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December 12, 2006

Ms. Gail L. Mowry, P.E.
Clean Water Engineer
Marion County Transportation Department
412 SE 25th Avenue
Ocala, FL 34471

RE: Marion County Aquifer Vulnerability Assessment, Progress Report #2

Dear Mrs. Mowry:

We are pleased to present you with the second progress report for the MCAVA project detailing work we have completed during the previous seven-week project period. An invoice for work completed to date is also attached. Please call if you have any questions.

Best regards,

Alex Wood

Alex Wood, President
Advanced GeoSpatial Inc.

AW/aw

attachments

MARION COUNTY AQUIFER VULNERABILITY ASSESSMENT PROJECT PROGRESS REPORT #2 – WEEK 14 (DECEMBER 7 - 13)

As agreed upon between Marion County and Advanced GeoSpatial Inc., AGI will provide progress reports along with invoices at four intervals throughout the 27-week project period. Each report will be submitted to Marion County approximately every seven weeks, will detail the progress and metrics of the MCAVA project and accompany each invoice. This second report details the development of the remainder of evidential theme input data (Intermediate Confining Unit, overburden thickness, karst features, and other themes), and preliminary vulnerability modeling results.

Intermediate Confining Unit and Overburden Thickness Theme

Results of past aquifer vulnerability projects have shown that aquifer confinement either in the form of overburden overlying the Floridan Aquifer System (FAS,) or the Intermediate Confining Unit (ICU), is typically the most critical layer in determining aquifer vulnerability. A point dataset containing information about depths to hydrostratigraphic units was developed (as described in progress report one) and analyzed to identify potential statistical outliers and erroneous data points. Data from the points was then combined with the Florida geologic map, LIDAR data, and extents used in previous works to estimate the areal extent of the ICU.

The point dataset was used to predict two hydrostratigraphic surfaces: top of FAS (Figure 1) and top of ICU (Figure 2). Ordinary kriging was selected as the surface prediction method because of its flexibility and data exploration options. A sensitivity analysis was completed to determine the best modeling protocol for creating surfaces. These surfaces were combined with LIDAR data to resolve areas where the prediction technique estimated values above land surface. Resulting surfaces were used to calculate thickness of the ICU (Figure 3) and thickness of material overlying the FAS (Figure 4). These thickness grids are used as input into the aquifer vulnerability model. This task is 100% complete.

Karst Feature Theme

Karst features can provide preferential pathways for movement of ground water into the underlying aquifer system and can enhance an area's aquifer vulnerability where present. Closed topographic depressions were extracted from both the county's 10-ft and 25-ft LIDAR raster-format datasets (Figure 5). To establish the best source for estimating karst, sensitivity analyses were completed for both datasets and revealed the 25-ft LIDAR as the superior estimator of karst. The primary factor is the tendency of the 10-ft dataset to over predict karst features.

The following analytical processes were applied to the closed topographic depressions in an effort to estimate the extent of effective karst features. This task is 95% complete.

Feature size and depth restriction

LIDAR data reveals highly resolved and detailed information about an area's surface elevation, including the characterization of very small or very shallow depressional features. These minor features are real, but may not be karstic in nature. Use of the 25-ft raster LIDAR dataset to develop a closed topographic depressions coverage greatly reduces the number of these minor depressional features. Further restriction was applied through use of zonal geometry and setting a minimum feature depth restriction of three feet.

Shape and orientation analysis

Karst features, which form as the result of the dissolution of carbonate material, are generally round in nature – their longest and shortest axes are relatively the same length. Further, non karstic depressional features are common in Florida in near-shore modern or relic dune terrains, such as in eastern Marion County, which is underlain by a geologic province known as the beach ridge and dune province.

Depressions of this province have a common elongate shape and orientation. To filter these types of non-karst features out, shape and feature- orientation analyses were applied to this province. Features with a long-to-short axis ratio of 2:1 were eliminated, along with features which shared a common azimuth orientation between 90° and 150°.

