Assessment of the 2008 North Florida Numerical Groundwater Flow Model

Limitations & Implications for Groundwater Resource Management

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January 21, 2014

Prepared for:

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I, Kevin E. Day, P.G., no. 2517, have read and agree with the findings in this report titled *Assessment of the 2008 North Florida Numerical Groundwater Flow Model: Limitations & Implications for Groundwater Resource Management* dated January 21, 2014 and do hereby certify that I currently hold an active professional geology license in the state of Florida. The report describes an assessment of the model construction, calibration, and limitations that bear directly on its application to groundwater resource management in the Suwannee River Basin. The report was prepared by Dr. Todd R. Kincaid & Brent A. Meyer of GeoHydros, LLC. The document and the methods used for the assessment have been reviewed by me and found to be in conformance with currently accepted geologic practices, pursuant to Chapter 492 of the Florida Statutes.

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January 21, 2014
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EXECUTIVE SUMMARY

GeoHydros was originally contracted by Ginnie Springs Outdoors, Inc. to evaluate a regional-scale steady-state equivalent porous media groundwater flow model of north Florida that was developed for the Suwannee River Water Management District (SRWMD) in 2008 by the SDII Global Corporation (NFM-08) and compare the results of that model to the results of a sub-regional scale steady-state hybrid groundwater flow model of the western Santa Fe River basin that GeoHydros had previously completed for Coca-Cola North America in 2008 (WSFM-08).

The stated purpose of the NFM-08 is for use in the evaluation of "the effects of existing and proposed groundwater withdrawals on the aquifers … of the District" primarily to support the evaluation of impacts associated with consumptive use permit applications, and the designation and management of Minimum Flows and Levels. The goal of the WSFM-08 was to accurately simulate karstic groundwater flow patterns to the 1st and 2nd magnitude springs on the Santa Fe River under both low water and high water conditions.

The purpose of GeoHydros' investigation was three-fold: 1) to identify any design issues that would be reasonably expected to diminish the reliability of the model's assessments of impacts to spring and river flows associated with cumulative groundwater pumping in and surrounding the SRWMD; 2) to evaluate the efficacy of the equivalent porous media approach through a comparison of the SDII model results in the western Santa Fe River basin to results obtained from the hybrid model; and 3) to describe the key groundwater modeling processes, reasonable expectations for model quality and disclosure, and the degree to which the NFM-08 meets these expectations.

The NFM-08 was evaluated on the basis of three broadly accepted criteria for quality of a groundwater flow model: 1) the degree to which simulated groundwater levels and flows match real-world conditions; 2) the degree to which the framework of model parameters adheres to a reasonable conceptualization of the hydrogeologic conditions being simulated; and 3) the appropriateness of the mathematical representation of the flow processes. In addition, the supporting documentation was evaluated to determine the degree to which it provides the reader with a complete and transparent understanding of the model development process, all underpinning assumptions, and any limitations that have bearing on the model's intended applications.

The Upper Floridan Aquifer is represented in the NFM-08 as an equivalent porous media, homogenous within 5,000 x 5,000 foot grid blocks, that does not contain conduits though conduits are known to be ubiquitous throughout much of the model domain and to have evolved as a consequence of karstification. Because the model does not address conduit flow, it relies on implausible parameter values to force the porous media groundwater flow equations to simulate observed spring flows and river gains. As a result, the simulated groundwater surface poorly represents observed groundwater levels and local hydraulic gradients.

The NFM-08 was intended to calibrate to average groundwater levels and spring flows occurring between June 1, 2001 and May 31, 2002, however it represents both poorly. SDII defined the model's calibration target as +/- 5% of the total change in observed Upper Floridan Aquifer groundwater levels as measured in 676 wells across the model domain. The NFM-08 Model domain spans the width of the Florida peninsula from South Georgia to southern Marion County. The calibration criterion of +/- 5 feet was only applied to the average of the absolute differences between simulated and observed values at the 676 wells. The resulting criterion is broad relative to the observed variation in groundwater levels during the calibration period, during which groundwater levels in more than 50% of the wells in the SRWMD having at least monthly measurements varied by less than 3 feet.

Application of the chosen calibration criterion allowed widespread and large magnitude differences between observed and simulated groundwater levels across the model domain. Differences at 147 of 534 wells (~28%) within the SRWMD were larger than the 5-foot criterion. Differences at more than 10% of those wells distributed throughout the central Suwannee River and Santa Fe River basins were greater than 10 feet. Where such large-magnitude errors exist, the model cannot reliably predict groundwater level fluctuations and the widespread distribution of large-magnitude errors significantly undermines the reliability of the predictions throughout the model domain.

The model cannot simulate flow to discrete springs as is implied in the SDII report because the resolution of the model is predicated on the use of 5,000 X 5,000 foot grid cells and many of the springs described as correctly simulated fall within a single grid cell. Individual spring flows within a single grid cell were accounted for through the use of multiple conductance terms associated with Drain and River assignments to the grid cells. The conductance terms describe the ability of the streambed at the respective locations to transmit water from the aquifer to the river thereby acting as confining material that separates the springs and rivers from the Upper Floridan Aquifer.

The use of the streambed conductance terms is inconsistent with well-established unconfined conditions of the Upper Floridan Aquifer existing at the majority of the simulated springs. The values assigned during the calibration process are implausible because they equate to the presence of substantial confining material where confining material does not exist. As a consequence and in almost all instances, the match between simulated and observed spring and river flows was achieved at the expense of realistic simulations of groundwater levels at the rivers. The simulated levels deviate from observed values by more than 10 feet along much of the central Suwannee and western Santa Fe Rivers. These deviations were not discussed or disclosed in the report accompanying the NFM-08.

Discrepancies between observed and simulated groundwater levels at the rivers exceeded the 5-foot criterion for matching groundwater levels at more than 50% of the assignments, some exceeding 20 feet. Considering that river stage is known to match the groundwater level in the unconfined portion of the Upper Floridan Aquifer where the rivers flow directly on Upper Floridan Aquifer limestones, these discrepancies raise the average difference between observed and simulated groundwater levels in the SRWMD to 5.6 feet, which violates SDII's criterion for model calibration.

The absence of conduits from the model design required the calibration effort to rely on implausible hydraulic conductivity, recharge, and streambed conductance assignments in order to force the model to approximate hydrogeologic conditions that the underlying mathematical equations were not intended to represent. Hydraulic conductivities deviate from values derived from aquifer performance tests and reported by the US Geological Survey (USGS) by 0.5 to 2.6 orders of magnitude across much of the model domain. Assigned recharge distributions fail to correlate to precipitation or documented land use. The magnitude of assigned recharge results in simulated groundwater discharge to rivers and streams that flow to the Gulf of Mexico that exceeds measured values by between 300 and 950 cfs, or when compared to sub-watershed scale discharge, exceeds measured values by between 231 and 750 cfs. The streambed conductance terms imply the existence of confining material in the unconfined part of the aquifer that does not exist. As a consequence of implausible parameter values, the model violates the assumptions underpinning the groundwater flow equations with which it was constructed throughout approximately half of the model domain including much of the Suwannee River basin.

The model under-estimates the measured impacts to Upper Floridan Aquifer groundwater levels from municipal groundwater pumping at two locations evaluated, the City of Gainesville and Fernandina Beach, by more than 30 feet in both cases. The model under-estimates the capture zone for City of Gainesville's well field by more than 100 square miles, and it fails to accurately simulate documented groundwater flow paths to the Santa Fe and Ichetucknee Rivers.

Model boundaries were not designed or assigned according to standard practices that focus on limiting the degree to which simulated pumping is derived directly from external model boundaries. Approximately 38% of the simulated flow through the UFA is to external model boundaries (24% to the general head nodes defining the southern model boundary, and 14% to the constant head nodes defining the Gulf of

Mexico boundary). Removing the assigned pumping (not including wells used to represent river siphons) revealed that the boundary conditions permit more than 40% of the simulated well extractions to intercept flow that would otherwise be to the external boundaries (35.5% to the general head nodes representing the southern boundary, and 5.1% to the constant head nodes representing the Gulf of Mexico). These boundary condition effects are not disclosed in the NFM-08 report and the associated limitations on the model's ability to reliably predict impacts to groundwater levels or flows have therefore not been disclosed to readers or model users.

These problems reveal that the NFM-08 is poorly constructed and not reliable for its stated purpose. Furthermore, the model report is misleading because it does not disclose the necessary information for readers or model users to indentify the degree to which the model fails to meet these criteria.

With respect to the technical practicability of improving on these model limitations, comparisons of the NFM-08 (equivalent porous media model) to the WSFM-08 (hybrid model that includes conduits) reveal substantial differences that are consequential to groundwater resource management decisions. The hybrid model, in which the UFA was simulated as a dual-permeability framework consisting of conduits embedded in a porous media, achieved substantially better matches to observed groundwater levels and spring flows under both low-water and high-water conditions where the improvement stemmed from significantly different simulations of groundwater flow patterns and velocities. Where the NFM-08 failed to simulate tracer defined groundwater flow paths, the hybrid model accurately did so. Where the NFM-08 failed to match tracer-defined groundwater velocities, the hybrid model accurately did so. And, where the NFM-08 used unrealistically high hydraulic conductivities, resulting in an inability to simulate observed impacts to groundwater levels derived from municipal groundwater pumping in areas such as Fernandina Beach and the Gainesville municipal well field, the substantially lower hydraulic conductivity values used in the hybrid model support the simulation of much larger simulated drawdowns in the aquifer matrix that are more consistent with observed conditions.

These discrepancies demonstrate that the equivalent porous media approach is incapable of adequately simulating the patterns of groundwater flow to springs and therefore the impacts of groundwater pumping on those flow patterns. Moreover, the fact that the hybrid model was constructed with commercially available, widely used software as well as publically available datasets demonstrates that the decision to use and rely on equivalent porous media assumptions and methods cannot be argued to be based on technological impracticability.

In summary, the flaws in the NFM-08 and the manner in which it is being used by the SRWMD identified through this investigation impart substantial limitations on the model's assessments of the magnitude and spatial distribution of impacts to spring and river flows associated with current and future groundwater extractions. The limitations have direct bearing on water management district consumptive use permit application review processes and Minimum Flows and Levels programs. The most relevant conclusions in this regard are: 1) the NFM-08 is poorly constructed and fails to meet broadly accepted measures of quality, and therefore cannot be reliably used to simulate or predict impacts to groundwater flows and levels created by groundwater extractions within or surrounding the SRWMD; 2) the approach and software used for the NFM-08 do not represent the best available technology; 3) alternative methods and software could be, and could have been leveraged to build a better model that provides substantially more reliable predictions; and 4) by using the NFM-08, the SRWMD is not pursuing a reasonably conservative approach to the characterization and mitigation of impacts to spring and river flows associated with groundwater withdrawals.

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ABBREVIATIONS & DEFINITIONS

ACEPD	Alachua County Environmental Protection Department
BMAP	Basin Management Action Plan
CCNA	Coca-Cola North America
CFS	cubic feet per second
CUP	Consumptive Use Permit
DF	Douglas Farm
ET	evapotranspiration
FGS	Florida Geological Survey
FLDEP	Florida Department of Environmental Protection
GIS	Geographic Information System
GOM	Gulf of Mexico
GPD	gallons per day
GSO	Ginnie Springs Outdoors LLC
Hydraulic Conductivity	A description of the capacity of a material to transmit water. The volume of water at a given kinematic viscosity that will move in unit time under a unit hydraulic gradient (45°) through a unit area measured at right angles to the direction of flow.
IAS	Intermediate Aquifer System – primarily functions as a confining unit that separates the Upper Floridan Aquifer from the Surficial Aquifer System throughout roughly the eastern half of the peninsula and northern half of the panhandle in north-central Florida
LFA	Lower Floridan Aquifer

MCU	middle confining unit separating the lower Floridan aquifer from the upper Floridan aquifer
MFL	a regulatory program designed to establish and maintain Minimum Flows and Levels in designated Florida water bodies including lakes, rivers, and springs.
MGD	million gallons per day
NFM-08	a 3D finite-difference equivalent porous media groundwater flow model of north Florida developed by the SDII Global Corporation for the SRWMD
NWFWMD	Northwest Florida Water Management District
PEST	Parameter Estimation (typically the algorithm that performs parameter estimation)
QA	Quality Assurance
SAS	Surficial Aquifer System – comprised primarily of sand and other sediments deposited over top of the rocks comprising the Intermediate Aquifer System and in some locations also the Upper Floridan Aquifer. This unit is typically only modeled as a distinct aquifer only where it is present over the Intermediate Aquifer System.
SJRWMD	St Johns River Water Management District
SRWMD	Suwannee River Water Management District
SWFWMD	Southwest Florida Water Management District
UFA	Upper Floridan Aquifer
WSFM-08	a finite-element hybrid groundwater flow model developed for the western Santa Fe River basin by GeoHydros LLC for Coca-Cola North America.

1 INTRODUCTION

1.1 Background

GeoHydros was originally contracted by Ginnie Springs Outdoors, Inc. (GSO) to evaluate a regional-scale steady-state groundwater flow model that was developed for the Suwannee River Water Management District (SRWMD) in 2008 by the SDII Global Corporation (SDII). Despite the presence of numerous springs, caves, swallets, and sinkholes in the SRWMD, [1,2,3,4,5,6,7] the model was based on an assumption that the Floridan aquifer in north-central Florida is a porous media meaning that karstic conduits were considered to be either non-existent or not significant. [8] The SRWMD is currently using the SDII model to determine potential impacts of groundwater pumping on aquifer water levels and spring flows as part of their permitting process for new consumptive use permit applications and in the development and implementation of minimum flows and levels (MFLs) for the lower Santa Fe and Ichetucknee Rivers. [9,10]

GSO is a private recreational park encompassing eight springs on the western Santa Fe River of north-central Florida. The owners of GSO also own and operate the Seven Springs Water Company, which leases access to groundwater supply wells that intercept the spring discharge for the purpose of water bottling. The group of spring vents managed by GSO and from which the Seven Springs Water Company derives its water are: 1) Twin spring, 2) Deer spring, 3) Dogwood spring, 4) Ginnie spring, 5) Devil's Ear spring, 6) Devil's Eye spring, 7) Little Devil's spring, and 8) July spring (Figure 1). Both business entities have an interest in preserving the quantity and quality of the water discharging to this group of springs on the western Santa Fe River, which will be called the Ginnie Springs Group in this report. GSO has recognized persistent declines in spring and river flows in the western Santa Fe river basin, as well as a rapid increase in the amount and distribution of algae covering the substrate in the spring runs and river channel presumably due to elevated nitrate concentrations, both of which GSO perceives as a threat to their business interests.

The District used SDII's model to evaluate the potential impact to spring and river flows along the Santa Fe River associated with a consumptive use permit (CUP) application filed by Joshua Moore on behalf of the Richard Douglas Farm, which is located less than 1 mile from Ginnie Springs (Appendix 1). The District granted a temporary permit to the Douglas Farm for an average groundwater pumping rate of 23,600 GPD in 2012 [11] and a final permit for an average daily groundwater pumping rate of 37,800 GPD and a maximum daily groundwater pumping of 1.44 MGD in 2012 [12] (Appendix 2). The water is to be mixed with fertilizers and used to grow vegetable crops during one or more growing seasons annually.

Given the addition of a groundwater user in such close proximity to the Ginnie Springs Group and the stated purpose of the water to support heavily fertilized agriculture, GSO's specific concerns are 1) that the operation of the Douglas Farm well will significantly degrade water quality at Ginnie Springs, the Santa Fe River, and the permitted Seven Springs Water Company production wells; 2) that the operation of the Douglas Farm well will progressively diminish the flow of groundwater to these entities; and 3) that the management of groundwater in the western Santa Fe River basin is not adequately protecting the quantity and quality of groundwater discharge to the Ginnie Springs and the Santa Fe River. GSO solicited this evaluation to understand and report on limitations of the SDII model that would likely affect District or State assessments of the impacts of groundwater pumping on spring and river flows in the basin as well as any indirect assessments of the vulnerability of springs to contamination arising from the increased application of nitrogen-based fertilizers in the western Santa Fe River basin.

GSO selected GeoHydros to perform this work because of previous modeling work that GeoHydros performed for Coca-Cola North America (CCNA) between 2004 and 2009. That work centered on the development of a groundwater flow model for the western Santa Fe River basin that specifically addressed karstic features such as caves, conduits, and swallets that are known to impart significant hydraulic controls on groundwater flow to springs in the basin. Prior to 2010, CCNA operated a water bottling facility in the western Santa Fe River basin that relied on groundwater leased from the Seven Springs Water

Company. They chose to pursue the development of such a model because they identified their western Santa Fe River basin facility as one of their most at-risk facilities world-wide through an internally performed risk assessment. CCNA attributed the risk to: 1) the significance of karst features to groundwater flow patterns in the basin, 2) the likelihood that the quantity and quality of the groundwater within the Ginnie Springs basin would become impacted by increased groundwater extractions and an increased use of nitrate fertilizers in the basin; and 3) the absence of consideration of karst features from the groundwater quantity and quality management strategies being used by the relevant management entities.

CCNA intended the model to be released to the public such that it could contribute to improvements to groundwater management strategies. The model was completed in 2008. An exhaustive review of the model construction and results [13] was presented to representatives of the SRWMD, the St John's River Water Management District (SJRWMD), the Florida Department of Environmental Protection (FDEP), the US Geological Survey (USGS), and the INTERA Corporation in August 2009. CCNA offered the model to the SRWMD and the FDEP free of charge during that meeting. The SRWMD did not accept the offer but the FDEP requested several forms of the model output that have since been incorporated into their Basin Management Action Plan (BMAP) for the Santa Fe River basin. In April 2013, the SRWMD formally requested the model from CCNA who approved the request. GeoHydros made the model available to the SRWMD for download in May 2013.

1.2 Scope of Work

The scope of work for this investigation provided for:

1) an evaluation of the groundwater flow model developed for the SRWMD by SDII;
2) a comparison of that model to the model GeoHydros developed for CCNA (Figure 1); and
3) the development of this report.

1.3 Groundwater Models

Groundwater models are sophisticated tools that are used to predict how manmade and/or natural changes to a hydrologic system will affect the quantity and/or quality of groundwater discharge to water bodies and wells. To achieve this purpose, groundwater models incorporate a wide range of data and subjective interpretations and assumptions describing the fundamental components of a groundwater flow system. Groundwater models have come to provide the foundation for all manners of environmental impact assessments related to groundwater (and surface water) resources including the prediction of impacts to groundwater levels and spring and river flows related to groundwater pumping, Minimum Flows and Levels designations, contaminant transport predictions and contaminant remediation design.

The degree to which subjective terms and controls are incorporated into groundwater models is typically substantial and necessitated by a lack of available data with which all necessary model parameters and design features can be directly defined. Given this subjectivity and the relative importance of model results and predictions to water resource management decisions, prominent groundwater modelers and scientific entities have published guidelines for model development, the determination of quality and therefore reliability, and for the documentation of the model development and results such that transparency with regard to both the data and subjective controls used to define a model can be assured. [14,15,16,17,18] In the face of both growing demands for groundwater resources and mounting groundwater quality and quantity issues, selection of modeling tools that accurately simulate existing conditions and therefore reliably predict future conditions is critical to sound regulatory and management decisions.

1.4 Purpose

The purpose of this investigation was four-fold. The primary purpose was to deconstruct SDII's groundwater flow model and identify any design issues that can be reasonably expected to diminish the model's ability to assess impacts to spring and river flows associated with cumulative groundwater pumping in and surrounding the SRWMD. A second purpose was to compare the SDII model, which represents an equivalent porous media modeling approach applied to the UFA, against the GeoHydros model, which represents a hybrid approach that addresses both porous media flow and conduit flow. This comparison is intended to identify substantive differences that could impact groundwater resource management decisions, and address the practicability of such an approach. Finally, and most broadly, the purpose was to describe the key groundwater modeling processes and reasonable expectations for model quality and disclosure, and the degree to which SDII's model meets those expectations.

1.5 Document Overview

This document is comprised of 9 sections. Sections 2 and 3 are intended to provide the non-technical reader with the necessary background to understand the technical aspects presented in the subsequent sections. Section 2 defines the key hydrogeologic concepts and parameters that are incorporated into groundwater flow models. Section 3 describes the key components of any groundwater flow model and some of the considerations and limitations related to those components.

Sections 4, 5, and 9 present the results of the deconstruction and evaluation of SDII's model and an evaluation of the supporting documentation in terms of the degree to which reasonably identifiable problems were disclosed and the associated limitations on the model's reliability were discussed. Section 4 describes: 1) how each of the key model components discussed in Section 3 were defined in the SDII model; 2) how the chosen definition compares to data; and 3) the effect of the chosen definition on the model's ability to accurately simulate groundwater flow patterns in the Floridan aquifer as well as its ability to reliably achieve its intended purpose. Section 5 discusses the degree to which critical model limitations were disclosed and discussed in the report supporting the model development and results. Section 9 provides the figures that are referenced in Sections 4 and 5, which are intended to be evaluated as they are referenced in the text but also as stand-alone items that can be used independently to disseminate the particular concepts depicted. They have been provided in an independent section to facilitate such use. It is recommended that the reader print or open the figures separately such that they can be viewed and evaluated alongside of the text.

Section 0 describes how the GeoHydros model was constructed, presents some of the most significant results related to groundwater resource management, and also compares the GeoHydros model to the SDII model in order to explore the limitations of the equivalent porous media modeling approach and the technical practicability of using a different approach that addresses conduit flow. Readers interested in a more in-depth description of the GeoHydros model are referred to the technical presentation described in Section 1.1 [13], which provides an overview of how the model was constructed and how all of the required model parameters were defined. All of the key findings discussed in Sections 4, 5, and 6 are summarized in Section 7, which also provides conclusions drawn from the individual analyses.

It is recommended that the non-technical reader print or open Sections 2 and 3 independently such that the supporting descriptions of key groundwater and groundwater modeling concepts can be easily referenced while reading Sections 4 through 7. To the extent possible, the vernacular used in this report is intended to represent the respective groundwater and modeling concepts in non-technical terms. As a result, the technical reader will see some variations in terminology, such as “groundwater surface” as opposed to “potentiometric surface.” It is hoped that the technical readers will abide such discrepancies in recognition of their intent.

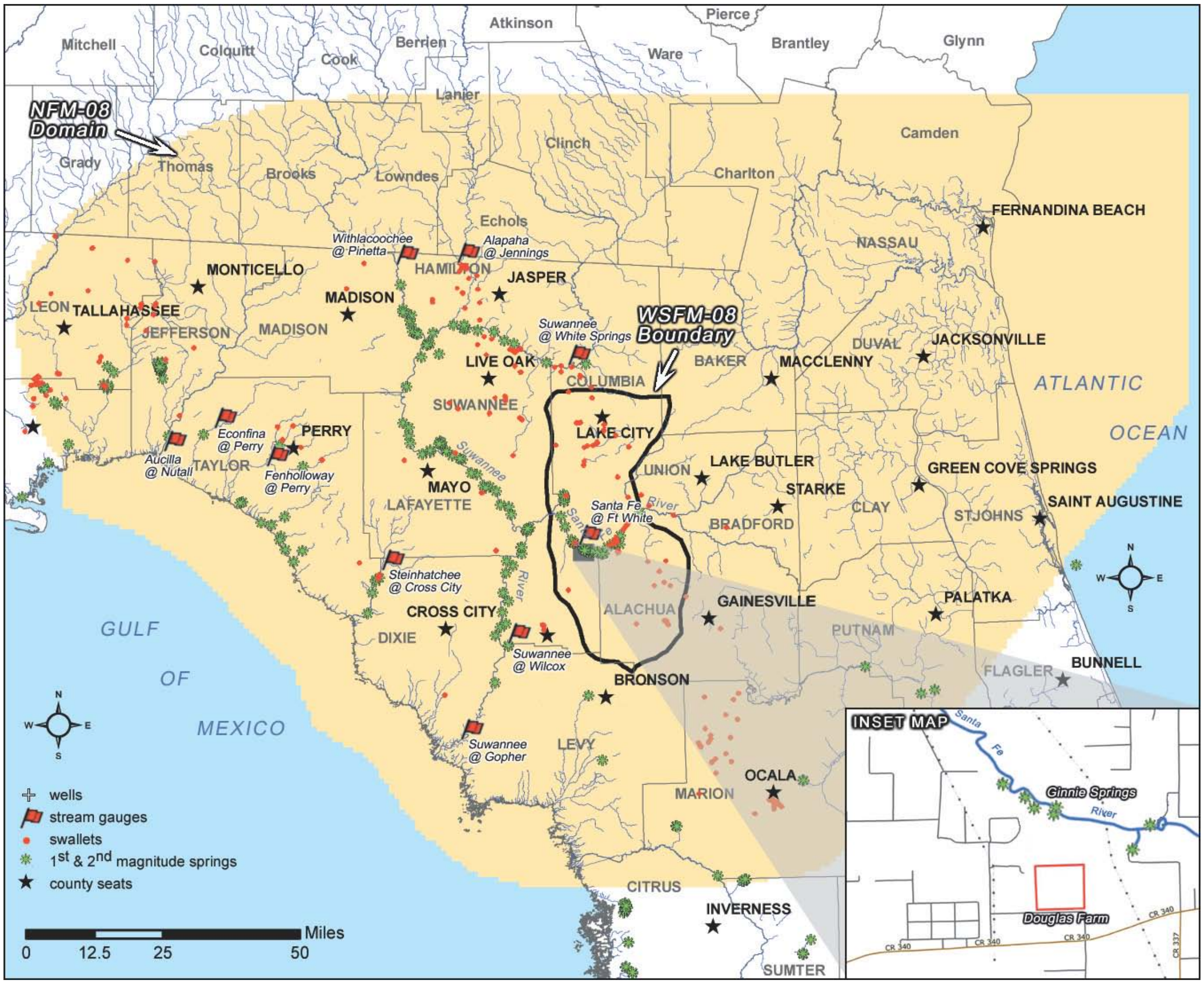

Figure 1. Location Map and Relevant Groundwater Model Boundaries.

Map showing the orientation of the groundwater model boundaries relevant to the characterization and management of groundwater discharge to Ginnie Springs located on the Western Santa Fe River, Florida relative to location of the Douglas Farm property, the Seven Springs Water Company production wells, and the springs, swallets, and stream gauges relevant to this study.

2 RELEVANT GROUNDWATER PRINCIPLES

2.1 Springs

Table 1. Spring Magnitude Classification

Magnitude	Average Flow (cfs)	Average Flow (gpd)
1	100 or more	64.6 million or more
2	10 – 100	6.46 – 64.6 million
3	1 – 10	646,000 – 6.46 million
4	0.22 – 1	142,000 – 646,000
5	0.02 – 0.22	14,200 – 142,000
6	0.002 – 0.02	1,420 – 14,200

- from Meinzer, 1927

Springs are points where underground water emerges onto the Earth's surface. [19] Though this definition is inclusive of any form of natural groundwater discharge, the springs of Florida are most often associated with discrete points of large-magnitude discharge from a conduit created by the dissolution of limestone (Figure 2). Some springs are singular vents through which large quantities of water discharge to the land surface (e.g. Wakulla Spring and Manatee Spring) while others are comprised of several separate vents (e.g. Spring Creek Springs and Silver Springs). Springs are classified by the magnitude of their discharge where a 1st magnitude spring is the largest and higher numbers denote progressively smaller discharges (Table 1). [20] Ginnie spring is a 2nd magnitude spring that discharges water from a discrete vent into the Santa Fe River. The group of eight vents comprising the Ginnie Springs group is classified as a 1st magnitude discharge because the aggregate flow is greater than 100 cfs.

The magnitude of spring flow is controlled by: 1) the amount of water entering the aquifer (*recharge*) within the region from which the spring draws water *(its springshed);* 2) the amount of groundwater extractions; 3) the ability of the aquifer to convey water *(its permeability or sometimes called hydraulic conductivity or transmissivity)*; and 4) the slope of the groundwater surface (*hydraulic gradient*) within the springshed. Recharge occurs as some combination of infiltration of rainfall directly into the aquifer where the aquifer rocks are exposed at the land surface, infiltration through rocks and sediments that overly the aquifer, and stream flow that is conveyed directly into the aquifer through karst features called swallets (Figure 2).

2.2 Hydraulic Gradient

Hydraulic gradient is a term used to describe the slope of the groundwater surface. It is the difference between the highest part of the surface and the elevation of the spring boil divided by the distance between those locations (Figure 2). Where the aquifer is confined by overlying lower permeability rocks or sediments, the groundwater surface is called the potentiometric surface. Where the aquifer is unconfined, the groundwater surface is called the water table surface. When aquifer recharge exceeds its discharge, the groundwater surface rises resulting in steeper hydraulic gradients. The groundwater surface falls and hydraulic gradients flatten when discharge exceeds recharge.

In confined regions, the potentiometric surface can rise above the top of the aquifer creating a pressurized flow system whereas in unconfined regions, wetlands expand or are created when the water table surface rises above the top of the aquifer. When the potentiometric surface falls, the hydraulic gradient flattens, pressure is reduced, and the buoying effect of the groundwater diminishes resulting in an increased probability of sinkhole formation due to collapse of caves and cavities in the aquifer. When the water table surface falls, the hydraulic gradient flattens and wetland areas shrink. Spring flows diminish when either form of the groundwater surface falls. Spring flows will stop when either the groundwater surface becomes flat or when even a sloping surface drops below the elevation of the spring vent.

2.3 Springsheds

Spring flow originates as recharge through the land surface in the form of infiltration through the rocks and soils covering the aquifer and in some cases through karst features called swallets that direct all or part of stream or river flow directly into the aquifer (Figure 2). The land area that collects the water that recharges the aquifer and comprises a spring's flow is called its springshed (Figure 3). Springsheds feeding springs that derive part of their flow from swallet recharge are divided into groundwater and surface water components whereas springsheds that do not contain swallets have only the groundwater component.

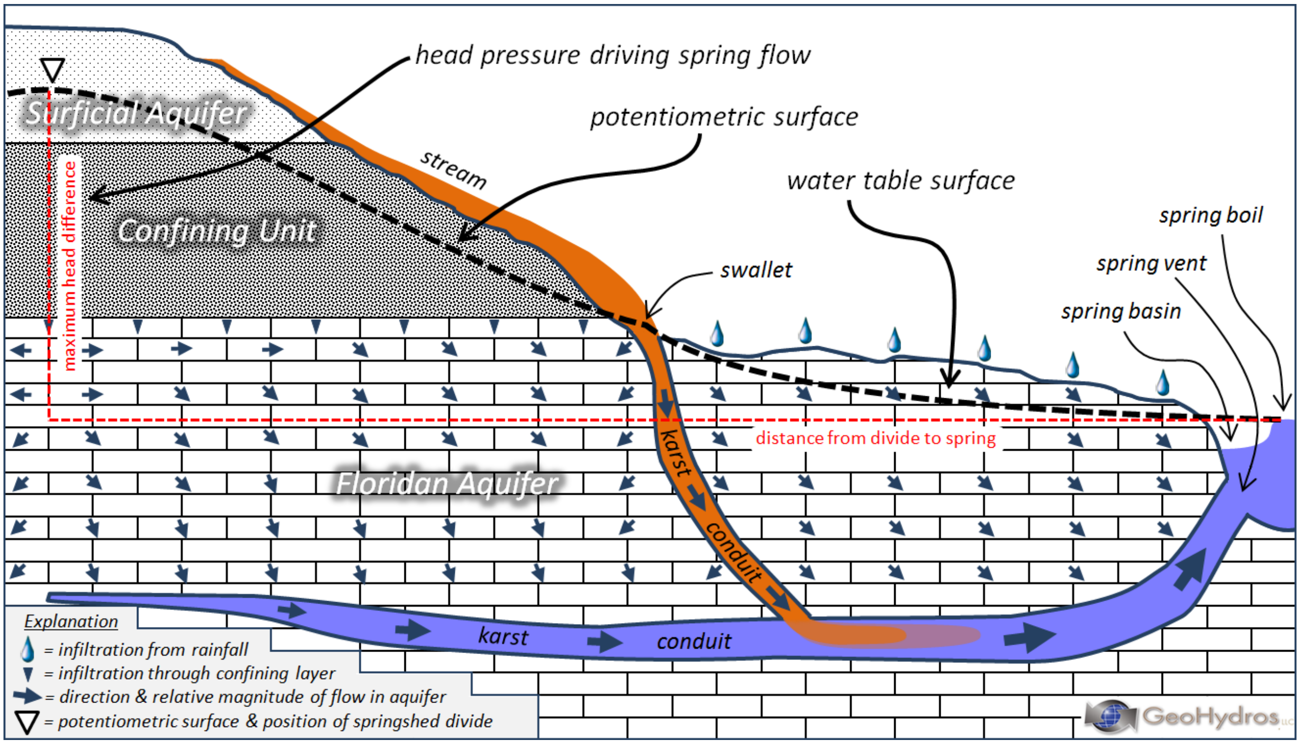

Figure 2. Spring Flow Diagram

Florida springs are fed by recharge entering the aquifer by infiltration and, in many cases, swallets that convey stream flow into the aquifer. Both types of recharge are collected by conduits dissolved out of the limestone rocks that connect to the spring vents. The amount and distribution of recharge establishes the hydraulic gradients and springshed boundaries that dictate the magnitude of spring flow.

The groundwater component of a springshed comprises the region of the aquifer in which the hydraulic gradients are toward the spring. Those surfaces are defined by developing contour maps from groundwater elevation data. Such data is most often collected from wells but can be inclusive of lake, river, and spring water surface elevations. Maps derived from that data are then used to identify divides between adjacent groundwater basins. The basin containing the spring in question is the groundwater component of its springshed (Figure 3).

The accuracy and resolution of groundwater basin divides are dependent on the number, location, and accuracy of groundwater elevation measurements, and the continuity of the aquifer material. Sand aquifers tend to have consistent aquifer properties and can therefore be confidently characterized by relatively sparse groundwater elevation datasets. On the contrary, karst limestone aquifers are highly heterogeneous due to dissolution and the presence of conduits. Reliable basin delineations in karst aquifers are therefore considerably more dependent on the density of the groundwater elevation datasets and the interpolation method(s) used to define groundwater elevation maps.

Groundwater basin boundaries are not static. Their location and orientation can vary significantly, particularly in regions where the groundwater surface is nearly flat. Changes can result from any forces that impact the surface including variations in rainfall, land surface modifications that change the location and/or rate of recharge, and groundwater pumping. The highest elevation springs will tend to be the most impacted by boundary changes resulting from depressed groundwater surfaces because the slope of the surfaces will always tend to favor lower elevation discharges. Boundaries can also change as a result of excessive recharge and flooding if the capacity of one spring to discharge, or the capacity of the conduit(s) connecting to that spring is exceeded resulting in overflow into an adjacent spingshed. [21]

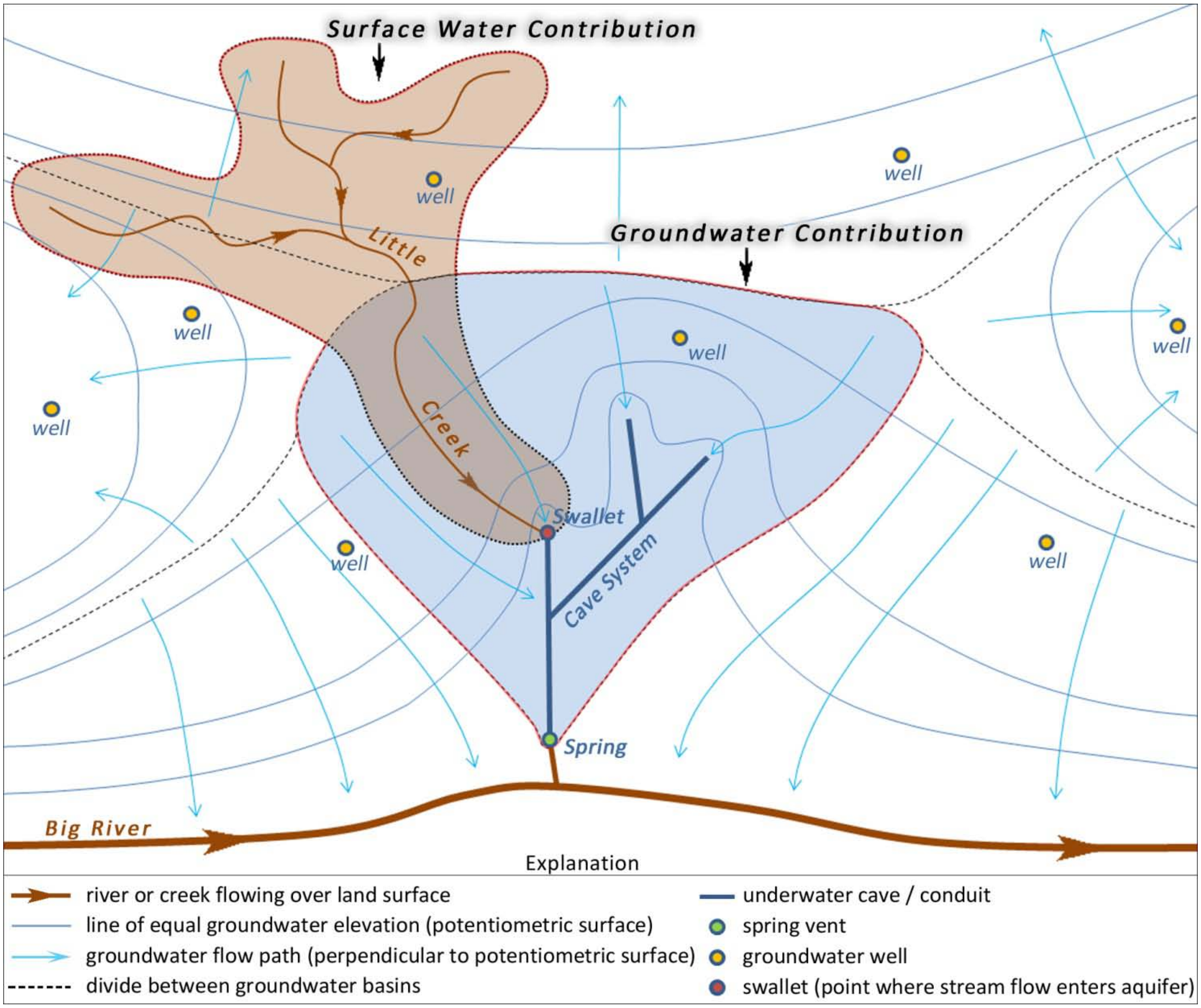

Figure 3. Springshed Diagram

Delineation of groundwater and surface water components of a springshed. The groundwater component is defined by delineating divides between groundwater basins on a map contouring groundwater elevation data (potentiometric or water table surface map). The surface water component only applies to springs that derive part of their flow from swallets and is defined by delineating boundaries for the watershed(s) contributing runoff and stream flow to the swallet(s) from topographic maps.

The surface water component of a springshed comprises the entirety of the watersheds that contribute runoff and stream flow to swallets (Figure 3). Reliably delineating the surface water component of a springshed requires knowledge of the swallets that contribute flow to the spring and then a comparably simple delineation of the topographic divides that create the swallet's watershed boundaries. Knowledge of the swallets requires first that all of the swallets in a basin be identified and then that they are correctly associated with the spring or springs that receive their flow. The former has been done to varying degrees by the Florida Geological Survey [5] and the Florida Water Management Districts. The latter can be more challenging because it is not always possible to confidently delineate groundwater basin boundaries in swallet regions from available groundwater elevation data. In such cases, artificial groundwater tracing provides the most definitive method of associating swallets and springs. [5,22,23] Surface watershed boundaries are ostensibly static except where the land surface becomes physically modified. The fate of swallet recharge is however susceptible to changes in the boundaries of the groundwater basins into which the swallets flow.

2.4 Aquifer Permeability

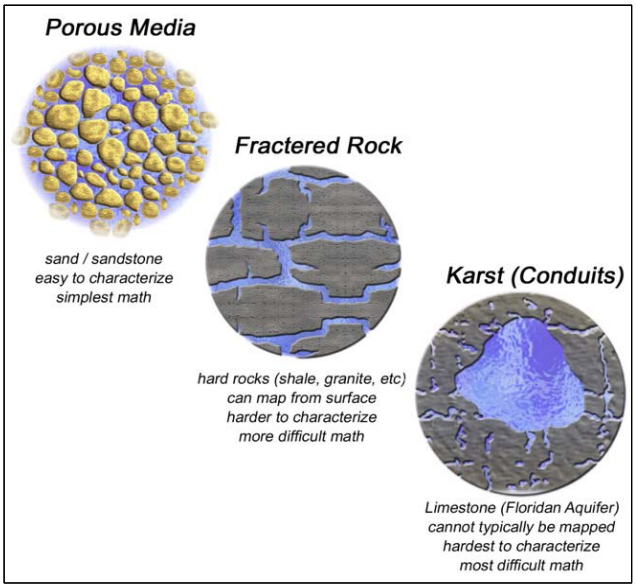

Figure 4. Aquifer Permeability Types

Porous media aquifers are those in which flow occurs through void spaces between rock or sediment grains as in sand. Fractured rock and karst aquifer are those in which flow primarily occurs through continuous open spaces created by fractures or conduits. The Upper Floridan Aquifer contains a combination of conduits and porous media type void spaces.

Permeability is a term used to describe the capacity of a material to transmit a fluid. Two related terms, *hydraulic conductivity* and *transmissivity*, are used to describe the capacity of an aquifer to transmit groundwater. Both terms apply to a type of aquifer that can be classified as a porous media, in which water travels through void spaces between rock or sediment grains. Fractured rock and karst are other types of aquifers in which groundwater flow occurs predominantly through continuous open spaces created by fractures or dissolved conduits (Figure 4). The most common aquifer characterization methods, flow equations, and numerical modeling methods are based on an assumption that the aquifer is a porous media. Where an aquifer framework deviates from a porous media, those equations and methods become invalid and can produce erroneous estimations of groundwater flow behavior and response.

The term hydraulic conductivity describes the rate of groundwater flow through a unit area of aquifer (i.e. a 1-foot by 1-foot square) under a unit hydraulic gradient (i.e. a groundwater surface sloping downward at 45°). Hydraulic conductivity is higher and therefore groundwater flow can be faster in aquifers comprised of larger grains, which have larger voids between the grains. Silt has a lower hydraulic conductivity and slower potential flow than sand, which has a lower hydraulic conductivity and slower potential flow than gravel (Figure 5, A & B). In any aquifer with a given hydraulic conductivity, groundwater flow will be faster under higher hydraulic gradients, i.e. steeper groundwater surfaces (Figure 5, C). The term transmissivity describes the same property as hydraulic conductivity but pertains to a unit width of the entire aquifer thickness and is only relevant to 2-D groundwater flow models. [24]

Hydraulic conductivity values for various rock and sediment types characteristic of porous media have been measured in laboratories and the values compiled in text books (Table 2). [24,25,26] Transmissivity values have been estimated from field-scale aquifer performance tests for a wide variety of porous media, fractured rock, and karst aquifers. The tests are performed by adding water to or removing water from the aquifer and measuring the resulting change in the groundwater surface and the time required for it to return to its pre-test level. The observed permeability of most aquifer materials increases as the scale of the test increases, which is considered to be the result of the increased probability of intersecting discrete higher-than-average permeable pathways. [27,28] As the aquifer type transitions from porous media to fractured rock and karst, scale dependence of permeability increases and the discrete pathways come to dominate groundwater flow patterns and velocities. [29,30,31]

Transmissivity values derived through field testing for rocks typical of fractured rock and karst aquifers are often much higher (10x, 100x, 1000x, or more) than those for rocks characteristic of porous media. [24,25,32] In those aquifers, the estimated transmissivity values are not reflective of the inter-granular void spaces, but are instead, a measure of the capacity of that space plus any connected and/or nearby fractures or conduits to transmit water. The published values are often used as a guide in the development of numerical groundwater flow models to constrain the magnitude of the values that get assigned where the actual values are typically derived through a process called model calibration (Section 3.4).

2.5 Aquifer Storage

Aquifers are bodies of rock or sediment that hold and transmit appreciable amounts of water. The amount of water that an aquifer can hold and transmit is defined as its storage and is a function of the porosity of the rocks or sediments comprising the aquifer where porosity is defined as the percentage of void spaces comprising the aquifer material. Aquifers comprised of higher porosity rocks or sediments can hold more water in storage than aquifers comprised of lower porosity material.

Aquifers release water from storage when the groundwater surface is lowered. Where aquifers are unconfined (i.e. not covered by low permeability material - Figure 2) water is released from storage due to dewatering of the pore spaces, whereas in confined parts of an aquifer, where the groundwater surface is above the top of the aquifer, the release from storage is due to a decline in pressure. Depressions in the groundwater surface arise as a consequence of lower than average precipitation (and thus recharge) and as a consequence of pumping from wells.

Aquifer storage increases when recharge is greater than discharge as for instance during periods of higher than average precipitation. Where an aquifer is unconfined, maximum storage is achieved when the groundwater surface reaches the top of the aquifer (typically at or near the land surface). Where an aquifer is confined, maximum storage occurs when the groundwater surface rises to meet the elevation of the groundwater surface in the overlying recharging aquifer.

2.6 Groundwater Pumping

Groundwater is the major source of freshwater for nearly all applications in Florida. The primary uses in the study area are agricultural irrigation and public/domestic supply. The majority of the water used for these purposes comes from the Floridan aquifer. Groundwater use typically occurs in the form of pumping from wells that are open to the Floridan aquifer.

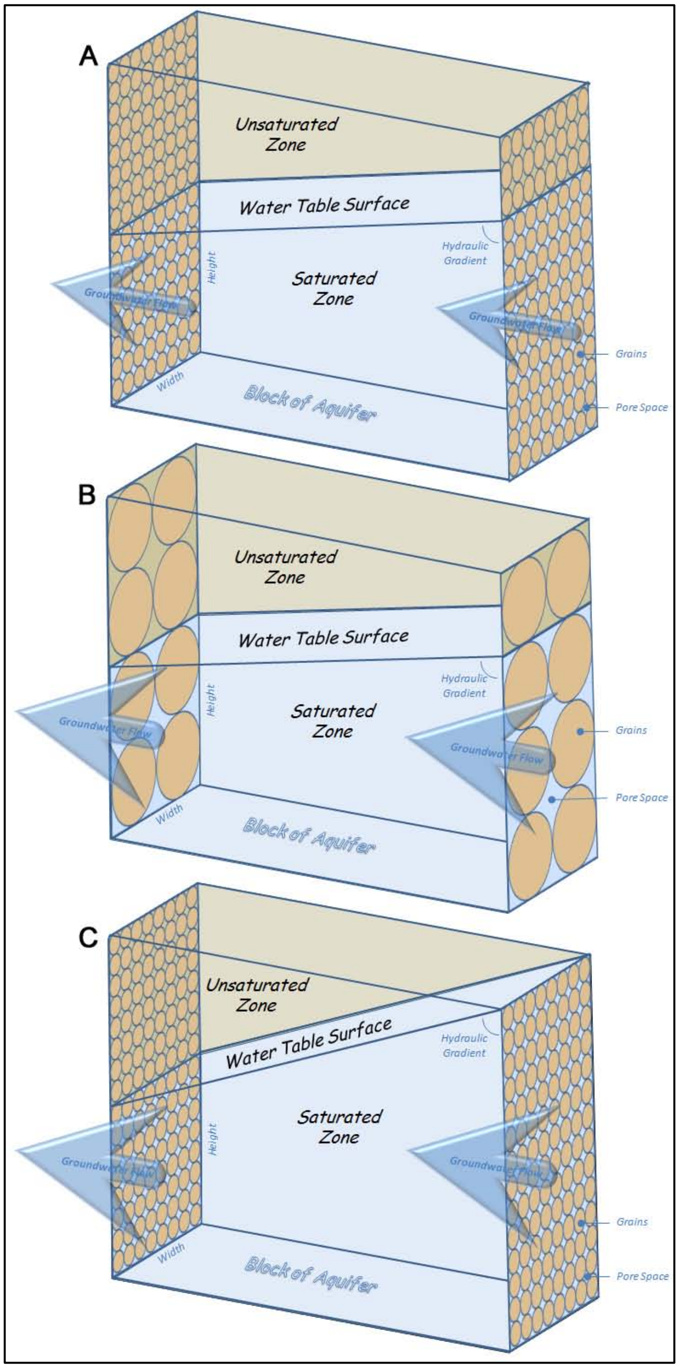

Figure 5. Aquifer Permeability and Groundwater Flow

The rate of groundwater flow through an aquifer is dependent on the aquifer permeability and the hydraulic gradient (slope of the groundwater surface). Under the same hydraulic gradient, aquifers comprised of larger grains will allow faster flow (A) and (B). Similarly, for a given aquifer permeability, flow will be faster under steeper hydraulic gradients (C).

Extracting water from the Floridan aquifer causes a depression in the groundwater surface that directs groundwater flow toward the point of extraction (Figure 6). The depression is typically called a “cone-of-depression” though its actual shape is not necessarily uniform. The area over which the ground-water surface is impacted by extraction is typically called the “zone-of-influence.” The extent and depth of both the cone-of-depression and the zone-of-influence are dependent on the magnitude of the extraction and the permeability of the aquifer. Larger impacts are associated with larger extractions but also lower permeability zones. [24] Impacts are larger in lower permeability zones because a larger area of the aquifer must be drained to supply a desired extraction rate than would be necessary in higher permeability zones. Spring flows are reduced as a consequence of groundwater pumping when the groundwater surface within a springshed falls and when the size of the springshed becomes reduced.

The impacts of groundwater extractions on groundwater levels in the Floridan aquifer have been substantial, particularly in regions where the aquifer is confined and the extractions are large. For example, reported groundwater level declines due to extraction range from approximately 10 feet in Orange County, 20-26 feet in Duval County, 12-28 feet in Clay County, more than 15 feet in northeast Columbia County, 40 feet in Alachua County, 15-40 feet in Polk County, and more than 80 feet in Okaloosa County. [33,34,35,36,37] In most cases, the authors report declines in potentiometric or water table surfaces to be widespread encompassing large regions of the counties in which the major extractions are or have occurred as well as all or parts of adjacent counties where groundwater extractions are substantially lower.

Table 2. Representative hydraulic conductivity values for various material types.

	Material	Hydraulic Conductivity (ft/day)	
Sediments	gravel	85	8,504
	coarse sand	0.3	1,701
	medium sand	0.3	142
	fine sand	0.06	57
	silt, loess	0.0003	6
	till	0.0000003	0.6
	clay	0.0000002	0.001
Sedimentary Rock	karst and reef limestone	0.3	5,669
	limestone, dolomite	0.0003	2
	sandstone	0.00009	2
	siltstone	0.000003	0.004
	salt	0.0000003	0.00003
	anhydrite	0.0000001	0.006
	shale	0.00000003	0.0006
Crystalline Rock	Permeable basalt	0.1	5,669
	fractured igneous/metamorphic rock	0.002	85
	weathered granite	0.9	15
	weathered gabbro	0.2	1
	basalt	0.000006	0.1
	unfractured igneous/metamorphic rock	0.000000009	0.00006

- from Domenico & Schwartz, 1990 [26]

2.7 Water Budget / Mass Balance

A water budget is, as the name implies, an accounting of all inflows and outflows entering and leaving a water body, such as a lake, watershed or aquifer. The basis for a water budget analysis is the hydrologic equation (*Inflow* = *Outflow* ± *Changes in Storage*), which is a fundamental equation in the study of hydrology and a simple statement of the law of mass conservation. [25]

The hydrologic equation essentially states that once the aquifer equilibrates to any given set of conditions, the sum all outflows must equal the sum of all inflows. With respect to groundwater pumping, the hydrologic equation states that the magnitude of all groundwater extractions must result in an equal depletion of natural discharge. Reductions in natural discharge due to extraction occur as a result of either a direct interception of flow and/or a reduction in hydraulic gradient. An example of direct interception would be a well that intersects a spring's conduit network. Spring flow reductions due to decreased hydraulic gradient occur when groundwater pumping causes a regional and sustained depression in groundwater surface elevations.

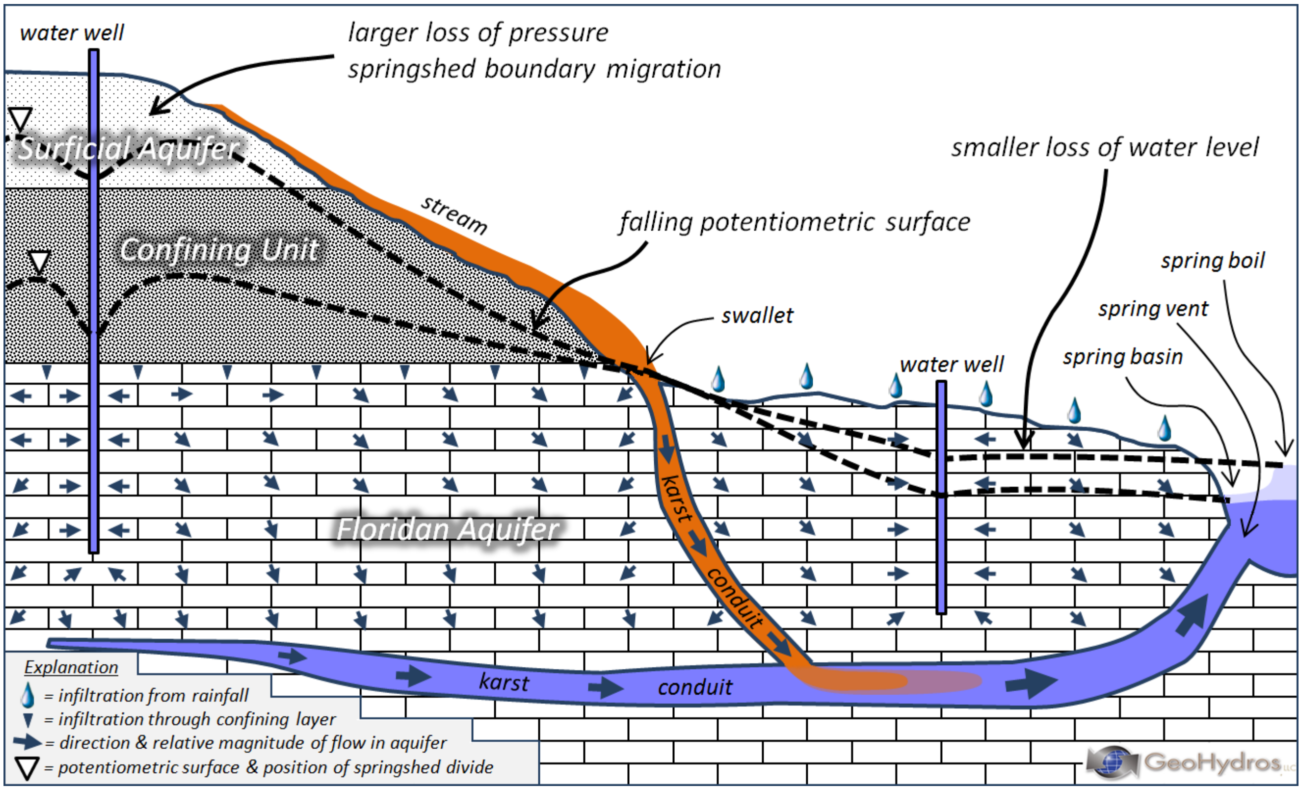

Figure 6. Impact of Groundwater Pumping on Spring Flow

Diagram showing the relationship between spring flow and groundwater extraction as it effects the hydraulic gradient and springshed boundaries. Extractions in the up-gradient region of the aquifer can impact both the elevation of the groundwater surface and the location of the springshed divides whereas impacts of extractions in the down-gradient regions will be limited to the change in the groundwater surface.

3 KEY COMPONENTS OF A NUMERICAL GROUNDWATER FLOW MODEL

A numerical groundwater flow model is a computer program used to: 1) simulate groundwater flow through a conceptualized hydrogeologic environment (i.e. aquifer or series of aquifers and confining layers) under a set of specified hydrologic conditions (i.e. low-water or high-water groundwater levels and discharges); 2) identify sources of groundwater flow to sensitive receptors (i.e. wells, springs, rivers, lakes, etc); and 3) to predict how the pattern and quantity of groundwater flow will likely change as a result of changes to the conceptualized environment (i.e. higher or lower recharge, groundwater extraction, etc.). Such a model can be 2D, or 3D; steady-state or transient; and regional or site-scale in focus. The accuracy of the model simulations and predictions is primarily dependant on the degree to which the conceptualized model framework honors the real-world environment, the degree to which the model accurately simulates observed conditions, the accuracy of the explicit and implicit assumptions underlying the modeling approach, and the degree to which the model configuration honors those assumptions. As such, the general objectives for the construction of a groundwater flow model are to: 1) replicate the real-world hydrogeologic framework as accurately as possible in the model design; 2) choose a modeling approach that addresses the fundamental hydrogeologic conditions as directly as possible; 3) minimize the number of required assumptions in the modeling process; 4) ensure that all required assumptions can be supported by data or sound hydrogeologic reasoning, and 5) match the observed hydrologic conditions representative of the specified model conditions to within an acceptable margin of error.

Two-dimensional (2D) models address horizontal flow through only one aquifer. Three-dimensional (3D) models simulate horizontal and vertical flow through multiple aquifers. Steady-state models simulate groundwater surface elevations and discharges that have equilibrated to the assigned inputs (i.e. recharge and/or groundwater pumping). Transient models simulate changing hydrologic conditions through time such as daily fluctuations in spring discharge and/or daily or seasonal fluctuations in groundwater surface elevations. Regional models address groundwater flow patterns through one or more groundwater basins while site-scale models are typically intended to simulate groundwater flow patterns across only a small portion of one groundwater basin.

In all numerical models, the modeled area, usually called the model domain, is subdivided into a large number of comparatively small cells (or elements) using a grid (or mesh) through a process called discretization. The resolution of the model, which defines the size of the smallest portion of the model domain over which the model can describe changes, is established by the size of the component cells (or elements). Models that use smaller cells have higher resolution and can resolve changes at smaller scales than models that use larger cells but they typically take longer to process. There are two basic types of numerical models. Finite-difference models have, until 2013, been generally limited to using rectangular-shaped grid cells that have generally had to be uniform in size across the lateral and vertical directions of the model domain. Because of the shape and size limitations, it is difficult to represent complex-shaped structures in a finite-difference model. Finite-element models typically use triangular-shaped elements that can be distributed across the model domain at nearly any size making it substantially easier to represent complex-shaped features.

All numerical models use the 2D or 3D grid of cells or mesh of elements as a framework for the simulation of groundwater flow within which one or more equations are solved describing the elevation of the groundwater surface in each of the cells or elements based on: 1) assigned material properties, 2) groundwater surface elevations set at the model boundaries or actions that effect those elevations, and 3) the relationship of the simulated surface between adjacent cells or elements.

The equations used to simulate the groundwater surface elevations are based on the physics of groundwater flow through the type of material thought to be characteristic of the aquifer or aquifers being simulated. The most common assumed material type is a porous media, which is like a sand box wherein the distribution of pore space in any block of material is the same as or very similar to any other block having the same material properties, i.e. any block of sand is the same as any other block of sand, and any block of clay is the same as any other block of clay. The physics of groundwater flow through porous media is described by Darcy's Law, [24,25] which is the basis for the groundwater flow equations solved by porous media numerical models. [18]

Other types of materials that are governed by non-porous media physics include fractured rocks in which groundwater flow occurs predominantly through networks of connected fractures that can occur in any type of rock, [38] and karst aquifers in which groundwater flows through networks of conduits that have dissolved out of soluble rocks such as limestone and dolomite and that typically connect to large-magnitude springs. [39,40,41,42] There are significant limitations to the use of porous media models to simulate groundwater flow through fractured rock and karst aquifers [43,44] that can be overcome in very large scale models designed to address broad-scale general questions [45,46] or through the use of models based on non-porous media equations and/or statistics [47,48] or hybrid models that link porous media and pipe flow equations. [49,50,51]

Both the SDII and GeoHydros models are 3D in that they simulate groundwater flow through and between the surficial aquifer system (SAS), intermediate aquifer system (IAS) and the UFA. Both are steady-state models. The SDII model was constructed to simulate low-water hydrologic conditions representative of the period June 1, 2001 – May 31, 2002. Two versions of the GeoHydros model were constructed: one to match low-water hydrologic conditions representative of the periods January 2001 – December 2002 and May – October 2007; and one to match high-water hydrologic conditions representative of the periods January 1998 – May 1999 and October 2004 – December 2005.

The fundamental differences between the two models are:

1. the SDII model is a porous media model that generalizes the probable existence of karst conduits as very highly permeable porous media [8] whereas the GeoHydros model, uses a combination of porous media and pipe flow equations to explicitly simulate groundwater flow through networks of karstic conduits embedded in a porous rock matrix; [13]
2. the SDII model is a finite-difference model that uses a grid composed of cells measuring nearly one mile on the sides to represent the spatial relationship of rivers, springs, and wells within the model domain [8] whereas the GeoHydros model is a finite-element model that uses variably sized triangles with node spacings between 12 and 2,397 feet; [13] and
3. the SDII model is a regional-scale model covering an area of approximately 23,500 square miles from south Georgia down the Florida peninsula to southern Marion County [8] whereas the GeoHydros model is a sub-regional model covering an area of approximately 962 square miles of the western Santa Fe River basin [13] (Figure 1).

Before exploring the specific characteristics of the SDII model, this section will describe the key components of a numerical groundwater flow model relative to criteria specific to the Floridan aquifer and some of the basic steps involved in their development. These include: 1) the conceptual model framework, 2) the water balance, and 3) model calibration.

3.1 Conceptual Framework

Several things are known about the Floridan aquifer in north-central Florida and particularly in the Suwannee River basin that can be used to steer the conceptualization of a groundwater flow model.

1. Springs are the dominant discharge features. [45] In some cases, the springs are located in the river channels while in other cases they are located some distance from the channel at the head of short tributaries. In either case, a comparison of measured spring flows and stream flows measured at gauging stations reveals that the majority of river gains from the UFA throughout north-central Florida occur at discrete springs. This indicates that flow through the Floridan aquifer is convergent rather than diffusive (Figure 7).
2. Recharge occurs both as diffusive seepage through rocks and sediments overlying the Floridan aquifer, and as rapid large-magnitude flux through discrete features called swallets, which receive river or stream flows and convey them into the Floridan aquifer through karstic caves and conduits (Figure 2). [5,7]

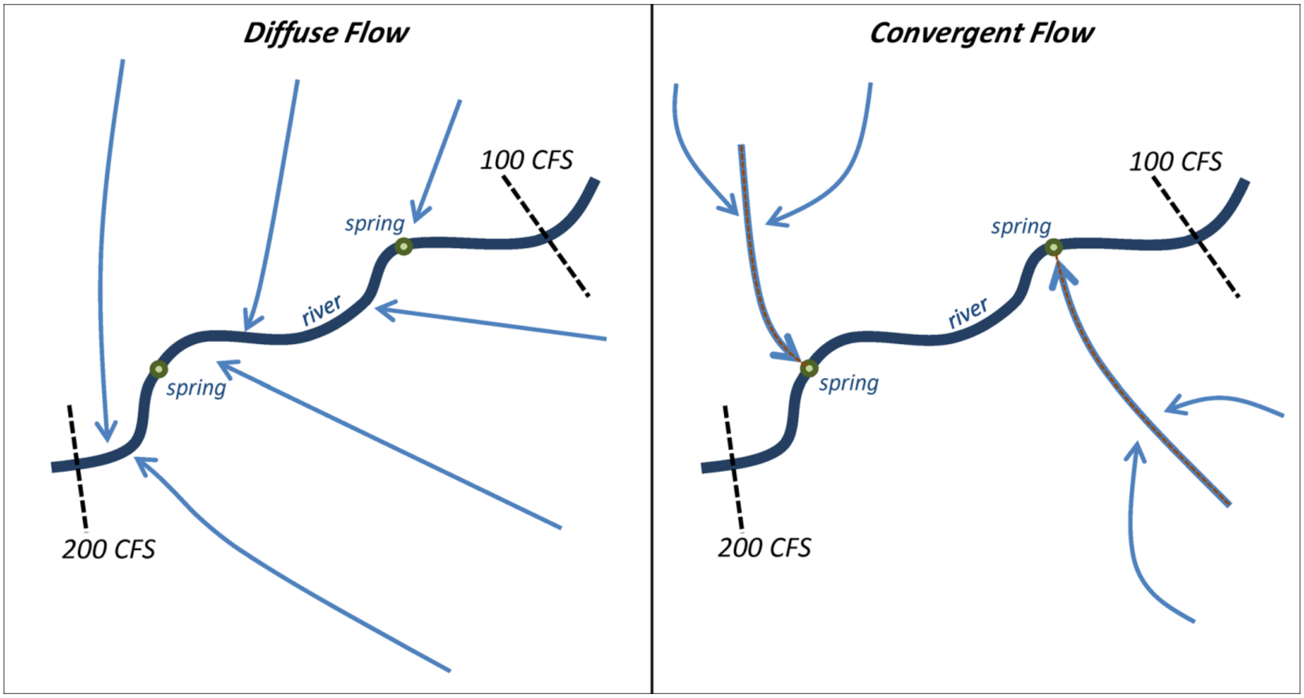

Figure 7 - Comparison of Diffuse and Convergent Groundwater Flow Patterns

Diffuse flow is characteristic of porous media aquifers whereas convergent flow is characteristic of karst aquifers.

3. Karstic caves and conduits are pervasive throughout the Floridan aquifer, particularly in unconfined regions, and can be laterally extensive, extending for miles and tens of miles through the aquifer. Many caves in the Suwannee River Basin have been mapped and many of the available maps have been compiled and published. [2,3] Others have been shown to exist through artificial groundwater tracing. [52,53,54,55,56,57,58]
4. The aquifer material is highly permeable but not so permeable as to preclude the development of deep and expansive cones of depression around large extractions such as municipal water supply well fields. [59]
5. Rivers and streams in the unconfined portion of the Floridan aquifer are typically in direct contact with the aquifer such that the river and stream surfaces are an expression of the groundwater surface and such that river water and groundwater are often actively exchanged over short distances via siphons and spring vents. [1,2,7]
6. Many of the apparent spring vents in the Suwannee and Santa Fe Rivers discharge resurgent river water that was lost to the aquifer in siphons located short distances upstream of the vents and thus do not reflect significant groundwater gains. [60,2,7]

3.2 Water Balance

Most specifically, the water balance describes the degree to which the simulated flow into a groundwater flow model matches the simulated flow out of the model. Unless there is a fatal flaw in the software, these two values will match or very nearly match in most models. More broadly however, the water balance also describes the distribution of those inflows and outflows to the various design features in a model.

Ideally, a model would be constructed to match measured sets of both inflows and outflows but, in reality, there is usually insufficient data available to measure both of them and very often insufficient data to fully constrain either one. As a result, groundwater flow models must usually be designed to meet estimates of the magnitudes of inflows and outflows. The magnitude of the outflows (i.e. river gains, spring discharges, and pumping rates) is typically better constrained by data than the magnitude of the inflows (i.e. recharge). Recognizing this, it is both possible and desirable to design a model in such a way as to minimize the simulation of flow across arbitrary model boundaries that cannot be constrained from data or reasonable estimations. For instance, model boundaries drawn to follow or approximate groundwater divides result in models for which the majority of the simulated flow is to internal features that can often be constrained from data or estimations (i.e. rivers or springs). By contrast, model boundaries that cut across groundwater flow pathways allow for a potentially substantial portion of the simulated flow to leave the model across an external boundary in non-verifiable quantities. The former is obviously more desirable because the prediction of impact to an aquifer associated with changing conditions is, in large part, a function of the percentage of the total flow through the aquifer (i.e. a 1 MGD groundwater extraction creates a large impact to an aquifer through which the total flow is 2 MGD but a relative small impact to an aquifer through which the total flow is 2,000,000 MGD).

Inflows to the Floridan aquifer in north-central Florida are comprised of:

1. direct seepage recharge from precipitation into the unconfined part of the aquifer,
2. seepage from loosing rivers and streams into the unconfined part of the aquifer,
3. seepage from the surficial and intermediate aquifers through an overlying confining unit,
4. runoff recharge through swallets, and
5. groundwater flow into the region from the Floridan aquifer underlying parts of south Georgia.

Recharge through swallets is the only one of these five vectors that is directly measurable but it is rarely, if ever done. All five forms of recharge must therefore be estimated through either independent studies or through the groundwater flow modeling process. For each case, the estimates tend to be only broadly constrained by data leaving a wide margin of error in the magnitudes and distributions.

Discharge from the Floridan aquifer in north-central Florida is in the form of:

1. spring discharge,
2. diffuse flow to rivers that are in hydraulic contact with aquifer,
3. diffuse flow to the Gulf of Mexico and possibly into Georgia,
4. upward seepage into the surficial and intermediate aquifers through an overlying confining unit,
5. groundwater extractions from wells that penetrate and are open to the aquifer, and
6. groundwater extractions from mining operations that intersect the aquifer.

Spring flows, river gains, and both forms of groundwater extractions are directly measurable though they are not always thoroughly and regularly measured. Despite incomplete records however, it is possible to constrain the magnitude of discharge from each one with data, or estimates than can be reasonably constrained by data. Table 3 provides estimates of the total groundwater discharge to rivers and springs from the Floridan aquifer in north-central Florida. The estimates were calculated by subtracting the total river flow entering the region where the aquifer is unconfined from the total river flow entering the Gulf of Mexico. Estimated total groundwater extractions by County and usage type can be obtained from the water management districts and the USGS. [61]

Upward seepage into the surficial aquifer can only occur where there is an upward gradient between the Floridan and surficial aquifers. Though such upward gradients were once prevalent in the confined regions of the aquifer, as demonstrated by historical accounts of artesian and flowing artesian wells, those conditions are now either non-existent or rare and isolated due to long-term and documented drawdowns in the groundwater surface. [33,34,35,36,37]

Diffuse discharge to the Gulf of Mexico cannot be measured directly and has not been confidently estimated. It is significant to a groundwater model's water budget because the magnitude of this component affects the model-simulated springsheds and the simulated impacts of groundwater extractions on spring flows. When diffusive discharge to the Gulf of Mexico is assumed to be large, the size of the simulated springsheds and the simulated impacts of pumping on spring flows will be smaller than when such diffusive discharge is assumed to be small. The effects of this inversely proportional relationship are particularly relevant to coastal springs but also effect inland springs because the total amount of simulated groundwater flow through the model will be higher when large diffuse coastal discharge is assumed.

Table 3. Recorded River Flows and Estimated Groundwater Discharge to Springs and Rivers from the Floridan Aquifer in North Central Florida

	Total River Outflow		Total River Inflow		Total GW Discharge
Year	Note	(cfs)	Note	(cfs)	(cfs)
2000	1	6,641[4]	8	1,946	4,696
2001	1	7,602[5]	9	2,619	4,983
2002	2	6,558[5]	10	1,895	4,663
2003	3	17,315	10	5,862	11,452
2004	4	15,131	10	5,686	9,444
2005	5	18,643	10	6,674	11,969
2006	-	9,055	10	2,553	6,502
2007	6	5,638	10	964	4,674
2008	-	9,079	11	3,814	5,265
2009	-	11,376	11	5,206	6,170
2010	1	12,212	11	4,112	8,100
2011	1	6,319	11	713	5,606
2012	7	9,454	11	2,309	7,145
Minimum	-	4,548	-	279	4,269
Average	-	10,507	-	5,192	5,315
Period	2	7,688	12	2,075	5,613

Notes

Total River Outflow = Suwannee@Gopher + Steinhatchee@Cross City + Fenholloway@Perry + Econfina@Perry + Aucilla@Nutall + Waccasassa@Gulf Hammock + Withlacoochee@Inglis Bypass + Withlacoochee@Inglis Dam + 25% of Wakulla + 25% of St. Marks

Total River Inflow = Suwannee@White Springs + Withlacoochee@Pinetta + Alapaha@Jennings + Santa Fe@High Springs

Total GW Discharge = Total River Outflow - Total River Inflow

Assumptions due to lack of data

1: period of record average flow for Aucilla and Wakulla flow = St. Marks flow
2: Wakulla flow = St. Marks flow
3: period of record average flow for Waccasassa and Wakulla flow = St. Marks flow
4: period of record average flow for St. Marks and Wakulla flow = St. Marks flow
5: period of record average flow for St. Marks
6: period of record average flow for Waccasassa
7: period of record average flow for Aucilla
8: average of 1993-1999 for Santa Fe and average of 1980-1987 for Alapaha
9: average of period 10/1/99 - 9/30/00 for Santa Fe and 10/1/00 - 9/30/01 for Alapaha
10: average of period 10/1/01 - 9/30/02 for Santa Fe and 10/1/00 - 9/30/01 for Alapaha
11: average of period 10/1/01 - 9/30/02 for Santa Fe
12: monthly averages May-September 2000 for 2001 Santa Fe and average 10/1/00 - 9/30/01 for Alapaha

Consequently, models that simulate higher diffuse coastal discharge yield smaller simulated impacts to spring flows due to groundwater extractions and, more broadly, a larger estimation of the amount of available groundwater in the aquifer. Since the real-world magnitude of diffuse coastal discharge is unknown, the amount simulated by a model is primarily determined by the way the flow system, and particularly recharge, is conceptualized.

A conservative approach would be to use the measurable (at least estimable) total groundwater discharge per watershed (best option) or the total aggregated discharge for all watersheds (Table 3) as a target for the definition of recharge. Using such an approach, recharge would be calculated from discharge divided by the area of the watersheds. Such an approach ensures that the bulk of the simulated groundwater flow through the model domain is captured by the dominant known discharge features (rivers and springs) leaving a relatively small fraction of the simulated flow free to occur as non-verifiable coastal seepage or flow across other external model boundaries. Models that establish recharge independently of the measurable discharge can result in much higher simulated coastal seepage and cross boundary discharge. Such results are less likely to be correct because the only measurable constraint on recharge using such a method is precipitation, which allows for a broader estimation of recharge where overestimates result in larger flows to non-verifiable discharge boundaries and in a non-conservative prediction of impacts or the total amount of available groundwater in the aquifer.

3.3 Model Resolution

As described in Section 3 above, a model's resolution is defined by the size of the grid cells or elements used to cover the model domain and dictates the spatial range over which a model can discriminate changes to the simulated groundwater surface and the distribution of simulated discharges. For example, a model that uses square cells that measure one mile on the sides cannot resolve individual spring flows or well discharges that are spaced less than one mile apart. Instead, the total number of such features in any given model cell must be aggregated wherein the model will only be capable of resolving how the combined flow or discharge is impacted by other features included in the model design. It is therefore critical that the model grid or mesh be sufficiently fine to resolve differences that relate to the stated purpose of the model, where models intended to simulate specific impacts to individual wells or springs generally need to have finer grids or meshes than models intended to simulate aquifer-wide or river-wide changes.

3.4 Model Calibration

Calibration is the process of matching model-simulated conditions to observed values. Typically the process focuses on groundwater elevations (heads) but should also include groundwater discharge, and to the extent possible, other observable conditions. In karst aquifers, important conditions to consider or attempt to match during the calibration process include individual spring discharges and tracer-defined groundwater flow paths and velocities.

Calibration is performed by estimating model input parameters that describe components of the model that cannot be or have not been directly measured, running the model to simulate the desired natural conditions, comparing the resulting condition values to measured values, modifying the configuration of parameter values if the model results are not acceptable, and repeating the process until the model achieves acceptable results. Estimated input parameters typically include hydraulic conductivity (transmissivity in 2D models), recharge, boundary conditions, and pumping (if it hasn't been measured) and could also or otherwise include conduit locations and sizes, and fracture patterns and apertures if the model includes conduits and/or fractures.

In order to be "acceptably" calibrated, a model must match the observable natural conditions that it is intended to simulate to within stated target criteria, such as a particular range in groundwater elevations or discharges. Multiple different types of calibration targets (i.e. head, total discharge, individual spring discharges, and velocities), small target criteria, and many target locations (i.e. many wells and/or many springs) likely result in more accurate models that yield higher certainty in their predictions because fewer model configurations will produce an acceptable calibration. Conversely, fewer types of calibration targets, large target criteria, and few target locations likely result in less accurate models with large uncertainties in their predictions because many different model configurations can yield an acceptable calibration.

3.4.1 *Groundwater Elevations (Head)*

In terms of groundwater elevations (often described as "head"), a common "rule-of-thumb" used by groundwater modelers is to set the calibration criterion to 5% of the total change across the model domain. For instance, if the highest recorded groundwater elevation in the model domain is 100 feet and the lowest is sea-level, the calibration criterion for groundwater elevations would be 5% of 100 feet, or +/- 5 feet. This practice is particularly useful when there is insufficient data to define the real range in groundwater elevation at the target locations within the calibration period. It can however be overly broad in regions of a model where groundwater elevation fluctuations are very small. If there is sufficient data to define the actual range, more appropriate calibration criteria can be established from the data, such as the average range or the actual range on a well-by-well basis.

The difference between the model simulated and measured groundwater elevation at the target locations (usually wells but can also be rivers, lakes, mine pits and/or springs) is called a residual. Typically, a requirement for an acceptably calibrated model is that the average of the absolute value of all residuals is less that the calibration criterion. Another desirable condition is that the number and magnitude of the residuals is normally distributed meaning that there are an equal number and cumulative magnitude of positive and negative values. This condition helps to ensure that the model configuration doesn't favor one hydrologic state over another. [16]

Exclusive focus on the absolute average residual and the residual statistics can result in poor model configurations and unreliable predictions even if the standard guidelines are achieved. This is particularly true in karst aquifers where the spatial distribution of residuals and the location of few large residuals, often called "outliers," are often demonstrative of conduit pathways. Attempts to enforce the calibration criterion at as many of the target locations in the calibration dataset as possible will therefore tend to yield substantially better model configurations and therefore more reliable predictions of groundwater flow pathways and velocities. A reasonable goal in this regard would be to choose a calibration criterion that is close to the average observed range in groundwater elevations at the wells comprising the calibration dataset and then attempt to achieve that criterion at as many of the wells as possible.

3.4.2 Discharge

In terms of discharge, calibration is the process of matching the simulated groundwater discharges to the observed values (such as aggregate river gains measured between river gauging stations or specific spring flows) unless those discharges are specified in the model design, i.e. designated pumping well rates or spring discharges. The calibration targets might be the average flows measured during the calibration period or reasonable estimates of those flows for rivers or springs that have not been gauged, or they might be the range of values observed during the calibration period. Porous media models often focus only on aggregate river gains rather than specific spring discharges (Figure 7) but such an approach precludes the ability to simulate springshed boundaries or to predict flow or water quality impacts to specific spring vents because they cannot resolve complex discrete flow paths to individual spring vents.

3.4.3 Groundwater Flow Paths & Velocities

In addition to attempting to match observed groundwater elevations and spring and river flows, it is also possible to calibrate a model to groundwater flow paths and velocities that have been observed through artificial groundwater tracing. Artificial groundwater tracing constitutes the use of non-natural substances (most frequently fluorescent dyes) as a tracer to establish flow paths between points of tracer injection and points where the tracer is subsequently detected. Such tests can be used to definitively establish both general flow vectors (the direction of groundwater flow) as well as the minimum groundwater velocities necessary to transport the tracer from the injection location(s) to the points where the tracer was detected (often called the travel-time).

Calibrating a model to observed flow paths involves exporting a simulated set of flow paths (typically derived from a process called "particle tracking") and comparing them to the tracer-defined vectors. Since the tracer tests cannot delineate the actual flow paths but rather points that are connected along one or more flow paths, the objective of the comparison should be limited to confirming that the model correctly simulates the observed connections leaving the delineation of the path free to conform to the simulated conditions. If a model fails to do so, then the parameter set and potentially the conceptual model should be revised and the calibration process repeated. Similarly, simulated connections between points that have been shown by tracing not to be connected should be scrutinized closely though such incongruities may be determined to not warrant model revision [22].

Simulating groundwater velocities in a porous media model, or the matrix component of a hybrid model, involves assigning a porosity value to the particle tracking function from which the travel-time between points within the model domain and thus the simulated groundwater velocities can be calculated. Calibrating porous media models to tracer-defined velocities in karst aquifers is not possible because a porous media model necessarily simulates flow over a broader area of the aquifer than is occupied by conduits yet tracer tests measure the velocities characteristic of the actual conduit dimensions; and the broader the area through which the flow occurs, the slower the velocity. The general inability of porous media models to match observed groundwater velocities render them incapable of adequately simulating contaminant transport times. If this weakness is recognized however, it is possible to estimate observed travel-times and velocities by using unrealistically low porosity values. Typical reductions necessary to approximate conduit velocities might be from 20% or 30%, to 1%, 0.1%, or less. Such large required reductions are indicative of unrealistic conceptual models and therefore indicate that a model may not be suited for the delineation of sub-regional scale groundwater flow patterns.

Calibrating to tracer-defined velocities in hybrid models is substantially easier because hybrids models directly simulate conduit flow. The simulated conduit flow velocities can therefore be queried from the model and compared to the observed values.

3.4.4 Calibration Process

In order to achieve the calibrated condition, a model is often run numerous (10s, 100s, even 1000s) times using different configurations of the estimated input parameters, constrained to hydrogeologically reasonable ranges, but holding the known or desired parameters constant. The goal is to identify the optimal configuration of uncertain parameters that produces the best fit to the calibration target values. This process is often performed with an external computer program, generally described as parameter estimation or "PEST". [62] Once a model configuration achieves the target calibration either through manual iteration, PEST-generated iteration, or a combination of the two, the resulting parameter configuration and the simulated groundwater surface and groundwater discharges are subjectively evaluated for reasonableness. If they're deemed to reasonably conform to the conceptual model of the aquifer, the model can be considered calibrated, if not, it may be rerun more times until the results meet the calibration targets and the parameter configuration required to meet the targets is deemed reasonable.

The calibration process for steady-state models focuses on matching model-simulated values to observed values that are representative of a specific equilibrated hydrologic condition, for instance a dataset that represents average low-water or average high-water groundwater elevations and discharges. Some modelers construct the calibration dataset from a set of measurements collected at the same or nearly the same time such as a dry month. Others construct the dataset by compiling data over a broader time period that can be shown to represent the same or similar hydrologic conditions such as a dry year, or multiple dry periods. Constructing the broader dataset is more rigorous but likely results in a more accurate model from which higher confidence can be ascribed to the predictions because the calibration dataset will likely be denser resulting in fewer model configurations that acceptably calibrate.

Once a model is calibrated to the target conditions, it is assumed that it can be used to reliably predict how the equilibrated hydrologic conditions will change in response to changes to the input parameters, i.e. additional groundwater extraction and/or increased or decreased recharge associated with changes to the climate, land-use, or both. Confidence in the veracity of those predictions diminishes as the conditions being tested deviate from the target conditions to which the model was calibrated. For instance, a model that was calibrated to low-water hydrologic conditions may not be able to reliably predict impacts to an aquifer due to actions taken during high-water periods.

This problem can be addressed by simultaneously calibrating a model to end-member hydrologic conditions, i.e. average low-water and average high-water conditions. This is done by going through the calibration process described above using one of the end-member datasets as the target values, changing the input parameters to conform to the other end-member state, going through the calibration process again using the other end-member dataset as the target values, and then repeating the process until a single model configuration acceptably calibrates to both end-member target datasets using the end-member input values (i.e. recharge). The multi-target set calibration process is laborious because it involves repeating the calibration process multiple times where each process itself involves many 10's, 100's, or 1000's of model iterations, but it is the only way to ensure that a model is capable of matching different sets of hydrologic conditions without requiring different conceptualizations of the aquifer framework for different hydrologic conditions. Such changes are invalid because the aquifer framework (i.e. the distribution of aquifer permeability) does not change.

3.5 Aquifer Permeability Framework

The aquifer permeability framework is the 3D distribution of material properties defined in a groundwater flow model that establish the capacity of the simulated geologic environment to transmit groundwater flow. In a porous media model, the aquifer permeability framework is defined by the distribution and magnitude of hydraulic conductivities (in 3D models) or transmissivities (in 2D models), which are assigned to the model grid cells and are constant across the area/volume of each cell. In a hybrid model, the aquifer permeability framework is comprised of the hydraulic conductivities assigned to the grid cells and an embedded network of pipe-like features that exchange water with the cells and deliver water to simulated discharge features. In the hybrid model design, the capacity of the aquifer to transmit water is therefore defined by the hydraulic conductivities of the cells and the length, distribution, and size of the pipes where the cells represent the aquifer matrix and the pipes represent conduits.

Neither the hydraulic conductivities nor the conduit characteristics can be measured directly in the field over an entire model domain. The values assigned in a groundwater flow model must therefore be estimated. This is typically done through the model calibration process using the published range in values as a guide. The resulting design should however relate to the conceptual framework (Figure 4, Figure 5, Figure 6) in terms of the horizontal and vertical relationship of relative high and low permeability zones but can differ considerably depending on how the calibration process is executed. This is because the values are assigned, either manually or automatically through PEST, in order to minimize calibration residuals. Without sufficient checks on the process, the model assignments, when viewed collectively, can differ from the initial conceptualization. If the framework of values does differ substantially from the conceptualization, it can be concluded that either the conceptualization is not accurate, or that the model design is incapable of yielding a simulation that acceptably calibrates. Unrealistic frameworks can have significant impacts on model predictions because the extent and depth of a simulated cone-of-depression will be under-estimated in higher-than-realistic permeability zones and over-estimated in lower-than-realistic zones. Evaluating the reasonableness of the aquifer permeability framework after the calibration process is therefore a critical component of quality control.

