.1 (CSM v1.1). The modified parameters were compared with the LFA APT measurement data. The goal was to improve representation of hydrogeology in the area and achieve a better calibration result.

The hydraulic parameters in the vicinity of The Villages were updated in CSM v1.1 based on values in the expanded NDM5 model (Andreyev Engineering, Inc. 2022). A comparison of the MODFLOW Discretization (DIS) packages in the area revealed that the CSM spatial discretization agreed with the NDM5 model grid except for slight differences in layer thickness. Therefore, the only necessary adjustments were to the hydraulic parameters in the MODFLOW Upstream Weighting Package (UPW) package. The horizontal hydraulic conductivity (Kh) and vertical hydraulic conductivity (Kv) of 3515 cells covering 37 rows (rows 127 through 163), 19 columns (columns 119 through 137), and 5 layers (layers 3 through 7) were copied from the expanded NDM5 and merged into the existing CSM parameter array. An initial model run with the merged parameter set demonstrated that the modification did not have significant impact on the overall model performance, which was expected due to the very limited extent of the modifications (3515 model cells out of 639,100 total model cells in the CSM). In the modified area, the parameter changes improved model performance in the LFA and slightly decreased the calibration metrics of UFA target wells. The modifications did not significantly change the calibration of spring and river targets. A qualitative comparison with the groundwater levels reported by Andreyev Engineering shows that the revised model achieved better representation of groundwater flow in the area. Based on these findings, the modifications are deemed acceptable and should be incorporated into the CSM v1.1.

The modified hydraulic conductivity values were incorporated into the CSM v1.1 existing parameter array using Parameter ESTimation code (PEST) pilot points (Doherty 2015). New pilot points were incorporated in the refinement area and assigned a fixed hydraulic conductivity value that was extracted from the

modified arrays. The purpose of this was to provide a smoothed array of Kh and Kv values in the vicinity of the modifications without impacting the values imported from the expanded NDM5 model. Appendix B includes the pilot point distributions for the modified layers described in this report. The final hydraulic parameters in the CSM v1.1 are compared with the hydraulic parameters in CSM v1.0 in Figures 1 through 6.

Figure 1 shows the transmissivity of the LFA (model layer 6) in The Villages area in CSM v1.1 compared with measured values from APT wells provided by Andreyev Engineering. As seen in the figure, the CSM v1.1 transmissivity values are comparable to the APT measurements and resulted in better representation of the hydrogeology in the LFA compared to CSM v1.0 (Figure 2) (Hill and Basso, 2015). A comparison of UFA (layers 3 and 4) transmissivity between CSM v1.1 and v1.0 showed that the modifications were rather limited, and the essential features remained in agreement (Figure 3 and 4). As illustrated in Figures 5 and 6, the vertical leakances of MCU I (layer 5) in the CSM v1.1 are generally lower than that of the CSM v1.0, reflecting an increased confinement of the model layer.

References:

1. Andreyev Engineering, Inc. 2022. *Summary Report for Expansion of LFA Western Boundary in NDM5 Model Expansion of Active Model Cells in Layer 7 and Model Re-Calibration The Villages, Sumter County, Florida*
2. Andreyev Engineering, Inc. 2023. *Review of Central Springs Model, Evaluation of Model Calibration Comparison to Real Data and Recommendations for WUP Permitting The Villages, Sumter County, Florida*
3. Doherty, J., 2015, PEST – The Book: Calibration and Uncertainty Analysis for Complex Environmental Models. Watermark Numerical Computing, Brisbane, Australia, ISBN: 978-0-9943786-0-6, 227 p.
4. Hill M.E. and R. Basso. 2005. *Hydrogeologic Conceptual Model of The Villages Area, Sumter County, Florida*. Southwest Florida Water Management District.
5. Sun, Q., W. Jin, A. Nur, F. Gordu, J. Kokjohn, H. Zhang, and C. Joseph. 2024. *Central Springs Groundwater Flow Model (CSM) Version 1.0*. St. Johns River Water Management District, Palatka, Florida.
6. Vikus Water. 2023. *Technical Review Comments on the Central Springs Model for Southern Marion County, Western Lake County, and Sumter County*