Separation from aquifer analysis

The thickness of material separating a depression from the top of the underlying aquifer system has great bearing on its connectivity to the aquifer system. Features separated by more than 100’ of material from the underlying aquifer system tend to have little or no impact on that system (Wright 1974, Cichon, 2003). Accordingly, a filter value of 100’ was applied to extract features underlain by more than 100’ of overburden.

Application of the above described analytical techniques results in the development of an effective karst feature coverage as displayed in Figure 6.

Preliminary Sensitivity Analysis/Test Modeling

A model extent was selected, and test modeling was initiated on model evidential themes as they were completed. This task is approximately 75% complete. Testing and analysis are still to be completed with the karst theme.

Model extent

The political boundaries of Marion County were selected as the modeling extent. Water bodies were omitted from the model extent for two main reasons: the main goal of this project is to estimate aquifer vulnerability and not surface water features, and two, data for water bodies is typically not available – i.e., wells are not drilled in water bodies, nor do soil surveys normally contain information regarding lake and stream bottoms.

Soil permeability

Soil permeability ranges from 0.2 to 35.0 inches per hour (in/hr) across the study area. Test modeling indicates that areas underlain by 35.0 to 31.4 in/hr are more associated with the training points, and are therefore associated with higher aquifer vulnerability. Conversely, areas underlain by 31.4 to 0.2 in/hr soil permeability are less associated with the training points, and therefore lower aquifer vulnerability. Based on this analysis, the evidential theme was generalized into two classes as displayed in Figure 7.

Aquifer recharge

Recharge to the FAS ranges from -15.0 to 35.0 in/yr across the study area. Test modeling indicates that areas underlain by -15.0 to 15.0 in/yr are more associated with aquifer vulnerability, areas underlain by 15.0 to 22.4 in/yr are somewhat associated with aquifer vulnerability, and areas underlain by 22.4 to 30.5 in/yr are less associated with aquifer vulnerability. Based on this analysis, the evidential theme was generalized into three classes as displayed in Figure 8.

Thickness of Intermediate Confining Unit

The Intermediate Confining Unit ranges from absent to 145 feet thick across the study area. Test modeling indicates that areas underlain by zero to 72 feet of ICU are more associated with the training points, and are therefore associated with higher aquifer vulnerability. Areas underlain by 72 to 145 feet ICU thickness are less associated with the training points, and therefore lower aquifer vulnerability. Based on this analysis, the evidential theme was generalized into two classes as displayed in Figure 9.

Thickness of Overburden on the Floridan Aquifer System

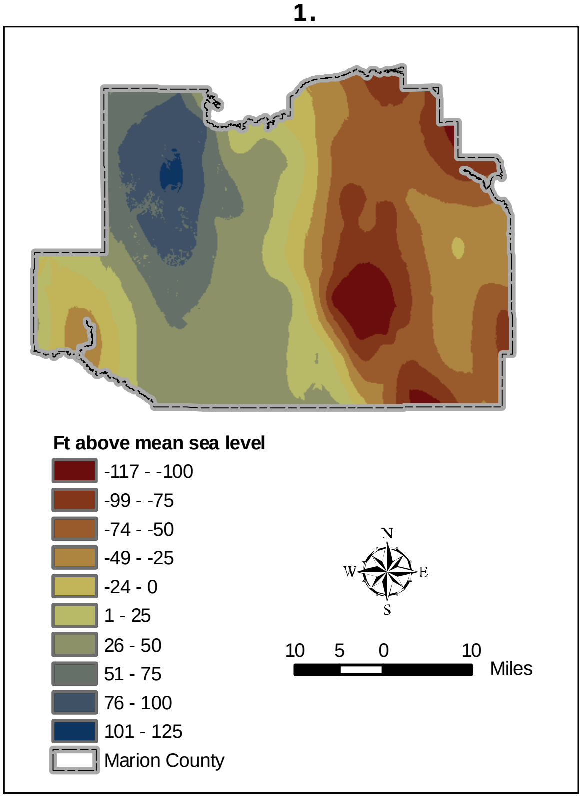
Overburden on the Floridan Aquifer System ranges from absent to 271 feet thick across the study area. Test modeling indicates that areas underlain by zero to 73 feet of overburden are more associated with the training points, and are therefore associated with higher aquifer vulnerability. Areas underlain by 73 to 271 feet overburden thickness are less associated with the training points, and therefore lower aquifer vulnerability. Based on this analysis, the evidential theme was generalized into two classes as displayed in Figure 10.