3.6 Aquifer Recharge

In the simplest system, recharge would equal precipitation and would be distributed based on regional rainfall patterns (in this case highest rainfall along the coast of the Gulf of Mexico and decreasing inland). The simple system is made complex however due to ET and runoff according to the following water balance equation:

Recharge = Precipitation – ET – Surface Runoff

where: Recharge is the amount of water entering the aquifer or system of aquifers being simulated;
Precipitation is the total amount of precipitation falling in the model domain;
ET is the total amount of precipitation consumed by evaporation and transpiration; and
Surface Runoff is the total amount of precipitation that either sheet flows into the rivers and streams within the model domain or falls directly in them.

The system is made further complex by the spatial variability in each of these processes and the fact that neither ET nor surface runoff are typically constrainable by available data. Thus, both the spatial distribution and the magnitude of recharge must be estimated during the modeling process.

In terms of the spatial variability, both ET and surface runoff are associated with observable conditions at the land surface. Both the magnitude and spatial distribution of ET are determined by the density and type of vegetation growing at the land surface as well as the frequency, size, and depth of surface water bodies, and the depth of the groundwater surface. Higher ET is associated with reduced recharge and is associated with water-intense vegetation, a large amount of shallow open water surface, and a shallow groundwater surface whereas lower ET is associated with higher recharge and the converse in surface and vegetation characteristics. In terms of surface runoff, flat ground allows for the most recharge while an increasing slope leads to increased overland flow and reduced recharge. Similarly, high permeable soils such as sand and gravel allow for high recharge where as soil permeability goes down (silts, clays, unfractured rock), so does recharge. Regions of low permeability soils are also usually associated with surface water features such as streams, lakes, and wetlands that tend to have high ET.

Human activities can also cause recharge variability. Irrigation of crops, golf courses, lawns and parks and waste water spray-fields can increase recharge. Construction of roads, parking lots and buildings create impervious surfaces and decrease recharge.

In order to be defensible and to pass a reasonable level of quality assurance, recharge variability assigned in a model should be based on one or more of the above influencing factors. In some models, recharge is assigned through the PEST calibration process in a manner similar to that described for hydraulic conductivity. In such cases, PEST typically adjusts both the hydraulic conductivity and recharge parameters simultaneously, runs the model, checks the simulated groundwater levels against the calibration dataset, calculates the residuals, and if the residuals are unacceptable, makes new parameter value assignments and repeats the process. In most cases, PEST varies parameter assignments in polygons that subdivide the model domain. Ranges can be established to prevent extreme and unreasonable parameter assignments but otherwise PEST will tend to vary the values as needed to produce an acceptable match to the calibration dataset.

Regardless of the allowable range settings, PEST cannot independently establish reasonable spatial relationships between parameter assignments. For example, the PEST system may identify high permeability and low recharge as a viable configuration in terms of matching the observed groundwater levels in a particular polygon or group of polygons despite observable conditions that do not support such a configuration. The spatial relationship between model-defined parameter settings must therefore be monitored by the modeler in order to ensure that the resulting model is consistent with observable conditions (the conceptual model) as well as adequately calibrated. This is important because models are non-unique, meaning that many combinations of parameter values can be found that give the same calibration result yet only the subset of calibrated results that also conform closely to the conceptual model deliver reasonable predictions.

Regions in a model characterized by extremely low recharge should correspond to regions known to have characteristics such as above average density of vegetation, a high density of wetlands and lakes, or below average surface permeability such as paved or otherwise covered areas. Regions characterized by extremely high recharge should correspond to regions where observable conditions include features such as localized irrigation or above average surface permeability (parks, open land with little vegetation, etc). If such spatial correlations between the PEST assignments and observable conditions exist, then the model-defined parameter values can be considered defensible. If not, the model-defined values should be rejected and the configuration adjusted. Otherwise, the model may grossly misrepresent critical conditions such as groundwater travel times and the total amount of flow through the aquifer.

The total magnitude of simulated recharge into a simulated aquifer or system of aquifers must also be evaluated and constrained in order to establish a defensible and reliable model. The total simulated magnitude is critical because under-estimations will tend to preclude the ability of a model to match observable spring and river flows while over-estimations will over-predict the total amount of groundwater moving through the simulated aquifer or system of aquifers and thereby under-estimate impacts as for instance due to groundwater extractions or drought.

The most conservative way to constrain the total magnitude of aquifer recharge is by using a basin-by-basin approach where basin recharge is constrained by measured basin discharge. This type of approach minimizes the probability of over-estimating the total magnitude of groundwater flow (and thereby under-estimating impacts from pumping) because the amount of water going into and through the simulated aquifer(s) will be constrained by data (i.e. measured gains in river or stream flows). The general water budget equation for this method is:

Recharge = (Surface Discharge – Surface Runoff) + Groundwater & Surface Water Extractions + Leakage

where: *Surface Discharge* can be directly measured through stream and spring gauging;
Groundwater & Surface Water Extractions can be constrained from published data; and
Leakage is the amount of vertical flow through a confining unit to a lower aquifer, which can be constrained from published estimates or through model calibration where for example, Bush and Johnson (1982) estimated a leakage range of 0 to 5 in/yr from the SAS/IAS into the UFA in the confined regions of the Suwannee and Santa Fe River basins.

This equation should be modified based on the conceptual model of the system being simulated and on how the model was constructed. For example, the leakage term can be omitted if a lower confined aquifer does not exist or is not included in the model design, and in some cases the surface runoff term can be omitted if all stream flow is known to result in aquifer recharge, as for instance in cases where all stream flow is lost to swallets.

In all cases, a conservative estimate for the maximum total recharge in regions of aquifers that supply flow to rivers, streams, and springs can be assumed to be the total measured surface discharge plus groundwater & surface water extractions plus leakage, which is a value that can be reasonably and typically constrained by available data.

3.7 Reporting & Documentation

The professional expectation of reporting on and documentation of a groundwater flow model, particularly one intended to be used to support management decisions, is that it provides reviewers and decision-makers with a complete transparent understanding of the model development process, all underpinning assumptions, and any limitations that have bearing on the model's intended applications. [15,17] Particularly with respect to groundwater resource management, accurate, thorough, and transparent documentation is critical because it forms the basis for public trust in the model and its applications. This is because it generally provides the only mechanism for verifying that the model adequately represents the aquifer (or aquifer system) to the degree necessary to achieve its stated purposes, and that the limitations stemming from the model's accuracy and precision have been sufficiently documented as to preclude applications of the model to problems for which it was not intended to address. An adequate report should include the following components.

- A description of the hydrogeologic setting that focuses on the issues that will be addressed (or not addressed) in the model including:
    - the hydrostratigraphic relationship between aquifers and confining units that occur within the study area, which would typically be based on published geologic and hydrostratigraphic maps as well as borehole logs and well data;
    - controls on and spatial distribution of recharge and discharge relevant to each unit, which would typically be based on available precipitation, ET, and surface runoff (stream and river flow) data;
    - locations and mechanisms for other sources and sinks and their relationship to the hydrostratigraphic units, which would include compilations of spring discharge and groundwater pumping data, and the locations and estimated capacities of swallets; and
    - knowledge of the permeability structure characterizing the relevant hydrostratigraphic units, which would include a compilation and discussion of aquifer performance test (pump test) data, lithologic data, cave maps, and groundwater tracer tests that have been performed within and around the study area.
- An explanation of how the interaction between the hydrogeologic features in the study area were conceptualized for representation in the groundwater flow model (the conceptual model), which would include:

  - a justification for the delineation of horizontal and vertical model boundaries and the probable influence of the resulting model size on the reliability of the model's predictive capacity (i.e. is the model equally valid across the entire domain or is there an internal region for which the designers believe model predictions should be constrained);
  - a related justification for how flow across the external model boundaries is defined and the probable influence of those assignments on the reliability of the model's predictive capacity;
  - a justification for the model discretization (the scale to which the model domain is broken up for numerical processing and the method to create the sub-divisions), which would address the reason for and consequences of choosing a finite-difference verses finite-element method of discretization, and the limitations on the model's predictive and computational capabilities dictated by the scale of the sub-divisions;
  - a discussion of how hydraulic communication between hydrostratigraphic units was accommodated, i.e. vertical flow based on variability in hydraulic conductivity, prescribed leakance, transmission along or blockage across faults (if present), etc;
  - a discussion of how spatial variability in recharge was addressed;
  - a justification for the chosen method of describing sources and sinks, which would include a discussion of limitations driven by the assignment of well locations, depths, and pumping rates, spring discharges, gaining rivers, lakes, and wetlands, and swallets; and
  - a justification for how known complexities in the permeability structure were addressed such as how the model was designed to account for conduit or fracture flow, or extreme heterogeneity when those processes are known to exist and be significant.
- A justification for the choice of groundwater modeling software used to construct the model and a discussion of any limitations on model applications resulting from that choice, i.e. driven by the availability and cost of the software.
- A summary of all of the key assumptions underlying the conceptual model and those required to convey the components of the conceptual model into the chosen groundwater modeling software.
- An explanation of how the model was calibrated, which would include:
  - identification of the chosen calibration targets. i.e. groundwater levels measured in wells, river reach gains and/or losses, specific spring discharges, tracer-defined groundwater flow paths and velocities, specific hydrographs or aquifer test response curves, etc;
  - identification of and justification for the calibration criteria by which the model configuration is considered to be acceptably calibrated, (i.e. the range in groundwater levels, discharges, and velocities), and where the criteria were expected to be honored (i.e. at all wells and discharges, some percentage of them, or no specific locations);
  - a discussion of and justification for PEST procedures, parameter range constraints, and the resulting uncertainty in the PEST results;
  - a discussion and statistical analysis of the calibration results including plots, maps, and statistics comparing the simulated and observed values; and
  - verification that the resulting parameter magnitudes and distributions reasonably conform to the conceptual model.
- A discussion of the quality assurance (QA) procedures, other than model calibration, used to evaluate and define the model's accuracy and precision, which would include:
  - a description of any sensitivity analyses performed on the uncertain model parameters such as hydraulic conductivities, recharge, boundary conditions, etc. and a discussion of how the results were used to identify probable error bars on the model's predictive capability; and
  - a discussion of any internal or external peer reviews that were conducted and their conclusions and recommendations.

- A summary of the limitations of the model as well as a review of the applications for which the model is believed to be reliable, and a discussion of how the model could be improved to reduce the identified limitations.

Supporting documentation should include all of the electronic files necessary for an independent investigator to duplicate the model results [15] including: all files necessary to run the model and verify the critical assignments against the data used to develop and constrain the values; and the data necessary to verify the model calibration. [17]

Another valuable component to a groundwater flow modeling report is a discussion that outlines what the model developer learned about the hydraulics of the aquifer system as a consequence of the model development and calibration process. This is because groundwater flow modeling, at its core, is a learning process. There tend to be far more unknowns or uncertainties about a given flow system than knowns. A thorough and meaningful modeling process requires the modeler to explore those unknowns or uncertainties and identify cause and affect relationships between uncertain parameter values and the resulting configuration of groundwater surface elevations and the magnitude and distribution of groundwater discharge. The report therefore provides an important opportunity for the modeler to convey the knowledge and insights gained through the modeling process to the broader community.

3.8 Basis for Model Evaluation

To a significant extent, all models are subjective. This is because there is very rarely sufficient data to define all of the critical model parameters such as: 1) the boundary conditions, which define the rate and magnitude of water flowing into and out of the model domain (including recharge, spring flows, river gains, etc.); 2) the magnitude and distribution of differing hydraulic conductivity zones in the subsurface; and 3) the distribution of porosity, which controls aquifer storage and groundwater velocities. It is therefore often up to the modeler to make hydrogeologically sound assumptions when making assignments that cannot be derived directly from data.

Those assumptions ultimately limit the degree to which a model can be used to address real-world problems. In general, simpler models have greater limitations than more complex models meaning that they are applicable to a more limited set of problems or questions. While more complex models may be more suitable to a broader set of more site specific and/or detailed questions, they require substantially greater effort and data to construct, and it becomes more critical to identify the underpinning assumptions and ensure that they are reasonable relative to what is known about the hydrogeologic environment being simulated.

Whether simple or complex, the quality of a model is predicated on its ability to confidently address the problems and questions to which it is intended to be used, which stems from: 1) the accuracy and relevance of the conceptual model, which defines the manner in which the model addresses observable conditions as well as the applicability of the various assumptions used to develop the model; 2) the degree to which it matches (calibrates to) the observable conditions that it was designed to represent; 3) the veracity or reasonableness of the parameter assignments required to produce the calibration; and 4) the water budget, which defines the distribution and magnitude of inflows and outflows.

This report addresses the degree to which the SDII model meets these criteria for quality relative to the stated purposes of the model. This report also describes the degree to which the critical assumptions and limitations of the model are accurately and transparently described in the SDII report on the model development. Where applicable, results from both the SDII and GeoHydros models are compared in order to demonstrate the degree to which different conceptualizations of the Floridan aquifer and different choices of software and approach affect modeling results and the defensibility of the subsequent predictions.

4 SDII GLOBAL 3D MODFLOW MODEL

The SDII model covers an area of approximately 23,500 square miles including the entire SWRMD and all or part of the following Florida counties: Leon, Wakulla, Jefferson, Madison, Hamilton, Baker, Nassau, Duval, St John's, Clay, Bradford, Union, Columbia, Suwannee, Lafayette, Taylor, Dixie, Levy, Gilchrist, Alachua, Putnam, Flagler, Marion, and Citrus, as well as all or part of the following Georgia counties: Grady, Thomas, Brooks, Lowndes, Cook, Berrien, Lanier, Echols, Clinch, Ware, Brantley, Charlton, Camden, and Glynn (Figure 1). It is described by a report that SDII issued with the model in 2008 [8] as the "North Florida Model" (NFM). The following assessment is based on information presented in the SDII report [8] and an evaluation of a copy of the calibrated version of the model that is provided on and was downloaded from the SRWMD website that is described in the subsequent discussions as the NFM-08. [63]

4.1 Purpose

SDII reports that the primary purpose of the NFM-08 is to evaluate "the effects of existing and proposed groundwater withdrawals on the aquifers (primarily the Upper Floridan Aquifer) of the District" [8]. They listed the intended uses for the model as:

- evaluating the effects of proposed and existing groundwater uses on springs and surface water bodies in the SRWMD;
- evaluating the potential impacts of groundwater withdrawals on established Minimum Flows and Levels (MFLs);
- identifying new water sources;
- assessing and optimizing groundwater management strategies including aquifer storage and recovery, injection of treated wastewater, and inter-basin transfers of water from well fields;
- delineating springshed boundaries;
- assessing the susceptibility of spring flows to changes in rainfall;
- determining the cause of spring flow declines; and
- identifying remedial measures that could effectively restore spring flows.

4.2 Conceptual Model

The NFM-08 is 3D and is intended to simulate flow through and between the Surficial Aquifer System (SAS), Intermediate Aquifer System (IAS), Upper Floridan Aquifer (UFA), Middle Confining Unit (MCU), and the Lower Floridan Aquifer (LFA). [8] The model represents the conceptualization of the hydrogeologic framework described below. Components specifically identified in the SDII report are marked with a citation to the report. The remaining components were discerned by GeoHydros based on a review of the report and model files. The veracity of the conceptualization and the degree to which it is honored by the model are discussed in the subsequent discussions.

1. Each of the simulated aquifers is a porous media that is homogenous within 5,000-foot x 5,000-foot east-west / north-south oriented grid blocks (Figure 8).
2. The IAS is primarily a confining unit that hydraulically separates the SAS from the UFA. [8]
3. The IAS is discontinuous but where present inhibits vertical flow between the SAS and the UFA (Figure 9). [8]
4. The MCU is discontinuous but where present inhibits vertical flow between the UFA and LFA. [8]
5. Flow in the SAS is primarily to rivers and wetlands with some flow to the Atlantic Ocean and some vertical flow into the IAS. [8]
6. Some flow occurs vertically from the IAS into the UFA. [8]
7. Flow in the UFA is to rivers, springs, wells, and the Gulf of Mexico. [8]
8. Saltwater intrusion into the UFA is not possible. [8]
9. Discharge, from the UFA to rivers and springs, is through a variably conductive layer of streambed material that separates the rivers from the aquifer that creates local artesian conditions.

10. The magnitude of individual spring flows and river gains over discrete reaches of the rivers is controlled by spatial variability in the conductance of the streambed material.
11. Recharge from precipitation occurs in variable amounts across the entire upper surface of the model and related to the distribution of precipitation and ET. [8]
12. Additional recharge to the UFA occurs in the form of inflow from drainage wells and siphons located in some of the rivers. [8]
13. Total groundwater extractions in the model domain equal 1,250 cfs (~825 MGD) of which approximately 1,075 cfs (~710 MGD) is from the UFA. [8]

4.3 Modeling Approach

The NFM-08 was constructed using the software Groundwater Modeling System (GMS) version 6.0, which leverages the USGS finite difference groundwater modeling code MODFLOW-2000 [64] and the general purpose parameter estimation utility PEST. [62] The modeling approach relied heavily on PEST to match simulated discharge to observed spring flows and river gains and losses while also attempting to match observed groundwater levels. In this model, the process involved automatically varying aquifer permeability (hydraulic conductivity), recharge, and the artificial control term called streambed conductance, which limits the rate at which water can pass from the aquifer into overlying rivers and springs, and vice versa, on a spatial basis as needed with the goal of matching the observed values. Hydraulic conductivity and recharge were varied spatially in an effort to match the observed groundwater elevations and then the streambed conductance values were changed as needed to match the observed flows given the simulated groundwater levels.

The model does not address conduit flow in the Floridan aquifer but rather simulates the aquifer as a very highly permeable porous media. The model does not simulate discrete spring discharges at a scale of less than 5,000 X 5,000 feet but it does provide a means to compare nodal discharges to flows from individual spring vents that occur within a model cell. Spring and river discharges were simulated using MODFLOW's Drain and River packages respectively where multiple drain and/or river nodes were assigned to any cell that contains multiple observed discharges. Arbitrary streambed conductance terms were then used to control the magnitude of the simulated flows. This procedure assumes that the UFA is separated from the spring vents and river bottom by a local confining layer that inhibits groundwater discharge into the springs and rivers and that the conductance of that confining layer varies within and between individual model cells. By doing this, the simulated discharge out of a single model cell representing multiple springs could be parsed by the drain and/or river nodes and compared to the individual observed flows. The PEST process worked to match the discharge from the model cells to those observed spring flows while also working to match the observed groundwater levels in the calibration wells but it was free to vary the streambed conductance terms as necessary to match the flows resulting in an unconstrained simulation of groundwater levels at the rivers.

The premise on which the model can be used to evaluate the impact of proposed groundwater pumping applications is that by adding a well to the design configuration and re-running the model, the resulting simulated groundwater surface and water balance will differ from the original by only the amount related to the additional pumping. In order to do this, the model grid would typically be refined to a smaller grid size along orthogonal lines that intersect at the well in question. Such a refinement is evident in the grid design shown in Figure 8. This is done to create finer resolution output around the well such that changes in the groundwater surface can be more precisely evaluated. Since the boundary conditions are assigned to the grid cells, the modified model must be evaluated to ensure that the refinement process did not cause unintended changes to those assignments. After each new permit is issued, the new pumping rate should then be added to the master wells file such that the cumulative impact of new applications can be evaluated as new permits applications are processed. These processes were part of the usage guidelines set forth in the SDII report [8].

4.4 Model Calibration

The model was calibrated to average heads and flows representing only low-water hydrologic conditions. The data was collected from the period between June 1, 2001 and May 31, 2002, [8]. The dataset included groundwater levels measured at 676 wells, 135 spring discharges, and river flow changes measured between 38 gauging stations. The calibration process involved varying the configuration of hydraulic conductivity, recharge, and streambed conductance values assigned in the model framework and evaluating the difference between simulated and observed groundwater levels (residuals) and spring discharges. A model configuration that yielded simulated groundwater levels and drain and river cell discharges that fell within an acceptable range of the observed values was considered to be calibrated.

SDII chose 5% of the total change in the elevation of the groundwater surface of the UFA across the model, which was 100 feet, as the target calibration criterion for groundwater levels. The resulting permissible deviation between simulated and observed groundwater levels (residual) was +/- 5 feet. Rather than enforce that criterion at each observation point however, SDII required only that the average of absolute residuals be less than the 5 foot criterion. The calibration criteria for river and spring flows were not specified but the modeling approach ensured that the observed flow values were honored almost exactly through the unconstrained variation of the streambed conductance terms.

Five issues with the calibration will be discussed: 1) the magnitude and spatial distribution of individual residuals; 2) the calibration to spring and river flows; 3) reasonable simulation of aquifer stress conditions created by groundwater pumping for the City of Gainesville and Fernandina Beach; 4) the relevance of the 5-foot criterion; and 5) comparison of simulated and tracer-defined groundwater flow paths and velocities.

4.4.1 Magnitude and Spatial Distribution of Residuals

Figure 10 shows how the SDII model calibrated to the observed groundwater elevations (heads). The average error (residual) between simulated and observed groundwater levels was 4.3 feet and because that value is less than the 5-foot target, SDII considered the model to be acceptably calibrated. The plot shown in Figure 10A was reproduced from the SDII report. It shows however that the error at many of the wells is considerably larger than the 5-foot criterion. The calibration dataset was not made available for this review but an estimate from the plot provided in the SDII report revealed that the error at 13 of the wells (~2% of values) is larger than 20 feet, the error at approximately 63 of the wells (~9% of values) is larger than 10 feet, and the error at approximately 207 of the wells (~31% of values) is larger than the 5-foot calibration criterion.

In order to more adequately explore the calibration status, an independent dataset was compiled. Groundwater level data from the calibration period was obtained from the SRWMD, the Alachua County Environmental Protection Department (ACEPD), and Karst Environmental Services (KES) who managed and maintains data collected from wells installed by CCNA for their former Ginnie Springs water bottling facility. This combined dataset consisted of 534 wells distributed throughout the SRWMD portion of the NFM-08 domain. The average elevation was computed for each well and the resulting dataset was compared to model-simulated values for the UFA that were extracted from the calibrated version of the NFM-08. Figure 10B shows the distribution of errors (residuals) where those greater than +/- 5, 10, and 20 feet are uniquely identified. One hundred forty-seven (28%) of the simulated values deviated from the average observed groundwater levels by more than 5 feet. A significant portion of the simulated values deviated from the observed levels by exceptionally large magnitudes: 54 (~10%) by more than 10 feet, and 12 (~2%) by more than 20 feet. Appendix 3 provides a compilation of the SRWMD, Alachua County and CCNA well data.

4.4.2 Calibration to Spring Flows

SDII reports that the NFM-08 matched the observed spring flows to within 1% of the observed flows at 90% of the 145 springs reported to be simulated by the model and to within 8% of the observed flows when all of the springs were considered. [8] As described in Section 4.3 above however, the model does not actually simulate flow to discrete springs but rather to square cells measuring 5,000 by 5,000 feet that comprise one or more springs. The model therefore equates the individual spring flows to upward seepage occurring over an area of 0.9 square miles. As is also described above, calibration to the observed spring flows was achieved through PEST at the expense of simulated groundwater levels at the rivers. The manner in which the model's calibration to individual spring flows is described in the SDII report is therefore misleading because it depicts discrete spring flows rather than aggregate cell flux as model output and fails to demonstrate the degree to which the model configuration was able to match river elevations along with the spring flows.

Table 4. Deviations between model-simulated heads at discharging non-boundary River and Drain assignments and target river stage values.

	River Nodes	Drain Nodes
# Discharging assignments in unconfined portion of UFA	831	147
Maximum deviation between simulated head and stage (ft)	28.8	19.1
Average deviation between simulated head and stage (ft)	6.3	6.4
# Deviations that exceed target river stage by >5 feet	397 *(48%)*	74 *(50%)*
# Deviations that exceed target river stage by >10 feet	198 *(24%)*	33 *(22%)*
# Deviations that exceed target river stage by >15 feet	65 *(8%)*	15 *(10%)*
# Deviations that exceed target river stage by >20 feet	7 *(1%)*	0 *(0%)*
# Deviations that miss target stage by >5 feet or <-5 feet	397 *(32%)*	74 *(50%)*

Notes:
Computed from values exported from NFM-08 (Appendix 4)
Nodes are assignments to the center-point of model cells within the MODFLOW River & Drain packages.

A more appropriate reporting of the model performance would be to compare the simulated discharge from the model cells containing the drain nodes to the total flow from the aggregate of individual spring vents that occur within the respective cells. The model is too coarse to simulate individual spring flows and as a result it cannot be used to delineate individual springshed boundaries or even the boundaries of springsheds feeding groups of springs. This is because the proximity of springs to one another is not an indicator of shared source, as for instance is the case for the vents at Silver Springs, Ginnie and July Springs, or Ichetucknee and Blue Hole Springs.

In terms of calibration, an acceptable match to spring and river flows requires also simulating observed groundwater levels at the discharge locations to within the bounds of the established calibration head criterion (+/- 5 feet). An inspection of those values from the NFM-08 revealed that the simulated groundwater levels at the discharging river and drain nodes were excessively high relative to the observed river stage. Table 4 shows that the NFM-08 over-estimates groundwater levels that should correspond to river stage by as much as 29 feet at the river and drain nodes, and that the deviations are more than the calibration target criterion (5 feet) at approximately half of the assignment cells. This statistic remains about the same when also considering locations where the model under-simulated groundwater levels at the rivers. Considering these deviations together with the 534-well dataset compiled to evaluate the quality of the model calibration (Section 4.4.1) reveals an average absolute residual of 5.6 feet, which violates SDII's stated calibration criterion. Appendix 4 provides the values from the NFM-08 model used to compile these deviation statistics.

Figure 11 shows that the deviations occur at a significant portion of the assignments representing river reaches that receive groundwater discharge from the UFA. The largest deviations occur in the central Suwannee, Santa Fe, Steinhatchee, and Aucilla Rivers. The model simulated groundwater levels throughout a significant portion of the central Suwannee and Santa Fe Rivers is higher than the observed river stage by more than 5 feet. The reaches surrounding the confluence with the Santa Fe River and below the confluence with the Withlacoochee River is elevated by between 10 and 20 feet. Deviations in some of the coastal rivers rise to more than 20 feet. These discrepancies occurred because PEST was allowed to adjust the streambed conductance term as needed to match the flows. If the model simulated too much flow, PEST reduced the streambed conductance, which allowed less flow out of the cell while maintaining or increasing the groundwater level. By doing this, the model indicates that the springs and rivers are separated from the aquifer by a confining layer, which is not true because the simulated rivers occur within the unconfined portion of the UFA and flow directly on UFA limestone.

4.4.3 Calibration to Aquifer Stress

Given that the stated purpose of the NFM-08 is to evaluate the impact to aquifer water levels associated with groundwater extractions, a prudent form of model calibration would have been to compare the model-simulated groundwater surface (potentiometric surface) in an area where groundwater pumping is known to have created a measurable cone-of-depression with a delineation of that surface from measured groundwater levels. One such location available to SDII at the time of model construction that is both central to the model domain and relevant to the model-simulated groundwater flow patterns to the Santa Fe River is the cone-of-depression created by municipal groundwater pumping by the City of Gainesville. The ACEPD developed and published biannual maps of the groundwater surface throughout Alachua County during the years surrounding the model calibration period. One of those maps shows the cone-of-depression in September 2001, which is near the middle of the NFM-08 calibration period.

Figure 12 and Figure 13 compare the model-simulated groundwater surface to the May 2001 and September 2001 surfaces measured by the ACEPD. [59] The comparison shows that the NFM-08 over-predicts the groundwater surface, which means it under-predicts the impact of the pumping by as much as 30 feet in the vicinity of the Gainesville well field even though the model simulated the appropriate pumping rate of 25 MGD for the collective City wells. The magnitude of the error is highest in the center of the mapped cone-of-depression and extends for approximately 2 miles in all directions from that point.

Figure 14 compares the model-simulated capture zone for the Gainesville well field as defined by particle tracking to the capture zones defined from potentiomentric surface maps developed by the ACEPD from groundwater elevations measured during May and September 2001. [59] The model substantially under-estimates the size of the capture zone for the well field. This significantly affects the model’s ability to predict impacts to the Santa Fe River because the model underestimates the western extent of the measured and thus confirmed zone of influence by as much as 5 miles. That equates to nearly 50 square miles of recharge that the model indicates will flow to the springs along the Santa Fe River, which in fact flows instead to the well field. More broadly, it therefore under-estimates the extent to which any investments in return flow (artificial recharge, aquifer storage and recovery, etc) will result in a benefit to the City and the river.

Figure 15 and Figure 16 compare the model-simulated groundwater surface to the May 2001 and May 2002 groundwater surfaces measured by the SJRWMD in the vicinity of Fernandina Beach, where the UFA groundwater surface is known to be impacted by pumping. [65,66] These maps reveal that the model’s inability to reasonably simulate the response of the UFA to stress due to pumping is not limited to the Gainesville area. In the Fernandina area, the model under-predicts the impact of pumping by approximately 35 feet. The impacts of unreasonably simulating the cone-of-depression occur both locally and regionally. Local impacts are demonstrated by the magnitude of the difference between the simulated and measured depth of the cone-of-depression. Regional impacts are manifest by the difference in the size and location of the simulated capture zone. In the case of the Fernandina area, those regional differences affect the location of simulated groundwater divides that, in turn, affect model-simulated flow to the upper Suwannee River basin.

4.4.4 5-foot Calibration Criterion

As described in Section 3.4, setting the calibration criterion to 5% of the total change in groundwater surface elevation across the model domain is simply a rule-of-thumb. Since the NFM-08 was calibrated to average groundwater elevations derived from a 12-month period, there was sufficient data available to define criteria or a criterion that reflects the observed range. Five or more groundwater elevation measurements recorded during the calibration period were available for 175 of the 475 wells obtained from the SRWMD that were part of the SDII calibration process. The average recorded range in groundwater elevations for those wells was 3.2 feet. A range of less than three feet was recorded in more than half of those wells (55%) and less than the 5-foot criterion chosen by SDII in 87% of the wells. Based on these statistics, a target calibration criterion of 3.5 or 4 feet would have been more reflective of the actual observed range in groundwater elevations, particularly since SDII chose to enforce the criterion only on the average of absolute residuals rather than on the wells individually.

Table 5 compares histogram values for the observed range in groundwater elevations at the 175 wells with five or more measurements during the calibration period to the associated absolute residuals produced by the model for the 175-well subset and the full 534-well record. The statistics show that water levels varied by more than 9 feet in only about 1% of the subset wells whereas approximately 12% - 13% of the model residuals exceeded that value again indicating that the 5-foot calibration criterion was too broad. Figure 17 shows the bin values and cumulative percentages graphically.

Table 5. Range in observed groundwater elevations during the calibration period at select SRWMD wells and calibration residuals at those and all SRWMD wells.

bin (ft)	# subset wells with smaller head range	# residuals from subset with smaller value	# residuals from full set with smaller value	% subset wells with smaller head range	% residuals from subset with smaller value	% residuals from full set with smaller value
1	20	34	88	11.4%	19.4%	16.5%
2	48	69	187	27.4%	39.4%	35.0%
3	97	98	265	55.4%	56.0%	49.6%
4	127	117	331	72.6%	66.9%	62.0%
5	152	133	385	86.9%	76.0%	72.1%
6	161	143	422	92.0%	81.7%	79.0%
7	168	147	439	96.0%	84.0%	82.2%
8	172	154	457	98.3%	88.0%	85.6%
9	173	158	468	98.9%	90.3%	87.6%
10	173	159	479	98.9%	90.9%	89.7%
12	174	161	498	99.4%	92.0%	93.3%
14	174	165	508	99.4%	94.3%	95.1%
16	174	167	515	99.4%	95.4%	96.4%
18	174	169	521	99.4%	96.6%	97.6%
20	174	169	522	99.4%	96.6%	97.8%
22	175	171	526	100.0%	97.7%	98.5%
24	175	173	529	100.0%	98.9%	99.1%
26	175	173	529	100.0%	98.9%	99.1%
28	175	173	530	100.0%	98.9%	99.3%
30	175	173	532	100.0%	98.9%	99.6%
32	175	173	532	100.0%	98.9%	99.6%
34	175	174	533	100.0%	99.4%	99.8%
36	175	175	534	100.0%	100.0%	100.0%
38	175	175	534	100.0%	100.0%	100.0%

Notes:
subset = 175 wells with 5 or more groundwater elevation measurements recorded by the SRWMD during the calibration period
full set = 534 wells with 1 or more measurements recorded by the SRWMD and the ACEPD during the calibration period
cells highlighted in yellow denote the bin for observed groundwater level variation and absolute magnitude of residuals at which at least 90% of the values are less than

4.4.5 Tracer-Defined Flow Paths & Velocities

Figure 18 compares flow paths simulated by the NFM-08 to connections established by groundwater tracing. A reasonable expectation for a model intended to predict impacts to specific springs, rivers, and wells would be a reasonable approximation (or calibration to) known connections between different locations in the aquifer. Six such known connections, as well as the groundwater flow velocities between the connected locations, had been established prior to the development of the NFM-08.

Figure 18 (top) shows tracer-defined connections between three sources of direct recharge to the UFA (Black Sink, Dyal Sink, and Rose Creek swallets) and select springs discharging to the Ichetucknee River. [55] The tests revealed that flow from the three sinks traveled specifically to Blue Hole, Mission, and Devil's Eye Springs and not to Ichetucknee Head, Cedar Head, Mill Pond or Grassy Hole Springs. [55] The NFM-08 cannot discriminate different flow paths and thus different springsheds for Ichetucknee Head, Cedar Head, Blue Hole, and Mission Springs because all of those springs were assigned to the same model cell. Similarly, the model grouped Devil's Eye, Grassy Hole, and Mill Pond Springs into a single cell located immediately south (downstream) of the cell containing the head springs. The model correctly simulated the flow path from the Rose Creek swallet to Blue Hole but, because of the spring groupings, failed to show that Blue Hole and Inchetucknee Head Springs derive water from distinctly separate sources. The model incorrectly simulates flow paths between Dyal and Black Sinks and the springs because it fails to show that the water travels through Rose Creek Swallet before discharging at the springs and it shows that part of the flow reaching Devil's Eye, Grassy Hole, and Mill Pond Springs travels upstream to Ichetucknee Head, Cedar Head, Blue Hole, and Mission Springs.

Figure 18 (bottom) shows tracer-defined connections between three sources of direct recharge to the UFA (Lee Sink, Mill Creek Sink, and O'leno Sink swallets) and the River Rise and Hornsby Spring at the upper end of the western Santa Fe River. The connection between O'leno Sink and the River Rise has been well established since 1991 through artificial and natural tracer tests. [54,56,57] The connections between Lee Sink and Mill Creek swallets and Hornsby Spring were established in 2006 through dye tracing. [58] Those traces revealed a strong connection to Hornsby Spring, a weaker connection to Darby Spring, located immediately downstream of the Hornsby Spring run and east of Highway 441, and no connection to the downriver springs.

The NFM-08 correctly simulates the established connection between O'leno Sink and the River Rise. However, the NFM-08 fails to simulate the connection between Mill Creek and Lee Sinks and Hornsby Spring and instead shows flow from those swallets to the downriver springs including Poe, Gilchrist Blue, July, and Ginnie Springs for which the tracer tests indicated no connections. The failures of the model to reasonably simulate these observed connections are indication of an inadequate aquifer conceptualization and an insufficiently rigorous calibration process.

As discussed in *Section 3.4.3*, a porous media model will not be able to adequately simulate real-world groundwater velocities as determined by travel times established through groundwater tracing unless unrealistically low porosity values are assigned during the process of exporting simulating flow paths (particle tracking). A typical porosity value that has been observed to work in other models is 1% (as opposed to the 20% or 30% values characteristic of the limestones that constitute much of the Floridan aquifer).

Table 6 lists the observed connections and travel times determined through artificial groundwater tracing in the western Santa Fe River Basin relative to the travel times and corresponding groundwater velocities simulated by the NFM-08. Travel time comparisons can only be made for three of the eight connections because the NFM-08 did not correctly simulate the other 5 connections. A porosity value of 0.1% is required in order for the NFM-08 to approximate the observed travel-times (and thus groundwater velocities) between those connections and even then the simulated travel time between O'leno Sink and the River Rise remains 40 times too slow.

Table 6. Comparison of flow paths, travel times and groundwater velocities determined through artificial groundwater tracing and simulated by the NFM-08.

Observed Data			NFM-08			
Flow Path			30% Porosity		0.1% Porosity	
Injection	Discharge	Travel Time	Travel Time	Velocity	Travel Time	Velocity
Black Sink	Rose Sink Swallet	25-34	***no***	***no***	***no***	***no***
Black Sink	Ichetucknee Headspring	ND	65,403	1	218	300
Black Sink	Cedar Head Spring	ND	65,403	1	218	300
Black Sink	Blue Hole Spring	65-92	65,403	1	218	300
Black Sink	Mission Spring Group	65-92	65,403	1	218	300
Black Sink	Devil's Eye Spring	65-123	63,681	1	212	300
Black Sink	Grassy Hole Spring	ND	63,681	1	212	300
Black Sink	Mill Pond Spring	ND	63,681	1	212	300
Dyal Sink	Rose Sink Swallet	34-125	***no***	***no***	***no***	***no***
Mill Creek Sink	Hornsby Spring	12-28	***no***	***no***	***no***	***no***
Mill Creek Sink	ALA930971	*na*	18,119	2	60	659
Mill Creek Sink	Poe / Lilly Spring Group	ND	19,047	2	63	710
Mill Creek Sink	COL101974	*na*	20,143	2	67	747
Mill Creek Sink	Rum Island / Gilcrist Blue Group	*na*	21,426	3	71	773
Mill Creek Sink	Ginnie / Devil's Ear Group	*na*	22,837	3	76	791
Lee Sink	Hornsby Spring	28-59	***no***	***no***	***no***	***no***
Lee Sink	Poe / Lilly Spring Group	ND	32,802	2	109	550
Lee Sink	COL101974	*na*	33,757	2	113	576
Lee Sink	Rum Island / Gilcrist Blue Group	*na*	35,040	2	117	600
Lee Sink	Ginnie / Devil's Ear Group	*na*	36,452	2	122	618
O'leno Sink	Santa Fe River Rise	1	12,066	1	40	398

4.5 Aquifer Permeability Framework

Figure 19 shows the permeability framework assigned in the calibrated version of the NFM-08 (top) relative to the equivalent type of unconsolidated material known to have a similar hydraulic conductivity (bottom). As can be seen by comparing the two plots, the NFM-08 essentially assumes that the UFA is extremely conductive comprising material similar to cobbles and boulders throughout much of the model domain. The plot also reveals that the distribution of simulated hydraulic conductivities bears no resemblance to any form of geologic zonation or variation. Instead, the values were defined purely through model calibration in order to match observed groundwater levels. The NFM-08 values represent a gridded distribution of values created from a set of control points (pilot points) using a form of PEST (automated parameter estimation – *see Section 3.4.4*) where each of the individual control-point values was allowed to vary across the full range of values represented in the entire control point dataset. [8]

Significant deviations in both the magnitude and distribution of hydraulic conductivities exist when comparing the NFM-08 values to reported values (in the form of transmissivity) based on aquifer test data (Figure 20 and Figure 21) that were published by the USGS in 1990 [67] and 2012. [32] The 2012 USGS transmissivity map is based on an interpolation of 1,487 aquifer tests that produced a grid of transmissivity in the UFA with a range between 2,400 to 520,000 feet squared per day. [32] The 1990 USGS map is based on aquifer tests, geology, and simulation and shows a range in transmissivity for the UFA between <10,000 and >1,000,000 feet squared per day. [67] By comparison, the equivalent NFM-08 transmissivity values range from 2,300 to 9,654,000 feet squared per day.

With respect to the differences in magnitude, it is assumed here that any value within one order of magnitude of measured field data would be within reasonable bounds for model assignment (overall a two order of magnitude range). This is because aquifer transmissivity (and related hydraulic conductivity) is known to be scale-dependent due to heterogeneity in the aquifer material where transmissivity measured at the kilometer scale (e.g. from long-term aquifer pumping tests) will be larger than values measured at the meter scale (e.g. from slug-tests), which are larger than the values measured at the centimeter scale (e.g. lab experiments). [27,28] With this in mind, Figure 22 shows the difference between the NFM-08 transmissivity values and those reported on the 2012 and 1990 USGS maps using an order of magnitude scale. Both comparisons reveal that the NFM-08 transmissivity values differ from the USGS values by more than 1 order of magnitude over much of the NFM-08 domain (56% relative to the 2012 values and 24% relative to the 1990 values) where much of those deviations are higher (~18% of the 2012 deviation area is marked by values more than 2 orders of magnitude higher). These comparisons indicate that the SDII values are unreasonably high throughout most of the northeast quadrant of the model domain. The comparison with the 2012 USGS map indicates that the NFM-08 values are also unreasonably high throughout most of the Suwannee and Santa Fe River basins.

With respect to the distribution of the transmissivity values, both USGS maps reflect a general pattern that reflects hydrogeologic conditions. Such a pattern is to be expected, and is borne out by the aquifer test data, because transmissivity (aquifer permeability) is a rock property that is related to the depositional environment in which the rocks were deposited and the amount of dissolution that has taken place after deposition. The most transmissive regions of the UFA are associated with unconfined conditions where high recharge has enhanced karstic dissolution particularly near large springs known to derive water from extensive conduit systems (e.g. 1st and 2nd magnitude springs along the Western Santa Fe River and the Suwannee River, Silver Springs, and Rainbow Springs). The least transmissive regions are associated with confined conditions that limit recharge and have less karstic dissolution (e.g. the eastern part of the state) and in areas where the limestones in the UFA consist of fine-grained lower permeability material (e.g. the Gulf Trough-Apalachicola Embayment regions). Regardless of the actual transmissivity values, a reasonable model should reflect a spatial distribution of transmissivity that can be defined from data and/or reflected by established hydrogeologic zonation.

Figure 23 compares the NFM-08 equivalent transmissivity values to the 2012 USGS values where the distribution of values on both maps have been classified to show variation at a half order of magnitude scale in order to emphasize zonation. Comparison of the two maps at that scale clearly reveals that the distribution of the NFM-08 transmissivity values fails to correspond to the known hydrogeologic zonations in north Florida. This is likely a result of overly broad constraints placed on PEST during the model calibration and indicates that the SDII values are merely an artifact of model calibration designed to yield an expedient correlation between simulated and observed groundwater elevations. By example, much of the lower permeability zones defined in the NFM-08 correlate with the river corridors, which is contrary to what is known about the extensively karstified limestones along the rivers. The resulting model permeability framework cannot therefore be considered to be constrained by known and available data, nor reasonably represent well established and accepted Floridan aquifer characteristics.

The substantial differences between the NFM-08 hydraulic conductivity values and the equivalent measured transmissivity values can be attributed to lack of rigor in the calibration. The NFM-08 relies on unreasonably high hydraulic conductivities to deliver the observed flows. The resulting problems are disguised by the chosen calibration target which relied only on the absolute average of residuals rather than on the individual residuals or on reasonably matching observed local hydraulic gradients. Deviations from established permeability values and distributions are significant because the model-simulated size and depth of a cone-of-depression around a pumping well are inversely proportional to the magnitude of the hydraulic conductivity. Larger impacts are simulated in zones that have low hydraulic conductivity than in zones that have high hydraulic conductivity (*see Section 2.4*). The propensity of the NFM-08 to under-predict the impacts of pumping is demonstrated by the difference between the simulated and measured capture zones for the Gainesville well field (Figure 12, Figure 13, and Figure 14) and the cone-of-depression that has developed beneath Fernandina Beach (Figure 15 and Figure 16). In both cases, the dramatic discrepancies are a function of unrealistically high hydraulic conductivity values.

4.6 Recharge

Recharge in the NFM-08 was not constrained by measurable groundwater discharge as was discussed in *Section 3.6.* Instead, both the magnitude and distribution of recharge were established through the calibration process using measured rainfall and estimates of ET and runoff to constrain the range of values that PEST was able to assign. [8] The problem with this method is that the constraints permit a broad range of assigned values which result in a total flux of water through the model that is in no way constrained by available data. Because recharge and river and spring discharges were incorporated into the calibration process, the established magnitude of recharge was required to be large enough to accommodate the measured river and spring flows. The rainfall, ET, and runoff constraints were however permissive of larger values that could result in substantially higher than measured flow through the simulated aquifer system. With a precipitation range of 32 in/yr to 68 in/yr, an ET range of 27 in/yr to 46 in/yr and a runoff range of 1 in/yr to 7 in/yr, the permissible range of recharge across the model domain is 0 in/yr to 40 in/yr.

Regardless of how recharge is established, the distribution across the simulated land surface should follow reasonable correlation to three factors that are known to strongly influence recharge:

- rainfall, which is the source of recharge;
- land surface slope, which affects runoff and therefore recharge; and
- land use, which determines the permeability of the land surface as well as ET.

The following analysis focuses on the reasonableness of the distribution of recharge assigned in the NFM-08. Specifically, the objective was to determine if the calibrated distribution of recharge can be supported by hydrogeologic conditions, or if it was simply derived to minimize calibration error. If the values differ greatly from what should be expected from existing conditions, then less confidence should be prescribed to the resulting model simulations and predictions. A comparison between the assigned values and measured groundwater discharge in select watersheds within the unconfined region of the UFA was also performed to provide another check on the reasonableness of the recharge assignments.

4.6.1 Correlation to Hydrologic Factors

Recharge in the NFM-08 was assigned to 85 polygons that subdivide the model domain. The average of the assigned values was 12 in/yr. The distribution of the values ranged from 0.44 – 19.6 in/yr, where the lowest values occurred in unconfined regions of the aquifer where recharge is expected to be highest including the central part of the southwestern Santa Fe River basin (Figure 24).

The calibration process leveraged PEST to define a distribution of recharge and hydraulic conductivity values that resulted in a simulation of groundwater levels that deviated from the observed conditions by <= 5.0 feet on average. With respect to recharge, the values were assigned to Thiessen polygons, which defined areas of influence around the distribution of precipitation stations in the model domain. The purpose of the polygons was to foster variation that could be attributable to rainfall. PEST was then allowed to vary the recharge value in each polygon within a prescribed range that was based on measurements of precipitation and estimates of ET and runoff.

Figure 25 and Figure 26 show gridded distributions of precipitation and ground surface slope across the model domain and the respective average values for each of the Thiessen polygons used to assign the SDII recharge values. Precipitation values were obtained from all of the NOAA climate stations in the model domain containing a complete record for the time period June 1, 2001 to May 31, 2002. Ground surface slope values were obtained through Arc GIS using the Florida 30-meter National Elevation Datasets (NED) covering the model domain.

A Pearson correlation coefficient (PCC) analysis was performed to measure the strength of the linear dependence between recharge and precipitation and recharge and ground surface slope. The PCC analysis yields values between -1 and +1. A +1 value reflects a perfect positive (increasing) linear relationship (correlation) between the two variables. A -1 value reflects a perfect decreasing (negative) linear relationship, and some value between -1 and +1 marks the degree of linear dependence between the variables. A value of 0 implies that there is no correlation between the variables.

The relationship between recharge and precipitation is not expected to be perfectly linear but should be positive meaning that more precipitation should generally equate to more recharge. The correlation isn't expected to be perfect because increased precipitation also equates to increased runoff and ET. In general, a PCC of between +0.5 and +1.0 was considered consistent with the expectation in north Florida and therefore a reasonable correlation. Similarly, there is also a reasonable expectation of a correlation between recharge and the slope of the ground surface where steeper slopes tend to result in more runoff and less recharge. Because of the inverse relationship, the expected PCC in areas of higher topographic slope is negative and a value between -0.5 and -1 was considered to be a reasonable correlation.

The results of PCC analysis revealed a PCC of +0.169 for model-assigned recharge relative to measured precipitation, and +0.123 for model-assigned recharge relative to ground surface slope (Figure 27). The very small magnitude of the two PCC values reveals that there is essentially no correlation to either variable and indicates that the NFM-08 recharge values were not based on a direct correlation to these measureable hydrologic factors. The analysis was however carried one step further in order to determine if the correlations are stronger when considering the effect of land use.

To do this, the recharge polygons were grouped according to the dominant land use in each polygon. Land use assignments were compiled from the Northwest Florida Water Management District, [68] the Suwannee River Water Management District, [69] the St Johns River Water Management District, [70] and the Southwest Florida Water Management District [71] (Figure 28 – Top). The correlation analyses were limited to the subset of polygons that were at least 90% covered by the land use maps. For each of the resulting polygons, a group was established containing it and all other polygons with similar distributions of four types of land use: upland forest, agriculture, wetland, and urban where the test for similarity was a coefficient of determination (RSQ) of greater than 0.89 (Figure 28 – Bottom). The precipitation and ground surface slope correlation analyses were then performed for the members of each group. The recharge polygons and recharge values assigned in the NFM-08, along with the average precipitation, average ground surface slope, land use distribution and correlations, and the resulting PCCs representing the correlation between recharge and precipitation and ground surface slope for each polygon's land use group are presented in Appendix 5.

The results of the correlation analyses relative to land use are depicted in Figure 29. Nineteen (19) of the 85 Thiessen polygons were omitted from the correlation analyses due to a lack of land use coverage or the absence of a correlation in dominant land use type to other polygons. Of the 66 polygons that were included in the correlation analyses, only 10 display a correlation to measured precipitation that meets the expectation and only 2 display a correlation to ground surface slope that meets the expectation. The 10 polygons meeting the expected correlation to precipitation were predominantly located in the eastern part of the model domain where the UFA is confined. None were located in the central part of the domain in the Suwannee River basin. The 2 polygons meeting the expected correlation to ground surface slope were both located in the southwestern part of the model domain along the Gulf of Mexico coast.

Thirty-three (33) of the polygons displayed a correlation to precipitation opposite of the expectation meaning that the assigned recharge was lower in polygons with higher precipitation, and 32 of the polygons displayed a correlation to ground surface slope opposite of the expectation meaning that assigned recharge was higher in polygons with steeper land surface slope. The majority of the polygons displaying a correlation to precipitation opposite of the expectation occur in the central part of the model domain in the Suwannee River basin. The polygons displaying a correlation to ground surface slope opposite to the expectation were distributed across the model domain. The remaining polygons in each case showed very weak or no correlation to the respective variables. These analyses indicate that the NFM-08 recharge values were not based on a correlation to measureable hydrologic factors even when considering varying land use across the model domain.

4.6.2 Correlation to Measured Watershed Flows

This section compares the magnitude and distribution of recharge assigned in the NFM-08 to estimates of sub-watershed scale recharge that can be conservatively derived from available stream flow data as described in Section 3.6. The analysis pertains to 6 sub-watershed basins covering the central and western part of the NFM-08 domain (Figure 30).

4.6.2.1 Groundwater Discharge by Basin

Table 7 lists the equivalent recharge required to supply the observable groundwater discharge from the 6 sub-watershed basins for which stream flow data was available for the NFM-08 model calibration period (June 1, 2001 to May 31, 2002). The table also lists the magnitude of groundwater pumping assigned in the NFM-08 within the basins and estimates of leakage into the UFA through the upper confining unit for the 2 basins that extend into the confined portion of the UFA. Surface water extraction was estimated from county data for the year 2000. [72] Surface water extraction is an estimate of consumptive use (not returned to the system) based on percentages for use-type. [72] The three terms were used to calculate groundwater discharge from the basins according to:

Basin Groundwater Discharge = River Gain + GW/SW Extraction - Leakage

where: River Gain is the difference between upstream and downstream gauged flows;
GW/SW Extraction is the total pumping assigned in the NFM-08 within the basin + the consumptive component of river extractions for commercial use and power generation; and
Leakage is the estimated inflow to the UFA through the upper confining layer in the basin.

The equivalent recharge required to supply the groundwater discharge for each basin was then calculated according to:

Equivalent Basin Recharge = Basin Groundwater Discharge / Basin Area (converted to in/yr)

The stream flow data used to define recharge in 6 control basins (average of mean daily discharge over the model calibration period) was obtained from the USGS stream gauges accessible via the Internet. The Upper Econfina, Upper Fenholloway, Upper Steinhatchee, and Wacasassa Rivers exist completely within the unconfined portion of the UFA, therefore discharge measured at a mid-river station could be assumed to represent the total groundwater discharge into the basin area above the gauge. There is no significant topographic divide separating the Econfina and Fenholloway drainage basins which means that a persistent hydrologic divide is unlikely to exist. Therefore, the two basins were combined and analyzed as a single unit. In addition, the Fenholloway gauge (02325000) is above the confluence with Spring Creek, a significant drainage feature between the Econfina and Fenholloway Rivers. No discharge data exist for Spring Creek for the NFM-08 calibration period. However, Spring Creek and Fenholloway discharge was simultaneously measured on a daily basis from May 1992 through May 1993. An analysis of discharge for the two drainage systems during this period showed that on average, Spring Creek discharge (02325495) was 58% of Fenholloway discharge. This relationship was applied to the 2001-2002 Fenholloway discharge data in order to estimate discharge for Spring Creek in this analysis. Table 7 shows the discharge data for the three Upper Econfina-Fenholloway basin gauges which were summed to yield the total discharge for the basin.

Stream flow in the Upper Suwannee River and the Western Santa Fe River is a combination of groundwater discharge and runoff from the part of the watersheds where the UFA is confined. Groundwater discharge into these river sections was therefore defined as the difference between the upstream and downstream gauges. For the Upper Suwannee River, these were the upstream Ellaville gauge (02319500) and the downstream Branford gauge (02320500). For the Western Santa Fe River, these were the upstream Worthington Springs gauge (02321500) and the downstream Fort White Gauge (0233500). Similarly, groundwater discharge to the Lower Suwannee River was defined as the difference between the sum of two upstream gauges (Branford, 02320500 and Fort White, 02322500) and the downstream Gopher Hole gauge (02323592).

Table 7. Measured groundwater discharges and the equivalent required recharge in sub-watershed scale basins within the NFM-08.

Basin	Map ID	USGS Gauge ID	Gauge Discharge	Basin Groundwater Discharge				Basin Area	Equivalent Basin Recharge
				River Gain	GW/SW Extraction	Leakage	Total		
Upper Econfina-Fennholloway	1	02326000	39	190	47	*na*	231	465	6.9
		02325000	94						
		02325495	55*						
Upper Steinhatchee	2	02324000	233	233	0.5	*na*	234	374	8.5
Upper Suwannee	3	02319500	2336	560	45	*14.5*	620	865	9.7
		02320500	2896						
Lower Suwannee	4	02322500	2896	1034	61	24	1071	1100	13.2
		02320500	643						
		02323592	4574						
Waccasassa	5	02313700	112	112	8	*na*	120	267	6.1
Western Santa Fe	6	02321500	90	553	97	64	586	963	8.3
		02322500	643						

Units: discharge, river gain, pumping, leakage = cfs; basin area = square miles; basin recharge = in/yr

Notes:
Map ID = ID # shown on Figure 30 and Figure 31
River Gain = lowest gauge discharge – upper gauge discharges shown
Pumping = sum of all pumping assignments in the NFM-08 that fall within the basin boundaries
Leakage = inflow to the UFA through the upper confining layer within the basin assuming a leakance rate of 2 in/yr
Total = River Gain + Pumping – Leakage
Basin Recharge = total discharge converted to in/yr using the basin area
* = estimated

Basin areas were delineated using ArcGIS and the Watershed Boundary Dataset (WBD) at the HUC-12 scale obtained from the US Department of Agriculture (USDA). They are depicted on all of the maps shown on Figure 30 and Figure 31. Leakage was estimated using a leakance of 2 in/yr through the confining layer over an area equal to the portion of the confined region of the UFA that contributes flow to the Western Santa Fe River and the Lower Suwannee River basins as defined by the May 2002 potentiometric surface map for the UFA published by the SJRWMD.

The reasonableness of the resulting recharge values was checked by comparing the ET rate for each basin derived from the estimated recharge (Basin ET) to the ET rates provided in the SDII report [8] and the potential ET (PET) rates for the basins reported by the USGS. Basin ET was estimated by subtracting the estimated recharge value from precipitation for each basin derived from the map developed for the model calibration period (Figure 25). Basin ET ranged from 33.6 in/yr to 46.5 in/yr across the 6 basins with the maximum value in the most coastal Wacasassa River basin and the minimum value in the inland Suwannee River basins. By comparison, the SDII report cited the mean annual ET rate for the region to be 40.8 in/yr with a range of 27 in/yr to 46 in/yr. [8] The USGS reported PET for the 6 basins to be between 46.7 in/yr to 47.6 in/yr for the model calibration period with the highest PET in the Wacasassa River basin and the lowest in the Upper Suwannee River basin. [73] The favorable comparison in both cases supports the reasonableness of the estimated ET and therefore the reasonableness of the recharge values estimated from gauged basin stream/river gains. The recharge values presented in Table 7 should however be considered maximum values because, though surface runoff is expected to be small due to the unconfined hydrologic setting, it is not accounted for in the gauged river gains.

4.6.2.2 Comparison to NFM-08 Recharge

Recharge in the NFM-08 consists of two components: an assigned recharge value and a simulated ET, where actual recharge to the simulated aquifer equals:

Aquifer Recharge = Assigned Recharge – Simulated ET.

The equivalent recharge in the NFM-08 per basin is shown in Figure 30. Comparisons between the basin-wide recharge values determined on the basis of measured stream flows, and the equivalent NFM-08 values are reflected by the difference between the two sets of values where:

Difference = NFM-08 Recharge – Basin Discharge Based Recharge.

The results are shown in Figure 31 and Table 8 where they are reported in terms of in/yr and cfs per basin. The result of the comparison shows that the NFM-08 over-estimates recharge into 5 of the 6 basins by a total of 472 cfs and under estimates 1 of the 6 by a total of 241 cfs for a total difference of +231 cfs. The largest discrepancies occur in the coastal basins where the NFM-08 prescribes 1.6 times as much inflow to the Upper Steinhatchee basin than discharges to the river and 1.5 times as much as discharges to the Upper Econfina-Fenholloway. The discrepancies are less in the central part of the domain but the prescribed inflows are still more than the measured river gain to the Upper Suwannee River by 1.2 times.

The discrepancies become considerably worse when considering that the NFM-08 includes 3 additional sources of recharge to the UFA: 1) injection wells intended to represent siphon inflows, 2) inflow from river nodes, and 3) inflow from general head nodes. The model contains 4 siphon injections within the 6 basins addressed in the recharge analysis, all along the Santa Fe River. The locations of siphon injections are shown on Figure 30 and Figure 31. Table 9 lists the prescribed inflows, the resulting change in effective model-defined recharge per basin, and the effect of the prescribed inflows on the comparison between total model-assigned recharge and measured groundwater discharge from the sub-watershed basins. The largest impact, due mostly to the siphon injections, occurs in the Western Santa Fe River basin where the discrepancy between the total model-defined inflows to the UFA and the measured groundwater discharge rises from 85 cfs to 555 cfs, and the discrepancy over the 6 basins analyzed rises from 231 cfs to 760 cfs when considering the other sources of inflows in the model (Table 8 and Table 9).

Table 8. Comparison of sub-watershed basin recharge as defined by the NFM-08 and the equivalent recharge needed to match measured stream flows.

Basin	Map ID	NFM-08 Values (in/yr)			Discharge Based Recharge	Difference		
		Assigned Recharge	Simulated ET	Effective Recharge		In/yr	cfs	% Basin Discharge
Upper Econfina-Fenholloway	1	13.3	2.7	10.6	6.9	3.7	126	53%
Upper Steinhatchee	2	18.4	5.1	13.3	8.5	4.8	132	57%
Upper Suwannee	3	11.8	0.5	11.3	9.7	1.6	99	16%
Lower Suwannee	4	11.2	1.0	10.2	13.2	-3.0	-241	-22%
Waccassa	5	9.2	1.6	7.6	6.1	1.5	30	25%
Western Santa Fe	6	10.6	1.1	9.5	8.3	1.2	85	14%

Notes:

Assigned Recharge = the equivalent recharge for the respective basin determined from the values assigned in the NFM-08 to the Theissen polygons and weighted by the percentage of the polygons within the basin boundaries.

Simulated ET = the equivalent ET for the respective basin determined from the values exported from the NFM-08 cells and weighted by the percentage of the cells within the basin boundaries.

Effective Recharge = Assigned Recharge – Simulated ET.

Discharge Based Recharge = equivalent recharge required to supply the measured stream flows plus groundwater pumping within the respective basin as defined in the NFM-08.

Difference = NFM-08 Effective Recharge – Discharge Based Recharge.

% Basin Discharge = NFM-08 Effective Recharge / Discharge Based Recharge.

Table 9. Effect of siphon inflows defined in the NFM-08 on the comparison between model recharge and the equivalent recharge needed to match measured stream flows.

		NFM-08 Values				Discharge	Difference	
Basin	Map ID	River & GH Inflow	Siphon Inflow	Effective Recharge	Total Recharge	Based Recharge	(cfs)	% Basin Discharge
Upper Econfina-Fenholloway	1	44.4	0	10.6	11.9	6.9	171	72%
Upper Steinhatchee	2	3.3	0	13.3	13.4	8.5	136	58%
Upper Suwannee	3	0.2	8.6	11.3	11.4	9.7	108	17%
Lower Suwannee	4	0	0	10.2	10.2	13.2	-241	-22%
Waccassa	5	1.7	0	7.6	7.7	6.1	31	26%
Western Santa Fe	6	109.3	361.3	9.5	16.1	8.3	555	95%

Notes: See Table 8

The substantial discrepancy between the model-defined recharge (with or without the other inflow assignments) and the recharge needed to meet observable groundwater discharge from the 6 sub-watershed basins covering the central and western portion of the model domain strongly indicates that the model specifies too much recharge to the UFA. The significance of assigning too much recharge in the model is three-fold.

First and foremost over-assigning recharge causes the model to significantly over-estimate the total amount of groundwater flowing through the UFA and thus overestimates the amount of groundwater available for consumption as well as the amount available to sustain environmental flows. An example of this overestimation is the difference between the NFM-08 simulated discharge from the UFA to the Fenholloway River between the Gulf Coast and the confluence with Spring Creek and the amount indicated from stream gauging data. As described in Section 4.6.2.1, an estimate of the groundwater gains for this section of the river was derived from data collected between May 1992 and May 1993. That timeframe was a low-water period but does not correspond exactly to the NFM-08 calibration period. It does however represent a slightly higher-water condition than the model calibration period indicating that the data is a reasonable proxy for the modeled conditions.

Those data show the lower section of the Fenholloway basin to be losing flow to the UFA at a rate of 141 cfs (Figure 32), which was approximately 49% of the upstream flow, and that the river lost water during the entirety of the one-year period of record. Applying the same percentage loss to the measured and estimated upstream flow during the 2001-2002 period (Table 7) reveals a probable loss to the UFA from the Fenholloway River during the NFM-08 calibration period of approximately 73 cfs ((94+55)*0.49). Comparing that value (-73 cfs) to the simulated gain from the UFA to the Fenholloway by the NFM-08 (+24 cfs) reveals an imbalance of at least 97 cfs.

Second and more specifically, over-assigning recharge causes the impacts to river and spring flows due to groundwater extractions to be under-estimated. By example, consider that a hypothetical 5 MGD (7.7 cfs) expansion in groundwater pumping for the City of Perry in the Upper Econfina-Fenholloway basin. Such an extraction would represent 3.2% of the total measured groundwater discharge in the basin yet a model like the NFM-08 would simulate the majority of, if not all of the impact occurring to the coastal discharge rather than the river discharges. This is because models in which recharge greatly exceeds basin discharge simulate more groundwater flow than can be accommodated by the rivers wherein flow paths pass through the river cells and ultimately discharge to the lowest assigned heads, which in this case are along the Gulf of Mexico coast. By comparison, models constructed such that basin recharge is constrained by basin discharge will simulate most if not all of the impact occurring as loss of groundwater discharge to the rivers. This is because the majority of the simulated groundwater flow paths within the basin would be forced to converge on the rivers in order to produce a model that calibrates to the observed river gains or losses. In such cases, the locations and types of natural groundwater discharge impacted by groundwater pumping are consequences of the chosen model design where designs in which recharge is constrained by measured discharge better honor the available data and produce substantially more conservative predictions of impacts.

Figure 33 shows groundwater flow paths simulated by the NFM-08 relative to the river basin boundaries. Analysis of the simulated flow paths reveals that, while flow to the Suwannee and Santa Fe Rivers is fairly well constrained within the river basins, almost all of the simulated flow through the Econfina, Fenholloway, Steinhatchee, and Wacasassa basins is to the Gulf of Mexico coast rather than to the rivers. None of the simulated flow terminates at Econfina or Fenholloway river nodes. Because of this, the model is not capable of simulating impacts to the rivers due to pumping (as per say from the hypothetical expansion groundwater pumping for the City of Perry) because most of the simulated flow is to the coast.

Finally, the elevated recharge assignments impacted the hydraulic conductivity assignments and thus the simulated groundwater flow patterns and velocities. This is because the calibration process was allowed to vary both recharge and hydraulic conductivity as needed in order to approximate the observed groundwater levels where relatively high levels can be simulated through the use of either high recharge or low hydraulic conductivity and conversely low levels can be simulated using either low recharge or high hydraulic conductivity. Where high groundwater elevations were needed, the high recharge values enabled PEST to achieve calibration using high hydraulic conductivity values whereas lower recharge would have necessitated lower hydraulic conductivities to achieve the same calibration. In the western part of the model domain, this would have reduced simulated travel times and directed groundwater flow paths away from coast to the rivers. Both types of parameter configurations (high recharge/high hydraulic conductivity, lower recharge/lower hydraulic conductivity) can be used to produce similar calibrations but the lower recharge/lower hydraulic conductivity configuration would have been more consistent with the available data and produced a more conservative model.

In summary, the results of these analyses indicate that, though the determination of recharge is to some degree subjective because it cannot be measured directly, the NFM-08 values are significantly larger than what can be supported by available data and that the method used to assign recharge in the NFM-08 was certainly not conservative. This is particularly true when considering the addition of the siphon inputs, river losses, and boundary inflows as recharge. In terms of application, the effect of high recharge assignments is to reduce model-simulated impacts of groundwater pumping on the magnitude of groundwater discharge to springs and rivers, particularly in the coastal river basins.

4.7 Water Balance

As described in Section 3.2, a model's water balance describes the degree to which the simulated inflows equal simulated outflows, and the distribution of those inflows and outflows to the various sources and sinks defined in the model design. As is also discussed in Section 3.2, inflows and outflows in most models will very closely match. This is true for the NFM-08. An evaluation of the distribution of simulated flows, while being substantially more subtle, is crucial because the distribution dictates how and where the model will simulate the impacts of changing conditions, such as increases in the magnitude and/or distribution of groundwater pumping. The simulated distribution of flows, particularly outflows, is therefore the focus of this section.

Table 10 shows the distribution of inflows and outflows in the NFM-08 as they were listed in the SDII report [8] and as they were derived from the version of the model downloaded from the SRWMD website. [63] The table also breaks out the fraction of the total simulated flux through the UFA. Three issues are of concern: 1) a discrepancy between simulated spring and river flows and measured values derived from the available data for the model calibration period; 2) the distribution of a substantial portion of the simulated flux through the UFA to external model boundaries (~38%) and the effect that distribution has on the model's ability to simulate the impacts of groundwater pumping to spring and river flows; and 3) discrepancies between the reported values and the values derived from the actual model, which are also discussed in Section 5.

Table 10. Component flux values derived from the water budget exported from pumping (calibrated version) and no-pumping condition versions of the NFM-08 obtained from the SRWMD.

	Component of Simulated Flow	Full Extent of Model					Approximate UFA		
		Model Flux	% Total	No Pump Flux	Effect of Pumping	% Total Pumping	Model Flux	% Total UFA	% Total Model
Inflows	Recharge	16,678	87.0%	16,678	0	0.0%	235	9.3%	1.2%
	Recharge - ET	*13,212*	*69.0%*	*13,118*	*94*	*NA*	*235*	*9.3%*	*1.2%*
	River Nodes (Loosing Rivers)	666[1]	3.5%	644	22	1.9%	650	25.8%	3.4%
	Non-Coastal Model Boundaries	848[2]	4.4%	755	93	7.8%	666	26.4%	3.5%
	Wells	970	5.1%	938	32	2.7%	970	38.5%	5.1%
	Man-made (injection wells)	*32*	*0.2%*	*0*	*32*	*2.7%*	*32*	*1.3%*	*0.2%*
	Natural (siphons & swallets)	*938*	*4.9%*	*938*	*0*	*0.0%*	*938*	*37.2%*	*4.9%*
	Total Inflows	*19,162*[3]	*100.0%*	19,014	147	12.4%	*2,521*	*100.0%*	*13.2%*
Outflows	Evapotranspiration (ET)	3,466	18.1%	3,560	-94	7.9%	0	0%	0.0%
	River Nodes (Gaining Rivers)	3,004[4]	15.7%	3,177	-174	14.6%	1,839	14.0%	9.6%
	Drain Nodes	5,568	29.1%	5,858	-289	24.4%	5,316	40.5%	27.7%
	Springs	*5,316*[5]	*27.7%*	*5,600*	*-284*	*23.9%*	*5,316*	*40.5%*	*27.7%*
	Wetlands & Lakes	*252*	*1.3%*	*258*	*-6*	*0.5%*	*0*	*0.0%*	*0.0%*
	Non-Coastal Model Boundaries	3,536[6]	18.5%	3,957	-421	35.5%	3,150	24.0%	16.4%
	Coastal Model Boundaries	2,401	12.5%	2,462	-61	5.1%	1,804	13.7%	9.4%
	Atlantic Ocean	*597*	*3.1%*	*642*	*-45*	*3.8%*	*0*	*0.0%*	*0.0%*
	Gulf of Mexico	*1,804*	*9.4%*	*1,820*	*-16*	*1.3%*	*1,804*	*13.7%*	*9.4%*
	Extraction Wells	1,186[7]	6.2%	0	1,186	100.0%	1,011	7.7%	5.3%
	Total Outflows	*19,162*[8]	*100.0%*	19,014	-1,039[9]	87.6%	*13,120*	*100.0%*	*68.5%*

Notes:

Approximate UFA Discharge = all layer-3 discharge plus layer-2 discharge to the Gulf of Mexico.
UFA drain node discharge includes all layer-3 drain nodes minus drains assigned to the northern model boundary.
No pump flux values derived from a version of the model run with all well assignments removed.
Effect of pumping determined by subtracting the no-pump value from the model flux value.
All units are cfs.

1) report states 671 cfs
2) report states 878 cfs
3) report states 19,198 cfs
4) report states 3,009 cfs
5) report states 4,790 cfs but it omitted Rainbow from total, model springs without Rainbow = 4,763 cfs
6) report states 3,566 cfs
7) text in report states 1,250 but Table 9 value = 1,186 cfs
8) report states 19,198 cfs
9) Total outflows for the effect of pumping is the sum of all outflow components other than the extraction wells

4.7.1 Simulated Flow to Springs and Rivers

The sum of all simulated groundwater flow to drain and river nodes designed to represent discharge from the UFA to springs and rivers in the model domain equals 7,155 cfs (Table 10: UFA Drain discharge + UFA River discharge). Of that amount, 589 cfs was to surface water features that do not flow into the Gulf of Mexico (Appendix 4) leaving approximately 6,560 cfs as the model-simulated discharge to surface water features that do drain to the Gulf of Mexico. The groundwater gains calculated from river flows for the rivers that drain into the Gulf of Mexico measured during the model calibration period was 5,613 cfs (Table 3). The model therefore apparently over-estimates total spring and river discharge from the UFA to those surface water features by 947 cfs (17%). Even if the simulated river losses are subtracted from the estimate, the model still over-estimates this component of groundwater discharge by 297 cfs. These figures are comparable to the results of the sub-watershed analyses described in Section 4.6.2, which revealed an over-estimation of recharge based on measured sub-watershed discharge of between 231 and 760 cfs depending on whether or not simulated river siphons were considered. A review of the spring flow targets reported in the SDII report [8] indicates that the values are likely too high, being indicative of higher than low-water conditions. Those combined with the results of the recharge analyses described in Section 4.6.2 indicate that a substantial portion of the over-estimation is likely distributed to the coastal rivers.

Table 11 compares the some of the target spring flow values used in the development of the NFM-08 to data compiled from the Florida Geological Survey (FGS) and USGS for either the model calibration period or more recent dry periods that were not as severe or prolonged as the 2001-2002 drought (*meaning that the 2001-2002 flows should be less than or equal to the reported values*). Values from 32 springs were checked from which only the ones showing a deviation from the SDII target values of more than one cfs (lower or higher) were reported in Table 11. For the 32 springs evaluated, the net difference between the SDII targets and the reported values was +156 cfs indicating that the SDII values overestimate low-water flows.

Table 11. Comparison of Reported and SDII Target Spring Flows

Spring Name	Target (cfs)	FGS (cfs)	FGS DATE	USGS (cfs)	USGS DATE	MIN (cfs)	DIFF (cfs)
AlapahaRise	495.0	594.0	08/01/01			594.0	-99.0
Columbia	43.9	39.5	11/01/01			39.5	4.4
Devil'sEar,Devil'sEye,LittleDevil	122.7	206.6	09/05/01	48.0	06/15/07	48.0	74.7
Fanning	56.9	51.5	10/24/01	47.0	P-Ave	47.0	9.9
HoltonCreekRise	75.0	0.0	12/07/01			0.0	75.0
Hornsby	4.2	0.0	10/02/02			0.0	4.2
LafayetteBlue	51.6	45.9	10/24/01			45.9	5.7
MadisonBlue	67.6	71.4	10/23/01			71.4	-3.8
Manatee	118.5	154.0	10/23/01	105.0	P-Ave	105.0	13.5
Poe	35.2	6.1	05/14/02			6.1	29.1
SantaFeSpring	43.1	47.9	11/01/01			47.9	-4.8
SilverSprings	500.0	556.0	11/15/01	464.0	P-Ave	464.0	36.0
Suwannacoochee	19.7	0.5	08/06/02			0.5	19.2
Treehouse	56.4	39.9	10/30/01			39.9	16.5
Troy	90.9	106.0	10/30/01			106.0	-15.1
WacissaSprings	283.5	293.0	10/02/01			293.0	-9.5
						Net Difference	*156.0*

P-Ave = period average

4.7.2 Simulated Flow to Boundaries & Effect on Simulated Impacts of Pumping

Flow through the external model boundaries cannot be constrained by data. There are no available data defining the magnitude of flow across the arbitrary non-coastal model boundaries or the diffuse discharge to the Gulf of Mexico. Field observations of stream flows and their salinities in coastal regions however indicate that diffuse groundwater discharge to the Gulf of Mexico is small relative to discrete and documented spring flows. [74,75] As described in Section 3.2, abiding this observation as an assumption in the absence of definitive data will produce a more conservative model because it will result in less total simulated flux through the UFA. Similarly, the southern model boundary could have been designed more conservatively such that there is less simulated non-verifiable flux out of the model across the boundary. As it was constructed however, the NFM-08 allows 24% of the simulated flux through the UFA to exit through the arbitrary southern model boundary and approximately 14% of the flux through the UFA to discharge to the Gulf of Mexico. Approximately 38% of the simulated flux through the UFA cannot therefore be verified against measured data.

At face value, these percentages are noticeably large but the effect of the distribution cannot truly be identified without evaluating how the model simulates the impacts of groundwater pumping on the components of the model's water budget. To do this, Table 10 shows the water budget component values derived from a version of the NFM-08 from which all well assignments designed to represent groundwater pumping (not river siphons) were removed. The difference between the values derived from the pumping (calibrated) and no-pumping versions denotes the simulated impact of the groundwater pumping assigned in the calibrated version of the model on the respective component of the water budget. The total assigned groundwater pumping in the NFM-08 is 1,186 cfs. Removing the pumping from the model resulted in a decrease in recharge of 147 cfs and an increase in discharge of 1,039 cfs (note that 147 + 1039 = 1186 = the assigned pumping). More than 40% of those effects were absorbed by the change in simulated discharge to the external model boundaries (35.5% to the general head nodes defining the arbitrary southern model boundary, and 5.1% to the constant head nodes representing the Gulf of Mexico coast). An additional 7.8% of the effects were absorbed by increased recharge from the general head nodes defining the northern model boundary. Considered collectively, the model distributes nearly 50% of the simulated impacts of pumping to the external model boundaries.

Since the model-simulated flows across the external boundaries cannot be constrained by data, it is difficult to determine if the simulated distribution of impacts is due to a reliable depiction of groundwater flow patterns or simply a consequence of the model design. The results of the recharge (Section 4.6) and aquifer permeability framework (Section 4.5) analyses indicate that the latter is more probable. At very least, a well established modeling practice is to design the boundaries such that the contribution of flow from the boundaries to features critical to the model objectives (i.e. pumping wells) is minimized.

4.8 Veracity of Key Underpinning Assumptions

In addition to the assumptions required to conceptualize a hydrogeologic environment and articulate that environment in groundwater modeling software, every numerical model uses one or more equations to describe the configuration of the groundwater surface in response to some set of hydrogeologic variables (i.e. hydraulic conductivity, recharge, pumping rates, spring flows, etc). All such equations are based on some additional set of assumptions that describe the specific conditions under which the equations are valid. When those assumptions are violated, the veracity of the resulting model is undermined. If the degree to which the assumptions are violated and the significance of the violations is not documented and disclosed, the model results and predictions can be misleading.

The NFM-08 is based on a conceptualization of the Floridan aquifer as a porous media and describes flow through the aquifer using Darcy's law.

$$v = -K\left(\frac{dh}{dl}\right)$$

where: *v = the specific discharge through the aquifer (flow per unit area of aquifer material [L/T]);*
K = the hydraulic conductivity of the aquifer material [L/T];
dh = change in head (change in groundwater surface elevation) [L];
dl = distance across which the change in head is measured [L]; and
$\left(\frac{dh}{dl}\right)$ *= hydraulic gradient in the aquifer [-].*

Darcy's law is considered to be valid only when flow rates (specific discharge rates) are relatively slow such that flow is laminar, meaning that flow is orderly and occurs in parallel lines where viscous forces are dominant. [24] The veracity of this assumption can be tested for various model configurations by calculating the Reynolds number, which is a dimensionless number that expresses the ratio of inertial to viscous forces during flow and is widely used to distinguish between laminar and turbulent flow.

$$R_e = \frac{\rho v d}{\mu}$$

where: Re = the Reynolds number;

ρ = the fluid density (generally considered to be 1 for groundwater);
v = the specific discharge through the aquifer;
d = the average pore dimension, which is directly proportional to the average diameter of the rock grains comprising the porous media aquifer; and
μ = the fluid viscosity (generally considered to be 1 for groundwater).

Substituting for v (specific discharge) and simplifying yields the following equation that can be readily solved using the distribution of hydraulic conductivities and equivalent grain diameters assigned in the NFM-08 (Figure 19), and the resulting distribution of simulated groundwater levels and hydraulic gradients (Figure 34).

$$R_e = -K\left(\frac{dh}{dl}\right)d$$

In the NFM-08, hydraulic conductivities were assigned using PEST during the model calibration process (Section 4.4). Simulated groundwater levels were produced from the calibrated model. Hydraulic gradients were derived directly from the simulated groundwater levels, and the equivalent average grain diameters required to support the assigned hydraulic conductivities were obtained from grain-size classifications used for engineering. [26] Figure 35 shows the distribution of simulated flow rates (specific discharge through the aquifer) and the distribution of calculated Reynolds numbers based on the assigned and simulated parameter values described above. Darcy's law is considered valid only as long as the Reynolds number, based on average grain diameters, does not exceed some number between 1 and 10. [24,76]

The distribution of Reynolds numbers calculated from the NFM-08 reveal that the model configuration violates Darcy's law through approximately half of the model domain. This is because the NFM-08 is based on a purely porous media conceptualization and SDII used extremely high hydraulic conductivity values to simulate the observed flows. The equations underpinning the model results and subsequent predictions are therefore invalid for much of the conditions that the model is trying to simulate.

5 REPORTING & DISCLOSURE

In at least one way, the discussion of simulated spring and river flows, the SDII report accompanying the NFM-08 [8] is inaccurate in its depiction of the model results and capabilities. In several ways, the report also fails to adequately and transparently document the critical underpinning assumptions and limitations.

5.1 Simulated Flow to Springs and Rivers

The SDII report states that the NFM-08 simulates flow to 145 individual springs and compares observed verses simulated flows for 135 individual springs or spring groups and that the model was able to match the observed spring and river flows to less than 1% for 90% of the springs and 30 of the 38 river reaches. [8] Both the discussion and the presentation of results convey that the model is capable of accurately discerning flow patterns to the different springs and therefore capable of accurately delineating individual springsheds and reliably predicting impacts to the specific springs due to various changes to the other model parameters. These claims are extremely misleading because of the way the spring and river flows were assigned and simulated.

In actuality, the model is not capable of discriminating between flows to many of the individually listed springs because multiple springs were often assigned to a single 5,000 X 5,000 foot model cell and the model only simulates flow through cells. Separate assignments in the model cells therefore simply provide a way to breakout the simulated cellular flows to compare against the actual spring discharges and river-reach gains. The breakouts were achieved by using multiple occurrences of and multiple types of assignments in most of the model cells representing the springs and rivers. For instance, many cells carry multiple drain assignments representing springs, a river assignment representing river discharge, and one or more well assignments representing pumping wells or siphons. In doing this, the modeler has used a trick to force the model results to include a tally of the individual flows, when in reality the model is only simulating one outflow or inflow distributed evenly across the entire area of the cell. A more transparent assignment and reporting method would have been to first prepare and present a table that describes the composition of composite cell assignments (for example: 1 assignment per cell representing the total spring flow and river gain within the model cell, and 1 well assignment per cell representing the total groundwater withdrawals occurring in the model cell). Calibration results would then be presented in terms of how the simulated cellular fluxes compare to the composite of the observed flows in each cell.

Figure 36 depicts the distribution of cells that contain river, drain, and well assignments in the region of the model domain that includes the western Santa Fe River, and depicts the number of drain assignments per cell. A table is provided on the figure that lists the specific assignments for the 22 springs listed in the SDII report between Sawdust Spring (downstream) and the Santa Fe River Rise (upstream). Sixteen of the springs are assigned across only 5 model cells. Five springs (July, Sawdust, Deer, Twin, and Dogwood) were assigned to a single cell. In all of the cells with drain (spring) assignments, the model also breaks out a flux into or out of the Santa Fe River using river assignments. Four of the cells also carry well assignments that were used to describe groundwater pumping, and two of the cells contained injection well assignments intended to represent river siphons. In actuality, the model does not simulate these specific individual flows but rather just the net flux into or out of the cells containing the assignments (also listed on Figure 36).

The aggregate model-simulated cell flux was subdivided for reporting using the different types of assignments. Groundwater pumping and river siphon fluxes were assigned directly so the values shown in a model export (i.e. the table on Figure 36) simply lists the assignments. The individual spring and river fluxes were derived through a segregation of the cellular flows using PEST during model calibration. The desired flows at each drain (spring) assignment were specified as targets for PEST. Each assignment was associated with an independent streambed conductance term that PEST was allowed to vary as needed, without any apparent constraints, in order to match the desired flows. The result was a near perfect match to the observed flows but substantial variation in the value of the conductance term within each of the cells carrying multiple drain and river assignments, and an unreasonable simulation of groundwater levels at the rivers where the model typically overestimated stage by feet to tens of feet (Figure 11). Both the variation in streambed conductance and the unreasonable simulation of groundwater levels at the rivers substantially undermine the significance of the near-perfect match between simulated and observed spring and river flows yet neither of these conditions were discussed in the report.

The independent well assignments, though not ideal, are not as significant of a problem. This is because the well assignment is treated differently than river and drain assignments by the modeling software. There is no streambed conductance term associated with wells to be modified during calibration and the model does not therefore have the capacity to create unrealistic geologic complexity to accommodate the flux. The assignment of multiple wells per cell is still however misleading because the model does not have the capacity to simulate changes in the groundwater surface within the boundaries of the individual cells. Thus, the model cannot simulate impacts of groundwater pumping from the independent wells within a cell and itemizing multiple well assignments per cell is therefore misleading. The model contains 8,432 cells that contain a total of 14,539 well assignments intended to represent extraction wells, injection wells, and river siphons.

5.2 Conceptual Model

5.2.1 Diffuse Flow Assumption

The SDII report reveals that prior to beginning the model development process, the modelers recognized the significance of karst and conduits in the hydrogeology of the study area. This is evident from their statement in their description of the study area:

> *"… the movement of water through the aquifer system is via both "conduit flow" (flow through fractures and caverns) and "diffuse flow" (flow through intergranular pore spaces and in-filled voids in the rock)."* [8]

Despite this recognition, SDII chose to pursue a modeling methodology that addresses only the diffuse flow component of the flow system and thereby assumed that the conduit flow component of the flow system is either irrelevant or could be reasonably simulated using the diffuse flow approach. The SDII report fails to disclose this assumption, which ultimately provides the basis for much of the rest of the modeling approach. Accordingly, the report provides no basis for the validity of the assumption or any discussion of the potential impact it has on the reliability of the model results or any predictions that flow from the results.

The groundwater flow equations used by the resulting model are valid only for porous media systems through which groundwater moves according to the diffuse flow assumption. As can be seen from Figure 35, the parameter settings used to calibrate the NFM-08 resulted in flow conditions that violate this assumption throughout close to half of the model domain. The lack of disclosure and discussion of the diffuse flow assumption therefore portrays veracity and reliability that cannot be supported by the mathematics on which the model was constructed.

