Alachua County
Environmental Protection Department

Chris Bird, *Director*

July 1, 2016

Fatih Gordu, P.E.
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

RE: North Florida-Southeast Georgia (NFSEG) Regional Groundwater Flow Model

Dear Mr. Gordu:

Alachua County has been following with great interest the development of the NFSEG model. The County looks forward the results of the External Peer Review process and the Water Management Districts response to the comments and questions submitted by stakeholders regarding the potential limitations of the NFSEG model.

In addition to the technical concerns raised by the stakeholders, Alachua County is interested to know how the Model will be used by the District; specifically any potential limitations associated with the use of a large regional Model to validate substantiate Consumptive Use Permit decisions at the local level. Alachua County's geology is complex and unique. The Floridan aquifer system is present under both confined and unconfined conditions with confinement becoming discontinuous along the Cody Scarp where numerous swallets and other karst features occur. Due to the heterogeneity of geologic conditions, aquifer recharge and aquifer hydraulic properties (e.g. transmissivity or hydraulic conductivity) are highly variable throughout the county. The lack of sufficient spatial data for these parameters may result in inadequate protection of the Floridan aquifer system and springs. Alachua County continues to see a need for collection of additional data to better define aquifer recharge and aquifer hydraulic properties.

Thank you for the opportunity to provide comments. If you have any questions regarding this letter please contact Gus Olmos at (352) 264-6806

Sincerely,

A. Olmos for CB

Chris Bird
Director
CB/ao

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Mr. Drew Bartlett
Deputy Secretary for Ecological Restoration
Florida Department of Environmental Protection
3900 Commonwealth Blvd.
Tallahassee, FL 32399

March 28, 2016

Dear Mr. Bartlett:

A key component of the North Florida Regional Water Supply Plan – the North Florida-Southeast Georgia (NFSEG) Regional Groundwater Flow Model – is nearing completion. The NFSEG model will be central to all regulatory decisions made by DEP and by both the Suwannee River and the St. Johns River Water Management Districts (WMD) regarding groundwater extractions and springs protection in the region.

The Florida Springs Council (FSC) has reason to be concerned that the NFSEG model may not be adequately peer-reviewed before it is implemented. Last year, FSC sent the following public records request to all five water management districts:

Please provide all documentation on file related to the following items concerning the use and application of groundwater models in your water management district:

1. *A listing of all groundwater models that are used by your District as part of regulatory decision-making and water-use planning. This listing should include all models used in the review and issuance of water-use permits, minimum flows and levels, prevention and recovery strategies, water supply plans, basin management action plans, and other similar activities.*
2. *A description of the review process for each groundwater model. Specifically, please provide information on whether, and the extent to which, each model has been peer-reviewed by internal or external parties, the names of the reviewers, and the dates of the reviews.*
3. *A copy of the documents related to any peer review and your district's responses to the review's comments and suggestions, including the changes in model simulations resulting from modifications based on the review's comments and suggestions.*

Responses from the WMDs were revealing. There was no uniformity whatsoever in how the five districts conducted peer-review of their models. One district in fact claimed that it uses no models at all in its water-related regulatory determinations. For some district models, there was no record of any peer-review, while in others both the peer-reviewers and the report that they produced appeared to be highly professional.

One constant, however, stood out in these peer-review exercises. Even when the reviews were conducted with care, there was little if any documentation of how the district in question responded to the peer-reviewers' comments and critiques. High-quality peer-review guidelines, such as those utilized by the U.S. Geological Survey (http://www.usgs.gov/fsp/), mandate that an agency whose science is being reviewed should respond to all peer-review suggestions with an explanation of whether, how, and why these suggestions did or did not result in modifications to the model being reviewed. This basic guideline is rarely if ever followed by Florida's WMDs in developing groundwater models. The most specific response to peer-reviewers' critiques that we found in reviewing WMD documents was a vague assurance that "…we intend to address these issues in the next iteration of the model".

State leaders – both elected officials and appointed environmental managers – repeatedly talk about the importance of sound science in developing environmental regulations. But by and large, the State's use of peer-review in evaluating groundwater models has not been characterized by a level of rigor that would justify use of the term "sound science".[1]

What would the FSC recommend regarding peer-review of the NFSEG model?

During consideration of the omnibus water bill (SB 552) approved in January, FSC noted that some groundwater models developed in the private sector might be more flexible and accurate than those currently used by WMDs. We recommended that the State should fund one or more of these outside models and suggested that qualified peer reviewers compare their usefulness with that of the State's models. [See amendment #16 from FSC's recommended amendment package: http://springsforever.org/wp-content/uploads/2015/02/Springs-Bills-2016-Recommended-Amendments.pdf.] The legislature chose not to include this amendment in SB 552, and WMDs have not followed our recommendation to fund alternative groundwater models.

The next best outcome, from FSC's perspective, would be to conduct rigorous peer-review on all groundwater models, using standards endorsed by USGS, and to involve the best peer-reviewers available, including those who have been critical of past modeling efforts by WMDs. **Specifically, we would strongly recommend that Dr. Todd Kincaid should be one of the peer-reviewers for the NFSEG model.**

You are familiar with Dr. Kincaid and his work, having hosted a lengthy meeting in Live Oak about two years ago when Dr. Kincaid discussed his views on the shortcomings of WMD approaches to groundwater modeling. Several WMD executive directors and senior modelers attended Dr. Kincaid's presentation. His credentials are impeccable – a Ph.D. from the University of Wyoming, founder and President of a successful consulting company, vast experience with groundwater and geology in North Florida, experienced cave diver. Dr. Kincaid's client list includes Fortune 500 companies as well as the Department of Energy, which hired him to assess groundwater flows in perhaps the most sensitive project imaginable – namely, our nation's primary nuclear testing site, the Nevada National Security Site (NNSS). If he were not at the top of his profession, Dr. Kincaid and his team would not have been hired at the NNSS.

[1] See Dr. Robert Knight's comments on peer-review of groundwater models in: http://www.gainesville.com/article/20160422/OPINION03/160429980/-1/opinion?Title=Robert-Knight-Flawed-models-used-to-permit-groundwater-pumping

Dr. Kincaid, as you know, has been critical of the groundwater models developed by our State agencies. I don't speak for Dr. Kincaid, but it is safe to say that he believes that these models are neither state-of-the-art nor particularly accurate and that the State could do a much better job developing models, especially those like NFSEG that have significant regulatory import. Dr. Kincaid summarized many of his concerns in a talk to UF's annual water symposium in February of this year: http://waterinstitute.ufl.edu/Symposium2016/downloads/presentations/kincaid.pdf

No doubt, some WMD staff will bristle at the thought of a critic like Dr. Kincaid serving on the NFSEG peer-review panel. They shouldn't. Science proceeds most effectively when conflicting views are brought to the fore and debated. Any serious State modeler should welcome both Dr. Kincaid's input and the opportunity to engage him in serious back-and-forth discussions concerning alternative modeling approaches.

Last week, Scott Laidlaw and John Fitzgerald of SRWMD briefed Sierra Club representatives on the North Florida Regional Water Supply Plan and the NFSEG model. In that meeting, it was suggested that Dr. Kincaid would make an excellent peer-reviewer for the NFSEG model. The SRWMD representatives expressed some concern that Dr. Kincaid might be an inappropriate choice given his involvement in the technical meetings undergirding development of NFSEG. This should not be a serious concern. Dr. Kincaid attended only one of these technical meetings, and even then only to help Alachua County officials understand how the model might affect their county.

In the past, the public's lack of faith in the State's management of its water resources has led to numerous lawsuits and administrative challenges. A vigorous, open process for establishing groundwater models could reduce future challenges by enhancing the credibility of the process. FSC would strongly urge you both to utilize the strong peer-review procedures in your implementation of the NFSEG model and to retain Dr. Kincaid as a peer-reviewer for that model. It is critical that the model's limitations be identified, described, and honestly considered when making resource management decisions. Dialogue with critics can only improve the process and give your effort credibility.

Sincerely,

Dan Hilliard

Dan Hilliard, Chairman
Florida Springs Council
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CC: Dr. Ann Shortelle, St. Johns River WMD
Mr. Noah Valenstein, Suwannee River WMD

From: Bob Knight [mailto:bknight@floridaspringsinstitute.org]
Sent: Sunday, May 29, 2016 4:21 PM
To: Fatih Gordu <fgordu@sjrwmd.com>; Heather Barnes <HBarnes@sjrwmd.com>; 'Brent Goodman' <goodmanbp@gru.com>; 'Brian J. Megic:' <bmegic@liquidsolutionsgroup.com>; 'Camilo Gaitan' <camilo.gaitan@freshfromflorida.com>; 'Carlos Herd' <CDH@srwmd.org>; 'Cliff Lewis' <Cliff.lewis@gadnr.org>; 'Curt Williams' <Curt.Williams@ffbf.org>; Dale R Jenkins <drjenkins@sjrwmd.com>; 'Darrin Herbst' <darrin.herbst@swfwmd.state.fl.us>; 'Del Bottcher' <dbottcher@swet.com>; Douglas Durden <DDurden@sjrwmd.com>; Douglas Hearn <DHearn@sjrwmd.com>; 'Douglas P. Dufresne' <DDufresne@Ardaman.com>; George Robinson <grobinson@sjrwmd.com>; 'Jeff Lehnen' <Jeff.Lehnen@CH2M.com>; 'Jill McGuire' <mikejillmcguire@earthlink.net>; 'Jim Kennedy' <jim_kennedy@dnr.state.ga.us>; John Fitzgerald <JFitzgerald@sjrwmd.com>; 'John Sloane' <limestonebungalow@gmail.com>; 'Katherine Van Zant ' <klvanzant@gmail.com>; 'Parks Small' <parks.small@dep.state.fl.us>; Patrick Burger <pburger@sjrwmd.com>; 'Paul Steinbrecher' <steipk@jea.com>; 'Paul Still' <StillPE@aol.com>; 'Richard H. Hutton' <HUTTONRH@gru.com>; 'Rob Denis' <rdenis@liquidsolutionsgroup.com>; 'Ron Basso' <Ron.Basso@swfwmd.state.fl.us>; 'Ron Stewart ' <rstewart@fppaea.org>; Tim Cera <TCera@sjrwmd.com>; Tim Desmarais <TDesmarais@sjrwmd.com>; 'Tom Bartol' <barttj@jea.com>; 'Tony Cunningham' <CUNNINGHAAL@gru.com>; 'Trey Grubbs' <JWG@srwmd.org>; 'Ty Edwards' <tedwards@jaxbchfl.net>; 'Vivian Katz' <save-our-lakes@comcast.net>; Wei Jin <WJin@sjrwmd.com>; Alisha B. Gipe <AGipe@sjrwmd.com>; James Walters <jwalters@sjrwmd.com>; Tammy Bader <TBader@sjrwmd.com>; 'Kennedy, Jim' <Jim.Kennedy@dnr.ga.gov>; 'Davis, Valerie' <VDavis2@ardaman.com>; Joanne Chamberlain <jchamber@sjrwmd.com>; Kraig McLane <kmclane@sjrwmd.com>; Yanbing Jia <YJia@sjrwmd.com>; Sherry Brandt-Williams <SBrandt-Williams@sjrwmd.com>
Cc: 'Brown, Amy' <alb@srwmd.org>; Scott Laidlaw <SLaidlaw@sjrwmd.com>; hculp@floridaspringsinstitute.org; Todd Kincaid <kincaid@geohydros.com>; ulan@umces.edu; bob palmer <rpa711@yahoo.com>; Casey Fitzgerald <cfitzger@sjrwmd.com>
Subject: RE: NFSEG Technical Team Meeting - Florida Springs Institute Review Comments

Fatih

In response to your presentation dated May 11 to the North Florida Southeast Georgia (NFSEG) Technical Team, please find attached model review comments from the Florida Springs Institute. These were compiled with input from Dr. Todd Kincaid, a member of our Advisory Panel. We look forward to your responses to our concerns.

At face value, the NFSEG Model looks better than the North Florida Model (NFM) because the calibration residuals are smaller and more randomly distributed, while they appear to have achieved a similar match to spring and river flows. However, we are concerned that the NFSEG Model includes some of the same fundamental problems as the NFM and that these limitations are not presented in a manner that will make their ramifications apparent to many non-modelers.

Here is a bulleted list of some critical issues that we wish to raise:

- How were springs and river flows simulated? If through the use of river and drain cells in MODFLOW, what are the residuals between the head values at the cells to which those boundary types were assigned and the river/spring stage values? Unless both flow and stage are reported for the discharge cells, it is easy to show a good match to flows while having a large error in stage. Not matching both means that you have essentially not matched either.

- Transmissivity values appear unrealistically high. Compare the map on slide 45 to the Transmissivity map published by the USGS (Kuniansky). We think you'll see big differences. Note the scale where T's around the central part of the domain (springs country) are 5-30 Million ft^2/day. High T means small drawdown around pumping wells. One of the analyses you should include is to subtract the model T assignments from the Kuniansky values leaving a map showing the residuals. Though you can't consider her values as gospel, you definitely should not accept very large residuals that cannot be supported by data or geologic reasoning.
- Please compare the model results to known drawdowns around pumping centers. Note the large over-estimates in central Alachua County. We think these large residuals may be due to the model's inability to match the drawdown around the Murphree Well field, which in turn is because very large transmissivity values are assigned. Full reporting of these discrepancies is critical to reporting uncertainty in model drawdown estimates. All model-simulated drawdowns at wells and springs must be accompanied by statistically-valid error estimates.
- The water budget looks good at face value but "inches" need to be converted to cfs and MGD to allow ready comparison to empirical water budgets. Moreover, there needs to be a comparison between the recharge values assigned in the MODFLOW model and the recharge values that came out of the HPSF model. The HPSF model is expected to be the more advanced method for estimating recharge because the surface water model is presumably calibrated to measured sub-watershed discharges. This is a better method to estimate recharge because it is directly tied to measured data. Please provide an analysis of how those recharge values were changed in MODFLOW to achieve calibration. The concern is that the recharge rates may have been inaccurately raised as a consequence of using high transmissivity values.
- There are no springshed delineations presented. Since this model will be used to assess MFLs for springs, we need to see how well it simulates their springsheds.
- There is no assessment of where the pumped water comes from, i.e. from internal or external boundary conditions. Pumping that is supplied as a consequence of boundary assignments cannot be considered adequately simulated for impact assessment purposes.
- Simulation of ET is in our opinion a mistake. Model-estimated ET represents a huge reservoir of uncertainty. The point of initial modeling and a rigorous empirical water budget analyses is to constrain recharge, which is rainfall minus runoff minus ET. So, if we use realistic recharge estimates, then essentially you don't need to simulate ET, thus removing a large portion of uncertainty from the model. By doing this, pumping must necessarily directly affect river, spring, or boundary discharges only at a 1:1 ratio. By throwing ET into the mix, it is possible that simulated pumping could be offset by a reduction in ET and thus have little or no effect on simulated spring and/or river flows. This is the same basic issue we have with the boundaries – large simulated boundary flows will lower the model's simulation of impacts to springs and rivers.

Please let me know if you have any questions or need any clarification about these comments.

Bob

Robert L. Knight, Ph.D.
Director
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June 28, 2016

Michael A. Register
Director,
Division of Water Supply Planning and Assessment
St. Johns River Water Management District
P.O. Box 1429
Palatka, FL 32178-1429

Dear Mr. Register,

On behalf of Florida Pulp and Paper Association Environmental Affairs ("FPPAEA"), thank you for your time and attention during our meeting on June 1, 2016. This letter summarizes the views of the FPPAEA regarding development and use of the North Florida Southeast Georgia groundwater model ("NFSEG model") being developed by the St. Johns River Water Management District ("SJRWMD" or "the District").

The Florida Pulp and Paper Association, known as FPPAEA, is the State trade association for Florida's Forest Products Industry, representing pulp, paper, packaging, and wood products manufacturers, and forest landowners. The Forest Products Industry is ranked in the top 5 manufacturing sector employers for both number of jobs and employee compensation. The industry is also Florida's leading manufacturer in sustainability and providing green jobs. The industry employs over 30,000 Floridians in high-paying jobs, leads the way on recycling and renewable energy generation, and sustainably manages Florida's forests. Five FPPAEA mills are located within the NFSEG model boundaries, so the FPPAEA is closely monitoring and keenly interested in the development of NFSEG model.

As we discussed, the Forest Products Industry provides important benefits to groundwater replenishment through the maintenance of forested areas. In addition, over the last 20 years, FPPAEA's members have reduced the demand on Florida's water supply by more than 35 million gallons per day. This reduction was achieved as the production from Florida's Pulp and Paper Industry has grown. Development of processes that allow water to be reused within the mill, conservation of heat from cooling water, and innovative engineering to replace water seals with mechanical seals are examples of how FPPAEA members are using technology to continually help protect Florida. Since 1955, FPPAEA members have **reduced consumptive water usage by over 40%** despite dramatic growth of the industry over the same period. The proactive response by our industry has helped conserve the water supply for the rapid growth experienced in agricultural irrigation and public water supply, both of which have increased over 800% in the same time period, and now far eclipse other uses of water in the state.

The FPPAEA views development of the NFSEG model as a major step forward over the previous models that it will eventually replace, and we appreciate the leadership and hard work of SJRWMD and the Suwanee River Water Management District in model development. The NFSEG's model expanded geographic boundaries and more sophisticated approach potentially yield a much higher degree of accuracy than the current models. Nonetheless, as a model that is likely to be used by SJRWMD and SRWMD for the foreseeable future, we believe it is imperative that the model be properly developed and that the model include a clear, thorough, written description of its intended uses, in-built assumptions, limitations, and uncertainties. Given the complexity of groundwater model, we also believe that this description should be transparently developed and, most important, should be included within the scope of the District's planned peer review of the NFSEG model. This should be developed now, rather than delayed until the end of NFSEG model development. Updates can be made to this description as justified by model development.

Regarding peer review, FPPAEA does not accept that any form of internal or technical team process is a substitute for independent, third party peer review. We urge the District to broaden its current list of proposed peer reviewers, and be scrupulous in avoiding even the appearance partiality by avoiding the selection of a peer review member whose business may have in the past, present or future contracted with the District. If such businesses are too difficult to locate in Florida, their presence on a peer review panel should be balanced by out-of-state experts whose lack of ties to the District will provide public confidence in the work of the entire group. We also ask that the charge to the peer reviewers be made public and available for public input and that all meetings and correspondence be made public as well. To further this end, individual peer reviewers should be instructed that they are free to write minority views if their opinions cannot be reconciled with the other members of the peer review panel.

We understand this process is probably more cumbersome, and therefore more time-consuming than originally envisioned by some members of the SJRWMD team working on the NFSEG model. Nonetheless, as we have said, such efforts will bolster public confidence in the NFSEG model. Based on our attendance at the technical team meetings, FPPAEA believes that other stakeholders who might normally be expected to disagree share our views on this matter.

As we discussed, we think it is premature to use the model for many purposes in the near future, including the assessment or development of Minimum Flows or Levels ("MFLs"), development of MFL prevention or recovery strategies, or analysis of consumptive use permit ("CUP") applications. While the nature of the regional water supply planning process does not necessarily require a fully functioning NFSEG model, we are concerned that it will be easily misapplied by some stakeholders and members of the public who may seek changes to MFLs, MFL recovery or prevention strategies, or CUP applications. Moving forward with the beginning of the water supply plan process and the peer review process could be done on a "parallel path" but only so long as the model limitations, uncertainties, and assumptions are clearly and explicitly addressed. Regardless, we believe any delay is justified by the need to ensure a sound model that has public confidence.

If you have any questions or further comments on this issue, please let me know. I can be reached by telephone at (813) 215-8856 or by email at rstewart@fppaea.org.

Thank you for your time and attention to our concerns.

Best Regards,
Florida Pulp and Paper Association EA, Inc.

James R. Stewart, PE
Executive Director

cc: Fatih Gordu
FPPAEA Members
Greg Munson
Mercer Fearington

Summary of Key Concerns with the North Florida-Southeast Georgia (NFSEG) Model
Liquid Solutions Group, LLC
July 1, 2016

For the past several years, staffs at the water management districts have been working to develop the North Florida-Southeast Georgia (NFSEG) groundwater flow model and surface water models (herein referred to as the NFSEG Model). The NFSEG Model is the largest, most ambitious coupled surface water-groundwater model developed by any State agency, and it encompasses an area of almost 60,000 square miles in Florida, Georgia and South Carolina.

Since the NFSEG Model was publicly released on May 2, 2016, Liquid Solutions Group (LSG), on behalf of the North Florida Utility Coordinating Group (NFUCG), has devoted significant resources to the review of the initial NFSEG Model calibration simulations. As a result of this review, we have identified a number of concerns, which are detailed in the attached comprehensive comment document. Several of our key concerns are summarized as follows:

1. The HSPF surface water models produce unrealistic recharge and evapotranspiration (ET) estimates in some areas due to:
    a. Anomalies in rainfall input data
    b. Unsuitable calibration for 2001 and 2009 conditions in some basins
    c. Adjacent HSPF models producing incompatible results due to an inconsistent model development process
2. The MODFLOW groundwater flow model is not sufficiently calibrated in critical areas due to:
    a. Incorrect recharge and ET input data
    b. Computerized calibration process forcing uncharacteristic localized hydrogeology
    c. Concerning representation of rivers in key areas
3. The coupling of the surface water and groundwater models requires improvement due to:
    a. Concerning closed basin and springflow assumptions utilized for the coupled model approach
    b. Incompatible results from individual HSPF models provided directly to MODFLOW
    c. Inability of third parties to execute and evaluate the model coupling algorithms

We believe that in its current state the NFSEG Model will not yet provide reliable predictions. Therefore, we suggest the following steps be completed and fully documented, with enough time in the model development schedule to allow stakeholders to meaningfully review all revisions:

1. Update and recalibrate the 72 HSPF models to address issues and to ensure consistency among the models and technical accuracy of all models
2. Implement a process to address potentially inconsistent output at the interfaces between HSPF models
3. Undertake a review of the HSPF output/MODFLOW input and assess suitability of the model coupling
4. Update and recalibrate the MODFLOW groundwater model to address issues and to ensure technical accuracy
5. Complete a sensitivity analysis and 2010 verification simulation

Given the scope, breadth, and intended applications for the NFSEG Model, the Districts' staff should be commended for the work they have done to date, and we are confident that once the model has been appropriately revised and reviewed, it will serve the North Florida region, as a key tool for years to come. However, at this stage in the model development process, the concerns identified should be fully addressed before the NFSEG Model is utilized for any purpose and before it is released for external peer review. We are committed to development of a model that is properly calibrated and that yields accurate results, and look forward to continuing to work with the Districts to achieve these goals.

Consolidated Review Comments on the North Florida Southeast Georgia (NFSEG) Model
Liquid Solutions Group, LLC
July 1, 2016

Liquid Solutions Group, LLC (LSG) appreciates the opportunity to review the North Florida Southeast Georgia (NFSEG) MODFLOW groundwater flow model and HSPF surface water models (referred to collectively as NFSEG Model herein). Review of the NFSEG Model has occurred in multiple phases as discussed below.

The Districts released a partially complete version of the NFSEG Model in October 2015 in order to solicit preliminary impressions of the structure of the NFSEG Model from the Technical Team. LSG submitted comments on the preliminary version of the NFSEG Model in a series of e-mails sent to the Technical Team from November 2015 through January 2016. The Districts responded to most of these comments in May 2016. Preliminary comments from LSG along with the Districts' responses are provided in Appendix B.

On May 2, 2016, the Districts released a completed version of the NFSEG Model to the Technical Team for formal review. With the release of the completed version of the NFSEG Model, the Districts requested that the Technical Team submit initial comments by May 27, 2016 and all comments by July 1, 2016. Per the Districts request, LSG submitted initial questions and comments on the NFSEG Model on May 27, 2016, which are included in Appendix A. As of the date of this submittal, LSG has not received written responses to these questions and comments.

Since May 27, 2016, LSG has developed additional or follow-on questions and comments on the NFSEG Model. These additional questions and comments are provided below for consideration by the Districts and the NFSEG Technical Team.

Review Questions and Comments

<u>HSPF</u>

1. In previous comments, LSG identified an issue with incorrect rainfall input to one HSPF model. Because of this issue, LSG broadened its review of the rainfall input to the HSPF models. **Figure 1** and **Figure 2** depict 2001 and 2009 rainfall used in the HSPF Models. Based on this review, some areas appear to have higher or lower rainfall than anticipated Please describe the source of rainfall data that was used in the HSPF models. Please provide a comprehensive analysis of how the data used for the HSPF models compares to other available sources of rainfall data, such as gage observations, for the area of the NFSEG Model? Please review and confirm the accuracy of the rainfall data used in the HSPF models.

2. On June 17, 2016, the Districts provided an ftp link to revised NFSEG HSPF Models. One of the changes made to the revised HSPF models was to provide model output for 2001 and 2009 including daily and monthly flow hydrographs and cumulative frequency distributions for simulated and observed flows. We appreciate the Districts providing these additional output data as was previously discussed at the Technical Team meeting on June 1, 2016. However, based on the Districts' response to a previous comment, the Districts indicated the following broader group of metrics and aspects of model performance were considered during calibration:

- Average daily flow;
- Average monthly flow;
- Average yearly flow;
- Average period of record flow;
- Frequency distribution curve;
- Literature estimates of evapotranspiration from different land uses; and
- Hydrologic indices:
  - Mean of daily flow;
  - Mean monthly flow of all Januaries, Februaries, etc.;
  - Ratio of total flow to base flow;
  - Mean of rise rate (calculated from when flow is increasing); and
  - Mean of fall rate (calculated from when flow is decreasing).

Therefore, we request that the Districts provide additional detailed calibration statistics for the HSPF models for both the entire simulation period and specific years of 2001 and 2009. Namely, please provide calculated statistics for the metrics used to calibrate the HSPF models.

3. Though calibration statistics for 2001 and 2009 HSPF predicted flows have not been received from the Districts, LSG has reviewed HSPF predicted average flows for 2001 and 2009 for several observation gages being used by the Districts in the calibration of the HSPF models. The difference between observed flow and predicted flow (e.g., error) for the observation gages reviewed are presented in **Table 1**.

Table 1: Summary of Error in HSPF Predicted Flows at Select Gages

River Flow Gage	2001 Error in Simulated Average River Flow (MGD)	2001 Error in Simulated Average River Flow (%)	2009 Error in Simulated Average River Flow (MGD)	2009 Error in Simulated Average River Flow (%)
Ichetucknee River	NA	NA	-12	-7
New River at Lake Butler	16	119	-7	-11
North Fork Black Creek near Middleberg	-4	-6	-14	-11
North Fork Black Creek at Doctors Inlet	-29	-14	-152	-37
South Fork Black Creek at Penney Farms	20	49	-43	-34
St. Johns River at Jacksonville	-94	-2	-3,451	-49
St. Marys River at McClenney	78	113	-17	-6
Santa Fe River near Worthington Springs	75	163	-52	-29
Santa Fe River near Hildreth	-46	-7	-160	-17
Suwannee River at Dowling Park	408	21	-395	-11
Suwannee River near Luraville	301	14	-613	-15
Suwannee River near Bell Springs	237	7	-448	-9

NA – Not available: Observed data not available

We are concerned about the accuracy of HSPF predicted average flows for 2001 and 2009 at some locations. Errors in surface water flows indicate errors in predicted runoff and baseflow, which could be resulting in errors in the predicted recharge and maximum saturated ET values being assigned from the HSPF models to the groundwater flow model. The magnitude of some of the predicted errors in **Table 1** are several inches per year and could be resulting in significant errors (on the order of inches per year) in recharge to the surficial aquifer system in the groundwater flow model. Also, for the selected watersheds within the North Florida Regional Water Supply Planning area listed in **Table 1**, the models all underpredict streamflow for 2009. Please address the accuracy of 2001 and 2009 recharge rates being predicted by HSPF and assigned to the groundwater flow model given the significant inaccuracies in runoff in several basins. Please consider the use of alternative HSPF model calibration techniques that would result in an improved calibration for the periods for which the HSPF models are coupled to MODFLOW.

4. As previously noted, the 2001 annual rainfall used as input to HSPF model for sub-basin (Sub-basin 37 of Model 03080103) in the Keystone Heights area was considerably higher than expected (>57 inches). On June 17, 2016, LSG received an ftp link from the Districts providing updated HSPF models indicating that the rainfall in the subject sub-basin had been changed. However, we have the following questions on these revision(s):

    - What was the error or issue with the original rainfall data assigned to the model?
    - If a new source of data was used for the revised HSPF model, then what was the source?
    - Since rainfall is a primary component of the water budget of the model, do the Districts plan to recalibrate the HSPF model for sub-basin 37?
    - Do the Districts plan to recalibrate all or a portion of the MODFLOW groundwater flow model based on any changes in recharge and maximum saturated ET calculated in the revised HSPF model?

5. LSG previously noted that significant discontinuities in HSPF-derived recharge estimates occur in the vicinity of Union County, Bradford County, and Clay County along HSPF model boundaries. Because of this issue, LSG broadened its review of recharge being calculated by HSPF and assigned as MODFLOW input. Four figures have been included as follows:

    - **Figure 3**: 2001 HSPF calculated recharge by watershed and subwatershed
    - **Figure 4**: 2001 recharge assigned to the MODFLOW groundwater flow model
    - **Figure 5**: 2009 HSPF calculated recharge by watershed and subwatershed
    - **Figure 6**: 2009 recharge assigned to the MODFLOW groundwater flow model

    From these figures, discontinuities in recharge along HSPF model boundaries can be observed in other areas of the model. This result of HSPF means that two adjacent areas with similar land use, soil type, elevation, etc. on either side of an HSPF model boundary have been assigned notably different recharge values. This does not appear to be a reasonable representation of the physical system. We recommend a thorough evaluation of the model conceptualizations causing this issue and the development of a revised methodology to address this issue.

6. HSPF was also used to calculate the maximum saturated evapotranspiration (ET) assigned to the ET Package in MODFLOW. Similar to HSPF-calculated recharge, discontinuities in HSPF calculated maximum saturated ET along HSPF model boundaries can be observed in

Figure 7, **Figure 8**, **Figure 9**, and **Figure 10**. Again, this result of HSPF means that two adjacent areas with similar land use, soil type, elevation, etc. on either side of an HSPF model boundary have been assigned notably different maximum ET values. This does not appear to be a reasonable representation of the physical system. We recommend a thorough evaluation of the model conceptualizations causing this issue and the development of a revised methodology to address this issue.

7. The HSPF models developed in support of the North Florida Southeast Georgia (NFSEG) groundwater flow model were based on United States Geologic Survey (USGS) 8-digit hydrologic unit code (HUC8) watershed boundaries. It is our understanding that USGS 12-digit hydrologic unit code (HUC12) subwatershed boundaries were used as a guide to subdivide HUC8 watersheds, but in the case of sub-watersheds 36, 37, and 38 of HSPF Model 03080103 the HUC12 basin boundaries were modified to represent that these are isolated or "closed" basins. **Figure 11** presents USGS HUC8 watersheds, USGS HUC12 sub-watersheds, and the sub-watersheds used to develop the NFSEG HSPF models. In many cases, the HSPF sub-watersheds appear to align with USGS HUC 12 sub-watersheds. However, in many other cases, the HSPF sub-watersheds do not appear to align with USGS HUC 12 sub-watersheds. Please provide a detailed description of the methodology used to subdivide HUC8-level watersheds for the development of HSPF sub-watershed models?

8. The HSPF-calculated parameters "Active Groundwater Inflow" (AGWI) and "Inactive Groundwater Inflow" (IGWI) are summed to derive recharge input to the NFSEG groundwater flow model. It is also our understanding that HSPF-calculated parameters "Direct Surface Runoff" (SURO), "Interflow Zone Outflow" (IFWO), and "Active Groundwater Outflow" (AGWO) are the components that comprise total surface water flow out of a watershed, which is the parameter used to calibrate the HSPF models.

   In a closed watershed (e.g., a watershed with no surface water outflow), surface water runoff (SURO), surficial aquifer system groundwater lateral seepage to surface water bodies (IFWO), and baseflow (AGWO) stay within the watershed and ultimately become recharge to the surficial aquifer system (and ultimately available as recharge to the Upper Floridan aquifer [UFA]) through stormwater retention systems, low-lying areas, lakes and wetlands.

   As an example, the results for 2009 for the HSPF sub-basin 37 of Model 03080103 in the Keystone Heights area are summarized in **Table 2**. For this sub-basin, HSPF calculates 13.11 inches per year (in/yr) of recharge and 15.10 in/yr of streamflow. However, there is no discharge from this sub-basin so based on the HSPF model results, 28.21 in/yr (15.10 in/yr + 13.11 in/yr) remains in the watershed and could become recharge the surficial aquifer system.

   As previously described by the Districts, the HSPF models were calibrated to streamflow gages. However, in closed watersheds, there is no streamflow gage to use for calibration of this subwatershed and these subwatersheds do not contribute flow to any gage. Therefore, we request additional details on how closed basins were calibrated. Specifically, for this sub-basin, how was the distribution between recharge (13.11 in/yr) and streamflow (15.1 in/yr) determined?