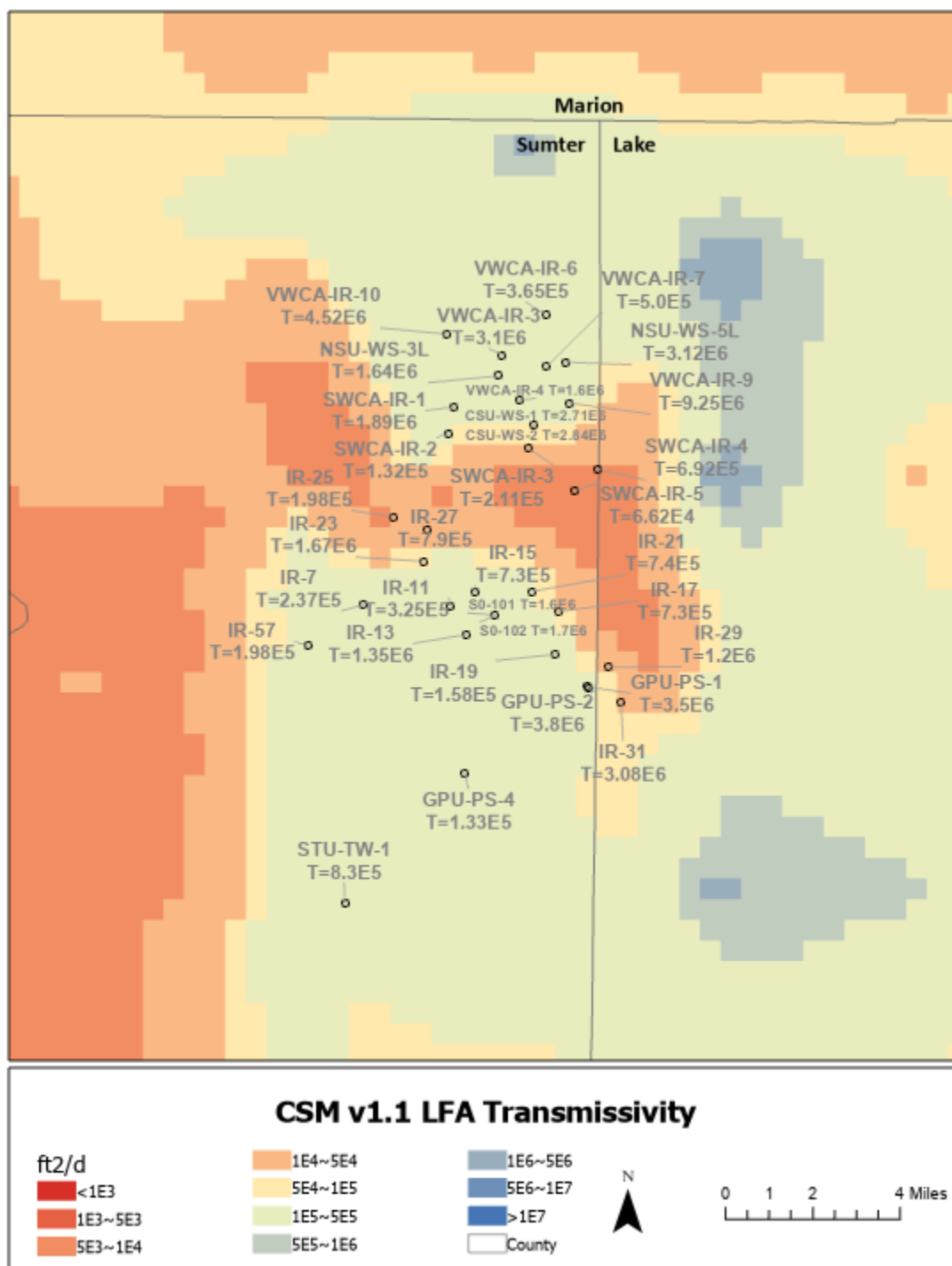


Figure 1. Transmissivity of the Lower Floridan Aquifer (LFA) in Central Spring Model (CSM) version 1.1.