5.2.2 Streambed Conductance

The NFM-08 simulation of spring and river flows is entirely predicated on the use and variation of the streambed conductance term yet the SDII report provides no substantive discussion of: 1) how the values relate to real-world physical conditions or the conceptual model of conditions, 2) how the values were or were not constrained, 3) the conceptual justification for significant variation in the values within individual cells, or 4) the sensitivity of the model calibration and results to the values used. An evaluation of the model reveals that a conceptual justification for the use of the terms is weak because though the selected values resulted in a near perfect patch to observed flows, they also fostered large discrepancies between the simulated groundwater levels at the rivers and observed river stages throughout most of the model domain. In effect, the terms were used to create an artificial confining unit between the aquifer and the river and springs, that does not exist in reality but through which the simulated flows could be regulated to match the target values at the expense of reasonably matching groundwater levels with river stages. This combined with the inter-cellular variation, and the apparent absence of any constraints on the range of values available to PEST, indicates that the primary function of the streambed conductance terms was simply to provide an expedient way to make the model match the target flows, when in fact the undisclosed problems generated by their use render the model configuration implausible and the model results misleading.

5.3 Code Selection

Selection of the groundwater modeling software (code) with which a model is constructed should be predicated on the conceptual model and justified in terms of the code's ability to address key hydrogeologic complexities. The SDII report provides no justification for the selection of a finite-difference approach and MODFLOW for this model nor does it describe any of the limitations that followed including: the inability to describe a conduit component of the flow system, which SDII acknowledged to be both active and significant in the model domain; and the need to use a uniform orthogonal grid, which limited the model's ability to simulate complicated geometries characteristic of the rivers in the model domain.

The absence of a justification or discussion of their code selection misleads readers and model users into believing that the chosen approach and software represented either the only or best available option when in fact neither is correct. At the time the NFM-08 was constructed there was ample access to other commercially available, well documented, widely used, and defensible software that would have offered substantial benefits related to the three limitations described above. The fact that no such options were discussed in the report indicates that SDII's choice of approach and software were predicated more on the basis of convenience and familiarity than benefit to the project and that the initial conceptual model was simplified in order to conform to the chosen software's limitations.

5.4 Calibration

The model's ability to calibrate to observed conditions is the most used metric for determining whether or not the model adequately simulates the physical processes and parameters governing groundwater flow through the area and aquifers of interest, and thus, whether or not it can be used to reliably predict the types of impacts to groundwater flows and levels consistent with the model's stated purpose. The degree to which a model can be considered "calibrated" is therefore predicated on: 1) the ability of the model to adequately simulate observed groundwater levels and flows; and 2) the plausibility of the model parameters and parameter values.

With respect to the ability of the model to adequately simulate observed groundwater levels and flows, the commonly accepted practice is to discuss both the global "fit" to observed conditions and the spatial distribution of the differences between simulated and observed conditions associated with the global fit. [16,17] SDII's comparison between simulated and observed spring flows must be dismissed as invalid and misleading due to the issues discussed in Sections 5.1 and 5.2.2 above. Their comparison between simulated and observed groundwater levels only addressed the global fit to observed conditions. The SDII report failed to provide a map showing the spatial distribution and magnitude of residuals (differences between simulated and observed groundwater levels) such as is provided in this report as Figure 11 and discussed in Section 4.4.1. SDII therefore failed to disclose that the distribution of residuals favors substantially flatter hydraulic gradients than are recorded by the well data (simulated groundwater levels are too low near the potentiometric divides and too high near the river and spring discharges), which reflects a substantial failure to adequately simulate the physical processes and parameters governing groundwater flow through the UFA. The report also failed to justify the calibration criterion used (5% of the total head change across the model domain applied only to the absolute average of the differences at all wells), or the effect of that criterion on reliability and precision. This is particularly significant because an analysis of groundwater level data collected from 534 wells within the SRWMD during the calibration period reveled that the measured variation in groundwater levels at over 50% of the wells was less than 3 feet and less than 4 feet at approximately 75% of the wells (see Section 4.4.4 and Figure 17).

With respect to the plausibility of the model parameters and parameter values, the consensus among leading groundwater modelers is that good (well calibrated) models must reasonably match observed groundwater levels and flows and use reasonable and realistic parameter values to describe the aquifer or aquifer system being studied. [16,17,77] The SDII report fails to present or discuss the plausibility of any of the key parameter values (hydraulic conductivity, recharge, and streambed conductance) needed for the model to render the simulation of groundwater levels and flows that they considered to be "calibrated."

Evaluation of the model revealed:

1) the hydraulic conductivity values used differ from observed values by as much as 2.7 orders of magnitude (502 times; Figure 22);
2) the distribution of hydraulic conductivity values fails to correspond to well established hydrogeologic zonation (Figure 23);
3) the distribution of recharge values is arbitrary and does not correspond to hydrologic variables or land use (Figure 24 and Figure 29); and
4) the magnitude of and variation in streambed conductance does not correspond to a reasonable conceptualization of the relationship between the UFA and the rivers in the unconfined portion of the aquifer (see Sections 5.1 and 5.2.2 above).

Failure to disclose and discuss these issues renders the assertion that the model is well calibrated invalid and the report misleading.

5.5 Model Boundaries

The location of and condition assigned to the external boundaries of a model fundamentally effect the quality of the model as well as the reliability of model predictions related to the model's purpose. [17] Other than a simple description, the SDII report fails to provide a justification for either the location or the assigned conditions nor a discussion of how either effect the model's ability to predict impacts to groundwater levels and flows. A well-established modeling procedure is to locate the external model boundaries far enough away from the area of interest to ensure that the desired predictions (in this case, impacts to groundwater levels and flows due to pumping) are not substantively affected by cross-boundary flows. [18,17] As was discussed in Section 4.7.2 however, approximately 38% of the simulated flux through the UFA is to the external boundaries, and nearly 50% of the simulated groundwater pumping is supplied from the external model boundaries neither of which was discussed in the SDII report.

It is reasonable to assume that the NFM-08 is not intended to simulate impacts across the entire domain and therefore that some percentage of flow from the external boundaries to the simulated wells is acceptable. But, SDII should have disclosed the boundary effects on simulated pumping and delineated an area internal to the model in which boundary effects are negligible in order to adequately and transparently disclose the model limitations with respect to boundaries.

5.6 Discretization

As described in Section 3, the resolution of a model is a function of the chosen discretization, which is the process of dividing the model domain into cells across which the model solves the groundwater flow equations. The ability of a model to achieve its stated purpose is partly predicated on the resolution and it is therefore incumbent on the modeler to justify the chosen discretization and discuss any limitations with respect to the model's stated purpose imposed by the cell or element sizes. [17] The SDII report provides no such justification for their choice of the 5,000 X 5,000 foot cell size. Moreover, the report misleads readers and model users by reporting multiple individual spring flows that occur within a single model cell.

Typically, the model cell size is limited by the available computational capacity where smaller cells equate to a larger number of cells over which the model must solve equations and track results. Smaller cell sizes therefore require longer computer runtimes and larger amounts of computer memory where the requirements are generally linear, i.e. a model with 100 cells will take approximately 10 times longer to run than a model with 10 cells. The NFM-08 contains 116,551 active cells. Using GeoHydros' computers, the model takes approximately 45 seconds to run and requires only about 0.25 MB of memory. In terms of calibration, this equates to approximately 12.5 hours per 1,000 runs. By linear extrapolation, a cell size of

2,500 X 2,500 feet would require a run time of approximately 3 minutes and a calibration time of 50 hours per 1000 runs, and a cell size of 1,250 X 1,250 feet would require a run time of 12 minutes and a calibration time of 200 hours (8.3 days).

Run times are applicable to model scenario analyses, including any applications that the SRWMD would perform. As the term implies, calibration times are relevant to only the calibration of the model. Given that the stated purpose of model is to predict impacts to specific springs associated with specific well permits, the additional computational times associated with the 2,500 X 2,500 and even the 1,250 X 1,250 foot grids are not unreasonable. Calibration runs for complicated models where water resource decisions depend on an ability to resolve small-scale changes often take weeks or even months. The decision to limit the model resolution therefore cannot be reasonably supported on the basis of computational capacity.

5.7 Model Error & Limitations

It is incumbent on the modeler to disclose and discuss limitations of the model's representation of the real-world groundwater flow system and the impact those limitations have on the model's ability to achieve its stated purpose. [14,17] Such a discussion should address non-uniqueness, which is the extent to which other combinations of parameter values or configurations may result in an equally good fit to the observed data, [14,17] and, it is argued here that the discussion should also identify the probable margin of error associated with predictions crucial to the model's stated purpose. The basis for these discussions should include model sensitivity analyses, which identify how the results change as a consequence of varying uncertain parameters, as well as the subjective opinion of the model developer(s).

The SDII report provides no discussion of model limitations, no meaningful discussion or apparent exploration of non-uniqueness, very limited discussion of inadequate sensitivity analyses, and no discussion of how the sensitivity analyses that were performed affect confidence in the model results and subsequent predictions.

5.7.1 Non-uniqueness

Non-uniqueness is desirable because confidence in the model results and subsequent predictions increases when an acceptable result can be achieved by a narrow range of possible parameter configurations. Non-uniqueness is fostered by: 1) limiting the range in parameter values and the spatial relationships in the parameter distributions to correspond to available data and reasonable conceptualizations based on established hydrogeologic conditions and characteristics; and 2) a rigorous definition of the calibration criteria. The SDII report states that uniqueness was maximized by constraining recharge by precipitation data yet an evaluation of the model revealed that the final recharge values and distributions fail to correspond to spatial variation in precipitation or documented land use characteristics (Section 4.6.1; Figure 29). Moreover, SDII allowed an excessively broad range in hydraulic conductivity during model calibration (Section 4.5; Figure 23), no apparent limits on the streambed conductance terms (Section 5.2.2), and a non-rigorous definition of the calibration criteria applied to simulated groundwater elevations (Section 4.4.4). None of these issues were identified or discussed in the report yet the consequence is a very highly non-unique model in which many configurations of hydraulic conductivity, recharge, and streambed conductance values falling within the SDII's allowable range for the respective parameters that would result in a model simulation of groundwater levels and flows that would meet SDII's calibration criteria.

5.7.2 Sensitivity to Hydraulic Conductivity Variation

Sensitivity analyses are performed to identify how the model results, and therefore the subsequent predictions, are affected by variation in key parameters used in the model for which the values are relatively uncertain. SDII performed three sensitivity analyses in which they independently evaluated the affect of variation in hydraulic conductivity, recharge, and ET. An evaluation of the model's sensitivity to streambed conductance was not described in the report. Only a cursory discussion of the results was provided: two sentences each devoted to recharge and ET and four short paragraphs devoted to hydraulic conductivity. Though the report states that simulated spring flows and groundwater levels (particularly in the UFA) are sensitive to variation in all three of the parameters, the report provided no insights as to how the sensitivities affect the reliability of model-predicted impacts to groundwater levels and groundwater discharge to springs and rivers.

The discussion of the sensitivity of simulated groundwater levels to hydraulic conductivity only addresses the observed change in the average of all groundwater level residuals (differences between observed and simulated groundwater levels at the 676 wells comprising the calibration dataset). The discussion is misleading because the average residual and the change in average residuals due to the tested variation in hydraulic conductivity are both very small (-0.19 and -0.22) but: 1) the report fails to describe the relative affect. Put in other terms, the reported values reflect a 116% change ((more than double) in the residuals due to only a 10% change in hydraulic conductivity. This change reflects a substantial sensitivity to hydraulic conductivity values particularly considering that the values in the calibrated model differ from observed conditions by as much as 500 times (Figure 22). The report also fails to disclose how variation in hydraulic conductivity values affects the range in residuals, which is very large in the calibrated version of the model (at least -36 to +28 feet; Figure 10).

The discussion of the affects of varying hydraulic conductivity values on simulated groundwater discharge to springs and rivers is also misleading, if not flawed. The SDII report provides the following statements.

> *"An increase in hydraulic conductivity of the UFA caused spring discharge to decline, and a decrease in hydraulic conductivity caused spring discharge to increase. These relationships are a result of use of a steady-state model. Higher hydraulic conductivities allow the aquifer to drain to steady state with lowered aquifer potentials, while lower conductivities retain water in the aquifer."* [8]

The fact that the model is steady-state has no bearing on the relationship between simulated spring and river flows and hydraulic conductivity. Total inflows to the model were held constant. The steady-state nature of the model ensures therefore that the total outflows will be constant as well. The change in hydraulic conductivity simply changes the distribution of simulated discharge between the various non-assigned simulated discharge features. With respect to the NFM-08's simulation of flow through the UFA, these features include: drain and river assignments that were used to simulate groundwater discharge to springs and rivers; constant head assignments used to simulate discharge to the Gulf of Mexico; general head assignments used to simulate flow across the southern external model boundary; and upward leakage into the IAS and SAS.

The reported change in spring and river flows is, in actuality, a function of the model's reliance on the streambed conductance terms to match the observed spring and river flows without regard to the corresponding simulated groundwater levels at the rivers. Higher hydraulic conductivity values resulted in lower hydraulic gradients to the springs and rivers (as was reported), which in turn caused less discharge to the springs and rivers, largely because of the streambed conductance terms, and therefore more discharge to the model boundaries. Similarly, lower hydraulic conductivities resulted in higher simulated spring and river discharge because the simulated gradient increased, from which the streambed conductance terms allowed more water to pass out through the drain and river assignments and therefore less water to pass onto the external model boundaries. The results of SDII's analysis therefore demonstrates the sensitivity of the model results to the streambed conductance values yet no analysis of these terms or discussion their affect on the reliability of the model was provided.

5.7.3 Sensitivity to Recharge

Essentially, variation in both recharge and ET assesses the same model condition, the amount of recharge entering the simulated aquifer system. Here again, the manner in which the SDII report presents the results belies the significance of the actual sensitivity of the model to these parameters. The tabulated change in simulated groundwater levels reflects a 184% change in the average residuals due to a 10% change in recharge, which reflects substantial sensitivity yet no substantive discussion of this sensitivity is provided in the text nor is any discussion of how the observed sensitivity affects the reliability of the model predictions.

5.7.4 Margin of Error

The SDII report states that the model is intended to be used to assess the impacts of specific actions such as groundwater pumping associated with individual consumptive use applications on groundwater levels and groundwater discharge to springs and rivers; as well as for the establishment of MFLs for rivers and springs within the SRWMD. [8] An evaluation of the model revealed:

- differences between observed and simulated groundwater levels of between -36 to +28 feet (Figure 10);
- differences between the observed depth of the cone-of-depression associated with groundwater pumping by the city of Gainesville and the simulated value of more than 30 feet (Figure 12 and Figure 13);
- substantial discrepancies between observed and simulated groundwater flow paths (Figure 18);
- substantial discrepancies between the modeled hydraulic conductivity values and the magnitude of values established by data (Figure 22) as well as divergence from the distribution of values reflected by established hydrogeologic zonation in the UFA (Figure 23);
- substantial discrepancies between the modeled distribution of recharge and distributions that can be supported by the spatial variation in precipitation or documented land use (Figure 29);
- substantial discrepancies between the magnitude of modeled recharge and the magnitude that can be supported by available stream flow data (Figure 31); and
- a substantial portion of the model domain in which the modeled configuration of aquifer parameters results in simulated flow conditions that violate the assumptions underpinning the groundwater flow equations on which the model was constructed (Figure 35).

Despite these discrepancies, which could have been identified and disclosed by SDII, the SDII report provides no discussion of the probable margin of error associated with the modeled results or the predictions that follow. It is reasonable to expect the SRWMD to use the model to identify specific values for impacts to both groundwater levels and flows associated with the various groundwater use and environmental condition scenarios that they are required to evaluate, and that those specific values will factor significantly into the District’s decisions regarding groundwater resource management. The results of these evaluations demonstrate that there is a significant margin of error associated with those values yet no such error was disclosed nor even the possibility of such error discussed in the SDII report.

5.8 Supporting Files

Established groundwater documentation standards state that the report associated with groundwater flow models, particularly ones intended to be used to support critical groundwater resource decisions, should be accompanied by sufficient supporting documents and files for an independent investigator to duplicate the model results. [15,17,14] No such supporting materials were provided with the report or on the SRWMD website from which the model file was obtained. Because of this, many of the supporting data files including the groundwater levels used to establish the calibration dataset, rainfall and stream flow data used to establish recharge, and the aquifer transmissivity data used to constrain hydraulic conductivity values had to be independently compiled from the various government data repositories, which rendered this review substantially more time consuming and costly than necessary.

6 ALTERNATIVE MODELING APPROACH

6.1 Overview

As described in Section 4, many of the problems with the NFM-08 stem from poor attention to detail and lack of rigor applied to the model calibration but notwithstanding those failings, some of the problems stem from the equivalent porous media approach. The largest of these are the inability to reasonably simulate groundwater flow patterns to springs and the inability to reasonably simulate groundwater velocities, both of which are due to the presence of conduits in the UFA that are disregarded in the equivalent porous media conceptualization. These problems are therefore typical of all porous media models that have been developed for the UFA. A critical question therefore is whether or not the equivalent porous media approach to simulating groundwater flow through the UFA represents the best available technology.

GeoHydros has developed two different numerical models that endeavor to address this question. One is a regional model that spans the Florida Panhandle from the Gulf of Mexico north to Albany Georgia and from the Apalachicola River east to the hydraulic divide between the Aucilla and Econfina Rivers. It was developed for the Florida Geological Survey to delineate groundwater flow patterns to Wakulla, Spring Creek, Wacissa springs and the St. Marks River Rise. It was last updated in 2011. The second model is a sub-regional scale model centered on the western Santa Fe River Basin that was developed for CCNA between 2004 and 2008.

Both models are hybrid numerical models that simulate groundwater flow through a porous block of limestone embedded with networks of conduits that connect to the 1st and 2nd magnitude springs in the respective regions. The term “hybrid” describes the linkage of two different types of mathematical and numerical simulation methods. Groundwater flow through the block, *or matrix*, component of the model domain is described with the conventional porous media groundwater flow equations, which are governed by Darcy’s Law [24,25] while groundwater flow through the conduit components of the model is described by the Manning-Strickler equation.

Both models were calibrated to groundwater levels at individual wells and individual spring flows as well as the corresponding river stage elevations; and both models produced plausible simulations of groundwater flow patterns to springs and reasonably simulated groundwater velocities documented through groundwater tracing. This section focuses on the model constructed for the Western Santa Fe River Basin for CCNA because it falls within the NFM-08 boundaries and was calibrated to conditions measured during the same period (low-water conditions in 2001-2002). Thus it provides an excellent opportunity to contrast the hybrid modeling and equivalent porous media modeling approaches as well as different levels of rigor with respect to calibration. The model will be described in the subsequent sections as the Western Santa Fe Model (WSFM-08).

Model results and detailed descriptions of the model construction and calibration process were presented to representatives of the SRWMD, SJRWMD, FDEP, USGS, and the INTERA Corporation at a meeting held near Ginnie Springs in August 2009 [13], as well as to the public at meetings of the Santa Fe River Springs Working Group. Shortly after the August 2009 meeting, FDEP requested copies of the model-defined springsheds and spring vulnerability delineations for use in the Santa Fe River Basin BMAP.

6.2 WSFM-08

6.2.1 Model Setup

The WSFM-08 simulates groundwater flow through and between the Surficial Aquifer System (SAS), and Upper Floridan Aquifer (UFA) within a portion of the Western Santa Fe River basin including approximately the western half of Alachua County, eastern half of Gilchrist County, and southern half of Columbia County, as well as small parts of Suwannee, Baker, Union, and Levy Counties (Figure 1). The conceptual model framework assumes porous media flow through the SAS and IAS, and a combination of porous media and conduit flow through the UFA wherein conduits receive flow from the aquifer matrix and known or reasonably estimable swallets and lakes to springs. The model was developed with the software FEFLOW™ [78] using a finite-element formulation and a mesh of 817,345 triangular elements and 493,836 nodes with node spacings that range between approximately 12 and 2,400 feet. The model resolution therefore ranges from approximately 60 ft^2 to 0.04 mi^2 where smaller elements and thus finer resolution was assigned around all wells, springs, and the Santa Fe River. The model included:

- 17 1st and 2nd magnitude groundwater springs;
- all municipal, industrial, large magnitude private supply, and irrigation wells permitted by the SRWMD;
- representations of all mapped conduit systems emanating from the springs;
- all known swallets; and
- delineations of the major geologic units and sub-units in the model domain.

Conduits were represented in the model as 1D saturated pipes through which flow was simulated using the Manning-Strickler equation, [50] which allows for the control of conduit flux and flow velocity through the assignment of cross-sectional areas and roughness coefficients that can change independently at each mesh element. The location, cross-sectional area, and roughness of the pipes were used as the primary variables for model calibration. The cross-sectional area was used to allow the model to simulate the observed spring flows. Roughness was used to constrain conduit flow velocities by the measured range, and the location of the conduits was used as the primary mechanism to calibrate to the observed groundwater levels.

Conduit locations were delineated in three phases. The first phase involved interpolating locations of known conduits from available cave maps, which were available for the River Rise, Hornsby Spring, Ginnie Spring, Devil’s Ear, Rose Sink, Mill Creek Sink and Blue Hole caves. The river caves were not explicitly simulated but were instead assumed to be part of the conceptualized high hydraulic conductivity zone located along the river. The second phase involved adding conduits or extending the mapped conduits to correspond to conduit flow paths that had been defined by the three groundwater tracer tests described above where the pathways were set to follow observable depressions in the groundwater surfaces constructed from the two calibration datasets. The final phase involved adding and/or extending those conduits as necessary to connect the simulated springs and swallets and to achieve calibration. Vertical placement of conduits was set to approximately 100-150 feet below land surface except where they rose to meet springs or swallets where the placement depth was chosen based on the average reported depth of the mapped caves.

The river and springs were assigned in the model as constant heads. River assignments allowed for discharge or recharge depending on the relationship between the simulated groundwater levels and the assigned river stages, while spring assignments carried constraints that only allowed discharge. This method ensured that the simulated groundwater levels along the river and at the springs would reasonably match real-world conditions while also allowing for river loss to the aquifer. The simulated spring and river flows were then achieved through the calibration process through the initial adjustment of aquifer hydraulic conductivity in three zones and then the subsequent adjustment of conduit locations and sizes.

6.2.2 Model Calibration

The WSFM-08 was simultaneously calibrated to two different datasets representing groundwater levels and spring flows occurring under low-water and high-water conditions. The low-water dataset was compiled from groundwater level, spring flow, and river flow measurements collected from 188 wells, 9 springs, and 4 river gauging stations between January 2001 – December 2002, and May – October 2007. The high-water dataset was compiled from groundwater level, spring flow, and river flow measurements collected from 145 wells, 17 springs, and 2 river gauging stations during the periods January 1998 – May 1999 and October 2004 – December 2005. The model was also calibrated to conduit flow velocities calculated from travel times between O’leno Sink and the River Rise derived from hydrographic analyses, [13] and four groundwater tracer tests that had been previously conducted between:

- Rose Sink south of Lake City and the springs along the Ichetucknee River; [55]
- Dyal Sink south of Lake City and the springs along the Ichetucknee River; [55]

- Mill Creek Sink in Alachua and the springs along the upper part of the western Santa Fe River below the River Rise; [58] and
- Lee Sink in San Felasco State Preserve and the springs along the upper part of the western Santa Fe River below the River Rise. [58]

Model calibration was performed by developing two models, one representing high-water conditions, and the other representing low-water conditions each associated with a specific set of recharge and boundary condition assignments representative of the respective hydrologic conditions. Calibration then involved identifying a single set of aquifer permeability assignments (matrix hydraulic conductivity distribution and values, and conduit placement, conduit area, and conduit roughness) that resulted in an acceptable match to the independent high-water and low-water calibration datasets when assigned to the respective models. Specific calibration target criteria for each of the respective periods included +/- 3.5 feet of the average measured groundwater surface elevation at each of the individual wells, spring flows within the observed range, aggregate river gains within the observed range, swallet inflows based on catchment areas measured from GIS and drainage rates estimated from historical aerial photographic analyses and anecdotal descriptions, and tracer-defined conduit velocities.

In general, this was done through an 8-step process involving:

1. manually establishing a conduit pattern,
2. defining a configuration of hydraulic conductivity that resulted in a reasonable match to the observed groundwater surface elevations in the high-water conditions model,
3. moving, adding, and/or redefining conduits if and where necessary to resolve calibration problems,
4. manually modifying conduit areas and roughness to improve the calibration to groundwater surface elevations and spring flows as much as possible,
5. iterating on steps 2-4 until an acceptable match to the high-water calibration dataset was achieved,
6. importing the resulting parameter set into the low-water conditions model,
7. repeating steps 2-5 until an acceptable match to the low-water calibration dataset was achieved,
8. repeating steps 2-7 until a single model configuration produced an acceptable match to both end-member calibration datasets.

An effort was made to use PEST to automate and optimize step-2 however the standard process cannot address the conduit assignments, which proved to be the controlling variables in the calibration process. The inability to use PEST was overcome however through additional manual manipulations.

6.2.2.1 Groundwater Levels

Excellent calibration was achieved to the observed groundwater surface elevations, spring flows, and tracer-defined travel-times along the established conduit pathways (Figure 37). Residuals between simulated and observed groundwater elevations in the low-water version of the model were less than 3.5 feet, which was approximately 5% of the total change in the elevation of the groundwater surface in the UFA across the model domain, at 176 of the 188 calibration wells (94%) and the model matched 61% of the wells to within the observed range in groundwater surface elevations where that range was greater than 1 foot. Groundwater surface elevation residuals in the high-water version of the model were less than 3 feet at 99% of the 145 calibration wells and the model matched 72% of the wells to within the observed range in groundwater surface elevations where that range was greater than 1 foot.

In terms of discharge, the model matched 5 of 8 springs with multiple measurements of flow under low-water conditions to within the observed range, and 6 of 9 springs with at least one measurement to within 30% of the observed or average flow, where none of the simulated springs deviated from the observed value by more than two times (Figure 37). Under high-water conditions, the model matched 10 of 10 springs with multiple measurements to within the observed range, and 13 of 17 springs with at least one measurement to within 30% of the observed or average flow, where none of the simulated springs deviated from the observed value by more than 71% (Figure 37). The model also matched the aggregate river gains between the High Springs and Ft White, and the Ft White and Hildredth river gauges to within the observed ranges for both the low-water and high-water conditions.

6.2.2.2 Groundwater Flow Paths & Velocities

In terms of groundwater flow paths and velocities, the model was designed to honor tracer-defined groundwater flow paths and calibrated to closely match travel-times obtained from the tracer tests and hydrograph analyses described above. Those values were 1400-2400 feet/day between the Mill Creek and Lee Creek swallets and Hornsby spring on the Santa Fe River, 700-1100 feet/day between the Rose Creek and Clay Hole swallet system and Blue Hole and Mission springs on the Ichetucknee River and 7000-14000 feet/day between O'leno Sink and the Santa Fe River Rise. The model also simulated substantially slower velocities through the aquifer matrix between the conduits. Values estimated using the range in hydraulic conductivities and gradients observed in the basin range from 10^{-6} to 10^{-3} m/day. Model values ranged from 10^{-3} to 10^{-1} m/day. Figure 38 shows the simulated conduit flow paths relative to the locations of simulated springs and swallets and the tracer-defined groundwater flow paths. Table 12 compares the specific tracer and hydrograph defined travel times to the simulated travel times and velocities. Figure 39 depicts the spatial distribution of simulated groundwater velocities and shows how the WSFM-08 simulates slow groundwater flow through the matrix that then substantially increases in velocity once it enters the conduits. The velocity distribution is therefore commensurate with the observed head distributions that reflect trough-like lows throughout the basin.

Table 12. Comparison of flow paths, travel times and groundwater velocities determined through artificial groundwater tracing and values simulated by the WSFM-08.

Observed Data			WSFM-08			
Flow Path			Low Water		High Water	
Injection	Discharge	Travel Time	Travel Time	Velocity	Travel Time	Velocity
Black Sink	Rose Sink Swallet	25-34	45	444	51	389
Black Sink	Ichetucknee Headspring	ND	no	no	no	no
Black Sink	Cedar Head Spring	ND	no	no	no	no
Black Sink	Blue Hole Spring	65-92	143	479	102	674
Black Sink	Mission Spring Group	65-92	146	485	103	683
Black Sink	Devil's Eye Spring	65-123	***no***	***no***	***no***	***no***
Black Sink	Grassy Hole Spring	ND	152	487	108	682
Black Sink	Mill Pond Spring	ND	153	488	109	684
Dyal Sink	Rose Sink Swallet	34-125	28	614	19	870
Mill Creek Sink	Hornsby Spring	12-28	134	467	41	1517
Mill Creek Sink	ALA930971	*na*	no	no	no	no
Mill Creek Sink	Poe / Lilly Group	ND	no	no	no	no
Mill Creek Sink	COL101974	*na*	no	no	no	no
Mill Creek Sink	Rum Island / Blue Group	*na*	no	no	no	no
Mill Creek Sink	Ginnie / Devil's Ear Group	*na*	no	no	no	no
Lee Sink	Hornsby Spring	28-59	87	814	55	1277
Lee Sink	Poe / Lilly Group	ND	no	no	no	no
Lee Sink	COL101974	*na*	no	no	no	no
Lee Sink	Rum Island / Blue Group	*na*	no	no	no	no
Lee Sink	Ginnie / Devil's Ear Group	*na*	no	no	no	no
O'leno Sink	Santa Fe River Rise	1	8	3,475	3	7,913

<u>Notes</u>
Units: travel time (days), velocity (ft/day)
na: not analyzed
Red: simulated flow path doesn't agree with tracer test results
ND: sampled but not detected
no: no observed connection

6.2.3 Model Results

The fundamental results from any groundwater flow model are depictions of groundwater levels and the groundwater flow patterns and velocities that stem from them in each of the aquifers simulated. Those results are presented in Figure 37 and Figure 39 and discussed above. Additional information was derived from those results including delineations of springsheds (Figure 40), spring and aquifer vulnerability (Figure 41), and an assessment of the impacts of groundwater pumping in the model domain on spring flows (Figure 42).

6.2.3.1 Springshed Delineations

Springsheds for 10 springs and spring groups were delineated under both the simulated high-water and low-water hydrologic conditions (Figure 40). As described in Section 2.3, springsheds define the area that contributes groundwater flow to specific springs or spring groups. Springshed boundaries are hydraulic divides that demark lines across which groundwater flow changes direction and that fluctuate under varying hydrologic conditions. Table 13 lists the simulated springshed areas and the percent change in area that occurs when hydrologic conditions change from high-water to low-water conditions. The model shows that the majority of the springsheds increase in size under low-water conditions, which occurs because the capacity of the springs to discharge requires a larger recharge area to fill under low-water conditions. When the springsheds are bounded by fixed divides however, the springsheds can contract as was simulated for Ichetucknee and Hornsby Springs. The relative springshed areas depicted on Figure 40 reveal that the springsheds for lower elevation springs will tend to expand at the expense of higher elevation springs under low-water conditions. Thus, the springshed for the Ginnie/Blue Springs group expands at the expense of the springshed for the Poe/Lilly Springs group, which in turn expands at the expense of the springshed for Hornsby Spring.

Table 13. Simulated springshed areas

Spring or Spring Group	Springshed Area mi^2 *(km^2)* High Water	Low Water	% Change
Ichetucknee	96 *(248)*	86 *(222)*	-10
Blue Hole	146 *(377)*	188 *(488)*	+29
Sunbeam	31 *(80)*	40 *(103)*	+29
River Rise	45 *(116)*	52 *(134)*	+16
Rum Island	9 *(24)*	10 *(26)*	+11
July	5 *(12)*	4 *(11)*	-25
Twin	11 *(29)*	19 *(49)*	+73
Ginnie / Blue	152 *(395)*	160 *(414)*	+5
Poe / Lilly	91 *(237)*	93 *(241)*	+2
Hornsby	106 *(274)*	81 *(210)*	-31

6.2.3.2 Spring Vulnerability

Figure 41 shows delineations of probable spring vulnerability zones associated with pumping and no-pumping conditions that were derived from the simulated groundwater velocities converted to travel-times. The plots show the approximate travel times from every point in the model domain to the point at which water from that point leaves the model through springs, wells, or model boundaries. The plots depict the logical consequence of conduit flow in that travel times to the springs are very short from any point in the conduits feeding water to the springs and become progressively longer from points in the aquifer matrix between the conduits. The vulnerability of springs to contamination from surface sources such as contaminant spills, fertilizer application, or wastewater disposal is therefore predicated on the distance from the source to the nearest conduit supplying water to the springs, not on the distance to the springs themselves. Less obvious but apparent through comparing the two maps, is the effect of pumping where pumping can be seen to substantially reduce travel times in some regions, which occurs because flow is being directed from those locations away from the conduits to the wells through the aquifer matrix.

6.2.3.3 Effects of Pumping on Springsheds

Figure 42 shows the simulated capture zones for the major pumping wells simulated by the model under high-water and low-water conditions relative to the simulated springshed boundaries. The capture zones were defined through particle tracking. Some of the capture zones fall completely within the simulated springsheds while others cross springshed boundaries or exist outside of but adjacent to the springsheds.

In all cases, it can be surmised from the maps that the capture zones influence the position and thus the size of the springsheds. Table 14 provides an example in which the Blue Hole springshed is reduced by 19% and 30% due to groundwater pumping for Lake City under high water and low water conditions respectively.

Table 14. Effects of Pumping on Ichetucknee & Blue Hole Springsheds

	Springshed Area mi^2 *(km^2)*			
	High Water		Low Water	
Condition	Ichetucknee	Blue Hole	Ichetucknee	Blue Hole
No Pumping	96 *(248)*	134 *(347)*	86 *(222)*	188 *(488)*
Pumping	95 *(245)*	122 *(316)*	86 *(222)*	146 *(377)*
% Change	-1	-19	0	-30

6.3 Comparison to the NFM-08

6.3.1 Calibration

6.3.1.1 Heads

Figure 43 and Figure 44 compare how well the WSFM-08 and the NFM-08 calibrate to measured groundwater levels during the respective calibration periods, both of which focused on hydrologic conditions measured in 2001/2002. The WSFM-08 produced a very different head field that is substantially better calibrated. In terms of the criterion used by SDII (average of absolute residuals < 5% of total head change), the average absolute residual in the WSFM-08 was 1.4 feet. The average absolute residual for the 132 NFM-08 calibration wells that are located within the WSFM-08 domain was 4.2 feet. In terms of the WSFM-08 criterion (best possible match at all wells), the WSFM-08 matched groundwater levels at 176 of 188 wells to less than 3.5 feet with only 5 residuals greater than 5 feet and 1 greater than 10 feet. The NFM-08 matched groundwater levels to less than 5 feet at only 101 of the 132 wells located within the WSFM-08 domain and to less than 3.5 feet at only 80 of the 132 wells. Nine of the wells had residuals greater than 10 feet and 5 of those wells had residuals greater than 20 feet.

The lower residuals stem from a fundamentally different depiction of the groundwater surface where the GH-NFM predicted a complex topology including numerous troughs that extend across the basin to springs whereas the NFM-08 predicted a relatively smooth surface dipping toward a single trough encompassing the confluence of the Santa Fe and Ichetucknee Rivers. The fact that the more complex representation better honors the data strongly suggests that it is a better representation of actual flow patterns.

6.3.1.2 Spring Flows

As discussed in Section 4.4.2 and Section 5.2.2, the NFM-08 uses a method for simulating spring flows that matches flows at the expense of honoring measured groundwater levels at the river (river stage). Throughout much of the western Santa Fe River and particularly the section west of Ginnie Springs to the confluence with the Suwannee River, the NFM-08 over-predicted groundwater levels along the river by between 5 and 20 feet (Figure 11). This is because the streambed conductance terms used to achieve the simulated spring flows are inconsistent with a reasonable conceptualization of the UFA and the values therefore resulted in an unreasonable simulation of groundwater levels. Thus, the reported near-perfect match to spring flows cannot be considered valid.

A collective evaluation of both spring flows and groundwater levels at the river simulated by the WSFM-08 reveals that it achieves a significantly better match to observed conditions. This is because groundwater levels along the river and at the springs were specified to match the appropriate levels for high-water and low-water hydrologic conditions for the two different model versions and then aquifer properties consistent with a reasonable conceptual model of the UFA were varied until the model also matched flows. The result is a set of simulations that match spring flows to within the observed range while also matching groundwater levels at the river and springs under both high-water and low-water conditions.

6.3.1.3 Flow Paths & Velocities

Figure 45 compares the simulated groundwater flow paths between swallets and springs from the NFM-08 and WSFM-08 to the paths observed through groundwater tracing. The WSFM-08 simulated paths match seven of the eight tracer-defined paths and four of the six tracer-defined null pathways while the NFM-08 simulated paths fail to match four of the eight tracer-defined paths and incorrectly predict connections to all six of the springs for which groundwater tracing indicated no connection to the respective swallets. From this, it can be seen that the equivalent porous media approach combined with a calibration method that focuses only on the average absolute residual, as applied in the NFM-08, fails to reasonably represent observed conditions. The NFM-08 simulated flow paths will yield springshed boundaries and predicted impacts that are simply incorrect. On the basis of calibration to observed conditions, the hybrid modeling approach combined with a more rigorous calibration method clearly better represents reality. Predictions that stem from those representations will therefore be more reliable.

6.3.2 Recharge

Figure 46 compares the distribution of assigned recharge in the NFM-08 and the WSFM-08. Both distributions assumed essentially the same distribution of rainfall, which was based on measured rainfall throughout the respective model domains. The western Santa Fe River basin falls predominantly in the unconfined part of the Floridan aquifer where surface runoff is limited due to rapid infiltration to the UFA through thin or non-existent surficial sediments. The expectation therefore is that recharge in that region will be higher relative to other sections of the State where surface runoff is higher. The recharge values assigned to the western Santa Fe River Basin in the NFM-08 were however some of the lowest values across the entirety of the model domain, which covered all of north Florida. The lowest value in the entire domain occurs, in fact, in the southern part of the basin. As was discussed in Section 4.6.1, the pattern of recharge assignments furthermore fails to relate to the measured distribution of rainfall, ground surface slope, or land use.

Recharge values assigned in the WSFM-08 were comparatively much higher in the low-water version of the model that was calibrated to a similar time period as the NFM-08. The distribution was considered to be uniform because the available data indicates that the entire model domain receives similar rainfall. Adjustments were then made to account for land use, particularly irrigation, which was assumed to increase recharge, particularly at operations with large reported groundwater extractions reported to be for irrigation.

6.3.3 Permeability Framework

Figure 47 compares the assigned permeability framework of the UFA underlying the simulations of groundwater flow produced by the two different models. The most significant difference is the pattern of the hydraulic conductivity assignments. The WSFM-08 is constructed on a pattern that can be directly correlated to known, well-documented, or reasonably inferred geologic zonation. The largest zone represents the Ocala and Suwannee Limestones, which are known to have relatively high porosity, and aside from differential karstic development, are widely accepted to be homogeneous in permeability characteristics. This zone was considered to have moderately high hydraulic conductivity (100 feet/day). The most permeable zone was delineated on the basis of topography and potentiometric surface. It represents a zone of intensive karstification along the Santa Fe River and was assigned a hydraulic conductivity value of 1000 feet/day. The lowest permeability zone follows the Bell Ridge wherein borehole data reveal that the limestones in the UFA have substantially lower permeability, which is also evidenced by numerous lakes, ponds, and wetlands that exist on top of exposed or thinly covered limestone, and a comparatively high potentiometric surface. This region was assigned a hydraulic conductivity value of 0.5 feet/day.

Comparatively, the NFM-08 displays no apparent correlation between the assigned hydraulic conductivities and known geologic zonation, other than along the Bell Ridge. Alternatively, the pattern indicates and the SDII report describes that hydraulic conductivities were assigned exclusively on the basis of model calibration without any meaningful regard to known geologic conditions. This means that they were set to whatever values necessary to simulate groundwater levels to within the calibration criterion when combined with the other parameter settings. This was done through PEST (Sections 3.4.4 and 4.3), which is an automated process that, in this case, was allowed to vary the assigned values across the entire range of permeability values that have been estimated through aquifer testing. Essentially, this process overrides and ignores the best information available regarding the geologic and hydrogeologic setting and relies instead exclusively on a computer-generated pattern.

6.3.4 Model Validity

Figure 48 compares the validity of the assumptions underlying the use of the porous media equations that were used to simulate groundwater flow in the NFM-08 and the WSFM-08. The NFM-08 relied exclusively on those equations whereas the WSFM-08 used both porous media and conduit flow equations to describe different components of the groundwater flow system; conduits and the rocks in between them. Validity is determined here on the basis of the Reynolds Number, which can be calculated from the hydraulic conductivity values assigned in the respective models and the associated simulated groundwater levels and hydraulic gradients that stem from those assignments. In order for the porous media equations to be valid, Reynolds Numbers must fall within or near the laminar range. [24,76]

The Reynolds Numbers calculated at each cell of the respective models reveal that the assumptions underlying the porous media equations are violated across much of NFM-08 domain whereas those assumptions have not been violated anywhere within the WSFM-08 domain. The difference stems from the different conceptualizations underlying the two models and the different parameter assignments needed to match or approximate observed groundwater levels and flows given the respective conceptualizations. Because the NFM-08 assumes that the aquifer is exclusively a porous media, unrealistically large hydraulic conductivity assignments were required to approximate heads and flows. These values and the associated simulated gradients resulted in very large Reynolds Numbers that violate the assumptions upon which the equations were developed. The hybrid conceptualization, on the other hand, in which conduits embedded in a porous media are predominantly responsible for the large spring flows and complex potentiometric surface, results not only in a better match to observed conditions, but also a substantially more valid model where the assumptions underlying the equations used by the model have not been violated.

6.4 Discussion

Comparison of the two models reveals that the WSFM-08 calibrates substantially better to observed groundwater levels and spring flows while also using substantially more realistic parameter settings. Comparing the two models also reveals that they yield substantially different predictions of groundwater flow patterns and velocities as well as the springshed boundaries and impacts from spring flows that stem from those simulations. The differences are not therefore academic but, in fact consequential to decisions and actions related to groundwater resource management in the western Santa Fe River basin. More broadly, the comparison reveals that modeling the Floridan aquifer in north Florida as an equivalent porous media imparts substantial errors in the simulation of both local and regional groundwater flow patterns and heads that will render predictions of the impacts of groundwater pumping on spring flows invalid. The ability of the WSFM-08 to simulate both conduit and matrix flow using realistic estimates of aquifer parameters and then to very closely match observed groundwater levels and spring flows demonstrates that the equivalent porous media assumption is not necessary. It does not represent the best technology available to groundwater modelers and resource managers.

7 SUMMARY & CONCLUSIONS

7.1 NFM-08 Conceptual and Design Problems

The NFM-08 relies on a conceptual framework that simplifies the established and recognized karstic characteristics of the UFA, namely conduit flow from recharge areas that include large-magnitude swallets to large-magnitude discrete springs, into an equivalent porous media. The model does not address conduit flow. Instead, the model relies on implausible parameter values to force the porous media groundwater flow equations to simulate observed spring flows and river gains. As a result, the model framework fails to honor well-established characteristics of the UFA, the simulated groundwater surface poorly represents observed groundwater levels and local hydraulic gradients, and the assumptions underpinning the groundwater flow equations on which the model is based are violated throughout much of the model domain.

The NFM-08 poorly calibrates to observed groundwater levels. SDII chose to use a criterion for calibration of +/- 5 feet relative to the average of the absolute value of the difference between observed and simulated groundwater elevations (residual) at 676 UFA wells. SDII's choice of the calibration criterion appears to be arbitrary because groundwater levels at more than half of the well data published by the SRWMD for the model calibration period varied by less than 3 feet and nearly 75% of those wells showed variations less 4 feet. SDII classified the model as "well calibrated" (indicating high quality) because the average of those 676 residuals was 4.3 feet. The analyses presented here however revealed that simulated groundwater levels at 147 of the 534 wells within the SRWMD (28%) deviated from the average groundwater levels measured during the NFM-08 calibration period by more than 5 feet, 10% of those 534 residuals were higher than 10 feet, and only 48% of those residuals were less than a 3-foot range that can be defined by the data (Section 4.4.1; Figure 10).

The NFM-08 fails to adequately calibrate to measured or estimated spring and river flows. This is because the model uses streambed conductance terms in a manner that is inconsistent with established hydrogeologic conditions in the unconfined part of the UFA to force the results to closely match flows at the expense of reasonable approximations of groundwater levels at the rivers (Section 5.2.2). The model contains 831 river assignments and 147 drain assignments intended to represent groundwater discharges to rivers and springs in the UFA. The simulated groundwater levels at the majority of those locations deviated substantially from reasonable estimates: 48% of river assignments and 50% of drain assignments by more than 5 feet, and 8% and 10% of those assignments by more than 15 feet respectively (Section 4.4.2; Figure 11). If simulated groundwater levels at the rivers were considered as calibration points, the deviations between simulated levels and observed stage raise the average absolute residual to approximately 5.6 feet (based on the 534 wells evaluated in this report), which violates SDII's calibration criterion (Section 4.4.2). These deviations were not disclosed in the SDII report therefore SDII's assertion that the model nearly precisely matches spring flows is strongly misleading.

The NFM-08 fails to adequately simulate the observed impacts to groundwater levels and flows associated with relatively large-magnitude municipal groundwater pumping. The model under-estimates the depth of the cone-of-depression created by groundwater pumping by the City of Gainesville by more than 30 feet (Section 4.4.3; Figure 12 and Figure 13). The model under-estimates the capture zone for the associated wells by between 108 and 130 square miles, which is between 54% and 59% of the capture zone documented by the ACEPD during the model calibration period (Section 4.4.3; Figure 14). The model under-estimates the magnitude of the cone-of-depression associated with groundwater pumping near Fernandina Beach by an even larger amount (~35 feet) indicating that the problem is not localized to one area of the model domain.

The SDII model fails to honor known groundwater flow paths established through groundwater tracing (Section 4.4.5; Figure 18). The model correctly simulates only 4 of 21 established groundwater flow paths (19%; Table 6). The model missed critical connections between swallets and Blue Hole and Hornsby springs (Figure 18) rendering the springshed delineations for these springs invalid and therefore any predictions of impacts due to groundwater pumping invalid. Those flow path data were published well before the 2008 model completion date, yet the SDII report makes no reference to those data nor provides any discussion that would indicate to readers or model users that the model has failed to honor those documented flow paths.

The hydraulic conductivity values in the NFM-08 representing the capacity of the UFA to transmit water deviate substantially from values derived from aquifer performance testing: between 40 times less to 502 times more as compared to values published by the USGS in 2012, and between 323 times less to 126 times more as compared to a map published by the USGS in 1990 (Section 4.5; Figure 22). Moreover, the modeled distribution of values fails to correspond to established hydrogeologic zonation in the UFA (Figure 23). Taken together, these deviations indicate that the permeability framework was established purely as an artifact of the model calibration process with little regard to plausibility. The resulting values are likely between 1 and 2.6 orders of magnitude too high throughout much of the model domain including much of the Suwannee River and Santa Fe River basins. The high values resulted in overly flat hydraulic gradients wherein simulated groundwater levels are generally too low near documented groundwater divides and too high nears the rivers (Figure 10). The overly flat hydraulic gradients led to the model's inability to adequately simulate the impacts of groundwater pumping (Section 4.4.3; Figure 13, Figure 14, and Figure 16). SDII acknowledged the sensitivity of the model to relatively small variation in hydraulic conductivity values but failed to adequately disclose the significance of that sensitivity to model error or the model's predictive capacity (Section 5.7.2).

The spatial distribution of recharge assigned in the NFM-08 fails to correspond to the observed distribution of precipitation or documented land use patterns throughout most of the model domain and particularly in the western part of the domain where the UFA is unconfined (Section 4.6.1; Figure 29). The magnitude of simulated recharge in the model over-estimates measured sub-watershed scale river gains by between 30 and 132 cfs in the Upper Econfina-Fennholloway, Upper Steinhatchee, Upper Suwannee, Waccasassa, and western Santa Fe River basins and under-estimates the measured river gain in the lower Suwannee River basin by 241 cfs (Section 4.6.2; Figure 31). In total, the model over-estimates sub-basin scale recharge, as defined by measured discharge by 231 cfs in these basins. These deviations were likely the result of not following a conservative practice for bounding the range in the magnitude of recharge available to PEST during model calibration by measured sub-watershed scale stream flows. The result contributed to an over-estimation in the total amount of groundwater flow through the UFA to rivers and springs of between 230 and 950 cfs (Sections 4.6.2 and 4.7.1). Given the recharge assignments and calibration method, the bulk of this discrepancy likely occurs in the coastal rivers downstream of the river gauges where available data indicates that the rivers lose water to the UFA rather than gain in flow (Figure 32 and Figure 33).

The NFM-08 model boundaries were not designed or assigned according to standard practices that focus on limiting the degree to which simulated pumping is derived directly from external model boundaries. An evaluation of the model's water budget revealed that approximately 38% of the simulated flow through the UFA is to external model boundaries (24% to the general head nodes defining the southern model boundary, and 14% to the constant head nodes defining the Gulf of Mexico boundary. Removing the assigned pumping (not including wells used to represent river siphons) revealed that the boundary conditions permit more than 40% of the simulated well extractions to intercept flow that would otherwise be to the external boundaries (35.5% to the general head nodes representing the southern boundary, and 5.1% to the constant head nodes representing the Gulf of Mexico). These boundary condition effects are not disclosed in the SDII report and the associated limitations on the model's ability to reliably predict the impacts to groundwater levels or flows have therefore not been disclosed to readers or model users.

The unrealistic hydraulic conductivity and recharge distributions in the NFM-08 are a consequence of overly broad ranges prescribed to those values in PEST. The broad range constraints, excessive reliance on unbounded streambed conductance terms, and large proportion of the simulated flow occurring across the external model boundaries resulted in a non-unique calibration to the chosen criterion meaning that it is likely that several different configurations could have resulted in an equivalent match to spring flows and observed groundwater levels. This is particularly true with respect to spring flows where the unbounded streambed conductance terms and lack of verification applied to the corresponding simulated groundwater levels at the rivers allow the model to match spring flows under a broad range of conditions. This is because the model is free to modify the simulated hydraulic gradient near the rivers as needed to match the desired flows. With respect to simulated groundwater levels, the sole reliance on a single calibration criterion (the average absolute residual) ensures that multiple configurations of recharge and hydraulic conductivity can produce a similarly classified result with respect to calibration because the spatial distribution of residuals was not considered. Thus multiple configurations of hydraulic conductivity and recharge could likely produce the same or similar average absolute residual but depict considerably different groundwater flow patterns, particularly at local scales.

7.2 Validity of the Equivalent Porous Media Approach

The UFA underlying most, if not all, of north Florida is known to be extensively karstified where the most intensive karstification is in the unconfined region of the aquifer that spans much of the SRWMD. A multitude of studies conducted over the course of several decades confirm the existence, prevalence, and significance of karstic features including conduits. These conditions were acknowledged by SDII in their report yet they chose to simplify the representation of the UFA in the NFM-08 to that of an equivalent porous media without addressing the probable consequences of that simplification. This practice has become commonplace in Florida based on the reasoning that to do otherwise is technically impracticable with currently available technology. The WSFM-08 was constructed, in part, to demonstrate the practicability of addressing, rather than ignoring, karst features in groundwater resource modeling, and to demonstrate the effect of simulating conduit flow conditions on the resulting simulations of groundwater flow and impacts.

Comparisons of the NFM-08, in which the UFA was simulated as an equivalent porous media and the WSFM-08, in which the UFA was simulated as a dual-permeability framework consisting of conduits embedded in a porous media, reveal substantial differences that are consequential to groundwater resource management decisions. Specifically, the WSFM-08 produced substantially better agreement with observed groundwater levels and spring flows under both low-water and high-water conditions where the improvement stemmed from different simulations of groundwater flow patterns and velocities. Where the NFM-08 failed to simulate tracer defined groundwater flow paths, the WSFM-08 accurately did so. Where the NFM-08 failed to match tracer-defined groundwater velocities, the WSFM-08 accurately did so. And, where the NFM-08 used unrealistically high hydraulic conductivities resulting in an inability to simulate observed impacts to groundwater levels due to existing municipal pumping, the lower hydraulic conductivity values used in the WSFM-08 support the simulation of substantially larger simulated drawdowns in the aquifer matrix that are more consistent with observed conditions.

These discrepancies demonstrate that the equivalent porous media approach is incapable of adequately simulating the patterns of groundwater flow to springs and therefore the impacts of groundwater pumping on those flow patterns. Moreover, the fact that the hybrid model was constructed with commercially available, widely used software as well as publically available datasets demonstrates that the decision to use and rely on equivalent porous media assumptions and methods cannot be argued to be based on technological impracticability.

7.3 Conclusions

Numerical groundwater flow models are, to a large extent, qualitative tools that provide quantitative answers to questions involving groundwater flow systems. The quality of modeling results (and the quantitative answers that stem from those results) is predicated on:

1) the degree to which simulated groundwater levels and flows match real-world conditions;
2) the degree to which the parameters used to produce the simulated conditions adheres to a reasonable conceptualization of the relevant hydrogeologic framework and processes; and

3) the appropriateness of the mathematical representation of the flow processes relative to the conceptualized groundwater system.

The reliability of model predictions is predicated on the three criteria for model quality evaluated at a scale appropriate to the stated purpose for the model. The stated purpose of the NFM-08 is to assess the impacts of groundwater pumping associated with individual consumptive use applications on groundwater levels and groundwater discharge to springs and rivers; as well as to provide a basis for establishing MFLs for rivers and springs within the SRWMD. [8] The NFM-08 fails to meet the three criteria for quality described above and therefore cannot be reliably used for the stated purposes. Furthermore, the report associated with the model must be considered misleading because it fails to disclose the necessary information for readers or model users to indentify the degree to which the model fails to meet these criteria.

A comparison of model results to measured data reveals that the NFM-08 fails to reasonably represent observed groundwater levels or spring flows. Large discrepancies between measured and simulated groundwater levels are distributed throughout the model domain in a spatial pattern that favors unrealistically flat hydraulic gradients. The model does not simulate individual spring flows at the scale represented in the SDII report. Spring flows were simulated using streambed conductance terms that are inconsistent with the unconfined conditions of the aquifer existing at the majority of the simulated springs. Arbitrary values for the term ensured a match to the specified flows at the expense of realistic simulations of groundwater levels at the rivers, which invalidates the simulated flows. Both the groundwater level and spring flow discrepancies are widespread across the model domain.

The hydrogeologic parameter values upon which the model is based fail to plausibly correspond to well-established conditions in the UFA or represent conservative approximations in regions where those conditions are less well established. Hydraulic conductivities deviate from values derived from aquifer performance tests and those reported by the USGS by 0.5 to 2.6 orders of magnitude across much of the model domain. Assigned recharge distributions fail to correlate to precipitation or documented land use. The magnitude of assigned recharge results in simulated groundwater discharge to rivers and streams that flow to the Gulf of Mexico that exceeds measured values by between 300 and 950 cfs, or when compared to sub-watershed scale discharge, exceeds measured values by between 231 and 750 cfs. As a consequence of implausible parameter values, the model violates the assumptions underpinning the groundwater flow equations with which it was constructed throughout approximately half of the model domain including much of the Suwannee River basin.

The model under-estimates the measured impacts to UFA groundwater levels from municipal groundwater pumping in both the central part of the model domain (City of Gainesville) and the northeastern part of the model domain (Fernandina Beach) by more than 30 feet in both cases. The model under-estimates the capture zone for City of Gainesville's well field by more than 100 square miles, and it fails to accurately simulate documented groundwater flow paths to the Santa Fe and Ichetucknee Rivers.

Taken together or individually, these flaws impart substantial limitations on the applicability of the NFM-08 for its stated purposes, which are ostensibly to evaluate all manner of impacts to specific springs and river reaches associated with specific groundwater pumping activities, and to delineate the magnitude and spatial distribution of cumulative impacts to spring and river flows associated with current and future groundwater extractions in support of MFL designation and enforcement. Such limitations are not discussed or disclosed in the documentation supporting the NFM-08. Without defining the model's limitations and establishing a margin of error on the model results and predictions, predictions derived from the NFM-08 should not be considered to reliably represent the probable impacts of groundwater pumping on specific spring flows, river reach flows, or groundwater levels within the SRWMD.

With respect to model reporting, the failure of the supporting documentation to discuss or disclose the problems identified in this investigation indicates that the SRWMD neither performed nor required a substantive internal or external peer review of the model or the conclusions regarding its reliability with respect to its intended applications.

The model developers chose to represent the UFA as an equivalent porous media when, in fact, the UFA is not a porous media but a dual permeability aquifer where flow patterns and rates are known to be significantly controlled by conduits. SDII acknowledged this in their report on the model development and results. The equivalent porous media representation was not the only choice available at the time the NFM-08 was constructed. Several authors had published works on the use of hybrid modeling techniques applied to karst aquifers for at least a decade prior to the development of the NFM-08, and well-documented, scientifically vetted, and widely used software capable of incorporating a hybrid design was commercially available well before the NFM-08 was constructed. The WSFM-08 is an example of a model that capitalized on those alternative ideas and technologies. The fact that, within the western Santa Fe River basin, the WSFM-08 is significantly better calibrated to observed groundwater levels and spring flows and uses parameter values that more closely match observed hydrogeologic conditions than the NFM-08, demonstrates the superiority of the non-porous media approach.

The fundamental broader conclusions from this investigation are:

1) spring and river flows in the SRWMD are suffering from declines in the quantity and quality of groundwater discharge;
2) a reliable groundwater flow model is a tool that is well suited to facilitating a better understanding of the cause of these declines and indentifying and designing mitigation strategies;
3) the NFM-08 is a poorly constructed model that fails to meet broadly accepted measures of model quality, and therefore cannot be reliably used to pursue these objectives;
4) the approach and software used in the NFM-08 does not represent the best available technology;
5) there exist alternative methods and software that could be, and could have been used that are able to incorporate much more of the available hydrologic information and provide substantially more reliable predictions;
6) though it is possible, reasonable, and prudent to identify the magnitude and spatial extent of a model's reliability, no such delineations have been presented; and
7) by using the NFM-08, the SRWMD is not pursuing a reasonably conservative approach to the characterization and mitigation of impacts to spring and river flows associated with groundwater withdrawals.

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9 FIGURES

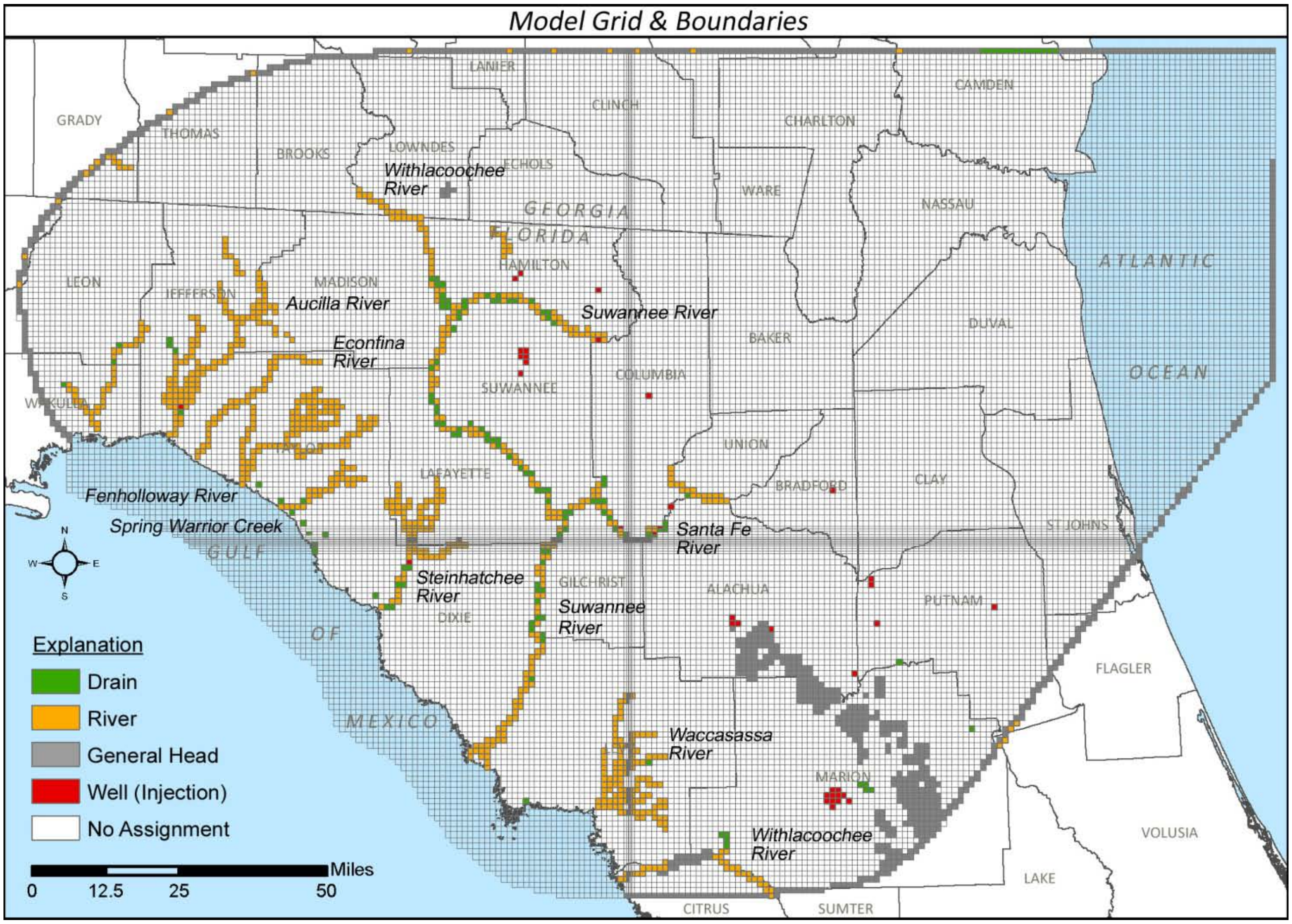


Figure 8 – Douglas Farm Version of the NFM-08 – Model Domain, Grid, and Layer-3 Boundary Conditions

The NFM-08 is a 3D 5-layer numerical groundwater model constructed in the software MODFLOW. It uses a north-south oriented orthogonal grid with cell sizes approximately equal to 5,000 X 5,000 feet. The model cannot simulate flow patterns at a resolution finer than the grid cell size nor can it discriminate between flows to individual spring discharges that fall within a single grid cell. The grid shown above was refined by the SRWMD in order to evaluate proposed pumping at the Douglas Farm as the basis for a permitting decision. Drains represent springs. Injection wells represent drainage wells and river siphons. The UFA also discharges to the Gulf of Mexico through constant head cells assigned in Layer-1 and Layer-2.

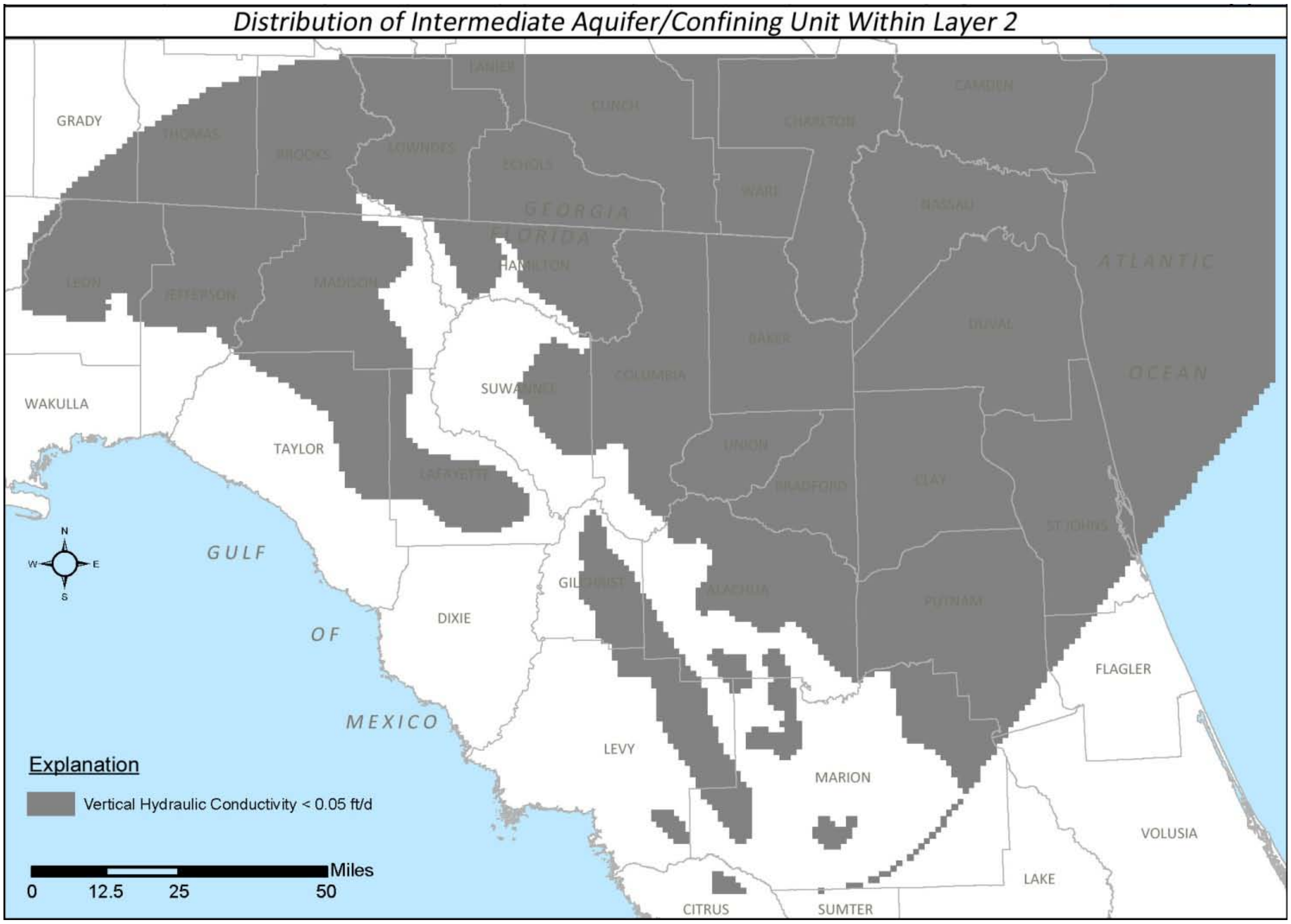


Figure 9 – NFM-08 – Distribution of the IAS

The Intermediate Aquifer system (IAS) is primarily a confining unit that separates flow in the Surficial Aquifer system (SAS) from flow in the Upper Floridan Aquifer (UFA). The delineation of the IAS in the NFM-08 is therefore significant to the simulated flow in the UFA because it limits vertical recharge wherever it is present. In general, the IAS represents the Hawthorne Formation, which is a predominantly clay unit that is continuous across north-central Florida except in the western part of the peninsula and southern part of the panhandle where it has been eroded away.

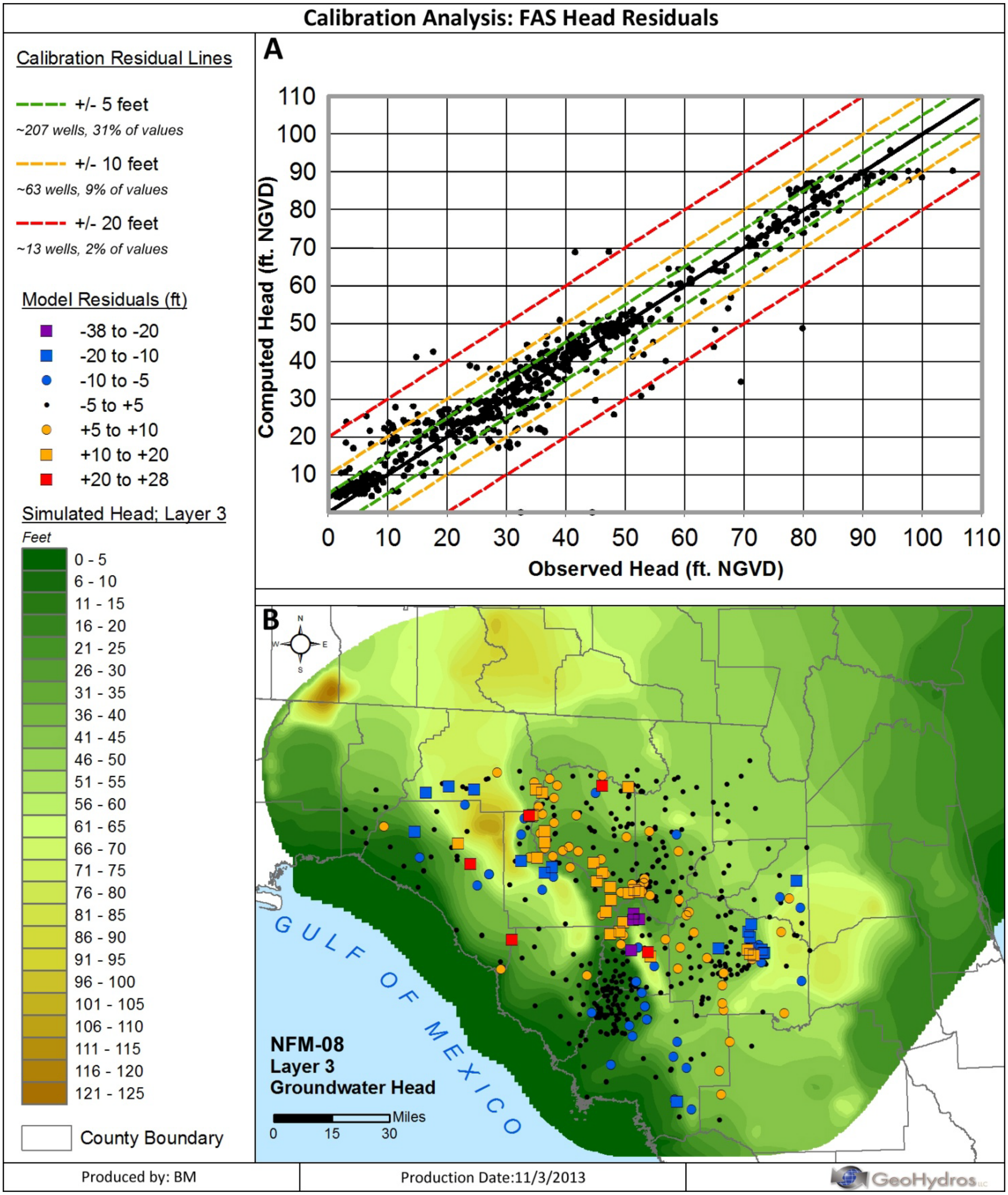


Figure 10 – NFM-08 Calibration Residuals

Calibration residuals mark the difference between UFA groundwater elevations measured between 6/1/01 and 5/31/02 and values simulated by the NFM-08. The plot (A) is reproduced from the SDII report, which compares modeled values to measurements from 676 wells throughout the domain. Points that fall exactly along the black line represent a perfect match between simulated and measured values. The dashed lines bracket progressively larger discrepancies. Statistics revealing that the calibration criterion was violated at more than 30% of the wells are shown at the top left. The map (B) shows the distribution of residuals determined from 534 wells monitored by the SRWMD and the ACEPD. In that dataset, residuals were larger than 5 feet at 147 wells (28%), larger than 10 feet at 54 wells (10%), and larger than 20 feet at 12 wells (2%). The model under-predicts groundwater elevations in the high regions and over-predicts in the low regions.

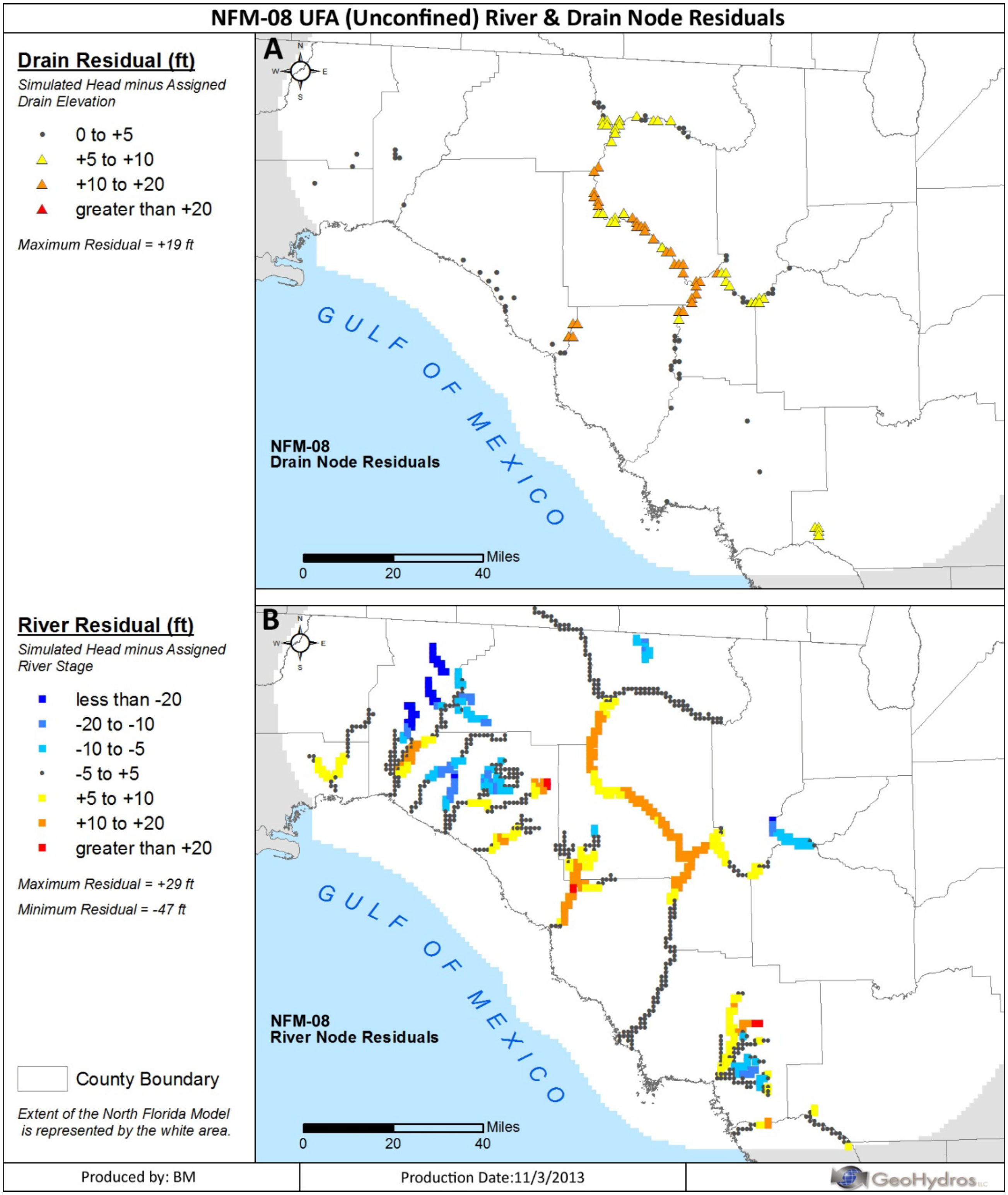


Figure 11 – NFM-08 – River and Drain Cell Deviations from Target River Stage

The distribution of all drain (top) and river (bottom) assignments applied to model cells in layer-3 (the UFA layer) in the calibrated version of the NFM-08 and the degree to which the simulated groundwater elevation at the river deviated from the observed river stage. Colors denote errors of 5, 10, and 20 feet. The model contained 831 discharging River assignments and 147 discharging Drain assignments. The model over-estimated the groundwater levels at the rivers by more than 5 feet at 471 (48%) of these cells, by more than 10 feet at 231 (24%) of these cells, and by more than 15 feet at 80 (8%) of these cells. Adding these deviations to the residuals computed for the 534 average groundwater elevations recorded in the SRWMD during the model calibration period raises the average absolute residual to 5.6 feet, which causes the model to fail SDII's test for calibration.

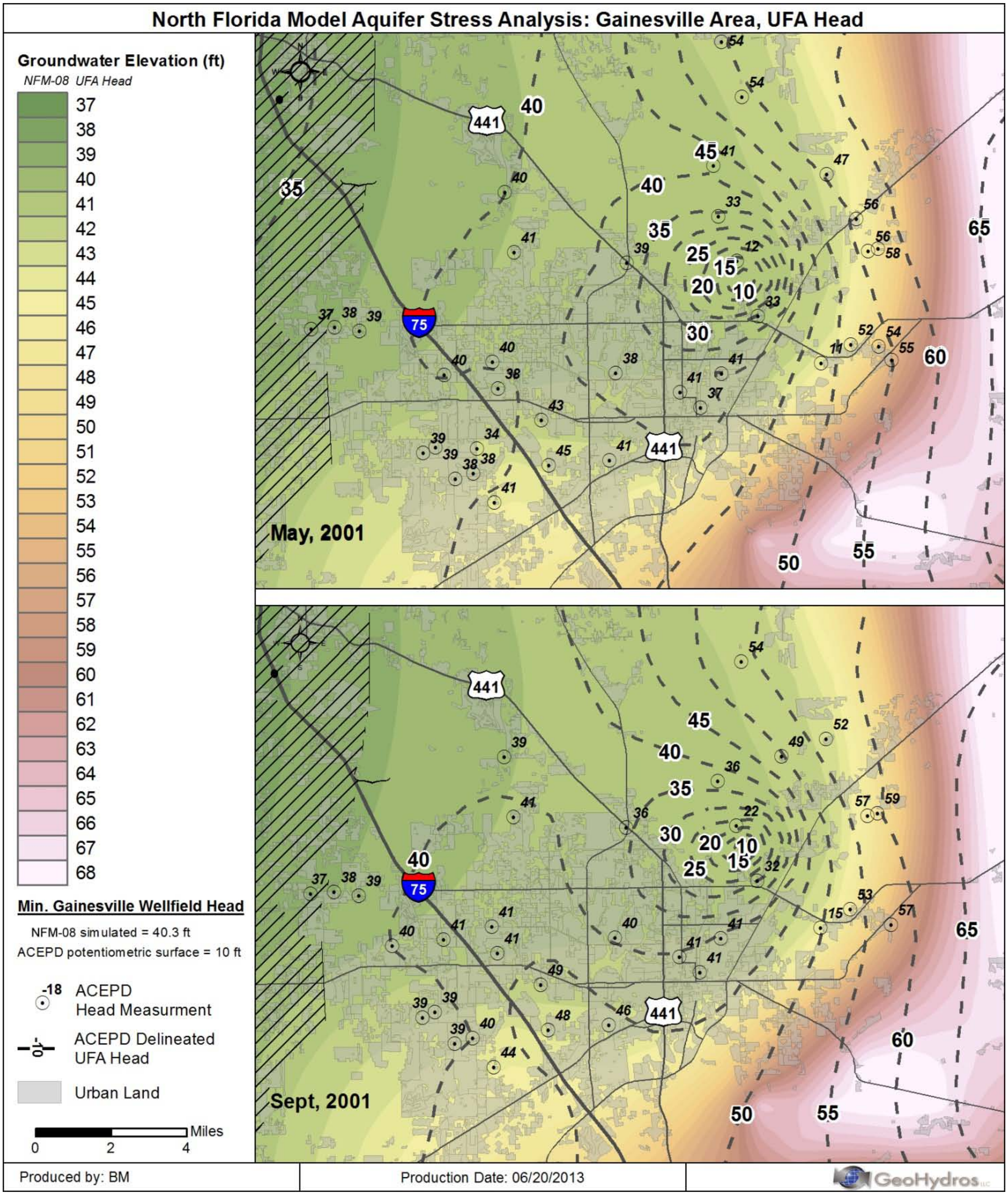


Figure 12 – NFM-08 – Comparison of Simulated & Measured Groundwater Surfaces – Gainesville Well Field

Both figures show the model-simulated groundwater surface (potentiometric surface) for the period between June 1, 2001 and May 31, 2002 as a color-flood. The dashed lines show the groundwater surface for the same region as mapped and published by the Alachua County Environmental Protection Department for May 2001 (top) and September 2001 (bottom). The two surfaces strongly disagree in the vicinity of the City of Gainesville well field where pumping has caused a deep and broad cone of depression. The lowest elevation in the simulated groundwater surface is 40.3 feet, which occurs near the centroid of the three Gainesville municipal water supply wells. The measured elevation at that point was approximately 10 feet during both of the measurement periods.

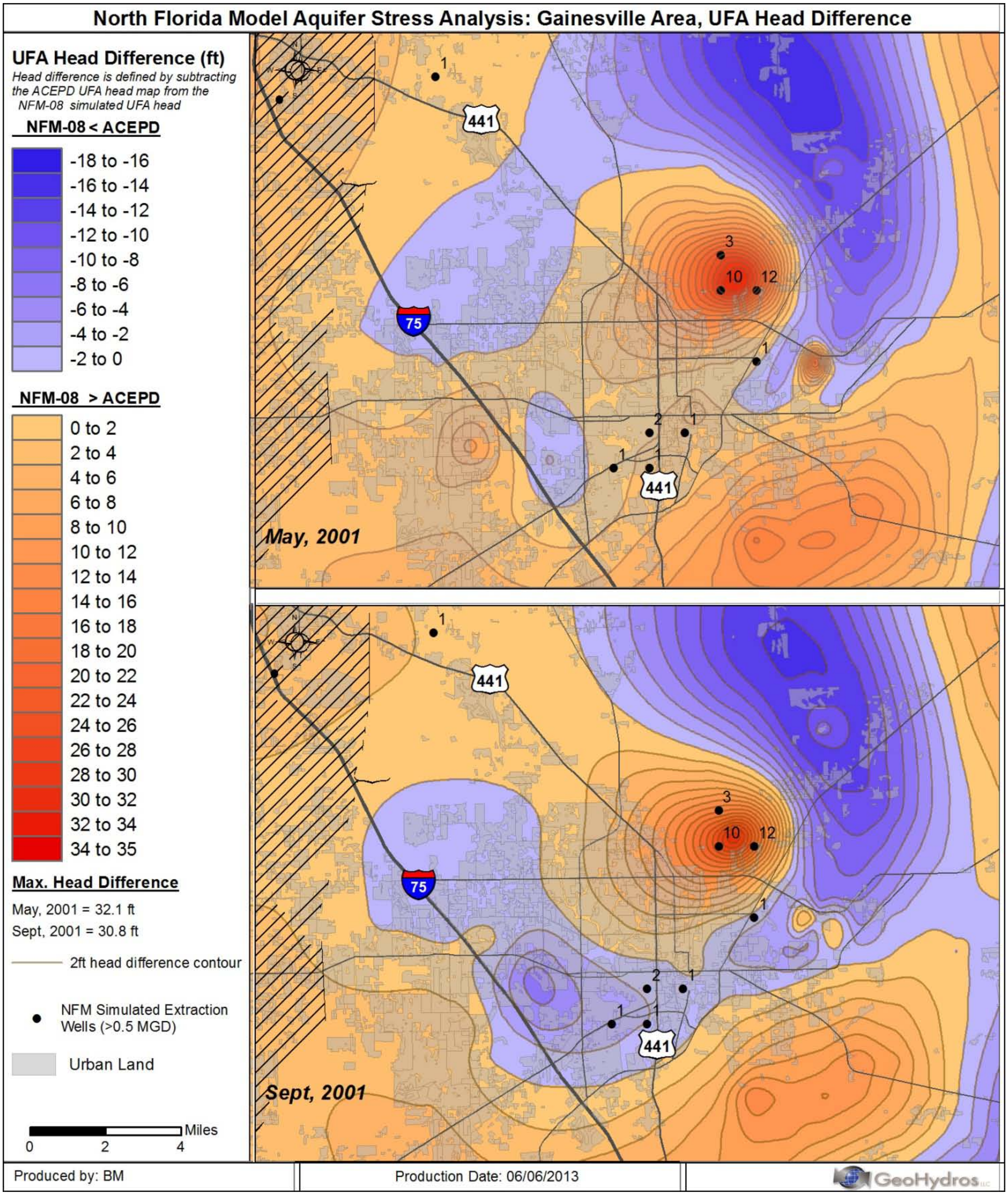


Figure 13 – NFM-08 – Difference between Simulated & Measured Groundwater Surfaces – Gainesville Well Field

Both figures show the difference between the simulated and measured groundwater surfaces in the vicinity of the City of Gainesville municipal well field (simulated minus measured) as color floods. Red and orange colors mark regions where the simulated surface is higher than the measured surface. Blue colors mark regions where the simulated surface is lower than the measured surface. The measured surfaces are from pontentiometric surfaces drafted by the Alachua County Environmental Protection Department (ACEPD) for May 2001 (top) and September 2001 (bottom). The maximum differences between the simulated and observed depth of the cone-of-depression in the groundwater surface created by Gainesville's pumping were 32.1 and 30.8 feet respectively revealing that the model dramatically under-predicts the impact of the pumping on aquifer water levels and groundwater flow paths.

