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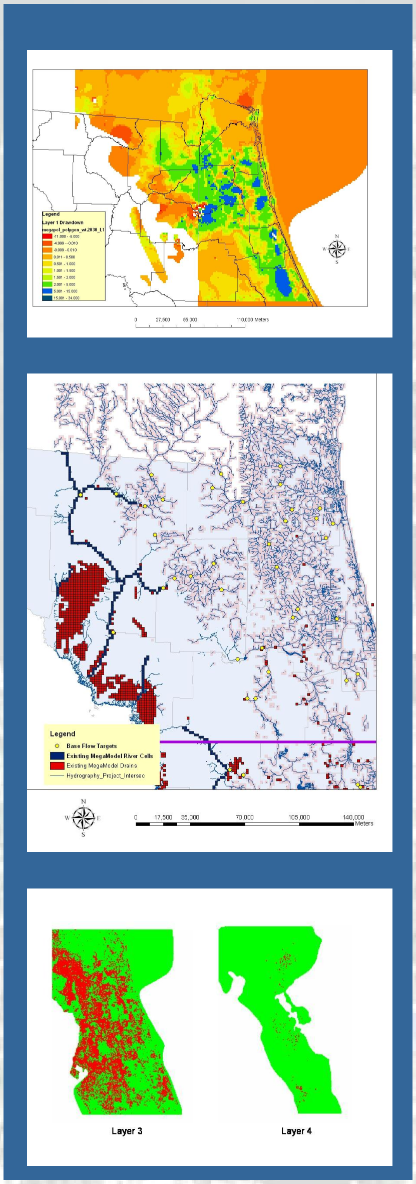
ADAPTATION OF THE USGS MEGAMODEL FOR THE PREDICTION OF 2030 GROUNDWATER IMPACTS

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Final Report Final Report Final Report

Adaptation of the USGS MegaModel for the Prediction of 2030 Groundwater Impacts



Prepared for:

The St. Johns River
Water Management District

Prepared by:

INTERA

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Executive Summary

This report describes the modifications to the USGS Peninsular Florida Model to assist SJRWMD in water supply planning activities. The evaluation of groundwater levels in the St. Johns River Water Management District (the District) through the year 2030 requires the utilization of an appropriate model and methodology. In the past, the District has utilized the Northeast Florida Regional Groundwater Flow Model (NEF Model) for projecting changes in groundwater levels. The domain of the NEF model, however, does not extend sufficiently into the Suwannee River Water Management District (SRWMD) in order to accurately assess the potential impacts due to withdrawals across the District Boundaries. Based on a review of available models in the domain, the USGS Peninsular Florida Model (the MegaModel) was selected for boundary condition adjustment of the NEF and for additional use for water supply planning.

In addition to providing an adjustment to the NEF general head boundary (GHB) package, INTERA was tasked to make additional modifications to the existing USGS MegaModel. The modifications included the activation of the Surficial Aquifer on layer 1, the addition of a river package, and the use of a net recharge package to account for the existing calibrated constant head fluxes. The river package was developed using the National Hydrography Dataset (NHD) and Strahler stream ordering. Reach characteristics (channel width, channel depth, bed conductance) were assigned to each river cell based on Strahler order. This allowed for systematic calibration of river cells. The river cell flux resulting from the assigned reach characteristics was a component of the net recharge flux that replaced the original constant head cells on layer 1. The activation of layer 1 and the development of a river package allowed for the assessment of 2030 impacts to reaches that were constrained by baseflow estimates.

After the 1993-1994 baseline model was calibrated, predictive simulations of the model were run using 2030 pumping rates. The predictive simulations included maintaining pumping rates for selected water management districts at 1993-1994 levels and modifying other districts to 2030 rates in order to assess the relative impacts of each district. Results of the 2030 simulations show rebound in areas where 2030 projected pumping rates are lower than 1993-1994 pumping rates, and aquifer drawdown in areas where 2030 projected rates are higher that 1993-1994 pumping rates.

Additional tasks associated with the scope of work given to INTERA by the District include the development of an artificial neural network (ANN) to determine the spring flow target at White Springs, additional model simulations using modified pumping for PCS Phosphate wells, and a comprehensive predictive sensitivity analysis. These additional tasks were documented and included in this report as additional appendix.

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Introduction

The evaluation of groundwater levels in the St. Johns River Water Management District (SJRWMD or the District) through the year 2030 requires the utilization of an appropriate model and methodology. In the past, the District has utilized the Northeast Florida Regional Groundwater Flow Model (NEF Model) for projecting changes in groundwater levels. The domain of the NEF model, however, does not extend sufficiently into the Suwannee River Water Management District (SRWMD) in order to accurately assess the potential impacts due to withdrawals across the District Boundaries. Two additional models were considered in order to analyze potential impacts due to withdrawals through the year 2030: the USGS Peninsular Florida Model (the MegaModel) and the currently existing SRWMD MODFLOW model (the North Florida model). INTERA was tasked to evaluate and compare the models as well as make modifications to the existing USGS MegaModel. The modifications included the activiation of the Surficial Aquifer on layer 1, the addition of a river package, and the use of a net recharge package to account for the existing calibrated constant head fluxes. This report describes the modifications to the USGS Peninsular Florida Model to assist SJRWMD in water supply planning activities. Also included in the appendices are additional tasks associated with the scope of work given to INTERA by the District. These additional tasks included the development of an artificial neural network (ANN) to determine the spring flow target at White Springs, additional model simulations using modified pumping for PCS Phosphate wells, and a comprehensive predictive sensitivity analysis.

Model Evaluation and Comparison

Data was collected mainly from the District. In some cases data was collected directly from the original source of the data. The USGS provided an excellent source for streamflow data and hydrography coverage. The Suwannee River Water Management District also had a MODFLOW model that covered the area of interest.

Model Collection

The MegaModel and the Suwannee River MODFLOW model were obtained from the St. Johns River Water Management District and the Suwannee River Water Management District, respectively, in order to evaluate all currently available models that fit the current needs of the District. Prior to selecting which model to utilize, both were compared and evaluated in order to determine which data set was the most complete and most suitable for the needs of the District.

Mega Model

The MegaModel is a steady state MODFLOW model consisting 4 layers which simulates average flow conditions for 1993 to 1994. Original MODFLOW 2000 files were obtained from the District and imported into Groundwater Vistas. The model domain extends northward to portions of Southern Georgia and southward into portions of Charlotte, Glades and Palm Beach counties. Layer descriptions are shown in Table 1. The model is discretized into a 5,000 foot by 5,000 foot grid consisting of 300 rows and

210 columns. Along the Gulf coast a region is defined as unconfined for the Floridan, where layer 3 is the upper most active layer. In that region, the model has active river cells in layer 3 which represent portions of the Suwannee, Santa Fe, Waccasassa, Steinhatchee, Withlacoochee, St. Johns, Ocklawaha, and Hillsborough Rivers. Layer 1 of the model is defined as constant heads, and therefore no hydrography existed in the original model conceptualization.

Table 1. MegaModel Layer Description

Layer Number	Description
1	Surficial Aquifer
2	Intermediate Aquifer
3	Upper Floridan Aquifer
4	Lower Floridan Aquifer

Suwannee River Model

The Suwannee River model is a steady state MODFLOW model developed by the Suwannee River Water Management District (with origins back to the Mega Model) to evaluate the effects of existing and proposed groundwater withdrawals. The model was originally created in GMS and imported from GMS to Groundwater Vistas by Jim Rumbaugh (who was selected to evaluate the SRWMD model). The Groundwater Vistas version of the Suwannee River Model was obtained for use in this project. The model is discretized into approximately 5000-foot cells (which are actually 4998 x 4988 ï feet, this was due to errors in coordinate conversions), with a total of 190 rows and 245 columns. The grid was to be coincident with the MegaModel but a slight rotation exists, again related to the coordinate shift. The model was calibrated to average groundwater heads and flows from June 1, 2001 to May 31, 2002. The model domain consists of the Suwannee River Water Management District plus portions of Southern Georgia and an area east of the District extending to the Atlantic Ocean. The model domains of the Suwannee River Model and the MegaModel are shown in Figure 1.

Model Comparison

The MegaModel and the Suwannee River MODFLOW model were compared in order to assess the differences in the models and respective model domains and evaluate which model would better be able to meet the current needs of the District with the least amount of modification. The model domains are shown in Figure 1. As shown in the Figure, the Suwannee River model extends further westward than the MegaModel. The SRWMD model also had issues with water above land as well as the poorly explained coordinate shift. After examination and comparison of the models and discussion with the District, it was decided to proceed with the use of the MegaModel. The proposed southern boundary for activating layer 1 is also shown in the Figure (see the cyan line in figure). Activating layer 1 to the extent of the cyan line eliminated a great deal of hydrography and hydrography calibration from this project. The extent of the activated layer 1 is sufficient to define impacts in the area of interest. The northwestern corner of the existing MegaModel was activated using the data from the SRWMD model to fill in the data gap. Properties from the Suwannee River Model, such as layer top and bottom elevations, were used to activate the northwestern corner of the MegaModel. The data was interpolated using an area weighted average since the cells were not coincident (see section below for more detail).

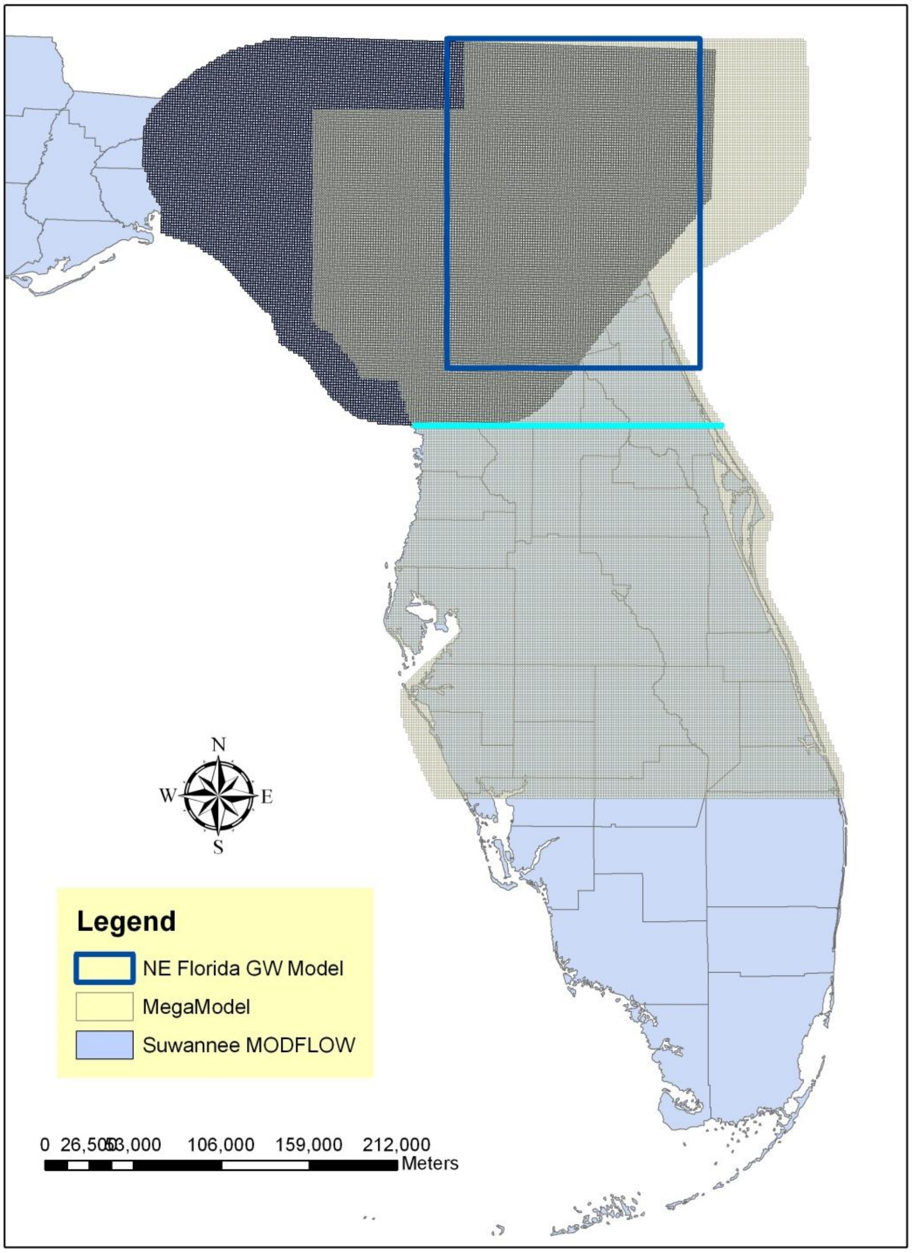


Figure 1. Model Domains and Proposed MegaModel Southern Boundary

Approach to MegaModel Update

Based on the evaluation of the available models and discussion with the District, it was decided that the utilization of the MegaModel would best suit the needs of the District. In order to allow for the evaluation of impacts to surface water hydrography (rivers and streams), the Surficial Aquifer (layer 1) of the MegaModel was updated by replacing the existing constant head layer with a river package, a recharge package, and active cells on layer 1. In order to add additional flux constraint to the model, observed (estimated) baseflows were compared to model generated baseflow. The river cells were systematically calibrated using common river cell characteristics based on Strahler ordering.

Data Collection

Additional data collection included the following:

- Hydrography from the National Hydrography Dataset (NHD),
- 1993-1994 and 2030 pumping data from GIS Associates,
- Updated head calibration targets from the District,
- USGS streamflow records for all available stations within the model domain.

The above data was used to develop the river package, update the well package, and provide flux and head constraint to the model.

USGS NHD

Hydrography was obtained from the National Hydrography Dataset (NHD), as shown in Figure 2. In order to develop a river package for layer 1, the NHD hydrography was processed in the GIS. First, the hydrography was classified using the Strahler reach ordering scheme. Next, the hydrography arcs were intersected with the MegaModel grid and the lengths of each arc were computed for each model cell. Lastly, additional river characteristics, defined by the Strahler reach order, were used to compute the necessary MODFLOW variables. The defined reach characteristics were calibrated in the data base and the NHD hydrography was incorporated into the MegaModel as additional river cells to be defined for the activated layer 1. The original layer 3 river cells were left on layer 3; all other river cells were placed on layer 1 after the constant head boundary condition was removed.

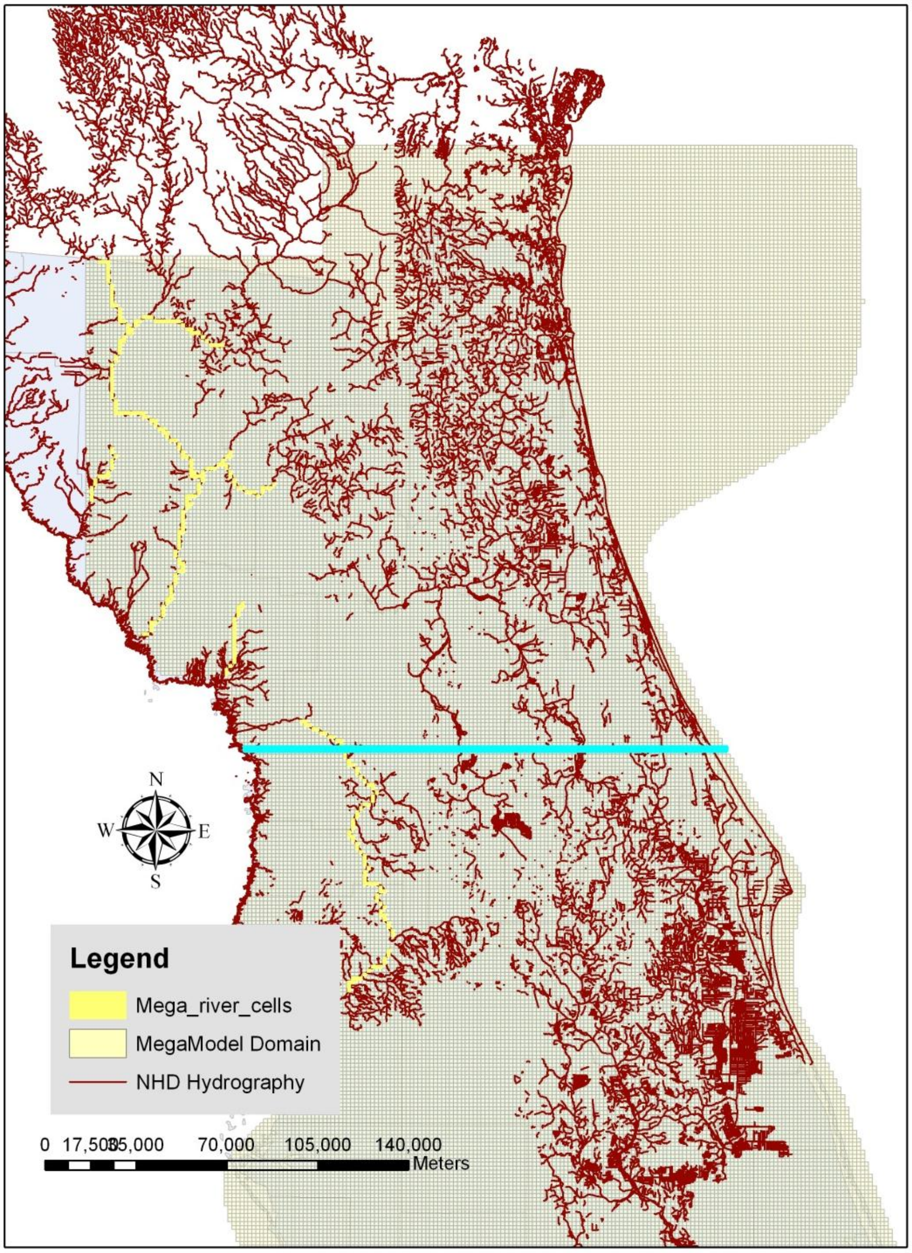


Figure 2. Existing Layer 3 River Cells and NHD Hydrography

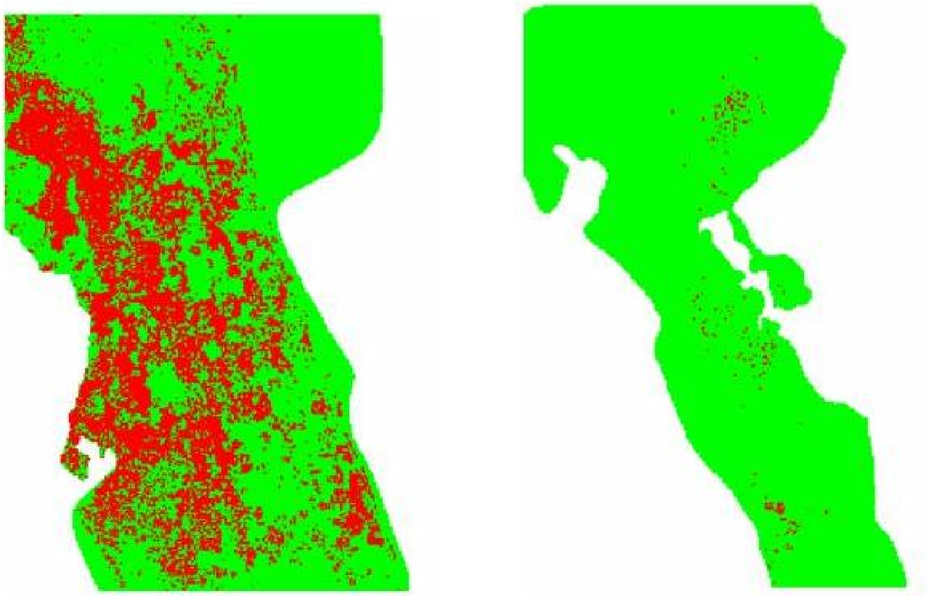
Pumping Data

Pumping data within the project area was provided by GIS Associates (GISA). GISA provided 1993-1994 pumping rates for rows 1 through 224 of the MegaModel. Due to an incomplete row 224, the original Sepulveda (2002) pumping for 1993-1994 was used for rows 224 through 300 for the 1993-1994 simulation. The locations of the wells are shown in Figures 3 and 4. A summary of wells per layer is shown in Table 2.

Layer 1

Layer 2

Figure 3. Pumping Well Locations, Layers 1 and 2



Layer 3

Layer 4

Figure 4. Pumping Well Locations, Layers 3 and 4

Table 2. Well Summary, 1993-1994 Simulation

Layer Number	Total Number of Wells
1	0
2	3162
3	18991
4	256

Projections for 2030 withdrawals were also provided by GISA for the northern portion of the MegaModel (from rows 1 through 223). Projected 2030 data was spliced with estimated 2020 pumping from the original Sepulveda model (2002) by GISA. The entire well package was provided by GISA in a database (USGS_2030_PFGWM.mdb). Due to sign convention issues in the data provided by GISA, the pumping rates for rows 1 through 223 were multiplied by -1. All pumping rates provided were converted into cubic feet per day and used to create the MegaModel well package for the 2030 simulation. A summary of the wells for the 2030 simulation is provided in Table 3.

Table 3. Well Summary, 2030 Simulation

Layer Number	Total Number of Wells
1	52
2	2785
3	34213
4	335

SJRWMD Calibration Targets

A total of 1156 calibration targets were provided by the District. Targets were provided for the surficial aquifer, intermediate aquifer, upper Floridan aquifer, and lower Floridan aquifer. These targets represent average water levels in monitoring wells (or surface water bodies) maintained by the District, the Southwest Florida Water Management District, the Suwannee River Water Management District, and the USGS (Florida and Georgia) for water year 1993-1994. Intermediate targets were removed since there is no real producing unit in northern Florida. Surficial targets were shifted given the delta between the local elevation (elevation at the well) and the average elevation of the cell (similar to the baseflow fluxes for rivers as shown in Figure 5). Several additional targets were removed after examination by the District for potential errors in readings. A total of 1013 targets were imported into the MegaModel. The targets are summarized by layer in Table 4 and shown in Figure 6. A complete description of all targets can be found in Appendix 1.

Table 4. Summary of Calibration Targets By Layer

Layer	Number of Targets
1	341
3	667
4	5

Groundwater Vistas has the ability to assign weights to targets when needed. The target weight is a multiplier which is applied to the residual error when computing statistics. By default, a weight of 1.0 is utilized for the calculation of statistics. For the case where there is more than 1 target within the same cell and the same layer, it is more appropriate to apply a weight to all targets within that cell so that the cell results are not over-represented when the residual statistics are calculated. For all targets, the weight applied to the target was calculated as:

$$W = \frac{1}{N} \qquad (1)$$

Where N is the total number of targets in a specific layer of a cell.

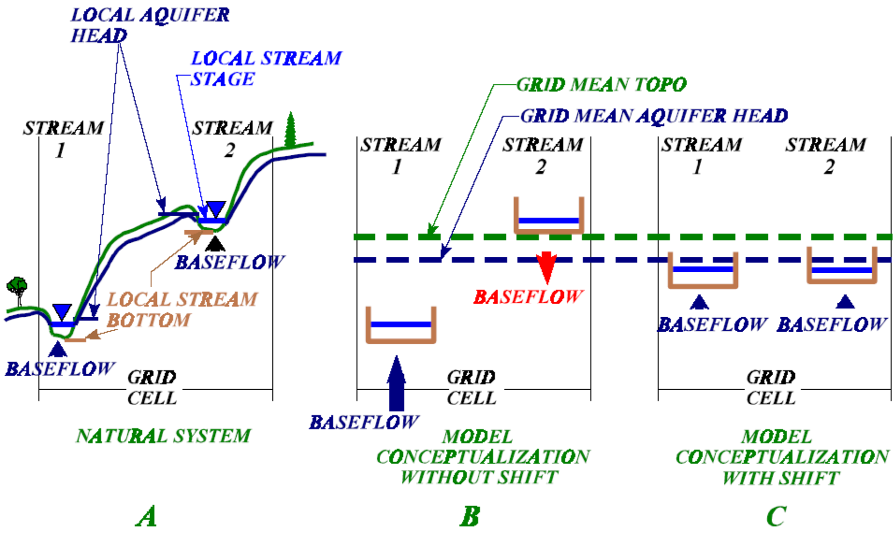


Figure 5. Topography Adjustment

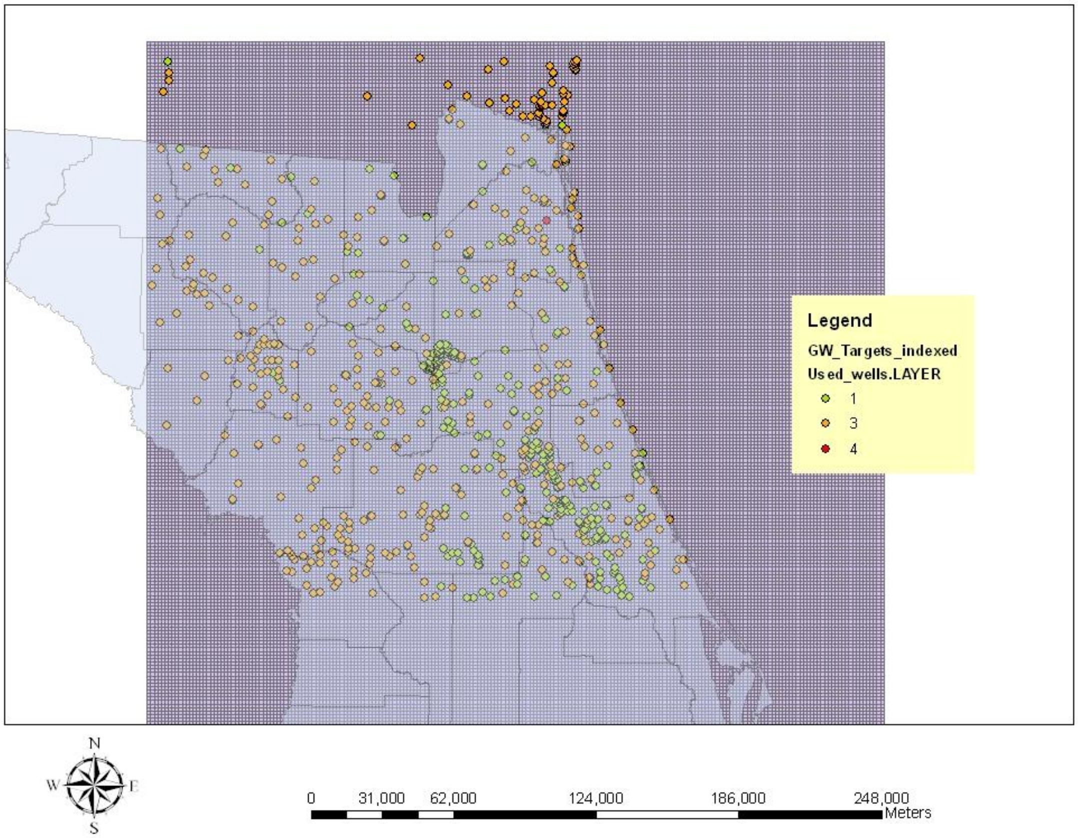


Figure 6. Groundwater Calibration Targets by Layer

USGS Flows and Baseflow Separation

USGS stream flow data was collected and analyzed in order to calculate base flow targets for use during calibration. Base flow targets were calculated using stream flow data from the calibration period (August 1993 to July 1994) and a low pass filter baseflow separation method. A moving 120 day window was utilized for base flow separation. For every given day, the minimum flow for a 120-day window (60 days prior and 60 after) was determined. Once the minimum 120-day flow was computed, the average of the minimums was calculated for each 120-day period (again 60 days prior and 60 days after). Examples of the base flow separation are shown in Figures 1 and 2. The resulting base flow targets are shown in Table 2 and Figure 3.

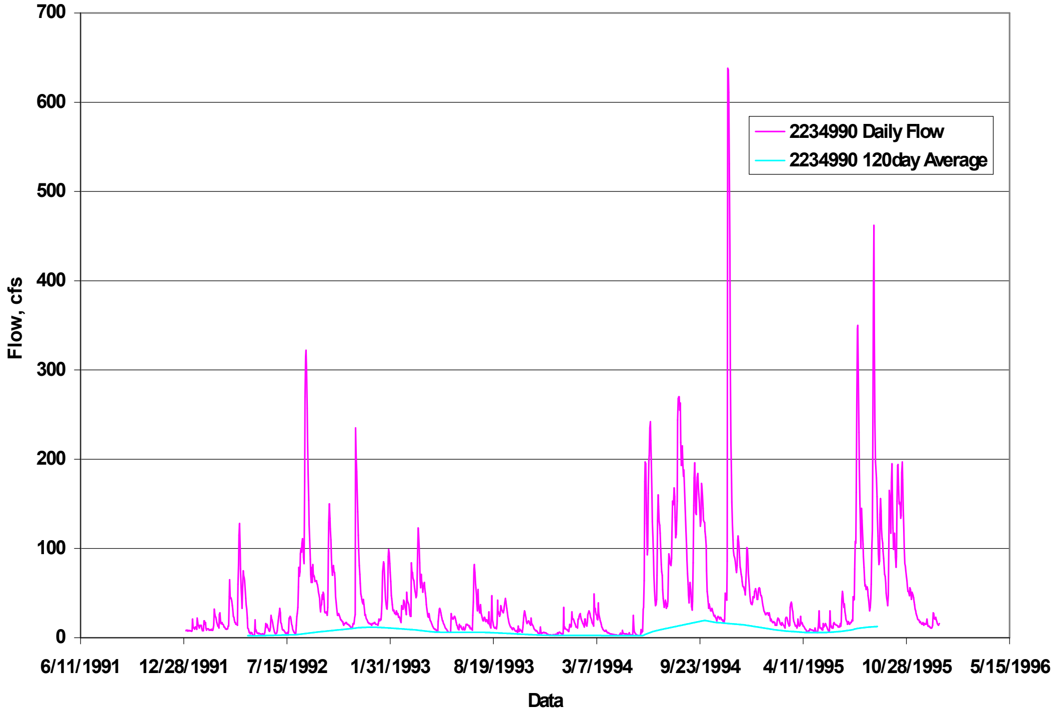


Figure 7. Little Wekiva River Near Altamonte Springs, Base Flow and Stream Flow

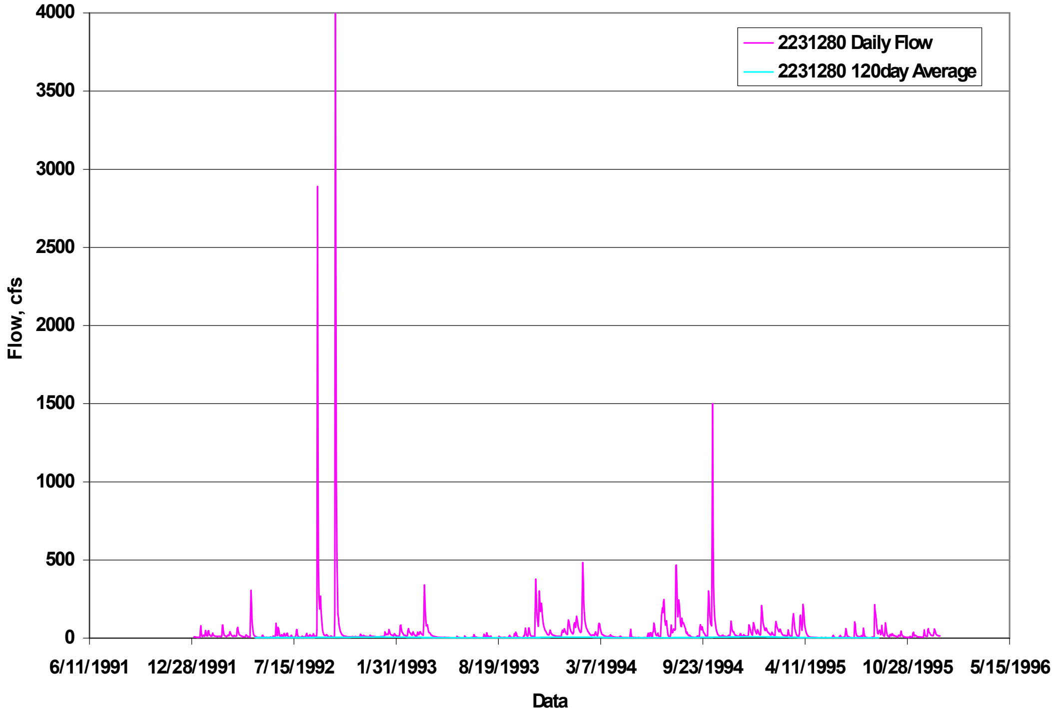


Figure 8. Thomas Creek near Crawford, Base Flow and Stream Flow

Table 5. Baseflow Summary by Reach

Station Number	Average Baseflow for 1993-1994	Station Name	REACHID
2319500	1915.34	SUWANNEE RIVER AT ELLAVILLE, FLA	4
2231268	0.49	ALLIGATOR CREEK AT CALLAHAN, FL	5
2231280	3.68	THOMAS CREEK NEAR CRAWFORD, FL	6
2246520	1.63	STRAWBERRY CREEK NEAR ARLINGTON, FL	7
2246515	2.09	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	8
2246300	2.72	ORTEGA RIVER AT JACKSONVILLE, FL	9
2321000	5.57	NEW RIVER NR LAKE BUTLER FLA	11
2321500	14.07	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	12
2321900	0.11	PARENERS BRANCH NEAR BLAND, FL.	13
2321975	154.47	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	14
2322616	0	CANNON CREEK NEAR LAKE CITY, FL	16
2315200	1.92	DEEP CREEK NR SUWANNEE VALLEY FL	17
2315500	147.72	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	18
2315000	117.27	SUWANNEE R NR BENTON FLA	19
2246828	9.53	PABLO CREEK AT JACKSONVILLE, FL	20
2246150	2	BIG DAVIS CREEK AT BAYARD, FL	21
2234384	1.14	SOLDIER CREEK NEAR LONGWOOD, FL	23
2234400	2	GEE CREEK NEAR LONGWOOD, FL	24
2234324	3.15	HOWELL CREEK NEAR SLAVIA, FL	25
2312667	2.86	SHADY BROOK NEAR SUMTERVILLE, FL	26
2312700	72.79	OUTLET RIVER AT PANACOOCHEE RETREATS, FL	27
2315550	330.68	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	33
2228500	7.47	NORTH PRONG ST. MARYS RIVER AT MONIAC, GA	34
2229000	2.06	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	35
2231000	53.26	ST. MARYS RIVER NEAR MACCLENNY, FL	36
2244473	3.27	RICE CREEK NEAR SPRINGSIDE	37
2323500	4318.24	SUWANNEE RIVER NEAR WILCOX, FLA.	38
2246000	29.02	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	39
2239501	607.96	SILVER RIVER NEAR OCALA, FL	44
2240000	643.75	OCKLAWAHA RIVER NEAR CONNER, FL	45
2240500	659.34	OCKLAWAHA RIVER AT EUREKA, FL	46
2242451	0	ORANGE LAKE OUTLET NEAR CITRA, FL	47
2243000	2.88	ORANGE CREEK AT ORANGE SPRINGS, FL	48
2246359	1.9	CEDAR RIVER AT MARIETTA, FL	49
2245500	21.54	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	51
2245140	8.87	SIMMS CREEK NEAR BARDIN, FL	52
2244320	0.3	MIDDLE HAW CREEK NR KORONA, FLA.	55
2244420	2.13	LITTLE HAW CREEK NEAR SEVILLE, FL	56
2245255	0.6	DEEP CREEK NEAR HASTINGS, FL	58
2320700	1.46	SANTA FE RIVER NEAR GRAHAM, FLA.	61
2248000	0.9	SPRUCE CREEK NEAR SAMSULA, FL	62
2247510	1.7	TOMOKA RIVER NEAR HOLLY HILL, FL	63

Based on the base flow targets shown in Table 5, reach identification numbers (ReachIDs) were assigned to each reach in the model domain. The NHD hydrography was intersected with the MegaModel domain, and then assigned a reach number based on the table above.

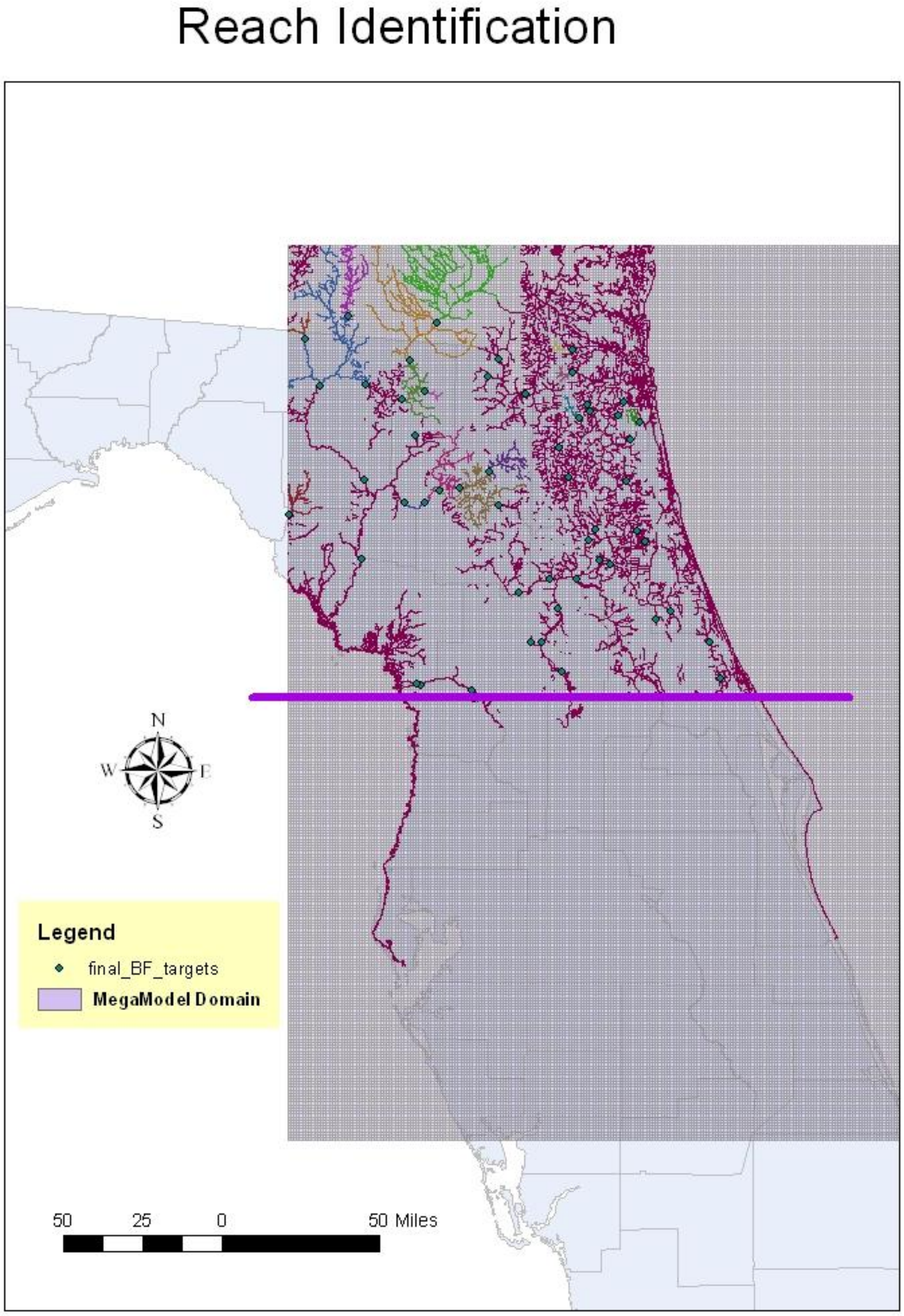


Figure 9. Reach Identification

All ungauged hydrography was assigned reach identification numbers according to Table 6. Reach numbers were assigned in order to allow for easier database and GIS analyses.

Table 6. Additional Reach Identification Numbers

ReachID	Description
101	Ungauged St. Maryôs River
102	Ungauged St. Johns River
103	Ungauged Waccasassa River
104	Ungauged Suwannee River
105	Ungauged Withlacoochee River
200	Coastal Suwannee
201	Coastal St. Johns
300	Coastline
301	Dead Ends
999	Outside Model Domain

Model Modifications

Modifications to the MegaModel were made on both a global and a regional scale. Global updates included land surface elevation, water table elevation, calibration targets, and pumping updates. Regional properties were modified in the Northwest corner of the MegaModel, which was previously inactive (Sepulveda, 2002). Activation of this corner of the model included updating layer bottom elevations, initial heads, hydraulic conductivities, and leakance values.

Global Updates

Global updates to the MegaModel were performed where better data were available. Data know to prone to error was the pumping database. Also the targets were improved upon as compared to the original work from Sepulveda (2002). Details of the model update are listed in the following sections.

Updated Top Elevation and Water Table

An updated DEM was provided by the District, as shown in Figure 10. The District provided a shapefile (megapol_polygon_wt.shp) which contained an updated land surface elevation and water table elevation for each cell within the MegaModel. The updated water table is shown in Figure 11. The water table elevation was calculated by the District based on equations in Sepulveda (2002) which relate the depth of the water table to physiographic region. Using the shapefile provided by the District, the depth to water table was calculated. Where the depth to water table was negative (ie. water above land), the water table elevation was corrected and set equal to land surface elevation. These arrays were exported to ASCII files and imported into the MegaModel dataset using Groundwater Vistas.

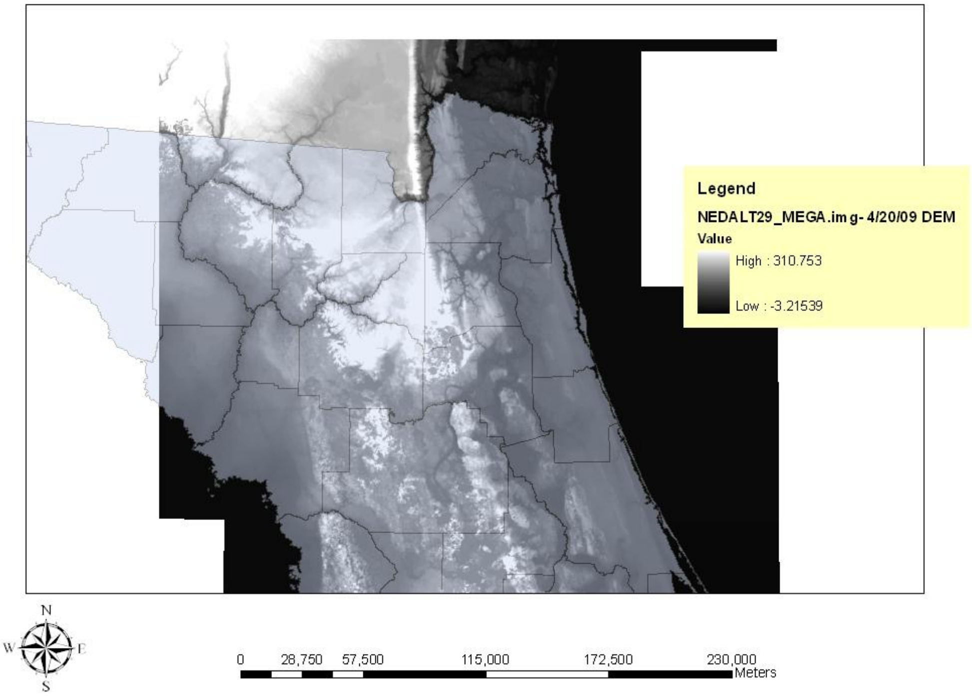


Figure 10. Updated Digital Elevation Model (DEM)

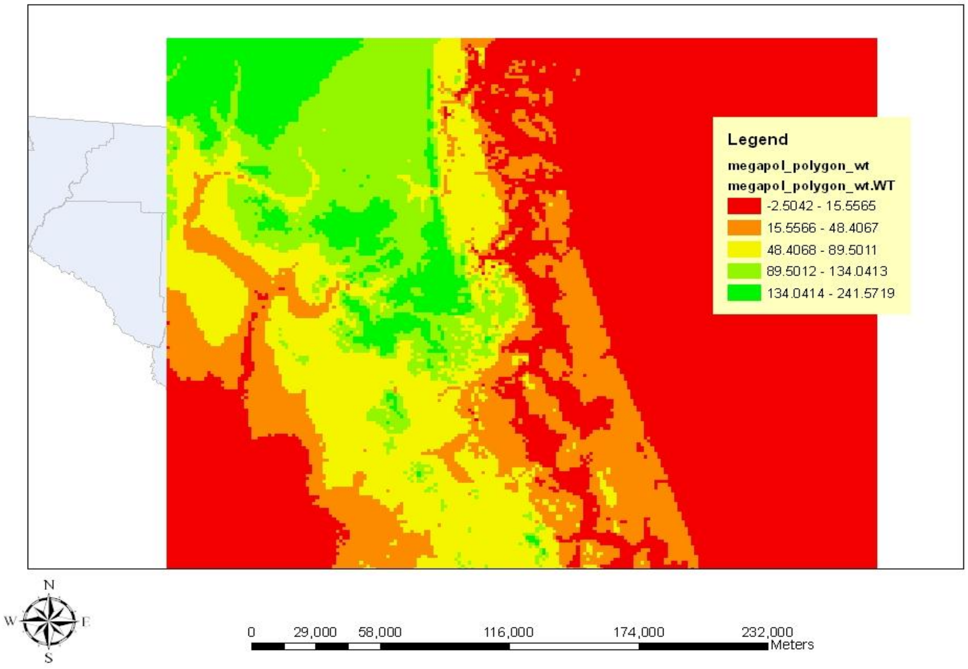


Figure 11. Updated Water Table Elevation

Updated Targets

All targets were provided by the District as described in the *SJRWMD Targets* section of this report. The targets were exported from the database into an ASCII file and imported into the MegaModel. The computed weights for each target, described in the sections above, were also imported into Groundwater Vistas.

Updated Pumping

For the 1993-1994 simulation, pumping provided by GISA was used from rows 1 through 223. Original Sepulveda (2002) pumping rates were used for rows 224 through 300. The new pumping was imported into the MegaModel using Groundwater Vistas.

Northwest Corner

The northwest corner of the original MegeModel (Sepulveda, 2002) was defined with inactive cells. This corner was activated so that impacts from groundwater pumping could be evaluated. There was very limited data in this region so the certainties of the model results are limited.

GIS Intersection: Area Weighted Averaging

Properties were assigned to the inactive Northwest corner of the MegaModel using the properties from the existing Suwannee River MODFLOW model. A close-up of the 2 model grids is shown in Figure 12. As shown in the figure, the grids are not coincident. The 2 grids were intersected using GIS, and area weighted averaging was used to assign properties to the MegaModel cells. The activated corner included all cells in rows 1 through 26 and columns 1 through 60, for a total of 1560 cells. The following properties were assigned using the area weighted averaging from the Suwannee MODFLOW model:

- Layer top elevations (layers 2, 3, and 4)
- Layer bottom elevations (layers 1, 2, 3, and 4)
- Leakance (layers 1, 2, and 3)
- Hydraulic conductivity (layers 1, 2, 3 and 4)
- Initial heads (layers 2, 3, and 4)

Due to differences in aquifer stratigraphy between the models, properties from layer 5 of the Suwannee River Model were used for layer 4 of the MegaModel. Additionally, the top of layer 1 (land surface elevation) and the initial head in layer 1 were not obtained using area weighted averaging. These properties were updated globally for the entire model domain using data provided by the District.

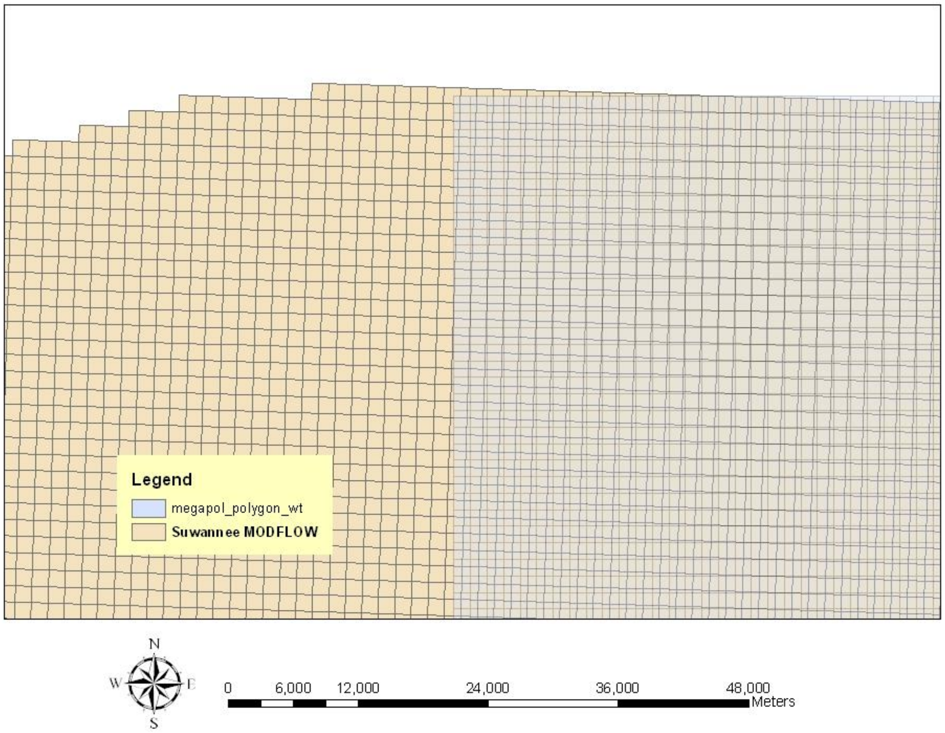
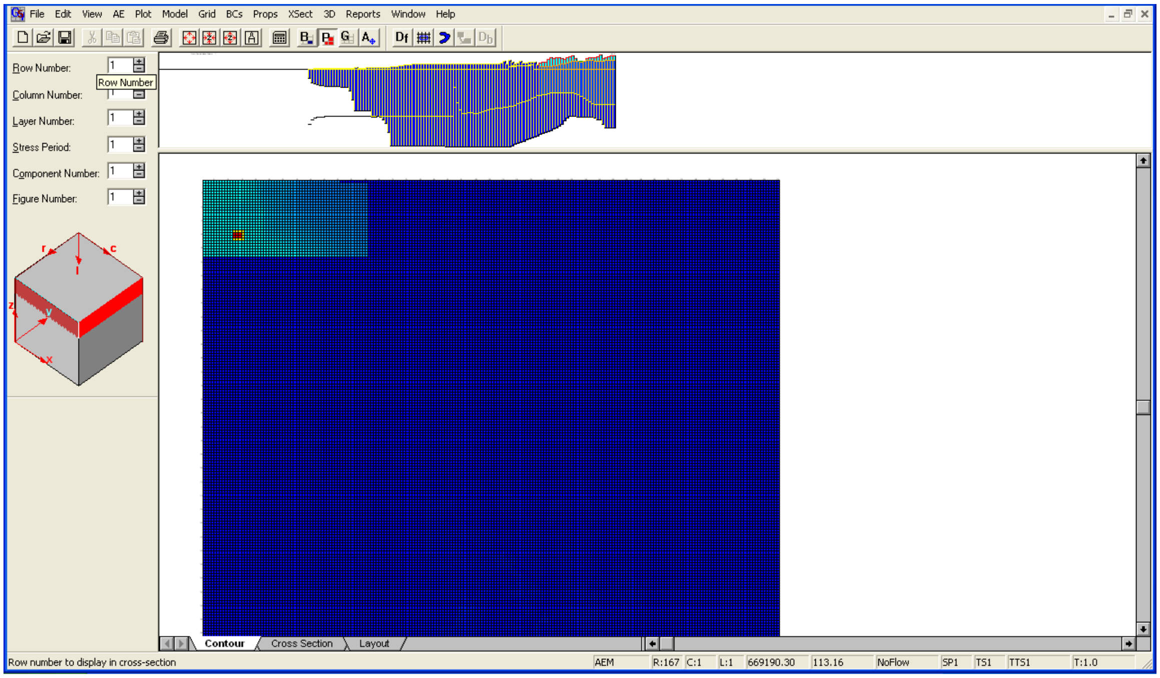


Figure 12. Overlay of MegaModel and Suwannee River Model

The original Suwannee River model utilized the .lpf package, while the MegaModel uses the .bcf package. Leakance values are included in the .bcf package, but not in the .lpf package. The .bcf package was created for the Suwannee River Model in Groundwater Vistas. The BCF package parameters were exported from Groundwater Vistas and imported into a database in order to calculate area weighted average leakance values for each cell in the Northwest corner of the MegaModel. These values were used to update the leakance array, as shown in Figure 13.



Row Number: 1
Column Number: 1
Layer Number: 1
Stress Period: 1
Component Number: 1
Figure Number: 1

Row number to display in cross-section

AEM | R:167 | C:1 | L:1 | 669190.30 | 113.16 | NoFlow | SP1 | TS1 | TTS1 | T:1.0

Figure 13. Leakance Array with Northwest Corner Activated

Modified Mega Model Calibration

After all the model modifications were completed the model was cursorily calibrated. This effort relied heavily on the original calibration as a comprehensive model calibration was out of the project scope. The calibration focused on the added features: northwest corner and the springs and river cells. All model calibration was performed with the layer 1 defined with constant head cells. The calibrated model was then used to define the fluxes from the surficial and therefore define the recharge package when the layer 1 was activated.

Northwest Corner Leakance

As shown in the figure, there is a clear discontinuity between the leakance values from the original MegaModel and those calculated using the Suwannee MODFLOW model. Table 7 shows a comparison of the order of magnitude of the Suwannee MODFLOW leakance values to the MegaModel leakance values.

Table 7. Leakance Magnitude Comparison

Layer	Suwannee Model (ft/day)	MegaModel (ft/day)
1	10^{-3}	10^{-5}
2	10^{-3}	10^{-5}
3	10^{-3}	10^{-4} ï 10^{-6}

There are only three observation points in the northwest corner. With so few observations, any parameter adjustment would be poorly constrained. Given the poor constraint, the residuals at the observation points, shown in Table 8, clearly showed the need for marked improvement in model performance. The obvious parameter to adjust was the leakance.

Table 8. Available Targets in Northwest Corner

Target Number	SiteID	Layer (Aquifer)	Residual before leakance adjustment	Residual after leakance adjustment
1139	3054210831530	3 (UF)	-109.62	-13.51
1137	3052410831544	3 (UF)	-106.62	-2.63
1132	3049490831653	3 (UF)	-103.41	-7.48

Given the discrepancy in the leakance values from the SRWMD model (see Figure 13), the leakance values for the Northwest corner of the MegaModel were divided by 100 in order to create a more continuous array in the MegaModel. When the model was run with the new leakance array, the weighted mean residual error decreased when compared to the model run using the original area weighted leakance array. A comparison of the residual statistics is shown in Table 8. (Note that the residual for a target is calculated as the observed target value minus the simulated value). As shown in the table, the residual mean and standard deviation improved when the leakance values were calibrated. Due to the improvement in residuals and the more continuous leakance array, the adjusted leakance values were utilized for the Northwest corner of the model.

Table 9. Residual Statistic Comparison with Leakance Aqjustment

	MegaModel using Suwannee Leakance in Northwest Corner	MegaModel using *Adjusted* Suwannee Leakance in Northwest Corner
Non-weighted Residual Mean	-1.12	0.95
Non-weighted Residual Standard Deviation	11.46	8.98
Weighted Residual Mean	-1.01	0.57
Weighted Residual Standard Deviation	9.36	6.39

Existing Springs and Rivers

The existing 156 springs in the MegaModel were calibrated in order to improve the baseflow calibration and produce more accurate river fluxes. Springs were represented in the MegaModel as both river cells and drains. Flow from springs outside river cells was simulated by drain cells, while flow from springs in river cells was simulated as the flow from the aquifer to the river. Baseflow from the additional river cells could not be calibrated until the existing spring flow and river cells were calibrated. The existing drains and river cells are shown in Figure 14, along with additional river cells. All springs were simulated on layer 3, which represents the Upper Floridan Aquifer. Springs were calibrated by modifying the conductance of individual springs in the model. Each spring was assigned to a river reach based on its location in order to include the spring flux in the baseflow calibration. Observed spring flow rates were obtained from Sepulveda (2002). The calibrated spring flows are shown in Figure 15 and Table 10. As shown in the table, there is good agreement between the observed spring flow and model predicted spring flow, with a correlation coefficient of 0.9867 and a trend line slope of 0.9962. A trend line slope of unity would indicate no bias in the model, while a slope of slightly less than unity indicates a very slight bias towards underestimation of flow by the model. Springs were calibrated prior to baseflow and river cell calibration by modifying the conductance values for each spring until there was good agreement between observed and simulated spring flow.

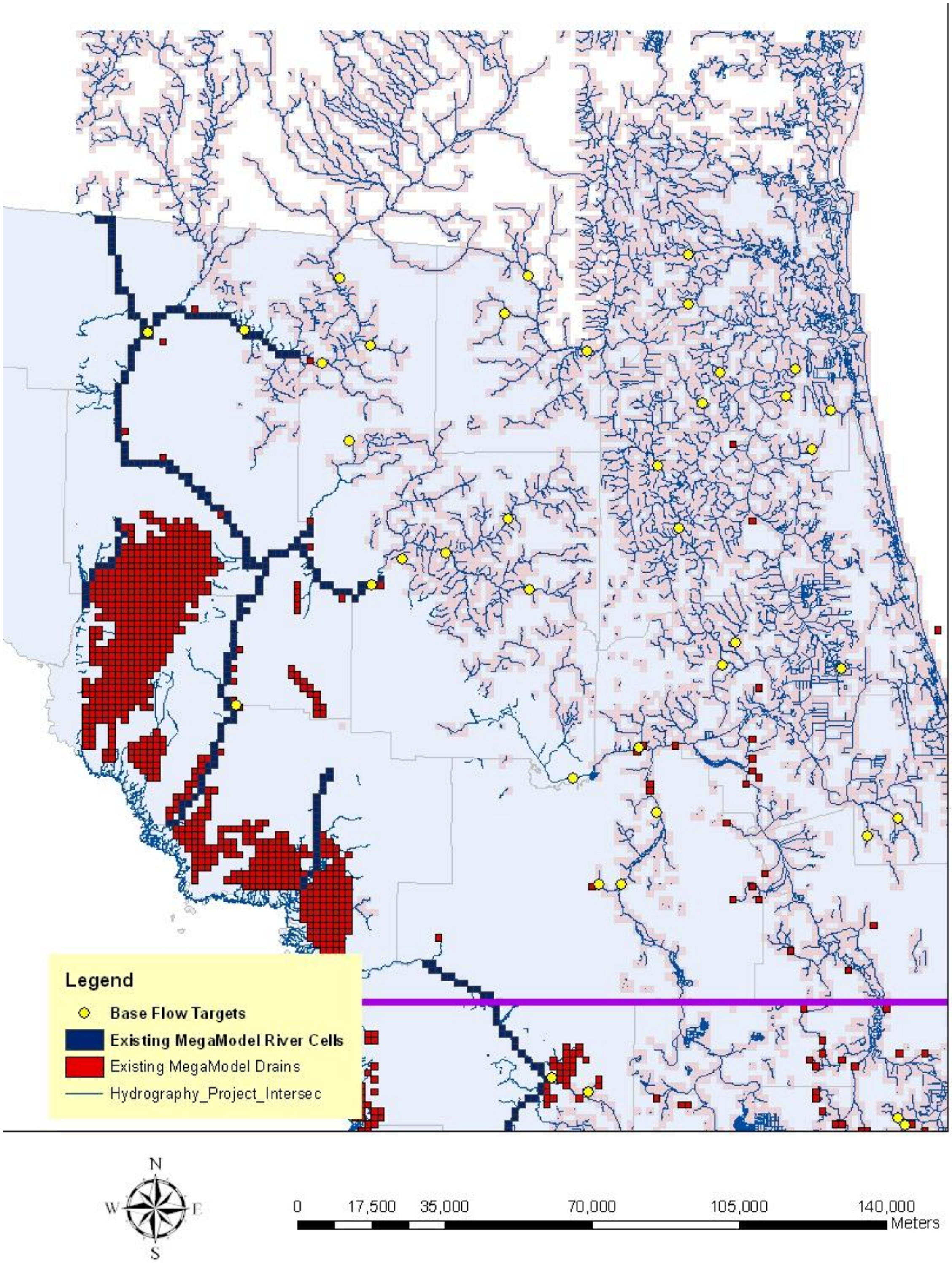


Figure 14. Existing River and Drain Cells and Additional River Cells

Table 10. Comparison of Measured and Model Estimated Spring Flow. Note: Measured Flows from (Sepulveda, 2002).

Row	Col.	GridID	Spring_name	Boundary Type	Measured Flow, cfs	Simulated Flow, cfs	Residual	Percent Error
41	7	41007	Blue Spring near Madison	River	118	101.34	16.66	14.12
44	17	44017	Alapaha Rise near Fort Union	River	427	408.13	18.87	4.42
44	19	44019	Holton Spring near Fort Union	Drain	12.5	14.02	-1.52	-12.16
47	27	47027	Suwannee Springs near Live Oak	River	9.8	6.22	3.58	36.53
48	12	48012	Suwanacoochee Spring and Ellaville Spring at Ellaville	River	112	112.23	-0.23	-0.21
49	14	49014	Falmouth Spring at Falmouth	Drain	134	148.34	-14.34	-10.70
52	37	52037	White Sulphur Springs at White Springs	Drain	42.3	89.86	-47.56	-112.43
63	8	63008	Charles Springs near Dell	Drain	4.7	5.09	-0.39	-8.30
64	7	64007	Allen Mill Pond Spring near Dell	River	12.2	12.26	-0.06	-0.49
65	103	65103	Wadesboro Spring near Orange Park	Drain	1	0.99	0.01	1.00
66	8	66008	Blue Spring near Dell	River	70	61.43	8.57	12.24
67	14	67014	Peacock Springs	Drain	81.1	86.08	-4.98	-6.14
68	12	68012	Telford Spring at Luraville	River	35.8	36.2	-0.4	-1.12
68	15	68015	Running Springs (East and West) near Luraville	River	88	98.88	-10.88	-12.36
69	16	69016	Convict Spring near Mayo	River	1.1	1.51	-0.41	-37.27
70	17	70017	Royal Spring near Alton	River	1.9	1.85	0.05	2.63
72	19	72019	Owens Spring	River	43.3	51.4	-8.1	-18.71
73	20	73020	Mearson Spring near Mayo	River	51	64.93	-13.93	-27.31
75	22	75022	Troy Spring near Branford	River	132	141.55	-9.55	-7.23
76	23	76023	Ruth Spring near Branford	Drain	7.5	19.61	-12.11	-161.47
76	24	76024	Little River Springs near Branford	River	67	53.33	13.67	20.40
77	37	77037	Ichetucknee Head Spring near Fort White and Cedar Head Spring	Drain	49	43.01	5.99	12.22
77	106	77106	Green Cove Springs at Green Cove Springs	Drain	3	2.93	0.07	2.33
78	37	78037	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	River	258	246.16	11.84	4.59
79	26	79026	Branford Springs at Branford	River	35.8	36.38	-0.58	-1.62
81	37	81037	Jamison Spring	Drain	3	1.86	1.14	38.00
87	2	87002	Steinhatchee Spring near Clara	River	0.7	1.18	-0.48	-68.57
87	29	87029	Turtle Spring near Hatchbend and Fletcher Spring	River	61.9	52.04	9.86	15.93
87	48	87048	Hornsby Spring near High Springs	Drain	49.8	53.26	-3.46	-6.95
88	41	88041	Ginnie Spring near High Springs	River	57.1	49.83	7.27	12.73
89	42	89042	Blue Springs near High Springs (including Lilly Springs)	Drain	41.2	39.5	1.7	4.13
89	44	89044	Poe Springs near High Springs	River	53.6	56.36	-2.76	-5.15
91	27	91027	Rock Bluff Springs near Bell	River	33.2	42.16	-8.96	-26.99

Row	Col.	GridID	Spring_name	Boundary Type	Measured Flow, cfs	Simulated Flow, cfs	Residual	Percent Error
92	26	92026	Guaranto Spring near Rock Bluff Landing	River	12	2.94	9.06	75.50
94	135	94135	Crescent Beach Submarine Spring	Drain	30	41.03	-11.03	-36.77
97	26	97026	Lumbercamp Springs and Sun Springs near Wannee	Drain	46.3	52.32	-6.02	-13.00
100	25	100025	Hart Springs near Wilcox	Drain	90.8	95.79	-4.99	-5.50
102	25	102025	Otter Springs near Wilcox	Drain	16	6.24	9.76	61.00
103	107	103107	Whitewater Springs	Drain	1.2	1.02	0.18	15.00
104	23	104023	Copper Springs near Oldtown (including Little Copper Spring)	River	25.4	27.16	-1.76	-6.93
105	25	105025	Bell Springs	Drain	5.1	1.68	3.42	67.06
106	26	106026	Fannin Springs near Wilcox (including Little Fannin Spring)	Drain	97.7	88.86	8.84	9.05
111	106	111106	Satsuma Spring	Drain	1.1	0.89	0.21	19.09
112	89	112089	Orange Spring at Orange Springs	Drain	2	1.29	0.71	35.50
112	94	112094	Blue Springs near Orange Springs	Drain	0.5	0.43	0.07	14.00
113	23	113023	Manatee Spring near Chiefland	Drain	187	198.61	-11.61	-6.21
113	88	113088	Camp Seminole Spring at Orange Springs	Drain	0.8	0.24	0.56	70.00
114	106	114106	Welaka Spring near Welaka	Drain	1	0	1	100.00
116	40	116040	Blue Spring near Bronson	River	8	8.11	-0.11	-1.38
116	106	116106	Mud Spring near Welaka	Drain	2.3	1.94	0.36	15.65
117	107	117107	Beecher Springs near Fruitland	Drain	6.3	6.15	0.15	2.38
118	90	118090	Tobacco Patch Landing Spring Group near Fort McCoy	Drain	1	0.82	0.18	18.00
118	105	118105	Croaker Hole Spring near Welaka	Drain	90.3	87.69	2.61	2.89
119	90	119090	Wells Landing Springs near Fort McCoy	Drain	5	3.87	1.13	22.60
124	102	124102	Salt Springs near Eureka	Drain	79	74.23	4.77	6.04
129	43	129043	Wekiva Springs near Gulf Hammock	Drain	45.4	45.24	0.16	0.35
132	108	132108	Silver Glen Springs near Astor	Drain	100	81.66	18.34	18.34
134	81	134081	Silver Springs near Ocala	Drain	640	641.55	-1.55	-0.24
134	106	134106	Sweetwater Springs along Juniper Creek	Drain	12.5	12.49	0.01	0.08
136	103	136103	Juniper Springs and Fern Hammock Springs near Ocala	Drain	18.8	6.97	11.83	62.93
136	107	136107	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	Drain	3	4.53	-1.53	-51.00
140	125	140125	Ponce de Leon Springs near De Land	Drain	24.3	22.12	2.18	8.97
142	57	142057	Rainbow Springs near Dunnellon	Drain	637	614.27	22.73	3.57
144	112	144112	Alexander Springs near Astor	Drain	113	99.7	13.3	11.77
147	121	147121	Mosquito Springs Run Alexander Springs Wilderness	Drain	2	0.22	1.78	89.00
151	64	151064	Wilson Head Spring near Holder	River	1.9	2.5	-0.6	-31.58

Row	Col.	GridID	Spring_name	Boundary Type	Measured Flow, cfs	Simulated Flow, cfs	Residual	Percent Error
151	65	151065	Blue Spring near Holder	River	10.6	10.71	-0.11	-1.04
152	70	152070	Gum Springs near Holder	Drain	67.6	68.38	-0.78	-1.15
153	114	153114	Camp La No Che Springs near Paisley	Drain	1	0	1	100.00
153	127	153127	Blue Spring near Orange City	Drain	135	121.96	13.04	9.66
157	46	157046	Crystal River Spring Group	Drain	613.2	699.5	-86.3	-14.07
158	117	158117	Blackwater Springs near Cassia	Drain	1.4	0	1.4	100.00
159	79	159079	Little Jones Creek Head Spring near Wildwood	Drain	8	7.54	0.46	5.75
160	79	160079	Little Jones Creek Spring No. 2 near Wildwood	Drain	5	4.87	0.13	2.60
160	117	160117	Messant Spring near Sorrento	Drain	12	11.38	0.62	5.17
160	129	160129	Gemini Springs near DeBary (all 3)	Drain	10.5	9.94	0.56	5.33
160	133	160133	Green Springs	Drain	0.3	0.23	0.07	23.33
161	80	161080	Little Jones Creek Spring No. 3 near Wildwood	Drain	3	2.92	0.08	2.67
161	115	161115	Seminole Springs near Sorrento	Drain	37	15.46	21.54	58.22
161	120	161120	Palm Springs Seminole State Forest	Drain	0.5	1.2	-0.7	-140.00
162	47	162047	Halls River Head Spring	Drain	4.8	5.08	-0.28	-5.83
162	116	162116	Droty Springs near Sorrento	Drain	0.6	0.17	0.43	71.67
162	122	162122	Island Spring near Sanford	Drain	6.4	6.88	-0.48	-7.50
163	46	163046	Halls River Springs	Drain	102.2	111.09	-8.89	-8.70
164	47	164047	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	Drain	120.7	133.11	-12.41	-10.28
164	82	164082	Fenney Springs near Coleman Head Spring of Shady Brook Creek	Drain	15	12.21	2.79	18.60
165	82	165082	Shady Brook Creek Springs No. 2 and 3	Drain	5.8	5.83	-0.03	-0.52
166	47	166047	Hidden River Springs near Homosassa (including Hidden River Head Spring)	Drain	6.7	7.66	-0.96	-14.33
166	80	166080	Shady Brook Creek Spring No. 4	Drain	2.9	2.93	-0.03	-1.03
166	116	166116	Sulphur Camp Springs	Drain	0.6	2.02	-1.42	-236.67
167	79	167079	Shady Brook Creek Spring No. 5	Drain	2.9	2.97	-0.07	-2.41
167	91	167091	Bugg Spring at Okahumpka	Drain	8.6	9.09	-0.49	-5.70
167	116	167116	Rock Springs near Apopka	Drain	53	62.25	-9.25	-17.45
168	46	168046	Potter Spring near Chassahowitzka (including Ruth Spring)	Drain	14.4	16.37	-1.97	-13.68
168	95	168095	Mooring Cove Springs near Yalaha	Drain	0.4	0	0.4	100.00
168	96	168096	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	Drain	6.6	8.83	-2.23	-33.79
169	47	169047	Salt Creek Head Spring	Drain	0.4	0.44	-0.04	-10.00
169	48	169048	Lettuce Creek Spring	Drain	3.7	4.38	-0.68	-18.38

Row	Col.	GridID	Spring_name	Boundary Type	Measured Flow, cfs	Simulated Flow, cfs	Residual	Percent Error
169	117	169117	Witherington Spring near Apopka	Drain	1	1.62	-0.62	-62.00
170	47	170047	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	Drain	23.7	27.57	-3.87	-16.33
170	48	170048	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	Drain	99.6	113.09	-13.49	-13.54
171	46	171046	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	Drain	7.3	8.84	-1.54	-21.10
171	47	171047	Rita Maria Spring near Chassahowitzka	Drain	3.3	4.12	-0.82	-24.85
171	119	171119	Wekiwa Springs in State Park near Apopka	Drain	56.5	68.52	-12.02	-21.27
171	120	171120	Miami Springs near Longwood	Drain	4	4.96	-0.96	-24.00
171	131	171131	Lake Jesup Spring near Wagner	Drain	0.6	3.47	-2.87	-478.33
172	45	172045	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	Drain	27.3	36.21	-8.91	-32.64
172	46	172046	Blue Run Head Spring near Chassahowitzka	Drain	4.6	5.51	-0.91	-19.78
172	123	172123	Palm Springs and Sanlando Springs near Longwood	Drain	22.6	35.17	-12.57	-55.62
172	124	172124	Starbuck Spring near Longwood	Drain	12.3	18.98	-6.68	-54.31
172	133	172133	Clifton Springs near Oviedo	Drain	1.5	12.38	-10.88	-725.33
173	44	173044	Unnamed Spring No. 8	Drain	4.9	7.36	-2.46	-50.20
173	101	173101	Double Run Road Seepage near Astatula	Drain	2	4.85	-2.85	-142.50
174	44	174044	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	Drain	42.7	42.06	0.64	1.50
181	105	181105	Apopka (Gourdneck) Spring near Oakland	Drain	31.4	34.43	-3.03	-9.65
182	44	182044	Unnamed Spring No. 6	Drain	2.8	7.15	-4.35	-155.36
182	45	182045	Salt Spring and Mud Spring near Bayport	Drain	39.3	30.84	8.46	21.53
184	44	184044	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	Drain	21.6	43.4	-21.8	-100.93
184	48	184048	Weeki Wachee Springs near Brooksville	Drain	129	198.6	-69.6	-53.95
188	43	188043	Unnamed Spring No. 2	Drain	0.7	1.7	-1	-142.86
190	42	190042	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	Drain	7.2	10	-2.8	-38.89
190	43	190043	Bobhill Springs	Drain	1.8	6.45	-4.65	-258.33
193	40	193040	Horseshoe Spring near Hudson	Drain	9.7	7	2.7	27.84
193	41	193041	Unnamed Spring No. 3 near Aripeka	Drain	17.8	21.53	-3.73	-20.96
200	38	200038	Salt Springs near Port Richey	Drain	8.2	10.97	-2.77	-33.78
209	72	209072	Crystal Springs near Zephyrhills	River	37	32.66	4.34	11.73
220	55	220055	Sulphur Springs at Sulphur Springs	Drain	25	24.24	0.76	3.04
221	61	221061	Lettuce Lake Spring	Drain	8.3	7.64	0.66	7.95
221	62	221062	Six-Mile Creek Spring and Eureka Springs near Tampa	Drain	2.6	2.4	0.2	7.69
230	64	230064	Buckhorn Spring near Riverview	Drain	15	12.2	2.8	18.67

Row	Col.	GridID	Spring_name	Boundary Type	Measured Flow, cfs	Simulated Flow, cfs	Residual	Percent Error
232	69	232069	Lithia Springs Minor and Lithia Springs Major near Lithia	Drain	39.1	30.84	8.26	21.13
289	68	289068	Little Salt Spring near Murdock	Drain	0.9	0.87	0.03	3.33
290	67	290067	Warm Mineral Springs near Woodmere	Drain	6.7	6.56	0.14	2.09

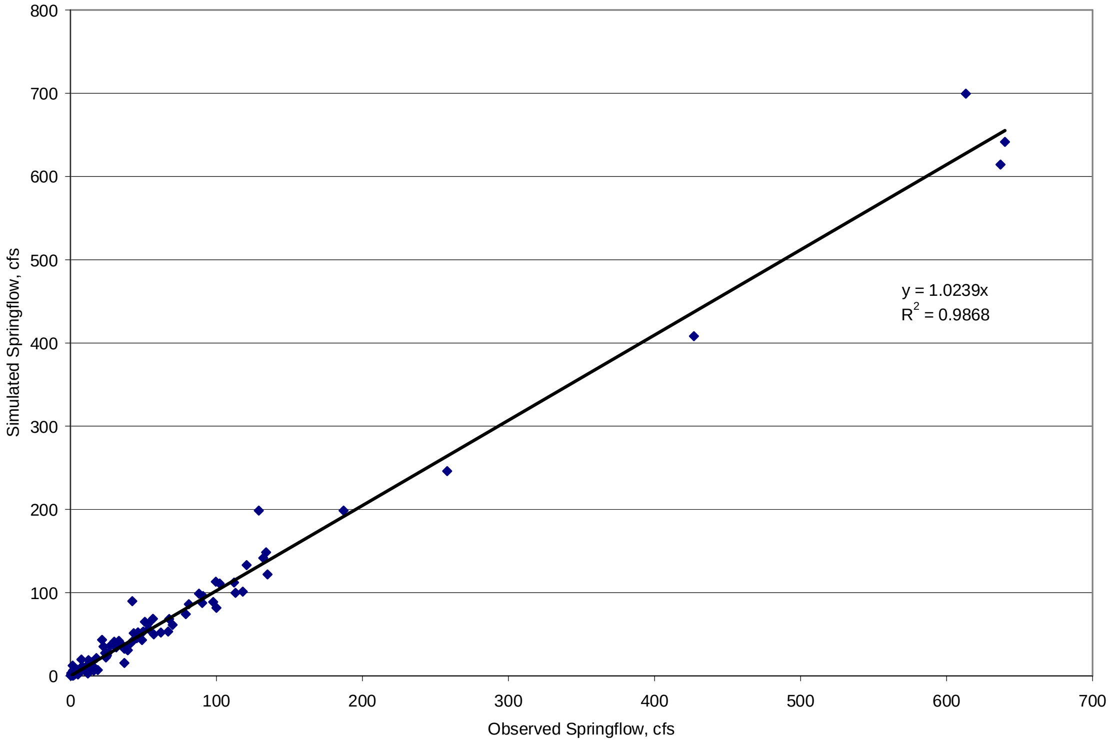


Figure 15. Observed versus Simulated Springflow (Drain and River Cells)

River Calibration

After the calibration of the existing springs and rivers, the new rivers were calibrated together within the context of the total baseflow calibration. River cells were assigned a Strahler stream order through the use of a GIS utility. The reach properties (based on stream order, as shown in Table 11 and Figure 17) were calibrated to match stream baseflows based on the accumulated fluxes. For each reach, the calculated river fluxes were summed and compared to the existing baseflow targets in a database.