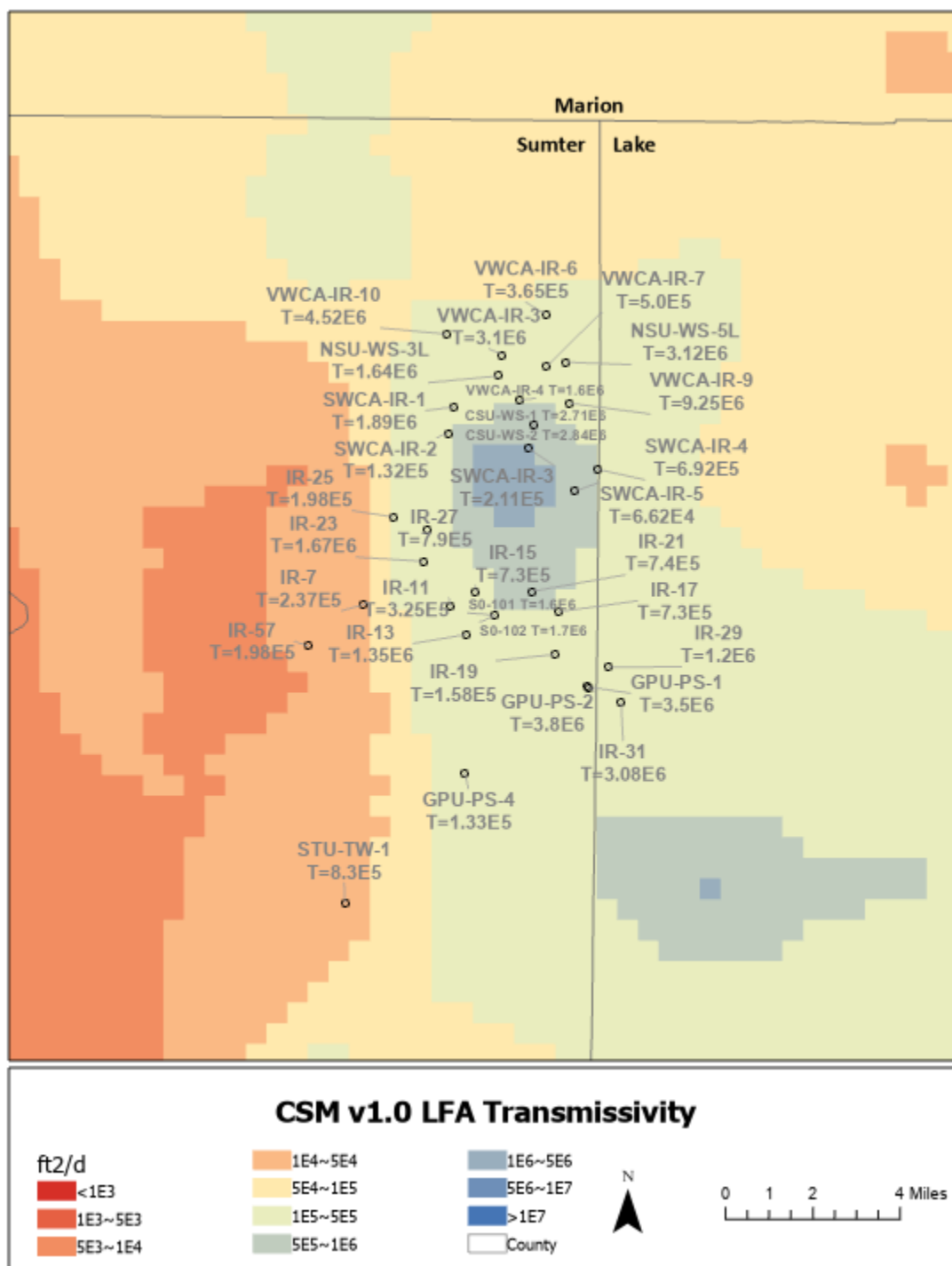


Figure 2. Transmissivity of the Lower Floridan Aquifer (LFA) in Central Spring Model (CSM) version 1.0.