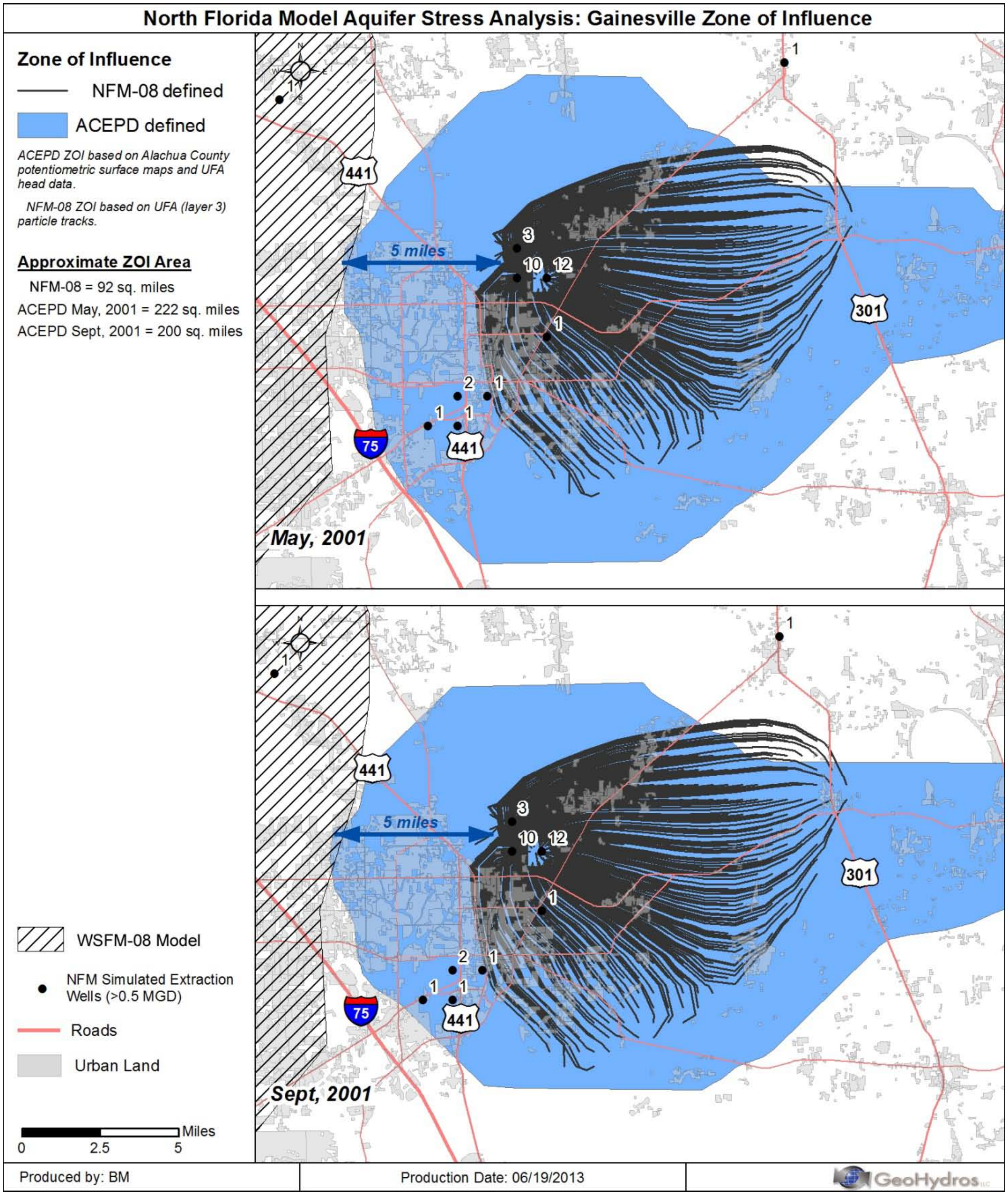


Figure 14 – NFM-08 – Simulated Capture Zone for the City of Gainesville Well Field

The black lines in both the upper and lower figures are particle tracks marking the groundwater flow paths to the City of Gainesville's water supply wells as simulated by the NFM-08. The simulated well extraction rates are shown as black dots and labeled by the simulated magnitude of extraction in MGD. The underlying blue regions are the capture zones delineated from the May 2001 (top) and September 2001 (bottom) potentiometric surface maps produced by the Alachua County Environmental Protection Department (ACEPD) from measured groundwater elevations, which denote measured real-world conditions during the model calibration period. In both cases, the simulated capture zone is substantially smaller than the measured extent and, most importantly, does not extend as far to the west where depressed groundwater elevations more greatly impact groundwater flow to the western Santa Fe River.

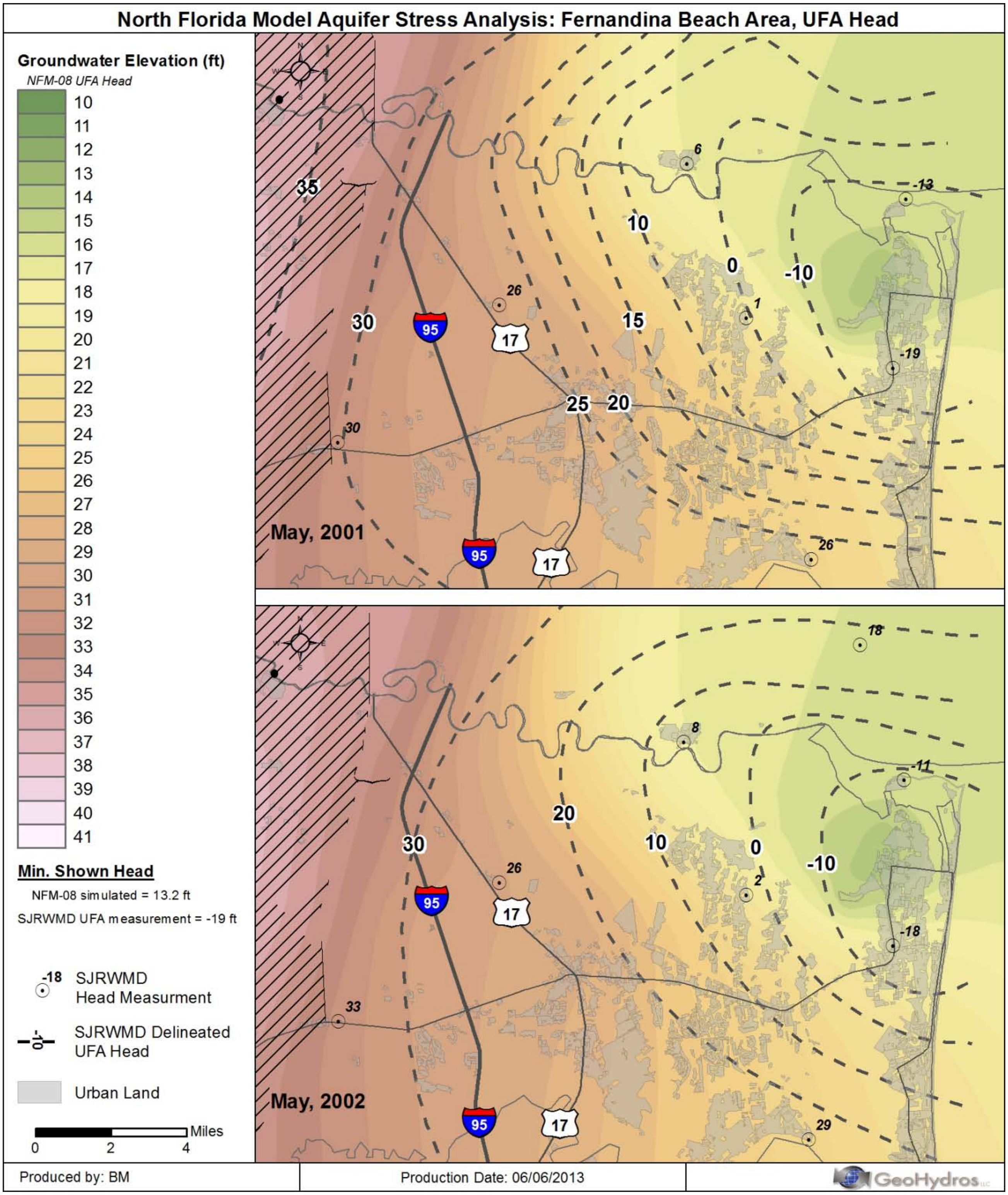


Figure 15 – NFM-08 – Comparison of Simulated & Measured Groundwater Surfaces – Fernandina Beach

Both figures show the model-simulated groundwater surface (potentiometric surface) for the period between June 1, 2001 and May 31, 2002 as a color-flood. The dashed lines show the groundwater surface for the same region as mapped and published by the St. Johns River Water Management District (SJRWMD) for May 2001 (top) and May 2002 (bottom). The two surfaces strongly disagree in the vicinity of the pumping center, which has caused a deep and broad cone of depression. The lowest simulated elevation is 13.2 feet, which occurs near the center of cone-of-depression whereas the measured elevation at that point ranged from -18 to -19 feet during both measurement periods. By not reasonably simulating the depth or extent of the cone-of-depression, the model not only under-predicts the local impacts of pumping but also under-predicts regional impacts on groundwater flow directions such as flow to the upper Suwannee River basin.

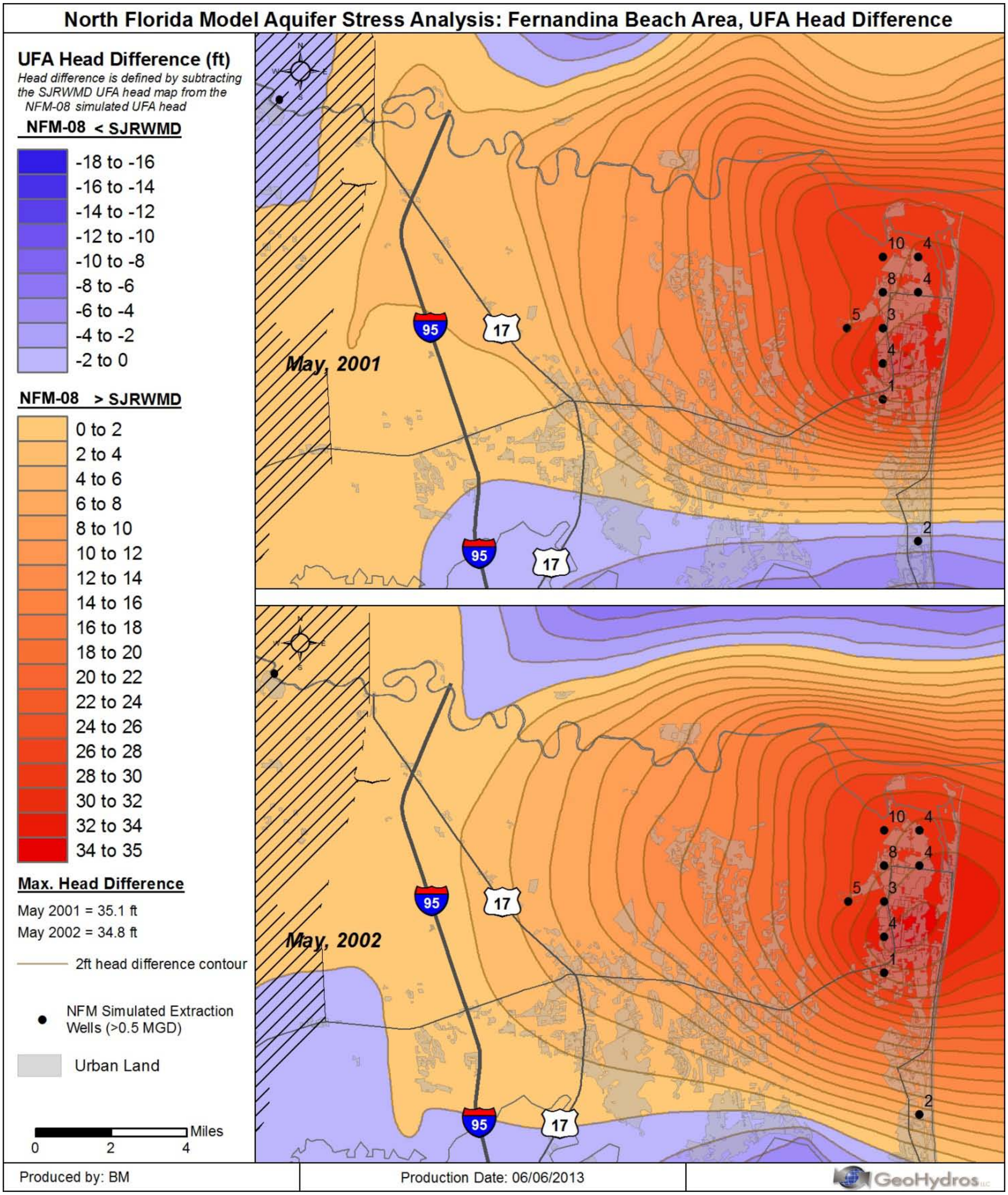


Figure 16 – NFM-08 – Difference between Simulated & Measured Groundwater surfaces – Fernandina Beach

Both figures show the difference between the simulated and measured groundwater surfaces in the vicinity of Fernandina Beach as color floods. Red and orange colors mark regions where the simulated surface is higher than the measured surface. Blue colors mark regions where the simulated surface is lower than the measured surface. The measured surfaces are from pontentiometric surfaces drafted by the St. Johns River Water Management District (SJRWMD) for May 2001 (top) and May 2002 (bottom). The maximum differences between the simulated and observed depth of the cone-of-depression in the groundwater surface created by Gainesville's pumping were 35.1 and 34.8 feet respectively revealing that the model dramatically under-predicts the impact of the pumping on aquifer water levels and groundwater flow paths.

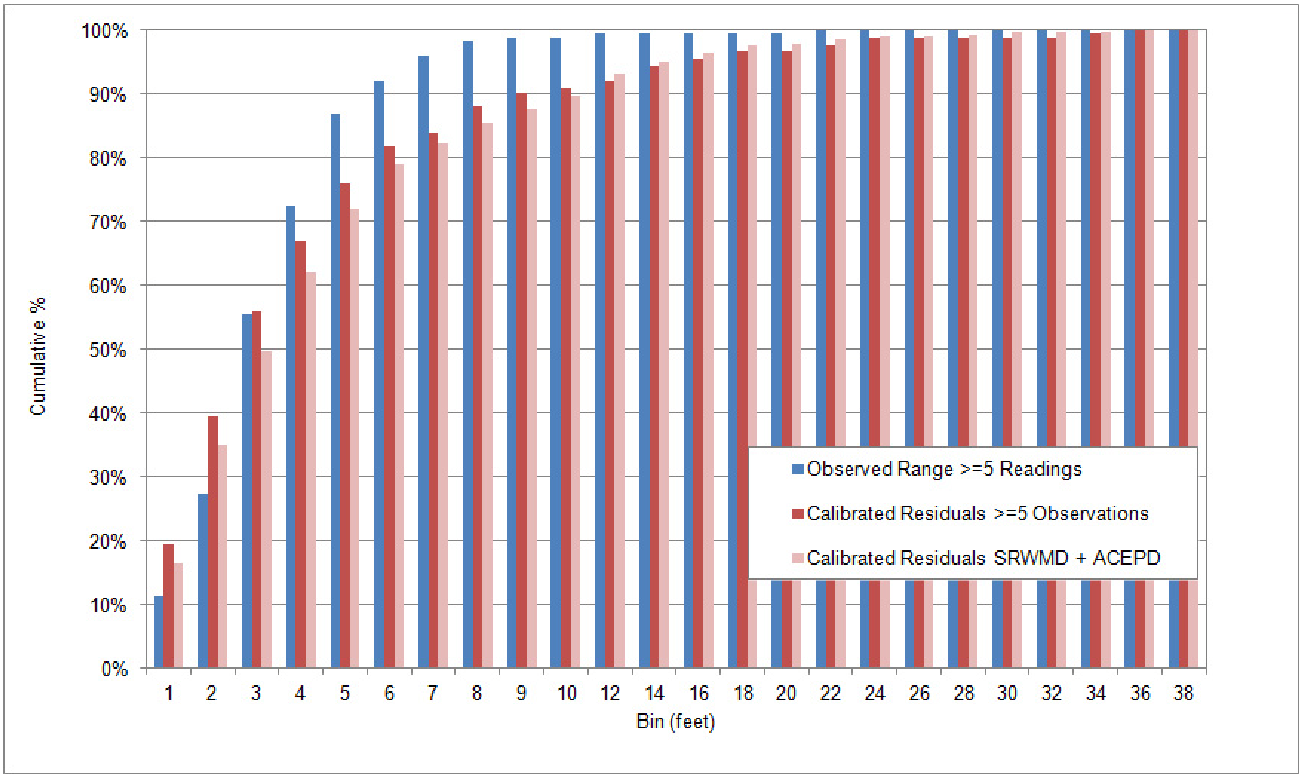


Figure 17 – NFM-08 – Comparison of Model Residuals to Observed Range in Groundwater Surface

The blue bars show the cumulative distribution of groundwater surface variations measured in 175 of the 475 wells maintained by the SRWMD that were used for model calibration and had more than five measurements during the June 1, 2001 to May 31, 2002 calibration period. The groundwater surface varied by less than 3 feet in 56% of those wells and by less than 4 feet in 73% of the wells. By comparison, the distribution of model residuals was skewed toward higher values indicating that the 5-foot criterion for calibration was too permissive to insure that the final model realistically simulated the observed range in groundwater surface elevations.

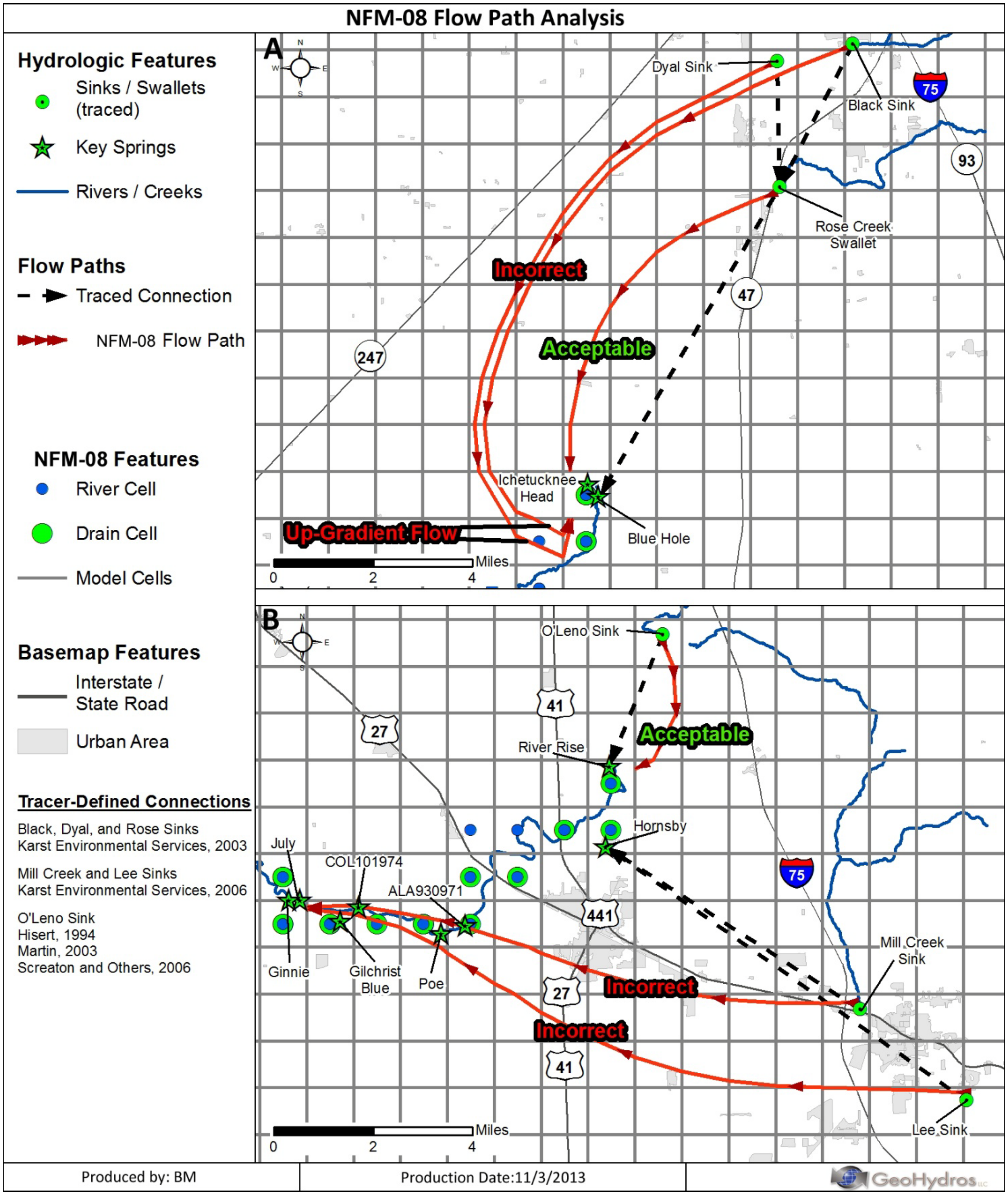
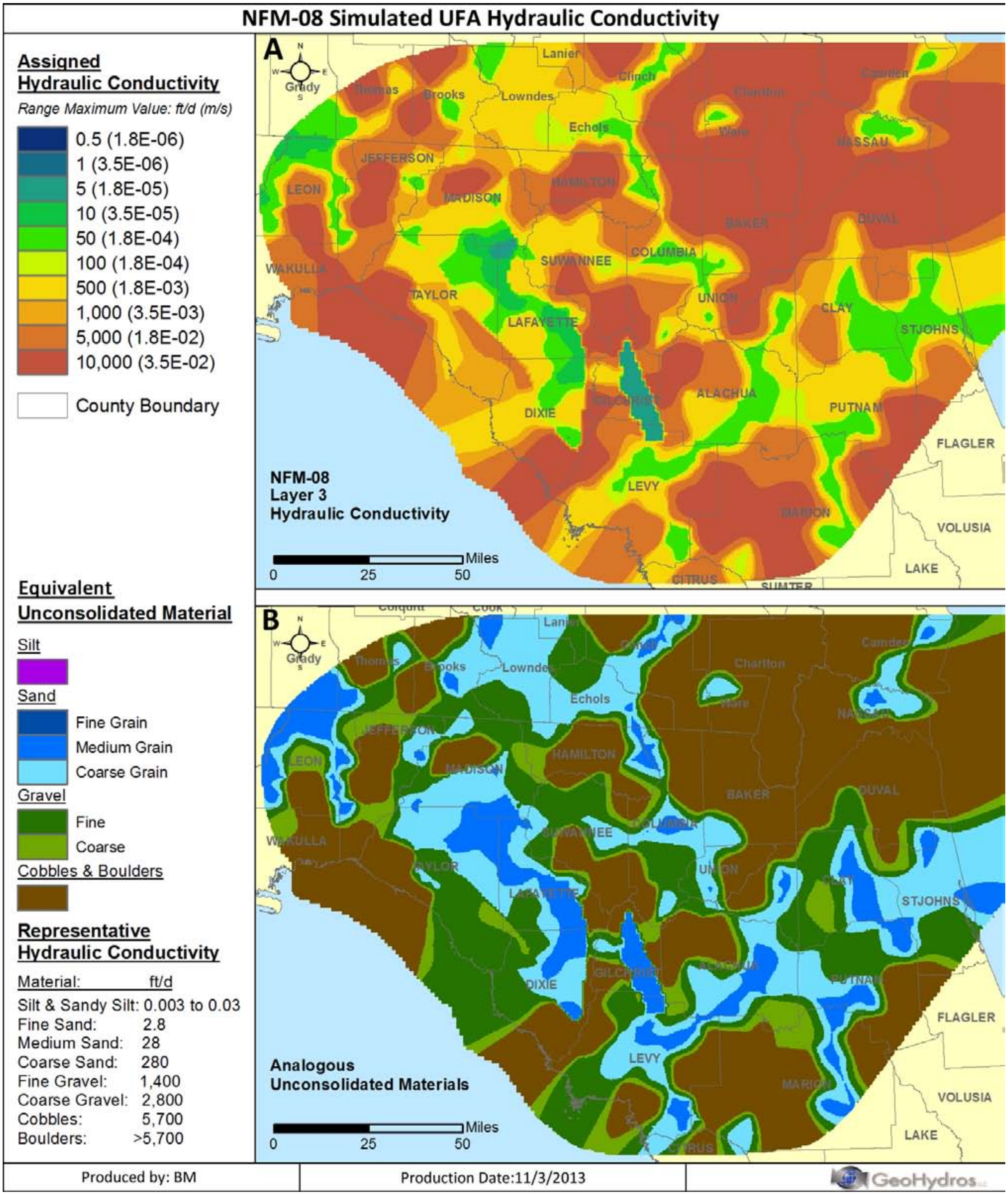


Figure 18 – NFM-08 – Comparison of Simulated Flow Paths to Traced Connections

Both figures show connections between locations of direct recharge (swallets) and springs that have been established through groundwater tracing as black dashed arrows. The green lines show the flow paths from the same swallets to springs as simulated by the WSFM-08. The red lines show the flow paths from the same swallets to springs as simulated by the NFM-08. The WSFM-08 honors all of the established connections. The NFM-08 fails to discriminate between flow from swallet sources to Blue Hole and Mission Springs and flow from non-swallet sources to Ichetucknee Head and Cedar Head Springs. It also failed to correctly simulate flow from the swallets northwest of Gainesville to Hornsby Spring but instead incorrectly shows that flow going to the downriver Santa Fe springs including Poe, Gilchrist Blue, July, and Ginnie Springs.

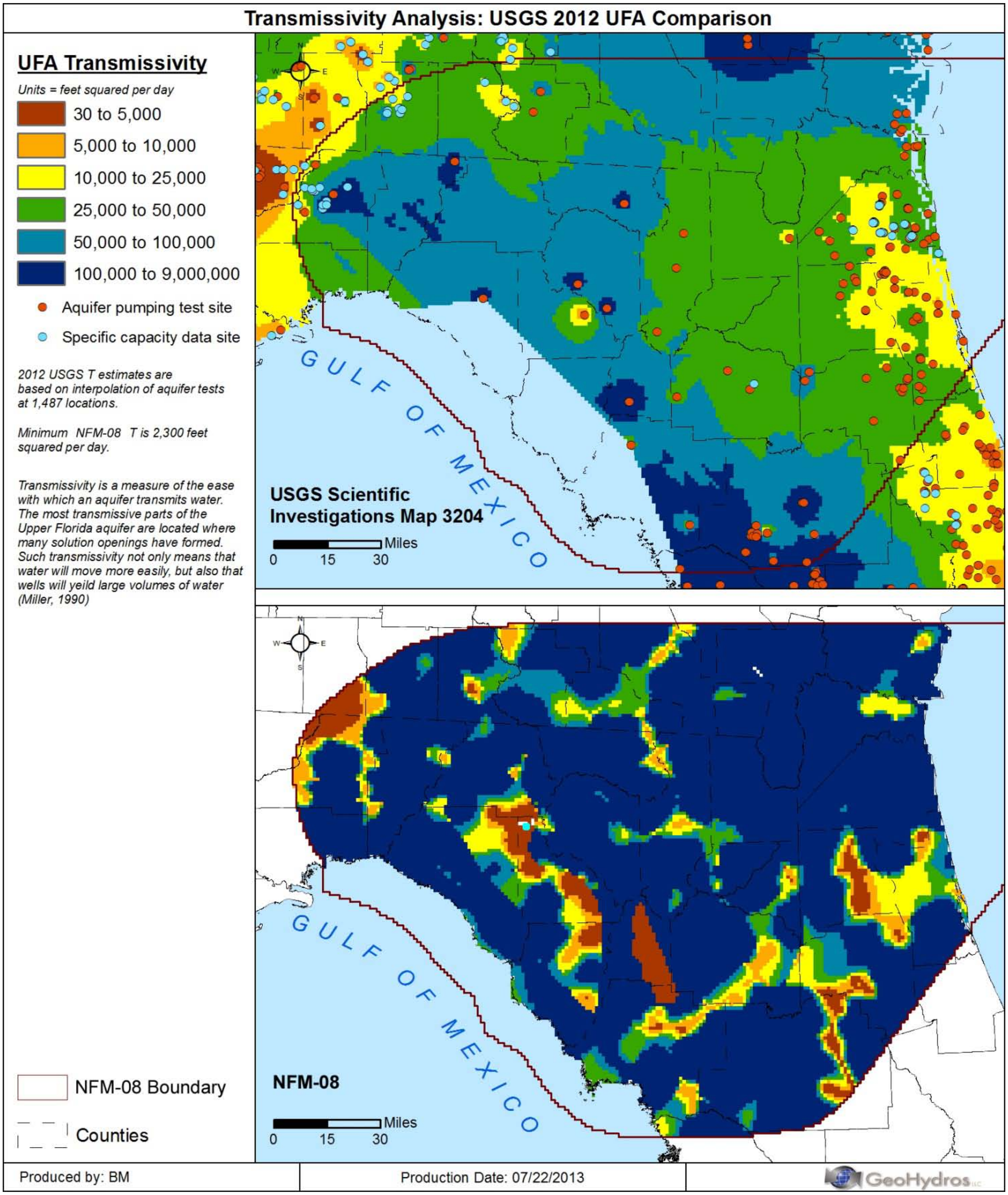


Representative Hydraulic Conductivity

Material:	ft/d
Silt & Sandy Silt:	0.003 to 0.03
Fine Sand:	2.8
Medium Sand:	28
Coarse Sand:	280
Fine Gravel:	1,400
Coarse Gravel:	2,800
Cobbles:	5,700
Boulders:	>5,700

Figure 19 – NFM-08 – Simulated Hydraulic Conductivities Relative to the WSFM-08 Values

Distribution of model-simulated hydraulic conductivity values in the calibrated version of the NFM-08 (Top) relative to the distribution of equivalent types of unconsolidated materials known to have similar hydraulic conductivities. The modeled values reflect an assumption that the aquifer is comprised of extremely conductive materials over much of the domain and that the distribution of those materials is not controlled by reasonable geologic processes or known zonation. Since higher hydraulic conductivity values equate to simulations of smaller cones of depression for a given groundwater pumping rate, the SDII model will likely under-predict impacts to the groundwater surface due to pumping.



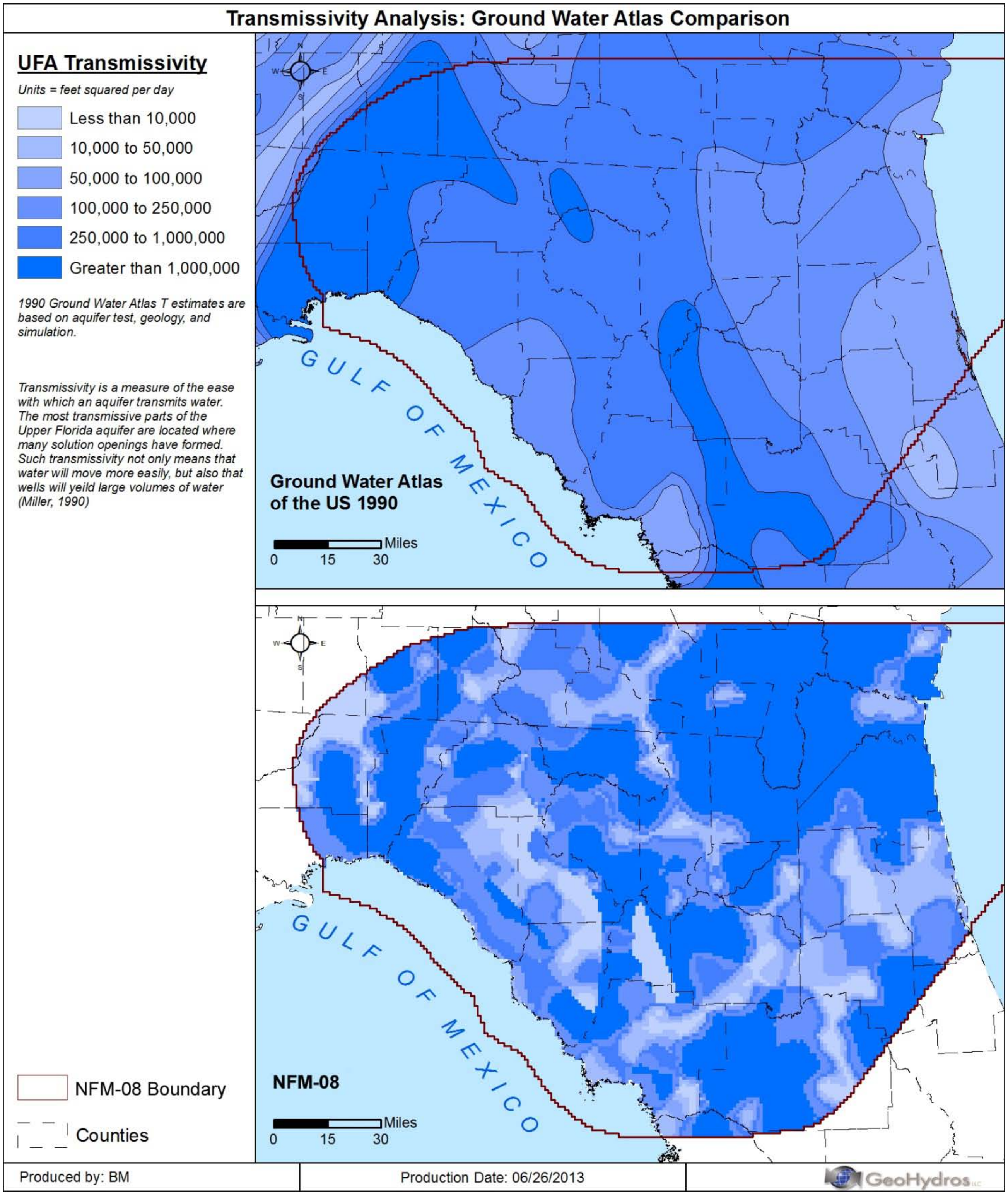
2012 USGS T estimates are based on interpolation of aquifer tests at 1,487 locations.

Minimum NFM-08 T is 2,300 feet squared per day.

Transmissivity is a measure of the ease with which an aquifer transmits water. The most transmissive parts of the Upper Florida aquifer are located where many solution openings have formed. Such transmissivity not only means that water will move more easily, but also that wells will yeild large volumes of water (Miller, 1990)

Figure 20 – NFM-08 – Comparison of Equivalent Transmissivity Values to Values Derived from Data Published in 2012

(Top) Distribution of transmissivity in the UFA defined from aquifer test data and presented by the USGS [32] generally showing lower tansmissivity in the eastern part of the aquifer and in the Gulf Trough where the UFA is confined and higher transmissivity in the western part of the aquifer where it is unconfined. The very high points in the west are associated with tests reported to be close to known conduit systems. The very low point is associated with a test reported to be distant from a conduit zone. (Bottom) Distribution of eqivalent transmissivity in the NFM-08, which was calculated by by multiplying the assigned horizontal hydraulic conductivity and the thickness of the UFA (model layer 3) at each model cell. The SDII values were set by PEST during model calibration. They are generally 1-2 orders of magnitude higher than the USGS values and are not distributed according to known hydrogeologic zonation.



1990 Ground Water Atlas T estimates are based on aquifer test, geology, and simulation.

Transmissivity is a measure of the ease with which an aquifer transmits water. The most transmissive parts of the Upper Florida aquifer are located where many solution openings have formed. Such transmissivity not only means that water will move more easily, but also that wells will yeild large volumes of water (Miller, 1990)

Figure 21 - NFM-08 – Comparison of Equivalent Transmissivity Values to Values Derived from Data Published in 1990

(Top) Distribution of transmissivity in the UFA defined from aquifer test data, geology, and simulation presented by the USGS [67] that generally shows lower tansmissivity in the eastern part of the aquifer where it is confined by the overlying Hawthorn Formation and higher transmissivity in the western part of the aquifer where it is unconfined with another lower transmissivity zone along the Gulf of Mexico coast. (Bottom) Distribution of eqivalent transmissivity in the NFM-08, which was calculated by by multiplying the assigned horizontal hydraulic conductivity and the thickness of the UFA (model layer 3) at each model cell and binned according to the USGS map values. The SDII values were set by PEST during model calibration. They are generally higher than the USGS values and are not distributed according to known hydrogeologic zonation.

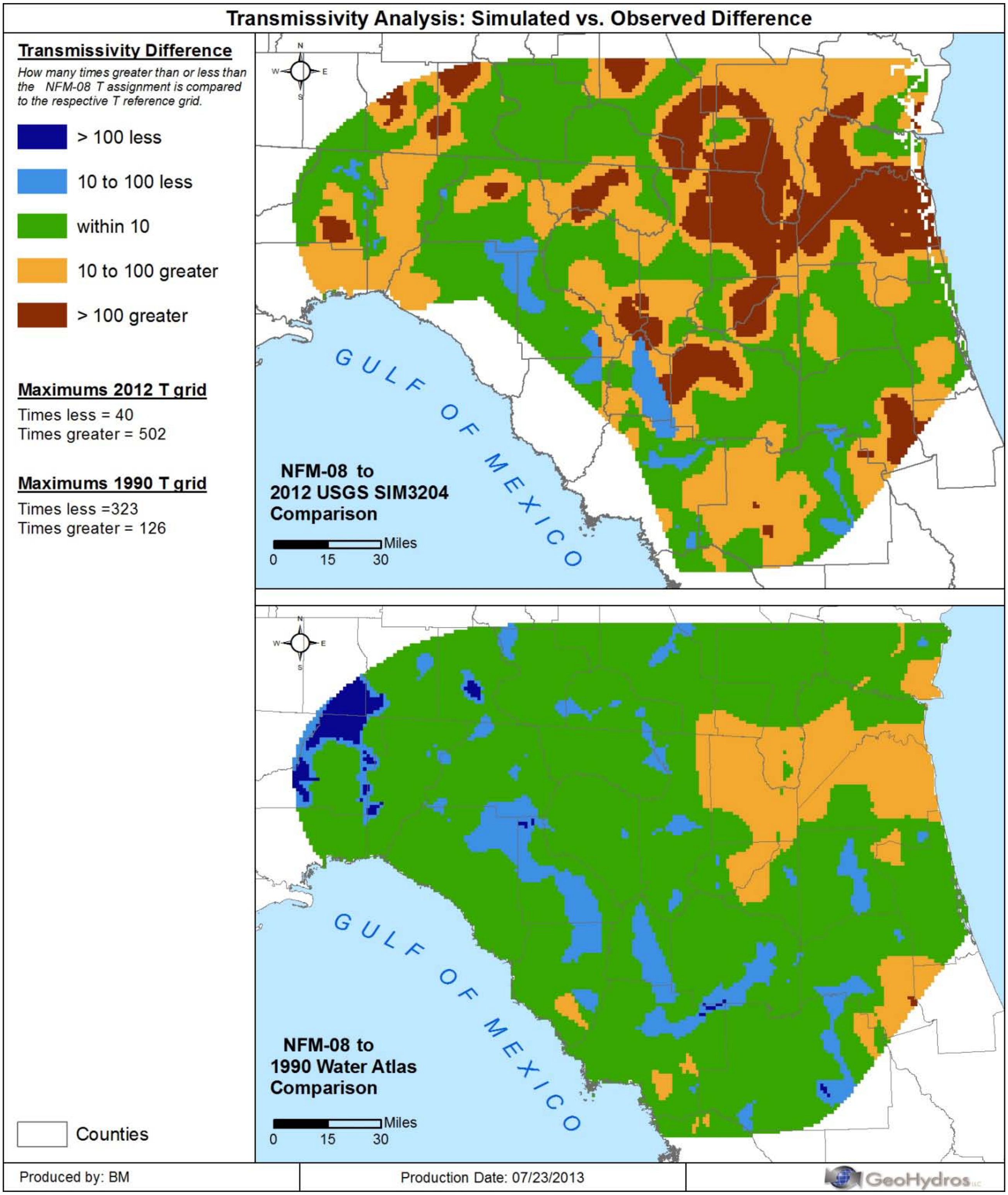
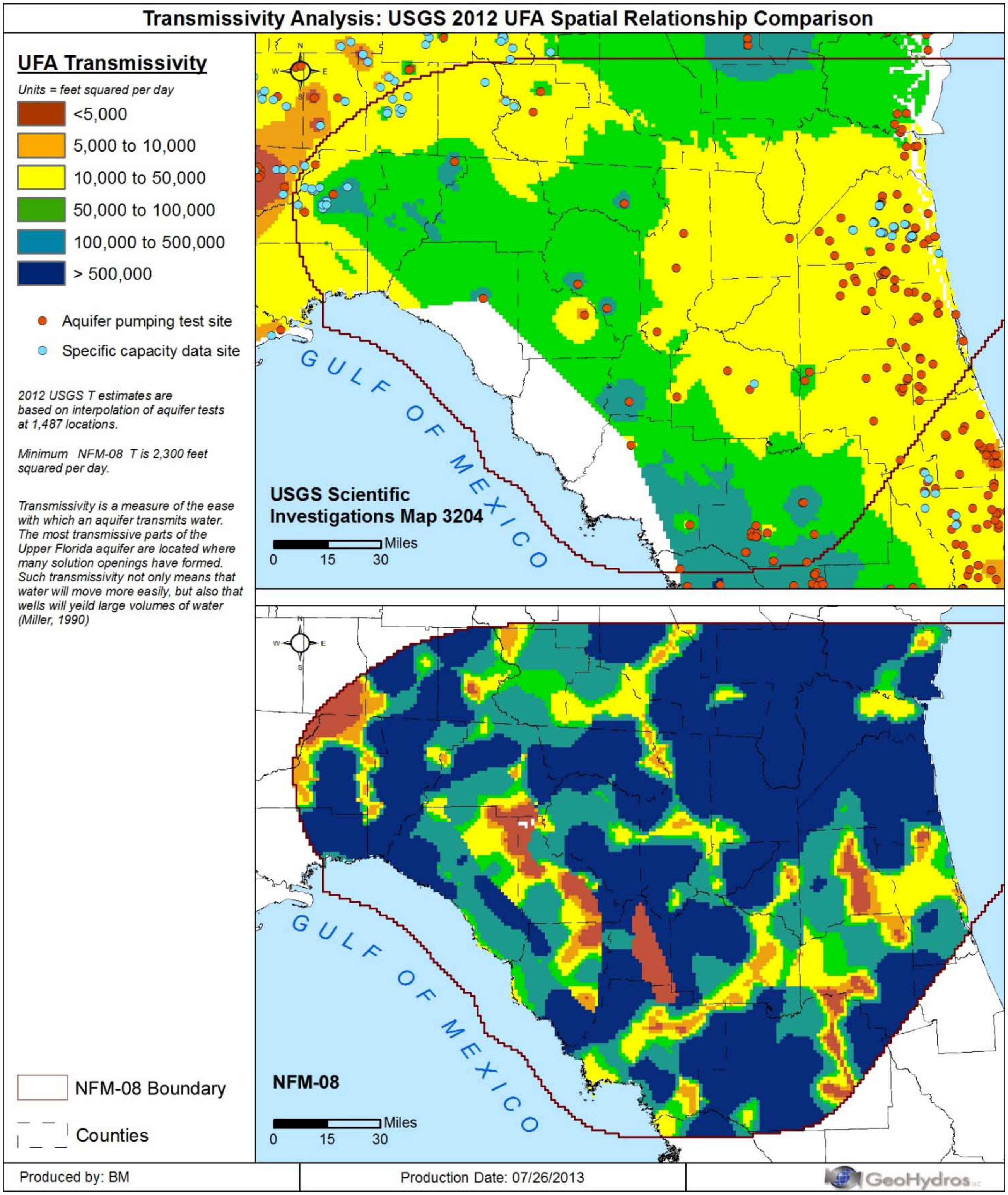


Figure 22 – NFM-08 – Ratio between Equivalent Model Transmissivity Values and Values Reported by the USGS

Difference between the NFM-08 equivalent transmissivity values and values reported by the USGS in 2012 (Top) and 1990 (Bottom) shown as the ratio between the SDII and USGS values (SDII/USGS). The SDII values differ from the 2012 USGS values by more than one order of magnitude over 56% of the comparable model domain, ~4% of which is marked by values lower by 1 or more orders of magnitude, 35% of which by values higher by 1-2 orders of magnitude, and 18% of which by values higher by 2 or more orders of magnitude. The SDII values differ from the 1990 USGS values by more than one order of magnitude over 24% of the comparable model domain, ~2% of which is marked by values lower by 2 or more orders of magnitude, ~9% of which by values lower by 1-2 orders of magnitude, and ~13% of which by values higher by 1 or more orders of magnitude.


Transmissivity Analysis: USGS 2012 UFA Spatial Relationship Comparison

2012 USGS T estimates are based on interpolation of aquifer tests at 1,487 locations.

Minimum NFM-08 T is 2,300 feet squared per day.

Transmissivity is a measure of the ease with which an aquifer transmits water. The most transmissive parts of the Upper Florida aquifer are located where many solution openings have formed. Such transmissivity not only means that water will move more easily, but also that wells will yeild large volumes of water (Miller, 1990)

Produced by: BM

Production Date: 07/26/2013

GeoHydros

Figure 23 – NFM-08 – Comparison of Equivalent Transmissivity Values to USGS 2012 Values Binned to Emphasize the Difference in Distribution

The two maps compare transmissivity in the Upper Floridan Aquifer as defined by the USGS in 2012 (top) to equivalent values derived from hydraulic conductivities and aquifer thicknesses defined in the NFM-08 (bottom). The colors in both maps reflect values that have been binned to emphasize zonation. Comparison of the two maps clearly reveals that while the USGS map reflects well-established hydrogeologic zones (i.e. lower transmissivity in the confined part of the aquifer in the eastern half of the peninsula and in the Gulf Trough, and higher transmissivity in the unconfined part of the aquifer in the western part of the peninsula), the distribution of the NFM-08 transmissivity values fails to correspond to the known hydrogeologic zonations in north Florida.

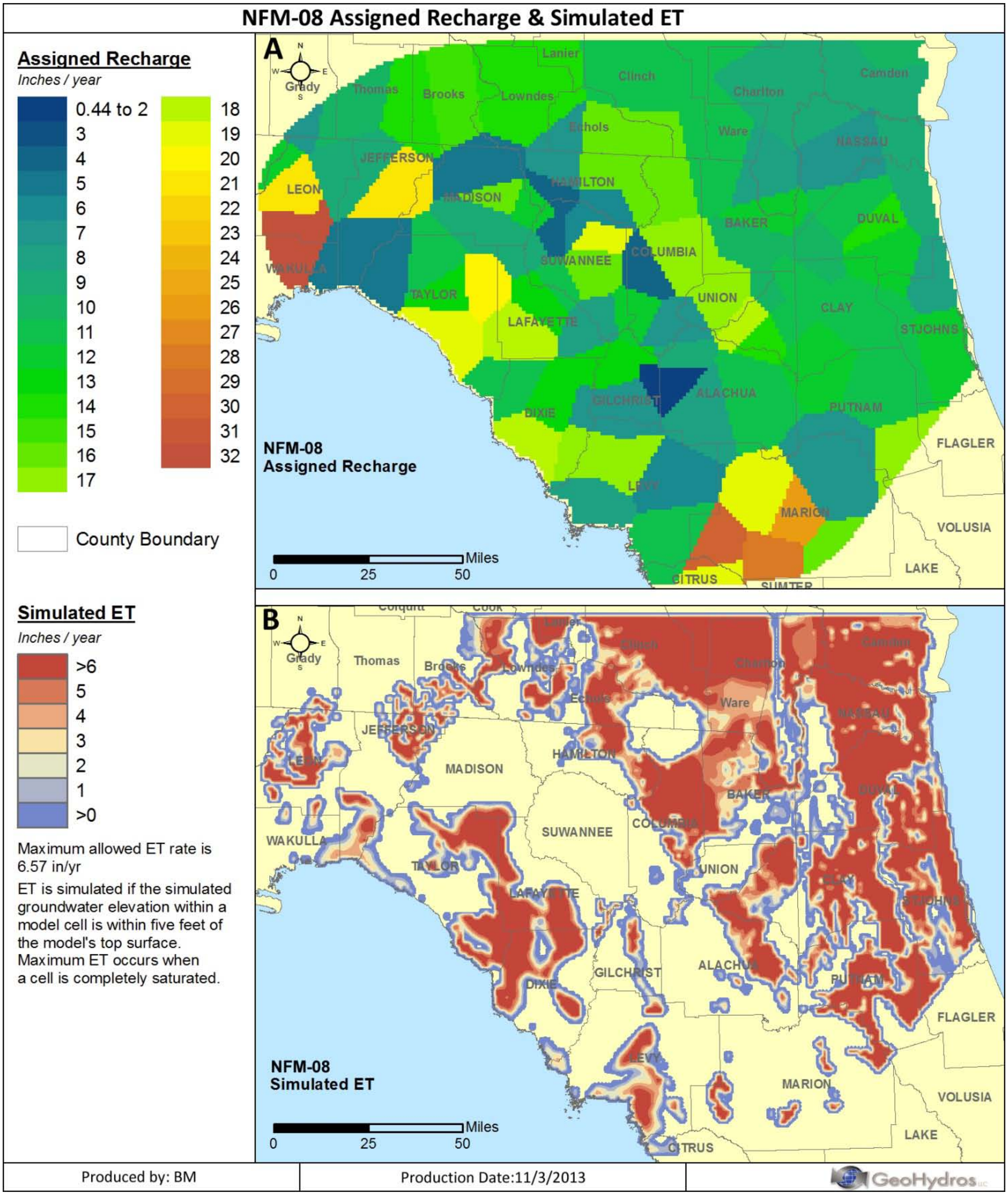


Figure 24 – NFM-08 – Assigned Recharge Relative to WSFM-08 Values

(Top) Recharge assigned in the NFM-08 to Thiessen polygons defined from the distribution of precipitation data through the Calibration / PEST process. The average recharge across the model domain was 12 in/yr but the polygon values varied from 0.44 – 19.6 in/yr. The variation was generated through the PEST process to produce the lowest calibration residuals but the distribution does not reflect real-world variation in recharge capacity driven by land use, topographic slope or permeability. The bottom plot shows the simulated distribution of ET, which was the variable used by PEST to assign recharge such that the model adequately simulated groundwater elevations.

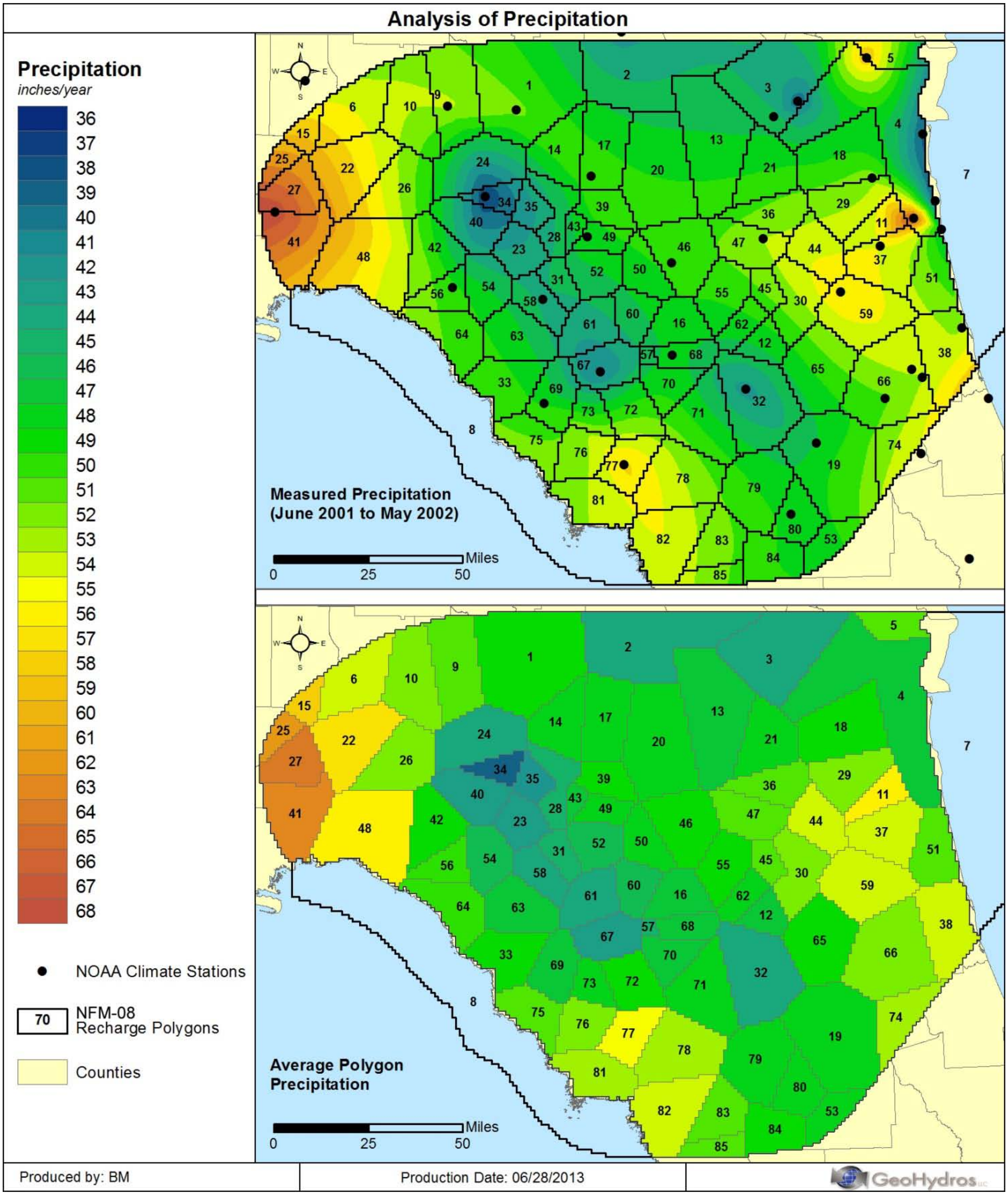


Figure 25 – NFM-08 – Measured Precipitation & Average Values by Thiessen Polygon

(Top) Grid of total precipitation measured at all NOAA climate stations in the model domain occurring between June 1, 2001 and May 31, 2002 where only the values from stations containing a complete record for the time period were used in the calculations. (Bottom) Average precipitation from the grid occurring within each of the Thiessen polygons used to assign recharge in the SDII model. All calculations were performed with Arc GIS.

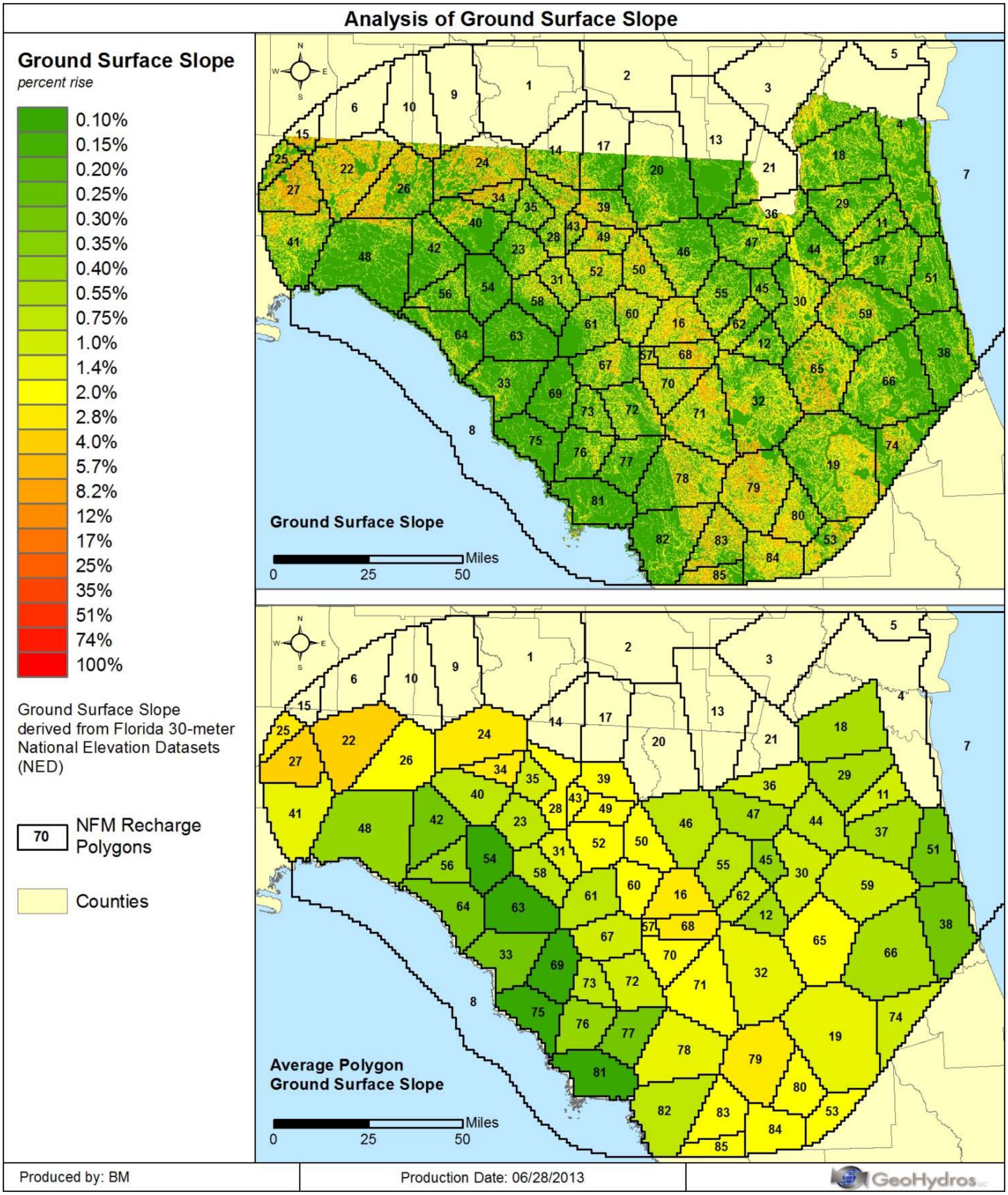
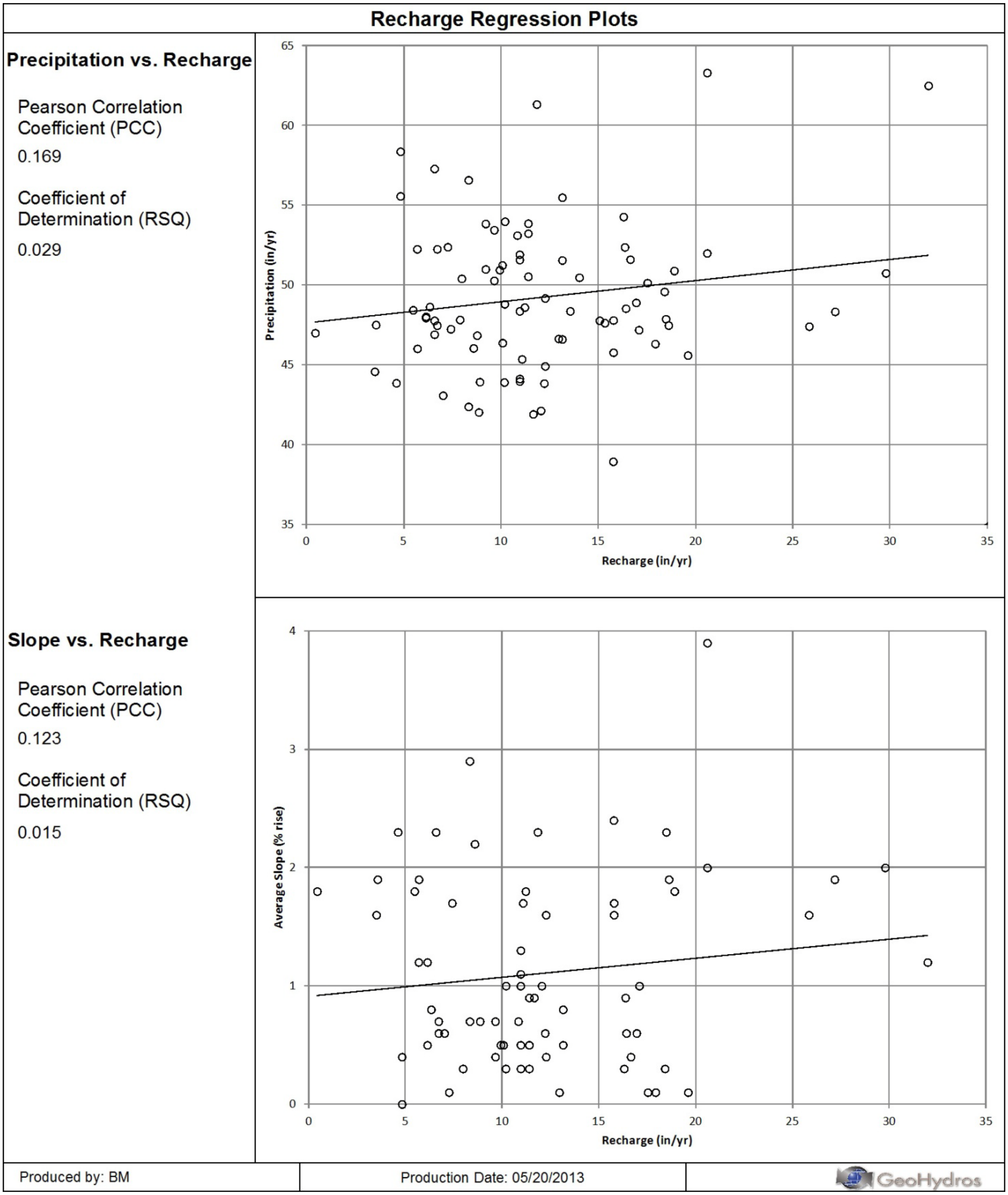


Figure 26 – NFM-08 – Ground Surface Slope & average Values by Thiessen Polygon

(Top) grid of ground surface slope calculated from the Florida 30-meter National Elevation Datasets (NEDs). (Bottom) Average ground surface slope from the grid occurring within each of the Thiessen polygons used to assign recharge in the SDII model. All calculations were performed with Arc GIS.



Recharge Regression Plots

Precipitation vs. Recharge

Pearson Correlation Coefficient (PCC)

0.169

Coefficient of Determination (RSQ)

0.029

Slope vs. Recharge

Pearson Correlation Coefficient (PCC)

0.123

Coefficient of Determination (RSQ)

0.015

Produced by: BM

Production Date: 05/20/2013

Figure 27 – NFM-08 – Relationships between Model-Assigned Recharge and Measured Precipitation and Ground Surface Slope.

(Top) Relationship between model-assigned recharge and measured precipitation in the Theissen polygons used to assign recharge in the NFM-08 where the expectation is a positive correlation with a PCC value of between 0.5 and 1.0. The very small correlation coefficients denote a lack of correlation between the two factors where for example the range of precipitation between 45 and 50 inches is associated with a range in model-assigned recharge of between nearly 0 and 27 inches. (Bottom) Relationship between model-assigned recharge and measured ground surface slope in the same polygons where the expectation is a negative correlation with a PCC value of between -0.5 and -1.0.The very small positive value reflects the absence of a correlation.

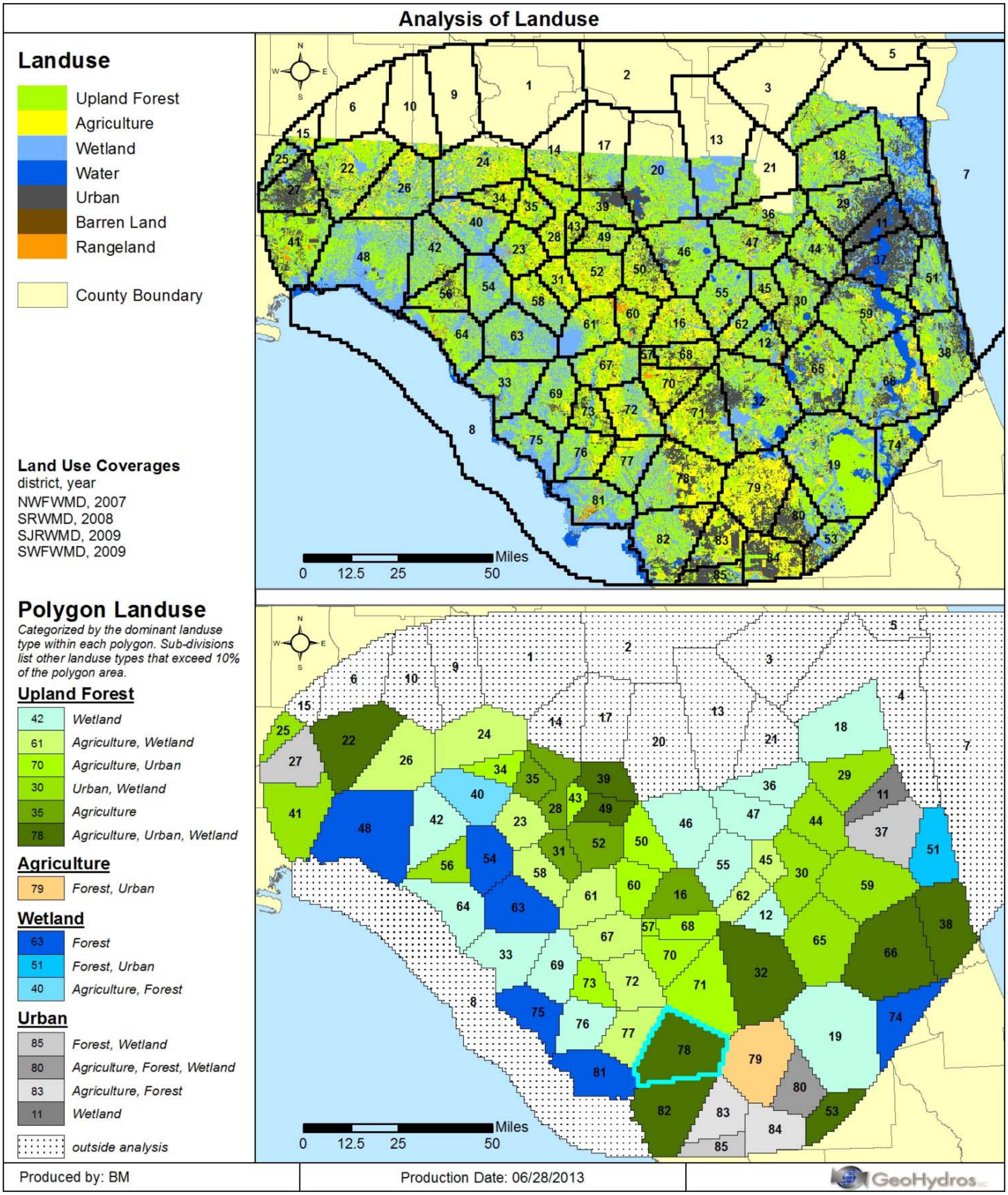


Figure 28 – NFM-08 – Land Use Variation across the Model Domain

(Top) Land use in the model domain as defined by maps compiled from the Northwest Florida Water Management District (2007), the Suwannee River Water Management District (2008), the St Johns River Water Management District (2009), and the Southwest Florida Water Management District (2009). (Bottom) Dominant land use in the Thiessen polygons used to assign recharge in the SDII model as determined by a regression analysis of the percent area covered by each land use type depicted in each of the Theissen polygons.

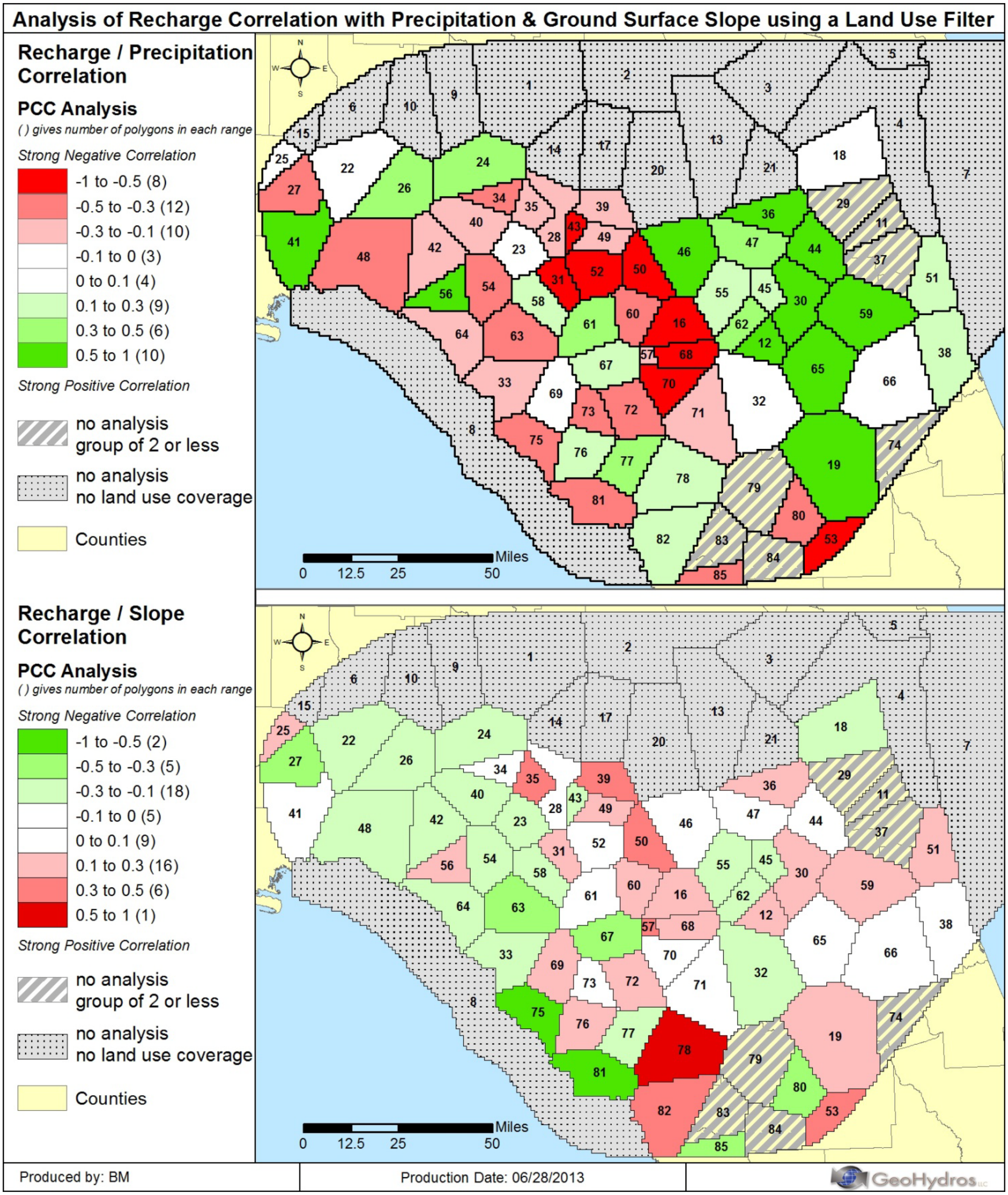


Figure 29 –NFM-08 – Distribution of Correlations between Model-Assigned Recharge and Measured Precipitation and Ground Surface Slope.

(Top) Distribution of Pearson Correlation Coefficients describing the relationship between model-assigned recharge and measured precipitation in groups of the Theissen polygons used to assign recharge in the NFM-08 having statistically similar land use where the expectation is a positive correlation with a PCC value of between 0.5 and 1.0. (Bottom) Distribution of PCC values describing the relationship between model-assigned recharge and measured ground surface slope in the same groups where the expectation is a negative correlation with a PCC value of between -0.5 and -1.0. In both maps, the polygons in which the correlation meets the expectation are colored bright green and the red polygons mark those where the relationship is the opposite of the expectation.

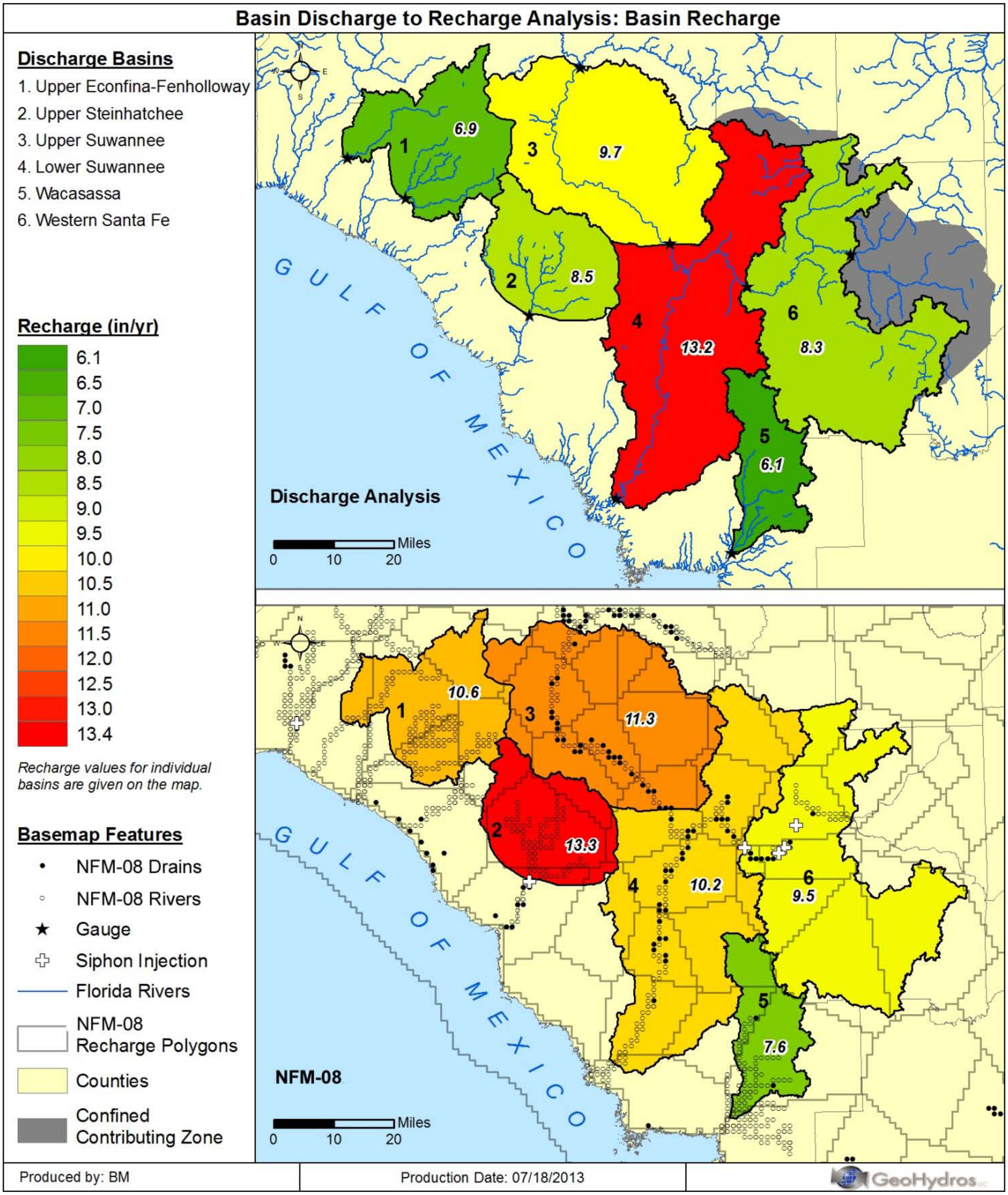


Figure 30 – NFM-08 – Comparison of Assigned Recharge to Estimated Recharge Constrained by Basin Discharge

(Top) Recharge in six sub-watershed scale basins constrained by measured groundwater discharge, meaning the amount of recharge necessary to supply the measured groundwater discharge. (Bottom) Recharge assigned in the NFM-08 where the values were derived through PEST during model calibration and were not constrained by measured or reasonably estimable groundwater discharge.

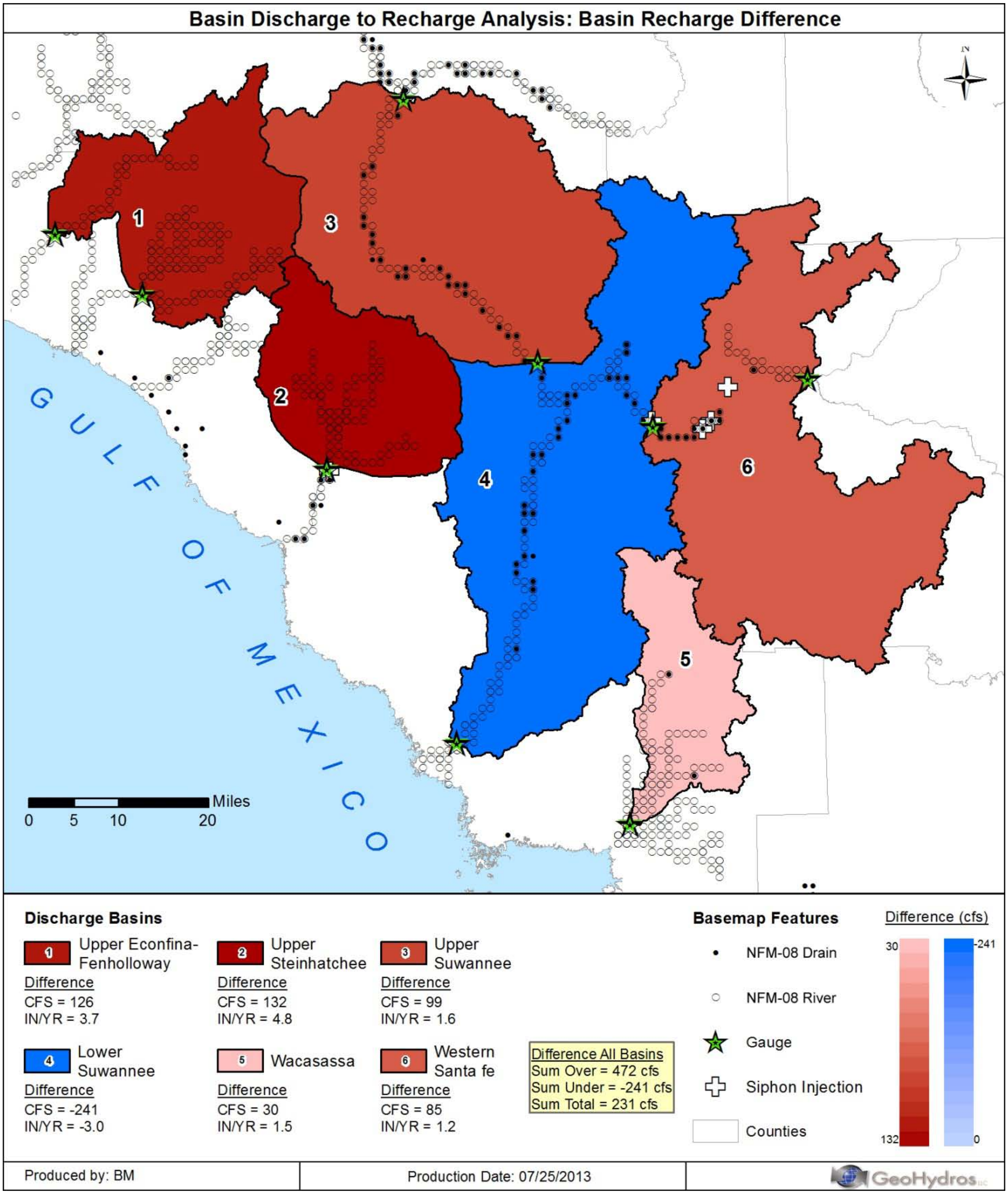


Figure 31 – NFM-08 – Difference between Assigned Recharge and Recharge Constrained by Basin Discharge

The NFM-08 recharge equates to inflows to the UFA that exceed cumulative measured basin groundwater discharge by 231 cfs (149 MGD). Inflows from assigned recharge exceed measured basin discharge in 5 of the 6 evaluated basins by 472 cfs (305 MGD) and are less than measured basin discharge in 1 of the 6 evaluated basins by 241 cfs (156 MGD). The largest exceedances occurred in the basins along the Gulf of Mexico coast while modeled inflows from recharge to the Lower Suwannee River basin was less than measured groundwater discharges.

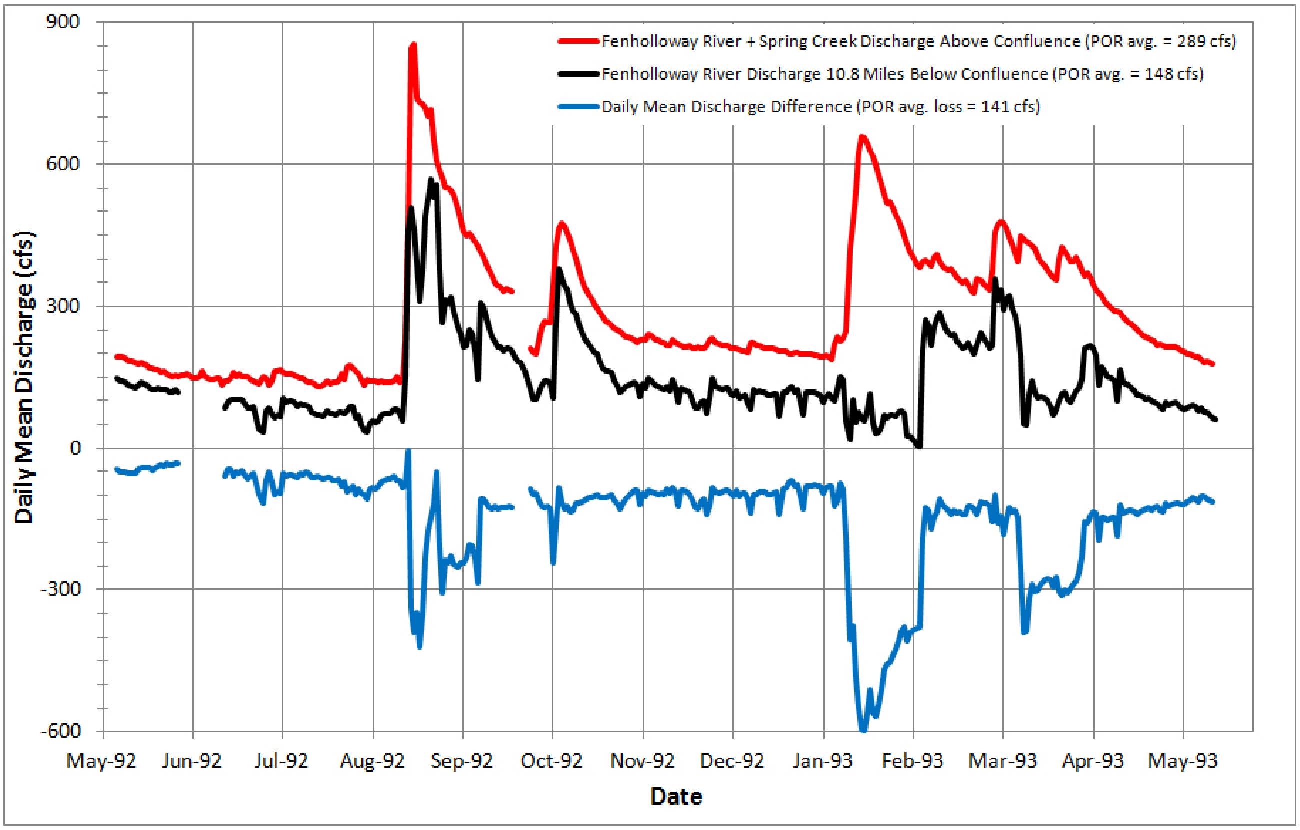


Figure 32 – Fenholloway River Discharge & Gauged Losses to the UFA

The red line shows the stream discharge hydrograph at the upstream gauge. The black line shows the stream hydrograph at the downstream gauge, which is everywhere lower than the upstream hydrograph revealing the losses to the UFA reflected by the blue line. These hydrographs reflect stream flow conditions between May 1992 and May 1993. The NFM-08 model calibration period (June 1, 2001 – May 31, 2002) was not used for this analysis because no data was available for the Spring Creek component of the basin during that time period. Analysis of data from the Fenholloway component for which data was available during both time periods revealed that water levels during the '92-'93 period were higher than during the '01-'02 period indicating that the river was likely losing during the NFM-08 model calibration period and probably to a larger extent.