Table 2: HSPF Model 03080103 Sub-basin 37 Select Results

HSPF Parameter	HSPF Result (in/yr)	Lumped Parameter used for Calibration or MODFLOW Input	Lumped Parameter Result (in/yr)
SURO	6.07	Total Stream Flow	15.10
IFWO	0.0		
AGWO	9.03		
AGWI	13.10	Recharge	13.11
IGWI	0.01		

9. In a closed watershed (e.g., a watershed with no surface water outflow), surface water runoff, surficial aquifer system groundwater lateral seepage to surface water bodies, and baseflow stay within the watershed and ultimately become recharge to the surficial aquifer system (and ultimately available as recharge to the Upper Floridan aquifer [UFA]) through stormwater retention systems, low-lying areas, lakes and wetlands. To account for this the Districts previously indicated that each closed basin has assigned to it a conceptual concentrated discharge mechanism to the UFA estimated from the stage in the HSPF closed basin reach (through the programming of an HSPF Special Action). However, a Special Action to represent the closed basins in Model 03080103 could not be located. Without these discharge mechanisms in the NFSEG Model, the calculated recharge will be significantly underpredicted. Please update the HSPF Models as required to accurately simulate these closed basins.

10. The designation of closed watersheds in the NFSEG Model area was reviewed in more detail. **Figure 12** presents sub-watersheds designated as “closed” by the USGS at a HUC12 level. The Florida Geological Survey’s sinkhole GIS coverage have been included on the **Figure 12** to demonstrate other potential subwatersheds that may effectively be considered closed.

    As previously noted by the Districts, each closed basin has assigned to it a conceptual concentrated discharge mechanism to the Upper Floridan aquifer estimated from the stage in the HSPF closed basin reach (through the programming of an HSPF Special Action). In **Figure 12**, drainage wells and sinks included in the NFSEG groundwater flow model are included and show that many closed basins have a modeled drainage well or sink. However, please confirm that the Special Action to represent recharge to the UFA was applied in all closed basins and that all drainage wells and sinks as included in the NFSEG groundwater flow model were included in the corresponding NFSEG HSPF model. Please indicate which HSPF model sub-basins included the closed basin Special Action programming (and corresponding injection well in the groundwater flow model). If there are closed basins that do not include this Special Action and injection well, please indicate which ones and explain why. Lastly, please explain how calculated streamflow within closed basins was accounted for when assigning recharge results from HSPF to MODFLOW.

11. In certain areas, the HSPF models developed include a simulated “underground reservoir” of groundwater by summing model-calculated groundwater inflow to the inactive groundwater zone (IGWI). This “underground reservoir”, was used to simulate river baseflow (via concentrated discharge from the UFA to springs and rivers) in areas where the Suwannee River and its tributaries are springfed or are incised into the UFA. We have the following questions regarding the use of this method for estimating UFA discharge to surface waters in the HSPF models:

- Please provide a detailed description of this process.
- Springshed and watershed boundaries do not often coincide and can be quite different. What is the rationale for using HSPF watershed boundaries in the development of springflow estimates?
- IGWI is being used to calculate springflows based on an HSPF watershed, but AGWI plus IGWI are being use to drive MODFLOW estimates of springflow based on simulated groundwater levels. Please explain the reasonableness of this difference in conceptualization. Has HSPF been used in this way before?
- Are there any other studies or models that utilize HSPF to represent the magnitude and timing of springflows in a coupled model in this manner? If so, please provide citations. Based on those studies or models, is the use of HSPF in this way reasonable for use in the NFSEG model?
- Do the estimates of IGWI include simulated discharges to the aquifer via sinks and drainage wells as noted in the Districts responses?
    - If yes, then please explain how UFA discharge to river systems and recharge to the UFA from sinks and recharge wells were separately aggregated into the IGWI term in select basins and how these terms were calibrated.
    - Furthermore, given that recharge from sinks and drainage wells are handled as injection wells into the UFA in MODFLOW, are these flows also included in the IGWI term that is mapped as surficial aquifer recharge in MODFLOW for these basins?
- How were springs represented as IGWI in HSPF calibrated?
- Please provide the calibration statistics for springs or spring baseflow represented as IGWI in the HSPF models.

12. The results for AGWI and IGWI from HSPF were evaluated in more detail for several basins. **Table 3** presents a summary of the disaggregation of these two parameters for several example HSPF models:

Table 3: Specific AGWI and IGWI HSPF Model Results

HSPF Model	AGWI (in/yr)	IGWI (in/yr)
Lower St. Johns River Basin - 03080103	14.15	0.014
Lower Suwannee River Basin – 03110205	0.01	10.83
Santa Fe River Basin – 03110206	6.34	3.82

Based on the results presented in **Table 2**, it appears that essentially all recharge in the Lower St. Johns River Basin is calculated in the HSPF Model as AGWI. It also appears that all recharge in the Lower Suwannee River Basin is calculated in the HSPF Model as IGWI. Recharge within the Santa Fe River Basin is calculated as both AGWI and IGWI. Considering these example watersheds, please explain how the conceptualization and representation of springs in the HSPF models is affecting the specific recharge components calculated by HSPF (AGWI and IGWI). Specifically, please provide further explanation of the following:

- In a basin such as the Lower Suwannee River Basin, where IGWI dominates, is basically all HSPF-simulated groundwater recharge being represented as discharge from the UFA to the river system as IGWI? Does this model conceptualization mean that effectively all rainfall that recharges the surficial aquifer system in this surface water basin is assumed to be discharged to the river system as spring-derived baseflow?
- For basins with both AGWI and IGWI such as the Santa Fe River Basin, how was the disaggregation between AGWI and IGWI determined and calibrated?
- Would the assumptions made regarding model input and calibration that resulted in the disaggregation of the components of recharge have a significant effect on other HSPF computed results (e.g., maximum saturated ET)? Please elaborate.

13. As previously noted, total streamflow was calculated as the sum of HSPF parameters SURO, IFWO, and AGWO. It was noted from review of HSPF results that IFWO is frequently calculated as 0 in/yr (or effectively 0 in/yr). This appears to have occurred in 55 of the 72 HSPF models. However, in the remaining 17 HSPF models, this parameter was calculated to be as high as 11.2 in/yr. How was this parameter determined/calibrated and why does there appear to be such as wide range of results for this parameter? How was the disaggregation between SURO, IFWO, and AGWO determined/calibrated? Would the assumptions made regarding model input and calibration of the components of total streamflow have a significant effect on other HSPF computed results (please elaborate)? Could the difference in these parameters between HSPF models lead to issues at the boundaries between HSPF models?

14. HSPF Model 03110205 representing the Lower Suwannee River Basin has the following calculated values for the components of streamflow:

    - SURO: 1.35 in/yr
    - IFWO: 0 in/yr
    - AGWO: 0.0002 in/yr

    Of the 72 HSPF models, this is the only model that has a calculated baseflow (AGWO) that is effectively 0 in/yr. We recognize that much if not all of the baseflow for this system may be comprised of spring discharge represented in the inactive groundwater zone for this watershed; however, please confirm that this watershed does not effectively have any contributing surficial aquifer system baseflow.

15. We have reviewed the Ichetucknee River basin in the HSPF model and the groundwater flow model. In HSPF Model 03110206, the Ichetucknee River appears to be represented by sub-basins 5, 9, 23, 24, and 51, where 51 is a "virtual" reservoir representing springflow (as previously discussed). The HSPF model appears to route sub-basins 23 and 24 to virtual sub-basin 51, which is routed to sub-basin 5 (location of Ichetucknee River gage), which is then routed to sub-basin 9 as it discharges to the Santa Fe River. We have the following questions regarding the representation of the Ichetucknee River in HSPF:

    - Please explain where the individual components of the HSPF water budget for sub-basins 23 and 24 are routed. Specifically, are AGWI and IGWI from sub-basins 23 and 24 routed to sub-basin 51 and are AGWO, SURO, and IFWO from sub-basins 23 and 24 routed to sub-basin 5?

- Is the water routed from sub-basins 23 and 24 to sub-basin 51 converted to IGWO (which represents springflow in virtual sub-basins) in sub-basin 51?
- Is IGWO (springflow) from sub-basin 51 routed as streamflow to sub-basin 5?
- The streamflow gage for the Ichetucknee River is at the discharge of sub-basin 5. What terms (e.g., AGWO, SURO, IFWO, AGWI, IGWI, and IGWO) from which sub-basins (5, 23, 24, and 51) are summed to calculate total streamflow in the Ichetucknee River for calibration to gage data?

Table 4 presents the output for the various HSPF terms discussed above. We have the following questions regarding these HSPF model outputs.

- In sub-basins 5 and 9, AWGI and IGWI are the same value. In sub-basins 23 and 24, AGWI and IGW are not the same value. How was the disaggregation between AGWI and IGWI conceptualized? For these basins, how was the disaggregation of AGWI and IGWI calibrated?
- The sum is AGWI and IGWI represents recharge that is ultimately mapped to the groundwater flow model. The term "AGWI + IGWI" in **Table 4** is a calculation made by LSG based on the results of the individual HSPF components AGWI and IGWI provided by the Districts. In **Table 4**, the term "RCH" is also from an output file provided by the Districts. For the Ichetucknee River, LSG's calculation using District information and the District's calculation of recharge do not match. Please review and explain this discrepancy.
- The HSPF results for the Ichetucknee River basin show significant surface water runoff and baseflow components being calculated by HSPF. However, in the MODFLOW calibration, the Ichetucknee River was conceptualized as being exclusively composed of spring baseflows (no contributing surface runoff or surficial baseflow). It appears that the hydrologic conceptualization for the Ichetucknee River is inconsistent between HSPF and MODFLOW. We are concerned that this inconsistency will lead to unreliable conclusions in the application of the model in this critical area.
- What is the source of the data used to perform the MODFLOW calibration of the Ichetucknee River in 2001?

Table 4: Summary of HSPF Results for the Ichetucknee River Basin (2001)

Basin	AGWI (in/yr)	IGWI (in/yr)	AGWI+ IGWI (in/yr)	RCH (in/yr)	AGWO (in/yr)	SURO (in/yr)	IFWO (in/yr)	Surface Water Runoff and Baseflow (in/yr)
5	3.91	3.91	7.82	7.63	0.65	1.26	0	1.91
9	4.51	4.51	9.02	7.95	0.92	2.25	0	3.17
23	6.1	1.53	7.63	7.82	5.95	2.84	0	8.79
24	6.36	1.59	7.95	9.02	6.26	1.41	0	7.67

Average recharge input assigned to the groundwater flow model for each of the sub-basins presented in **Table 4** are presented in **Table 5**.

Table 5: Summary of Ichetucknee River Basin Recharge (2001)

Basin	Calculated Recharge (AGWI+IGWI) (in/yr)	District Provided Recharge (in/yr)	MODFLOW Recharge (in/yr)
5	7.82	7.63	9.2
9	9.02	7.95	9.0
23	7.63	7.82	6.7
24	7.95	9.02	7.0

We understand that the Districts developed a process for mapping transient HSPF recharge output to MODFLOW as steady-state input for 2001 and 2009. We also understand that this process can result in differences between the HSPF recharge output and MODLFOW recharge input. However, in this instance, some sub-basins have MODFLOW input recharge higher than HSPF and others the opposite situation occurs. We do not understand how this occurs. Please confirm the accuracy of the recharge mapped from HSPF to MODFLOW. Also, as noted elsewhere, the process whereby HSPF output is coupled to MODLFOW as input is a vital component of the NFSEG model. We request a detailed description of how recharge is mapped from HSPF to MODFLOW and the opportunity to thoroughly review and apply the algorithms utilized in this process.

16. The Districts indicated both the 2001 and 2009 calibration simulations are based on 2001 land use. Has the effect and sensitivity of using 2001 land use in the 2009 calibration simulation been evaluated?

<u>PEST Calibration</u>

17. In previous comments, it was noted that in some areas of the MODFLOW model there are significant differences in the PEST pilot point range used across small areas. The example area provided was in southeast Putnam County where there is a wide range in PEST pilot points for UFA hydraulic conductivity that appear to be driving the model calibrated hydraulic conductivity. This PEST setup led to maximum UFA hydraulic conductivities of 5,000 ft/day in an area where APTs have measured hydraulic conductivities on the order of 10s and 100s of ft/day.

    LSG has broadened the review of the pilot point ranges being used to calibrate the MODFLOW model. **Figure 13** presents the calibrated hydraulic conductivity of the UFA and a summary of the calibrated hydraulic conductivities compare to the pilot point ranges assigned to the model.

    As can be seen, most of the areas of the groundwater model with highest UFA hydraulic conductivity coincide with areas where the PEST calibration process utilized the highest hydraulic conductivity allowed. As such, the calibration is being influenced by the pilot points ranges assumed for calibration. Because the pilot point assumptions appear to be critical to the calibration, please confirm the appropriateness of the assumed pilot point ranges in these areas.

18. To what degree was manual calibration performed before the PEST calibration was implemented? Was manual calibration limited to specific geographical areas, aquifer systems, or hydrogeologic parameters? Please provide a description of any manual

calibration performed. Also, to the extent manual calibration was performed, please provide the manually calibrated model input and output files.

19. On June 15, 2016 the Districts provided the computer program and associated configuration files that the Districts are using to extract simulated river and springflows from the NFSEG groundwater flow model for calibration and output processing. For the Santa Fe River at the Ft. White gage, the program extracts predicted flows from the River Nodes (representing river baseflow from the surficial aquifer) and General Head Boundary (GHB) Nodes (representing springs) used to represent the Santa Fe River upstream of Ft. White in the NFSEG groundwater flow model. Upon review of the results, the program does not appear to be accurately calculating Santa Fe River flows from MODFLOW. The program also appears to be inaccurately compiling MODFLOW results for other river systems, but specific issues for the Santa Fe River are described below.

    Figure 14 attached presents the River Nodes and GHB Nodes in the NFSEG groundwater flow model and the River Nodes and GHB Nodes the program provided by the District designates as being associated with the Santa Fe River upstream of Ft. White. From review of the attached figure, there appears to be River Nodes that are not in the Santa Fe River system that the program provided by the Districts appears to be associating with this system. Conversely, there are River Nodes and GHB Nodes that are on the Santa Fe River system that the program does not appear to be associating with this system. It was also noted that the program appears to only be extracting predicted flows from River Nodes in Layer 1 of the model, though several river systems represented in the NFSEG groundwater flow model also have River Nodes in Layer 2 of the model. Please confirm that the output compiling program is extracting the correct flow information for each river system and that the correct predicted flows for specific river and spring systems were used in the calibration process.

20. As part of previously submitted comments it was noted that approximately 328 streamflow gages appeared to have been used to generate results from the HSPF Models, 166 of the 328 gages were used in the PEST calibration process, but that less than 10 gages may have been given full weight in the calibration of river baseflows in MODFLOW. To the extent that changes in MODFLOW predicted river baseflows will be a key output from the NFSEG Model, we suggest that a more robust calibration of the rivers represented in the groundwater flow model is required to ensure that it produces reliable results.

Hydrologic Boundary Conditions

21. Along the Suwannee River and Santa Fe River, overlapping boundary conditions and other potential issues with the hydrologic boundary conditions have been identified. Several figures are provided to illustrate the concerns, but the issues extend beyond the specific areas provided.

    Figure 15 attached presents a segment of the Santa Fe River basin that demonstrates some of the potential issues that have been identified. Using this figure as an example, LSG has the following questions regarding the hydrologic boundary conditions used in the model:

    - Along the Santa Fe River, there are often overlapping boundary conditions that appear to be conflicting with one another. **Figure 15** presents three examples. The northernmost example has four River Nodes in one cell; one in Layer 1 and three in Layer 2. The stages set in the River Nodes vary from 47.04 feet to 52.11 feet. The river bottom elevations set in these River Nodes vary from 31.66 feet to 45.71 feet. Riverbed conductance values set in these River Nodes range from 0 feet/day to 1.64 feet/day. Based on this information, we have the following questions:

  - How were River Node stages and bottom elevations set? If overlapping boundary conditions are going to be maintained, we believe the river stages should be set at the same elevation in these River Nodes. In this particular example, the river stage predicted by the model is 53.6 feet. Based on this result, it appears the calculated stage in this cell is being driven by the River Node stage assignment of 52.11 feet. This is creating a “hump” in the calculated river gradient as the calculated river stage upstream and downstream of this cell are lower than 53.6 feet.
  - Why are conductance values of 0 feet/day being used? This occurs in several river cells.

- The next example has three River Nodes and one Drain Node in one cell; all located in Layer 1. The stage set in the River Nodes is consistently 37.99 feet, which appears conceptually appropriate. However, the river bottom elevations set in the River Nodes range from 36.91 feet to 37.69 feet. This indicates the river depth in this location is as low as 0.3 feet. Please confirm the river bottom elevations being used in this location. The riverbed conductance values set for in these three River Nodes ranges from 37.55 feet/day to 28,828 feet/day. Why is there such a broad range of conductance values set in the River Nodes in this location? The Drain elevation in this location is set at 46.16 feet with a conductance of 100,000 feet/day. In this case, the Drain Node does not appear to be interfering with the River Nodes.
- The third example has four River Nodes located in Layer 1. The river stages set in these River Nodes vary from 38.94 feet to 50.55 feet. The bottom elevations set in these River Nodes vary from 37.21 to 49.98 feet. Why do these values vary by over 10 feet, and why is the river bottom elevation set in some River Nodes higher than the river stage set in other River Nodes? The conductance values set in these River Nodes vary from 3,141 feet/day to 12,540 feet/day. Why is there such a broad range of conductance values set in the River Nodes in this location?

Figure 16 presents a segment of the Upper Suwannee River as represented in the NFSEG groundwater flow model. Using this figure as a second example, LSG has the following questions and comments regarding the hydrologic boundary conditions used in the model:

- There are segments of the Suwannee River with Layer 2 River Nodes, but no Layer 1 River Nodes. Why are the Layer 1 River Nodes discontinuous in this (and other) locations? What does this conceptualization represent? What process was used to define the assignment of rivers to the hydrostratigraphic layers represented in the groundwater flow model?
- In **Figure 16**, the assigned Layer 1 River Node stage and simulated Layer 1 heads have been added in red and black text, respectively.
- “Humps” in the assigned stages can be observed along the Suwannee River.
- There are Layer 1 River Node stages set to 0 feet.
- There are multiple cells with overlapping hydrologic boundary conditions.

Figure 17 presents a segment of the Upper Suwannee River, just downstream of the segment presented in **Figure 16**, as represented in the NFSEG groundwater flow model. Using this figure as an example, LSG has the following questions and comments regarding the hydrologic boundary conditions used in the model:

- There are Layer 1 River Node stages (presented in red text) that are set to 0 feet.
- Though we understand the groundwater head in Layer 1 (presented in black text) is not necessarily going to converge to the assigned stage of the Layer 1 River Node, we would expect the calibrated heads and assigned stages to be reasonably close, particularly if the assigned stages were based on historical data. There are cells presented in **Figure 17** where the calculated head in Layer 1 is over 20 feet different than the assigned stage of the Layer 1 River Node. Please explain why the Layer 1 calculated heads are sometimes notably different than the assigned stages of the Layer 1 River Nodes.
- There are multiple cells with overlapping hydrologic boundary conditions.

The above represent just several examples of potential issues associated with hydrologic boundary conditions set in some areas of the model. In addition to the questions above regarding assigned river stages, river bottom elevations, and riverbed conductance values, the following general questions were also developed based on this review of the hydrologic boundary conditions:

- In some model cells, there are GHB Nodes set in Layer 3 to represent springs. These spring GHB Nodes are sometimes located in the same cell as Layer 1 and Layer 2 River Nodes. Have the spring pool elevations set in the GHB Nodes been compared to the stages set in overlapping River Nodes and evaluated to determine how any potential differences in these set stages are influencing the results?
- A segment of the Santa Fe River from Oleno State Park to just upstream of the City of High Springs is underground. In the NFSEG groundwater flow model, this segment of the River is represented with River Nodes in Layer 1. We understand the inherent complexity of representing this system in the model; however, can the Districts please provide additional information on the conceptualization of this segment of the river and the sensitivity of the results to this conceptualization?

22. Riverbed conductance in MODFLOW is intended to simulate the hydraulic conductivity of the soil material present at the bed of a river, which could be different than the hydraulic conductivity of the soil material in the aquifer system beneath or adjacent to the river. **Figure 18** presents riverbed conductance values set in River Nodes representing the Santa Fe River and Ichetucknee River systems. It was noted that the riverbed conductance values set in some River Nodes can be on the order of millions of feet per day and in excess of 70,000,000 feet per day in some cells along the Santa Fe River. These riverbed conductance values appear unrealistically high and will significantly affect the change in flow predicted in these River Nodes.

    Please review the riverbed conductance values assigned to the MODFLOW groundwater flow model and confirm the reasonableness of these values. Please provide the limits being assigned to riverbed conductance values being assigned to the PEST calibration process. Please note that the legend for **Figure 18** presents riverbed conductance values in excess of 1 billion feet/day that are not shown on the figure. These values are located elsewhere within the model domain and generally appear to be located in areas where the Hawthorn Formation is not present.

Wells

23. The flows for Gainesville Regional Utilities' (GRU's) recharge wells at the Kanapaha Water Reclamation Facility are not correct in the latest version of the model.

    District Response:

    This comment was conveyed to District staff by phone and the District has already indicated that these recharge well flows will be corrected.

24. It was generally noted that the injection well flows associated with sink features represented in the NFSEG groundwater flow model (e.g., the sink at Orange Lake) appeared to have notably changed between the preliminary version of the model released in October 2015 and the current version of the model release in May 2016. How are these flows being calculated and why did they change between the two versions of the model?

Other

25. Appendix A and Appendix B provide comments previously submitted by LSG during of review of the NFSEG Model. We look forward to resolving all outstanding comments previously provided with the Districts.

26. As noted in an email to District staff on June 1, 2016, we found a few potential minor issues with the NFSEG groundwater model as follows:

    - Cell R368 C153 in Layer 5 is inactive
    - Extinction depth is different in 2001 and 2009 in Cell R635, C405.
    - The following are noted as RIBs (recharge) but they are negative flows (withdrawals) in the WEL file:
        - Sunny Hill Plantation Well Number 001
        - Camp Kulaqua, RIB

27. We have previously noted the importance of having a model which can be fully utilized and reviewed by third parties. In previous comments during the review period, we noted that a key component(s) of the NFSEG Model used to couple the HSPF models with the MODFLOW model could not be readily run by stakeholders. At that time, we requested that the Districts' provide this component to the Technical Team in a form that could be more readily utilized

    As of the date of these comments, the component(s) have not been provided to the Technical Team. As a result, we have been unable to review the execution of the process used to couple the models via the transformation of HSPF model output for use as MODFLOW input. We also have no written documentation on this process so we have been unable to evaluate it at a conceptual level. Therefore, we are unable to render an opinion on the suitability of this coupling process.

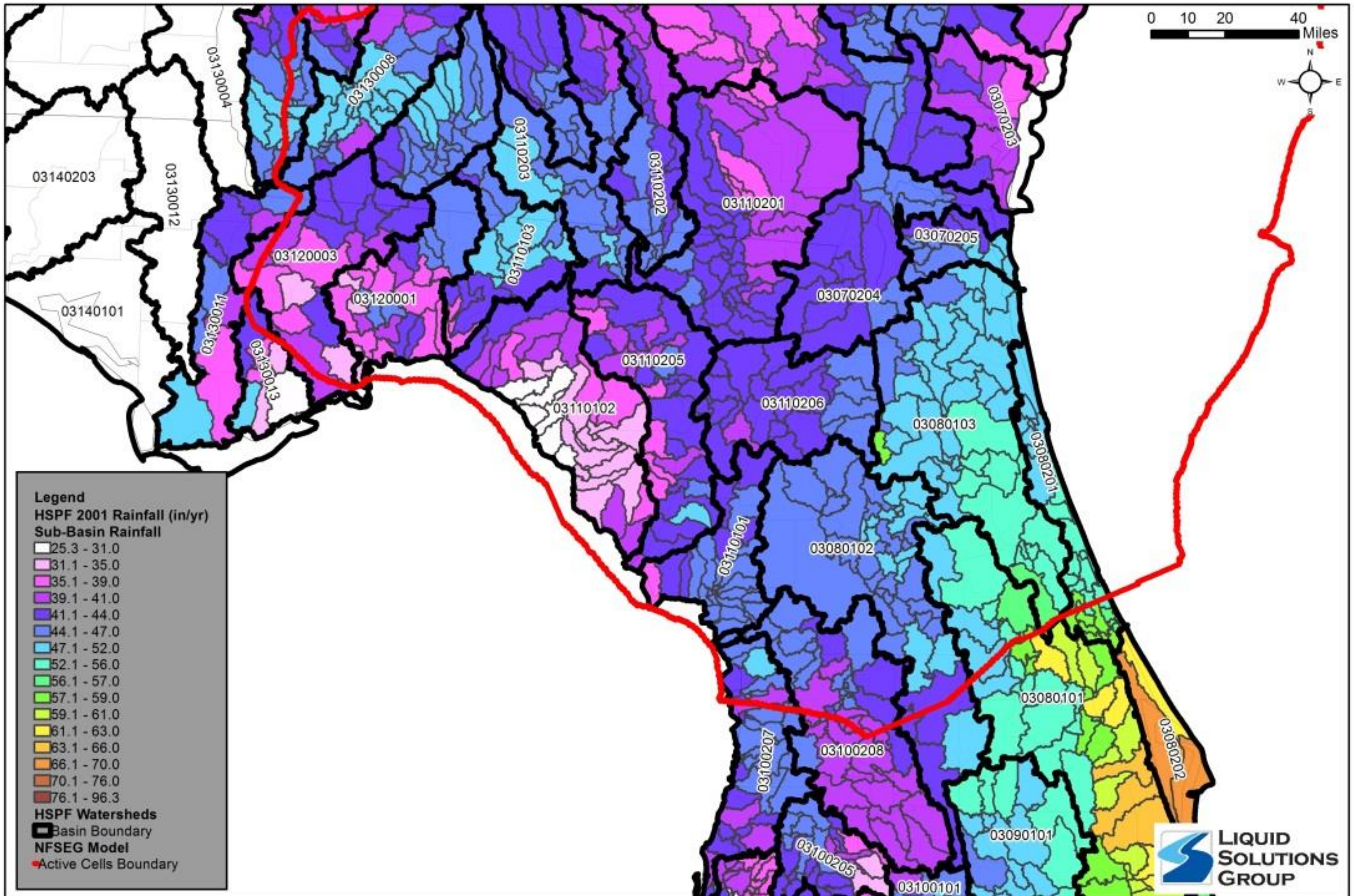
    We believe that this coupling process is a key component of the NFSEG Model. As a result, a thorough review of this process must be a part of the review process

28. What is the schedule for the completion of the 2010 verification simulation? When will the results of the verification simulation be provided to the Technical Team for review?

Performance of a verification simulation is included in the NFSEG Model Work Plan as a task to be completed before use of the model for predictive simulations.

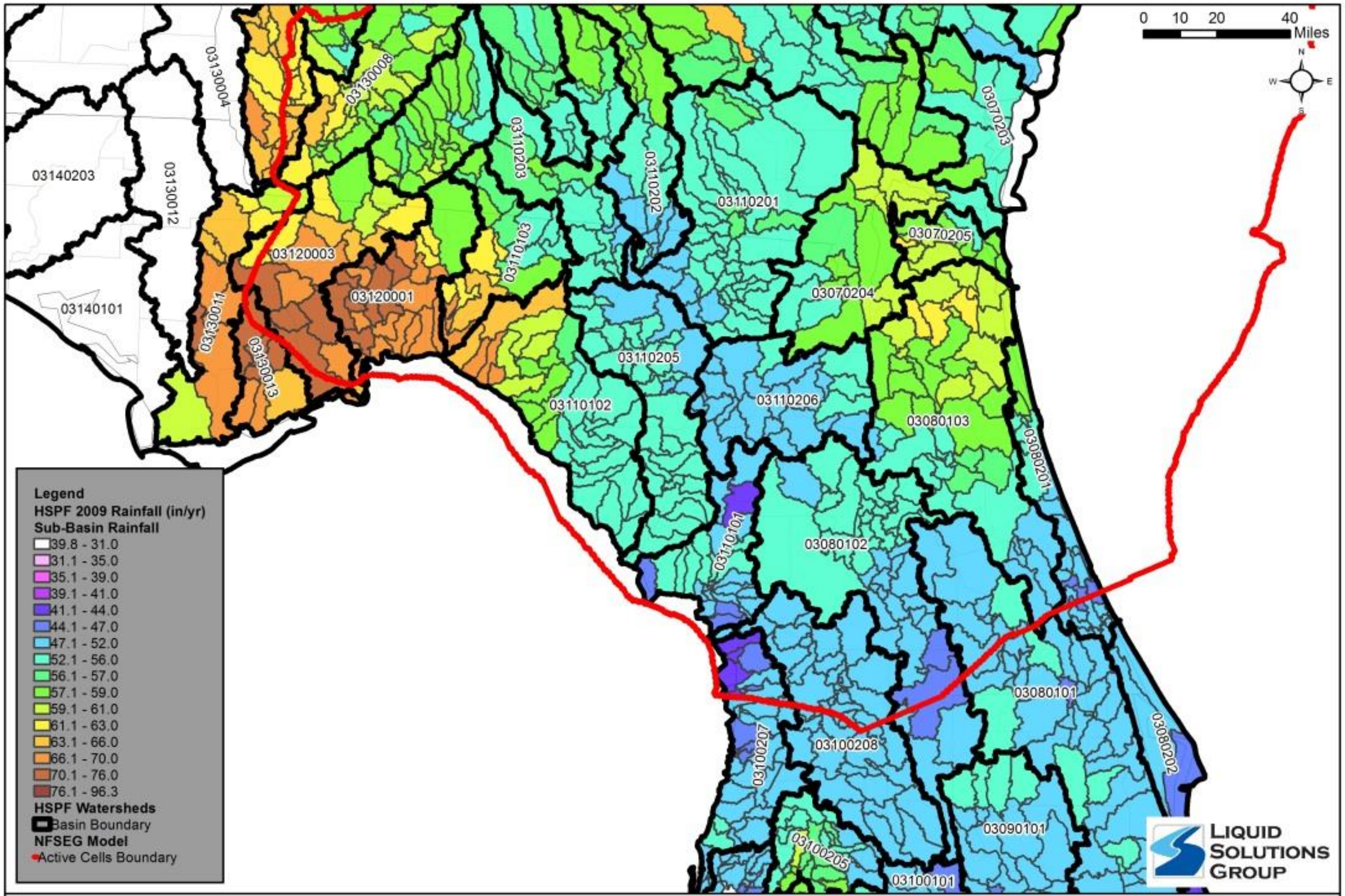
29. As documented in the approved NFSEG Work Plan and due to the importance of the NFSEG Model, a robust parameter sensitivity analysis was identified as a key analysis to be performed during the development of the NFSEG Model. What is the schedule for the completion of the parameter sensitivity analysis? When will the results be provided to the Technical Team for review?