To represent aquifer confinement in the final aquifer vulnerability assessment, only one of the above two evidential themes will serve as final input. They are both presented herein to display the results of the sensitivity analysis.

Overall, the MCAVA project is on schedule. The upcoming third progress report is due the week of January 25, 2007, and will detail the rest of the sensitivity analysis/test modeling task along with the majority of the final modeling results and initial results from the model validation task. The next and final TAC meeting is tentatively planned for February 27, 2007; the results of the sensitivity analysis and the final modeling phase will be presented in this meeting.

Figures

1.



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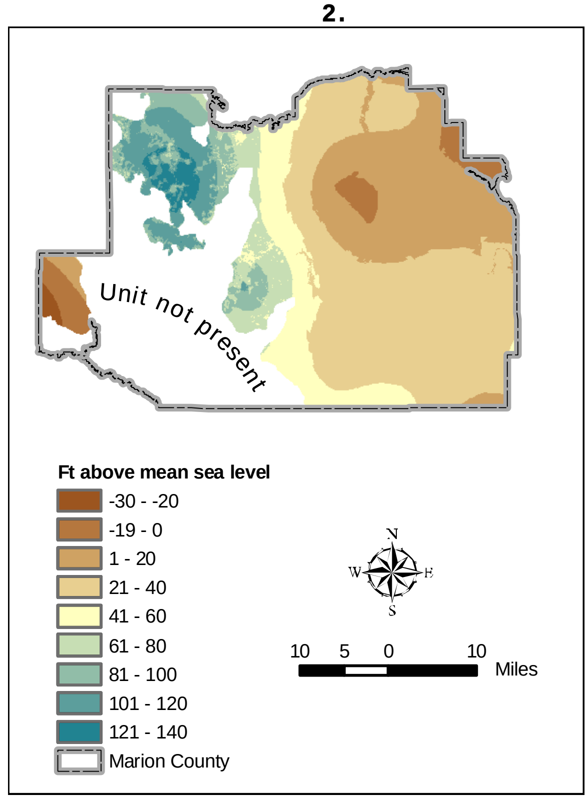
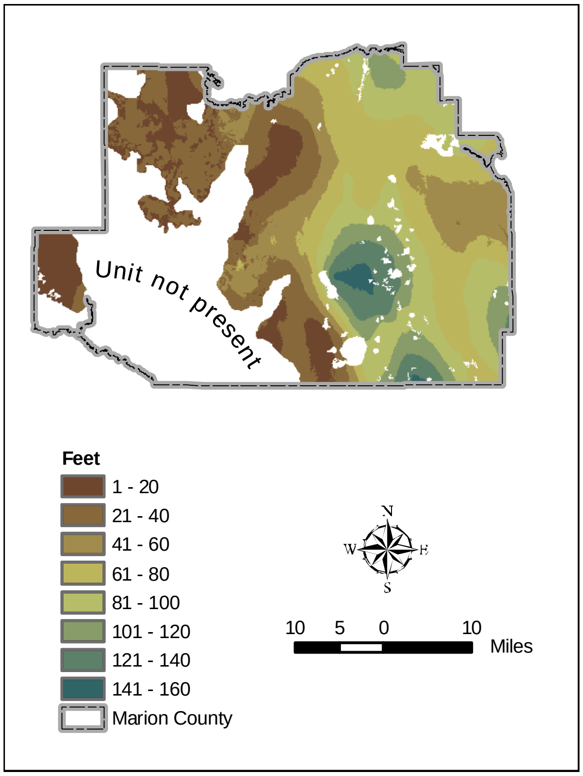


Figure 1. Predicted surface of the Floridan Aquifer System. | Figure 2. Predicted surface of the Intermediate Confining Unit.