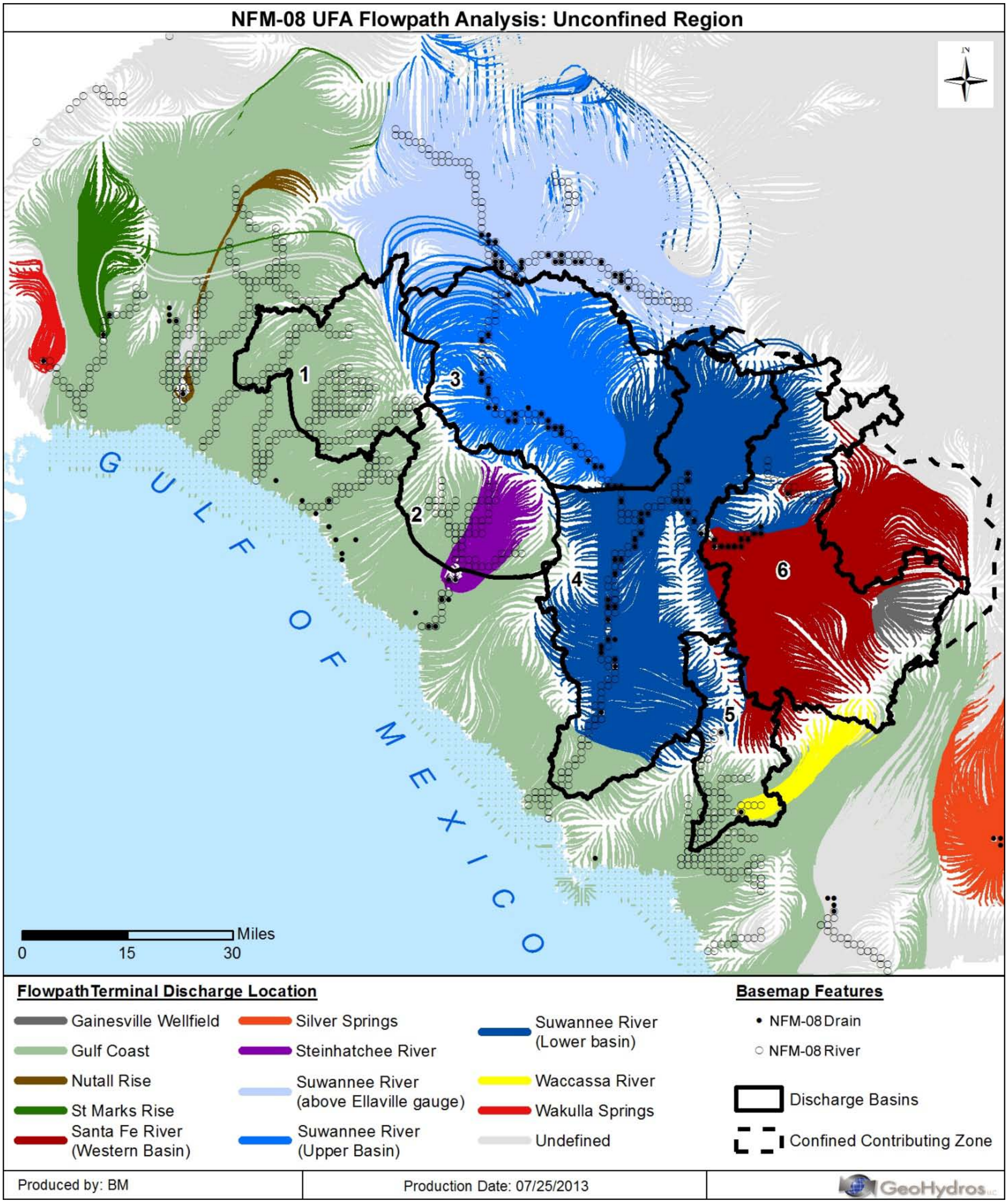


Figure 33 – NFM-08 – Comparison of Simulated Groundwater Flow Paths through the UFA to River Basin Boundaries

The depicted groundwater flow patterns were created by executing forward particle tracks from the grid cells in the NFM-08. Flow patterns are colored to match the basin in which the model indicates groundwater will terminally discharge. Flow is from the basin boundaries to the rivers. The gray areas depict flow to locations that were not evaluated. The light green colors depict flow lines that pass the rivers and terminally discharge directly to the Gulf of Mexico. Some of the flow in these areas along the depicted particle tracks discharges at the river and drain assignments but the flow lines all terminate at the constant head boundary assignments along the coast. The fact that so many of the flow lines pass through the basins to the coast while the model calibrates to observed upstream river gains indicates that substantially more recharge was assigned in the model than can be accounted for by observable river gains.

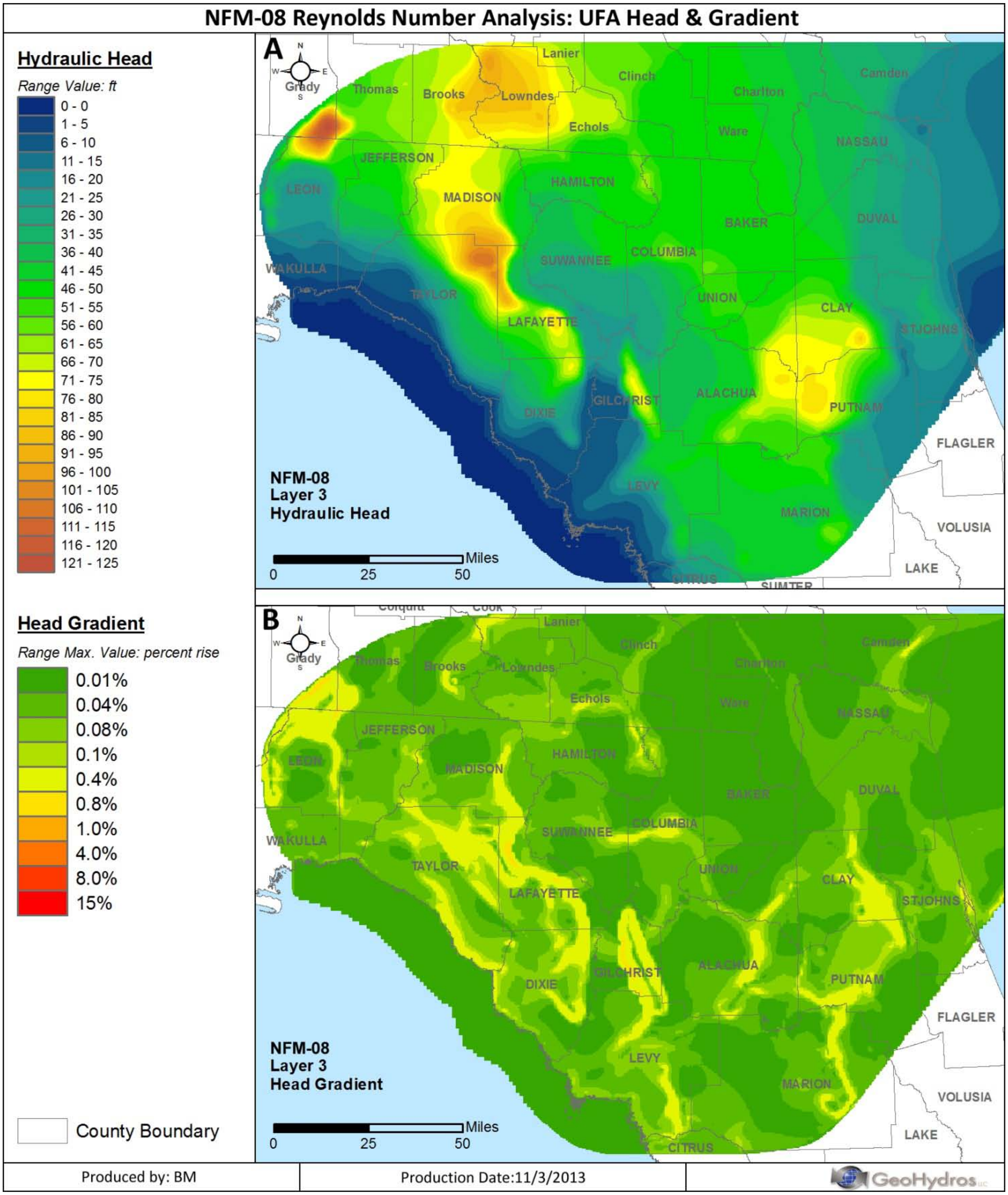


Figure 34 – NFM-08 – Simulated Groundwater Elevations (head) and Hydraulic Gradients in the UFA

Groundwater surface elevations are the fundamental product of numerical groundwater modeling. Flow patterns can be discerned from maps of simulated groundwater surfaces because flow is from high to low groundwater surface elevations perpendicular to lines contouring equal elevations. Hydraulic gradients are defined by the slope of groundwater surface where steeper slopes are marked by a closer spacing of groundwater elevation contours. Capture zones and springsheds can be delineated from the maps by drawing polygons around the regions in which the hydraulic gradients are toward the respective wells or springs. (Top) Simulated surface of groundwater in UFA and (Bottom) simulated hydraulic gradients derived from the calibrated version of the NFM-08.

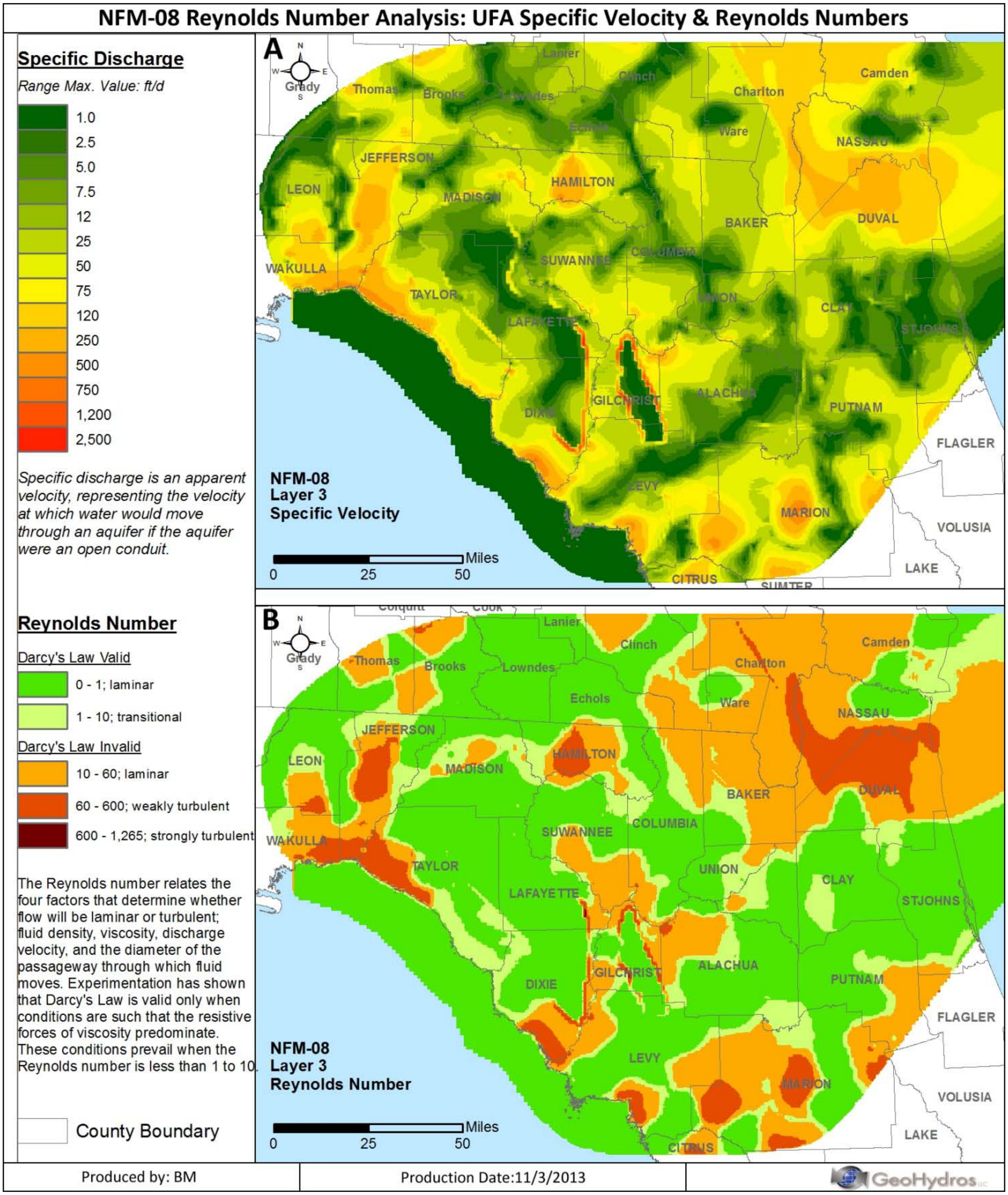
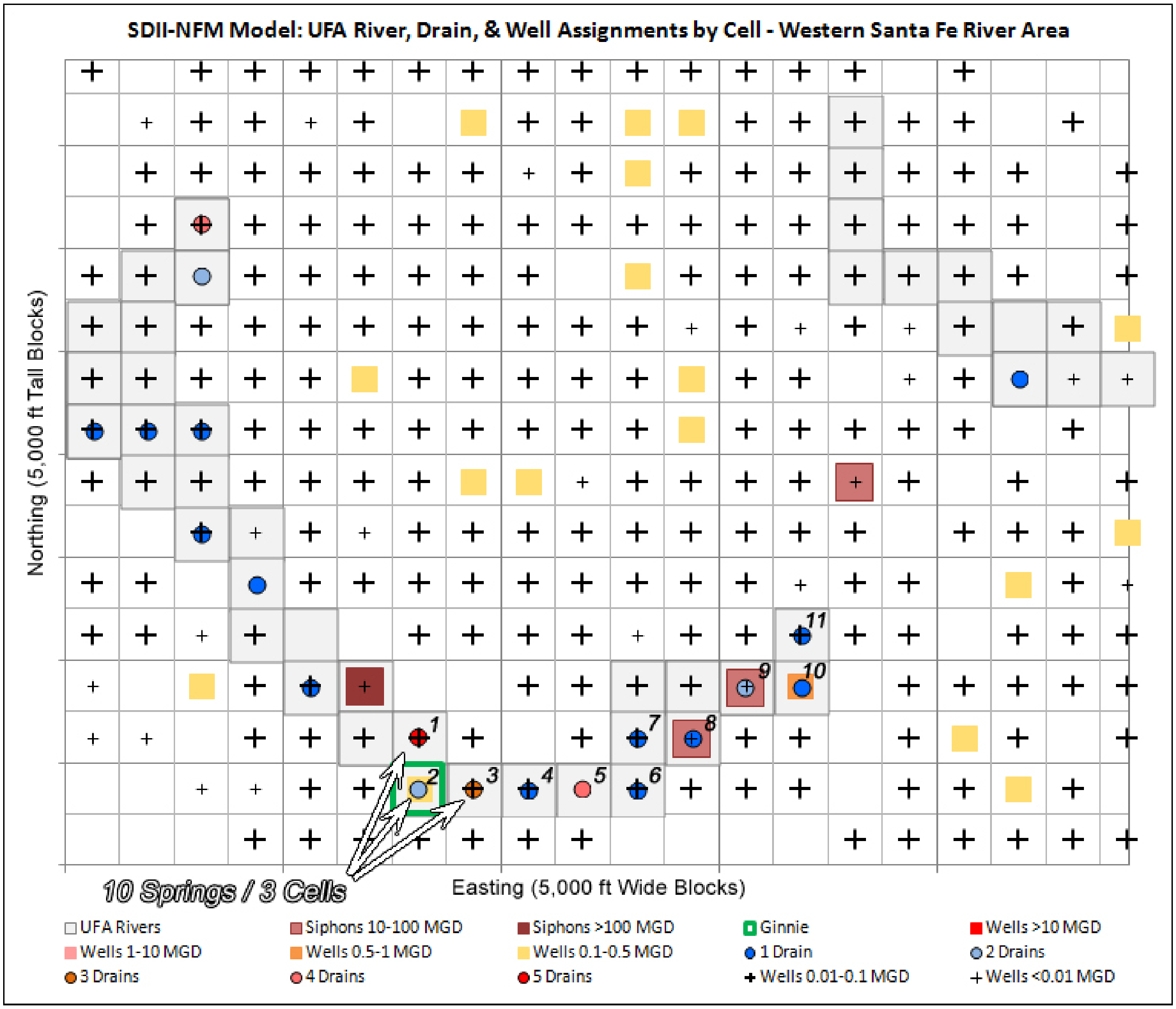


Figure 35 – NFM-08 – Distribution of Simulated Specific Velocities & Calculated Reynolds Numbers

(Top) Flow rates (specific velocities) through the aquifer matrix simulated by the NFM-08 and the distribution of Reynolds numbers (bottom) calculated from the model assigned hydraulic conductivities and equivalent grain diameters, and the simulated groundwater levels, hydraulic gradients, and specific velocities. In order for Darcy's law to be valid, the assigned hydraulic conductivities cannot result in Reynolds numbers greater than between 1 and 10. The distribution of Reynolds numbers calculated from the NFM-08 reveal that the model configuration violates Darcy's law through approximately half of the model domain. This is because the NFM-08 is based on a purely porous media conceptualization and the authors used extremely high hydraulic conductivity values to simulate the observed flows.

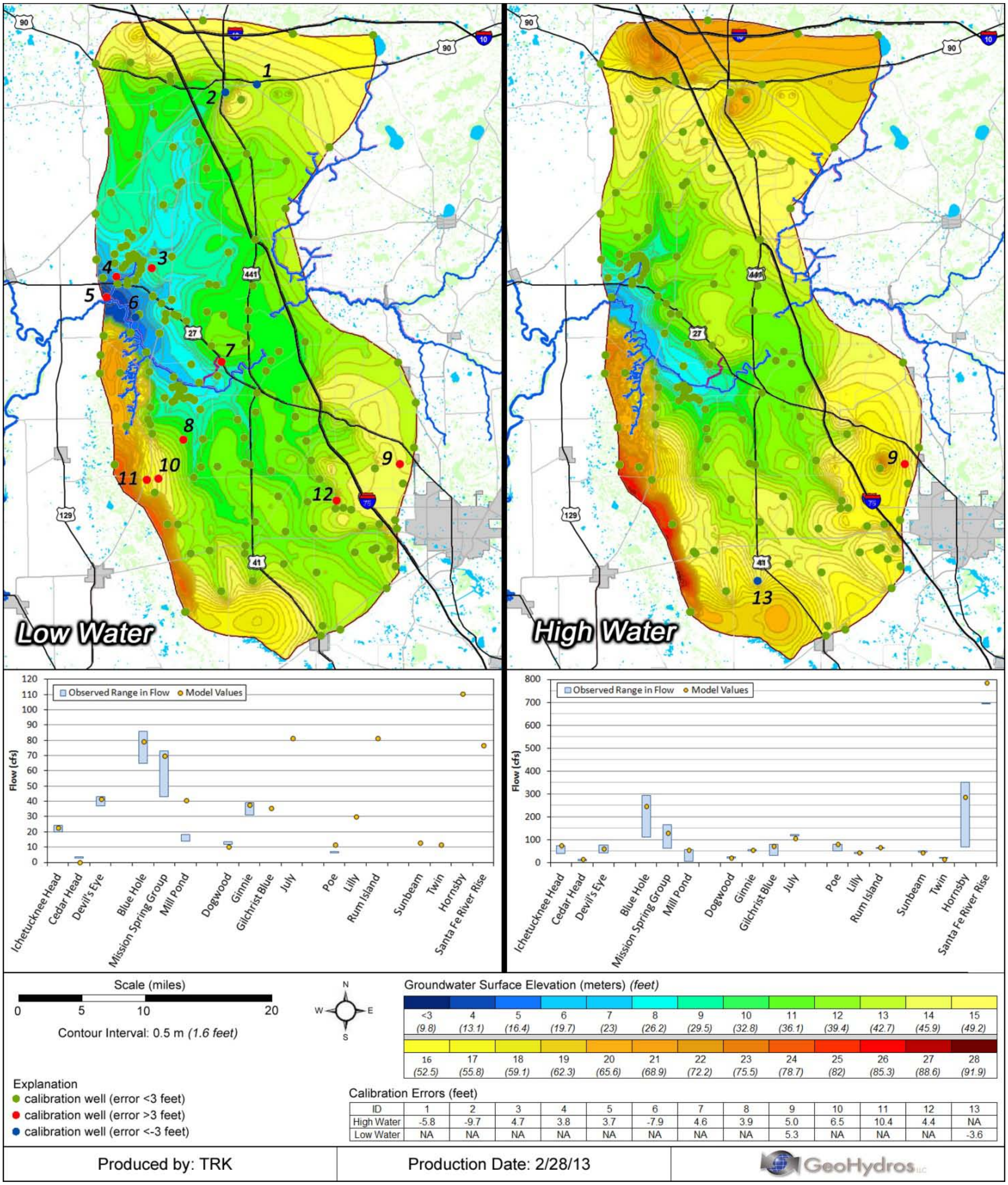


Example Cell Assignments

Map Label	Model Cell (i-j-k)	Spring Names	# Drains	Total Drain Flux	Total River Flux	Total Well or Siphon Flux	Net Cell Flux
1	109-128-3	July,Sawdust,Deer,Twin,Dogwood	5	-124.1	-0.8	-0.1	-125.0
2	110-128-3	Ginnie, Devils Eye / Devils Ear / Little Devils Group	2	-162.0	0.2	-0.5	-162.2
3	110-129-3	Rum Island,Gilchrist Blue,Johnson	3	-89.3	-1.9	-0.1	-91.3
4	110-130-3	COL101974	1	-7.5	-6.0	0.0	-13.5
5	110-131-3	Lily,Pikard,Poe,COL930971	4	-83.6	-8.6	0.0	-92.2
6	110-132-3	ALA930971	1	-15.0	-8.8	0.0	-23.9
7	109-132-3	ALA930972	1	-20.6	-8.3	0.0	-28.9
8	109-133-3	S3,ALA930972	1	-32.0	-6.4	66.7	28.3
9	108-134-3	S1,S2,Treehouse,Columbia	2	-100.3	-5.4	43.3	-62.4
10	108-135-3	Hornsby	1	-4.2	-1.5	-1.2	-7.0
11	107-135-3	Santa Fe River Rise	1	-46.3	-4.4	0.0	-50.7

Figure 36 – NFM-08 - River, Drain, and Well Assignments in part of the Western Santa Fe River Basin

The map illustrates how the SDII-NFM uses multiple drain assignments per model cell to account for individual spring flows occurring within the 5,000 x 5,000 foot grid cells and multiple types of assignments to account for differing types of discharge. Though the respective packages in MODFLOW allow for the multiplicity of assignments, the model does not simulate flow to the individual features but rather a composite flux through each model cell as depicted in the values provided in the table. Different streambed conductance values were allowed to be set for the individual assignments within a cell, which forced the model to match the target flows but at the expense simulated river stage.



Calibration Errors (feet)

ID	1	2	3	4	5	6	7	8	9	10	11	12	13
High Water	-5.8	-9.7	4.7	3.8	3.7	-7.9	4.6	3.9	5.0	6.5	10.4	4.4	NA
Low Water	NA	NA	NA	NA	NA	NA	NA	NA	5.3	NA	NA	NA	-3.6

Figure 37 – WSFM-08 – Spatial Distribution of Groundwater Level Calibration Residuals

Location and magnitude of calibration residuals derived from the low-water (upper left) and high-water (upper right) versions of the WSFM-08 and the corresponding calibration to spring flows (lower bar graphs). The model was calibrated by varying the configuration of simulated conduits and matrix hydraulic conductivity values, applying the configurations to both low-water and high-water versions of the model. The simulated groundwater surfaces are from the model configuration that yielded the fewest wells in both versions that deviated from the observed values by more than three feet, which was approximately 5% of the total change in groundwater elevation across the model domain.

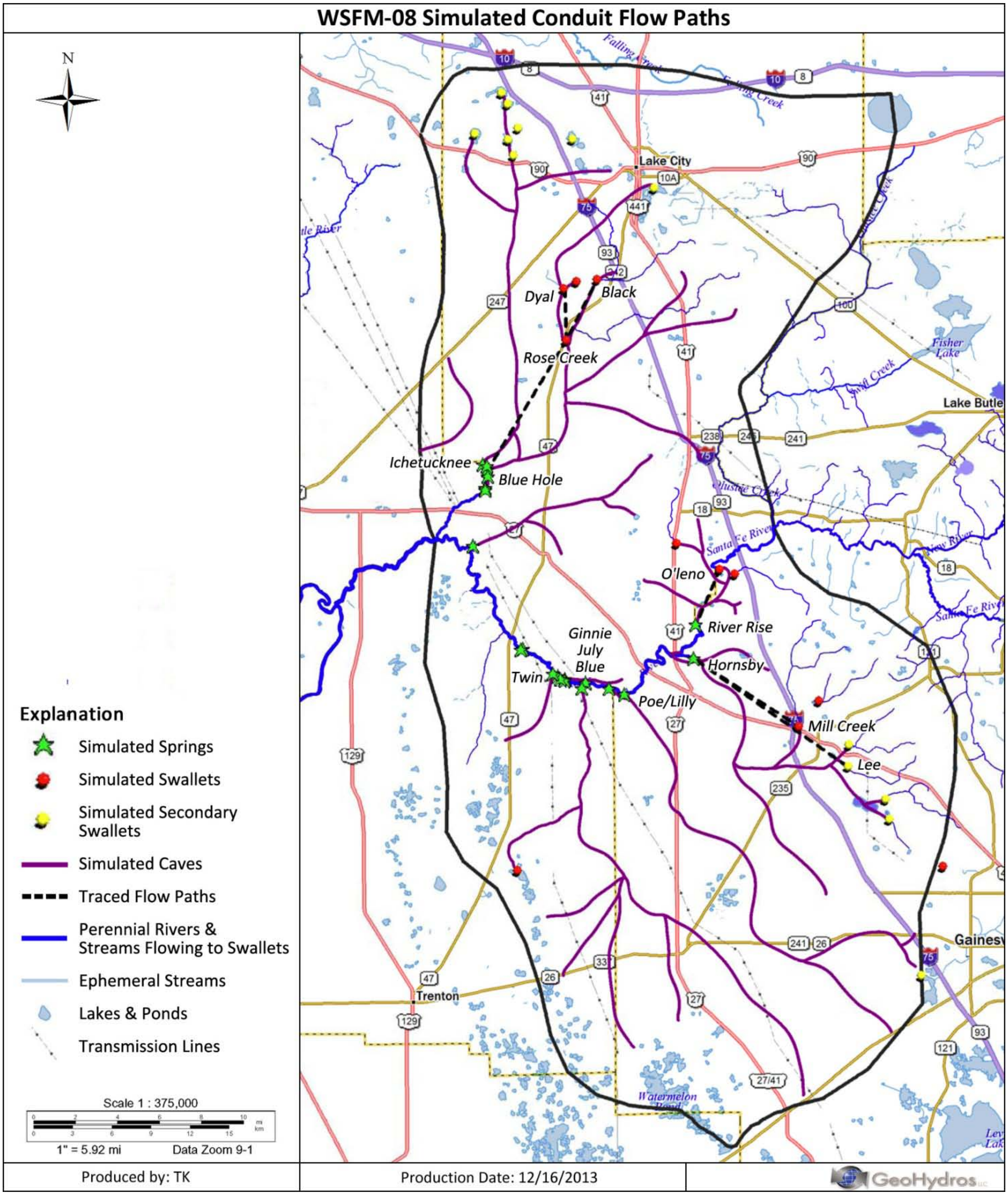
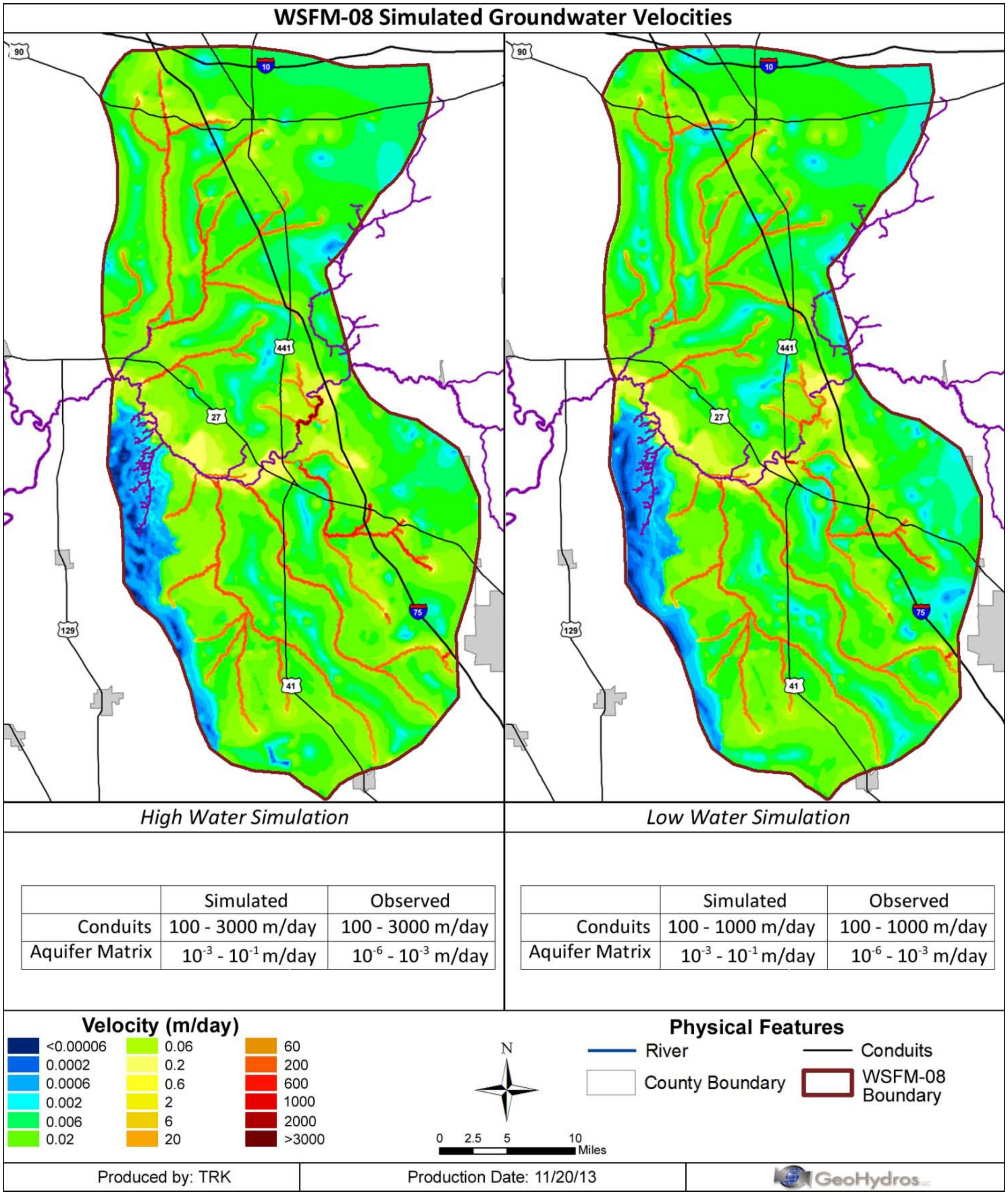


Figure 38 – WSFM-08 – Simulated conduit Flow Paths

Simulated conduit flows paths convey water to the simulated springs and collect water from the surrounding aquifer matrix and from discrete recharge sources including swallets and leaky lakes and ponds (secondary swallets). The conduit flow paths were designed to honor traced groundwater flow paths but the specific paths were determined through calibration to groundwater levels in wells.



High Water Simulation

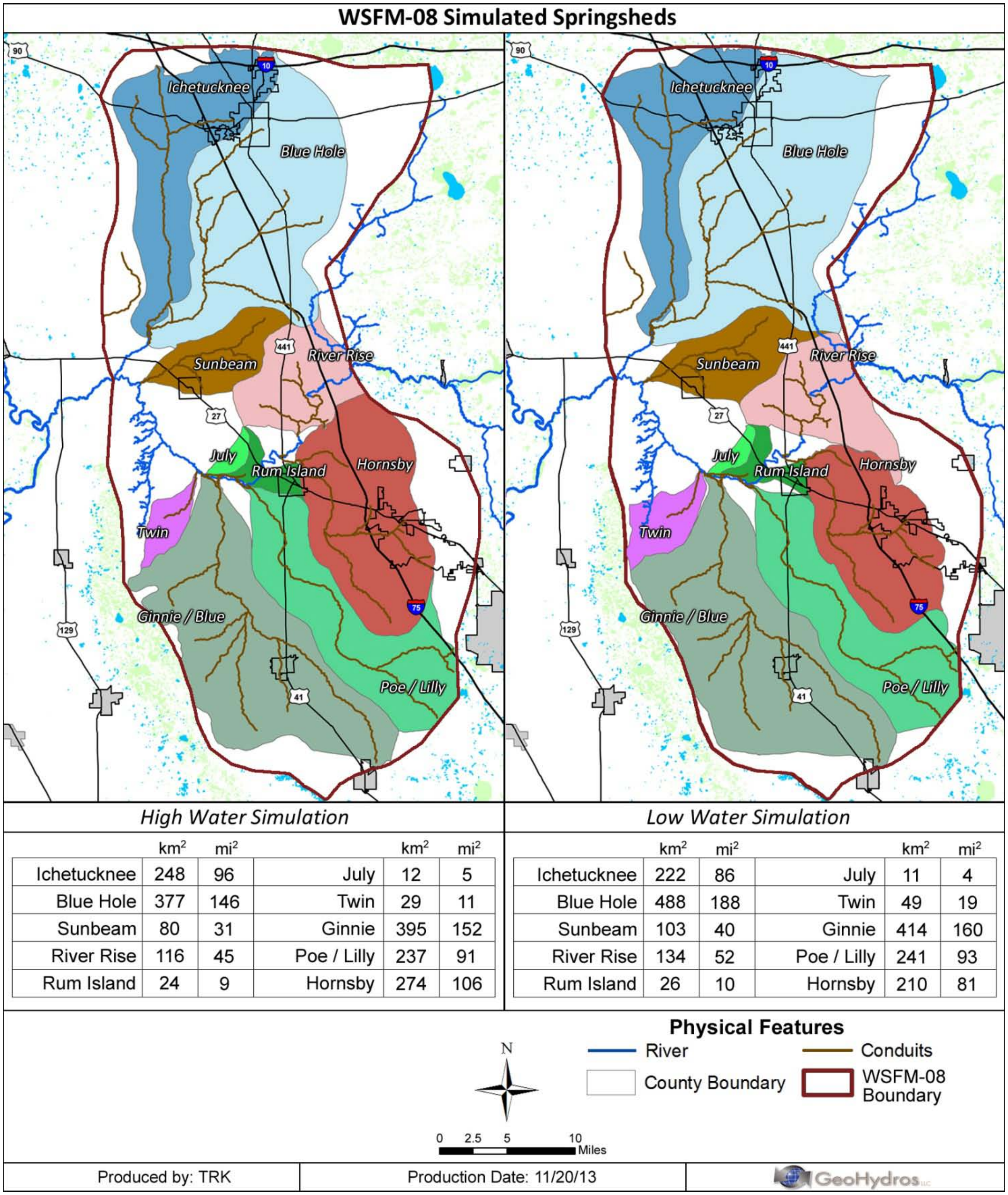
	Simulated	Observed
Conduits	100 - 3000 m/day	100 - 3000 m/day
Aquifer Matrix	10^{-3} - 10^{-1} m/day	10^{-6} - 10^{-3} m/day

Low Water Simulation

	Simulated	Observed
Conduits	100 - 1000 m/day	100 - 1000 m/day
Aquifer Matrix	10^{-3} - 10^{-1} m/day	10^{-6} - 10^{-3} m/day

Figure 39 – WSFM-08 – Simulated Groundwater Velocities

The WSFM-08 simulates the full range of groundwater velocities that have been observed in the Western Santa Fe river Basin including very slow matrix velocities and very fast conduit velocities calculated from comparative analysis of hydrographs for O'leno Sink and the Santa Fe River Rise, and groundwater tracer tests performed between Lee and Mill Creek Sinks and Hornsby Spring, and between Black, Dyal, and Rose Sinks and the springs in the upper Ichetucknee River.



High Water Simulation

	km^2	mi^2		km^2	mi^2
Ichetucknee	248	96	July	12	5
Blue Hole	377	146	Twin	29	11
Sunbeam	80	31	Ginnie	395	152
River Rise	116	45	Poe / Lilly	237	91
Rum Island	24	9	Hornsby	274	106

Low Water Simulation

	km^2	mi^2		km^2	mi^2
Ichetucknee	222	86	July	11	4
Blue Hole	488	188	Twin	49	19
Sunbeam	103	40	Ginnie	414	160
River Rise	134	52	Poe / Lilly	241	93
Rum Island	26	10	Hornsby	210	81

Figure 40 – WSFM-08 – Simulated Springsheds & Boundary Response to Groundwater Levels

Springsheds define the area that contributes groundwater flow to specific springs or spring groups. Springshed boundaries are hydraulic divides that demark lines across which groundwater flow changes direction and that fluctuate under varying hydrologic conditions. Springsheds for lower elevation springs tend to expand at the expense of higher elevation springs under lower hydrologic conditions. Thus under low water conditions, the springshed for the Ginnie/July/Blue Springs group expands at the expense of the springshed for the Poe/Lilly Springs group, which in turn expands at the expense of the springshed for Hornsby Spring.

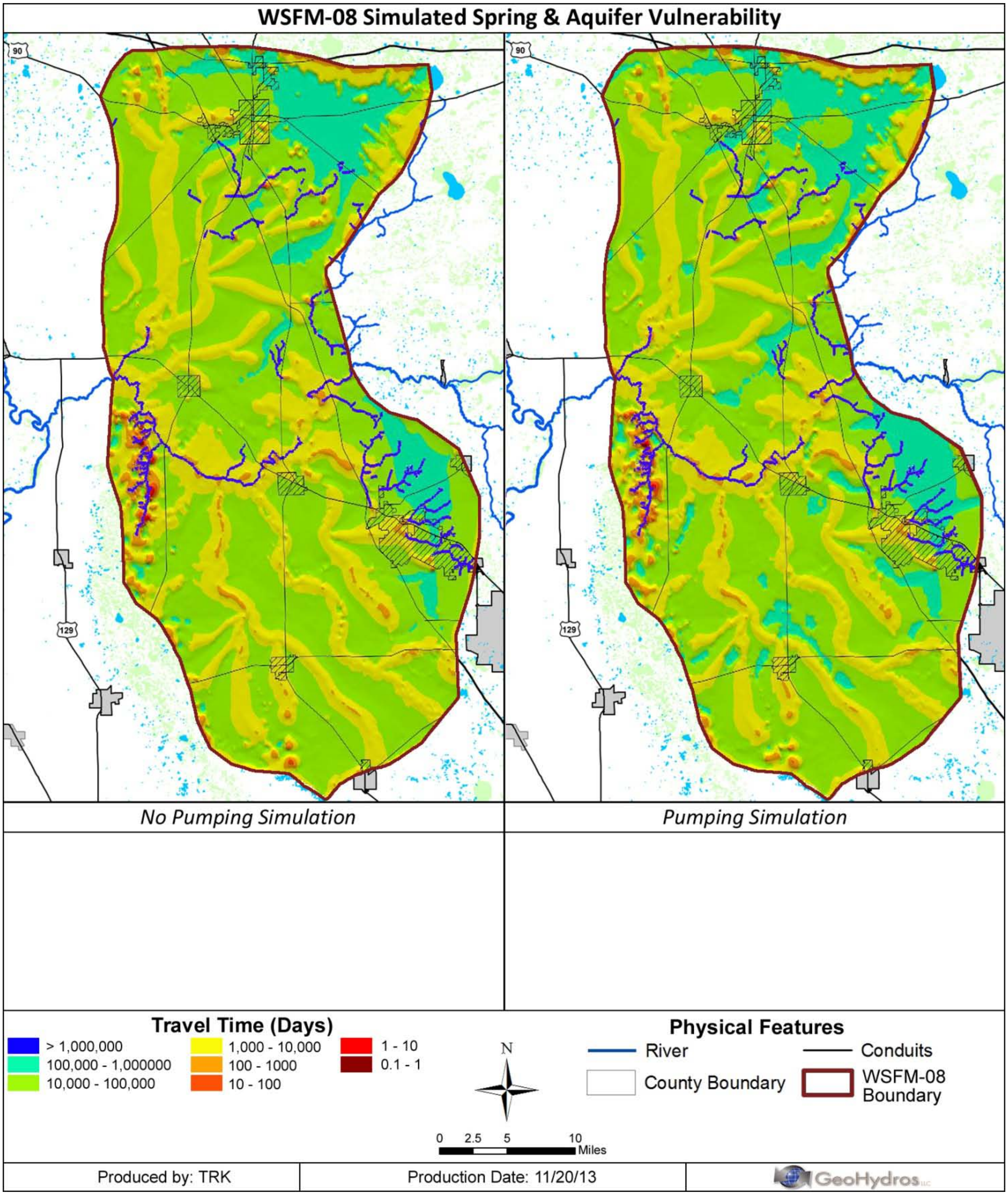
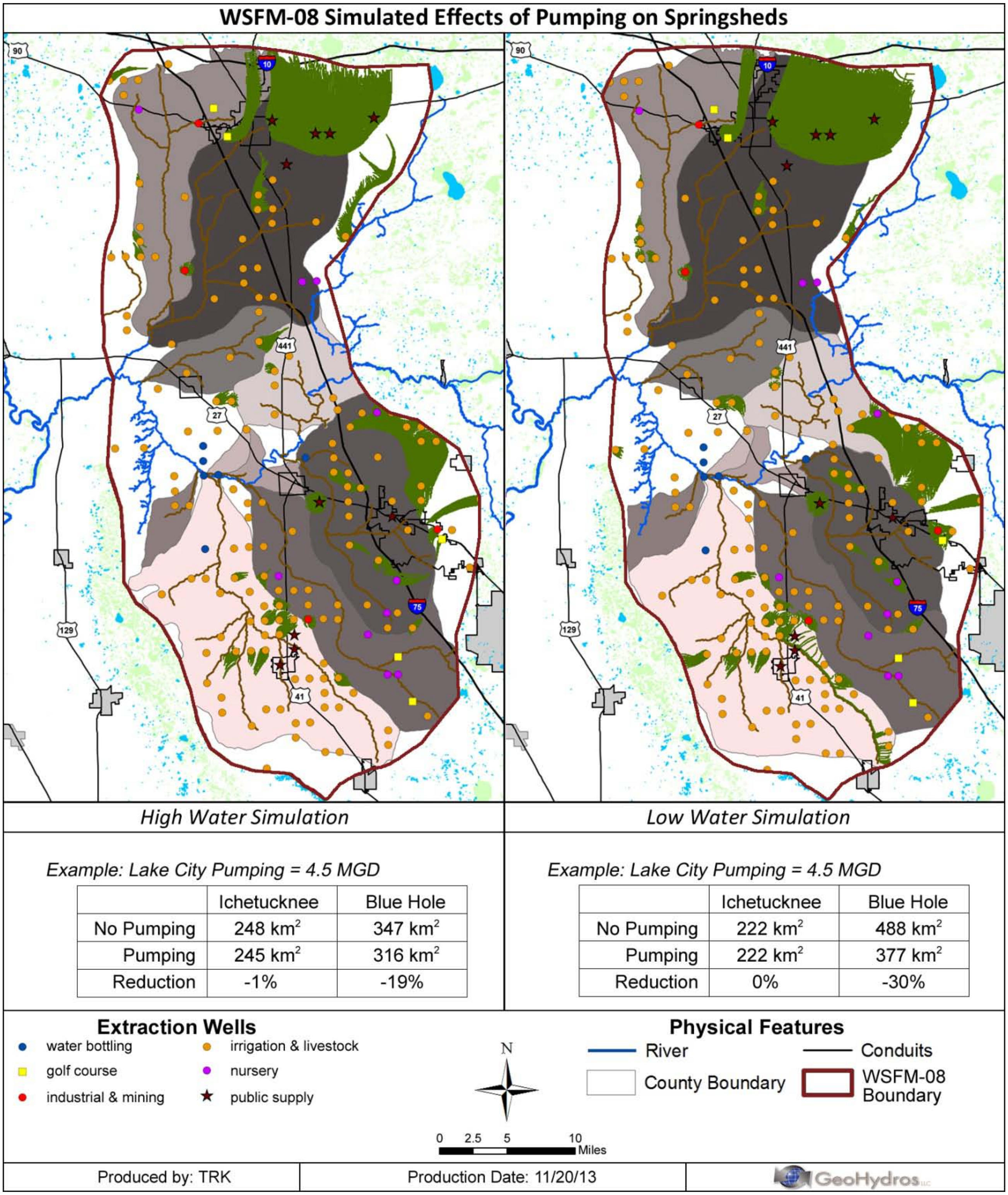


Figure 41 – WSFM-08 – Simulated Spring Vulnerability Based on Travel Times to Discharge

The color-floods show the simulated travel times from every point in the model domain to the point at which water from that point leaves the model through either springs, wells, or model boundaries. Two simulations are shown: one in which all of the wells used in the calibration process were pumping at their prescribed rates, and another in which all wells were turned off. The effect of the conduits is obvious. Spring Vulnerability to contamination is predicated on the distance from a source of potential contamination to the nearest conduit supplying water to the springs, not on the distance to the springs themselves. Less obvious but apparent through comparing the two maps, is the effect of pumping. Pumping can be seen to substantially reduce travel times in some regions which occurs because flow is being directed from those locations away from the conduits to the wells through the aquifer matrix.



Example: Lake City Pumping = 4.5 MGD (High Water Simulation)

	Ichetucknee	Blue Hole
No Pumping	248 km^2	347 km^2
Pumping	245 km^2	316 km^2
Reduction	-1%	-19%

Example: Lake City Pumping = 4.5 MGD (Low Water Simulation)

	Ichetucknee	Blue Hole
No Pumping	222 km^2	488 km^2
Pumping	222 km^2	377 km^2
Reduction	0%	-30%

Figure 42 – WSFM-08 – Effects of Groundwater Pumping on Springs

The model revealed reductions in springshed sizes as a consequence of groundwater pumping. The simulated springsheds are shown in shades of gray (beige for the Ginnie/July/Blue Springs group). Simulated capture zones for groundwater pumping wells are shown in green, which are a collection of flow paths determined through particle tracking. The tabulated values document the change in size of the Ichetucknee and Blue Hole springsheds due to pumping by the city of Lake City. The Blue Hole springshed is particularly effected loosing 19% of its area due to pumping under high water conditions and 30% of its area due to pumping under low water conditions.

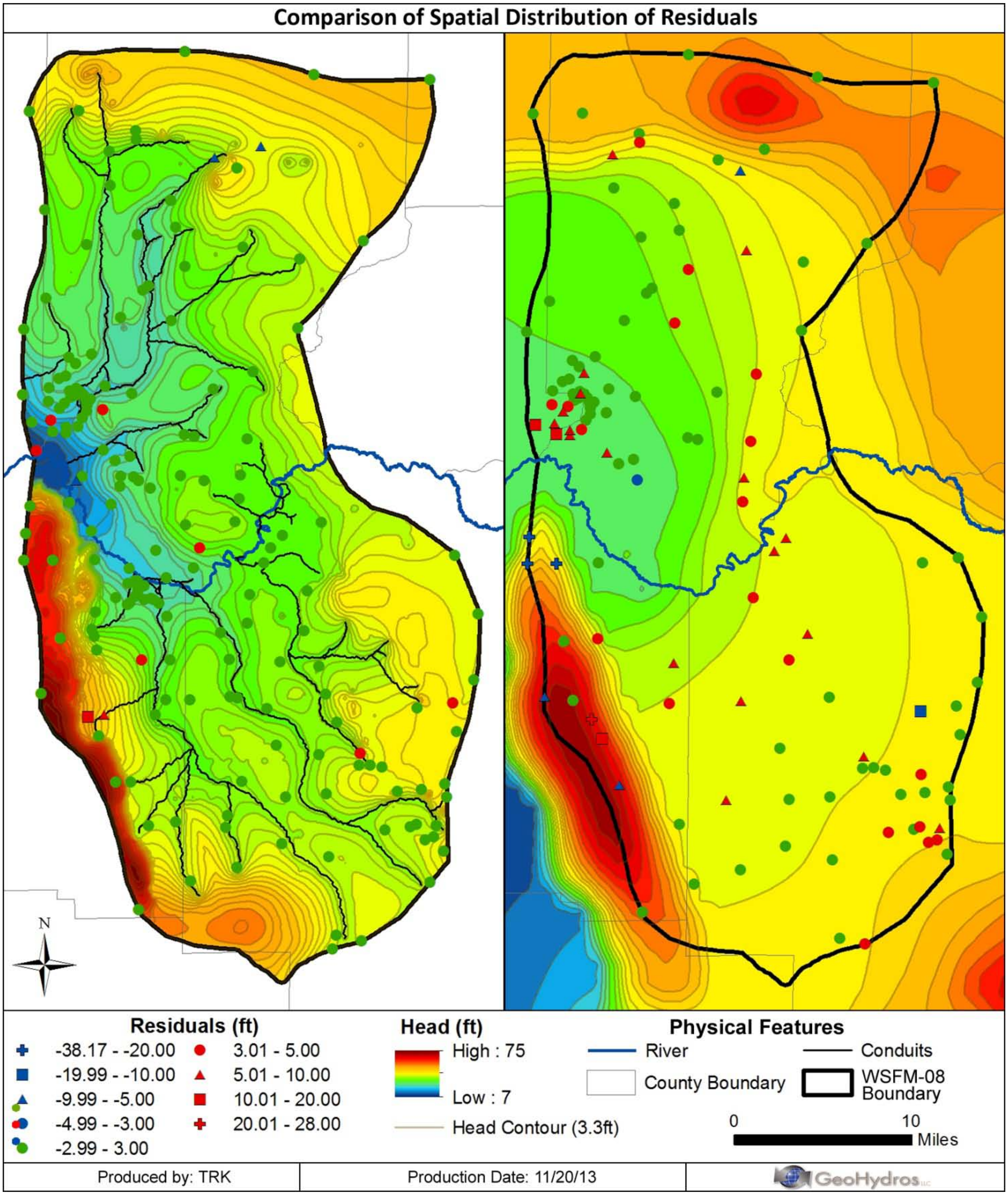


Figure 43 – WSFM-08 & NFM-08 – Comparison of Spatial Distribution of Residuals

Maps comparing the spatial distribution of calibration head residuals measured at wells for the low-water version of the WSFM-08 (left) and the NFM-08 (right). Data used to determine residuals are the average of groundwater levels measured in wells by the SRWMD and the ACEPD between June 1 2001 and May 31 2002. The WSFM-08 produced a very different head field that is substantially better calibrated. It matched groundwater levels at 176 of 188 wells to less than 3.5 feet with only 5 residuals greater than 5 feet and 1 greater than 10 feet and an average absolute residual of 1.4 feet. The NFM-08 matched groundwater levels to less than 5 feet at only 101 of 132 wells in the same domain and to less than 3.5 feet at only 80 of the 132 wells. Residuals at 9 wells were greater than 10 feet and greater than 20 feet at 5 wells. The average absolute residual for wells within the WSFM-08 domain was 4.2 feet.

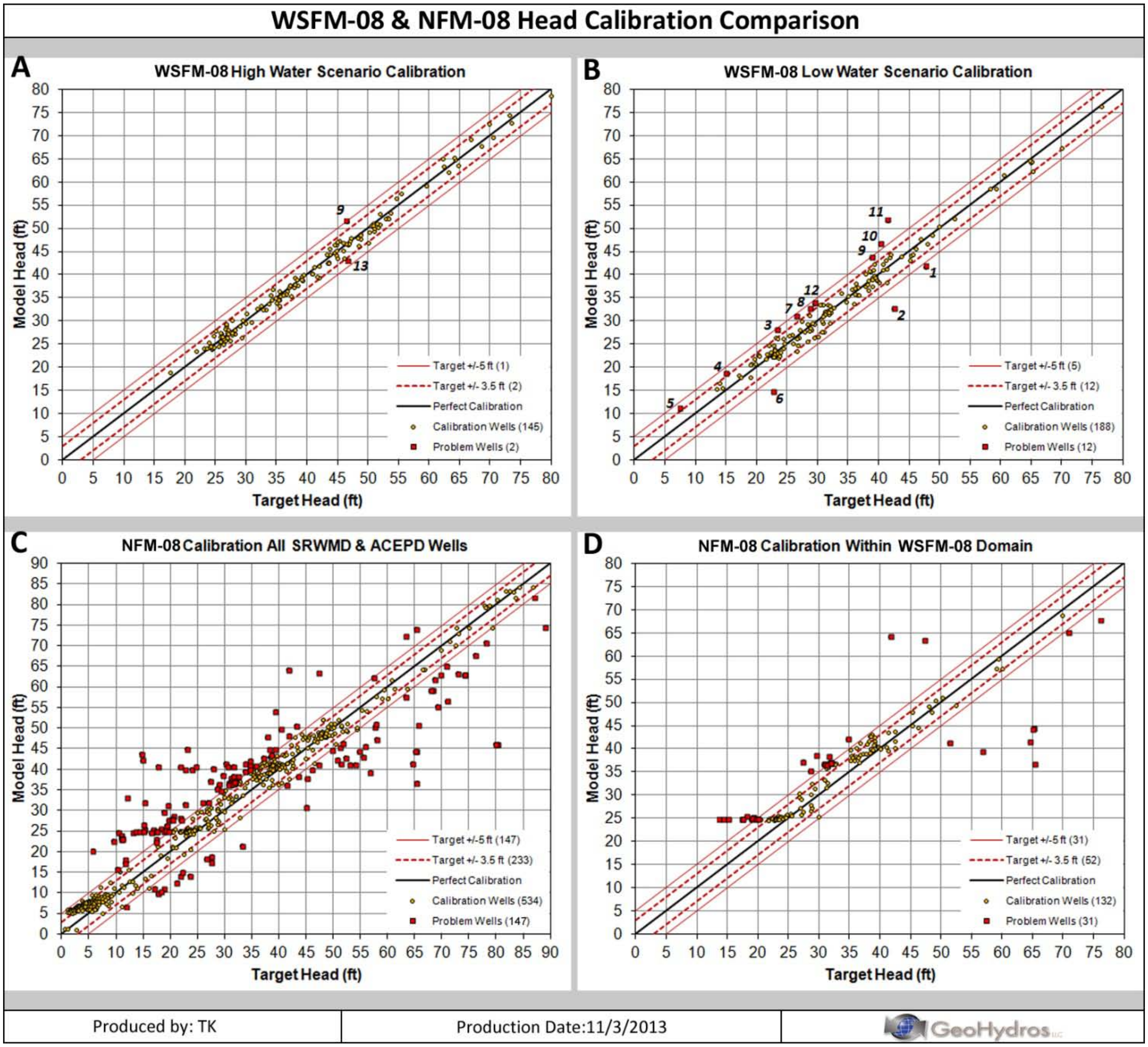


Figure 44 – WSFM-08 & NFM-08 – Comparison of Head Calibration Regression Plots

Comparison of measured and simulated UFA groundwater elevations at wells used for calibration from the WSFM-08 (A) and (B) and the NFM-08 (C) and (D). Points that fall exactly along the black line represent a perfect match between simulated and measured values. The red lines bracket progressively larger errors where the red dashed lines mark +/- 3.5 feet, which was the target calibration criterion for the WSFM-08, and the solid red lines mark +/- 5 feet, which was the calibration criterion for the NFM-08. (A) Calibration results from the high-water version of the WSFM-08. (B) Calibration results from the low-water version of the WSFM-08. (C) Calibration results using all available wells from the SRWMD and the ACEPD within the NFM-08 domain that had measurements during the model calibration period. (D) Calibration results from the NFM-08 using only the SRWMD and ACEPD wells that fall within the WSFM-08 domain that had measurements during the NFM-08 calibration period. The plots clearly show dramatically better calibration to heads achieved using the hybrid modeling approach that embraces conduit flow and a more rigorous calibration process.

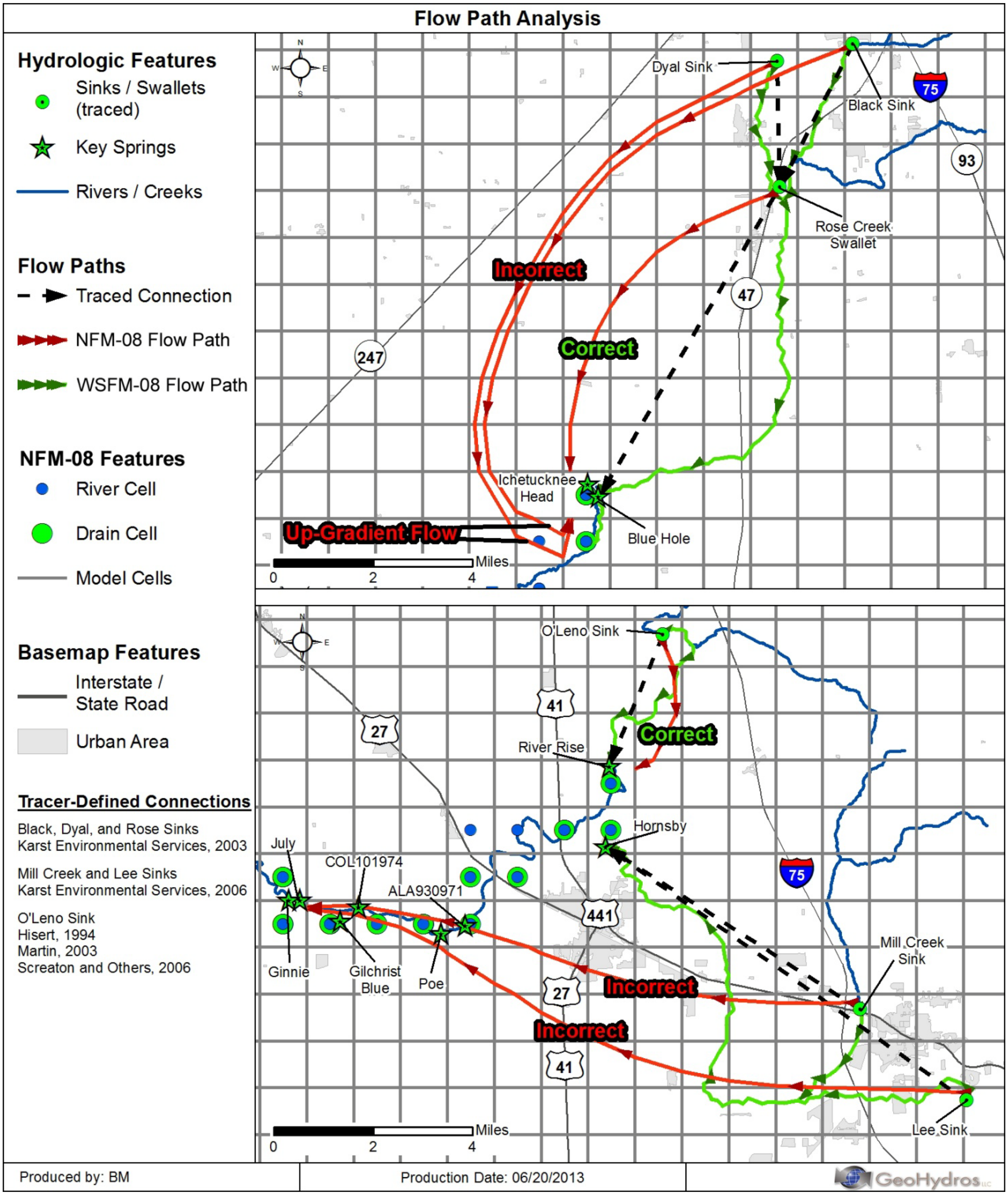
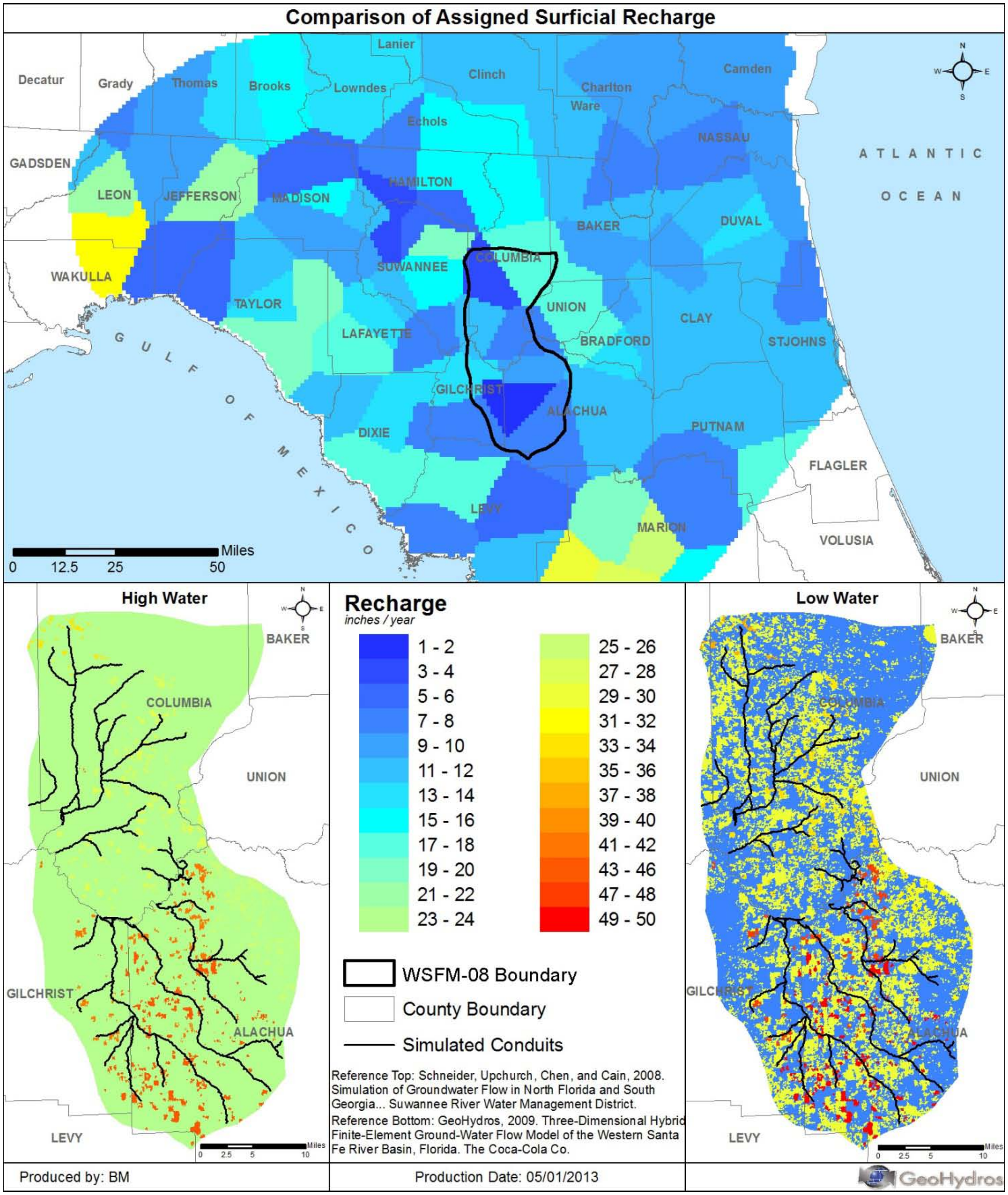


Figure 45 – WSFM-08 & NFM-08 – Comparison of Simulated Groundwater Flow Paths & Travel Times

Both figures show connections between locations of direct recharge (swallets) and springs that have been established through groundwater tracing as black dashed arrows. The green lines show the flow paths from the same swallets to springs as simulated by the WSFM-08. The red lines show the flow paths from the same swallets to springs as simulated by the NFM-08. The WSFM-08 honors all of the established connections. The NFM-08 fails to discriminate between flow from swallet sources to Blue Hole and Mission Springs and flow from non-swallet sources to Ichetucknee Head and Cedar Head Springs. It also failed to correctly simulate flow from the swallets northwest of Gainesville to Hornsby Spring but instead incorrectly shows that flow going to the downriver Santa Fe springs including Poe, Gilchrist Blue, July, and Ginnie Springs.



Reference Top: Schneider, Upchurch, Chen, and Cain, 2008. Simulation of Groundwater Flow in North Florida and South Georgia... Suwannee River Water Management District.

Reference Bottom: GeoHydros, 2009. Three-Dimensional Hybrid Finite-Element Ground-Water Flow Model of the Western Santa Fe River Basin, Florida. The Coca-Cola Co.

Produced by: BM

Production Date: 05/01/2013

Figure 46 – WSFM-08 & NFM-08 – Comparison of Assigned Recharge

(Top) Recharge assigned in the NFM-08 to Thiessen polygons defined from the distribution of precipitation data through the Calibration / PEST process. The polygon values varied from 0.44 – 19.6 in/yr where the variation was generated through the PEST process to produce the lowest calibration residuals but the distribution does not reflect real-world variation in recharge capacity driven by land use, topographic slope or permeability. The bottom two plots show the distribution of recharge assigned in the high-water version (left) and low-water version (right) of the WSFM-08. The total recharge in the model domain was 23.65 in/yr and 16.12 in/yr respectively, which were derived from the water balance. The distribution was assigned to conform to land use variations. Neither the total recharge nor the distribution of values were derived through model calibration.

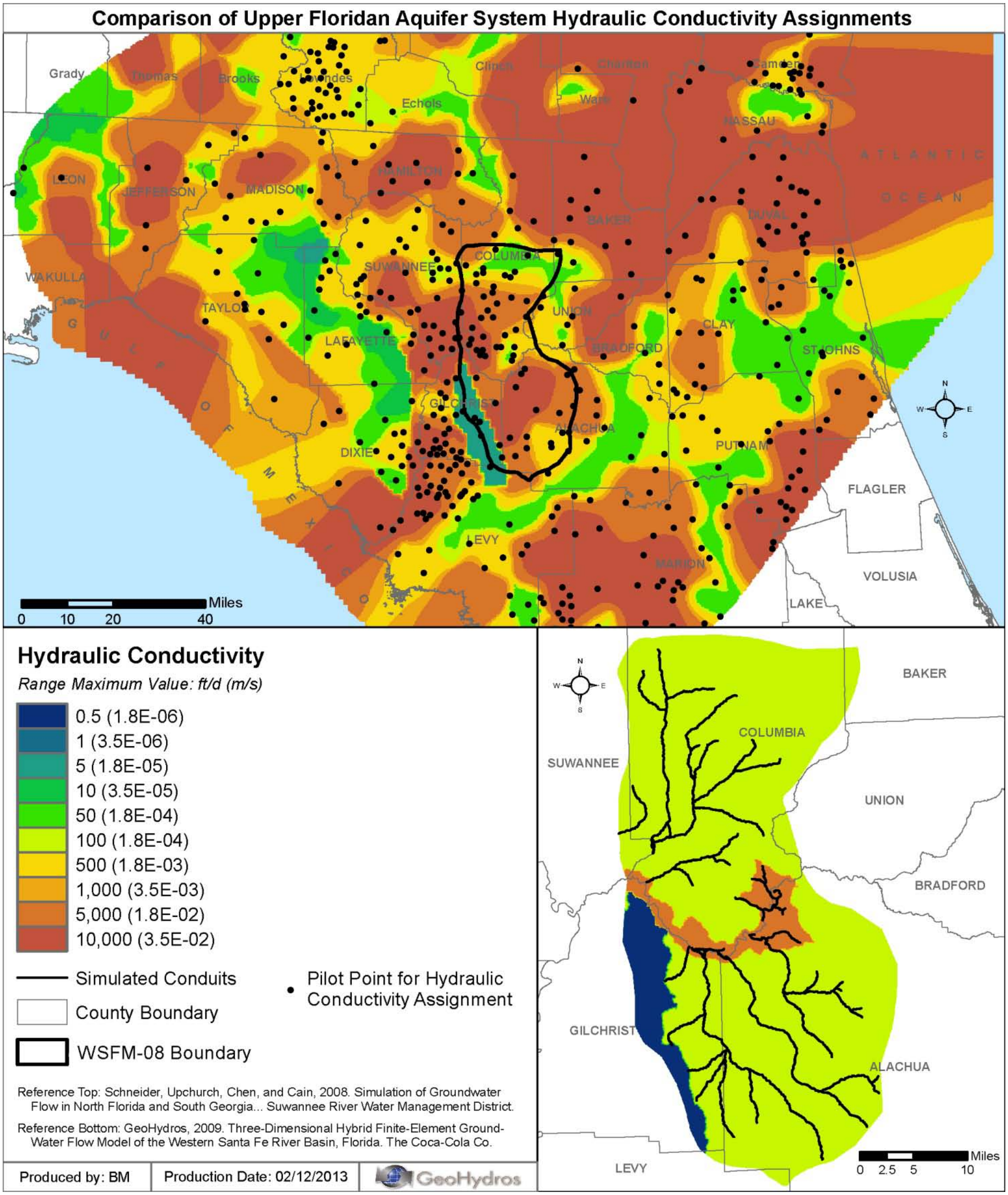
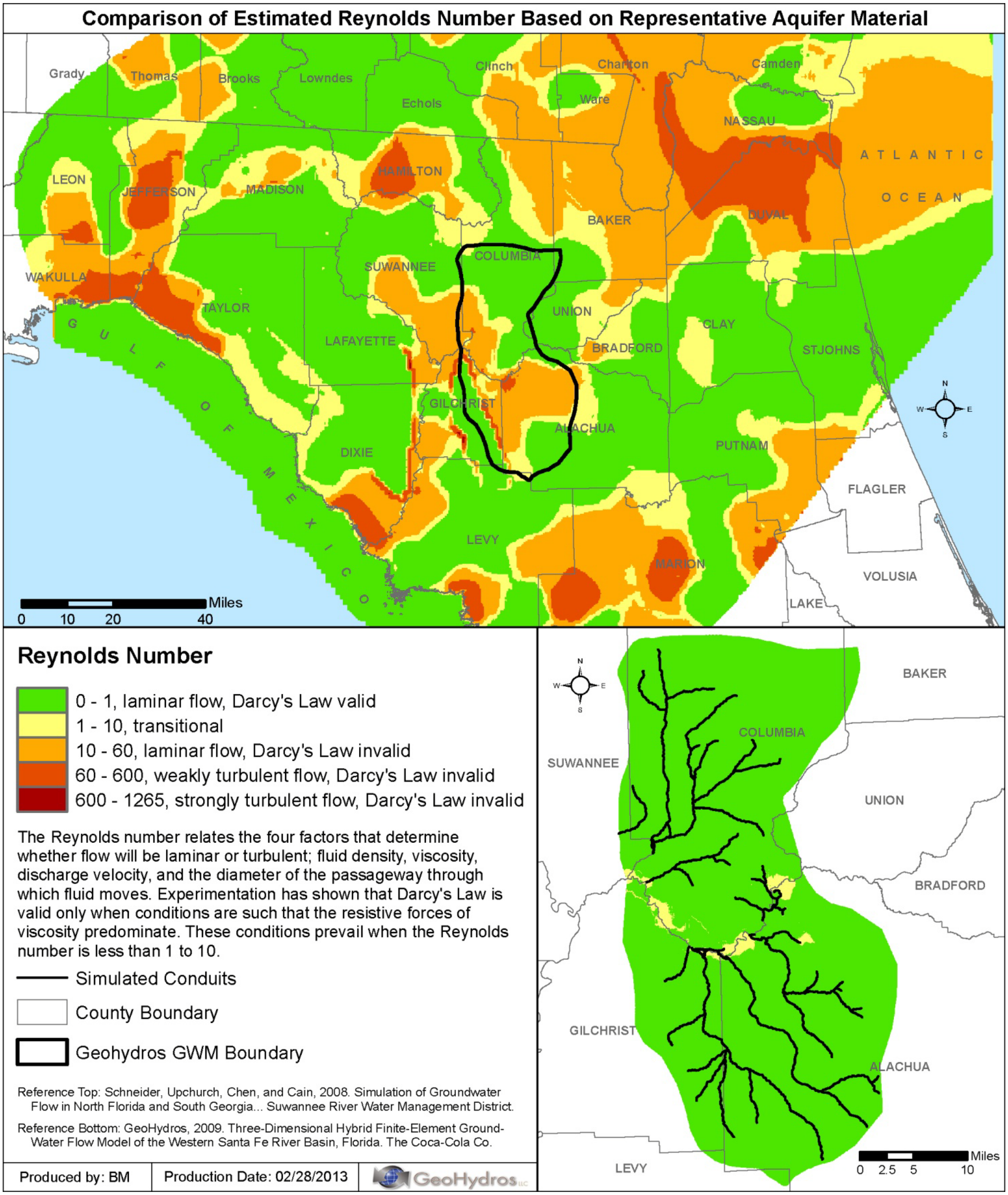


Figure 47 – WSFM-08 & NFM-08 – Comparison of the Simulated Permeability Frameworks

Distribution of model-simulated hydraulic conductivity values in the calibrated version of the NFM-08 (Top) relative to the distribution of values in the calibrated version of the WSFM-08 (bottom right). The SDII values were derived through model calibration with PEST from pilot point values defined by aquifer performance tests and are predominantly higher than the WSFM-08 values by between 5 and 100 times. The higher values allowed the model to simulate the observed spring and river flows despite the absence of conduits in the model design. The higher hydraulic conductivity values in the NFM-08 generate simulations of smaller cones of depression for a given groundwater pumping rate as evidenced by the model's inability to reasonably simulate the drawdowns in Gainesville and Fernandina Beach. The two models therefore produce very different predicts of impacts due to pumping.



The Reynolds number relates the four factors that determine whether flow will be laminar or turbulent; fluid density, viscosity, discharge velocity, and the diameter of the passageway through which fluid moves. Experimentation has shown that Darcy's Law is valid only when conditions are such that the resistive forces of viscosity predominate. These conditions prevail when the Reynolds number is less than 1 to 10.

Reference Top: Schneider, Upchurch, Chen, and Cain, 2008. Simulation of Groundwater Flow in North Florida and South Georgia... Suwannee River Water Management District.

Reference Bottom: GeoHydros, 2009. Three-Dimensional Hybrid Finite-Element Ground-Water Flow Model of the Western Santa Fe River Basin, Florida. The Coca-Cola Co.

Figure 48 – WSFM-08 & NFM-08 – Comparison of Validity as Defined by Reynolds Numbers

The Reynolds number is a function of the assigned hydraulic conductivity, which in turn is a function of the assumed grain and pore space diameters, and the simulated groundwater surface elevations (head). In order for Darcy's law to be valid, the assigned hydraulic conductivities cannot result in Reynolds numbers greater than between 1 and 10. The distribution of Reynolds numbers calculated from the NFM-08 reveal that the model configuration violates Darcy's law through approximately half of the model domain while the WSFM-08 shows no significant violations. This is because the NFM-08 is based on a purely porous media conceptualization and the authors used extremely high hydraulic conductivity values to simulate the observed flows.

Appendix 1

Digital copy of files received from the SRWMD describing their model-based assessment of probable impacts to spring and river flows associated with groundwater pumping at the Douglas Farm

SRWMD MFL Report for NFM Version 1

- original data received in file named: "Richard_Douglas_2-11-00063.xlsx"

Number of Wells in Permit: 1

Well Name	Easting	Northing	Pumping Rate	Top Layer	Bottom Layer
1	2540559	304809	23600	3	3

Flow Rate Units: Gallons per day

MFL Definition File: C:\NFM1\NFM_v1.02_2sp\work\srwmd_mfl.csv

Modeler: Kevin_Wright

Project: Richard_Douglas

Permit ID: 2-11-00063

Spring Flow Comparisons:

					Added by GeoHydros	
Spring Name	Target Name	Base Period Flow (cfs)	Flow with New Permit (cfs)	Percent Difference	Change (cfs)	Change (gpd)
ALA930971	(drnf33)	-15.0394	-15.0394	-0.000144	0	0
ALA930972	(drnf34)	-52.7549	-52.7548	-0.000148	-1E-04	-65
Alapaha Rise	(drnf106)	-490.1107	-490.1107	0	0	0
Allen Mill Pond Spring	(drnf9)	-2.9073	-2.9073	-0.000006	0	0
Anderson Spring	(drnf61)	-7.0276	-7.0276	0	0	0
Bathtub Spring	(drnf65)	-5.0238	-5.0238	-0.000014	0	0
Beaver Creek Spring	(drnf108)	-49.2732	-49.2732	0	0	0
Bell Spring	(drnf129)	-3.2015	-3.2015	0	0	0
Big Spring and TAY69991 and TAY69992	(drnf97)	-17.8952	-17.8952	0	0	0
Blue Creek Spring	(drnf117)	-6.4714	-6.4714	0	0	0
Blue Hole Spring	(drnf88)	-60.9151	-60.915	-0.000145	-0.0001	-65
Bonnet Spring	(drnf86)	-18.7804	-18.7804	-0.000021	0	0
Bradley Spring	(drnf115)	-3.5986	-3.5986	0	0	0
Branford Spring	(drnf74)	-5.6343	-5.6343	-0.000024	0	0
Cedar Head Spring	(drnf87)	-4.0146	-4.0146	-0.000145	0	0
Cedar Island Spring	(drnf116)	-9.7632	-9.7632	0	0	0
Charles Spring	(drnf49)	-4.415	-4.415	-0.000008	0	0
COL101974	(drnf15)	-7.5178	-7.5178	-0.000298	0	0
COL928971 and GIL928971	(drnf19)	-2.1031	-2.1031	-0.000138	0	0
COL930971	(drnf18)	-10.0235	-10.0235	-0.000181	0	0
Columbia Spring	(drnf35)	-44.0946	-44.0945	-0.000174	-0.0001	-65
Convict Spring	(drnf104)	-5.0236	-5.0236	-0.000014	0	0
Copper Spring	(drnf131)	-14.2094	-14.2094	0	0	0
Deer Spring	(drnf46)	-3.8526	-3.8525	-0.000398	-1E-04	-65
Devils Ear, Devils Eye, Little Dev	(drnf54)	-122.6676	-122.6444	-0.018931	-0.0232	-14,994
Devil's Eye Spring	(drnf90)	-26.1722	-26.1721	-0.000137	-1E-04	-65
DIX625991	(drnf110)	-4.3973	-4.3973	0	0	0
DIX625993	(drnf109)	-27.6758	-27.6758	0	0	0
DIX95971	(drnf79)	-1.802	-1.802	-0.00001	0	0
Dogwood Spring	(drnf51)	-15.729	-15.7288	-0.001066	-0.0002	-129
Fanning Spring	(drnf98)	-56.9665	-56.9665	-0.00001	0	0

Spring Name	Target Name	Base Period Flow (cfs)	Flow with New Permit (cfs)	Percent Difference	Change (cfs)	Change (gpd)
Fara Spring	(drnf60)	-4.9154	-4.9154	-0.000007	0	0
GIL1012971 and GIL1012972 and GIL1012973	(drnf21)	-145.4288	-145.4284	-0.000247	-0.0004	-259
GIL101971	(drnf14)	-6.2218	-6.2217	-0.001771	-1E-04	-65
GIL107971 and GIL729971	(drnf128)	-10.7352	-10.7352	-0.00002	0	0
GIL107972 and Trail and SUW107971	(drnf72)	-29.3676	-29.3676	-0.000025	0	0
GIL84971	(drnf99)	-5.0335	-5.0335	-0.000014	0	0
GIL917973	(drnf43)	-2.1526	-2.1526	-0.000017	0	0
GIL99972 and SUW917971	(drnf44)	-3.7062	-3.7062	-0.000039	0	0
Gilchrist Blue Spring	(drnf126)	-37.6133	-37.6128	-0.001515	-0.0005	-323
Ginnie Spring	(drnf52)	-39.4376	-39.4302	-0.018931	-0.0074	-4,782
Guaranto Spring	(drnf83)	-9.3433	-9.3433	-0.000015	0	0
HAM1017974	(drnf6)	-4.2158	-4.2158	-0.000009	0	0
HAM1023971	(drnf32)	-12.5379	-12.5379	0	0	0
HAM610982	(drnf64)	-4.4196	-4.4196	-0.000004	0	0
HAM610983	(drnf71)	-13.07	-13.07	0	0	0
HAM610984	(drnf105)	-8.8444	-8.8444	-0.000008	0	0
HAM612982	(drnf24)	-2.6651	-2.6651	0	0	0
HAM923971	(drnf10)	-8.0363	-8.0363	0	0	0
HAM923973	(drnf26)	-7.9558	-7.9558	0	0	0
Hart Spring	(drnf77)	-36.5638	-36.5638	0	0	0
Holton Creek Rise	(drnf29)	-74.6049	-74.6049	-0.000008	0	0
Horn Spring	(drnf101)	-13.2862	-13.2862	0	0	0
Hornsby Spring	(drnf92)	-4.2518	-4.2518	-0.000425	0	0
Ichetucknee Spring	(drnf55)	-37.8097	-37.8096	-0.000145	-1E-04	-65
Jabo Spring	(drnf120)	-6.9253	-6.9253	0	0	0
July Spring	(drnf53)	-84.7113	-84.7093	-0.002418	-0.002	-1,293
LAF718972	(drnf40)	-4.9165	-4.9165	-0.000032	0	0
LAF922975	(drnf59)	-1.7038	-1.7038	0	0	0
LAF924971	(drnf68)	-6.0312	-6.0312	-0.000012	0	0
LAF929972	(drnf57)	-1.1024	-1.1024	-0.000008	0	0
LAF929973	(drnf56)	-4.7145	-4.7145	-0.000008	0	0
LAF93971 LAF718971	(drnf37)	-6.7553	-6.7553	-0.000021	0	0
Lafayette Blue Spring	(drnf58)	-51.8848	-51.8848	-0.000006	0	0
LEV97991	(drnf114)	-3.0634	-3.0634	0	0	0
Levy Blue Spring	(drnf95)	-1.9092	-1.9092	-0.00018	0	0
Lily Spring	(drnf17)	-29.8897	-29.8897	-0.000175	0	0
Lime Lime Run Ellaville Springs	(drnf132)	-39.8601	-39.8601	0	0	0
Little Copper Spring	(drnf48)	-2.301	-2.301	0	0	0
Little Otter Spring GIL94972	(drnf76)	-1.5008	-1.5008	-0.000006	0	0
Little River	(drnf38)	-45.0504	-45.0504	-0.000019	0	0
MAD610981	(drnf8)	-2.5118	-2.5118	0	0	0
Madison Blue Spring	(drnf25)	-66.3075	-66.3075	0	0	0
Manatee Spring	(drnf0)	-118.6172	-118.6172	0	0	0
Mattair Spring	(drnf113)	-6.7404	-6.7404	-0.000011	0	0

Spring Name	Target Name	Base Period Flow (cfs)	Flow with New Permit (cfs)	Percent Difference	Change (cfs)	Change (gpd)
McCrabb Spring	(drnf80)	-1.9017	-1.9017	0	0	0
Mearson Spring	(drnf130)	-22.6492	-22.6492	-0.000013	0	0
Mill Pond and Grassy Hole Spring	(drnf91)	-13.5463	-13.5463	-0.00008	0	0
Mission Spring	(drnf89)	-37.8097	-37.8097	-0.000145	0	0
Morgan Spring	(drnf70)	-7.7402	-7.7402	0	0	0
Natural Bridge Spring	(drnf100)	-143.2908	-143.2908	0	0	0
Nutall Rise	(drnf63)	-358.716	-358.716	0	0	0
Orange Spring	(drnf2)	-2.1959	-2.1959	-0.000008	0	0
Otter Spring	(drnf78)	-2.2513	-2.2513	-0.000008	0	0
Peacock Spring	(drnf85)	-18.1706	-18.1706	-0.000021	0	0
Perry Spring	(drnf69)	-8.0421	-8.0421	-0.000009	0	0
Pickard Spring	(drnf16)	-8.6193	-8.6193	-0.000175	0	0
Poe Spring	(drnf22)	-35.29	-35.2899	-0.000203	-1E-04	-65
Pot Hole Spring	(drnf84)	-11.4999	-11.4999	-0.000019	0	0
Pot Spring	(drnf23)	-16.4926	-16.4926	0	0	0
Rainbow Springs	(drnf103)	-547.2112	-547.2112	0	0	0
Rock Bluff Spring	(drnf75)	-14.5798	-14.5798	-0.00002	0	0
Rock Sink	(drnf82)	-3.707	-3.707	0	0	0
Royal Spring	(drnf62)	-2.9146	-2.9146	-0.000012	0	0
Rum Island	(drnf13)	-45.7113	-45.7105	-0.001771	-0.0008	-517
Running Spring	(drnf66)	-29.7334	-29.7334	-0.00001	0	0
Ruth	(drnf39)	-5.6731	-5.6731	-0.000019	0	0
Salt Springs	(drnf3)	-76.1284	-76.1284	0	0	0
Santa Fe River Rise	(drnf12)	-46.5791	-46.579	-0.000205	-1E-04	-65
Santa Fe Spring COL61981	(drnf93)	-44.0478	-44.0478	-0.000099	0	0
Sawdust Spring	(drnf50)	-5.214	-5.214	-0.000833	0	0
Shingle Spring	(drnf45)	-4.3308	-4.3308	-0.000025	0	0
Silver Springs	(drnf1)	-504.5387	-504.5387	0	0	0
Spring Warrior Spring	(drnf122)	-14.9866	-14.9866	0	0	0
Steinhatchee River Rise	(drnf96)	-228.2555	-228.2555	0	0	0
Sun Springs	(drnf81)	-3.5038	-3.5038	-0.00001	0	0
Sunbeam and Jamison and COL917971	(drnf73)	-21.5618	-21.5618	-0.000056	0	0
SUW1017971	(drnf107)	-3.3102	-3.3102	0	0	0
SUW1017972	(drnf133)	-11.2268	-11.2268	0	0	0
SUW1019971	(drnf31)	-11.3524	-11.3524	0	0	0
SUW718971 SUW725971 LAF57982	(drnf4)	-9.8663	-9.8663	-0.000015	0	0
SUW923973	(drnf11)	-48.9321	-48.9321	0	0	0
SUW925971	(drnf30)	-21.7927	-21.7927	0	0	0
SUW925972	(drnf28)	-8.3125	-8.3125	0	0	0
SUW925973	(drnf5)	-4.4049	-4.4049	0	0	0
Suwannacoochee	(drnf27)	-19.705	-19.705	0	0	0
Suwannee Spring	(drnf41)	-12.7634	-12.7634	-0.000011	0	0
Suwannee Springs	(drnf7)	-1.367	-1.367	0	0	0
Tanner Spring	(drnf124)	-40.0606	-40.0606	0	0	0

Spring Name	Target Name	Base Period Flow (cfs)	Flow with New Permit (cfs)	Percent Difference	Change (cfs)	Change (gpd)
TAY616991	(drnf123)	-9.7917	-9.7917	0	0	0
TAY616992	(drnf121)	-20.0211	-20.0211	0	0	0
TAY622991	(drnf119)	-7.4997	-7.4997	0	0	0
TAY625993	(drnf111)	-9.892	-9.892	0	0	0
TAY76991	(drnf112)	-2.5997	-2.5997	0	0	0
TAY819991	(drnf118)	-14.8996	-14.8996	0	0	0
Telford Spring	(drnf67)	-28.4505	-28.4505	-0.00001	0	0
Treehouse Spring	(drnf36)	-56.617	-56.6169	-0.000182	-1E-04	-65
Troy	(drnf125)	-90.9976	-90.9975	-0.000031	-0.0001	-65
Turtle Spring	(drnf42)	-5.7327	-5.7327	-0.000019	0	0
Twin Spring	(drnf47)	-14.8097	-14.8096	-0.000503	-1E-04	-65
Upper Suwannee Drain in GA	(drnf137)	-59.9078	-59.9078	-0.000001	0	0
Wacissa Springs	(drnf20)	-282.7047	-282.7047	-0.000001	0	0
Wakulla Springs	(drnf102)	-127.9812	-127.9812	0	0	0
Wekiva Springs	(drnf94)	-47.5118	-47.5118	0	0	0
Wilson Spring	(drnf127)	-14.0621	-14.0621	-0.000103	0	0

Number of Springs Effected by More Than 1 percent:	0
Number of Springs Effected by More Than 10 percent:	0
Total Reduction in Spring Flow (gpd)	23,072
Reduction in Flow at Ginnie, Blue, Dogwood, July, & Devil's	21,521
Unaccounted for Flow (gpd)	528

SRWMD MFL Report for NFM Version 1

- original data received in file named: "Richard_Douglas_2-11-00063.xlsx"

Number of Wells in Permit: 1

Well Name	Easting	Northing	Pumping Ra	Top Layer	Bottom Layer
1	2540559	304809	23600	3	3

Flow Rate Units: Gallons per day
MFL Definition File: C:\NFM1\NFM_v1.02_2sp\work\srwmd_mfl.csv
Modeler: Kevin_Wright
Project: Richard_Douglas
Permit ID: 2-11-00063

MFL Flow Comparisons:

MFL Site Name	USGS Number	River	Number of Cells	Base Period Flow (cfs)	Flow with New Permit (cfs)	Percent Difference	Change (gpd)
Aucilla near Lamont	2326500	Aucilla	213	-44.7244	-44.7244	0	0
Econfina	2326000	Econfina	37	-17.4325	-17.4325	0	0
Fenholloway	2324690	Fenholloway	62	-9.2541	-9.2541	0	0
Steinhatchee	2324000	Steinhatchee	91	-94.6945	-94.6945	0	0
Benton	2315000	Suwannee	638	-100.813	-100.813	-0.000001	0
White Springs	2315500	Suwannee	724	-121.3561	-121.3561	-0.000002	0
Suwannee Springs US129	2315550	Suwannee	751	-160.6412	-160.6412	-0.000005	0
Alapaha near Jennings	2317620	Suwannee	166	-123.5917	-123.5917	0	0
Alapaha near Jasper	2317630	Suwannee	175	272.2327	272.2327	0	0
Pinetta	2319000	Suwannee	273	-183.8433	-183.8433	0.000001	0
Madison	2319300	Suwannee	283	-238.244	-238.244	0	0
Lee	2139394	Suwannee	295	-392.9193	-392.9193	0	0
Ellaville	2319500	Suwannee	1249	-1154.789	-1154.7889	-0.000002	-65
Luraville	2320000	Suwannee	1288	-1297.3135	-1297.3134	-0.000002	-65
Branford	2320500	Suwannee	1319	-1725.841	-1725.8409	-0.000007	-65
Graham	2320700	Suwannee	21	-0.4677	-0.4677	-0.000009	0
Worthington Springs	2321500	Suwannee	208	-6.6214	-6.6214	-0.000014	0
Ft. White	2322500	Suwannee	307	-731.7339	-731.6985	-0.004832	-22,878
Ichetucknee	2322700	Suwannee	5	-198.3347	-198.3344	-0.000132	-194
Hildreth	2322800	Suwannee	330	-1165.119	-1165.0829	-0.003093	-23,330
Bell	2323000	Suwannee	1673	-3082.296	-3082.2598	-0.001174	-23,395
Wilcox	2323500	Suwannee	1698	-3324.7871	-3324.7509	-0.001089	-23,395
Gulf Hammock	2313700	waccasassa	54	-85.0793	-85.0793	-0.000005	0

Number of MFLs Effected by More Than 1 percent:	0
Number of MFLs Effected by More Than 10 percent:	0
Total Reduction in MFL and Spring Flow (cfs):	-0.036213
Total Reduction in MFL and Spring Flow (gpd):	-23,403
Unaccounted for Flow (gpd):	197

Appendix 2
Consumptive use permit granted to the Douglas Farm by the SRWMD in 2012

Permit: **2-11-00063.001**
Permit Type: **Original**
Permit Category: **General**
Project Name: **Richard Douglas Farm**

Suwannee River
Water Management District
9225 CR 49
Live Oak, FL 32060
386.362.1001
800.226.1066
EMAIL: district@srwmd.org
www.mysuwanneeriver.com

Permit Granted To:
JOSHUA MOORE
PO BOX 145
BELL, FL 32619

Permit Issue Date	**11/19/2012**
Expiration Date	**12/31/2016**
Permit Duration (Years)	**4**

Permit Summary

Permitted Allocations			
Average Daily Rate (Million Gallons Per Day)	Maximum Daily Rate (Million Gallons Per Day)	Total Annual Allocation (Million Gallons Per Year)	Freeze Protection (Million Gallons Per Year)
0.0378	1.4400	13.7970	0.0000

Water Use Description

Drip irrigation system from 72 acres.