Figure 1 – HSPF 2001 Rainfall



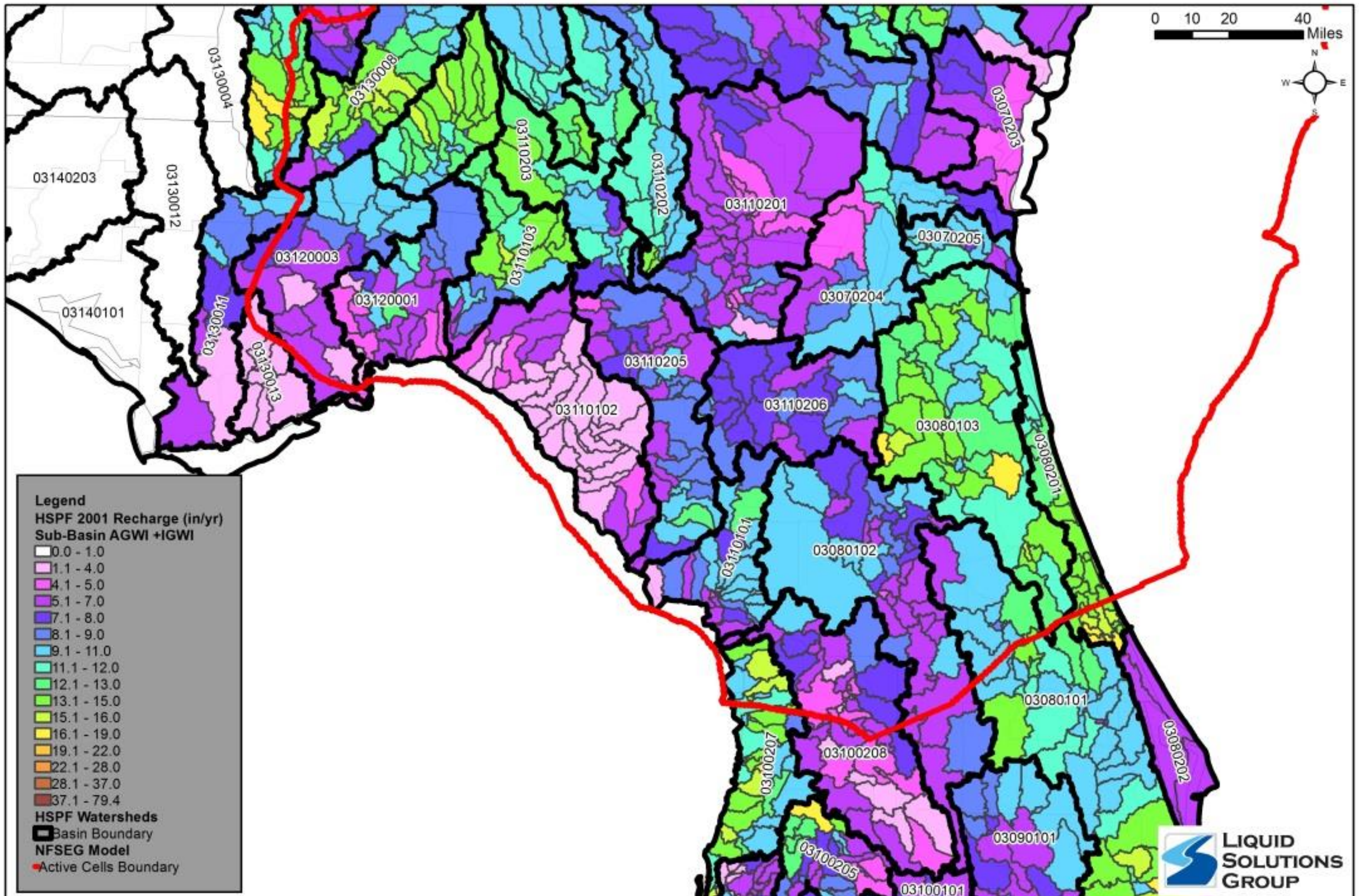
NFSEG Groundwater Flow Model
HSPF 2001 Rainfall

Figure 2 – HSPF 2009 Rainfall



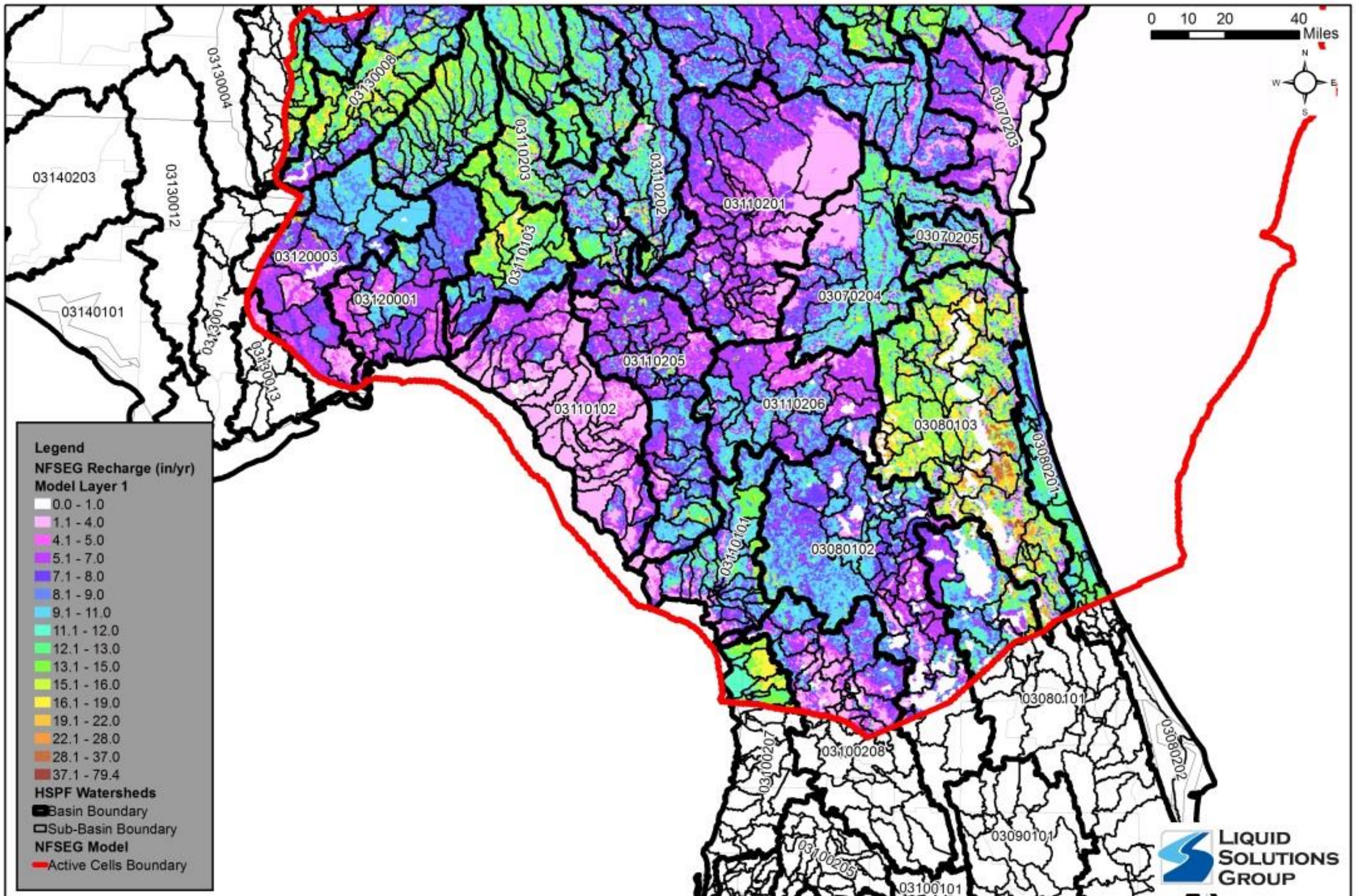
NFSEG Groundwater Flow Model
HSPF 2009 Rainfall

Figure 3 – HSPF 2001 Calculated Recharge



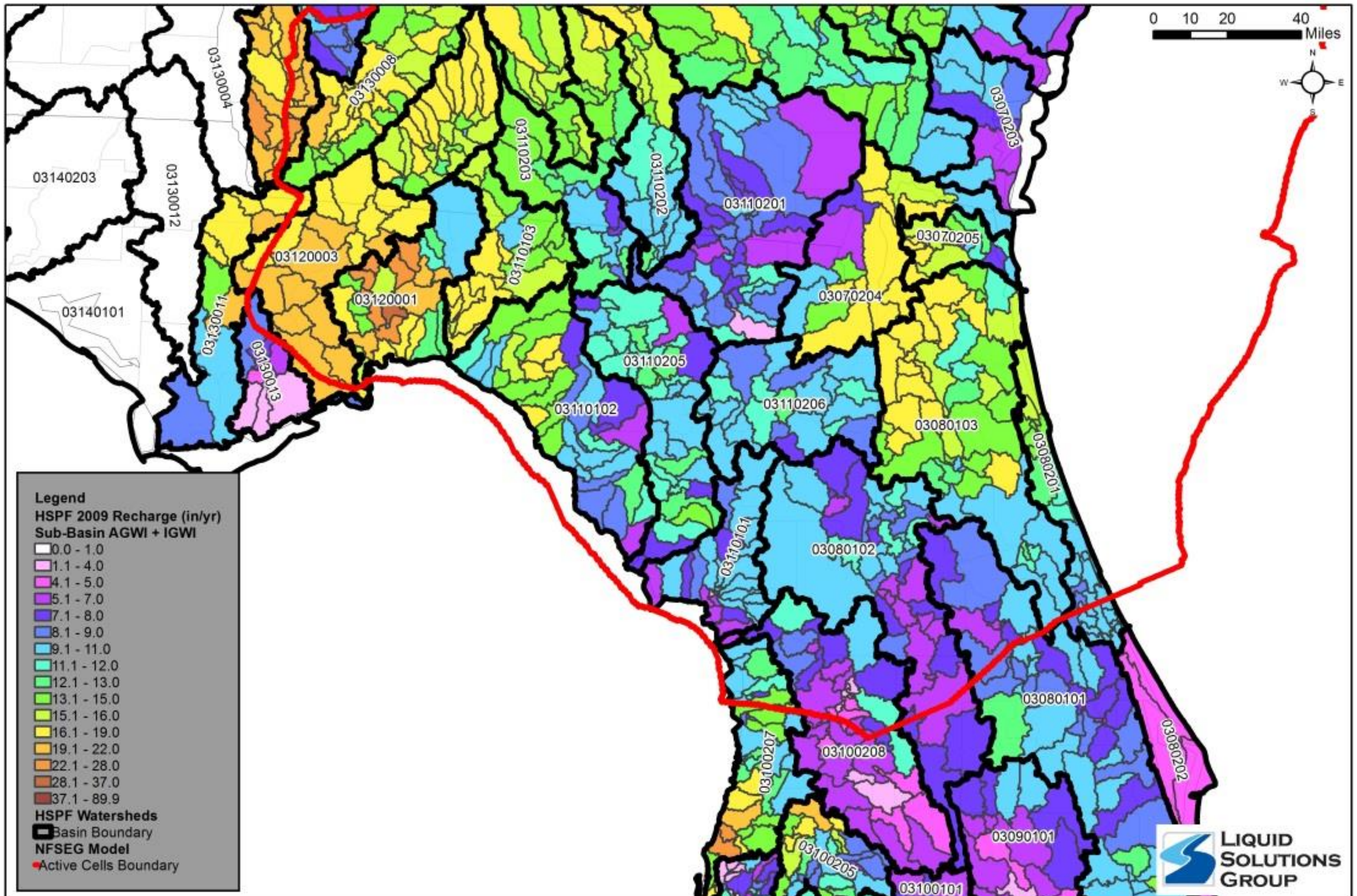
NFSEG Groundwater Flow Model
HSPF 2001 Calculated Recharge

Figure 4 – 2001 MODFLOW Net Recharge



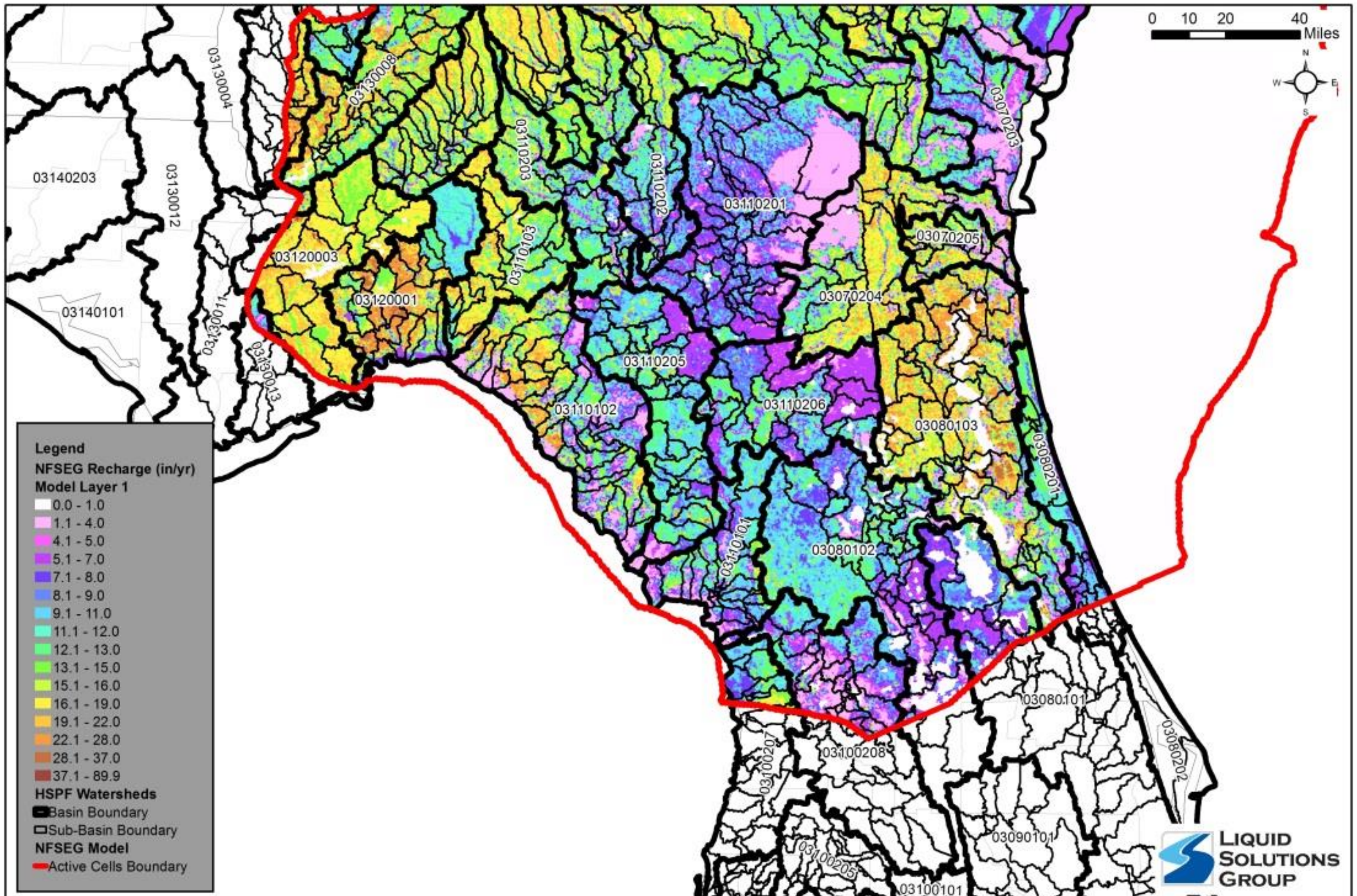
NFSEG Groundwater Flow Model
2001 Steady State Simulation (Stress Period 1)
Distribution of Net Recharge in Selected HSPF Watersheds

Figure 5 – 2009 HSPF Calculated Recharge



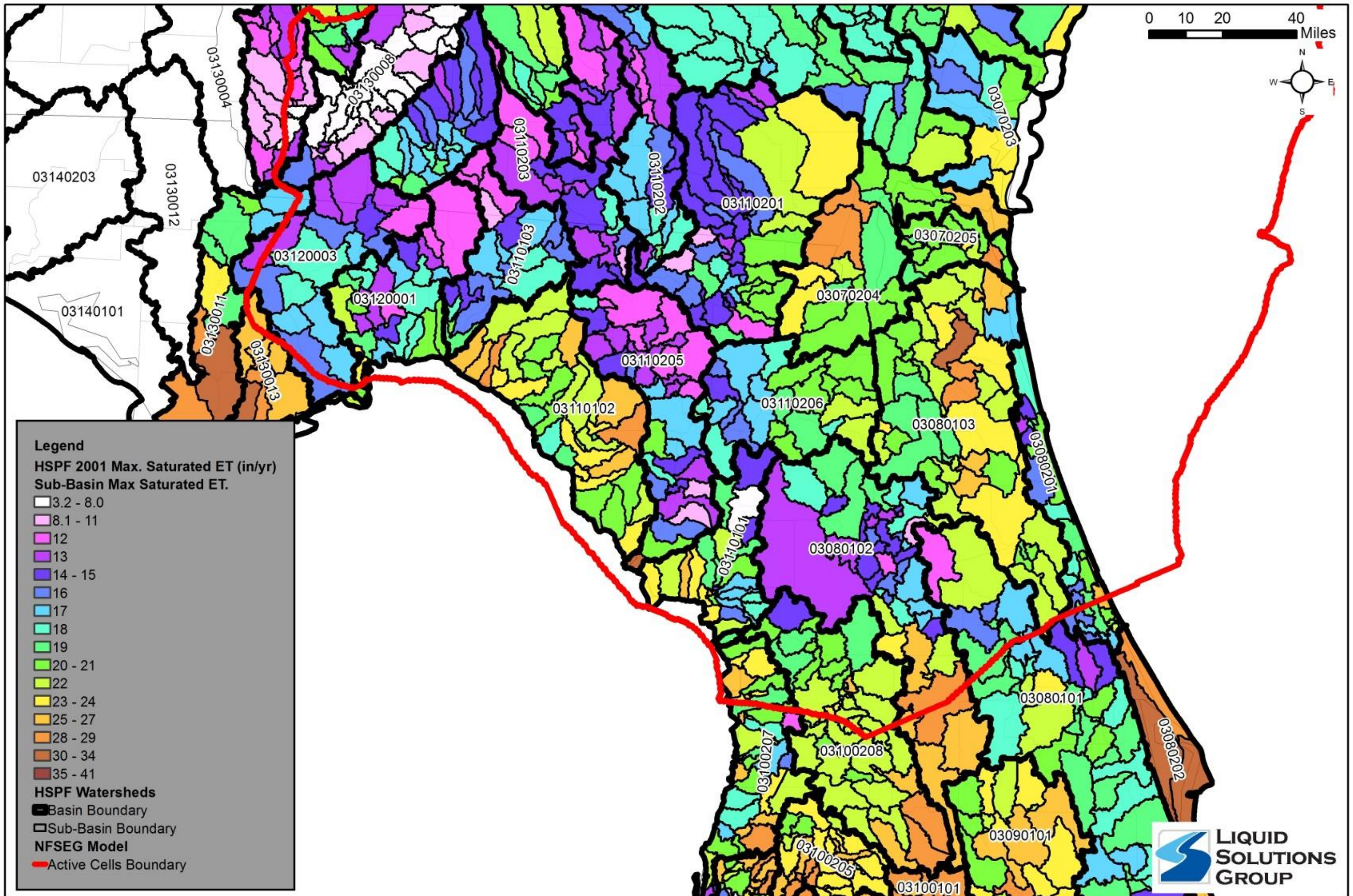
NFSEG Groundwater Flow Model
HSPF 2009 Calculated Recharge

Figure 6 – 2009 MODFLOW Net Recharge



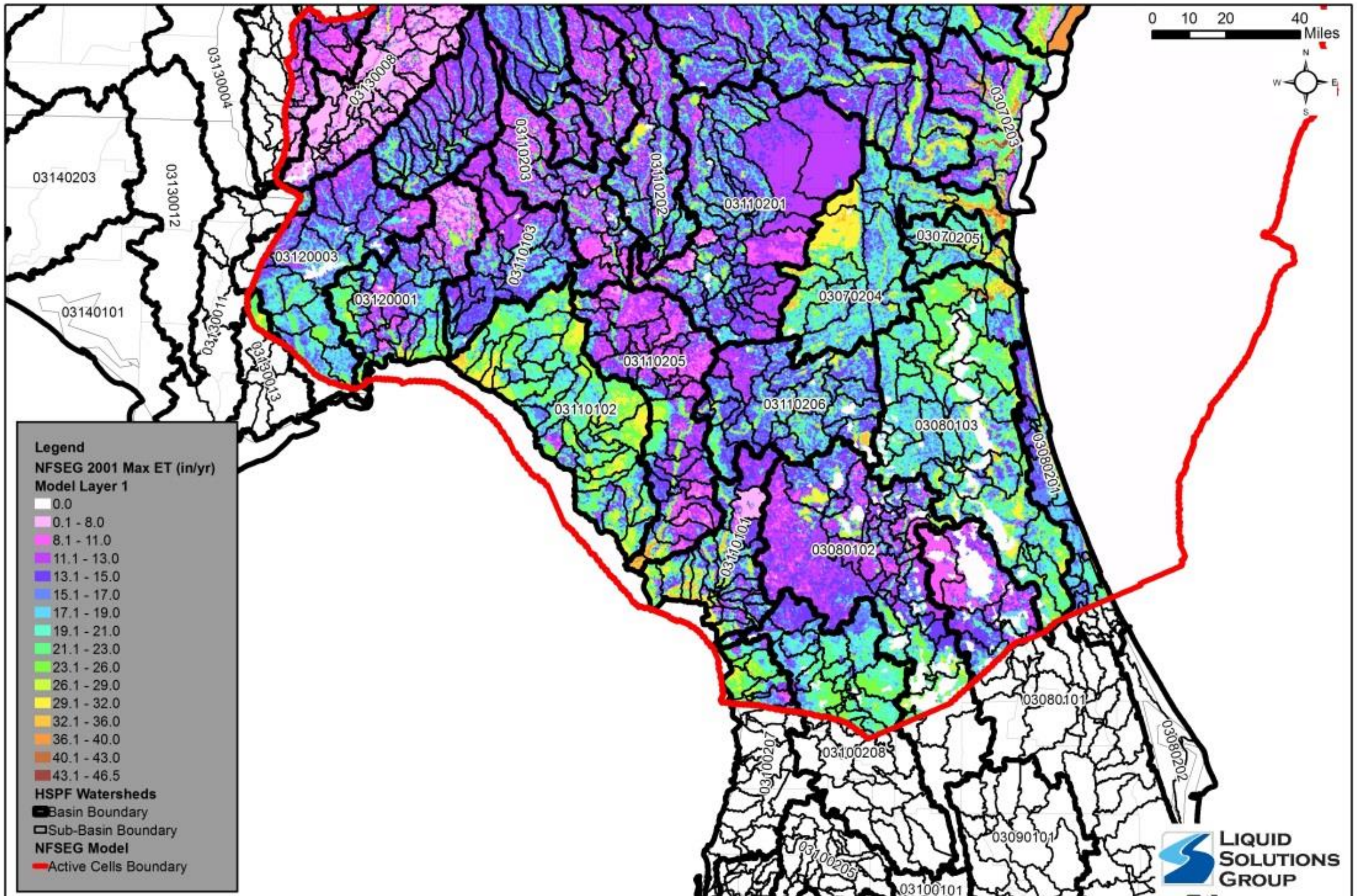
NFSEG Groundwater Flow Model
2009 Steady State Simulation (Stress Period 1)
Distribution of Net Recharge in Selected HSPF Watersheds

Figure 7 – 2001 HSPF Maximum Saturated ET



NFSEG Groundwater Flow Model
2001 HSPF Maximum Evapotranspiration

Figure 8 – 2001 MODFLOW Maximum Saturated ET



NFSEG Groundwater Flow Model
2001 Steady State Simulation (Stress Period 1)
Distribution of Maximum Evapotranspiration in Selected HSPF Watersheds

Figure 9 – 2009 HSPF Maximum Saturated ET

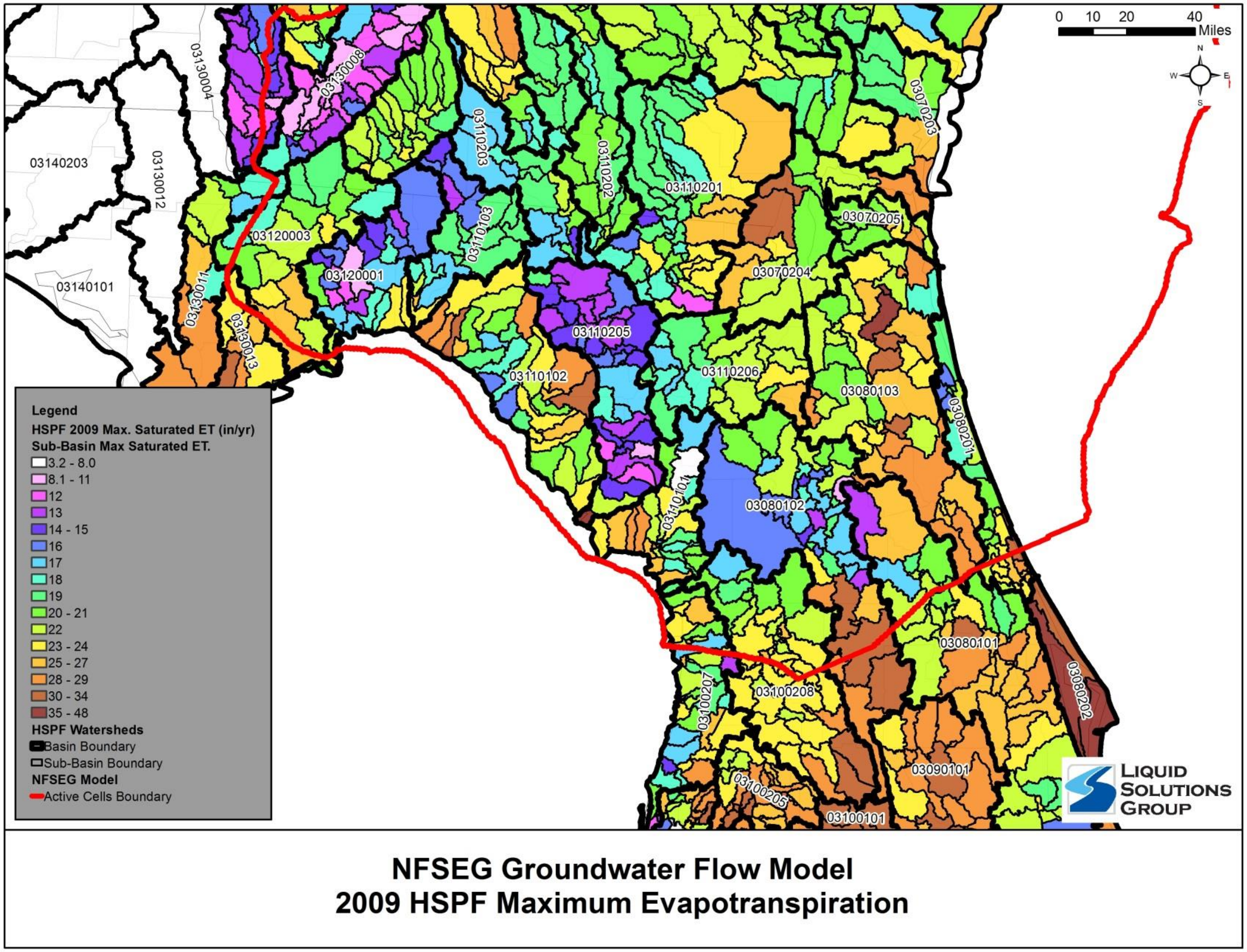
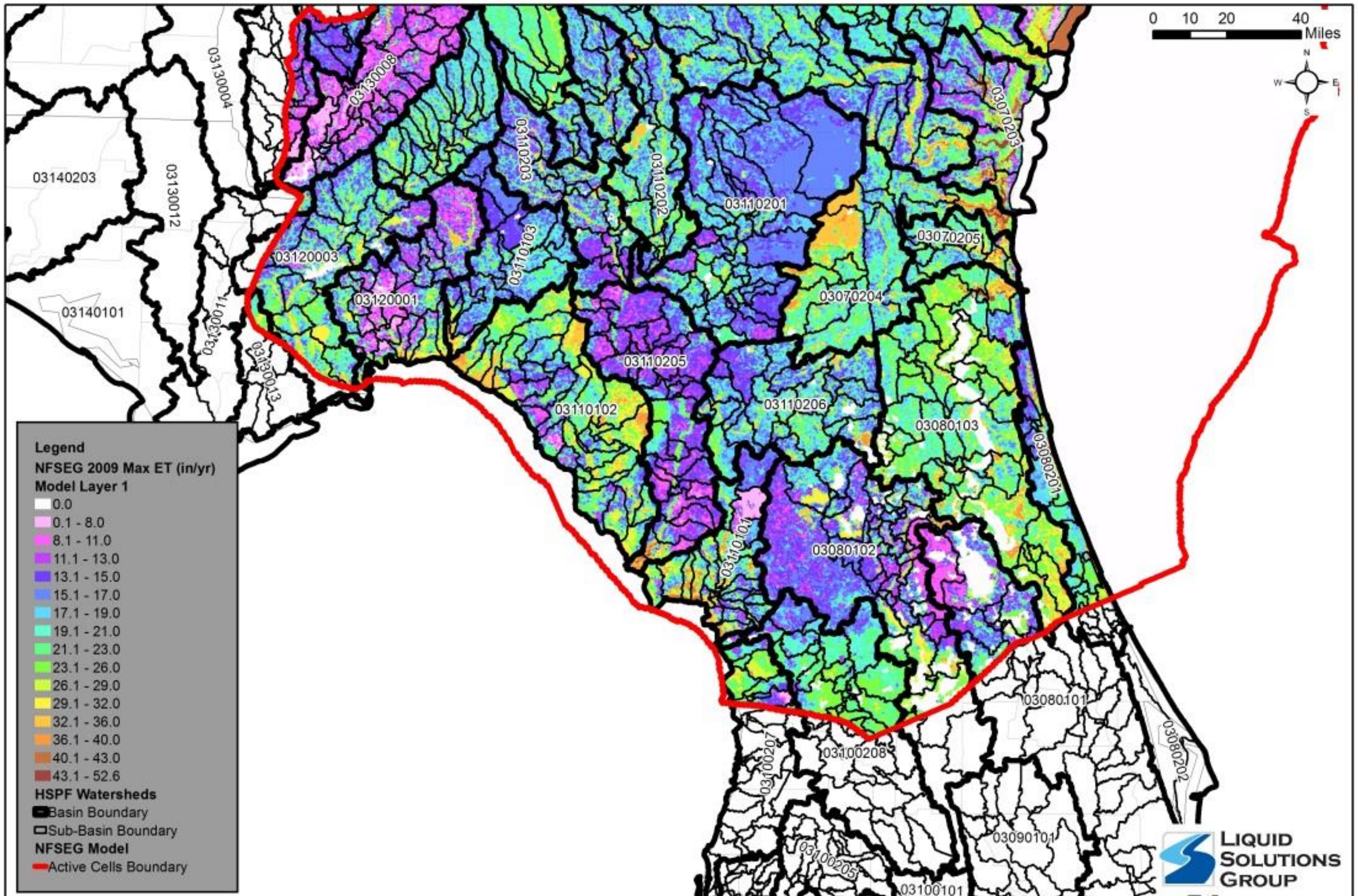
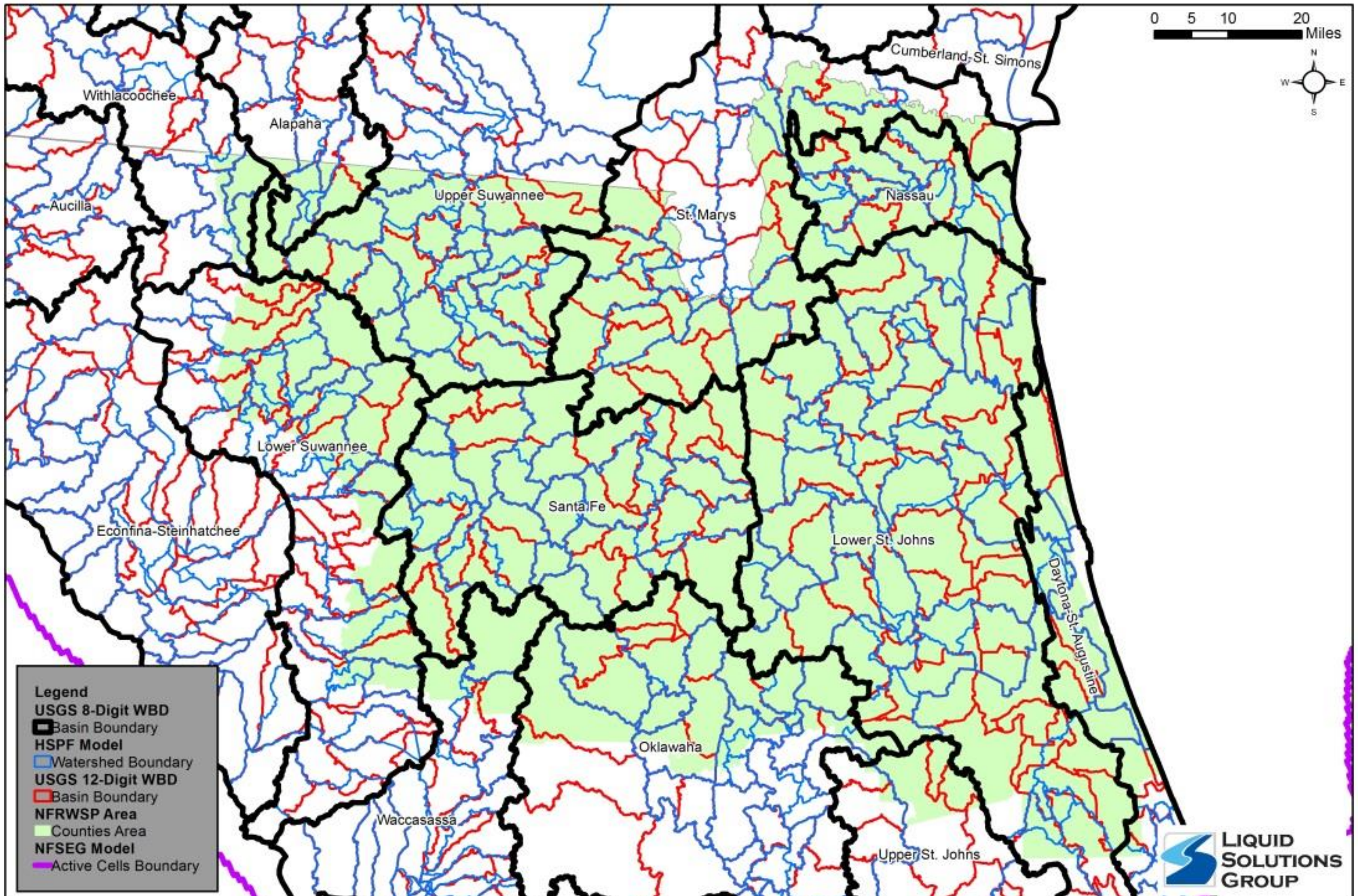