3.



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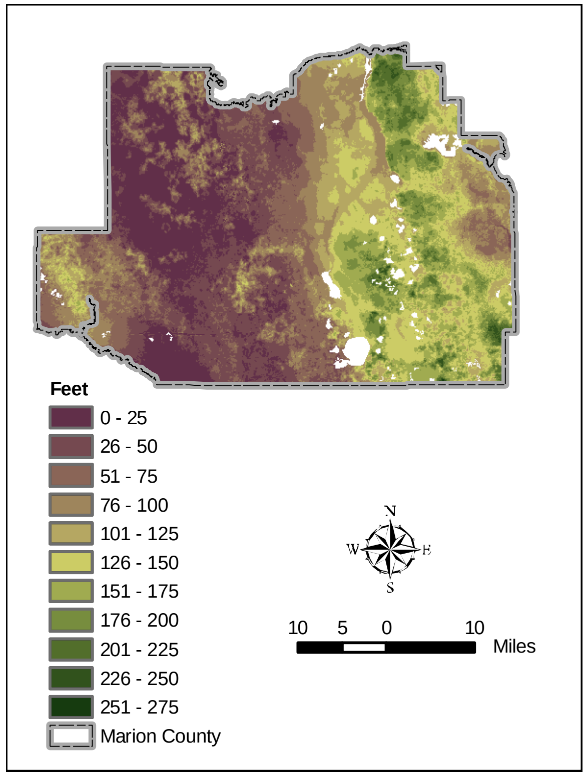

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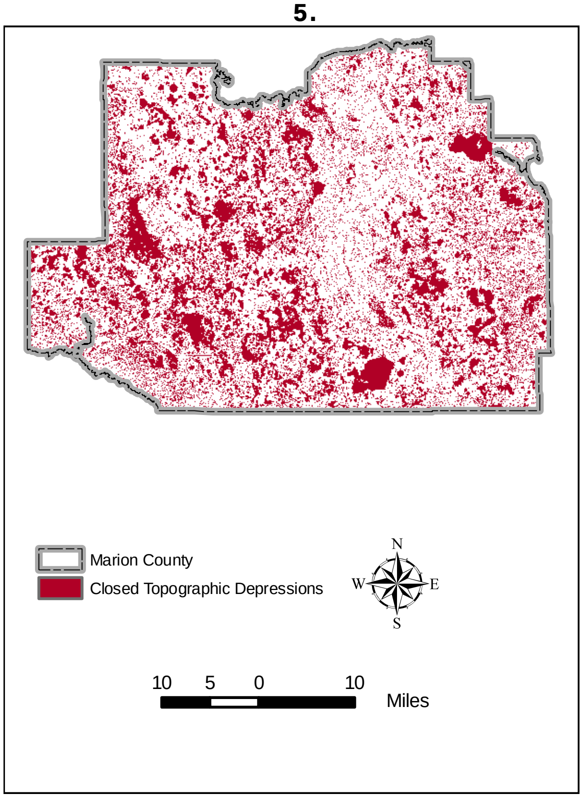