Withdrawal Point Information

ID	Withdrawal Point Name	Status	Diameter (Inches)	County	Source	Capacity (Gallons per minute)	Water Use (Primary)
7048	Well No.1	Proposed	10	GILCHRIST	Groundwater	1000	Irrigation

Project Description

Project Area Description

The project area consists of approximately 145 acres with approximately 72 acres being irrigated.

Water Use Calculations

The crop rotation will be watermelons planted one out of every four years, also truck crops will be grown on the property one out of every four years.

Project Quantity

7.0 inches of supplemental irrigation annually. Based on a once every four year rotation.

Water Conservation

Josh Moore has provided a water conservation worksheet for the drip irrigation.

Minimum Flows and Levels Compliance

Staff determined through the SRWMD North Florida Model, version 1.0, that the proposed water use would not violate minimum flows and levels (MFLs) at any downstream MFL points established along the Suwannee River or its tributaries. However, a special limiting condition has been included in the permit for the District to seek a modification to the permit to assist in the recovery and/or prevention strategy associated with an adopted MFL.

Permit

This Permit is issued pursuant to Application **2-11-00063.001** dated **12/28/2011** for the Use of Water as specified above and subject to the Conditions as set forth below. Said Application, including all plans and specifications attached thereto, is by reference made a part hereof. If there is any conflict between the Application and the conditions of this Permit, the Permit shall supersede.

Upon written notice to the permittee, this permit may be temporarily modified, or restricted under a Declaration of Water Shortage or a Declaration of Emergency due to Water Shortage in accordance with provisions of Chapter 373, Florida Statutes, (F.S.) and applicable rules and regulations of the Suwannee River Water Management District (District).

In compliance with Florida Statutes, the District is establishing Minimum Flows & Levels (MFLs) for priority water bodies within the District. In some cases, these MFLS may indicate that there is insufficient water available to protect the water resources from significant harm as defined by the District Governing Board. In such cases, it may be necessary for the District to modify existing water use permits in order to provide protection from significant harm to the water resources.

Therefore, upon written notice to the permittee, this permit may be modified in accordance with provisions of Chapter 373, F.S., and applicable rules and regulations of the District.

This Permit may be permanently or temporarily revoked, in whole or in part, for the violation of the conditions of the permit or for the violation of any provision of the Water Resources Act and regulations thereunder.

Standard Conditions

1. This permit shall expire on **12/31/2016**. The permittee must submit the appropriate application form incorporated by reference in subsection 40B-2.041(2), Florida Administrative Code (F.A.C.) and the required fee to the District pursuant to section 40B-2.361, F.A.C., prior to this expiration date in order to continue the use of water.
2. The permittee may apply for a permit modification at any time in accordance with section 40B-2.331, F.A.C.
3. Primary Water Use classification(s): **Irrigation**
4. Source classification(s) : **Groundwater**
5. In the event of a District-declared water shortage, the permittee must immediately comply with any restrictions or requirements ordered in accordance with the District's Water Shortage Plan, chapter 40B-21, F.A.C.
6. The permitted water withdrawal facilities consist of the items in the Withdrawal Point Information table on page 1.
7. Permittee must mitigate interference with existing legal uses caused in whole or in part by the permittee's withdrawals, consistent with a District-approved mitigation plan. As necessary to offset such interference, mitigation may include, but is not limited to, reducing pumpage, replacing the existing legal user's withdrawal equipment, relocating wells, changing withdrawal source, supplying water to existing legal user, or other means needed to mitigate the impacts.
8. Permittee must mitigate harm to existing off-site land uses caused by the permittee's withdrawals. When harm occurs, or is imminent, the permittee must modify withdrawal rates or mitigate the harm.

9. Permittee must mitigate harm to the natural resources caused by the permittee's withdrawals. When harm occurs or is imminent, the permittee must modify withdrawal rates or mitigate the harm.
10 If any condition of the permit is violated, the permittee shall be subject to enforcement action pursuant to chapter 373, F.S.
11. Authorized representatives of the District, upon reasonable notice to the permittee, shall be permitted to enter and inspect the permitted water use to determine compliance with the permit conditions.
12. This permit does not relieve the permittee from complying with any applicable local government, state, or federal law, rule, or ordinance.
13. This permit does not convey to the permittee any property rights or privileges other than those specified herein.
14. Permittee shall notify the District in writing within 90 days of any sale, conveyance, or other transfer of ownership or control of the real property on which the permitted water use activities are located. All water use permit transfers are subject to the requirements of section 40B-2.301, F.A.C.
15. Permittee must notify the District in writing prior to implementing any changes in the water use that may alter the permit allocations. Such changes include, but are not limited to, change in irrigated acreage, crop type, irrigation system, water treatment method, or entry into one or more large water use agreements. In the event a proposed change will alter the allocation, permittee must first obtain a permit modification.
16. All correspondence sent to the District regarding this permit must include the permit number **2-11-00063.001**.
17. When the District provides a permanent identification tag, the tag shall be prominently displayed at the withdrawal site by permanently affixing such tag to the pump, headgate, valve, or other withdrawal facility. If the permit covers several facilities such as a well field, a tag shall be affixed to each facility. Failure to display a tag as prescribed herein shall constitute a violation of the permit. The permittee shall be allowed ten (10) days after the notice of violation of this section to obtain a replacement tag.
18. The District reserves the right to open this permit, following notice to the permittee, to include a permit condition prohibiting withdrawals for resource protection.

Special Limiting Conditions

19. The Permittee shall ensure that the irrigation systems will water target areas only under field operations. Irrigation of non-target areas (roads, woods, structures, etc.) is prohibited.
20. The Permittee shall implement and/or maintain the conservation practices selected on the water conservation worksheet(s) which are associated with this permit. Any new practices selected shall be implemented in one year from the date of permit issuance. Practices that involve scheduling methods or maintenance shall be documented. Documentation for implementation and/or maintenance shall be maintained on all practices and available upon request.
21. It is understood that Permittee, is lessee on this property for the purposes of water withdrawal for the use mentioned in the application. If the lease is modified at any time during the life of this permit, the District shall be notified by Permittee in writing within 30 days of such change.
22. The Permittee shall implement automated monitoring of groundwater withdrawals, at Permittee's expense, upon commencement of withdrawals. The monitoring and reporting shall include reporting daily volume pumped by each well of inside diameter eight inches or greater at land surface and shall be delivered by 12:00 pm local time the following day via approved telemetry consistent with District data formats. The Permittee may opt for a standardized SRWMD automated monitoring system to fulfill this requirement.

SEAL

SUWANNEE RIVER WATER MANAGEMENT

DISTRICT, BY ITS GOVERNING BOARD

By ______________________

EXECUTIVE DIRECTOR

JMD ______________________

DISTRICT RULES CLERK

November 21, 2012

DATE

NOTICE OF RIGHTS

1. A person whose substantial interests are or may be determined has the right to request an administrative hearing by filing a written petition with the Suwannee River Water Management District (District), or may choose to pursue mediation as an alternative remedy under Section 120.569 and 120.573, Florida Statutes, (F.S.) before the deadline for filing a petition. Choosing mediation will not adversely affect the right to a hearing if mediation does not result in a settlement. The procedures for pursuing mediation are set forth in Sections 120.569 and 120.57 F.S. Pursuant to Rule 28-106.111, Florida Administrative Code (F.A.C.), the petition must be filed at the office of the District Clerk at District Headquarters, 9225 C.R. 49, Live Oak, Florida 32060 within twenty-one (21) days of receipt of written notice of the decision or within twenty-one (21) days of newspaper publication of the notice of District decision (for those persons to whom the District does not mail actual notice). A petition must comply with Chapter 28-106, F.A.C.

2. If the Governing Board takes action which substantially differs from the notice of District decision to grant or deny the permit application, a person whose substantial interests are or may be determined has the right to request an administrative hearing or may chose to pursue mediation as an alternative remedy as described above. Pursuant to Rule 28-106.111, F.A.C., the petition must be filed at the office of the District Clerk at District Headquarters, 9225 C.R. 49, Live Oak, Florida 32060 within twenty-one (21) days of receipt of written notice of the decision or within twenty-one (21) days of newspaper publication of the notice of District decision (for those persons to whom the District does not mail actual notice). Such a petition must comply with Chapter 28-106, F.A.C.

3. A substantially interested person has the right to a formal administrative hearing pursuant to Section 120.569 and 120.57(1), F.S., where there is a dispute between the District and the party regarding an issue of material fact. A petition for formal hearing must comply with the requirements set forth in Rule 28-106.201, F.A.C.

4. A substantially interested person has the right to an informal hearing pursuant to Section 120.569 and 120.57(2), F.S. where no material facts are in dispute. A petition for an informal hearing must comply with the requirements set forth in Rule 28-106.301, F.A.C.

5. A petition for an administrative hearing is deemed filed upon receipt of the petition by the Office of the District Clerk at the District Headquarters in Live Oak, Florida.

6. Failure to file a petition for an administrative hearing within the requisite time frame shall constitute a waiver of the right to an administrative hearing pursuant to Rule 28-106.111, F.A.C.

7. The right to an administrative hearing and the relevant procedures to be followed is governed by Chapter 120, F.S., and Chapter 28-106, F.A.C.

8. Pursuant to Section 120.68, F.S., a person who is adversely affected by final District action may seek review of the action in the District Court of Appeal by filing a notice of appeal pursuant to the Florida Rules of Appellate Procedure, within 30 days of the rendering of the final District action.

9. A party to the proceeding before the District who claims that a District order is inconsistent with the provisions and purposes of Chapter 373, F.S., may seek review of the order pursuant to Section 373.114, F.S., by the Florida Land and Water Adjudicatory Commission, by filing a request for review with the Commission and serving a copy of the Department of Environmental Protection and any person named in the order within 20 days of adoption of a rule or the rendering of the District order.

10. For appeals to the District Courts of Appeal, a District action is considered rendered after it is signed on behalf of the District, and is filed by the District Clerk.

11. Failure to observe the relevant time frames for filing a petition for judicial review, or for

Commission review, will result in waiver of the right to review.

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Notice of Rights has been sent by U.S. Mail to:

JOSHUA MOORE
PO BOX 145
BELL, FL 32619

At 4:00 p.m. this 21st day of Nov, 2012

Tim Sagul

Tim Sagul
Deputy Clerk
Suwannee River Water Management District
9225 C.R. 49
Live Oak, Florida 32060
386.362.1001 or 800.226.1066 (Florida Only)

cc: File Number : **2-11-00063.001**

Appendix 3

Compilation of well data compiled from the SRWMD, ACEPD, and CCNA that describe groundwater levels measured in the SRWMD between June 1, 2001 and May 31, 2002 that were used to evaluate the NFM-08 calibration

Measured Heads & Calibration Residuals

- SDII North Florida Model - 2008
- Well Data from Suwannee River Water Management District & Alachua County EPD (June 1, 2001 - May 31, 2002)

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-010729001	4	69.6	72.5	2.9	71.5	71.1	-0.3	0.3
SRWMD	-010734003	1	89.0	89.0	0.0	89.0	74.6	-14.5	14.5
SRWMD	-010832002	2	76.4	79.2	2.8	77.8	79.9	2.0	2.0
SRWMD	-010833001	1	80.1	80.1	0.0	80.1	81.2	1.1	1.1
SRWMD	-010911003	12	62.6	67.9	5.3	65.2	74.1	9.0	9.0
SRWMD	-010920001	1	78.0	78.0	0.0	78.0	79.3	1.2	1.2
SRWMD	-010920002	22	75.9	80.5	4.6	78.7	79.8	1.1	1.1
SRWMD	-011011002	15	40.8	44.1	3.3	42.2	46.0	3.8	3.8
SRWMD	-011035001	12	41.8	45.0	3.2	43.3	44.6	1.3	1.3
SRWMD	-011129001	2	32.9	34.6	1.7	33.7	41.4	7.7	7.7
SRWMD	-011213001	1	34.6	34.6	0.0	34.6	39.1	4.5	4.5
SRWMD	-011219001	1	30.6	30.6	0.0	30.6	36.4	5.7	5.7
SRWMD	-011232006	24	30.9	33.5	2.6	32.4	38.2	5.8	5.8
SRWMD	-011323001	1	37.2	37.2	0.0	37.2	41.6	4.4	4.4
SRWMD	-011420001	2	38.5	38.5	0.0	38.5	43.6	5.0	5.0
SRWMD	-011420006	8	39.7	42.3	2.6	40.9	43.5	2.6	2.6
SRWMD	-011432004	1	23.0	23.0	0.0	23.0	45.0	22.0	22.0
SRWMD	-011511001	12	46.4	49.5	3.1	47.7	47.6	0.0	0.0
SRWMD	-011521001	1	44.2	44.2	0.0	44.2	47.3	3.1	3.1
SRWMD	-011534001	376	46.3	49.1	2.8	47.5	48.1	0.7	0.7
SRWMD	-011535004	4	46.5	47.9	1.4	47.3	48.4	1.1	1.1
SRWMD	-011627001	1	47.2	47.2	0.0	47.2	49.1	2.0	2.0
SRWMD	-011727001	752	46.7	49.9	3.2	47.6	48.8	1.2	1.2
SRWMD	-011728001	1	48.0	48.0	0.0	48.0	49.0	1.0	1.0
SRWMD	-012003001	24	45.2	47.8	2.6	46.4	46.9	0.5	0.5
SRWMD	-012029001	754	45.5	48.3	2.7	46.7	47.3	0.6	0.6
SRWMD	-020332002	1	19.3	19.3	0.0	19.3	18.4	-0.9	0.9
SRWMD	-020404001	12	35.6	43.4	7.8	40.3	36.9	-3.5	3.5
SRWMD	-020404002	11	31.9	35.5	3.6	33.9	36.9	2.9	2.9
SRWMD	-020425002	1	28.3	28.3	0.0	28.3	28.3	0.0	0.0
SRWMD	-020433001	13	24.5	29.0	4.6	26.9	25.7	-1.3	1.3
SRWMD	-020603001	1	69.8	69.8	0.0	69.8	62.9	-6.8	6.8
SRWMD	-020603002	2	72.2	76.2	4.0	74.2	62.9	-11.3	11.3
SRWMD	-020603003	2	72.3	75.9	3.6	74.1	62.9	-11.2	11.2
SRWMD	-020731002	12	58.7	63.6	4.8	61.2	59.7	-1.5	1.5
SRWMD	-020731003	13	61.2	65.5	4.3	63.5	59.7	-3.8	3.8
SRWMD	-020802001	12	80.4	84.9	4.5	83.2	83.2	0.0	0.0
SRWMD	-020802002	12	90.1	100.4	10.3	95.7	83.2	-12.6	12.6
SRWMD	-020828001	376	80.9	85.7	4.8	83.5	81.7	-1.8	1.8
SRWMD	-020828002	367	84.3	89.8	5.6	87.0	81.7	-5.3	5.3
SRWMD	-021104001	1	30.1	30.1	0.0	30.1	41.4	11.4	11.4
SRWMD	-021111001	1	27.8	27.8	0.0	27.8	40.3	12.5	12.5

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-021113001	1	37.9	37.9	0.0	37.9	39.2	1.3	1.3
SRWMD	-021126001	1	35.3	35.3	0.0	35.3	39.4	4.1	4.1
SRWMD	-021127001	1	33.7	33.7	0.0	33.7	39.6	5.9	5.9
SRWMD	-021217001	1	31.1	31.1	0.0	31.1	38.0	6.9	6.9
SRWMD	-021231001	32	30.8	33.0	2.1	32.0	36.3	4.3	4.3
SRWMD	-021312012	1	52.2	52.2	0.0	52.2	42.9	-9.2	9.2
SRWMD	-021322008	8	33.8	35.5	1.7	34.7	39.2	4.5	4.5
SRWMD	-021335001	530	34.7	37.2	2.5	36.2	39.1	2.9	2.9
SRWMD	-021407003	752	39.3	41.8	2.5	40.5	43.7	3.2	3.2
SRWMD	-021504001	1	37.8	37.8	0.0	37.8	47.9	10.2	10.2
SRWMD	-021507001	2	44.4	44.9	0.5	44.7	47.8	3.2	3.2
SRWMD	-021512003	49	46.5	49.7	3.2	47.7	48.7	1.0	1.0
SRWMD	-021512005	50	46.5	49.8	3.2	47.8	48.7	0.9	0.9
SRWMD	-021516001	24	46.3	49.2	2.9	47.3	48.3	1.0	1.0
SRWMD	-021516003	1	46.3	46.3	0.0	46.3	48.4	2.1	2.1
SRWMD	-021533004	1	44.1	44.1	0.0	44.1	48.6	4.5	4.5
SRWMD	-021607006	50	47.8	55.8	8.0	50.1	48.8	-1.4	1.4
SRWMD	-021624001	24	48.2	50.5	2.3	48.8	49.6	0.8	0.8
SRWMD	-021711003	754	47.9	51.5	3.6	48.7	48.8	0.1	0.1
SRWMD	-021805001	24	46.4	49.0	2.6	47.4	48.5	1.0	1.0
SRWMD	-021902001	24	46.5	49.1	2.6	47.7	47.7	0.0	0.0
SRWMD	-021930001	24	48.9	51.5	2.5	49.7	48.3	-1.5	1.5
SRWMD	-021934001	24	47.6	50.0	2.5	48.6	47.9	-0.7	0.7
SRWMD	-030328001	1	7.0	7.0	0.0	7.0	11.3	4.3	4.3
SRWMD	-030419001	1	10.6	10.6	0.0	10.6	15.1	4.6	4.6
SRWMD	-030424001	1	11.6	11.6	0.0	11.6	17.3	5.7	5.7
SRWMD	-030629002	1	33.1	33.1	0.0	33.1	21.5	-11.6	11.6
SRWMD	-030730001	303	36.0	41.6	5.6	38.5	40.7	2.2	2.2
SRWMD	-030833001	12	82.0	85.6	3.6	84.2	84.3	0.1	0.1
SRWMD	-030833002	12	84.7	89.2	4.5	86.7	84.3	-2.4	2.4
SRWMD	-031012001	12	54.8	59.2	4.4	57.6	50.3	-7.4	7.4
SRWMD	-031035001	4	44.7	45.8	1.1	45.1	37.8	-7.3	7.3
SRWMD	-031103002	1	31.2	31.2	0.0	31.2	37.1	5.9	5.9
SRWMD	-031105006	752	22.0	27.1	5.1	23.9	40.0	16.1	16.1
SRWMD	-031107004	2	14.5	15.0	0.5	14.8	42.3	27.5	27.5
SRWMD	-031108001	1	22.7	22.7	0.0	22.7	39.9	17.2	17.2
SRWMD	-031130004	2	36.7	38.4	1.7	37.5	37.7	0.2	0.2
SRWMD	-031134001	1	22.6	22.6	0.0	22.6	31.6	9.1	9.1
SRWMD	-031135002	1	19.5	19.5	0.0	19.5	31.4	11.9	11.9
SRWMD	-031207001	1	29.6	29.6	0.0	29.6	34.2	4.6	4.6
SRWMD	-031219001	1	25.9	25.9	0.0	25.9	31.9	6.0	6.0
SRWMD	-031232001	24	24.4	27.7	3.4	25.6	29.8	4.2	4.2
SRWMD	-031232002	8	25.9	27.9	2.0	26.8	29.7	3.0	3.0
SRWMD	-031305005	4	32.2	34.1	1.9	33.3	33.7	0.4	0.4
SRWMD	-031307004	1	26.9	26.9	0.0	26.9	32.1	5.2	5.2

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-031326001	1	28.6	28.6	0.0	28.6	30.0	1.4	1.4
SRWMD	-031335002	12	28.8	31.4	2.6	30.0	29.8	-0.2	0.2
SRWMD	-031336010	1	29.5	29.5	0.0	29.5	29.9	0.4	0.4
SRWMD	-031403007	3	49.9	50.6	0.7	50.4	46.1	-4.2	4.2
SRWMD	-031413001	4	46.7	49.3	2.6	48.4	47.8	-0.6	0.6
SRWMD	-031426002	4	41.9	43.0	1.1	42.6	41.1	-1.5	1.5
SRWMD	-031521002	3	48.5	49.6	1.1	49.1	48.3	-0.8	0.8
SRWMD	-031522007	4	47.7	49.0	1.3	48.4	48.1	-0.2	0.2
SRWMD	-031524001	3	45.1	45.5	0.4	45.3	48.0	2.7	2.7
SRWMD	-031529005	4	44.6	45.8	1.2	45.4	47.7	2.3	2.3
SRWMD	-031530002	4	42.6	43.2	0.6	42.9	47.9	4.9	4.9
SRWMD	-031601003	24	48.2	51.8	3.6	49.0	50.5	1.4	1.4
SRWMD	-031628004	4	41.2	41.5	0.3	41.3	43.6	2.3	2.3
SRWMD	-031632005	3	30.5	32.2	1.7	31.6	38.4	6.9	6.9
SRWMD	-031633008	3	35.5	36.4	0.9	36.1	40.2	4.2	4.2
SRWMD	-031734011	32	47.4	49.6	2.2	47.9	49.3	1.4	1.4
SRWMD	-031807001	8	49.7	50.7	0.9	50.2	51.1	0.9	0.9
SRWMD	-031908001	520	51.9	54.0	2.1	52.4	49.5	-2.9	2.9
SRWMD	-031923004	32	48.5	50.8	2.4	49.4	51.1	1.6	1.6
SRWMD	-032012001	24	47.5	50.0	2.5	48.7	47.8	-0.9	0.9
SRWMD	-040407001	12	0.5	4.8	4.3	1.6	5.9	4.3	4.3
SRWMD	-040518001	1	9.0	9.0	0.0	9.0	7.8	-1.2	1.2
SRWMD	-040633001	1	17.7	17.7	0.0	17.7	9.8	-7.8	7.8
SRWMD	-040636001	1	22.3	22.3	0.0	22.3	19.4	-2.9	2.9
SRWMD	-040723011	4	29.2	31.9	2.7	30.5	33.0	2.4	2.4
SRWMD	-040736005	11	30.8	33.0	2.2	32.0	33.6	1.7	1.7
SRWMD	-040736006	12	30.8	33.6	2.8	32.1	33.6	1.5	1.5
SRWMD	-040807001	1	39.3	39.3	0.0	39.3	54.2	14.9	14.9
SRWMD	-041014001	12	35.4	37.3	1.9	36.2	38.3	2.1	2.1
SRWMD	-041111001	1	18.7	18.7	0.0	18.7	29.7	11.0	11.0
SRWMD	-041112005	264	22.0	26.4	4.4	24.8	29.4	4.6	4.6
SRWMD	-041123001	1	20.6	20.6	0.0	20.6	28.6	8.0	8.0
SRWMD	-041131002	1	28.9	28.9	0.0	28.9	36.4	7.5	7.5
SRWMD	-041133001	1	15.2	15.2	0.0	15.2	32.0	16.8	16.8
SRWMD	-041223004	24	20.9	23.9	3.0	21.9	28.2	6.4	6.4
SRWMD	-041227001	4	19.6	21.5	1.9	20.3	27.8	7.5	7.5
SRWMD	-041231002	4	18.0	21.0	3.0	19.6	27.7	8.1	8.1
SRWMD	-041324005	1	24.0	24.0	0.0	24.0	28.1	4.1	4.1
SRWMD	-041329001	672	18.6	22.9	4.3	20.2	28.0	7.8	7.8
SRWMD	-041402002	30	27.3	31.8	4.5	30.0	34.9	4.9	4.9
SRWMD	-041426001	8	26.2	27.3	1.1	26.8	26.8	0.0	0.0
SRWMD	-041505002	3	30.6	34.2	3.6	32.8	37.0	4.2	4.2
SRWMD	-041508001	4	28.5	29.7	1.2	29.2	34.8	5.6	5.6
SRWMD	-041523001	8	28.1	29.0	0.9	28.5	28.0	-0.6	0.6
SRWMD	-041608002	14	28.4	30.4	2.0	29.2	31.5	2.3	2.3

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-041614004	3	30.4	31.3	0.8	30.9	33.4	2.5	2.5
SRWMD	-041625001	744	30.6	32.8	2.2	31.2	32.9	1.6	1.6
SRWMD	-041627017	4	28.1	29.0	0.9	28.6	30.4	1.8	1.8
SRWMD	-041704004	3	45.6	60.1	14.5	51.3	41.4	-9.9	9.9
SRWMD	-041705001	550	41.8	43.0	1.3	42.4	41.7	-0.7	0.7
SRWMD	-041734002	34	30.2	31.4	1.2	30.7	36.8	6.1	6.1
SRWMD	-041827002	754	45.6	47.1	1.5	46.2	44.7	-1.5	1.5
SRWMD	-041831001	4	38.2	38.9	0.8	38.4	40.1	1.6	1.6
SRWMD	-041923001	752	49.8	52.1	2.3	51.0	52.0	1.0	1.0
SRWMD	-042132001	4	51.2	52.0	0.8	51.6	49.3	-2.3	2.3
SRWMD	-042236001	24	50.7	54.8	4.1	52.6	49.3	-3.3	3.3
SRWMD	-050511001	1	5.5	5.5	0.0	5.5	5.7	0.2	0.2
SRWMD	-050529001	1	2.7	2.7	0.0	2.7	1.1	-1.6	1.6
SRWMD	-050615001	1	7.7	7.7	0.0	7.7	9.1	1.4	1.4
SRWMD	-050615002	12	7.4	11.7	4.3	9.1	9.4	0.3	0.3
SRWMD	-050701001	12	30.0	32.9	2.9	31.3	32.0	0.8	0.8
SRWMD	-050809002	1	38.7	38.7	0.0	38.7	37.4	-1.2	1.2
SRWMD	-050810001	12	15.3	23.5	8.2	17.7	40.7	23.0	23.0
SRWMD	-050928003	11	64.2	70.8	6.6	68.3	59.2	-9.2	9.2
SRWMD	-050928004	11	64.2	70.4	6.3	67.9	59.2	-8.7	8.7
SRWMD	-051002001	1	69.1	69.1	0.0	69.1	55.4	-13.7	13.7
SRWMD	-051004001	12	79.5	83.3	3.8	81.7	83.4	1.6	1.6
SRWMD	-051004002	10	80.6	85.2	4.6	82.4	83.4	1.0	1.0
SRWMD	-051123001	1	65.7	65.7	0.0	65.7	50.7	-14.9	14.9
SRWMD	-051208001	365	24.6	29.4	4.9	26.4	28.0	1.6	1.6
SRWMD	-051209001	4	25.5	27.8	2.2	26.4	28.0	1.6	1.6
SRWMD	-051214008	13	20.9	24.9	4.0	21.9	27.7	5.8	5.8
SRWMD	-051218002	12	43.9	46.2	2.3	45.0	30.9	-14.2	14.2
SRWMD	-051230001	1	68.6	68.6	0.0	68.6	61.9	-6.8	6.8
SRWMD	-051311001	24	13.9	17.0	3.1	15.1	26.7	11.6	11.6
SRWMD	-051331002	13	34.3	41.8	7.6	38.8	36.3	-2.5	2.5
SRWMD	-051331003	316	35.2	42.1	6.9	39.9	36.3	-3.6	3.6
SRWMD	-051405002	14	18.1	20.5	2.4	19.3	26.5	7.2	7.2
SRWMD	-051426002	3	19.7	21.7	2.0	20.7	25.5	4.8	4.8
SRWMD	-051428004	612	15.2	18.6	3.4	16.7	25.4	8.6	8.6
SRWMD	-051429001	1	15.3	15.3	0.0	15.3	25.4	10.2	10.2
SRWMD	-051511002	7	26.5	28.8	2.3	27.4	26.5	-0.9	0.9
SRWMD	-051521001	8	26.6	27.4	0.9	27.0	26.0	-1.0	1.0
SRWMD	-051536004	4	25.1	25.8	0.7	25.4	25.7	0.3	0.3
SRWMD	-051536011	1	23.2	23.2	0.0	23.2	25.8	2.6	2.6
SRWMD	-051601006	4	28.4	29.1	0.7	28.8	32.6	3.9	3.9
SRWMD	-051610001	3	26.4	27.1	0.7	26.7	29.7	3.0	3.0
SRWMD	-051610006	7	26.4	28.0	1.7	27.0	29.3	2.3	2.3
SRWMD	-051621002	6	26.6	27.1	0.5	26.8	27.5	0.6	0.6
SRWMD	-051624001	4	26.3	27.0	0.7	26.7	30.5	3.8	3.8

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-051630002	6	25.0	25.9	0.9	25.3	26.1	0.7	0.7
SRWMD	-051631004	1	18.1	18.1	0.0	18.1	25.6	7.4	7.4
SRWMD	-051734001	3	30.0	33.1	3.1	31.2	36.1	4.9	4.9
SRWMD	-051810004	4	38.5	38.7	0.2	38.6	43.3	4.7	4.7
SRWMD	-051819001	28	37.5	38.0	0.5	37.7	39.1	1.4	1.4
SRWMD	-051832002	1	42.4	42.4	0.0	42.4	40.4	-2.0	2.0
SRWMD	-051922001	10	50.7	52.4	1.7	51.5	50.4	-1.2	1.2
SRWMD	-051933001	110	49.6	51.3	1.7	50.1	50.3	0.2	0.2
SRWMD	-060608001	1	0.5	0.5	0.0	0.5	1.3	0.8	0.8
SRWMD	-060801001	2	42.6	44.3	1.6	43.4	38.3	-5.2	5.2
SRWMD	-061005001	361	64.4	70.0	5.6	66.7	64.3	-2.4	2.4
SRWMD	-061005002	291	63.8	69.1	5.4	66.5	64.3	-2.2	2.2
SRWMD	-061025003	14	44.1	50.3	6.3	48.0	52.2	4.1	4.1
SRWMD	-061025004	12	44.9	50.4	5.6	48.0	52.2	4.2	4.2
SRWMD	-061114001	12	59.9	67.1	7.2	63.2	57.7	-5.6	5.6
SRWMD	-061301007	710	9.8	15.6	5.8	11.1	23.2	12.1	12.1
SRWMD	-061313006	4	22.1	23.6	1.6	22.8	24.0	1.2	1.2
SRWMD	-061401003	30	22.8	24.9	2.1	23.9	25.2	1.3	1.3
SRWMD	-061410001	4	12.5	14.4	1.9	13.1	24.7	11.6	11.6
SRWMD	-061434006	4	9.7	11.8	2.2	10.9	23.9	13.0	13.0
SRWMD	-061501001	1	24.4	24.4	0.0	24.4	25.3	0.9	0.9
SRWMD	-061501007	1	23.4	23.4	0.0	23.4	24.9	1.5	1.5
SRWMD	-061502002	2	21.8	21.9	0.1	21.8	25.1	3.3	3.3
SRWMD	-061502005	1	23.5	23.5	0.0	23.5	25.3	1.8	1.8
SRWMD	-061509003	3	18.1	20.1	2.1	19.1	25.1	6.0	6.0
SRWMD	-061511007	1	20.2	20.2	0.0	20.2	25.0	4.7	4.7
SRWMD	-061512001	4	22.9	23.1	0.2	23.0	24.8	1.8	1.8
SRWMD	-061512006	5	22.5	22.6	0.1	22.6	24.7	2.1	2.1
SRWMD	-061512008	3	20.3	20.4	0.2	20.4	24.8	4.5	4.5
SRWMD	-061512009	3	21.5	21.8	0.3	21.7	24.7	3.0	3.0
SRWMD	-061512010	8	22.7	22.9	0.2	22.8	24.9	2.1	2.1
SRWMD	-061512011	3	18.7	18.8	0.1	18.8	24.9	6.1	6.1
SRWMD	-061514002	3	14.8	15.2	0.4	15.0	24.9	9.9	9.9
SRWMD	-061514003	3	19.6	19.8	0.2	19.7	24.9	5.2	5.2
SRWMD	-061515001	2	13.4	13.8	0.4	13.6	24.9	11.3	11.3
SRWMD	-061519004	4	15.2	17.4	2.2	16.4	24.7	8.3	8.3
SRWMD	-061521005	7	8.8	12.5	3.7	10.3	24.7	14.5	14.5
SRWMD	-061523002	5	14.1	14.5	0.4	14.3	24.8	10.5	10.5
SRWMD	-061524003	5	17.4	17.7	0.3	17.5	24.9	7.4	7.4
SRWMD	-061524013	5	17.2	17.5	0.3	17.4	24.9	7.5	7.5
SRWMD	-061605001	1	23.7	23.7	0.0	23.7	25.6	1.9	1.9
SRWMD	-061607001	7	22.8	23.0	0.2	22.9	24.9	2.0	2.0
SRWMD	-061607010	5	22.5	22.9	0.3	22.7	25.0	2.3	2.3
SRWMD	-061607011	1	24.0	24.0	0.0	24.0	25.1	1.1	1.1
SRWMD	-061607012	6	23.0	23.1	0.1	23.1	24.9	1.9	1.9

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-061607013	1	22.8	22.8	0.0	22.8	24.9	2.1	2.1
SRWMD	-061607014	2	22.7	22.8	0.1	22.8	24.9	2.2	2.2
SRWMD	-061607015	3	22.7	23.1	0.4	23.0	25.0	2.0	2.0
SRWMD	-061607016	8	22.9	23.9	0.9	23.2	24.9	1.7	1.7
SRWMD	-061610001	12	24.3	25.0	0.7	24.6	26.0	1.3	1.3
SRWMD	-061617006	1	23.4	23.4	0.0	23.4	25.3	1.9	1.9
SRWMD	-061618003	8	22.1	22.3	0.2	22.2	25.0	2.8	2.8
SRWMD	-061618004	3	21.4	21.8	0.5	21.7	24.9	3.3	3.3
SRWMD	-061618005	3	19.5	20.2	0.7	19.9	24.9	5.0	5.0
SRWMD	-061624001	2	28.1	29.0	0.9	28.6	26.8	-1.8	1.8
SRWMD	-061628007	4	24.1	24.7	0.6	24.4	25.5	1.1	1.1
SRWMD	-061629001	26	18.7	19.8	1.1	19.1	25.3	6.1	6.1
SRWMD	-061633028	4	22.6	23.4	0.7	23.0	25.4	2.4	2.4
SRWMD	-061634003	5	28.7	31.0	2.3	29.9	25.5	-4.4	4.4
SRWMD	-061708002	4	30.5	32.3	1.8	31.2	31.8	0.6	0.6
SRWMD	-061719008	3	28.6	29.1	0.6	28.9	27.4	-1.5	1.5
SRWMD	-061722002	4	31.8	33.2	1.4	32.4	37.1	4.7	4.7
SRWMD	-061734001	26	31.1	32.8	1.7	31.8	36.9	5.1	5.1
SRWMD	-061920001	2	46.3	47.9	1.6	47.1	47.7	0.6	0.6
SRWMD	-061932026	22	44.7	47.7	3.0	46.9	46.6	-0.3	0.3
SRWMD	-062102001	754	53.0	55.2	2.3	54.3	50.1	-4.2	4.2
SRWMD	-062135004	1	57.8	57.8	0.0	57.8	51.0	-6.8	6.8
SRWMD	-062210002	1	71.0	71.0	0.0	71.0	56.6	-14.4	14.4
SRWMD	-071234001	4	60.0	61.6	1.5	60.8	61.8	1.0	1.0
SRWMD	-071417001	12	10.0	11.9	1.9	11.0	23.3	12.3	12.3
SRWMD	-071419005	1	17.4	17.4	0.0	17.4	23.2	5.8	5.8
SRWMD	-071515001	2	65.3	65.3	0.0	65.3	36.8	-28.5	28.5
SRWMD	-071526002	2	64.5	64.5	0.0	64.5	41.5	-23.1	23.1
SRWMD	-071528001	24	63.9	67.0	3.1	65.0	44.4	-20.6	20.6
SRWMD	-071528002	24	64.2	67.3	3.1	65.2	44.4	-20.8	20.8
SRWMD	-071531009	2	10.2	11.6	1.4	10.9	23.1	12.2	12.2
SRWMD	-071630002	6	21.9	23.2	1.3	22.7	25.0	2.3	2.3
SRWMD	-071710008	5	31.1	33.0	1.9	32.0	36.7	4.6	4.6
SRWMD	-071723003	4	30.8	31.8	1.0	31.3	36.5	5.2	5.2
SRWMD	-071724007	4	31.2	32.1	0.9	31.7	37.0	5.2	5.2
SRWMD	-071923003	4	40.5	42.3	1.9	41.4	41.4	0.0	0.0
SRWMD	-071927008	4	39.2	40.0	0.8	39.6	40.5	1.0	1.0
SRWMD	-071929003	1	41.3	41.3	0.0	41.3	39.6	-1.7	1.7
SRWMD	-072002001	20	53.1	55.0	1.9	54.3	49.9	-4.5	4.5
SRWMD	-072111001	1	56.1	56.1	0.0	56.1	54.1	-2.0	2.0
SRWMD	-072132001	732	56.6	58.7	2.1	57.9	57.8	-0.1	0.1
SRWMD	-072205001	8	56.6	57.8	1.2	57.3	62.4	5.1	5.1
SRWMD	-072215001	752	76.8	78.7	1.9	78.0	70.8	-7.2	7.2
SRWMD	-080701001	1	2.2	2.2	0.0	2.2	5.4	3.2	3.2
SRWMD	-080907002	1	28.6	28.6	0.0	28.6	30.5	1.8	1.8

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-080907003	12	25.4	28.3	2.8	27.0	30.1	3.1	3.1
SRWMD	-081016006	1	12.0	12.0	0.0	12.0	33.1	21.1	21.1
SRWMD	-081104001	1	39.5	39.5	0.0	39.5	43.3	3.8	3.8
SRWMD	-081132001	300	34.6	39.4	4.8	37.0	36.2	-0.8	0.8
SRWMD	-081313005	367	17.0	19.5	2.4	18.1	19.2	1.1	1.1
SRWMD	-081412001	8	8.6	10.0	1.5	9.5	22.6	13.1	13.1
SRWMD	-081416001	2	5.6	5.6	0.0	5.6	20.3	14.7	14.7
SRWMD	-081425001	4	11.2	12.1	0.8	11.7	18.1	6.5	6.5
SRWMD	-081434001	4	10.4	12.2	1.8	11.1	11.8	0.7	0.7
SRWMD	-081513001	2	59.3	59.3	0.0	59.3	59.4	0.2	0.2
SRWMD	-081518005	22	16.3	18.5	2.2	17.4	22.5	5.1	5.1
SRWMD	-081535002	6	75.3	76.8	1.5	76.1	67.8	-8.3	8.3
SRWMD	-081536002	2	69.8	69.8	0.0	69.8	68.9	-0.9	0.9
SRWMD	-081618001	2	32.6	32.6	0.0	32.6	36.7	4.1	4.1
SRWMD	-081624004	8	28.2	29.1	0.9	28.5	35.3	6.8	6.8
SRWMD	-081703001	752	30.5	32.2	1.7	31.2	36.0	4.8	4.8
SRWMD	-081724001	1	32.8	32.8	0.0	32.8	37.1	4.3	4.3
SRWMD	-081833003	4	34.3	36.2	1.9	35.1	37.6	2.6	2.6
SRWMD	-081911001	1	39.1	39.1	0.0	39.1	40.4	1.3	1.3
SRWMD	-081912004	4	39.2	40.0	0.8	39.6	40.6	1.0	1.0
SRWMD	-081926001	750	37.0	39.1	2.1	38.1	40.1	2.1	2.1
SRWMD	-082003001	1	55.4	55.4	0.0	55.4	43.2	-12.2	12.2
SRWMD	-082202001	758	71.2	74.0	2.8	73.0	73.0	0.1	0.1
SRWMD	-082221001	2	72.0	73.2	1.2	72.6	74.3	1.7	1.7
SRWMD	-090914003	12	15.1	17.4	2.3	16.3	14.1	-2.2	2.2
SRWMD	-090925014	2	3.3	3.4	0.1	3.4	6.9	3.5	3.5
SRWMD	-090926001	1	-0.9	-0.9	0.0	-0.9	4.4	5.3	5.3
SRWMD	-091011004	4	24.9	29.1	4.2	27.4	30.7	3.4	3.4
SRWMD	-091212003	13	42.9	47.4	4.5	45.2	47.1	1.9	1.9
SRWMD	-091231001	2	33.1	34.3	1.1	33.7	35.7	2.0	2.0
SRWMD	-091231003	4	36.7	40.0	3.3	38.0	35.7	-2.3	2.3
SRWMD	-091323001	5	11.7	13.3	1.6	12.2	15.6	3.4	3.4
SRWMD	-091329003	4	26.2	28.9	2.7	28.0	25.1	-2.9	2.9
SRWMD	-091415002	1	5.5	5.5	0.0	5.5	8.2	2.8	2.8
SRWMD	-091420001	24	3.7	5.3	1.6	4.4	7.6	3.2	3.2
SRWMD	-091436008	2	4.2	4.9	0.7	4.6	7.8	3.3	3.3
SRWMD	-091504001	24	78.0	82.4	4.3	79.9	46.2	-33.7	33.7
SRWMD	-091504002	24	78.9	82.8	3.9	80.3	46.2	-34.1	34.1
SRWMD	-091506002	2	9.4	9.9	0.6	9.7	11.3	1.6	1.6
SRWMD	-091520001	2	12.0	12.9	0.9	12.4	12.7	0.3	0.3
SRWMD	-091530005	10	4.8	6.5	1.7	5.6	8.4	2.8	2.8
SRWMD	-091602005	1	31.4	31.4	0.0	31.4	36.1	4.7	4.7
SRWMD	-091607001	688	39.9	43.7	3.8	41.7	64.3	22.6	22.6
SRWMD	-091617012	2	47.0	47.6	0.6	47.3	63.4	16.1	16.1
SRWMD	-091628005	8	68.7	73.3	4.5	70.8	65.2	-5.6	5.6

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-091704001	1	31.0	31.0	0.0	31.0	36.7	5.8	5.8
SRWMD	-091733001	2	18.4	36.2	17.8	27.3	37.3	10.0	10.0
SRWMD	-091736001	4	34.8	36.6	1.8	35.7	37.6	1.8	1.8
SRWMD	-091822001	1	29.5	29.5	0.0	29.5	38.6	9.1	9.1
SRWMD	-091938002	668	47.8	68.3	20.5	56.7	39.4	-17.4	17.4
SRWMD	-092307001	377	77.4	80.4	3.0	79.3	74.4	-4.9	4.9
SRWMD	-101210001	375	30.3	35.0	4.7	32.7	28.4	-4.3	4.3
SRWMD	-101303003	5	8.3	12.4	4.1	10.1	15.8	5.7	5.7
SRWMD	-101313010	2	5.6	5.9	0.3	5.8	6.7	0.9	0.9
SRWMD	-101320006	2	17.5	17.8	0.2	17.6	21.2	3.6	3.6
SRWMD	-101324025	1	6.4	6.4	0.0	6.4	6.6	0.2	0.2
SRWMD	-101334002	2	13.4	13.5	0.0	13.5	11.9	-1.5	1.5
SRWMD	-101336025	6	5.2	7.4	2.3	6.1	6.3	0.3	0.3
SRWMD	-101401002	2	4.3	4.8	0.5	4.5	7.9	3.4	3.4
SRWMD	-101406004	2	1.9	3.9	2.0	2.9	7.0	4.2	4.2
SRWMD	-101408003	2	2.9	3.7	0.8	3.3	6.9	3.6	3.6
SRWMD	-101410005	2	3.6	4.3	0.7	4.0	7.6	3.6	3.6
SRWMD	-101413010	2	4.8	5.3	0.6	5.1	8.0	2.9	2.9
SRWMD	-101414001	2	3.8	4.5	0.7	4.1	7.5	3.4	3.4
SRWMD	-101416006	2	3.3	4.0	0.7	3.6	7.3	3.6	3.6
SRWMD	-101420026	1	3.6	3.6	0.0	3.6	6.3	2.8	2.8
SRWMD	-101421003	2	3.2	4.3	1.1	3.7	6.8	3.0	3.0
SRWMD	-101425008	2	3.4	4.1	0.7	3.7	8.1	4.4	4.4
SRWMD	-101426007	3	3.9	4.4	0.5	4.1	7.5	3.4	3.4
SRWMD	-101427005	3	3.1	3.5	0.4	3.3	7.1	3.8	3.8
SRWMD	-101428001	28	2.7	4.2	1.5	3.3	6.7	3.4	3.4
SRWMD	-101429011	28	1.4	3.5	2.1	2.3	6.1	3.8	3.8
SRWMD	-101429016	756	1.6	4.0	2.3	2.9	6.3	3.4	3.4
SRWMD	-101429020	4	2.3	3.0	0.7	2.7	6.5	3.8	3.8
SRWMD	-101429021	2	2.0	3.0	0.9	2.5	6.5	4.0	4.0
SRWMD	-101429022	2	2.2	3.2	1.1	2.7	6.4	3.7	3.7
SRWMD	-101429023	4	2.0	2.9	1.0	2.5	6.4	4.0	4.0
SRWMD	-101429024	2	2.5	3.0	0.6	2.8	6.5	3.7	3.7
SRWMD	-101429025	4	2.1	3.1	1.0	2.6	6.3	3.6	3.6
SRWMD	-101430002	2	0.5	1.7	1.3	1.1	6.1	5.0	5.0
SRWMD	-101430024	2	1.4	2.9	1.5	2.2	6.1	3.9	3.9
SRWMD	-101432001	3	3.1	3.9	0.8	3.6	6.3	2.7	2.7
SRWMD	-101433012	2	2.8	3.3	0.6	3.1	6.9	3.8	3.8
SRWMD	-101435007	3	5.4	5.8	0.4	5.6	8.0	2.3	2.3
SRWMD	-101435008	3	5.0	5.9	0.9	5.4	7.6	2.1	2.1
SRWMD	-101506003	668	3.8	5.9	2.1	4.9	8.2	3.3	3.3
SRWMD	-101508002	2	6.0	6.9	0.9	6.4	8.5	2.1	2.1
SRWMD	-101515004	2	17.6	18.7	1.1	18.1	10.4	-7.8	7.8
SRWMD	-101516017	734	5.8	7.9	2.1	6.8	8.9	2.1	2.1
SRWMD	-101520004	2	7.1	7.4	0.3	7.2	9.0	1.8	1.8

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-101522006	2	7.7	7.9	0.3	7.8	9.6	1.8	1.8
SRWMD	-101524001	1	41.9	41.9	0.0	41.9	37.9	-4.0	4.0
SRWMD	-101527001	4	13.0	14.6	1.5	13.9	11.1	-2.8	2.8
SRWMD	-101528013	2	6.0	6.4	0.4	6.2	9.6	3.4	3.4
SRWMD	-101535004	3	20.1	22.1	2.0	21.1	12.5	-8.6	8.6
SRWMD	-101601002	26	35.1	36.8	1.7	36.1	38.4	2.3	2.3
SRWMD	-101634001	24	57.4	60.2	2.8	59.0	57.4	-1.6	1.6
SRWMD	-101634002	24	58.3	61.5	3.3	60.0	57.4	-2.7	2.7
SRWMD	-101713003	4	34.4	36.0	1.6	35.4	38.3	2.9	2.9
SRWMD	-101719001	4	37.1	45.1	8.0	40.1	40.4	0.3	0.3
SRWMD	-101722001	560	35.2	37.1	1.9	36.4	38.3	1.9	1.9
SRWMD	-101812013	10	36.2	37.2	1.0	36.8	41.4	4.7	4.7
SRWMD	-101816001	1	38.4	38.4	0.0	38.4	40.1	1.7	1.7
SRWMD	-101929001	1	38.2	38.2	0.0	38.2	44.9	6.7	6.7
SRWMD	-102006001	722	38.4	41.9	3.5	40.0	41.6	1.6	1.6
SRWMD	-111117007	12	11.7	15.0	3.3	12.9	10.0	-2.9	2.9
SRWMD	-111202001	4	19.4	23.0	3.6	20.8	23.3	2.6	2.6
SRWMD	-111232001	1	3.7	3.7	0.0	3.7	7.0	3.3	3.3
SRWMD	-111311020	3	5.2	6.4	1.2	6.0	6.0	0.0	0.0
SRWMD	-111314013	2	0.8	2.1	1.3	1.5	5.9	4.4	4.4
SRWMD	-111317001	3	19.3	20.8	1.4	20.2	21.4	1.2	1.2
SRWMD	-111324026	4	3.7	6.7	3.1	5.2	5.9	0.7	0.7
SRWMD	-111324027	2	3.9	5.7	1.9	4.8	6.0	1.2	1.2
SRWMD	-111324028	4	4.0	5.2	1.2	4.6	6.1	1.5	1.5
SRWMD	-111324029	3	5.5	5.8	0.4	5.6	5.9	0.3	0.3
SRWMD	-111324030	1	3.0	3.0	0.0	3.0	6.1	3.1	3.1
SRWMD	-111324033	1	1.9	1.9	0.0	1.9	5.9	4.0	4.0
SRWMD	-111325001	2	3.8	3.8	0.0	3.8	5.7	1.9	1.9
SRWMD	-111325008	1	2.5	2.5	0.0	2.5	5.7	3.2	3.2
SRWMD	-111325016	2	2.6	3.3	0.7	3.0	5.7	2.7	2.7
SRWMD	-111325017	6	2.1	3.9	1.8	2.9	5.7	2.8	2.8
SRWMD	-111325018	3	2.5	3.6	1.1	2.9	5.7	2.8	2.8
SRWMD	-111326004	752	0.5	3.2	2.7	1.9	5.2	3.3	3.3
SRWMD	-111326008	2	1.3	1.5	0.1	1.4	5.3	3.9	3.9
SRWMD	-111327001	2	10.8	11.1	0.3	10.9	6.7	-4.2	4.2
SRWMD	-111327003	3	10.6	12.4	1.8	11.8	6.6	-5.1	5.1
SRWMD	-111330001	1	21.0	21.0	0.0	21.0	21.1	0.1	0.1
SRWMD	-111335005	6	1.1	3.2	2.0	1.8	5.5	3.7	3.7
SRWMD	-111336002	3	2.0	2.2	0.2	2.0	5.9	3.9	3.9
SRWMD	-111336003	3	1.7	3.1	1.4	2.2	5.7	3.5	3.5
SRWMD	-111403008	2	5.1	5.3	0.2	5.2	7.4	2.2	2.2
SRWMD	-111405001	3	3.5	4.0	0.5	3.6	6.5	2.9	2.9
SRWMD	-111408002	2	4.8	5.1	0.3	4.9	6.6	1.7	1.7
SRWMD	-111410024	2	3.2	5.4	2.3	4.3	7.5	3.2	3.2
SRWMD	-111413007	2	5.8	7.6	1.8	6.7	9.3	2.6	2.6

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-111414008	2	5.7	6.6	0.9	6.1	8.1	2.0	2.0
SRWMD	-111415002	2	5.6	6.0	0.4	5.8	7.3	1.5	1.5
SRWMD	-111417003	2	4.9	5.5	0.6	5.2	6.7	1.5	1.5
SRWMD	-111421001	2	5.1	5.9	0.8	5.5	7.1	1.7	1.7
SRWMD	-111423013	3	5.8	9.2	3.4	7.4	8.6	1.2	1.2
SRWMD	-111425001	4	7.3	9.6	2.3	8.5	9.6	1.1	1.1
SRWMD	-111425012	3	7.5	9.8	2.3	8.5	8.9	0.4	0.4
SRWMD	-111426010	3	7.4	9.4	2.0	8.4	8.7	0.4	0.4
SRWMD	-111428007	2	5.4	6.1	0.7	5.7	7.3	1.5	1.5
SRWMD	-111429005	2	3.8	4.8	1.0	4.3	6.8	2.5	2.5
SRWMD	-111429006	3	2.9	3.9	0.9	3.4	6.5	3.2	3.2
SRWMD	-111430014	2	2.2	2.8	0.6	2.5	6.1	3.7	3.7
SRWMD	-111430015	1	1.6	1.6	0.0	1.6	6.1	4.5	4.5
SRWMD	-111431006	2	2.9	3.6	0.7	3.2	6.6	3.4	3.4
SRWMD	-111434010	2	6.9	8.0	1.1	7.5	8.0	0.5	0.5
SRWMD	-111435007	3	7.0	9.0	2.0	8.1	8.3	0.2	0.2
SRWMD	-111503011	2	10.9	11.9	1.0	11.4	11.5	0.1	0.1
SRWMD	-111506010	2	5.2	5.9	0.7	5.5	9.5	4.0	4.0
SRWMD	-111513001	2	21.8	21.8	0.1	21.8	14.2	-7.6	7.6
SRWMD	-111513007	1	23.5	23.5	0.0	23.5	14.3	-9.3	9.3
SRWMD	-111527005	3	13.9	16.6	2.6	15.3	13.6	-1.7	1.7
SRWMD	-111534005	2	12.8	13.3	0.5	13.0	12.8	-0.3	0.3
SRWMD	-111631002	10	21.9	25.9	4.0	23.7	20.5	-3.2	3.2
SRWMD	-111809001	1	39.0	39.0	0.0	39.0	41.1	2.1	2.1
SRWMD	-111811001	752	37.8	40.0	2.2	39.0	42.6	3.6	3.6
SRWMD	-111920001	1	41.8	41.8	0.0	41.8	48.3	6.6	6.6
SRWMD	-112136001	1	43.1	43.1	0.0	43.1	50.6	7.5	7.5
SRWMD	-121319001	2	3.9	5.3	1.4	4.6	6.1	1.5	1.5
SRWMD	-121324001	2	7.9	9.1	1.2	8.5	6.9	-1.6	1.6
SRWMD	-121330002	245	4.2	9.0	4.8	6.1	5.9	-0.2	0.2
SRWMD	-121332003	4	1.2	1.9	0.8	1.5	6.0	4.4	4.4
SRWMD	-121402003	2	6.3	7.3	0.9	6.8	8.0	1.2	1.2
SRWMD	-121410001	2	4.9	5.9	1.1	5.4	7.7	2.3	2.3
SRWMD	-121410003	1	5.2	5.2	0.0	5.2	7.8	2.6	2.6
SRWMD	-121415003	2	5.7	7.0	1.2	6.3	8.0	1.6	1.6
SRWMD	-121420001	4	6.0	7.3	1.2	6.7	7.3	0.6	0.6
SRWMD	-121422001	4	5.5	6.5	1.0	6.0	7.8	1.8	1.8
SRWMD	-121422002	2	4.5	5.3	0.8	4.9	7.9	2.9	2.9
SRWMD	-121423007	1	5.6	5.6	0.0	5.6	8.1	2.6	2.6
SRWMD	-121424006	2	5.2	6.3	1.1	5.8	8.8	3.1	3.1
SRWMD	-121429005	10	6.1	12.1	6.1	8.2	7.4	-0.8	0.8
SRWMD	-121501001	3	26.2	28.8	2.7	27.5	18.9	-8.6	8.6
SRWMD	-121506002	2	8.7	12.2	3.6	10.5	10.2	-0.2	0.2
SRWMD	-121508005	754	15.3	22.0	6.7	18.8	11.0	-7.8	7.8
SRWMD	-121519001	1	8.4	8.4	0.0	8.4	9.5	1.1	1.1

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
SRWMD	-121528003	3	24.8	28.0	3.2	26.6	18.3	-8.3	8.3
SRWMD	-121708005	24	39.2	42.4	3.2	40.7	41.1	0.4	0.4
SRWMD	-131203001	12	5.1	8.9	3.8	7.4	5.0	-2.4	2.4
SRWMD	-131306003	3	0.2	1.5	1.3	1.1	5.4	4.3	4.3
SRWMD	-131433001	2	15.0	17.0	2.1	16.0	11.1	-4.9	4.9
SRWMD	-131433002	2	17.0	17.0	0.0	17.0	11.2	-5.8	5.8
SRWMD	-131526001	11	17.7	24.6	6.9	20.4	21.0	0.7	0.7
SRWMD	-131705001	24	49.1	54.5	5.4	51.2	45.4	-5.8	5.8
SRWMD	-131730003	1	41.3	41.3	0.0	41.3	36.3	-5.0	5.0
SRWMD	-131736001	752	35.8	40.5	4.7	38.2	41.2	2.9	2.9
SRWMD	-131821001	1	38.2	38.2	0.0	38.2	43.2	5.0	5.0
SRWMD	-131903001	1	39.3	39.3	0.0	39.3	44.9	5.6	5.6
SRWMD	-132009001	1	43.2	43.2	0.0	43.2	45.4	2.2	2.2
SRWMD	-141305001	24	0.8	4.3	3.6	3.0	6.7	3.7	3.7
SRWMD	-141429001	698	7.9	10.5	2.6	9.3	9.9	0.5	0.5
SRWMD	-141429005	8	7.0	9.3	2.3	7.9	9.9	2.0	2.0
SRWMD	-141612001	2	22.4	24.8	2.3	23.6	24.4	0.8	0.8
SRWMD	-141620001	24	7.5	10.7	3.1	8.8	12.6	3.7	3.7
SRWMD	-141707004	754	23.8	24.6	0.8	24.1	24.4	0.3	0.3
SRWMD	-141711001	1	46.0	46.0	0.0	46.0	40.0	-6.0	6.0
SRWMD	-141907001	1	37.1	37.1	0.0	37.1	42.9	5.8	5.8
SRWMD	-151317001	2	1.0	1.0	0.0	1.0	1.2	0.2	0.2
SRWMD	-151624001	1	22.2	22.2	0.0	22.2	15.1	-7.1	7.1
SRWMD	-151719004	4	26.2	28.7	2.5	27.5	17.5	-10.1	10.1
SRWMD	-151734001	1	49.8	49.8	0.0	49.8	44.7	-5.1	5.1
SRWMD	-151813001	1	34.6	34.6	0.0	34.6	39.9	5.3	5.3
SRWMD	-161707001	1	21.9	21.9	0.0	21.9	24.8	2.9	2.9
SRWMD	-161813001	1	29.8	29.8	0.0	29.8	33.2	3.4	3.4
Alachua County	UNKOWN	NA	NA	NA	NA	40.3	41.2	0.9	0.9
Alachua County	UNKOWN	NA	NA	NA	NA	72.9	63.3	-9.6	9.6
Alachua County	UNKOWN	NA	NA	NA	NA	40.5	40.6	0.1	0.1
Alachua County	UNKOWN	NA	NA	NA	NA	51.4	50.7	-0.8	0.8
Alachua County	UNKOWN	NA	NA	NA	NA	38.2	42.8	4.6	4.6
Alachua County	UNKOWN	NA	NA	NA	NA	35.3	38.6	3.3	3.3
Alachua County	UNKOWN	NA	NA	NA	NA	36.7	38.8	2.1	2.1
Alachua County	UNKOWN	NA	NA	NA	NA	40.2	49.8	9.6	9.6
Alachua County	UNKOWN	NA	NA	NA	NA	38.1	41.8	3.7	3.7
Alachua County	UNKOWN	NA	NA	NA	NA	39.9	41.1	1.2	1.2
Alachua County	UNKOWN	NA	NA	NA	NA	30.6	40.7	10.1	10.1
Alachua County	UNKOWN	NA	NA	NA	NA	57.9	47.3	-10.6	10.6
Alachua County	UNKOWN	NA	NA	NA	NA	31.9	37.3	5.3	5.3
Alachua County	UNKOWN	NA	NA	NA	NA	46.5	41.6	-4.9	4.9
Alachua County	UNKOWN	NA	NA	NA	NA	37.8	41.2	3.4	3.4
Alachua County	UNKOWN	NA	NA	NA	NA	42.4	43.8	1.5	1.5
Alachua County	UNKOWN	NA	NA	NA	NA	37.2	39.0	1.8	1.8

		Measured Data (feet)					Simulated	Residual (ft)	
SOURCE	SITEID	Count	Min	Max	Range	Average	Head (ft)	Difference	ABS
Alachua County	UNKOWN	NA	NA	NA	NA	39.7	40.4	0.8	0.8
Alachua County	UNKOWN	NA	NA	NA	NA	38.6	41.1	2.5	2.5
Alachua County	UNKOWN	NA	NA	NA	NA	51.7	46.4	-5.4	5.4
Alachua County	UNKOWN	NA	NA	NA	NA	52.5	51.1	-1.4	1.4
Alachua County	UNKOWN	NA	NA	NA	NA	49.7	50.0	0.3	0.3
Alachua County	UNKOWN	NA	NA	NA	NA	38.4	42.9	4.4	4.4
Alachua County	UNKOWN	NA	NA	NA	NA	54.6	44.4	-10.2	10.2
Alachua County	UNKOWN	NA	NA	NA	NA	54.0	41.2	-12.8	12.8
Alachua County	UNKOWN	NA	NA	NA	NA	44.9	42.8	-2.1	2.1
Alachua County	UNKOWN	NA	NA	NA	NA	45.2	45.2	0.0	0.0
Alachua County	UNKOWN	NA	NA	NA	NA	36.8	40.8	4.0	4.0
Alachua County	UNKOWN	NA	NA	NA	NA	72.4	70.2	-2.3	2.3
Alachua County	UNKOWN	NA	NA	NA	NA	55.8	45.6	-10.2	10.2
Alachua County	UNKOWN	NA	NA	NA	NA	39.7	41.6	1.9	1.9
Alachua County	UNKOWN	NA	NA	NA	NA	40.9	40.6	-0.3	0.3
Alachua County	UNKOWN	NA	NA	NA	NA	40.1	40.1	0.0	0.0
Alachua County	UNKOWN	NA	NA	NA	NA	63.3	72.3	9.0	9.0
Alachua County	UNKOWN	NA	NA	NA	NA	38.4	41.0	2.6	2.6
Alachua County	UNKOWN	NA	NA	NA	NA	34.7	42.2	7.6	7.6
Alachua County	UNKOWN	NA	NA	NA	NA	39.1	41.9	2.8	2.8
Alachua County	UNKOWN	NA	NA	NA	NA	42.5	42.5	0.0	0.0
Alachua County	UNKOWN	NA	NA	NA	NA	36.5	40.6	4.1	4.1
Alachua County	UNKOWN	NA	NA	NA	NA	50.7	42.4	-8.3	8.3
Alachua County	UNKOWN	NA	NA	NA	NA	21.8	40.6	18.9	18.9
Alachua County	UNKOWN	NA	NA	NA	NA	39.8	41.1	1.3	1.3
Alachua County	UNKOWN	NA	NA	NA	NA	40.0	40.1	0.1	0.1
Alachua County	UNKOWN	NA	NA	NA	NA	38.2	39.3	1.1	1.1
Alachua County	UNKOWN	NA	NA	NA	NA	41.4	41.4	0.0	0.0
Alachua County	UNKOWN	NA	NA	NA	NA	40.6	41.2	0.6	0.6
Alachua County	UNKOWN	NA	NA	NA	NA	47.2	41.2	-6.0	6.0
Alachua County	UNKOWN	NA	NA	NA	NA	34.7	41.0	6.3	6.3
Alachua County	UNKOWN	NA	NA	NA	NA	35.6	40.9	5.3	5.3
Alachua County	UNKOWN	NA	NA	NA	NA	38.8	39.9	1.1	1.1
Alachua County	UNKOWN	NA	NA	NA	NA	55.1	54.4	-0.8	0.8
Alachua County	UNKOWN	NA	NA	NA	NA	35.2	40.0	4.8	4.8
Alachua County	UNKOWN	NA	NA	NA	NA	38.9	40.9	2.1	2.1
Alachua County	UNKOWN	NA	NA	NA	NA	36.5	37.2	0.7	0.7
Alachua County	UNKOWN	NA	NA	NA	NA	75.0	74.4	-0.6	0.6
Alachua County	UNKOWN	NA	NA	NA	NA	53.0	41.2	-11.8	11.8
Alachua County	UNKOWN	NA	NA	NA	NA	24.7	40.7	16.1	16.1
Alachua County	UNKOWN	NA	NA	NA	NA	31.5	40.7	9.2	9.2
Alachua County	UNKOWN	NA	NA	NA	NA	14.7	43.8	29.2	29.2

Statistics: Calibration Residuals & Observed Range

- SDII North Florida Model - 2008
- Well Data from Suwannee River Water Management District & Alachua County EPD (June 1, 2001 - May 31, 2002)

Statistics	Calibrated Residuals SRWMD + ACEPD		Observed Range >=5 Readings		Calibrated Residuals >=5 Observations	
Count	534		175		175	
Max	34.12		20.5		34.1	
Min	0.01		0.1		0.0	
Average	4.40		3.2		4.4	
<= 3	265	*49.6%*	98	*56.0%*	98	*56.0%*
> 3	269	*50.4%*	77	*44.0%*	77	*44.0%*
> 5	147	*27.5%*	23	*13.1%*	42	*24.0%*
> 10	54	*10.1%*	2	*1.1%*	16	*9.1%*
> 15	19	*3.6%*	1	*0.6%*	8	*4.6%*
> 20	12	*2.2%*	1	*0.6%*	6	*3.4%*
Histogram	*534*		*175*		*175*	
< 1	88	*16.5%*	20	*11.4%*	34	*19.4%*
< 2	187	*35.0%*	48	*27.4%*	69	*39.4%*
< 3	265	*49.6%*	97	*55.4%*	98	*56.0%*
< 4	331	*62.0%*	127	*72.6%*	117	*66.9%*
< 5	385	*72.1%*	152	*86.9%*	133	*76.0%*
< 6	422	*79.0%*	161	*92.0%*	143	*81.7%*
< 7	439	*82.2%*	168	*96.0%*	147	*84.0%*
< 8	457	*85.6%*	172	*98.3%*	154	*88.0%*
< 9	468	*87.6%*	173	*98.9%*	158	*90.3%*
< 10	479	*89.7%*	173	*98.9%*	159	*90.9%*
< 12	498	*93.3%*	174	*99.4%*	161	*92.0%*
< 14	508	*95.1%*	174	*99.4%*	165	*94.3%*
< 16	515	*96.4%*	174	*99.4%*	167	*95.4%*
< 18	521	*97.6%*	174	*99.4%*	169	*96.6%*
< 20	522	*97.8%*	174	*99.4%*	169	*96.6%*
< 22	526	*98.5%*	175	*100.0%*	171	*97.7%*
< 24	529	*99.1%*	175	*100.0%*	173	*98.9%*
< 26	529	*99.1%*	175	*100.0%*	173	*98.9%*
< 28	530	*99.3%*	175	*100.0%*	173	*98.9%*
< 30	532	*99.6%*	175	*100.0%*	173	*98.9%*
< 32	532	*99.6%*	175	*100.0%*	173	*98.9%*
< 34	533	*99.8%*	175	*100.0%*	174	*99.4%*
< 36	534	*100.0%*	175	*100.0%*	175	*100.0%*
< 38	534	*100.0%*	175	*100.0%*	175	*100.0%*

Appendix 4

Target river stage elevations assigned to river and drain cell assignments in the NFM-08 and comparison to the simulated groundwater elevations at those locations

NFM-08: River & Drain Assignment Analysis

GOM Assignments: 1,378
Non-GOM Assignments: 48
Maximum GOM Assignment Discharge (cfs): -490.1
Maximum GOM Assignment Inflow (cfs): 86.1