Table 11. Reach Characteristics

Strahler Order	Width, ft. [w]	Depth of bed, ft.[D_b]	Depth of Water above Bed, ft. [D_w]	Vertical Conductivity [Kv]	Bed thickness, ft. [b]
1	3	9	1	0.15	1
2	8	10	2	0.15	1
3	12	15	3	0.15	1
4	20	17	4	0.15	1
5	30	25	5	0.15	1
6	175	23	6	0.15	1
7	180	10	6	0.15	1

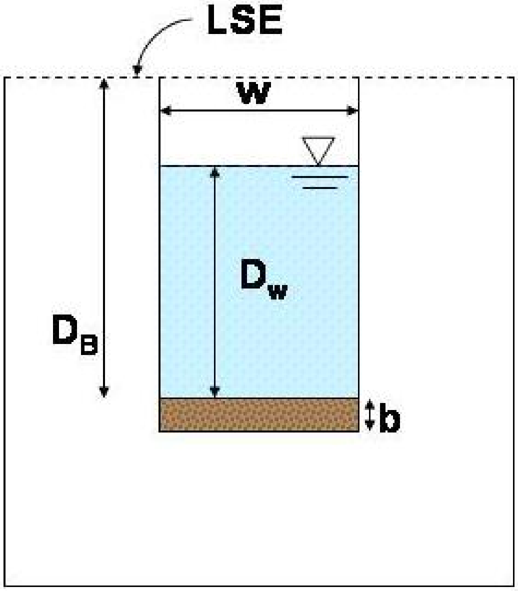


Figure 16. Reach Characteristics

Based on the comparison, the reach characteristics defined above were modified and calibrated until the calculated river fluxes closely match the observed baseflows. For each river cell, the total river flux was calculated as:

$$q = \left(\frac{L \times w \times K_v}{b} \right) * \left(LSE - D_B + D_w - H_i \right) \qquad \text{for } H_i > (LSE\text{-}D_B) \qquad (2)$$

Or

$$q = \left(\frac{L \times w \times K_v}{b} \right) * \left(D_w \right) \qquad \text{for } H_i < (LSE\text{-}D_B) \qquad (3)$$

Where: L = Reach length, ft.
w = Reach width, ft.
K_v = Hydraulic Conductivity, ft/day
b = Bed thickness, ft.
LSE = Land surface elevation
D_B = Depth to top of bank, ft.
D_w = Depth of water above bed, ft.
H_i = constant head elevation of cell, ft.

The comparison of the calculated baseflow versus the observed baseflow is shown in the scatter plot in Figure 18. The scatter plot shows good agreement of the simulated baseflows. The comparison of the simulated baseflow to the observed baseflow is also shown in Table 13. The baseflow fluxes were also examined as a function of Strahler order, as shown in Table 12. With the exception of order 7 reaches, the baseflow fluxes increases with increasing Strahler order. There were very few order 7 reaches (as evidenced by the low reach length total). The fluxes in order 7 reaches were throttled down during the calibration (by changing bed depth) in order to improve the calibration and better represent the physical characteristics of the system. The lower Suwannee River was the only order 7 reach in the model domain. A lower bed depth is realistic for this portion of the river, because the entrenchment of the river decreases as it moves closer to the mouth, also larger rivers tend to be represented more accurately with the DEM.

Table 12. Baseflow fluxes by Strahler Order

STRAHLER	Total Length of all Reaches, ft	Q, cfs	Q, ft^3/day	q, ft^2/day (per unit length of river)
1	24607047.7	653.9	56495550.7	2.30
2	9640515.2	699.0	60392417.9	6.26
3	4370256.6	814.4	70360769.5	16.10
4	3167742.1	1078.8	93210155.9	29.42
5	2113593.1	1495.0	129163824	61.11
6	901466.0	3833.7	331227982	367.43
7	128953.0	90.9	7857432.38	60.93

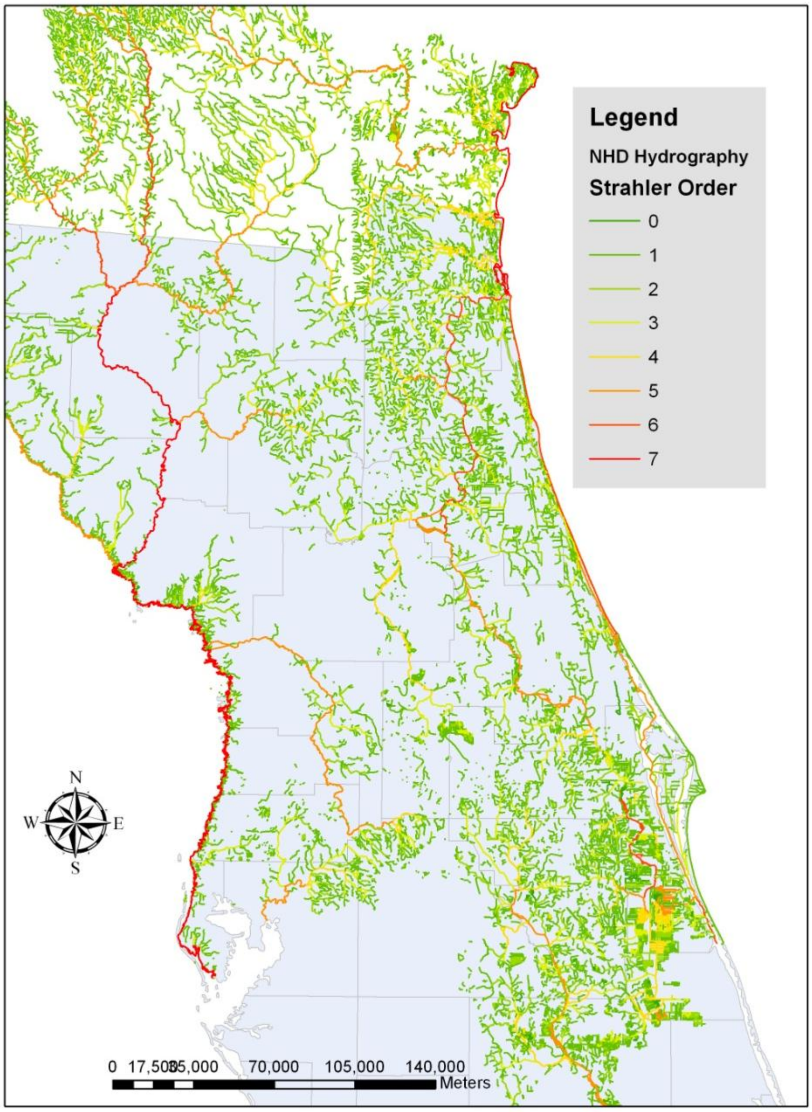


Figure 17. Strahler Order

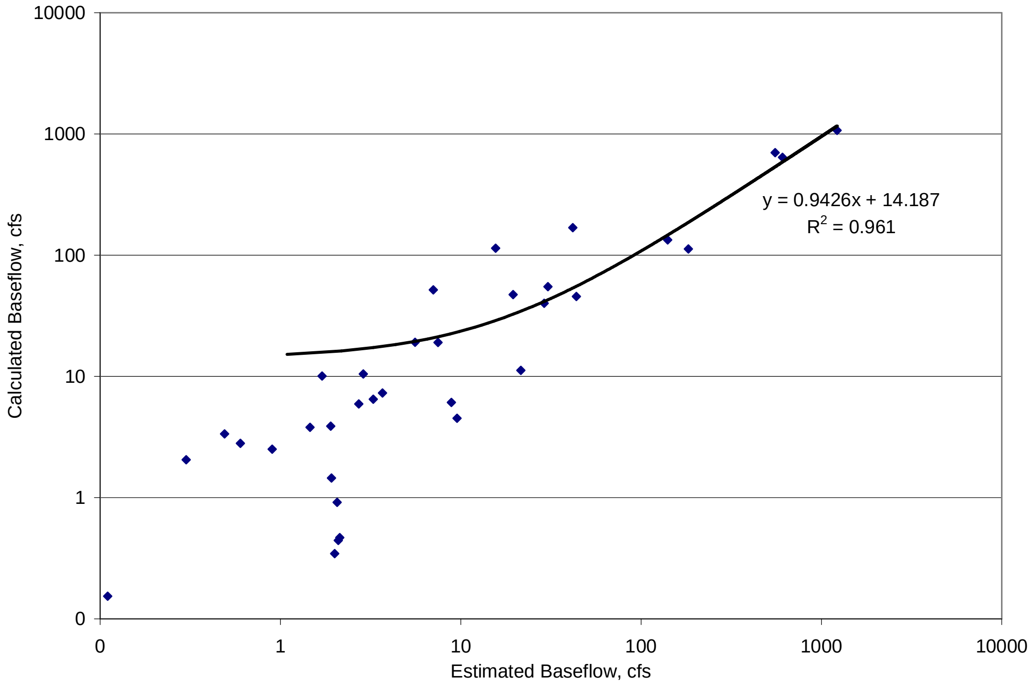


Figure 18. Observed versus Calculated Baseflow, cfs

Table 13. Reach Calibration Results

REACH ID	(1) River Cell Contribution Layer 1	(2) Original Contribution Drain, cfs	(3) Original Contribution River, cfs	(1)+(2)+(3) Total Calculated Base Flow, cfs	Estimated Baseflow, cfs	Station Name	Residual [cfs]
4	309.1	162.4	597.8	1069.3	1219.6	SUWANNEE RIVER AT ELLAVILLE, FLA	150.33
5	3.4	0.0	0.0	3.4	0.5	ALLIGATOR CREEK AT CALLAHAN, FL	-2.86
6	7.3	0.0	0.0	7.3	3.7	THOMAS CREEK NEAR CRAWFORD, FL	-3.61
7	0.1	0.0	0.0	0.1	1.6	STRAWBERRY CREEK NEAR ARLINGTON, FL	1.56
8	0.4	0.0	0.0	0.4	2.1	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	1.65
9	5.9	0.0	0.0	5.9	2.7	ORTEGA RIVER AT JACKSONVILLE, FL	-3.21
11	19.1	0.0	0.0	19.1	5.6	NEW RIVER NR LAKE BUTLER FLA	-13.52
12	51.7	0.0	0.0	51.7	7.0	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	-44.66
13	0.2	0.0	0.0	0.2	0.1	PARENERS BRANCH NEAR BLAND, FL.	-0.04
14	27.2	53.3	53.2	133.7	140.4	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	6.67
16	0.0	0.0	0.0	0.0	0.0	CANNON CREEK NEAR LAKE CITY, FL	0.04

REACH ID	(1) River Cell Contribution Layer 1	(2) Original Contribution Drain, cfs	(3) Original Contribution River, cfs	(1)+(2)+(3) Total Calculated Base Flow, cfs	Estimated Baseflow, cfs	Station Name	Residual [cfs]
17	1.5	0.0	0.0	1.5	1.9	DEEP CREEK NR SUWANNEE VALLEY FL	0.47
18	55.1	0.0	0.0	55.1	30.5	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	-24.61
19	168.8	0.0	0.0	168.8	41.8	SUWANNEE R NR BENTON FLA	-126.97
20	4.5	0.0	0.0	4.5	9.5	PABLO CREEK AT JACKSONVILLE, FL	5.01
21	0.3	0.0	0.0	0.3	2.0	BIG DAVIS CREEK AT BAYARD, FL	1.65
33	10.7	89.9	12.2	112.7	183.0	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	70.27
34	19.1	0.0	0.0	19.1	7.5	NORTH PRONG ST. MARYS RIVER AT MONIAC, GA	-11.58
35	0.9	0.0	0.0	0.9	2.1	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	1.14
36	45.6	0.0	0.0	45.6	43.7	ST. MARYS RIVER NEAR MACCLENNY, FL	-1.85
37	6.5	0.0	0.0	6.5	3.3	RICE CREEK NEAR SPRINGSIDE	-3.22
38	6.8	205.8	489.8	702.5	553.6	SUWANNEE RIVER NEAR WILCOX, FLA.	-148.90
39	40.1	0.0	0.0	40.1	29.0	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	-11.13
44	0.3	641.6	0.0	641.8	608.0	SILVER RIVER NEAR OCALA, FL	-33.86
45	47.3	0.0	0.0	47.3	19.5	OCKLAWAHA RIVER NEAR CONNER, FL	-27.74
46	114.1	0.0	0.0	114.1	15.6	OCKLAWAHA RIVER AT EUREKA, FL	-98.55
47	25.5	0.0	0.0	25.5	0.0	ORANGE LAKE OUTLET NEAR CITRA, FL	-25.53
48	10.3	0.2	0.0	10.5	2.9	ORANGE CREEK AT ORANGE SPRINGS, FL	-7.61
49	3.9	0.0	0.0	3.9	1.9	CEDAR RIVER AT MARIETTA, FL	-1.98
51	11.2	0.0	0.0	11.2	21.5	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	10.34
52	6.1	0.0	0.0	6.1	8.9	SIMMS CREEK NEAR BARDIN, FL	2.76
55	2.1	0.0	0.0	2.1	0.3	MIDDLE HAW CREEK NR KORONA, FLA.	-1.76
56	0.5	0.0	0.0	0.5	2.1	LITTLE HAW CREEK NEAR SEVILLE, FL	1.66
58	2.8	0.0	0.0	2.8	0.6	DEEP CREEK NEAR HASTINGS, FL	-2.20
61	3.8	0.0	0.0	3.8	1.5	SANTA FE RIVER NEAR GRAHAM, FLA.	-2.34
62	2.5	0.0	0.0	2.5	0.9	SPRUCE CREEK NEAR SAMSULA, FL	-1.61
63	10.1	0.0	0.0	10.1	1.7	TOMOKA RIVER NEAR HOLLY HILL, FL	-8.37

Activating Layer 1

In order to activate layer 1, net recharge must be defined across the model domain which replaces the flux from the constant head cells. To do this, the constant head fluxes from the MegaModel were captured (including the lateral fluxes; constant head to constant head), and the river fluxes were computed via the database (since MODFLOW ignores river cells located on constant head cells). These fluxes were used to develop a recharge package for the active layer 1 simulation. Once the active layer 1 simulation was run, the results were compared to the constant head version to verify that the models were producing the same results (zero drawdown as compared to the constant head simulation). The recharge for the activated layer 1 in the modified MegaModel was defined as shown in Figure 19. The following procedure was executed in order to develop a recharge package for the activated layer 1 while maintaining the original MegaModel results:

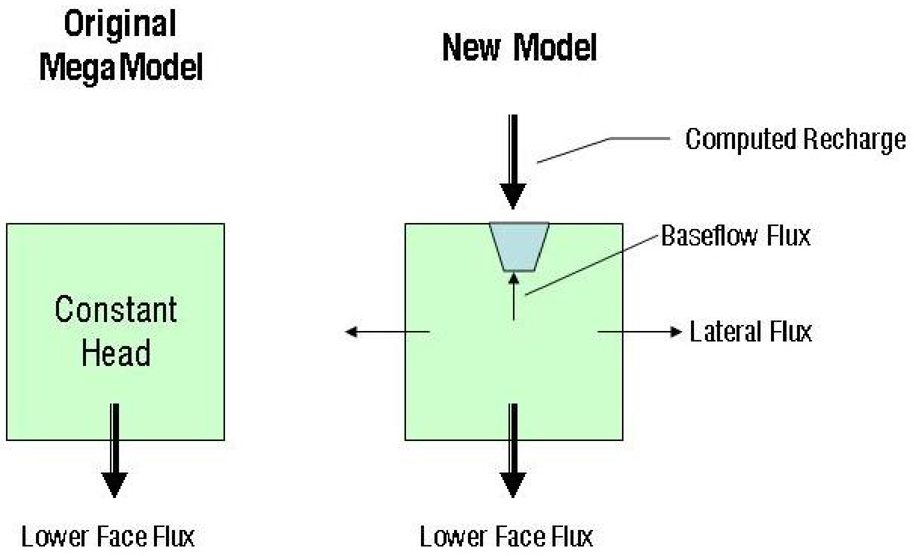


Figure 19. Comparison of Layer 1, Original MegaModel and New Model

The MegaModel (with constant heads in layer 1) was run in order to calculate lower face fluxes and lateral fluxes, as shown in Figure 19. The CHTOCH option was turned on in the Basic Package of MODFLOW 2000. When CHTOCH is turned on in MODFLOW 2000, the cell to cell (lateral) fluxes for constant head cells are printed in the .cbb output file. This makes it possible to obtain all face fluxes (right face, left face, front face, and back face) from the .cbb file. A perl script was developed in order to read the .cbb file into a text file. This text file was imported into a database in order to merge the lateral fluxes with the river cell fluxes.

Merging the lateral fluxes with the river cell fluxes produced a new recharge array. This new recharge array was imported into the MegaModel merged with the existing recharge which Sepulveda (2002) used on the layer 3. The river package was activated. Initial heads in layer 1 were set equal to the final heads from the constant head simulation. The constant head boundary condition in layer 1 was de-activated, and the simulation was run. After the simulation, the drawdowns were examined. Zero drawdown indicated that the model with layer 1 activated was simulating the same results as the constant head version of the MegaModel, and that the recharge fluxes were calculated properly. The updated layer 1 boundary conditions are shown in Figure 25. The recharge was spatially examined as shown in Figure 20.

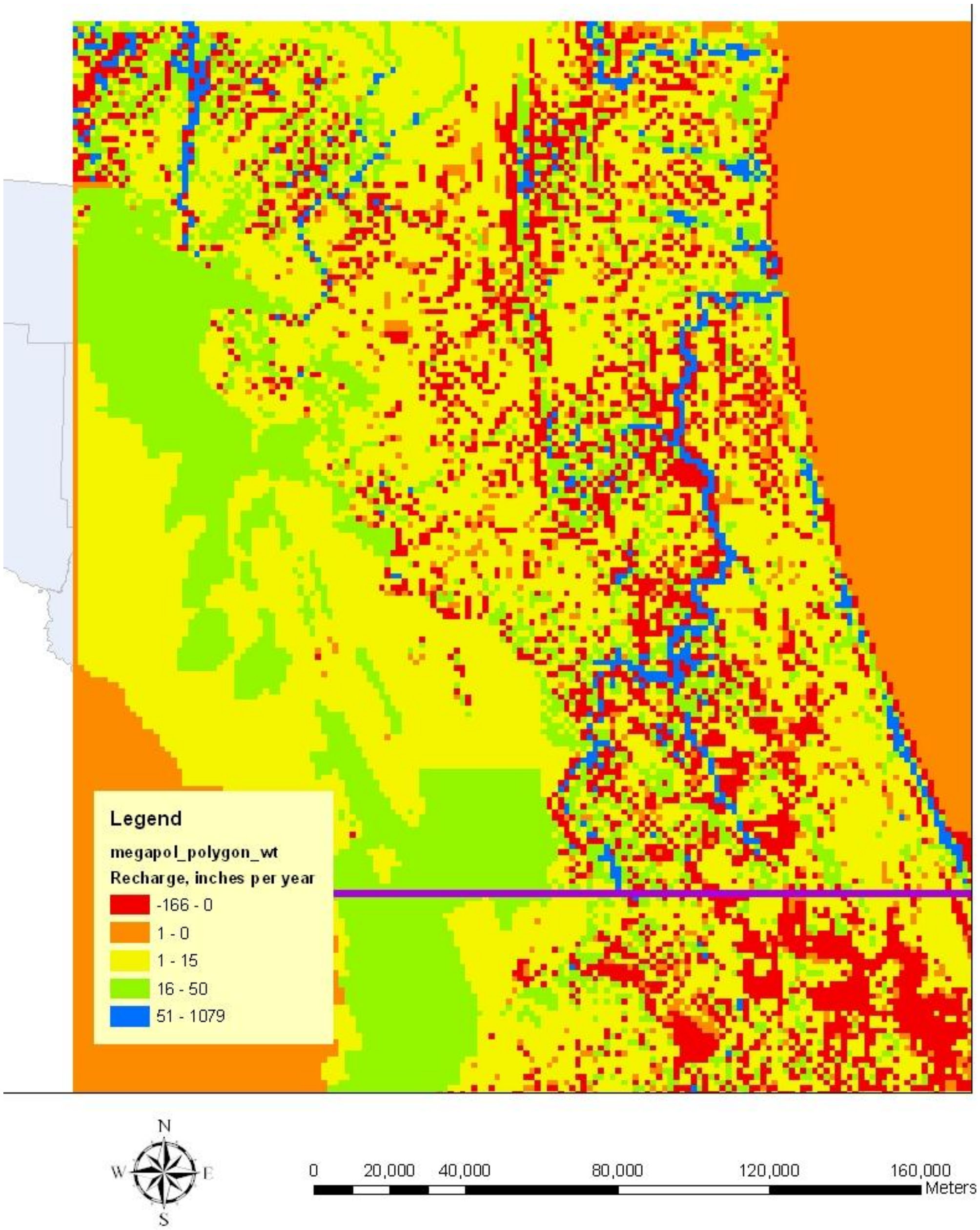


Figure 20. Recharge, inches/year

As shown in the figure, the majority of the recharge values are within the expected range, with a small percentage of extreme high and low values. The 2 components of the recharge package, the river cell flux and the cell-to-cell flux, were examined separately (as shown in Figures 21 and 22) in order to determine their relative magnitude on the total recharge.

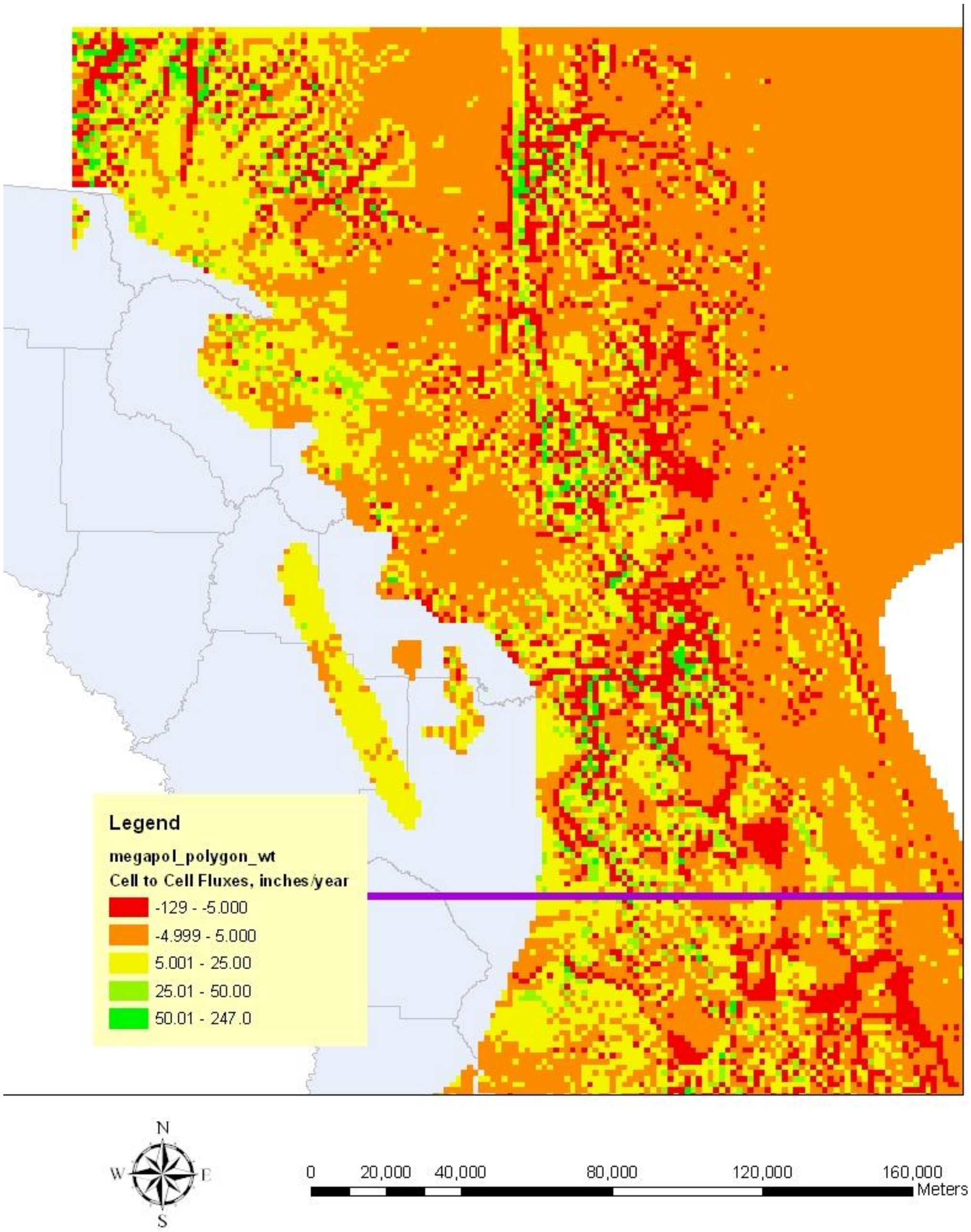


Figure 21. Cell to Cell Flux, inches/year

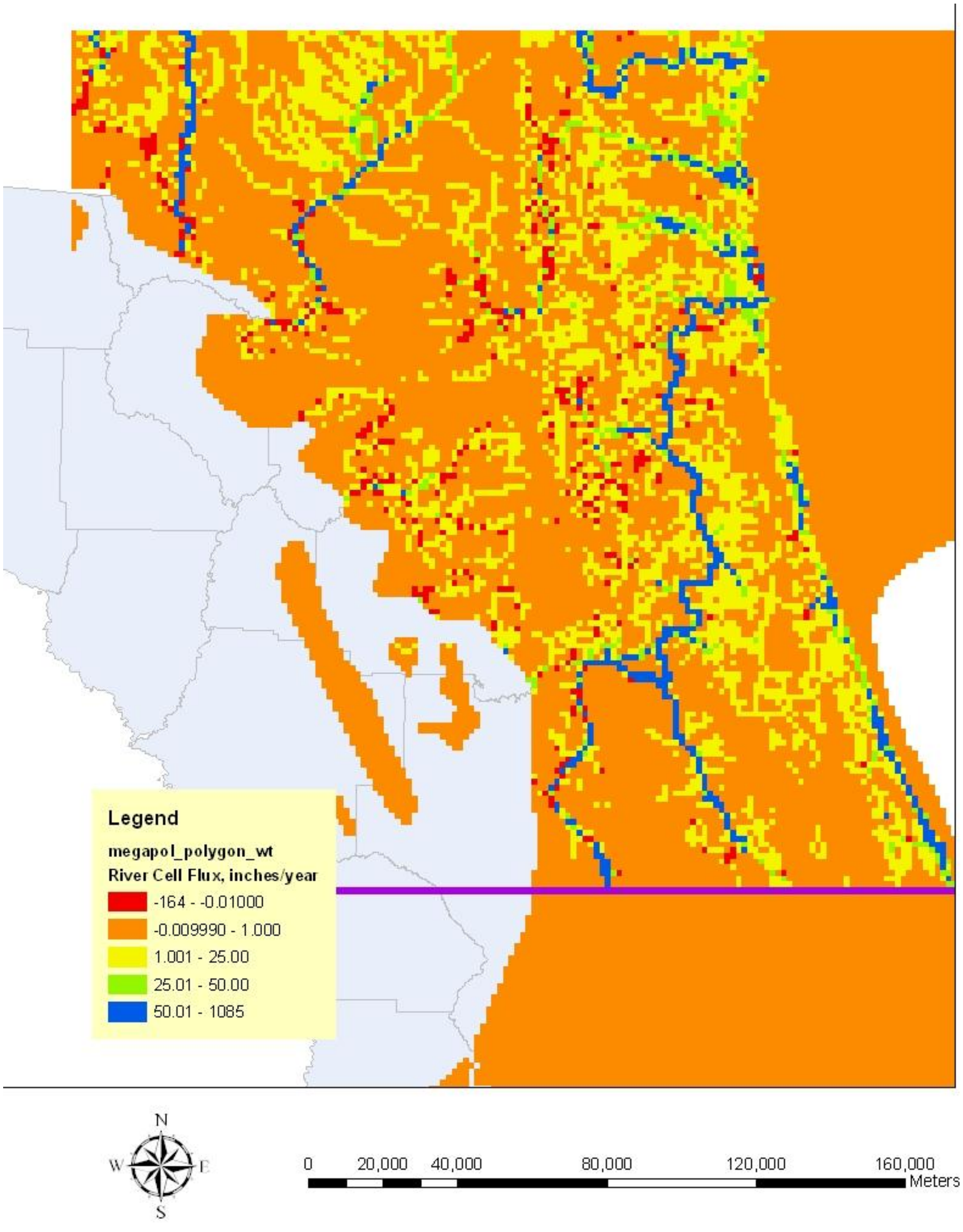


Figure 22. River Cell Flux, inches/year

As shown in Figure 22, the hydrography is clearly visible upon examination of the river cell flux component of recharge. Note that the sign convention for Figure 22 is positive for gaining rivers and negative for losing rivers. As expected, higher order streams exhibit higher river cell fluxes, indicating large baseflow contributions. Higher order streams typically have larger baseflow components since they are deeper, wider more incised than lower order streams (thus creating more contact area for baseflow to occur).

The statistics of the recharge components for all active cells in Layer 1 are shown in Table 14. As shown in the table, the mean recharge over the active domain is 5.45 inches per year. This is reasonable, considering that recharge typically varies from 5 to 10 inches per year. Although there are extreme values, particularly in the river cell flux, on average, the recharge rates are reasonable. In order to examine the distribution of fluxes, probability of exceedence curves were constructed for total recharge, river cell flux, and cell to cell flux. As shown in Figures 23 and 24, although there are some extreme values for total recharge flux, the majority of the values are within a reasonable range (-15 inches per year to 15 inches per year).

Table 14. Recharge Array Statistics

	Total Recharge, in/yr	River Cell Flux, in/yr	Cell to Cell Flux, in/yr
Mean	5.45	3.21	2.24
Standard Error	0.14	0.14	0.06
Median	0.56	0.00	0.03
Standard Deviation	28.71	27.83	11.34
Sample Variance	824.12	774.44	128.48
Kurtosis	266.35	353.60	28.74
Skewness	13.39	16.51	1.13
Range	1245.10	1246.94	375.87
Minimum	-166.02	-164.42	-129.25
Maximum	1079.08	1082.52	246.62
Sum	222640.48	131173.66	91466.82
Count	40844	40844	40844
Confidence Level(95.0%)	0.28	0.27	0.11

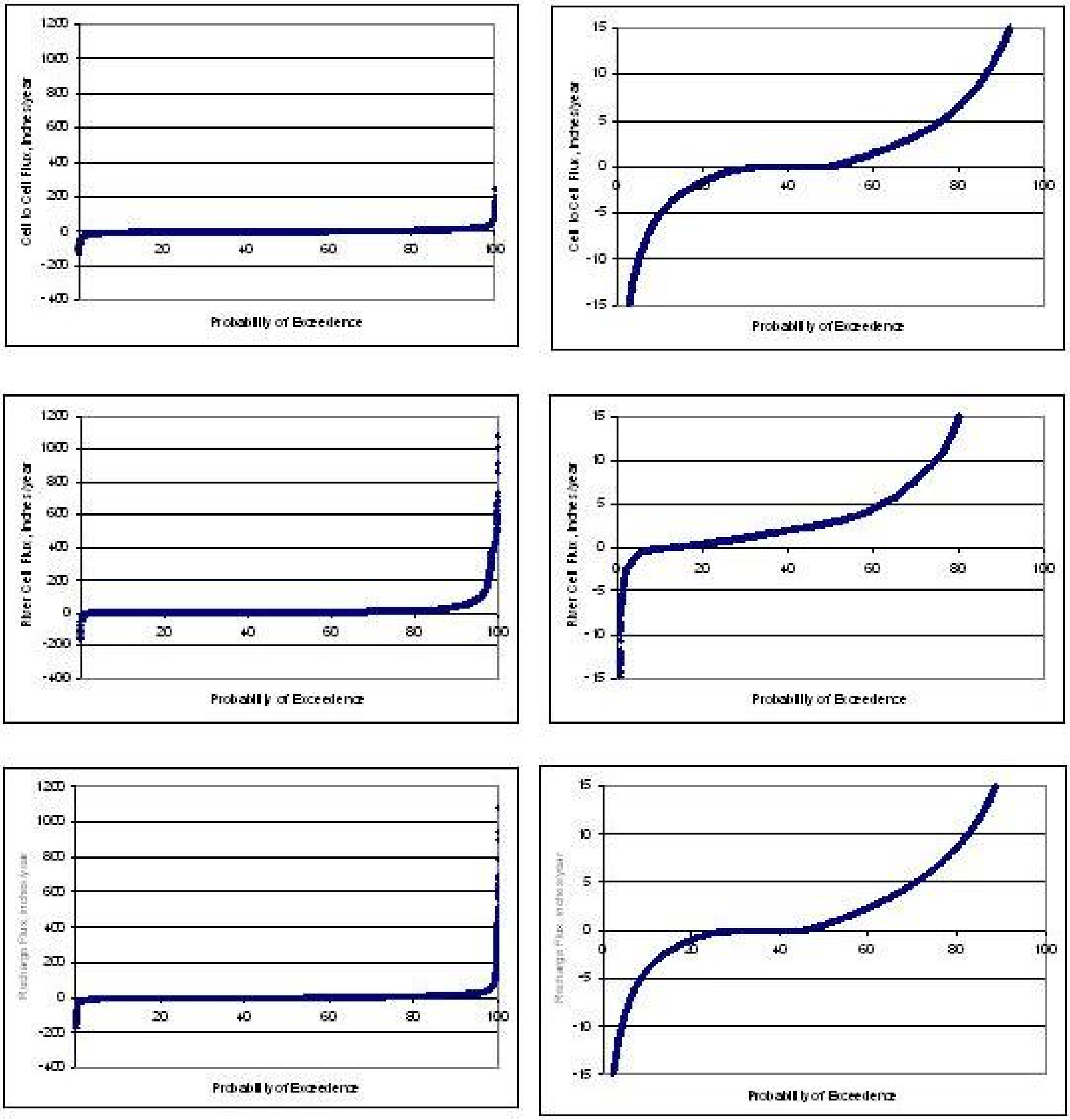


Figure 23. Probability of Exceedance, Recharge Flux (full scale and zoomed), River Cell Flux (full scale and zoomed), and Cell to Cell Flux (full scale and zoomed), inches/year

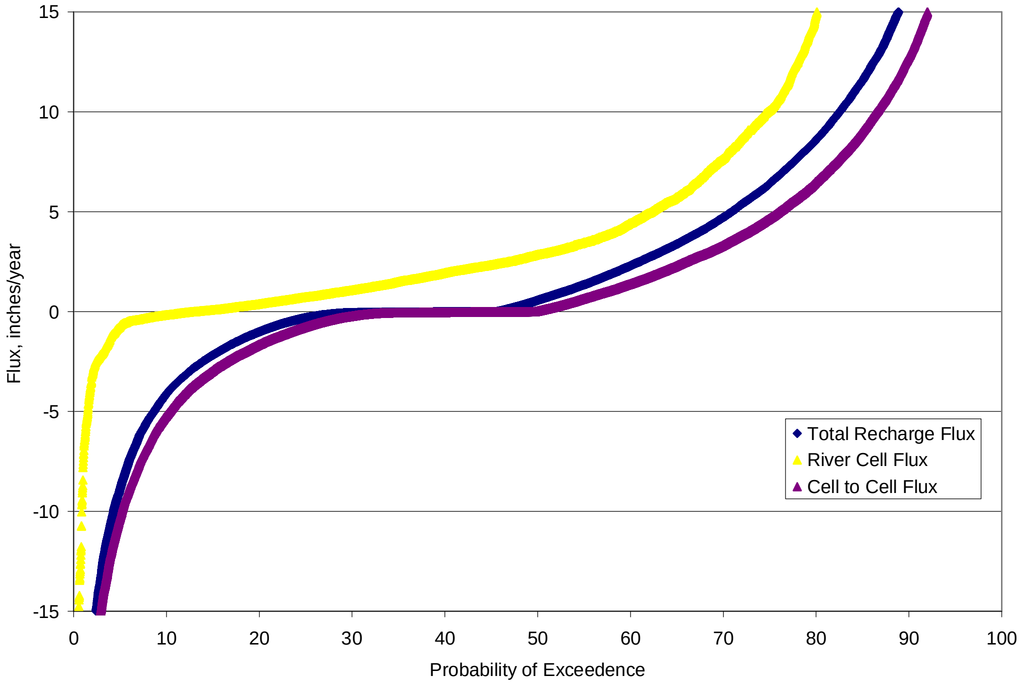


Figure 24. Probability of Exceedance, Recharge Flux Components, inches/year

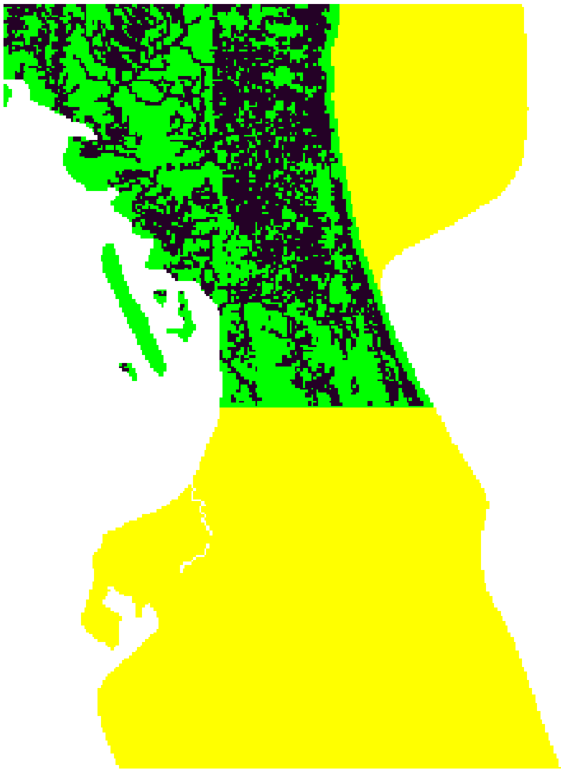


Figure 25. MegaModel Updated Layer 1 Boundary Conditions (Yellow: Constant Head Cells, Black: River Cells, Green: Active Cell without River Cell)

1993-1994 Simulation Results

After the activation of layer 1, the 1993-1994 simulation was conducted. Zero drawdown was verified, indicating that the simulation was providing the same results as the constant head version of the MegaModel. The calibration targets (well levels provided by the District) were examined spatially by layer. Figures 26 through 28 show the residual error (observed water level minus simulated water level) for all layers with calibration targets (layers 1, 3 and 4). Scatter plots of the observed versus simulated well levels are shown in Figures 29 through 31. It should be noted that the errors in the surficial layer (layer 1) are imposed from the constant heads elevations and are set from the predefine water table elevation defined by the land surface elevation algorithm used in Sepulveda (2002). A revised water table elevation used in the constant head simulation would eliminate this error. A revised water table could also reduce the error in the Floridan as the leakage fluxes are defined by the head gradient between the two layers.

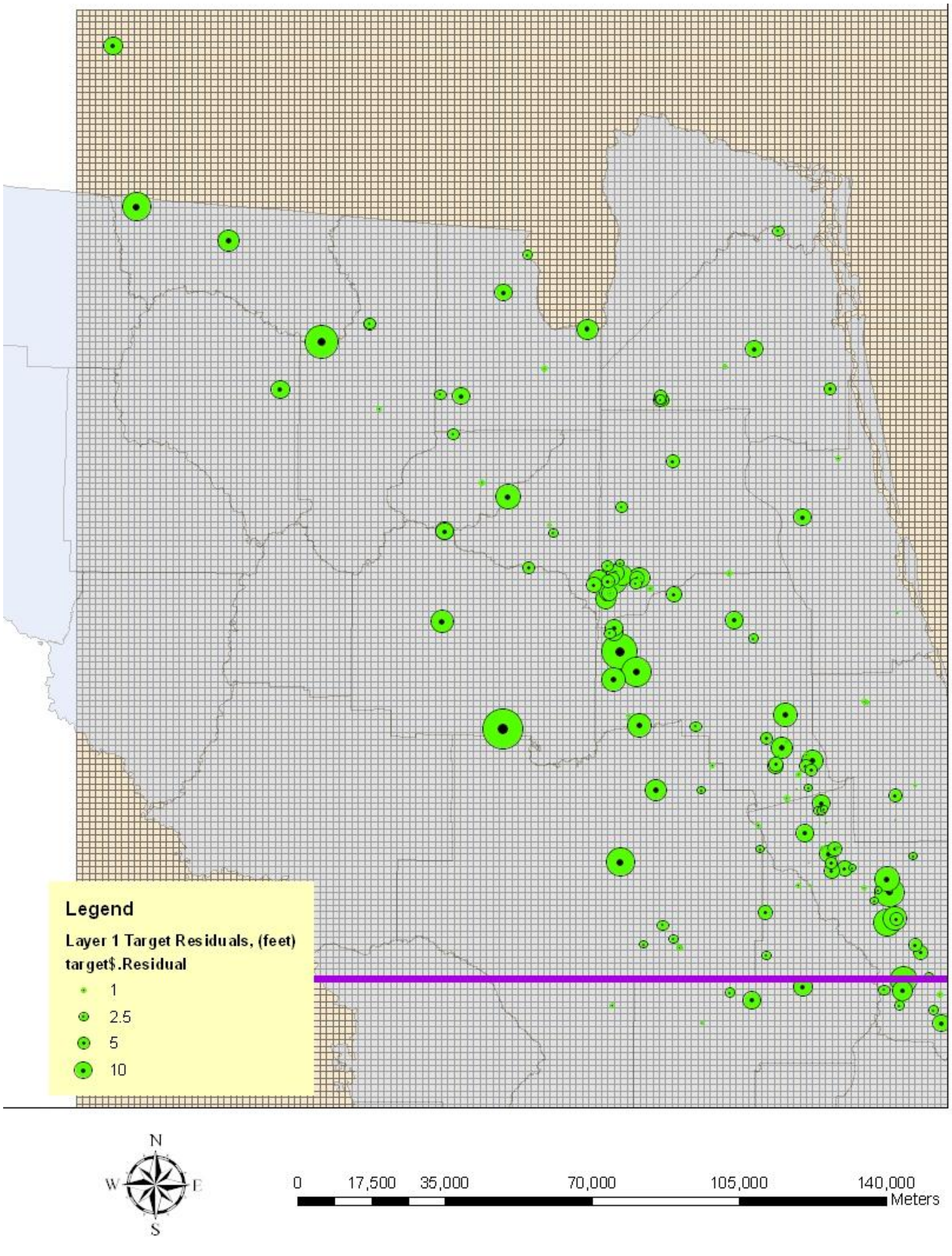


Figure 26. Residuals, Layer 1

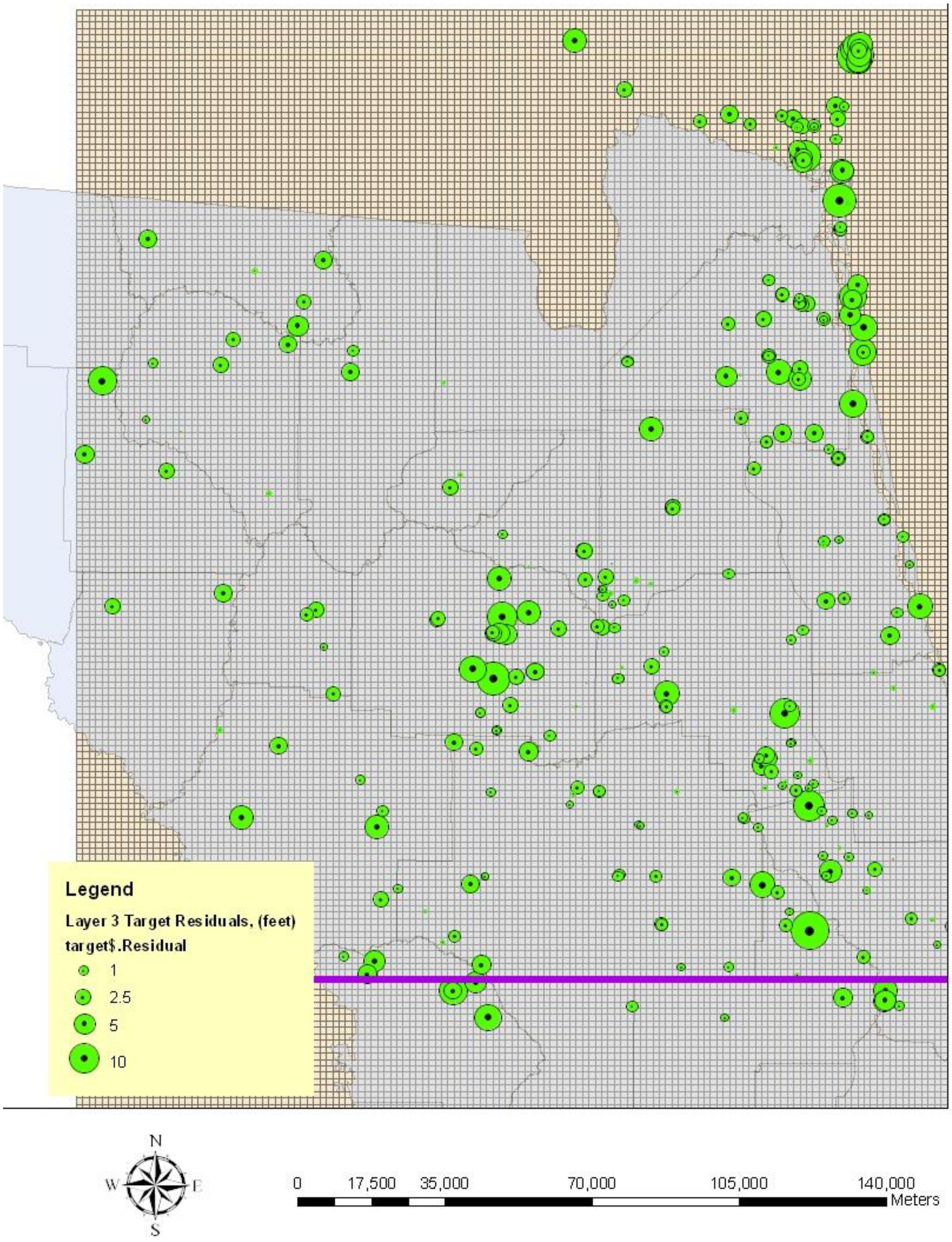


Figure 27. Residuals, Layer 3

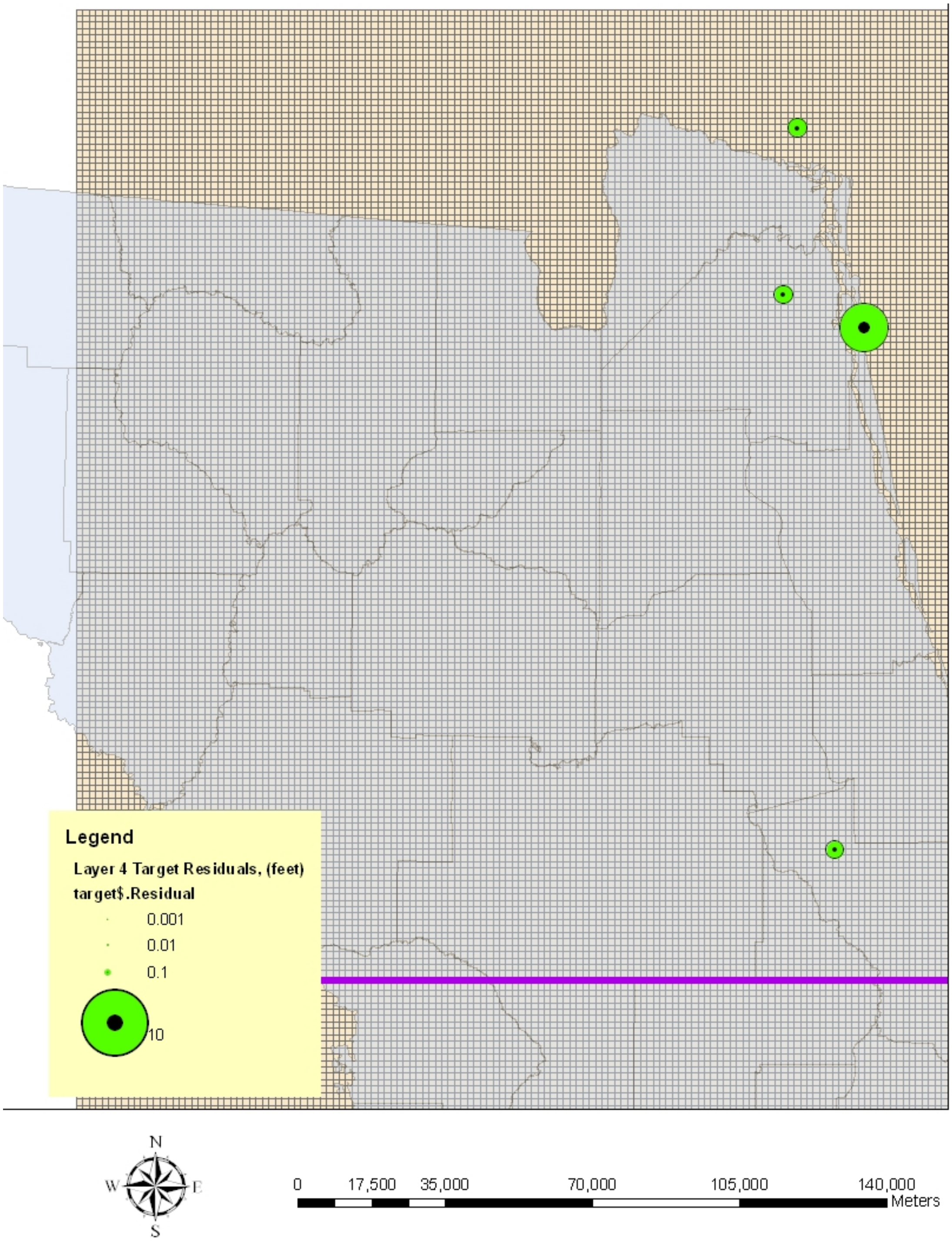


Figure 28. Residuals, Layer 4

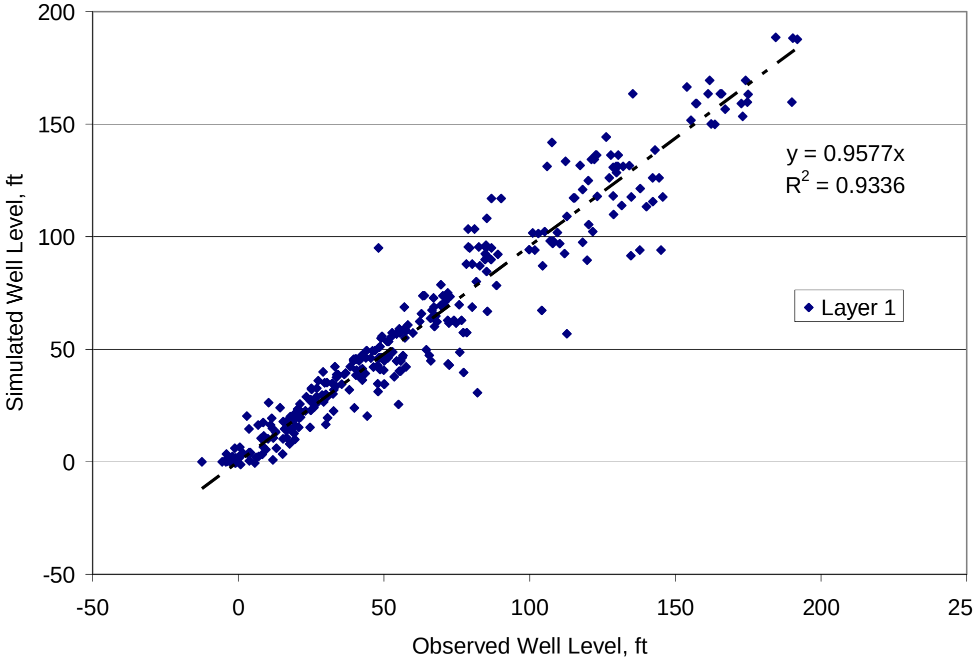


Figure 29. Layer 1: Observed versus Simulated Well Levels (target_residuals.xls)

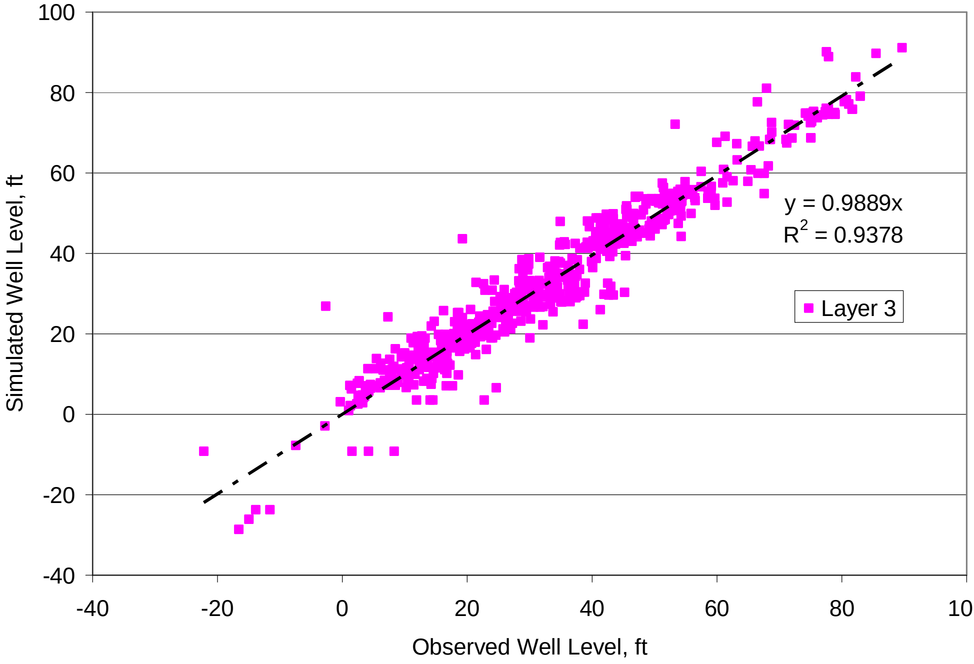


Figure 30. Layer 3: Observed versus Simulated Well Levels (target_residuals.xls)

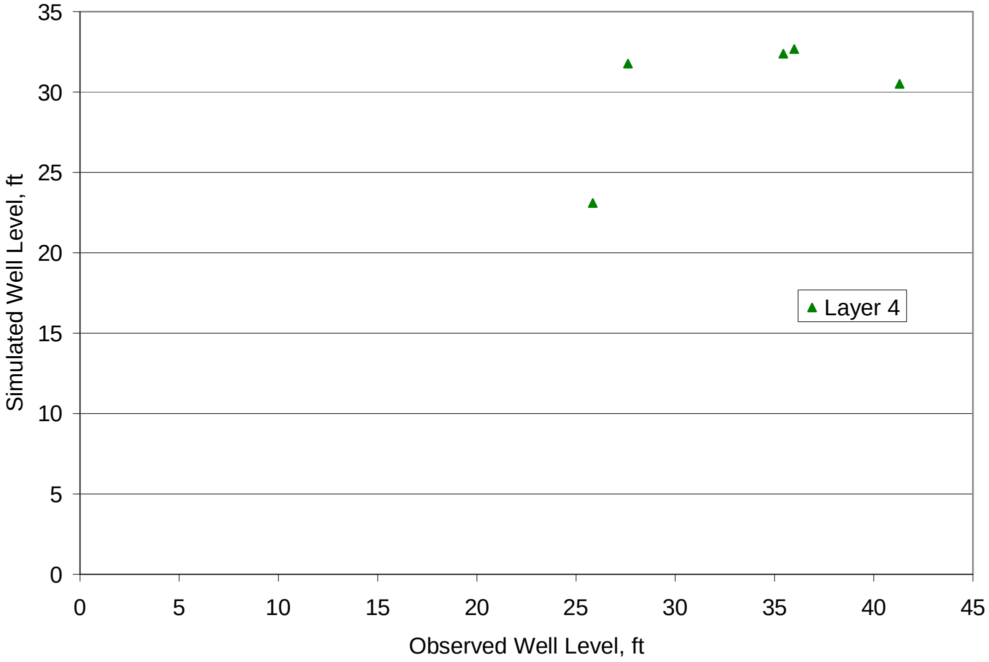


Figure 31. Layer 4: Observed versus Simulated Well Levels (target_residuals.xls)

As shown in the figures, with the exception of a few outlier points, there is relatively good agreement between the observed and simulated well levels for layers 1 and 3. The trend line slopes of less than 1 indicate that the model is slightly biased towards underestimation of well levels. Residual statistics are shown in Table 15.

Table 15. Residual Statistics

	Layer 1	Layer 3	Layer 4	All Layers
Residual Mean	1.73	-0.08	3.15	0.54
Res. Std. Dev.	9.76	4.03	4.73	6.61
Sum of Squares	33718.02	10889.19	161.73	44768.95
Abs. Res. Mean	6.07	2.71	4.81	3.85
Min. Residual	-34.22	-29.53	-4.15	-34.22
Max. Residual	55.93	16.21	10.80	55.93
Range in Target Values	204.41	111.85	15.47	214.10
Std. Dev./Range	0.05	0.04	0.31	0.03

Sensitivity Analysis

In order to determine the sensitivity of the MegaModel to calibration parameters, a sensitivity analysis was conducted. The sensitivity of the MegaModel to layer 1 leakance was investigated by modifying the leakance array in layer 1 by factors of 0.1, 2, 5, and 10. For each simulation, weighted residual statistics were examined. Figures 32 through

34 show the weighted residual mean error, weighted residual standard deviation, and weighted absolute residual mean, respectively. As shown in the figures, a leakance factor of 1.0 (the calibrated leakance) results in the lowest error and smallest residual standard deviation. Based on the calibration statistics, the model is much more sensitive to dividing the leakance by a factor of 10 than it is to increasing the leakance by a factor of 10.

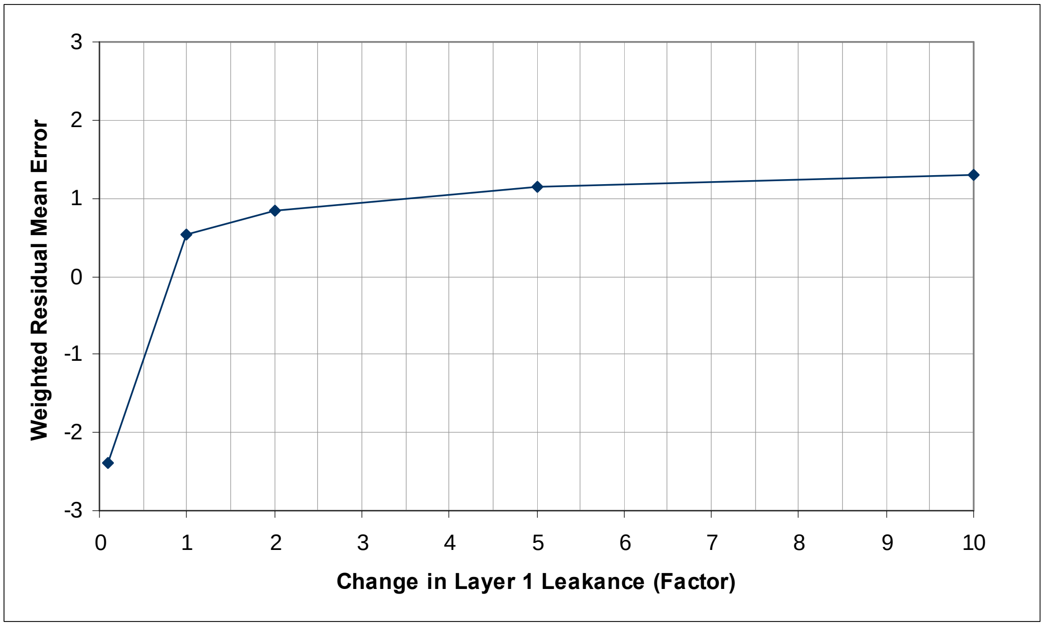


Figure 32. Weighted Residual Mean Error versus Leakance Factor

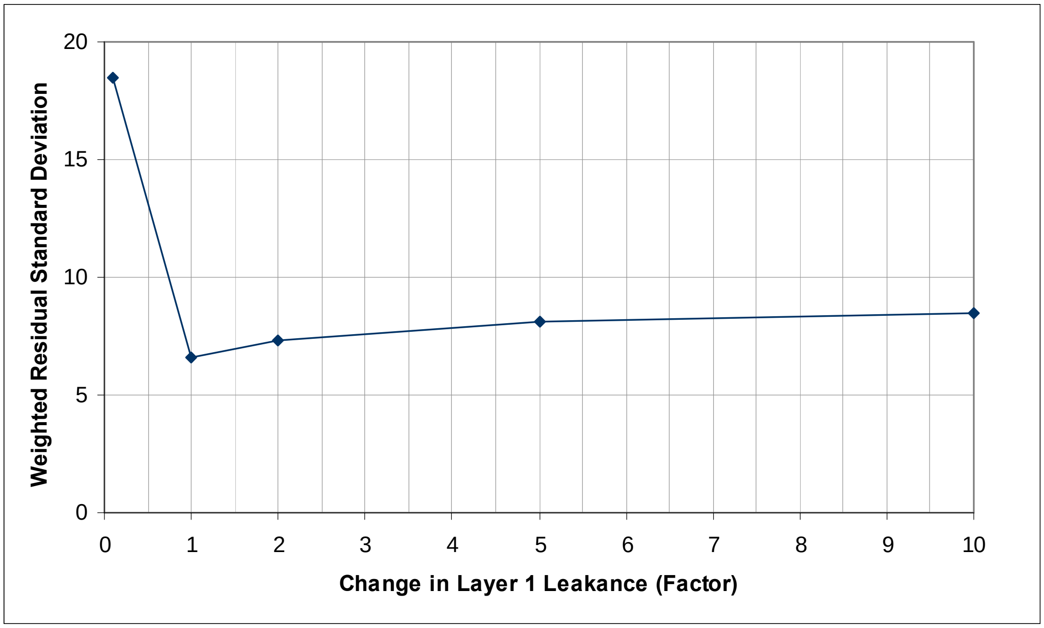


Figure 33. Weighted Residual Standard Deviation versus Leakance Factor

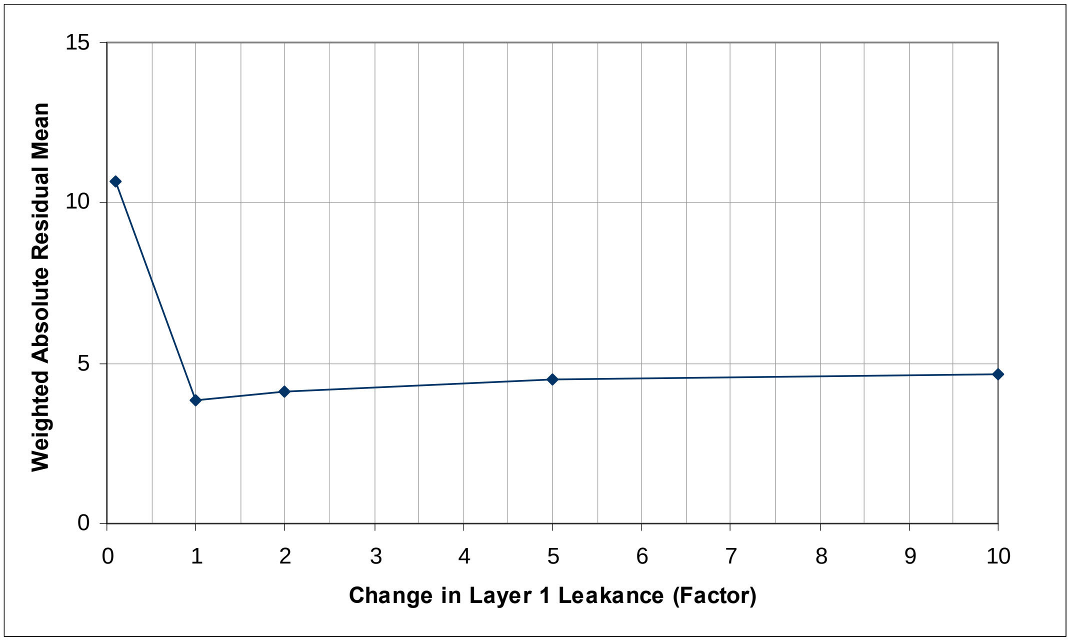


Figure 34. Weighted Absolute Residual Mean versus Leakance Factor

Water Level Comparison

The drawdown for layers 1 and 3 (the Surficial and the Upper Floridan Aquifers, respectively), is shown in Figures 35 through 39. As shown in Figure 35, when the calibrated leakance array is divided by 10, less water is able to leak between layers 1 and 2, resulting in negative drawdown, particularly in the Northwest corner of the model. The effect of this negative drawdown is that there is less water available to leak into the intermediate and the Floridan, as shown in the positive drawdown in layer 3. There are two large cones of depression shown in Figure 35. It should be noted that there is no negative drawdown in layer 1 in the southern portion of the model because the southern cells are constant head cells.

When the leakance array is increased, the opposite trend occurs with regards to drawdown. Figures 37 through 39 show the drawdown in layers 1 and 3 when the leakance array is multiplied by 2, 5, and 10. As the factor is increased, the effect of changing the leakance array becomes more pronounced. Increasing leakance in layer 1 allows more water to leave the layer, causing drawdowns in layer 1 cells that are not constant head cells. The net effect of this is negative drawdowns in the Upper Floridan (layer 3).

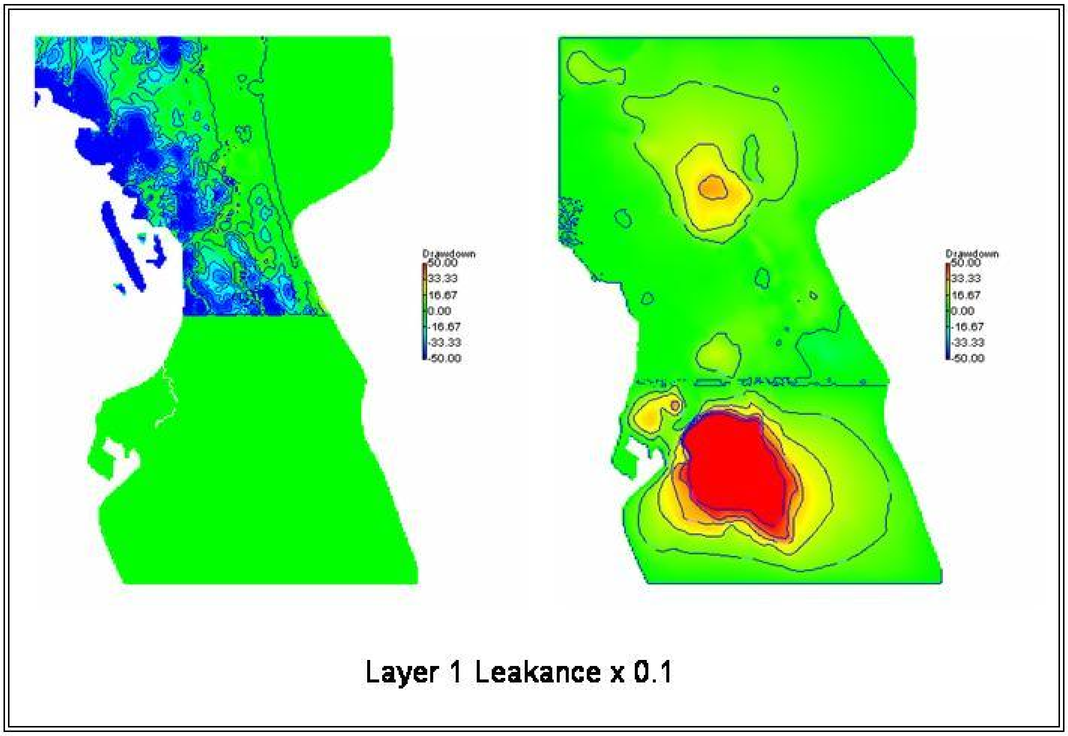


Figure 35. Layer 1 Drawdown (left) and Layer 3 Drawdown (right). Layer 1 Leakance x 0.1

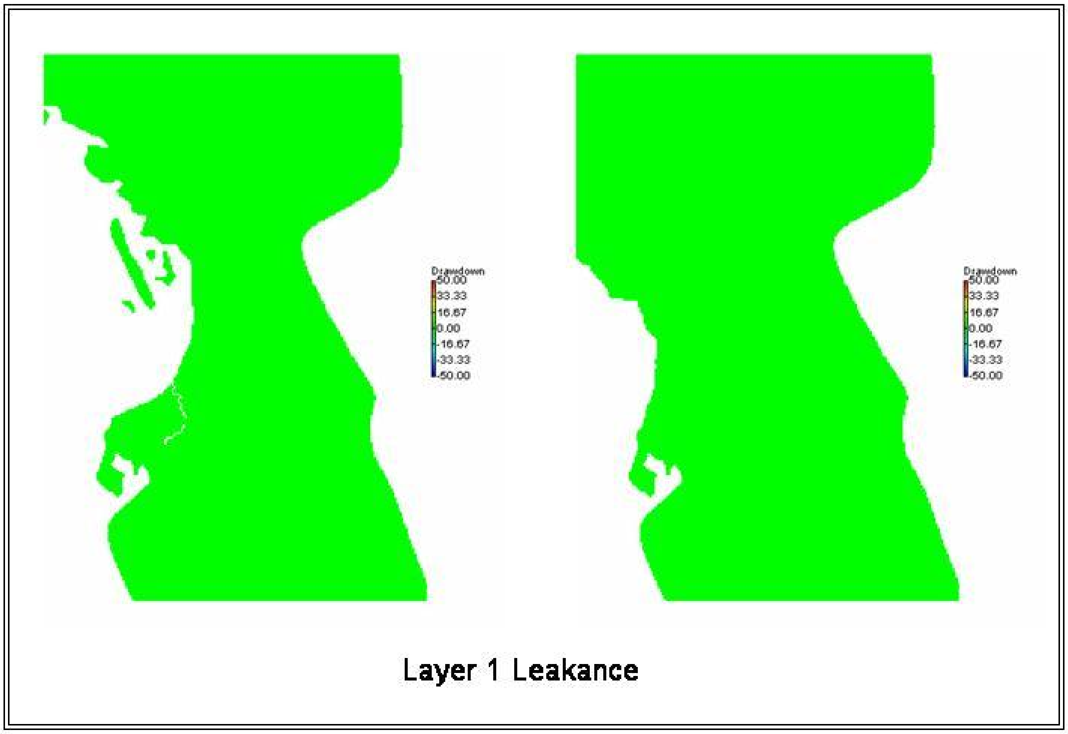


Figure 36. Layer 1 Drawdown (left) and Layer 3 Drawdown (right). Calibrated Layer 1 Leakance

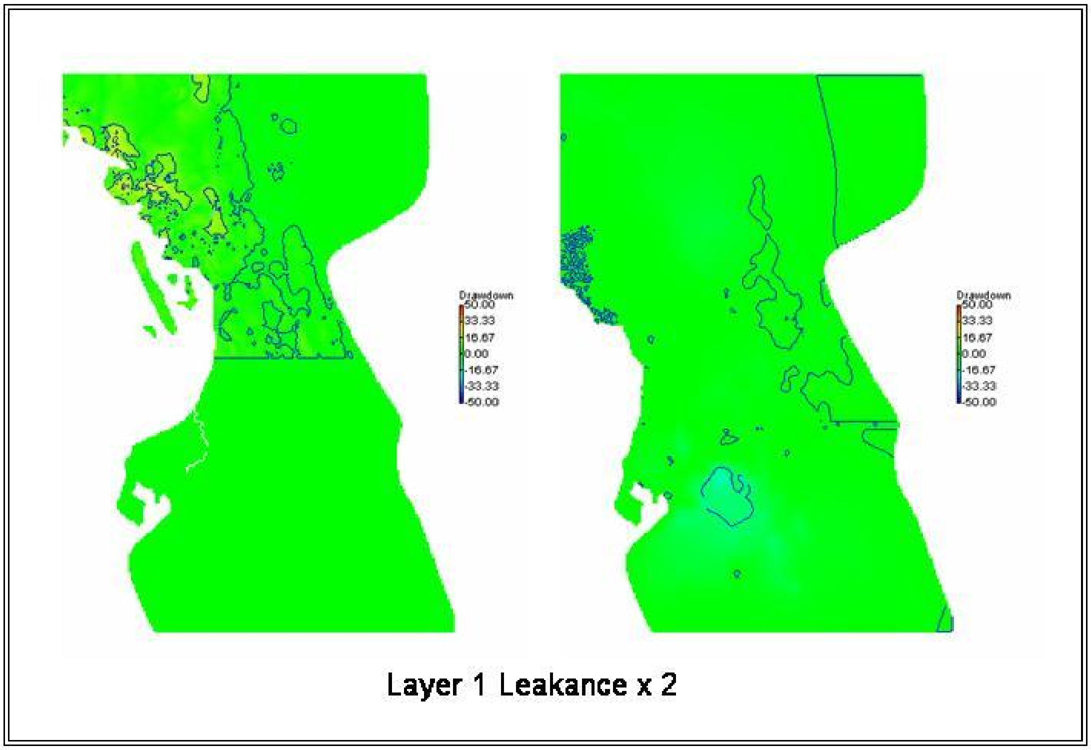


Figure 37. Layer 1 Drawdown (left) and Layer 3 Drawdown (right). Layer 1 Leakance x 2.0

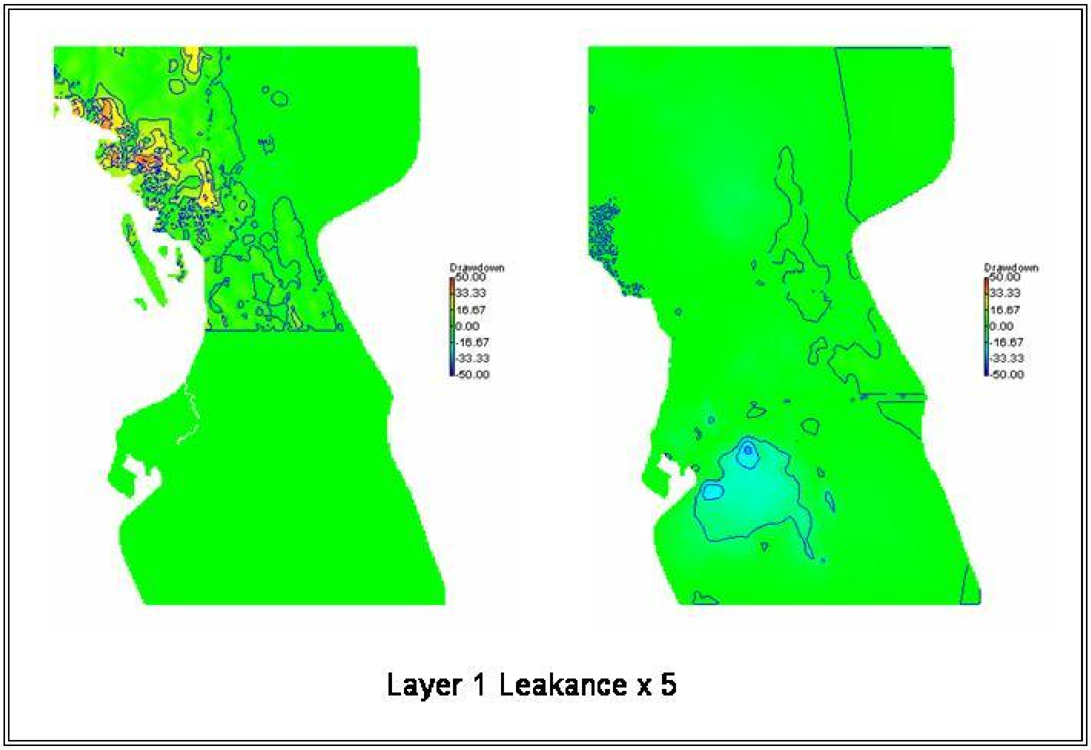


Figure 38. Layer 1 Drawdown (left) and Layer 3 Drawdown (right). Layer 1 Leakance x 5

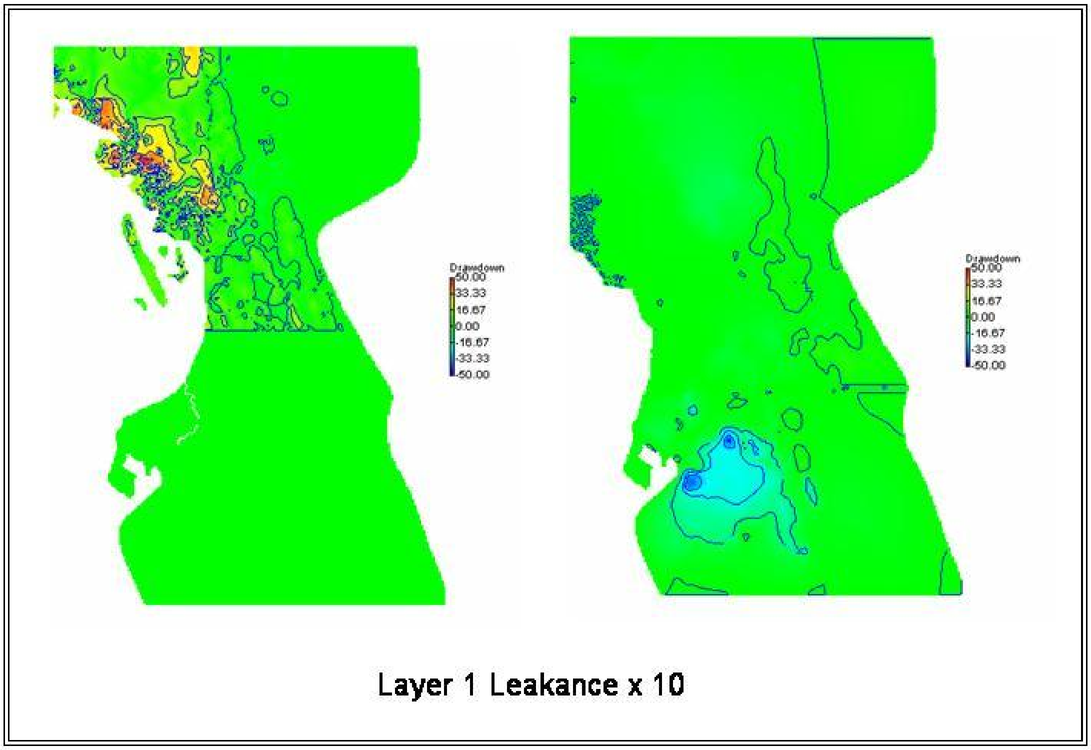


Figure 39. Layer 1 Drawdown (left) and Layer 3 Drawdown (right). Layer 1 Leakance x 10

Baseflow Comparison

The impact of leakance changes on simulated baseflow was examined by calculating the baseflow for each reach for each of the sensitivity simulations. A perl script was used to create a text file of all cell fluxes from the .cbb file. Each text file was imported into a database. The river cell fluxes were grouped by the Reach Identifications, and the total baseflow was calculated for each reach. The resulting baseflow fluxes for each simulation are shown in Table 16. As shown in the table, when leakance values are decreased, the baseflow increases, due to the fact that less water is leaking through the bottom of layer 1. This causes the heads in layer 1 to increase (as shown in the drawdown map in Figure 35), resulting in higher baseflow. Conversely, when leakance is increased, baseflow decreases due to more water leaking through the bottom of layer 1. The additional drawdown will only occur to a point, however, since the heads in layer 1 will not decrease beyond the heads in layer 2. Thus, the decrease in baseflow due to increasing leakance by a factor of 10 is less drastic than the increase in baseflow due to decreasing leakance by a factor of 10, as shown in Figure 39.