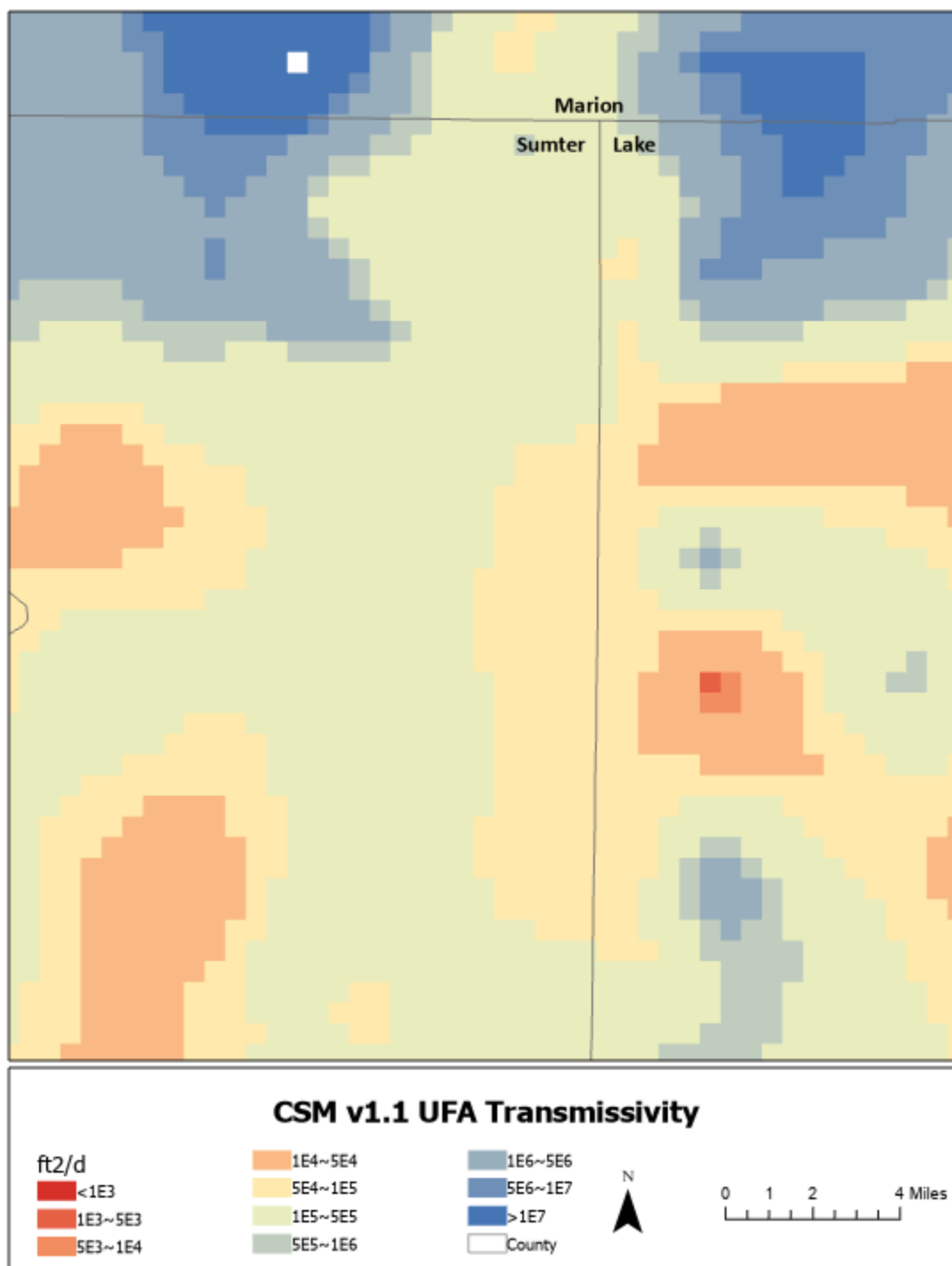


Figure 3. Transmissivity of the Upper Floridan Aquifer (UFA) in Central Spring Model (CSM) version 1.1.