Figure 10 – 2009 MODFLOW Maximum Saturated ET



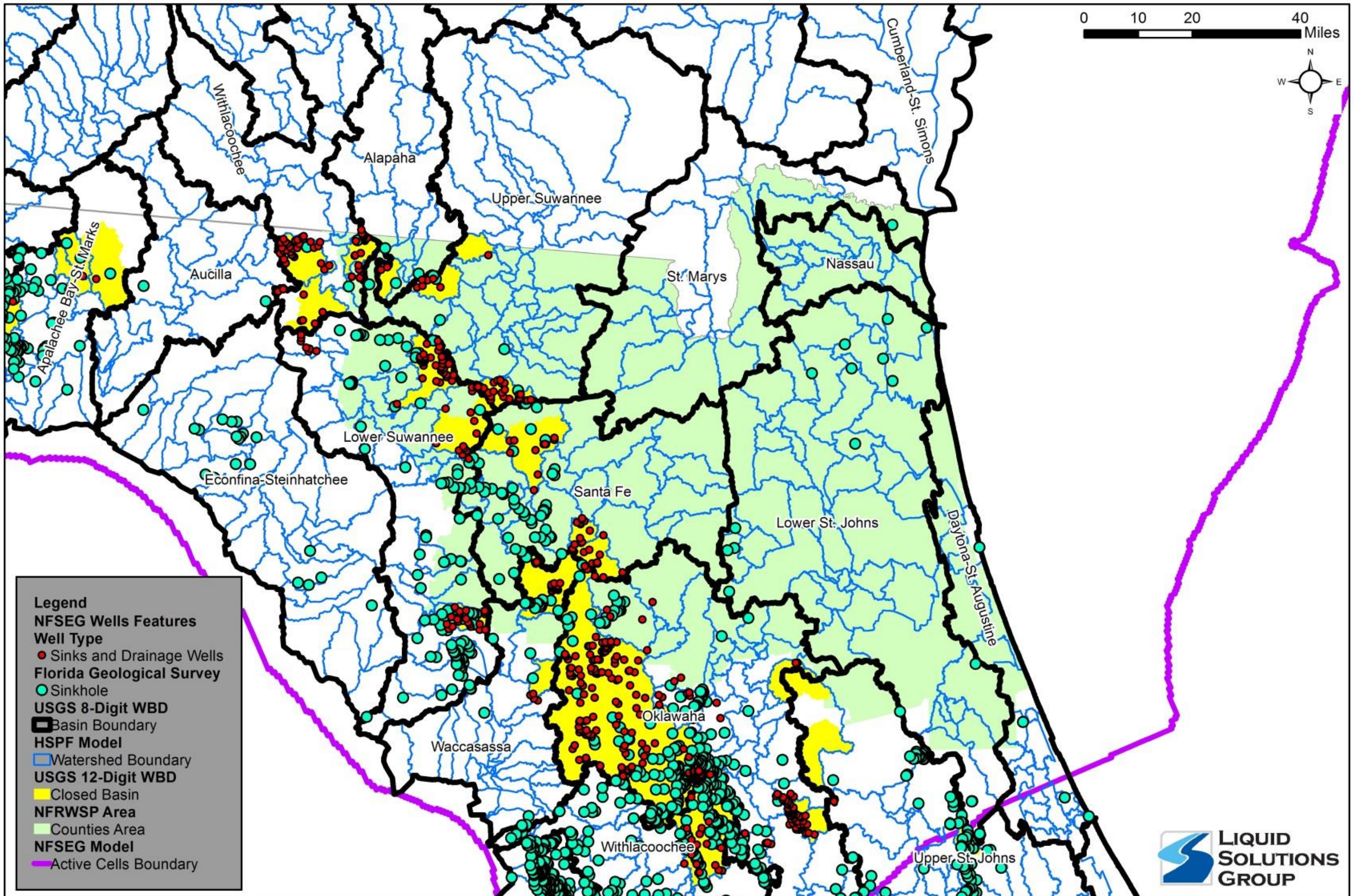
NFSEG Groundwater Flow Model
2009 Steady State Simulation (Stress Period 2)
Distribution of Maximum Evapotranspiration in Selected HSPF Watersheds

Figure 11 – HSPF Watershed Boundaries



NFSEG Groundwater Flow Model
Comparison of HSPF Model Watersheds to USGS 12-Digit HUC Basins
In the Vicinity of the NFRWSP Area

Figure 12 – Closed Basins and Sinkholes



NFSEG Groundwater Flow Model
Location of Closed Basins and Sinkholes in the Vicinity of the NFRWSP Area

Figure 13 - UFA Hydraulic Conductivity and PEST Pilot Point Ranges

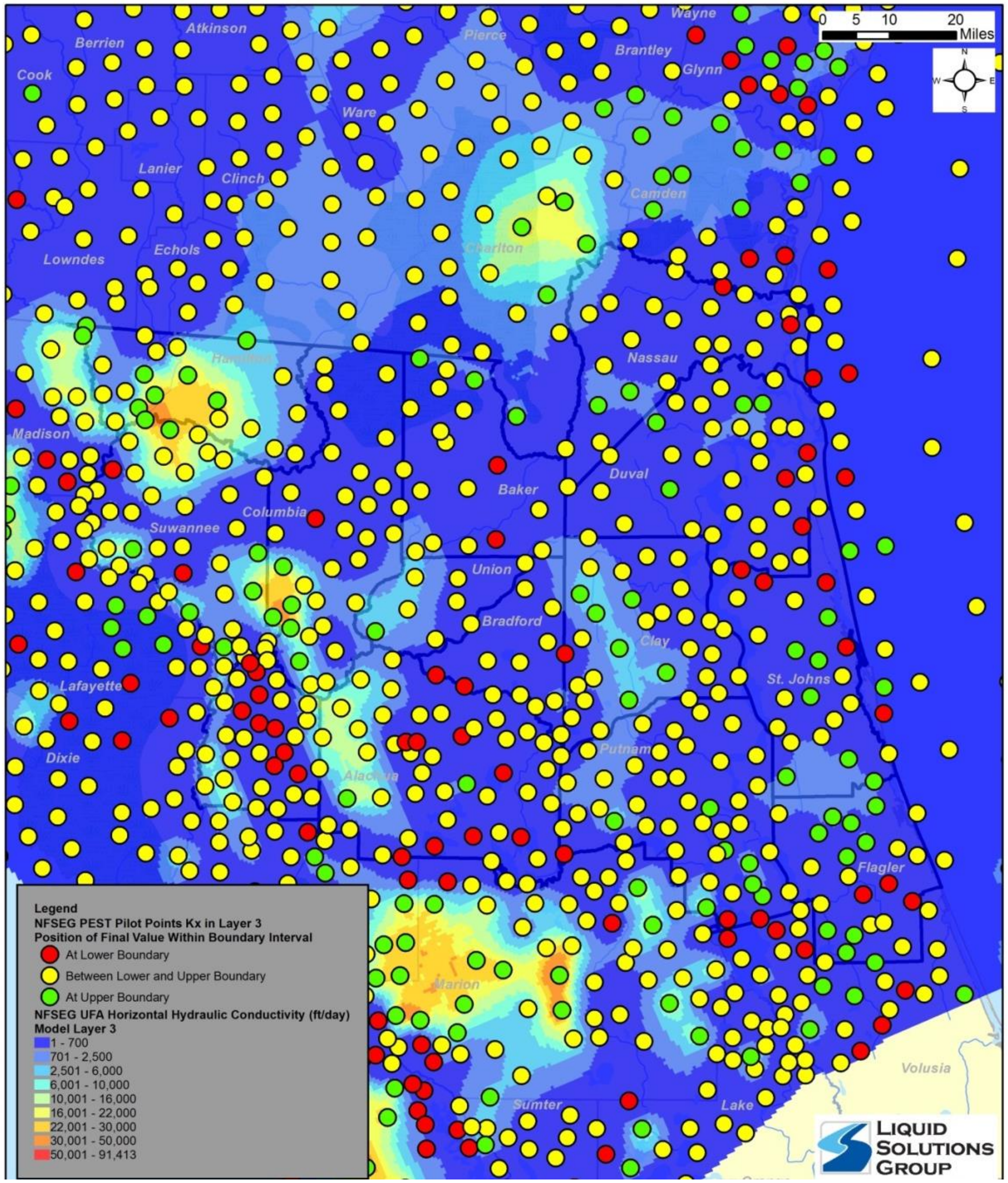
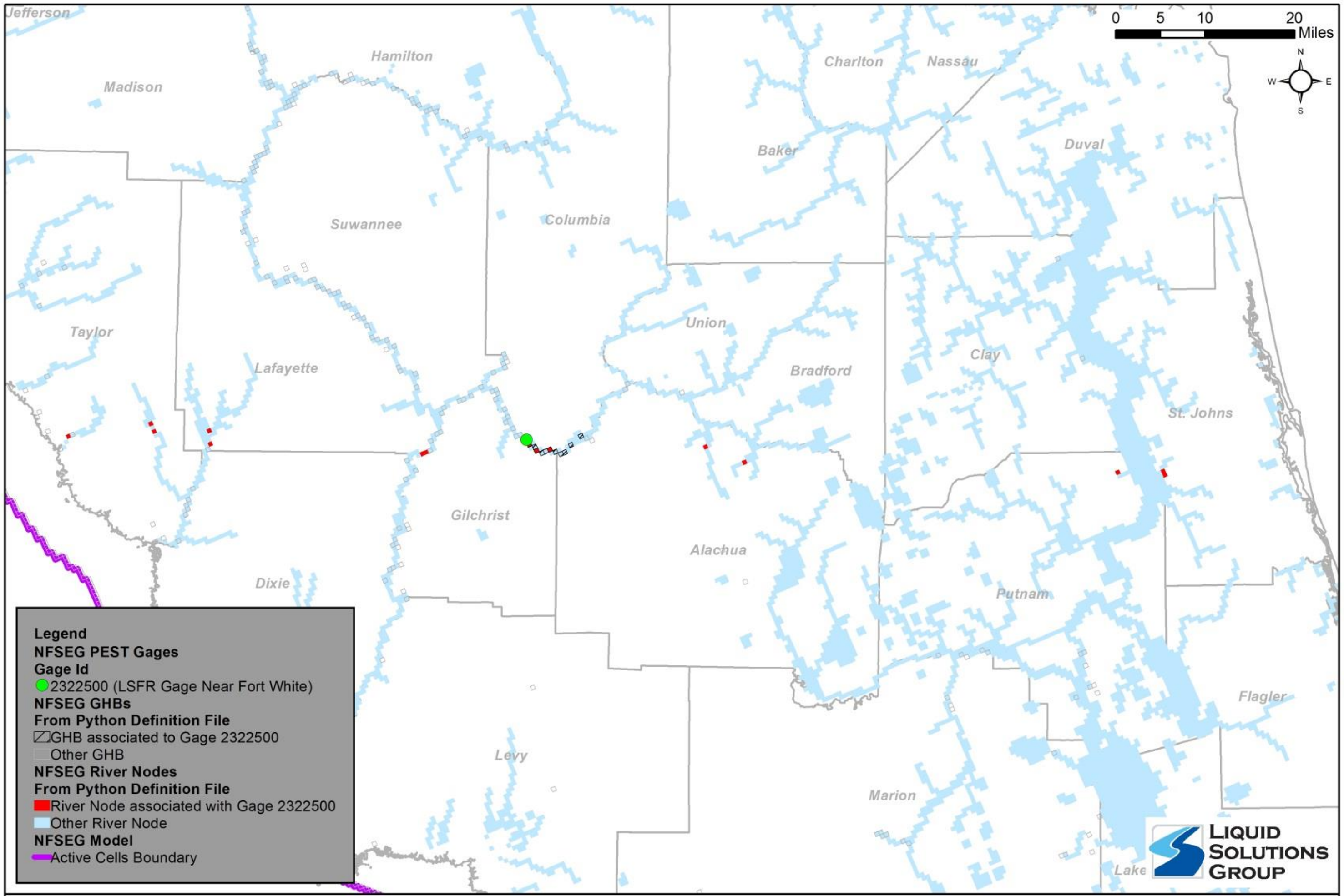
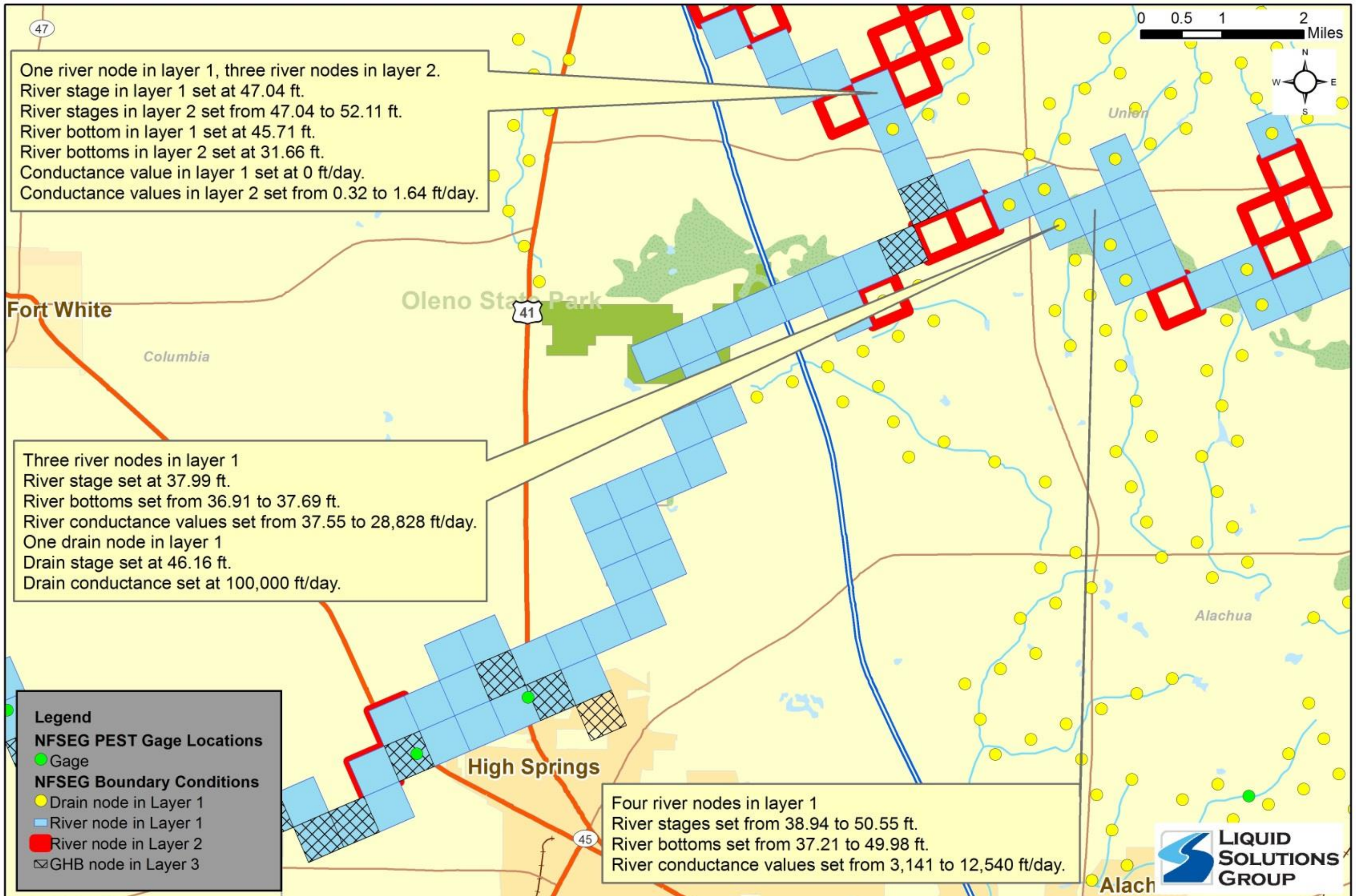


Figure 14 – Location of River and General Head Boundary Nodes Associated with the Santa Fe River



NFSEG Groundwater Flow Model
Python Program Gaged-Reach Definition File
Location of River and GHB Nodes Associated with the LSFR Gage Near Fort White

Figure 15 – Hydrologic Boundary Conditions set for the Lower Santa Fe River



NFSEG Groundwater Flow Model
Lower Santa Fe River Segment
Location of Boundary Conditions

Figure 16 – Hydrologic Boundary Conditions set for the Suwannee River

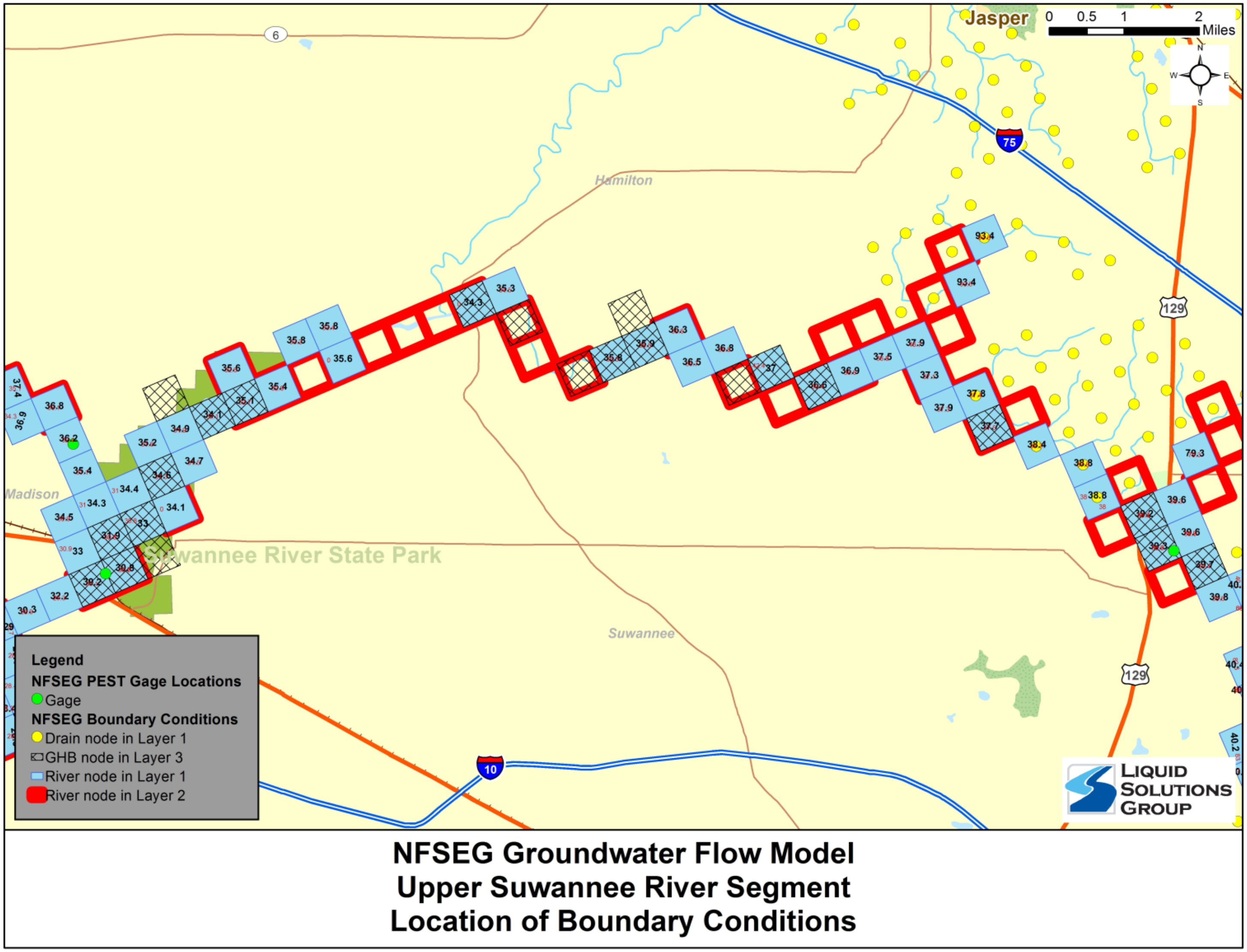
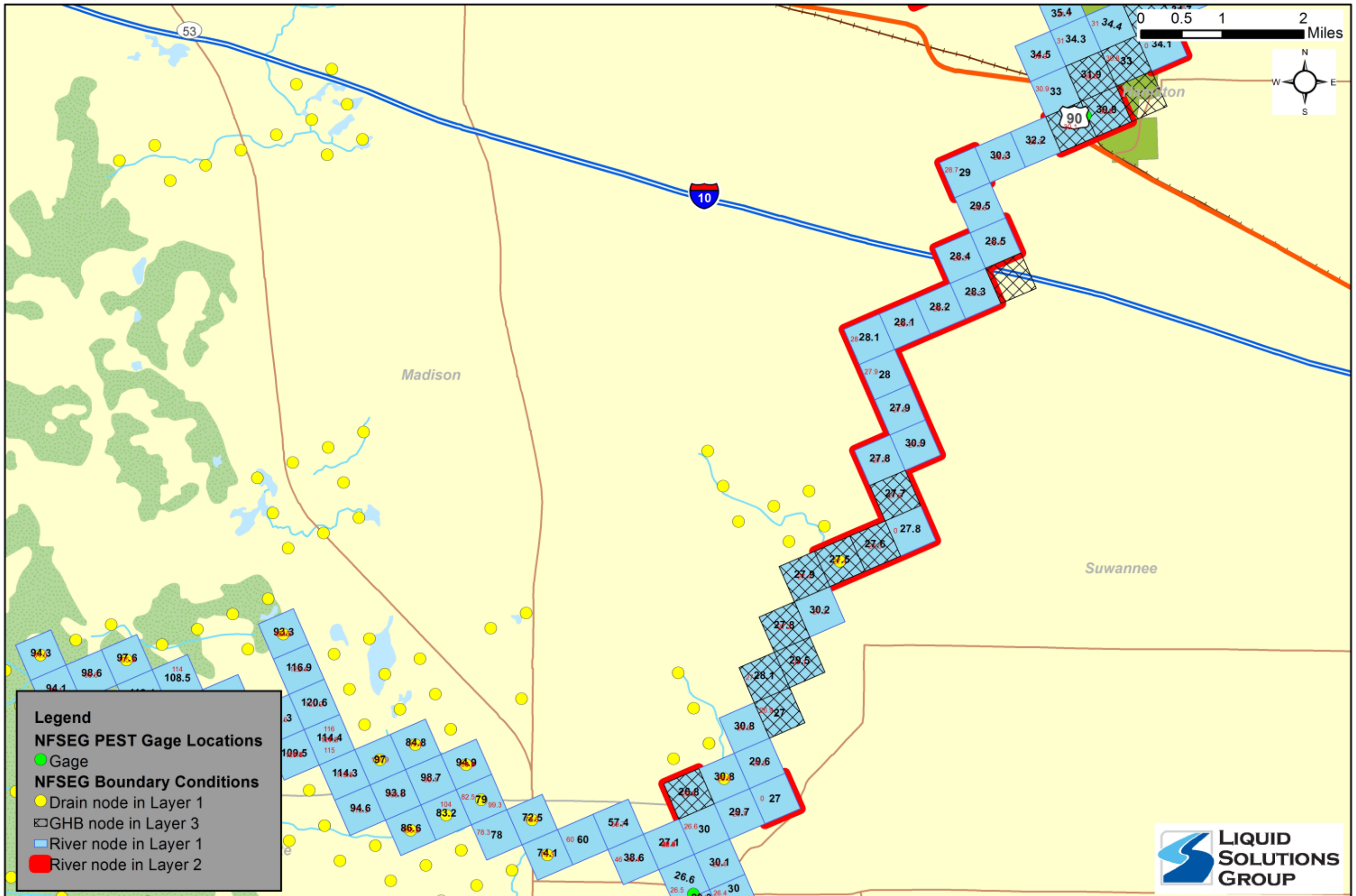
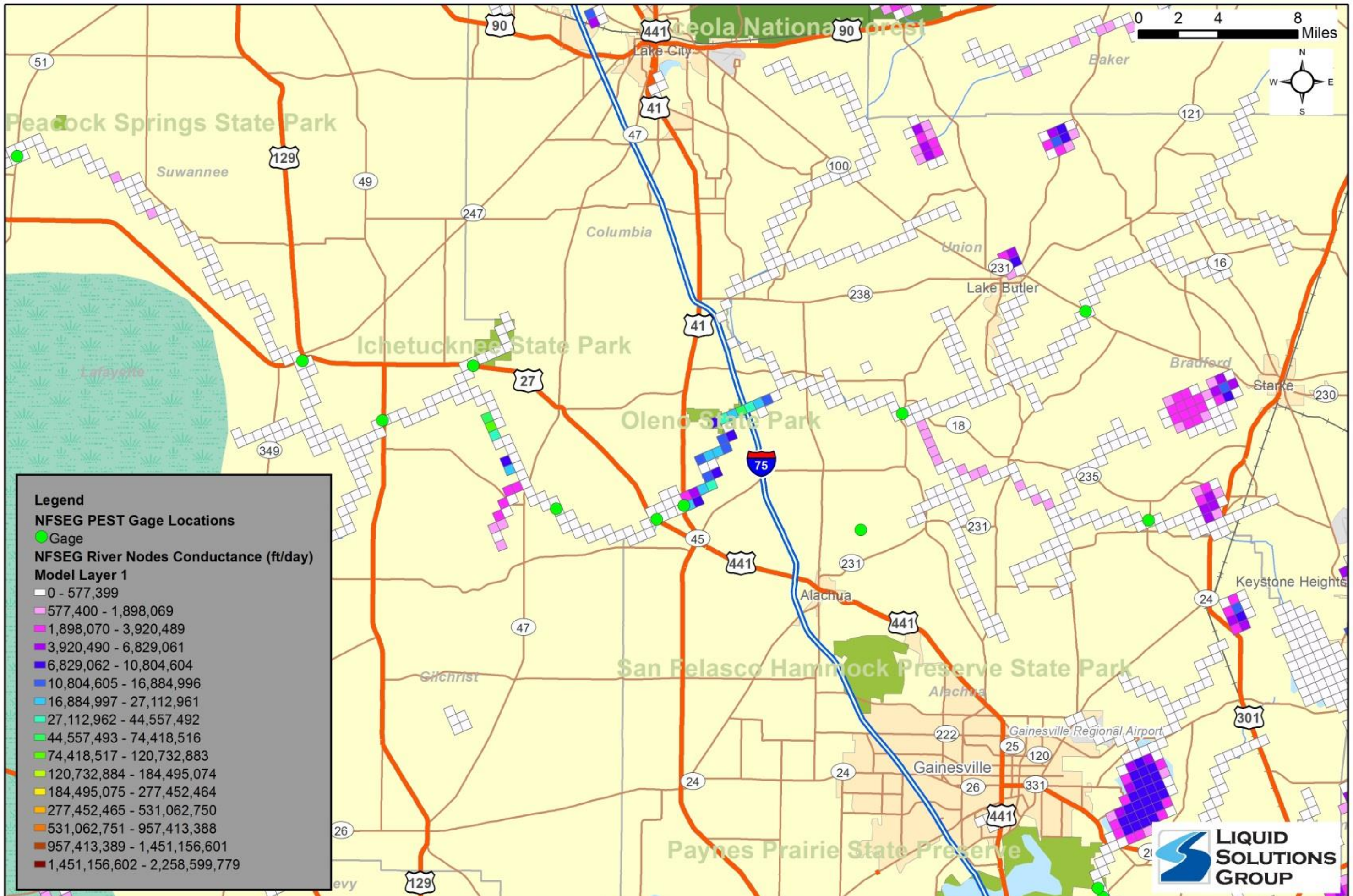


Figure 17 – Hydrologic Boundary Conditions set for the Suwannee River 2



NFSEG Groundwater Flow Model
Upper Suwannee River Segment
Location of Boundary Conditions

Figure 18 – Riverbed Conductance Values used for the Santa Fe River and Ichetucknee River



NFSEG Groundwater Flow Model
Santa Fe River and Ichetucknee River Basins
Distribution of River Nodes Conductance in Model Layer 1

Appendix A
Initial Review Questions and Comments
Liquid Solutions Group, LLC
May 27, 2016

LSG's comments submitted on May 27, 2016 are reiterated below. Please note that specific references to figures have been added to the original comment for clarity.

Questions on District Responses to Previous Comments

We appreciate the Districts' responses to our previous comments. However, we respectfully request additional follow-up on the comments below.

A1) On December 16, 2015, we submitted two questions regarding the golf course irrigation included in the NFSEG Model. The Districts responses do not appear to have addressed these questions. The original questions are provided below for convenience.

a. What is the source(s) of water for the golf course irrigation provided by the Districts?
b. Why is there such a significant annual average variation in the quantities of golf course irrigation the Districts are proposing to include in the model? For example, the quantity of golf course irrigation proposed for Duval County reduces from 9.86 MGD to 2.41 MGD from 2001 to 2009, and then stays relatively constant from 2009 to 2010. The change in magnitude in golf course irrigation in Duval County from 2001 to 2009 is greater than would be anticipated from climatic variations in irrigation demand and implies a significant reduction in the number of golf courses within Duval County. In addition, the District's data implies that no golf courses within St. Johns County were irrigated in 2001.

A2) The comment responses from the Districts appear to indicate they have made specific changes to the Keystone Heights area as a result of preliminary review comments from the Technical Team. Please provide a detailed explanation of those changes.

A3) As part of the comments submitted in support of the preliminary review of the NFSEG Model, the following question was asked, "Are calibration parameters varied by subwatershed and then indexed to a single land use, or are specific calibration parameters across the entire model domain set at same value and then indexed?" The Districts response indicated that the model was developed with the ability to vary subwatershed parameters by zone. Was this done, or was the model just set up with the ability to do this? We would request a review the input parameter indexing method at the next Technical Team meeting.

A4) There are several comment responses from the Districts that indicate they are revising or reviewing certain aspects of, or data used in, the NFSEG Model as a result of the preliminary comments received from the Technical Team. What is the Districts' timeline for completing these evaluations and any associated changes? A brief list of the items the Districts indicated they are currently re-evaluated is provided below:

- Overlapping hydrologic boundary conditions in MODFLOW (e.g., overlapping drain and river nodes).
- Reclaimed water land application including irrigation, RIBs, sprayfields, etc.
- Non-agricultural irrigation.

Changes made to recharge as a result of the Districts re-evaluation of these items should be incorporated into both the HSPF Models and MODFLOW Model, as appropriate.

HSPF

A5) As discussed during the May 11, 2016 Technical Team meeting, please provide a detailed summary of the calibration statistics for the HSPF Models for the modeled period of record at the simulated gages. We would also specifically like to see the calibration for 2001 and 2009 since these are the years used for the MODFLOW Model.

A6) From review of the HSPF Models and as we discussed, it appears the simulated streamflows from the calibration simulations and the “No Water Use” simulations, are exactly the same for each model provided to the Technical Team. Please confirm that the correct model simulations were provided to the Technical Team.

A7) Rainfall used as input to the HSPF Models was reviewed. The year 2001 is generally considered a “dry” year. However, based on the information provided to us, in 2001 the annual rainfall used in the HSPF sub-basin (Sub-basin 37 of Model 03080103) that includes Lake Brooklyn and Lake Geneva in the Keystone Heights area was considerably higher than expected (>57 inches). The rainfall used for this HSPF sub-basin in 2009 is also different, though to a lesser degree, than the surrounding sub-basins. **Figure A1** and **Figure A2** depict 2001 and 2009 rainfall, respectively, used in the referenced area. Please confirm the accuracy of the rainfall data used in these HSPF sub-basins.

A8) We do not note any gage data utilized in the Keystone Heights area. Please describe how the Keystone Heights area was calibrated in the HSPF model.

A9) The HSPF Models used to develop recharge and maximum saturated ET for the MODFLOW Model were calibrated to observed daily data from 1991 through 2014. However, only annual average data from 2001 and 2009 are currently being used to develop a steady-state version of the NFSEG Groundwater Model. As such, the calibration of the HSPF Models for 2001 and 2009 conditions is critical to the HSPF-calculated recharge being used to calibrate the MODFLOW Model. **Figure A3** through **Figure A6** depict HSPF model calibration results for 2001 and 2009 for two streamflow gages in the NFRWSP area; the Santa Fe River at Worthington Springs and South Fork Black Creek near Penny Farms. In 2001, the flow in the Santa Fe River at Worthington Springs was over-predicted by 163 percent by the HSPF Model. In 2009, flows at the same gage were under-predicted by 29 percent. In 2001 and 2009, the flows in the South Fork Black Creek were over-predicted by 49 percent and under-predicted by 34 percent, respectively. Please review the calibrations for the years 2001 and 2009 for the HSPF Models assure they are calibrated to acceptable levels for the intended purpose of the HSPF Models at this time.

A10) We have previously noted the importance of having a NFSEG Model which can be fully utilized by third parties. We appreciate the Districts’ work to develop a version of the MODFLOW model that can be used on standard PC computers. The HSPF Models are complex, and we appreciate the Districts’ assistance to date to allow us to run the HSPF Models. However, at this time, we have been unable to fully utilize the HSPF Models, specifically to derive the net recharge and maximum ET estimates used as input to the MODFLOW Model. We request the Districts develop versions of all HSPF pre-processors and HSPF post-processors that can be readily run by a stakeholder or permittee on standard PC computers. Again, while we appreciate the assistance provided to date, we would appreciate detailed documentation of the HSPF Models and a user's manual so third parties can utilize the tools developed by the Districts.

A11) Due to the importance of the output and the varying calibration results, a robust sensitivity analysis of the HSPF models should be performed to assess the effects of changing various parameters on the model output. Recharge and ET are by far the largest inflow and outflow water budget parameters in the MODFLOW model.

MODFLOW Calibration

A12) The NFSEG Model is a large, complex model that is intended to improve upon and overcome limitations of previous models of the area. We think that a comparison of the NFSEG Model calibration to the calibration of other available models would be helpful for the Technical Team and other stakeholders to better understand the potential performance of the NFSEG Model. Therefore, we request the following:

- An analysis comparing on an apples-to-apples basis (e.g., same area, same layer, etc) the calibration of the NFSEG Model to other available models used for the area (e.g., NEF Model, NF Model, MegaModel).
- Please provide and analysis comparing (apples-to-apples) the water budget of the NFSEG Model to other available models used for the area (e.g., NEF Model, NF Model, MegaModel).