It should be noted that the baseline baseflow values shown in Table 16 are slightly different than the calculated baseflow values used for calibration as shown in Table 13. The baseflow values shown in Table 13 were calculated using heads from the constant head MegaModel simulation prior to the activation of layer 1. The baseline baseflow values shown in the table below were calculated by importing the .cbb file from the active layer 1 simulation into a database and grouping the river cell fluxes by reach.

While the Table 13 values are based on the assumption of constant head, the values shown in the Table 16 (below) were derived from the active layer 1 simulation. Since this simulation has an active water table in layer 1, slight shifts in the fluxes can be induced, creating slight differences between these two sets of values.

Table 16. Baseflow (cfs) by Reach

	Leakance Factor				
ReachID	**0.1**	**1 (Baseline)**	**2**	**5**	**10**
4	513.51	309.14	288.75	277.53	273.63
5	4.85	3.46	3.09	2.76	2.63
6	9.41	7.32	6.89	6.55	6.41
7	0.08	0.07	0.07	0.07	0.07
8	0.88	1.17	1.25	1.32	1.34
9	10.33	6.90	6.02	5.23	4.89
11	56.42	18.75	10.65	6.04	4.58
12	91.72	52.04	41.17	34.39	32.60
13	2.00	0.15	-0.08	-0.08	-0.08
14	104.22	27.30	16.92	14.97	14.41
16	3.25	-0.04	-0.04	-0.04	-0.04
17	9.51	1.45	0.55	0.05	0.09
18	121.81	55.06	45.56	42.49	41.11
19	341.08	168.76	141.75	122.44	115.48
20	5.21	5.27	5.33	5.35	5.35
21	0.34	0.53	0.60	0.65	0.67
33	96.25	10.67	2.08	-0.33	0.74
34	31.80	19.24	15.34	11.78	10.28
35	3.97	0.92	0.32	-0.17	-0.32
36	88.79	45.42	35.30	28.17	25.87
37	3.97	6.55	7.45	8.16	8.43
38	69.06	6.78	1.00	-0.57	-0.78
39	100.82	40.33	28.88	21.73	19.35
44	0.84	0.25	0.21	0.18	0.17
45	62.56	46.26	45.24	44.83	44.77
46	136.99	115.17	113.79	113.68	113.61
47	53.92	25.53	21.60	18.62	17.60
48	15.93	10.26	9.86	9.67	9.62
49	3.59	3.97	4.17	4.34	4.42
51	49.05	12.51	8.15	5.75	5.05
52	12.18	6.20	5.85	5.72	5.76
55	1.63	2.10	2.23	2.32	2.36
56	0.23	0.58	0.64	0.69	0.70
58	4.53	3.62	3.40	3.21	3.14
61	13.58	3.80	1.88	1.37	0.99
62	3.79	3.26	3.17	3.10	3.07
63	13.13	10.07	9.64	9.31	9.18

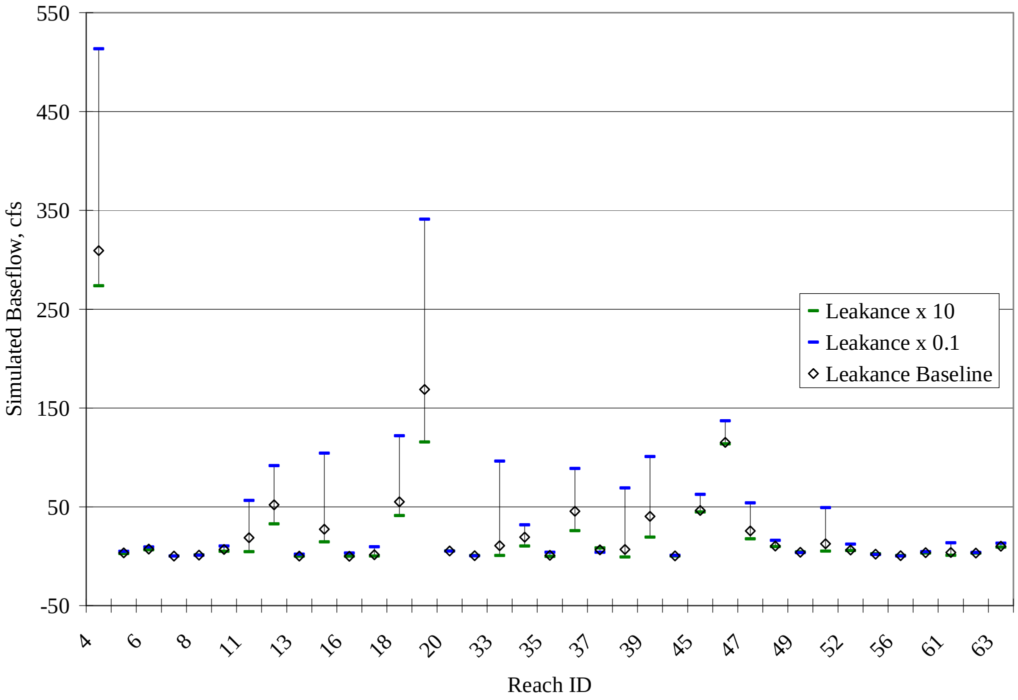


Figure 40. Changes in Baseflow based on Modified Leakance Arrays (Leakance_summary_by_reach.xls)

Spring Comparison

In addition to the examination of the effect of the leakance array on baseflow, the effect of the array on spring flow was also examined. The range of spring flow rates from the sensitivity simulations are shown in Table 17 and Figure 41. As shown from the data, some springs, such as White Sulphur Springs at White Springs, are highly sensitive to changes in the leakance array. Springs located in cells with large head gradients between layers will be more affected by the changes in leakance. Other springs, such as Hart Springs near Wilcox, are not sensitive to changes in the leakance array. These springs are located in cells with smaller head gradients between layers and are thus less affected by changes in the leakance array.

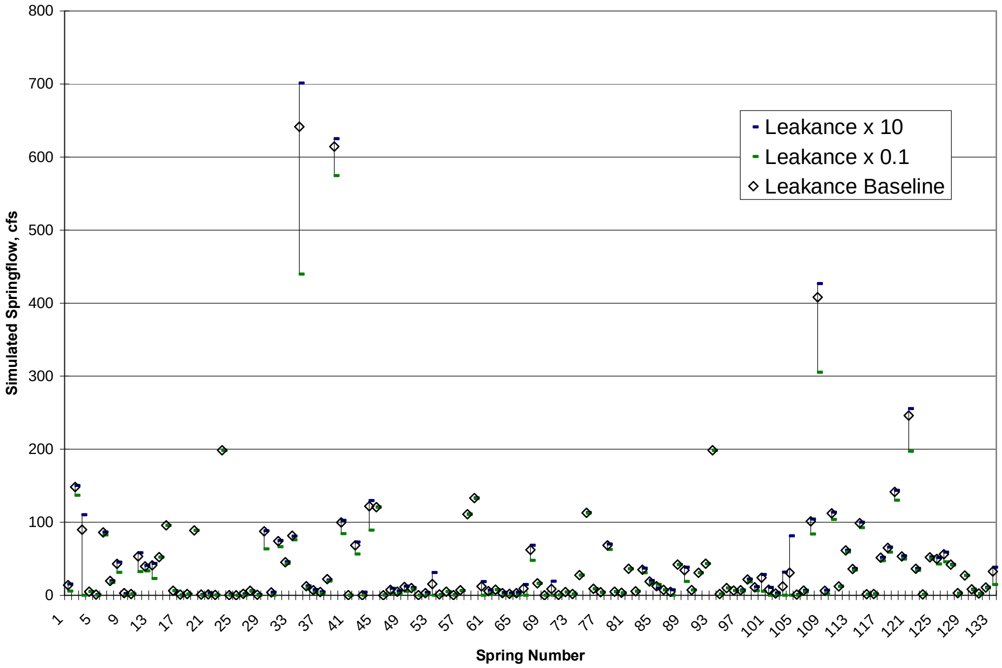


Figure 41. Springflow Variability with Leakance

Table 17. Springflow (cfs) based on Leakance Factor

GridID	Spring Name	0.1	1 (Baseline)	2	5	10
44019	Holton Spring near Fort Union	5.77	14.02	14.88	15.35	15.51
49014	Falmouth Spring at Falmouth	136.87	148.34	149.59	150.18	150.37
52037	White Sulphur Springs at White Springs	0.00	89.86	103.60	109.90	110.33
63008	Charles Springs near Dell	4.86	5.09	5.12	5.13	5.14
65103	Wadesboro Spring near Orange Park	0.00	0.99	1.02	0.95	0.90
67014	Peacock Springs	82.58	86.08	86.47	86.63	86.68
76023	Ruth Spring near Branford	17.49	19.61	19.85	19.95	19.98
77037	Ichetucknee Head Spring near Fort White and Cedar Head Spring	31.39	43.01	44.47	45.07	45.24
77106	Green Cove Springs at Green Cove Springs	0.00	2.93	2.76	2.43	2.26
81037	Jamison Spring	1.57	1.86	1.89	1.91	1.91
87048	Hornsby Spring near High Springs	32.23	53.26	56.42	57.85	58.33
89042	Blue Springs near High Springs (including Lilly Springs)	33.46	39.50	40.38	40.80	40.93
94135	Crescent Beach Submarine Spring	22.77	41.03	42.60	43.40	43.63
97026	Lumbercamp Springs and Sun Springs near Wannee	52.04	52.32	52.36	52.37	52.38
100025	Hart Springs near Wilcox	95.45	95.79	95.84	95.87	95.87
102025	Otter Springs near Wilcox	6.23	6.24	6.24	6.24	6.24
103107	Whitewater Springs	0.00	1.02	0.92	0.72	0.61
105025	Bell Springs	1.68	1.68	1.68	1.68	1.68
106026	Fannin Springs near Wilcox	88.72	88.86	88.89	88.90	88.90

GridID	Spring Name	0.1	1 (Baseline)	2	5	10
111106	Satsuma Spring	0.00	0.89	1.03	1.10	1.11
112089	Orange Spring at Orange Springs	0.00	1.29	2.45	3.11	3.31
112094	Blue Springs near Orange Springs	0.00	0.43	0.47	0.49	0.49
113023	Manatee Spring near Chiefland	198.17	198.61	198.68	198.72	198.73
113088	Camp Seminole Spring at Orange Springs	0.00	0.24	0.99	1.42	1.56
114106	Welaka Spring near Welaka	0.00	0.00	0.00	0.00	0.00
116106	Mud Spring near Welaka	0.00	1.94	2.05	2.06	2.06
117107	Beecher Springs near Fruitland	5.46	6.15	6.19	6.21	6.21
118090	Tobacco Patch Landing Spring Group near Fort McCoy	0.00	0.82	0.89	0.92	0.93
118105	Croaker Hole Spring near Welaka	63.56	87.69	88.60	88.55	88.42
119090	Wells Landing Springs near Fort McCoy	0.00	3.87	4.10	4.15	4.16
124102	Salt Springs near Eureka	66.39	74.23	74.70	74.85	74.91
129043	Wekiva Springs near Gulf Hammock	43.38	45.24	45.49	45.66	45.72
132108	Silver Glen Springs near Astor	75.89	81.66	81.34	80.93	80.75
134081	Silver Springs near Ocala	439.60	641.55	671.33	693.09	701.18
134106	Sweetwater Springs along Juniper Creek	10.13	12.49	12.69	12.80	12.84
136103	Juniper Springs and Fern Hammock Springs near Ocala	3.97	6.97	7.36	7.64	7.74
136107	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	2.47	4.53	4.71	4.82	4.85
140125	Ponce de Leon Springs near De Land	19.39	22.12	21.59	21.08	20.86
142057	Rainbow Springs near Dunnellon	574.67	614.27	619.90	623.76	625.19
144112	Alexander Springs near Astor	84.42	99.70	101.15	102.10	102.42
147121	Mosquito Springs Run Alexander Springs Wilderness	0.00	0.22	0.00	0.00	0.00
152070	Gum Springs near Holder	56.54	68.38	70.50	72.16	72.80
153114	Camp La No Che Springs near Paisley	0.00	0.00	1.97	3.68	4.29
153127	Blue Spring near Orange City	89.00	121.96	125.91	128.72	129.76
157046	Crystal River Spring Group	696.77	699.51	699.98	700.36	700.50
158117	Blackwater Springs near Cassia	0.00	0.00	0.00	0.30	0.59
159079	Little Jones Creek Head Spring near Wildwood	3.01	7.54	8.39	9.07	9.34
160079	Little Jones Creek Spring No. 2 near Wildwood	2.06	4.87	5.37	5.76	5.91
160117	Messant Spring near Sorrento	5.46	11.38	12.01	12.43	12.56
160129	Gemini Springs near DeBary (all 3)	8.34	9.94	10.17	10.35	10.41
160133	Green Springs	0.00	0.23	0.31	0.35	0.36
161080	Little Jones Creek Spring No. 3 near Wildwood	0.70	2.92	3.31	3.61	3.73
161115	Seminole Springs near Sorrento	0.00	15.46	22.98	29.01	31.15
161120	Palm Springs Seminole State Forest	0.00	1.20	1.09	0.84	0.69
162047	Halls River Head Spring	5.05	5.08	5.08	5.08	5.08
162116	Droty Springs near Sorrento	0.00	0.17	0.45	0.64	0.71
162122	Island Spring near Sanford	6.45	6.88	6.62	6.33	6.19
163046	Halls River Springs	110.56	111.09	111.18	111.26	111.29
164047	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	132.46	133.11	133.22	133.31	133.35

GridID	Spring Name	0.1	1 (Baseline)	2	5	10
164082	Fenney Springs near Coleman Head Spring of Shady Brook Creek	0.00	12.21	15.36	17.79	18.73
165082	Shady Brook Creek Springs No. 2 and 3	2.02	5.83	6.39	6.81	6.97
166047	Hidden River Springs near Homosassa (including Hidden River Head Spring)	7.62	7.66	7.67	7.68	7.68
166080	Shady Brook Creek Spring No. 4	0.21	2.93	3.33	3.63	3.74
166116	Sulphur Camp Springs	0.00	2.02	2.50	2.89	3.03
167079	Shady Brook Creek Spring No. 5	0.00	2.97	3.48	3.85	3.98
167091	Bugg Spring at Okahumpka	0.00	9.09	11.98	14.03	14.79
167116	Rock Springs near Apopka	47.69	62.25	65.22	67.63	68.51
168046	Potter Spring near Chassahowitzka (including Ruth Spring)	16.29	16.37	16.38	16.39	16.40
168095	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
168096	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	0.00	8.83	14.15	17.83	19.17
169047	Salt Creek Head Spring	0.44	0.44	0.45	0.45	0.45
169048	Lettuce Creek Spring	4.35	4.38	4.39	4.39	4.39
169117	Witherington Spring near Apopka	1.05	1.62	1.72	1.80	1.82
170047	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	27.44	27.57	27.59	27.61	27.62
170048	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	112.55	113.09	113.18	113.26	113.29
171046	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	8.80	8.84	8.85	8.85	8.86
171047	Rita Maria Spring near Chassahowitzka	4.10	4.12	4.12	4.13	4.13
171119	Wekiwa Springs in State Park near Apopka	62.72	68.52	69.42	70.06	70.29
171120	Miami Springs near Longwood	4.60	4.96	5.00	5.02	5.02
171131	Lake Jesup Spring near Wagner	3.57	3.47	3.31	3.15	3.08
172045	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	36.08	36.21	36.23	36.25	36.26
172046	Blue Run Head Spring near Chassahowitzka	5.50	5.51	5.52	5.52	5.52
172123	Palm Springs and Sanlando Springs near Longwood	30.90	35.17	36.05	36.75	37.03
172124	Starbuck Spring near Longwood	16.51	18.98	19.54	20.00	20.19
172133	Clifton Springs near Oviedo	14.97	12.38	11.30	10.28	9.84
173044	Unnamed Spring No. 8	7.34	7.36	7.36	7.36	7.37
173101	Double Run Road Seepage near Astatula	0.00	4.85	6.24	7.16	7.49
174044	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	41.99	42.06	42.07	42.08	42.09
181105	Apopka (Gourdneck) Spring near Oakland	18.93	34.43	36.53	37.93	38.42
182044	Unnamed Spring No. 6	7.15	7.15	7.16	7.16	7.16
182045	Salt Spring and Mud Spring near Bayport	30.82	30.84	30.85	30.85	30.85
184044	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	43.38	43.40	43.40	43.40	43.40

GridID	Spring Name	0.1	1 (Baseline)	2	5	10
184048	Weeki Wachee Springs near Brooksville	198.44	198.60	198.63	198.65	198.66
188043	Unnamed Spring No. 2	1.69	1.70	1.70	1.70	1.70
190042	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	9.88	10.00	10.01	10.02	10.02
190043	Bobhill Springs	6.37	6.45	6.46	6.46	6.47
193040	Horseshoe Spring near Hudson	5.64	7.00	7.13	7.21	7.24
193041	Unnamed Spring No. 3 near Aripeka	18.36	21.53	21.83	22.04	22.11
200038	Salt Springs near Port Richey	6.12	10.97	11.40	11.67	11.76
220055	Sulphur Springs at Sulphur Springs	5.58	24.24	26.28	27.73	28.26
221061	Lettuce Lake Spring	0.00	7.64	9.07	10.15	10.58
221062	Six-Mile Creek Spring and Eureka Springs near Tampa	0.00	2.40	2.78	3.08	3.19
230064	Buckhorn Spring near Riverview	0.00	12.20	18.23	26.44	31.48
232069	Lithia Springs Minor and Lithia Springs Major near Lithia	0.00	30.84	45.84	67.07	81.29
289068	Little Salt Spring near Murdock	0.00	0.87	1.00	1.06	1.06
290067	Warm Mineral Springs near Woodmere	4.76	6.56	6.74	6.82	6.80
41007	Blue Spring near Madison	83.92	101.34	103.06	104.04	104.38
44017	Alapaha Rise near Fort Union	305.32	408.13	418.82	424.70	426.71
47027	Suwannee Springs near Live Oak	1.90	6.22	6.71	6.91	6.97
48012	Suwanacoochee Spring and Ellaville Spring at Ellaville	103.84	112.23	113.12	113.58	113.73
64007	Allen Mill Pond Spring near Dell	11.90	12.26	12.30	12.32	12.32
66008	Blue Spring near Dell	59.26	61.43	61.68	61.79	61.83
68012	Telford Spring at Luraville	34.33	36.20	36.41	36.50	36.53
68015	Running Springs (East and West) near Luraville	92.49	98.88	99.60	99.89	99.97
69016	Convict Spring near Mayo	1.41	1.51	1.53	1.53	1.53
70017	Royal Spring near Alton	1.72	1.85	1.87	1.88	1.88
72019	Owens Spring	47.25	51.40	51.86	52.04	52.10
73020	Mearson Spring near Mayo	59.01	64.93	65.59	65.85	65.92
75022	Troy Spring near Branford	130.07	141.55	142.84	143.36	143.51
76024	Little River Springs near Branford	49.57	53.33	53.76	53.94	53.99
78037	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	197.17	246.16	252.37	254.95	255.67
79026	Branford Springs at Branford	34.05	36.38	36.67	36.78	36.82
87002	Steinhatchee Spring near Clara	1.18	1.18	1.18	1.18	1.18
87029	Turtle Spring near Hatchbend and Fletcher Spring	50.17	52.04	52.28	52.37	52.40
88041	Ginnie Spring near High Springs	42.75	49.83	50.86	51.33	51.48
89044	Poe Springs near High Springs	45.85	56.36	57.91	58.64	58.88
91027	Rock Bluff Springs near Bell	41.32	42.16	42.27	42.31	42.33
92026	Guaranto Spring near Rock Bluff Landing	2.89	2.94	2.94	2.94	2.94
104023	Copper Springs near Oldtown (including Little Copper Spring)	27.10	27.16	27.18	27.18	27.18
116040	Blue Spring near Bronson	7.58	8.11	8.20	8.25	8.27

GridID	Spring Name	0.1	1 (Baseline)	2	5	10
151064	Wilson Head Spring near Holder	2.22	2.50	2.55	2.58	2.60
151065	Blue Spring near Holder	10.07	10.71	10.82	10.91	10.94
209072	Crystal Springs near Zephyrhills	14.62	32.66	35.32	37.41	38.23

Predictive Simulations

Estimated 2030 Pumping

A predictive simulation was run with estimated 2030 pumping rates provided by GISA. Projections for 2030 withdrawals were only computed by GISA for the northern portion of the MegaModel (from rows 1 through 223). These projected 2030 data was spliced by GISA with estimated 2020 pumping from the original Sepulveda (2002) work. The entire well package was provided by GISA in a database (USGS_2030_PFGWM.mdb). Due to sign convention issues in the data provided by GISA, the pumping rates for rows 1 through 223 were multiplied by -1. All pumping rates provided were converted into cubic feet per day and used to create the MegaModel well package for the 2030 simulation. A summary of the wells by layer for the 2030 simulation is provided in Table 18.

Table 18. Well Summary, 2030 Simulation

Layer Number	Total Number of Wells
1	52
2	2785
3	34213
4	335

Water Level Comparison

With the exception of the well package, all other properties and boundary conditions were identical to the 1993-1994 simulation. The recharge rates were defined from the 1993-1994 simulation as explained above. Any additional induced recharge imposed by drawdown of the surficial is not accounted for in this simulation. This, in effect, may slightly overestimate surficial drawdown and therefore also the Floridan Aquifer system drawdown. That being the case, these results can be considered to be conservative. Figures 42 through 45 show the drawdowns by layer. The maximum drawdowns per layer are shown in Table 19.

Table 19. Maximum Drawdown by Layer

Layer	Maximum Drawdown, ft
1 (Surficial)	33.62
2 (Intermediate)	35.01
3 (Upper Floridan)	36.56
4 (Lower Floridan)	15.71

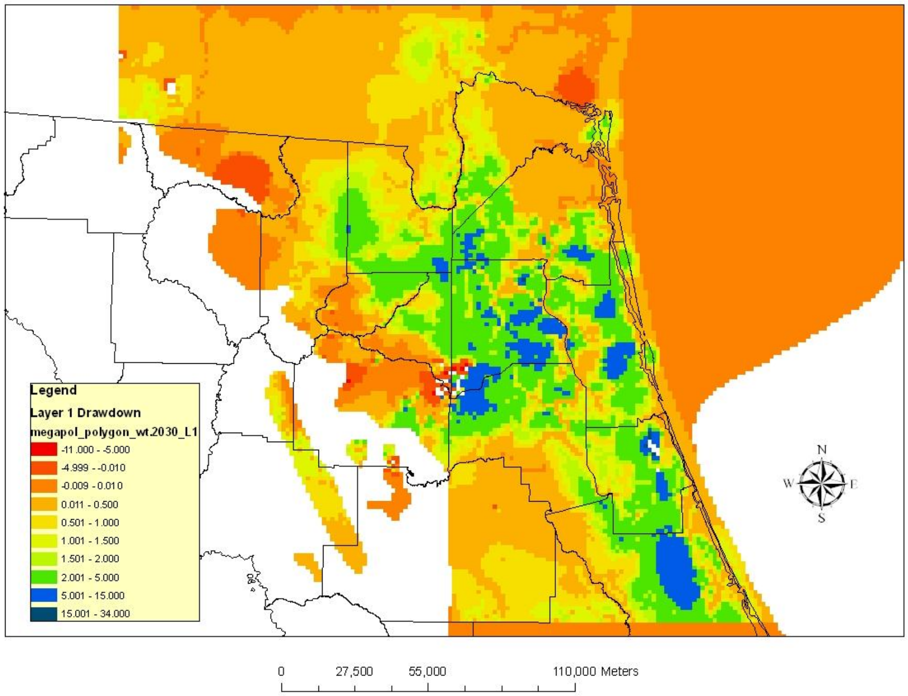


Figure 42. 2030 Simulation Drawdown (feet), Layer 1

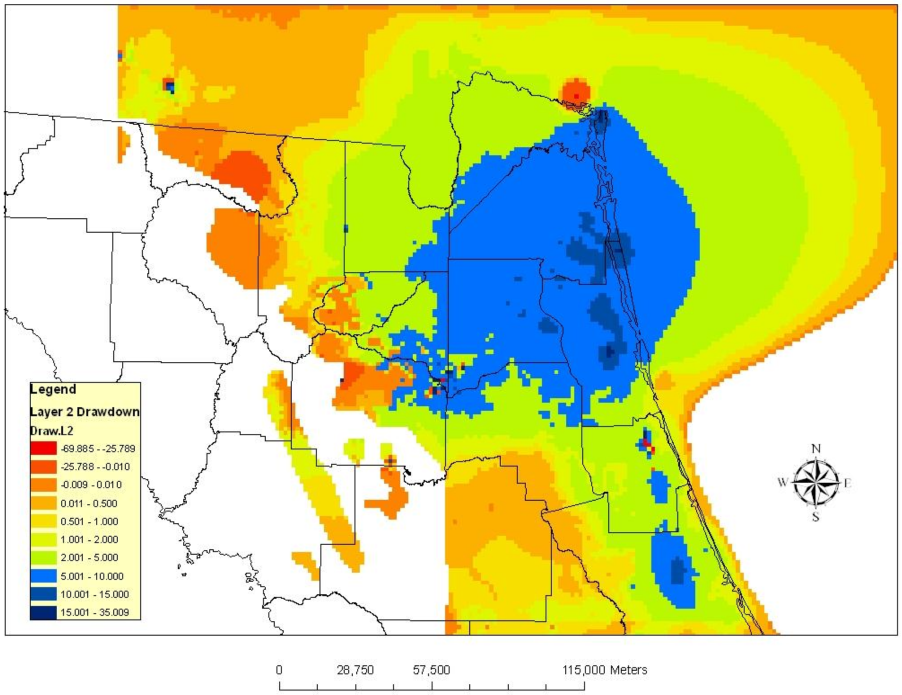


Figure 43. 2030 Simulation Drawdown (feet), Layer 2

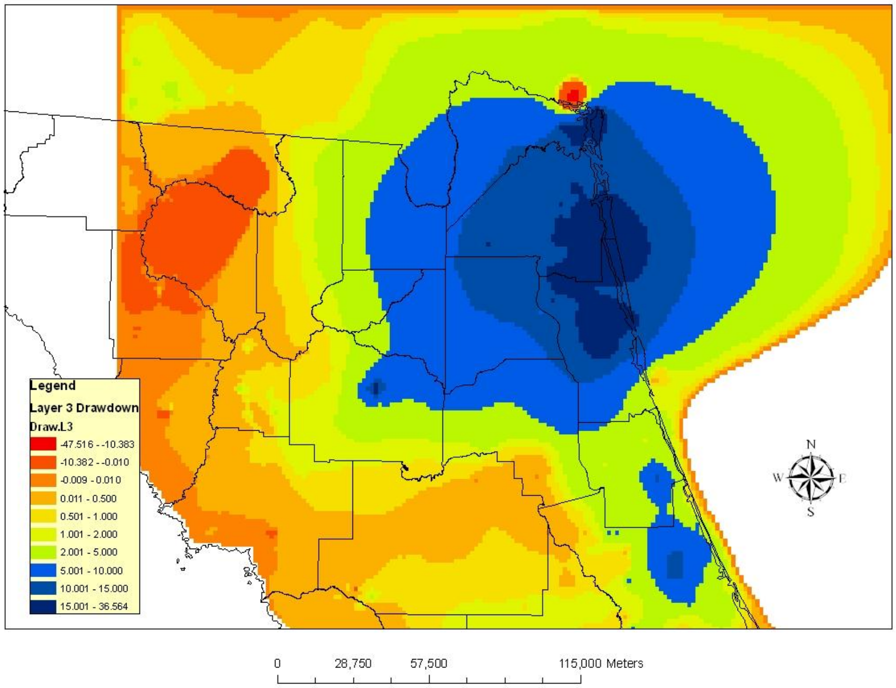


Figure 44. 2030 Simulation Drawdown (feet), Layer 3

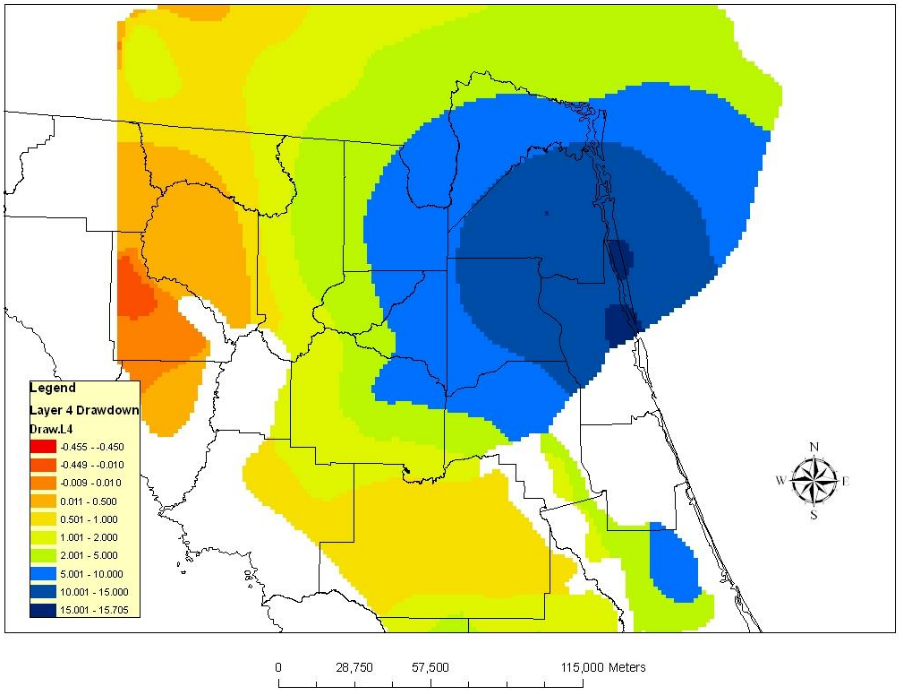


Figure 45. 2030 Simulation Drawdown (feet), Layer 4

Baseflow Comparison

Baseflow was calculated for each reach by using the .cbb output file from MODFLOW. A perl script was run on the .cbb file resulting in a text file of all cell to cell fluxes (constant head, right face, front face, lower face, drain, well, river and recharge) for each layer. Baseflow was calculated in a database by joining the river cell flux for layer 1 with the previously developed óGridId to ReachIdô query.

The baseflow calculated from the 2030 simulation was compared to the simulated baseflow calculated from the 1993-1994 simulation, as shown in Table 20. Baseflow comparisons were made for all reaches that are flux constrained (ie. have an estimated baseflow target). As shown in the table, the Suwannee River stations (ReachID numbers 4, 17, 18, and 33) experienced small changes in baseflow between simulations. Other reaches, such as the St. Maryôs River near Macclenny (ReachID 36) and North Fork Black Creek (ReachID 39) experienced higher percent changes in baseflow between simulations.

Table 20. Baseflow Comparison by Reach

ReachID	Station Name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
4	SUWANNEE RIVER AT ELLAVILLE, FLA	309.14	308.95	-0.06
5	ALLIGATOR CREEK AT CALLAHAN, FL	3.46	2.98	-13.84
6	THOMAS CREEK NEAR CRAWFORD, FL	7.32	6.30	-13.96
7	STRAWBERRY CREEK NEAR ARLINGTON, FL	0.07	0.00	-98.11
8	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	1.17	0.90	-23.16
9	ORTEGA RIVER AT JACKSONVILLE, FL	6.90	5.36	-22.31
11	NEW RIVER NR LAKE BUTLER FLA	18.75	15.52	-17.24
12	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	52.04	50.83	-2.32
13	PARENERS BRANCH NEAR BLAND, FL.	0.15	0.15	0.01
14	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	27.30	26.37	-3.41
16	CANNON CREEK NEAR LAKE CITY, FL	-0.04	-0.04	0.00
17	DEEP CREEK NR SUWANNEE VALLEY FL	1.45	1.34	-7.79
18	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	55.06	54.59	-0.85
19	SUWANNEE R NR BENTON FLA	168.76	167.00	-1.04
20	PABLO CREEK AT JACKSONVILLE, FL	5.27	3.68	-30.11
21	BIG DAVIS CREEK AT BAYARD, FL	0.53	0.23	-56.43
33	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	10.67	10.68	0.04
34	NORTH PRONG ST. MARYS RIVER AT MONIAC, GA	19.24	18.33	-4.71
35	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	0.92	0.75	-18.49
36	ST. MARYS RIVER NEAR MACCLENNY, FL	45.42	40.97	-9.79
37	RICE CREEK NEAR SPRINGSIDE	6.55	5.58	-14.87
38	SUWANNEE RIVER NEAR WILCOX, FLA.	6.78	6.41	-5.56
39	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	40.33	26.88	-33.34

ReachID	Station Name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
44	SILVER RIVER NEAR OCALA, FL	0.25	0.24	-3.30
45	OCKLAWAHA RIVER NEAR CONNER, FL	46.26	45.44	-1.76
46	OCKLAWAHA RIVER AT EUREKA, FL	115.17	114.44	-0.63
47	ORANGE LAKE OUTLET NEAR CITRA, FL	25.53	24.06	-5.77
48	ORANGE CREEK AT ORANGE SPRINGS, FL	10.26	9.74	-4.99
49	CEDAR RIVER AT MARIETTA, FL	3.97	3.36	-15.27
51	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	12.51	3.81	-69.57
52	SIMMS CREEK NEAR BARDIN, FL	6.20	3.87	-37.54
55	MIDDLE HAW CREEK NR KORONA, FLA.	2.10	1.34	-36.36
56	LITTLE HAW CREEK NEAR SEVILLE, FL	0.58	0.46	-20.77
58	DEEP CREEK NEAR HASTINGS, FL	3.62	3.11	-14.05
61	SANTA FE RIVER NEAR GRAHAM, FLA.	3.80	3.65	-3.95
62	SPRUCE CREEK NEAR SAMSULA, FL	3.26	2.98	-8.55
63	TOMOKA RIVER NEAR HOLLY HILL, FL	10.07	9.10	-9.71

Spring Comparison

Similar to baseflow, springflow was compared to the springflow from the 1993-1994 simulation, as shown in Table 21. The springs that are reduced to exactly zero are either the head gradient between the aquifer and the drain cell is exactly zero (improbable) or the head in the aquifer is below the elevation of the drain cell (the drain elevation is uncertain and in most cases can not be measured).

Table 21. Springflow Comparison by Reach

Gridid	Spring_name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
44019	Holton Spring near Fort Union	14.02	13.99	-0.17
49014	Falmouth Spring at Falmouth	148.34	150.16	1.23
52037	White Sulphur Springs at White Springs	89.86	83.48	-7.11
63008	Charles Springs near Dell	5.09	5.13	0.80
65103	Wadesboro Spring near Orange Park	0.99	0.00	-100.00
67014	Peacock Springs	86.08	86.52	0.52
76023	Ruth Spring near Branford	19.61	19.55	-0.31
77037	Ichetucknee Head Spring near Fort White and Cedar Head Spring	43.01	41.49	-3.53
77106	Green Cove Springs at Green Cove Springs	2.93	0.00	-100.00
81037	Jamison Spring	1.86	1.81	-2.31
87048	Hornsby Spring near High Springs	53.26	47.55	-10.73
89042	Blue Springs near High Springs (including	39.50	37.46	-5.15

Gridid	Spring_name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
	Lilly Springs)			
94135	Crescent Beach Submarine Spring	41.03	25.39	-38.11
97026	Lumbercamp Springs and Sun Springs near Wannee	52.32	51.61	-1.36
100025	Hart Springs near Wilcox	95.79	94.02	-1.86
102025	Otter Springs near Wilcox	6.24	6.16	-1.30
103107	Whitewater Springs	1.02	0.00	-100.00
105025	Bell Springs	1.68	1.65	-1.69
106026	Fannin Springs near Wilcox (including Little Fannin Spring)	88.86	87.51	-1.52
111106	Satsuma Spring	0.89	0.47	-47.42
112089	Orange Spring at Orange Springs	1.29	0.00	-100.00
112094	Blue Springs near Orange Springs	0.43	0.30	-30.23
113023	Manatee Spring near Chiefland	198.61	194.84	-1.90
113088	Camp Seminole Spring at Orange Springs	0.24	0.00	-100.00
114106	Welaka Spring near Welaka	0.00	0.00	
116106	Mud Spring near Welaka	1.94	1.59	-18.29
117107	Beecher Springs near Fruitland	6.15	6.04	-1.89
118090	Tobacco Patch Landing Spring Group near Fort McCoy	0.82	0.69	-15.98
118105	Croaker Hole Spring near Welaka	87.69	83.14	-5.19
119090	Wells Landing Springs near Fort McCoy	3.87	3.14	-18.95
124102	Salt Springs near Eureka	74.23	72.23	-2.69
129043	Wekiva Springs near Gulf Hammock	45.24	44.12	-2.48
132108	Silver Glen Springs near Astor	81.66	80.39	-1.55
134081	Silver Springs near Ocala	641.55	564.89	-11.95
134106	Sweetwater Springs along Juniper Creek	12.49	12.24	-2.00
136103	Juniper Springs and Fern Hammock Springs near Ocala	6.97	6.49	-6.82
136107	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.53	4.28	-5.61
140125	Ponce de Leon Springs near De Land	22.12	20.47	-7.46
142057	Rainbow Springs near Dunnellon	614.27	588.95	-4.12
144112	Alexander Springs near Astor	99.70	96.44	-3.27
147121	Mosquito Springs Run Alexander Springs Wilderness	0.22	0.00	-100.00
152070	Gum Springs near Holder	68.38	62.54	-8.54
153114	Camp La No Che Springs near Paisley	0.00	0.00	
153127	Blue Spring near Orange City	121.96	101.03	-17.16
157046	Crystal River Spring Group	699.51	682.80	-2.39
158117	Blackwater Springs near Cassia	0.00	0.00	
159079	Little Jones Creek Head Spring near Wildwood	7.54	6.12	-18.77

Gridid	Spring_name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
160079	Little Jones Creek Spring No. 2 near Wildwood	4.87	4.13	-15.19
160117	Messant Spring near Sorrento	11.38	10.45	-8.18
160129	Gemini Springs near DeBary (all 3)	9.94	8.70	-12.48
160133	Green Springs	0.23	0.00	-100.00
161080	Little Jones Creek Spring No. 3 near Wildwood	2.92	2.47	-15.35
161115	Seminole Springs near Sorrento	15.46	6.70	-56.64
161120	Palm Springs Seminole State Forest	1.20	0.72	-40.08
162047	Halls River Head Spring	5.08	4.98	-1.87
162116	Droty Springs near Sorrento	0.17	0.00	-100.00
162122	Island Spring near Sanford	6.88	7.01	1.90
163046	Halls River Springs	111.09	109.12	-1.77
164047	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	133.11	130.86	-1.69
164082	Fenney Springs near Coleman Head Spring of Shady Brook Creek	12.21	9.93	-18.68
165082	Shady Brook Creek Springs No. 2 and 3	5.83	5.49	-5.74
166047	Hidden River Springs near Homosassa (including Hidden River Head Spring)	7.66	7.52	-1.88
166080	Shady Brook Creek Spring No. 4	2.93	2.72	-7.16
166116	Sulphur Camp Springs	2.02	0.17	-91.37
167079	Shady Brook Creek Spring No. 5	2.97	2.74	-7.71
167091	Bugg Spring at Okahumpka	9.09	6.87	-24.43
167116	Rock Springs near Apopka	62.25	50.12	-19.49
168046	Potter Spring near Chassahowitzka (including Ruth Spring)	16.37	16.14	-1.40
168095	Mooring Cove Springs near Yalaha	0.00	0.00	
168096	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	8.83	3.20	-63.72
169047	Salt Creek Head Spring	0.44	0.44	-1.36
169048	Lettuce Creek Spring	4.38	4.30	-1.89
169117	Witherington Spring near Apopka	1.62	1.03	-36.04
170047	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	27.57	27.22	-1.28
170048	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	113.09	111.65	-1.27
171046	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	8.84	8.72	-1.32
171047	Rita Maria Spring near Chassahowitzka	4.12	4.06	-1.41
171119	Wekiwa Springs in State Park near Apopka	68.52	60.97	-11.03
171120	Miami Springs near Longwood	4.96	4.40	-11.20

Gridid	Spring_name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
171131	Lake Jesup Spring near Wagner	3.47	2.17	-37.27
172045	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	36.21	35.85	-1.00
172046	Blue Run Head Spring near Chassahowitzka	5.51	5.46	-0.90
172123	Palm Springs and Sanlando Springs near Longwood	35.17	29.16	-17.10
172124	Starbuck Spring near Longwood	18.98	15.53	-18.18
172133	Clifton Springs near Oviedo	12.38	8.42	-32.03
173044	Unnamed Spring No. 8	7.36	7.30	-0.82
173101	Double Run Road Seepage near Astatula	4.85	3.25	-32.97
174044	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	42.06	41.81	-0.59
181105	Apopka (Gourdneck) Spring near Oakland	34.43	29.50	-14.33
182044	Unnamed Spring No. 6	7.15	7.11	-0.58
182045	Salt Spring and Mud Spring near Bayport	30.84	30.65	-0.61
184044	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	43.40	43.20	-0.45
184048	Weeki Wachee Springs near Brooksville	198.60	196.79	-0.91
188043	Unnamed Spring No. 2	1.70	1.70	-0.07
190042	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	10.00	10.07	0.74
190043	Bobhill Springs	6.45	6.47	0.35
193040	Horseshoe Spring near Hudson	7.00	6.94	-0.87
193041	Unnamed Spring No. 3 near Aripeka	21.53	21.44	-0.41
200038	Salt Springs near Port Richey	10.97	10.49	-4.33
220055	Sulphur Springs at Sulphur Springs	24.24	23.74	-2.05
221061	Lettuce Lake Spring	7.64	7.29	-4.53
221062	Six-Mile Creek Spring and Eureka Springs near Tampa	2.40	2.30	-3.91
230064	Buckhorn Spring near Riverview	12.20	11.08	-9.24
232069	Lithia Springs Minor and Lithia Springs Major near Lithia	30.84	27.59	-10.52
289068	Little Salt Spring near Murdock	0.87	0.50	-42.92
290067	Warm Mineral Springs near Woodmere	6.56	5.98	-8.87
41007	Blue Spring near Madison	101.34	100.91	-0.43
44017	Alapaha Rise near Fort Union	408.13	407.51	-0.15
47027	Suwannee Springs near Live Oak	6.22	6.68	7.37
48012	Suwanacoochee Spring and Ellaville Spring at Ellaville	112.23	112.82	0.52
64007	Allen Mill Pond Spring near Dell	12.26	12.33	0.63
66008	Blue Spring near Dell	61.43	61.89	0.75
68012	Telford Spring at Luraville	36.20	36.44	0.67
68015	Running Springs (East and West) Luraville	98.88	99.58	0.71

Gridid	Spring_name	1993-1994 Baseflow, cfs	2030 Baseflow, cfs	Percent Change
69016	Convict Spring near Mayo	1.51	1.52	0.65
70017	Royal Spring near Alton	1.85	1.87	0.62
72019	Owens Spring	51.40	51.59	0.36
73020	Mearson Spring near Mayo	64.93	65.03	0.15
75022	Troy Spring near Branford	141.55	141.48	-0.05
76024	Little River Springs near Branford	53.33	53.18	-0.28
78037	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	246.16	239.54	-2.69
79026	Branford Springs at Branford	36.38	36.10	-0.77
87002	Steinhatchee Spring near Clara	1.18	1.18	0.00
87029	Turtle Spring near Hatchbend and Fletcher Spring	52.04	51.47	-1.10
88041	Ginnie Spring near High Springs	49.83	47.58	-4.52
89044	Poe Springs near High Springs	56.36	52.87	-6.20
91027	Rock Bluff Springs near Bell	42.16	41.62	-1.28
92026	Guaranto Spring near Rock Bluff Landing	2.94	2.90	-1.21
104023	Copper Springs near Oldtown (including Little Copper Spring)	27.16	26.60	-2.07
116040	Blue Spring near Bronson	8.11	7.62	-6.10
151064	Wilson Head Spring near Holder	2.50	1.93	-22.62
151065	Blue Spring near Holder	10.71	9.93	-7.29
209072	Crystal Springs near Zephyrhills	32.66	32.66	-0.03

Predictive Simulations

Six additional predictive simulations were performed at the request of the District. These simulations modified pumping to 2030 levels in some areas, while maintaining 1993-1994 levels in other areas in order to isolate potential sources of drawdown. For consistency between simulations, all wells south of row 224 were kept at 2020 levels for all of the simulations. This included wells within the Southwest Florida Water Management District and the South Florida Water Management District. The following scenarios were performed:

- Scenario 1: Georgia and Suwannee River Water Management District wells were held at 1993-1994 pumping rates; St. Johns River Water Management District wells were simulated at 2030 rates.
- Scenario 2: Suwannee River Water Management District wells were held at 1993-1994 pumping rates; St. Johns River Water Management District and Georgia wells were simulated at 2030 rates.
- Scenario 3: Suwannee River Water Management District and St. Johns River Water Management District wells were held at 1993-1994 pumping rates; Georgia wells were simulated at 2030 rates.

- Scenario 4: St. Johns River Water Management District wells were held at 1993-1994 pumping rates; Suwannee River Water Management District and Georgia wells were simulated at 2030 rates.
- Scenario 5: St. Johns River Water Management District and Georgia wells were held at 1993-1994 pumping rates; Suwannee River Water Management District wells were simulated at 2030 rates.
- Scenario 6: Georgia wells were held at 1993-1994 pumping rates; St. Johns River Water Management District and Suwannee River Water Management District wells were simulated at 2030 rates.

Scenario 1

For this simulation, Georgia and Suwannee River Water Management District wells were held at 1993-1994 pumping rates; St. Johns River Water Management District wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 46.

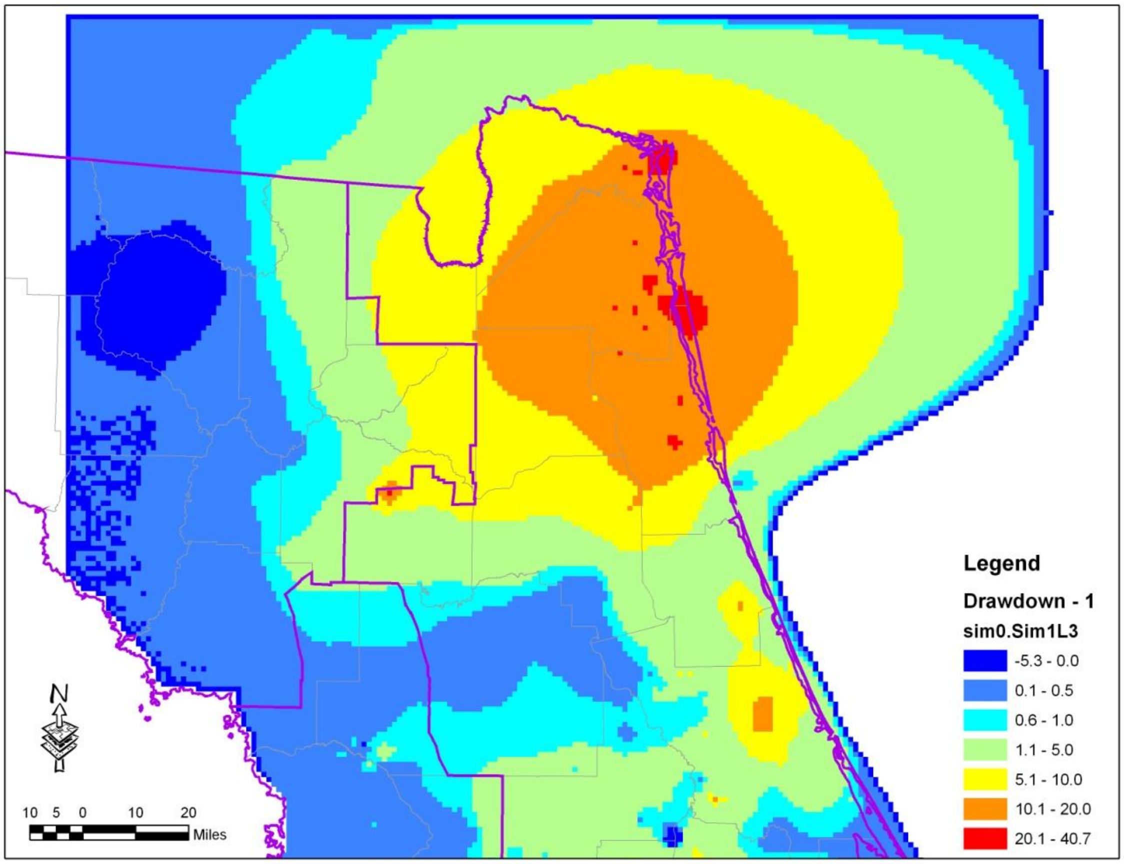


Figure 46. Scenario 1, Upper Floridan Drawdown

Scenario 2

For this simulation, Suwannee River Water Management District wells were held at 1993-1994 pumping rates; St. Johns River Water Management District and Georgia wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 47.

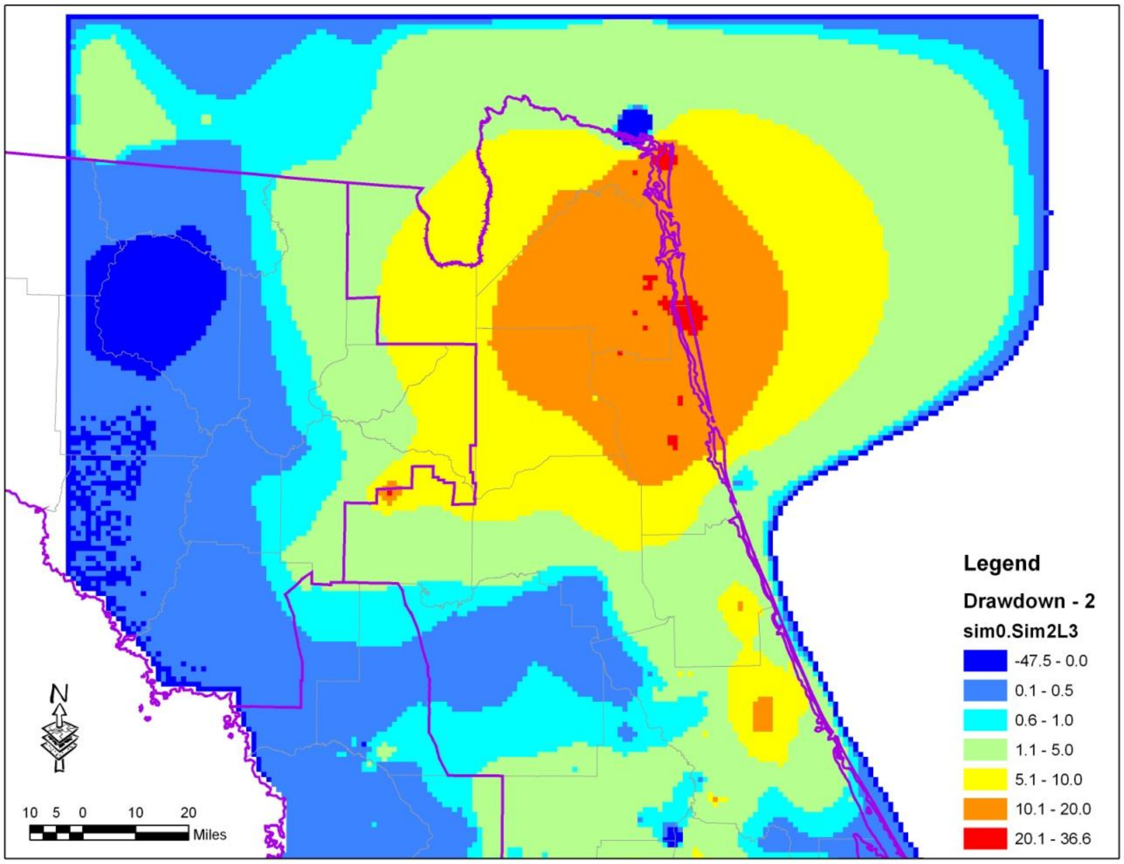


Figure 47. Scenario 2, Upper Floridan Drawdown

Scenario 3

For this simulation, Suwannee River Water Management District and St. Johns River Water Management District wells were held at 1993-1994 pumping; Georgia wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 48.

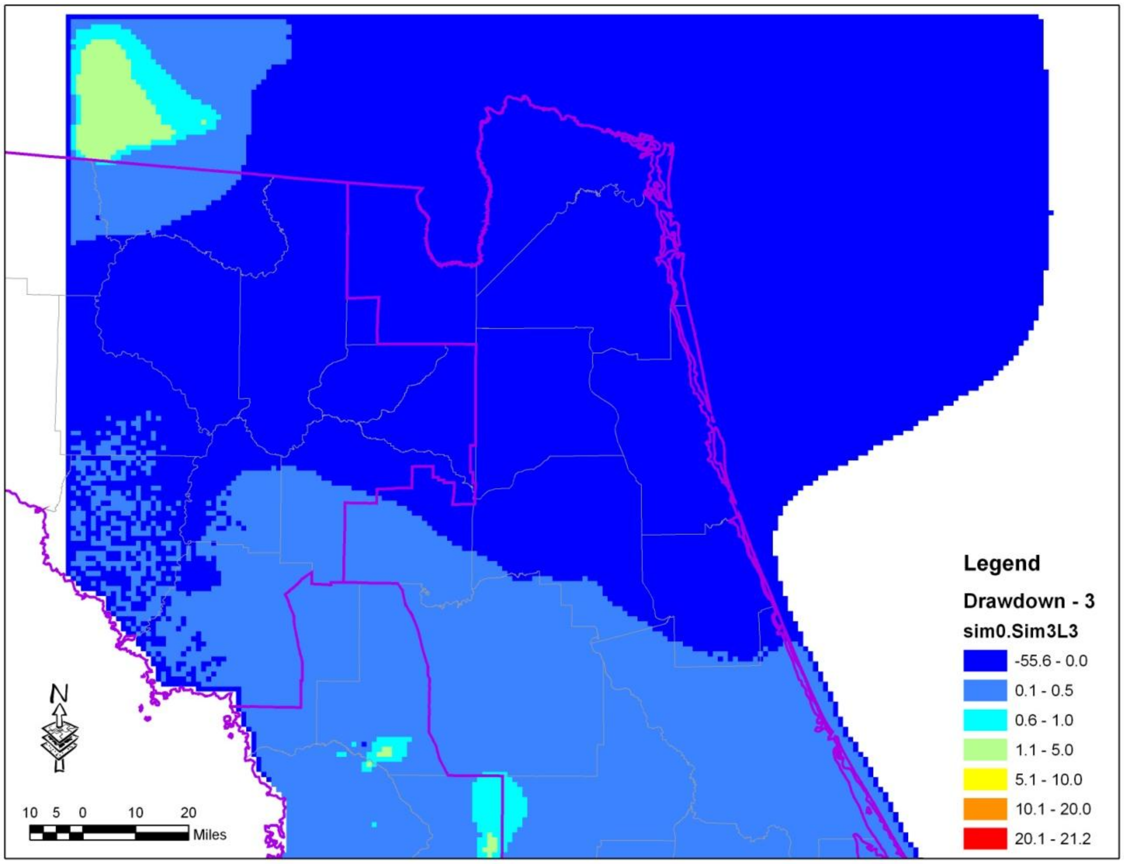


Figure 48. Scenario 3, Upper Floridan Drawdown

Scenario 4

For this simulation, St. Johns River Water Management District wells were held at 1993-1994 pumping rates; Suwannee River Water Management District and Georgia wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 49.

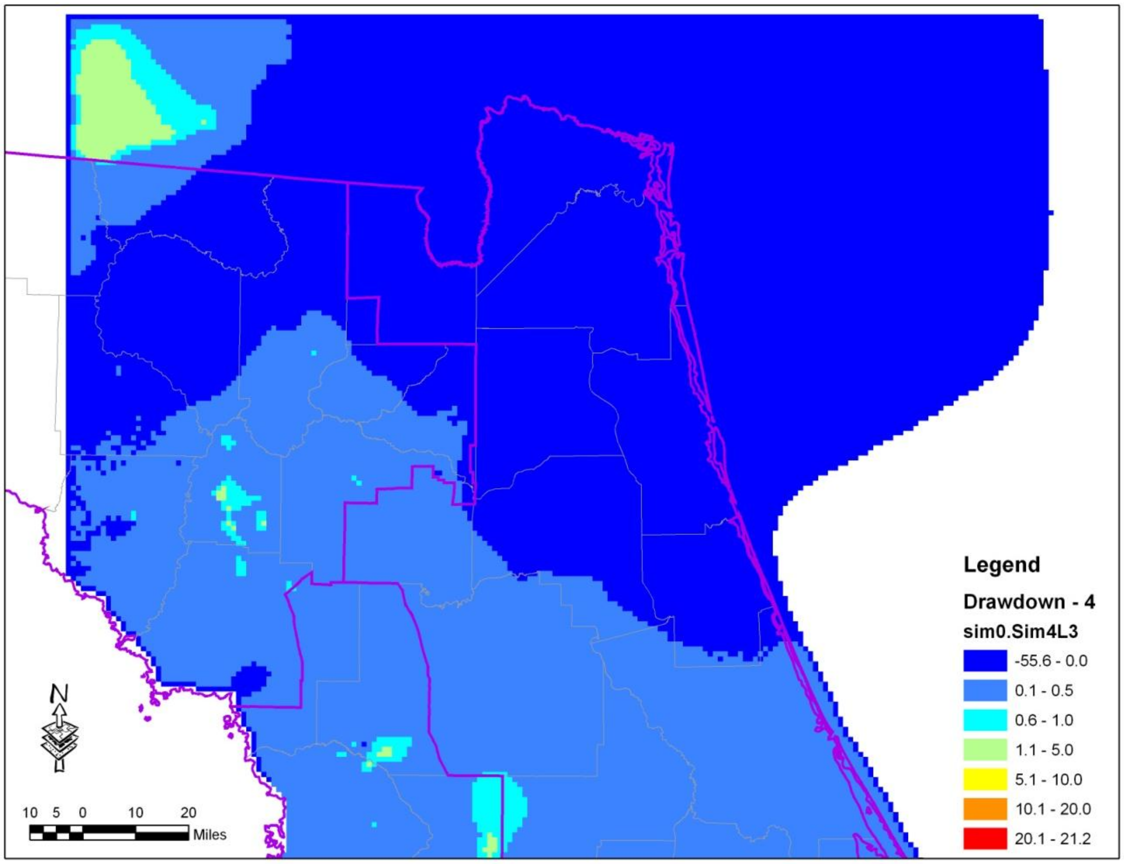


Figure 49. Scenario 4, Upper Floridan Drawdown

Scenario 5

For this simulation, St. Johns River Water Management District and Georgia wells were held at 1993-1994 pumping rates; Suwannee River Water Management District wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 50.

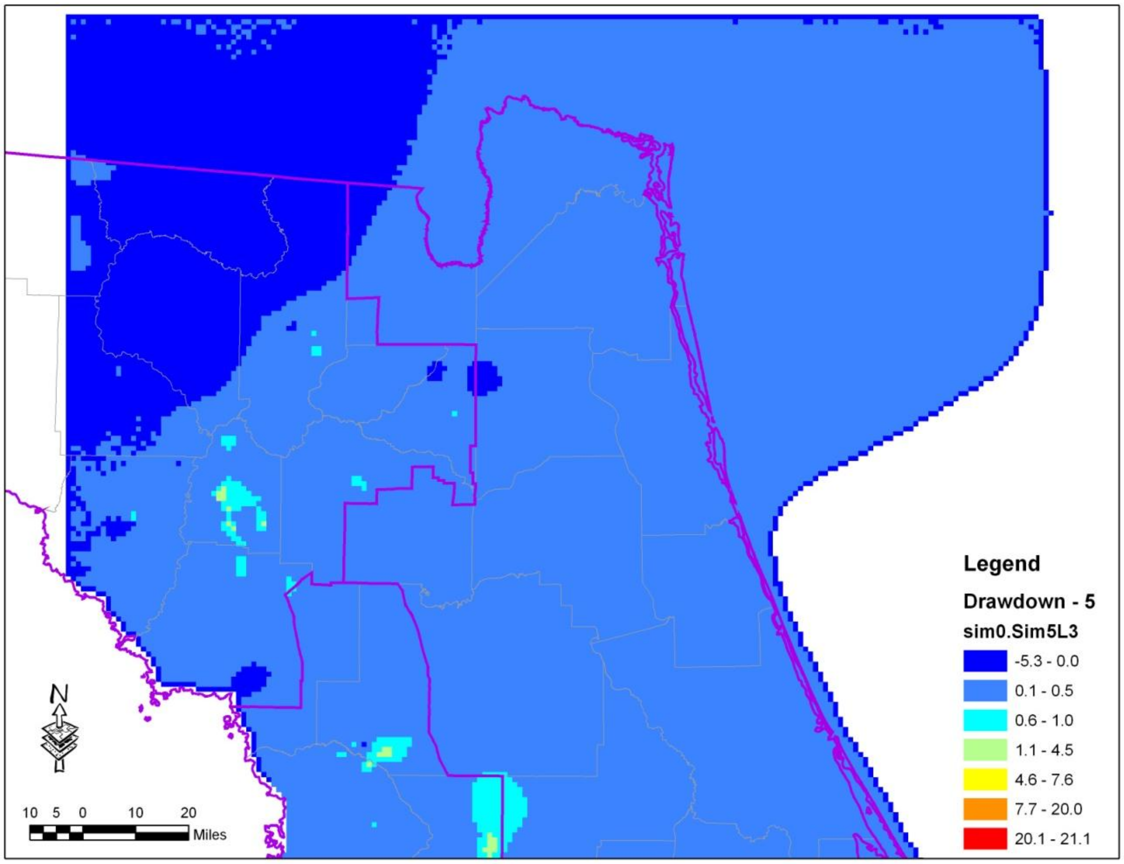


Figure 50. Scenario 5, Upper Floridan Drawdown

Scenario 6

For this simulation, Georgia wells were held at 1993-1994 pumping rates; St. Johns River Water Management District and Suwannee River Water Management District wells were simulated at 2030 rates. This simulation was compared to the original 1993-1994 simulation. The resulting drawdown in the Upper Floridan Aquifer is shown in Figure 51.

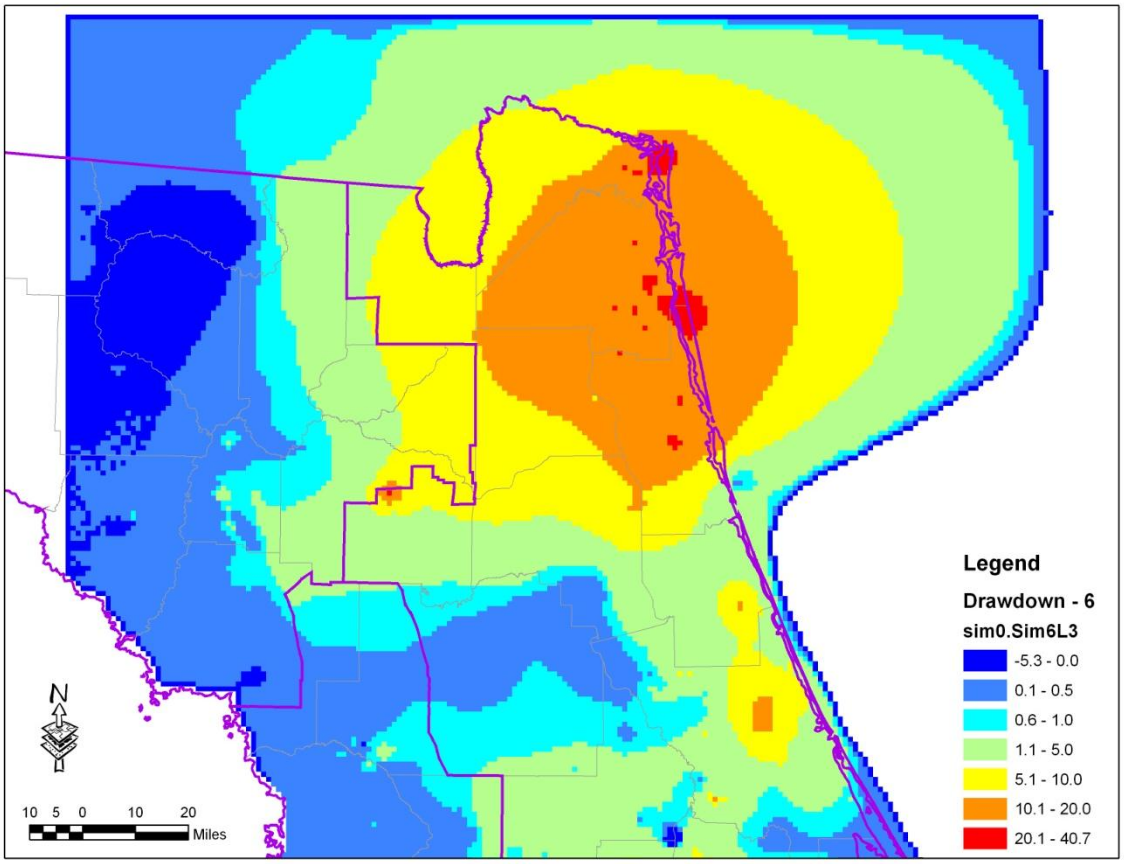


Figure 51. Scenario 6, Upper Floridan Drawdown

Baseflow Comparison

Baseflow was calculated for each reach by using the .cbb output file from MODFLOW. A perl script was run on the .cbb file resulting in a text file of all cell to cell fluxes (constant head, right face, front face, lower face, drain, well, river and recharge) for each layer. Baseflow was calculated in a database by joining the river cell flux for layer 1 with the previously developed óGridId to ReachIdô query.

The baseflow calculated for each 2030 simulation was compared to the simulated baseflow calculated from the 1993-1994 simulation, as shown in Table 22.

Table 22. Baseflow by Simulation. (Values in cfs).

ReachID	Station Name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
4	SUWANNEE RIVER AT ELLAVILLE, FLA	309.14	308.95	309.08	308.92	308.99	309.02	309.18	309.11
5	ALLIGATOR CREEK AT CALLAHAN, FL	3.46	2.98	2.92	2.98	3.52	3.52	3.46	2.92
6	THOMAS CREEK NEAR CRAWFORD, FL	7.32	6.30	6.20	6.30	7.42	7.42	7.32	6.20
7	STRAWBERRY CREEK NEAR ARLINGTON, FL	0.07	0.00	0.00	0.00	0.08	0.08	0.07	0.00
8	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	1.17	0.90	0.88	0.90	1.18	1.18	1.17	0.88
9	ORTEGA RIVER AT JACKSONVILLE, FL	6.90	5.36	5.26	5.36	7.00	7.00	6.90	5.26
11	NEW RIVER NR LAKE BUTLER FLA	18.75	15.52	15.38	15.56	18.94	18.89	18.71	15.33
12	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	52.04	50.83	50.84	50.90	52.10	52.02	51.95	50.77
13	PARENERS BRANCH NEAR BLAND, FL.	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
14	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	27.30	26.36	26.44	26.49	27.36	27.23	27.19	26.32
16	CANNON CREEK NEAR LAKE CITY, FL	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
17	DEEP CREEK NR SUWANNEE VALLEY FL	1.45	1.34	1.33	1.34	1.46	1.46	1.45	1.33
18	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	55.06	54.53	54.44	54.48	55.12	55.17	55.13	54.49
19	SUWANNEE R NR BENTON FLA	168.76	166.98	166.91	166.87	168.74	168.85	168.89	167.02
20	PABLO CREEK AT JACKSONVILLE, FL	5.27	3.68	3.60	3.68	5.34	5.34	5.26	3.60
21	BIG DAVIS CREEK AT BAYARD, FL	0.53	0.23	0.22	0.23	0.54	0.54	0.53	0.22
23	SOLDIER CREEK NEAR LONGWOOD, FL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	GEE CREEK NEAR LONGWOOD, FL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	HOWELL CREEK NEAR SLAVIA, FL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	SHADY BROOK NEAR SUMTERVILLE, FL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	OUTLET RIVER AT PANACOOCHEE RETREATS, FL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
33	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	10.67	10.65	10.57	10.58	10.70	10.78	10.77	10.64
34	NORTH PRONG ST. MARYS RIVER AT MONIAC, GA	19.24	18.33	18.23	18.33	19.34	19.34	19.24	18.22
35	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	0.92	0.75	0.73	0.75	0.93	0.93	0.92	0.73
36	ST. MARYS RIVER NEAR	45.42	40.97	40.65	40.99	45.76	45.73	45.39	40.63

ReachID	Station Name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
	MACCLENNY, FL								
37	RICE CREEK NEAR SPRINGSIDE	6.55	5.58	5.55	5.58	6.58	6.57	6.55	5.55
38	SUWANNEE RIVER NEAR WILCOX, FLA.	6.78	6.40	6.46	6.48	6.82	6.73	6.71	6.38
39	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	40.33	26.88	26.18	26.90	41.09	41.07	40.31	26.16
44	SILVER RIVER NEAR OCALA, FL	0.25	0.24	0.24	0.24	0.25	0.25	0.25	0.24
45	OCKLAWAHA RIVER NEAR CONNER, FL	46.26	45.42	45.42	45.43	45.97	45.97	45.96	45.42
46	OCKLAWAHA RIVER AT EUREKA, FL	115.17	114.43	114.44	114.44	114.97	114.96	114.95	114.43
47	ORANGE LAKE OUTLET NEAR CITRA, FL	25.53	24.06	24.06	24.09	25.53	25.49	25.46	24.03
48	ORANGE CREEK AT ORANGE SPRINGS, FL	10.26	9.74	9.74	9.75	10.23	10.22	10.21	9.73
49	CEDAR RIVER AT MARIETTA, FL	3.97	3.36	3.32	3.37	4.01	4.01	3.97	3.32
51	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	12.51	3.81	3.49	3.84	12.89	12.85	12.47	3.42
52	SIMMS CREEK NEAR BARDIN, FL	6.20	3.87	3.79	3.88	6.28	6.28	6.19	3.78
55	MIDDLE HAW CREEK NR KORONA, FLA.	2.10	1.34	1.34	1.34	2.10	2.10	2.10	1.32
56	LITTLE HAW CREEK NEAR SEVILLE, FL	0.58	0.46	0.46	0.46	0.58	0.58	0.58	0.46
58	DEEP CREEK NEAR HASTINGS, FL	3.62	3.11	3.11	3.12	3.63	3.63	3.62	3.10
61	SANTA FE RIVER NEAR GRAHAM, FLA.	3.80	3.65	3.65	3.66	3.81	3.81	3.80	3.57
62	SPRUCE CREEK NEAR SAMSULA, FL	3.26	2.98	2.98	2.98	3.26	3.26	3.26	2.98
63	TOMOKA RIVER NEAR HOLLY HILL, FL	10.07	9.10	9.10	9.10	10.07	10.07	10.07	9.10

Springflow Impacts

Similar to baseflow, springflow was compared to the springflow from the 1993-1994 simulation, as shown in Table 23. The springs that are reduced to exactly zero are either a result of the head gradient between the aquifer and the drain cell being exactly zero (improbable) or the head in the aquifer being below the elevation of the drain cell (the drain elevation is uncertain and in most cases can not be measured).