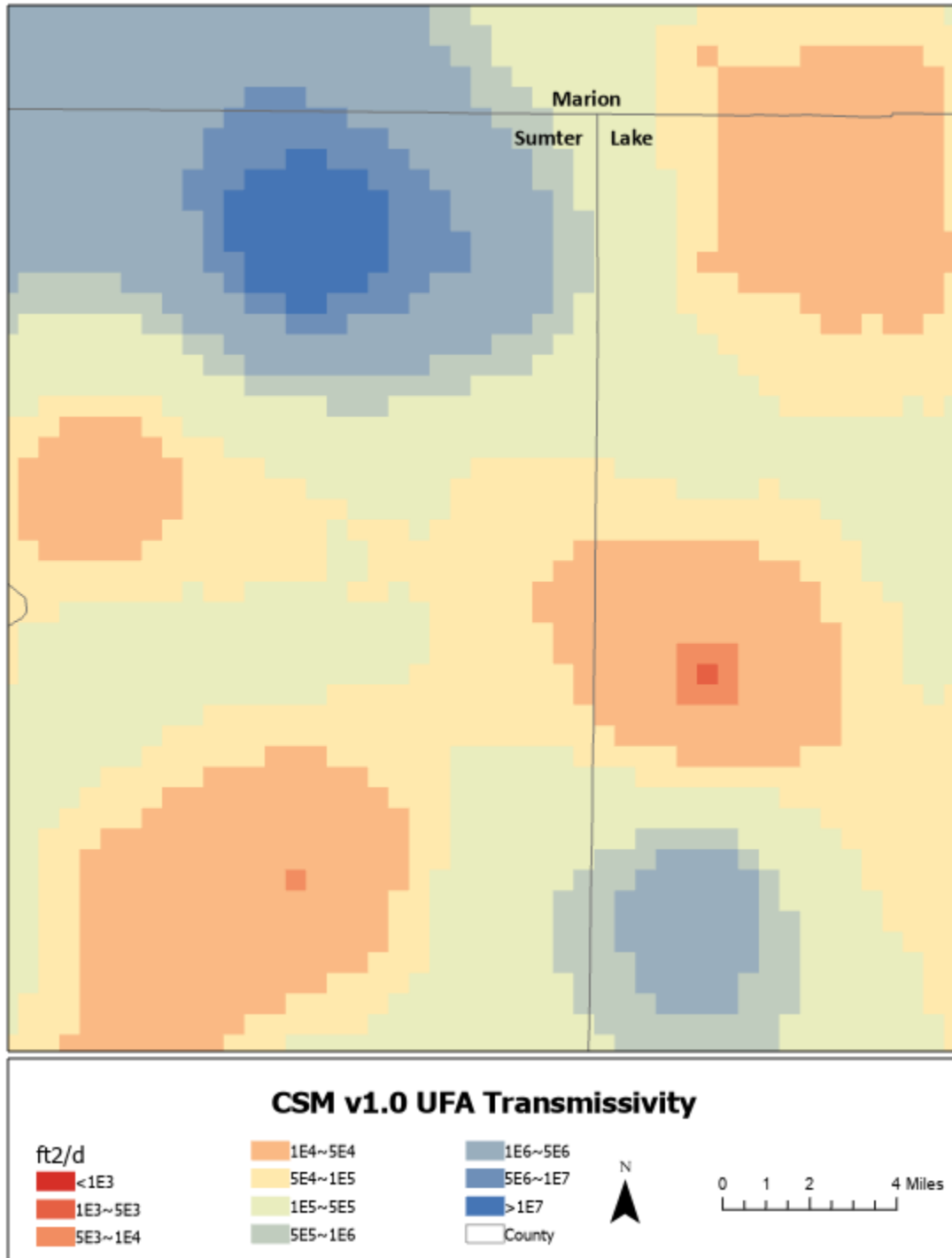


Figure 4. Transmissivity of the Upper Floridan Aquifer (UFA) in Central Spring Model (CSM) version 1.0.