A13) The NFSEG MODFLOW model has several areas in the NFRWSP region that appear to uniformly (or almost uniformly) overpredict or underpredict the UFA potentiometric surface by more than average. As shown in **Figure A7**, we note areas in Union, Bradford, Baker, Columbia and Clay Counties, and Putnam and Volusia Counties as having underpredicted potentiometric levels. While an area in Alachua County has overpredicted potentiometric levels. We would request that the Districts further evaluate these areas to improve the calibration.

A14) We request that the Districts provide more information on how the PEST calibration parameters for pilot points were developed. Specifically, we would like to understand how the geospatial distribution of pilot points (e.g., for UFA hydraulic conductivity) was determined and how the range of values was derived for each pilot point. We note that in some areas of the MODFLOW model, that there are significant differences in a small area in the PEST pilot point range used. For example, in **Figure A8**, in southeast Putnam County, there is a wide range in PEST pilot points for UFA hydraulic conductivity, which are driving the model hydraulic conductivity. For this area, please confirm that this pilot point arrangement is appropriate.

A15) We request that the Districts provide additional information on how PEST was used to calibrate baseflows and springflows in the MODFLOW model. We appreciate the information provided to date on this; however, we require additional information to better understand how this information was utilized in the PEST calibration. For example, were spring (GHB) and river cell conductances individually calibrated, or were rivers and springs grouped with conductances adjusted by some relative method? In addition for "spring groups" were the individual springs also used for the calibration? Lastly, as shown in **Figure B9**, we are unable to reproduce the "observed" values provided for the LSFR

Spring Group. Additional information to reconcile the difference noted would be appreciated.

A16) Please explain how the Keystone Heights region was calibrated in the MODFLOW model. Specifically, how were lake levels (or levels/conductances/fluxes at lake boundary conditions), creek flows, and the surficial aquifer calibrated (e.g., what parameters were varied, what data were used, etc.)?

MODFLOW Recharge

A17) Recharge to MODFLOW is derived as an output from the HSPF models. In our review of MODFLOW recharge input, significant discontinuities in recharge occur in some locations along HSPF model boundaries. As shown in **Figure A10** and **Figure A11**, one such area is in Union and Bradford Counties where the Lower St. Johns River, St. Mary's River and Santa Fe River HSPF models converge. Please explain the differences in MODFLOW recharge in this area.

MODFLOW Baseflows

A18) The HSPF Models developed by the Districts were used to calculate the recharge and maximum saturated ET to use in the MODFLOW Model. However, the HSPF Models were also used to estimate baseflow targets for rivers and streams represented in the MODFLOW Model. Approximately 328 streamflow gages appeared to have been used to generate results from the HSPF Models. It also appears that 166 of the 328 gages were used in the PEST calibration process; however, many of these 166 PEST gages are noted as not being used. Ultimately, from the information provided, it appears that less than ten gages may have been used as baseflow targets in MODFLOW. Please provide a detailed listing of which gages were used to calibrate baseflows from the MODFLOW Model (for each year).

A19) It is our understanding that the Districts original intent was to use river and stream baseflows calculated from the HSPF Models as targets in MODFLOW. However, as presented to the Technical Team, issues were identified by the District with some of the HSPF baseflow estimates. As such, alternative methods to estimate baseflow were utilized for many streams and rivers. Based on the information provided by the District, it appears three methods may have been used to estimate baseflow, including "HSPF," "observed," and "PART." At the next Technical Team meeting, please review the methods used to develop baseflow and the reasons why the alternative methods were developed.

Questions on Future Use of the NFSEG Model for the NFRWSP

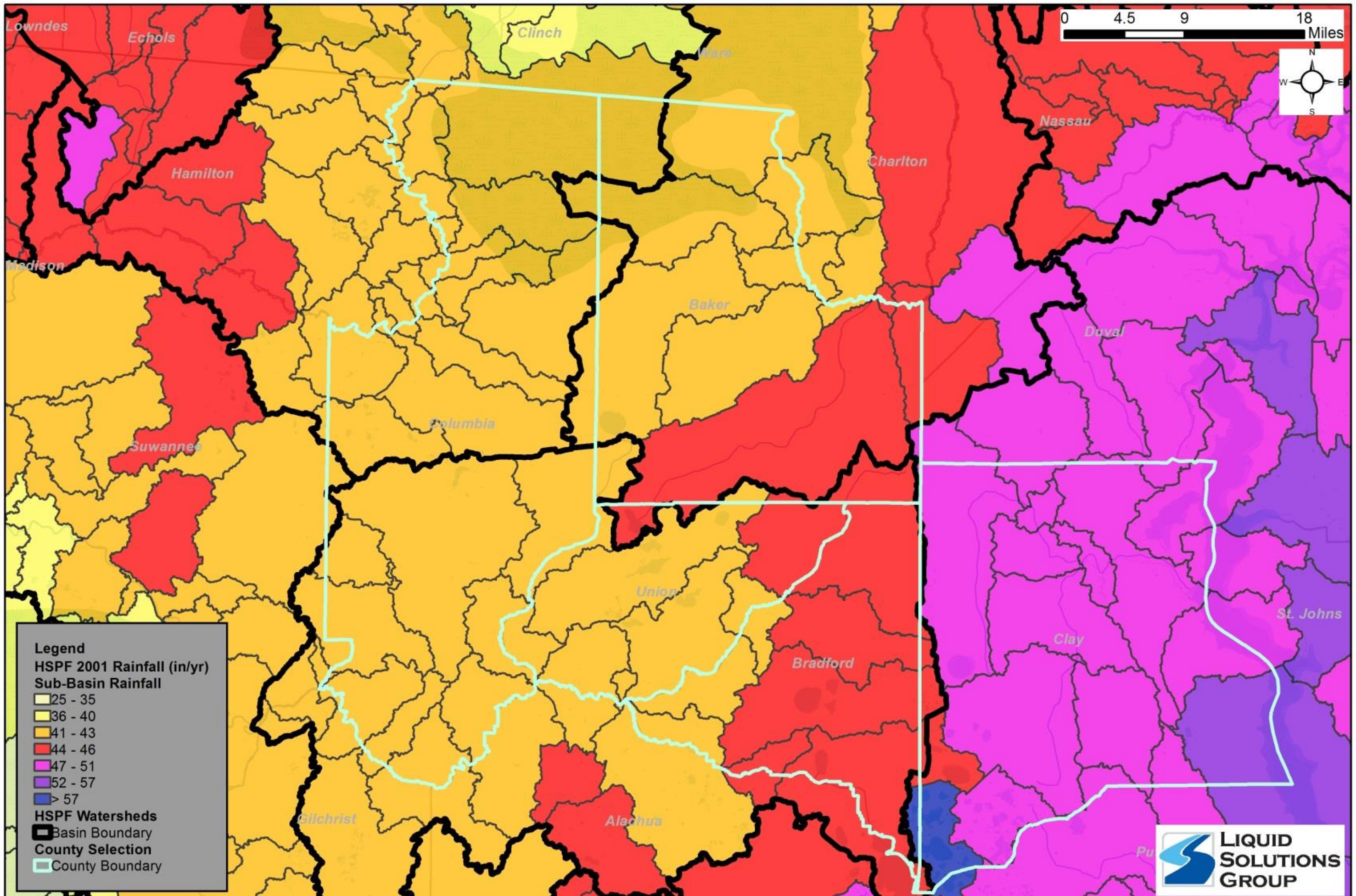
A20) On several occasions, the Districts have indicated that the current version of the NFSEG Model should be considered a "regional planning" model. However, the Districts have not provided detailed information on how the NFSEG Model will be used in the planning process (e.g., specific simulation information, etc.) We understand that the District is in the process of developing these simulations and defining necessary model outputs. As part of the Technical Team's review of the NFSEG Model, it would be useful to have more detail on how the model will be used as soon as possible. Since the NFSEG Model is an evaluation tool, this information is critical to better understand if the model tool is suitable for the intended use.

A21) As discussed during the May 11, 2016 Technical Team meeting, please provide a summary of how future increased recharge (e.g., irrigation, RIBs, Sprayfields, etc.) will be developed and represented in the model for planning simulations.

A22) Are the Districts developing tools and procedures to evaluate specific water resource constraints (e.g., the Lower Santa Fe River and the Ichetucknee River). When will they be available for review?

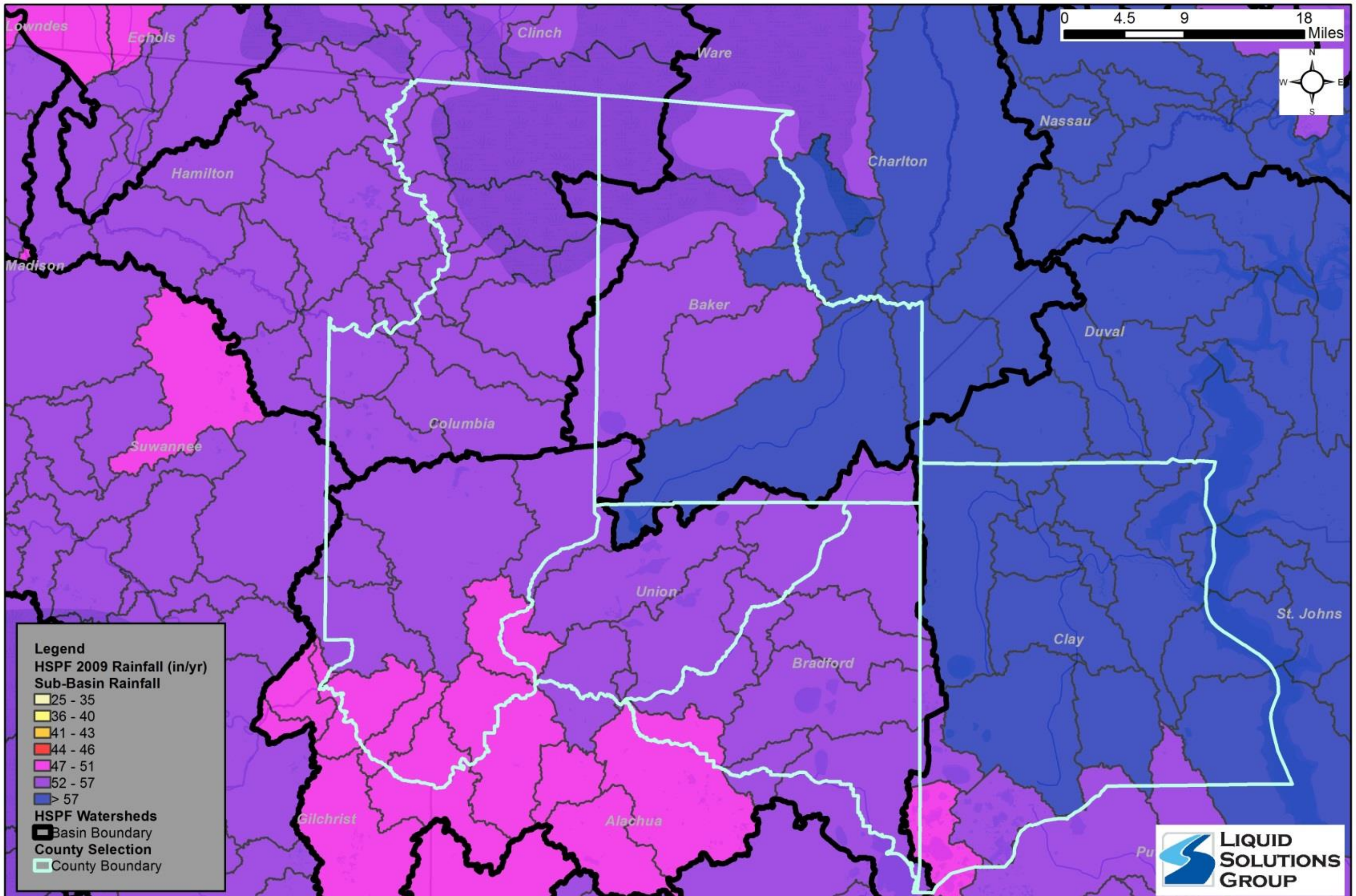
A23) When will the Districts review the simulations being performed in support of the NFRWSP with the Technical Team?

Figure A1 – HSPF 2001 Rainfall In Clay County, Bradford County and Union County Area



NFSEG Groundwater Flow Model
HSPF 2001 Rainfall

Figure A2 – HSPF 2009 Rainfall in the Clay County, Bradford County, and Union County Area



NFSEG Groundwater Flow Model
HSPF 2009 Rainfall

Figure A3 – 2001 Streamflow at USGS Gauge 2321500 (Santa Fe River near Worthington Springs)

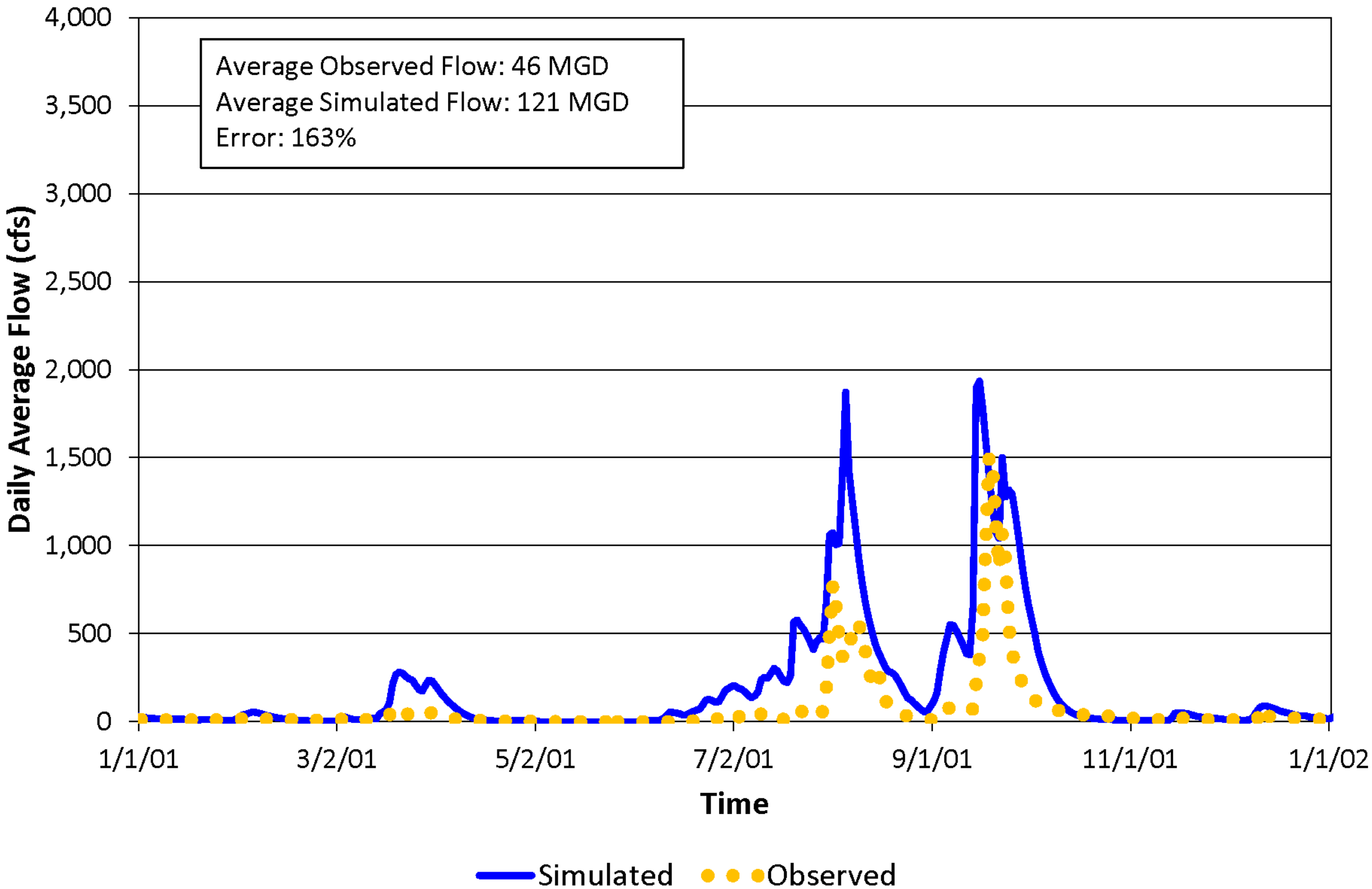


Figure A4 – 2009 Streamflow at USGS Gauge 2321500 (Santa Fe River near Worthington Springs)

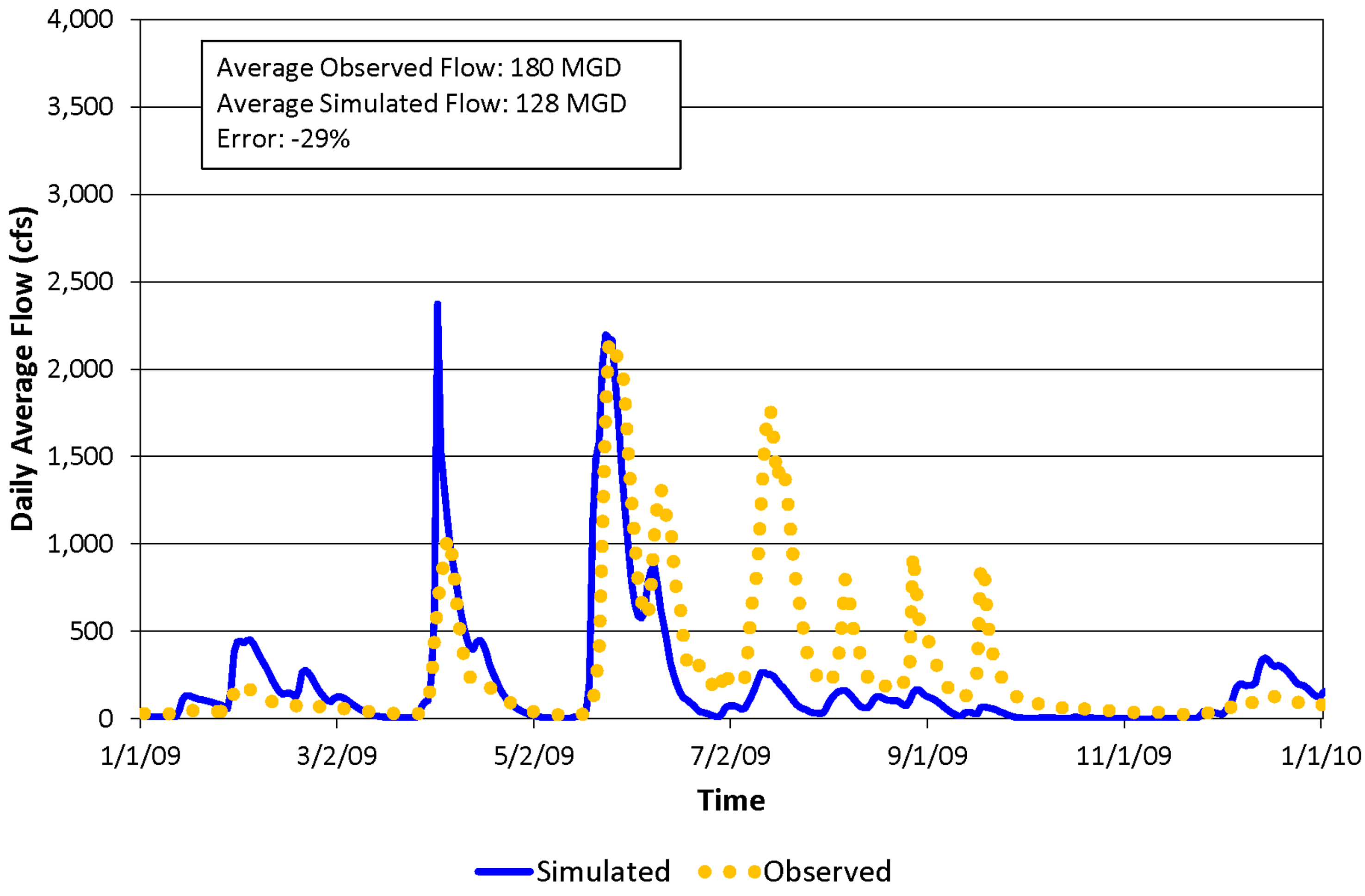


Figure A5 - 2001 Streamflow at USGS Gauge 2245500 (South Fork Black Creek at Penney Farms)

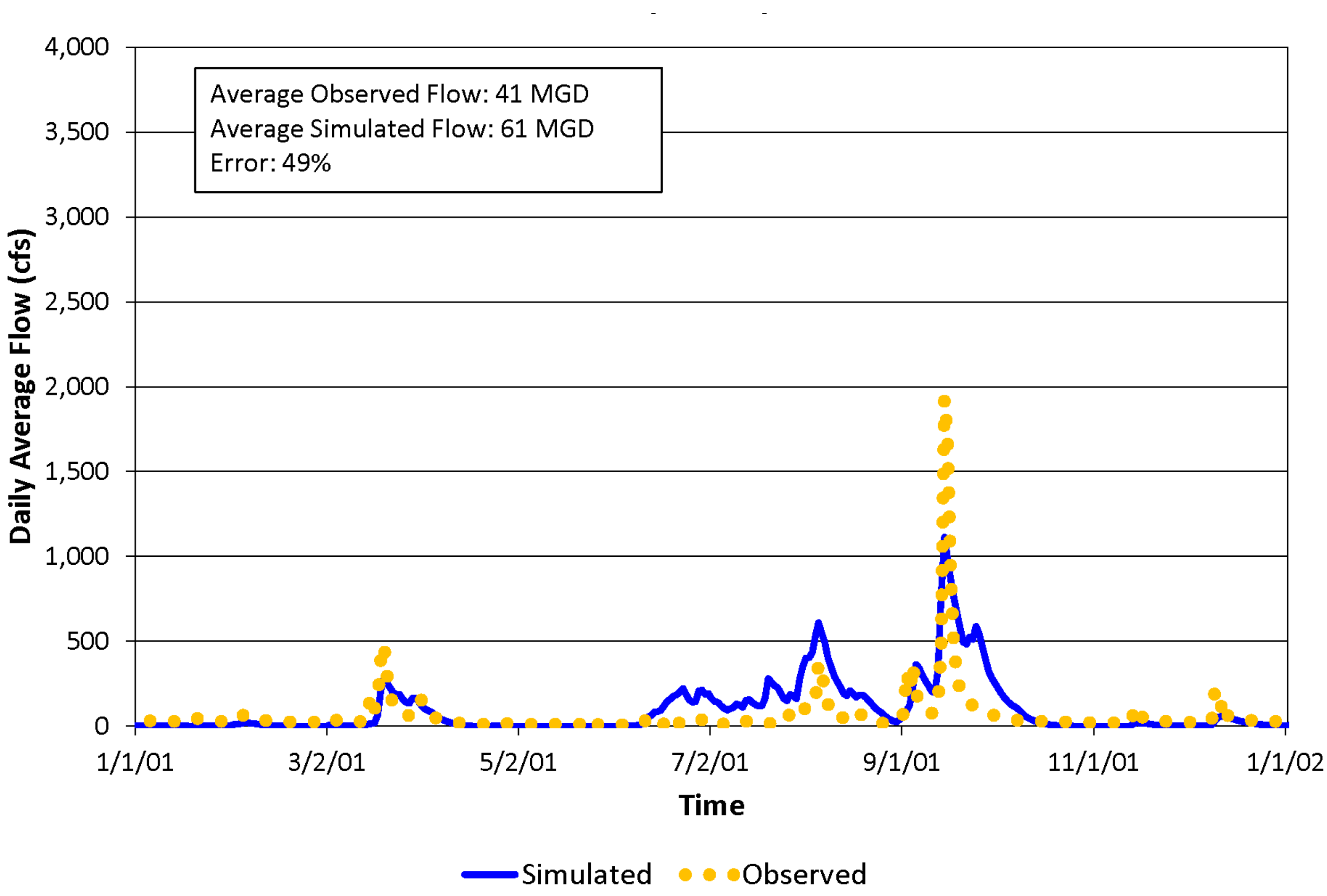


Figure A6 – 2001 Streamflow at USGS Gauge 2245500 (South Fork Black Creek at Penney Farms)

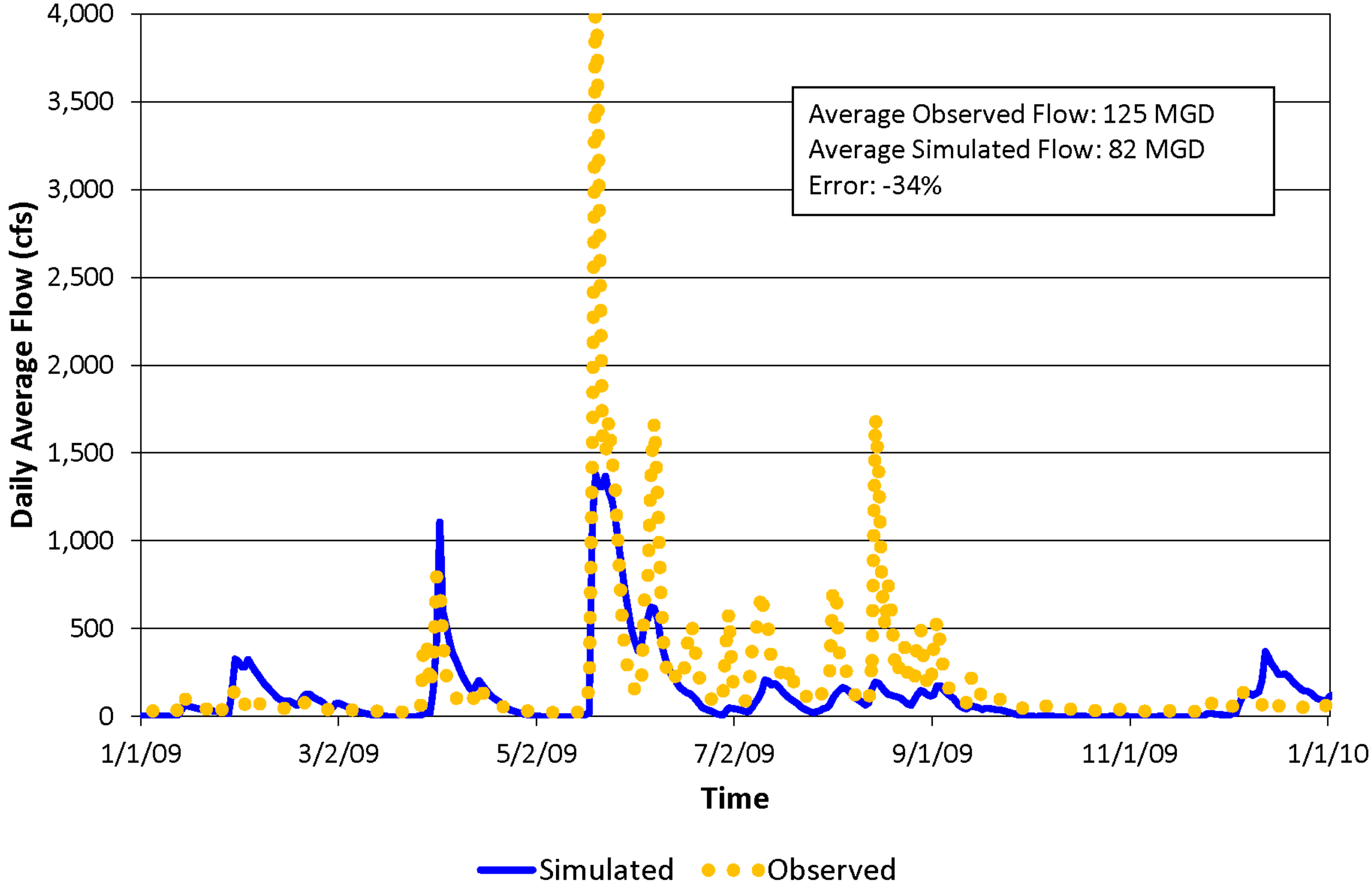


Figure A7 – 2009 MODFLOW Calibration Results

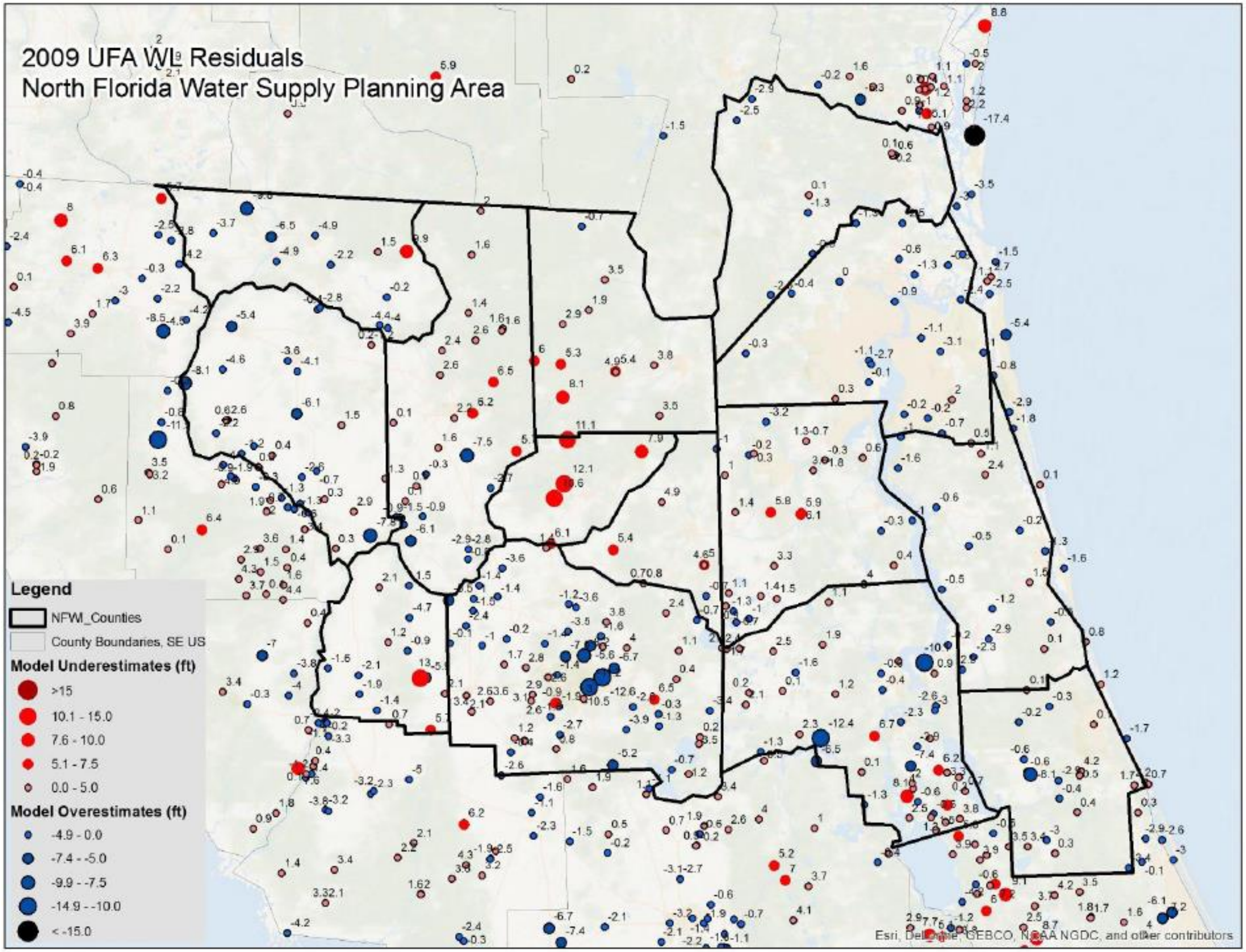
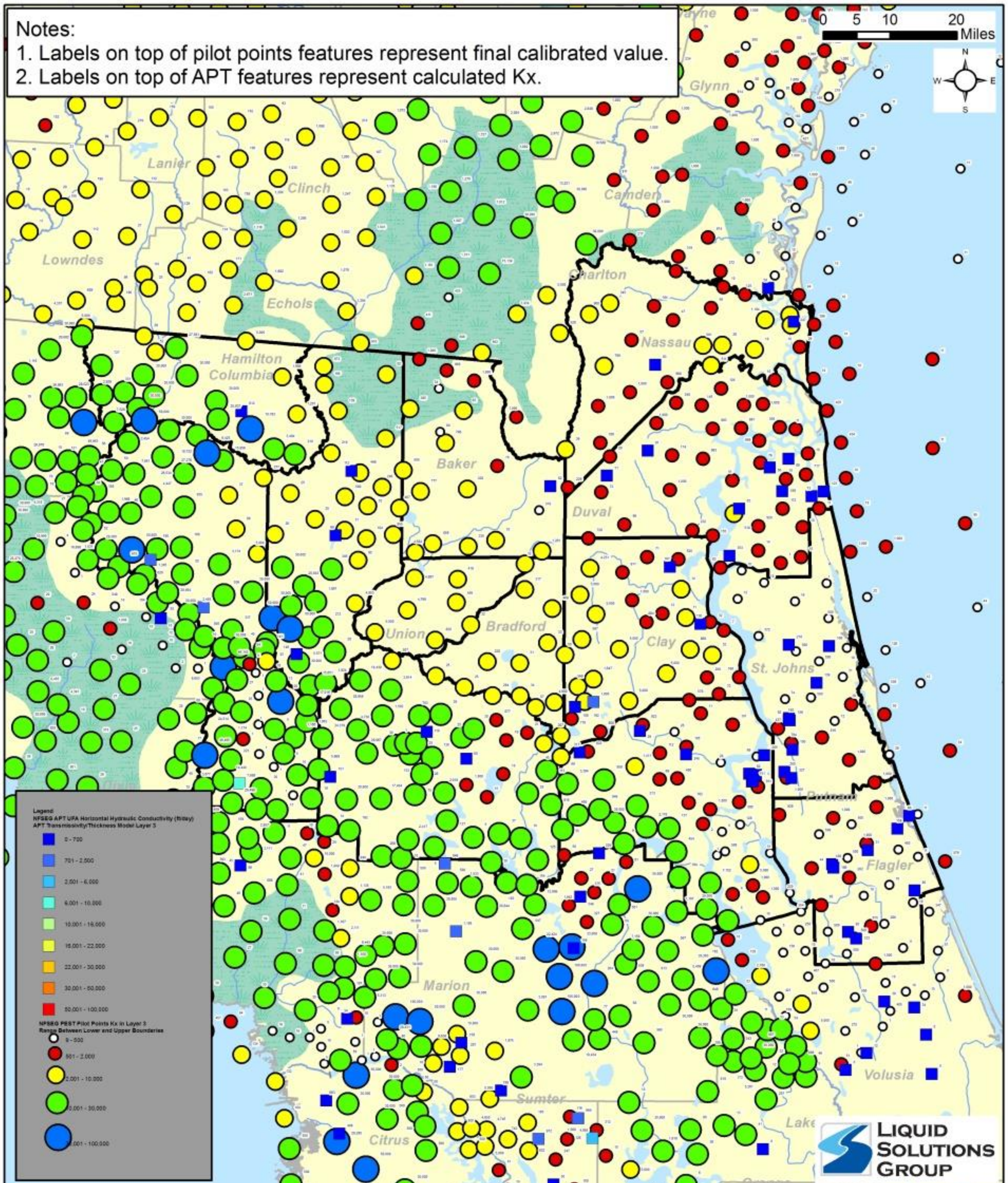