Table 23. Springflow Impacts by Simulation (Values in cfs).

Grid ID	Spring name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
44019	Holton Spring near Fort Union	14.2	14.2	14.2	14.1	14.2	14.3	14.5	14.3
49014	Falmouth Spring at Falmouth	149.1	150.9	150.8	150.6	151.1	151.4	151.5	151.1

Grid ID	Spring name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
52037	White Sulphur Springs at White Springs	42.7	37.3	35.5	36.0	43.8	45.0	44.5	36.8
63008	Charles Springs near Dell	5.1	5.2	5.1	5.1	5.2	5.2	5.2	5.2
65103	Wadesboro Spring near Orange Park	1.0	0.0	0.0	0.0	1.1	1.1	1.0	0.0
67014	Peacock Springs	86.4	86.9	86.7	86.7	86.9	87.1	87.1	86.9
76023	Ruth Spring near Branford	19.8	19.7	19.7	19.7	19.9	19.9	19.9	19.7
77037	Ichetucknee Head Spring near Fort White and Cedar Head Spring	43.6	42.0	42.3	42.3	43.7	43.4	43.3	42.0
77106	Green Cove Springs at Green Cove Springs	2.9	0.0	0.0	0.0	3.1	3.1	2.9	0.0
81037	Jamison Spring	1.9	1.8	1.8	1.8	1.9	1.9	1.9	1.8
87048	Hornsby Spring near High Springs	53.7	48.0	48.9	49.0	53.8	52.8	52.6	47.8
89042	Blue Springs near High Springs (including Lilly Springs)	39.6	37.6	38.0	38.1	39.6	39.2	39.1	37.6
94135	Crescent Beach Submarine Spring	41.1	25.4	25.2	25.4	41.3	41.3	41.1	24.6
97026	Lumbercamp Springs and Sun Springs near Wannee	52.3	51.6	52.3	52.3	52.3	51.7	51.7	51.6
100025	Hart Springs near Wilcox	95.8	94.0	95.7	95.7	95.8	94.1	94.1	94.0
102025	Otter Springs near Wilcox	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
103107	Whitewater Springs	1.0	0.0	0.0	0.0	1.1	1.1	1.0	0.0
105025	Bell Springs	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
106026	Fannin Springs near Wilcox (including Little Fannin Spring)	88.9	87.5	88.8	88.8	88.9	87.6	87.6	87.5
111106	Satsuma Spring	0.9	0.5	0.5	0.5	0.9	0.9	0.9	0.5
112089	Orange Spring at Orange Springs	1.3	0.0	0.0	0.0	1.3	1.3	1.2	0.0
112094	Blue Springs near Orange Springs	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.3
113023	Manatee Spring near Chiefland	198.6	194.8	198.4	198.4	198.6	195.1	195.1	194.8
113088	Camp Seminole Spring at Orange Springs	0.2	0.0	0.0	0.0	0.2	0.2	0.2	0.0
114106	Welaka Spring near Welaka	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
116106	Mud Spring near Welaka	1.9	1.6	1.6	1.6	1.9	1.9	1.9	1.6
117107	Beecher Springs near Fruitland	6.2	6.0	6.0	6.0	6.2	6.2	6.1	6.0
118090	Tobacco Patch Landing Spring Group near Fort McCoy	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.7
118105	Croaker Hole Spring near Welaka	87.7	83.1	83.1	83.1	87.6	87.5	87.5	83.0
119090	Wells Landing Springs near Fort McCoy	3.9	3.1	3.1	3.1	3.8	3.8	3.8	3.1
124102	Salt Springs near Eureka	74.2	72.2	72.2	72.2	74.1	74.1	74.0	72.2
129043	Wekiva Springs near Gulf Hammock	45.2	44.1	44.2	44.2	44.8	44.8	44.8	44.1
132108	Silver Glen Springs near Astor	81.6	80.3	80.3	80.3	81.5	81.5	81.4	80.3
134081	Silver Springs near Ocala	638.4	560.7	561.4	561.6	613.9	613.0	612.8	560.5
134106	Sweetwater Springs along Juniper Creek	12.5	12.2	12.2	12.2	12.4	12.4	12.4	12.2
136103	Juniper Springs and Fern Hammock Springs near Ocala	6.9	6.4	6.4	6.4	6.8	6.8	6.8	6.4
136107	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.5	4.2	4.2	4.2	4.5	4.5	4.5	4.2
140125	Ponce de Leon Springs near De Land	22.1	20.4	20.4	20.4	22.1	22.1	22.1	20.4
142057	Rainbow Springs near Dunnellon	613.9	588.5	589.2	589.3	602.0	601.1	601.1	588.4

Grid ID	Spring name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
144112	Alexander Springs near Astor	99.1	95.6	95.6	95.6	98.6	98.6	98.6	95.6
147121	Mosquito Springs Run Alexander Springs Wilderness	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0
152070	Gum Springs near Holder	68.0	62.0	62.1	62.1	64.6	64.5	64.5	62.0
153114	Camp La No Che Springs near Paisley	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
153127	Blue Spring near Orange City	120.7	99.3	99.3	99.3	120.6	120.6	120.6	99.2
157046	Crystal River Spring Group	671.4	653.7	653.7	653.7	653.8	653.8	653.8	653.7
158117	Blackwater Springs near Cassia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
159079	Little Jones Creek Head Spring near Wildwood	7.4	6.0	6.0	6.0	6.7	6.7	6.7	6.0
160079	Little Jones Creek Spring No. 2 near Wildwood	4.8	4.1	4.1	4.1	4.4	4.4	4.4	4.1
160117	Messant Spring near Sorrento	10.6	9.3	9.3	9.3	10.6	10.6	10.6	9.3
160129	Gemini Springs near DeBary (all 3)	9.3	7.9	7.9	7.9	9.3	9.3	9.3	7.9
160133	Green Springs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
161080	Little Jones Creek Spring No. 3 near Wildwood	2.9	2.4	2.4	2.4	2.6	2.6	2.6	2.4
161115	Seminole Springs near Sorrento	9.5	0.0	0.0	0.0	8.9	8.9	8.9	0.0
161120	Palm Springs Seminole State Forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
162047	Halls River Head Spring	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7
162116	Droty Springs near Sorrento	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
162122	Island Spring near Sanford	5.9	5.7	5.7	5.7	5.8	5.8	5.8	5.7
163046	Halls River Springs	103.5	101.2	101.2	101.2	101.3	101.3	101.3	101.2
164047	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	123.4	120.8	120.8	120.8	120.8	120.8	120.8	120.8
164082	Fenney Springs near Coleman Head Spring of Shady Brook Creek	12.0	9.6	9.6	9.6	10.4	10.4	10.4	9.6
165082	Shady Brook Creek Springs No. 2 and 3	5.8	5.4	5.4	5.4	5.5	5.5	5.5	5.4
166047	Hidden River Springs near Homosassa (including Hidden River Head Spring)	6.9	6.7	6.7	6.7	6.7	6.7	6.7	6.7
166080	Shady Brook Creek Spring No. 4	2.9	2.7	2.7	2.7	2.7	2.7	2.7	2.7
166116	Sulphur Camp Springs	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
167079	Shady Brook Creek Spring No. 5	2.9	2.7	2.7	2.7	2.7	2.7	2.7	2.7
167091	Bugg Spring at Okahumpka	8.4	5.9	5.9	5.9	7.9	7.9	7.9	5.9
167116	Rock Springs near Apopka	50.3	34.4	34.4	34.4	49.5	49.5	49.5	34.4
168046	Potter Spring near Chassahowitzka (including Ruth Spring)	14.8	14.5	14.5	14.5	14.5	14.5	14.5	14.5
168095	Mooring Cove Springs near Yalaha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
168096	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	4.0	0.0	0.0	0.0	3.3	3.3	3.3	0.0
169047	Salt Creek Head Spring	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
169048	Lettuce Creek Spring	3.8	3.7	3.7	3.7	3.7	3.7	3.7	3.7
169117	Witherington Spring near Apopka	0.9	0.1	0.1	0.1	0.8	0.8	0.8	0.1
170047	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	24.5	24.0	24.0	24.0	24.0	24.0	24.0	24.0

Grid ID	Spring name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
170048	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	100.6	98.7	98.7	98.7	98.7	98.7	98.7	98.7
171046	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.6	7.4	7.4	7.4	7.4	7.4	7.4	7.4
171047	Rita Maria Spring near Chassahowitzka	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4
171119	Wekiwa Springs in State Park near Apopka	54.5	43.9	43.9	43.9	53.6	53.6	53.6	43.9
171120	Miami Springs near Longwood	3.8	3.0	3.0	3.0	3.7	3.7	3.7	3.0
171131	Lake Jesup Spring near Wagner	0.4	0.0	0.0	0.0	0.2	0.2	0.2	0.0
172045	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	29.9	29.3	29.3	29.3	29.3	29.3	29.3	29.3
172046	Blue Run Head Spring near Chassahowitzka	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6
172123	Palm Springs and Sanlando Springs near Longwood	21.8	12.7	12.7	12.7	20.9	20.9	20.9	12.7
172124	Starbuck Spring near Longwood	11.7	6.5	6.5	6.5	11.2	11.2	11.2	6.5
172133	Clifton Springs near Oviedo	1.6	0.0	0.0	0.0	0.9	0.9	0.9	0.0
173044	Unnamed Spring No. 8	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4
173101	Double Run Road Seepage near Astatula	1.7	0.0	0.0	0.0	1.5	1.5	1.5	0.0
174044	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	31.6	30.9	30.9	30.9	30.9	30.9	30.9	30.9
181105	Apopka (Gourdneck) Spring near Oakland	17.5	9.4	9.4	9.4	16.5	16.5	16.5	9.4
182044	Unnamed Spring No. 6	4.7	4.5	4.5	4.5	4.5	4.5	4.5	4.5
182045	Salt Spring and Mud Spring near Bayport	19.6	18.9	18.9	18.9	18.9	18.9	18.9	18.9
184044	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	29.4	28.2	28.2	28.2	28.2	28.2	28.2	28.2
184048	Weeki Wachee Springs near Brooksville	71.9	63.9	63.9	63.9	63.9	63.9	63.9	63.9
188043	Unnamed Spring No. 2	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2
190042	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	8.4	8.1	8.1	8.1	8.1	8.1	8.1	8.1
190043	Bobhill Springs	3.3	2.9	2.9	2.9	2.9	2.9	2.9	2.9
193040	Horseshoe Spring near Hudson	6.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3
193041	Unnamed Spring No. 3 near Aripeka	17.8	17.3	17.3	17.3	17.3	17.3	17.3	17.3
200038	Salt Springs near Port Richey	10.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1
220055	Sulphur Springs at Sulphur Springs	24.2	23.7	23.7	23.7	23.7	23.7	23.7	23.7
221061	Lettuce Lake Spring	7.6	7.3	7.3	7.3	7.3	7.3	7.3	7.3
221062	Six-Mile Creek Spring and Eureka Springs near Tampa	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3
230064	Buckhorn Spring near Riverview	12.2	11.1	11.1	11.1	11.1	11.1	11.1	11.1
232069	Lithia Springs Minor and Lithia Springs Major near Lithia	30.8	27.5	27.5	27.5	27.5	27.5	27.6	27.5
289068	Little Salt Spring near Murdock	0.9	0.5	0.5	0.5	0.5	0.5	0.5	0.5
290067	Warm Mineral Springs near Woodmere	6.6	6.0	6.0	6.0	6.0	6.0	6.0	6.0
41007	Blue Spring near Madison	101.7	101.2	101.6	101.1	101.4	101.5	102.0	101.7

Grid ID	Spring name	Base 9394	Base 2030	Sim. 1	Sim. 2	Sim. 3	Sim. 4	Sim. 5	Sim. 6
44017	Alapaha Rise near Fort Union	410.5	409.8	410.7	408.8	410.5	411.6	413.5	411.8
47027	Suwannee Springs near Live Oak	6.7	7.2	6.9	6.8	7.0	7.3	7.3	7.2
48012	Suwanacoochee Spring and Ellaville Spring at Ellaville	112.6	113.2	113.2	113.1	113.4	113.5	113.6	113.3
64007	Allen Mill Pond Spring near Dell	12.3	12.4	12.3	12.3	12.3	12.4	12.4	12.4
66008	Blue Spring near Dell	61.6	62.1	61.8	61.8	62.0	62.3	62.3	62.1
68012	Telford Spring at Luraville	36.4	36.6	36.5	36.5	36.7	36.8	36.8	36.6
68015	Running Springs (East and West) near Luraville	99.5	100.2	99.9	99.9	100.4	100.7	100.7	100.2
69016	Convict Spring near Mayo	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
70017	Royal Spring near Alton	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
72019	Owens Spring	51.8	52.0	51.8	51.8	52.1	52.3	52.3	52.0
73020	Mearson Spring near Mayo	65.5	65.6	65.4	65.4	65.9	66.1	66.0	65.5
75022	Troy Spring near Branford	142.5	142.5	142.2	142.3	143.3	143.5	143.4	142.4
76024	Little River Springs near Branford	53.6	53.5	53.5	53.5	53.8	53.8	53.8	53.5
78037	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	248.4	241.7	242.8	243.1	249.0	247.7	247.4	241.5
79026	Branford Springs at Branford	36.5	36.2	36.3	36.3	36.6	36.5	36.5	36.2
87002	Steinhatchee Spring near Clara	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
87029	Turtle Spring near Hatchbend and Fletcher Spring	52.1	51.6	51.9	51.9	52.2	51.8	51.8	51.6
88041	Ginnie Spring near High Springs	50.0	47.7	48.3	48.3	50.0	49.5	49.4	47.7
89044	Poe Springs near High Springs	56.6	53.1	53.7	53.8	56.6	55.9	55.8	53.0
91027	Rock Bluff Springs near Bell	42.2	41.7	42.1	42.1	42.2	41.8	41.8	41.7
92026	Guaranto Spring near Rock Bluff Landing	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
104023	Copper Springs near Oldtown (including Little Copper Spring)	27.2	26.6	27.1	27.1	27.2	26.6	26.6	26.6
116040	Blue Spring near Bronson	8.1	7.6	7.8	7.8	8.1	7.9	7.9	7.6
151064	Wilson Head Spring near Holder	2.4	1.8	1.8	1.8	1.9	1.9	1.9	1.8
151065	Blue Spring near Holder	10.6	9.8	9.8	9.8	10.0	10.0	10.0	9.8
209072	Crystal Springs near Zephyrhills	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9

Conclusions and Recommendations

The USGS MegaModel was modified in order to assist the District in water supply planning activities. Modifications included the activation of layer 1 through the addition of a river package and a recharge package, and the addition of baseflow flux constraint. The model modifications maintained the constant head fluxes from the original version of the model.

Calibration was accomplished through systematic assignment of reach characteristics (channel width, channel depth, bed conductance) to each river cell based on Strahler order. This allowed for systematic calibration of river cells. The river cell flux resulting from the assigned reach characteristics was a component of the net recharge flux that replaced the original constant head cells on layer 1. The activation of layer 1 and the development of a river package allowed for the assessment of 2030 impacts to reaches that were constrained by baseflow estimates.

Predictive simulations of the model were run using 2030 pumping rates. The predictive simulations included maintaining pumping rates for selected water management districts at 1993-1994 levels and modifying other districts to 2030 rates in order to assess the relative impacts of each district. Results of the 2030 simulations show rebound in areas where 2030 projected pumping rates are lower than 1993-1994 pumping rates, and aquifer drawdown in areas where 2030 projected rates are higher that 1993-1994 pumping rates.

Recommendations for future work with the MegaModel may include automated calibration with PEST, comparison of the current calibrated recharge to a defensible recharge generation method, dual calibration under varying hydrologic conditions, conversion to a transient calibration, and/or conversion to an integrated surface water/groundwater model. The current effort maintained the USGS calibration for most of the model parameters.

It may be beneficial to perform an automated calibration with inverse modeling tools such as PEST. PEST will optimize the model performance by automatically adjusting model parameters. The modifications to the model described above maintained the fluxes from the original constant head cells. The recharge utilized and documented in this study maintained the lower face flux as simulated with the original constant head cells. Ideally, recharge would be estimated from a water budget analysis of the overlying basin. Currently the recharge array contains outliers that may locally impact the model performance.

The confidence in the model will be increased if a dual calibration approach were performed. The model calibration adequately represents average conditions but a dual calibration with a dry condition would enhance the confidence in the model performance under extreme situations. A transient calibration will also enhance the model confidence and further constrain the calibration. The additional simulation time will enable the use of extra data that is not available in a steady state calibration. If the transient period includes extreme climatic and pumping conditions, then the confidence in the model over a large range of conditions will be enhanced. Lastly, if the model were to be constrained through the use of a transient integrated hydrologic model, further evaluation of surface water and groundwater interaction as well surface water impacts can be performed.

Future water use estimation is an uncertain prediction of future conditions. It might be best handled through the use of statistically based uncertainty analysis. Uncertainty analysis will define confidence intervals around the future impacts of the uncertain boundary condition. Other internal model parameters can also have ranges of uncertainty defined. Depending of the parameter sensitivity the lack of certainty will impact the simulated results. An uncertainty analysis will better represent the ranges of possible outcomes and define probabilities to the possible outcomes.

References

Sepulveda, N. (2002). *Simulation of Ground-Water Flow in the Intermediate and Floridan Aquifer Systems in Peninsular Florida.* USGS Water-Resources Investigations Report 02-4009.

Appendix I: Calibration Head Targets

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
1	GSF_02238300	USGSFL	159	94	1	57.99	55.85
2	SJR_LKGRIF	SJRWMD	159	92	1	58.25	49.31
7	SJR_SENECA	SJRWMD	159	111	1	72.80	66.99
10	GSF_02238000	USGSFL	159	98	1	61.61	69.48
11	SJR_V-1040	SJRWMD	159	138	1	22.66	10.42
12	GSF_02238001	USGSFL	159	98	1	58.29	70.77
13	SJR_LKBUTL	SJRWMD	159	136	1	19.51	32.72
14	GSF_02235200	USGSFL	159	117	1	23.97	28.78
21	SJR_GRIFFIT	SJRWMD	158	96	1	53.61	49.01
25	SJR_LKGLE	SJRWMD	157	132	1	19.69	18.90
26	SJR_MCGARI	SJRWMD	157	135	1	31.23	19.54
27	SJR_THERSA	SJRWMD	157	136	1	17.70	8.50
29	SJR_V-0199	SJRWMD	156	144	1	16.92	14.36
33	SWF_23027	SWFWMD	156	84	1	48.80	57.16
35	SJR_V-0197	SJRWMD	156	129	1	66.24	56.52
39	SJR_MALLARD	SJRWMD	156	122	1	32.24	32.22
44	GSF_02237865	USGSFL	155	106	1	67.76	88.60
50	SJR_YALELK	SJRWMD	155	100	1	58.45	57.63
51	SJR_DUPONT	SJRWMD	155	135	1	17.41	20.85
52	SJR_LKASHB	SJRWMD	154	142	1	11.42	29.33
53	GSF_02238180	USGSFL	154	103	1	57.39	67.82
54	SJR_V-1045	SJRWMD	154	130	1	8.55	30.05
58	GSF_02235500	USGSFL	154	127	1	1.97	15.22
61	SJR_3ISLK	SJRWMD	154	135	1	20.30	18.22
63	SJR_NORRIS	SJRWMD	153	114	1	29.11	47.87
65	SJR_SOTWIN	SJRWMD	153	106	1	59.22	55.25
68	SJR_COLBY	SJRWMD	152	134	1	22.92	32.75
69	SJR_V-1049	SJRWMD	152	130	1	52.50	44.26
72	SJR_LKMACY	SJRWMD	152	134	1	26.97	38.12
77	SJR_LKHEL	SJRWMD	151	134	1	42.78	42.40
82	SJR_LKNIC	SJRWMD	150	103	1	52.25	52.68
88	SJR_SNYHU	SJRWMD	150	95	1	58.19	55.42
89	SJR_SNYHD	SJRWMD	150	95	1	54.82	52.80
94	GSF_02238800	USGSFL	149	90	1	53.09	57.43
96	SJR_V-1051	SJRWMD	149	129	1	57.29	11.45
98	GSF_02236000	USGSFL	149	124	1	0.91	0.30
101	SJR_SNYH1	SJRWMD	149	95	1	51.90	46.92
102	SJR_DORRLK	SJRWMD	148	108	1	42.98	41.07

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
107	SJR_V-0109	SJRWMD	148	142	1	39.16	47.88
110	SJR_SNYH2	SJRWMD	148	95	1	52.11	51.12
111	SJR_SNYH3	SJRWMD	148	95	1	52.70	51.60
114	SJR_WINELK	SJRWMD	148	133	1	55.70	67.37
119	SJR_LTLKWR	SJRWMD	147	86	1	53.15	58.19
125	SJR_SNYH4	SJRWMD	147	95	1	51.99	52.05
126	SJR_SHCDS	SJRWMD	147	95	1	52.74	52.96
127	SJR_SNYHCD	SJRWMD	147	95	1	52.67	52.90
129	SJR_SLKTAL	SJRWMD	147	132	1	55.20	68.21
134	SJR_BOWERS	SJRWMD	147	88	1	53.70	48.64
135	SJR_LKWERU	SJRWMD	146	89	1	53.09	66.02
146	GSF_02248000	USGSFL	146	146	1	8.10	11.11
147	SJR_SNYH6	SJRWMD	146	94	1	51.20	59.91
150	SJR_SMTLKM	SJRWMD	145	85	1	49.56	44.02
157	SJR_SNYH7	SJRWMD	144	93	1	45.16	46.04
166	SJR_MBRD8	SJRWMD	144	92	1	43.22	67.14
169	SJR_V-1058	SJRWMD	143	127	1	78.56	82.11
176	SJR_V-1060	SJRWMD	143	130	1	60.38	48.29
179	SJR_LKMAM	SJRWMD	143	129	1	64.16	75.80
182	SJR_V-1061	SJRWMD	143	128	1	79.42	65.54
184	SJR_LKDAU	SJRWMD	143	131	1	41.16	43.75
185	SJR_V-1062	SJRWMD	142	131	1	50.72	41.88
190	SJR_V-0744	SJRWMD	142	129	1	75.20	66.44
191	SJR_V-1064	SJRWMD	142	125	1	0.98	0.45
197	SJR_SELRLK	SJRWMD	142	108	1	43.30	64.54
200	SJR_L-0456	SJRWMD	141	112	1	38.75	30.44
202	SJR_V-1065	SJRWMD	141	137	1	36.37	36.33
204	SJR_LKHIR	SJRWMD	141	130	1	37.56	33.66
206	SJR_V-0608	SJRWMD	140	130	1	41.80	39.59
207	SJR_V-0609	SJRWMD	140	130	1	42.56	40.35
208	SJR_V-0610	SJRWMD	140	130	1	42.31	40.10
209	SJR_V-0611	SJRWMD	140	130	1	42.22	40.01
210	SJR_V-0670	SJRWMD	140	130	1	43.60	41.39
211	SJR_V-0671	SJRWMD	140	130	1	42.65	40.44
212	SJR_V-0675	SJRWMD	140	130	1	43.71	41.50
213	SJR_V-0676	SJRWMD	140	130	1	42.75	40.54
214	SJR_V-0680	SJRWMD	140	130	1	43.79	41.58
215	SJR_V-0681	SJRWMD	140	130	1	42.53	40.32
216	SJR_V-0685	SJRWMD	140	130	1	43.74	41.53
217	SJR_V-0686	SJRWMD	140	130	1	42.67	40.46
218	SJR_V-1066	SJRWMD	140	126	1	15.55	6.79

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
220	SJR_PONCEDEL	SJRWMD	140	125	1	4.29	6.15
227	SJR_V-0529	SJRWMD	139	141	1	33.37	23.38
234	SJR_LKDIAS	SJRWMD	139	128	1	33.81	72.01
238	SJR_LKODUM	SJRWMD	138	126	1	27.40	25.96
244	GSF_02236120	USGSFL	138	124	1	7.39	10.24
247	SJR_V-1068	SJRWMD	138	124	1	13.82	15.31
250	GSF_02236125	USGSFL	137	115	1	0.59	3.66
252	SJR_V-0087	SJRWMD	137	138	1	34.40	34.26
253	SJR_V-1089	SJRWMD	137	138	1	33.90	33.77
256	SJR_L-0460	SJRWMD	137	113	1	16.83	8.58
264	SJR_V-1071	SJRWMD	137	129	1	38.72	27.43
267	GSF_02247496	USGSFL	137	141	1	22.39	24.84
269	SJR_WINOLK	SJRWMD	136	127	1	31.87	66.05
283	SJR_M-0045	SJRWMD	136	91	1	53.81	54.30
294	SJR_LKEMP	SJRWMD	135	119	1	36.63	48.65
295	SJR_LKPUR	SJRWMD	135	121	1	35.81	49.90
297	SJR_V-0063	SJRWMD	135	125	1	19.56	8.75
298	SJR_RHODES	SJRWMD	135	122	1	41.55	40.39
299	SJR_DRUDY	SJRWMD	134	119	1	41.92	50.09
303	GSF_02247510	USGSFL	134	142	1	6.75	21.33
304	SJR_V-0142	SJRWMD	134	115	1	5.41	4.16
305	GSF_02240000	USGSFL	134	86	1	34.89	76.01
310	SJR_V-0770	SJRWMD	133	128	1	35.84	25.19
314	SJR_V-1074	SJRWMD	133	121	1	44.52	38.42
317	SJR_V-0578	SJRWMD	133	117	1	24.19	17.85
318	SJR_V-0088	SJRWMD	133	131	1	31.39	32.48
320	SJR_LKPIE	SJRWMD	132	118	1	34.16	54.96
321	SJR_SHAWLK	SJRWMD	132	120	1	35.95	33.50
323	SJR_V-0069	SJRWMD	132	118	1	24.60	26.45
324	GSF_02236160	USGSFL	132	108	1	1.66	7.02
326	SJR_V-0528	SJRWMD	132	119	1	59.55	72.40
330	SJR_V-0599	SJRWMD	131	120	1	62.46	51.37
331	SJR_V-0601	SJRWMD	131	120	1	59.73	48.64
332	SJR_V-0602	SJRWMD	131	120	1	62.42	51.33
333	SJR_V-0617	SJRWMD	131	120	1	60.34	49.25
334	SJR_V-0620	SJRWMD	131	120	1	61.51	50.42
335	SJR_V-0621	SJRWMD	131	120	1	61.19	50.10
336	SJR_V-0625	SJRWMD	131	120	1	62.15	51.06
337	SJR_V-0629	SJRWMD	131	120	1	60.54	49.45
338	SJR_V-0641	SJRWMD	131	120	1	60.86	49.77
339	SJR_V-0645	SJRWMD	131	120	1	61.69	50.60

Model Index	**UNIQUEID**	**AGENCY**	**Row**	**Col**	**Layer**	**Average Water Level, ft.**	**Adjusted Water Level, ft. (Layer 1 only)**
340	SJR_V-0649	SJRWMD	131	120	1	62.49	51.40
341	SJR_V-0652	SJRWMD	131	120	1	60.96	49.87
342	SJR_V-0653	SJRWMD	131	120	1	61.51	50.42
344	SJR_V-0202	SJRWMD	131	120	1	59.20	48.27
347	SJR_V-0525	SJRWMD	131	117	1	19.71	16.95
357	SJR_V-0523	SJRWMD	129	114	1	20.25	11.91
358	SJR_HOPKIN	SJRWMD	129	103	1	22.66	21.09
363	SJR_02236210	SJRWMD	128	107	1	0.80	0.77
367	SJR_LKDISS	SJRWMD	128	125	1	12.87	12.83
369	SJR_V-0541	SJRWMD	128	118	1	37.58	3.68
371	SJR_V-0603	SJRWMD	128	118	1	42.31	15.88
372	SJR_V-0604	SJRWMD	128	118	1	43.43	17.00
373	SJR_V-0605	SJRWMD	128	118	1	44.13	17.70
374	SJR_V-0606	SJRWMD	128	118	1	42.53	16.10
375	SJR_V-0654	SJRWMD	128	118	1	43.13	16.70
376	SJR_V-0658	SJRWMD	128	118	1	43.15	16.72
377	SJR_V-0659	SJRWMD	128	118	1	43.02	16.59
378	SJR_V-0662	SJRWMD	128	118	1	43.89	17.46
379	SJR_V-0663	SJRWMD	128	118	1	43.47	17.04
380	SJR_V-0665	SJRWMD	128	118	1	42.97	16.54
381	SJR_V-0666	SJRWMD	128	118	1	44.16	17.73
382	SJR_V-0667	SJRWMD	128	118	1	43.57	17.14
386	SJR_F-0252	SJRWMD	127	128	1	23.18	18.88
396	SJR_02244420	SJRWMD	126	124	1	7.25	0.54
397	SJR_V-1081	SJRWMD	126	117	1	33.77	35.49
398	SJR_LLKLOU	SJRWMD	126	117	1	29.97	50.20
402	SJR_V-0565	SJRWMD	126	117	1	36.76	50.00
408	SJR_JUANTA	SJRWMD	125	118	1	32.82	30.54
411	SJR_COWPND	SJRWMD	124	117	1	39.65	56.28
412	SJR_ULKLOU	SJRWMD	124	116	1	34.63	34.17
413	SJR_V-1085	SJRWMD	124	140	1	26.70	26.82
414	SJR_V-1086	SJRWMD	124	140	1	26.77	26.90
417	SJR_LKGEOM	SJRWMD	124	112	1	0.83	-1.09
418	SJR_P-0734	SJRWMD	124	112	1	0.99	-0.93
421	SJR_P-0737	SJRWMD	124	112	1	7.59	5.67
423	SJR_DAVISLK	SJRWMD	124	116	1	33.51	34.35
424	GSF_02244320	USGSFL	123	129	1	11.51	16.52
436	SJR_P-0147	SJRWMD	123	113	1	22.53	23.04
437	GSF_02240500	USGSFL	122	91	1	19.89	39.85
438	SJR_KERRLK	SJRWMD	122	98	1	19.54	24.86
445	SJR_P-0724	SJRWMD	122	115	1	35.53	42.54

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
447	SJR_V-1087	SJRWMD	122	141	1	0.87	-2.93
453	SJR_F-0291	SJRWMD	122	132	1	16.07	16.82
454	SJR_V-1088	SJRWMD	122	141	1	0.94	-3.84
457	SJR_P-0743	SJRWMD	121	111	1	20.07	24.74
462	SJR_P-0742	SJRWMD	120	113	1	33.05	43.57
468	SJR_P-0778	SJRWMD	119	109	1	25.38	21.13
470	SJR_DREAM	SJRWMD	119	115	1	46.58	54.30
472	SJR_ENGLIS	SJRWMD	119	115	1	44.04	55.78
473	SJR_ESTELA	SJRWMD	119	110	1	36.34	55.70
474	SJR_DELANC	SJRWMD	119	100	1	17.89	20.91
476	SJR_MARVIN	SJRWMD	119	110	1	36.30	55.29
478	SJR_LKBELL	SJRWMD	118	114	1	39.92	41.44
480	SJR_LTMALL	SJRWMD	118	113	1	33.83	33.16
481	SJR_ESTELN	SJRWMD	118	110	1	36.23	36.86
482	SJR_PALMER	SJRWMD	118	114	1	35.97	39.59
486	SJR_F-0177	SJRWMD	118	140	1	1.11	-0.90
488	GSF_292604081062401	USGSFL	118	142	1	4.76	-12.52
491	SJR_STELLA	SJRWMD	118	116	1	37.31	48.00
495	SJR_SILVLK	SJRWMD	117	112	1	32.64	26.94
498	SJR_MARGARET	SJRWMD	117	110	1	32.81	30.02
502	SJR_OMEGA	SJRWMD	117	115	1	54.77	42.56
504	SJR_TARHOE	SJRWMD	117	112	1	32.76	25.08
511	SJR_BANANA	SJRWMD	116	111	1	33.62	53.53
517	SJR_LIZZIE	SJRWMD	115	112	1	39.10	40.56
522	SJR_P-0473	SJRWMD	115	101	1	3.78	-3.99
523	SJR_LKCOMO	SJRWMD	115	112	1	33.11	41.83
527	SJR_P-0409	SJRWMD	114	108	1	66.56	57.57
533	SJR_P-0738	SJRWMD	113	95	1	19.51	2.94
537	SJR_TUSKCA	SJRWMD	113	67	1	74.41	112.80
538	GSF_02243958	USGSFL	113	97	1	18.00	13.10
539	GSF_02243960	USGSFL	113	97	1	3.67	-1.23
540	GSF_02243000	USGSFL	112	88	1	21.02	85.50
543	SJR_BROWRD	SJRWMD	112	111	1	35.11	29.60
545	SJR_F-0226	SJRWMD	111	139	1	1.20	-5.56
547	SJR_MCCART	SJRWMD	111	87	1	70.41	85.22
549	SJR_SUSAN	SJRWMD	111	85	1	77.91	84.73
551	SJR_P-0818	SJRWMD	111	111	1	34.82	77.32
563	SJR_SKNER	SJRWMD	109	88	1	69.69	72.68
570	SJR_F-0205	SJRWMD	109	124	1	21.55	20.77
572	SJR_F-0295	SJRWMD	109	124	1	20.78	24.62
575	SJR_FANNY	SJRWMD	109	86	1	79.62	80.25

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
577	GSF_02244440	USGSFL	108	109	1	0.90	-0.65
579	SR_-101634002	SRWMD	107	41	1	63.33	71.03
585	GSF_02244040	USGSFL	106	105	1	0.74	3.96
586	SJR_SJRBFLO	SJRWMD	106	105	1	1.77	3.70
590	SJR_P-0475	SJRWMD	106	112	1	38.34	45.49
595	SJR_A-0436	SJRWMD	106	80	1	119.95	112.34
598	SJR_COWPEN	SJRWMD	105	84	1	81.96	128.77
613	SJR_GALILE	SJRWMD	104	88	1	76.68	119.70
617	SJR_P-0511	SJRWMD	104	98	1	66.73	63.32
622	SJR_F-0191	SJRWMD	104	136	1	2.14	-2.02
629	SJR_NEWBAKER	SJRWMD	103	70	1	65.99	62.84
631	SJR_LEVYS	SJRWMD	103	84	1	84.44	85.26
639	SJR_SLLKNI	SJRWMD	101	92	1	80.59	86.78
641	SJR_P-0148	SJRWMD	101	104	1	21.57	15.40
643	SJR_LONGPD	SJRWMD	101	85	1	79.98	134.77
646	SJR_P-0774	SJRWMD	101	93	1	78.79	86.88
647	SJR_02245255	SJRWMD	100	120	1	11.69	12.68
651	GSF_02244473	USGSFL	99	101	1	4.61	16.99
656	SJR_MELRSE	SJRWMD	99	82	1	104.25	101.03
657	SJR_RICECRK	SJRWMD	99	106	1	4.71	3.77
664	SJR_2MILE	SJRWMD	98	84	1	96.59	112.79
666	SJR_LKROSA	SJRWMD	98	85	1	85.64	107.91
668	GSF_02322550	USGSFL	97	39	1	68.56	71.85
672	SJR_SWANLK	SJRWMD	97	85	1	83.94	112.00
676	SJR_02245260	SJRWMD	97	118	1	-0.31	1.59
677	GSF_02322016	USGSFL	96	58	1	106.27	131.58
680	SJR_ETONIAA	SJRWMD	96	95	1	66.55	85.04
681	GSF_02245140	USGSFL	96	104	1	9.16	30.65
687	SJR_LKLILY	SJRWMD	95	84	1	103.40	89.09
689	SR_-081536001	SRWMD	95	37	1	71.19	63.85
693	SJR_SJ0517	SJRWMD	95	129	1	25.93	27.15
695	SJR_B-0103	SJRWMD	95	82	1	126.34	126.27
696	SJR_B-0098	SJRWMD	95	82	1	127.68	126.23
697	SJR_B-0107	SJRWMD	94	81	1	125.76	123.01
699	SJR_02320600	SJRWMD	94	80	1	140.40	115.46
700	SJR_B-0101	SJRWMD	94	81	1	129.76	130.38
704	SJR_B-0102	SJRWMD	94	81	1	127.25	127.89
705	SJR_B-0100	SJRWMD	94	81	1	121.91	122.68
710	SJR_B-0099	SJRWMD	93	82	1	105.83	82.58
713	SJR_C-0438	SJRWMD	93	84	1	96.50	84.67
714	GSF_02320610	USGSFL	93	79	1	139.79	115.06

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
717	SJR_C-0500	SJRWMD	93	82	1	90.04	78.95
719	SJR_GENEVALK	SJRWMD	93	83	1	90.03	110.29
720	SJR_B-0105	SJRWMD	93	81	1	124.96	107.65
722	SJR_LKEYST	SJRWMD	92	83	1	88.86	85.08
723	SJR_B-0104	SJRWMD	92	82	1	117.62	86.87
725	SJR_GRGES	SJRWMD	92	94	1	98.15	109.53
727	SJR_B-0106	SJRWMD	92	81	1	119.47	117.35
730	SJR_C-0444	SJRWMD	92	84	1	89.51	101.78
731	SJR_BRKLYN	SJRWMD	92	84	1	95.50	137.82
736	SJR_C-0426	SJRWMD	92	82	1	109.51	90.20
738	SJR_BRKLNBAY	SJRWMD	92	84	1	88.69	145.06
744	SJR_SMTLKC	SJRWMD	91	89	1	78.66	69.55
746	SJR_HALL	SJRWMD	91	90	1	77.13	81.68
749	SJR_C-0452	SJRWMD	91	83	1	96.14	48.14
751	SJR_C-0412	SJRWMD	91	84	1	81.12	78.88
753	SJR_C-0411	SJRWMD	91	84	1	83.30	81.07
755	SJR_ALLIMM	SJRWMD	91	83	1	110.38	79.38
756	SJR_BDFRDR	SJRWMD	90	82	1	93.72	134.88
757	SJR_WHTSND	SJRWMD	90	87	1	80.63	70.18
758	SJR_GTRBNE	SJRWMD	90	88	1	79.93	104.44
765	SJR_ALLTRT	SJRWMD	90	84	1	123.91	142.23
766	SJR_C-0519	SJRWMD	90	84	1	119.40	127.37
769	SJR_C-0455	SJRWMD	90	88	1	97.69	82.88
770	SJR_SPRING	SJRWMD	90	86	1	87.84	78.29
771	SJR_CRSTLK	SJRWMD	90	82	1	100.58	145.68
773	SJR_MAGNOLIA	SJRWMD	90	84	1	124.42	144.42
774	SJR_C-0518	SJRWMD	90	85	1	125.30	142.28
775	SJR_BIGJON	SJRWMD	89	89	1	89.03	102.94
776	SJR_PEBBLE	SJRWMD	89	88	1	87.42	174.73
777	SJR_C-0520	SJRWMD	89	84	1	129.97	121.18
779	SJR_LTLKJON	SJRWMD	89	88	1	91.28	190.03
782	SJR_C-0521	SJRWMD	89	84	1	138.97	122.18
783	SJR_C-0516	SJRWMD	89	86	1	161.42	163.57
784	SJR_C-0517	SJRWMD	89	85	1	152.58	167.09
788	SJR_C-0125	SJRWMD	89	103	1	105.42	99.82
790	SJR_ALLGGS	SJRWMD	88	85	1	130.08	130.28
791	SJR_LOWRY	SJRWMD	88	86	1	131.42	129.64
792	SJR_C-0523	SJRWMD	88	84	1	143.63	157.33
793	SJR_C-0522	SJRWMD	88	84	1	142.79	157.05
794	SJR_C-0515	SJRWMD	88	86	1	147.51	106.01
796	GSF_02320700	USGSFL	88	71	1	107.70	128.70

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
797	SJR_C-0524	SJRWMD	88	84	1	176.85	172.63
800	SJR_C-0514	SJRWMD	87	86	1	168.78	161.77
803	SJR_C-0441	SJRWMD	87	84	1	131.09	165.47
804	SJR_C-0456	SJRWMD	87	84	1	131.50	165.88
805	SJR_ALILRY	SJRWMD	87	84	1	134.48	161.24
810	SJR_C-0513	SJRWMD	87	85	1	139.61	153.95
811	SJR_SPGABV	SJRWMD	87	86	1	138.06	174.15
812	SJR_C-0512	SJRWMD	87	84	1	146.06	135.41
830	SJR_SJ0028	SJRWMD	84	118	1	9.96	16.58
838	GSF_02320742	USGSFL	82	75	1	130.55	134.22
839	GSF_02321500	USGSFL	82	58	1	52.83	77.22
840	SR_-061932009	SRWMD	82	58	1	52.84	78.41
844	GSF_02320750	USGSFL	81	74	1	130.53	132.06
850	GSF_02245328	USGSFL	80	114	1	10.57	17.59
856	SJR_KNGSLK	SJRWMD	78	86	1	175.95	191.90
858	GSF_02245500	USGSFL	78	95	1	12.07	29.09
860	SJR_C-0126	SJRWMD	78	90	1	142.95	118.18
864	GSF_02321000	USGSFL	77	68	1	87.21	118.19
872	GSF_02321300	USGSFL	74	64	1	130.04	129.83
876	SR_-051922002	SRWMD	73	61	1	138.42	128.70
882	GSF_02246010	USGSFL	71	94	1	2.20	19.18
890	SJR_SJ0032	SJRWMD	71	120	1	48.39	46.39
897	SJR_B-0108	SJRWMD	69	82	1	201.33	184.49
899	GSF_02246000	USGSFL	68	91	1	3.35	7.79
909	GSF_02229400	USGSFL	67	59	1	143.24	143.02
916	GSF_02246150	USGSFL	66	115	1	5.22	-4.11
930	SR_-031734023	SRWMD	63	48	1	191.78	190.33
933	GSF_02245913	USGSFL	62	92	1	47.61	74.72
934	GSF_02245927	USGSFL	62	92	1	45.68	72.29
935	GSF_02245924	USGSFL	61	92	1	53.97	73.99
936	GSF_02245925	USGSFL	61	92	1	53.65	71.87
938	SR_-031923003	SRWMD	61	61	1	173.77	173.10
939	GSF_02245922	USGSFL	61	92	1	62.04	76.62
940	GSF_02228700	USGSFL	61	58	1	154.35	155.36
943	GSF_02320275	USGSFL	60	33	1	149.28	174.96
944	GSF_02246828	USGSFL	60	118	1	4.55	8.18
952	GSF_02246300	USGSFL	59	98	1	31.89	62.24
969	SJR_BA0056	SJRWMD	57	74	1	120.89	123.17
972	SJR_CEDARRIV	SJRWMD	56	102	1	0.74	12.02
973	GSF_02246459	USGSFL	56	102	1	0.74	12.02
991	SJR_02246500	SJRWMD	53	107	1	0.76	19.42

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
995	GSF_02315500	USGSFL	52	39	1	55.87	104.20
1002	GSF_02231000	USGSFL	51	80	1	44.30	120.26
1007	GSF_02315200	USGSFL	50	46	1	86.72	107.05
1008	SR_-011733005	SRWMD	50	46	1	87.22	108.08
1040	GSF_02229000	USGSFL	45	67	1	93.15	121.69
1044	GSF_02231280	USGSFL	43	96	1	15.89	19.54
1052	GSF_02315000	USGSFL	39	42	1	79.22	85.31
1053	GSF_02228500	USGSFL	39	71	1	96.04	105.19
1060	SJR_BA0059	SJRWMD	37	64	1	121.62	120.10
1061	GSF_303220082582201	USGSFL	37	24	1	134.40	137.96
1065	GSF_02231268	USGSFL	36	96	1	6.65	11.64
1066	GSF_02231289	USGSFL	35	110	1	0.92	9.46
1078	GSF_02319200	USGSFL	31	10	1	105.74	140.10
1087	GSG_304311081281302	USGSGA	25	119	1	0.81	-4.30
1111	GSG_304730081342501	USGSGA	19	113	1	24.97	20.33
1154	GSG_023177483	USGSGA	6	6	1	130.55	162.29
4	GSF_285150082044001	USGSFL	159	80	3	45.56	
6	SWF_23135	SWFWMD	159	83	3	46.63	
8	GSF_285207082014501	USGSFL	159	83	3	46.66	
9	GSF_285221081095002	USGSFL	159	138	3	20.80	
17	GSF_285257081434201	USGSFL	158	102	3	55.79	
19	SWF_20085	SWFWMD	158	48	3	2.33	
20	GSF_285248082183201	USGSFL	158	65	3	35.93	
23	GSF_285254082323001	USGSFL	158	50	3	3.38	
28	SJR_V-0198	SJRWMD	156	144	3	16.72	
30	GSF_285420081571901	USGSFL	156	87	3	49.50	
32	GSF_285422082001901	USGSFL	156	84	3	44.31	
34	SJR_V-0196	SJRWMD	156	129	3	15.17	
37	SWF_20075	SWFWMD	156	54	3	4.01	
38	GSF_285414082284201	USGSFL	156	54	3	4.22	
40	SJR_V-0521	SJRWMD	156	154	3	10.19	
41	GSF_285421082361601	USGSFL	156	46	3	1.30	
42	GSF_285421082361602	USGSFL	156	46	3	1.28	
43	GSF_285504081405901	USGSFL	155	105	3	48.23	
45	GSF_285512081202801	USGSFL	155	127	3	16.65	
46	SJR_V-0082	SJRWMD	155	127	3	17.64	
47	GSF_285539081262901	USGSFL	155	120	3	33.85	
48	GSF_285514082275402	USGSFL	155	55	3	4.51	
49	GSF_285536082044001	USGSFL	155	80	3	45.53	
55	GSF_285608082233401	USGSFL	154	60	3	18.81	
56	SJR_S-0243	SJRWMD	154	127	3	24.65	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
57	SWF_23439	SWFWMD	154	59	3	18.60	
59	SJR_V-0083	SJRWMD	154	127	3	6.05	
60	GSF_285612082294201	USGSFL	154	53	3	4.56	
64	SJR_V-0101	SJRWMD	153	143	3	28.43	
66	GSF_285720082201301	USGSFL	152	63	3	32.15	
67	GSF_285745081054001	USGSFL	152	143	3	28.53	
70	GSF_285737082400601	USGSFL	152	42	3	2.55	
71	GSF_285737082413001	USGSFL	152	40	3	2.82	
73	GSF_285833082233301	USGSFL	151	60	3	12.67	
74	GSF_285827081331401	USGSFL	151	113	3	41.33	
75	SJR_V-0435	SJRWMD	151	151	3	7.59	
76	GSF_285812082360901	USGSFL	151	46	3	11.44	
78	GSF_285900082072001	USGSFL	151	77	3	45.04	
80	SJR_V-0111	SJRWMD	150	144	3	27.24	
81	GSF_285934081041801	USGSFL	150	144	3	23.96	
83	GSF_285930081430901	USGSFL	150	103	3	50.84	
86	SJR_M-0483	SJRWMD	150	95	3	50.99	
90	GSF_285933082192501	USGSFL	150	64	3	37.00	
91	GSF_285930082283702	USGSFL	150	54	3	7.25	
92	GSF_290000081380001	USGSFL	150	108	3	43.24	
93	GSF_285935082324501	USGSFL	150	50	3	6.75	
95	GSF_285951082350901	USGSFL	149	47	3	16.42	
99	SJR_L-0059	SJRWMD	149	124	3	15.52	
100	GSF_290052081271201	USGSFL	149	120	3	24.36	
103	GSF_290023082393601	USGSFL	148	42	3	10.46	
105	SJR_V-0164	SJRWMD	148	152	3	3.74	
106	SJR_V-0508	SJRWMD	148	154	3	3.59	
112	GSF_290106082191001	USGSFL	148	64	3	40.67	
113	SWF_23243	SWFWMD	148	64	3	40.18	
115	GSF_290138081203202	USGSFL	148	127	3	8.03	
116	SJR_V-0115	SJRWMD	148	127	3	8.03	
117	GSF_290107082400501	USGSFL	148	42	3	2.72	
118	GSF_290112082371101	USGSFL	147	45	3	5.48	
120	GSF_290130082082001	USGSFL	147	76	3	44.80	
121	SJR_M-0042	SJRWMD	147	76	3	44.60	
123	GSF_290133082140901	USGSFL	147	70	3	43.06	
124	GSF_290132082324201	USGSFL	147	50	3	11.36	
130	SJR_V-0117	SJRWMD	147	144	3	20.49	
131	GSF_290225081040301	USGSFL	147	144	3	20.49	
132	SJR_V-0118	SJRWMD	147	135	3	35.25	
133	GSF_290230081123401	USGSFL	147	135	3	33.11	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
136	GSF_290215082152401	USGSFL	146	68	3	42.18	
137	SWF_22966	SWFWMD	146	41	3	4.04	
138	GSF_290202082403901	USGSFL	146	41	3	4.78	
139	GSF_290200082432301	USGSFL	146	38	3	2.49	
140	SWF_22964	SWFWMD	146	38	3	2.50	
141	GSF_290216082292001	USGSFL	146	53	3	12.73	
143	GSF_290244081302601	USGSFL	146	116	3	14.72	
144	GSF_290227082250801	USGSFL	146	58	3	54.13	
145	GSF_290238082120901	USGSFL	146	72	3	43.13	
148	GSF_290230082412501	USGSFL	146	41	3	3.94	
149	GSF_290306082232802	USGSFL	145	60	3	54.30	
151	GSF_290301082335601	USGSFL	145	49	3	51.89	
152	GSF_290312082190601	USGSFL	145	64	3	46.53	
153	GSF_290312082250801	USGSFL	145	58	3	39.28	
154	SJR_M-0041	SJRWMD	144	75	3	43.47	
155	GSF_290400082091001	USGSFL	144	75	3	43.52	
158	GSF_290447081102301	USGSFL	144	138	3	33.51	
160	SJR_L-0066	SJRWMD	144	112	3	15.50	
161	GSF_290456081044401	USGSFL	144	144	3	17.90	
162	SJR_ALX	SJRWMD	144	112	3	10.30	
163	SJR_V-0123	SJRWMD	144	144	3	18.34	
167	GSF_290455081530401	USGSFL	143	92	3	49.11	
168	SJR_M-0013	SJRWMD	143	92	3	50.09	
171	GSF_290447082250901	USGSFL	143	58	3	32.48	
172	SJR_V-0156	SJRWMD	143	126	3	13.25	
173	SJR_V-0157	SJRWMD	143	126	3	13.23	
174	GSF_290503082323101	USGSFL	143	50	3	71.47	
175	SJR_V-0028	SJRWMD	143	130	3	31.24	
177	GSF_290541081132902	USGSFL	143	134	3	35.20	
178	GSF_290514082270701	USGSFL	143	56	3	30.83	
180	SWF_23316	SWFWMD	143	56	3	31.45	
181	SJR_V-0081	SJRWMD	143	134	3	35.31	
183	GSF_290550081162601	USGSFL	143	131	3	37.32	
187	SJR_M-0058	SJRWMD	142	80	3	42.83	
188	SJR_V-0742	SJRWMD	142	129	3	30.15	
192	GSF_290628081425301	USGSFL	142	103	3	43.87	
195	GSF_290633081375201	USGSFL	142	108	3	29.85	
196	GSF_290605082372601	USGSFL	142	45	3	27.34	
198	GSF_290614082274801	USGSFL	142	55	3	32.62	
199	SJR_L-0040	SJRWMD	141	112	3	35.52	
201	GSF_290647081342101	USGSFL	141	112	3	36.65	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
203	GSF_290708081233101	USGSFL	141	124	3	10.71	
205	GSF_290737081220301	USGSFL	140	125	3	7.88	
221	GSF_290739082245701	USGSFL	140	58	3	34.33	
222	GSF_290806081013901	USGSFL	140	147	3	2.81	
223	GSF_290743082341501	USGSFL	140	48	3	53.35	
224	GSF_290752082271101	USGSFL	140	56	3	34.21	
226	GSF_290815082025701	USGSFL	139	82	3	41.97	
228	SJR_V-0183	SJRWMD	139	140	3	16.75	
229	SJR_V-0188	SJRWMD	139	140	3	14.60	
231	SJR_M-0037	SJRWMD	139	81	3	41.96	
232	GSF_290822082310101	USGSFL	139	52	3	43.43	
233	GSF_290900081342002	USGSFL	139	112	3	28.26	
235	GSF_290910081360001	USGSFL	138	110	3	40.69	
236	SJR_V-0008	SJRWMD	138	142	3	13.35	
237	SJR_V-0080	SJRWMD	138	142	3	13.02	
239	GSF_290930081230201	USGSFL	138	124	3	16.05	
240	SJR_V-0213	SJRWMD	138	124	3	16.74	
241	GSF_290913082245601	USGSFL	138	58	3	36.17	
242	GSF_290910082315001	USGSFL	138	51	3	42.30	
245	SJR_L-0045	SJRWMD	138	114	3	12.19	
248	GSF_290950081315501	USGSFL	138	115	3	12.24	
251	SJR_V-0086	SJRWMD	137	138	3	23.15	
254	GSF_291006081101004	USGSFL	137	138	3	23.43	
255	SJR_L-0455	SJRWMD	137	113	3	10.92	
257	GSF_290953082031301	USGSFL	137	81	3	41.99	
258	SJR_M-0038	SJRWMD	137	81	3	41.24	
259	SJR_V-0215	SJRWMD	137	126	3	12.94	
260	SJR_M-0049	SJRWMD	137	108	3	35.15	
261	GSF_290951082211201	USGSFL	137	62	3	42.86	
262	SJR_V-0099	SJRWMD	137	143	3	4.25	
263	SJR_V-0200	SJRWMD	137	150	3	-0.32	
266	GSF_291004082382901	USGSFL	137	44	3	24.18	
268	SJR_V-0700	SJRWMD	137	133	3	31.51	
270	SJR_V-0187	SJRWMD	136	145	3	3.23	
272	SJR_FHS	SJRWMD	136	103	3	23.29	
274	SJR_JUN	SJRWMD	136	103	3	30.13	
275	GSF_291100082010003	USGSFL	136	84	3	41.38	
276	SJR_M-0048	SJRWMD	136	85	3	44.80	
277	SJR_V-0206	SJRWMD	136	118	3	22.80	
278	GSF_291059082190801	USGSFL	136	64	3	42.39	
279	SWF_23349	SWFWMD	136	64	3	42.44	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
280	GSF_291056082263201	USGSFL	136	57	3	37.66	
281	SJR_M-0059	SJRWMD	136	64	3	42.40	
282	SJR_M-0044	SJRWMD	136	91	3	47.23	
284	GSF_291110082060001	USGSFL	136	78	3	40.95	
285	GSF_291115081592501	USGSFL	136	85	3	45.13	
286	SJR_M-0032	SJRWMD	136	78	3	40.76	
287	GSF_291115082102901	USGSFL	136	74	3	41.83	
288	SJR_M-0321	SJRWMD	136	74	3	41.82	
290	GSF_291130082015001	USGSFL	135	83	3	40.61	
291	SJR_M-0026	SJRWMD	135	83	3	40.56	
292	GSF_291150081282501	USGSFL	135	118	3	28.60	
293	SJR_M-0040	SJRWMD	135	79	3	40.26	
296	SJR_V-0062	SJRWMD	135	125	3	24.60	
300	SJR_V-0127	SJRWMD	134	141	3	6.84	
302	GSF_291258081313701	USGSFL	134	115	3	6.17	
307	SJR_SWE	SJRWMD	134	106	3	7.87	
309	SJR_V-0769	SJRWMD	133	128	3	25.81	
311	SJR_M-0039	SJRWMD	133	80	3	41.37	
312	SJR_V-0090	SJRWMD	133	132	3	26.33	
313	SJR_V-0089	SJRWMD	133	121	3	30.68	
316	SJR_V-0577	SJRWMD	133	117	3	22.13	
322	SJR_V-0066	SJRWMD	132	118	3	20.52	
325	SJR_SGS	SJRWMD	132	108	3	1.02	
328	SJR_V-0531	SJRWMD	132	119	3	24.93	
343	SJR_V-0147	SJRWMD	131	120	3	28.93	
345	SJR_V-0068	SJRWMD	131	117	3	17.30	
348	GSF_291414082560901	USGSFL	131	25	3	10.24	
349	SR_-141429005	SRWMD	131	25	3	9.69	
350	GSF_291508081302801	USGSFL	131	116	3	12.76	
351	SJR_V-0065	SJRWMD	131	116	3	12.96	
352	GSF_291523081095001	USGSFL	131	138	3	16.87	
353	SJR_V-0130	SJRWMD	131	138	3	18.12	
354	GSF_291508082432901	USGSFL	130	39	3	9.46	
355	GSF_291600081550001	USGSFL	130	90	3	42.69	
356	SJR_M-0036	SJRWMD	130	90	3	42.78	
359	SJR_V-0449	SJRWMD	129	145	3	-2.78	
360	SJR_M-0288	SJRWMD	129	73	3	19.25	
361	GSF_291728081390501	USGSFL	128	107	3	11.65	
362	GSF_291712082351801	USGSFL	128	47	3	45.37	
364	GSF_291748081290301	USGSFL	128	118	3	22.10	
365	SJR_V-0510	SJRWMD	128	118	3	22.93	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
366	GSF_291740081562001	USGSFL	128	89	3	43.55	
368	SJR_M-0025	SJRWMD	128	89	3	43.77	
383	GSF_291818081190401	USGSFL	127	128	3	16.44	
385	SJR_F-0251	SJRWMD	127	128	3	16.39	
387	SJR_V-0064	SJRWMD	127	119	3	22.37	
388	GSF_291835081324201	USGSFL	127	114	3	5.30	
389	SJR_V-0155	SJRWMD	127	114	3	4.11	
390	SJR_M-0021	SJRWMD	127	105	3	14.00	
391	GSF_291849081411401	USGSFL	127	105	3	13.83	
392	GSF_291806082545601	USGSFL	127	27	3	21.36	
393	GSF_291913081224201	USGSFL	126	124	3	16.78	
394	GSF_291905081251001	USGSFL	126	122	3	19.78	
395	SJR_V-0096	SJRWMD	126	122	3	19.76	
399	GSF_291910082341101	USGSFL	126	49	3	44.02	
400	SJR_V-0184	SJRWMD	126	117	3	26.00	
404	SJR_V-0446	SJRWMD	126	141	3	8.94	
406	GSF_291955081200901	USGSFL	125	127	3	11.11	
407	SJR_F-0097	SJRWMD	125	127	3	11.99	
409	SJR_V-0567	SJRWMD	125	115	3	30.06	
410	SJR_M-0063	SJRWMD	125	78	3	45.12	
416	SJR_SAL	SJRWMD	124	102	3	1.22	
419	SJR_P-0735	SJRWMD	124	112	3	10.86	
420	SJR_P-0736	SJRWMD	124	112	3	7.59	
426	SJR_P-0423	SJRWMD	123	108	3	9.48	
427	SJR_M-0012	SJRWMD	123	78	3	45.81	
428	GSF_292146082182501	USGSFL	123	65	3	46.35	
429	GSF_292200081510001	USGSFL	123	94	3	22.79	
430	GSF_292143082282201	USGSFL	123	55	3	44.58	
431	SJR_M-0024	SJRWMD	123	95	3	22.77	
432	GSF_292204082022801	USGSFL	123	82	3	47.96	
433	SJR_M-0052	SJRWMD	123	82	3	48.21	
434	GSF_292218081333101	USGSFL	123	113	3	23.82	
435	SJR_P-0410	SJRWMD	123	113	3	24.07	
440	SJR_M-0284	SJRWMD	122	79	3	47.60	
441	SJR_P-0255	SJRWMD	122	118	3	13.12	
442	SJR_P-0422	SJRWMD	122	108	3	12.31	
444	SJR_P-0696	SJRWMD	122	115	3	26.35	
446	SJR_V-0443	SJRWMD	122	140	3	8.43	
448	SJR_P-0421	SJRWMD	122	108	3	10.12	
449	GSF_292254081382101	USGSFL	122	108	3	10.48	
450	SJR_P-0469	SJRWMD	122	111	3	17.38	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
451	GSF_292302081155901	USGSFL	122	132	3	13.39	
452	SJR_F-0240	SJRWMD	122	132	3	9.99	
455	SJR_P-0341	SJRWMD	122	116	3	24.99	
458	SJR_P-0744	SJRWMD	121	111	3	19.73	
459	GSF_292310082373701	USGSFL	121	45	3	52.82	
461	SJR_P-0705	SJRWMD	120	113	3	27.69	
463	GSF_292435081441301	USGSFL	120	102	3	9.00	
465	SJR_P-0427	SJRWMD	120	102	3	9.14	
466	SJR_P-0776	SJRWMD	119	109	3	23.08	
469	GSF_292430082283001	USGSFL	119	55	3	44.81	
471	SWF_22931	SWFWMD	119	55	3	44.88	
475	GSF_292528081383501	USGSFL	119	108	3	16.89	
477	SJR_P-0270	SJRWMD	118	108	3	17.24	
479	SJR_M-0023	SJRWMD	118	94	3	19.24	
483	GSF_292546081513301	USGSFL	118	94	3	19.21	
484	GSF_292507082560201	USGSFL	118	25	3	2.43	
485	SJR_F-0176	SJRWMD	118	140	3	8.50	
487	GSF_292603081082502	USGSFL	118	140	3	7.50	
490	SJR_P-0242	SJRWMD	118	115	3	26.61	
492	SJR_P-0373	SJRWMD	118	109	3	20.44	
493	SJR_P-0396	SJRWMD	117	107	3	10.63	
494	GSF_292628081385501	USGSFL	117	107	3	10.63	
496	SJR_LE0002	SJRWMD	117	56	3	44.93	
497	GSF_292615082272601	USGSFL	117	56	3	44.94	
500	GSF_292647081182001	USGSFL	117	129	3	8.25	
501	SJR_F-0126	SJRWMD	117	129	3	8.25	
503	SJR_P-0416	SJRWMD	117	109	3	19.59	
505	GSF_292640082381201	USGSFL	117	44	3	49.87	
506	SJR_M-0351	SJRWMD	117	71	3	51.23	
507	SJR_P-0517	SJRWMD	116	115	3	20.77	
508	SJR_P-0417	SJRWMD	116	115	3	20.96	
509	SJR_F-0182	SJRWMD	116	125	3	10.49	
510	GSF_292718082202601	USGSFL	116	63	3	49.99	
512	GSF_292750081152001	USGSFL	116	132	3	13.35	
513	SJR_F-0087	SJRWMD	116	132	3	13.35	
514	GSF_292713082493601	USGSFL	116	32	3	23.21	
516	SR_-121508002	SRWMD	115	32	3	26.17	
518	GSF_292824081341501	USGSFL	115	112	3	28.97	
519	GSF_292824081443301	USGSFL	115	101	3	6.54	
520	SJR_P-0246	SJRWMD	115	112	3	29.35	
521	SJR_P-0472	SJRWMD	115	101	3	6.81	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
524	GSF_292816082234501	USGSFL	115	60	3	51.49	
525	GSF_292859081375701	USGSFL	114	108	3	15.90	
526	SJR_P-0408	SJRWMD	114	108	3	17.19	
528	SR_-111631002	SRWMD	114	37	3	28.78	
529	SJR_F-0206	SJRWMD	114	124	3	12.31	
530	SJR_A-0034	SJRWMD	114	75	3	54.41	
531	GSF_292948081503001	USGSFL	113	95	3	18.64	
532	SJR_P-0450	SJRWMD	113	95	3	18.46	
534	SR_-111326004	SRWMD	113	23	3	3.27	
535	SJR_A-0035	SJRWMD	113	66	3	52.54	
536	GSF_292951082174001	USGSFL	113	66	3	52.03	
541	SJR_P-0382	SJRWMD	112	109	3	26.96	
542	GSF_293113081370301	USGSFL	112	109	3	26.31	
544	GSF_293128081090501	USGSFL	112	139	3	6.11	
546	SJR_F-0225	SJRWMD	111	139	3	6.11	
550	SJR_P-0817	SJRWMD	111	111	3	23.93	
552	SJR_A-0069	SJRWMD	111	58	3	46.16	
553	SJR_P-0413	SJRWMD	110	111	3	32.14	
554	SJR_A-0037	SJRWMD	110	64	3	53.64	
555	GSF_293203082200601	USGSFL	110	64	3	53.64	
556	SJR_P-0280	SJRWMD	110	103	3	20.13	
557	SR_-111117007	SRWMD	110	6	3	13.19	
558	SJR_P-0411	SJRWMD	109	112	3	21.12	
559	SJR_A-0038	SJRWMD	109	79	3	68.58	
560	GSF_293253082055701	USGSFL	109	79	3	68.45	
561	SJR_P-0306	SJRWMD	109	93	3	59.08	
562	GSF_293300081523901	USGSFL	109	93	3	58.61	
565	SJR_F-0158	SJRWMD	109	134	3	13.62	
566	SR_-111811001	SRWMD	109	54	3	43.41	
567	GSF_293252082292301	USGSFL	109	54	3	42.88	
568	SJR_A-0039	SJRWMD	109	68	3	56.47	
569	SJR_F-0204	SJRWMD	109	124	3	15.28	
571	GSF_293344081232401	USGSFL	109	124	3	13.92	
573	SJR_F-0294	SJRWMD	109	124	3	15.68	
576	SJR_A-0070	SJRWMD	109	59	3	43.38	
578	SJR_P-0017	SJRWMD	107	93	3	64.95	
580	SR_-101634001	SRWMD	107	41	3	62.59	
583	GSF_293529081191701	USGSFL	107	128	3	14.03	
584	SJR_F-0165	SJRWMD	106	128	3	14.88	
587	SJR_A-0005	SJRWMD	106	73	3	68.80	
588	GSF_293554081342601	USGSFL	106	112	3	15.42	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
589	SJR_P-0474	SJRWMD	106	112	3	16.54	
591	SJR_A-0008	SJRWMD	106	58	3	42.31	
592	SJR_A-0040	SJRWMD	106	80	3	74.19	
593	GSF_293556082043401	USGSFL	106	80	3	74.33	
594	SJR_A-0071	SJRWMD	106	80	3	74.95	
599	SJR_P-0464	SJRWMD	105	85	3	76.07	
600	GSF_293633081594601	USGSFL	105	85	3	76.07	
601	SJR_A-0032	SJRWMD	105	66	3	67.58	
602	SR_-101722001	SRWMD	105	47	3	40.61	
603	GSF_293620082362001	USGSFL	105	47	3	40.93	
604	SJR_A-0054	SJRWMD	105	69	3	59.12	
605	SJR_A-0068	SJRWMD	105	47	3	40.61	
607	SJR_A-0020	SJRWMD	105	63	3	51.29	
609	SJR_A-0016	SJRWMD	105	59	3	45.45	
610	GSF_293644082244201	USGSFL	105	59	3	45.60	
611	SR_-101516017	SRWMD	104	33	3	13.28	
612	GSF_293729081221201	USGSFL	104	125	3	14.35	
614	SJR_SJ0115	SJRWMD	104	125	3	15.67	
615	SR_-101516001	SRWMD	104	33	3	11.02	
616	SJR_P-0510	SJRWMD	104	98	3	46.93	
618	GSF_293733081474801	USGSFL	104	98	3	47.49	
619	SJR_A-0058	SJRWMD	104	72	3	75.05	
620	GSF_293723082120102	USGSFL	104	72	3	75.05	
621	GSF_293754081121901	USGSFL	104	136	3	13.55	
623	SJR_F-0200	SJRWMD	104	136	3	14.37	
624	GSF_293728082282401	USGSFL	104	55	3	41.76	
625	SJR_A-0041	SJRWMD	104	55	3	41.36	
626	SJR_A-0059	SJRWMD	104	62	3	59.71	
627	SJR_P-0008	SJRWMD	103	86	3	75.49	
628	SJR_P-0016	SJRWMD	103	91	3	71.08	
630	GSF_293731083061801	USGSFL	103	15	3	34.07	
633	SR_-101601002	SRWMD	102	43	3	41.21	
634	SR_-102006001	SRWMD	102	63	3	45.52	
635	SJR_P-0172	SJRWMD	102	112	3	17.21	
636	GSF_293933081342801	USGSFL	101	112	3	15.74	
637	SR_-091534001	SRWMD	101	35	3	63.20	
640	SJR_P-0123	SJRWMD	101	104	3	27.93	
642	SJR_SJ0152	SJRWMD	101	116	3	12.99	
644	SJR_P-0772	SJRWMD	101	93	3	72.05	
648	SR_-091628005	SRWMD	100	39	3	72.46	
649	SJR_P-0077	SJRWMD	100	111	3	17.88	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
650	SJR_A-0057	SJRWMD	100	54	3	42.78	
652	SJR_SJ0263	SJRWMD	99	118	3	14.10	
653	SR_-091530005	SRWMD	99	31	3	12.02	
654	SJR_A-0055	SJRWMD	99	60	3	45.57	
655	SJR_P-0490	SJRWMD	99	112	3	20.17	
658	SJR_SJ0602	SJRWMD	98	128	3	16.07	
659	SR_-091420001	SRWMD	98	26	3	7.91	
660	SJR_A-0001	SJRWMD	98	68	3	49.35	
661	SJR_A-0044	SJRWMD	98	66	3	14.08	
662	SJR_A-0042	SJRWMD	98	66	3	22.74	
663	SJR_A-0045	SJRWMD	98	66	3	14.50	
665	SJR_A-0047	SJRWMD	98	66	3	11.89	
667	SJR_P-0076	SJRWMD	98	114	3	18.43	
669	SJR_A-0049	SJRWMD	97	76	3	74.99	
670	GSF_294307082020903	USGSFL	97	83	3	80.41	
671	SJR_P-0001	SJRWMD	97	85	3	80.75	
673	SR_-092307001	SRWMD	97	82	3	81.14	
674	SJR_C-0009	SJRWMD	97	82	3	81.14	
675	SJR_SJ0076	SJRWMD	97	120	3	12.43	
678	SR_-091212003	SRWMD	96	17	3	46.68	
679	SR_-091607001	SRWMD	96	38	3	51.28	
682	SJR_A-0075	SJRWMD	96	57	3	58.55	
683	SR_-091938002	SRWMD	96	57	3	58.54	
684	SJR_A-0052	SJRWMD	96	67	3	54.29	
685	SR_-091504001	SRWMD	95	33	3	82.25	
688	SR_-081536002	SRWMD	95	37	3	71.19	
691	SR_-081535002	SRWMD	95	35	3	77.90	
692	SJR_SJ0516	SJRWMD	95	129	3	15.27	
694	SJR_A-0051	SJRWMD	95	71	3	68.23	
698	SR_-081631001	SRWMD	94	38	3	53.56	
701	SR_-081926001	SRWMD	94	60	3	41.74	
702	GSF_294530082232001	USGSFL	94	60	3	41.99	
703	GSF_294553081344301	USGSFL	94	112	3	22.47	
706	SJR_SJ0432	SJRWMD	94	132	3	14.21	
708	SR_-081132001	SRWMD	94	6	3	37.59	
709	SR_-081425001	SRWMD	94	30	3	18.44	
711	SJR_C-0436	SJRWMD	93	84	3	77.88	
715	SJR_SJ0290	SJRWMD	93	118	3	20.70	
716	SJR_C-0031	SJRWMD	93	86	3	77.52	
718	SR_-081624004	SRWMD	93	43	3	29.86	
721	SJR_SJ0317	SJRWMD	93	121	3	18.28	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
724	SJR_C-0132	SJRWMD	92	83	3	78.86	
728	SJR_C-0442	SJRWMD	92	84	3	77.38	
732	SR_-081313005	SRWMD	92	24	3	21.30	
734	SR_-081515002	SRWMD	92	35	3	66.51	
737	SR_-081513001	SRWMD	92	36	3	61.32	
739	SR_-081618001	SRWMD	91	38	3	41.35	
742	SR_-081518005	SRWMD	91	31	3	25.29	
745	GSF_294807082020903	USGSFL	91	83	3	77.97	
748	SJR_C-0120	SJRWMD	91	83	3	78.94	
754	SR_-081416001	SRWMD	91	27	3	8.48	
760	SJR_C-0457	SJRWMD	90	90	3	74.62	
762	SR_-081412001	SRWMD	90	30	3	14.27	
763	GSF_294839082230701	USGSFL	90	61	3	43.51	
764	SJR_A-0053	SJRWMD	90	61	3	43.51	
767	SJR_C-0453	SJRWMD	90	88	3	76.03	
772	SR_-082202001	SRWMD	90	80	3	75.20	
778	SJR_A-0065	SJRWMD	89	66	3	59.69	
780	SJR_C-0451	SJRWMD	89	83	3	76.96	
781	SR_-081703001	SRWMD	89	47	3	33.31	
785	SR_-071532001	SRWMD	89	32	3	28.32	
786	SJR_C-0123	SJRWMD	89	103	3	65.46	
795	SJR_SJ0133	SJRWMD	88	114	3	23.28	
798	SR_-072132001	SRWMD	88	71	3	61.06	
799	SR_-071630004	SRWMD	88	38	3	39.02	
801	SJR_C-0439	SJRWMD	87	84	3	75.47	
806	GSF_295132081164801	USGSFL	87	131	3	16.59	
809	SR_-071529003	SRWMD	87	33	3	53.33	
814	SR_-071528001	SRWMD	87	34	3	67.97	
815	SR_-071526001	SRWMD	87	36	3	66.12	
817	SR_-071630002	SRWMD	87	38	3	22.63	
819	SR_-071525001	SRWMD	87	37	3	34.90	
820	SR_-071927008	SRWMD	87	59	3	43.22	
823	SR_-071515001	SRWMD	85	34	3	68.75	
824	SR_-072215001	SRWMD	85	80	3	81.74	
825	SJR_B-0011	SJRWMD	85	80	3	81.64	
826	SR_-071417001	SRWMD	85	26	3	16.21	
827	SJR_SJ0415	SJRWMD	85	128	3	19.11	
828	GSF_295357081294301	USGSFL	84	117	3	28.45	
829	SJR_SJ0027	SJRWMD	84	118	3	30.72	
831	SR_-071401005	SRWMD	83	31	3	7.33	
832	SJR_SJ0119	SJRWMD	83	120	3	29.01	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
834	SJR_SJ0413	SJRWMD	83	130	3	22.48	
835	SR_-072002001	SRWMD	83	67	3	57.48	
836	SR_-072205001	SRWMD	83	77	3	59.98	
841	SR_-061734001	SRWMD	82	47	3	33.18	
842	SJR_CO0008	SJRWMD	82	47	3	33.18	
846	SR_-061025003	SRWMD	81	4	3	49.69	
847	SR_-061629001	SRWMD	81	39	3	21.41	
848	GSF_295713081203401	USGSFL	80	127	3	29.95	
849	SJR_SJ0412	SJRWMD	80	127	3	29.05	
854	GSF_295835081515001	USGSFL	78	94	3	66.58	
855	SJR_C-0018	SJRWMD	78	94	3	67.49	
857	SJR_C-0607	SJRWMD	78	94	3	67.59	
859	SR_-061114001	SRWMD	78	9	3	65.68	
862	SJR_C-0128	SJRWMD	78	90	3	66.81	
863	GSF_295903081334301	USGSFL	78	113	3	25.80	
865	SR_-062102001	SRWMD	76	74	3	57.49	
866	SR_-061401003	SRWMD	76	31	3	30.42	
867	GSF_300048081414301	USGSFL	76	105	3	25.67	
868	SR_-051331002	SRWMD	76	18	3	40.67	
869	SR_-051331003	SRWMD	76	18	3	41.01	
871	SR_-051933001	SRWMD	75	59	3	54.20	
873	SR_-051428004	SRWMD	74	27	3	22.02	
874	SJR_CO0005	SJRWMD	73	50	3	41.22	
875	SR_-051922001	SRWMD	73	61	3	55.42	
878	SR_-051215001	SRWMD	73	15	3	61.63	
879	GSF_300341081395401	USGSFL	72	107	3	30.57	
880	SR_-051214008	SRWMD	72	17	3	25.84	
881	SR_-051218002	SRWMD	72	12	3	48.65	
883	SR_-051311001	SRWMD	71	23	3	17.98	
884	SJR_C-0038	SJRWMD	71	98	3	42.27	
885	GSF_300450081482801	USGSFL	71	98	3	42.27	
886	SR_-051208001	SRWMD	71	13	3	28.92	
887	GSF_300507081272701	USGSFL	71	120	3	42.50	
888	SJR_SJ0029	SJRWMD	71	120	3	38.92	
891	SR_-051004001	SRWMD	70	2	3	82.95	
893	SR_-051205001	SRWMD	70	14	3	21.92	
895	GSF_300622081284701	USGSFL	69	118	3	34.10	
896	SR_-042236001	SRWMD	69	82	3	54.92	
898	GSF_300649081485901	USGSFL	68	97	3	35.72	
900	GSF_300656081463401	USGSFL	68	100	3	33.49	
901	SJR_C-0094	SJRWMD	68	100	3	32.88	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
902	SR_-041827002	SRWMD	68	54	3	50.67	
903	SJR_SJ0436	SJRWMD	68	108	3	30.26	
904	GSF_300717081381001	USGSFL	68	108	3	30.11	
905	SR_-041329001	SRWMD	68	19	3	24.64	
906	SR_-041625001	SRWMD	68	43	3	37.30	
907	SJR_SJ0005	SJRWMD	67	124	3	33.87	
908	GSF_300758081230501	USGSFL	67	124	3	33.16	
910	SR_-041923001	SRWMD	67	61	3	54.80	
911	GSF_300820081354001	USGSFL	67	111	3	33.30	
912	GSF_300824081305401	USGSFL	67	116	3	36.57	
913	SR_-041223004	SRWMD	67	17	3	25.09	
914	GSF_300834081421301	USGSFL	66	104	3	26.40	
915	GSF_300850081552001	USGSFL	66	90	3	55.87	
917	SR_-041014001	SRWMD	65	3	3	39.59	
918	SR_-041608002	SRWMD	65	39	3	35.58	
920	SR_-041112005	SRWMD	65	11	3	26.76	
921	GSF_301132081225801	USGSFL	64	125	3	-2.66	
922	GSF_301018081415101	USGSFL	64	105	3	28.82	
923	GSF_301037081243901	USGSFL	64	123	3	25.60	
924	GSF_301022082103301	USGSFL	64	74	3	54.14	
925	SJR_BA0019	SJRWMD	64	74	3	54.86	
926	SR_-041501001	SRWMD	64	37	3	34.93	
927	SJR_CO0010	SJRWMD	63	45	3	47.85	
928	SR_-041705001	SRWMD	63	45	3	47.85	
929	SR_-031232001	SRWMD	63	13	3	28.71	
931	SR_-031734011	SRWMD	63	48	3	54.54	
932	GSF_301212081252401	USGSFL	62	122	3	37.40	
937	SR_-031923004	SRWMD	61	61	3	53.76	
941	GSF_301333081324101	USGSFL	60	114	3	31.52	
942	GSF_301339081531203	USGSFL	60	93	3	45.90	
945	GSF_301408081253101	USGSFL	60	122	3	24.40	
950	GSF_301434082021401	USGSFL	59	83	3	50.83	
951	SJR_BA0015	SJRWMD	59	58	3	56.12	
953	SR_-031012001	SRWMD	58	5	3	61.62	
954	SJR_D-0291	SJRWMD	58	114	3	36.18	
955	GSF_301522081331301	USGSFL	58	114	3	43.01	
956	GSF_301537081441901	USGSFL	58	102	3	37.22	
958	SJR_BA0011	SJRWMD	58	68	3	52.46	
959	SJR_D-0129	SJRWMD	58	104	3	27.06	
960	GSF_301551081415701	USGSFL	58	104	3	26.75	
961	GSF_301535082162001	USGSFL	58	68	3	52.46	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
962	SR_-031105006	SRWMD	57	7	3	25.92	
963	SR_-031601003	SRWMD	57	43	3	56.52	
964	GSF_301604081361501	USGSFL	57	110	3	36.83	
965	GSF_301617081421601	USGSFL	57	104	3	25.40	
966	GSF_301618082110901	USGSFL	57	74	3	52.19	
967	SJR_BA0054	SJRWMD	57	74	3	52.77	
970	GSF_301639081330802	USGSFL	57	114	3	34.48	
971	SR_-021934001	SRWMD	56	61	3	52.95	
974	SR_-021335001	SRWMD	56	23	3	43.31	
975	SR_-021930001	SRWMD	56	57	3	55.05	
976	SR_-021231001	SRWMD	56	13	3	36.33	
977	GSF_301725081584501	USGSFL	56	87	3	52.20	
978	SJR_D-0254	SJRWMD	56	87	3	52.31	
979	GSF_301817081374901	USGSFL	55	109	3	32.68	
980	GSF_301817081374902	USGSFL	55	109	3	36.47	
981	SJR_D-425T	SJRWMD	55	109	3	32.80	
983	SJR_D-0246	SJRWMD	54	123	3	33.75	
984	SJR_D-0018	SJRWMD	54	106	3	27.99	
985	GSF_301844081403801	USGSFL	54	106	3	27.99	
986	SJR_D-0160	SJRWMD	54	124	3	29.50	
987	GSF_301852081234201	USGSFL	54	124	3	29.37	
989	SR_-021624001	SRWMD	54	44	3	54.09	
990	SJR_D-0094	SJRWMD	54	112	3	30.63	
993	SR_-021516001	SRWMD	53	34	3	51.73	
994	SR_-021711003	SRWMD	53	49	3	54.54	
996	GSF_302022081393501	USGSFL	52	107	3	29.10	
997	SR_-021407003	SRWMD	52	25	3	45.51	
998	GSF_302052081323201	USGSFL	52	114	3	27.62	
1000	SJR_CO0007	SJRWMD	51	52	3	52.08	
1001	SR_-021902001	SRWMD	51	61	3	51.59	
1004	GSF_302159081235601	USGSFL	50	123	3	41.32	
1005	SR_-011534001	SRWMD	50	35	3	54.27	
1006	SR_-011035001	SRWMD	50	4	3	49.48	
1009	GSF_302227081435001	USGSFL	50	103	3	38.00	
1010	GSF_302304081383202	USGSFL	49	108	3	36.93	
1011	SJR_D-0424	SJRWMD	49	117	3	31.00	
1012	GSF_302307081293801	USGSFL	49	117	3	33.70	
1013	SJR_D-0667	SJRWMD	49	108	3	37.07	
1015	SJR_BA0018	SJRWMD	49	65	3	50.68	
1016	SR_-011727001	SRWMD	49	47	3	52.85	
1017	GSF_302330081463001	USGSFL	48	100	3	36.80	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
1018	GSF_302339081254702	USGSFL	48	121	3	34.29	
1022	GSF_302416081522601	USGSFL	47	94	3	39.22	
1023	SJR_D-0348	SJRWMD	47	94	3	40.13	
1025	GSF_302502081330701	USGSFL	47	114	3	34.10	
1026	GSF_302502081321001	USGSFL	47	115	3	32.80	
1027	GSF_302503081332001	USGSFL	47	114	3	32.00	
1028	GSF_302511081331201	USGSFL	46	114	3	31.70	
1029	GSF_302519081331501	USGSFL	46	114	3	30.67	
1030	SR_-011511001	SRWMD	46	36	3	49.21	
1031	SJR_D-0164	SJRWMD	46	122	3	37.60	
1032	GSF_302538081253101	USGSFL	46	122	3	37.60	
1033	GSF_302550081331501	USGSFL	46	114	3	29.34	
1034	GSF_302557081253101	USGSFL	45	122	3	38.05	
1035	SR_-011011002	SRWMD	45	4	3	46.47	
1036	GSF_302608081354902	USGSFL	45	111	3	36.49	
1038	GSF_302608081354901	USGSFL	45	111	3	35.32	
1039	GSF_302608081354903	USGSFL	45	111	3	35.02	
1041	GSF_302620082173501	USGSFL	45	67	3	50.10	
1042	SJR_BA0009	SJRWMD	44	67	3	50.25	
1043	GSF_302724081244801	USGSFL	44	123	3	33.29	
1045	SJR_D-0145	SJRWMD	43	109	3	36.24	
1046	GSF_302801081375101	USGSFL	43	109	3	36.10	
1047	SR_+011422007	SRWMD	41	28	3	46.61	
1048	SR_+011316001	SRWMD	41	21	3	39.35	
1050	SR_+011714002	SRWMD	40	48	3	51.44	
1051	SR_+011608001	SRWMD	40	39	3	60.96	
1054	GSF_303216081433301	USGSFL	38	103	3	34.95	
1056	SR_+021332004	SRWMD	37	20	3	42.21	
1057	SR_+021432001	SRWMD	37	26	3	43.08	
1058	SJR_BA0057	SJRWMD	37	64	3	48.66	
1062	SR_+021125001	SRWMD	36	12	3	46.40	
1063	SJR_N-0051	SJRWMD	36	96	3	38.06	
1064	GSF_303357081295601	USGSFL	36	117	3	26.45	
1067	SJR_N-0046	SJRWMD	35	120	3	26.18	
1068	GSF_303435081271401	USGSFL	35	120	3	26.97	
1069	SJR_N-0009	SJRWMD	35	120	3	25.76	
1070	SR_+021514001	SRWMD	34	36	3	55.48	
1071	GSF_303518081275001	USGSFL	34	119	3	20.45	
1072	SR_+021211001	SRWMD	33	17	3	43.26	
1075	GSF_303658081422601	USGSFL	32	104	3	34.04	
1076	SR_+021202001	SRWMD	32	17	3	42.08	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
1077	SR_+021002001	SRWMD	31	5	3	63.24	
1079	SJR_N-0112	SJRWMD	31	121	3	-7.46	
1080	SJR_N-0190	SJRWMD	30	120	3	-16.58	
1081	GSF_303939081312601	USGSFL	29	116	3	1.45	
1082	SJR_N-0053	SJRWMD	28	108	3	28.41	
1084	SJR_N-0003	SJRWMD	26	120	3	-11.61	
1085	GSF_304213081270801	USGSFL	26	120	3	-13.89	
1088	GSG_304256082092101	USGSGA	25	76	3	43.20	
1089	GSG_304313081330001	USGSGA	24	114	3	8.32	
1090	GSG_304328081325101	USGSGA	24	114	3	1.55	
1091	GSF_304324081555901	USGSFL	24	90	3	34.82	
1092	GSG_304348081323901	USGSGA	24	114	3	4.20	
1095	GSG_304408081323301	USGSGA	23	114	3	-14.95	
1097	GSF_304410081592101	USGSFL	23	87	3	40.55	
1098	SJR_N-0120	SJRWMD	23	87	3	40.68	
1099	GSG_304450081333401	USGSGA	23	113	3	10.25	
1100	GSG_304512081343601	USGSGA	22	112	3	18.53	
1101	GSG_304514081365801	USGSGA	22	110	3	28.45	
1102	GSG_304514081390201	USGSGA	22	108	3	32.30	
1103	GSG_304522081281301	USGSGA	22	119	3	19.37	
1104	GSG_304551081342901	USGSGA	21	112	3	18.50	
1105	GSG_304608081345201	USGSGA	21	112	3	21.85	
1106	GSG_304610081280901	USGSGA	21	119	3	22.05	
1107	GSG_304619081280501	USGSGA	21	119	3	26.60	
1108	GSG_304640081423301	USGSGA	20	104	3	29.70	
1109	GSG_304646081280901	USGSGA	20	119	3	20.55	
1110	SJR_WN0018	SJRWMD	20	88	3	40.09	
1112	GSG_304740081343001	USGSGA	19	112	3	27.11	
1113	GSG_304742081334501	USGSGA	19	113	3	33.36	
1114	GSG_304748081335301	USGSGA	19	113	3	28.94	
1116	GSG_304752081311201	USGSGA	19	116	3	27.23	
1117	GSG_304748081331401	USGSGA	19	114	3	29.02	
1118	GSG_304756081311101	USGSGA	19	116	3	29.36	
1119	GSG_304809081404601	USGSGA	19	106	3	35.99	
1120	GSG_304830081481201	USGSGA	18	98	3	39.91	
1121	GSG_304847081342101	USGSGA	18	113	3	37.20	
1122	GSG_304851081274001	USGSGA	18	120	3	31.35	
1123	GSG_304850081342001	USGSGA	18	113	3	36.90	
1124	GSG_304916081360701	USGSGA	17	111	3	34.00	
1125	GSG_304922081435501	USGSGA	17	103	3	40.10	
1127	GSG_304952081541201	USGSGA	16	92	3	31.65	