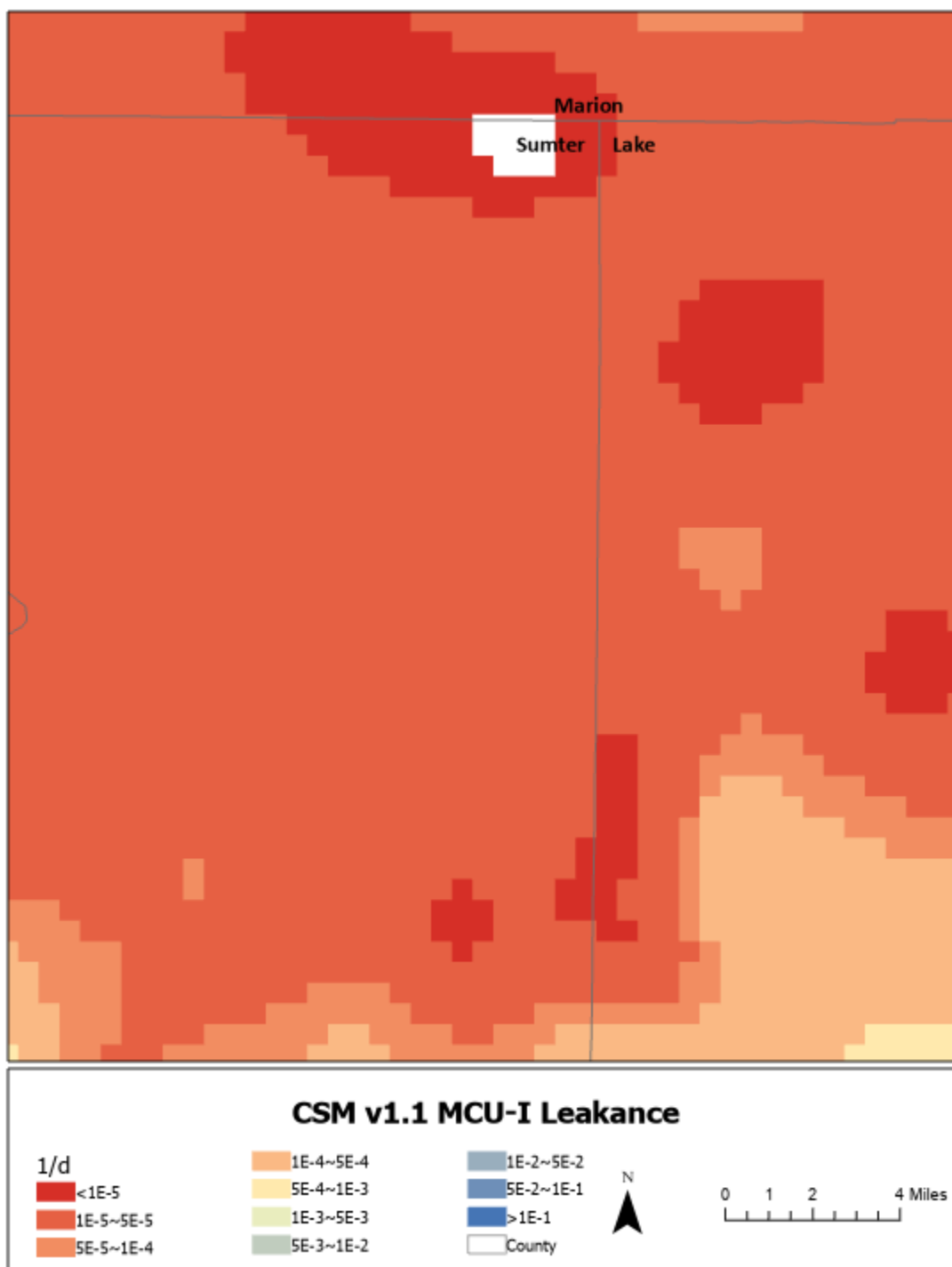


Figure 5. Vertical leakance of the Middle Confining Unit (MCU) I in Central Spring Model (CSM) version 1.1.