Figure A8 – UFA PEST Pilot Points and APT Locations



NFSEG Groundwater Flow Model
NFSEG PEST Pilot Points in the UFA
Comparison to APT UFA Horizontal Hydraulic Conductivity

Figure A9 – Springflow Calibration Summary

From "PEST_Springs041516.xlsx" provided on May 2, 2016								
ReachID	Name	SiteID	District	River	PestID	Observed	Simulated	Residuals
	LSFR Spring Group				qr01_lsf_sprgrp	-602.0	-622.6	20.6
	Sum of 59 LSFR Springs Listed Below					-834.9	-622.6	-212.3
4008	UN_NAMED_SPRING	-71505004	SR	Santa_Fe_River	qspring01_s071505004	-0.2	-0.2	0.0
4005	UN_NAMED_SPRING	-71505005	SR	Santa_Fe_River	qspring01_s071505005	-0.5	-0.4	-0.1
4018	WILSON_SPRINGS	-71606004	SR	Santa_Fe_River	qspring01_s071606004	-5.0	-6.3	1.3
4019	UN_NAMED_SPRING	-71607003	SR	Santa_Fe_River	qspring01_s071607003	-3.8	-2.4	-1.4
4020	UN_NAMED_SPRING	-71618018	SR	Santa_Fe_River	qspring01_s071618018	-0.9	-0.8	-0.1
4021	UN_NAMED_SPRING	-71618019	SR	Santa_Fe_River	qspring01_s071618019	-0.6	-0.5	0.0
4029	UN_NAMED_SPRING	-71620005	SR	Santa_Fe_River	qspring01_s071620005	-2.9	-2.1	-0.8
4027	UN_NAMED_SPRING	-71620006	SR	Santa_Fe_River	qspring01_s071620006	-2.0	-1.7	-0.3
4028	UN_NAMED_SPRING	-71620007	SR	Santa_Fe_River	qspring01_s071620007	-3.4	-2.2	-1.2
4025	UN_NAMED_SPRING	-71620008	SR	Santa_Fe_River	qspring01_s071620008	-1.6	-1.4	-0.1
4022	UN_NAMED_SPRING	-71620010	SR	Santa_Fe_River	qspring01_s071620010	-70.0	-7.2	-62.8
4024	UN_NAMED_SPRING	-71629003	SR	Santa_Fe_River	qspring01_s071629003	-3.9	-2.3	-1.6
4035	JULY_SPRING	-71634005	SR	Santa_Fe_River	qspring01_s071634005	-44.7	-35.4	-9.3
4034	GINNIE_SPRING_NR_HIGH_SPRINGS_FL	-71634006	SR	Santa_Fe_River	qspring01_s071634006	-38.1	-25.2	-12.9
4032	DEER_SPRINGS	-71634011	SR	Santa_Fe_River	qspring01_s071634011	-3.8	-2.6	-1.2
4040	DEVILS_EAR_SANTA_FE_RIVER	-71634012	SR	Santa_Fe_River	qspring01_s071634012	-92.4	-102.8	10.4
4036	DOGWOOD_SPRINGS	-71634013	SR	Santa_Fe_River	qspring01_s071634013	-9.9	-9.4	-0.5
4039	DEVIL_EYE_SANTA_FE_RIVER	-71634014	SR	Santa_Fe_River	qspring01_s071634014	-31.9	-27.1	-4.8
4037	LITTLE_DEVILS	-71634015	SR	Santa_Fe_River	qspring01_s071634015	-1.6	-1.0	-0.6
4033	SAWDUST_SPRING	-71634016	SR	Santa_Fe_River	qspring01_s071634016	-5.3	-2.6	-2.7
4031	TWIN_SPRINGS	-71634017	SR	Santa_Fe_River	qspring01_s071634017	-15.1	-14.2	-0.8
4042	BLUE_SPRING_IN_GILCHRIST_COUNTY	-71635003	SR	Santa_Fe_River	qspring01_s071635003	-26.8	-24.1	-2.7
4044	RUM_ISLAND_SPRING	-71635004	SR	Santa_Fe_River	qspring01_s071635004	-14.5	-13.3	-1.1
4048	UN_NAMED_SPRING	-71635006	SR	Santa_Fe_River	qspring01_s071635006	-4.7	-3.5	-1.2
4046	UN_NAMED_SPRING	-71635007	SR	Santa_Fe_River	qspring01_s071635007	-6.9	-3.7	-3.2
4045	UN_NAMED_SPRING	-71635008	SR	Santa_Fe_River	qspring01_s071635008	-0.4	-0.5	0.0
4043	UN_NAMED_SPRING	-71635009	SR	Santa_Fe_River	qspring01_s071635009	-6.4	-3.6	-2.7
4050	LILLY_SPRINGS	-71636002	SR	Santa_Fe_River	qspring01_s071636002	-27.4	-24.9	-2.5

Figure B9 (cont.) – Springflow Calibration Summary

4047	UN_NAMED_SPRING	-71636004	SR	Santa_Fe_River	qspring01_s071636004	-2.0	-1.9	0.0
4051	PICKARD_SPRINGS	-71636005	SR	Santa_Fe_River	qspring01_s071636005	-8.9	-9.2	0.4
4060	HORNSBY_SPRINGS_NEAR_HIGH_SPRINGS_FL	-71727010	SR	Santa_Fe_River	qspring01_s071727010	-7.2	-8.7	1.5
4056	TREEHOUSE_SPRING	-71727012	SR	Santa_Fe_River	qspring01_s071727012	-74.2	-46.9	-27.3
4055	UN_NAMED_SPRING	-71727013	SR	Santa_Fe_River	qspring01_s071727013	-1.9	-1.3	-0.5
4054	DARBY_SPRINGS	-71727014	SR	Santa_Fe_River	qspring01_s071727014	-11.6	-10.4	-1.2
4049	COLUMBIA_SPRINGS_NEAR_HIGH_SPRINGS_FLA	-71728014	SR	Santa_Fe_River	qspring01_s071728014	-45.3	-28.2	-17.1
4053	UN_NAMED_SPRING	-71729003	SR	Santa_Fe_River	qspring01_s071729003	-37.9	-31.4	-6.4
4052	UN_NAMED_SPRING	-71731004	SR	Santa_Fe_River	qspring01_s071731004	-10.3	-10.4	0.2
4059	UN_NAMED_SPRING	-81705010	SR	Santa_Fe_River	qspring01_s081705010	-15.4	-15.2	-0.2
4057	POE_SPRINGS_NEAR_HIGH_SPRINGS_FL	-81706005	SR	Santa_Fe_River	qspring01_s081706005	-31.3	-27.9	-3.4
4058	UN_NAMED_SPRING	-81706008	SR	Santa_Fe_River	qspring01_s081706008	-19.4	-18.5	-0.9
4000	UN_NAMED_SPRING	-61527025	SR	Santa_Fe_River	qspring01_s061527025	-5.5	-0.6	-4.9
4001	UN_NAMED_SPRING	-61527026	SR	Santa_Fe_River	qspring01_s061527026	-2.3	-1.8	-0.5
4006	UN_NAMED_SPRING	-61531010	SR	Santa_Fe_River	qspring01_s061531010	-0.1	-0.1	0.0
4007	BETTY_SPRINGS	-61532013	SR	Santa_Fe_River	qspring01_s061532013	-1.0	-0.6	-0.4
4009	UN_NAMED_SPRING	-61532014	SR	Santa_Fe_River	qspring01_s061532014	-0.4	-0.5	0.1
4010	UN_NAMED_SPRING	-61533007	SR	Santa_Fe_River	qspring01_s061533007	-0.8	-1.0	0.2
4013	OASIS_SPRINGS	-61535012	SR	Santa_Fe_River	qspring01_s061535012	-0.8	-0.9	0.1
4015	UN_NAMED_SPRING	-61536028	SR	Santa_Fe_River	qspring01_s061536028	-7.4	-1.2	-6.3
4017	UN_NAMED_SPRING	-61536029	SR	Santa_Fe_River	qspring01_s061536029	-6.1	-1.9	-4.2
4016	JAMISON_SPRINGS	-61536030	SR	Santa_Fe_River	qspring01_s061536030	-3.3	-2.3	-0.9
4014	SUNBEAM_SPRINGS	-61536031	SR	Santa_Fe_River	qspring01_s061536031	-10.5	-11.0	0.5
4030	SANTA_FE_SPRING	-61829003	SR	Santa_Fe_River	qspring01_s061829003	-34.4	-17.3	-17.2
4023	UN_NAMED_SPRING	-61829004	SR	Santa_Fe_River	qspring01_s061829004	-0.8	-0.6	-0.1
333	WORTHINGTON_SPRINGS_AT_WORTHINGTON_SPRIN	-61932013	SR	Santa_Fe_River	qspring01_s061932013	-0.3	-0.1	-0.2
4003	TRAIL_SPRING_GROUP	-71401009	SR	Santa_Fe_River	qspring01_s071401009	-7.3	-0.4	-6.9
4004	UN_NAMED_SPRING	-71401011	SR	Santa_Fe_River	qspring01_s071401011	-23.1	-17.5	-5.6
4012	UN_NAMED_SPRING	-71412009	SR	Santa_Fe_River	qspring01_s071412009	-23.1	-18.7	-4.4
4011	UN_NAMED_SPRING	-71412010	SR	Santa_Fe_River	qspring01_s071412010	-3.0	-2.2	-0.8
4002	UN_NAMED_SPRING	-71412011	SR	Santa_Fe_River	qspring01_s071412011	-15.4	-12.5	-2.9

Figure A10 – 2001 MODFLOW Net Recharge near Union County

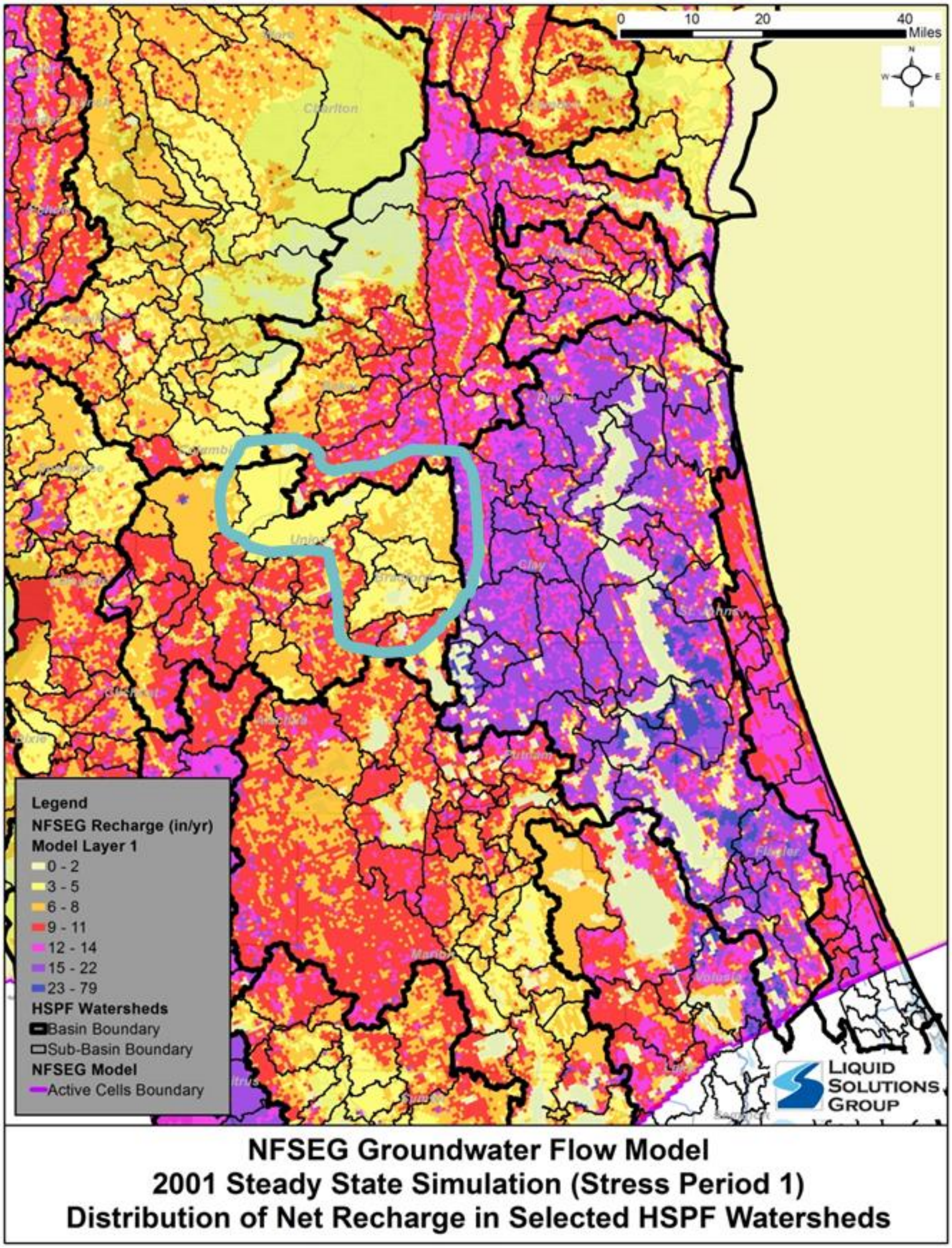
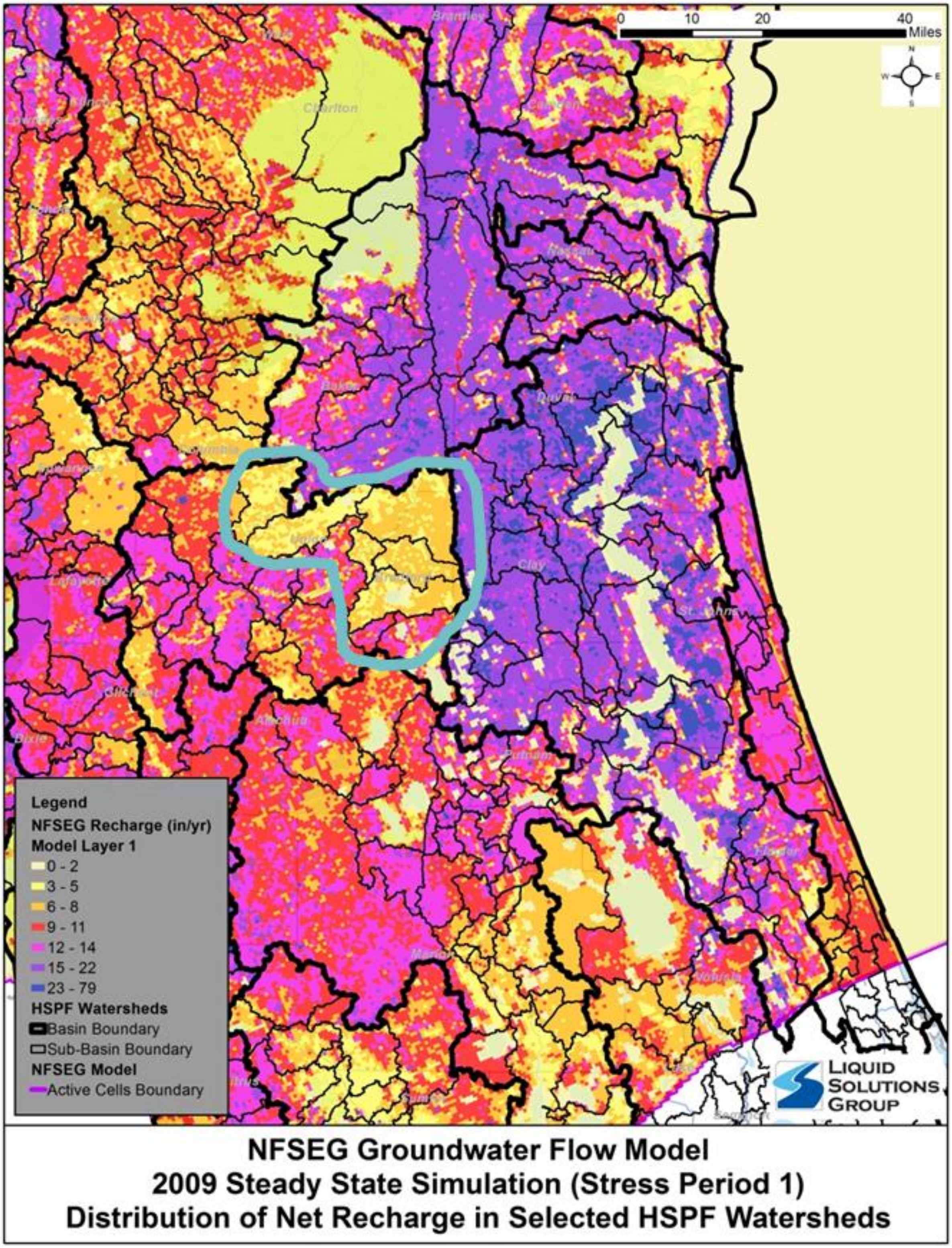


Figure A11 – 2009 MODFLOW Net Recharge near Union County



Appendix B
Preliminary Review Questions, Comments and Responses
Liquid Solutions Group, LLC
October 2015 to January 2016

Comments received on 11/12/2015:

B1) Based on our initial comparison and shown in the table below, historical water withdrawals at the utility level from the attached District database do not match with the withdrawals included in the NFSEG geodatabase (GDB). We request that you review the source data being used as the basis of the model. We are available to discuss this at your convenience.

Comparison of Groundwater Withdrawals for NFUCG Utilities						
	2001		2009		2010	
	NFSEG Model GDB	SJRWMD Records(1)	NFSEG Model GDB	SJRWMD Records(1)	NFSEG Model GDB	SJRWMD Records(1)
Utility	(MGD AADF)	(MGD AADF)	(MGD AADF)	(MGD AADF)	(MGD AADF)	(MGD AADF)
Atlantic Beach	3.1	3.1	2	2.3	2.3	2.5
City of Jacksonville Beach	3.3	3.1	2.4	2.4	2.4	2.4
City of Neptune Beach	0.7	1.2	0.8	1.2	0.8	1.2
Clay County Utility Authority	11.1	11.5	12.1	12.6	12.8	12.8
Gainesville Regional Utilities	24.7	25.6	24.2	25	22.6	23.4
JEA	115.3	106.3	120.6	116.4	110.2	118.6
St. Johns County Utilities	9.2	8.3	11.2	11.7	11.5	12.3
Town of Orange Park	1.3	1.4	1	1	1	1
TOTAL	168.6	160.6	174.4	172.6	163.6	174.1

Notes: 1. Source: SJRWMD "Region 1 PS Historic Database MASTER.xls"

District Response:
The water-use data used in the NFSEG groundwater model calibration is based on the September 2015 version of the SJRWMD water-use database which was the most up-to-date version at that time. The data (in "Region 1 PS Historic Database MASTER.xls") used for comparison was not up-to-date and should be ignored. However, it should be noted that the District's water use database is being regularly updated when new information becomes available. It would not be practical and necessary to constantly update the model GDB during model calibration since the water use database updates have generally been minor. However, before the release of final version of the model (after technical team review process), The NFSEG model

water use GDB will be updated with the latest version of the District's water use database used in the Regional Water-Supply Plan.

Comments received on 11/16/2015:

B2) We have found that multiple hydrologic boundary conditions are sometimes assigned to a single model cell in the same model layer. Specifically, MODFLOW River boundary condition nodes and MODFLOW Drain boundary condition nodes are sometimes assigned to the same cell within Layer 1 (the surficial aquifer system) of the model. River nodes have generally been used to represent lakes and rivers. Drain nodes have generally been used to represent rivers, streams, and seeps. In an effort to better understand the NFSEG model, we have the following questions:

a) Could the District please describe the conceptualization of overlapping hydrologic boundary conditions in Layer 1?
b) Often, the heads set within the River and Drain nodes within a single cell are different. How were these heads established for both types of boundary conditions?
c) How does the District envision the overlapping boundary conditions interacting with one another? For example, if a Drain node within a cell has a higher assigned stage than the stage assigned to a River node in the same cell, it is likely the River node will "over-ride" the Drain node. However, how will the boundary conditions interact if the stage assigned to the Drain node is between the River node stage and bottom elevation? In addition, if a Drain node within a cell has a lower assigned stage than the river bottom assigned to the River node, the Drain node could be trying to discharge water from the model at the same time that the River node is pulling water into the cell (River nodes simulate a losing reach when simulated surficial aquifer groundwater levels are below the River node bottom elevation). How will the model react in these situations?
d) Could there be cases where the River node is intended to be the controlling boundary condition in a cell, but the stage elevations were mapped in a fashion that the Drain node unintentially controls flow discharging from a cell?

At this time, we are not sure this model conceptualization poses any issues. However, we are interested in better understanding the District's rationale for setting up the model in this manner and how it may affect model results. In particular, the following text related to the differences between a model developed in a standalone version of MODFLOW and in the Groundwater Vistas software package was extracted from the Groundwater Vistas version 6 Manual (page 128):

"The second area where MODFLOW and Vistas may differ is when there are multiple boundary conditions of the same type in the same cell. GV will normally not allow you to create such a situation. However, if you import a model created outside of GV and that model has overlapping boundary conditions, then they will all be imported to the model and can result in a discrepancy in the mass balance. This happens in a similar manner to the constant head problem discussed in the preceding paragraph. If some of the boundary conditions in a cell are inflow and some are outflow, MODFLOW will separate them in the output file. The cell-by-cell flow file, on the other hand, will only contain a net flux for each cell and that value is reported by GV."

It is our understanding that the District developed the NFSEG model on a standalone version of MODFLOW on a Linux platform, and then converted that model to Groundwater

Vistas for stakeholder distribution. The above text from the Groundwater Vistas manual raises concerns that issues may arise from assigning multiple boundary conditions to the same cell in the same model layer in the Groundwater Vistas version of the model being provided to stakeholders.

To illustrate the point, attached please find a presentation containing “screen shots” of various spatial locations within the NFSEG Model in Groundwater Vistas. A description of these three locations is below:

1) Orange Lake/Lake Lockloosa: A series of Drain boundary conditions “run” through the middle of the River boundary conditions representing Lake Lockloosa. In some cases the head in the Drain nodes is a few tenths of a foot higher than the head in the River node, but in some cases the head in the Drain node is between the River node head and bottom elevation.
2) Upper Etonia Chain-of-Lakes: Multiple overlapping River and Drain nodes throughout the system, particularly Magnolia Lake.
3) Ichetucknee River: At the location of one of the springs on the river, the Layer 1 cell is assigned a Drain node and a River node with the same stage.

These are just three examples of overlapping boundary conditions. We have not performed an exhaustive evaluation of all boundary conditions in the model at this time.

In addition to the above, we have reviewed the NFSEG model conceptualization report (District, 2013). This report indicates that rivers and streams would be represented with River boundary condition nodes and surficial aquifer seeps would be represented with General Head boundary condition nodes. However, rivers and streams were ultimately represented with both Drain and River boundary condition nodes and seeps appear to be represented with Drain boundary condition nodes in the NFSEG model. Why did the District change their proposed conceptualization of these features?

*The attachment included with the submitted comment has been included as **Attachment B1**.*

<u>District Response:</u>

The river boundary conditions represent a down-slope stream gradient obtained by implementation of an ArcGIS process. The elevations of drain cells that represent the bottoms of the ephemeral streams (which are usually small and may be dry for most of the year) may be less accurate in some areas due to a lack of resolution in the available topographic data and potential issues with the NHDplus dataset. We, however, feel that this representation is adequate and the implementation of alternative approaches would not be justified in most cases by the potential degree of improvement in model performance. Although we believe that the current approach for assigning drain elevations is not affecting the results of the model simulations significantly, we nevertheless will develop an approach that is consistent with that used in assigning elevations to river boundary conditions and discuss it with the Technical Team during the NFSEG Technical Team review period (i.e., after the 5/2/2016 delivery). In addition, because site-specific data was available and the site is one of the most critical areas of concern, the drain elevations in the Keystone lakes area was updated based on the measured water levels and structural information such as culvert inlet elevations. Furthermore, we inactivated drain boundaries that are coincident with river-boundary lake representations by assigning high elevations (8888 feet), which should address the issue of overlapping lake and drain boundary assignments. Inactivating the drain cells rather than simply removing them was necessary not to interrupt the PEST calibration process. However, before the final version of the model release, the inactive drain cells will be removed. Regarding the use of drain boundaries versus GHB boundaries in the representation of seeps, the flow of water in the case of the seeps being represented is consistently from aquifer to land surface. Therefore, we feel that drains are an adequate representation of this phenomenon.

The assignment of multiple boundary conditions to a single model grid cell reflects the common situation in the real world in which actual hydrologic features (e.g., springs, river reaches, lakes, ephemeral streams, wells, etc.) occur in such close proximity that their locations correspond to only one model grid cell. This is does not present any fundamental conceptual or computational problem in regards to the application of the MODFLOW code. In some cases, the resolution of the model grid may make detailed representation of some features difficult, but if deemed necessary, such instances might be best represented with a more highly discretized subregional-scale model developed specifically for addressing the more localized area in question.

It is quite common for various graphical interfaces to MODFLOW (not just Groundwater Vistas) to have some limitations. The Districts did not use Groundwater Vistas in the model calibration process. It should be noted that the Groundwater Vistas files were developed as a courtesy to the reviewers. Therefore, if there are limitations in that software, then the reviewers can always extract the necessary information from the files that are produced directly by the command-line, MODFLOW executable (i.e. cell-by-cell flow files; output listing file, head and drawdown files). These files are provided to the Technical Team for review as well.

<u>Comments received on 12/1/2015:</u>

B3) The NFSEG HSPF model submittal provided by the Districts included 61 zip files containing specific HSPF watersheds developed at the United States Geologic Survey (USGS) Hydrologic Unit Code (HUC) 8 level. Each of the zip files contained multiple versions of the HUC8-level model, data and GIS files developed in support of the model, and model results. The multiple versions of each HUC8-level model included the originally developed model (for windows and Linux), the calibration version of the model without anthropogenic recharges, and the calibration version of the model with agricultural irrigation. The Districts also provided the version of HSPF being used to run the models, as it is not the version of HSPF contained in EPA's Basins 4.1, which was the user interface originally used to develop the HSPF models.

The amount of information provided was extensive. In addition, we understand from conversations with the St. Johns River Water Management District (SJRWMD) that some aspects of the models provided were not yet complete. For these reasons, reviewing all of the models in detail was not appropriate or feasible, nor did the Districts request a detailed review, at this time. Based on the foregoing, please consider the comments, questions, and suggestions provided by the NFUCG below to be "big picture" or "structural" in nature. The NFUCG will continue to review data, input files, and the NFSEG model in detail as they are released.

a. The NFSEG HSPF models are being used to disaggregate rainfall/runoff/recharge for input to the NFSEG model. Recharge and evapotranspiration calculated using the HSPF models will be used as input parameters in the NFSEG model. The HSPF models have daily stress periods. The NFSEG model is currently steady-state (being calibrated to 2001 and 2009 hydrologic conditions), but will potentially have monthly stress periods if converted to a transient model in the future. The daily results of the HSPF models are currently aggregated to annual average values for the specific simulation being performed (e.g., 2001, 2009, etc.). Due to this, we feel the calibration of the HSPF watershed models to mass is more critical than calibration to daily streamflows. We suggest the Districts ensure that the cumulative mass of streamflow in a watershed be a critical calibration parameter that is balanced with the calibration of other parameters such as daily streamflow. In addition to the daily calibration graphics, please provide output graphics and calibration parameters that show the mass balance is being achieved for each calibration target.
b. The District appears to have primarily calibrated the HSPF models to specific stream gage data, spring flow measurements, etc., which is reasonable. However, in the case of closed watersheds, it is our understanding that data was not always available for calibration. In addition, we understand that USGS HUC12 watershed data were used to designate closed watersheds, which may not encompass all potential closed subwatersheds within the NFSEG model domain. Of particular interest are the subwatersheds associated with the Upper Etonia Creek basin in the Keystone Heights area. Subwatersheds 36 and 37 of HUC8 watershed model 03080103 represent the mine area/Blue Pond/Lowrey Lake and Lake Magnolia/Lake Brooklyn/Lake Geneva, respectively. Subwatershed 36 discharges to subwatershed 37 at the outlet of Lowry Lake to Alligator Creek. Subwatershed 37 is a closed basin that does not discharge to another basin in the model. It appears from review of the information provided that these basins are not designated as closed watersheds in the USGS HUC12 data coverage. In addition, the Districts did not establish a calibration point for either of these subwatersheds. We recommend the District develop a method to ensure and confirm that the calibrations of these two watersheds are reasonable and are willing to discuss some approaches for accomplishing this.
c. Is the open water within the mine area at the headwaters of the Upper Etonia Creek basin simulated within subwatershed 36? Will the subwatershed 36 model be modified to include the Alligator Creek Enhancement Strategy (ACES) Project, currently being implemented by the SJRWMD, in future simulations?
d. It is our understanding that the HSPF-based water balance is performed at a 30 meter x 30 meter level, and then aggregated up to a watershed-level for calibration. It is also our understanding that land-use based HSPF calibration parameters are indexed to the forest land use to more easily ratio parameters up or down to achieve calibration. Are specific calibration parameters varied by subwatershed, and then indexed to the forest land use for that watershed; or are specific calibration parameters across the entire HUC8 watershed set at the same value, and then indexed to the forest land use? Does the District have a summary of the calibration parameters used that could be provided?
e. The NFSEG model conceptualization document indicates that the models utilize 2006 land use. Can the Districts please confirm that 2006 land use is being used for the entire HSPF model simulation period from 1990 through 2014? What land use data (year) will be used for the 2010 baseline simulation and for future simulations performed with the NFSEG model?
f. In the development of the HSPF models for the NFSEG model, how was leakage to and discharge from the groundwater system addressed at key resource features. For

example in the Upper Ocklawaha River Basin Minimum Flow and Level HSPF model, special actions were used.

g. The HSPF models provided were calibrated to historical conditions on an interim basis without anthropogenic recharge and with only agricultural irrigation. However, we agree with the Districts that the following anthropogenic recharges should be included in the final HSPF models and NFSEG Model:
    - Public supply irrigation (potable and non-potable);
    - Domestic self-supply irrigation;
    - Septic tank leakage;
    - Reclaimed water sprayfields; and
    - Rapid infiltration basins (RIBs) – though not as common in North Florida as in other parts of the SJRWMD, there is a RIB site on the south side of Lake Brooklyn in the Upper Etonia Creek basin that could be significant in an area of interest.

District Response:

Due to the nature of comments, each comment was responded to separately below

Comment: Recharge and maximum evapotranspiration available for water table calculated using the HSPF models will be used as input parameters in the NFSEG model. The HSPF models have daily stress periods.

> **Response:** HSPF results used as direct boundary conditions for the MODFLOW model are recharge and maximum saturated evapotranspiration. The time interval for calculations in HSPF is hourly, and the results aggregated to daily and greater to calibrate against flow observations from USGS.

Comment: Due to this, we feel the calibration of the HSPF watershed models to mass is more critical than calibration to daily streamflows. We suggest the Districts ensure that the cumulative mass of streamflow in a watershed be a critical calibration parameter that is balanced with the calibration of other parameters such as daily streamflow.