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
8	22	192	3		0.00	29.62	Drain	-1244.8	0.0	-29.62	NO
9	22	193	3		0.00	29.26	Drain	-40002.0	-0.5	-29.26	NO
10	22	194	3		0.00	28.91	Drain	-39590.9	-0.5	-28.91	NO
11	22	195	3		0.00	28.57	Drain	-39187.8	-0.5	-28.57	NO
12	22	196	3		0.00	28.23	Drain	-38791.7	-0.4	-28.23	NO
13	22	197	3		0.00	27.90	Drain	-38399.0	-0.4	-27.90	NO
14	22	198	3		0.00	27.56	Drain	-38002.6	-0.4	-27.56	NO
15	22	199	3		0.00	27.22	Drain	-37589.9	-0.4	-27.22	NO
16	22	200	3		0.00	26.85	Drain	-37136.1	-0.4	-26.85	NO
17	22	201	3		0.00	26.42	Drain	-36608.7	-0.4	-26.42	NO
18	22	202	3		0.00	25.93	Drain	-35993.8	-0.4	-25.93	NO
19	22	203	3		0.00	25.41	Drain	-35320.4	-0.4	-25.41	NO
20	22	204	3		0.00	24.89	Drain	-34662.4	-0.4	-24.89	NO
21	22	205	3		0.00	24.43	Drain	-26923.7	-0.3	-24.43	NO
799	132	177	3		19.20	43.36	Drain	-189724.5	-2.2	-24.16	NO
755	115	89	3		4.40	23.46	Drain	-19716902.0	-228.2	-19.06	YES
765	118	88	3		7.10	25.91	Drain	-257052.5	-3.0	-18.81	YES
764	118	87	3		7.10	23.47	Drain	-977733.4	-11.3	-16.37	YES
669	105	118	3		7.23	23.59	Drain	-1835241.8	-21.2	-16.36	YES
719	110	116	3		6.31	22.67	Drain	-434779.4	-5.0	-16.36	YES
710	109	116	3		6.53	22.85	Drain	-495112.7	-5.7	-16.32	YES
699	108	117	3		6.80	23.11	Drain	-185889.3	-2.2	-16.31	YES
668	105	117	3		7.23	23.49	Drain	-700439.6	-8.1	-16.26	YES
288	79	93	3		24.10	40.26	Drain	-147200.5	-1.7	-16.16	YES
680	106	117	3		7.18	23.30	Drain	-927147.2	-10.7	-16.12	YES
764	118	87	3		7.40	23.47	Drain	-977733.4	-11.3	-16.07	YES
754	115	88	3		10.00	25.98	Drain	-4257646.0	-49.3	-15.98	YES
596	101	114	3		9.05	24.24	Drain	-371615.3	-4.3	-15.19	YES
629	103	114	3		8.75	23.82	Drain	-374055.7	-4.3	-15.07	YES
595	101	113	3		9.05	24.09	Drain	-115057.2	-1.3	-15.04	YES
743	112	114	3		5.41	20.10	Drain	-1259353.8	-14.6	-14.69	YES
742	112	113	3		5.67	20.20	Drain	-993242.6	-11.5	-14.53	YES
594	101	112	3		9.72	23.96	Drain	-583379.7	-6.8	-14.24	YES
279	78	94	3		24.91	38.97	Drain	-424664.5	-4.9	-14.06	YES
348	84	93	3		21.70	35.00	Drain	-95233.2	-1.1	-13.30	YES
515	93	105	3		14.48	27.35	Drain	-852217.4	-9.9	-12.87	YES
370	85	93	3		21.50	34.00	Drain	-407259.6	-4.7	-12.50	YES
496	92	105	3		15.19	27.52	Drain	-1102347.9	-12.8	-12.33	YES
495	92	104	3		15.37	27.57	Drain	-251687.1	-2.9	-12.20	YES
534	95	107	3		13.30	25.43	Drain	-1956126.6	-22.6	-12.13	YES
556	98	111	3		10.94	23.00	Drain	-3890880.8	-45.0	-12.06	YES
494	92	103	3		15.91	27.63	Drain	-433877.0	-5.0	-11.72	YES
487	91	103	3		16.08	27.72	Drain	-433918.4	-5.0	-11.64	YES
391	86	94	3		21.12	32.09	Drain	-381384.3	-4.4	-10.97	YES
632	103	122	3		13.80	24.67	Drain	-320045.6	-3.7	-10.87	YES
471	90	102	3		16.86	27.71	Drain	-2568433.8	-29.7	-10.85	YES
555	98	110	3		11.23	21.96	Drain	-489977.0	-5.7	-10.73	YES
408	87	94	3		20.85	31.56	Drain	-251161.9	-2.9	-10.71	YES
197	72	97	3		28.63	38.59	Drain	-607157.2	-7.0	-9.96	YES
964	163	145	3		24.50	33.84	Drain	-8014133.0	-92.8	-9.34	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
965	163	146	3		24.50	33.83	Drain	-6195829.0	-71.7	-9.33	YES
634	103	124	3		15.60	24.89	Drain	-1797341.6	-20.8	-9.29	YES
633	103	123	3		15.60	24.79	Drain	-64370.6	-0.7	-9.19	YES
446	89	94	3		20.18	29.33	Drain	-2432586.0	-28.2	-9.15	YES
482	91	97	3		19.14	28.09	Drain	-694650.9	-8.0	-8.95	YES
448	89	100	3		18.00	26.92	Drain	-3191485.0	-36.9	-8.92	YES
448	89	100	3		18.00	26.92	Drain	-3191485.0	-36.9	-8.92	YES
483	91	98	3		18.65	27.35	Drain	-520943.8	-6.0	-8.70	YES
111	66	103	3		28.27	36.79	Drain	-42344324.0	-490.1	-8.52	YES
447	89	95	3		20.18	28.51	Drain	-2049535.0	-23.7	-8.33	YES
753	114	113	3		5.14	13.23	Drain	-807073.2	-9.3	-8.09	YES
467	90	98	3		18.50	26.41	Drain	-2457683.3	-28.4	-7.91	YES
966	164	146	3		24.50	32.31	Drain	-20481458.0	-237.1	-7.81	YES
832	144	190	3		13.00	20.55	Drain	-6588114.5	-76.3	-7.55	NO
724	110	132	3		26.70	34.05	Drain	-1296524.9	-15.0	-7.35	YES
967	165	146	3		24.50	31.78	Drain	-12583883.0	-145.6	-7.28	YES
714	109	133	3		28.00	35.05	Drain	-2762717.5	-32.0	-7.05	YES
670	105	124	3		18.00	24.94	Drain	-1214074.4	-14.1	-6.94	YES
723	110	131	3		25.30	31.82	Drain	-7226424.0	-83.6	-6.52	YES
723	110	131	3		25.30	31.82	Drain	-7226424.0	-83.6	-6.52	YES
723	110	131	3		25.50	31.82	Drain	-7226424.0	-83.6	-6.32	YES
548	97	109	3		11.98	18.14	Drain	-8284584.5	-95.9	-6.16	YES
125	67	99	3		31.35	37.51	Drain	-1431357.3	-16.6	-6.16	YES
125	67	99	3		31.42	37.51	Drain	-1431357.3	-16.6	-6.09	YES
681	106	125	3		19.00	25.09	Drain	-181525.0	-2.1	-6.09	YES
172	70	98	3		30.19	36.23	Drain	-1702526.6	-19.7	-6.04	YES
548	97	109	3		12.22	18.14	Drain	-8284584.5	-95.9	-5.92	YES
125	67	99	3		31.60	37.51	Drain	-1431357.3	-16.6	-5.91	YES
713	109	132	3		28.00	33.86	Drain	-1783070.3	-20.6	-5.86	YES
142	68	95	3		32.83	38.67	Drain	-190357.4	-2.2	-5.84	YES
143	68	96	3		31.87	37.61	Drain	-408484.2	-4.7	-5.74	YES
723	110	131	3		26.20	31.82	Drain	-7226424.0	-83.6	-5.62	YES
135	67	111	3		37.40	43.01	Drain	-364146.4	-4.2	-5.61	YES
132	67	108	3		35.73	41.27	Drain	-969922.9	-11.2	-5.54	YES
156	69	98	3		30.33	35.85	Drain	-3443800.0	-39.9	-5.52	YES
123	67	95	3		33.00	38.48	Drain	-1523486.8	-17.6	-5.48	YES
146	68	99	3		31.42	36.79	Drain	-3539704.0	-41.0	-5.37	YES
131	67	107	3		35.38	40.69	Drain	-285921.8	-3.3	-5.31	YES
124	67	96	3		33.00	38.26	Drain	-274436.7	-3.2	-5.26	YES
722	110	130	3		24.30	29.49	Drain	-648172.6	-7.5	-5.19	YES
159	69	113	3		38.67	43.62	Drain	-118096.0	-1.4	-4.95	YES
779	122	85	3		0.90	5.78	Drain	-224620.2	-2.6	-4.88	YES
129	67	105	3		34.44	39.24	Drain	-2600490.0	-30.1	-4.80	YES
143	68	96	3		32.83	37.61	Drain	-408484.2	-4.7	-4.78	YES
123	67	95	3		33.70	38.48	Drain	-1523486.8	-17.6	-4.78	YES
582	100	124	3		20.00	24.78	Drain	-3424189.5	-39.6	-4.78	YES
113	66	105	3		34.63	39.39	Drain	-6445254.5	-74.6	-4.76	YES
707	109	74	3		20.00	24.52	Drain	-559198.1	-6.5	-4.52	YES
611	102	139	3		34.00	38.50	Drain	-3729179.0	-43.2	-4.50	YES
128	67	104	3		34.15	38.64	Drain	-380519.4	-4.4	-4.49	YES
129	67	105	3		34.79	39.24	Drain	-2600490.0	-30.1	-4.45	YES
704	108	134	3		31.00	35.37	Drain	-8662942.0	-100.3	-4.37	YES
174	70	114	3		40.00	44.33	Drain	-980573.9	-11.3	-4.33	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
704	108	134	3		31.20	35.37	Drain	-8662942.0	-100.3	-4.17	YES
790	127	113	3		2.33	6.47	Drain	-276590.6	-3.2	-4.14	YES
725	111	72	3		0.00	4.12	Drain	-842060.9	-9.7	-4.12	YES
700	108	126	3		20.50	24.59	Drain	-12551100.0	-145.3	-4.09	YES
771	120	83	3		9.00	13.07	Drain	-310964.6	-3.6	-4.07	YES
691	107	135	3		32.00	36.03	Drain	-4002088.0	-46.3	-4.03	YES
804	135	111	3		1.05	5.05	Drain	-10247089.0	-118.6	-4.00	YES
783	124	112	3		3.08	6.97	Drain	-129659.5	-1.5	-3.89	YES
784	124	113	3		3.25	7.08	Drain	-194477.2	-2.3	-3.83	YES
787	126	111	3		2.78	6.61	Drain	-1227754.9	-14.2	-3.83	YES
785	125	111	3		3.01	6.80	Drain	-198803.0	-2.3	-3.79	YES
619	103	70	3		11.70	15.31	Drain	-1294834.3	-15.0	-3.61	YES
792	128	113	3		2.48	5.97	Drain	-4922817.5	-57.0	-3.49	YES
769	119	112	3		3.82	7.30	Drain	-155672.5	-1.8	-3.48	YES
185	71	115	3		42.56	45.96	Drain	-582116.2	-6.7	-3.40	YES
777	121	112	3		3.53	6.89	Drain	-3323042.8	-38.5	-3.36	YES
780	122	86	3		3.30	6.63	Drain	-2391285.8	-27.7	-3.33	YES
770	119	113	3		3.99	7.30	Drain	-302702.9	-3.5	-3.31	YES
777	121	112	3		3.64	6.89	Drain	-3323042.8	-38.5	-3.25	YES
108	66	95	3		36.20	39.36	Drain	-763939.5	-8.8	-3.16	YES
160	69	114	3		41.01	44.12	Drain	-1083014.3	-12.5	-3.11	YES
766	118	112	3		4.51	7.58	Drain	-320248.2	-3.7	-3.07	YES
582	100	124	3		22.00	24.78	Drain	-3424189.5	-39.6	-2.78	YES
569	99	124	3		22.00	24.62	Drain	-12112506.0	-140.2	-2.62	YES
569	99	124	3		22.00	24.62	Drain	-12112506.0	-140.2	-2.62	YES
569	99	124	3		22.00	24.62	Drain	-12112506.0	-140.2	-2.62	YES
569	99	124	3		22.00	24.62	Drain	-12112506.0	-140.2	-2.62	YES
811	138	129	3		39.00	41.16	Drain	-164417.9	-1.9	-2.16	YES
705	108	135	3		34.00	36.05	Drain	-363475.8	-4.2	-2.05	YES
682	107	70	3		3.00	4.99	Drain	-1246249.3	-14.4	-1.99	YES
682	107	70	3		3.00	4.99	Drain	-1246249.3	-14.4	-1.99	YES
92	63	94	3		40.10	42.07	Drain	-118094.8	-1.4	-1.97	YES
264	78	36	3		12.00	13.86	Drain	-12380234.0	-143.3	-1.86	YES
99	64	95	3		38.80	40.35	Drain	-3460248.5	-40.0	-1.55	YES
618	103	66	3		0.00	1.55	Drain	-846071.4	-9.8	-1.55	YES
220	74	46	3		31.66	33.07	Drain	-19417178.0	-224.7	-1.41	YES
721	110	129	3		24.00	25.38	Drain	-7719629.0	-89.3	-1.38	YES
91	63	93	3		40.85	42.21	Drain	-5958089.5	-69.0	-1.36	YES
721	110	129	3		24.20	25.38	Drain	-7719629.0	-89.3	-1.18	YES
721	110	129	3		24.20	25.38	Drain	-7719629.0	-89.3	-1.18	YES
98	64	94	3		40.10	41.19	Drain	-1307016.1	-15.1	-1.09	YES
572	100	62	3		0.00	1.09	Drain	-1546224.9	-17.9	-1.09	YES
396	87	48	3		3.00	4.08	Drain	-30993002.0	-358.7	-1.08	YES
712	109	128	3		22.20	23.16	Drain	-10721565.0	-124.1	-0.96	YES
912	154	171	3		34.02	34.90	Drain	-4134202.5	-47.8	-0.88	NO
712	109	128	3		22.40	23.16	Drain	-10721565.0	-124.1	-0.76	YES
307	82	27	3		5.00	5.72	Drain	-11057362.0	-128.0	-0.72	YES
720	110	128	3		22.00	22.69	Drain	-13992512.0	-162.0	-0.69	YES
720	110	128	3		22.00	22.69	Drain	-13992512.0	-162.0	-0.69	YES
91	63	93	3		41.58	42.21	Drain	-5958089.5	-69.0	-0.63	YES
920	155	172	3		32.98	33.51	Drain	-15122687.0	-175.0	-0.53	NO
911	154	170	3		34.33	34.81	Drain	-13701806.0	-158.6	-0.47	NO
712	109	128	3		22.70	23.16	Drain	-10721565.0	-124.1	-0.46	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
712	109	128	3		22.80	23.16	Drain	-10721565.0	-124.1	-0.36	YES
919	155	171	3		33.61	33.88	Drain	-10630690.0	-123.0	-0.27	NO
235	75	46	3		30.99	31.25	Drain	-3595270.5	-41.6	-0.26	YES
245	76	47	3		30.15	30.38	Drain	-1412214.4	-16.3	-0.22	YES
712	109	128	3		23.00	23.16	Drain	-10721565.0	-124.1	-0.16	YES
885	150	132	3		23.00	23.06	Drain	-4104851.8	-47.5	-0.06	YES
735	112	72	3		0.00	0.04	Drain	-1386.5	0.0	-0.04	YES
659	105	68	3		0.00	0.03	Drain	-1729846.5	-20.0	-0.03	YES
706	109	71	3		3.00	3.02	Drain	-1287343.3	-14.9	-0.02	YES
231	75	37	3		17.80	17.82	Drain	-1148087.1	-13.3	-0.02	YES
928	157	110	3		1.00	1.00	Drain	-264683.0	-3.1	0.00	YES
244	76	46	3		30.48	29.62	Drain	0.0	0.0	0.86	YES
7	22	177	3	4.97	3.97	35.32	River	-4177.5	0.0	-30.35	NO
752	114	89	3	12.01	8.05	40.78	River	-444460.2	-5.1	-28.77	YES
423	88	83	3	65.94	64.93	94.58	River	-9666.6	-0.1	-28.64	YES
445	89	83	3	63.78	62.58	88.11	River	-32678.7	-0.4	-24.33	YES
744	113	89	3	14.85	10.95	37.90	River	-473820.7	-5.5	-23.05	YES
841	145	133	3	15.80	12.75	38.41	River	-71980.9	-0.8	-22.61	YES
840	145	132	3	15.39	12.25	36.18	River	-67376.8	-0.8	-20.80	YES
858	147	195	3	0.00	-5.00	20.19	River	-310732.1	-3.6	-20.19	NO
422	88	82	3	65.15	64.07	85.20	River	-81609.6	-0.9	-20.05	YES
849	146	196	3	0.00	-5.00	20.05	River	-74823.0	-0.9	-20.05	NO
833	144	197	3	0.00	-5.00	19.88	River	-302297.8	-3.5	-19.88	NO
736	112	89	3	17.91	14.09	37.71	River	-413930.9	-4.8	-19.80	YES
828	143	198	3	0.00	-5.00	19.78	River	-73243.4	-0.8	-19.78	NO
839	145	131	3	14.96	11.72	34.13	River	-65742.3	-0.8	-19.16	YES
762	117	88	3	8.03	6.54	26.69	River	-27712.4	-0.3	-18.66	YES
736	112	89	3	19.46	15.68	37.71	River	-413930.9	-4.8	-18.25	YES
736	112	89	3	19.46	15.68	37.71	River	-413930.9	-4.8	-18.25	YES
762	117	88	3	8.73	7.11	26.69	River	-27712.4	-0.3	-17.96	YES
761	117	87	3	7.79	6.35	25.46	River	-382642.9	-4.4	-17.66	YES
838	145	130	3	14.52	11.18	32.07	River	-60761.1	-0.7	-17.54	YES
758	116	88	3	9.26	7.55	26.67	River	-339144.1	-3.9	-17.41	YES
726	111	89	3	20.80	17.06	38.08	River	-273854.1	-3.2	-17.28	YES
761	117	87	3	8.36	6.81	25.46	River	-382642.9	-4.4	-17.10	YES
737	112	90	3	21.00	17.26	37.83	River	-358084.8	-4.1	-16.83	YES
764	118	87	3	6.85	4.73	23.47	River	-310994.0	-3.6	-16.62	YES
654	104	118	3	7.30	2.30	23.90	River	-512820.1	-5.9	-16.60	YES
305	81	93	3	24.11	19.11	40.69	River	-88251.5	-1.0	-16.58	YES
768	119	87	3	6.04	3.87	22.48	River	-354623.2	-4.1	-16.44	YES
718	110	115	3	6.19	1.19	22.60	River	-105941.7	-1.2	-16.41	YES
698	108	116	3	6.67	1.67	23.04	River	-212682.4	-2.5	-16.37	YES
719	110	116	3	6.33	1.33	22.67	River	-500402.7	-5.8	-16.35	YES
699	108	117	3	6.78	1.78	23.11	River	-285366.0	-3.3	-16.33	YES
710	109	116	3	6.53	1.53	22.85	River	-420777.0	-4.9	-16.33	YES
669	105	118	3	7.27	2.27	23.59	River	-76304.1	-0.9	-16.32	YES
688	107	117	3	6.93	1.93	23.22	River	-420516.5	-4.9	-16.29	YES
668	105	117	3	7.23	2.23	23.49	River	-482315.0	-5.6	-16.27	YES
764	118	87	3	7.24	5.50	23.47	River	-310994.0	-3.6	-16.23	YES
680	106	117	3	7.09	2.09	23.30	River	-640645.3	-7.4	-16.21	YES
680	106	117	3	7.17	2.17	23.30	River	-640645.3	-7.4	-16.13	YES
654	104	118	3	7.78	2.78	23.90	River	-512820.1	-5.9	-16.12	YES
680	106	117	3	7.18	2.18	23.30	River	-640645.3	-7.4	-16.12	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
754	115	88	3	9.88	8.05	25.98	River	-309239.5	-3.6	-16.09	YES
732	111	113	3	5.75	0.75	21.84	River	-187279.0	-2.2	-16.09	YES
734	111	115	3	6.09	1.09	22.18	River	-336666.0	-3.9	-16.08	YES
764	118	87	3	7.47	6.08	23.47	River	-310994.0	-3.6	-16.00	YES
278	78	93	3	25.80	20.80	41.80	River	-559.9	0.0	-16.00	YES
837	145	129	3	14.15	10.72	30.11	River	-39748.4	-0.5	-15.96	YES
727	111	90	3	22.37	18.66	38.30	River	-64109.8	-0.7	-15.93	YES
733	111	114	3	5.91	0.91	21.81	River	-504116.3	-5.8	-15.91	YES
679	106	116	3	7.39	2.39	23.28	River	-786139.8	-9.1	-15.89	YES
667	105	116	3	7.65	2.65	23.48	River	-370147.1	-4.3	-15.84	YES
444	89	82	3	63.01	61.73	78.66	River	-62011.8	-0.7	-15.66	YES
666	105	115	3	7.82	2.82	23.46	River	-544727.0	-6.3	-15.64	YES
772	120	87	3	5.01	2.78	20.60	River	-295277.8	-3.4	-15.59	YES
754	115	88	3	10.39	8.46	25.98	River	-309239.5	-3.6	-15.59	YES
716	110	90	3	23.63	19.96	39.09	River	-310983.9	-3.6	-15.46	YES
317	82	93	3	23.58	18.58	38.94	River	-58039.7	-0.7	-15.36	YES
678	106	115	3	7.98	2.98	23.30	River	-256829.5	-3.0	-15.33	YES
665	105	114	3	8.17	3.17	23.47	River	-370768.4	-4.3	-15.30	YES
306	81	94	3	23.84	18.84	39.14	River	-11498.1	-0.1	-15.30	YES
677	106	114	3	8.06	3.06	23.33	River	-117823.9	-1.4	-15.27	YES
596	101	114	3	9.00	4.00	24.24	River	-160656.9	-1.9	-15.24	YES
666	105	115	3	8.27	3.27	23.46	River	-544727.0	-6.3	-15.19	YES
653	104	114	3	8.45	3.45	23.64	River	-514000.6	-5.9	-15.19	YES
608	102	114	3	8.87	3.87	24.04	River	-394622.7	-4.6	-15.17	YES
665	105	114	3	8.32	3.32	23.47	River	-370768.4	-4.3	-15.15	YES
629	103	114	3	8.67	3.67	23.82	River	-429932.5	-5.0	-15.15	YES
979	169	135	3	0.95	-4.05	15.99	River	-335659.9	-3.9	-15.04	YES
595	101	113	3	9.05	4.05	24.09	River	-779435.1	-9.0	-15.04	YES
655	104	119	3	9.06	4.06	24.06	River	-431756.6	-5.0	-15.00	YES
288	79	93	3	25.32	20.32	40.26	River	-73280.6	-0.8	-14.94	YES
709	109	90	3	25.65	22.03	40.49	River	-397304.2	-4.6	-14.84	YES
595	101	113	3	9.28	4.28	24.09	River	-779435.1	-9.0	-14.81	YES
248	76	94	3	26.72	21.72	41.49	River	-49722.5	-0.6	-14.77	YES
296	80	93	3	24.72	19.72	39.45	River	-127304.9	-1.5	-14.73	YES
848	146	129	3	13.75	10.23	28.43	River	-54599.2	-0.6	-14.68	YES
743	112	114	3	5.48	0.48	20.10	River	-275717.3	-3.2	-14.63	YES
742	112	113	3	5.63	0.63	20.20	River	-335315.2	-3.9	-14.57	YES
444	89	82	3	64.22	63.05	78.66	River	-62011.8	-0.7	-14.45	YES
263	77	94	3	26.38	21.38	40.79	River	-63505.2	-0.7	-14.41	YES
972	168	135	3	0.98	-4.02	15.35	River	-588141.1	-6.8	-14.37	YES
709	109	90	3	26.15	22.55	40.49	River	-397304.2	-4.6	-14.33	YES
594	101	112	3	9.66	4.66	23.96	River	-533248.6	-6.2	-14.30	YES
738	112	91	3	23.64	19.97	37.94	River	-251352.0	-2.9	-14.29	YES
716	110	90	3	24.85	21.21	39.09	River	-310983.9	-3.6	-14.24	YES
580	100	112	3	10.02	5.02	24.12	River	-634503.3	-7.3	-14.10	YES
716	110	90	3	25.04	21.41	39.09	River	-310983.9	-3.6	-14.05	YES
776	121	87	3	4.17	1.90	17.97	River	-193950.7	-2.2	-13.81	YES
249	76	95	3	27.02	22.02	40.82	River	-46867.8	-0.5	-13.80	YES
241	75	95	3	27.38	22.38	41.17	River	-63589.3	-0.7	-13.79	YES
656	104	120	3	10.47	5.47	24.24	River	-285492.7	-3.3	-13.77	YES
318	82	94	3	23.77	18.77	37.51	River	-9285.5	-0.1	-13.73	YES
289	79	94	3	25.66	20.66	39.38	River	-38175.1	-0.4	-13.72	YES
579	100	111	3	10.26	5.26	23.96	River	-111676.1	-1.3	-13.70	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
293	80	51	3	9.24	6.24	22.77	River	-494964.6	-5.7	-13.53	YES
302	81	51	3	7.16	4.16	20.67	River	-829420.7	-9.6	-13.51	YES
334	83	93	3	23.22	18.22	36.71	River	-59884.1	-0.7	-13.49	YES
227	74	95	3	27.79	22.79	41.24	River	-64883.8	-0.8	-13.45	YES
709	109	90	3	27.06	23.47	40.49	River	-397304.2	-4.6	-13.43	YES
857	147	129	3	13.51	9.94	26.84	River	13065.2	0.2	-13.33	YES
695	108	91	3	30.12	26.61	43.40	River	-384287.8	-4.4	-13.28	YES
568	99	111	3	10.51	5.51	23.77	River	-643315.7	-7.4	-13.26	YES
315	82	51	3	5.52	2.52	18.71	River	-784702.1	-9.1	-13.19	YES
279	78	94	3	25.79	20.79	38.97	River	-58809.5	-0.7	-13.17	YES
694	108	90	3	29.23	25.70	42.26	River	-248364.5	-2.9	-13.03	YES
516	93	106	3	14.28	9.28	27.30	River	-63222.9	-0.7	-13.02	YES
279	78	94	3	26.00	21.00	38.97	River	-58809.5	-0.7	-12.97	YES
528	94	107	3	13.67	8.67	26.63	River	-350813.0	-4.1	-12.97	YES
751	113	114	3	5.28	0.28	18.19	River	-750514.9	-8.7	-12.91	YES
527	94	106	3	14.02	9.02	26.94	River	-695107.8	-8.0	-12.91	YES
315	82	51	3	5.80	2.80	18.71	River	-784702.1	-9.1	-12.91	YES
630	103	120	3	11.54	6.54	24.43	River	-215604.2	-2.5	-12.89	YES
209	73	95	3	28.20	23.20	41.04	River	-57106.0	-0.7	-12.84	YES
751	113	114	3	5.36	0.36	18.19	River	-750514.9	-8.7	-12.83	YES
315	82	51	3	5.88	2.88	18.71	River	-784702.1	-9.1	-12.83	YES
515	93	105	3	14.55	9.55	27.35	River	-710895.1	-8.2	-12.80	YES
314	82	50	3	5.73	2.73	18.46	River	-86044.1	-1.0	-12.73	YES
750	113	113	3	5.22	0.22	17.95	River	-561675.7	-6.5	-12.73	YES
755	115	89	3	10.78	8.78	23.46	River	-9235.4	-0.1	-12.68	YES
514	93	104	3	14.88	9.88	27.51	River	-239937.3	-2.8	-12.64	YES
685	107	90	3	31.87	28.41	44.39	River	-35390.0	-0.4	-12.52	YES
495	92	104	3	15.05	10.05	27.57	River	-865338.4	-10.0	-12.52	YES
535	95	108	3	13.04	8.04	25.43	River	-491565.9	-5.7	-12.38	YES
496	92	105	3	15.17	10.17	27.52	River	-69767.9	-0.8	-12.34	YES
588	101	73	3	19.53	17.38	31.85	River	-56499.1	-0.7	-12.32	YES
195	72	95	3	28.45	23.45	40.68	River	-14346.3	-0.2	-12.23	YES
745	113	91	3	25.13	21.50	37.35	River	-52028.0	-0.6	-12.23	YES
708	109	89	3	26.94	23.37	39.16	River	-479223.6	-5.5	-12.22	YES
686	107	91	3	33.01	29.57	45.21	River	-392745.4	-4.5	-12.20	YES
348	84	93	3	22.83	17.83	35.00	River	-51077.5	-0.6	-12.16	YES
495	92	104	3	15.42	10.42	27.57	River	-865338.4	-10.0	-12.16	YES
686	107	91	3	33.11	29.68	45.21	River	-392745.4	-4.5	-12.09	YES
587	101	72	3	16.81	14.54	28.90	River	-59334.0	-0.7	-12.09	YES
378	86	48	3	3.17	0.17	15.24	River	-826084.1	-9.6	-12.07	YES
534	95	107	3	13.38	8.38	25.43	River	-448475.8	-5.2	-12.05	YES
556	98	111	3	10.96	5.96	23.00	River	-667647.7	-7.7	-12.04	YES
715	110	89	3	26.39	22.81	38.43	River	-172120.5	-2.0	-12.04	YES
694	108	90	3	30.25	26.75	42.26	River	-248364.5	-2.9	-12.01	YES
283	79	52	3	13.44	10.44	25.40	River	-288754.5	-3.3	-11.97	YES
709	109	90	3	28.58	25.03	40.49	River	-397304.2	-4.6	-11.91	YES
443	89	81	3	61.99	60.62	73.88	River	-56212.7	-0.7	-11.89	YES
378	86	48	3	3.38	0.38	15.24	River	-826084.1	-9.6	-11.86	YES
494	92	103	3	15.78	10.78	27.63	River	-387157.7	-4.5	-11.85	YES
695	108	91	3	31.60	28.13	43.40	River	-384287.8	-4.4	-11.80	YES
421	88	80	3	65.04	63.95	76.82	River	-42439.5	-0.5	-11.78	YES
709	109	90	3	28.72	25.17	40.49	River	-397304.2	-4.6	-11.77	YES
463	90	82	3	61.35	59.92	73.10	River	-73350.2	-0.8	-11.75	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
294	80	52	3	11.51	8.51	23.23	River	-831719.3	-9.6	-11.72	YES
487	91	103	3	16.03	11.03	27.72	River	-300140.4	-3.5	-11.69	YES
327	83	50	3	5.00	2.00	16.64	River	-324250.7	-3.8	-11.64	YES
631	103	121	3	12.92	7.92	24.55	River	-369170.7	-4.3	-11.63	YES
328	83	51	3	5.22	2.22	16.82	River	-352752.8	-4.1	-11.60	YES
746	113	92	3	25.87	22.26	37.46	River	-144094.9	-1.7	-11.59	YES
823	142	126	3	25.90	22.51	37.45	River	-10605.6	-0.1	-11.55	YES
739	112	92	3	27.05	23.47	38.58	River	-122954.6	-1.4	-11.53	YES
370	85	93	3	22.48	17.48	34.00	River	-45270.3	-0.5	-11.53	YES
210	73	96	3	28.72	23.72	40.24	River	-11267.8	-0.1	-11.51	YES
824	142	127	3	26.81	23.45	38.23	River	-25944.7	-0.3	-11.42	YES
695	108	91	3	32.02	28.72	43.40	River	-384287.8	-4.4	-11.38	YES
540	96	108	3	12.68	7.68	23.94	River	-478891.6	-5.5	-11.26	YES
486	91	102	3	16.46	11.46	27.67	River	-792865.1	-9.2	-11.21	YES
196	72	96	3	28.59	23.59	39.69	River	-70815.9	-0.8	-11.09	YES
673	106	91	3	36.09	32.73	47.14	River	-275327.1	-3.2	-11.06	YES
856	147	128	3	13.24	9.61	24.26	River	-46929.2	-0.5	-11.02	YES
541	96	109	3	12.45	7.45	23.47	River	-107009.3	-1.2	-11.02	YES
341	84	49	3	3.99	0.99	14.98	River	-219441.0	-2.5	-10.99	YES
549	97	110	3	11.59	6.59	22.55	River	-551451.6	-6.4	-10.96	YES
604	102	73	3	20.28	18.16	31.19	River	-19876.6	-0.2	-10.91	YES
603	102	72	3	16.92	14.66	27.83	River	-1958.9	0.0	-10.91	YES
471	90	102	3	16.82	11.82	27.71	River	-128965.0	-1.5	-10.89	YES
196	72	96	3	28.85	23.85	39.69	River	-70815.9	-0.8	-10.84	YES
355	85	48	3	3.39	0.39	14.23	River	-121460.1	-1.4	-10.84	YES
587	101	72	3	18.07	15.86	28.90	River	-59334.0	-0.7	-10.83	YES
708	109	89	3	28.36	24.85	39.16	River	-479223.6	-5.5	-10.80	YES
820	141	127	3	29.42	26.14	40.19	River	-36847.1	-0.4	-10.76	YES
632	103	122	3	13.91	8.91	24.67	River	-190912.2	-2.2	-10.76	YES
342	84	50	3	4.12	1.12	14.83	River	-910091.8	-10.5	-10.70	YES
371	85	94	3	22.23	17.23	32.93	River	-18221.1	-0.2	-10.70	YES
555	98	110	3	11.29	6.29	21.96	River	-190926.5	-2.2	-10.68	YES
686	107	91	3	34.55	31.15	45.21	River	-392745.4	-4.5	-10.66	YES
632	103	122	3	14.02	9.02	24.67	River	-190912.2	-2.2	-10.65	YES
708	109	89	3	28.51	25.00	39.16	River	-479223.6	-5.5	-10.65	YES
470	90	101	3	17.04	12.04	27.65	River	-391097.7	-4.5	-10.61	YES
632	103	122	3	14.09	9.09	24.67	River	-190912.2	-2.2	-10.58	YES
196	72	96	3	29.14	24.14	39.69	River	-70815.9	-0.8	-10.55	YES
609	102	122	3	14.22	9.22	24.75	River	-458515.2	-5.3	-10.52	YES
284	79	53	3	15.33	12.33	25.84	River	-728354.7	-8.4	-10.51	YES
775	121	86	3	3.62	1.32	14.07	River	-74942.9	-0.9	-10.45	YES
588	101	73	3	21.45	19.38	31.85	River	-56499.1	-0.7	-10.40	YES
609	102	122	3	14.36	9.36	24.75	River	-458515.2	-5.3	-10.39	YES
485	91	101	3	17.30	12.30	27.67	River	-233879.6	-2.7	-10.37	YES
597	101	122	3	14.49	9.49	24.84	River	-127758.5	-1.5	-10.35	YES
827	143	126	3	24.26	20.83	34.59	River	-43668.6	-0.5	-10.33	YES
589	101	74	3	23.54	21.57	33.86	River	-62462.9	-0.7	-10.32	YES
598	101	123	3	14.57	9.57	24.85	River	-698630.5	-8.1	-10.28	YES
342	84	50	3	4.61	1.61	14.83	River	-910091.8	-10.5	-10.22	YES
391	86	94	3	21.93	16.93	32.09	River	-51068.0	-0.6	-10.16	YES
610	102	123	3	14.71	9.71	24.83	River	-12576.1	-0.1	-10.12	YES
408	87	94	3	21.47	16.47	31.56	River	-55297.2	-0.6	-10.09	YES
484	91	100	3	17.50	12.50	27.59	River	-237800.6	-2.8	-10.08	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
824	142	127	3	28.16	24.84	38.23	River	-25944.7	-0.3	-10.07	YES
632	103	122	3	14.60	9.60	24.67	River	-190912.2	-2.2	-10.07	YES
609	102	122	3	14.68	9.68	24.75	River	-458515.2	-5.3	-10.06	YES
673	106	91	3	37.16	33.94	47.14	River	-275327.1	-3.2	-9.98	YES
686	107	91	3	35.28	31.91	45.21	River	-392745.4	-4.5	-9.93	YES
686	107	91	3	35.30	31.92	45.21	River	-392745.4	-4.5	-9.91	YES
356	85	49	3	3.65	0.65	13.55	River	-671347.6	-7.8	-9.89	YES
708	109	89	3	29.29	25.83	39.16	River	-479223.6	-5.5	-9.86	YES
674	106	92	3	38.19	34.89	48.05	River	-181951.3	-2.1	-9.86	YES
855	147	127	3	12.46	8.67	22.28	River	-38057.6	-0.4	-9.83	YES
424	88	94	3	21.17	16.17	30.94	River	-11473.4	-0.1	-9.77	YES
696	108	92	3	34.92	32.09	44.68	River	-202559.8	-2.3	-9.76	YES
184	71	96	3	29.45	24.45	39.15	River	-42395.1	-0.5	-9.70	YES
693	108	89	3	31.20	27.80	40.89	River	-512175.8	-5.9	-9.70	YES
197	72	97	3	28.97	23.97	38.59	River	-10088.9	-0.1	-9.62	YES
462	90	81	3	59.30	57.69	68.91	River	-87726.1	-1.0	-9.61	YES
633	103	123	3	15.18	10.18	24.79	River	-472870.1	-5.5	-9.60	YES
823	142	126	3	27.87	24.54	37.45	River	-10605.6	-0.1	-9.58	YES
464	90	95	3	20.19	15.19	29.76	River	-56321.4	-0.7	-9.57	YES
469	90	100	3	17.76	12.76	27.32	River	-324340.5	-3.8	-9.57	YES
855	147	127	3	12.78	9.04	22.28	River	-38057.6	-0.4	-9.50	YES
855	147	127	3	12.84	9.07	22.28	River	-38057.6	-0.4	-9.44	YES
590	101	75	3	25.77	23.89	35.19	River	-39091.2	-0.5	-9.42	YES
620	103	71	3	12.54	10.08	21.90	River	-29276.4	-0.3	-9.36	YES
465	90	96	3	19.74	14.74	29.06	River	-40414.0	-0.5	-9.32	YES
462	90	81	3	59.63	58.05	68.91	River	-87726.1	-1.0	-9.28	YES
693	108	89	3	31.68	28.31	40.89	River	-512175.8	-5.9	-9.21	YES
634	103	124	3	15.68	10.68	24.89	River	-28842.7	-0.3	-9.21	YES
746	113	92	3	28.27	24.72	37.46	River	-144094.9	-1.7	-9.20	YES
818	140	127	3	31.83	28.62	40.98	River	-29712.1	-0.3	-9.15	YES
269	78	54	3	19.22	16.22	28.35	River	-152778.5	-1.8	-9.12	YES
598	101	123	3	15.76	11.21	24.85	River	-698630.5	-8.1	-9.09	YES
425	88	95	3	20.97	15.97	30.00	River	-30501.7	-0.4	-9.03	YES
602	102	71	3	14.45	12.08	23.46	River	-50655.8	-0.6	-9.01	YES
684	107	89	3	34.27	30.99	43.25	River	-229734.0	-2.7	-8.98	YES
468	90	99	3	18.15	13.15	27.08	River	-488536.2	-5.7	-8.94	YES
864	148	127	3	11.19	7.36	20.10	River	-27958.8	-0.3	-8.91	YES
871	149	127	3	8.85	4.96	17.76	River	-29743.4	-0.3	-8.90	YES
357	85	50	3	4.25	1.25	13.14	River	-163406.7	-1.9	-8.89	YES
482	91	97	3	19.21	14.21	28.09	River	-47849.8	-0.6	-8.88	YES
170	70	96	3	29.66	24.66	38.53	River	-2568.9	0.0	-8.87	YES
633	103	123	3	15.92	10.92	24.79	River	-472870.1	-5.5	-8.87	YES
586	101	71	3	16.20	13.91	24.99	River	-21099.7	-0.2	-8.78	YES
847	146	127	3	16.08	12.40	24.82	River	-10436.7	-0.1	-8.74	YES
379	86	49	3	3.35	0.35	12.07	River	-45511.8	-0.5	-8.72	YES
693	108	89	3	32.18	28.82	40.89	River	-512175.8	-5.9	-8.72	YES
879	150	126	3	5.33	1.32	13.98	River	-24350.9	-0.3	-8.65	YES
483	91	98	3	18.71	13.71	27.35	River	-146464.6	-1.7	-8.65	YES
684	107	89	3	34.61	31.35	43.25	River	-229734.0	-2.7	-8.64	YES
285	79	54	3	17.81	14.81	26.40	River	-457650.7	-5.3	-8.59	YES
466	90	97	3	19.50	14.50	28.08	River	-9814.9	-0.1	-8.58	YES
831	144	126	3	21.32	17.79	29.88	River	-33685.5	-0.4	-8.56	YES
378	86	48	3	6.74	3.74	15.24	River	-826084.1	-9.6	-8.50	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
483	91	98	3	18.87	13.87	27.35	River	-146464.6	-1.7	-8.48	YES
657	104	123	3	16.42	11.42	24.81	River	-198899.8	-2.3	-8.39	YES
574	100	76	3	27.85	26.06	36.21	River	-54411.9	-0.6	-8.35	YES
505	93	67	3	12.16	10.20	20.51	River	-942385.0	-10.9	-8.35	YES
663	105	91	3	40.73	37.79	49.06	River	-156349.5	-1.8	-8.33	YES
846	146	126	3	15.30	11.59	23.60	River	-17168.6	-0.2	-8.31	YES
756	115	112	3	4.95	-0.05	13.23	River	-536420.5	-6.2	-8.28	YES
461	90	80	3	58.04	56.31	66.28	River	-17179.0	-0.2	-8.24	YES
978	169	134	3	0.88	-4.12	9.04	River	-1060811.6	-12.3	-8.16	YES
753	114	113	3	5.11	0.11	13.23	River	-804762.1	-9.3	-8.11	YES
505	93	67	3	12.43	10.46	20.51	River	-942385.0	-10.9	-8.07	YES
880	150	127	3	7.56	3.62	15.62	River	-1997.9	0.0	-8.06	YES
573	100	75	3	27.21	25.39	35.26	River	-19668.1	-0.2	-8.05	YES
658	104	124	3	16.94	11.94	24.93	River	-126503.9	-1.5	-8.00	YES
461	90	80	3	58.34	56.64	66.28	River	-17179.0	-0.2	-7.94	YES
467	90	98	3	18.51	13.51	26.41	River	-226198.8	-2.6	-7.90	YES
747	113	93	3	30.31	26.82	38.19	River	-179951.0	-2.1	-7.88	YES
447	89	95	3	20.64	15.64	28.51	River	-32973.6	-0.4	-7.88	YES
461	90	80	3	58.42	56.72	66.28	River	-17179.0	-0.2	-7.86	YES
507	93	69	3	17.22	15.22	24.98	River	-59479.5	-0.7	-7.76	YES
581	100	123	3	17.12	13.10	24.87	River	-88598.3	-1.0	-7.76	YES
836	145	126	3	18.70	15.10	26.34	River	-25277.5	-0.3	-7.64	YES
697	108	93	3	38.28	36.00	45.86	River	-139182.3	-1.6	-7.58	YES
879	150	126	3	6.40	2.43	13.98	River	-24350.9	-0.3	-7.58	YES
687	107	93	3	39.93	37.92	47.49	River	-6225.3	-0.1	-7.56	YES
270	78	55	3	21.16	18.16	28.71	River	-595493.6	-6.9	-7.55	YES
442	89	80	3	63.66	62.45	71.16	River	-11856.9	-0.1	-7.49	YES
675	106	93	3	41.50	38.29	48.98	River	-177262.2	-2.1	-7.48	YES
171	70	97	3	29.89	24.89	37.34	River	-36515.2	-0.4	-7.46	YES
574	100	76	3	28.76	26.97	36.21	River	-54411.9	-0.6	-7.44	YES
505	93	67	3	13.07	11.13	20.51	River	-942385.0	-10.9	-7.43	YES
914	155	125	3	1.24	-3.65	8.67	River	-194467.3	-2.3	-7.43	YES
684	107	89	3	35.85	32.64	43.25	River	-229734.0	-2.7	-7.40	YES
574	100	76	3	28.81	27.06	36.21	River	-54411.9	-0.6	-7.40	YES
888	151	126	3	4.91	0.82	12.27	River	-154932.3	-1.8	-7.36	YES
962	161	135	3	26.69	23.69	33.99	River	-25203.7	-0.3	-7.30	YES
724	110	132	3	26.76	22.88	34.05	River	-764031.9	-8.8	-7.29	YES
505	93	67	3	13.23	11.23	20.51	River	-942385.0	-10.9	-7.28	YES
757	115	113	3	5.02	0.02	12.25	River	-245751.5	-2.8	-7.24	YES
670	105	124	3	17.72	12.72	24.94	River	-323829.6	-3.7	-7.22	YES
967	165	146	3	24.57	21.53	31.78	River	-115186.5	-1.3	-7.21	YES
506	93	68	3	15.49	13.49	22.68	River	-788659.0	-9.1	-7.19	YES
898	153	126	3	3.08	-1.41	10.18	River	-228363.7	-2.6	-7.10	YES
504	93	66	3	11.46	9.51	18.56	River	-714046.9	-8.3	-7.10	YES
854	147	126	3	14.02	10.28	21.08	River	-18185.0	-0.2	-7.06	YES
893	152	126	3	4.00	-0.28	11.04	River	-179969.3	-2.1	-7.03	YES
914	155	125	3	1.67	-3.12	8.67	River	-194467.3	-2.3	-6.99	YES
913	155	124	3	0.80	-4.18	7.78	River	-131313.6	-1.5	-6.98	YES
904	154	125	3	2.00	-2.72	8.98	River	-215734.6	-2.5	-6.98	YES
897	153	125	3	2.59	-2.00	9.55	River	-19268.3	-0.2	-6.95	YES
960	160	135	3	25.96	22.96	32.91	River	-22703.5	-0.3	-6.95	YES
960	160	135	3	26.07	23.07	32.91	River	-22703.5	-0.3	-6.83	YES
914	155	125	3	1.90	-2.87	8.67	River	-194467.3	-2.3	-6.76	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
582	100	124	3	18.02	14.36	24.78	River	-487740.1	-5.6	-6.76	YES
321	83	34	3	4.70	0.73	11.42	River	-248053.5	-2.9	-6.73	YES
671	105	125	3	18.38	13.38	25.09	River	-39118.4	-0.5	-6.71	YES
921	156	124	3	0.48	-4.52	7.12	River	-278712.6	-3.2	-6.63	YES
921	156	124	3	0.51	-4.49	7.12	River	-278712.6	-3.2	-6.61	YES
846	146	126	3	17.01	13.36	23.60	River	-17168.6	-0.2	-6.60	YES
650	104	91	3	44.26	41.61	50.85	River	-119245.5	-1.4	-6.59	YES
676	106	94	3	43.42	40.26	49.98	River	-4844.1	-0.1	-6.56	YES
904	154	125	3	2.42	-2.20	8.98	River	-215734.6	-2.5	-6.55	YES
350	85	30	3	2.08	-2.92	8.63	River	-395923.1	-4.6	-6.55	YES
921	156	124	3	0.57	-4.43	7.12	River	-278712.6	-3.2	-6.55	YES
969	166	146	3	25.07	21.73	31.57	River	-655856.3	-7.6	-6.50	YES
703	108	133	3	28.42	24.88	34.90	River	-832617.1	-9.6	-6.48	YES
904	154	125	3	2.51	-2.21	8.98	River	-215734.6	-2.5	-6.47	YES
921	156	124	3	0.65	-4.35	7.12	River	-278712.6	-3.2	-6.46	YES
373	86	31	3	1.29	-3.71	7.73	River	-416102.7	-4.8	-6.44	YES
815	139	128	3	35.65	32.55	42.08	River	-4433.6	-0.1	-6.44	YES
748	113	94	3	33.19	29.77	39.58	River	-124280.1	-1.4	-6.39	YES
921	156	124	3	0.74	-4.25	7.12	River	-278712.6	-3.2	-6.37	YES
561	99	76	3	29.88	28.08	36.22	River	-54894.8	-0.6	-6.34	YES
904	154	125	3	2.65	-1.98	8.98	River	-215734.6	-2.5	-6.32	YES
681	106	125	3	18.81	13.81	25.09	River	-170876.1	-2.0	-6.28	YES
320	83	29	3	3.63	-1.37	9.90	River	-962120.1	-11.1	-6.27	YES
714	109	133	3	28.82	25.37	35.05	River	-556237.3	-6.4	-6.22	YES
336	84	34	3	4.16	0.08	10.32	River	-789410.2	-9.1	-6.16	YES
309	82	35	3	5.93	2.24	12.09	River	-302901.7	-3.5	-6.16	YES
374	86	33	3	1.84	-2.76	7.99	River	-129824.6	-1.5	-6.15	YES
713	109	132	3	27.74	24.06	33.86	River	-712902.8	-8.3	-6.12	YES
172	70	98	3	30.15	25.15	36.23	River	-772060.0	-8.9	-6.08	YES
683	107	88	3	35.90	32.69	41.97	River	-136102.4	-1.6	-6.07	YES
723	110	131	3	25.76	21.67	31.82	River	-740875.3	-8.6	-6.06	YES
664	105	94	3	45.30	42.18	51.33	River	-139139.5	-1.6	-6.03	YES
548	97	109	3	12.11	7.11	18.14	River	-408042.3	-4.7	-6.03	YES
921	156	124	3	1.08	-3.85	7.12	River	-278712.6	-3.2	-6.03	YES
375	86	34	3	2.03	-2.52	8.03	River	-685235.8	-7.9	-6.00	YES
503	93	65	3	10.36	8.41	16.36	River	-558873.1	-6.5	-6.00	YES
393	87	32	3	0.34	-4.59	6.32	River	-685044.8	-7.9	-5.99	YES
335	84	29	3	3.01	-1.99	8.98	River	-805017.8	-9.3	-5.97	YES
351	85	34	3	3.23	-1.06	9.18	River	-955266.3	-11.1	-5.95	YES
172	70	98	3	30.28	25.28	36.23	River	-772060.0	-8.9	-5.95	YES
905	154	126	3	3.84	-0.73	9.77	River	-188022.7	-2.2	-5.93	YES
644	104	70	3	9.17	6.57	15.10	River	-2946.5	0.0	-5.93	YES
874	149	133	3	30.23	27.23	36.13	River	-118528.3	-1.4	-5.90	YES
393	87	32	3	0.43	-4.57	6.32	River	-685044.8	-7.9	-5.89	YES
759	116	112	3	4.88	-0.12	10.77	River	-164004.1	-1.9	-5.89	YES
172	70	98	3	30.35	25.36	36.23	River	-772060.0	-8.9	-5.88	YES
814	139	127	3	34.20	31.06	40.08	River	-19489.7	-0.2	-5.87	YES
322	83	35	3	5.29	1.46	11.16	River	-863015.0	-10.0	-5.87	YES
372	86	30	3	1.69	-3.31	7.52	River	-716390.5	-8.3	-5.83	YES
930	157	124	3	0.37	-4.63	6.18	River	-140532.4	-1.6	-5.81	YES
930	157	124	3	0.39	-4.61	6.18	River	-140532.4	-1.6	-5.80	YES
374	86	33	3	2.20	-2.32	7.99	River	-129824.6	-1.5	-5.79	YES
939	157	135	3	31.94	28.94	37.72	River	-11542.7	-0.1	-5.78	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
157	69	99	3	31.10	26.10	36.87	River	-134212.2	-1.6	-5.77	YES
692	108	88	3	33.96	30.68	39.72	River	-34391.7	-0.4	-5.76	YES
999	174	154	3	28.99	28.84	34.75	River	-189132.0	-2.2	-5.76	YES
481	91	80	3	57.01	55.18	62.76	River	-24448.1	-0.3	-5.76	YES
522	94	69	3	18.70	16.70	24.43	River	-532168.7	-6.2	-5.73	YES
349	85	29	3	2.47	-2.53	8.17	River	-670647.2	-7.8	-5.70	YES
977	169	133	3	0.76	-4.24	6.42	River	-735914.3	-8.5	-5.66	YES
271	78	56	3	23.60	20.60	29.20	River	-233222.3	-2.7	-5.60	YES
702	108	132	3	28.33	24.78	33.93	River	-92710.9	-1.1	-5.60	YES
905	154	126	3	4.19	-0.39	9.77	River	-188022.7	-2.2	-5.58	YES
375	86	34	3	2.46	-1.99	8.03	River	-685235.8	-7.9	-5.57	YES
155	69	97	3	31.10	26.18	36.65	River	-1720057.5	-19.9	-5.55	YES
749	113	95	3	35.37	32.01	40.91	River	-70159.0	-0.8	-5.55	YES
392	87	31	3	0.91	-4.09	6.44	River	-617380.4	-7.1	-5.53	YES
689	107	125	3	19.56	14.56	25.06	River	-171161.5	-2.0	-5.49	YES
146	68	99	3	31.32	26.32	36.79	River	-581722.3	-6.7	-5.48	YES
998	173	154	3	28.95	28.43	34.39	River	-274776.3	-3.2	-5.43	YES
125	67	99	3	32.09	27.09	37.51	River	-691083.8	-8.0	-5.42	YES
377	86	47	3	6.33	3.33	11.72	River	-219476.6	-2.5	-5.39	YES
873	149	132	3	25.93	22.93	31.26	River	-82885.6	-1.0	-5.33	YES
394	87	33	3	1.07	-3.69	6.38	River	-1174895.1	-13.6	-5.31	YES
968	166	145	3	26.08	22.14	31.38	River	-698866.6	-8.1	-5.31	YES
189	72	42	3	29.90	29.44	35.19	River	-202022.4	-2.3	-5.29	YES
145	68	98	3	31.58	26.58	36.86	River	-245018.0	-2.8	-5.28	YES
962	161	135	3	28.74	25.74	33.99	River	-25203.7	-0.3	-5.25	YES
310	82	36	3	6.55	3.00	11.80	River	-745456.6	-8.6	-5.25	YES
683	107	88	3	36.74	33.57	41.97	River	-136102.4	-1.6	-5.22	YES
156	69	98	3	30.63	25.67	35.85	River	-1300368.3	-15.1	-5.22	YES
561	99	76	3	31.03	29.37	36.22	River	-54894.8	-0.6	-5.20	YES
701	108	127	3	21.09	16.09	26.26	River	-75813.9	-0.9	-5.17	YES
224	74	59	3	38.36	35.36	43.52	River	-226075.0	-2.6	-5.16	YES
377	86	47	3	6.56	3.56	11.72	River	-219476.6	-2.5	-5.16	YES
156	69	98	3	30.71	25.71	35.85	River	-1300368.3	-15.1	-5.14	YES
355	85	48	3	9.10	6.10	14.23	River	-121460.1	-1.4	-5.13	YES
913	155	124	3	2.65	-2.08	7.78	River	-131313.6	-1.5	-5.12	YES
975	169	131	3	0.56	-4.44	5.67	River	-202385.5	-2.3	-5.11	YES
690	107	126	3	20.02	15.02	25.12	River	-22032.7	-0.3	-5.10	YES
126	67	100	3	32.79	27.79	37.88	River	-1032991.8	-12.0	-5.09	YES
297	81	36	3	7.50	4.15	12.58	River	-761619.8	-8.8	-5.09	YES
582	100	124	3	19.71	16.44	24.78	River	-487740.1	-5.6	-5.07	YES
146	68	99	3	31.75	26.75	36.79	River	-581722.3	-6.7	-5.05	YES
308	82	28	3	4.34	-0.66	9.38	River	-630930.3	-7.3	-5.04	YES
779	122	85	3	0.76	-2.00	5.78	River	-92224.5	-1.1	-5.01	YES
662	105	88	3	41.90	38.93	46.86	River	-114292.3	-1.3	-4.96	YES
409	88	32	3	0.00	-5.00	4.96	River	-884996.5	-10.2	-4.96	YES
319	83	28	3	4.01	-0.99	8.97	River	-128978.6	-1.5	-4.96	YES
703	108	133	3	29.95	26.73	34.90	River	-832617.1	-9.6	-4.95	YES
910	154	134	3	32.37	29.34	37.31	River	-11503.8	-0.1	-4.94	YES
566	99	81	3	45.98	44.98	50.89	River	-452.6	0.0	-4.91	YES
280	79	36	3	8.97	5.95	13.87	River	-590483.0	-6.8	-4.90	YES
290	80	36	3	8.43	5.29	13.33	River	-670370.9	-7.8	-4.90	YES
672	106	88	3	39.62	36.56	44.52	River	-92326.6	-1.1	-4.90	YES
155	69	97	3	31.77	26.90	36.65	River	-1720057.5	-19.9	-4.88	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
127	67	101	3	33.25	28.25	38.12	River	-54552.2	-0.6	-4.87	YES
409	88	32	3	0.10	-4.90	4.96	River	-884996.5	-10.2	-4.87	YES
377	86	47	3	6.86	3.86	11.72	River	-219476.6	-2.5	-4.86	YES
480	91	79	3	54.29	52.29	59.14	River	-154327.7	-1.8	-4.86	YES
109	66	101	3	33.53	28.53	38.38	River	-592027.3	-6.9	-4.85	YES
254	77	56	3	25.98	22.98	30.80	River	-366997.3	-4.2	-4.82	YES
760	116	113	3	4.78	-0.22	9.60	River	-570978.1	-6.6	-4.82	YES
619	103	70	3	10.49	7.95	15.31	River	-28054.9	-0.3	-4.82	YES
740	112	95	3	37.30	33.99	42.11	River	-76029.0	-0.9	-4.80	YES
409	88	32	3	0.16	-4.80	4.96	River	-884996.5	-10.2	-4.80	YES
560	99	75	3	30.51	28.70	35.27	River	-5394.2	-0.1	-4.76	YES
817	140	109	3	1.42	-3.58	6.18	River	-147587.8	-1.7	-4.76	YES
722	110	130	3	24.74	20.44	29.49	River	-519531.7	-6.0	-4.76	YES
822	142	108	3	1.26	-3.74	5.92	River	-643803.6	-7.5	-4.66	YES
813	139	109	3	1.50	-3.50	6.12	River	-371527.0	-4.3	-4.63	YES
819	141	108	3	1.32	-3.68	5.94	River	-869633.3	-10.1	-4.63	YES
491	92	67	3	16.91	15.03	21.53	River	-534070.8	-6.2	-4.62	YES
705	108	135	3	31.46	28.46	36.05	River	-133830.3	-1.5	-4.59	YES
812	139	108	3	1.47	-3.53	6.05	River	-542571.8	-6.3	-4.58	YES
816	140	108	3	1.38	-3.62	5.96	River	-1336412.0	-15.5	-4.58	YES
906	154	127	3	6.25	1.84	10.81	River	-57109.4	-0.7	-4.56	YES
366	85	73	3	64.84	63.83	69.39	River	-57096.1	-0.7	-4.55	YES
124	67	96	3	33.73	29.02	38.26	River	-110951.6	-1.3	-4.54	YES
704	108	134	3	30.84	27.80	35.37	River	-470060.6	-5.4	-4.53	YES
354	85	47	3	8.67	5.67	13.20	River	-205385.5	-2.4	-4.53	YES
816	140	108	3	1.43	-3.57	5.96	River	-1336412.0	-15.5	-4.52	YES
779	122	85	3	1.28	-1.47	5.78	River	-92224.5	-1.1	-4.50	YES
256	77	65	3	54.69	54.69	59.19	River	-120482.9	-1.4	-4.50	YES
821	142	107	3	1.22	-3.78	5.71	River	-692183.7	-8.0	-4.50	YES
809	138	109	3	1.54	-3.46	6.03	River	-920558.8	-10.7	-4.49	YES
976	169	132	3	0.64	-4.36	5.11	River	-581980.9	-6.7	-4.48	YES
561	99	76	3	31.77	29.94	36.22	River	-54894.8	-0.6	-4.46	YES
189	72	42	3	30.75	30.41	35.19	River	-202022.4	-2.3	-4.44	YES
683	107	88	3	37.54	34.40	41.97	River	-136102.4	-1.6	-4.43	YES
826	143	107	3	1.17	-3.83	5.60	River	-690417.7	-8.0	-4.43	YES
502	93	64	3	9.28	7.31	13.70	River	-437140.4	-5.1	-4.42	YES
144	68	97	3	32.64	27.84	37.04	River	-1553222.6	-18.0	-4.40	YES
156	69	98	3	31.49	26.60	35.85	River	-1300368.3	-15.1	-4.36	YES
807	137	109	3	1.59	-3.41	5.92	River	-424009.8	-4.9	-4.33	YES
808	137	110	3	1.64	-3.36	5.94	River	-852737.8	-9.9	-4.30	YES
741	112	96	3	38.87	35.59	43.15	River	-30713.6	-0.4	-4.29	YES
691	107	135	3	31.77	28.77	36.03	River	-380250.7	-4.4	-4.27	YES
825	143	106	3	1.12	-3.88	5.35	River	-747528.3	-8.7	-4.23	YES
704	108	134	3	31.19	28.19	35.37	River	-470060.6	-5.4	-4.18	YES
189	72	42	3	31.04	30.74	35.19	River	-202022.4	-2.3	-4.16	YES
883	150	130	3	18.55	15.18	22.71	River	-96088.8	-1.1	-4.16	YES
790	127	113	3	2.32	-2.68	6.47	River	-169348.5	-2.0	-4.15	YES
143	68	96	3	33.47	28.74	37.61	River	-1274851.5	-14.8	-4.14	YES
273	78	65	3	52.51	52.51	56.65	River	-324911.9	-3.8	-4.14	YES
390	86	77	3	80.15	79.13	84.29	River	-55508.1	-0.6	-4.13	YES
780	122	86	3	2.52	0.03	6.63	River	-136777.7	-1.6	-4.11	YES
700	108	126	3	20.49	15.49	24.59	River	-129698.4	-1.5	-4.10	YES
830	144	106	3	1.04	-3.96	5.14	River	-467666.7	-5.4	-4.10	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
582	100	124	3	20.68	17.53	24.78	River	-487740.1	-5.6	-4.10	YES
898	153	126	3	6.09	1.64	10.18	River	-228363.7	-2.6	-4.09	YES
806	136	111	3	1.68	-3.32	5.77	River	-105926.3	-1.2	-4.09	YES
795	130	113	3	2.13	-2.87	6.21	River	-525784.6	-6.1	-4.08	YES
652	104	94	3	48.60	45.57	52.68	River	-77370.2	-0.9	-4.08	YES
794	130	112	3	2.09	-2.91	6.16	River	-527331.6	-6.1	-4.07	YES
830	144	106	3	1.09	-3.91	5.14	River	-467666.7	-5.4	-4.06	YES
797	131	112	3	2.06	-2.94	6.11	River	-301623.1	-3.5	-4.05	YES
805	136	110	3	1.67	-3.33	5.72	River	-628888.9	-7.3	-4.05	YES
806	136	111	3	1.72	-3.28	5.77	River	-105926.3	-1.2	-4.04	YES
796	131	111	3	2.02	-2.98	6.05	River	-662127.6	-7.7	-4.03	YES
805	136	110	3	1.70	-3.30	5.72	River	-628888.9	-7.3	-4.02	YES
929	157	123	3	0.19	-4.81	4.18	River	-80317.1	-0.9	-3.98	YES
280	79	36	3	9.89	6.96	13.87	River	-590483.0	-6.8	-3.98	YES
793	129	113	3	2.18	-2.82	6.16	River	-687363.2	-8.0	-3.98	YES
882	150	129	3	16.27	12.70	20.24	River	-61111.2	-0.7	-3.97	YES
240	75	59	3	36.72	33.72	40.68	River	-147957.6	-1.7	-3.96	YES
110	66	102	3	34.06	29.06	38.02	River	-490070.6	-5.7	-3.96	YES
835	145	106	3	0.94	-4.06	4.89	River	-594917.7	-6.9	-3.95	YES
798	132	111	3	1.96	-3.04	5.90	River	-813646.2	-9.4	-3.94	YES
347	84	72	3	64.92	63.91	68.85	River	95305.6	1.1	-3.93	YES
810	138	128	3	37.40	34.35	41.30	River	-16245.8	-0.2	-3.90	YES
569	99	124	3	20.73	17.58	24.62	River	-156664.0	-1.8	-3.89	YES
929	157	123	3	0.29	-4.71	4.18	River	-80317.1	-0.9	-3.89	YES
929	157	123	3	0.30	-4.70	4.18	River	-80317.1	-0.9	-3.88	YES
728	111	96	3	40.43	37.20	44.30	River	-61295.7	-0.7	-3.87	YES
800	133	111	3	1.88	-3.12	5.74	River	-1095066.4	-12.7	-3.86	YES
142	68	95	3	34.81	30.19	38.67	River	-470594.8	-5.4	-3.86	YES
783	124	112	3	3.11	-1.89	6.97	River	-434253.7	-5.0	-3.86	YES
789	127	112	3	2.61	-2.39	6.47	River	-362910.8	-4.2	-3.86	YES
785	125	111	3	2.94	-2.06	6.80	River	-402966.7	-4.7	-3.86	YES
788	127	111	3	2.69	-2.31	6.54	River	-49163.8	-0.6	-3.85	YES
829	144	105	3	1.02	-3.98	4.87	River	-319229.6	-3.7	-3.85	YES
355	85	48	3	10.38	7.41	14.23	River	-121460.1	-1.4	-3.85	YES
786	125	112	3	3.02	-1.98	6.85	River	-27524.0	-0.3	-3.83	YES
787	126	111	3	2.78	-2.22	6.61	River	-454259.9	-5.3	-3.82	YES
845	146	106	3	0.92	-4.08	4.74	River	-33028.5	-0.4	-3.82	YES
829	144	105	3	1.07	-3.93	4.87	River	-319229.6	-3.7	-3.80	YES
782	123	112	3	3.26	-1.74	7.06	River	-400600.1	-4.6	-3.80	YES
377	86	47	3	7.92	4.92	11.72	River	-219476.6	-2.5	-3.80	YES
801	134	110	3	1.81	-3.19	5.58	River	-515283.6	-6.0	-3.78	YES
791	128	112	3	2.49	-2.51	6.27	River	-304821.4	-3.5	-3.78	YES
287	79	65	3	51.24	51.24	55.00	River	-136095.0	-1.6	-3.77	YES
763	117	113	3	4.62	-0.38	8.37	River	-375525.1	-4.3	-3.75	YES
802	134	111	3	1.83	-3.17	5.57	River	-106010.1	-1.2	-3.74	YES
792	128	113	3	2.23	-2.77	5.97	River	-947587.6	-11.0	-3.74	YES
426	89	32	3	0.00	-5.00	3.73	River	-93355.9	-1.1	-3.73	YES
651	104	92	3	47.71	45.33	51.43	River	-66433.9	-0.8	-3.72	YES
354	85	47	3	9.48	6.48	13.20	River	-205385.5	-2.4	-3.72	YES
711	109	127	3	21.33	16.33	25.04	River	-255945.4	-3.0	-3.71	YES
792	128	113	3	2.27	-2.73	5.97	River	-947587.6	-11.0	-3.70	YES
115	66	107	3	37.40	32.40	41.10	River	-17386.0	-0.2	-3.69	YES
803	135	110	3	1.78	-3.22	5.46	River	-78603.0	-0.9	-3.68	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
986	170	131	3	0.50	-4.50	4.17	River	-331839.0	-3.8	-3.67	YES
948	158	135	3	30.64	27.64	34.31	River	-3786.0	0.0	-3.67	YES
395	87	47	3	3.96	0.96	7.62	River	-239539.7	-2.8	-3.65	YES
781	122	112	3	3.42	-1.58	7.06	River	-412730.6	-4.8	-3.65	YES
891	151	129	3	14.87	11.19	18.50	River	-28955.3	-0.3	-3.63	YES
903	154	124	3	4.70	0.22	8.32	River	-77806.3	-0.9	-3.62	YES
792	128	113	3	2.39	-2.61	5.97	River	-947587.6	-11.0	-3.58	YES
997	173	153	3	28.90	27.74	32.47	River	-316773.8	-3.7	-3.58	YES
479	91	78	3	52.28	50.28	55.82	River	-153286.6	-1.8	-3.54	YES
619	103	70	3	11.78	9.30	15.31	River	-28054.9	-0.3	-3.53	YES
569	99	124	3	21.10	18.00	24.62	River	-156664.0	-1.8	-3.52	YES
960	160	135	3	29.40	26.40	32.91	River	-22703.5	-0.3	-3.51	YES
122	67	94	3	36.61	32.14	40.11	River	-260360.0	-3.0	-3.49	YES
769	119	112	3	3.82	-1.18	7.30	River	-314313.0	-3.6	-3.48	YES
480	91	79	3	55.67	53.72	59.14	River	-154327.7	-1.8	-3.47	YES
834	145	105	3	1.00	-4.00	4.46	River	-620843.4	-7.2	-3.46	YES
625	103	92	3	49.53	47.29	52.98	River	-4072.6	0.0	-3.45	YES
143	68	96	3	34.18	29.51	37.61	River	-1274851.5	-14.8	-3.43	YES
773	120	112	3	3.72	-1.28	7.14	River	-347837.8	-4.0	-3.43	YES
971	167	145	3	26.99	22.50	30.40	River	-344933.6	-4.0	-3.42	YES
994	171	152	3	28.63	24.55	32.05	River	-288444.3	-3.3	-3.41	YES
532	95	69	3	21.02	19.02	24.42	River	-216720.0	-2.5	-3.40	YES
117	66	109	3	38.91	33.91	42.31	River	-116260.3	-1.3	-3.40	YES
112	66	104	3	35.23	30.23	38.60	River	-264237.3	-3.1	-3.38	YES
354	85	47	3	9.83	6.84	13.20	River	-205385.5	-2.4	-3.37	YES
114	66	106	3	37.00	32.00	40.36	River	-432513.0	-5.0	-3.37	YES
774	120	113	3	3.91	-1.09	7.27	River	-220069.3	-2.5	-3.36	YES
996	172	153	3	28.80	26.53	32.15	River	-528080.6	-6.1	-3.35	YES
369	85	76	3	81.69	80.68	85.03	River	-39768.2	-0.5	-3.34	YES
711	109	127	3	21.70	16.77	25.04	River	-255945.4	-3.0	-3.34	YES
766	118	112	3	4.26	-0.74	7.58	River	-482763.6	-5.6	-3.32	YES
777	121	112	3	3.57	-1.43	6.89	River	-353125.7	-4.1	-3.32	YES
804	135	111	3	1.75	-3.25	5.05	River	-518191.7	-6.0	-3.30	YES
767	118	113	3	4.34	-0.66	7.63	River	-293668.0	-3.4	-3.29	YES
662	105	88	3	43.57	40.80	46.86	River	-114292.3	-1.3	-3.29	YES
773	120	112	3	3.86	-1.14	7.14	River	-347837.8	-4.0	-3.28	YES
427	89	33	3	0.00	-5.00	3.28	River	-424268.9	-4.9	-3.28	YES
770	119	113	3	4.04	-0.96	7.30	River	-415894.9	-4.8	-3.26	YES
627	103	94	3	50.68	47.70	53.94	River	-45545.6	-0.5	-3.26	YES
255	77	57	3	27.78	24.78	31.04	River	-42406.5	-0.5	-3.26	YES
780	122	86	3	3.38	1.07	6.63	River	-136777.7	-1.6	-3.25	YES
533	95	70	3	23.12	21.12	26.35	River	-254838.3	-2.9	-3.23	YES
662	105	88	3	43.63	40.74	46.86	River	-114292.3	-1.3	-3.23	YES
628	103	95	3	51.29	48.32	54.51	River	-874.6	0.0	-3.22	YES
844	146	105	3	0.89	-4.11	4.11	River	-577946.8	-6.7	-3.22	YES
410	88	47	3	3.00	0.00	6.21	River	-194215.0	-2.2	-3.22	YES
410	88	47	3	3.00	0.00	6.21	River	-194215.0	-2.2	-3.21	YES
767	118	113	3	4.43	-0.57	7.63	River	-293668.0	-3.4	-3.20	YES
562	99	77	3	33.89	32.36	37.09	River	-21889.7	-0.3	-3.20	YES
769	119	112	3	4.15	-0.85	7.30	River	-314313.0	-3.6	-3.15	YES
553	98	76	3	33.13	31.28	36.23	River	-14209.3	-0.2	-3.11	YES
569	99	124	3	21.53	18.47	24.62	River	-156664.0	-1.8	-3.09	YES
767	118	113	3	4.54	-0.46	7.63	River	-293668.0	-3.4	-3.09	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
624	103	89	3	48.80	46.75	51.89	River	-14751.7	-0.2	-3.09	YES
766	118	112	3	4.51	-0.49	7.58	River	-482763.6	-5.6	-3.07	YES
113	66	105	3	36.32	31.32	39.39	River	-161446.1	-1.9	-3.07	YES
129	67	105	3	36.18	31.18	39.24	River	-331781.2	-3.8	-3.07	YES
884	150	131	3	21.43	18.29	24.49	River	-78710.2	-0.9	-3.07	YES
114	66	106	3	37.30	32.30	40.36	River	-432513.0	-5.0	-3.06	YES
132	67	108	3	38.23	33.23	41.27	River	-404641.0	-4.7	-3.04	YES
116	66	108	3	38.68	33.68	41.71	River	-225223.4	-2.6	-3.03	YES
376	86	46	3	7.61	4.61	10.63	River	-233261.6	-2.7	-3.01	YES
131	67	107	3	37.68	32.68	40.69	River	-378652.6	-4.4	-3.01	YES
895	152	128	3	11.10	7.10	14.08	River	-57221.7	-0.7	-2.98	YES
875	149	134	3	35.54	32.54	38.51	River	-70800.3	-0.8	-2.97	YES
113	66	105	3	36.42	31.42	39.39	River	-161446.1	-1.9	-2.97	YES
770	119	113	3	4.36	-0.64	7.30	River	-415894.9	-4.8	-2.94	YES
648	104	88	3	46.28	43.87	49.20	River	-51845.9	-0.6	-2.93	YES
353	85	46	3	9.40	6.40	12.32	River	-261598.5	-3.0	-2.92	YES
128	67	104	3	35.73	30.73	38.64	River	-457688.3	-5.3	-2.91	YES
410	88	47	3	3.30	0.30	6.21	River	-194215.0	-2.2	-2.91	YES
899	153	127	3	8.37	4.14	11.27	River	-103162.4	-1.2	-2.90	YES
843	146	104	3	0.75	-4.25	3.63	River	-523487.3	-6.1	-2.89	YES
129	67	105	3	36.37	31.37	39.24	River	-331781.2	-3.8	-2.87	YES
963	162	135	3	31.12	28.12	33.99	River	-15902.2	-0.2	-2.87	YES
476	91	67	3	20.01	18.16	22.87	River	-93512.5	-1.1	-2.86	YES
492	92	77	3	45.83	43.83	48.68	River	-76229.3	-0.9	-2.85	YES
130	67	106	3	37.20	32.20	40.04	River	-15504.5	-0.2	-2.84	YES
354	85	47	3	10.37	7.37	13.20	River	-205385.5	-2.4	-2.83	YES
843	146	104	3	0.81	-4.19	3.63	River	-523487.3	-6.1	-2.82	YES
376	86	46	3	7.81	4.81	10.63	River	-233261.6	-2.7	-2.82	YES
843	146	104	3	0.85	-4.15	3.63	River	-523487.3	-6.1	-2.78	YES
395	87	47	3	4.84	1.84	7.62	River	-239539.7	-2.8	-2.77	YES
247	76	57	3	29.66	26.66	32.42	River	-220176.6	-2.5	-2.76	YES
899	153	127	3	8.51	4.20	11.27	River	-103162.4	-1.2	-2.76	YES
353	85	46	3	9.57	6.57	12.32	River	-261598.5	-3.0	-2.75	YES
107	66	94	3	37.72	33.34	40.46	River	-286482.2	-3.3	-2.74	YES
123	67	95	3	35.75	31.21	38.48	River	-1341544.0	-15.5	-2.73	YES
340	84	48	3	12.29	9.42	15.00	River	-190360.2	-2.2	-2.71	YES
476	91	67	3	20.18	18.34	22.87	River	-93512.5	-1.1	-2.69	YES
493	92	78	3	49.44	47.44	52.13	River	-160795.4	-1.9	-2.69	YES
135	67	111	3	40.33	35.33	43.01	River	-143724.1	-1.7	-2.68	YES
133	67	109	3	39.23	34.23	41.90	River	-309698.1	-3.6	-2.67	YES
129	67	105	3	36.58	31.58	39.24	River	-331781.2	-3.8	-2.66	YES
411	88	48	3	2.99	-0.01	5.64	River	-53794.5	-0.6	-2.65	YES
411	88	48	3	3.00	0.00	5.64	River	-53794.5	-0.6	-2.64	YES
113	66	105	3	36.75	31.75	39.39	River	-161446.1	-1.9	-2.64	YES
134	67	110	3	39.85	34.85	42.47	River	-451515.2	-5.2	-2.62	YES
55	52	91	3	57.42	54.51	60.03	River	-764505.4	-8.8	-2.61	YES
48	51	87	3	62.62	59.86	65.22	River	-784484.9	-9.1	-2.60	YES
49	51	88	3	61.55	58.76	64.13	River	-727329.9	-8.4	-2.58	YES
264	78	36	3	11.30	8.49	13.86	River	-281834.4	-3.3	-2.56	YES
995	172	152	3	28.70	25.36	31.24	River	-202842.9	-2.3	-2.54	YES
853	147	104	3	0.77	-4.23	3.28	River	-14400.8	-0.2	-2.51	YES
971	167	145	3	27.90	22.90	30.40	River	-344933.6	-4.0	-2.50	YES
842	146	103	3	0.70	-4.30	3.20	River	-133605.6	-1.5	-2.50	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
890	151	128	3	13.32	9.51	15.79	River	-52311.3	-0.6	-2.46	YES
501	93	63	3	8.23	6.26	10.69	River	-212350.4	-2.5	-2.46	YES
970	167	144	3	27.59	22.74	30.01	River	-338666.8	-3.9	-2.42	YES
894	152	127	3	9.87	5.76	12.28	River	-26916.3	-0.3	-2.41	YES
896	153	124	3	6.56	2.31	8.97	River	-48181.5	-0.6	-2.41	YES
273	78	65	3	54.26	54.26	56.65	River	-324911.9	-3.8	-2.39	YES
395	87	47	3	5.23	2.23	7.62	River	-239539.7	-2.8	-2.38	YES
626	103	93	3	51.07	48.96	53.44	River	-35303.2	-0.4	-2.37	YES
346	84	71	3	59.99	58.90	62.34	River	49639.2	0.6	-2.35	YES
256	77	65	3	56.84	56.84	59.19	River	-120482.9	-1.4	-2.35	YES
429	89	48	3	2.99	-0.01	5.32	River	-15027.9	-0.2	-2.33	YES
52	52	88	3	60.87	58.06	63.18	River	-205740.6	-2.4	-2.31	YES
564	99	79	3	38.56	37.24	40.86	River	1839.6	0.0	-2.30	YES
339	84	47	3	12.18	9.18	14.47	River	-121571.4	-1.4	-2.29	YES
257	77	66	3	58.66	58.66	60.93	River	-232409.4	-2.7	-2.27	YES
477	91	68	3	22.60	20.79	24.87	River	-220155.0	-2.5	-2.27	YES
985	170	130	3	0.40	-4.60	2.64	River	-291767.4	-3.4	-2.24	YES
325	83	48	3	14.07	11.29	16.31	River	-33633.8	-0.4	-2.24	YES
250	77	36	3	13.61	10.99	15.85	River	-308524.4	-3.6	-2.24	YES
729	111	97	3	42.86	39.69	45.09	River	-44354.1	-0.5	-2.23	YES
238	75	57	3	32.31	29.31	34.52	River	-113670.8	-1.3	-2.21	YES
811	138	129	3	38.95	35.95	41.16	River	-300.8	0.0	-2.21	YES
991	171	128	3	0.11	-4.89	2.28	River	-61926.6	-0.7	-2.17	YES
970	167	144	3	27.87	22.87	30.01	River	-338666.8	-3.9	-2.14	YES
622	103	86	3	48.82	46.73	50.94	River	-12814.6	-0.1	-2.12	YES
43	49	84	3	69.36	66.81	71.47	River	-292909.1	-3.4	-2.11	YES
111	66	103	3	34.69	29.69	36.79	River	-362543.8	-4.2	-2.10	YES
547	97	79	3	45.51	43.52	47.61	River	-3671.0	0.0	-2.09	YES
175	70	115	3	43.52	38.52	45.60	River	-260522.8	-3.0	-2.09	YES
176	70	116	3	44.30	39.30	46.39	River	-48808.5	-0.6	-2.09	YES
261	77	70	3	68.77	68.77	70.85	River	-114150.0	-1.3	-2.07	YES
428	89	47	3	2.99	-0.02	5.05	River	-104768.1	-1.2	-2.06	YES
643	104	69	3	7.48	4.81	9.54	River	-14858.0	-0.2	-2.06	YES
148	68	112	3	41.18	36.18	43.23	River	-234339.7	-2.7	-2.05	YES
717	110	98	3	45.60	42.51	47.65	River	-6230.7	-0.1	-2.05	YES
993	171	151	3	28.53	23.53	30.56	River	-295576.2	-3.4	-2.03	YES
242	76	36	3	15.16	12.67	17.18	River	-146960.2	-1.7	-2.02	YES
147	68	111	3	40.69	35.69	42.69	River	-229147.5	-2.7	-2.00	YES
993	171	151	3	28.57	23.84	30.56	River	-295576.2	-3.4	-1.98	YES
852	147	103	3	0.59	-4.41	2.54	River	-357840.3	-4.1	-1.95	YES
108	66	95	3	37.42	33.01	39.36	River	-295847.4	-3.4	-1.95	YES
523	94	70	3	24.55	22.55	26.48	River	-34602.1	-0.4	-1.93	YES
202	73	41	3	27.79	27.01	29.72	River	-305524.3	-3.5	-1.93	YES
563	99	78	3	35.96	34.53	37.88	River	-5122.7	-0.1	-1.91	YES
989	170	150	3	28.45	23.45	30.35	River	-282499.1	-3.3	-1.91	YES
56	53	91	3	56.28	53.34	58.18	River	-621314.2	-7.2	-1.90	YES
930	157	124	3	4.29	-0.45	6.18	River	-140532.4	-1.6	-1.89	YES
219	74	41	3	26.13	25.10	28.02	River	-126867.0	-1.5	-1.89	YES
338	84	46	3	11.89	8.89	13.78	River	-112399.8	-1.3	-1.89	YES
54	52	90	3	58.64	55.76	60.52	River	-697072.8	-8.1	-1.88	YES
272	78	64	3	53.64	53.64	55.51	River	-48864.3	-0.6	-1.87	YES
47	51	86	3	64.89	62.20	66.76	River	-79680.4	-0.9	-1.87	YES
188	72	41	3	29.41	28.87	31.26	River	-136624.2	-1.6	-1.85	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
492	92	77	3	46.84	44.84	48.68	River	-76229.3	-0.9	-1.85	YES
258	77	67	3	61.43	61.43	63.26	River	-174832.2	-2.0	-1.83	YES
58	54	92	3	54.48	51.48	56.28	River	-365246.4	-4.2	-1.80	YES
239	75	58	3	34.66	31.66	36.46	River	-116220.4	-1.3	-1.80	YES
974	168	146	3	28.00	23.00	29.79	River	-166890.9	-1.9	-1.79	YES
649	104	89	3	48.08	45.92	49.86	River	-7191.1	-0.1	-1.78	YES
890	151	128	3	14.04	10.02	15.79	River	-52311.3	-0.6	-1.74	YES
57	54	91	3	55.58	52.61	57.30	River	-98981.8	-1.1	-1.73	YES
984	170	129	3	0.28	-4.72	1.98	River	-221522.2	-2.6	-1.70	YES
259	77	68	3	64.07	64.07	65.73	River	-153692.4	-1.8	-1.66	YES
524	94	71	3	26.53	24.53	28.19	River	-192007.2	-2.2	-1.65	YES
405	87	74	3	64.69	63.45	66.32	River	33006.1	0.4	-1.64	YES
53	52	89	3	60.01	57.18	61.63	River	-614253.4	-7.1	-1.63	YES
46	51	85	3	65.81	63.15	67.43	River	-746008.8	-8.6	-1.62	YES
264	78	36	3	12.24	9.51	13.86	River	-281834.4	-3.3	-1.61	YES
103	65	94	3	39.28	35.03	40.89	River	-247926.6	-2.9	-1.61	YES
863	148	124	3	15.66	12.56	17.26	River	-26485.9	-0.3	-1.60	YES
721	110	129	3	23.79	19.29	25.38	River	-167076.2	-1.9	-1.59	YES
909	154	133	3	30.92	27.81	32.50	River	-8651.2	-0.1	-1.58	YES
627	103	94	3	52.38	49.44	53.94	River	-45545.6	-0.5	-1.56	YES
260	77	69	3	66.69	66.69	68.25	River	-146680.2	-1.7	-1.56	YES
851	147	102	3	0.38	-4.62	1.94	River	-29338.2	-0.3	-1.55	YES
862	148	103	3	0.50	-4.50	2.05	River	-4923.4	-0.1	-1.54	YES
158	69	112	3	41.62	36.62	43.15	River	-140784.6	-1.6	-1.53	YES
161	69	115	3	43.97	38.97	45.48	River	-169344.3	-2.0	-1.51	YES
941	158	124	3	3.37	-1.43	4.87	River	-3027.5	0.0	-1.51	YES
50	52	86	3	64.24	61.53	65.73	River	-469111.8	-5.4	-1.50	YES
553	98	76	3	34.76	32.89	36.23	River	-14209.3	-0.2	-1.47	YES
173	70	113	3	42.60	37.60	44.06	River	-7241.1	-0.1	-1.47	YES
123	67	95	3	37.02	32.59	38.48	River	-1341544.0	-15.5	-1.46	YES
983	170	128	3	0.17	-4.83	1.61	River	-146809.5	-1.7	-1.45	YES
973	168	145	3	27.94	22.94	29.38	River	-210158.2	-2.4	-1.44	YES
45	50	85	3	67.42	64.81	68.85	River	-595140.1	-6.9	-1.43	YES
159	69	113	3	42.20	37.20	43.62	River	-255949.2	-3.0	-1.42	YES
892	152	124	3	8.42	4.42	9.84	River	-30476.8	-0.4	-1.41	YES
565	99	80	3	44.61	43.55	45.99	River	-8596.9	-0.1	-1.39	YES
982	169	148	3	28.23	23.23	29.61	River	-281594.3	-3.3	-1.38	YES
104	65	95	3	38.70	34.41	40.08	River	-268828.9	-3.1	-1.37	YES
175	70	115	3	44.23	39.23	45.60	River	-260522.8	-3.0	-1.37	YES
186	71	116	3	45.28	40.28	46.64	River	-229098.8	-2.7	-1.36	YES
476	91	67	3	21.52	19.71	22.87	River	-93512.5	-1.1	-1.35	YES
324	83	47	3	14.48	11.48	15.82	River	-69874.3	-0.8	-1.34	YES
174	70	114	3	42.99	37.99	44.33	River	-244105.4	-2.8	-1.34	YES
58	54	92	3	54.99	52.00	56.28	River	-365246.4	-4.2	-1.30	YES
337	84	45	3	11.79	8.79	13.08	River	-51691.3	-0.6	-1.29	YES
326	83	49	3	15.25	12.53	16.55	River	-53370.1	-0.6	-1.29	YES
389	86	76	3	77.14	76.08	78.39	River	-108523.4	-1.3	-1.24	YES
730	111	98	3	44.80	41.69	46.03	River	-6849.6	-0.1	-1.23	YES
108	66	95	3	38.16	33.81	39.36	River	-295847.4	-3.4	-1.21	YES
177	71	41	3	32.51	32.43	33.71	River	-80392.2	-0.9	-1.20	YES
869	149	103	3	0.19	-4.81	1.39	River	-110541.2	-1.3	-1.20	YES
606	102	94	3	53.91	51.01	55.11	River	-7153.8	-0.1	-1.20	YES
38	48	81	3	73.93	71.52	75.12	River	-232172.5	-2.7	-1.19	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
44	50	84	3	68.64	66.07	69.83	River	-297939.2	-3.4	-1.18	YES
187	71	117	3	45.90	40.90	47.05	River	-139277.8	-1.6	-1.15	YES
51	52	87	3	63.42	60.69	64.55	River	-150640.1	-1.7	-1.13	YES
42	49	83	3	70.63	68.12	71.74	River	-613422.3	-7.1	-1.11	YES
894	152	127	3	11.18	7.00	12.28	River	-26916.3	-0.3	-1.10	YES
497	93	52	3	3.00	1.36	4.09	River	-66758.8	-0.8	-1.09	YES
521	94	62	3	6.58	4.60	7.66	River	-81361.5	-0.9	-1.09	YES
185	71	115	3	44.87	39.87	45.96	River	-23917.5	-0.3	-1.08	YES
396	87	48	3	3.00	0.00	4.08	River	3227.2	0.0	-1.08	YES
352	85	45	3	10.60	7.60	11.67	River	-23374.9	-0.3	-1.06	YES
323	83	46	3	14.09	11.09	15.16	River	-102422.4	-1.2	-1.06	YES
188	72	41	3	30.20	29.78	31.26	River	-136624.2	-1.6	-1.05	YES
198	72	117	3	46.31	41.31	47.33	River	-71358.8	-0.8	-1.02	YES
175	70	115	3	44.59	39.59	45.60	River	-260522.8	-3.0	-1.01	YES
518	94	52	3	1.97	0.20	2.98	River	-85899.3	-1.0	-1.01	YES
992	171	150	3	28.50	23.50	29.49	River	-52853.6	-0.6	-1.00	YES
981	169	147	3	28.14	23.14	29.13	River	-181185.2	-2.1	-0.99	YES
517	94	51	3	1.15	-0.71	2.14	River	-29641.4	-0.3	-0.99	YES
500	93	62	3	7.37	5.40	8.35	River	-63747.7	-0.7	-0.98	YES
273	78	65	3	55.66	55.66	56.65	River	-324911.9	-3.8	-0.98	YES
513	93	78	3	47.79	45.79	48.77	River	-78.2	0.0	-0.97	YES
407	87	76	3	71.58	70.44	72.53	River	-77058.5	-0.9	-0.95	YES
323	83	46	3	14.21	11.21	15.16	River	-102422.4	-1.2	-0.95	YES
338	84	46	3	12.84	9.84	13.78	River	-112399.8	-1.3	-0.94	YES
861	148	102	3	0.38	-4.62	1.32	River	-225123.0	-2.6	-0.94	YES
313	82	49	3	17.27	14.64	18.20	River	-42564.3	-0.5	-0.93	YES
39	48	82	3	73.23	70.80	74.16	River	-294638.2	-3.4	-0.93	YES
988	170	149	3	28.37	23.37	29.29	River	-163188.0	-1.9	-0.92	YES
621	103	85	3	48.44	46.27	49.35	River	-8366.9	-0.1	-0.92	YES
307	82	27	3	4.80	-0.20	5.72	River	-83040.3	-1.0	-0.91	YES
861	148	102	3	0.42	-4.58	1.32	River	-225123.0	-2.6	-0.90	YES
861	148	102	3	0.48	-4.52	1.32	River	-225123.0	-2.6	-0.85	YES
850	147	101	3	0.31	-4.69	1.15	River	-117380.9	-1.4	-0.84	YES
938	157	134	3	27.70	24.70	28.53	River	-1224.6	0.0	-0.82	YES
887	151	124	3	10.27	6.49	10.99	River	-14121.6	-0.2	-0.72	YES
980	169	146	3	28.06	23.06	28.78	River	-113884.5	-1.3	-0.72	YES
498	93	53	3	3.91	2.38	4.63	River	-47844.0	-0.6	-0.71	YES
223	74	58	3	39.89	36.89	40.60	River	-22530.7	-0.3	-0.71	YES
450	90	47	3	2.98	-0.03	3.68	River	-36464.2	-0.4	-0.70	YES
36	47	80	3	76.23	73.89	76.91	River	-188960.0	-2.2	-0.68	YES
174	70	114	3	43.66	38.66	44.33	River	-244105.4	-2.8	-0.66	YES
60	55	92	3	53.80	50.74	54.46	River	-242405.6	-2.8	-0.66	YES
286	79	64	3	49.77	49.77	50.42	River	-44038.0	-0.5	-0.65	YES
712	109	128	3	22.52	17.76	23.16	River	-72384.7	-0.8	-0.63	YES
902	153	132	3	27.55	24.23	28.16	River	-1799.4	0.0	-0.62	YES
41	49	82	3	72.14	69.68	72.75	River	-165438.7	-1.9	-0.60	YES
199	72	118	3	46.96	41.96	47.56	River	-140352.4	-1.6	-0.60	YES
877	150	103	3	0.08	-4.92	0.66	River	-75518.4	-0.9	-0.58	YES
661	105	87	3	45.22	42.39	45.79	River	4949.3	0.1	-0.57	YES
860	148	101	3	0.21	-4.79	0.78	River	-44985.0	-0.5	-0.57	YES
204	73	58	3	42.30	39.30	42.86	River	-49476.0	-0.6	-0.57	YES
365	85	72	3	63.43	62.40	63.99	River	-23104.9	-0.3	-0.56	YES
37	48	80	3	75.45	73.08	76.00	River	-82389.2	-1.0	-0.56	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
543	97	60	3	2.57	0.58	3.12	River	-8591.0	-0.1	-0.55	YES
512	93	77	3	44.59	42.59	45.13	River	-12838.1	-0.1	-0.54	YES
575	100	78	3	37.25	35.86	37.78	River	-1697.2	0.0	-0.53	YES
889	151	127	3	13.22	9.16	13.75	River	4191.3	0.0	-0.53	YES
243	76	37	3	16.41	14.02	16.94	River	-51003.1	-0.6	-0.53	YES
868	149	102	3	0.28	-4.72	0.81	River	-36286.4	-0.4	-0.53	YES
552	98	60	3	1.62	-0.38	2.14	River	-45450.4	-0.5	-0.52	YES
38	48	81	3	74.61	72.22	75.12	River	-232172.5	-2.7	-0.51	YES
553	98	76	3	35.73	33.85	36.23	River	-14209.3	-0.2	-0.50	YES
311	82	46	3	16.06	13.06	16.53	River	-33502.5	-0.4	-0.47	YES
245	76	47	3	29.91	26.91	30.38	River	-1936.1	0.0	-0.47	YES
312	82	47	3	16.84	13.84	17.26	River	-17848.3	-0.2	-0.42	YES
160	69	114	3	43.70	38.70	44.12	River	-5792.1	-0.1	-0.41	YES
520	94	61	3	6.02	4.05	6.40	River	-8483.7	-0.1	-0.38	YES
509	93	74	3	34.66	32.66	35.04	River	50619.4	0.6	-0.37	YES
876	149	135	3	39.21	36.21	39.58	River	-2440.2	0.0	-0.37	YES
477	91	68	3	24.50	22.74	24.87	River	-220155.0	-2.5	-0.37	YES
488	92	53	3	5.09	3.70	5.46	River	-36789.2	-0.4	-0.37	YES
231	75	37	3	17.47	15.18	17.82	River	-3900.5	0.0	-0.34	YES
987	170	148	3	28.31	23.31	28.63	River	-29822.4	-0.3	-0.32	YES
97	64	93	3	41.93	37.89	42.25	River	-8840.7	-0.1	-0.32	YES
299	81	47	3	18.51	15.51	18.82	River	14182.8	0.2	-0.31	YES
366	85	73	3	69.08	68.08	69.39	River	-57096.1	-0.7	-0.31	YES
368	85	75	3	80.91	79.90	81.21	River	-6978.9	-0.1	-0.30	YES
104	65	95	3	39.78	35.57	40.08	River	-268828.9	-3.1	-0.30	YES
559	99	60	3	0.84	-1.16	1.14	River	-14971.8	-0.2	-0.30	YES
299	81	47	3	18.55	15.55	18.82	River	14182.8	0.2	-0.27	YES
870	149	124	3	14.05	10.75	14.31	River	-5101.8	-0.1	-0.26	YES
621	103	85	3	49.09	47.07	49.35	River	-8366.9	-0.1	-0.26	YES
576	100	79	3	38.15	36.81	38.41	River	699.0	0.0	-0.26	YES
878	150	124	3	12.16	8.63	12.42	River	-5753.5	-0.1	-0.25	YES
930	157	124	3	5.96	1.32	6.18	River	-140532.4	-1.6	-0.22	YES
211	73	118	3	47.58	42.58	47.79	River	-11973.0	-0.1	-0.22	YES
931	157	125	3	7.76	3.23	7.98	River	1835.9	0.0	-0.22	YES
538	96	61	3	3.91	1.93	4.12	River	4607.7	0.1	-0.21	YES
311	82	46	3	16.33	13.33	16.53	River	-33502.5	-0.4	-0.20	YES
449	90	33	3	0.00	-5.00	0.19	River	-2220.4	0.0	-0.19	YES
298	81	46	3	17.80	14.80	17.96	River	-6491.9	-0.1	-0.17	YES
525	94	72	3	29.74	27.74	29.87	River	-13099.9	-0.2	-0.13	YES
39	48	82	3	74.05	71.64	74.16	River	-294638.2	-3.4	-0.11	YES
940	158	123	3	0.05	-4.95	0.15	River	4639.4	0.1	-0.10	YES
885	150	132	3	22.97	19.97	23.06	River	1970.4	0.0	-0.09	YES
275	78	71	3	72.47	72.47	72.55	River	-10636.9	-0.1	-0.08	YES
65	56	92	3	52.53	49.37	52.61	River	-27510.2	-0.3	-0.08	YES
859	148	100	3	0.14	-4.86	0.22	River	-5673.6	-0.1	-0.08	YES
212	73	119	3	47.90	42.90	47.97	River	-4779.2	-0.1	-0.06	YES
642	104	68	3	4.65	1.86	4.71	River	-314.2	0.0	-0.05	YES
218	74	40	3	24.69	23.44	24.72	River	-4168.9	0.0	-0.03	YES
552	98	60	3	2.11	0.12	2.14	River	-45450.4	-0.5	-0.03	YES
552	98	60	3	2.11	0.12	2.14	River	-45450.4	-0.5	-0.03	YES
99	64	95	3	40.34	36.17	40.35	River	-3161.9	0.0	-0.02	YES
531	95	61	3	5.29	3.31	5.31	River	-1552.2	0.0	-0.01	YES
886	151	103	3	0.00	-5.00	0.01	River	-17.8	0.0	0.00	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
300	81	49	3	20.03	17.53	19.99	River	772.0	0.0	0.04	YES
867	149	100	3	0.05	-4.95	0.01	River	4464.4	0.1	0.04	YES
641	104	67	3	2.19	-0.72	2.14	River	239.2	0.0	0.04	YES
990	171	127	3	0.05	-4.95	0.00	River	4346.4	0.1	0.04	YES
299	81	47	3	18.90	15.90	18.82	River	14182.8	0.2	0.08	YES
98	64	94	3	41.27	37.19	41.19	River	27636.3	0.3	0.08	YES
941	158	124	3	4.96	0.27	4.87	River	-3027.5	0.0	0.09	YES
478	91	69	3	26.92	25.17	26.82	River	7709.5	0.1	0.10	YES
571	100	59	3	0.11	-1.89	0.00	River	1189.1	0.0	0.11	YES
89	62	93	3	44.14	40.29	44.01	River	48363.8	0.6	0.13	YES
558	99	59	3	0.28	-1.72	0.14	River	95533.6	1.1	0.14	YES
85	61	93	3	45.42	41.68	45.28	River	51978.8	0.6	0.15	YES
661	105	87	3	45.96	43.24	45.79	River	4949.3	0.1	0.16	YES
274	78	70	3	70.12	70.12	69.96	River	0.0	0.0	0.16	YES
538	96	61	3	4.30	2.33	4.12	River	4607.7	0.1	0.18	YES
545	97	77	3	38.91	36.99	38.72	River	17284.3	0.2	0.19	YES
544	97	61	3	3.30	1.31	3.11	River	9418.8	0.1	0.19	YES
607	102	95	3	55.78	52.93	55.53	River	4430.3	0.1	0.25	YES
890	151	128	3	16.04	12.13	15.79	River	-52311.3	-0.6	0.25	YES
778	122	84	3	0.34	-2.00	0.09	River	3457.4	0.0	0.26	YES
188	72	41	3	31.53	31.31	31.26	River	-136624.2	-1.6	0.27	YES
474	91	53	3	6.51	5.29	6.22	River	28418.5	0.3	0.28	YES
647	104	87	3	48.83	46.15	48.54	River	5170.7	0.1	0.29	YES
959	160	134	3	23.85	20.85	23.55	River	2074.7	0.0	0.30	YES
168	70	61	3	54.91	52.25	54.60	River	20328.4	0.2	0.31	YES
872	149	129	3	22.79	19.25	22.48	River	6998.2	0.1	0.31	YES
387	86	74	3	73.14	72.02	72.82	River	34166.9	0.4	0.31	YES
231	75	37	3	18.13	15.91	17.82	River	-3900.5	0.0	0.32	YES
299	81	47	3	19.14	16.14	18.82	River	14182.8	0.2	0.33	YES
646	104	86	3	47.65	45.30	47.32	River	6707.0	0.1	0.33	YES
538	96	61	3	4.47	2.49	4.12	River	4607.7	0.1	0.35	YES
543	97	60	3	3.47	1.52	3.12	River	-8591.0	-0.1	0.35	YES
529	95	51	3	0.47	-1.47	0.10	River	24520.0	0.3	0.37	YES
312	82	47	3	17.65	14.65	17.26	River	-17848.3	-0.2	0.39	YES
420	88	76	3	66.77	65.57	66.38	River	37989.5	0.4	0.39	YES
537	96	60	3	4.58	2.65	4.18	River	63921.4	0.7	0.40	YES
314	82	50	3	18.87	16.32	18.46	River	-86044.1	-1.0	0.41	YES
730	111	98	3	46.44	43.37	46.03	River	-6849.6	-0.1	0.41	YES
212	73	119	3	48.38	43.38	47.97	River	-4779.2	-0.1	0.41	YES
640	104	66	3	0.48	-2.49	0.05	River	954.5	0.0	0.43	YES
367	85	74	3	77.43	76.43	76.98	River	50533.7	0.6	0.45	YES
564	99	79	3	41.32	40.11	40.86	River	1839.6	0.0	0.45	YES
731	111	99	3	48.14	45.11	47.67	River	7249.7	0.1	0.46	YES
885	150	132	3	23.52	20.52	23.06	River	1970.4	0.0	0.47	YES
200	72	119	3	48.24	43.24	47.77	River	29006.0	0.3	0.47	YES
554	98	77	3	37.58	35.68	37.11	River	4922.9	0.1	0.47	YES
404	87	73	3	61.14	59.86	60.66	River	42070.2	0.5	0.48	YES
720	110	128	3	23.18	18.55	22.69	River	16272.1	0.2	0.48	YES
961	161	134	3	27.63	24.63	27.14	River	651.2	0.0	0.49	YES
661	105	87	3	46.29	43.51	45.79	River	4949.3	0.1	0.49	YES
83	60	93	3	46.89	43.26	46.39	River	232714.9	2.7	0.50	YES
386	86	72	3	60.51	59.42	60.02	River	27623.6	0.3	0.50	YES
68	57	92	3	51.25	47.98	50.75	River	187029.9	2.2	0.50	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
265	78	47	3	25.78	22.81	25.28	River	62285.4	0.7	0.50	YES
546	97	78	3	43.61	41.64	43.11	River	2546.5	0.0	0.50	YES
91	63	93	3	42.73	38.76	42.21	River	221695.2	2.6	0.52	YES
882	150	129	3	20.78	17.13	20.24	River	-61111.2	-0.7	0.54	YES
213	73	120	3	48.73	43.73	48.14	River	92492.0	1.1	0.58	YES
192	72	58	3	45.28	42.28	44.67	River	36254.2	0.4	0.61	YES
72	58	92	3	50.09	46.72	49.47	River	171601.8	2.0	0.62	YES
368	85	75	3	81.85	80.85	81.21	River	-6978.9	-0.1	0.64	YES
440	89	75	3	57.89	56.56	57.24	River	113336.1	1.3	0.65	YES
576	100	79	3	39.08	37.77	38.41	River	699.0	0.0	0.67	YES
944	158	127	3	10.88	6.73	10.21	River	800.0	0.0	0.67	YES
526	94	73	3	32.57	30.57	31.82	River	67404.9	0.8	0.75	YES
276	78	72	3	75.67	75.67	74.91	River	0.0	0.0	0.76	YES
179	71	58	3	46.74	43.74	45.97	River	28220.5	0.3	0.77	YES
623	103	87	3	52.42	49.88	51.63	River	14736.0	0.2	0.79	YES
346	84	71	3	63.15	62.11	62.34	River	49639.2	0.6	0.80	YES
881	150	128	3	18.63	14.86	17.82	River	19665.9	0.2	0.81	YES
251	77	47	3	28.70	25.70	27.87	River	42603.5	0.5	0.83	YES
73	58	93	3	49.37	45.95	48.51	River	107493.4	1.2	0.86	YES
554	98	77	3	38.01	36.11	37.11	River	4922.9	0.1	0.90	YES
405	87	74	3	67.27	66.07	66.32	River	33006.1	0.4	0.95	YES
551	98	59	3	2.84	0.91	1.89	River	80577.3	0.9	0.95	YES
347	84	72	3	69.80	68.80	68.85	River	95305.6	1.1	0.95	YES
214	73	121	3	49.29	44.29	48.32	River	182898.2	2.1	0.96	YES
291	80	47	3	21.59	18.59	20.62	River	55449.3	0.6	0.96	YES
79	59	93	3	48.44	44.94	47.47	River	385759.4	4.5	0.97	YES
558	99	59	3	1.11	-0.86	0.14	River	95533.6	1.1	0.97	YES
299	81	47	3	19.79	16.79	18.82	River	14182.8	0.2	0.98	YES
473	91	47	3	2.97	-0.04	1.96	River	25067.0	0.3	1.01	YES
292	80	50	3	23.47	21.15	22.43	River	45180.0	0.5	1.04	YES
168	70	61	3	55.64	53.34	54.60	River	20328.4	0.2	1.04	YES
931	157	125	3	9.04	4.60	7.98	River	1835.9	0.0	1.07	YES
605	102	87	3	56.07	53.68	54.99	River	20073.3	0.2	1.07	YES
265	78	47	3	26.36	23.36	25.28	River	62285.4	0.7	1.08	YES
281	79	47	3	23.88	20.88	22.80	River	79305.0	0.9	1.08	YES
537	96	60	3	5.26	3.37	4.18	River	63921.4	0.7	1.08	YES
943	158	126	3	10.18	5.92	9.08	River	6242.9	0.1	1.09	YES
301	81	50	3	21.51	19.09	20.38	River	56770.2	0.7	1.13	YES
509	93	74	3	36.20	34.20	35.04	River	50619.4	0.6	1.16	YES
932	157	126	3	10.50	6.14	9.34	River	19272.1	0.2	1.16	YES
889	151	127	3	14.93	10.96	13.75	River	4191.3	0.0	1.17	YES
451	90	53	3	8.13	7.10	6.94	River	133550.0	1.5	1.19	YES
940	158	123	3	1.37	-3.55	0.15	River	4639.4	0.1	1.22	YES
388	86	75	3	78.37	77.32	77.16	River	43919.3	0.5	1.22	YES
277	78	73	3	78.28	78.28	77.01	River	0.0	0.0	1.26	YES
313	82	49	3	19.46	16.94	18.20	River	-42564.3	-0.5	1.27	YES
945	158	129	3	13.08	9.29	11.79	River	199.9	0.0	1.29	YES
166	70	59	3	50.77	47.93	49.48	River	17710.6	0.2	1.29	YES
438	89	73	3	47.45	45.98	46.15	River	38623.9	0.4	1.30	YES
931	157	125	3	9.30	4.86	7.98	River	1835.9	0.0	1.32	YES
455	90	69	3	29.36	27.65	28.02	River	229065.2	2.7	1.35	YES
591	101	87	3	59.83	57.59	58.47	River	26821.1	0.3	1.36	YES
545	97	77	3	40.12	38.19	38.72	River	17284.3	0.2	1.40	YES