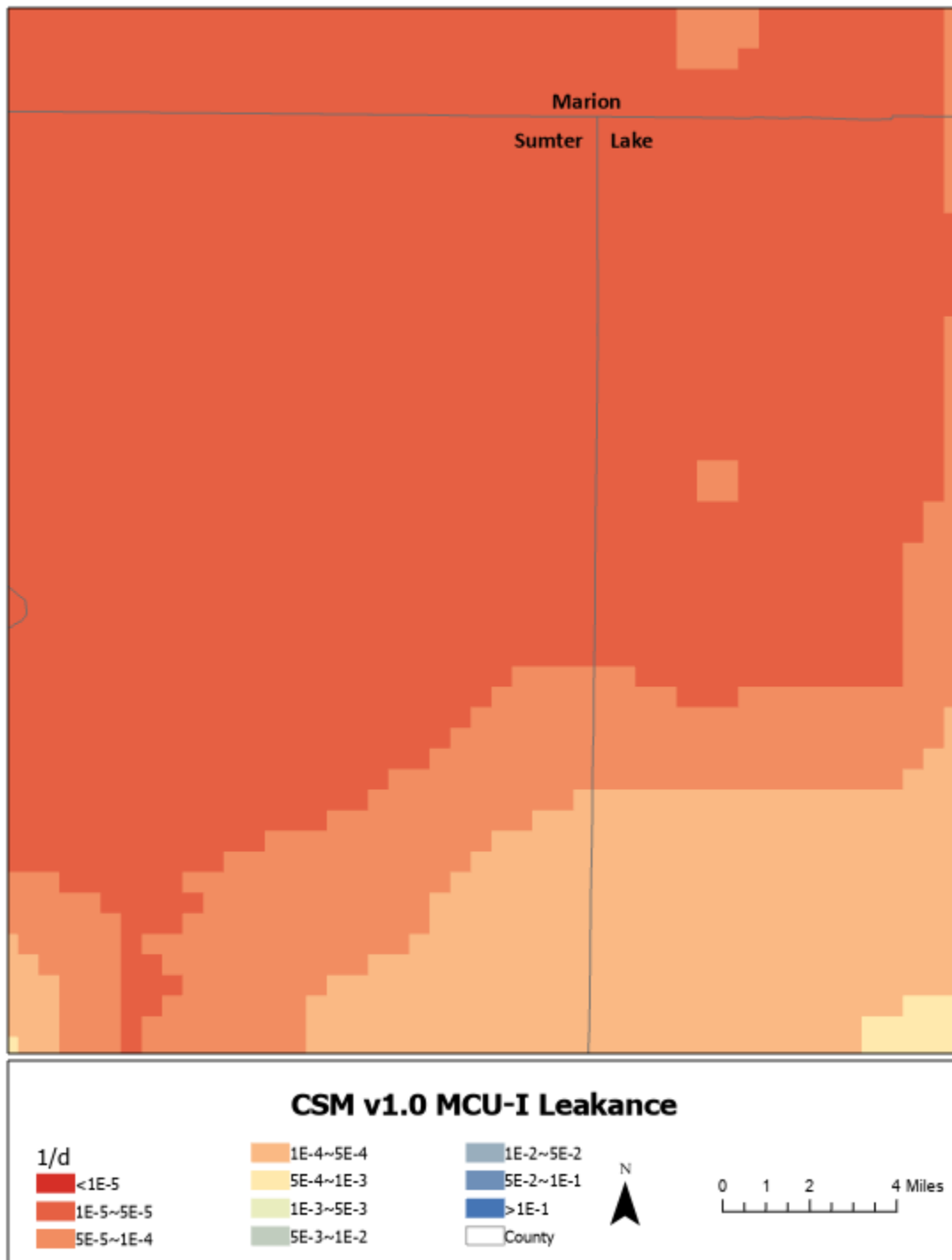


Figure 6. Vertical leakance of the Middle Confining Unit (MCU) I in Central Spring Model (CSM) version 1.0.