Model Index	UNIQUEID	AGENCY	Row	Col	Layer	Average Water Level, ft.	Adjusted Water Level, ft. (Layer 1 only)
1128	GSG_304942082213801	USGSGA	16	63	3	46.98	
1129	GSG_305029081265101	USGSGA	16	121	3	30.55	
1130	GSG_305032081280101	USGSGA	16	119	3	34.40	
1131	GSG_305045081334601	USGSGA	15	113	3	31.00	
1132	GSG_304949083165301	USGSGA	15	5	3	85.49	
1133	GSG_305122081275601	USGSGA	15	119	3	24.00	
1134	GSG_305122081275602	USGSGA	15	119	3	22.85	
1135	GSG_305226081593701	USGSGA	13	86	3	46.20	
1136	GSG_305316081310101	USGSGA	12	116	3	29.40	
1137	GSG_305241083154401	USGSGA	12	7	3	89.66	
1138	GSG_305505081305101	USGSGA	10	116	3	28.50	
1139	GSG_305421083153001	USGSGA	10	7	3	77.54	
1140	GSG_305538081305401	USGSGA	9	116	3	30.50	
1142	GSG_305614081244501	USGSGA	9	123	3	43.40	
1143	GSG_305619081244601	USGSGA	9	123	3	42.70	
1144	GSG_305627081473101	USGSGA	8	98	3	34.70	
1145	GSG_305630081244401	USGSGA	8	123	3	42.50	
1146	GSG_305658081251601	USGSGA	8	122	3	45.20	
1147	GSG_305709081244101	USGSGA	8	123	3	41.90	
1148	GSG_305710081315501	USGSGA	8	115	3	30.00	
1149	GSG_305739081243601	USGSGA	7	123	3	34.90	
1150	GSG_305742081252501	USGSGA	7	122	3	38.80	
1151	GSG_305803081243601	USGSGA	7	123	3	36.40	
1152	GSG_305804081441301	USGSGA	6	102	3	29.30	
1153	GSG_305813081250501	USGSGA	6	122	3	38.50	
1155	GSG_305824081243501	USGSGA	6	123	3	36.80	
1156	GSG_305907082070101	USGSGA	5	78	3	53.80	
327	SJR_V-0530	SJRWMD	132	119	4	25.85	
999	SJR_D-3060	SJRWMD	52	114	4	27.62	
1003	SJR_D-2386	SJRWMD	50	123	4	41.32	
1037	SJR_D-0262	SJRWMD	45	111	4	35.45	
1115	GSG_304750081335301	USGSGA	19	113	4	35.99	

Appendix II: White Springs ANN Development

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Introduction

Utilization and adaptation of the USGS MegaModel (Sepulveda, 2002) raised questions regarding the accuracy of flow targets for several springs within the Suwannee River Water Management District (SRWMD) domain. White Springs, located in Hamilton County, is of particular of interest because it is first magnitude spring with historical significance. In recent years, flow reversal in White Springs has occurred, making it particularly difficult to quantify the spring flow. An accurate estimation of flow for White Springs for the MegaModel calibration period (1993-1994) is an important target for model calibration. Since there is no available observed data during the calibration period, a statistical model is a viable option for the estimation of spring flow during this period. Using the best and most complete data available, two statistical models were developed to develop a flow time series for White Springs: a multiple linear regression and an artificial neural network (ANN).

Data Collection

All available data was collected from the Suwannee River Water Management District (SRWMD). Available data included spring discharge, spring condition, river stage, and elevations of nearby wells. In order to develop a time series for the 1993-1994 period, it was desired to have forcing functions (ie. well records, river stage) that were long term records dating back to the 1993-1994 time frame. Data was examined for completeness and selected based on the period of record requirement. Using physics to select the best explanatory variables to define the spring flow yields aquifer stage and river stage. The head gradient would define the spring flow. The long term USGS river stage at the US 41 bridge and the long term wells at 21711003 and -011534001 were selected as explanatory variables for the spring flow. Figure 1 shows the locations of the stations used in the statistical analysis. Table 1 shows the available spring flow data and the corresponding explanatory data for the same dates the spring flows were measured.

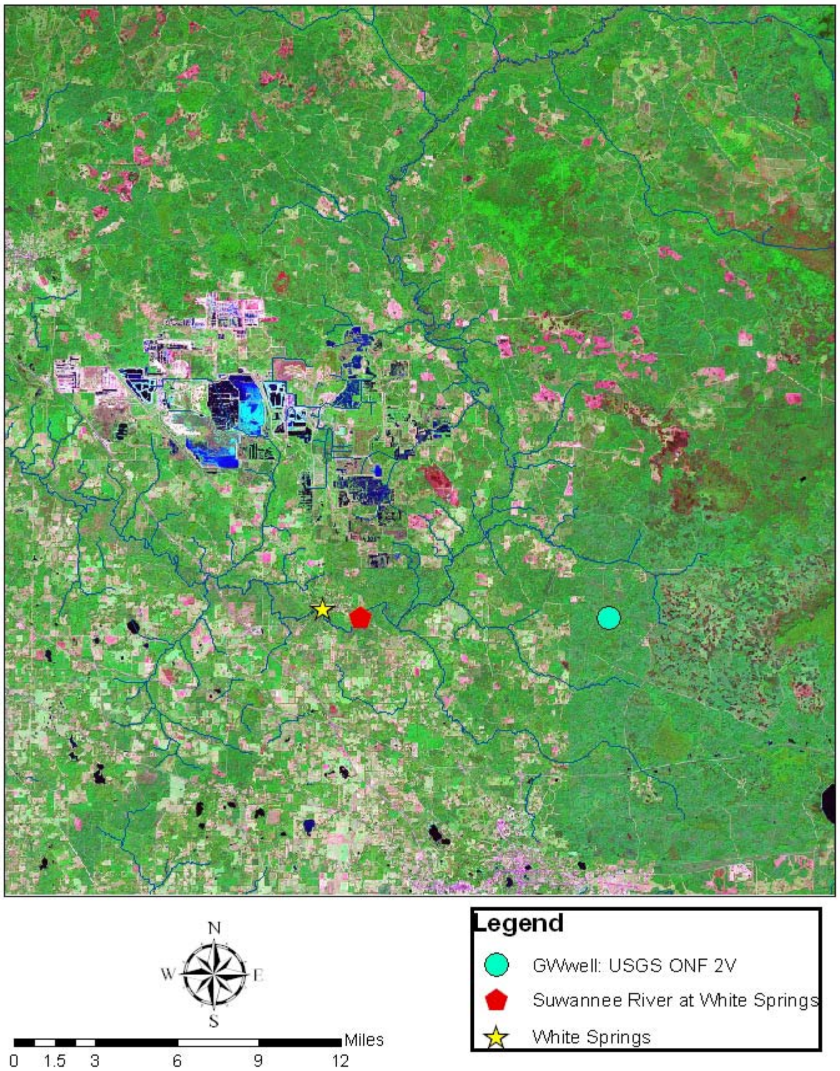

Figure 1. Explanatory Variable Locations

Table 1. Available White Springs Flow Data and Associated Explanatory Variables

Date	21711003 Well Level, feet	2315500 Stage, feet	-011534001 Well Level, feet	White Springs Discharge, cfs
4/30/1998	62.27	56.63	59.4	69.7
5/11/1998	61.45	54.87	58.35	84.4
5/18/1998	60.55	53.12	57.56	77.7
5/26/1998	59.87	51.92	57	78.4
6/4/1998	59.21	51.32	56.53	38.5
6/8/1998	58.77	51.05	56.12	80.8
6/16/1998	58.34	50.72	55.89	43.4
7/2/1998	57.1	50.38	55.04	33.3
7/23/1998	56.1	50.89	54.32	26.9
7/27/1998	56.14	51.02	54.34	26.7
8/21/1998	55.79	53.01	53.94	21.1
9/14/1998	55.56	52.84	53.66	12.8
12/7/1998	56.17	51.79	54.35	24.8
2/4/1999	56.04	54.69	53.61	16.6
4/5/1999	54.95	51.69	52.58	6.2
10/15/2003	54.98	52.37	52.78	6.7
10/15/2003	54.98	52.37	52.78	6.4
4/2/2004	54.91	52.92	52.91	7.6
11/23/2004	58.48	54.95	57.37	58.3
12/13/2004	58.07	54.41	56.1	49.8
12/22/2004	57.58	53.34	55.59	44.6
1/31/2006	58.18	56.59	55.77	39.9
6/14/2006	54.78	51.57	52.49	2.56
6/14/2006	54.78	51.57	52.49	3.8
11/1/2007	48.38	55.85	48	-4.9
4/16/2008	52.26	56.2	52.98	-27.4
9/2/2008	54.07	66.17	55.96	-126
10/22/2008	50.56	55.02	50.55	-10.21
4/30/2009	54.11	64.8	60.69	-68
5/4/2009	53.86	60.59	57.8	-56.6
5/7/2009	53.47	58.17	56.18	-21
5/13/2009	52.7	54.68	54.31	9.6
5/14/2009	52.58	54.26	54.07	7.2
5/27/2009	54.25	61.71	54.32	-103.7

Statistical Model Development

White Springs discharge data was sparse. As shown in Table 1, there were a total of 35 available discharge measurements for statistical model development. The available data spanned a wide range of flows including large flows in both directions (into and out of the aquifer). Using this available data, two models were developed: a multiple linear regression model and an artificial neural network (ANN).

Multiple Linear Regression

Linear regression, the most common regression procedure, is used to describe the effect of continuous or categorical variables upon a continuous response. The linear regression model assumes that the response is obtained by taking a specific linear combination of predictors and adding random variation (error). The error is assumed to have a Gaussian (normal) distribution with constant variance and to be independent of the predictor values. For the case of White Springs, a multiple linear regression model was developed using SPlus. The model was developed using two forcing functions: well stage at USGS Well 21711003 (USGS ONF 2V) and river stage at USGS gauging station 2315500 (Suwannee River at US 41). The observed data was plotted with the model predicted White Springs flow, as shown in Figure 2. As shown in the figure, there is a reasonable fit in the data. Although the model describes the flow at White Springs reasonably well, improvements in both the regression coefficient and the slope of the trend line would be desirable. In order to attempt to create a more robust model which can more accurately describe the data, an artificial neural network was also developed in order to predict flow at White Springs.

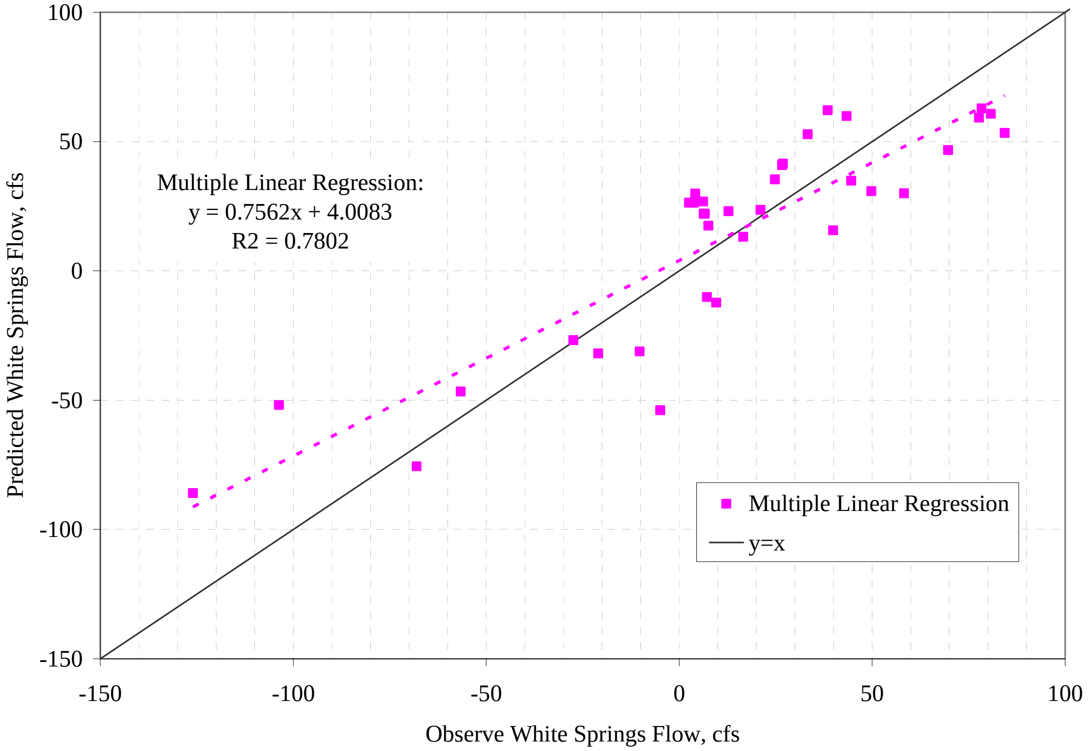

Figure 2. Results of Multiple Linear Regression

rtificial Neural Networks NN

An ANN was created for the estimation of White Springs flow with the identical input data that was utilized for the creation of the multiple linear regression model. Artificial neural networks (ANNs) have been used to solve a variety of engineering problems such as seismic discrimination, groundwater cleanup, and lithology prediction. The underlying theoretical principle of neural networks is the theory of learning (Valient, 1984).

A neural network is a nonlinear system consisting of an interconnected group of artificial neurons that can be represented by an input vector, $\underline{x}$, and an output vector, $\underline{y}$. The relationship between the inputs and outputs of the network can be written as $\underline{y}=f(\underline{x},\underline{w})$, where $\underline{w}$ denotes the weights of the network. A training set of input vectors and output vectors is utilized to determine the weight vectors. Thus, successful performance of the network will depend highly on the training data used. It is important to choose a large, well-distributed set of examples for the training data and to avoid overtraining. Overtraining occurs when it is assumed that all the examples used are noise free and a minimized error is forced in the network. ANNs learn based on examples presented to them, and thus are not inherently deterministic. The training of the network consists of showing the network example inputs and target outputs. The internal parameters of the network are iteratively adjusted during the training process until the network produces meaningful results.

The utilization of neural networks for the estimation of White Springs flow has several advantages over other statistical methods, including (French et al. 1992, Raman and Sunikumar, 1995):

- There is no need for *a priori* knowledge of the process underlying the training of the neural network.
- Complex relationships between the aspects of the process need not be fully understood.
- Constraints are not *a priori* placed on the solution.

The ANN is an adaptive system whose structure changes based on the information flowing through the network during the learning process. The most common method of supervised learning (training) is the backpropagation method. For the case of White Springs, there were 35 sets of available training data. Each training data set consists of the input forcing functions (stage, well level) at a given time, and the corresponding White Springs flow rate as output. Using a feed-forward, backpropagation algorithm, two different ANNs were trained for White Springs: one using well data at well 21711003, and another using well data from well -011534001 as input variables.

NN 1 Well 21 11003

A 3-layer ANN with 2 input nodes (well level at well 21711003 and stage at Suwannee River US 41) and 6 hidden nodes was developed in order to predict White Springs Flow. The results are shown in Figure 3. The network was trained using a feed-forward, back propagation algorithm.

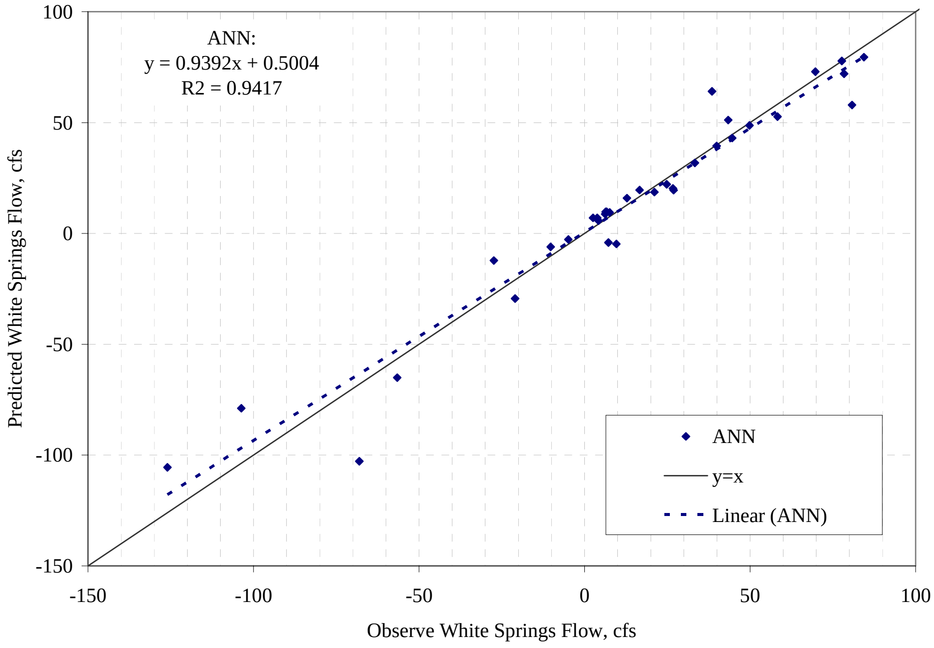

Figure 3. White Springs ANN Performance

The performance of the ANN was compared to the multiple linear regression, as shown in Figure 4. As shown in the figure, the ANN is better able to estimate the White Springs flow than the multiple linear regression model, as evidenced by both the higher regression coefficient (indicating a tighter fit to the trendline), and a trendline slope closer to unity (indicating less bias in the model). Thus, the ANN was both more accurate and more precise than the multiple linear regression model.

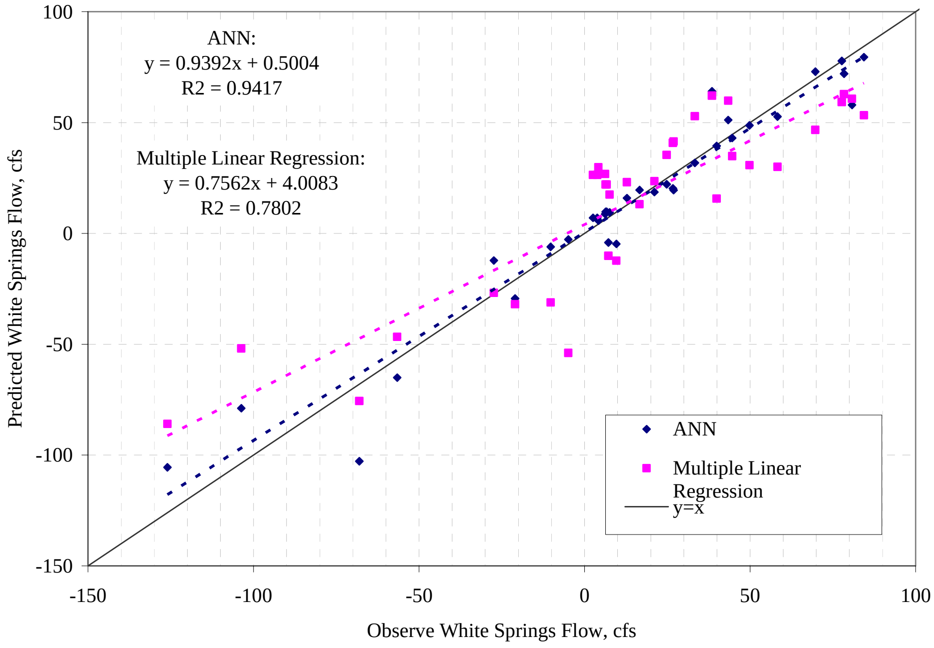

Figure 4. Statistical Model Comparison

The ANN-predicted White Springs flow rates for the training data were compared to the observed White Springs flow rates. This data is shown in Figure 5, along with the observed stage and well time series. As shown in the figure, the ANN predicts the observed White Springs flow rates very well for the training data.

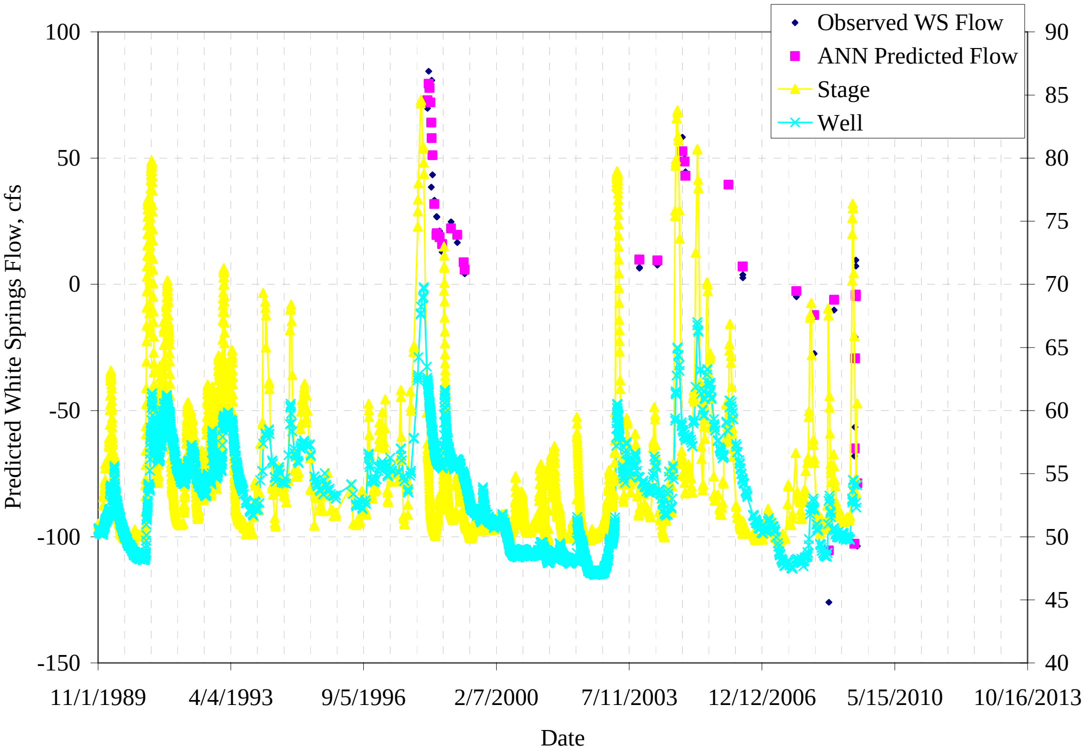

Figure 5. White Springs Observed and Predicted Flow

NN 2 Well 011534001

An additional 3-layer ANN with 2 input nodes (well level at well -011534001 and stage at Suwannee River US 41) and 6 hidden nodes was developed in order to predict White Springs Flow. The results are shown in Figure 3. The architecture of this network was identical to ANN 1, with the exception of the well level having a different source. The performance of that network is shown in Figure 6.

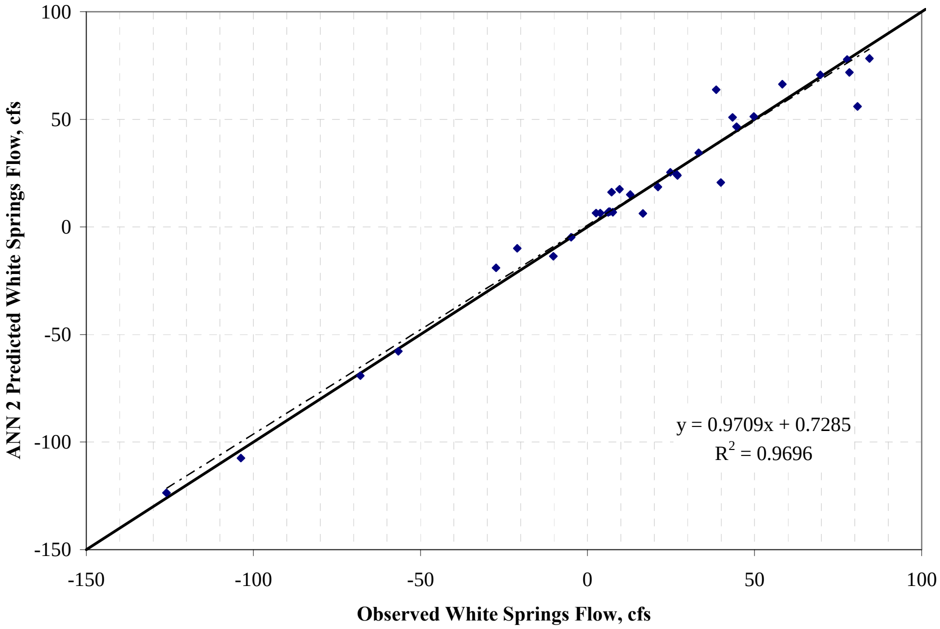

Figure 6. ANN 2 Performance

The two networks were compared to one another, as shown in Figure 7. ANN 2 performs slightly better than ANN 1, with a higher regression coefficient and less bias in the trendline. Due to their similar performance, both ANNs will be utilized to develop a predictive time series for August 1993 through July 1994.

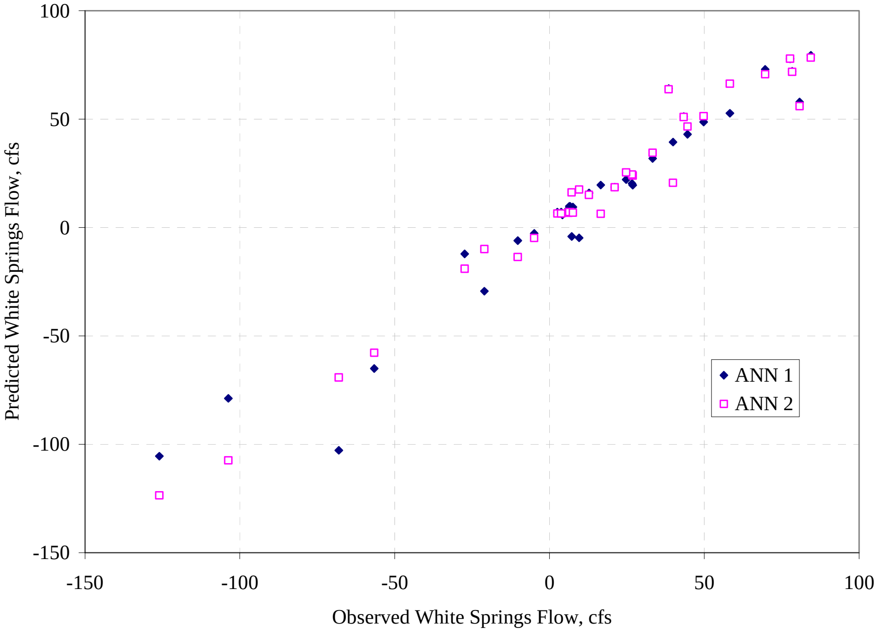

Figure 7. ANN Comparison

ANN Validation

In addition to the available measured flow data, there was a more extensive time series of qualitative data available for White Springs. The direction of flow of the spring was recorded from 1997 through 2004 by a park ranger. The direction was either recorded as (1) spring flowing into river, (2) no flow, or (3) river flowing into spring. In order to graphically compare the qualitative data to the ANN predicted time series, the flow directions were assigned values of 1 (spring flowing), 0 (no flow), and -1 (river flowing into spring). A comparison of the ANN 1 predicted time series to the qualitative data is shown in Figure 8. As shown in the figure, there is reasonably good agreement between the qualitative data and the ANN predicted spring flows. Thus, although it is not possible to verify the magnitude of the ANN predicted flows, the majority of the time, the ANN is able to accurately classify the direction of the spring flow. This adds confidence to the ANN's predictive capability.

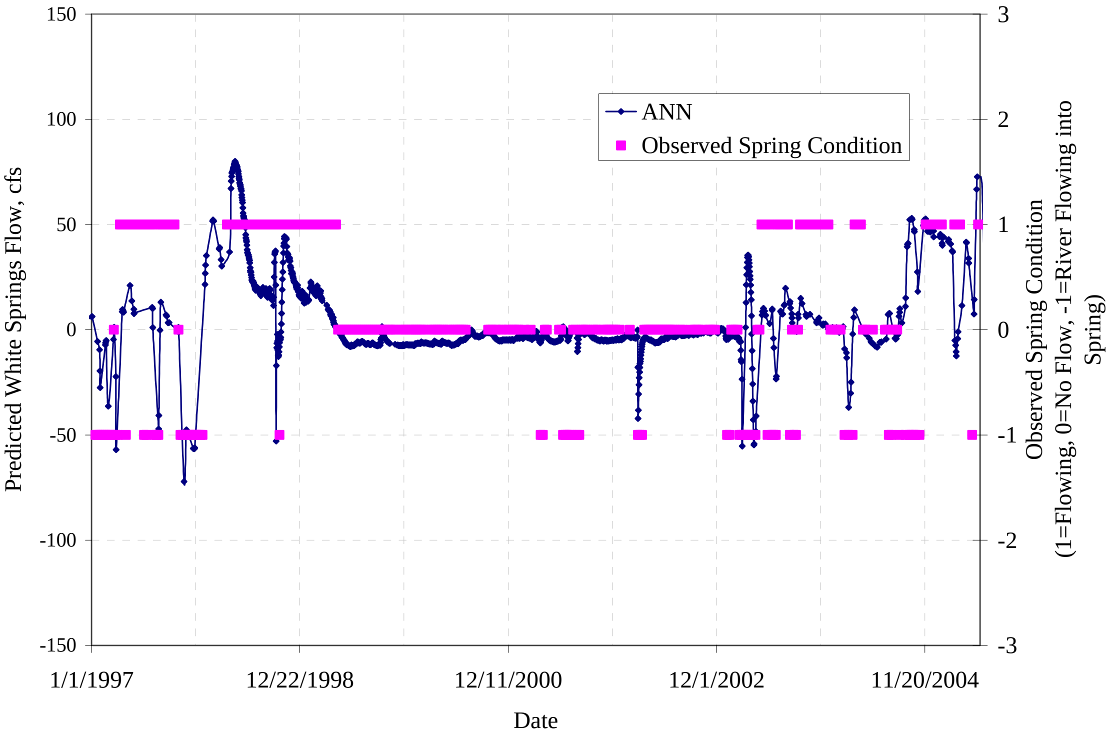

Figure 8. ANN 1 Performance Based on Qualitative Data

Like many models, ANNs perform well when they are utilized to predict data that is within the range of the data seen by the network during learning. In general, ANNs do not extrapolate well. In order to determine the extent to which the ANN is extrapolating for the August 1993 through July 1994 time series, the range of the input data for 1993-1994 was compared against the range of the training data, shown in Table 2. As shown in the table, the predictive data is within the range of the training data for the case of the well data. During the predictive period, the stage data is slightly outside of the training data range. Examination of the stage time series for the predictive period in Figure 10 shows that the stage data is outside of the range of the training data only for very short periods, which gives confidence to the ANN's capability to predict the 1993-1994 time period.

Table 2. Data Ranges

	21711003 Well Level, ft		2315500 Stage, ft	
	Training Data	Predictive Data	Training Data	Predictive Data
Minimum	48.38	51.65	50.38	50.19
Maximum	62.27	58.52	66.17	69.32

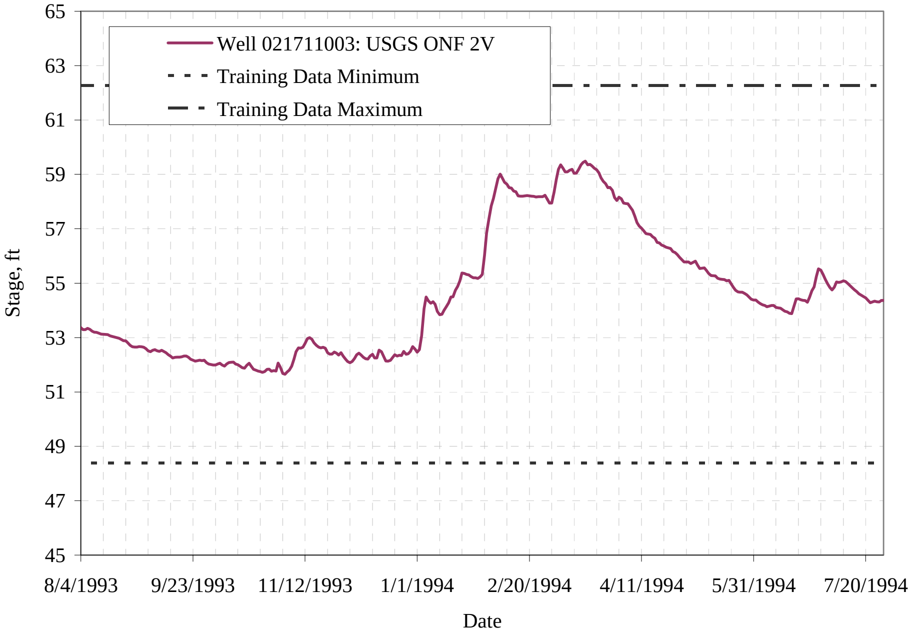

Figure 9. Well Time Series, 1993-1994

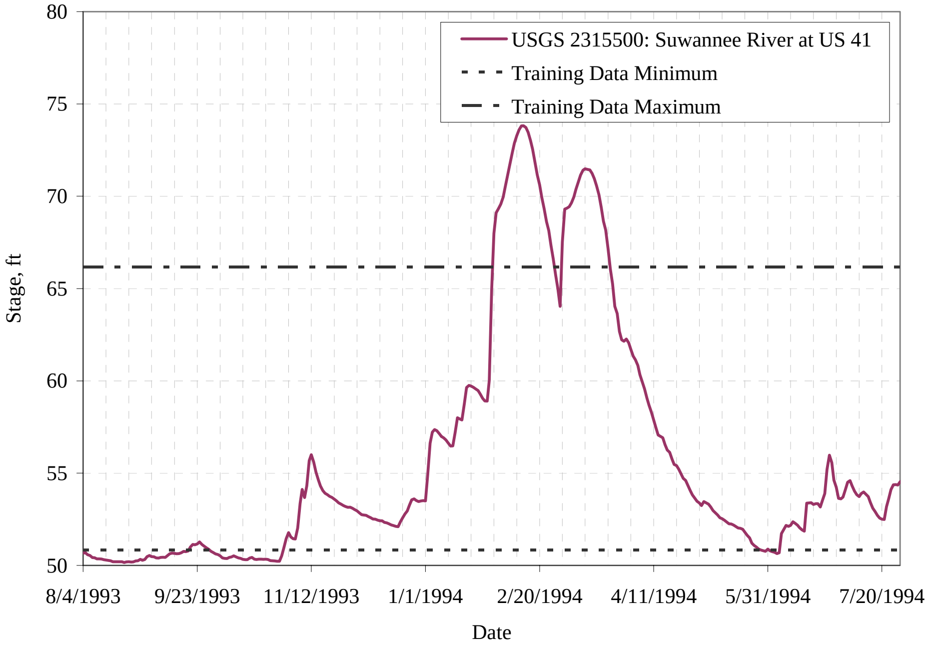

Figure 10. Stage Time Series, 1993-1994

Predicted Time Series

The predicted White Springs flow time series (using ANN 1) for all available data is shown in Figure 11. The time series was examined for August 1993 through July 1994, as shown in Figure 12. As shown in the figure, using ANN 1, the average White Springs flow for the MegaModel simulation period is -6.83 cfs. Using ANN 2, the average White Springs flow for the MegaModel simulation period is -6.92 cfs

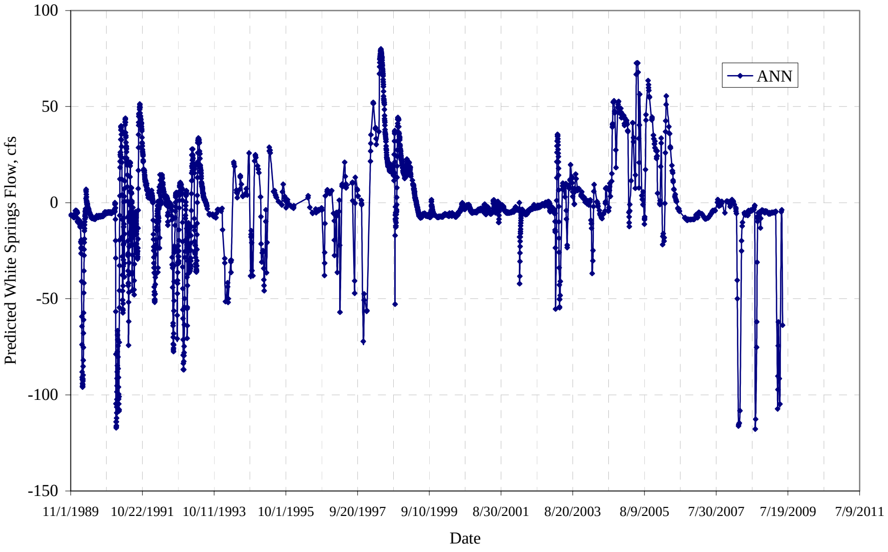

Figure 11. Predicted Time Series, Entire Period of Record, ANN 1

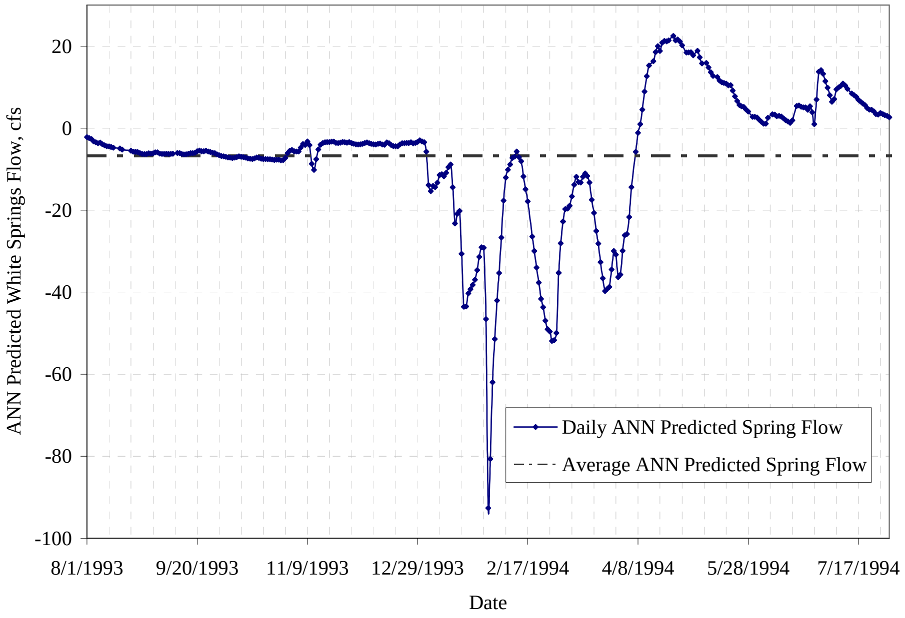

Figure 12. Predicted Time Series, August 1993- uly 1994, ANN 1

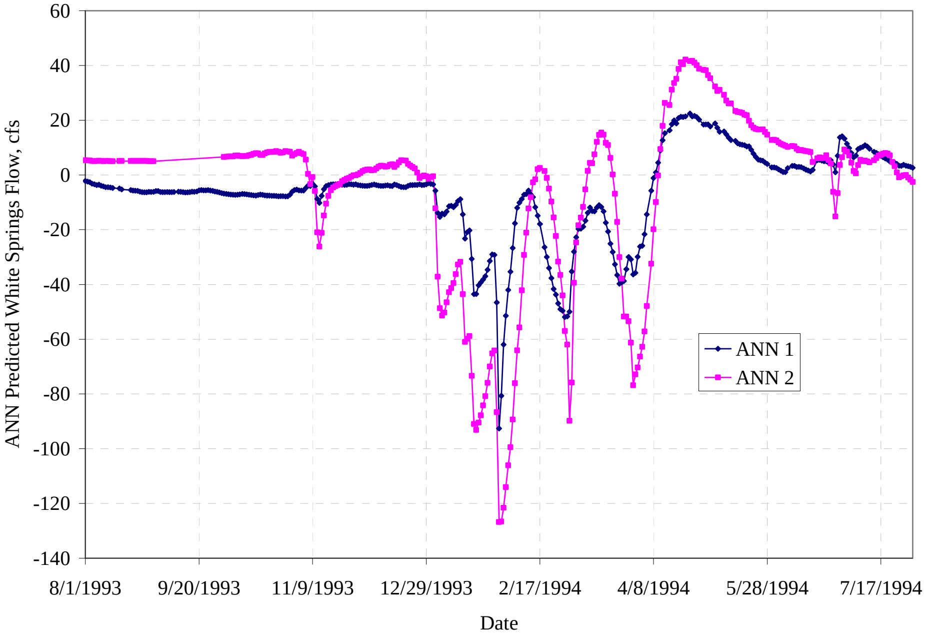

Figure 13. Predicted Time Series, August 1993- uly 1994, ANN 1 and ANN 2

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Appendix III: Additional Simulations

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Introduction

The modified Mega Model was utilized to determine the impacts of the phosphate mining groundwater withdrawals. Prior to doing this, further modifications to the existing representation of White Springs in the Mega Model were required. White Springs historically was a 2nd magnitude spring. The spring has historical significance and is now part of the Florida State Park system. It was desired to calibrate the model to the target statistically computed as described in the ANN development section. The original model represented the spring with a MODFLOW drain cell. Since the new spring flux target was negative (flow into the aquifer) the drain conceptualization needed to be modified. The sections below describe the necessary model modifications and the scenario results both with and without the phosphate pumping.

Mega Model Modifications

The original Mega Model utilized a drain as a boundary condition to compute the flow out of White Springs. In the original Sepulveda Mega Model, White Springs was calibrated to a target of 42.3 cfs with a residual of 11.1 cfs (simulated flux 53.4 cfs). Lack of documentation for the observed target measurement, combined with anecdotal data from White Springs made it desirable to determine a more refined estimation of observed spring flow for the simulation period. A previous report described the development of an artificial neural network (ANN) which simulated the spring flow given river stage and aquifer head. Based on the ANN results, the new estimate of White Springs flow for the 1993-1994 conditions was -6.8 cfs. The Mega Model was modified and recalibrated to this new flow target. The following sections describe the model modifications and re-calibration. To make the modifications listed, the constant head for the first layer was used to obtain a new recharge package. After modifications to the model were complete, phosphate pumping was turned off and compared to the original modified simulation.

Spring Representation Conversion

The original model represented the springs with both MODFLOW drain cells and MODFLOW river cells. White Springs was represented with a drain cell. Drain cells can only withdraw water from the aquifer and cannot reverse the direction of flow and add water to the aquifer. For this reason, the original drain was replaced with a general head boundary, or GHB cell. The first step was to change the drain to a GHB and verify the function. A GHB was added and given the same stage and conductance as the drain, then the drain was deleted. The GHB was verified to function exactly as the drain since the fluxes were the same and there were no recorded drawdown. Table 1 shows the original drain cell properties.

Table 1. Drain Cell Parameters

Parameter	Value
Layer	3
Row	52
Column	37
Head	50’
Conductance	$3.5\text{x}10^6$

Adjusted the GHB Flux

The GHB properties were adjusted in order to change the boundary condition flux representing White Springs, as shown in Table 2. The original drain flux was 53.4 cfs; given the ANN work described above, the boundary flux was adjusted to -6.8 cfs, which represents a flux into the aquifer. In order to do this, the GHB stage was adjusted. Since the boundary condition flux changed from a withdrawal of water to an addition of water, the end result was a groundwater mounding near the spring. Detailed description of the results and the impact changes had on the model calibration are shown in the following sections.

Table 2. GHB Parameters

Parameter	Value
Layer	3
Row	52
Column	37
Head	57.7
Conductance	$3.5\text{x}10^6$

Recomputed Recharge

Once the changes were completed for the White Springs conceptualization and calibration of the new boundary condition was complete, a new recharge package was developed. The recharge was computed from the constant head lower and lateral face fluxes as well as a river cell flux computation. Just as described in the original work, the active water table heads were identical to the constant head cells. The heads in the active layer 1 were compared to the constant head cells to verify the recharge was functioning correctly. The heads in layer 3 of the active layer 1 simulation included the same up-coning as in the constant head run, again demonstrating that the recharge computations were functioning correctly.

Calibration Comparison

A comparison of the weighted calibration statistics is shown in the table below. After the White Springs flux modification, the residual mean decreased slightly. The residual sum of squares increased slightly, while the remaining statistics were similar between the two model simulations.

Table 3. Calibration Statistic Comparison

	Prior to White Springs Flux Change	After White Springs Flux Change
Residual Mean	0.50	0.45
Residual Standard Deviation	6.62	6.64
Residual Sum of Squares	4.48e+004	4.50e+004
Absolute Residual Mean	3.86	3.88
Minimum Residual	-34.22	-34.22
Maximum Residual	55.93	55.93
Observed Range in Head	214.10	214.10
Residual Std. Dev./ Range	0.031	0.031

Observed and predicted heads are shown for the Mega Model both before and after the White Springs flux modification in Figures 1 and 2, respectively. As shown in the figures, the performance of the two simulations was very similar, with the exception of several targets surrounding White Springs.

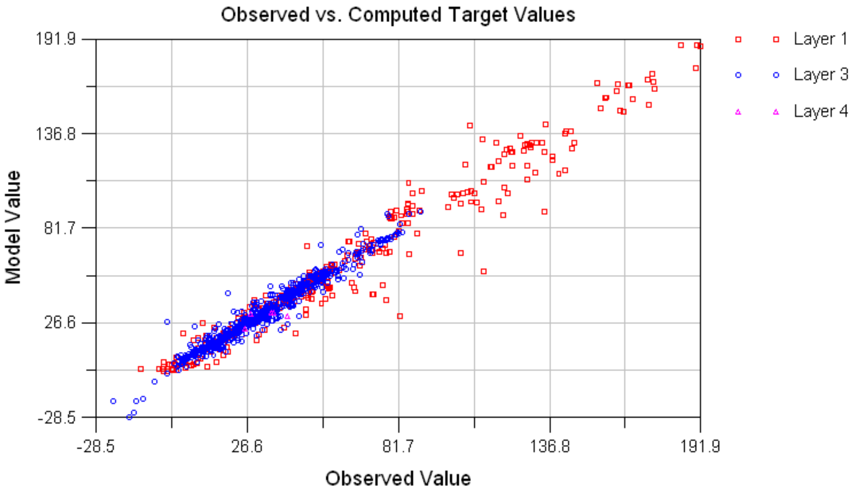

Figure 1. Original Calibrated Mega Model, Observed vs. Predicted Heads

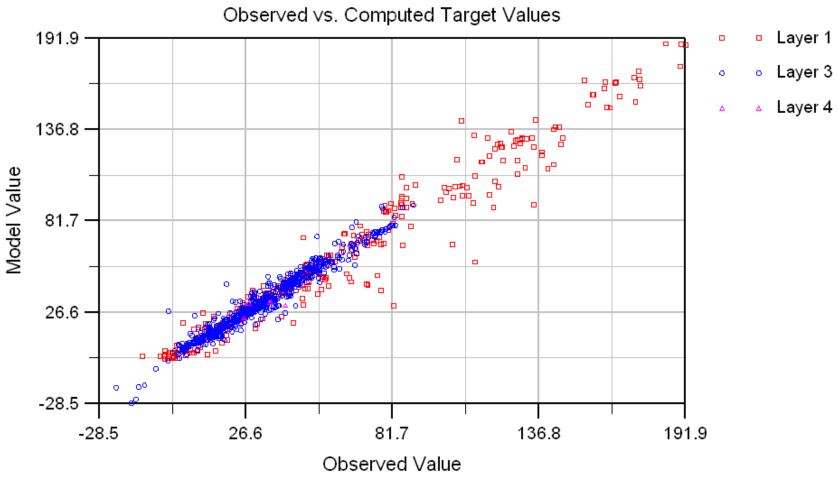

Figure 2. Mega Model: Modified White Springs Flux, Observed vs. Predicted Heads

Targets surrounding White Springs are shown for the original calibrated Mega Model and the adjusted White Springs simulation in Figures 3 and 4, respectively. A negative residual (shown in red) indicates that the model is overestimating head, while a positive value (shown in blue) indicated that the model is underestimating head. Prior to the flux adjustment, there were positive several positive residuals to the west of White Springs and negative residuals to the east. After the flux modification, several positive residual targets to the west of White Springs became negative, indicating a change from underestimation of head to overestimation of head. These three targets, with original residuals of +6.22, +2.39 and +1.10, overall exhibited improved performance with the flux modification, with final residuals of -1.93, -0.31, and -1.17, respectively. The new residuals reflect the fact that the aquifer head is slightly high in this area.

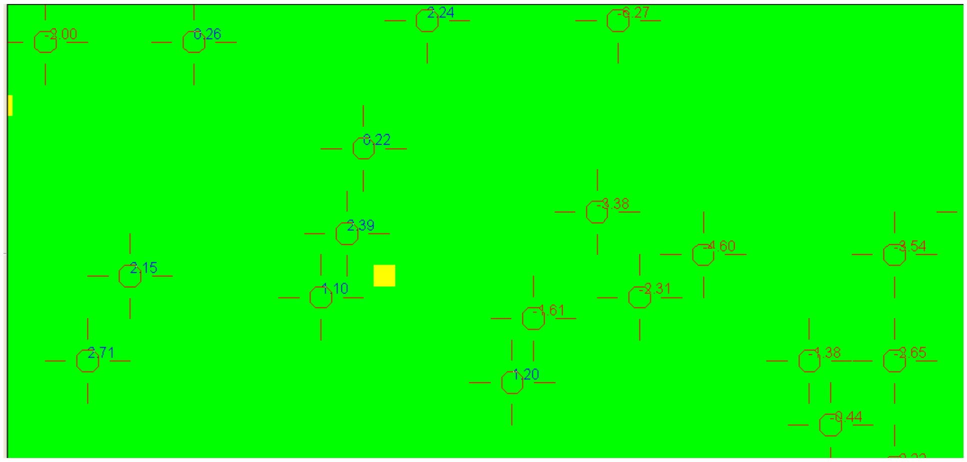

Figure 3. Layer 3 Residuals, Mega Model_INTERA.gwv, (White Springs = yellow)

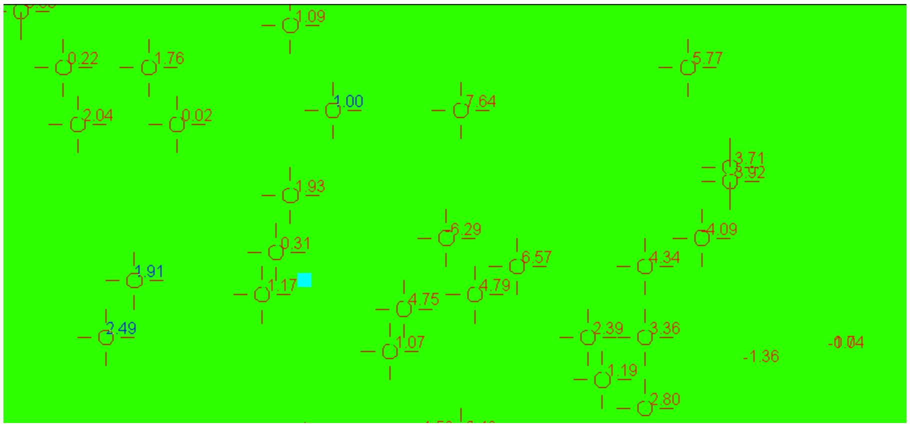

Figure 4. Layer 3 Residuals After Flux Modification (White Springs = Cyan)

Mega Model No Phosphate Pumping Scenario

A simulation was setup to determine the impacts the phosphate mining groundwater withdrawals have on White Springs flow. The pumping in the cells representing the phosphate pumping (shown in Table 4) was set to zero. The reduced pumping, and therefore stress on the aquifer, would allow a rebound in the aquifer heads, and thus also impact the river baseflow and spring flows. The model results are shown in the following sub-sections.

Table 4. Phosphate Pumping Cell Locations

Row	Column	Original Pumping Rate (mgd)
43	31	2.44
44	36	16.8
44	31	17.3
46	35	2.47

Aquifer Head Changes

Aquifer head rebound is shown for layers 1 through 4 in Figures 5 through 9, respectively. As shown in the figures, there is a large rebound are surrounding the cells where the phosphate pumping was turned off. This area extends southward far enough to impact White Springs as well as the Suwannee River.

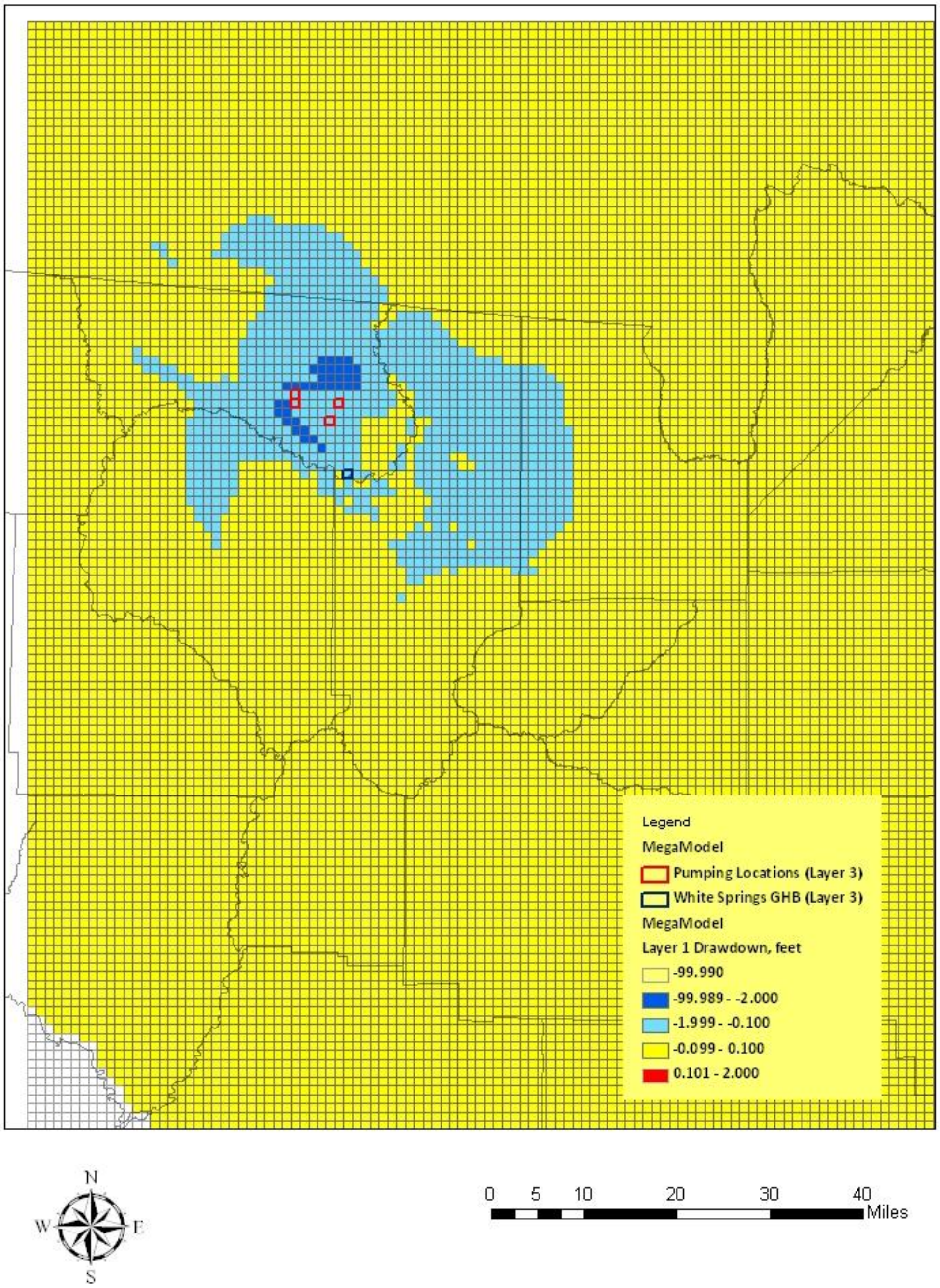

Figure 5. Layer 1 Drawdown

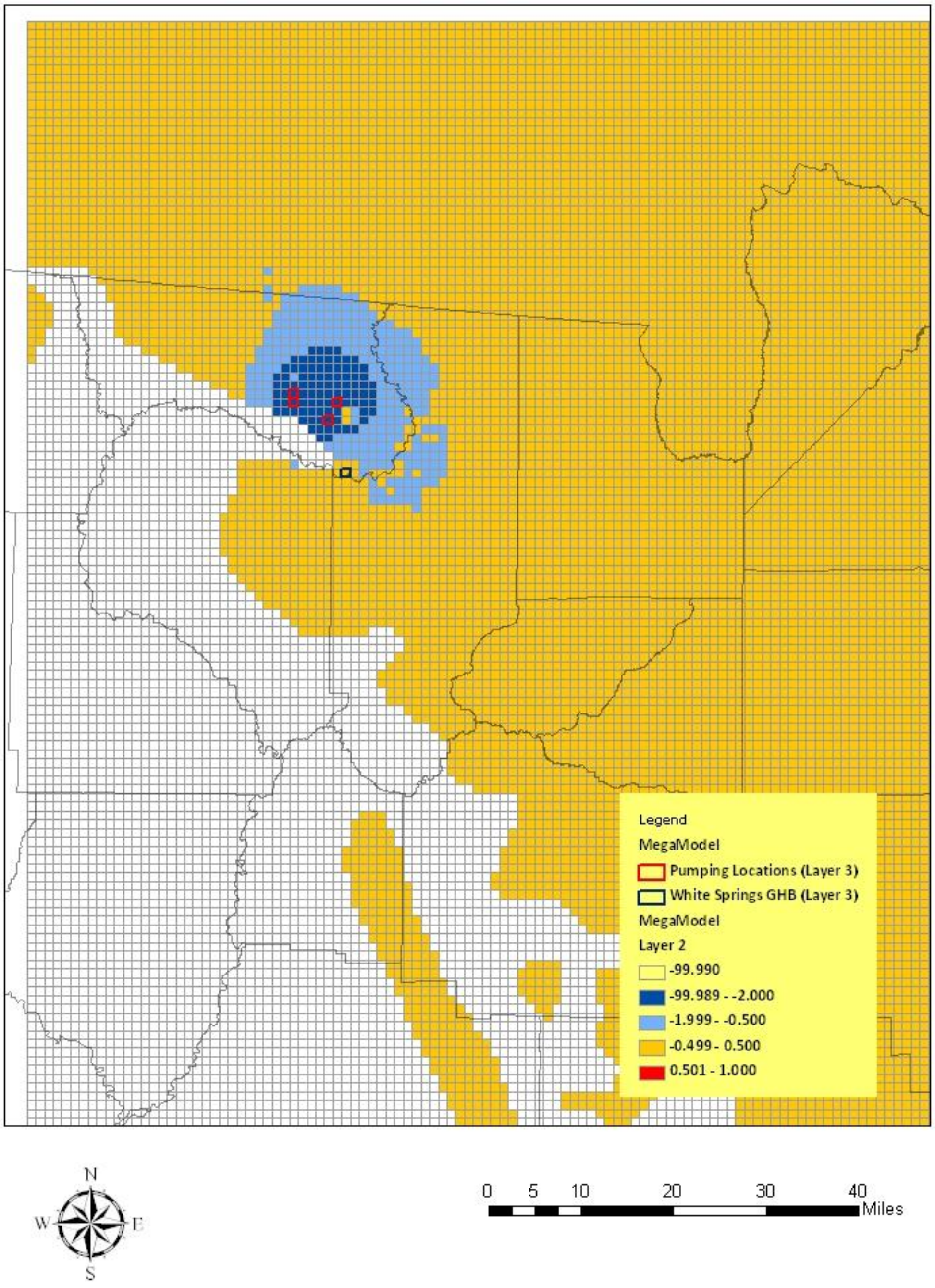

Figure 6. Layer 2 Drawdown

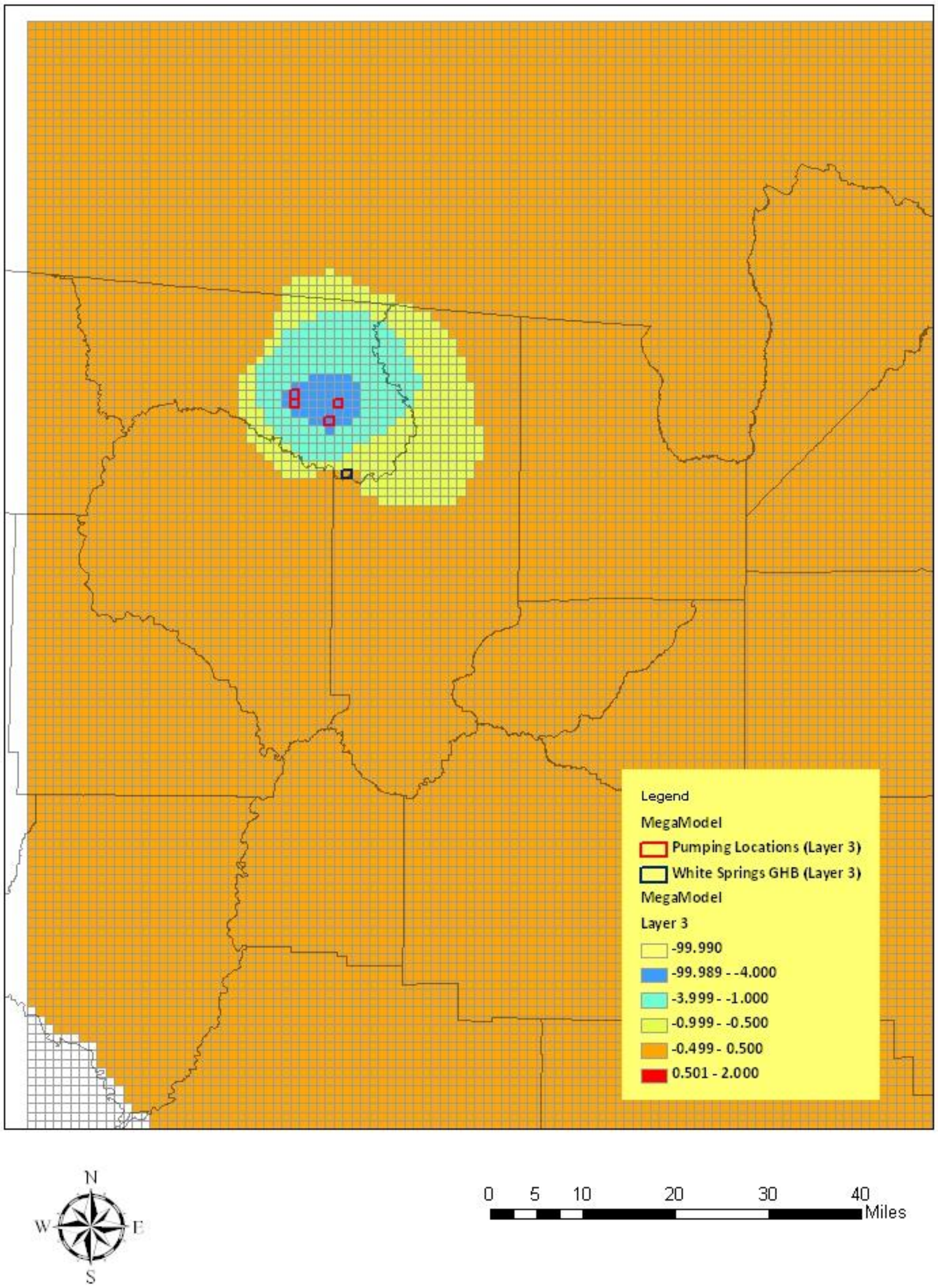

Figure 7. Layer 3 Drawdown

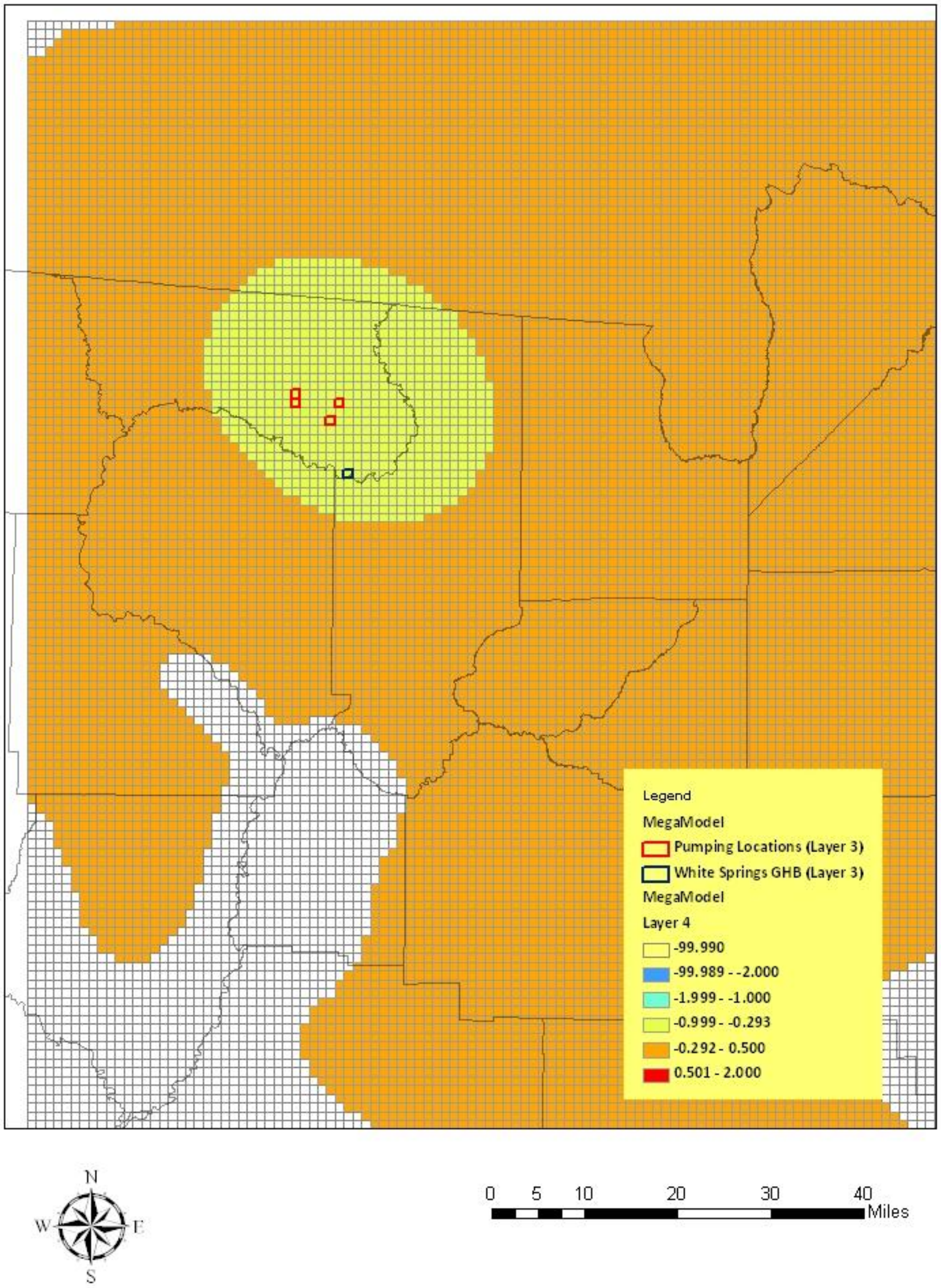

Figure 8. Layer 4 Drawdown

Baseflow

Impacts to baseflow are shown in Table 5. As shown in the table, many gauges were unaffected. The most visible impacts from the pumping changes appear in the Suwannee River, in particular the Suwannee River at Suwannee Springs (Reach 33), and Suwannee River at Ellaville (Reach 4). The remaining Suwannee River gauges (Reaches 18, 19, and 38) also experienced slight increases in baseflow when the phosphate pumping was turned off. In addition to baseflow changes in the Suwannee River, the Santa Fe River near High Springs gauge (Reach 14) also experienced a minimal increase in baseflow when the phosphate pumping was turned off.