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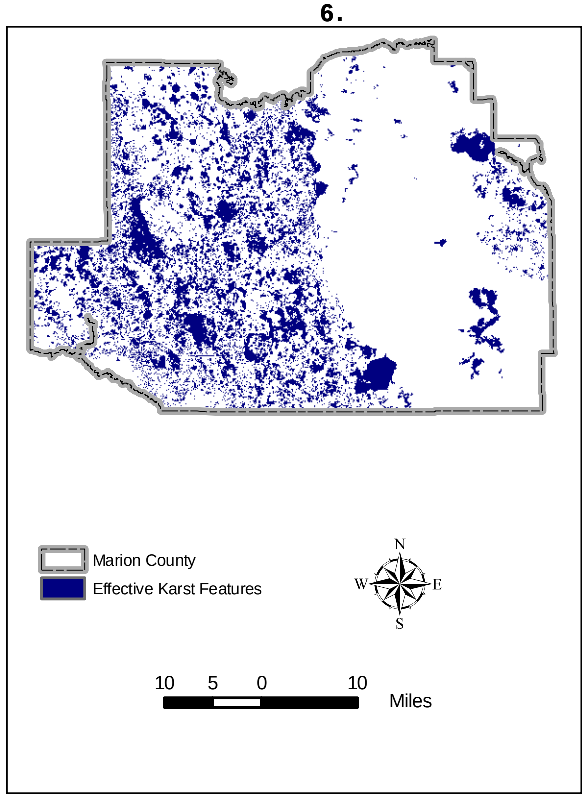
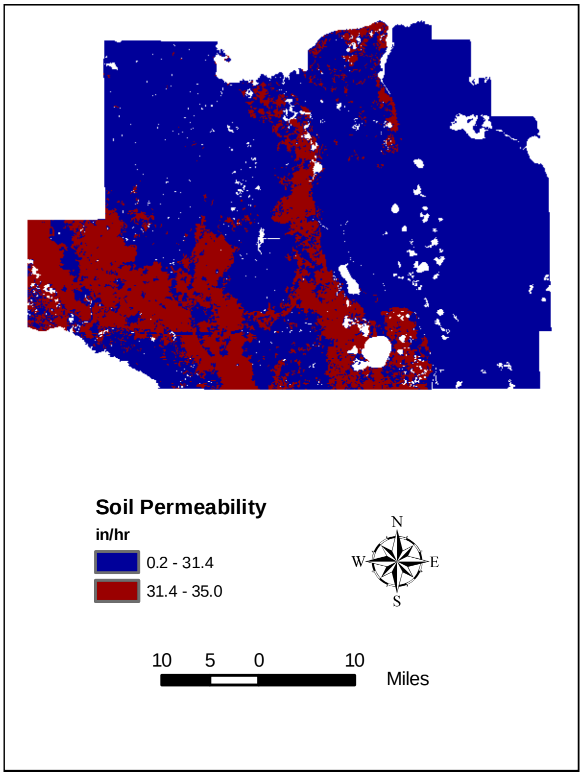


Figure 3. Calculated thickness of the Intermediate Confining Unit. | Figure 4. Calculated thickness of overburden overlying the Floridan Aquifer System | Figure 5. Closed topographic depressions extracted from LIDAR data | Figure 6. Effective karst features theme.

7.



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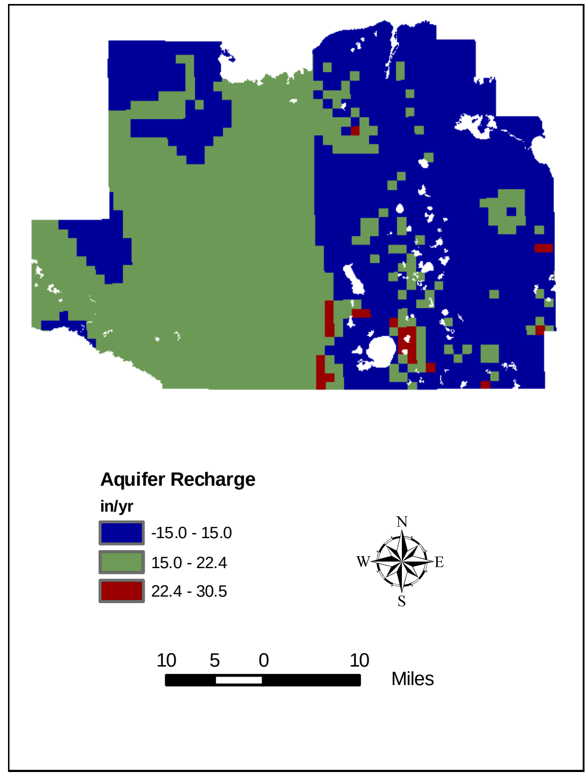