> **Response**: We considered several aspects of model performance including:
> 1. Average daily flow
> 2. Average monthly flow
> 3. Average yearly flow
> 4. Average period of record flow
> 5. Frequency distribution curve
> 6. Literature estimates of evapotranspiration from different land uses
> 7. Hydrologic indices
>   - 7.1. Mean of daily flow
>   - 7.2. Mean monthly flow of all Januaries, Februaries, etc.
>   - 7.3. Ratio of total flow to base flow
>   - 7.4. Mean of rise rate (calculated from when flow is increasing)
>   - 7.5. Mean of fall rate (calculated from when flow is decreasing)

Comment: In addition to the daily calibration graphics, please provide output graphics and calibration parameters that show the mass balance is being achieved for each calibration target.

Response: This actually proves to be rather difficult in HSPF. Once different land components of the surface water balance reach the stream in HSPF they are combined with all other terms tracked by HSPF.

Comment: We recommend the District develop a method to ensure and confirm that the calibrations of these two watersheds are reasonable and are willing to discuss some approaches for accomplishing this.

Response: The District used the USGS identified HUC12 closed basins as a guide, but in this case our knowledge of the system allowed us to correctly close off subwatersheds 36, 37, and 38 in the 03080103 model.

The old approach to representation of closed basins would involve increasing the fraction of the deep groundwater inflow (Inactive Groundwater Inflow: IGWI) until reaching a reasonable balance within the closed basin. This approach is problematic since it implies that there is a fundamental difference in soils, land cover, and evaporation parameters between a closed basin and an adjacent tributary basin. Some variation would be expected, but in order to maintain a reasonable balance with this approach you have to drive the closed basin parameters way outside of accepted bounds.

Something that is notable about closed basins is that there is often concentrated discharge to groundwater, either through sink holes that accept surface flows, drainage wells, or in this case; deep sand bottom lakes with connection to the Upper Floridan. Because of this observation, each closed basin has assigned to it a conceptual concentrated discharge mechanism to the Upper Floridan estimated from the stage in the HSPF closed basin reach. The District believes that this is the best practice for the representation of closed basins within HSPF.

Comment: Is the open water within the mine area at the headwaters of the Upper Etonia Creek basin simulated within subwatershed 36?

Response: Yes.

Comment: Will the subwatershed 36 model be modified to include the Alligator Creek Enhancement Strategy (ACES) Project, currently being implemented by the SJRWMD, in future simulations?

Response: Not currently planned for this project, and given the regional scope, an evaluation of ACES would be better suited to a localized, more detailed model.

Comment: Are specific calibration parameters varied by subwatershed, and then indexed to the forest land use for that watershed; or are specific calibration parameters across the entire HUC8 watershed set at the same value, and then indexed to the forest land use?

Response: It depends on the model. Most of the models only have one set of parameters for the entire HUC8 calibrated equally against all of the observations within the entire HUC8. If a modeler noted a regional difference within the HUC8 either in topography or land cover, there was the ability to group subwatersheds into zones that used different parameters.

Comment: Does the District have a summary of the calibration parameters used that could be provided?

Response: That will be in the final report.

Comment: The NFSEG model conceptualization document indicates that the models utilize 2006 land use. Can the Districts please confirm that 2006 land use is being used for the entire HSPF model simulation period from 1990 through 2014? What land use data (year) will be used for the 2010 baseline simulation and for future simulations performed with the NFSEG model?

Response: The land use for the HSPF models is actually the 2001, National Land Cover Database. The same land use is used for the 2009 baseline simulation. The future water use will be used to increase or decrease recharge based upon comparison of the HSPF model scenarios, with and without water use.

Comment: In the development of the HSPF models for the NFSEG model, how was leakage to and discharge from the groundwater system addressed at key resource features.

Response: As mentioned above for closed basins, there was an HSPF Special Action (a programming language built into HSPF) to estimate concentrated discharge to the Upper Floridan. Even though not in a closed basin, this Special Action was also used for Orange Lake Sink.

Discharge from the Upper Floridan aquifer to springs and rivers was handled in two different ways. For the Suwannee River Basin, an "underground reservoir" was included that collected deep groundwater (IGWI), and concentrated discharge from sinks and drainage wells to represent groundwater discharge from the Upper Floridan aquifer to the Suwannee River and its major tributaries in areas where these rivers are incised into the Upper Floridan aquifer. Outside of the Suwannee River Basin, springs were represented as imposed time series flowing into the reach. The imposed time series were developed from observations.

Comment: However, we agree with the Districts that the following anthropogenic recharges should be included in the final HSPF models and NFSEG models:

- Public supply irrigation (potable and non-potable);
- Domestic self-supply irrigation;
- Septic tank leakage;
- Reclaimed water sprayfields; and
- Rapid infiltration basins (RIBs) – though not as common in North Florida as in other parts of the SJRWMD, there is a RIB site on the south side of Lake Brooklyn in the Upper Etonia Creek basin that could be significant in an area of interest.

Response: All of these components are now included in the HSPF models. However, the particular RIB you mention is not in our database. The dataset was developed based on the best readily available information. The District is in the process of compiling annual FDEP flow rates on waste-water disposal systems, such as spray-fields, RIBs, waste-water treatment plants, etc., for the period 1995 through 2014, whereas previously we had data for such flows only for 2014. The updated rates will be implemented in the NFSEG model when the data is ready. In addition, if better information is provided by the Technical Team, we will consider including them into the model.

Comments received on 12/3/2015:

B4) At the Technical Team meeting on December 2, 2015, the Districts presented information on the hydrologic boundary conditions being utilized in the North Florida Southeast Georgia (NFSEG) groundwater flow model in response to questions/comments provided by the North Florida Utility Coordinating Group (NFUCG). As part of this discussion, the Districts noted that hydrologic boundary conditions used to represent rivers and streams (River Nodes and Drain Nodes) were assigned control heads to represent a downward gradient. The Districts also indicated that if model reviewers identified heads assigned to boundary conditions representing rivers/streams that did not have a down-gradient slope, to report those instances that to the Districts.

Attached please find a figure presenting the representation of the Upper Etonia Creek Chain-of-Lakes from Lowry Lake through Lake Brooklyn, and adjacent Lake Bedford and Crystal Lake (which are not part of the Upper Etonia Chain-of-Lakes). It can be seen in the figure that each lake is represented with River Nodes, and that the heads assigned to the set of boundary conditions representing each lake is a constant value across the lake. It can also be noted that Lowry Lake, Lake Magnolia, and Lake Brooklyn were assigned a downward gradient through the system.

Alligator Creek, which connects Lowry Lake, Lake Magnolia, and Lake Brooklyn, is represented as a series of Drain Nodes in the NFSEG model. The northeastern-most Drain Node, which falls within the footprint of the River Nodes representing Lowry Lake, has a head assignment that is greater than the head assigned to the River Node for Lake Lowry. The heads assigned to Alligator Creek from Lowry Lake to Lake Magnolia increase from 136.93 feet to 152.94 feet across three model cells before the assigned head decreases to 122.16 feet in a cell which falls within the footprint of the River Nodes representing Lake Magnolia. The three Drain Nodes that overlap with River Nodes within the footprint of Lake Magnolia all have higher assigned heads than the River Nodes. The Drain Nodes representing Alligator Creek between Magnolia Lake and Lake Brooklyn undulate from 115.7 feet to 141.41 feet to 133.24 feet to 144.06 feet in a westerly direction.

This represents one instance that we have identified as part of our review of the model where the heads assigned to the hydrologic boundary conditions representing a river/stream do not appear to have a downward gradient. We submit this for the Districts' review and consideration. We also look forward to the Districts' written responses to the comments submitted by the Technical Team.

*The attachment included with the submitted comment has been included as **Attachment B2**.*

District Response:

See the response to comments received on 11/16/2015.

Comments received on 12/8/2015:

B5) We have reviewed the data provided in your emails on December 3, 2015. The information provided presents statewide golf course irrigation and indoor and outdoor water use. Within the data provided, we cannot locate any RIB, sprayfield, or reclaimed water irrigation data needed to inform the modeling. We also have several questions on the information that was provided and how it is used in the NFSEG. As a result, we have the following questions:

a) Was reclaimed water land application, such as RIBs and sprayfields, included in the data provided to the Technical Team? If so, which file and what fields contain this information?
b) Was reclaimed water irrigation included in the data provided to the Technical Team? If so, which file and what fields contain this information?
c) Is 100 percent of indoor potable water use applied as septic recharge when a residential water user (public supply or DSS) has “septic” as their water reclamation facility designation? Or is some other percentage or method used for septic recharge?

District Response:
The files related to irrigation/return flow including both AG and Non-AG irrigation, septic tank and the sprayfields and RIB data were provided to the technical team. The methodology for estimating return flows was presented and discussed in the technical team meeting on November 4, 2015.

Comments Received on 12/15/2015:

B6) At the NFSEG Technical Team Meeting on December 2, 2015, the Districts requested input from the Tech Team on a number of items. One item presented at the meeting for Tech Team feedback was related to the use of different weights for surficial aquifer system (SAS) observation wells as part of the calibration process. The Districts explained that a low calibration weighting factor of 0.1 for certain SAS targets was utilized as part of the calibration of the model. As we understand it, a SAS target was assigned a weight of 0.1 if the ground surface elevation assigned to a NFSEG model cell was greater or lower than 10 feet different that the top-of-casing elevation of an observation well located within the cell. For other SAS targets, a higher calibration weighting of 0.5 was utilized, which is also lower than the typical calibration weighting used for targets located in other layers of the NFSEG Model.

We understand the challenges of calibrating the SAS, which tends to exhibit more local-scale topographic and groundwater variability than other aquifer layers. However, based on a review of the spatial distribution of the weighting factors, many of the SAS wells assigned a lower weighting factor of 0.1 are located in the center of the model, often in high recharge areas. Because it appears the Districts will be using the results of the NFSEG Model to evaluate wetlands as presented at the SAC meeting on December 7th, and due to the apparent spatial biasing of the weighted targets, we feel the influence of these wells should be increased as part of the calibration.

Due to the challenges which led the Districts to evaluate use of a low calibration weight for certain SAS wells, we support the District using an alternative calibration process for these SAS wells like the District has done in other regional modeling efforts. For example, in lieu of a comparison of observed water level to simulated water level, a comparison of observed to simulated depth to water could be performed. Alternatively, a comparison of the observed and simulated slopes and intercepts of a regression between SAS water levels and ground surface elevations could be completed as was done as part of the calibration of the SJRWMD's Northeast Florida (NEF) Model. We are also open to other options that achieve the objective of increasing the robustness of the model calibration in the SAS. These other options could also alleviate the need for using calibration factors of less than 1.0 in the SAS.

District Response:
We updated the weighting factors for the SAS because of the model layer 1 surface-elevation update. The residuals of the SAS targets have significantly improved since this comment was provided. However, it should be noted that it is always difficult to simulate SAS water levels in a regional model due to effect of topography on water levels and local influences such as local drainage features. The level of difficulty tends to increase in grid cells corresponding to areas of relatively high topographic relief. In the areas where the actual surveyed elevation of top of well casing is significantly different than the model layer 1 top elevation (which represents an average land surface elevation over a 2500 by 2500 feet area), we assigned a lower weighting factor of 0.5. The added difficulty of matching to targets in areas of high relief is the reason for the two-tiered weighting approach within the SAS layer. In addition, weighting factors are being updated as necessary after reviewing the calibration results to achieve the best calibration results.

The present approach has worked very well for the 2009 calibration and reasonably well for the 2001 calibration. In the interest of time, we suggest focusing on the calibration results rather than the weighting factors. If the calibration to SAS targets or other targets is determined to be lacking due to this approach, then other approaches can be considered. This can be discussed in more detail after the technical team reviews the model calibration results.

Comments Received on 12/16/2015:

B7) We have been reviewing the preliminary calibration data the Districts presented during the December 2, 2015, North Florida Southeast Georgia (NFSEG) Technical Team meeting and the associated preliminary calibration residuals provided by e-mail on December 8, 2015. Based on this review, it was noted that four (4) calibration weights are being applied to water level observation targets as follows: 0, 0.1, 0.5, and 1.0. We assume a weight of 0 means the target is not influencing the calibration, a weight of 1.0 means the target is fully influencing the calibration, and weights of 0.1 and 0.5 are influencing the calibration to lesser degrees. However, can the District provide information on how these specific weighting factors were developed and the method by which these weights are being applied to various targets? Also, has the District conducted any sensitivity analyses to determine how the use of these weighting factors affects the calibration of the model?

District Response:
First of all, it should be noted that weighting factors are used not only to inform PEST about the data quality but also facilitate the calibration process. Weights of 0 are used for target values determined to be incorrect. These targets will be removed from the model once the model is finalized after tech team review. The lower weights of 0.5 was used only for the SAS targets. Weight of 0.1 is no longer used for water level targets. Please see Response 6 for detail discussion of SAS weighting factors.

Comments Received on 12/16/2015:

B8) The North Florida Utility Coordinating Group (NFUCG) has continued review of the North Florida Southeast Georgia (NFSEG) groundwater flow model. As part of this review, the NFUCG has compared reclaimed water included in the NFSEG Model to data from published sources. This evaluation was based on GIS data provided by the Districts on December 8, 2015 and Florida Department of Environmental Protection (FDEP) Reuse Report data. The evaluation was performed at a County-wide level for the fourteen (14) counties within the North Florida Regional Water Supply Planning (NFRWSP) Area. The results of this evaluation are provided in the table below. This tabulation represents an evaluation of the 2001 steady-state model simulation and FDEP historical data. However, based on the information provided by the Districts, it appears that the reclaimed water land application data being used in the 2001 steady-state simulation are also be used in the 2009 steady-state simulation.

County	RIB Flow Observed (MGD)[1]	RIB Flow Model (MGD)[2]	Sprayfield Irrigation Observed (MGD)[1]	Sprayfield Irrigation Model (MGD)[2]	Agricultural Irrigation Observed (MGD)[1]	Agricultural Irrigation Model (MGD)[2]	Sprayfield + Agricultural Irrigation Observed (MGD)[1]	Sprayfield + Agricultural Irrigation Model (MGD)[2]
Alachua	0.946	0.0028	0.38	0.36	0.666	0	1.046	0.36
Baker	0	0	0	0.05	0.058	0	0.058	0.05
Bradford	0	0	0	0.24	1.459	0	1.459	0.24
Clay	0.708	0	0	0	0	0	0	0
Columbia	0	0	0	2.32	2.0074	0	2.0074	2.32
Duval	0	0	0	0	0	0	0	0
Flagler	1.644	0	0.18	0	0	0	0.18	0
Gilchrist	0	0	0	0	0.107	0	0.107	0
Hamilton	0	0	0.105	0	0	0	0.105	0
Nassau	0	0	0	0	0.278	0	0.278	0
Putnam	0	0	0	0.89	0	0	0	0.89
St. Johns	0.2	0	0	0	0	0	0	0
Suwannee	0	0.2	0	0	0.925	0	0.925	0
Union	0	0	0	0	0.478	0	0.478	0
Total	3.498	0.2028	0.665	3.86	5.9784	0	6.6434	3.86

1)Source: FDEP 2001 Reuse Report
2)Source: SJRWMD NFSEG reclaimed water land application data provided via email 12/8/2015

Based on the evaluation performed, the Districts are including 0.2 MGD of reclaimed water land application via rapid infiltration basins (RIBs), compared to 3.5 MGD as reported to the FDEP. In addition, the NFSEG Model includes a combined 3.9 MGD of sprayfield and agricultural reclaimed water irrigation compared to 6.6 MGD of sprayfield and agricultural irrigation reported to the FDEP. Sprayfield and agricultural irrigation were combined because, from review of this data, sprayfields are sometimes categorized as agricultural irrigation in the FDEP Reuse Reports.

The foregoing comparisons are limited to the NFRWSP area, but the identified mismatch is throughout the entire NFSEG model area. Therefore, considering the above, the NFUCG has the following comments:

1) Reported data of reclaimed water land application via RIBs from the FDEP should be included in the NFSEG Model for Florida counties within the model domain.
2) Reported data of reclaimed water use by sprayfields and agriculture from the FDEP should be included in the NFSEG Model for Florida counties within the model domain.
3) Reported 2009 and 2010 reclaimed water land application data should be utilized in the 2009 and 2010 NFSEG model simulations, as opposed to 2001 data.

The recommended changes are consistent with other District models such as the East Central Florida Transient Model where FDEP reuse reporting data and in some cases data provided directly from the stakeholders was incorporated into the groundwater model. Please note that public access reclaimed water irrigation has not been included above, and is currently being reviewed and evaluated by the NFUCG.

In addition, the reclaimed water land application data for 1992 through 2012 is needed for the NFSEG HSPF models. However, the District only provided 2001 reclaimed water land application data to the Technical Team. Could you please provide the data the District is currently proposing to incorporate into the HSPF models for 1992 through 2000 and 2002 through 2012?

District Response:
The land application flow dataset was developed based on the best readily available information. Since the recharge through land application sites such as RIBs are not significant within model domain, we believe that the current dataset is adequate for the calibration effort. However, the District is in the process of compiling annual FDEP flows for waste-water disposal systems, such as spray-fields, RIBs, waste-water treatment plants, etc., for the period 1995 through 2014, whereas previously we had data for such flows only for 2014. The updated flows will be implemented in the NFSEG model when the data is ready. In addition, if better information is provided by the Technical Team, we will consider including them in the model.

It would be also helpful if NFUCG can provide us with a shape file listing the historical annual flows up to 2012 for the NFUCG utilities. This will enable incorporation of that data into our models, where it differs from the FDEP data. Please note that agricultural irrigation is handled separately regardless of its water source, so the NFSEG reuse land application dataset should not be expected to include representations of agricultural irrigation.

Comments Received on 12/22/2015:

B9) The North Florida Utility Coordinating Group (NFUCG) has continued review of the North Florida Southeast Georgia (NFSEG) groundwater flow model. As part of this review, the NFUCG is evaluating the quantity of non-agricultural irrigation and reclaimed water irrigation (and other forms of land application) the Districts are proposing to include in the NFSEG model and the corresponding public supply utility water balance represented by the model.

On December 16, 2015, the NFUCG submitted comments via e-mail regarding the reclaimed water land application the Districts are proposing to include in the NFSEG Model. The NFUCG's review included reclaimed water agricultural irrigation. The Districts' response indicated that agricultural irrigation was being addressed separately from reclaimed water land application. Based on this, the NFUCG has performed a review of the Districts' NFSEG agricultural irrigation groundwater pumping and irrigation return flow data. A summary of this data for the fourteen (14) counties within the planning area is attached.

Based on the attached summary, the NFUCG has the following comments.

1) Agricultural groundwater pumping and groundwater irrigation appear to reasonably match for most of the counties within the planning area. However, there appears to be significant differences between groundwater pumping and groundwater irrigation in Alachua County and Putnam County, and a moderate difference in Bradford County. Please review the attached discrepancies and if necessary update the model as appropriate.
2) Surface water agricultural irrigation appears to have been omitted from the model. Surface water irrigation should be included in the model if it was omitted.

Reclaimed water agricultural irrigation appears to have been omitted from the model. Reclaimed water irrigation should be included in the model if it was omitted. A summary of reclaimed water agricultural irrigation for the fourteen (14) county planning area (previously submitted) has been attached for reference

*The attachments included with the submitted comments have been included as **Attachment B3** and **Attachment B4**.*

District Response:

After checking on this, we determined that we incorrectly summarized the data that we provided to you. The data as a whole as entered into the NFSEG model were correct, but the subtotals were not due to a number of missing records. We have since corrected the subtotals. A table summarizing Camilo Gaitan's handwritten edits and Brian Megic's original table can be found by clicking on the first hyperlink below. The corrected subtotals may be obtained by clicking on the second hyperlink below.

ftp://ftp.sjrwmd.com/gwp/NFSEG/DataForTechTeamReview/20151230_AgIrr_NFSEGcomments_using_updated%20subtotals.zip

ftp://ftp.sjrwmd.com/gwp/NFSEG/DataForTechTeamReview/AgIrr_201512_NFSEGupd_FL__subtotals.zip

Reclaimed water for agriculture in the NFSEG model domain is minimal but is being included. We do not differentiate on the basis of whether water is derived from a reclaimed vs. potable source. We do differentiate on whether water is derived from a surface-water vs. groundwater source, however, and surface-water irrigation is included. The FDACS data do not match ours perfectly because we use actual flows where available, whereas FDACS relies entirely on the AFSIRS-based regression model.

Comments received on 1/7/2016 and 1/8/2016:

B10) 1/7/2016 comment:

Thanks to you and to the water management district team for meeting with me on January 4, 2016, to discuss non-agricultural irrigation proposed to be included in the North Florida Southeast Georgia (NFSEG) groundwater flow model. Though the meeting was informative, the North Florida Utility Coordinating Group (NFUCG) still has questions regarding how the non-agricultural irrigation estimates included in the calibration simulations were developed. Specifically, the NFUCG is trying to better understand the “tensioning” process that reconciles historical public supply irrigation with historical public supply pumping in an effort to ensure that irrigation in the model is appropriately applied. In an attempt to understand and recreate the tensioning process used, the NFUCG has summarized data from two of the databases provided by the water management districts which are being used in support of the development of the NFSEG Model as follows:

1) Withdrawal geodatabase; and
2) Non-agricultural irrigation database, which includes indoor and outdoor public water supply use.

The NFUCG queried both of the above databases to summarize Public Water Supply pumping and water use being included in the calibration version of the NFSEG Model. The evaluation was performed at a County-wide level for the fourteen (14) counties within the North Florida Regional Water Supply Planning (NFRWSP) Area. A summary of the results are provided in the table below.

County	2001 PWS Pumping [1] (MGD)	2001 PWS Water Use [2] (MGD)	2001 Percent Difference	2009 PWS Pumping [1] (MGD)	2009 PWS Water Use [2] (MGD)	2009 Percent Difference
Alachua	29.57	28.65	3.1%	27.59	27.47	0.4%
Baker	0.95	0.94	1.3%	1.05	1.01	4.3%
Bradford	1.33	1.07	19.8%	1.32	0.71	46.3%
Clay	13.88	3.26	76.5%	14.26	2.69	81.1%
Columbia	2.97	3.77	-26.7%	3.69	3.94	-6.8%
Duval	119.12	94.78	20.4%	120.43	94.49	21.5%
Flagler	8.67	6.11	29.5%	11.13	5.68	49.0%
Gilchrist	0.90	0.25	72.2%	0.57	0.21	63.6%
Hamilton	1.01	0.02	98.0%	1.06	0.03	97.6%
Nassau	6.26	7.13	-13.8%	7.41	6.84	7.7%
Putnam	4.22	3.34	20.8%	2.48	2.99	-20.5%
St. Johns	18.09	8.94	50.6%	19.48	7.70	60.5%
Suwannee	1.31	0.91	30.2%	1.29	0.97	25.2%
Union	0.17	0.33	-98.4%	0.24	0.32	-30.7%
Total	208.45	159.50	23.5%	212.00	155.03	26.9%

Sources
1) NFSEG Withdrawal Geodatabase provided by e-mail on November 5, 2015
2) Non-agricultural irrigation database provided by e-mail on December 3, 2015

Based on information provided by the water management districts, the non-agricultural irrigation database includes residential indoor and outdoor public supply water uses, and some non-residential indoor public supply water uses (e.g., commercial use). As such, it would be expected that the public water supply totals from the withdrawal geodatabase could be greater than the public supply water use included in the non-agricultural irrigation database. However, there are three counties within the NFWRSP (Columbia, Nassau, and Union Counties) area where the public supply uses are greater than the public supply pumping. In other cases (Clay, Hamilton, and St. Johns Counties), the quantity of public supply uses accounted for within the non-agricultural irrigation database appear significantly, and potentially unreasonably, low when compared with the public supply pumping included in the withdrawal geodatabase

B11) 1/8/2016 comment:

On behalf of the NFUCG, Liquid Solutions Group has continued its review of the NFSEG Model. As part of that review, we have assessed the non-agricultural irrigation proposed to be included in the NFSEG Model. As a result of that review, we have generated the attached discussion and comments regarding the public water supply land application return flow proposed to be included in the model.

*The attachment included with the submitted comments has been included as **Attachment B5**.*

District Response:

We will be reviewing the return flow datasets in detail during the technical team review period. We will share our findings and updates with the technical team. Nonetheless, we believe the amount of recharge in question is insignificant when compared to total HSPF-derived recharge and will not affect the outcome of the calibration. For instance, in the case of Clay County, the total recharge applied in the NFSEG model for 2001 is approximately 492 mgd. The larger of the estimates of missing non-agricultural irrigation is 12.57 mgd, which is only 2.3 percent of total estimated recharge for Clay County in 2001.

It is worth noting that some minor discrepancies should be expected due to differences in withdrawal locations vs. use locations

Comments received on 2/24/2016 and 2/26/2016:

B12) 2/24/2016 comment:

At the February 3, 2016 North Florida Southeast Georgia (NFSEG) Groundwater Flow Model Technical Team meeting, the water management districts (Districts) indicated they are proposing to perform a “Pumps-off” simulation using the NFSEG Model. The results of the “Pumps-off” simulation would be incorporated into the evaluations of certain non-MFL water bodies performed in support of the North Florida Regional Water Supply Plan (NFRWSP). At that time, the Districts requested input from the Technical Team on potential alternative methods for these assessments.

As we stated at the Technical Team meeting and at other forums, we have significant concerns with performing a “Pumps-off” simulation. We understand that the Districts are working diligently to develop the NFSEG model and evaluation methods that are appropriate for the NFRWSP and we are optimistic that our concerns will be addressed. However, we suggest that the Districts consider using the results of the calibration, reference condition, and future simulations, or another alternative approach, to draw inferences regarding the potential effects of historical pumping, in lieu of performing a "Pumps-off" simulation.

B13) 2/26/2016 Comment:

Based on the information presented, our concerns with the use of a "Pumps-off" simulation for non-MFL water resource impact assessments as currently proposed by the Districts are as follows:

- A "Pumps-off" simulation is far outside the range of conditions which are being used to calibrate the NFSEG model; therefore, there could be a high degree of uncertainty in the results of this simulation.
- The "Pumps-off" simulation as described during the Technical Team meeting represents a condition that has never occurred. As such, there is no available data to quantitatively validate the results to reduce the uncertainty associated with this simulation.
- Since the "Pumps-off" simulation does not represent a historical condition, it is not an appropriate baseline condition for the assessments proposed by the Districts which are intended to estimate changes in springflow from a historical condition to a future condition.

We appreciate the Districts' diligent efforts to develop a robust NFSEG model and are optimistic that our concerns with the "Pumps-off" simulation are being addressed. Our previously suggested approach to address non-MFL water bodies was intended to avoid the potential issues associated with the "Pumps-off" simulation while providing the information required for the Districts' water resource assessments. The alternative approach was also suggested to provide a potential "Plan B" in the event that the Districts proceed with their current approach and the "Pumps-off" simulation proves infeasible.

If you would like to discuss the details of this or other potential alternative approaches, we will be happy to do so at the next Technical Team meeting or via a phone call.

District Response:
We referenced the pumps-off scenario primarily in regards to the model design, i.e., that the model lateral boundaries, extent, and other features were designed so that a reasonable pumps-off simulation can be performed. A more detailed discussion of the pumps-off scenario is not directly conducive to completion of the model development and calibration, which is our current priority. Nevertheless, a further in-depth discussion may be needed regarding the potential issues with the pumps-off scenario after the technical team review period. Moreover, we welcome any ideas that others may have for alternatives to use of the pumps-off scenario in the development of water supply plan and critical water resource evaluations.

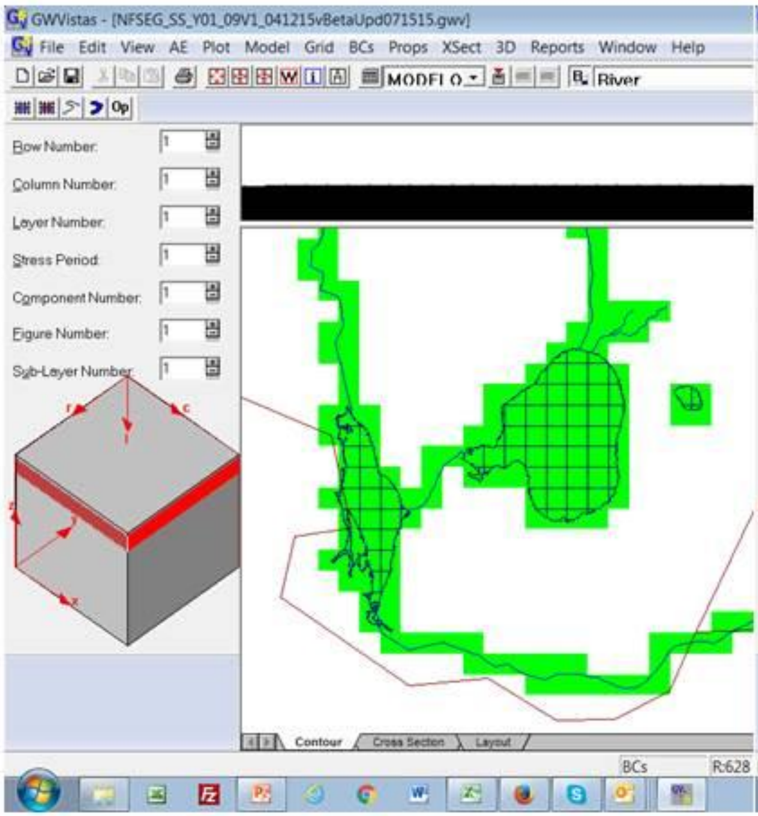
Attachment B1

Model Structure Review
Hydrologic Boundary Conditions

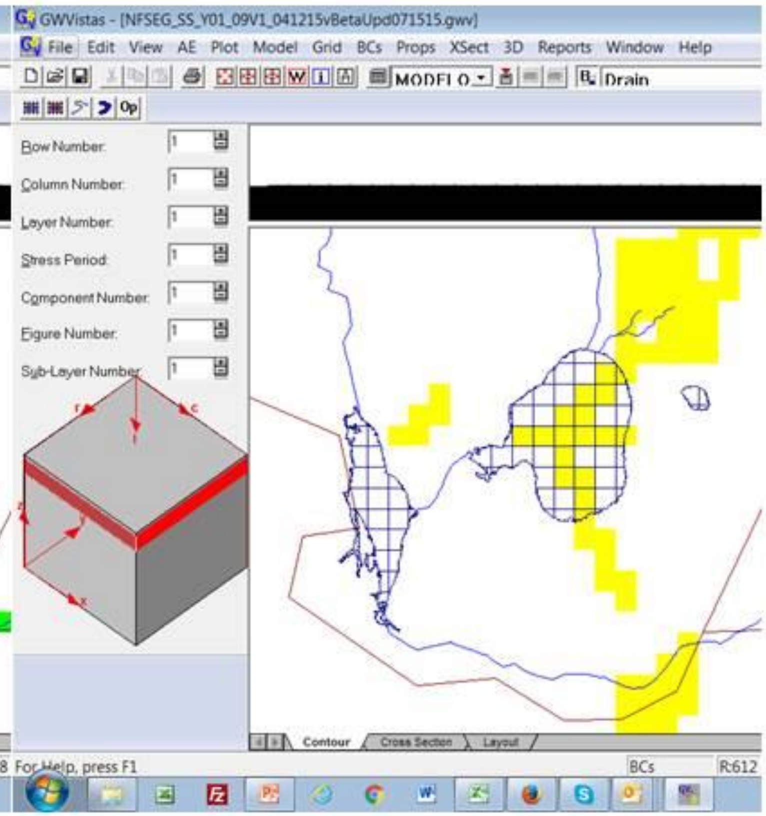
- Overlapping hydrologic boundary conditions within a single cell in the same model layer
- Three examples provided:
  - Orange Lake/Lake Lockloosa
  - Upper Etonia Creek Chain-of-Lakes
  - Ichetucknee Springs

Orange Lake/Lake Lockloosa

Layer 1 – River Nodes



Layer 1 – Drain Nodes

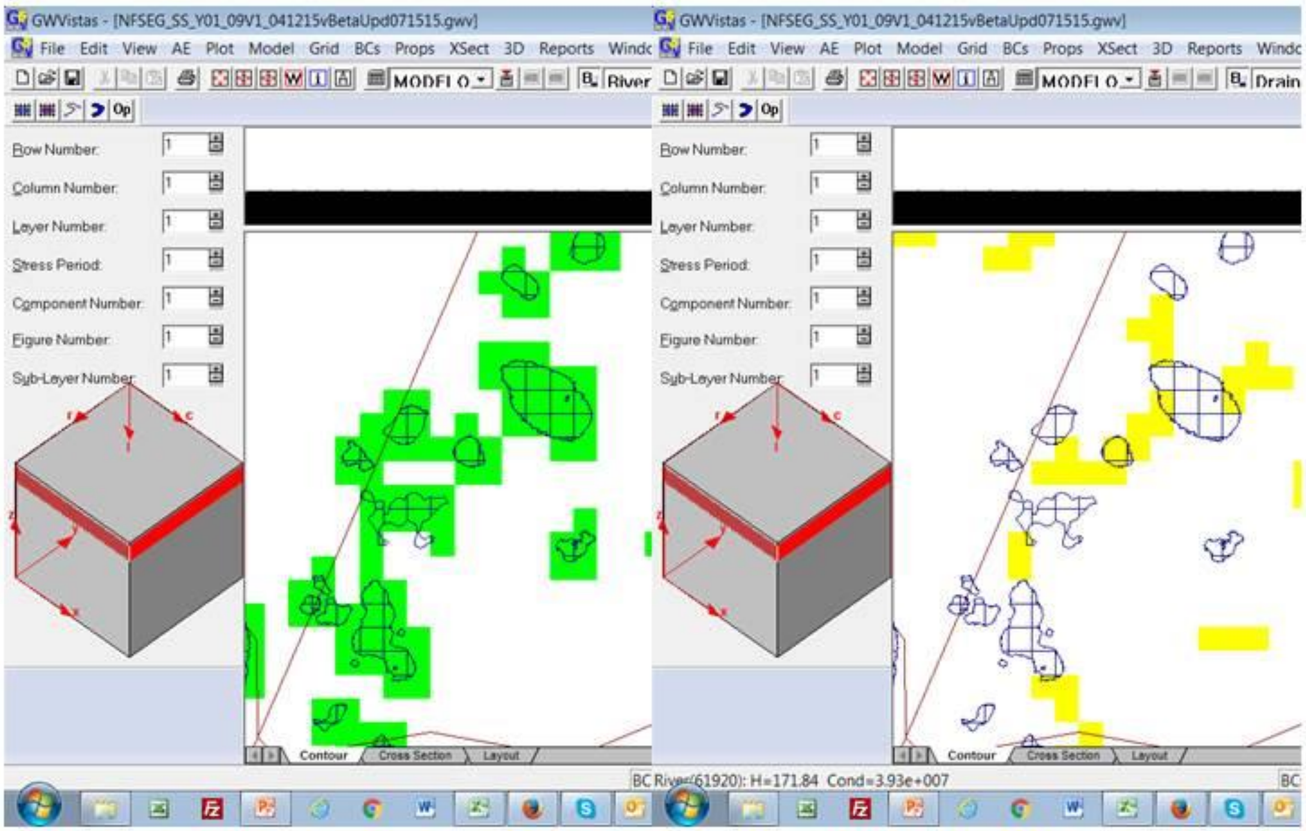


Multiple Drain nodes with area of River nodes representing Lake Lockloosa. The River node assigned heads can be > or < the Drain node assigned heads.