Table 5. Baseflow Impacts

REACH ID	Station Name	Estimated Baseflow, cfs	Simulated Baseflow, cfs	Simulated Baseflow, No Phosphate Pumping, cfs	Flow Increase due to No Phosphate Pumping, cfs
4	SUWANNEE RIVER AT ELLAVILLE, FLA	1219.59	1081.73	1106.61	24.88
5	ALLIGATOR CREEK AT CALLAHAN, FL	0.49	3.46	3.46	0.00
6	THOMAS CREEK NEAR CRAWFORD, FL	3.68	7.32	7.33	0.01
7	STRAWBERRY CREEK NEAR ARLINGTON, FL	1.63	0.07	0.07	0.00
8	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	2.09	1.17	1.17	0.00
9	ORTEGA RIVER AT JACKSONVILLE, FL	2.72	6.90	6.91	0.01
11	NEW RIVER NR LAKE BUTLER FLA	5.57	18.75	18.79	0.04
12	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	7.04	52.04	52.06	0.02
13	PARENERS BRANCH NEAR BLAND, FL.	0.11	0.15	0.15	0.00
14	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	140.4	135.67	135.99	0.31
16	CANNON CREEK NEAR LAKE CITY, FL	0	-0.04	-0.04	0.00
17	DEEP CREEK NR SUWANNEE VALLEY FL	1.92	1.45	1.48	0.03
18	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	30.45	55.06	55.60	0.54
19	SUWANNEE R NR BENTON FLA	41.79	168.76	169.61	0.85
20	PABLO CREEK AT JACKSONVILLE, FL	9.53	5.27	5.27	0.00
21	BIG DAVIS CREEK AT BAYARD, FL	2	0.53	0.53	0.00
33	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	182.96	42.17	65.48	23.31
34	NORTH PRONG ST. MARYS	7.47	19.24	19.26	0.02

REACH ID	Station Name	Estimated Baseflow, cfs	Simulated Baseflow, cfs	Simulated Baseflow, No Phosphate Pumping, cfs	Flow Increase due to No Phosphate Pumping, cfs
	RIVER AT MONIAC, GA				
35	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	2.06	0.92	0.92	0.01
36	ST. MARYS RIVER NEAR MACCLENNY, FL	43.73	45.42	45.50	0.09
37	RICE CREEK NEAR SPRINGSIDE	3.27	6.55	6.56	0.00
38	SUWANNEE RIVER NEAR WILCOX, FLA.	553.6	709.36	710.30	0.94
39	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	29.02	40.33	40.42	0.09
44	SILVER RIVER NEAR OCALA, FL	607.96	638.80	638.85	0.05
45	OCKLAWAHA RIVER NEAR CONNER, FL	19.52	46.26	46.26	0.00
46	OCKLAWAHA RIVER AT EUREKA, FL	15.59	115.17	115.17	0.00
47	ORANGE LAKE OUTLET NEAR CITRA, FL	0	25.53	25.54	0.00
48	ORANGE CREEK AT ORANGE SPRINGS, FL	2.88	10.50	10.50	0.00
49	CEDAR RIVER AT MARIETTA, FL	1.9	3.97	3.97	0.00
51	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	21.54	12.51	12.55	0.04
52	SIMMS CREEK NEAR BARDIN, FL	8.87	6.20	6.20	0.01
55	MIDDLE HAW CREEK NR KORONA, FLA.	0.3	2.10	2.10	0.00
56	LITTLE HAW CREEK NEAR SEVILLE, FL	2.13	0.58	0.58	0.00
58	DEEP CREEK NEAR HASTINGS, FL	0.6	3.62	3.62	0.00
61	SANTA FE RIVER NEAR GRAHAM, FLA.	1.46	3.80	3.81	0.00
62	SPRUCE CREEK NEAR SAMSULA, FL	0.9	3.26	3.26	0.00
63	TOMOKA RIVER NEAR HOLLY HILL, FL	1.7	10.08	10.08	0.00

Spring Flow

Spring flow was impacted when the phosphate pumping was turned off. Essentially, the groundwater heads rose due to the reduced stress. The increases in groundwater heads increase the head gradient at the springs, thus changing the spring flows. White Springs was the most impacted. The sections above described the changes and calibration made to the White Springs flow. During the White Springs re-calibration, White Springs was calibrated to 6.8 cfs into, or recharging, the aquifer. Turning off the phosphate pumping allows the aquifer to rebound, which, in turn, caused a reversal of flow at White Springs. The final computed flow in White Springs without the phosphate pumping is 3.39 cfs out of the aquifer flowing into the river, as shown in Table 6 (in bold), for a total increase in flow of 10.19 cfs. As shown in the table, of all springs represented in the Mega Model, White Springs showed the largest impact due to phosphate pumping.

Table 6. Phosphate Pumping Spring Impacts

*Measured and estimated flows were obtained from Sepulveda except for White Sulphur Springs which was defined in Appendix 2

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
44019	Holton Spring near Fort Union	12.5	14.429	15.363	0.934
49014	Falmouth Spring at Falmouth	134	149.96	151.469	1.509
52037	**White Sulphur Springs at White Springs**	**-6.83***	**-6.8**	**3.39**	**10.19**
63008	Charles Springs near Dell	4.7	5.139	5.155	0.016
65103	Wadesboro Spring near Orange Park	1	1.025	1.032	0.007
67014	Peacock Springs	81.1	86.784	86.98	0.196
76023	Ruth Spring near Branford	7.5	19.961	20.022	0.061
77037	Ichetucknee Head Spring near Fort White and Cedar Head Spring	49	44.118	44.261	0.143
77106	Green Cove Springs at Green Cove Springs	3	2.969	2.98	0.011
81037	Jamison Spring	3	1.881	1.884	0.003
87048	Hornsby Spring near High Springs	49.8	54.175	54.305	0.13
89042	Blue Springs near High Springs (including Lilly Springs)	41.2	39.774	39.814	0.04
94135	Crescent Beach Submarine Spring	30	41.095	41.111	0.016
97026	Lumbercamp Springs and Sun Springs near Wannee	46.3	52.349	52.353	0.004
100025	Hart Springs near Wilcox	90.8	95.827	95.832	0.005
102025	Otter Springs near Wilcox	16	6.242	6.243	0.001
103107	Whitewater Springs	1.2	1.031	1.035	0.004
105025	Bell Springs	5.1	1.681	1.681	0

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
106026	Fannin Springs near Wilcox (including Little Fannin Spring)	97.7	88.871	88.872	0.001
111106	Satsuma Spring	1.1	0.888	0.888	0
112089	Orange Spring at Orange Springs	2	1.302	1.308	0.006
112094	Blue Springs near Orange Springs	0.5	0.433	0.433	0
113023	Manatee Spring near Chiefland	187	198.619	198.621	0.002
113088	Camp Seminole Spring at Orange Springs	0.8	0.24	0.244	0.004
114106	Welaka Spring near Welaka	1	0	0	0
116106	Mud Spring near Welaka	2.3	1.944	1.945	0.001
117107	Beecher Springs near Fruitland	6.3	6.152	6.152	0
118090	Tobacco Patch Landing Spring Group near Fort McCoy	1	0.824	0.824	0
118105	Croaker Hole Spring near Welaka	90.3	87.673	87.677	0.004
119090	Wells Landing Springs near Fort McCoy	5	3.861	3.862	0.001
124102	Salt Springs near Eureka	79	74.198	74.199	0.001
129043	Wekiva Springs near Gulf Hammock	45.4	45.241	45.244	0.003
132108	Silver Glen Springs near Astor	100	81.62	81.62	0
134081	Silver Springs near Ocala	640	638.55	638.599	0.049
134106	Sweetwater Springs along Juniper Creek	12.5	12.473	12.474	0.001
136103	Juniper Springs and Fern Hammock Springs near Ocala	18.8	6.918	6.918	0
136107	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	3	4.512	4.512	0
140125	Ponce de Leon Springs near De Land	24.3	22.09	22.09	0
142057	Rainbow Springs near Dunnellon	637	614.019	614.054	0.035
144112	Alexander Springs near	113	99.137	99.137	0

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
	Astor				
147121	Mosquito Springs Run Alexander Springs Wilderness	2	0.139	0.139	0
152070	Gum Springs near Holder	67.6	67.97	67.971	0.001
153114	Camp La No Che Springs near Paisley	1	0	0	0
153127	Blue Spring near Orange City	135	120.733	120.733	0
157046	Crystal River Spring Group	613.2	671.36	671.37	0.01
158117	Blackwater Springs near Cassia	1.4	0	0	0
159079	Little Jones Creek Head Spring near Wildwood	8	7.436	7.436	0
160079	Little Jones Creek Spring No. 2 near Wildwood	5	4.808	4.808	0
160117	Messant Spring near Sorrento	12	10.637	10.637	0
160129	Gemini Springs near DeBary (all 3)	10.5	9.349	9.349	0
160133	Green Springs	0.3	0.025	0.025	0
161080	Little Jones Creek Spring No. 3 near Wildwood	3	2.881	2.881	0
161115	Seminole Springs near Sorrento	37	9.513	9.513	0
161120	Palm Springs Seminole State Forest	0.5	0	0	0
162047	Halls River Head Spring	4.8	4.757	4.757	0
162116	Droty Springs near Sorrento	0.6	0	0	0
162122	Island Spring near Sanford	6.4	5.87	5.87	0
163046	Halls River Springs	102.2	103.488	103.488	0
164047	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	120.7	123.357	123.357	0
164082	Fenney Springs near Coleman Head Spring of Shady Brook Creek	15	11.974	11.974	0
165082	Shady Brook Creek Springs No. 2 and 3	5.8	5.79	5.79	0
166047	Hidden River Springs near	6.7	6.88	6.88	0

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
	Homosassa (including Hidden River Head Spring)				
166080	Shady Brook Creek Spring No. 4	2.9	2.891	2.891	0
166116	Sulphur Camp Springs	0.6	0.154	0.154	0
167079	Shady Brook Creek Spring No. 5	2.9	2.916	2.916	0
167091	Bugg Spring at Okahumpka	8.6	8.383	8.383	0
167116	Rock Springs near Apopka	53	50.327	50.328	0.001
168046	Potter Spring near Chassahowitzka (including Ruth Spring)	14.4	14.765	14.765	0
168095	Mooring Cove Springs near Yalaha	0.4	0	0	0
168096	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	6.6	4.026	4.026	0
169047	Salt Creek Head Spring	0.4	0.399	0.399	0
169048	Lettuce Creek Spring	3.7	3.768	3.768	0
169117	Witherington Spring near Apopka	1	0.875	0.875	0
170047	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	23.7	24.462	24.462	0
170048	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	99.6	100.599	100.599	0
171046	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.3	7.559	7.559	0
171047	Rita Maria Spring near Chassahowitzka	3.3	3.501	3.501	0
171119	Wekiwa Springs in State Park near Apopka	56.5	54.503	54.503	0
171120	Miami Springs near Longwood	4	3.778	3.778	0
171131	Lake Jesup Spring near Wagner	0.6	0.428	0.428	0
172045	Unnamed Spring No. 10-12; Ryle Creek Lower	27.3	29.949	29.949	0

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
	Spring; and Ryle Creek Head Spring near Bayport				
172046	Blue Run Head Spring near Chassahowitzka	4.6	4.66	4.66	0
172123	Palm Springs and Sanlando Springs near Longwood	22.6	21.776	21.776	0
172124	Starbuck Spring near Longwood	12.3	11.684	11.684	0
172133	Clifton Springs near Oviedo	1.5	1.575	1.575	0
173044	Unnamed Spring No. 8	4.9	5.532	5.532	0
173101	Double Run Road Seepage near Astatula	2	1.741	1.741	0
174044	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	42.7	31.578	31.578	0
181105	Apopka (Gourdneck) Spring near Oakland	31.4	17.505	17.505	0
182044	Unnamed Spring No. 6	2.8	4.669	4.669	0
182045	Salt Spring and Mud Spring near Bayport	39.3	19.633	19.633	0
184044	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	21.6	29.45	29.45	0
184048	Weeki Wachee Springs near Brooksville	129	71.893	71.893	0
188043	Unnamed Spring No. 2	0.7	1.35	1.35	0
190042	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	7.2	8.367	8.367	0
190043	Bobhill Springs	1.8	3.269	3.269	0
193040	Horseshoe Spring near Hudson	9.7	6.407	6.407	0
193041	Unnamed Spring No. 3 near Aripeka	17.8	17.798	17.798	0
200038	Salt Springs near Port Richey	8.2	10.618	10.618	0
220055	Sulphur Springs at Sulphur Springs	25	24.239	24.239	0
221061	Lettuce Lake Spring	8.3	7.639	7.639	0
221062	Six-Mile Creek Spring and Eureka Springs near Tampa	2.6	2.395	2.395	0
230064	Buckhorn Spring near	15	12.194	12.194	0

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
	Riverview				
232069	Lithia Springs Minor and Lithia Springs Major near Lithia	39.1	30.797	30.797	0
289068	Little Salt Spring near Murdock	0.9	0.874	0.874	0
290067	Warm Mineral Springs near Woodmere	6.7	6.558	6.558	0
41007	Blue Spring near Madison	118	102.005	103.474	1.469
44017	Alapaha Rise near Fort Union	427	412.945	423.646	10.701
47027	Suwannee Springs near Live Oak	9.8	7.202	9.256	2.054
48012	Suwanacoochee Spring and Ellaville Spring at Ellaville	112	113.04	113.963	0.923
64007	Allen Mill Pond Spring near Dell	12.2	12.325	12.348	0.023
66008	Blue Spring near Dell	70	61.852	61.991	0.139
68012	Telford Spring at Luraville	35.8	36.573	36.681	0.108
68015	Running Springs (East and West) near Luraville	88	100.174	100.505	0.331
69016	Convict Spring near Mayo	1.1	1.535	1.54	0.005
70017	Royal Spring near Alton	1.9	1.881	1.888	0.007
72019	Owens Spring	43.3	52.193	52.354	0.161
73020	Mearson Spring near Mayo	51	66.032	66.242	0.21
75022	Troy Spring near Branford	132	143.579	143.946	0.367
76024	Little River Springs near Branford	67	53.945	54.051	0.106
78037	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	258	250.766	251.356	0.59
79026	Branford Springs at Branford	35.8	36.669	36.713	0.044
87002	Steinhatchee Spring near Clara	0.7	1.184	1.184	0
87029	Turtle Spring near Hatchbend and Fletcher Spring	61.9	52.241	52.269	0.028
88041	Ginnie Spring near High	57.1	50.189	50.239	0.05

Gridid	Spring Name	Measured/ Estimated flow (Sepulveda*)	Pumping On: Calc. flow (Baseline)	Pumping Off Calc. flow	Flow Increase due to No Phosphate Pumping, cfs
	Springs				
89044	Poe Springs near High Springs	53.6	56.813	56.879	0.066
91027	Rock Bluff Springs near Bell	33.2	42.25	42.263	0.013
92026	Guaranto Spring near Rock Bluff Landing	12	2.94	2.94	0
104023	Copper Springs near Oldtown (including Little Copper Spring)	25.4	27.17	27.171	0.001
116040	Blue Spring near Bronson	8	8.121	8.123	0.002
151064	Wilson Head Spring near Holder	1.9	2.396	2.397	0.001
151065	Blue Spring near Holder	10.6	10.621	10.621	0
209072	Crystal Springs near Zephyrhills	37	31.927	31.927	0

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Scott, T. M., Means, G. H., Meegan, R. P., Means, R. C., Upchurch S. B., Copeland, R. E., Jones, J., Roberts, T., Willet, A., 2004 Springs of Florida: Florida Geological Survey Bulletin 31 Revised, 677 p.

Appendix IV: Predictive Sensitivity Analysis

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Introduction

A predictive sensitivity analysis was conducted in order to quantify the relationships between the input hydraulic properties and boundary conditions on the MegaModel output. The District desired a comprehensive sensitivity analysis to examine the sensitivity of the MegaModel to properties and boundary conditions that were modified in the current revision. The following parameters were the subject of the calibration and predictive sensitivity analysis:

- Hydraulic conductivity, layer 1
- River stage
- River Conductance
- Spring pool elevation
- Drain conductance

The above parameters were selected from a list of parameters provided by the District. These parameters were selected because they were either added to the MegaModel (i.e., river cell parameters) or modified in the MegaModel by INTERA. A sensitivity analysis for other model parameters was previously conducted by Sepulveda (2002). The current sensitivity analysis expanded on the previous study and examined the effect of model parameters on model fluxes (baseflow and spring flow), and heads. Since constraint of baseflow fluxes was added to the model by INTERA, assessing the sensitivity of these fluxes was imperative in order to have confidence in model calibration and gain a better understanding of model prediction.

Methodology

The predictive sensitivity analysis was conducted in accordance with ASTM D5611-94, *Standard Guide for Conducting a Sensitivity Analysis for a Ground-Water Flow Model Application*. The focus of the standard test method is on evaluating model statistics and model conclusions in order to classify the model as having a sensitivity of Type I through Type IV. The classification of sensitivity is based on a matrix of the model change in calibration and change in conclusions as shown in Figure 1.

The ultimate goal of this sensitivity analysis is to determine whether or not the presence of Type IV sensitivity potentially exists for the parameters examined. Type IV sensitivity occurs when changes are made to the model calibration (i.e. a parameter is perturbed) and the changes to model calibration are insignificant, but the conclusions of the model are significantly different. This results in a model that remains calibrated, yet produces a very different result. Generally, when models exhibit Type IV sensitivity, it is due to the fact that the model is poorly constrained in a particular area.

Unlike Type IV sensitivity, the remaining 3 sensitivity classifications are not of concern to the modeler. Type I sensitivity occurs when modifying an input to the model causes insignificant changes in the model calibration and also insignificant changes in the model conclusions. In other words, the model remains calibrated, and the conclusions do not significantly change. Since changes to the conclusions are not significant, this is not of concern. Type II and III sensitivity both occur when there are significant changes to the calibration of the model. In one case (Type II), these changes cause insignificant changes to the model conclusions, while in the other case (Type III), these changes cause significant changes to the model conclusions. Both cases are not of concern to the modeler; since the model does not remain calibrated, it is not utilized for prediction.

		Changes in Model Calibration	
		INSIGNIFICANT	SIGNIFICANT
Changes in Model Conclusions	INSIGNIFICANT	Type I	Type II
	SIGNIFICANT	Type IV	Type III

Figure 1. Sensitivity Type Summary (ASTM D5611)

For the purposes of this predictive sensitivity analysis, the model calibration statistics and the model conclusions were defined as follows:

- *Model Calibration Statistics:* Calibration statistics examined include head statistics over the entire domain (residual mean, residual standard deviation, residual sum of squares), baseflow fluxes, and spring fluxes. For each sensitivity simulation, these metrics from the 1993-1994 sensitivity simulation will be compared to the baseline 1993-1994 run in order to evaluate whether or not the model calibration is maintained. For the purposes of this sensitivity analysis, a calibrated model will be defined by the following statistics:

Table 1. Calibrated Model Statistics

Calibration Target	Residual Mean	Absolute Residual Mean
Head	± 1’	< 6’
Baseflow	± 10 cfs	< 30 cfs
Springflow	± 2 cfs	< 6 cfs

- *Model Conclusions:* The MegaModel is currently being utilized to establish a boundary condition for the western, eastern and southern boundaries of the Northeast Florida Model (NEF). The boundary of the NEF for future conditions will be represented with a shift in the GHB heads. The shift will be computed by the MegaModel. The drawdown of the Upper and Lower Floridan Aquifers in the 2030 MegaModel simulation will be imposed into the 2030 predictive simulation of the NEF. For this reason, model conclusions will be defined as the drawdown in the Upper and Lower Floridan aquifers in the cells used for NEF boundary modifications for each simulation. For each sensitivity simulation, drawdown will be calculated as the difference between the head in the 1993-1994 sensitivity simulation and the 2030 sensitivity simulation for both the Upper and Lower Floridan aquifers. This will allow for the assessment of predictive sensitivity.

For this analysis, baseline 1993-1994 and 2030 predictive simulations were run using the calibrated model. For each property listed above, four additional 1993-1994 simulations and four additional 2030 predictive simulations were run. The emphasis on the sensitivity analysis was to identify parameters which exhibit Type IV sensitivity as defined in ASTM D5611-94. Type IV sensitivity can be identified as a case when the variation of an input parameter results in insignificant changes in the model’s calibration but significant changes in the conclusion of the model. The results from each simulation were quantified using the following:

- 1993-1994 head residual statistics over the model domain,
- 1993-1994 spring fluxes,
- 1993-1994 baseflow fluxes, and
- Changes in head (drawdown) in the Upper and Lower Floridan Aquifers at the western, eastern and southern boundaries of the Northeast Florida Model (NEF).

Since the MegaModel drawdown at the boundary of the NEF is ultimately being utilized by the District as a boundary condition for the NEF model, the sensitivity of the MegaModel drawdown to the model's current calibration is imperative to assess. Drawdown profiles along the western, eastern, and southern NEF boundary were developed in order to illustrate the model predictive sensitivity. In addition to drawdown profiles, the drawdown statistics along the boundaries of the NEF were also calculated for the Upper and Lower Floridan Aquifers.

Table 2. Proposed Sensitivity Analysis Simulations

Parameter	Simulations (in addition to baseline)
Hydraulic Conductivity, Layer 1	Factors: 0.1, 0.5, 2, 10
River Stage	-2 feet, -1 foot, +1 foot, +2 feet
River Conductance	Factors: 0.1, 0.5, 2, 10
Spring Pool Elevation	-2 feet, -1 foot, +1 foot, +2 feet
Drain Conductance	Factors: 0.1, 0.5, 2, 10

It was desired by the District that no changes to the solver package be made over the course of the sensitivity analysis. Several of the modified models shown in Table 2 failed to converge with the original MegaModel solver package. If this occurred, the range for the sensitivity analysis was narrowed until the model was able to converge with the original solver package. This resulted to changes in the planned ranges of sensitivity analysis. The final sensitivity analysis factors and shifts are shown in Table 3.

Table 3. Final Sensitivity Analysis Simulations

Parameter	Simulations (in addition to baseline)
Hydraulic Conductivity, Layer 1	Factors: 0.1, 0.5, 2, 10
River Stage	-2 feet, -1 foot, +1 foot, +2 feet
River Conductance	Factors: 0.1, 0.5, 2, 10
Spring Pool Elevation	-2 feet, -1 foot, +1 foot, +2 feet
Drain Conductance	Factors: 0.9, 0.95, 1.05, 1.1

Completion of the above proposed sensitivity analysis resulted in 42 additional model simulations (21 simulations for 1993-1994 and 21 simulations for 2030).

Sensitivity Analysis Results: Model Calibration

An evaluation of the change in the model calibration is based on comparison of the head targets, baseflow flux targets, and springflow flux targets to values defined for a calibrated model, as shown in Table 1.

Drain Conductance

The drain package of the MegaModel contained 898 drains, representing springs and other hydrographic features, as shown in Figure 2. All of the drains were located on layer 3, which represents the Upper Floridan Aquifer.

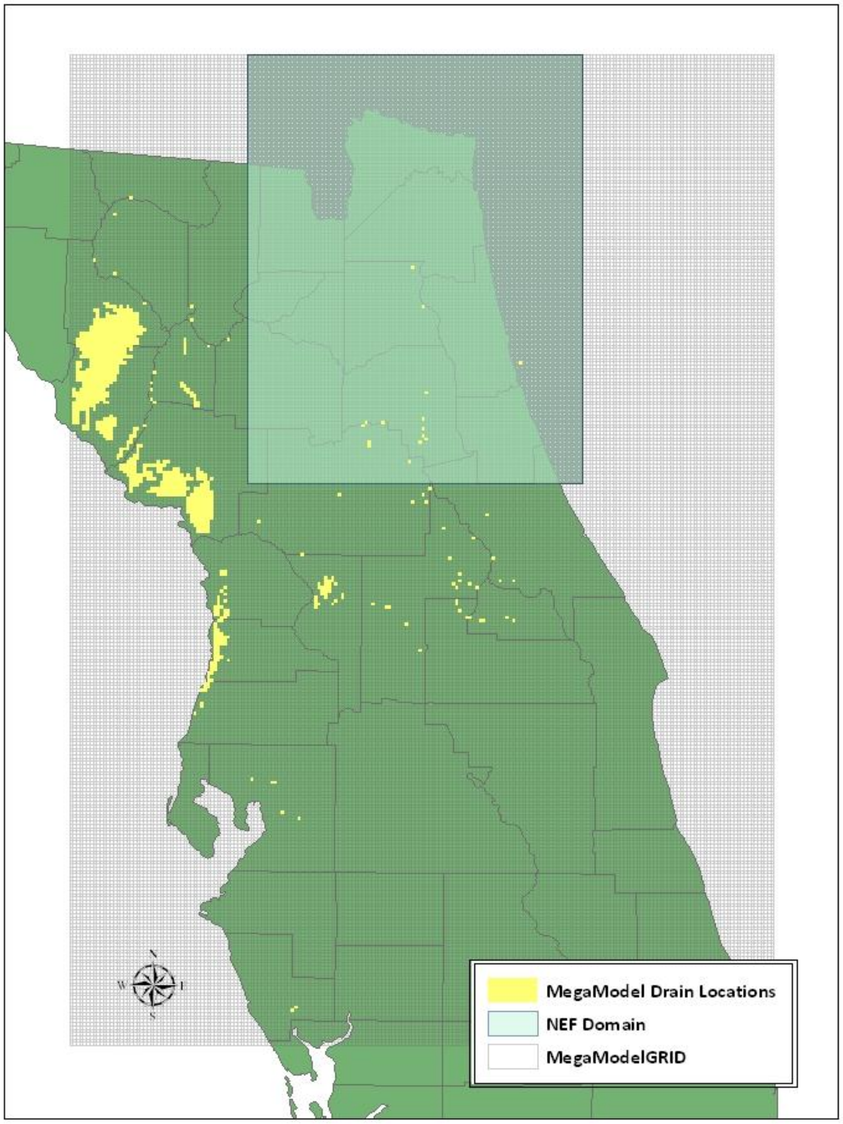


Figure 2. MegaModel Drain Locations

Aquifer Head Sensitivity

Residual head statistics for the drain conductance sensitivity analysis are shown in Table 4. As shown in the table, the head statistics remained within calibration and varied only slightly from the baseline run.

Table 4. Drain Conductance Sensitivity: Residual Statistics (feet)

	Times 0.9	Times 0.95	Baseline	Times 1.05	Times 1.1
Residual Mean	0.65	0.67	0.70	0.72	0.75
Res. Std. Dev.	8.14	8.14	8.14	8.14	8.14
Sum of Squares	67868.40	67870.31	67876.78	67885.08	67896.37
Abs. Res. Mean	5.12	5.12	5.11	5.11	5.11
Min. Residual	-46.92	-46.90	-46.89	-46.88	-46.86
Max. Residual	55.90	55.91	55.93	55.94	55.95
Range in Target Values	214.10	214.10	214.10	214.10	214.10
Std. Dev./Range	0.04	0.04	0.04	0.04	0.04

Baseflow Sensitivity

Residual baseflow statistics were calculated for the drain conductance simulations, as shown in Table 5. As shown in the table, the residual mean remained constant throughout all simulations, while the absolute residual mean and the sum of squares changed slightly. The baseflow statistics remained within calibration tolerance limits throughout all simulations. Baseflows for individual reaches are shown in Table 6 and Figure 3.

Table 5. Drain Conductance Sensitivity: Baseflow Statistics (cfs)

	0.90	0.95	1 (Baseline)	1.05	1.10
Residual Mean	-8.67	-8.67	-8.67	-8.67	-8.67
Absolute Residual Mean	24.72	24.64	24.57	24.49	24.43
Sum of Squares	91954.17	91726.01	91532.16	91357.00	91202.99

Table 6. Drain Conductance Sensitivity: Baseflow by Reach (cfs)

ReachID	Reach Name	0.9	0.95	1 (Baseline)	1.05	1.1	Target Baseflow
4	SUWANNEE RIVER AT ELLAVILLE, FLA	1084.45	1084.94	1085.38	1085.78	1086.15	1219.59
5	ALLIGATOR CREEK AT CALLAHAN, FL	3.46	3.46	3.46	3.46	3.46	0.49
6	THOMAS CREEK NEAR CRAWFORD, FL	7.32	7.32	7.32	7.32	7.32	3.68
7	STRAWBERRY CREEK NEAR ARLINGTON, FL	0.07	0.07	0.07	0.07	0.07	1.63
8	POTTSBURG CREEK NR SOUTH JACKSONVILLE, FLA.	1.17	1.17	1.17	1.17	1.17	2.09
9	ORTEGA RIVER AT JACKSONVILLE, FL	6.90	6.90	6.90	6.90	6.90	2.72
11	NEW RIVER NR LAKE BUTLER FLA	18.77	18.76	18.75	18.75	18.74	5.57
12	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.	52.06	52.05	52.04	52.03	52.02	7.04
13	PARENERS BRANCH NEAR BLAND, FL.	0.15	0.15	0.15	0.15	0.15	0.11
14	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.	133.63	134.69	135.71	136.70	137.62	140.40
16	CANNON CREEK NEAR LAKE CITY, FL	-0.04	-0.04	-0.04	-0.04	-0.04	0.00
17	DEEP CREEK NR SUWANNEE VALLEY FL	1.45	1.45	1.45	1.45	1.45	1.92
18	SUWANNEE RIVER AT WHITE SPRINGS, FLA.	55.07	55.06	55.06	55.05	55.05	30.45
19	SUWANNEE R NR BENTON FLA	168.77	168.76	168.76	168.75	168.75	41.79
20	PABLO CREEK AT JACKSONVILLE, FL	5.27	5.27	5.27	5.27	5.26	9.53
21	BIG DAVIS CREEK AT BAYARD, FL	0.53	0.53	0.53	0.53	0.53	2.00
33	SUWANNEE RIVER AT SUWANNEE SPRINGS FLA	50.99	50.93	50.86	50.80	50.74	182.96
34	NORTH PRONG ST. MARYS RIVER	19.24	19.24	19.24	19.24	19.23	7.47

ReachID	Reach Name	0.9	0.95	1 (Baseline)	1.05	1.1	Target Baseflow
35	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	0.92	0.92	0.92	0.92	0.91	2.06
36	ST. MARYS RIVER NEAR MACCLENNY, FL	45.43	45.42	45.42	45.41	45.40	43.73
37	RICE CREEK NEAR SPRINGSIDE	6.56	6.56	6.55	6.55	6.55	3.27
38	SUWANNEE RIVER NEAR WILCOX, FLA.	709.43	709.44	709.48	709.50	709.53	553.60
39	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	40.36	40.34	40.33	40.31	40.30	29.02
44	SILVER RIVER NEAR OCALA, FL	641.48	640.09	638.80	637.61	636.48	607.96
45	OCKLAWAHA RIVER NEAR CONNER, FL	46.30	46.28	46.26	46.24	46.22	19.52
46	OCKLAWAHA RIVER AT EUREKA, FL	115.24	115.20	115.17	115.14	115.11	15.59
47	ORANGE LAKE OUTLET NEAR CITRA, FL	25.55	25.54	25.53	25.52	25.51	0.00
48	ORANGE CREEK AT ORANGE SPRINGS, FL	10.54	10.52	10.50	10.47	10.46	2.88
49	CEDAR RIVER AT MARIETTA, FL	3.97	3.97	3.97	3.97	3.97	1.90
51	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	12.53	12.52	12.51	12.50	12.49	21.54
52	SIMMS CREEK NEAR BARDIN, FL	6.20	6.20	6.20	6.19	6.19	8.87
55	MIDDLE HAW CREEK NR KORONA, FLA.	2.11	2.10	2.10	2.10	2.09	0.30
56	LITTLE HAW CREEK NEAR SEVILLE, FL	0.58	0.58	0.58	0.58	0.58	2.13
58	DEEP CREEK NEAR HASTINGS, FL	3.62	3.62	3.62	3.62	3.62	0.60
61	SANTA FE RIVER NEAR GRAHAM, FLA.	3.81	3.81	3.80	3.80	3.80	1.46
62	SPRUCE CREEK NEAR SAMSULA, FL	3.26	3.26	3.26	3.26	3.26	0.90
63	TOMOKA RIVER NEAR HOLLY HILL,	10.08	10.08	10.08	10.07	10.07	1.70

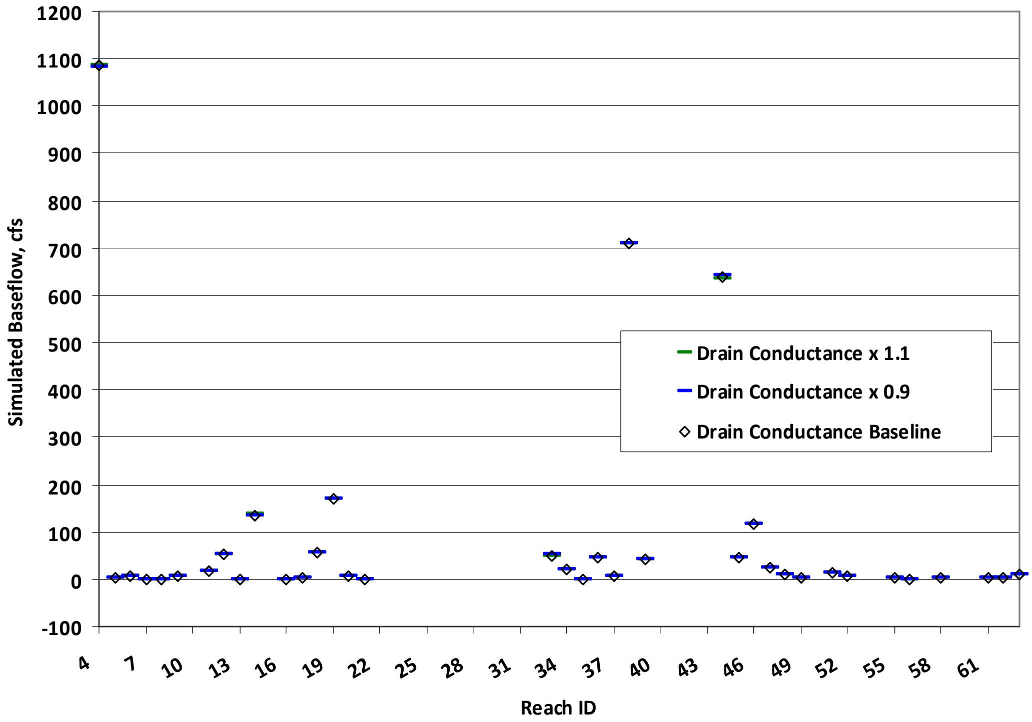


Figure 3. Changes in Baseflow Based on Modified Drain Conductance Arrays

Springflow Sensitivity

Residual springflow statistics were calculated for the drain conductance simulations, as shown in Table 7. As shown in the table, the residual mean decreased with increasing drain conductance arrays throughout all simulations, while the absolute residual mean and the sum of squares changed slightly. The springflow statistics remained within calibration tolerance limits throughout all simulations. Springflows for individual reaches are shown in Table 8 and Figure 4.

Table 7. Drain Conductance Sensitivity: Springflow Statistics (cfs)

	0.9	**0.95**	**1 (Baseline)**	**1.05**	**1.1**
Residual Mean	-1.34	-1.25	-1.17	-1.10	-1.03
Absolute Residual Mean	4.81	4.68	4.61	4.59	4.61
Sum of Squares	14224.27	13202.99	12413.75	11823.64	11406.58

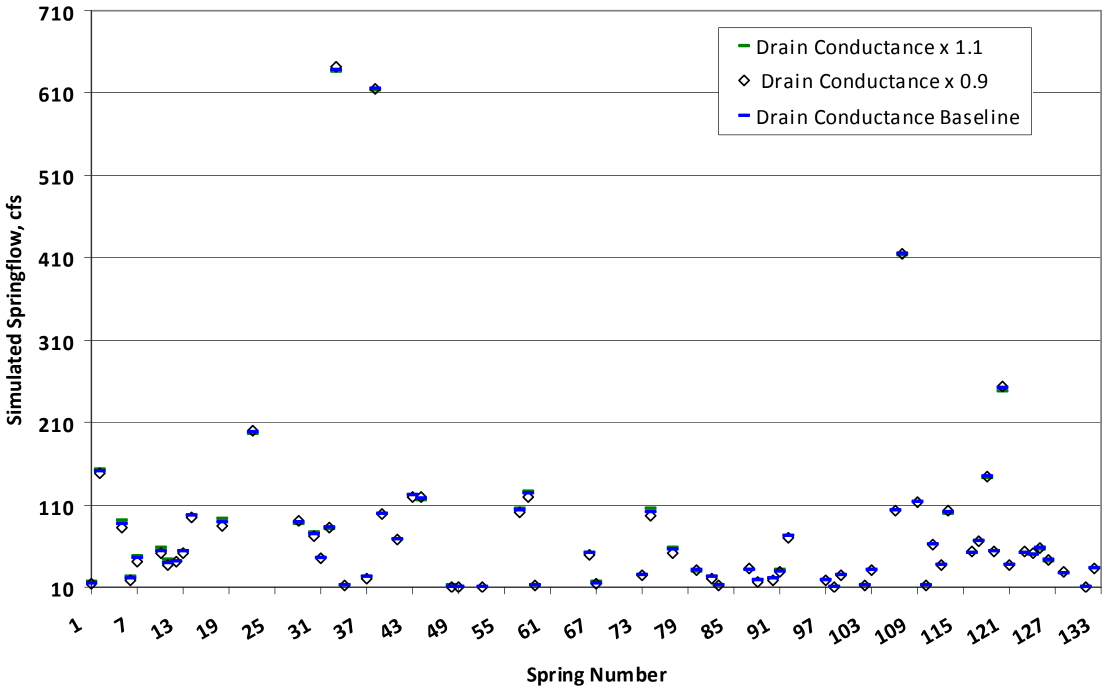


Figure 4. Springflow Variability with Drain Conductance

Table 8. Drain Conductance Sensitivity: Springflow (cfs)

Spring Number	Spring Name	Drain Conductance Factor				
		0.9	**0.95**	**1 (Baseline)**	**1.05**	**1.1**
1	Holton Spring near Fort Union	13.45	14.01	14.57	15.10	15.63
2	Falmouth Spring at Falmouth	148.65	149.46	150.19	150.85	151.45
3	White Sulphur Springs at White Springs	-5.17	-5.26	-5.34	-5.43	-5.51
4	Charles Springs near Dell	4.70	4.92	5.14	5.36	5.57
5	Peacock Springs	82.80	84.86	86.81	88.66	90.40
6	Ruth Spring near Branford	18.44	19.21	19.97	20.71	21.43
7	Ichetucknee Head Spring near Fort White and Cedar Head Spring	40.36	42.26	44.14	45.98	47.80
8	Green Cove Springs at Green Cove Springs	2.82	2.90	2.97	3.04	3.11
9	Jamison Spring	1.71	1.79	1.88	1.97	2.06
10	Hornsby Spring near High Springs	50.63	52.45	54.19	55.89	57.49
11	Blue Springs near High Springs (including Lilly Springs)	36.41	38.11	39.78	41.43	43.05
12	Crescent Beach Submarine Spring	41.05	41.08	41.10	41.12	41.13
13	Lumbercamp Springs and Sun Springs near Wannee	50.28	51.35	52.35	53.31	54.21
14	Hart Springs near Wilcox	94.33	95.12	95.83	96.42	96.93
15	Otter Springs near Wilcox	5.89	6.07	6.24	6.41	6.58

Spring Number	Spring Name	Drain Conductance Factor				
		0.9	0.95	1 (Baseline)	1.05	1.1
16	Whitewater Springs	0.97	1.00	1.03	1.06	1.09
17	Bell Springs	1.58	1.63	1.68	1.73	1.77
18	Fannin Springs near Wilcox (including Little Fannin Spring)	84.50	86.76	88.87	90.92	92.87
19	Satsuma Spring	0.83	0.86	0.89	0.91	0.94
20	Orange Spring at Orange Springs	1.31	1.30	1.30	1.30	1.30
21	Blue Springs near Orange Springs	0.40	0.42	0.43	0.45	0.46
22	Manatee Spring near Chiefland	200.93	199.74	198.62	197.56	196.55
23	Camp Seminole Spring at Orange Springs	0.27	0.26	0.24	0.23	0.21
24	Welaka Spring near Welaka	0.00	0.00	0.00	0.00	0.00
25	Mud Spring near Welaka	1.88	1.92	1.94	1.97	1.99
26	Beecher Springs near Fruitland	5.60	5.87	6.15	6.43	6.70
27	Tobacco Patch Landing Spring Group near Fort McCoy	0.77	0.80	0.82	0.85	0.87
28	Croaker Hole Spring near Welaka	89.66	88.64	87.67	86.75	85.88
29	Wells Landing Springs near Fort McCoy	4.00	3.93	3.86	3.80	3.74
30	Salt Springs near Eureka	71.54	72.92	74.20	75.40	76.52
31	Wekiva Springs near Gulf Hammock	44.31	44.80	45.24	45.65	46.02
32	Silver Glen Springs near Astor	82.33	81.96	81.62	81.30	81.00
33	Silver Springs near Ocala	641.24	639.85	638.55	637.37	636.23
34	Sweetwater Springs along Juniper Creek	12.23	12.36	12.47	12.58	12.68
35	Juniper Springs and Fern Hammock Springs near Ocala	6.98	6.95	6.92	6.89	6.86
36	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.53	4.52	4.51	4.50	4.49
37	Ponce de Leon Springs near De Land	21.21	21.67	22.09	22.49	22.85
38	Rainbow Springs near Dunnellon	614.61	614.32	614.02	613.74	613.45
39	Alexander Springs near Astor	99.01	99.08	99.14	99.19	99.22
40	Mosquito Springs Run Alexander Springs Wilderness	0.42	0.28	0.14	0.01	0.00
41	Gum Springs near Holder	67.29	67.65	67.97	68.26	68.53
42	Camp La No Che Springs near Paisley	0.00	0.00	0.00	0.00	0.00
43	Blue Spring near Orange City	120.24	120.50	120.73	120.93	121.08
44	Crystal River Spring Group	683.49	677.22	671.36	665.95	660.88
45	Blackwater Springs near Cassia	0.00	0.00	0.00	0.00	0.00
46	Little Jones Creek Head Spring near Wildwood	7.10	7.27	7.44	7.59	7.74
47	Little Jones Creek Spring No. 2 near Wildwood	4.64	4.73	4.81	4.88	4.95
48	Messant Spring near Sorrento	9.94	10.29	10.64	10.97	11.29
49	Gemini Springs near DeBary (all 3)	8.97	9.17	9.35	9.52	9.68
50	Green Springs	0.05	0.04	0.02	0.01	0.00
51	Little Jones Creek Spring No. 3 near Wildwood	2.74	2.81	2.88	2.94	3.00
52	Seminole Springs near Sorrento	10.35	9.92	9.51	9.12	8.70
53	Palm Springs Seminole State Forest	0.00	0.00	0.00	0.00	0.00
54	Halls River Head Spring	4.50	4.63	4.76	4.88	5.00
55	Droty Springs near Sorrento	0.00	0.00	0.00	0.00	0.00
56	Island Spring near Sanford	5.55	5.71	5.87	6.02	6.16
57	Halls River Springs	101.69	102.64	103.49	104.24	104.90

Spring Number	Spring Name	Drain Conductance Factor				
		0.9	0.95	1 (Baseline)	1.05	1.1
58	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	119.75	121.62	123.36	124.97	126.48
59	Fenney Springs near Coleman Head Spring of Shady Brook Creek	12.50	12.23	11.97	11.73	11.49
60	Shady Brook Creek Springs No. 2 and 3	5.35	5.57	5.79	6.00	6.21
61	Hidden River Springs near Homosassa (including Hidden River Head Spring)	6.60	6.74	6.88	7.01	7.14
62	Shady Brook Creek Spring No. 4	2.69	2.79	2.89	2.99	3.08
63	Sulphur Camp Springs	0.60	0.38	0.15	0.00	0.00
64	Shady Brook Creek Spring No. 5	2.73	2.82	2.92	3.00	3.09
65	Bugg Spring at Okahumpka	7.92	8.16	8.38	8.60	8.80
66	Rock Springs near Apopka	48.67	49.53	50.33	51.04	51.61
67	Potter Spring near Chassahowitzka (including Ruth Spring)	14.09	14.44	14.76	15.08	15.39
68	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
69	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	4.22	4.12	4.03	3.94	3.85
70	Salt Creek Head Spring	0.38	0.39	0.40	0.41	0.42
71	Lettuce Creek Spring	3.65	3.71	3.77	3.82	3.87
72	Witherington Spring near Apopka	0.88	0.88	0.88	0.87	0.86
73	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	23.50	23.99	24.46	24.91	25.33
74	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	96.65	98.68	100.60	102.41	104.14
75	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.36	7.46	7.56	7.65	7.73
76	Rita Maria Spring near Chassahowitzka	3.40	3.45	3.50	3.55	3.59
77	Wekiwa Springs in State Park near Apopka	51.94	53.26	54.50	55.68	56.79
78	Miami Springs near Longwood	3.54	3.66	3.78	3.89	4.00
79	Lake Jesup Spring near Wagner	0.44	0.43	0.43	0.42	0.41
80	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	30.67	30.31	29.95	29.59	29.22
81	Blue Run Head Spring near Chassahowitzka	4.47	4.57	4.66	4.75	4.84
82	Palm Springs and Sanlando Springs near Longwood	20.91	21.36	21.78	22.17	22.53
83	Starbuck Spring near Longwood	11.05	11.37	11.68	11.98	12.27
84	Clifton Springs near Oviedo	1.68	1.62	1.58	1.53	1.48
85	Unnamed Spring No. 8	5.64	5.59	5.53	5.48	5.42
86	Double Run Road Seepage near Astatula	1.67	1.71	1.74	1.77	1.80
87	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	33.16	32.34	31.58	30.88	30.23
88	Apopka (Gourdneck) Spring near Oakland	16.55	17.03	17.50	17.95	18.37
89	Unnamed Spring No. 6	4.51	4.59	4.67	4.74	4.82
90	Salt Spring and Mud Spring near Bayport	18.89	19.27	19.63	19.98	20.31
91	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	29.08	29.27	29.45	29.60	29.74
92	Weeki Wachee Springs near Brooksville	70.59	71.29	71.89	72.47	72.97
93	Unnamed Spring No. 2	1.38	1.37	1.35	1.33	1.31

Spring Number	Spring Name	Drain Conductance Factor				
		0.9	0.95	1 (Baseline)	1.05	1.1
94	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	7.96	8.17	8.37	8.56	8.75
95	Bobhill Springs	3.37	3.32	3.27	3.21	3.15
96	Horseshoe Spring near Hudson	6.50	6.45	6.41	6.37	6.33
97	Unnamed Spring No. 3 near Aripeka	18.42	18.10	17.80	17.52	17.26
98	Salt Springs near Port Richey	10.72	10.67	10.62	10.57	10.52
99	Sulphur Springs at Sulphur Springs	23.47	23.87	24.24	24.58	24.90
100	Lettuce Lake Spring	7.19	7.42	7.64	7.85	8.06
101	Six-Mile Creek Spring and Eureka Springs near Tampa	2.22	2.31	2.39	2.48	2.56
102	Buckhorn Spring near Riverview	12.23	12.21	12.19	12.18	12.16
103	Lithia Springs Minor and Lithia Springs Major near Lithia	30.82	30.81	30.80	30.79	30.78
104	Little Salt Spring near Murdock	0.81	0.84	0.87	0.91	0.94
105	Warm Mineral Springs near Woodmere	5.97	6.26	6.56	6.85	7.14
106	Blue Spring near Madison	102.33	102.27	102.22	102.17	102.12
107	Alapaha Rise near Fort Union	415.58	415.03	414.51	414.01	413.53
108	Suwannee Springs near Live Oak	7.54	7.53	7.52	7.50	7.50
109	Suwanacoochee Spring and Ellaville Spring at Ellaville	114.01	113.57	113.18	112.81	112.48
110	Allen Mill Pond Spring near Dell	12.40	12.37	12.33	12.29	12.26
111	Blue Spring near Dell	62.30	62.08	61.87	61.67	61.48
112	Telford Spring at Luraville	37.32	36.94	36.59	36.25	35.93
113	Running Springs (East and West) near Luraville	102.08	101.13	100.22	99.37	98.55
114	Convict Spring near Mayo	1.55	1.54	1.54	1.53	1.52
115	Royal Spring near Alton	1.90	1.89	1.88	1.88	1.87
116	Owens Spring	52.44	52.33	52.22	52.11	52.01
117	Mearson Spring near Mayo	66.37	66.21	66.06	65.92	65.78
118	Troy Spring near Branford	144.73	144.17	143.63	143.11	142.60
119	Little River Springs near Branford	54.39	54.17	53.96	53.76	53.56
120	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	253.32	252.07	250.85	249.65	248.48
121	Branford Springs at Branford	36.89	36.78	36.68	36.58	36.48
122	Steinhatchee Spring near Clara	1.21	1.20	1.18	1.17	1.16
123	Turtle Spring near Hatchbend and Fletcher Spring	52.62	52.42	52.24	52.07	51.91
124	Ginnie Spring near High Springs	50.80	50.50	50.20	49.90	49.62
125	Poe Springs near High Springs	57.62	57.21	56.82	56.44	56.07
126	Rock Bluff Springs near Bell	42.93	42.58	42.25	41.95	41.66
127	Guaranto Spring near Rock Bluff Landing	3.00	2.97	2.94	2.91	2.89
128	Copper Springs near Oldtown (including Little Copper Spring)	28.83	27.97	27.17	26.42	25.72
129	Blue Spring near Bronson	8.18	8.15	8.12	8.10	8.07
130	Wilson Head Spring near Holder	2.44	2.42	2.40	2.38	2.36
131	Blue Spring near Holder	10.69	10.65	10.62	10.59	10.56
132	Crystal Springs near Zephyrhills	31.93	31.93	31.93	31.93	31.93

Hydraulic Conductivity Layer 1

The hydraulic conductivity array of layer 1 was modified in order to examine the effect of changing the hydraulic conductivity on model calibration, resulting in four additional model simulations from the baseline simulation.

Aquifer Head Sensitivity

Residual head statistics for the hydraulic conductivity sensitivity analysis are shown in Table 9. The original hydraulic conductivity array was multiplied by the factors shown in the table. As shown in the table, the head statistics remained within calibration for the simulations where hydraulic conductivity was decreased. For the simulations involving multiplying the hydraulic conductivity array by 2 and 10, the model did not remain calibrated.

Table 9. Hydraulic Conductivity Sensitivity: Residual Statistics (feet)

	Times 0.1	**Times 0.5**	**Baseline**	**Times 2**	**Times 10**
Residual Mean	-0.12	0.01	0.70	1.71	4.97
Res. Std. Dev.	17.98	8.49	8.14	8.75	11.75
Sum of Squares	328654.61	73358.64	67876.78	80913.46	165490.14
Abs. Res. Mean	8.16	5.31	5.11	5.61	8.14
Min. Residual	-225.85	-41.60	-46.89	-56.66	-52.08
Max. Residual	108.84	55.62	55.93	60.60	82.34
Range in Target Values	214.10	214.10	214.10	214.10	214.10
Std. Dev./Range	0.08	0.04	0.04	0.04	0.05

Baseflow Sensitivity

Residual baseflow statistics were calculated for the hydraulic conductivity simulations, as shown in Table 10. As shown in the table, the both the residual mean and the absolute residual mean remained within calibration tolerances for these simulations. Baseflows for individual reaches are shown in Table 11 and Figure 5. Please refer to Table 6 for individual reach names.

Table 10. Hydraulic Conductivity Sensitivity: Baseflow Statistics (cfs)

	0.1	**0.5**	**1 (Baseline)**	**2**	**10**
Residual Mean	-9.22	-8.73	-8.67	-8.39	-6.98
Absolute Residual Mean	23.98	24.34	24.57	24.65	27.56
Sum of Squares	82617.09	88484.75	91532.16	95412.69	111159.52

Table 11. Hydraulic Conductivity Sensitivity: Baseflow by Reach (cfs)

	Hydraulic Conductivity Factor					
ReachID	0.1	0.5	1 (Baseline)	2	10	Target Baseflow
4	1098.09	1090.27	1085.38	1077.06	1055.14	1219.59
5	5.98	4.60	3.46	2.02	1.58	0.49
6	3.88	6.32	7.32	7.83	7.76	3.68
7	0.22	0.19	0.07	-0.07	-0.07	1.63
8	1.36	1.25	1.17	0.96	-0.08	2.09
9	6.11	6.60	6.90	6.32	1.22	2.72
11	16.94	17.21	18.75	19.44	16.35	5.57
12	53.45	52.46	52.04	52.87	50.84	7.04
13	0.66	0.37	0.15	0.04	-0.08	0.11
14	135.65	135.79	135.71	135.76	134.26	140.40
16	0.20	-0.04	-0.04	-0.04	-0.04	0.00
17	1.12	1.37	1.45	1.58	1.35	1.92
18	55.44	55.46	55.06	57.35	67.02	30.45
19	150.17	162.40	168.76	173.50	185.55	41.79
20	7.19	6.07	5.27	3.87	0.18	9.53
21	0.50	0.49	0.53	0.52	0.43	2.00
33	50.65	50.98	50.86	51.21	54.92	182.96
34	19.37	20.78	19.24	13.81	-0.70	7.47
35	0.15	0.66	0.92	1.03	0.26	2.06
36	47.55	43.35	45.42	47.24	55.07	43.73
37	6.00	6.25	6.55	7.02	8.25	3.27
38	705.44	709.70	709.48	708.07	705.88	553.60
39	43.13	40.66	40.33	40.40	36.04	29.02
44	662.62	651.86	638.80	620.10	559.08	607.96
45	40.04	43.35	46.26	50.05	61.77	19.52
46	104.24	109.64	115.17	121.53	137.46	15.59
47	24.04	24.96	25.53	26.45	27.60	0.00
48	10.51	10.47	10.50	11.58	15.58	2.88
49	4.54	3.80	3.97	4.26	5.32	1.90
51	34.94	12.71	12.51	15.60	20.07	21.54
52	4.63	6.04	6.20	5.93	5.53	8.87
55	2.03	2.07	2.10	2.15	2.27	0.30
56	0.54	0.56	0.58	0.61	0.75	2.13
58	3.36	3.59	3.62	3.52	2.60	0.60
61	3.92	4.23	3.80	3.64	2.24	1.46
62	3.19	3.22	3.26	3.31	3.25	0.90
63	9.74	9.92	10.08	10.28	10.15	1.70

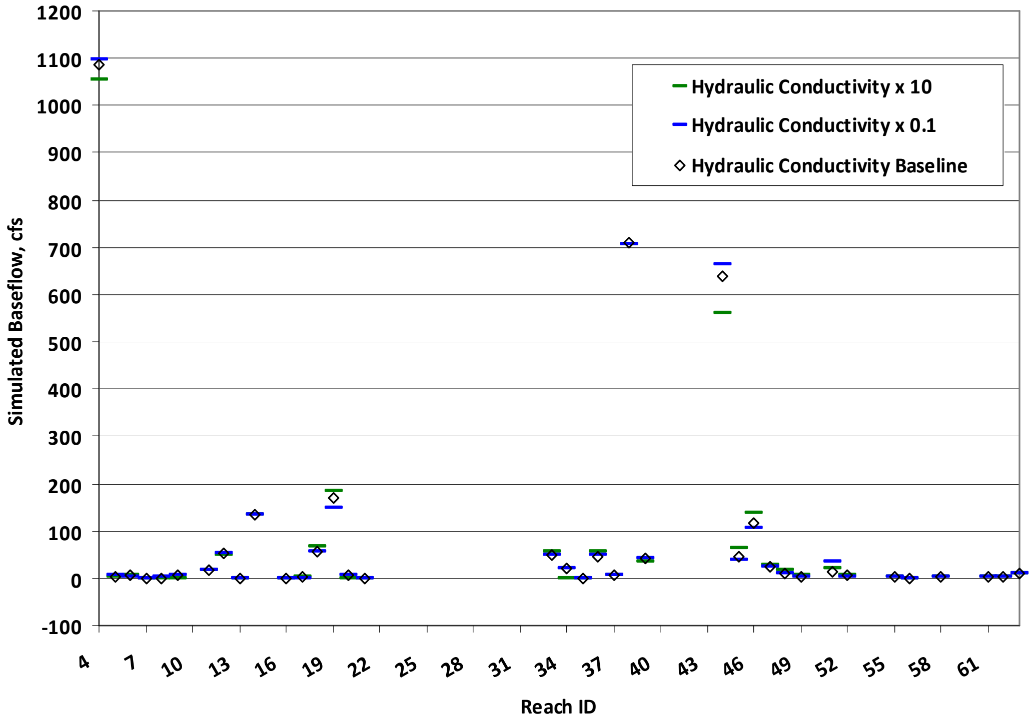


Figure 5. Changes in Baseflow Based on Modified Hydraulic Conductivity Arrays

Springflow Sensitivity

Residual springflow statistics were calculated for the hydraulic conductivity simulations, as shown in Table 12. As shown in the table, the residual mean decreased with decreasing hydraulic conductivity arrays throughout all simulations. The springflow statistics remained within calibration tolerance limits throughout all simulations with the exception of the simulation with a factor of 10. Springflows for individual reaches are shown in Table 13 and Figure 6.

Table 12. Hydraulic Conductivity Sensitivity: Springflow Statistics (cfs)

	0.1	0.5	1 (Baseline)	2	10
Residual Mean	-0.77	-0.82	-1.17	-1.68	-3.09
Absolute Residual Mean	4.82	4.66	4.61	4.99	6.09
Sum of Squares	12857.41	12365.56	12413.75	13422.36	22916.70

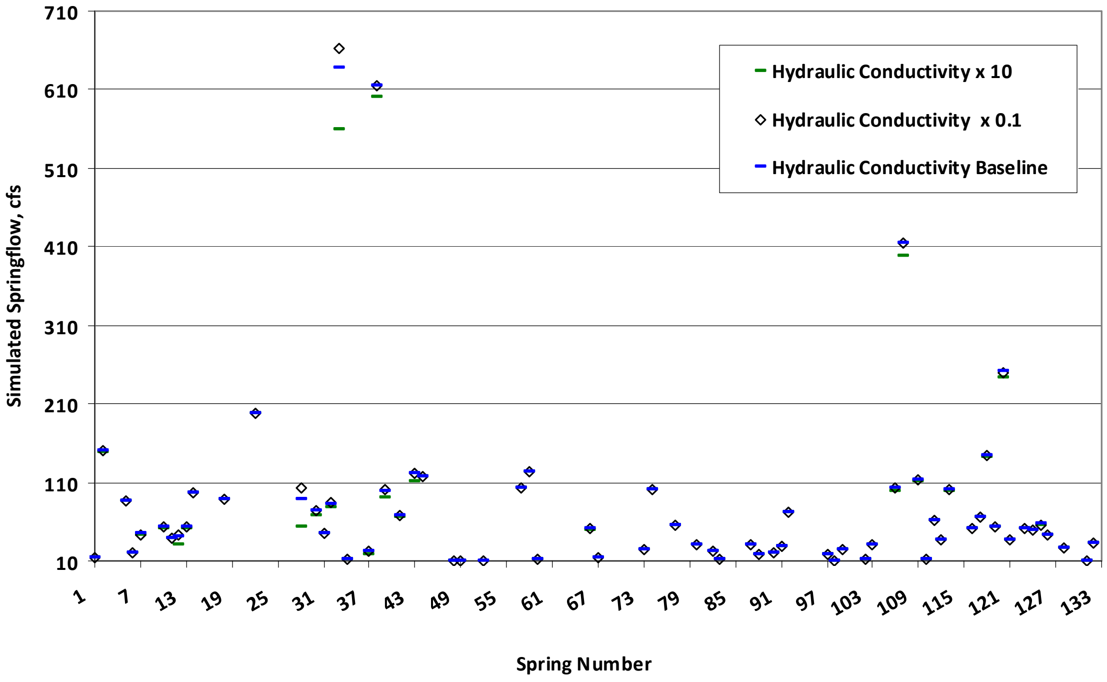


Figure 6. Springflow Variability with Hydraulic Conductivity

Table 13. Hydraulic Conductivity Sensitivity: Springflow (cfs)

Spring Number	Spring Name	Hydraulic Conductivity Factor				
		0.1	0.5	1 (Baseline)	2	10
1	Holton Spring near Fort Union	14.56	14.73	14.57	14.29	13.25
2	Falmouth Spring at Falmouth	150.09	150.40	150.19	149.76	148.18
3	White Sulphur Springs at White Springs	-7.84	-4.61	-5.34	-8.30	-17.96
4	Charles Springs near Dell	5.14	5.15	5.14	5.13	5.10
5	Peacock Springs	86.74	86.87	86.81	86.69	86.23
6	Ruth Spring near Branford	19.91	20.00	19.97	19.90	19.67
7	Ichetucknee Head Spring near Fort White and Cedar Head Spring	43.71	44.30	44.14	43.71	42.45
8	Green Cove Springs at Green Cove Springs	1.70	3.08	2.97	2.51	1.09
9	Jamison Spring	1.87	1.89	1.88	1.87	1.84
10	Hornsby Spring near High Springs	52.50	54.37	54.19	53.19	50.54
11	Blue Springs near High Springs (including Lilly Springs)	39.32	39.82	39.78	39.50	38.74
12	Crescent Beach Submarine Spring	43.40	42.93	41.10	38.68	31.31
13	Lumbercamp Springs and Sun Springs near Wannee	52.34	52.35	52.35	52.34	52.30
14	Hart Springs near Wilcox	95.81	95.83	95.83	95.81	95.77
15	Otter Springs near Wilcox	6.24	6.24	6.24	6.24	6.24
16	Whitewater Springs	2.39	1.92	1.03	0.00	0.00
17	Bell Springs	1.68	1.68	1.68	1.68	1.68

Spring Number	Spring Name	Hydraulic Conductivity Factor				
		0.1	0.5	1 (Baseline)	2	10
18	Fannin Springs near Wilcox (including Little Fannin Spring)	88.86	88.87	88.87	88.86	88.84
19	Satsuma Spring	2.81	1.80	0.89	0.00	0.00
20	Orange Spring at Orange Springs	2.11	2.54	1.30	0.00	0.00
21	Blue Springs near Orange Springs	0.64	0.55	0.43	0.29	0.00
22	Manatee Spring near Chiefland	198.58	198.62	198.62	198.59	198.53
23	Camp Seminole Spring at Orange Springs	1.26	1.15	0.24	0.00	0.00
24	Welaka Spring near Welaka	0.64	0.31	0.00	0.00	0.00
25	Mud Spring near Welaka	2.94	2.65	1.94	1.03	0.00
26	Beecher Springs near Fruitland	6.57	6.38	6.15	5.86	5.16
27	Tobacco Patch Landing Spring Group near Fort McCoy	1.43	1.17	0.82	0.47	0.00
28	Croaker Hole Spring near Welaka	102.99	96.45	87.67	77.14	54.19
29	Wells Landing Springs near Fort McCoy	7.44	5.63	3.86	2.10	0.00
30	Salt Springs near Eureka	74.14	76.18	74.20	71.91	67.38
31	Wekiva Springs near Gulf Hammock	45.24	45.29	45.24	45.12	44.73
32	Silver Glen Springs near Astor	83.67	82.94	81.62	80.11	77.47
33	Silver Springs near Ocala	662.37	651.61	638.55	619.85	558.84
34	Sweetwater Springs along Juniper Creek	12.87	12.72	12.47	12.19	11.59
35	Juniper Springs and Fern Hammock Springs near Ocala	7.03	7.07	6.92	6.65	5.46
36	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.57	4.64	4.51	4.32	3.70
37	Ponce de Leon Springs near De Land	22.97	22.59	22.09	21.30	18.54
38	Rainbow Springs near Dunnellon	615.63	615.56	614.02	611.06	601.55
39	Alexander Springs near Astor	101.85	100.46	99.14	97.21	91.20
40	Mosquito Springs Run Alexander Springs Wilderness	0.80	0.58	0.14	0.00	0.00
41	Gum Springs near Holder	68.73	68.38	67.97	67.39	65.48
42	Camp La No Che Springs near Paisley	0.00	0.00	0.00	0.00	0.00
43	Blue Spring near Orange City	122.51	121.65	120.73	119.11	111.60
44	Crystal River Spring Group	671.42	671.39	671.36	671.32	671.15
45	Blackwater Springs near Cassia	0.00	0.00	0.00	0.00	0.00
46	Little Jones Creek Head Spring near Wildwood	7.63	7.54	7.44	7.29	6.83
47	Little Jones Creek Spring No. 2 near Wildwood	4.90	4.85	4.81	4.74	4.54
48	Messant Spring near Sorrento	10.72	10.68	10.64	10.57	10.30
49	Gemini Springs near DeBary (all 3)	9.36	9.36	9.35	9.33	9.27
50	Green Springs	0.03	0.03	0.02	0.02	0.00
51	Little Jones Creek Spring No. 3 near Wildwood	2.93	2.90	2.88	2.85	2.74
52	Seminole Springs near Sorrento	10.01	9.76	9.51	9.12	7.66
53	Palm Springs Seminole State Forest	0.00	0.00	0.00	0.00	0.00
54	Halls River Head Spring	4.76	4.76	4.76	4.76	4.76
55	Droty Springs near Sorrento	0.00	0.00	0.00	0.00	0.00
56	Island Spring near Sanford	5.90	5.88	5.87	5.85	5.76
57	Halls River Springs	103.49	103.49	103.49	103.48	103.46
58	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	123.36	123.36	123.36	123.35	123.33
59	Fenney Springs near Coleman Head Spring of Shady Brook Creek	12.09	12.03	11.97	11.89	11.63

Spring Number	Spring Name	Hydraulic Conductivity Factor				
		0.1	**0.5**	**1 (Baseline)**	**2**	**10**
60	Shady Brook Creek Springs No. 2 and 3	5.80	5.80	5.79	5.78	5.76
61	Hidden River Springs near Homosassa (including Hidden River Head Spring)	6.88	6.88	6.88	6.88	6.88
62	Shady Brook Creek Spring No. 4	2.90	2.89	2.89	2.89	2.87
63	Sulphur Camp Springs	0.17	0.16	0.15	0.14	0.10
64	Shady Brook Creek Spring No. 5	2.92	2.92	2.92	2.91	2.89
65	Bugg Spring at Okahumpka	8.44	8.41	8.38	8.34	8.21
66	Rock Springs near Apopka	50.41	50.37	50.33	50.27	50.05
67	Potter Spring near Chassahowitzka (including Ruth Spring)	14.77	14.77	14.76	14.76	14.76
68	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
69	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	4.16	4.09	4.03	3.93	3.60
70	Salt Creek Head Spring	0.40	0.40	0.40	0.40	0.40
71	Lettuce Creek Spring	3.77	3.77	3.77	3.77	3.77
72	Witherington Spring near Apopka	0.88	0.88	0.88	0.87	0.86
73	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	24.46	24.46	24.46	24.46	24.46
74	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	100.60	100.60	100.60	100.60	100.58
75	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.56	7.56	7.56	7.56	7.56
76	Rita Maria Spring near Chassahowitzka	3.50	3.50	3.50	3.50	3.50
77	Wekiwa Springs in State Park near Apopka	54.53	54.52	54.50	54.48	54.41
78	Miami Springs near Longwood	3.78	3.78	3.78	3.78	3.77
79	Lake Jesup Spring near Wagner	0.43	0.43	0.43	0.43	0.42
80	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	29.95	29.95	29.95	29.95	29.95
81	Blue Run Head Spring near Chassahowitzka	4.66	4.66	4.66	4.66	4.66
82	Palm Springs and Sanlando Springs near Longwood	21.79	21.78	21.78	21.77	21.73
83	Starbuck Spring near Longwood	11.69	11.69	11.68	11.68	11.66
84	Clifton Springs near Oviedo	1.58	1.58	1.58	1.57	1.55
85	Unnamed Spring No. 8	5.53	5.53	5.53	5.53	5.53
86	Double Run Road Seepage near Astatula	1.76	1.75	1.74	1.72	1.66
87	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	31.58	31.58	31.58	31.58	31.58
88	Apopka (Gourdneck) Spring near Oakland	17.53	17.52	17.50	17.49	17.42
89	Unnamed Spring No. 6	4.67	4.67	4.67	4.67	4.67
90	Salt Spring and Mud Spring near Bayport	19.63	19.63	19.63	19.63	19.63
91	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	29.45	29.45	29.45	29.45	29.45
92	Weeki Wachee Springs near Brooksville	71.89	71.89	71.89	71.89	71.89
93	Unnamed Spring No. 2	1.35	1.35	1.35	1.35	1.35
94	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	8.37	8.37	8.37	8.37	8.37
95	Bobhill Springs	3.27	3.27	3.27	3.27	3.27
96	Horseshoe Spring near Hudson	6.41	6.41	6.41	6.41	6.41

Spring Number	Spring Name	Hydraulic Conductivity Factor				
		0.1	0.5	1 (Baseline)	2	10
97	Unnamed Spring No. 3 near Aripeka	17.80	17.80	17.80	17.80	17.80
98	Salt Springs near Port Richey	10.62	10.62	10.62	10.62	10.62
99	Sulphur Springs at Sulphur Springs	24.24	24.24	24.24	24.24	24.24
100	Lettuce Lake Spring	7.64	7.64	7.64	7.64	7.64
101	Six-Mile Creek Spring and Eureka Springs near Tampa	2.39	2.39	2.39	2.39	2.39
102	Buckhorn Spring near Riverview	12.19	12.19	12.19	12.19	12.19
103	Lithia Springs Minor and Lithia Springs Major near Lithia	30.80	30.80	30.80	30.80	30.80
104	Little Salt Spring near Murdock	0.87	0.87	0.87	0.87	0.87
105	Warm Mineral Springs near Woodmere	6.56	6.56	6.56	6.56	6.56
106	Blue Spring near Madison	102.11	102.53	102.22	101.72	99.65
107	Alapaha Rise near Fort Union	414.43	416.54	414.51	411.16	398.16
108	Suwannee Springs near Live Oak	7.51	7.60	7.52	7.34	6.72
109	Suwanacoochee Spring and Ellaville Spring at Ellaville	113.13	113.34	113.18	112.88	111.78
110	Allen Mill Pond Spring near Dell	12.32	12.33	12.33	12.31	12.26
111	Blue Spring near Dell	61.82	61.91	61.87	61.79	61.49
112	Telford Spring at Luraville	36.55	36.62	36.59	36.52	36.27
113	Running Springs (East and West) near Luraville	100.09	100.32	100.22	99.99	99.18
114	Convict Spring near Mayo	1.53	1.54	1.54	1.53	1.52
115	Royal Spring near Alton	1.88	1.88	1.88	1.88	1.86
116	Owens Spring	52.12	52.27	52.22	52.08	51.60
117	Mearson Spring near Mayo	65.92	66.14	66.06	65.87	65.20
118	Troy Spring near Branford	143.34	143.78	143.63	143.26	141.99
119	Little River Springs near Branford	53.86	54.01	53.96	53.83	53.42
120	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	249.00	251.53	250.85	249.02	243.65
121	Branford Springs at Branford	36.60	36.71	36.68	36.59	36.34
122	Steinhatchee Spring near Clara	1.18	1.18	1.18	1.18	1.18
123	Turtle Spring near Hatchbend and Fletcher Spring	52.18	52.27	52.24	52.18	51.97
124	Ginnie Spring near High Springs	49.68	50.25	50.20	49.87	49.00
125	Poe Springs near High Springs	55.99	56.90	56.82	56.32	54.99
126	Rock Bluff Springs near Bell	42.22	42.26	42.25	42.22	42.13
127	Guaranto Spring near Rock Bluff Landing	2.94	2.94	2.94	2.94	2.93
128	Copper Springs near Oldtown (including Little Copper Spring)	27.17	27.17	27.17	27.17	27.16
129	Blue Spring near Bronson	8.07	8.12	8.12	8.09	8.01
130	Wilson Head Spring near Holder	2.41	2.41	2.40	2.38	2.34
131	Blue Spring near Holder	10.66	10.64	10.62	10.59	10.47
132	Crystal Springs near Zephyrhills	31.93	31.93	31.93	31.93	31.93

River Conductance

Sensitivity of the model to river conductance was analyzed by modifying the river package of the model. Due to convergence issues in the model, only slight increases in the river package were able to be simulated. Higher increases in conductance could be possible through modification of convergence criteria, but the District requested that no changes to the original solver package be made during the sensitivity analysis process.