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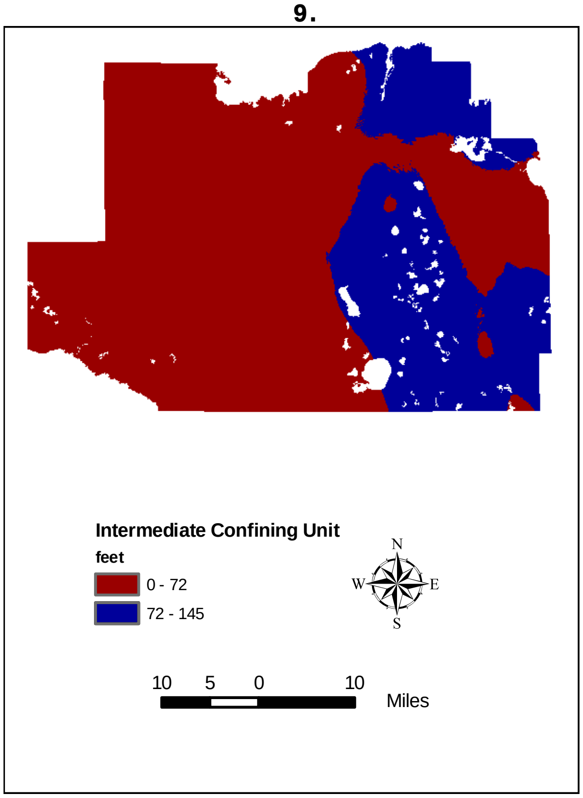

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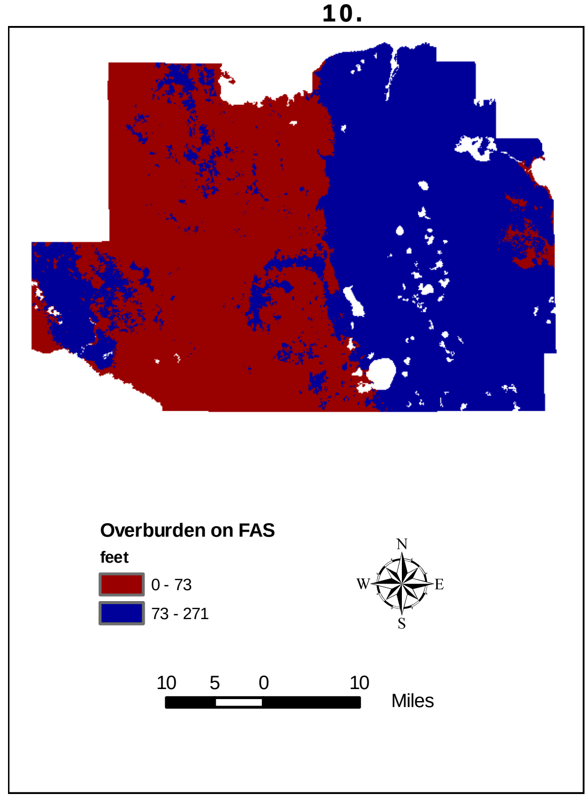

Figure 7. Generalized soil permeability evidential theme. | Figure 8. Generalized Aquifer Recharge (2002) evidential theme. Figure 9. Generalized Intermediate Confining Unit theme | Figure 10. Generalized Overburden on FAS theme.