Upper Etonia Creek Chain of Lakes

Layer 1 – River Nodes

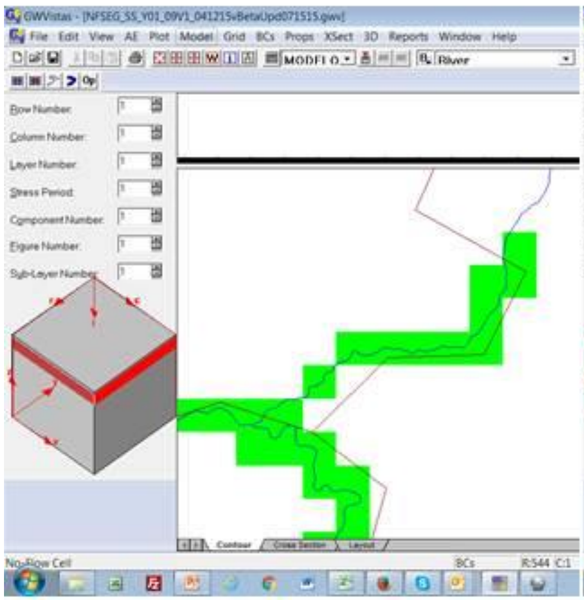
Layer 1 – Drain Nodes



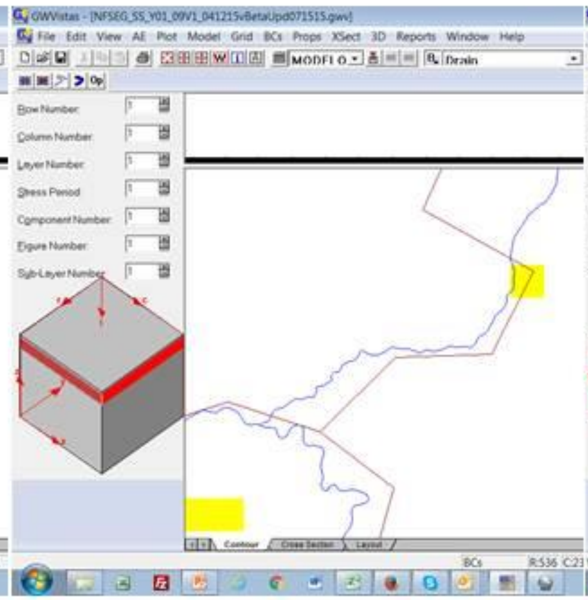
Multiple overlapping River and Drain nodes in Layer 1, particularly across Magnolia Lake.

Ichetucknee Springs

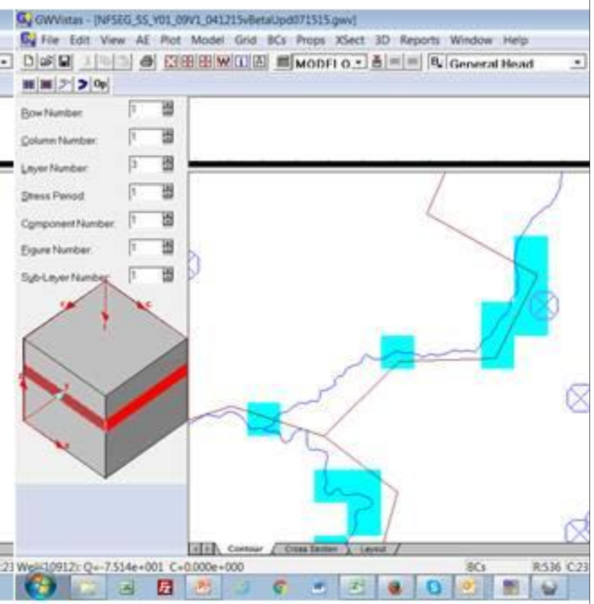
Layer 1 – River Nodes



Layer 1 – Drain Nodes



Layer 3 – GHBs
(shows location of springs)

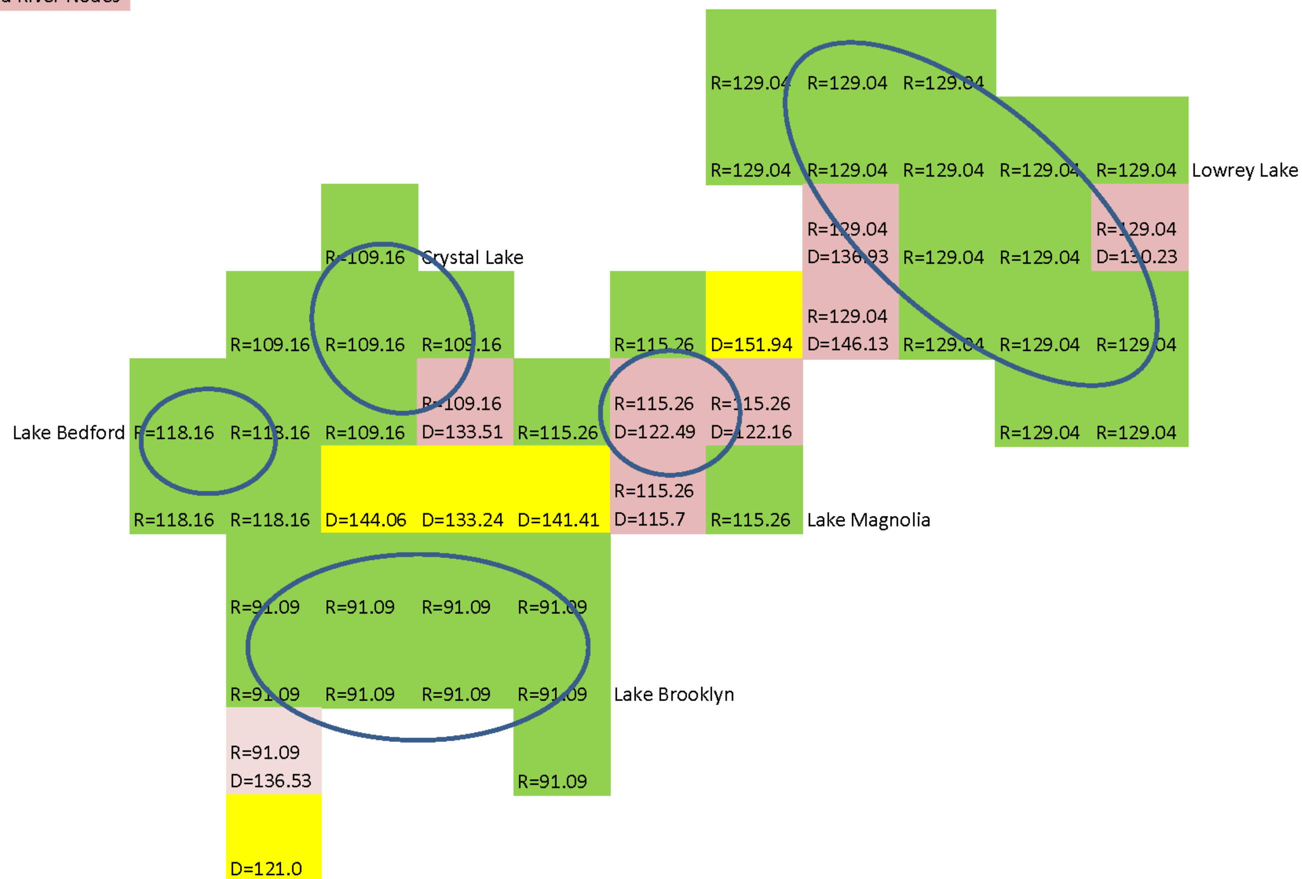


Layer 1 has a River node and Drain node in the same cell (at the location of a spring) with the same head assignment.

Attachment B2

NFSEG Groundwater Flow Model
Hydrologic Boundary Condition Figure
Portion of the Upper Etonia Creek Chain-of-Lakes

Drain Node
River Node
Drain and River Nodes



Attachment B3

North Florida Utility Coordinating Group
North Florida Southeast Georgia Model Review
Comparison of Agricultural Groundwater Withdrawals and Agricultural Irrigation

County	Groundwater Irrigation			Groundwater Pumping			Groundwater Pumping - Irrigation			Surface Water Irrigation		
	2001 (MGD)	2009 (MGD)	2010 (MGD)	2001 (MGD)	2009 (MGD)	2010 (MGD)	2001 (MGD)	2009 (MGD)	2010 (MGD)	2001 (MGD)	2009 (MGD)	2010 (MGD)
Alachua	9.42	8.11	9.68	15.40	13.83	16.51	5.98	5.71	6.83	0.04	0.05	0.06
Baker	1.72	0.77	0.93	1.72	0.78	0.93	0	0	0	0.02	0.17	0.23
Bradford	0.93	0.69	1.05	1.07	0.80	1.28	0.14	0.11	0.23	0.004	0.003	0.003
Clay	1.08	0.65	0.62	1.08	0.65	0.62	0	0	0	0.03	0.23	0.27
Columbia	4.16	3.55	3.87	4.16	3.56	3.87	0	0	0	0.03	0.03	0.04
Duval	0.90	0.96	1.32	0.90	0.96	1.32	0	0	0	1.38	1.56	2.10
Flagler	8.18	6.71	8.19	8.19	6.72	8.20	0.01	0.00	0.01	0.18	0.36	0.60
Gilchrist	9.43	8.15	7.46	9.40	8.15	7.45	-0.03	-0.01	-0.02	0.01	0.01	0.01
Hamilton	10.88	11.84	11.40	10.88	11.85	11.41	0.01	0.01	0.01	0.01	0.01	0.01
Nassau	0.34	0.38	0.44	0.34	0.38	0.44	0	0	0	0.13	0.14	0.17
Putnam	22.11	15.43	15.70	23.41	17.19	18.97	1.30	1.76	3.27	0.97	1.09	1.75
St Johns	35.49	20.15	23.61	35.31	20.22	23.69	-0.19	0.06	0.08	0.36	0.63	1.00
Suwannee	29.36	25.90	28.01	29.38	25.92	28.03	0.02	0.02	0.02	0.20	0.18	0.23
Union	0.68	0.43	0.64	0.68	0.43	0.64	0	0	0	0	0	0
Total	134.66	103.76	112.93	141.91	111.43	123.36	7.25	7.67	10.43	3.37	4.45	6.48

Sources
1) Agricultural Irrigation: “Historic Ag Irrigation Estimates for NFSEG Model” geodatabase file titled AgIrr_201509_NFSEGcomb.gdb.
2) Groundwater Withdrawals: NFSEG water use geodatabase file titled WaterUse092215upd.gdb.

Attachment B4

North Florida Utility Coordinating Group

North Florida Southeast Georgia Model Review

Comparison of Modeled and Observed Reclaimed Water RIB, Sprayfield, and Agricultural Irrigation Flows

County	RIB Flow Observed (MGD)[1]	RIB Flow Model (MGD)[2]	Sprayfield Irrigation Observed (MGD)[1]	Sprayfield Irrigation Model (MGD)[2]	Agricultural Irrigation Observed (MGD)[1]	Agricultural Irrigation Model (MGD)[2]	Sprayfield + Agricultural Irrigation Observed (MGD)[1]	Sprayfield + Agricultural Irrigation Model (MGD)[2]
Alachua	0.946	0.0028	0.38	0.36	0.666	0	1.046	0.36
Baker	0	0	0	0.05	0.058	0	0.058	0.05
Bradford	0	0	0	0.24	1.459	0	1.459	0.24
Clay	0.708	0	0	0	0	0	0	0
Columbia	0	0	0	2.32	2.0074	0	2.0074	2.32
Duval	0	0	0	0	0	0	0	0
Flagler	1.644	0	0.18	0	0	0	0.18	0
Gilchrist	0	0	0	0	0.107	0	0.107	0
Hamilton	0	0	0.105	0	0	0	0.105	0
Nassau	0	0	0	0	0.278	0	0.278	0
Putnam	0	0	0	0.89	0	0	0	0.89
St. Johns	0.2	0	0	0	0	0	0	0
Suwannee	0	0.2	0	0	0.925	0	0.925	0
Union	0	0	0	0	0.478	0	0.478	0
Total	3.498	0.2028	0.665	3.86	5.9784	0	6.6434	3.86

Notes:

1) Source: Florida Department of Environmental Protection 2001 Reuse Report.

2) Source: SJRWMD NFSEG reclaimed water land application data provided via e-mail on December 8, 2015.

Attachment B5

North Florida Southeast Georgia (NFSEG) Groundwater Flow Model
Public Water Supply Return Flow Assessment

On behalf of the NFUCG, Liquid Solutions Group has continued its review of the NFSEG Model. As part of that review, we have assessed the non-agricultural irrigation proposed to be included in the NFSEG Model as described further below. This review was based on several sources including the following:

1) NFSEG Withdrawal Geodatabase provided by e-mail on November 5, 2015;
2) NFSEG non-agricultural irrigation databases (also include indoor uses) provided by e-mail on December 3, 2015;
3) North Florida Regional Water Supply Plan (NFRWSP) area population and flow projections (latest MS Excel spreadsheet as provided by the SJRWMD)
4) Florida Department of Environmental Protection (FDEP) Reuse Reports

Specifically, we have evaluated the quantity of public water supply (PWS) that is proposed to be returned to the NFSEG Model as recharge via land application techniques such as irrigation, septic tanks, and rapid infiltration basins. Aquifer recharge via injection wells and sinks is being considered separately as their use in the NFRWSP is limited.

The first step in this evaluation was to summarize the quantity of recharge that originates from PWS sources as contained in the NFSEG non-agricultural irrigation databases. The evaluation was performed at a County-wide level for the 14 counties within the NFRWSP Area. A summary of the results for the 2001 calibration year are provided in the **Table 1** below.

Table 1 – Summary of Water Management District (DISTRICT) Proposed NFSEG PWS Recharge (2001)

County	[A] PWS Residential Irrigation (MGD)	[B] Reclaimed Water Sprayfield Irrigation (MGD)	[C] Septic Tank Recharge from PWS Supply (MGD)	[D] RIB Recharge (MGD)	[E = A+B+C+D] Total PWS Recharge (MGD)	[F] Total PWS Pumping from Withdrawal Geodatabase (MGD)	[G = E/F] Percent PWS Land Application Return Flow
Alachua	10.87	0.36	1.09	0.0028	12.33	29.57	42%
Baker	0.23	0.05	0.01	0	0.29	0.95	31%
Bradford	0.33	0.24	0.03	0	0.60	1.33	45%
Clay	0.91	0	0.09	0	1.00	13.88	7%
Columbia	1.02	2.32	0.81	0	4.16	2.97	140%
Duval	30.52	0	2.49	0	33.00	119.12	28%
Flagler	2.35	0	0.24	0	2.59	8.67	30%
Gilchrist	0.08	0	0.03	0	0.11	0.90	12%
Hamilton	0.01	0	0.00	0	0.01	1.01	1%
Nassau	2.33	0	0.25	0.20	2.78	6.26	44%
Putnam	0.97	0	0.44	0	1.42	4.22	34%
St. Johns	2.83	3.86	1.92	0.2028	8.81	18.09	49%
Suwannee	0.32	0	0.06	0	0.38	1.31	29%
Union	0.10	0	0.00	0	0.11	0.17	63%
Total	52.87	6.83	7.48	0.41	67.58	208.45	32%

In **Table 1**, the data presented in columns A through D are directly from the NFSEG non-agricultural irrigation databases, and the data in column F is directly from the NFSEG withdrawal geodatabase.

Public water supply is used to meet customer demands. A portion of PWS water supplies is used to meet outdoor demands such as irrigation, and this is water that should be represented in the NFSEG model as recharge. A portion of PWS water supplies is used to meet indoor demands such as residential and commercial indoor uses (e.g., toilet flushing, showering, dish washing, etc.). If a PWS customer is also connected to a municipal wastewater system, the indoor use is returned to a wastewater treatment facility (WWTF) as wastewater. Wastewater treated at a WWTF can be managed though techniques such as irrigation, recharge via rapid infiltration basins, sprayfields, surface water discharge and injection wells. As such, a portion of indoor water use is also reapplied to the ground. **Figure 1** presents a simplified schematic of the PWS water supply water balance and shows the means by which PWS flows end up as NFSEG Recharge. In general, utilities typically apply 50 to 90 percent of the water used within their service area to the ground (recharge) either as potable water or reclaimed water depending on their customer profile, service area limits, and reclaimed water management techniques. As such, many of the countywide percentages presented in **Table 1** appear lower than would be anticipated.

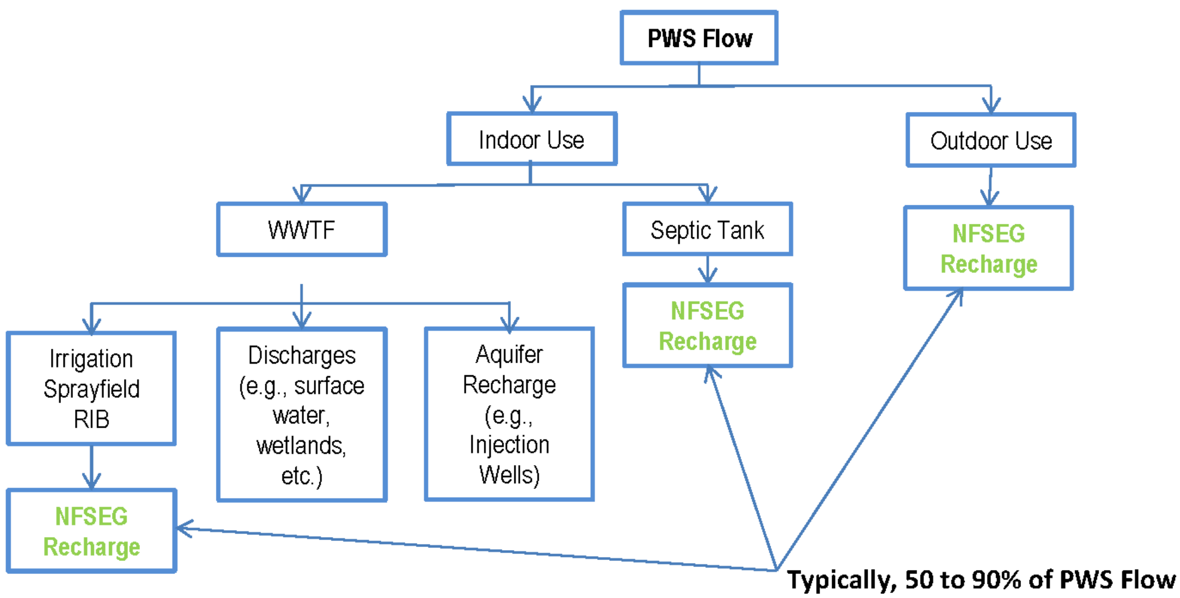


Figure 1. Generalized PWS Water Balance

Based on these results, which showed that Clay County, in particular, had very low land application return flows, we performed additional analyses to estimate the percent of PWS water that would be expected to be applied to the ground in Clay County. This was done using two methods to bracket the potential solution. These two methods are described below in the event that the Districts would like to replicate these methods or utilize one of these methods to update their data.

The first alternative method is based on historical water use and historical reclaimed water use and management. It was assumed that all water returned to a WWTF as wastewater for treatment represents PWS indoor water use and that the remainder of the PWS water use was used to meet outdoor demands such as irrigation or ends up in a septic tank. A portion of the reclaimed water generated at the WWTF may also be returned to the ground through land application techniques depending on the utility. The data used to perform this estimate was from the NFSEG Withdrawal Geodatabase and FDEP Reuse Reports. The last component included in this evaluation is PWS supply that is conveyed to customers on a septic tank in lieu of a municipal wastewater system. The best estimate we had of septic recharge that originates from PWS sources is the NFSEG non-agricultural irrigation databases. These sets of data were used to calculate an estimate of potential PWS recharge in Clay County as presented in **Table 2**.

It is acknowledged that WWTFs can experience inflow and infiltration (I&I) of groundwater and stormwater via the gravity portions of their wastewater collection system depending on climatic conditions. This could cause the quantity of wastewater received at a WWTF to be higher than the indoor water demand. However, to the extent it exists, I&I typically only represents a small percentage of the average flow received at a WWTF for public utilities. In addition, this potential overestimation of indoor water use is partially offset by water demands that are calculated to be indoor uses but are actually outdoor uses (e.g., hand watering and pool filling) and by WRF losses (e.g., evaporative losses associated with residuals drying). As such, I&I is not expected to significantly affect the results of this county-wide evaluation.

In addition, assuming all PWS supply not returned to a wastewater plant was used to meet outdoor demands may overestimate irrigation in some cases depending on a utility's customer profile. However, this method does help to bracket the potential range of PWS supply returned to the ground.

Table 2 – Summary of Alternative Method 1 to Calculate PWS Recharge

County	[A] Total PWS Pumping from NFSEG Withdrawal Geodatabase (MGD)	[B] FDEP Observed WRF Flow from FDEP Reuse Report (MGD)	[C] Septic Tank Recharge from PWS Sources from NFSEG Non-Agricultural Irrigation Database (MGD)	[D = B+C] Total WW Flow from PWS Sources (MGD)	[E = A-D] Total PWS Not Returned to WRF or Septic [Potential PWS Irrigation] (MGD)	[F] FDEP Observed Reclaimed Water Land Application from FDEP Reuse Report (MGD)	[G = E+F] Total Potential PWS Recharge (MGD)	[H] Percent PWS Land Applica-tion Return Flow
Clay	13.88	2.34	0.09	2.44	11.44	1.14	12.57	91%

The second alternative method applied to estimate PWS recharge also uses the NFSEG Withdrawal Geodatabase for historical water use and FDEP Reuse Reports for historical reclaimed water land application, but incorporates data from draft NFRWSP data and NFSEG non-agricultural irrigation databases to calculate potable water irrigation. Potable water irrigation was calculated by multiplying the total PWS pumping by the percent of the water use that is estimated to be residential as listed in the NFRWSP area population projections data provided by the St. Johns River Water Management District (SJRWMD). The resulting residential use was then multiplied by the percent residential outdoor use of 55 percent used by the Districts in the NFSEG non-agricultural irrigation databases. The resulting PWS recharge in Clay County resulting from this method is summarized in **Table 3**.

This method only includes outdoor potable water uses such as irrigation for residential customers. Because many commercial, industrial, and other customers also use potable water to meet outdoor demands such as irrigation, this method is expected to underestimate PWS recharge. However, this method does help to bracket the potential range of PWS supply returned to the ground.

Table 3 – Summary of Alternative Method 2 to Calculate PWS Recharge

County	[A] Total PWS Pumping from NFSEG Withdrawal Geodatabase (MGD)	[B] Percent RES Water Use from SJRWMD RWSP Data	[C = AxB] PWS RES Water Use (MGD)	[D] Percent RES Outdoor Use from NFSEG Non-AG Irrigation Database	[E = CxD] Estimated RES Outdoor Use [Potential PWS Irrigation] (MGD)	[F] Septic Tank Recharge from PWS Sources from NFSEG Non-AG Irrigation Database (MGD)	[G] FDEP Observed Reclaimed Water Land Application from FDEP Reuse Report (MGD)	[H = E+F+G] Total Potential PWS Recharge (MGD)	[I] Percent PWS Return Flow
Clay	13.88	76%	10.48	55%	5.76	0.09	1.14	6.99	50%

Table 4 compares the Districts' estimate of PWS recharge to the two methods discussed above for Clay County. Based on this evaluation, it appears the Districts could be significantly underestimating PWS recharge in Clay County. Though only evaluated for Clay County, an underestimation of recharge could be occurring in other counties within the model domain and could affect the calibration of the NFSEG model. In addition, at the December 3, 2015 NFSEG Technical Team meeting the water management districts proposed estimating future recharge by increasing historical recharge as a percentage of future increases in total water use. If historical recharge is underestimated as potentially indicated in **Table 4**, then future increases in recharge will also be underestimated.

Table 4 – Summary of Proposed and Alternative PWS Recharge Methods

County	NFSEG Proposed PWS Recharge (MGD)	Alternative Method 1 PWS Recharge (MGD)	Alternate Method 2 PWS Recharge (MGD)
Clay	1.0	6.99	12.57

We request the Districts reevaluate their proposed method for estimating land application return flow estimates currently utilized in the calibration version of the NFSEG Model and update these estimates as appropriate.

From: Paul Still [mailto:stillpe@aol.com]
Sent: Tuesday, May 31, 2016 12:33 PM
To: Fatih Gordu <fgordu@sjrwmd.com>
Cc: bknight@wetlandsolutionsinc.com; goodmanbp@gru.com; camilo.gaitan@freshfromflorida.com; CDH@srwmd.org; Cliff.lewis@gadnr.org; Curt.Williams@ffbf.org; Dale R Jenkins <drjenkins@sjrwmd.com>; darrin.herbst@swfwmd.state.fl.us; richardsondm@gru.com; dbottcher@swet.com; Douglas Durden <DDurden@sjrwmd.com>; Douglas Hearn <DHearn@sjrwmd.com>; DDufresne@Ardaman.com; Gary Foster <GFoster@sjrwmd.com>; portgl@jea.com; George Robinson <grobinson@sjrwmd.com>; Jeff.Lehnen@CH2M.com; mikejillmcguire@earthlink.net; jim_kennedy@dnr.state.ga.us; John Fitzgerald <JFitzgerald@sjrwmd.com>; limestonebungalow@gmail.com; klvanzant@gmail.com; mayorhildreth@aol.com; Michael Cullum <MCullum@sjrwmd.com>; nsepul@usgs.gov; parks.small@dep.state.fl.us; Patrick Burger <pburger@sjrwmd.com>; ptara@intera.com; steipk@jea.com; StillPE@aol.com; peter@schreuderwater.us; RDsouza@sjrwmd.com; HUTTONRH@gru.com; rdenis@liquidsolutionsgroup.com; Ron.Basso@swfwmd.state.fl.us; rstewart@fppaea.org; Tim Cera <TCera@sjrwmd.com>; Tim Desmarais <TDesmarais@sjrwmd.com>; kincaid@geohydros.com; barttj@jea.com; CUNNINGHAAL@gru.com; JWG@srwmd.org; tedwards@jaxbchfl.net; save-our-lakes@comcast.net; Wei Jin <WJin@sjrwmd.com>; Alisha B. Gipe <AGipe@sjrwmd.com>; James Walters <jwalters@sjrwmd.com>; Tammy Bader <TBader@sjrwmd.com>; Jim.Kennedy@dnr.ga.gov; VDavis2@ardaman.com; Joanne Chamberlain <jchamber@sjrwmd.com>; Kraig McLane <kmclane@sjrwmd.com>
Subject: NFSEG Model

As I understand it the NFSEG model was in part to address 5 geographic areas of concern 1. The Upper Santa Fe Basin; 2. The Lower Santa Fe Basin; 3. The Upper Suwannee River Basin; 4. The Alapaha River Basin; and 5. The Upper Etonia Creek Basin. All but the Upper Suwanee River Basin seem to have high residual values. It would be helpful if a Calibration Statistic Table could be prepared for the 5 basins of concern.

The Lower Santa Fe MFL rule language and the “Supplemental Regulatory Measures” for that rule reference the NFSEG model. The assumption is the NFSEG model will be better than existing models to evaluate withdrawals on MFL water bodies. It important that some mechanism be establish to demonstrate that the NFSEG model is better than existing models and that the NFSEG Model produces the best available information about the impacts of withdrawals on existing MFLs for area water bodies.

I have not seen any calibration data for the surface flow model. Brain’s comments seem to indicate that the model performance at Worthington Springs is not very good.

Is the poor performance of the NFSEG model in Union and Bradford Counties due in part to poor surface flow model results in those counties?

Getting water flow correct for flatwoods settings with wetlands that have been drained may be a real challenge to the model but getting it right in Bradford and Union Counties is important because of the acreage of the flatwoods and wetlands in these counties.

How was the water control structure for Lake Sampson in Bradford County addressed in the model?

From: Webb Farber [mailto:wfarberh20@gmail.com]
Sent: Tuesday, May 17, 2016 1:30 PM
To: Fatih Gordu <fgordu@sjrwmd.com>
Cc: Patrick Welsh <patwelsh@me.com>; CHANDLER & CAROL ROZEAR <cerozear@gmail.com>; Vivian and Sam Katz <save-our-lakes@comcast.net>; Paul Still <StillPE@aol.com>
Subject: Brooklyn, Geneva Seepage Question

Hello Fatih,

Sorry I was not able to attend last week's NFSEG meeting.

I have looked at the presentation, and noticed the Keystone lakes' range of leakage to the UFA seems to be quite low (page 38) -- "Literature" indication of maximums 13 in/yr for Geneva, and 100 in/yr for Brooklyn. If this is based on the 3 sq-mi and 1 sq-mi areas of the lakes, this would equate to 1.9 mgd for Geneva, and 4.8 mgd for Brooklyn, a total maximum of 6.7 mgd. (Please correct me if this is not based on surface areas.)

Attached are several SJRWMD water budget charts for Brooklyn and Geneva, showing a total of 6,950 ac-ft/yr seepage (2008 conditions). This equates to 6.2 mgd recharge to the aquifer, however during 2008, the lakes were very low, Brooklyn around 88 Ft and Geneva around 85 Ft. These levels are 26 Ft and 20 Ft below the full lakes respectively, and it would be expected that aquifer recharge under such conditions would be far below maximum.

Clarke, in *Hydrology of Brooklyn Lake Near Keystone Heights, Florida,* 1963, p. 37, indicates a net groundwater flow from Brooklyn (1960, with surface outflow) at 9,100 ac-ft/yr, or around 8.1 mgd. Assuming a similar increase compared to 2008 conditions for Geneva, the result is 5.5 mgd net groundwater flow, or a total flow to groundwater of 13.6 mgd for both Brooklyn and Geneva.

Robison, in SJ92-3, *Surface Water Modeling Study of the Upper Etonia Chain of Lakes,* 1992, p. 31, indicates losses to the Floridan Aquifer of 7,845 ac-ft/yr for Brooklyn in 1980 (with downstream outflow). This equates to 7.0 mgd recharge. Assuming similar increase from 2008 for Geneva, the result is 4.7 mgd, totaling 11.7 mgd for both lakes.

These figures (maximums) are much higher than those in the NFSEG presentation. The Clay-Putnam MFLs Group presentation (2013, attached) by Tom Bartol, stating that 11.5 mgd would sustain the lakes at 103 Ft and 110-112 Ft corroborates this recharge potential.

(Note: The figures for Lowry and perhaps Magnolia seem high as I believe Lowry is characterized as a "low recharge" lake in it's adopted MFL report. It has been long accepted that these lakes remain high due to non-recharge to the aquifer.)

Please let me know your thoughts on the difference in the NFSEG estimates. Thanks.

Webb Farber
Save Our Lakes Organization, Inc.

How was diversion of surface from one surface flow basin to another surface flow basin by the DuPont/Chemours mining operations in Bradford, Clay, and Baker Counties addressed in the model?

I thought I heard you say the layer 2 aquifers were not modeled. Can you provide more information about why the layer 2 aquifers were not modeled? How were the layer 2 aquifers addressed in the model? All recharge moves both vertically and laterally through the layer 2 aquifers where they exist so I would think intermediate aquifers would be an important part of any groundwater model.

The SRWMD has a number of monitoring wells in Bradford County that designated as intermediate aquifer wells. These wells should be reevaluated to verify if they are in layer 2 and not layer 1.

With respect to calibration wells, I would suggest that a well with fewer than 5 measurements in total and only 1 or 2 measurements in 2001 or 2009 no be used.

Thanks,
Paul Still