Aquifer Head Sensitivity

Residual head statistics for the river conductance sensitivity analysis are shown in Table 14. The original conductance values in the river package were multiplied by the factors shown in the table. As shown in the table, the head statistics remained within calibration for simulations where river conductance increased. When river conductance was decreased, the calibration of the model was not maintained.

Table 14. River Conductance Sensitivity: Residual Statistics (feet)

	0.1	0.5	Baseline (1)	1.01	1.015
Residual Mean	-16.03	-1.74	0.70	0.73	0.74
Res. Std. Dev.	17.10	8.61	8.14	8.14	8.13
Sum of Squares	558806.02	78488.61	67876.78	67850.32	67839.25
Abs. Res. Mean	17.61	5.89	5.11	5.11	5.11
Min. Residual	-124.30	-49.31	-46.89	-46.87	-46.86
Max. Residual	51.91	55.26	55.93	55.93	55.94
Range in Target Values	214.10	214.10	214.10	214.10	214.10
Std. Dev./Range	0.08	0.04	0.04	0.04	0.04

Baseflow Sensitivity

Residual baseflow statistics were calculated for the river conductance simulations, as shown in Table 15. As shown in the table, the both the residual mean and the absolute residual mean remained within calibration tolerances for all simulations. Baseflows for individual reaches are shown in Table 16 and Figure 7. Please refer to Table 6 for individual reach names.

Table 15. River Conductance Sensitivity: Baseflow Statistics (cfs)

	0.10	0.50	1 (Baseline)	1.01	1.015
Residual Mean	-9.30	-8.49	-8.67	-8.67	-8.68
Absolute Residual Mean	20.96	22.72	24.57	24.61	24.64
Sum of Squares	92630.16	67603.71	91532.16	91978.42	92202.76

Table 16. River Conductance Sensitivity: Baseflow by Reach (cfs)

	River Conductance Factor					
ReachID	**0.1**	**0.5**	**1 (Baseline)**	**1.01**	**1.015**	**Target Baseflow**
4	1242.59	1117.64	1085.38	1085.01	1084.82	1219.59
5	3.11	3.30	3.46	3.46	3.46	0.49
6	5.03	6.80	7.32	7.33	7.33	3.68
7	0.37	0.10	0.07	0.07	0.07	1.63
8	1.32	1.17	1.17	1.17	1.17	2.09
9	5.02	6.49	6.90	6.91	6.91	2.72
11	14.51	18.35	18.75	18.75	18.75	5.57
12	38.13	50.68	52.04	52.06	52.07	7.04
13	0.04	0.14	0.15	0.15	0.15	0.11
14	258.74	174.43	135.71	135.21	134.97	140.40
16	0.00	-0.02	-0.04	-0.04	-0.04	0.00
17	0.93	1.40	1.45	1.45	1.45	1.92
18	41.72	58.86	55.06	55.05	55.05	30.45
19	104.34	156.20	168.76	168.90	168.96	41.79
20	5.17	5.20	5.27	5.27	5.27	9.53
21	0.59	0.55	0.53	0.53	0.53	2.00
33	23.52	44.47	50.86	50.94	50.98	182.96
34	13.38	18.22	19.24	19.25	19.25	7.47
35	0.96	0.91	0.92	0.92	0.91	2.06
36	38.12	45.03	45.42	45.41	45.41	43.73
37	5.37	6.26	6.55	6.56	6.56	3.27
38	526.71	637.87	709.48	710.49	711.00	553.60
39	30.15	38.48	40.33	40.34	40.35	29.02
44	819.49	676.76	638.80	638.37	638.15	607.96
45	17.50	39.10	46.26	46.34	46.38	19.52
46	55.29	103.04	115.17	115.30	115.37	15.59
47	14.11	23.23	25.53	25.56	25.57	0.00
48	14.12	10.60	10.50	10.49	10.49	2.88
49	3.35	3.78	3.97	3.97	3.97	1.90
51	14.83	13.07	12.51	12.50	12.50	21.54
52	5.63	6.11	6.20	6.20	6.20	8.87
55	1.38	1.98	2.10	2.10	2.10	0.30
56	0.32	0.51	0.58	0.58	0.58	2.13
58	2.71	3.45	3.62	3.63	3.63	0.60
61	1.85	3.34	3.80	3.81	3.81	1.46
62	2.43	3.24	3.26	3.26	3.26	0.90
63	7.76	9.86	10.08	10.08	10.08	1.70

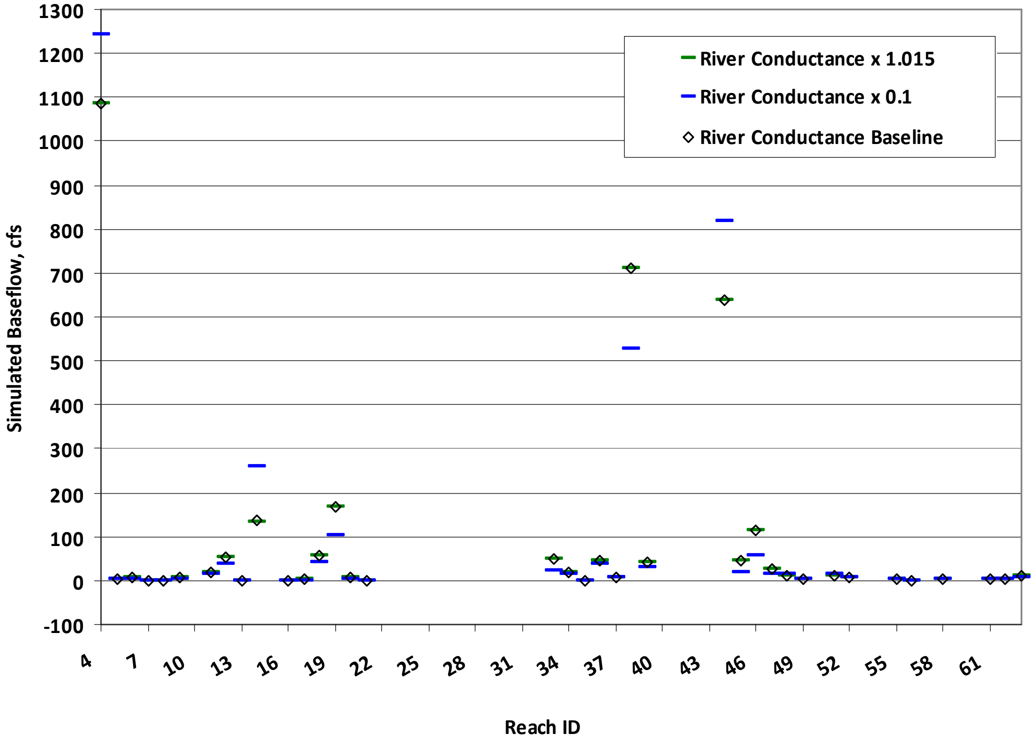


Figure 7. Changes in Baseflow Based on Modified River Conductance Arrays

Springflow Sensitivity

Residual springflow statistics were calculated for the river conductance simulations, as shown in Table 17. The springflow statistics remained within calibration tolerance limits throughout all simulations where river conductance was increased. For simulations where river conductance was decreased, the calibration of the model (residual mean, absolute residual mean, or both) did not remain within calibration tolerances. Springflows for individual reaches are shown in Table 18 and Figure 8.

Table 17. River Conductance Sensitivity: Springflow Statistics (cfs)

	0.1	0.5	1 (Baseline)	1.01	1.015
Residual Mean	8.35	0.67	-1.17	-1.20	-1.21
Absolute Residual Mean	20.02	7.36	4.61	4.60	4.60
Sum of Squares	247902.21	27508.81	12413.75	12383.42	12369.52

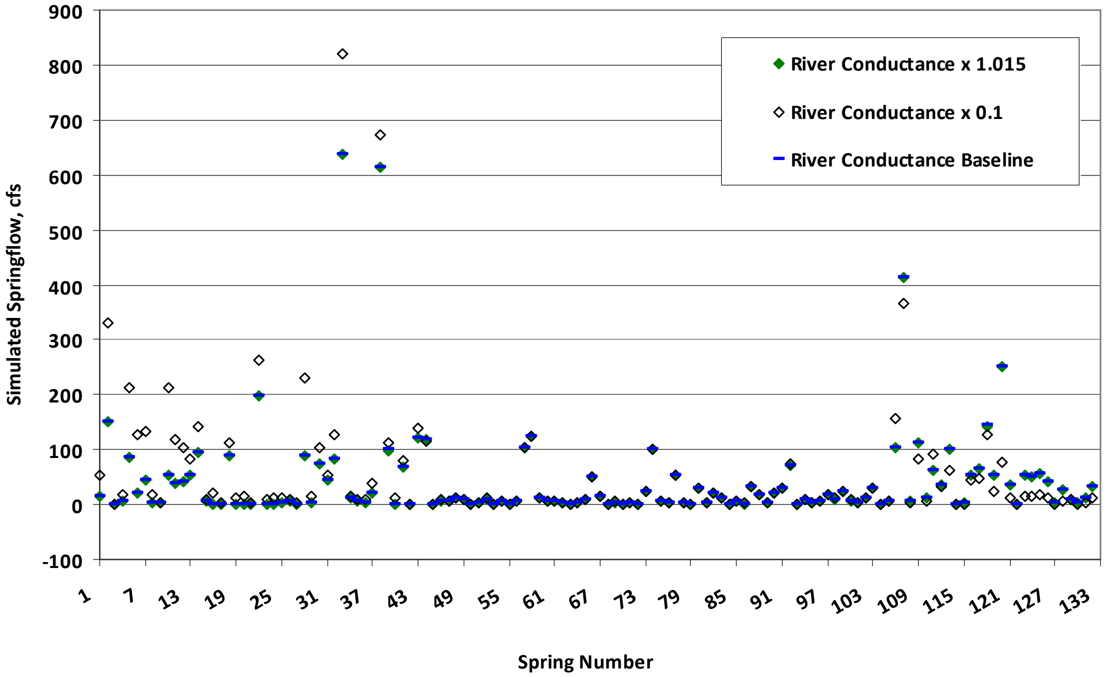


Figure 8. Springflow Variability with River Conductance

Table 18. River Conductance Sensitivity: Springflow (cfs)

Spring Number	Spring Name	River Conductance Factor				
		0.1	0.5	1 (Baseline)	1.01	1.015
1	Holton Spring near Fort Union	52.89	18.46	14.57	14.52	14.49
2	Falmouth Spring at Falmouth	331.38	182.41	150.19	149.80	149.61
3	White Sulphur Springs at White Springs	70.58	5.17	-5.34	-5.50	-5.57
4	Charles Springs near Dell	18.29	7.56	5.14	5.11	5.10
5	Peacock Springs	213.34	108.58	86.81	86.58	86.46
6	Ruth Spring near Branford	126.21	39.86	19.97	19.75	19.64
7	Ichetucknee Head Spring near Fort White and Cedar Head Spring	133.37	68.01	44.14	43.83	43.68
8	Green Cove Springs at Green Cove Springs	19.38	4.87	2.97	2.95	2.94
9	Jamison Spring	4.29	2.53	1.88	1.87	1.87
10	Hornsby Spring near High Springs	212.91	93.45	54.19	53.72	53.48
11	Blue Springs near High Springs (including Lilly Springs)	118.76	60.44	39.78	39.52	39.40
12	Crescent Beach Submarine Spring	103.04	49.11	41.10	41.01	40.97
13	Lumbercamp Springs and Sun Springs near Wannee	82.23	61.30	52.35	52.23	52.17
14	Hart Springs near Wilcox	142.34	110.26	95.83	95.63	95.54
15	Otter Springs near Wilcox	8.24	6.88	6.24	6.23	6.23
16	Whitewater Springs	21.34	3.27	1.03	1.01	1.00
17	Bell Springs	2.42	1.93	1.68	1.68	1.68

Spring Number	Spring Name	River Conductance Factor				
		0.1	0.5	1 (Baseline)	1.01	1.015
18	Fannin Springs near Wilcox (including Little Fannin Spring)	113.15	97.12	88.87	88.76	88.70
19	Satsuma Spring	10.95	2.04	0.89	0.88	0.87
20	Orange Spring at Orange Springs	16.02	3.39	1.30	1.28	1.27
21	Blue Springs near Orange Springs	2.09	0.64	0.43	0.43	0.43
22	Manatee Spring near Chiefland	263.26	223.46	198.62	198.24	198.05
23	Camp Seminole Spring at Orange Springs	9.23	1.62	0.24	0.23	0.22
24	Welaka Spring near Welaka	12.51	1.20	0.00	0.00	0.00
25	Mud Spring near Welaka	13.15	3.42	1.94	1.93	1.92
26	Beecher Springs near Fruitland	9.31	6.57	6.15	6.15	6.15
27	Tobacco Patch Landing Spring Group near Fort McCoy	2.75	1.07	0.82	0.82	0.82
28	Croaker Hole Spring near Welaka	230.89	107.07	87.67	87.47	87.37
29	Wells Landing Springs near Fort McCoy	15.91	5.70	3.86	3.84	3.83
30	Salt Springs near Eureka	103.29	78.47	74.20	74.15	74.13
31	Wekiva Springs near Gulf Hammock	52.81	47.28	45.24	45.22	45.20
32	Silver Glen Springs near Astor	126.90	89.54	81.62	81.53	81.49
33	Silver Springs near Ocala	819.44	676.59	638.55	638.12	637.90
34	Sweetwater Springs along Juniper Creek	16.51	13.21	12.47	12.47	12.46
35	Juniper Springs and Fern Hammock Springs near Ocala	9.37	7.39	6.92	6.91	6.91
36	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	8.20	5.24	4.51	4.50	4.50
37	Ponce de Leon Springs near De Land	39.35	25.32	22.09	22.05	22.04
38	Rainbow Springs near Dunnellon	672.04	627.24	614.02	613.86	613.79
39	Alexander Springs near Astor	113.14	102.13	99.14	99.10	99.09
40	Mosquito Springs Run Alexander Springs Wilderness	12.22	2.37	0.14	0.11	0.10
41	Gum Springs near Holder	79.62	70.93	67.97	67.93	67.92
42	Camp La No Che Springs near Paisley	0.93	0.00	0.00	0.00	0.00
43	Blue Spring near Orange City	138.08	124.00	120.73	120.70	120.68
44	Crystal River Spring Group	668.31	669.00	671.36	671.41	671.43
45	Blackwater Springs near Cassia	0.00	0.00	0.00	0.00	0.00
46	Little Jones Creek Head Spring near Wildwood	9.17	7.84	7.44	7.43	7.43
47	Little Jones Creek Spring No. 2 near Wildwood	5.78	5.05	4.81	4.81	4.80
48	Messant Spring near Sorrento	11.00	10.71	10.64	10.64	10.64
49	Gemini Springs near DeBary (all 3)	9.49	9.38	9.35	9.35	9.35
50	Green Springs	0.11	0.04	0.02	0.02	0.02
51	Little Jones Creek Spring No. 3 near Wildwood	3.39	3.01	2.88	2.88	2.88
52	Seminole Springs near Sorrento	11.57	9.95	9.51	9.51	9.51
53	Palm Springs Seminole State Forest	0.00	0.00	0.00	0.00	0.00
54	Halls River Head Spring	4.78	4.75	4.76	4.76	4.76
55	Droty Springs near Sorrento	0.00	0.00	0.00	0.00	0.00
56	Island Spring near Sanford	6.02	5.90	5.87	5.87	5.87
57	Halls River Springs	104.03	103.44	103.49	103.49	103.49
58	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	124.13	123.34	123.36	123.36	123.36
59	Fenney Springs near Coleman Head Spring of Shady Brook Creek	13.46	12.36	11.97	11.97	11.97

Spring Number	Spring Name	River Conductance Factor				
		0.1	0.5	1 (Baseline)	1.01	1.015
60	Shady Brook Creek Springs No. 2 and 3	5.98	5.84	5.79	5.79	5.79
61	Hidden River Springs near Homosassa (including Hidden River Head Spring)	6.94	6.88	6.88	6.88	6.88
62	Shady Brook Creek Spring No. 4	3.14	2.97	2.89	2.89	2.89
63	Sulphur Camp Springs	0.22	0.17	0.15	0.15	0.15
64	Shady Brook Creek Spring No. 5	3.29	3.03	2.92	2.91	2.91
65	Bugg Spring at Okahumpka	8.75	8.46	8.38	8.38	8.38
66	Rock Springs near Apopka	50.69	50.40	50.33	50.33	50.33
67	Potter Spring near Chassahowitzka (including Ruth Spring)	14.88	14.77	14.76	14.77	14.77
68	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
69	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	4.77	4.18	4.03	4.02	4.02
70	Salt Creek Head Spring	0.40	0.40	0.40	0.40	0.40
71	Lettuce Creek Spring	3.81	3.77	3.77	3.77	3.77
72	Witherington Spring near Apopka	0.89	0.88	0.88	0.88	0.88
73	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	24.66	24.48	24.46	24.46	24.46
74	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	101.45	100.66	100.60	100.60	100.60
75	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.63	7.56	7.56	7.56	7.56
76	Rita Maria Spring near Chassahowitzka	3.54	3.50	3.50	3.50	3.50
77	Wekiwa Springs in State Park near Apopka	54.63	54.53	54.50	54.50	54.50
78	Miami Springs near Longwood	3.79	3.78	3.78	3.78	3.78
79	Lake Jesup Spring near Wagner	0.44	0.43	0.43	0.43	0.43
80	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	30.17	29.97	29.95	29.95	29.95
81	Blue Run Head Spring near Chassahowitzka	4.69	4.66	4.66	4.66	4.66
82	Palm Springs and Sanlando Springs near Longwood	21.84	21.79	21.78	21.78	21.78
83	Starbuck Spring near Longwood	11.72	11.69	11.68	11.68	11.68
84	Clifton Springs near Oviedo	1.62	1.58	1.58	1.58	1.57
85	Unnamed Spring No. 8	5.57	5.54	5.53	5.53	5.53
86	Double Run Road Seepage near Astatula	1.86	1.77	1.74	1.74	1.74
87	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	31.73	31.59	31.58	31.58	31.58
88	Apopka (Gourdneck) Spring near Oakland	17.63	17.53	17.50	17.50	17.50
89	Unnamed Spring No. 6	4.69	4.67	4.67	4.67	4.67
90	Salt Spring and Mud Spring near Bayport	19.71	19.64	19.63	19.63	19.63
91	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	29.55	29.46	29.45	29.45	29.45
92	Weeki Wachee Springs near Brooksville	72.63	71.96	71.89	71.89	71.89
93	Unnamed Spring No. 2	1.36	1.35	1.35	1.35	1.35
94	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	8.39	8.37	8.37	8.37	8.37
95	Bobhill Springs	3.30	3.27	3.27	3.27	3.27
96	Horseshoe Spring near Hudson	6.41	6.41	6.41	6.41	6.41

Spring Number	Spring Name	River Conductance Factor				
		0.1	0.5	1 (Baseline)	1.01	1.015
97	Unnamed Spring No. 3 near Aripeka	17.82	17.80	17.80	17.80	17.80
98	Salt Springs near Port Richey	10.62	10.62	10.62	10.62	10.62
99	Sulphur Springs at Sulphur Springs	24.42	24.29	24.24	24.24	24.24
100	Lettuce Lake Spring	8.24	7.80	7.64	7.64	7.64
101	Six-Mile Creek Spring and Eureka Springs near Tampa	2.59	2.45	2.39	2.39	2.39
102	Buckhorn Spring near Riverview	12.37	12.24	12.19	12.19	12.19
103	Lithia Springs Minor and Lithia Springs Major near Lithia	31.03	30.86	30.80	30.80	30.80
104	Little Salt Spring near Murdock	0.87	0.87	0.87	0.87	0.87
105	Warm Mineral Springs near Woodmere	6.56	6.56	6.56	6.56	6.56
106	Blue Spring near Madison	157.80	106.84	102.22	102.17	102.14
107	Alapaha Rise near Fort Union	366.29	401.22	414.51	414.48	414.47
108	Suwannee Springs near Live Oak	2.88	5.74	7.52	7.54	7.55
109	Suwanacoochee Spring and Ellaville Spring at Ellaville	82.12	114.64	113.18	113.07	113.02
110	Allen Mill Pond Spring near Dell	5.71	9.91	12.33	12.36	12.38
111	Blue Spring near Dell	92.43	77.07	61.87	61.65	61.54
112	Telford Spring at Luraville	31.92	39.08	36.59	36.53	36.51
113	Running Springs (East and West) near Luraville	61.03	94.18	100.22	100.27	100.29
114	Convict Spring near Mayo	0.51	1.08	1.54	1.54	1.55
115	Royal Spring near Alton	0.61	1.31	1.88	1.89	1.90
116	Owens Spring	44.10	55.89	52.22	52.14	52.10
117	Mearson Spring near Mayo	48.62	67.04	66.06	66.02	66.00
118	Troy Spring near Branford	128.56	160.45	143.63	143.31	143.15
119	Little River Springs near Branford	22.70	44.28	53.96	54.10	54.17
120	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	75.56	194.08	250.85	251.58	251.94
121	Branford Springs at Branford	12.98	29.70	36.68	36.76	36.80
122	Steinhatchee Spring near Clara	0.14	0.65	1.18	1.19	1.20
123	Turtle Spring near Hatchbend and Fletcher Spring	15.07	40.09	52.24	52.40	52.48
124	Ginnie Spring near High Springs	15.60	39.13	50.20	50.34	50.42
125	Poe Springs near High Springs	18.96	45.56	56.82	56.96	57.04
126	Rock Bluff Springs near Bell	12.69	33.40	42.25	42.36	42.41
127	Guaranto Spring near Rock Bluff Landing	0.70	2.07	2.94	2.95	2.96
128	Copper Springs near Oldtown (including Little Copper Spring)	7.61	21.36	27.17	27.24	27.27
129	Blue Spring near Bronson	8.62	8.97	8.12	8.11	8.10
130	Wilson Head Spring near Holder	0.95	2.23	2.40	2.39	2.39
131	Blue Spring near Holder	2.39	7.49	10.62	10.67	10.69
132	Crystal Springs near Zephyrhills	11.20	25.53	31.93	32.01	32.06

River Stage

In order to examine model sensitivity to river stage, river stage was shifted by up and down by 1 and 2-feet.

Aquifer Head Sensitivity

Residual head statistics for the river stage sensitivity analysis are shown in Table 19. The original stage values in the river package were shifted as shown in the table. As shown in the table, the head statistics remained within calibration for simulations where river stage was increased. When river stage was shifted downward, the calibration of the model was not maintained.

Table 19. River Stage Sensitivity: Residual Statistics (feet)

	Minus 2'	**Minus 1'**	**Baseline**	**Plus 1'**	**Plus 2'**
Residual Mean	1.83	1.28	0.70	0.17	-0.33
Res. Std. Dev.	8.31	8.25	8.14	8.09	8.07
Sum of Squares	73591.42	70891.58	67876.78	66541.90	66328.23
Abs. Res. Mean	5.30	5.19	5.11	5.11	5.16
Min. Residual	-43.24	-45.06	-46.89	-49.53	-51.69
Max. Residual	53.36	55.56	55.93	55.81	55.55
Range in Target Values	214.10	214.10	214.10	214.10	214.10
Std. Dev./Range	0.04	0.04	0.04	0.04	0.04

Baseflow Sensitivity

Residual baseflow statistics were calculated for the river stage simulations, as shown in Table 20. As shown in the table, the both the residual mean and the absolute residual mean remained within calibration tolerances for all simulations. Baseflows for individual reaches are shown in Table 21 and Figure 9. Please refer to Table 6 for individual reach names.

Table 20. River Stage Sensitivity: Baseflow Statistics (cfs)

	Minus 2'	Minus 1'	Baseline	Plus 1'	Plus 2'
Residual Mean	-8.79	-8.74	-8.67	-8.74	-8.83
Absolute Residual Mean	25.57	25.11	24.57	24.08	23.63
Sum of Squares	102340.27	96961.31	91532.16	86983.11	82965.49

Table 21. River Stage Sensitivity: Baseflow by Reach (cfs)

	River Stage					
ReachID	Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’	Target Baseflow
4	1059.81	1071.98	1085.38	1097.90	1110.75	1219.59
5	3.69	3.58	3.46	3.36	3.29	0.49
6	7.33	7.33	7.32	7.29	7.26	3.68
7	0.13	0.10	0.07	0.04	0.00	1.63
8	1.17	1.17	1.17	1.16	1.15	2.09
9	6.97	6.93	6.90	6.85	6.79	2.72
11	19.18	18.95	18.75	18.53	18.31	5.57
12	55.84	53.97	52.04	51.08	50.23	7.04
13	0.30	0.25	0.15	0.11	0.06	0.11
14	134.30	136.30	135.71	138.48	141.41	140.40
16	0.04	0.00	-0.04	-0.08	-0.11	0.00
17	1.77	1.60	1.45	1.31	1.28	1.92
18	63.24	61.12	55.06	53.77	52.63	30.45
19	171.20	169.68	168.76	167.20	165.62	41.79
20	5.40	5.32	5.27	5.22	5.17	9.53
21	0.52	0.52	0.53	0.52	0.52	2.00
33	58.64	53.58	50.86	47.12	43.38	182.96
34	19.41	19.33	19.24	19.10	18.96	7.47
35	1.05	0.99	0.92	0.83	0.77	2.06
36	47.15	46.15	45.42	44.73	44.09	43.73
37	6.63	6.59	6.55	6.50	6.45	3.27
38	720.12	714.38	709.48	703.19	696.79	553.60
39	42.38	41.19	40.33	39.44	38.72	29.02
44	618.36	628.67	638.80	648.51	658.02	607.96
45	49.62	47.94	46.26	44.60	42.96	19.52
46	119.57	117.35	115.17	113.03	110.83	15.59
47	27.01	26.25	25.53	24.85	24.22	0.00
48	11.44	10.84	10.50	10.25	9.98	2.88
49	3.91	3.95	3.97	3.97	3.96	1.90
51	14.52	13.48	12.51	11.66	10.99	21.54
52	6.34	6.27	6.20	6.11	6.02	8.87
55	2.18	2.14	2.10	2.06	2.01	0.30
56	0.60	0.59	0.58	0.57	0.56	2.13
58	3.67	3.65	3.62	3.60	3.57	0.60
61	4.57	4.29	3.80	3.58	3.37	1.46
62	3.31	3.29	3.26	3.23	3.19	0.90
63	10.18	10.12	10.08	10.03	9.98	1.70

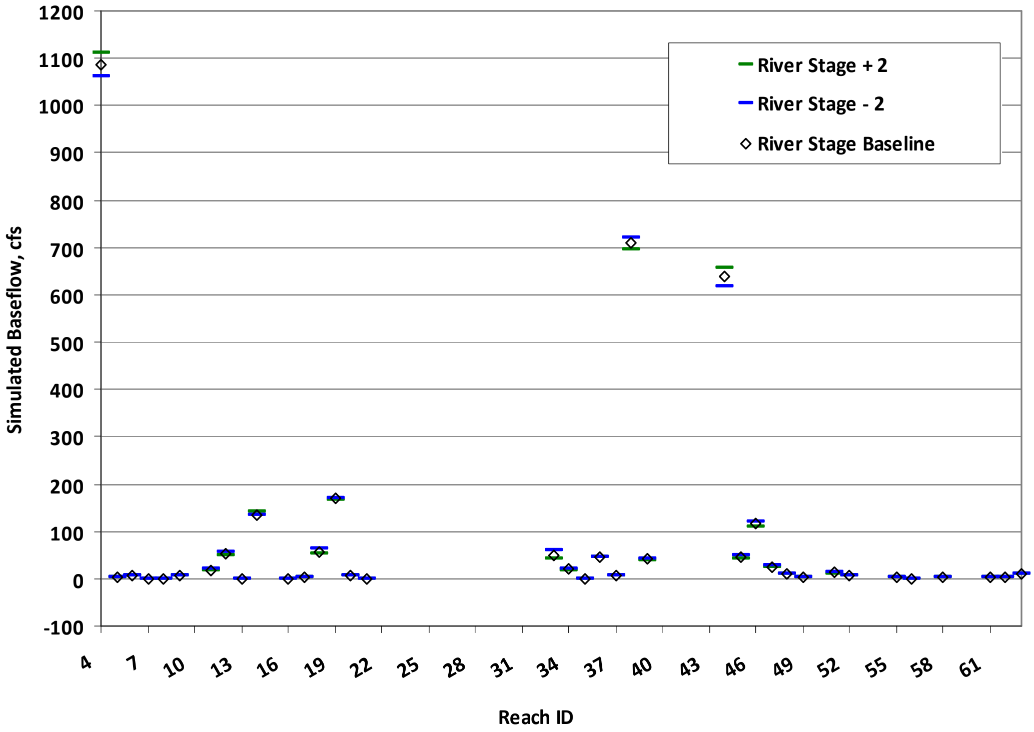


Figure 9. Changes in Baseflow Based on Modified River Stage Arrays

Springflow Sensitivity

Residual springflow statistics were calculated for the river stage simulations, as shown in Table 22. The springflow statistics remained within calibration tolerance limits only for the simulation where river stage was increased by 1-foot. Springflows for individual reaches are shown in Table 23 and Figure 10.

Table 22. River Stage Sensitivity: Springflow Statistics (cfs)

	Minus 2'	Minus 1'	Baseline	Plus 1'	Plus 2'
Residual Mean	-2.98	-2.18	-1.17	-0.42	0.32
Absolute Residual Mean	6.37	5.19	4.61	5.68	7.05
Sum of Squares	19760.23	13324.97	12413.75	18397.44	30763.60

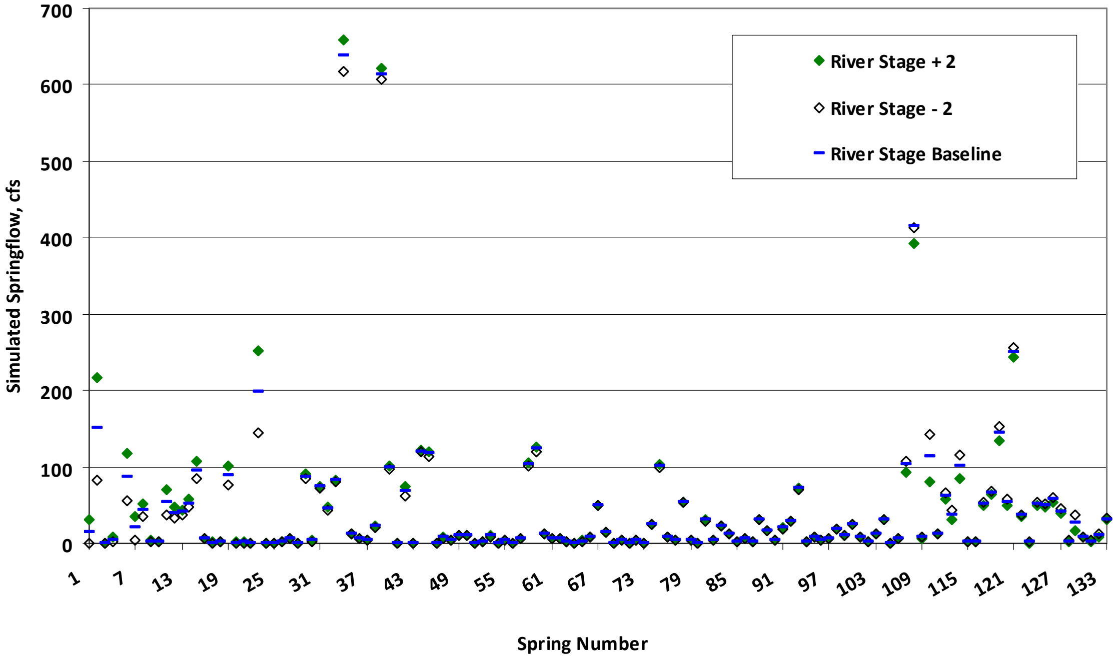


Figure 10. Springflow Variability with River Stage

Table 23. River Stage Sensitivity: Springflow (cfs)

Spring Number	Spring Name	River Stage				
		Minus 2’	**Minus 1’**	**Baseline**	**Plus 1’**	**Plus 2’**
1	Holton Spring near Fort Union	0.00	5.12	14.57	22.48	30.27
2	Falmouth Spring at Falmouth	82.00	115.62	150.19	183.61	216.94
3	White Sulphur Springs at White Springs	-22.51	-14.23	-5.34	0.91	6.93
4	Charles Springs near Dell	1.69	3.41	5.14	6.86	8.58
5	Peacock Springs	54.83	70.79	86.81	102.75	118.68
6	Ruth Spring near Branford	5.04	12.49	19.97	27.41	34.85
7	Ichetucknee Head Spring near Fort White and Cedar Head Spring	36.13	40.07	44.14	47.98	51.80
8	Green Cove Springs at Green Cove Springs	2.26	2.62	2.97	3.28	3.58
9	Jamison Spring	1.67	1.77	1.88	1.98	2.09
10	Hornsby Spring near High Springs	37.66	45.71	54.19	61.94	69.62
11	Blue Springs near High Springs (including Lilly Springs)	32.36	36.02	39.78	43.36	46.92
12	Crescent Beach Submarine Spring	37.97	39.59	41.10	42.50	43.87
13	Lumbercamp Springs and Sun Springs near Wannee	47.79	50.07	52.35	54.62	56.90
14	Hart Springs near Wilcox	83.96	89.89	95.83	101.75	107.68
15	Otter Springs near Wilcox	5.58	5.91	6.24	6.57	6.90

Spring Number	Spring Name	River Stage				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
16	Whitewater Springs	0.43	0.73	1.03	1.32	1.60
17	Bell Springs	1.31	1.50	1.68	1.87	2.05
18	Fannin Springs near Wilcox (including Little Fannin Spring)	76.47	82.67	88.87	95.07	101.26
19	Satsuma Spring	0.64	0.76	0.89	1.01	1.13
20	Orange Spring at Orange Springs	0.00	0.70	1.30	1.80	2.26
21	Blue Springs near Orange Springs	0.36	0.40	0.43	0.46	0.49
22	Manatee Spring near Chiefland	144.50	171.65	198.62	225.58	252.55
23	Camp Seminole Spring at Orange Springs	0.00	0.00	0.24	0.61	0.96
24	Welaka Spring near Welaka	0.00	0.00	0.00	0.00	0.00
25	Mud Spring near Welaka	1.64	1.79	1.94	2.09	2.24
26	Beecher Springs near Fruitland	6.07	6.11	6.15	6.19	6.24
27	Tobacco Patch Landing Spring Group near Fort McCoy	0.61	0.72	0.82	0.92	1.02
28	Croaker Hole Spring near Welaka	83.71	85.69	87.67	89.63	91.56
29	Wells Landing Springs near Fort McCoy	2.75	3.31	3.86	4.40	4.91
30	Salt Springs near Eureka	73.14	73.67	74.20	74.72	75.23
31	Wekiva Springs near Gulf Hammock	43.95	44.60	45.24	45.87	46.49
32	Silver Glen Springs near Astor	79.74	80.68	81.62	82.55	83.48
33	Silver Springs near Ocala	617.88	628.31	638.55	648.37	658.00
34	Sweetwater Springs along Juniper Creek	12.22	12.35	12.47	12.60	12.72
35	Juniper Springs and Fern Hammock Springs near Ocala	6.73	6.83	6.92	7.01	7.10
36	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.26	4.39	4.51	4.64	4.76
37	Ponce de Leon Springs near De Land	20.98	21.55	22.09	22.57	23.04
38	Rainbow Springs near Dunnellon	606.18	610.13	614.02	617.67	621.26
39	Alexander Springs near Astor	97.70	98.43	99.14	99.77	100.40
40	Mosquito Springs Run Alexander Springs Wilderness	0.00	0.00	0.14	0.50	0.86
41	Gum Springs near Holder	62.27	65.12	67.97	70.80	73.63
42	Camp La No Che Springs near Paisley	0.00	0.00	0.00	0.00	0.00
43	Blue Spring near Orange City	119.15	119.97	120.73	121.39	122.03
44	Crystal River Spring Group	655.84	663.61	671.36	679.12	686.87
45	Blackwater Springs near Cassia	0.00	0.00	0.00	0.00	0.00
46	Little Jones Creek Head Spring near Wildwood	6.99	7.21	7.44	7.66	7.87
47	Little Jones Creek Spring No. 2 near Wildwood	4.47	4.64	4.81	4.97	5.13
48	Messant Spring near Sorrento	10.60	10.62	10.64	10.65	10.67
49	Gemini Springs near DeBary (all 3)	9.34	9.34	9.35	9.35	9.36
50	Green Springs	0.02	0.02	0.02	0.03	0.03
51	Little Jones Creek Spring No. 3 near Wildwood	2.70	2.79	2.88	2.97	3.05
52	Seminole Springs near Sorrento	9.29	9.40	9.51	9.61	9.71
53	Palm Springs Seminole State Forest	0.00	0.00	0.00	0.00	0.00
54	Halls River Head Spring	4.65	4.70	4.76	4.81	4.86
55	Droty Springs near Sorrento	0.00	0.00	0.00	0.00	0.00
56	Island Spring near Sanford	5.85	5.86	5.87	5.88	5.88
57	Halls River Springs	101.18	102.34	103.49	104.64	105.79
58	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	120.63	122.00	123.36	124.72	126.08

Spring Number	Spring Name	River Stage				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
59	Fenney Springs near Coleman Head Spring of Shady Brook Creek	11.38	11.68	11.97	12.26	12.55
60	Shady Brook Creek Springs No. 2 and 3	5.69	5.74	5.79	5.84	5.88
61	Hidden River Springs near Homosassa (including Hidden River Head Spring)	6.70	6.79	6.88	6.97	7.06
62	Shady Brook Creek Spring No. 4	2.74	2.82	2.89	2.96	3.03
63	Sulphur Camp Springs	0.15	0.15	0.15	0.16	0.16
64	Shady Brook Creek Spring No. 5	2.68	2.80	2.92	3.03	3.15
65	Bugg Spring at Okahumpka	8.33	8.35	8.38	8.41	8.44
66	Rock Springs near Apopka	50.29	50.31	50.33	50.34	50.36
67	Potter Spring near Chassahowitzka (including Ruth Spring)	14.46	14.61	14.76	14.92	15.07
68	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
69	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	3.94	3.98	4.03	4.07	4.11
70	Salt Creek Head Spring	0.39	0.40	0.40	0.40	0.41
71	Lettuce Creek Spring	3.65	3.71	3.77	3.82	3.88
72	Witherington Spring near Apopka	0.87	0.87	0.88	0.88	0.88
73	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	23.97	24.22	24.46	24.71	24.95
74	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	98.55	99.58	100.60	101.62	102.64
75	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	7.40	7.48	7.56	7.64	7.72
76	Rita Maria Spring near Chassahowitzka	3.42	3.46	3.50	3.54	3.58
77	Wekiwa Springs in State Park near Apopka	54.49	54.50	54.50	54.51	54.51
78	Miami Springs near Longwood	3.78	3.78	3.78	3.78	3.78
79	Lake Jesup Spring near Wagner	0.43	0.43	0.43	0.43	0.43
80	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	29.45	29.70	29.95	30.20	30.45
81	Blue Run Head Spring near Chassahowitzka	4.59	4.63	4.66	4.69	4.73
82	Palm Springs and Sanlando Springs near Longwood	21.77	21.77	21.78	21.78	21.78
83	Starbuck Spring near Longwood	11.68	11.68	11.68	11.69	11.69
84	Clifton Springs near Oviedo	1.57	1.57	1.58	1.58	1.58
85	Unnamed Spring No. 8	5.45	5.49	5.53	5.57	5.61
86	Double Run Road Seepage near Astatula	1.73	1.73	1.74	1.75	1.75
87	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	31.28	31.43	31.58	31.73	31.87
88	Apopka (Gourdneck) Spring near Oakland	17.49	17.50	17.50	17.51	17.52
89	Unnamed Spring No. 6	4.64	4.66	4.67	4.68	4.70
90	Salt Spring and Mud Spring near Bayport	19.51	19.57	19.63	19.69	19.75
91	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	29.30	29.38	29.45	29.52	29.60
92	Weeki Wachee Springs near Brooksville	70.81	71.35	71.89	72.43	72.97
93	Unnamed Spring No. 2	1.33	1.34	1.35	1.36	1.37
94	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	8.34	8.35	8.37	8.38	8.40

Spring Number	Spring Name	River Stage				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
95	Bobhill Springs	3.23	3.25	3.27	3.29	3.31
96	Horseshoe Spring near Hudson	6.40	6.40	6.41	6.41	6.41
97	Unnamed Spring No. 3 near Aripeka	17.76	17.78	17.80	17.82	17.84
98	Salt Springs near Port Richey	10.61	10.62	10.62	10.62	10.62
99	Sulphur Springs at Sulphur Springs	24.20	24.22	24.24	24.26	24.28
100	Lettuce Lake Spring	7.51	7.57	7.64	7.70	7.77
101	Six-Mile Creek Spring and Eureka Springs near Tampa	2.35	2.37	2.39	2.42	2.44
102	Buckhorn Spring near Riverview	12.15	12.17	12.19	12.21	12.23
103	Lithia Springs Minor and Lithia Springs Major near Lithia	30.75	30.77	30.80	30.82	30.85
104	Little Salt Spring near Murdock	0.87	0.87	0.87	0.87	0.87
105	Warm Mineral Springs near Woodmere	6.56	6.56	6.56	6.56	6.56
106	Blue Spring near Madison	107.10	103.39	102.22	98.11	93.79
107	Alapaha Rise near Fort Union	413.98	406.28	414.51	403.64	391.36
108	Suwannee Springs near Live Oak	7.75	7.52	7.52	7.25	6.96
109	Suwanacoochee Spring and Ellaville Spring at Ellaville	143.44	127.83	113.18	97.39	81.53
110	Allen Mill Pond Spring near Dell	13.11	12.72	12.33	11.93	11.53
111	Blue Spring near Dell	66.19	64.00	61.87	59.68	57.47
112	Telford Spring at Luraville	42.75	39.65	36.59	33.48	30.36
113	Running Springs (East and West) near Luraville	115.65	107.88	100.22	92.42	84.60
114	Convict Spring near Mayo	1.67	1.60	1.54	1.47	1.40
115	Royal Spring near Alton	1.99	1.94	1.88	1.83	1.77
116	Owens Spring	54.03	53.10	52.22	51.26	50.30
117	Mearson Spring near Mayo	68.47	67.23	66.06	64.79	63.51
118	Troy Spring near Branford	152.45	147.98	143.63	139.09	134.53
119	Little River Springs near Branford	57.26	55.59	53.96	52.26	50.56
120	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	256.98	253.64	250.85	247.08	243.21
121	Branford Springs at Branford	37.70	37.18	36.68	36.13	35.58
122	Steinhatchee Spring near Clara	1.57	1.38	1.18	0.99	0.80
123	Turtle Spring near Hatchbend and Fletcher Spring	53.86	53.04	52.24	51.41	50.57
124	Ginnie Spring near High Springs	52.08	51.09	50.20	49.10	47.99
125	Poe Springs near High Springs	59.51	58.08	56.82	55.25	53.64
126	Rock Bluff Springs near Bell	45.40	43.82	42.25	40.67	39.08
127	Guaranto Spring near Rock Bluff Landing	3.21	3.07	2.94	2.80	2.67
128	Copper Springs near Oldtown (including Little Copper Spring)	36.91	32.04	27.17	22.30	17.43
129	Blue Spring near Bronson	8.76	8.44	8.12	7.79	7.46
130	Wilson Head Spring near Holder	3.65	3.03	2.40	1.77	1.14
131	Blue Spring near Holder	12.57	11.60	10.62	9.64	8.66
132	Crystal Springs near Zephyrhills	33.87	32.90	31.93	30.95	29.98

Spring Pool

Sensitivity to spring pool elevation was examined by shifting all of the springs identified by Sepulveda (2002). These springs were located in the MegaModel as drains, river cells, or general head boundaries. All 3 packages were simultaneously shifted for these sensitivity simulations.

Aquifer Head Sensitivity

Residual head statistics for the spring pool sensitivity analysis are shown in Table 24. The original stage values in the river package, drain package, and general head boundary (GHB) package were shifted as shown in the table. As shown in the table, similar to the river stage sensitivity, the head statistics remained within calibration for simulations where spring pool was increased. When spring pool was shifted downward, the calibration of the model was not maintained.

Table 24. Spring Pool Sensitivity: Residual Statistic (feet)

	Minus 2'	**Minus 1'**	**Baseline**	**Plus 1'**	**Plus 2'**
Residual Mean	1.46	1.08	0.70	0.36	-0.02
Res. Std. Dev.	8.11	8.13	8.14	8.10	8.15
Sum of Squares	69003.69	68424.06	67876.78	66882.27	67634.46
Abs. Res. Mean	5.19	5.11	5.11	5.14	5.23
Min. Residual	-46.65	-46.75	-46.89	-46.81	-47.09
Max. Residual	52.90	55.91	55.93	54.99	57.79
Range in Target Values	214.10	214.10	214.10	214.10	214.10
Std. Dev./Range	0.04	0.04	0.04	0.04	0.04

Baseflow Sensitivity

Residual baseflow statistics were calculated for the spring pool simulations, as shown in Table 25. As shown in the table, the residual mean was not within calibration tolerance limits when spring pool was shifted downward. Baseflows for individual reaches are shown in Table 26 and Figure 11. Please refer to Table 6 for individual reach names.

Table 25. Spring Pool Sensitivity: Baseflow Statistics (cfs)

	Minus 2'	**Minus 1'**	**Baseline**	**Plus 1'**	**Plus 2'**
Residual Mean	-9.44	-9.06	-8.67	-8.26	-7.87
Absolute Residual Mean	25.20	24.88	24.57	24.23	23.92
Sum of Squares	94909.09	92914.11	91532.16	90636.57	90503.49

Table 26. Spring Pool Sensitivity: Baseflow by Reach (cfs)

	Spring Pool					
ReachID	**Minus 2’**	**Minus 1’**	**Baseline**	**Plus 1’**	**Plus 2’**	**Target Baseflow**
4	1100.32	1092.85	1085.38	1077.91	1070.44	1219.59
5	3.45	3.45	3.46	3.47	3.47	0.49
6	7.29	7.31	7.32	7.33	7.35	3.68
7	0.07	0.07	0.07	0.07	0.07	1.63
8	1.16	1.16	1.17	1.17	1.17	2.09
9	6.86	6.88	6.90	6.92	6.94	2.72
11	18.52	18.64	18.75	18.87	18.98	5.57
12	51.83	51.93	52.04	52.24	52.29	7.04
13	0.15	0.15	0.15	0.15	0.15	0.11
14	136.05	135.88	135.71	135.52	135.34	140.40
16	-0.04	-0.04	-0.04	-0.04	-0.04	0.00
17	1.40	1.43	1.45	1.48	1.51	1.92
18	54.48	54.77	55.06	55.35	55.65	30.45
19	167.99	168.37	168.76	169.14	169.53	41.79
20	5.24	5.25	5.27	5.28	5.29	9.53
21	0.52	0.52	0.53	0.53	0.53	2.00
33	38.83	44.84	50.86	56.88	62.91	182.96
34	19.18	19.21	19.24	19.26	19.29	7.47
35	0.90	0.91	0.92	0.92	0.93	2.06
36	45.13	45.27	45.42	45.56	45.70	43.73
37	6.38	6.47	6.55	6.64	6.73	3.27
38	717.01	713.24	709.48	705.70	701.92	553.60
39	39.88	40.11	40.33	40.55	40.77	29.02
44	667.08	653.00	638.80	624.66	610.17	607.96
45	43.76	45.01	46.26	47.53	48.80	19.52
46	111.63	113.39	115.17	116.21	118.01	15.59
47	24.91	25.22	25.53	25.85	26.08	0.00
48	10.35	10.42	10.50	10.64	11.02	2.88
49	3.96	3.96	3.97	3.98	3.98	1.90
51	12.15	12.33	12.51	12.69	12.86	21.54
52	6.07	6.13	6.20	6.26	6.32	8.87
55	2.04	2.07	2.10	2.13	2.16	0.30
56	0.56	0.57	0.58	0.59	0.60	2.13
58	3.58	3.60	3.62	3.65	3.67	0.60
61	3.79	3.80	3.80	3.79	3.80	1.46
62	3.25	3.25	3.26	3.26	3.26	0.90
63	10.05	10.06	10.08	10.09	10.10	1.70

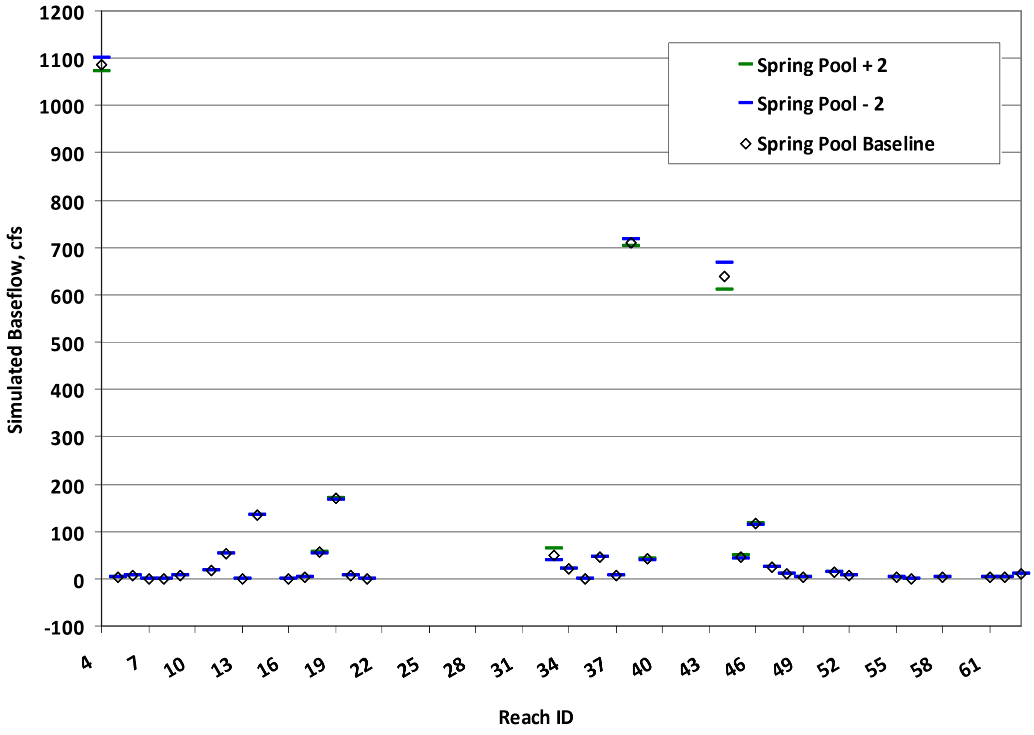


Figure 11. Changes in Baseflow Based on Modified Spring Pool Arrays

Springflow Sensitivity

Residual springflow statistics were calculated for the river stage simulations, as shown in Table 27. The springflow statistics remained within calibration tolerance limits only for the simulation where river stage was increased by 1-foot. Springflows for individual reaches are shown in Table 28 and Figure 12.

Table 27. Spring Pool Sensitivity: Springflow Statistics (cfs)

	Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
Residual Mean	3.30	1.06	-1.17	-3.41	-5.63
Absolute Residual Mean	6.76	5.25	4.61	5.38	6.85
Sum of Squares	25814.92	16001.23	12413.75	15115.85	24107.59

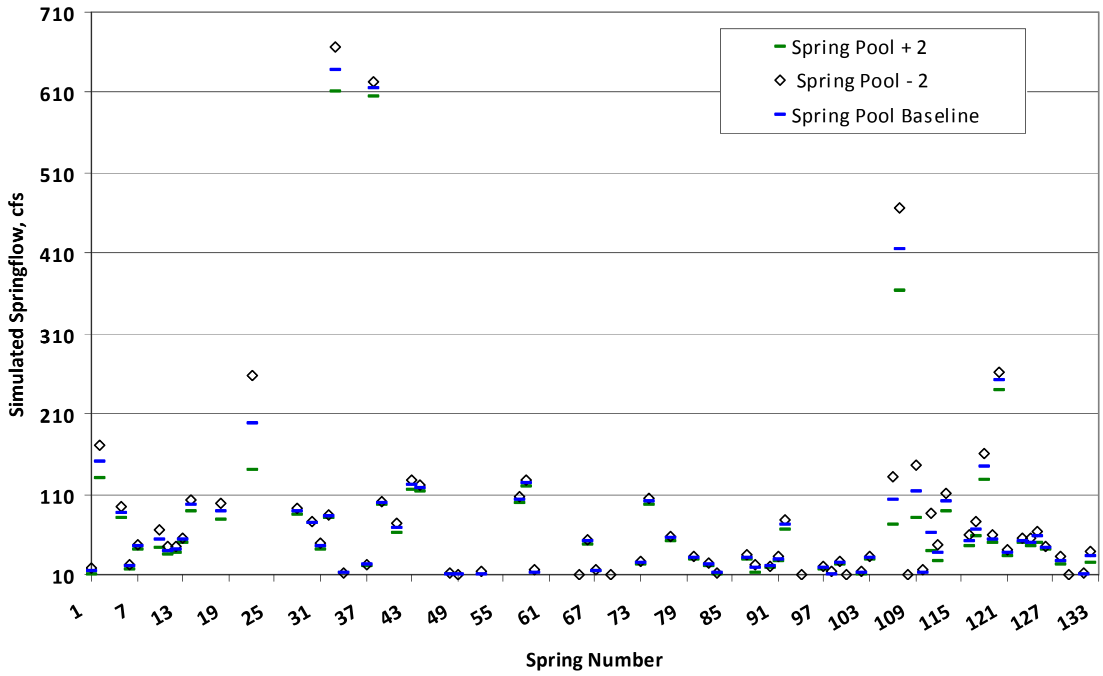


Figure 12. Springflow Variability with Spring Pool

Table 28. Spring Pool Sensitivity: Springflow (cfs)

Spring Number	Spring Name	Spring Pool				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
1	Holton Spring near Fort Union	18.36	16.46	14.57	12.67	10.77
2	Falmouth Spring at Falmouth	171.46	160.82	150.19	139.55	128.91
3	White Sulphur Springs at White Springs	3.47	-0.94	-5.34	-9.76	-14.18
4	Charles Springs near Dell	6.80	5.97	5.14	4.31	3.48
5	Peacock Springs	93.99	90.40	86.81	83.22	79.63
6	Ruth Spring near Branford	23.17	21.57	19.97	18.37	16.76
7	Ichetucknee Head Spring near Fort White and Cedar Head Spring	46.67	45.40	44.14	42.87	41.60
8	Green Cove Springs at Green Cove Springs	3.61	3.29	2.97	2.65	2.33
9	Jamison Spring	1.97	1.93	1.88	1.84	1.79
10	Hornsby Spring near High Springs	65.47	59.83	54.19	48.54	42.89
11	Blue Springs near High Springs (including Lilly Springs)	44.50	42.14	39.78	37.42	35.05
12	Crescent Beach Submarine Spring	45.74	43.42	41.10	38.77	36.45
13	Lumbercamp Springs and Sun Springs near Wannee	54.68	53.52	52.35	51.18	50.01
14	Hart Springs near Wilcox	102.62	99.22	95.83	92.43	89.04
15	Otter Springs near Wilcox	6.61	6.42	6.24	6.06	5.88
16	Whitewater Springs	1.64	1.34	1.03	0.73	0.42
17	Bell Springs	1.95	1.81	1.68	1.55	1.41

Spring Number	Spring Name	Spring Pool				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
18	Fannin Springs near Wilcox (including Little Fannin Spring)	98.83	93.85	88.87	83.89	78.91
19	Satsuma Spring	1.16	1.02	0.89	0.75	0.62
20	Orange Spring at Orange Springs	2.15	1.73	1.30	0.85	0.30
21	Blue Springs near Orange Springs	0.49	0.46	0.43	0.40	0.37
22	Manatee Spring near Chiefland	257.36	228.12	198.62	168.99	139.36
23	Camp Seminole Spring at Orange Springs	0.87	0.55	0.24	0.00	0.00
24	Welaka Spring near Welaka	0.00	0.00	0.00	0.00	0.00
25	Mud Spring near Welaka	2.26	2.10	1.94	1.79	1.63
26	Beecher Springs near Fruitland	6.24	6.20	6.15	6.11	6.06
27	Tobacco Patch Landing Spring Group near Fort McCoy	0.94	0.88	0.82	0.77	0.71
28	Croaker Hole Spring near Welaka	91.76	89.72	87.67	85.79	83.72
29	Wells Landing Springs near Fort McCoy	4.59	4.23	3.86	3.55	3.17
30	Salt Springs near Eureka	75.30	74.75	74.20	73.76	73.20
31	Wekiva Springs near Gulf Hammock	50.06	47.65	45.24	42.83	40.42
32	Silver Glen Springs near Astor	83.61	82.61	81.62	80.65	79.64
33	Silver Springs near Ocala	666.90	652.79	638.55	624.38	609.86
34	Sweetwater Springs along Juniper Creek	12.76	12.62	12.47	12.34	12.19
35	Juniper Springs and Fern Hammock Springs near Ocala	7.23	7.08	6.92	6.76	6.60
36	Morman Branch Seepage into Juniper Creek and Juniper Creek Tributary near Astor	4.83	4.67	4.51	4.35	4.19
37	Ponce de Leon Springs near De Land	23.24	22.67	22.09	21.45	20.77
38	Rainbow Springs near Dunnellon	623.97	619.00	614.02	609.04	604.01
39	Alexander Springs near Astor	101.50	100.35	99.14	97.88	96.59
40	Mosquito Springs Run Alexander Springs Wilderness	1.11	0.63	0.14	0.00	0.00
41	Gum Springs near Holder	73.92	70.95	67.97	64.99	61.99
42	Camp La No Che Springs near Paisley	0.41	0.00	0.00	0.00	0.00
43	Blue Spring near Orange City	126.71	123.76	120.73	117.55	114.29
44	Crystal River Spring Group	694.53	682.96	671.36	659.84	648.22
45	Blackwater Springs near Cassia	0.00	0.00	0.00	0.00	0.00
46	Little Jones Creek Head Spring near Wildwood	8.73	8.09	7.44	6.77	6.09
47	Little Jones Creek Spring No. 2 near Wildwood	5.98	5.40	4.81	4.19	3.58
48	Messant Spring near Sorrento	11.35	11.01	10.64	10.24	9.84
49	Gemini Springs near DeBary (all 3)	10.08	9.72	9.35	8.96	8.57
50	Green Springs	0.47	0.25	0.02	0.00	0.00
51	Little Jones Creek Spring No. 3 near Wildwood	3.60	3.24	2.88	2.51	2.14
52	Seminole Springs near Sorrento	13.77	11.69	9.51	7.22	4.91
53	Palm Springs Seminole State Forest	0.92	0.27	0.00	0.00	0.00
54	Halls River Head Spring	4.92	4.84	4.76	4.67	4.59
55	Droty Springs near Sorrento	0.00	0.00	0.00	0.00	0.00
56	Island Spring near Sanford	6.69	6.30	5.87	5.41	4.95
57	Halls River Springs	107.46	105.48	103.49	101.50	99.51
58	Homosassa Springs Southeast Fork of Homosassa Springs and Trotter Spring at Homosassa Springs	128.19	125.78	123.36	120.94	118.52

Spring Number	Spring Name	Spring Pool				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
59	Fenney Springs near Coleman Head Spring of Shady Brook Creek	15.28	13.63	11.97	10.31	8.64
60	Shady Brook Creek Springs No. 2 and 3	6.33	6.06	5.79	5.52	5.24
61	Hidden River Springs near Homosassa (including Hidden River Head Spring)	7.25	7.07	6.88	6.69	6.51
62	Shady Brook Creek Spring No. 4	3.49	3.19	2.89	2.59	2.29
63	Sulphur Camp Springs	0.67	0.42	0.15	0.00	0.00
64	Shady Brook Creek Spring No. 5	3.76	3.34	2.92	2.50	2.07
65	Bugg Spring at Okahumpka	10.80	9.59	8.38	7.17	5.86
66	Rock Springs near Apopka	53.45	51.91	50.33	48.67	46.89
67	Potter Spring near Chassahowitzka (including Ruth Spring)	15.59	15.18	14.76	14.35	13.94
68	Mooring Cove Springs near Yalaha	0.00	0.00	0.00	0.00	0.00
69	Blue Springs near Yalaha and Holiday Springs at Yalaha and106	9.62	6.83	4.03	1.22	0.00
70	Salt Creek Head Spring	0.42	0.41	0.40	0.39	0.38
71	Lettuce Creek Spring	4.01	3.89	3.77	3.65	3.53
72	Witherington Spring near Apopka	1.04	0.96	0.88	0.79	0.70
73	Unnamed Tributary above Chassahowitzka Springs and Baird Creek Head Spring near Chassahowitzka	25.67	25.07	24.46	23.86	23.26
74	Crab Creek Spring and Chassahowitzka Springs near Chassahowitzka	105.09	102.85	100.60	98.35	96.11
75	Beteejay Lower Spring near Chassahowitzka (including Beteejay Head Spring)	8.02	7.79	7.56	7.33	7.09
76	Rita Maria Spring near Chassahowitzka	3.71	3.61	3.50	3.40	3.29
77	Wekiwa Springs in State Park near Apopka	56.93	55.72	54.50	53.27	52.02
78	Miami Springs near Longwood	3.98	3.88	3.78	3.67	3.57
79	Lake Jesup Spring near Wagner	0.94	0.68	0.43	0.17	0.00
80	Unnamed Spring No. 10-12; Ryle Creek Lower Spring; and Ryle Creek Head Spring near Bayport	32.02	30.99	29.95	28.91	27.87
81	Blue Run Head Spring near Chassahowitzka	4.91	4.79	4.66	4.54	4.41
82	Palm Springs and Sanlando Springs near Longwood	23.64	22.71	21.78	20.84	19.88
83	Starbuck Spring near Longwood	12.69	12.19	11.68	11.17	10.65
84	Clifton Springs near Oviedo	3.42	2.50	1.58	0.65	0.00
85	Unnamed Spring No. 8	6.03	5.78	5.53	5.28	5.04
86	Double Run Road Seepage near Astatula	3.28	2.51	1.74	0.97	0.16
87	Blind Creek Springs (including unnamed spring No. 7 and Blind Creek Head Spring)	35.08	33.33	31.58	29.83	28.07
88	Apopka (Gourdneck) Spring near Oakland	21.88	19.69	17.50	15.31	13.10
89	Unnamed Spring No. 6	5.14	4.90	4.67	4.44	4.20
90	Salt Spring and Mud Spring near Bayport	21.24	20.44	19.63	18.83	18.03
91	Jenkins Creek Spring No. 5 and Unnamed Spring No. 4	32.06	30.75	29.45	28.15	26.84
92	Weeki Wachee Springs near Brooksville	78.61	75.25	71.89	68.53	65.17
93	Unnamed Spring No. 2	1.68	1.52	1.35	1.18	1.02

Spring Number	Spring Name	Spring Pool				
		Minus 2’	Minus 1’	Baseline	Plus 1’	Plus 2’
94	Boat Spring; Unnamed Spring No. 1; and Magnolia Springs at Aripeka	9.18	8.77	8.37	7.96	7.56
95	Bobhill Springs	4.08	3.68	3.27	2.86	2.45
96	Horseshoe Spring near Hudson	6.86	6.63	6.41	6.18	5.95
97	Unnamed Spring No. 3 near Aripeka	19.91	18.86	17.80	16.74	15.68
98	Salt Springs near Port Richey	13.15	11.89	10.62	9.35	8.08
99	Sulphur Springs at Sulphur Springs	26.92	25.58	24.24	22.90	21.56
100	Lettuce Lake Spring	10.07	8.85	7.64	6.42	5.21
101	Six-Mile Creek Spring and Eureka Springs near Tampa	3.03	2.71	2.39	2.08	1.76
102	Buckhorn Spring near Riverview	14.58	13.39	12.19	11.00	9.80
103	Lithia Springs Minor and Lithia Springs Major near Lithia	33.62	32.21	30.80	29.38	27.96
104	Little Salt Spring near Murdock	1.21	1.04	0.87	0.71	0.54
105	Warm Mineral Springs near Woodmere	7.08	6.82	6.56	6.30	6.04
106	Blue Spring near Madison	132.33	117.28	102.22	87.16	72.10
107	Alapaha Rise near Fort Union	466.62	440.57	414.51	388.44	362.36
108	Suwannee Springs near Live Oak	10.79	9.15	7.52	5.88	4.24
109	Suwanacoochee Spring and Ellaville Spring at Ellaville	145.42	129.30	113.18	97.05	80.93
110	Allen Mill Pond Spring near Dell	15.75	14.04	12.33	10.62	8.90
111	Blue Spring near Dell	85.63	73.75	61.87	49.99	38.12
112	Telford Spring at Luraville	47.37	41.98	36.59	31.20	25.80
113	Running Springs (East and West) near Luraville	111.46	105.84	100.22	94.60	88.98
114	Convict Spring near Mayo	1.68	1.61	1.54	1.46	1.39
115	Royal Spring near Alton	2.07	1.98	1.88	1.79	1.69
116	Owens Spring	58.65	55.43	52.22	49.00	45.79
117	Mearson Spring near Mayo	75.13	70.60	66.06	61.53	56.99
118	Troy Spring near Branford	159.78	151.71	143.63	135.56	127.48
119	Little River Springs near Branford	59.27	56.62	53.96	51.30	48.65
120	Blue Hole Roaring Singing Boiling Mill Pond Grassy Hole and Coffee Springs (parts of Ichetucknee Springs)	262.30	256.57	250.85	245.11	239.37
121	Branford Springs at Branford	40.17	38.42	36.68	34.93	33.18
122	Steinhatchee Spring near Clara	1.60	1.39	1.18	0.98	0.77
123	Turtle Spring near Hatchbend and Fletcher Spring	54.91	53.58	52.24	50.91	49.58
124	Ginnie Spring near High Springs	56.00	53.10	50.20	47.29	44.38
125	Poe Springs near High Springs	64.49	60.66	56.82	52.98	49.14
126	Rock Bluff Springs near Bell	44.41	43.33	42.25	41.17	40.09
127	Guaranto Spring near Rock Bluff Landing	3.08	3.01	2.94	2.87	2.80
128	Copper Springs near Oldtown (including Little Copper Spring)	32.16	29.67	27.17	24.67	22.18
129	Blue Spring near Bronson	9.59	8.86	8.12	7.38	6.65
130	Wilson Head Spring near Holder	4.08	3.24	2.40	1.56	0.71
131	Blue Spring near Holder	12.91	11.76	10.62	9.48	8.33
132	Crystal Springs near Zephyrhills	39.62	35.77	31.93	28.08	24.24

Model Calibration Summary

A summary of the model calibration for the sensitivity analysis runs is shown in Table 29. As shown in the Table, all parameters demonstrated significant overall changes in calibration, with the exception of drain conductance. Drain conductance changes resulted in insignificant changes in the model calibration. This is most likely due to the narrow range of the simulations run for this parameter; this narrow range was a result of the District's desire to not modify the solver package of the MegaModel during the sensitivity analysis.

Table 29. Summary of the Model Calibration for the Sensitivity Analysis

Parameter	Calibration Statistic	Simulations where model remains calibrated (insignificant changes)	Overall Changes in Calibration
Drain Conductance	Head	0.9, 0.95, 1.05, 1.1	Insignificant
	Baseflow	0.9, 0.95, 1.05, 1.1	
	Springflow	0.9, 0.95, 1.05, 1.1	
Hydraulic Conductivity	Head	0.1, 0.5	Significant
	Baseflow	0.1, 0.5, 2, 10	
	Springflow	0.1, 0.5, 2	
River Conductance	Head	1.01, 1.015	Significant
	Baseflow	0.1, 0.5, 1.01, 1.015	
	Springflow	1.01, 1.015	
River Stage	Head	1,2	Significant
	Baseflow	-2, -1, 1, 2	
	Springflow	1	
Spring Pool	Head	1,2	Significant
	Baseflow	1,2	
	Springflow	-1	

Sensitivity Analysis Results: Model Conclusions

The classification of a model sensitivity as Type I through IV is based on both the model results (the calibration), and the model conclusions (in this case, the prediction). Ultimately, the MegaModel is being utilized by the District for updating the general head boundary (GHB) heads on the 2030 predictive simulation of the Northeast Florida Model (NEF). It was desired by the District to impose the Upper Floridan and Lower Floridan drawdowns of the MegaModel on the GHB heads in the 2030 predictive simulation of the NEF. A summary of the layer representations of each model is shown in Table 30. As shown in the table, the Upper Floridan Aquifer corresponds to layer 3 in the MegaModel, and layer 2 in the NEF. Similarly, the Lower Floridan Aquifer corresponds to layer 4 in the MegaModel and layer 3 in the NEF. Since the model conclusions of the MegaModel are ultimately the drawdowns in the Upper and Lower Floridan Aquifers, 2030 simulations were run for each of the sensitivity simulations in order to examine the variability of drawdown in each of the aquifers. The locations of the MegaModel cells used to modify the NEF GHB package are shown in Figure 13.

Table 30. Summary of MegaModel and NEF Layer Representations

Aquifer Representation	MegaModel Layer	NEF Layer
Surficial Aquifer	1	1
Intermediate Aquifer	2	Not Represented
Upper Floridan Aquifer	3	2
Lower Floridan Aquifer	4	3
Fernandina Permeable Zone	Not Represented	4

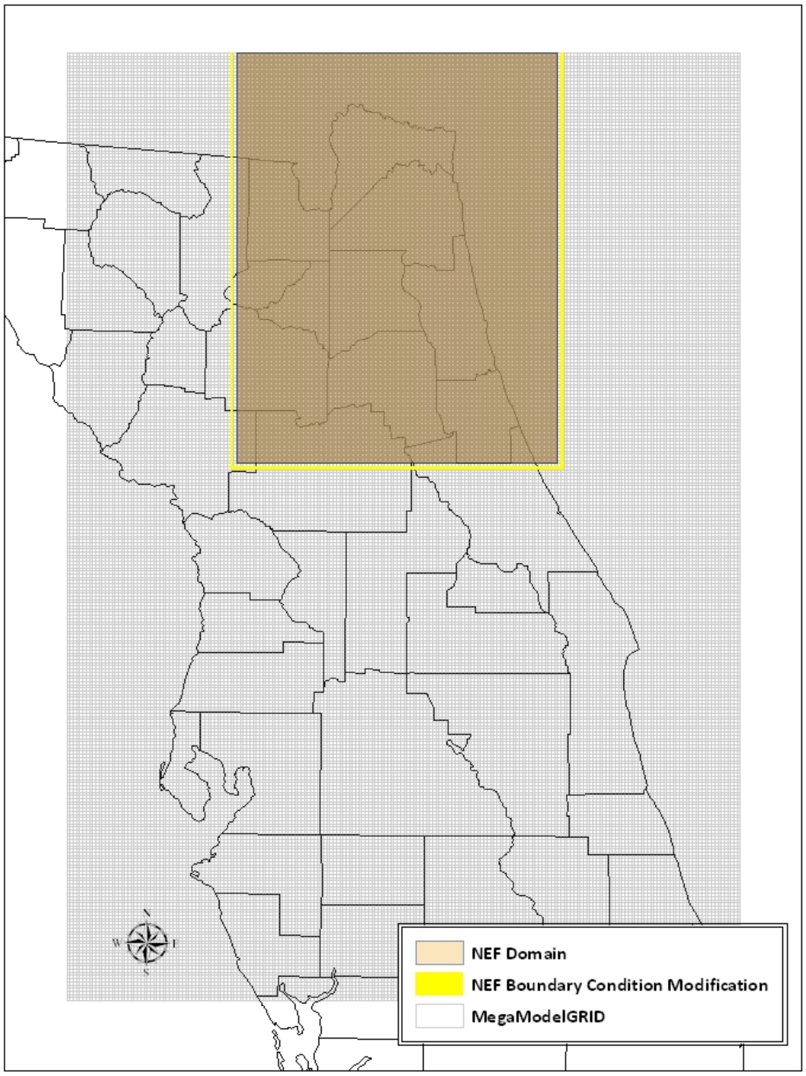


Figure 13. Location of the MegaModel Cells Used to Modify the NEF GHB Package

Drain Conductance

The drawdown statistics and profiles for drain conductance sensitivity are shown in Table 31 and Figures 14 and 15. As shown in the table, there was little change in the average drawdown across each boundary in both the Upper and Lower Floridan Aquifers as drain conductance was changed. Based on the drawdown profiles and statistics, it can be concluded that the model conclusions are insensitive to drain conductance and the change in the model conclusions is insignificant for all simulations. Since this simulation has insignificant changes in both the model results and conclusions, drain conductance sensitivity can be classified as Type I.

Table 31. Drain Conductance: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	Drain Conductance Factor				
			0.9	**0.95**	**1**	**1.05**	**1.1**
Western	3	min	0.21	0.21	0.21	0.21	0.21
		max	2.68	2.68	2.68	2.68	2.68
		avg	1.38	1.38	1.37	1.37	1.37
		stdev	0.71	0.71	0.71	0.71	0.71
	4	min	0.78	0.78	0.77	0.77	0.77
		max	3.54	3.54	3.53	3.53	3.53
		avg	2.11	2.10	2.10	2.10	2.10
		stdev	0.83	0.83	0.83	0.83	0.83
Eastern	3	min	0.21	0.21	0.21	0.21	0.21
		max	6.98	6.97	6.97	6.97	6.97
		avg	4.59	4.59	4.59	4.59	4.59
		stdev	2.04	2.04	2.04	2.04	2.04
	4	min	3.26	3.26	3.26	3.26	3.26
		max	8.55	8.54	8.54	8.54	8.54
		avg	5.99	5.98	5.98	5.98	5.98
		stdev	1.66	1.66	1.66	1.66	1.66
Southern	3	min	0.00	0.00	0.00	0.00	0.00
		max	6.91	6.91	6.91	6.91	6.90
		avg	1.73	1.72	1.72	1.72	1.72
		stdev	2.23	2.23	2.23	2.23	2.23
	4	min	0.54	0.54	0.54	0.54	0.54
		max	6.70	6.70	6.70	6.70	6.70
		avg	1.64	1.63	1.63	1.63	1.63
		stdev	1.75	1.75	1.75	1.75	1.75

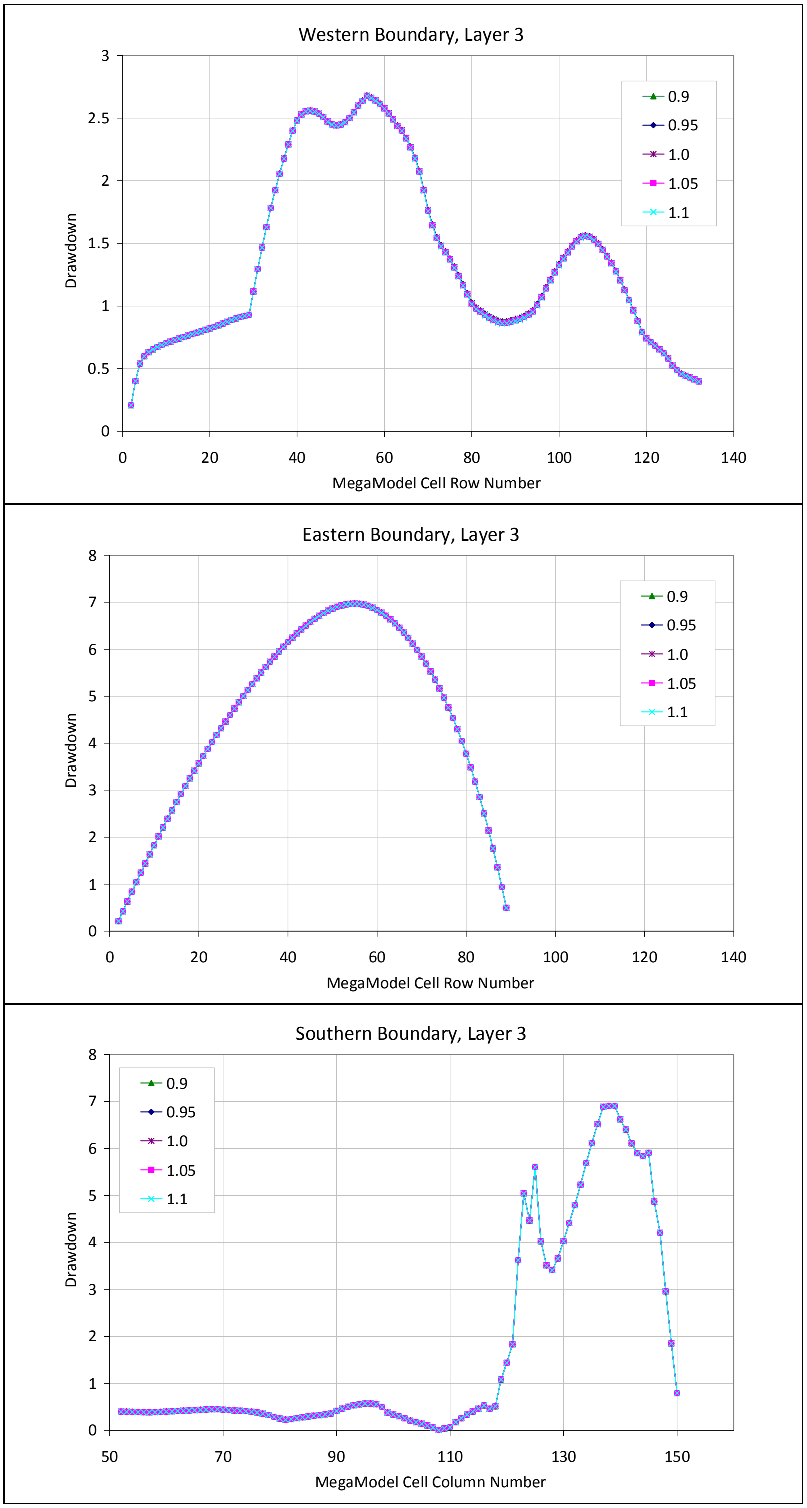


Figure 14. Drain Conductance: Layer 3 Drawdown Profiles

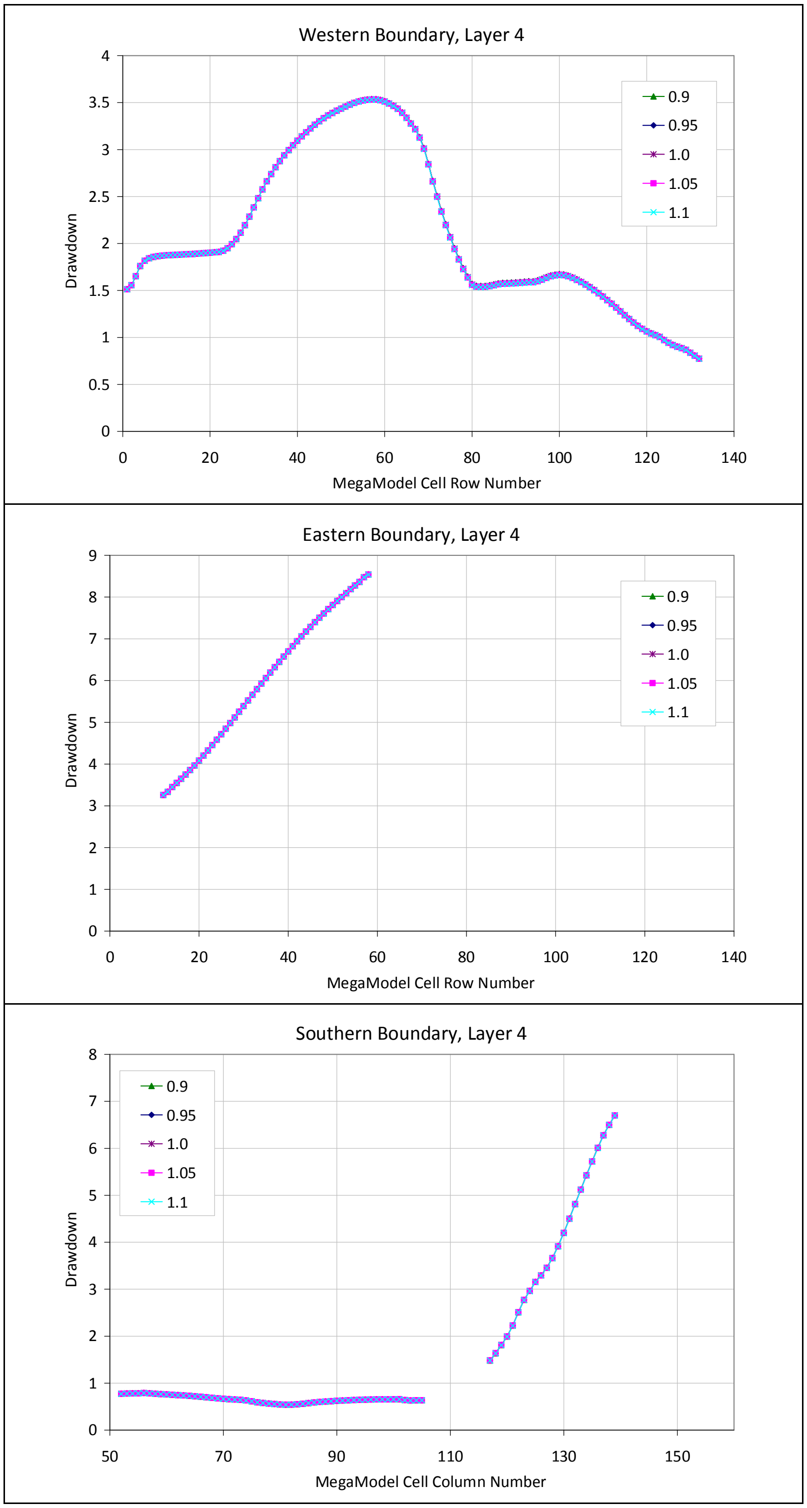


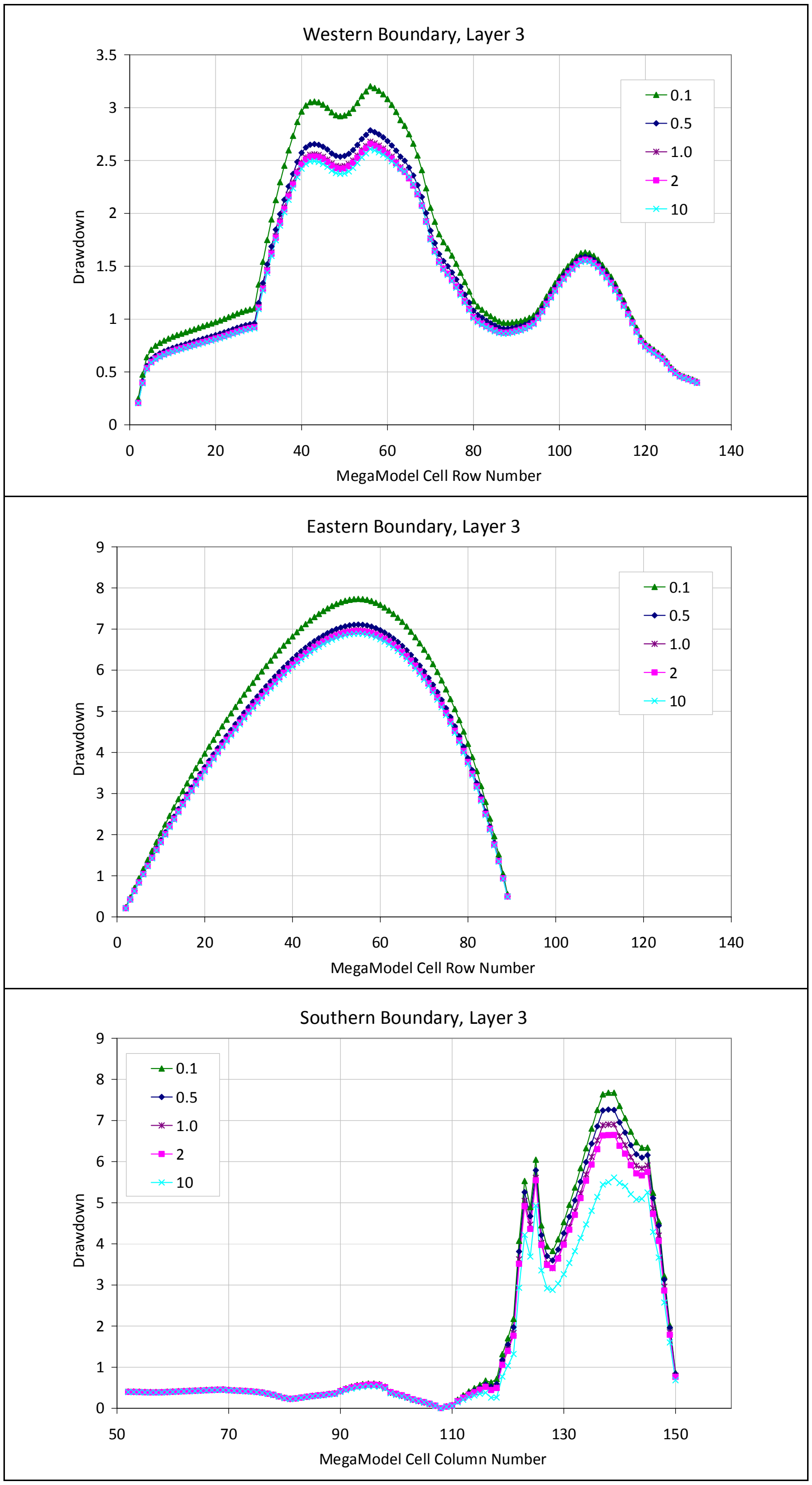
Figure 15. Drain Conductance: Layer 4 Drawdown Profiles

Hydraulic Conductivity

The drawdown statistics and profiles for hydraulic conductivity (layer 1) sensitivity are shown in Table 32 and Figures 16 and 17. As shown in the table, there was little change in the average drawdown across each boundary in both the Upper and Lower Floridan Aquifers as hydraulic conductivity was changed. Drawdown increased slightly as hydraulic conductivity was decreased, but the changes in drawdown compared to the baseline condition were minimal. Based on the drawdown profiles and statistics, it can be concluded that the model conclusions are insensitive to hydraulic conductivity and the change in the model conclusions is insignificant for all simulations. Since the modification of hydraulic conductivity results in significant changes in the model results for several simulations and insignificant changes in the model conclusions, hydraulic conductivity sensitivity can be classified as Type II.

Table 32. Hydraulic Conductivity: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	Hydraulic Conductivity Factor				
			0.1	**0.5**	**1**	**2**	**10**
Western	3	Min	0.25	0.22	0.21	0.21	0.20
		Max	3.20	2.79	2.68	2.66	2.61
		Avg	1.58	1.42	1.37	1.37	1.35
		Stdev	0.87	0.75	0.71	0.71	0.70
	4	Min	0.81	0.79	0.77	0.78	0.77
		Max	4.20	3.67	3.53	3.52	3.47
		Avg	2.43	2.17	2.10	2.09	2.07
		Stdev	1.04	0.87	0.83	0.82	0.81
Eastern	3	Min	0.24	0.22	0.21	0.21	0.21
		Max	7.73	7.11	6.97	6.95	6.89
		Avg	5.10	4.68	4.59	4.57	4.53
		Stdev	2.26	2.08	2.04	2.03	2.01
	4	Min	3.64	3.33	3.26	3.25	3.22
		Max	9.49	8.71	8.54	8.52	8.44
		Avg	6.65	6.10	5.98	5.96	5.91
		Stdev	1.84	1.69	1.66	1.65	1.64
Southern	3	Min	0.00	0.00	0.00	0.00	0.00
		Max	7.68	7.26	6.91	6.65	5.61
		Avg	1.90	1.80	1.72	1.69	1.45
		Stdev	2.47	2.34	2.23	2.16	1.83
	4	Min	0.57	0.54	0.54	0.55	0.54
		Max	7.34	7.00	6.70	6.46	5.37
		Avg	1.79	1.69	1.63	1.61	1.39
		Stdev	1.94	1.84	1.75	1.68	1.35


Western Boundary, Layer 3

Eastern Boundary, Layer 3

Southern Boundary, Layer 3

Figure 16. Hydraulic Conductivity: Layer 3 Drawdown Profiles

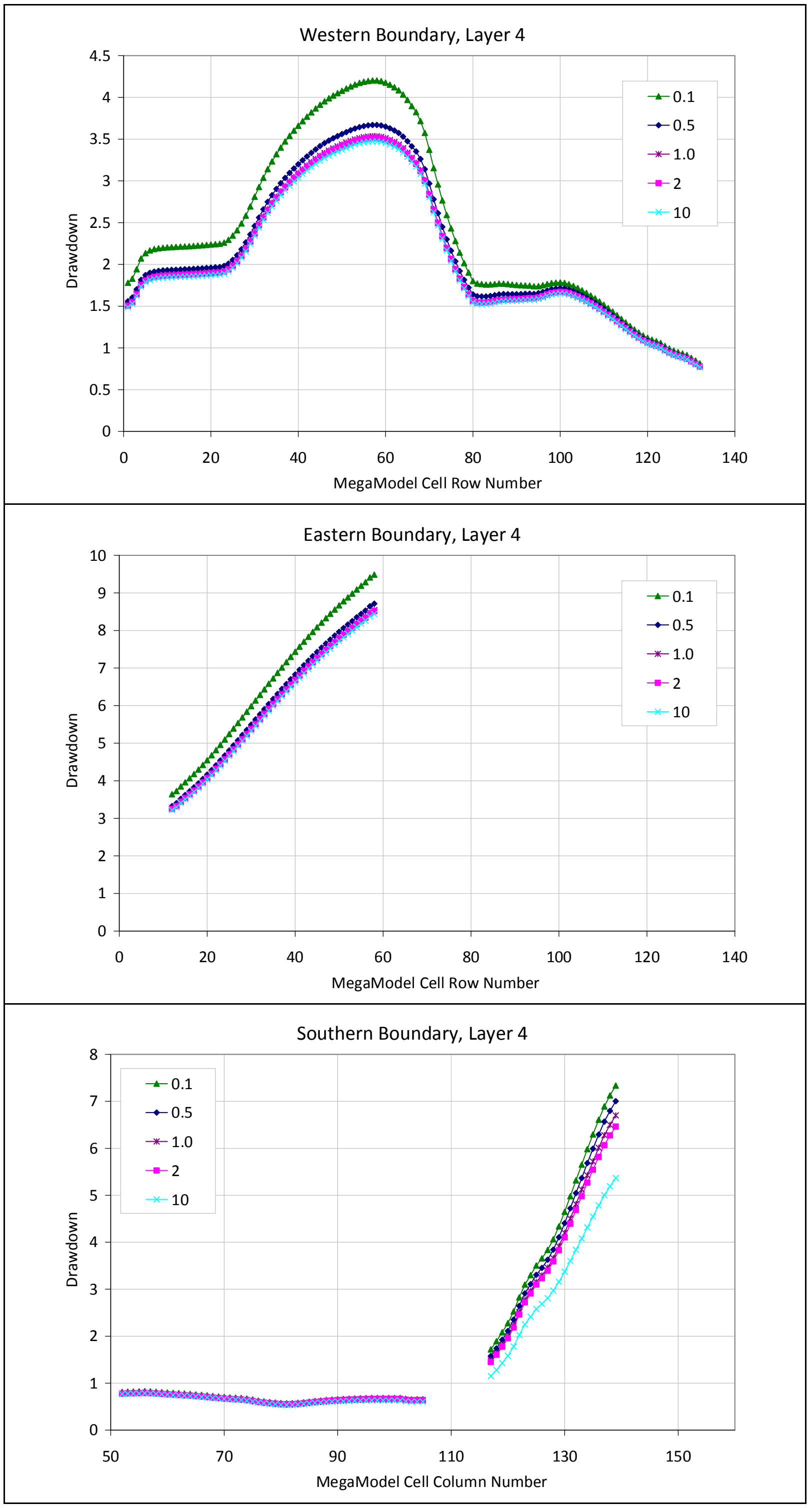


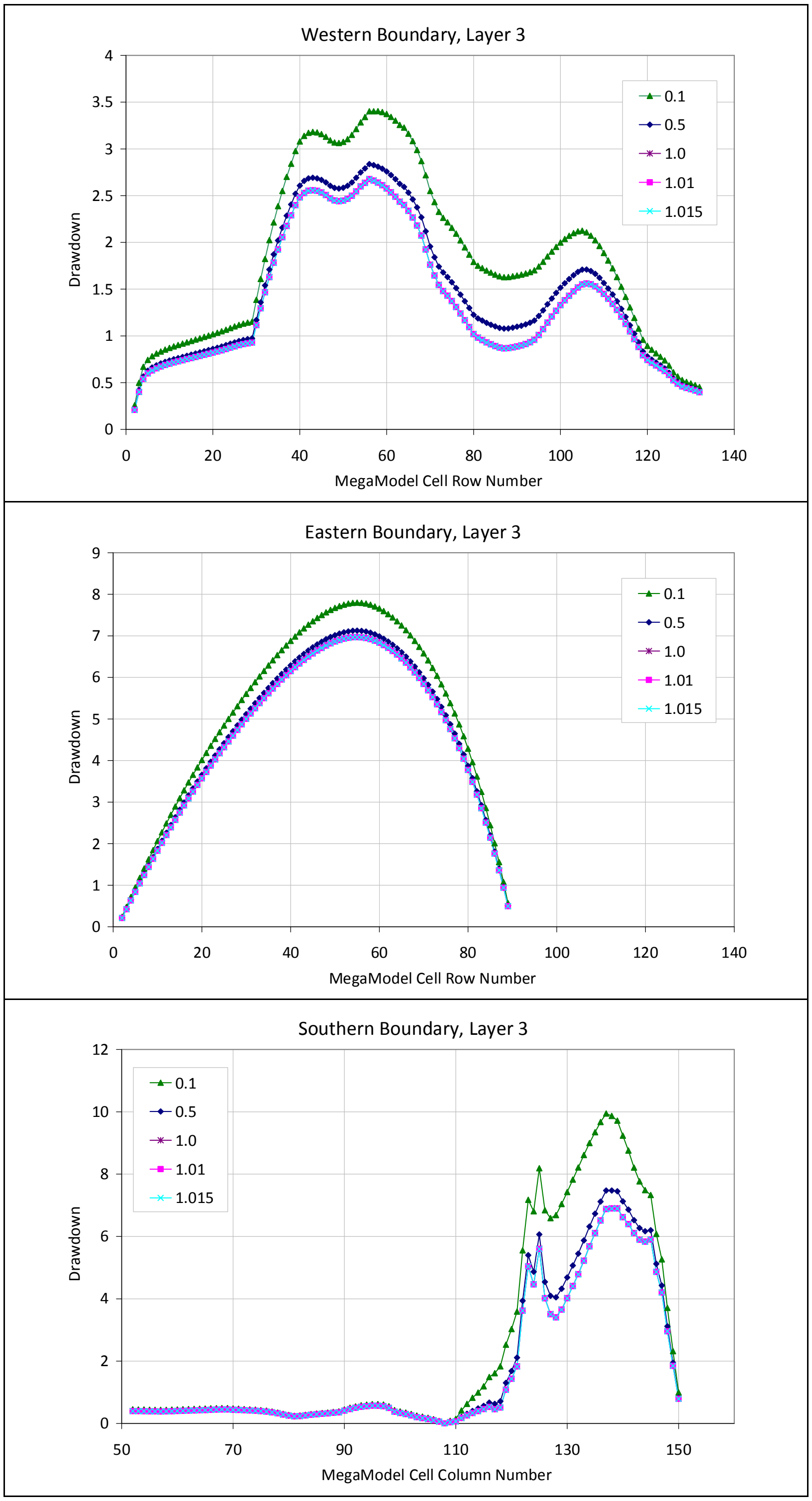
Figure 17. Hydraulic Conductivity: Layer 4 Drawdown Profiles

River Conductance

The drawdown statistics and profiles for river conductance sensitivity are shown in Table 33 and Figures 18 and 19. As shown in the table, there was little change in the average drawdown across the Western and Eastern boundaries in both the Upper and Lower Floridan Aquifers as river conductance was changed. Based on the drawdown profiles and statistics, it can be concluded that the model conclusions are moderately sensitive to river conductance, particularly along the southern boundary of the NEF. Whether or not this sensitivity causes the model conclusions to change significantly ultimately depends of the sensitivity of the NEF to changes in the GHB heads. For an analysis of the NEF sensitivity to GHB heads, please refer to the NEF documentation (INTERA 2011). Since the modification of river conductance results in an insignificant change in the model calibration, and either a significant or insignificant change in model conclusions, river conductance sensitivity can be classified as either Type II or Type III.

Table 33. River Conductance: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	River Conductance Factor				
			0.1	**0.5**	**1**	**1.01**	**1.015**
Western	3	min	0.26	0.22	0.21	0.21	0.21
		max	3.40	2.84	2.68	2.68	2.67
		avg	1.86	1.49	1.37	1.37	1.37
		stdev	0.91	0.75	0.71	0.71	0.71
	4	min	0.94	0.81	0.77	0.77	0.77
		max	4.45	3.73	3.53	3.53	3.53
		avg	2.69	2.24	2.10	2.10	2.10
		stdev	1.02	0.86	0.83	0.83	0.83
Eastern	3	min	0.24	0.22	0.21	0.21	0.21
		max	7.80	7.13	6.97	6.97	6.97
		avg	5.15	4.69	4.59	4.59	4.59
		stdev	2.28	2.08	2.04	2.04	2.04
	4	min	3.69	3.34	3.26	3.26	3.26
		max	9.56	8.73	8.54	8.54	8.54
		avg	6.70	6.12	5.98	5.98	5.98
		stdev	1.84	1.69	1.66	1.66	1.66
Southern	3	min	0.00	0.00	0.00	0.00	0.00
		max	9.95	7.48	6.91	6.90	6.90
		avg	2.56	1.88	1.72	1.72	1.72
		stdev	3.32	2.43	2.23	2.23	2.23
	4	min	0.60	0.55	0.54	0.54	0.54
		max	9.16	7.20	6.70	6.69	6.69
		avg	2.37	1.77	1.63	1.63	1.63
		stdev	2.73	1.93	1.75	1.74	1.74


Western Boundary, Layer 3

Eastern Boundary, Layer 3

Southern Boundary, Layer 3

Figure 18. River Conductance: Layer 3 Drawdown Profiles

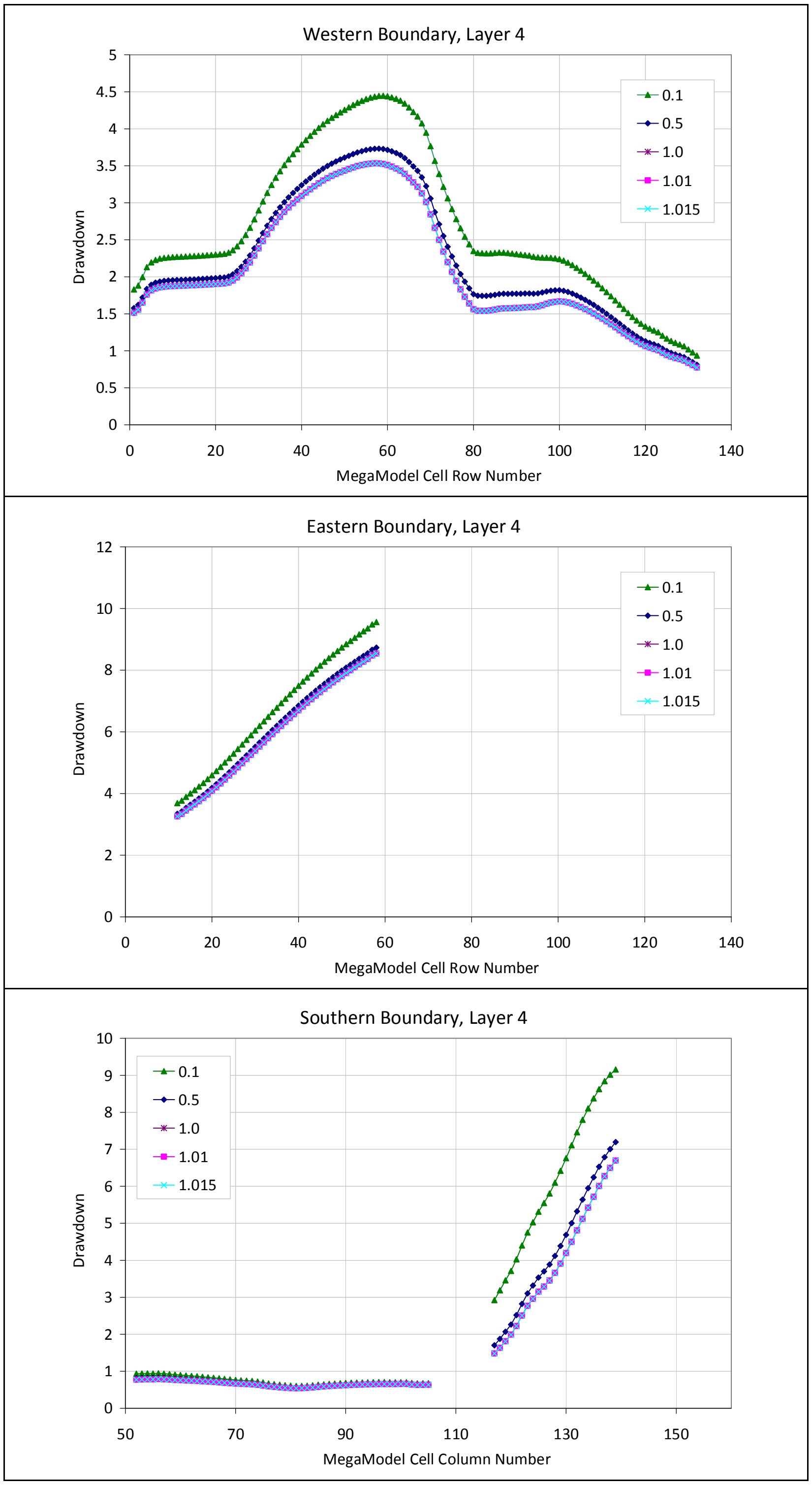


Figure 19. River Conductance: Layer 4 Drawdown Profiles

River Stage

The drawdown statistics and profiles for river stage sensitivity are shown in Table 34 and Figures 20 and 21. As shown in the table, there was very little change in the average drawdown across each boundary in both the Upper and Lower Floridan Aquifers as river stage was shifted. Based on the drawdown profiles and statistics, it can be concluded that the model conclusions are insensitive to river stage and the change in the model conclusions is insignificant for all simulations. Since the modification of river stage results in a significant change in the model results for several factors and insignificant changes in model conclusions, river stage sensitivity can be classified as Type II.

Table 34. River Stage: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	River Stage Shift				
			-2 ft	**-1 ft**	**0**	**+ 1 ft**	**+ 2 ft**
Western	3	min	0.22	0.21	0.21	0.21	0.21
		max	2.78	2.72	2.68	2.65	2.63
		avg	1.42	1.39	1.37	1.36	1.35
		stdev	0.74	0.73	0.71	0.71	0.70
	4	min	0.80	0.78	0.77	0.77	0.76
		max	3.67	3.59	3.53	3.50	3.47
		avg	2.18	2.13	2.10	2.08	2.07
		stdev	0.86	0.84	0.83	0.82	0.81
Eastern	3	min	0.22	0.21	0.21	0.21	0.21
		max	7.12	7.02	6.97	6.94	6.91
		avg	4.69	4.62	4.59	4.56	4.54
		stdev	2.08	2.05	2.04	2.03	2.02
	4	min	3.34	3.29	3.26	3.24	3.23
		max	8.73	8.61	8.54	8.50	8.46
		avg	6.11	6.03	5.98	5.95	5.92
		stdev	1.69	1.67	1.66	1.65	1.64
Southern	3	min	0.00	0.00	0.00	0.00	0.00
		max	7.00	6.94	6.91	6.92	6.90
		avg	1.75	1.73	1.72	1.73	1.72
		stdev	2.26	2.24	2.23	2.24	2.23
	4	min	0.56	0.55	0.54	0.53	0.53
		max	6.77	6.73	6.70	6.71	6.69
		avg	1.66	1.65	1.63	1.63	1.62
		stdev	1.77	1.75	1.75	1.76	1.75

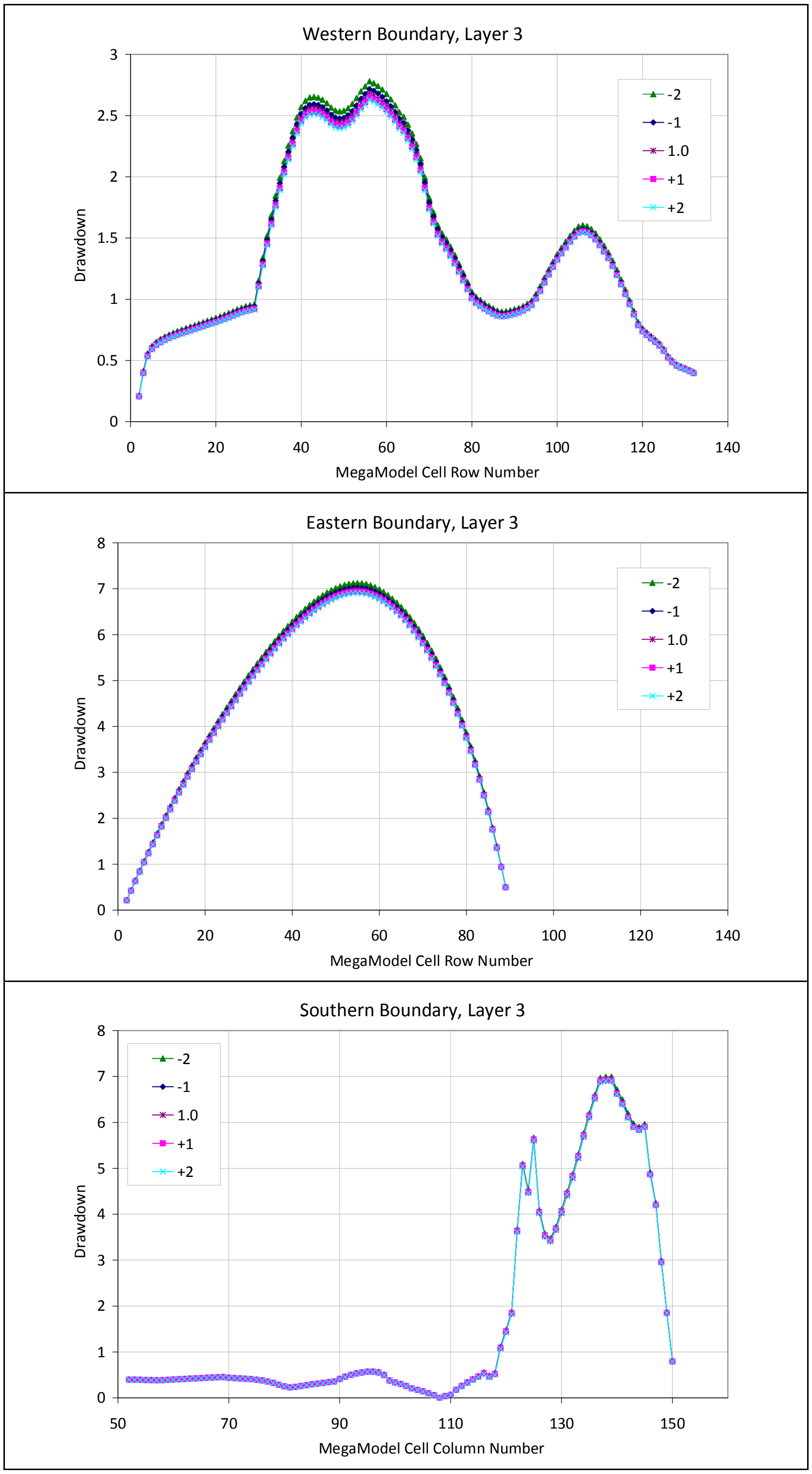


Figure 20. River Stage: Layer 3 Drawdown Profiles

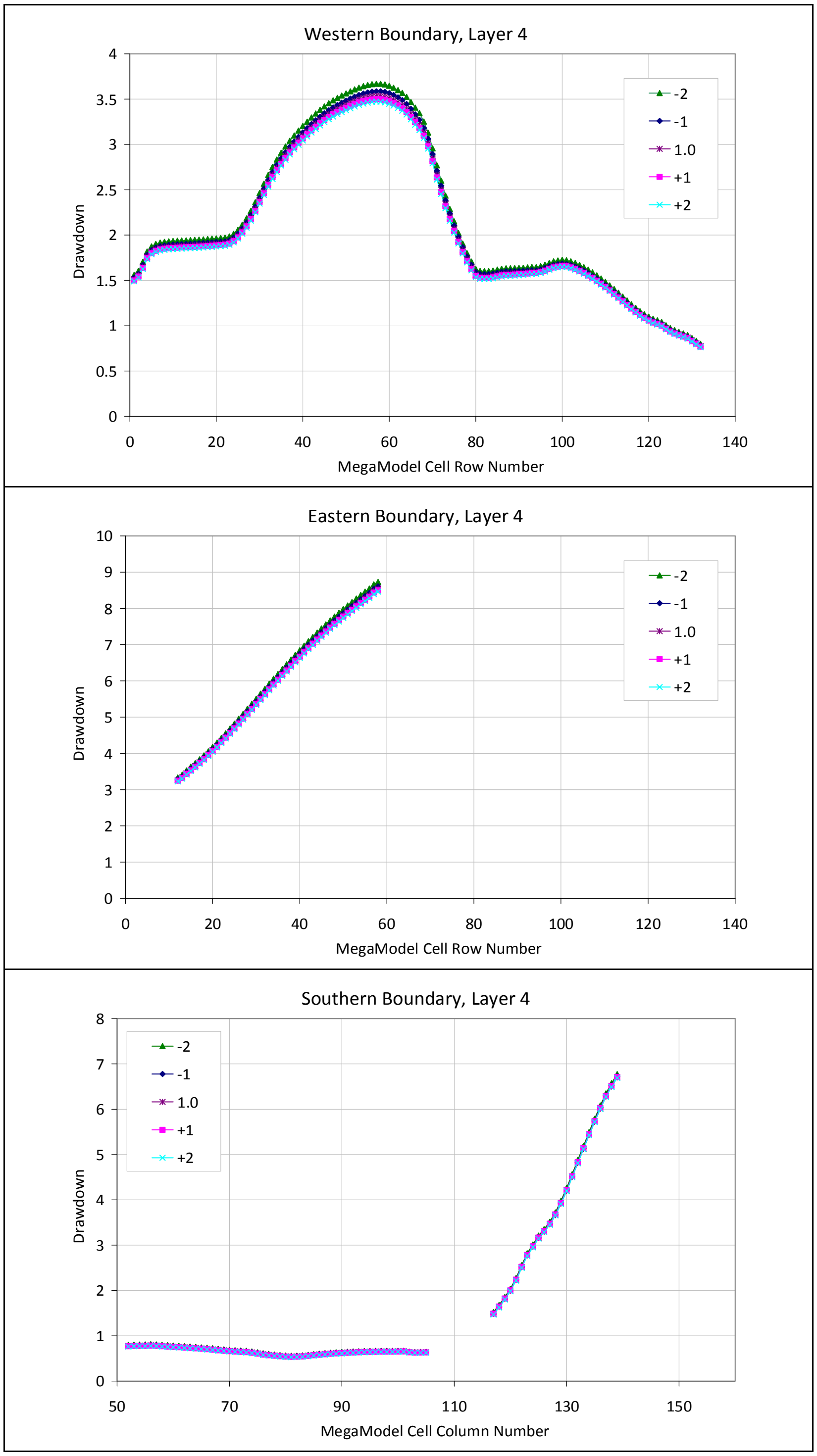


Figure 21. River Stage: Layer 4 Drawdown Profiles

Spring Pool

The drawdown statistics and profiles for spring sensitivity are shown in Table 35 and Figures 22 and 23. As shown in the table, there was very little change in the average drawdown across each boundary in both the Upper and Lower Floridan Aquifers as spring pool was shifted. Based on the drawdown profiles and statistics, it can be concluded that the model conclusions are insensitive to spring pool and the change in the model conclusions is insignificant for all simulations. Since the modification of spring pool results in a significant change in the model results for several factors and insignificant changes in model conclusions, river stage sensitivity can be classified as Type II.

Table 35. Spring Pool: Drawdown Statistics

NEF Boundary	Mega Model Layer	Statistic	Spring Pool Shift				
			-2 ft	-1 ft	0	+ 1 ft	+ 2 ft
Western	3	min	0.21	0.21	0.21	0.21	0.21
		max	2.67	2.68	2.68	2.68	2.68
		avg	1.37	1.37	1.37	1.37	1.38
		stdev	0.71	0.71	0.71	0.71	0.72
	4	min	0.77	0.77	0.77	0.78	0.78
		max	3.53	3.53	3.53	3.54	3.54
		avg	2.10	2.10	2.10	2.10	2.10
		stdev	0.83	0.83	0.83	0.83	0.83
Eastern	3	min	0.21	0.21	0.21	0.21	0.21
		max	6.96	6.97	6.97	6.98	6.98
		avg	4.58	4.58	4.59	4.59	4.60
		stdev	2.04	2.04	2.04	2.04	2.04
	4	min	3.26	3.26	3.26	3.26	3.27
		max	8.53	8.54	8.54	8.55	8.56
		avg	5.97	5.98	5.98	5.99	5.99
		stdev	1.66	1.66	1.66	1.66	1.66
Southern	3	min	0.00	0.00	0.00	0.00	0.00
		max	6.92	6.93	6.91	6.92	6.90
		avg	1.72	1.73	1.72	1.73	1.73
		stdev	2.24	2.24	2.23	2.23	2.23
	4	min	0.53	0.54	0.54	0.55	0.55
		max	6.71	6.71	6.70	6.72	6.70
		avg	1.63	1.63	1.63	1.65	1.64
		stdev	1.75	1.75	1.75	1.75	1.74

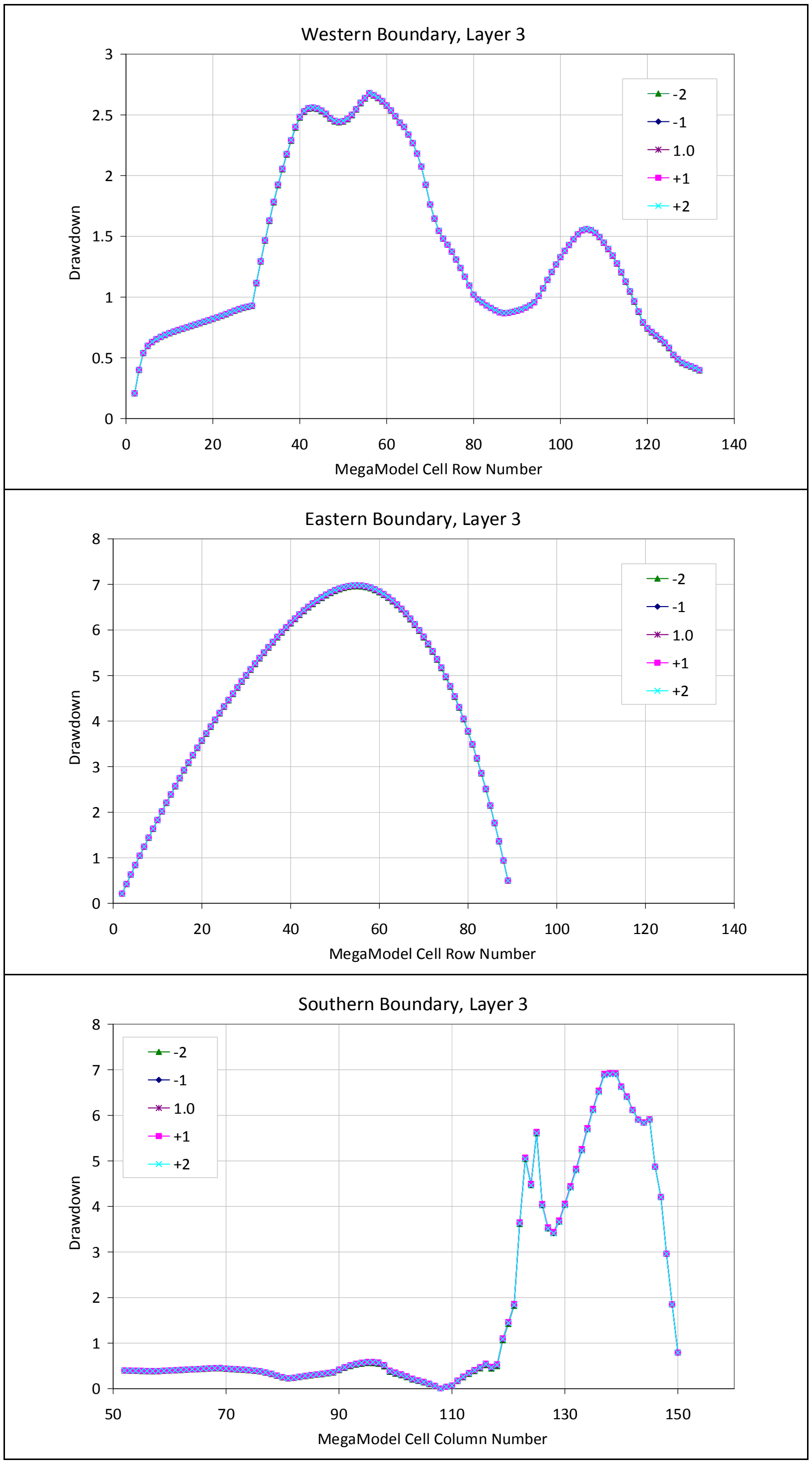


Figure 22. Spring Pool: Layer 3 Drawdown Profiles

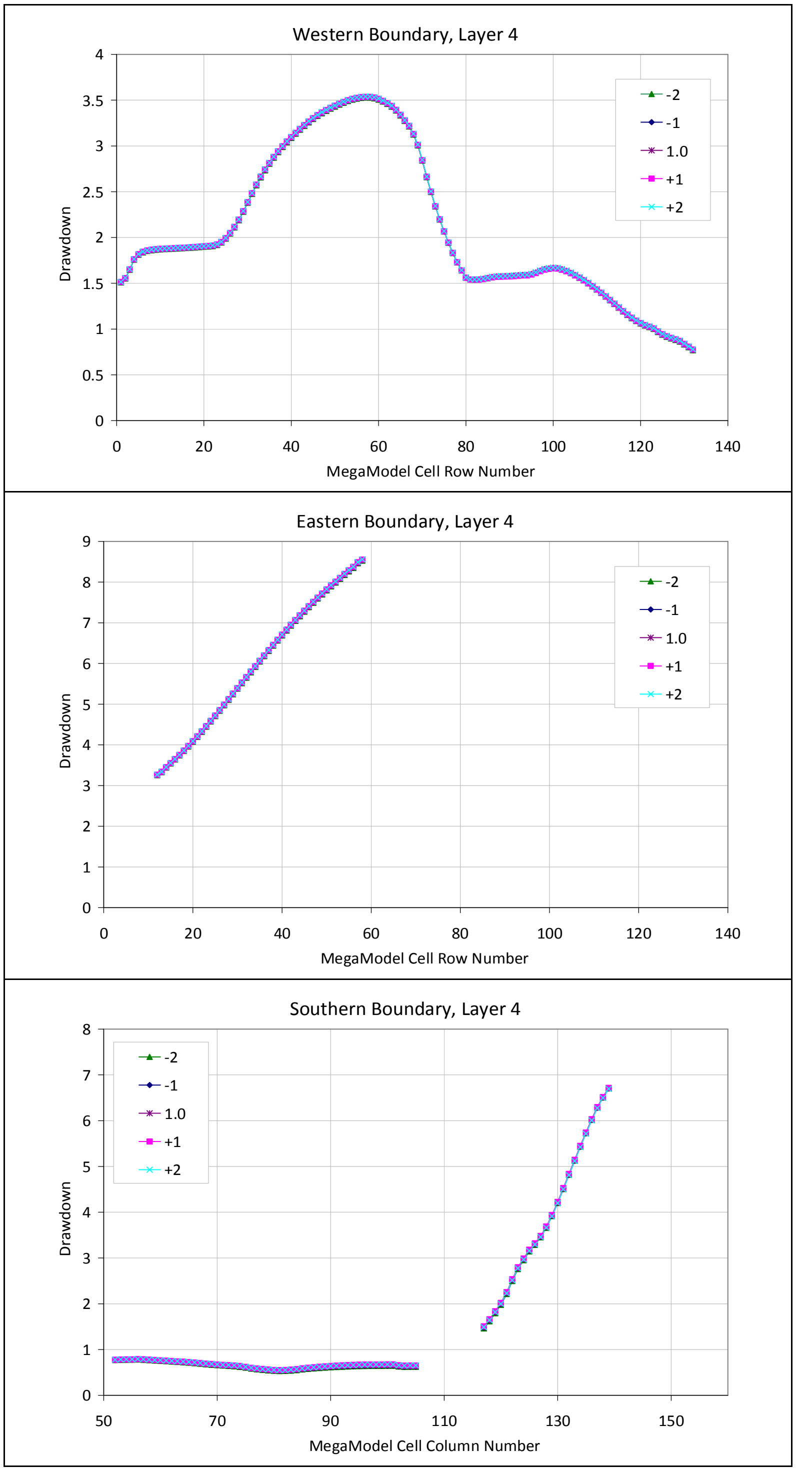


Figure 23. Spring Pool: Layer 4 Drawdown Profiles

Model Conclusions Summary

A summary of the model conclusions for the sensitivity analysis runs is shown in Table 36.

Table 36. Summary of the MegaModel Conclusions

Parameter	Sensitivity Classification
Drain Conductance	Type I
Hydraulic Conductivity	Type II
River Conductance	Type II or Type III
River Stage	Type II
Spring Pool	Type II

Calibrated Models: Drawdown Summary

A summary of drawdowns for only the simulations which remained within calibration tolerances (based on head, baseflow, and springflow statistics) is shown in Table 37. Average drawdowns for each boundary and layer are highlighted in the table. As shown, for the models that remained calibrated, there was very little change in average drawdowns across the NEF boundaries. The only significant changes occurred when river conductance was modified.

Table 37. Summary of Drawdowns for Calibrated Models

NEF Boundary	Mega Model Layer	Statistic	Baseline	Drain Conductance				Hydraulic Conductivity		River Conductance		River Stage
				0.9	**0.95**	**1.05**	**1.1**	**0.1**	**0.5**	**1.01**	**1.015**	**+ 1 ft**
Western	3	min	0.21	0.21	0.21	0.21	0.21	0.25	0.22	0.21	0.21	0.21
		max	2.68	2.68	2.68	2.68	2.68	3.20	2.79	2.68	2.67	2.65
		avg	1.37	1.38	1.38	1.37	1.37	1.58	1.42	1.37	1.37	1.36
		stdev	0.71	0.71	0.71	0.71	0.71	0.87	0.75	0.71	0.71	0.71
	4	min	0.77	0.78	0.78	0.77	0.77	0.81	0.79	0.77	0.77	0.77
		max	3.53	3.54	3.54	3.53	3.53	4.20	3.67	3.53	3.53	3.50
		avg	2.10	2.11	2.10	2.10	2.10	2.43	2.17	2.10	2.10	2.08
		stdev	0.83	0.83	0.83	0.83	0.83	1.04	0.87	0.83	0.83	0.82
Eastern	3	min	0.21	0.21	0.21	0.21	0.21	0.24	0.22	0.21	0.21	0.21
		max	6.97	6.98	6.97	6.97	6.97	7.73	7.11	6.97	6.97	6.94
		avg	4.59	4.59	4.59	4.59	4.59	5.10	4.68	4.59	4.59	4.56
		stdev	2.04	2.04	2.04	2.04	2.04	2.26	2.08	2.04	2.04	2.03
	4	min	3.26	3.26	3.26	3.26	3.26	3.64	3.33	3.26	3.26	3.24
		max	8.54	8.55	8.54	8.54	8.54	9.49	8.71	8.54	8.54	8.50
		avg	5.98	5.99	5.98	5.98	5.98	6.65	6.10	5.98	5.98	5.95
		stdev	1.66	1.66	1.66	1.66	1.66	1.84	1.69	1.66	1.66	1.65
Southern	3	min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		max	6.91	6.91	6.91	6.91	6.90	7.68	7.26	6.90	6.90	6.92
		avg	1.72	1.73	1.72	1.72	1.72	1.90	1.80	1.72	1.72	1.73
		stdev	2.23	2.23	2.23	2.23	2.23	2.47	2.34	2.23	2.23	2.24
	4	min	0.54	0.54	0.54	0.54	0.54	0.57	0.54	0.54	0.54	0.53
		max	6.70	6.70	6.70	6.70	6.70	7.34	7.00	6.69	6.69	6.71
		avg	1.63	1.64	1.63	1.63	1.63	1.79	1.69	1.63	1.63	1.63
		stdev	1.75	1.75	1.75	1.75	1.75	1.94	1.84	1.74	1.74	1.76

Maximum Drawdown Simulation

Based on the results of the sensitivity analysis and the maximum drawdowns for each predictive simulation, the maximum drawdown in the MegaModel would result when the river conductance in the river package is factored by 0.1 and hydraulic conductivity is factored by 0.1. Calibration statistics for this simulation are shown in Tables 38 through 40. As shown, the model does not remain calibrated for this simulation. The resulting drawdowns and drawdown statistics from this simulation of the MegaModel are shown in Figures 24 and 25 and Table 41.

Table 38. Maximum Drawdown Simulation: Head Statistics

	Baseline	**Max DD**
Residual Mean	0.70	-15.67
Res. Std. Dev.	8.14	23.50
Sum of Squares	67876.78	811160.18
Abs. Res. Mean	5.11	18.66
Min. Residual	-46.89	-173.16
Max. Residual	55.93	108.84
Range in Target Values	214.10	214.10
Std. Dev./Range	0.04	0.11

Table 39. Maximum Drawdown Simulation: Baseflow Statistics

	1 (Baseline)	**Max DD**
Residual Mean	-8.67	-8.66
Absolute Residual Mean	24.57	20.43
Sum of Squares	91532.16	86891.01

Table 40. Maximum Drawdown Simulation: Springflow Statistics

	1 (Baseline)	**Max DD**
Residual Mean	-1.17	7.34
Absolute Residual Mean	4.61	19.30
Sum of Squares	12413.75	231410.32

Table 41. Maximum Drawdown: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	Hydraulic Conductivity and River Conductance Factor	
			0.1	Baseline
Western	3	min	0.29	0.21
		max	3.78	2.68
		avg	2.02	1.37
		stdev	1.02	0.71
	4	min	0.97	0.77
		max	4.92	3.53
		avg	2.93	2.10
		stdev	1.16	0.83
Eastern	3	min	0.26	0.21
		max	8.33	6.97
		avg	5.51	4.59
		stdev	2.43	2.04
	4	min	3.97	3.26
		max	10.22	8.54
		avg	7.18	5.98
		stdev	1.96	1.66
Southern	3	min	0.00	0.00
		max	10.22	6.91
		avg	2.60	1.72
		stdev	3.39	2.23
	4	min	0.63	0.54
		max	9.46	6.70
		avg	2.40	1.63
		stdev	2.76	1.75

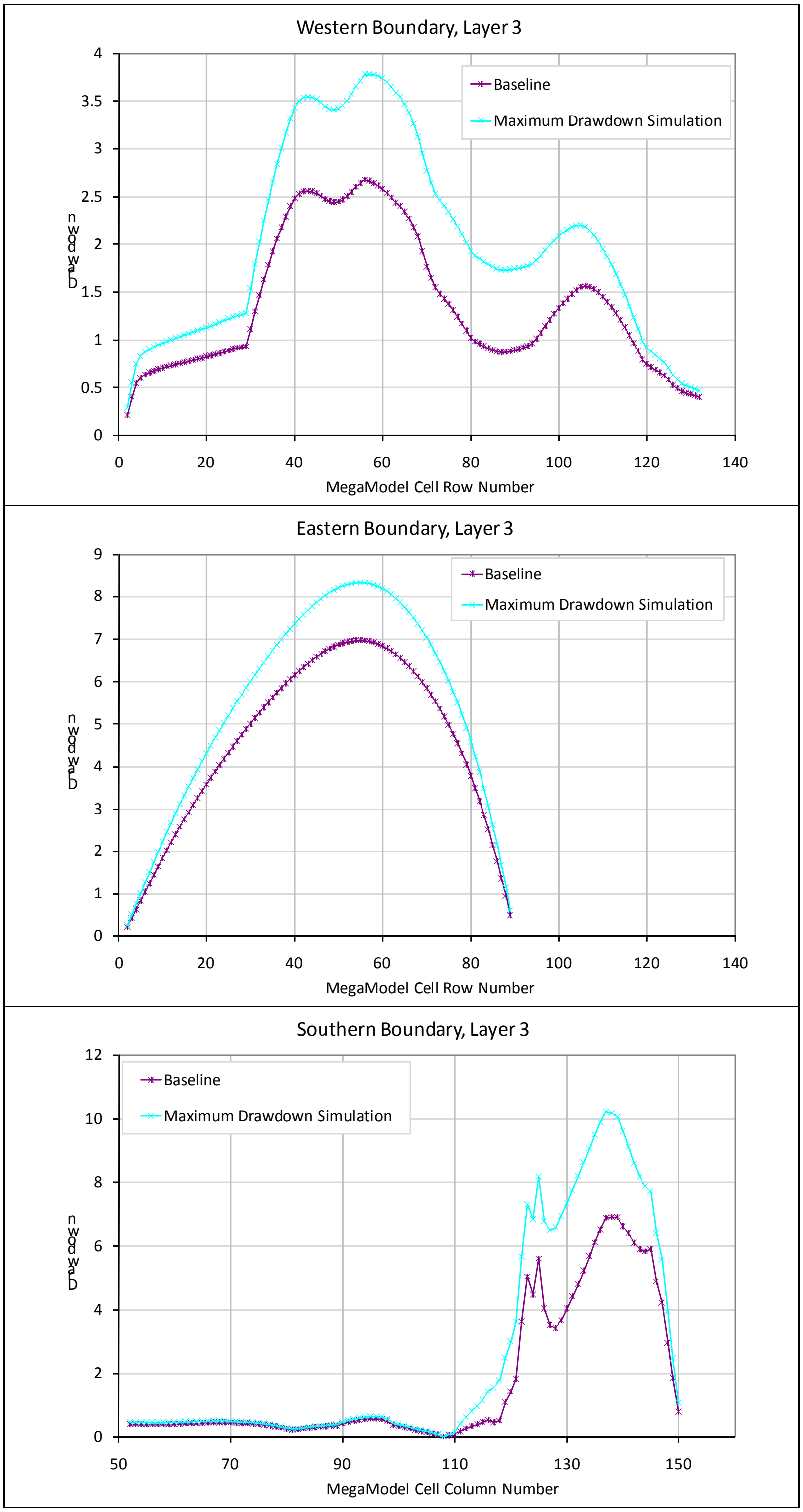


Figure 24. Layer 3 Maximum Drawdown Profiles

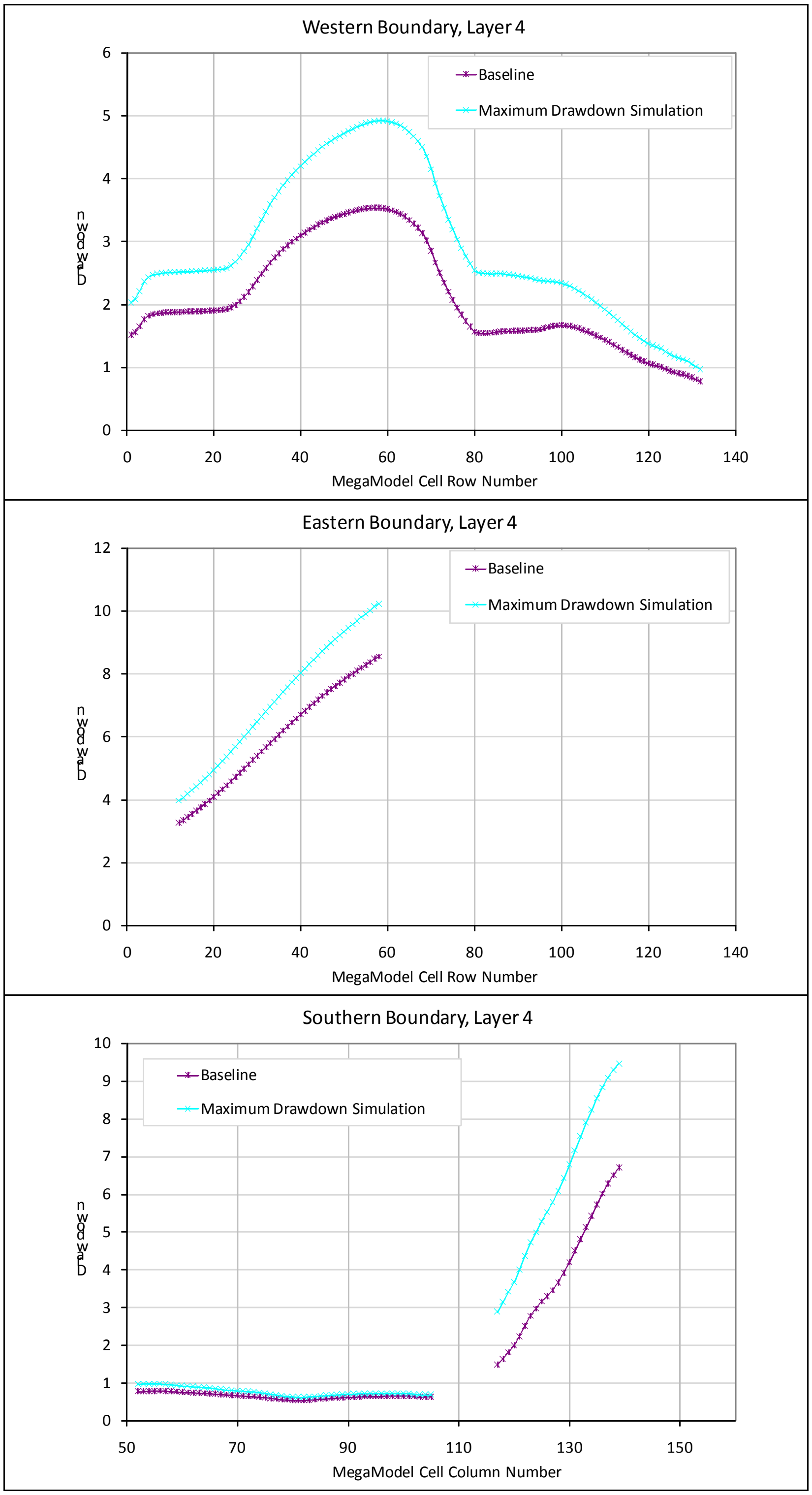


Figure 25. Layer 4 Maximum Drawdown Profiles

Minimum Drawdown Simulation

Based on the results of the sensitivity analysis and the minimum drawdowns for each predictive simulation, the minimum drawdown in the MegaModel would result when the river stage is shifted upward by 2-feet and layer 1 hydraulic conductivity is factored by 10. Calibration statistics for this simulation are shown in Tables 42 through 44. As shown, the model does not remain calibrated for this simulation. The resulting drawdowns and drawdown statistics from this simulation of the MegaModel are shown in Figures 26 and 27 and Table 45.

Table 42. Minimum Drawdown Simulation: Head Statistics

	Baseline	Min DD
Residual Mean	0.70	3.76
Res. Std. Dev.	8.14	11.62
Sum of Squares	67876.78	151796.59
Abs. Res. Mean	5.11	7.73
Min. Residual	-46.89	-59.59
Max. Residual	55.93	79.88
Range in Target Values	214.10	214.10
Std. Dev./Range	0.04	0.05

Table 43. Minimum Drawdown Simulation: Baseflow Statistics

	1 (Baseline)	Min DD
Residual Mean	-8.67	-6.91
Absolute Residual Mean	24.57	25.60
Sum of Squares	91532.16	97488.82

Table 44. Minimum Drawdown Simulation: Baseflow Statistics

	1 (Baseline)	Min DD
Residual Mean	-1.17	-1.56
Absolute Residual Mean	4.61	8.05
Sum of Squares	12413.75	37006.83

Table 45. Minimum Drawdown: Drawdown Statistics

NEF Boundary	MegaModel Layer	Statistic	Hydraulic Conductivity Factor and River Stage Shift	
			Min DD	1
Western	3	min	0.00	0.21
		max	2.57	2.68
		avg	1.32	1.37
		stdev	0.69	0.71
	4	min	0.76	0.77
		max	3.41	3.53
		avg	2.04	2.10
		stdev	0.79	0.83
Eastern	3	min	0.00	0.21
		max	6.82	6.97
		avg	4.44	4.59
		stdev	2.04	2.04
	4	min	3.19	3.26
		max	8.36	8.54
		avg	5.86	5.98
		stdev	1.62	1.66
Southern	3	min	0.00	0.00
		max	5.53	6.91
		avg	1.43	1.72
		stdev	1.80	2.23
	4	min	0.53	0.54
		max	5.29	6.70
		avg	1.37	1.63
		stdev	1.32	1.75

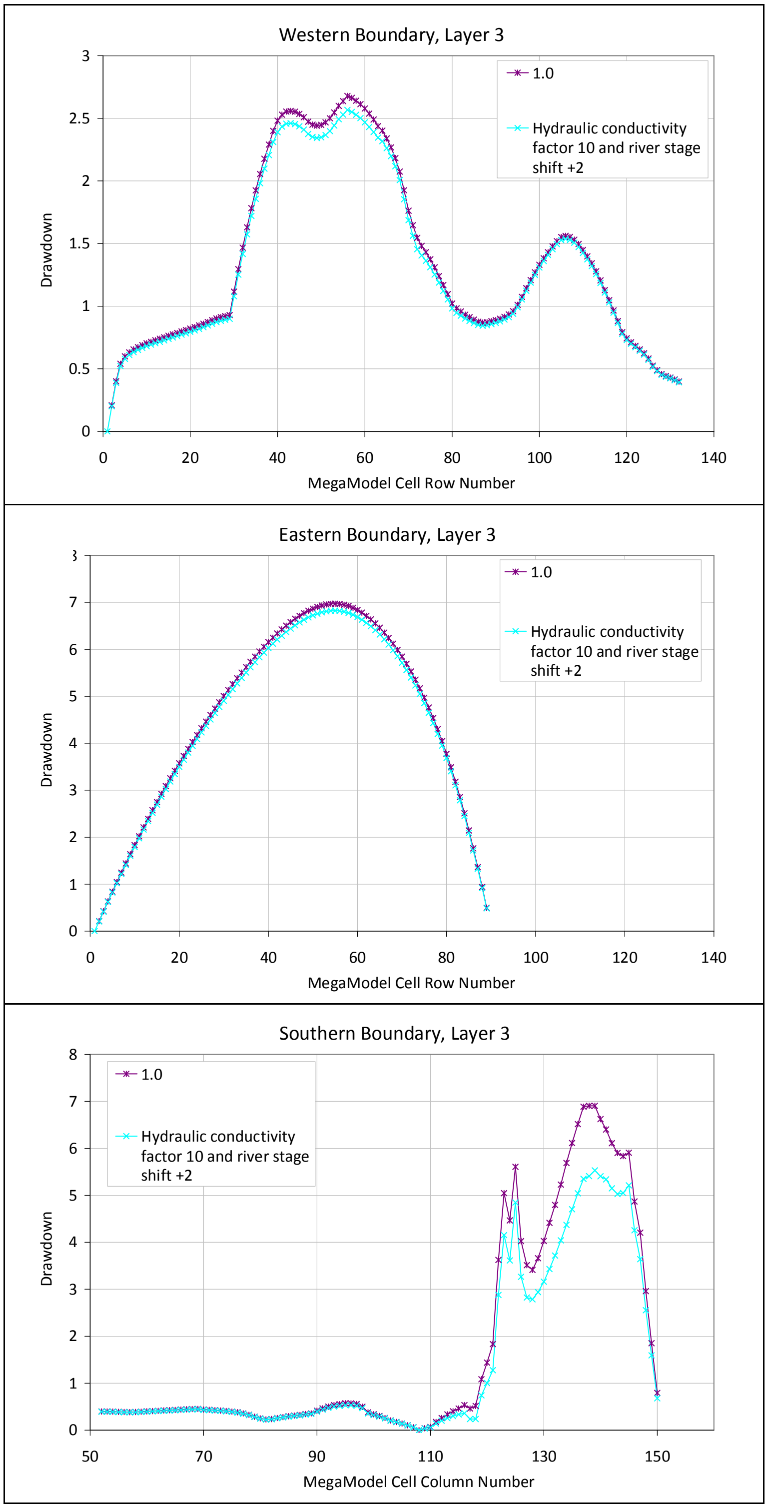


Figure 26. Layer 3 Minimum Drawdown Profiles

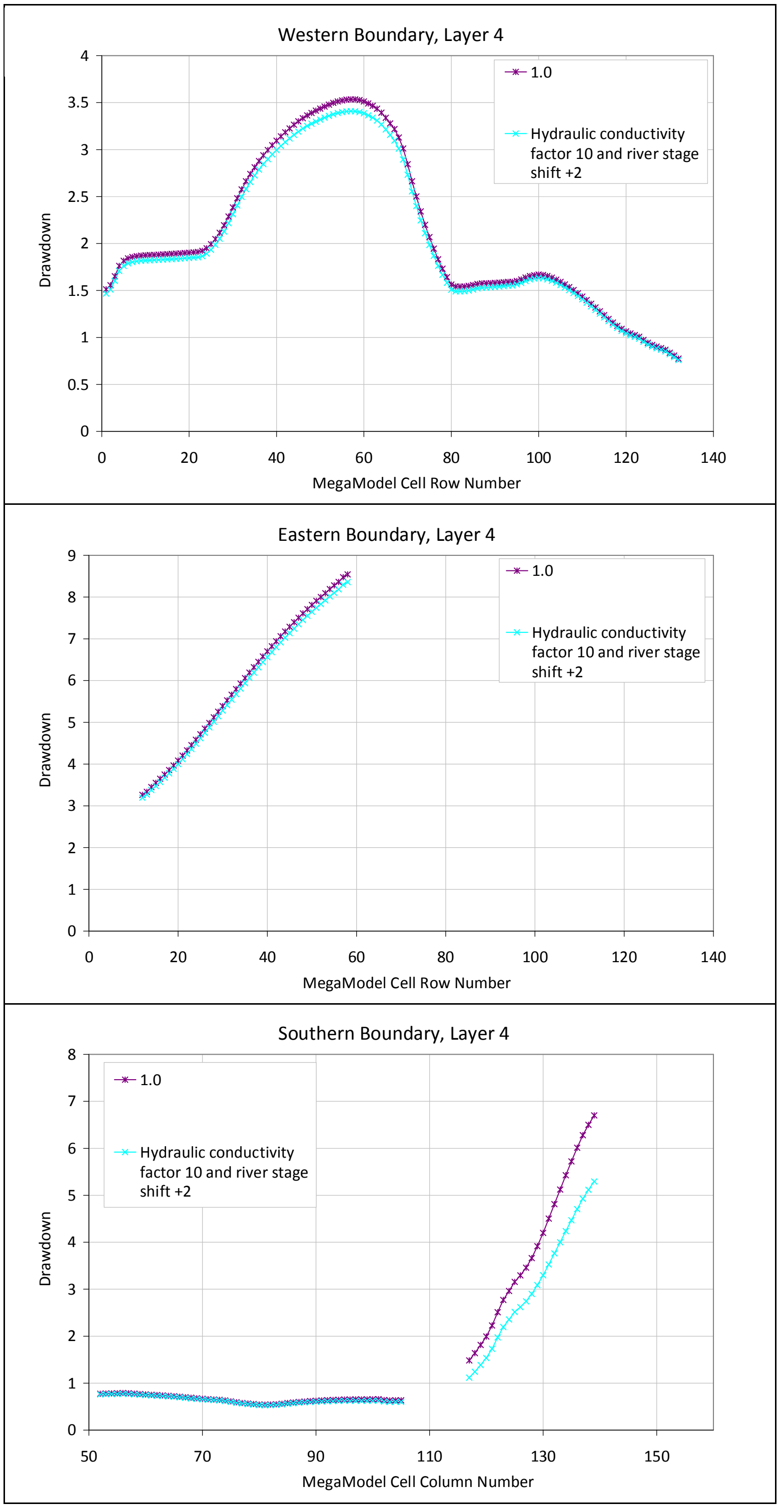


Figure 27. Layer 4 Minimum Drawdown Profiles

Conclusions and Recommendations

A summary of the sensitivity classifications determined for the parameters examined for the MegaModel is shown in Figure 28. As shown in the Figure, the sensitivity analysis performed verified that Type IV sensitivity is not present in the parameters examined for the MegaModel. The presence of Type IV sensitivity indicates that there are significant changes in the model conclusions and insignificant changes in the model calibration, and generally requires the collection of additional data to narrow the range of values for a specific parameter. An adequate range of values was examined for each parameter, with the exception of drain conductance, which was only modified slightly due to model closure issues. It was desired by the District that the solver package not be modified during the sensitivity analysis process, including head change criteria, relaxation and damping factors, and total iterations. It is recommended that drain conductance be further examined by the District at a wider range of values and that the solver package of the model be modified if needed. Modification of the solver package will not change the ultimate solution of the model and is therefore recommended for a more complete evaluation of drain conductance.

		Changes in Model Calibration	
		INSIGNIFICANT	SIGNIFICANT
Changes in Model Conclusions	INSIGNIFICANT	**Type I:** Drain Conductance	**Type II:** Hydraulic Conductivity River Conductance River Stage Spring Pool
	SIGNIFICANT	**Type IV**	**Type III:** River Conductance

Figure 28. MegaModel Parameter Sensitivity Classification

The Type I and Type II sensitivities exhibited by each of the parameters cause no concern or need for addition data collection or model calibration because regardless of the changes in the calibration, the conclusions of the model (the changes in predicted drawdown) were insignificant. Similar to the Type I and II sensitivities identified, the potential Type III sensitivity exhibited by river conductance causes no need for additional calibration or concern about the current calibration. Since the model calibration changes are significant for a Type III sensitivity, the calibration process would eliminate the unrealistic river conductance array from being used and thus eliminate the scenario(s) which cause significant changes in the model conclusions (the high drawdowns).

References

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