	Exported								Calculated		
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	i	j	k								
593	101	95	3	57.96	55.16	56.52	River	14137.4	0.2	1.44	YES
201	72	121	3	49.59	44.59	48.16	River	60231.7	0.7	1.44	YES
949	159	127	3	11.41	7.36	9.96	River	5940.6	0.1	1.45	YES
169	70	62	3	58.46	58.10	56.99	River	1143.2	0.0	1.47	YES
542	97	59	3	4.57	2.68	3.10	River	134180.0	1.6	1.47	YES
214	73	121	3	49.80	44.80	48.32	River	182898.2	2.1	1.48	YES
951	159	129	3	13.00	9.19	11.47	River	11266.7	0.1	1.53	YES
950	159	128	3	12.38	8.48	10.80	River	8544.2	0.1	1.57	YES
865	148	129	3	26.38	23.04	24.81	River	75356.4	0.9	1.58	YES
396	87	48	3	5.68	2.68	4.08	River	3227.2	0.0	1.61	YES
167	70	60	3	53.71	51.00	52.09	River	17985.3	0.2	1.62	YES
215	73	122	3	50.13	45.13	48.48	River	154472.0	1.8	1.65	YES
268	78	51	3	28.99	26.94	27.32	River	80706.0	0.9	1.67	YES
543	97	60	3	4.82	2.91	3.12	River	-8591.0	-0.1	1.70	YES
543	97	60	3	4.83	2.92	3.12	River	-8591.0	-0.1	1.71	YES
121	67	63	3	62.19	62.19	60.47	River	0.0	0.0	1.72	YES
282	79	51	3	26.79	24.63	25.04	River	99141.0	1.1	1.75	YES
577	100	87	3	63.68	61.60	61.92	River	34531.2	0.4	1.76	YES
232	75	38	3	19.60	17.60	17.79	River	287896.8	3.3	1.81	YES
407	87	76	3	74.39	73.28	72.53	River	-77058.5	-0.9	1.86	YES
179	71	58	3	47.85	44.89	45.97	River	28220.5	0.3	1.88	YES
857	147	129	3	28.73	25.51	26.84	River	13065.2	0.2	1.89	YES
942	158	125	3	9.37	4.98	7.48	River	4194.0	0.0	1.89	YES
536	96	59	3	6.09	4.23	4.17	River	238450.8	2.8	1.92	YES
138	68	62	3	59.70	59.70	57.77	River	0.0	0.0	1.93	YES
168	70	61	3	56.54	54.85	54.60	River	20328.4	0.2	1.94	YES
536	96	59	3	6.20	4.34	4.17	River	238450.8	2.8	2.03	YES
304	81	64	3	44.52	44.52	42.47	River	0.0	0.0	2.04	YES
947	158	134	3	25.04	22.04	22.98	River	16222.8	0.2	2.06	YES
454	90	68	3	28.30	26.61	26.23	River	147811.8	1.7	2.07	YES
228	74	122	3	50.69	45.69	48.60	River	359879.3	4.2	2.09	YES
508	93	73	3	34.18	32.18	32.07	River	38453.8	0.4	2.11	YES
951	159	129	3	13.59	9.88	11.47	River	11266.7	0.1	2.12	YES
151	69	61	3	57.15	55.89	55.04	River	14273.7	0.2	2.12	YES
430	89	53	3	9.74	8.90	7.62	River	81559.5	0.9	2.12	YES
281	79	47	3	25.02	22.02	22.80	River	79305.0	0.9	2.22	YES
293	80	51	3	24.99	22.75	22.77	River	-494964.6	-5.7	2.22	YES
439	89	74	3	54.60	53.23	52.25	River	79391.8	0.9	2.35	YES
554	98	77	3	39.47	37.55	37.11	River	4922.9	0.1	2.36	YES
345	84	70	3	58.42	57.29	56.03	River	66941.0	0.8	2.39	YES
281	79	47	3	25.27	22.29	22.80	River	79305.0	0.9	2.48	YES
511	93	76	3	42.11	40.11	39.59	River	107709.0	1.2	2.52	YES
539	96	77	3	43.54	41.57	41.02	River	8179.1	0.1	2.53	YES
165	70	58	3	49.35	46.45	46.82	River	42087.8	0.5	2.53	YES
389	86	76	3	80.94	79.92	78.39	River	-108523.4	-1.3	2.55	YES
512	93	77	3	47.70	45.70	45.13	River	-12838.1	-0.1	2.57	YES
932	157	126	3	11.95	7.68	9.34	River	19272.1	0.2	2.61	YES
952	159	130	3	14.67	11.13	12.05	River	15184.0	0.2	2.62	YES
545	97	77	3	41.35	39.40	38.72	River	17284.3	0.2	2.63	YES
229	74	123	3	51.35	46.35	48.72	River	359814.0	4.2	2.64	YES
510	93	75	3	39.08	37.08	36.44	River	112864.1	1.3	2.64	YES
364	85	71	3	60.74	59.66	58.10	River	29882.5	0.3	2.64	YES
545	97	77	3	41.36	39.42	38.72	River	17284.3	0.2	2.64	YES

	Exported								Calculated		
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	i	j	k								
295	80	64	3	47.50	47.50	44.79	River	0.0	0.0	2.72	YES
660	105	86	3	46.75	44.21	43.99	River	32085.5	0.4	2.76	YES
234	75	40	3	23.40	21.96	20.62	River	66351.4	0.8	2.77	YES
932	157	126	3	12.15	7.89	9.34	River	19272.1	0.2	2.81	YES
106	66	63	3	63.57	63.57	60.73	River	0.0	0.0	2.84	YES
455	90	69	3	30.87	29.18	28.02	River	229065.2	2.7	2.86	YES
120	67	62	3	60.90	60.90	58.03	River	0.0	0.0	2.87	YES
472	91	46	3	2.97	-0.05	0.09	River	7026.5	0.1	2.88	YES
431	89	54	3	10.58	9.84	7.69	River	16021.5	0.2	2.88	YES
955	159	133	3	17.95	14.94	15.03	River	24376.2	0.3	2.92	YES
266	78	48	3	28.93	26.07	26.01	River	168024.9	1.9	2.92	YES
217	73	124	3	51.71	46.71	48.72	River	38434.8	0.4	2.98	YES
169	70	62	3	60.00	60.00	56.99	River	1143.2	0.0	3.00	YES
230	74	124	3	51.80	46.80	48.79	River	89621.0	1.0	3.01	YES
166	70	59	3	52.49	49.73	49.48	River	17710.6	0.2	3.02	YES
536	96	59	3	7.20	5.37	4.17	River	238450.8	2.8	3.03	YES
441	89	76	3	63.37	62.11	60.33	River	40766.0	0.5	3.04	YES
216	73	123	3	51.66	46.66	48.61	River	22828.6	0.3	3.06	YES
180	71	59	3	51.83	49.04	48.71	River	13118.0	0.2	3.12	YES
645	104	85	3	48.21	45.99	45.08	River	681.5	0.0	3.13	YES
262	77	73	3	80.73	80.73	77.58	River	0.0	0.0	3.15	YES
403	87	72	3	57.27	55.93	54.10	River	31882.1	0.4	3.17	YES
233	75	39	3	21.91	20.26	18.71	River	257248.2	3.0	3.20	YES
137	68	61	3	58.59	58.30	55.36	River	1308.7	0.0	3.22	YES
165	70	58	3	50.06	47.19	46.82	River	42087.8	0.5	3.24	YES
303	81	63	3	42.42	42.42	39.14	River	0.0	0.0	3.27	YES
412	88	54	3	11.61	10.99	8.27	River	76476.1	0.9	3.34	YES
102	65	63	3	64.48	64.48	61.08	River	0.0	0.0	3.40	YES
333	83	73	3	79.20	78.20	75.75	River	66232.9	0.8	3.45	YES
316	82	63	3	40.28	40.28	36.76	River	0.0	0.0	3.52	YES
955	159	133	3	18.59	15.59	15.03	River	24376.2	0.3	3.56	YES
956	160	130	3	15.26	11.82	11.67	River	37.0	0.0	3.59	YES
592	101	94	3	59.81	57.06	56.18	River	37829.6	0.4	3.63	YES
957	160	131	3	15.86	12.52	12.15	River	19859.2	0.2	3.71	YES
406	87	75	3	74.06	72.95	70.32	River	9399.5	0.1	3.74	YES
137	68	61	3	59.12	59.12	55.36	River	1308.7	0.0	3.76	YES
922	156	126	3	13.33	9.14	9.54	River	15982.9	0.2	3.79	YES
440	89	75	3	61.08	59.80	57.24	River	113336.1	1.3	3.84	YES
901	153	131	3	25.95	22.53	22.10	River	19488.1	0.2	3.85	YES
530	95	59	3	8.97	7.20	5.10	River	149174.2	1.7	3.87	YES
954	159	132	3	17.26	14.14	13.37	River	19514.3	0.2	3.89	YES
182	71	63	3	62.74	62.74	58.84	River	0.0	0.0	3.90	YES
953	159	131	3	16.54	13.31	12.61	River	2504.3	0.0	3.93	YES
539	96	77	3	45.03	43.04	41.02	River	8179.1	0.1	4.01	YES
639	103	146	3	50.95	47.95	46.89	River	108829.3	1.3	4.06	YES
617	102	145	3	50.38	47.38	46.28	River	51417.5	0.6	4.10	YES
169	70	62	3	61.16	61.16	56.99	River	1143.2	0.0	4.16	YES
385	86	71	3	57.17	56.01	52.98	River	63887.2	0.7	4.19	YES
923	156	127	3	14.74	10.64	10.55	River	13962.7	0.2	4.19	YES
455	90	69	3	32.28	30.62	28.02	River	229065.2	2.7	4.26	YES
933	157	127	3	14.70	10.59	10.41	River	23925.3	0.3	4.28	YES
413	88	55	3	12.51	12.00	8.22	River	1231.0	0.0	4.29	YES
96	64	63	3	66.47	66.47	62.09	River	0.0	0.0	4.38	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft) (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
866	148	130	3	32.08	29.04	27.64	River	27095.9	0.3	4.44	YES
908	154	132	3	29.00	25.76	24.48	River	15886.7	0.2	4.51	YES
102	65	63	3	65.61	65.61	61.08	River	0.0	0.0	4.53	YES
331	83	63	3	38.45	38.45	33.91	River	0.0	0.0	4.54	YES
181	71	62	3	61.07	61.07	56.53	River	0.0	0.0	4.54	YES
183	71	64	3	65.65	65.65	60.96	River	0.0	0.0	4.69	YES
916	155	128	3	16.48	12.49	11.72	River	13459.5	0.2	4.77	YES
955	159	133	3	19.88	16.88	15.03	River	24376.2	0.3	4.85	YES
456	90	70	3	34.26	32.61	29.40	River	144611.3	1.7	4.87	YES
397	87	55	3	13.64	13.26	8.71	River	58902.7	0.7	4.93	YES
611	102	139	3	43.50	40.50	38.50	River	636908.9	7.4	5.00	YES
363	85	70	3	55.98	54.81	50.92	River	39596.1	0.5	5.06	YES
578	100	94	3	62.31	59.63	57.21	River	48343.9	0.6	5.10	YES
638	103	145	3	50.65	47.65	45.54	River	538257.9	6.2	5.11	YES
915	155	127	3	15.80	11.77	10.66	River	9419.9	0.1	5.15	YES
332	83	72	3	75.50	74.50	70.27	River	21159.8	0.2	5.22	YES
600	101	139	3	45.44	42.44	40.20	River	521280.4	6.0	5.24	YES
946	158	133	3	21.10	18.10	15.83	River	13390.2	0.2	5.27	YES
601	101	140	3	46.20	43.20	40.88	River	188865.9	2.2	5.32	YES
433	89	68	3	32.92	31.32	27.58	River	174121.9	2.0	5.34	YES
616	102	144	3	50.07	47.07	44.69	River	334252.2	3.9	5.38	YES
459	90	73	3	46.55	45.07	41.14	River	85746.4	1.0	5.41	YES
865	148	129	3	30.33	27.20	24.81	River	75356.4	0.9	5.52	YES
600	101	139	3	45.78	42.78	40.20	River	521280.4	6.0	5.59	YES
519	94	59	3	11.51	9.82	5.91	River	138777.9	1.6	5.61	YES
616	102	144	3	50.31	47.31	44.69	River	334252.2	3.9	5.63	YES
612	102	140	3	45.97	42.97	40.26	River	254578.0	2.9	5.71	YES
59	54	104	3	63.27	60.29	57.52	River	2596286.0	30.0	5.74	YES
460	90	74	3	52.10	50.69	46.28	River	52626.0	0.6	5.81	YES
194	72	65	3	69.24	69.24	63.39	River	0.0	0.0	5.85	YES
330	83	62	3	36.51	36.51	30.64	River	0.0	0.0	5.87	YES
924	156	128	3	17.41	13.47	11.49	River	17260.7	0.2	5.91	YES
415	88	68	3	35.57	34.01	29.55	River	57225.6	0.7	6.01	YES
613	102	141	3	47.38	44.38	41.36	River	514087.8	6.0	6.02	YES
419	88	72	3	53.44	52.05	47.32	River	120260.1	1.4	6.12	YES
398	87	56	3	14.77	14.53	8.64	River	517.0	0.0	6.13	YES
614	102	142	3	48.40	45.40	42.23	River	471981.7	5.5	6.17	YES
637	103	144	3	49.89	46.89	43.68	River	261527.6	3.0	6.21	YES
380	86	56	3	15.58	15.44	9.31	River	15957.2	0.2	6.27	YES
567	99	94	3	64.66	62.04	58.38	River	31234.1	0.4	6.29	YES
947	158	134	3	29.27	26.27	22.98	River	16222.8	0.2	6.29	YES
612	102	140	3	46.62	43.62	40.26	River	254578.0	2.9	6.36	YES
61	55	104	3	61.49	58.67	55.13	River	3859087.5	44.7	6.36	YES
900	153	130	3	24.38	20.86	17.98	River	9860.3	0.1	6.40	YES
193	72	64	3	67.38	67.38	60.96	River	0.0	0.0	6.43	YES
615	102	143	3	49.56	46.56	43.10	River	160732.8	1.9	6.46	YES
599	101	138	3	46.37	43.37	39.86	River	36065.3	0.4	6.51	YES
637	103	144	3	50.22	47.22	43.68	River	261527.6	3.0	6.54	YES
611	102	139	3	45.13	42.13	38.50	River	636908.9	7.4	6.63	YES
267	78	49	3	33.17	30.46	26.53	River	65335.6	0.8	6.64	YES
611	102	139	3	45.15	42.15	38.50	River	636908.9	7.4	6.65	YES
585	100	138	3	47.01	44.01	40.34	River	437581.9	5.1	6.67	YES
101	65	62	3	64.87	64.87	58.18	River	0.0	0.0	6.69	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
329	83	61	3	34.12	34.12	27.41	River	0.0	0.0	6.71	YES
916	155	128	3	18.47	14.59	11.72	River	13459.5	0.2	6.75	YES
152	69	62	3	64.18	64.18	57.42	River	0.0	0.0	6.76	YES
958	160	133	3	21.77	18.77	15.01	River	27.2	0.0	6.76	YES
934	157	128	3	18.06	14.17	11.30	River	21202.3	0.2	6.77	YES
80	59	106	3	52.45	50.42	45.64	River	2351546.3	27.2	6.81	YES
205	73	65	3	71.23	71.23	64.39	River	0.0	0.0	6.84	YES
636	103	143	3	49.40	46.40	42.51	River	385582.8	4.5	6.89	YES
74	58	106	3	53.66	51.51	46.77	River	4058563.5	47.0	6.89	YES
402	87	71	3	52.57	51.32	45.65	River	121652.9	1.4	6.92	YES
206	73	66	3	73.28	73.28	66.35	River	0.0	0.0	6.93	YES
434	89	69	3	36.20	34.62	29.24	River	74852.0	0.9	6.96	YES
70	57	107	3	54.84	52.60	47.85	River	7436595.5	86.1	7.00	YES
917	155	129	3	19.92	16.14	12.91	River	21900.0	0.3	7.02	YES
907	154	130	3	22.86	19.26	15.79	River	19347.2	0.2	7.07	YES
918	155	130	3	21.43	17.74	14.33	River	8708.8	0.1	7.10	YES
165	70	58	3	53.97	51.81	46.82	River	42087.8	0.5	7.15	YES
69	57	106	3	55.06	52.79	47.89	River	2021706.9	23.4	7.17	YES
62	55	105	3	60.81	58.05	53.62	River	6096399.5	70.6	7.18	YES
381	86	57	3	16.57	16.55	9.36	River	669.5	0.0	7.21	YES
636	103	143	3	49.72	46.72	42.51	River	385582.8	4.5	7.21	YES
611	102	139	3	45.75	42.75	38.50	River	636908.9	7.4	7.26	YES
61	55	104	3	62.40	59.51	55.13	River	3859087.5	44.7	7.28	YES
88	62	62	3	69.82	69.82	62.36	River	0.0	0.0	7.46	YES
635	103	142	3	49.04	46.04	41.55	River	273125.9	3.2	7.49	YES
415	88	68	3	37.10	35.57	29.55	River	57225.6	0.7	7.54	YES
499	93	59	3	14.15	12.55	6.58	River	145439.2	1.7	7.57	YES
208	73	68	3	77.92	77.92	70.32	River	0.0	0.0	7.60	YES
635	103	142	3	49.26	46.26	41.55	River	273125.9	3.2	7.70	YES
358	85	57	3	18.78	18.78	10.98	River	0.0	0.0	7.81	YES
925	156	129	3	20.28	16.51	12.45	River	1536.7	0.0	7.82	YES
416	88	69	3	39.12	37.64	31.29	River	103422.4	1.2	7.83	YES
75	58	107	3	54.55	52.33	46.72	River	837789.1	9.7	7.83	YES
381	86	57	3	17.33	17.33	9.36	River	669.5	0.0	7.97	YES
207	73	67	3	76.32	76.32	68.35	River	0.0	0.0	7.97	YES
457	90	71	3	38.42	36.82	30.42	River	188643.0	2.2	8.00	YES
62	55	105	3	61.69	58.86	53.62	River	6096399.5	70.6	8.07	YES
90	63	62	3	67.88	67.88	59.73	River	0.0	0.0	8.15	YES
359	85	58	3	20.00	20.00	11.72	River	0.0	0.0	8.29	YES
70	57	107	3	56.23	53.87	47.85	River	7436595.5	86.1	8.38	YES
924	156	128	3	19.92	16.14	11.49	River	17260.7	0.2	8.43	YES
584	100	137	3	48.36	45.36	39.87	River	546607.6	6.3	8.48	YES
459	90	73	3	49.67	48.23	41.14	River	85746.4	1.0	8.53	YES
252	77	49	3	37.59	35.04	28.95	River	158933.5	1.8	8.64	YES
433	89	68	3	36.38	34.84	27.58	River	174121.9	2.0	8.79	YES
489	92	59	3	15.96	14.42	7.13	River	43374.3	0.5	8.84	YES
95	64	62	3	67.33	67.33	58.36	River	0.0	0.0	8.97	YES
344	84	61	3	32.62	32.62	23.61	River	0.0	0.0	9.01	YES
90	63	62	3	68.82	68.82	59.73	River	0.0	0.0	9.09	YES
153	69	63	3	68.80	68.80	59.70	River	0.0	0.0	9.09	YES
362	85	69	3	53.13	51.91	44.04	River	92288.8	1.1	9.09	YES
437	89	72	3	47.36	45.89	38.15	River	130688.5	1.5	9.21	YES
418	88	71	3	47.73	46.39	38.52	River	85081.0	1.0	9.22	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
458	90	72	3	43.94	42.42	34.64	River	143819.9	1.7	9.30	YES
435	89	70	3	39.97	38.47	30.57	River	116992.1	1.4	9.40	YES
400	87	68	3	41.95	40.52	32.53	River	2209.2	0.0	9.42	YES
66	56	106	3	58.69	56.11	49.20	River	5480733.5	63.4	9.49	YES
225	74	68	3	79.59	79.59	69.94	River	0.0	0.0	9.64	YES
69	57	106	3	57.59	55.11	47.89	River	2021706.9	23.4	9.70	YES
226	74	69	3	81.60	81.60	71.88	River	0.0	0.0	9.72	YES
63	55	106	3	59.83	57.16	49.94	River	2056817.5	23.8	9.89	YES
490	92	60	3	17.34	15.84	7.42	River	93808.6	1.1	9.92	YES
935	157	129	3	22.10	18.45	12.11	River	20806.0	0.2	9.99	YES
401	87	69	3	44.28	42.89	34.29	River	122097.8	1.4	9.99	YES
583	100	136	3	49.11	46.11	38.97	River	5567.6	0.1	10.15	YES
570	99	136	3	49.16	46.16	38.91	River	533328.0	6.2	10.25	YES
457	90	71	3	40.86	39.30	30.42	River	188643.0	2.2	10.44	YES
343	84	60	3	30.76	30.76	20.24	River	0.0	0.0	10.52	YES
457	90	71	3	41.19	39.63	30.42	River	188643.0	2.2	10.77	YES
359	85	58	3	22.78	22.78	11.72	River	0.0	0.0	11.06	YES
384	86	69	3	48.87	47.57	37.68	River	114707.4	1.3	11.19	YES
382	86	58	3	21.08	21.08	9.59	River	0.0	0.0	11.49	YES
417	88	70	3	44.07	42.65	32.55	River	82862.4	1.0	11.52	YES
436	89	71	3	43.19	41.67	31.50	River	47774.5	0.6	11.69	YES
415	88	68	3	41.42	39.98	29.55	River	57225.6	0.7	11.87	YES
475	91	60	3	19.86	18.44	7.86	River	145775.5	1.7	12.01	YES
360	85	59	3	25.26	25.26	13.13	River	0.0	0.0	12.12	YES
253	77	50	3	41.70	39.29	29.30	River	43461.5	0.5	12.40	YES
936	157	130	3	25.39	21.93	12.95	River	18261.2	0.2	12.44	YES
139	68	63	3	72.58	72.58	60.12	River	0.0	0.0	12.46	YES
361	85	60	3	28.31	28.31	15.50	River	0.0	0.0	12.81	YES
570	99	136	3	51.72	48.95	38.91	River	533328.0	6.2	12.81	YES
140	68	64	3	75.67	75.67	62.38	River	0.0	0.0	13.28	YES
452	90	60	3	21.77	20.41	8.17	River	30957.4	0.4	13.60	YES
246	76	50	3	45.62	43.34	31.66	River	132986.1	1.5	13.95	YES
141	68	65	3	79.07	79.07	64.55	River	0.0	0.0	14.52	YES
453	90	61	3	23.17	21.85	8.50	River	89968.8	1.0	14.66	YES
937	157	131	3	28.55	25.29	13.89	River	17292.9	0.2	14.67	YES
927	156	132	3	31.71	28.65	16.75	River	11147.5	0.1	14.96	YES
926	156	131	3	30.38	27.24	14.81	River	2575.2	0.0	15.57	YES
236	75	50	3	50.00	47.88	33.90	River	146138.9	1.7	16.09	YES
154	69	65	3	80.71	80.71	63.83	River	0.0	0.0	16.88	YES
432	89	61	3	25.58	24.34	8.69	River	111206.7	1.3	16.89	YES
164	70	57	3	61.80	61.05	44.21	River	7227.4	0.1	17.60	YES
557	98	136	3	56.66	54.36	38.67	River	404075.9	4.7	18.00	YES
383	86	61	3	32.62	31.61	14.60	River	25044.1	0.3	18.02	YES
236	75	50	3	51.99	49.94	33.90	River	146138.9	1.7	18.08	YES
236	75	50	3	52.78	50.76	33.90	River	146138.9	1.7	18.88	YES
414	88	61	3	28.23	27.08	9.35	River	96876.0	1.1	18.89	YES
399	87	61	3	30.88	29.81	11.27	River	95410.0	1.1	19.61	YES
237	75	51	3	54.87	52.92	34.06	River	120141.7	1.4	20.81	YES
221	74	50	3	56.60	54.71	35.67	River	89044.1	1.0	20.92	YES
150	69	57	3	65.84	65.81	44.85	River	11.8	0.0	20.98	YES
550	97	136	3	59.54	57.50	38.21	River	67180.0	0.8	21.34	YES
150	69	57	3	66.30	66.30	44.85	River	11.8	0.0	21.45	YES
222	74	51	3	59.37	57.58	35.86	River	142005.0	1.6	23.51	YES

	Exported								Calculated		
Cell Count	Cell ID			Stage (ft)	Elevation (ft)	Head (ft)	Node Type	Flux (ft3/d)	Flux (cfs)	Stage-Head (ft)	Flow to GOM
	i	j	k								
222	74	51	3	60.00	58.23	35.86	River	142005.0	1.6	24.13	YES
149	69	56	3	67.82	67.82	42.76	River	0.0	0.0	25.06	YES
203	73	51	3	62.49	60.80	37.14	River	146255.4	1.7	25.35	YES
203	73	51	3	62.79	61.12	37.14	River	146255.4	1.7	25.66	YES
136	68	56	3	70.32	70.32	43.42	River	0.0	0.0	26.90	YES
203	73	51	3	65.38	63.80	37.14	River	146255.4	1.7	28.24	YES
119	67	56	3	73.06	73.06	44.11	River	0.0	0.0	28.96	YES
190	72	51	3	67.64	66.13	38.06	River	28374.0	0.3	29.58	YES
118	67	55	3	74.78	74.78	43.03	River	0.0	0.0	31.75	YES
87	62	59	3	82.01	82.01	50.21	River	0.0	0.0	31.80	YES
191	72	52	3	70.52	69.12	38.31	River	55238.2	0.6	32.22	YES
105	66	55	3	76.35	76.35	43.75	River	0.0	0.0	32.60	YES
100	65	55	3	78.40	78.40	44.45	River	0.0	0.0	33.95	YES
190	72	51	3	72.65	71.32	38.06	River	28374.0	0.3	34.59	YES
86	62	58	3	82.31	82.31	47.34	River	0.0	0.0	34.97	YES
100	65	55	3	79.71	79.71	44.45	River	0.0	0.0	35.25	YES
94	64	55	3	81.15	81.15	45.03	River	0.0	0.0	36.12	YES
84	61	58	3	84.00	84.00	47.47	River	0.0	0.0	36.52	YES
178	71	51	3	76.44	75.25	38.86	River	85832.6	1.0	37.58	YES
82	60	58	3	85.90	85.90	47.71	River	0.0	0.0	38.20	YES
81	60	57	3	87.50	87.50	47.32	River	0.0	0.0	40.18	YES
163	70	51	3	80.25	79.19	39.60	River	2734.3	0.0	40.65	YES
162	70	50	3	81.19	80.16	39.33	River	16213.2	0.2	41.86	YES
78	59	57	3	89.74	89.74	47.77	River	0.0	0.0	41.97	YES
77	59	56	3	91.08	91.08	47.58	River	0.0	0.0	43.51	YES
71	58	56	3	92.51	92.51	48.08	River	0.0	0.0	44.43	YES
67	57	56	3	94.93	94.93	48.74	River	0.0	0.0	46.20	YES
93	64	19	3	69.06	69.06	21.71	River	0.0	0.0	47.35	NO
64	56	56	3	97.07	97.07	49.61	River	0.0	0.0	47.46	YES
76	59	20	3	73.15	73.15	25.27	River	0.0	0.0	47.87	NO
40	49	26	3	93.30	93.30	34.31	River	0.0	0.0	58.99	NO
1	22	89	3	147.32	147.32	70.06	River	0.0	0.0	77.26	NO
35	44	31	3	121.28	121.28	40.32	River	0.0	0.0	80.96	NO
6	22	140	3	130.71	129.50	49.24	River	359.3	0.0	81.47	NO
26	41	36	3	147.80	147.80	64.41	River	0.0	0.0	83.39	NO
31	43	32	3	126.65	126.65	41.50	River	0.0	0.0	85.15	NO
2	22	107	3	146.60	144.60	61.19	River	17495.7	0.2	85.42	NO
28	42	36	3	170.58	170.58	82.73	River	0.0	0.0	87.86	NO
27	42	33	3	130.79	130.79	42.73	River	0.0	0.0	88.06	NO
25	41	35	3	135.63	135.63	44.70	River	0.0	0.0	90.94	NO
29	42	37	3	191.00	191.00	93.30	River	0.0	0.0	97.70	NO
32	43	37	3	206.33	206.33	106.18	River	0.0	0.0	100.14	NO
4	22	125	3	163.63	162.62	54.92	River	350.4	0.0	108.71	NO
5	22	130	3	163.28	162.27	52.99	River	340.3	0.0	110.29	NO
24	33	46	3	164.77	164.77	53.59	River	0.0	0.0	111.18	NO
22	25	65	3	180.17	180.17	63.03	River	0.0	0.0	117.14	NO
33	43	38	3	228.79	228.79	109.91	River	0.0	0.0	118.88	NO
3	22	115	3	180.03	178.63	58.07	River	5208.1	0.1	121.96	NO
23	26	61	3	195.91	195.91	60.91	River	0.0	0.0	135.01	NO
34	43	39	3	250.59	250.59	107.87	River	0.0	0.0	142.73	NO
30	42	39	3	261.05	261.05	97.25	River	0.0	0.0	163.80	NO

NFM-08: River & Drain Assignment Analysis

	Outflow	Inflow	Total
Total GOM Assignment Flux (cfs):	6557.6	650.1	5907.5
Total Non-GOM Flux (cfs):	597.4	0.3	597.1

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
569	7	4	3	-140.2	-1.8	YES
712	6	5	1	-124.1	-0.8	YES
921	6	0	6	0.0	-3.2	YES
129	5	2	3	-30.1	-3.8	YES
299	5	0	5	0.0	0.2	YES
582	5	2	3	-39.6	-5.6	YES
611	5	1	4	-43.2	7.4	YES
632	5	1	4	-3.7	-2.2	YES
686	5	0	5	0.0	-4.5	YES
709	5	0	5	0.0	-4.6	YES
723	5	4	1	-83.6	-8.6	YES
764	5	2	3	-11.3	-3.6	YES
113	4	1	3	-74.6	-1.9	YES
123	4	2	2	-17.6	-15.5	YES
125	4	3	1	-16.6	-8.0	YES
143	4	2	2	-4.7	-14.8	YES
156	4	1	3	-39.9	-15.1	YES
172	4	1	3	-19.7	-8.9	YES
354	4	0	4	0.0	-2.4	YES
377	4	0	4	0.0	-2.5	YES
505	4	0	4	0.0	-10.9	YES
543	4	0	4	0.0	-0.1	YES
545	4	0	4	0.0	0.2	YES
680	4	1	3	-10.7	-7.4	YES
704	4	2	2	-100.3	-5.4	YES
708	4	0	4	0.0	-5.5	YES
721	4	3	1	-89.3	-1.9	YES
792	4	1	3	-57.0	-11.0	YES
904	4	0	4	0.0	-2.5	YES
930	4	0	4	0.0	-1.6	YES
91	3	2	1	-69.0	2.6	YES
108	3	1	2	-8.8	-3.4	YES
146	3	1	2	-41.0	-6.7	YES
165	3	0	3	0.0	0.5	YES
168	3	0	3	0.0	0.2	YES
169	3	0	3	0.0	0.0	YES
174	3	1	2	-11.3	-2.8	YES
175	3	0	3	0.0	-3.0	YES
188	3	0	3	0.0	-1.6	YES
189	3	0	3	0.0	-2.3	YES
196	3	0	3	0.0	-0.8	YES
203	3	0	3	0.0	1.7	YES
231	3	1	2	-13.3	0.0	YES
236	3	0	3	0.0	1.7	YES
264	3	1	2	-143.3	-3.3	YES
273	3	0	3	0.0	-3.8	YES
279	3	1	2	-4.9	-0.7	YES
281	3	0	3	0.0	0.9	YES
315	3	0	3	0.0	-9.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
355	3	0	3	0.0	-1.4	YES
378	3	0	3	0.0	-9.6	YES
395	3	0	3	0.0	-2.8	YES
396	3	1	2	-358.7	0.0	YES
409	3	0	3	0.0	-10.2	YES
410	3	0	3	0.0	-2.2	YES
415	3	0	3	0.0	0.7	YES
455	3	0	3	0.0	2.7	YES
457	3	0	3	0.0	2.2	YES
461	3	0	3	0.0	-0.2	YES
476	3	0	3	0.0	-1.1	YES
483	3	1	2	-6.0	-1.7	YES
495	3	1	2	-2.9	-10.0	YES
536	3	0	3	0.0	2.8	YES
538	3	0	3	0.0	0.1	YES
548	3	2	1	-95.9	-4.7	YES
552	3	0	3	0.0	-0.5	YES
553	3	0	3	0.0	-0.2	YES
554	3	0	3	0.0	0.1	YES
561	3	0	3	0.0	-0.6	YES
574	3	0	3	0.0	-0.6	YES
595	3	1	2	-1.3	-9.0	YES
609	3	0	3	0.0	-5.3	YES
619	3	1	2	-15.0	-0.3	YES
633	3	1	2	-0.7	-5.5	YES
661	3	0	3	0.0	0.1	YES
662	3	0	3	0.0	-1.3	YES
683	3	0	3	0.0	-1.6	YES
684	3	0	3	0.0	-2.7	YES
693	3	0	3	0.0	-5.9	YES
695	3	0	3	0.0	-4.4	YES
716	3	0	3	0.0	-3.6	YES
720	3	2	1	-162.0	0.2	YES
736	3	0	3	0.0	-4.8	YES
754	3	1	2	-49.3	-3.6	YES
766	3	1	2	-3.7	-5.6	YES
767	3	0	3	0.0	-3.4	YES
769	3	1	2	-1.8	-3.6	YES
770	3	1	2	-3.5	-4.8	YES
777	3	2	1	-38.5	-4.1	YES
779	3	1	2	-2.6	-1.1	YES
780	3	1	2	-27.7	-1.6	YES
843	3	0	3	0.0	-6.1	YES
855	3	0	3	0.0	-0.4	YES
861	3	0	3	0.0	-2.6	YES
885	3	1	2	-47.5	0.0	YES
890	3	0	3	0.0	-0.6	YES
914	3	0	3	0.0	-2.3	YES
929	3	0	3	0.0	-0.9	YES
931	3	0	3	0.0	0.0	YES
932	3	0	3	0.0	0.2	YES
955	3	0	3	0.0	0.3	YES
960	3	0	3	0.0	-0.3	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
38	2	0	2	0.0	-2.7	YES
39	2	0	2	0.0	-3.4	YES
58	2	0	2	0.0	-4.2	YES
61	2	0	2	0.0	44.7	YES
62	2	0	2	0.0	70.6	YES
69	2	0	2	0.0	23.4	YES
70	2	0	2	0.0	86.1	YES
90	2	0	2	0.0	0.0	YES
98	2	1	1	-15.1	0.3	YES
99	2	1	1	-40.0	0.0	YES
100	2	0	2	0.0	0.0	YES
102	2	0	2	0.0	0.0	YES
104	2	0	2	0.0	-3.1	YES
111	2	1	1	-490.1	-4.2	YES
114	2	0	2	0.0	-5.0	YES
124	2	1	1	-3.2	-1.3	YES
128	2	1	1	-4.4	-5.3	YES
131	2	1	1	-3.3	-4.4	YES
132	2	1	1	-11.2	-4.7	YES
135	2	1	1	-4.2	-1.7	YES
137	2	0	2	0.0	0.0	YES
142	2	1	1	-2.2	-5.4	YES
150	2	0	2	0.0	0.0	YES
155	2	0	2	0.0	-19.9	YES
159	2	1	1	-1.4	-3.0	YES
160	2	1	1	-12.5	-0.1	YES
166	2	0	2	0.0	0.2	YES
179	2	0	2	0.0	0.3	YES
185	2	1	1	-6.7	-0.3	YES
190	2	0	2	0.0	0.3	YES
197	2	1	1	-7.0	-0.1	YES
212	2	0	2	0.0	-0.1	YES
214	2	0	2	0.0	2.1	YES
222	2	0	2	0.0	1.6	YES
245	2	1	1	-16.3	0.0	YES
256	2	0	2	0.0	-1.4	YES
265	2	0	2	0.0	0.7	YES
280	2	0	2	0.0	-6.8	YES
288	2	1	1	-1.7	-0.8	YES
293	2	0	2	0.0	-5.7	YES
307	2	1	1	-128.0	-1.0	YES
311	2	0	2	0.0	-0.4	YES
312	2	0	2	0.0	-0.2	YES
313	2	0	2	0.0	-0.5	YES
314	2	0	2	0.0	-1.0	YES
323	2	0	2	0.0	-1.2	YES
338	2	0	2	0.0	-1.3	YES
342	2	0	2	0.0	-10.5	YES
346	2	0	2	0.0	0.6	YES
347	2	0	2	0.0	1.1	YES
348	2	1	1	-1.1	-0.6	YES
353	2	0	2	0.0	-3.0	YES
359	2	0	2	0.0	0.0	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
366	2	0	2	0.0	-0.7	YES
368	2	0	2	0.0	-0.1	YES
370	2	1	1	-4.7	-0.5	YES
374	2	0	2	0.0	-1.5	YES
375	2	0	2	0.0	-7.9	YES
376	2	0	2	0.0	-2.7	YES
381	2	0	2	0.0	0.0	YES
389	2	0	2	0.0	-1.3	YES
391	2	1	1	-4.4	-0.6	YES
393	2	0	2	0.0	-7.9	YES
405	2	0	2	0.0	0.4	YES
407	2	0	2	0.0	-0.9	YES
408	2	1	1	-2.9	-0.6	YES
411	2	0	2	0.0	-0.6	YES
433	2	0	2	0.0	2.0	YES
440	2	0	2	0.0	1.3	YES
444	2	0	2	0.0	-0.7	YES
447	2	1	1	-23.7	-0.4	YES
448	2	2	0	-36.9	0.0	YES
459	2	0	2	0.0	1.0	YES
462	2	0	2	0.0	-1.0	YES
467	2	1	1	-28.4	-2.6	YES
471	2	1	1	-29.7	-1.5	YES
477	2	0	2	0.0	-2.5	YES
480	2	0	2	0.0	-1.8	YES
482	2	1	1	-8.0	-0.6	YES
487	2	1	1	-5.0	-3.5	YES
492	2	0	2	0.0	-0.9	YES
494	2	1	1	-5.0	-4.5	YES
496	2	1	1	-12.8	-0.8	YES
509	2	0	2	0.0	0.6	YES
512	2	0	2	0.0	-0.1	YES
515	2	1	1	-9.9	-8.2	YES
534	2	1	1	-22.6	-5.2	YES
537	2	0	2	0.0	0.7	YES
539	2	0	2	0.0	0.1	YES
555	2	1	1	-5.7	-2.2	YES
556	2	1	1	-45.0	-7.7	YES
558	2	0	2	0.0	1.1	YES
564	2	0	2	0.0	0.0	YES
570	2	0	2	0.0	6.2	YES
576	2	0	2	0.0	0.0	YES
587	2	0	2	0.0	-0.7	YES
588	2	0	2	0.0	-0.7	YES
594	2	1	1	-6.8	-6.2	YES
596	2	1	1	-4.3	-1.9	YES
598	2	0	2	0.0	-8.1	YES
600	2	0	2	0.0	6.0	YES
612	2	0	2	0.0	2.9	YES
616	2	0	2	0.0	3.9	YES
621	2	0	2	0.0	-0.1	YES
627	2	0	2	0.0	-0.5	YES
629	2	1	1	-4.3	-5.0	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
634	2	1	1	-20.8	-0.3	YES
635	2	0	2	0.0	3.2	YES
636	2	0	2	0.0	4.5	YES
637	2	0	2	0.0	3.0	YES
654	2	0	2	0.0	-5.9	YES
665	2	0	2	0.0	-4.3	YES
666	2	0	2	0.0	-6.3	YES
668	2	1	1	-8.1	-5.6	YES
669	2	1	1	-21.2	-0.9	YES
670	2	1	1	-14.1	-3.7	YES
673	2	0	2	0.0	-3.2	YES
681	2	1	1	-2.1	-2.0	YES
682	2	2	0	-14.4	0.0	YES
691	2	1	1	-46.3	-4.4	YES
694	2	0	2	0.0	-2.9	YES
699	2	1	1	-2.2	-3.3	YES
700	2	1	1	-145.3	-1.5	YES
703	2	0	2	0.0	-9.6	YES
705	2	1	1	-4.2	-1.5	YES
710	2	1	1	-5.7	-4.9	YES
711	2	0	2	0.0	-3.0	YES
713	2	1	1	-20.6	-8.3	YES
714	2	1	1	-32.0	-6.4	YES
719	2	1	1	-5.0	-5.8	YES
722	2	1	1	-7.5	-6.0	YES
724	2	1	1	-15.0	-8.8	YES
730	2	0	2	0.0	-0.1	YES
742	2	1	1	-11.5	-3.9	YES
743	2	1	1	-14.6	-3.2	YES
746	2	0	2	0.0	-1.7	YES
751	2	0	2	0.0	-8.7	YES
753	2	1	1	-9.3	-9.3	YES
755	2	1	1	-228.2	-0.1	YES
761	2	0	2	0.0	-4.4	YES
762	2	0	2	0.0	-0.3	YES
773	2	0	2	0.0	-4.0	YES
783	2	1	1	-1.5	-5.0	YES
785	2	1	1	-2.3	-4.7	YES
787	2	1	1	-14.2	-5.3	YES
790	2	1	1	-3.2	-2.0	YES
804	2	1	1	-118.6	-6.0	YES
805	2	0	2	0.0	-7.3	YES
806	2	0	2	0.0	-1.2	YES
811	2	1	1	-1.9	0.0	YES
816	2	0	2	0.0	-15.5	YES
823	2	0	2	0.0	-0.1	YES
824	2	0	2	0.0	-0.3	YES
829	2	0	2	0.0	-3.7	YES
830	2	0	2	0.0	-5.4	YES
846	2	0	2	0.0	-0.2	YES
857	2	0	2	0.0	0.2	YES
865	2	0	2	0.0	0.9	YES
879	2	0	2	0.0	-0.3	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
882	2	0	2	0.0	-0.7	YES
889	2	0	2	0.0	0.0	YES
894	2	0	2	0.0	-0.3	YES
898	2	0	2	0.0	-2.6	YES
899	2	0	2	0.0	-1.2	YES
905	2	0	2	0.0	-2.2	YES
913	2	0	2	0.0	-1.5	YES
916	2	0	2	0.0	0.2	YES
924	2	0	2	0.0	0.2	YES
940	2	0	2	0.0	0.1	YES
941	2	0	2	0.0	0.0	YES
947	2	0	2	0.0	0.2	YES
951	2	0	2	0.0	0.1	YES
962	2	0	2	0.0	-0.3	YES
967	2	1	1	-145.6	-1.3	YES
970	2	0	2	0.0	-3.9	YES
971	2	0	2	0.0	-4.0	YES
993	2	0	2	0.0	-3.4	YES
1	1	0	1	0.0	0.0	NO
2	1	0	1	0.0	0.2	NO
3	1	0	1	0.0	0.1	NO
4	1	0	1	0.0	0.0	NO
5	1	0	1	0.0	0.0	NO
6	1	0	1	0.0	0.0	NO
7	1	0	1	0.0	0.0	NO
8	1	1	0	0.0	0.0	NO
9	1	1	0	-0.5	0.0	NO
10	1	1	0	-0.5	0.0	NO
11	1	1	0	-0.5	0.0	NO
12	1	1	0	-0.4	0.0	NO
13	1	1	0	-0.4	0.0	NO
14	1	1	0	-0.4	0.0	NO
15	1	1	0	-0.4	0.0	NO
16	1	1	0	-0.4	0.0	NO
17	1	1	0	-0.4	0.0	NO
18	1	1	0	-0.4	0.0	NO
19	1	1	0	-0.4	0.0	NO
20	1	1	0	-0.4	0.0	NO
21	1	1	0	-0.3	0.0	NO
22	1	0	1	0.0	0.0	NO
23	1	0	1	0.0	0.0	NO
24	1	0	1	0.0	0.0	NO
25	1	0	1	0.0	0.0	NO
26	1	0	1	0.0	0.0	NO
27	1	0	1	0.0	0.0	NO
28	1	0	1	0.0	0.0	NO
29	1	0	1	0.0	0.0	NO
30	1	0	1	0.0	0.0	NO
31	1	0	1	0.0	0.0	NO
32	1	0	1	0.0	0.0	NO
33	1	0	1	0.0	0.0	NO
34	1	0	1	0.0	0.0	NO
35	1	0	1	0.0	0.0	NO

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
36	1	0	1	0.0	-2.2	YES
37	1	0	1	0.0	-1.0	YES
40	1	0	1	0.0	0.0	NO
41	1	0	1	0.0	-1.9	YES
42	1	0	1	0.0	-7.1	YES
43	1	0	1	0.0	-3.4	YES
44	1	0	1	0.0	-3.4	YES
45	1	0	1	0.0	-6.9	YES
46	1	0	1	0.0	-8.6	YES
47	1	0	1	0.0	-0.9	YES
48	1	0	1	0.0	-9.1	YES
49	1	0	1	0.0	-8.4	YES
50	1	0	1	0.0	-5.4	YES
51	1	0	1	0.0	-1.7	YES
52	1	0	1	0.0	-2.4	YES
53	1	0	1	0.0	-7.1	YES
54	1	0	1	0.0	-8.1	YES
55	1	0	1	0.0	-8.8	YES
56	1	0	1	0.0	-7.2	YES
57	1	0	1	0.0	-1.1	YES
59	1	0	1	0.0	30.0	YES
60	1	0	1	0.0	-2.8	YES
63	1	0	1	0.0	23.8	YES
64	1	0	1	0.0	0.0	YES
65	1	0	1	0.0	-0.3	YES
66	1	0	1	0.0	63.4	YES
67	1	0	1	0.0	0.0	YES
68	1	0	1	0.0	2.2	YES
71	1	0	1	0.0	0.0	YES
72	1	0	1	0.0	2.0	YES
73	1	0	1	0.0	1.2	YES
74	1	0	1	0.0	47.0	YES
75	1	0	1	0.0	9.7	YES
76	1	0	1	0.0	0.0	NO
77	1	0	1	0.0	0.0	YES
78	1	0	1	0.0	0.0	YES
79	1	0	1	0.0	4.5	YES
80	1	0	1	0.0	27.2	YES
81	1	0	1	0.0	0.0	YES
82	1	0	1	0.0	0.0	YES
83	1	0	1	0.0	2.7	YES
84	1	0	1	0.0	0.0	YES
85	1	0	1	0.0	0.6	YES
86	1	0	1	0.0	0.0	YES
87	1	0	1	0.0	0.0	YES
88	1	0	1	0.0	0.0	YES
89	1	0	1	0.0	0.6	YES
92	1	1	0	-1.4	0.0	YES
93	1	0	1	0.0	0.0	NO
94	1	0	1	0.0	0.0	YES
95	1	0	1	0.0	0.0	YES
96	1	0	1	0.0	0.0	YES
97	1	0	1	0.0	-0.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
101	1	0	1	0.0	0.0	YES
103	1	0	1	0.0	-2.9	YES
105	1	0	1	0.0	0.0	YES
106	1	0	1	0.0	0.0	YES
107	1	0	1	0.0	-3.3	YES
109	1	0	1	0.0	-6.9	YES
110	1	0	1	0.0	-5.7	YES
112	1	0	1	0.0	-3.1	YES
115	1	0	1	0.0	-0.2	YES
116	1	0	1	0.0	-2.6	YES
117	1	0	1	0.0	-1.3	YES
118	1	0	1	0.0	0.0	YES
119	1	0	1	0.0	0.0	YES
120	1	0	1	0.0	0.0	YES
121	1	0	1	0.0	0.0	YES
122	1	0	1	0.0	-3.0	YES
126	1	0	1	0.0	-12.0	YES
127	1	0	1	0.0	-0.6	YES
130	1	0	1	0.0	-0.2	YES
133	1	0	1	0.0	-3.6	YES
134	1	0	1	0.0	-5.2	YES
136	1	0	1	0.0	0.0	YES
138	1	0	1	0.0	0.0	YES
139	1	0	1	0.0	0.0	YES
140	1	0	1	0.0	0.0	YES
141	1	0	1	0.0	0.0	YES
144	1	0	1	0.0	-18.0	YES
145	1	0	1	0.0	-2.8	YES
147	1	0	1	0.0	-2.7	YES
148	1	0	1	0.0	-2.7	YES
149	1	0	1	0.0	0.0	YES
151	1	0	1	0.0	0.2	YES
152	1	0	1	0.0	0.0	YES
153	1	0	1	0.0	0.0	YES
154	1	0	1	0.0	0.0	YES
157	1	0	1	0.0	-1.6	YES
158	1	0	1	0.0	-1.6	YES
161	1	0	1	0.0	-2.0	YES
162	1	0	1	0.0	0.2	YES
163	1	0	1	0.0	0.0	YES
164	1	0	1	0.0	0.1	YES
167	1	0	1	0.0	0.2	YES
170	1	0	1	0.0	0.0	YES
171	1	0	1	0.0	-0.4	YES
173	1	0	1	0.0	-0.1	YES
176	1	0	1	0.0	-0.6	YES
177	1	0	1	0.0	-0.9	YES
178	1	0	1	0.0	1.0	YES
180	1	0	1	0.0	0.2	YES
181	1	0	1	0.0	0.0	YES
182	1	0	1	0.0	0.0	YES
183	1	0	1	0.0	0.0	YES
184	1	0	1	0.0	-0.5	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
186	1	0	1	0.0	-2.7	YES
187	1	0	1	0.0	-1.6	YES
191	1	0	1	0.0	0.6	YES
192	1	0	1	0.0	0.4	YES
193	1	0	1	0.0	0.0	YES
194	1	0	1	0.0	0.0	YES
195	1	0	1	0.0	-0.2	YES
198	1	0	1	0.0	-0.8	YES
199	1	0	1	0.0	-1.6	YES
200	1	0	1	0.0	0.3	YES
201	1	0	1	0.0	0.7	YES
202	1	0	1	0.0	-3.5	YES
204	1	0	1	0.0	-0.6	YES
205	1	0	1	0.0	0.0	YES
206	1	0	1	0.0	0.0	YES
207	1	0	1	0.0	0.0	YES
208	1	0	1	0.0	0.0	YES
209	1	0	1	0.0	-0.7	YES
210	1	0	1	0.0	-0.1	YES
211	1	0	1	0.0	-0.1	YES
213	1	0	1	0.0	1.1	YES
215	1	0	1	0.0	1.8	YES
216	1	0	1	0.0	0.3	YES
217	1	0	1	0.0	0.4	YES
218	1	0	1	0.0	0.0	YES
219	1	0	1	0.0	-1.5	YES
220	1	1	0	-224.7	0.0	YES
221	1	0	1	0.0	1.0	YES
223	1	0	1	0.0	-0.3	YES
224	1	0	1	0.0	-2.6	YES
225	1	0	1	0.0	0.0	YES
226	1	0	1	0.0	0.0	YES
227	1	0	1	0.0	-0.8	YES
228	1	0	1	0.0	4.2	YES
229	1	0	1	0.0	4.2	YES
230	1	0	1	0.0	1.0	YES
232	1	0	1	0.0	3.3	YES
233	1	0	1	0.0	3.0	YES
234	1	0	1	0.0	0.8	YES
235	1	1	0	-41.6	0.0	YES
237	1	0	1	0.0	1.4	YES
238	1	0	1	0.0	-1.3	YES
239	1	0	1	0.0	-1.3	YES
240	1	0	1	0.0	-1.7	YES
241	1	0	1	0.0	-0.7	YES
242	1	0	1	0.0	-1.7	YES
243	1	0	1	0.0	-0.6	YES
244	1	1	0	0.0	0.0	YES
246	1	0	1	0.0	1.5	YES
247	1	0	1	0.0	-2.5	YES
248	1	0	1	0.0	-0.6	YES
249	1	0	1	0.0	-0.5	YES
250	1	0	1	0.0	-3.6	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
251	1	0	1	0.0	0.5	YES
252	1	0	1	0.0	1.8	YES
253	1	0	1	0.0	0.5	YES
254	1	0	1	0.0	-4.2	YES
255	1	0	1	0.0	-0.5	YES
257	1	0	1	0.0	-2.7	YES
258	1	0	1	0.0	-2.0	YES
259	1	0	1	0.0	-1.8	YES
260	1	0	1	0.0	-1.7	YES
261	1	0	1	0.0	-1.3	YES
262	1	0	1	0.0	0.0	YES
263	1	0	1	0.0	-0.7	YES
266	1	0	1	0.0	1.9	YES
267	1	0	1	0.0	0.8	YES
268	1	0	1	0.0	0.9	YES
269	1	0	1	0.0	-1.8	YES
270	1	0	1	0.0	-6.9	YES
271	1	0	1	0.0	-2.7	YES
272	1	0	1	0.0	-0.6	YES
274	1	0	1	0.0	0.0	YES
275	1	0	1	0.0	-0.1	YES
276	1	0	1	0.0	0.0	YES
277	1	0	1	0.0	0.0	YES
278	1	0	1	0.0	0.0	YES
282	1	0	1	0.0	1.1	YES
283	1	0	1	0.0	-3.3	YES
284	1	0	1	0.0	-8.4	YES
285	1	0	1	0.0	-5.3	YES
286	1	0	1	0.0	-0.5	YES
287	1	0	1	0.0	-1.6	YES
289	1	0	1	0.0	-0.4	YES
290	1	0	1	0.0	-7.8	YES
291	1	0	1	0.0	0.6	YES
292	1	0	1	0.0	0.5	YES
294	1	0	1	0.0	-9.6	YES
295	1	0	1	0.0	0.0	YES
296	1	0	1	0.0	-1.5	YES
297	1	0	1	0.0	-8.8	YES
298	1	0	1	0.0	-0.1	YES
300	1	0	1	0.0	0.0	YES
301	1	0	1	0.0	0.7	YES
302	1	0	1	0.0	-9.6	YES
303	1	0	1	0.0	0.0	YES
304	1	0	1	0.0	0.0	YES
305	1	0	1	0.0	-1.0	YES
306	1	0	1	0.0	-0.1	YES
308	1	0	1	0.0	-7.3	YES
309	1	0	1	0.0	-3.5	YES
310	1	0	1	0.0	-8.6	YES
316	1	0	1	0.0	0.0	YES
317	1	0	1	0.0	-0.7	YES
318	1	0	1	0.0	-0.1	YES
319	1	0	1	0.0	-1.5	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
320	1	0	1	0.0	-11.1	YES
321	1	0	1	0.0	-2.9	YES
322	1	0	1	0.0	-10.0	YES
324	1	0	1	0.0	-0.8	YES
325	1	0	1	0.0	-0.4	YES
326	1	0	1	0.0	-0.6	YES
327	1	0	1	0.0	-3.8	YES
328	1	0	1	0.0	-4.1	YES
329	1	0	1	0.0	0.0	YES
330	1	0	1	0.0	0.0	YES
331	1	0	1	0.0	0.0	YES
332	1	0	1	0.0	0.2	YES
333	1	0	1	0.0	0.8	YES
334	1	0	1	0.0	-0.7	YES
335	1	0	1	0.0	-9.3	YES
336	1	0	1	0.0	-9.1	YES
337	1	0	1	0.0	-0.6	YES
339	1	0	1	0.0	-1.4	YES
340	1	0	1	0.0	-2.2	YES
341	1	0	1	0.0	-2.5	YES
343	1	0	1	0.0	0.0	YES
344	1	0	1	0.0	0.0	YES
345	1	0	1	0.0	0.8	YES
349	1	0	1	0.0	-7.8	YES
350	1	0	1	0.0	-4.6	YES
351	1	0	1	0.0	-11.1	YES
352	1	0	1	0.0	-0.3	YES
356	1	0	1	0.0	-7.8	YES
357	1	0	1	0.0	-1.9	YES
358	1	0	1	0.0	0.0	YES
360	1	0	1	0.0	0.0	YES
361	1	0	1	0.0	0.0	YES
362	1	0	1	0.0	1.1	YES
363	1	0	1	0.0	0.5	YES
364	1	0	1	0.0	0.3	YES
365	1	0	1	0.0	-0.3	YES
367	1	0	1	0.0	0.6	YES
369	1	0	1	0.0	-0.5	YES
371	1	0	1	0.0	-0.2	YES
372	1	0	1	0.0	-8.3	YES
373	1	0	1	0.0	-4.8	YES
379	1	0	1	0.0	-0.5	YES
380	1	0	1	0.0	0.2	YES
382	1	0	1	0.0	0.0	YES
383	1	0	1	0.0	0.3	YES
384	1	0	1	0.0	1.3	YES
385	1	0	1	0.0	0.7	YES
386	1	0	1	0.0	0.3	YES
387	1	0	1	0.0	0.4	YES
388	1	0	1	0.0	0.5	YES
390	1	0	1	0.0	-0.6	YES
392	1	0	1	0.0	-7.1	YES
394	1	0	1	0.0	-13.6	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
397	1	0	1	0.0	0.7	YES
398	1	0	1	0.0	0.0	YES
399	1	0	1	0.0	1.1	YES
400	1	0	1	0.0	0.0	YES
401	1	0	1	0.0	1.4	YES
402	1	0	1	0.0	1.4	YES
403	1	0	1	0.0	0.4	YES
404	1	0	1	0.0	0.5	YES
406	1	0	1	0.0	0.1	YES
412	1	0	1	0.0	0.9	YES
413	1	0	1	0.0	0.0	YES
414	1	0	1	0.0	1.1	YES
416	1	0	1	0.0	1.2	YES
417	1	0	1	0.0	1.0	YES
418	1	0	1	0.0	1.0	YES
419	1	0	1	0.0	1.4	YES
420	1	0	1	0.0	0.4	YES
421	1	0	1	0.0	-0.5	YES
422	1	0	1	0.0	-0.9	YES
423	1	0	1	0.0	-0.1	YES
424	1	0	1	0.0	-0.1	YES
425	1	0	1	0.0	-0.4	YES
426	1	0	1	0.0	-1.1	YES
427	1	0	1	0.0	-4.9	YES
428	1	0	1	0.0	-1.2	YES
429	1	0	1	0.0	-0.2	YES
430	1	0	1	0.0	0.9	YES
431	1	0	1	0.0	0.2	YES
432	1	0	1	0.0	1.3	YES
434	1	0	1	0.0	0.9	YES
435	1	0	1	0.0	1.4	YES
436	1	0	1	0.0	0.6	YES
437	1	0	1	0.0	1.5	YES
438	1	0	1	0.0	0.4	YES
439	1	0	1	0.0	0.9	YES
441	1	0	1	0.0	0.5	YES
442	1	0	1	0.0	-0.1	YES
443	1	0	1	0.0	-0.7	YES
445	1	0	1	0.0	-0.4	YES
446	1	1	0	-28.2	0.0	YES
449	1	0	1	0.0	0.0	YES
450	1	0	1	0.0	-0.4	YES
451	1	0	1	0.0	1.5	YES
452	1	0	1	0.0	0.4	YES
453	1	0	1	0.0	1.0	YES
454	1	0	1	0.0	1.7	YES
456	1	0	1	0.0	1.7	YES
458	1	0	1	0.0	1.7	YES
460	1	0	1	0.0	0.6	YES
463	1	0	1	0.0	-0.8	YES
464	1	0	1	0.0	-0.7	YES
465	1	0	1	0.0	-0.5	YES
466	1	0	1	0.0	-0.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
468	1	0	1	0.0	-5.7	YES
469	1	0	1	0.0	-3.8	YES
470	1	0	1	0.0	-4.5	YES
472	1	0	1	0.0	0.1	YES
473	1	0	1	0.0	0.3	YES
474	1	0	1	0.0	0.3	YES
475	1	0	1	0.0	1.7	YES
478	1	0	1	0.0	0.1	YES
479	1	0	1	0.0	-1.8	YES
481	1	0	1	0.0	-0.3	YES
484	1	0	1	0.0	-2.8	YES
485	1	0	1	0.0	-2.7	YES
486	1	0	1	0.0	-9.2	YES
488	1	0	1	0.0	-0.4	YES
489	1	0	1	0.0	0.5	YES
490	1	0	1	0.0	1.1	YES
491	1	0	1	0.0	-6.2	YES
493	1	0	1	0.0	-1.9	YES
497	1	0	1	0.0	-0.8	YES
498	1	0	1	0.0	-0.6	YES
499	1	0	1	0.0	1.7	YES
500	1	0	1	0.0	-0.7	YES
501	1	0	1	0.0	-2.5	YES
502	1	0	1	0.0	-5.1	YES
503	1	0	1	0.0	-6.5	YES
504	1	0	1	0.0	-8.3	YES
506	1	0	1	0.0	-9.1	YES
507	1	0	1	0.0	-0.7	YES
508	1	0	1	0.0	0.4	YES
510	1	0	1	0.0	1.3	YES
511	1	0	1	0.0	1.2	YES
513	1	0	1	0.0	0.0	YES
514	1	0	1	0.0	-2.8	YES
516	1	0	1	0.0	-0.7	YES
517	1	0	1	0.0	-0.3	YES
518	1	0	1	0.0	-1.0	YES
519	1	0	1	0.0	1.6	YES
520	1	0	1	0.0	-0.1	YES
521	1	0	1	0.0	-0.9	YES
522	1	0	1	0.0	-6.2	YES
523	1	0	1	0.0	-0.4	YES
524	1	0	1	0.0	-2.2	YES
525	1	0	1	0.0	-0.2	YES
526	1	0	1	0.0	0.8	YES
527	1	0	1	0.0	-8.0	YES
528	1	0	1	0.0	-4.1	YES
529	1	0	1	0.0	0.3	YES
530	1	0	1	0.0	1.7	YES
531	1	0	1	0.0	0.0	YES
532	1	0	1	0.0	-2.5	YES
533	1	0	1	0.0	-2.9	YES
535	1	0	1	0.0	-5.7	YES
540	1	0	1	0.0	-5.5	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
541	1	0	1	0.0	-1.2	YES
542	1	0	1	0.0	1.6	YES
544	1	0	1	0.0	0.1	YES
546	1	0	1	0.0	0.0	YES
547	1	0	1	0.0	0.0	YES
549	1	0	1	0.0	-6.4	YES
550	1	0	1	0.0	0.8	YES
551	1	0	1	0.0	0.9	YES
557	1	0	1	0.0	4.7	YES
559	1	0	1	0.0	-0.2	YES
560	1	0	1	0.0	-0.1	YES
562	1	0	1	0.0	-0.3	YES
563	1	0	1	0.0	-0.1	YES
565	1	0	1	0.0	-0.1	YES
566	1	0	1	0.0	0.0	YES
567	1	0	1	0.0	0.4	YES
568	1	0	1	0.0	-7.4	YES
571	1	0	1	0.0	0.0	YES
572	1	1	0	-17.9	0.0	YES
573	1	0	1	0.0	-0.2	YES
575	1	0	1	0.0	0.0	YES
577	1	0	1	0.0	0.4	YES
578	1	0	1	0.0	0.6	YES
579	1	0	1	0.0	-1.3	YES
580	1	0	1	0.0	-7.3	YES
581	1	0	1	0.0	-1.0	YES
583	1	0	1	0.0	0.1	YES
584	1	0	1	0.0	6.3	YES
585	1	0	1	0.0	5.1	YES
586	1	0	1	0.0	-0.2	YES
589	1	0	1	0.0	-0.7	YES
590	1	0	1	0.0	-0.5	YES
591	1	0	1	0.0	0.3	YES
592	1	0	1	0.0	0.4	YES
593	1	0	1	0.0	0.2	YES
597	1	0	1	0.0	-1.5	YES
599	1	0	1	0.0	0.4	YES
601	1	0	1	0.0	2.2	YES
602	1	0	1	0.0	-0.6	YES
603	1	0	1	0.0	0.0	YES
604	1	0	1	0.0	-0.2	YES
605	1	0	1	0.0	0.2	YES
606	1	0	1	0.0	-0.1	YES
607	1	0	1	0.0	0.1	YES
608	1	0	1	0.0	-4.6	YES
610	1	0	1	0.0	-0.1	YES
613	1	0	1	0.0	6.0	YES
614	1	0	1	0.0	5.5	YES
615	1	0	1	0.0	1.9	YES
617	1	0	1	0.0	0.6	YES
618	1	1	0	-9.8	0.0	YES
620	1	0	1	0.0	-0.3	YES
622	1	0	1	0.0	-0.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
623	1	0	1	0.0	0.2	YES
624	1	0	1	0.0	-0.2	YES
625	1	0	1	0.0	0.0	YES
626	1	0	1	0.0	-0.4	YES
628	1	0	1	0.0	0.0	YES
630	1	0	1	0.0	-2.5	YES
631	1	0	1	0.0	-4.3	YES
638	1	0	1	0.0	6.2	YES
639	1	0	1	0.0	1.3	YES
640	1	0	1	0.0	0.0	YES
641	1	0	1	0.0	0.0	YES
642	1	0	1	0.0	0.0	YES
643	1	0	1	0.0	-0.2	YES
644	1	0	1	0.0	0.0	YES
645	1	0	1	0.0	0.0	YES
646	1	0	1	0.0	0.1	YES
647	1	0	1	0.0	0.1	YES
648	1	0	1	0.0	-0.6	YES
649	1	0	1	0.0	-0.1	YES
650	1	0	1	0.0	-1.4	YES
651	1	0	1	0.0	-0.8	YES
652	1	0	1	0.0	-0.9	YES
653	1	0	1	0.0	-5.9	YES
655	1	0	1	0.0	-5.0	YES
656	1	0	1	0.0	-3.3	YES
657	1	0	1	0.0	-2.3	YES
658	1	0	1	0.0	-1.5	YES
659	1	1	0	-20.0	0.0	YES
660	1	0	1	0.0	0.4	YES
663	1	0	1	0.0	-1.8	YES
664	1	0	1	0.0	-1.6	YES
667	1	0	1	0.0	-4.3	YES
671	1	0	1	0.0	-0.5	YES
672	1	0	1	0.0	-1.1	YES
674	1	0	1	0.0	-2.1	YES
675	1	0	1	0.0	-2.1	YES
676	1	0	1	0.0	-0.1	YES
677	1	0	1	0.0	-1.4	YES
678	1	0	1	0.0	-3.0	YES
679	1	0	1	0.0	-9.1	YES
685	1	0	1	0.0	-0.4	YES
687	1	0	1	0.0	-0.1	YES
688	1	0	1	0.0	-4.9	YES
689	1	0	1	0.0	-2.0	YES
690	1	0	1	0.0	-0.3	YES
692	1	0	1	0.0	-0.4	YES
696	1	0	1	0.0	-2.3	YES
697	1	0	1	0.0	-1.6	YES
698	1	0	1	0.0	-2.5	YES
701	1	0	1	0.0	-0.9	YES
702	1	0	1	0.0	-1.1	YES
706	1	1	0	-14.9	0.0	YES
707	1	1	0	-6.5	0.0	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
715	1	0	1	0.0	-2.0	YES
717	1	0	1	0.0	-0.1	YES
718	1	0	1	0.0	-1.2	YES
725	1	1	0	-9.7	0.0	YES
726	1	0	1	0.0	-3.2	YES
727	1	0	1	0.0	-0.7	YES
728	1	0	1	0.0	-0.7	YES
729	1	0	1	0.0	-0.5	YES
731	1	0	1	0.0	0.1	YES
732	1	0	1	0.0	-2.2	YES
733	1	0	1	0.0	-5.8	YES
734	1	0	1	0.0	-3.9	YES
735	1	1	0	0.0	0.0	YES
737	1	0	1	0.0	-4.1	YES
738	1	0	1	0.0	-2.9	YES
739	1	0	1	0.0	-1.4	YES
740	1	0	1	0.0	-0.9	YES
741	1	0	1	0.0	-0.4	YES
744	1	0	1	0.0	-5.5	YES
745	1	0	1	0.0	-0.6	YES
747	1	0	1	0.0	-2.1	YES
748	1	0	1	0.0	-1.4	YES
749	1	0	1	0.0	-0.8	YES
750	1	0	1	0.0	-6.5	YES
752	1	0	1	0.0	-5.1	YES
756	1	0	1	0.0	-6.2	YES
757	1	0	1	0.0	-2.8	YES
758	1	0	1	0.0	-3.9	YES
759	1	0	1	0.0	-1.9	YES
760	1	0	1	0.0	-6.6	YES
763	1	0	1	0.0	-4.3	YES
765	1	1	0	-3.0	0.0	YES
768	1	0	1	0.0	-4.1	YES
771	1	1	0	-3.6	0.0	YES
772	1	0	1	0.0	-3.4	YES
774	1	0	1	0.0	-2.5	YES
775	1	0	1	0.0	-0.9	YES
776	1	0	1	0.0	-2.2	YES
778	1	0	1	0.0	0.0	YES
781	1	0	1	0.0	-4.8	YES
782	1	0	1	0.0	-4.6	YES
784	1	1	0	-2.3	0.0	YES
786	1	0	1	0.0	-0.3	YES
788	1	0	1	0.0	-0.6	YES
789	1	0	1	0.0	-4.2	YES
791	1	0	1	0.0	-3.5	YES
793	1	0	1	0.0	-8.0	YES
794	1	0	1	0.0	-6.1	YES
795	1	0	1	0.0	-6.1	YES
796	1	0	1	0.0	-7.7	YES
797	1	0	1	0.0	-3.5	YES
798	1	0	1	0.0	-9.4	YES
799	1	1	0	-2.2	0.0	NO

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
800	1	0	1	0.0	-12.7	YES
801	1	0	1	0.0	-6.0	YES
802	1	0	1	0.0	-1.2	YES
803	1	0	1	0.0	-0.9	YES
807	1	0	1	0.0	-4.9	YES
808	1	0	1	0.0	-9.9	YES
809	1	0	1	0.0	-10.7	YES
810	1	0	1	0.0	-0.2	YES
812	1	0	1	0.0	-6.3	YES
813	1	0	1	0.0	-4.3	YES
814	1	0	1	0.0	-0.2	YES
815	1	0	1	0.0	-0.1	YES
817	1	0	1	0.0	-1.7	YES
818	1	0	1	0.0	-0.3	YES
819	1	0	1	0.0	-10.1	YES
820	1	0	1	0.0	-0.4	YES
821	1	0	1	0.0	-8.0	YES
822	1	0	1	0.0	-7.5	YES
825	1	0	1	0.0	-8.7	YES
826	1	0	1	0.0	-8.0	YES
827	1	0	1	0.0	-0.5	YES
828	1	0	1	0.0	-0.8	NO
831	1	0	1	0.0	-0.4	YES
832	1	1	0	-76.3	0.0	NO
833	1	0	1	0.0	-3.5	NO
834	1	0	1	0.0	-7.2	YES
835	1	0	1	0.0	-6.9	YES
836	1	0	1	0.0	-0.3	YES
837	1	0	1	0.0	-0.5	YES
838	1	0	1	0.0	-0.7	YES
839	1	0	1	0.0	-0.8	YES
840	1	0	1	0.0	-0.8	YES
841	1	0	1	0.0	-0.8	YES
842	1	0	1	0.0	-1.5	YES
844	1	0	1	0.0	-6.7	YES
845	1	0	1	0.0	-0.4	YES
847	1	0	1	0.0	-0.1	YES
848	1	0	1	0.0	-0.6	YES
849	1	0	1	0.0	-0.9	NO
850	1	0	1	0.0	-1.4	YES
851	1	0	1	0.0	-0.3	YES
852	1	0	1	0.0	-4.1	YES
853	1	0	1	0.0	-0.2	YES
854	1	0	1	0.0	-0.2	YES
856	1	0	1	0.0	-0.5	YES
858	1	0	1	0.0	-3.6	NO
859	1	0	1	0.0	-0.1	YES
860	1	0	1	0.0	-0.5	YES
862	1	0	1	0.0	-0.1	YES
863	1	0	1	0.0	-0.3	YES
864	1	0	1	0.0	-0.3	YES
866	1	0	1	0.0	0.3	YES
867	1	0	1	0.0	0.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
868	1	0	1	0.0	-0.4	YES
869	1	0	1	0.0	-1.3	YES
870	1	0	1	0.0	-0.1	YES
871	1	0	1	0.0	-0.3	YES
872	1	0	1	0.0	0.1	YES
873	1	0	1	0.0	-1.0	YES
874	1	0	1	0.0	-1.4	YES
875	1	0	1	0.0	-0.8	YES
876	1	0	1	0.0	0.0	YES
877	1	0	1	0.0	-0.9	YES
878	1	0	1	0.0	-0.1	YES
880	1	0	1	0.0	0.0	YES
881	1	0	1	0.0	0.2	YES
883	1	0	1	0.0	-1.1	YES
884	1	0	1	0.0	-0.9	YES
886	1	0	1	0.0	0.0	YES
887	1	0	1	0.0	-0.2	YES
888	1	0	1	0.0	-1.8	YES
891	1	0	1	0.0	-0.3	YES
892	1	0	1	0.0	-0.4	YES
893	1	0	1	0.0	-2.1	YES
895	1	0	1	0.0	-0.7	YES
896	1	0	1	0.0	-0.6	YES
897	1	0	1	0.0	-0.2	YES
900	1	0	1	0.0	0.1	YES
901	1	0	1	0.0	0.2	YES
902	1	0	1	0.0	0.0	YES
903	1	0	1	0.0	-0.9	YES
906	1	0	1	0.0	-0.7	YES
907	1	0	1	0.0	0.2	YES
908	1	0	1	0.0	0.2	YES
909	1	0	1	0.0	-0.1	YES
910	1	0	1	0.0	-0.1	YES
911	1	1	0	-158.6	0.0	NO
912	1	1	0	-47.8	0.0	NO
915	1	0	1	0.0	0.1	YES
917	1	0	1	0.0	0.3	YES
918	1	0	1	0.0	0.1	YES
919	1	1	0	-123.0	0.0	NO
920	1	1	0	-175.0	0.0	NO
922	1	0	1	0.0	0.2	YES
923	1	0	1	0.0	0.2	YES
925	1	0	1	0.0	0.0	YES
926	1	0	1	0.0	0.0	YES
927	1	0	1	0.0	0.1	YES
928	1	1	0	-3.1	0.0	YES
933	1	0	1	0.0	0.3	YES
934	1	0	1	0.0	0.2	YES
935	1	0	1	0.0	0.2	YES
936	1	0	1	0.0	0.2	YES
937	1	0	1	0.0	0.2	YES
938	1	0	1	0.0	0.0	YES
939	1	0	1	0.0	-0.1	YES

Cell Count	Calculated					
	Assignment Count	Count		Flux (cfs)		Flow to GOM
		Drain	River	Drain	River	
942	1	0	1	0.0	0.0	YES
943	1	0	1	0.0	0.1	YES
944	1	0	1	0.0	0.0	YES
945	1	0	1	0.0	0.0	YES
946	1	0	1	0.0	0.2	YES
948	1	0	1	0.0	0.0	YES
949	1	0	1	0.0	0.1	YES
950	1	0	1	0.0	0.1	YES
952	1	0	1	0.0	0.2	YES
953	1	0	1	0.0	0.0	YES
954	1	0	1	0.0	0.2	YES
956	1	0	1	0.0	0.0	YES
957	1	0	1	0.0	0.2	YES
958	1	0	1	0.0	0.0	YES
959	1	0	1	0.0	0.0	YES
961	1	0	1	0.0	0.0	YES
963	1	0	1	0.0	-0.2	YES
964	1	1	0	-92.8	0.0	YES
965	1	1	0	-71.7	0.0	YES
966	1	1	0	-237.1	0.0	YES
968	1	0	1	0.0	-8.1	YES
969	1	0	1	0.0	-7.6	YES
972	1	0	1	0.0	-6.8	YES
973	1	0	1	0.0	-2.4	YES
974	1	0	1	0.0	-1.9	YES
975	1	0	1	0.0	-2.3	YES
976	1	0	1	0.0	-6.7	YES
977	1	0	1	0.0	-8.5	YES
978	1	0	1	0.0	-12.3	YES
979	1	0	1	0.0	-3.9	YES
980	1	0	1	0.0	-1.3	YES
981	1	0	1	0.0	-2.1	YES
982	1	0	1	0.0	-3.3	YES
983	1	0	1	0.0	-1.7	YES
984	1	0	1	0.0	-2.6	YES
985	1	0	1	0.0	-3.4	YES
986	1	0	1	0.0	-3.8	YES
987	1	0	1	0.0	-0.3	YES
988	1	0	1	0.0	-1.9	YES
989	1	0	1	0.0	-3.3	YES
990	1	0	1	0.0	0.1	YES
991	1	0	1	0.0	-0.7	YES
992	1	0	1	0.0	-0.6	YES
994	1	0	1	0.0	-3.3	YES
995	1	0	1	0.0	-2.3	YES
996	1	0	1	0.0	-6.1	YES
997	1	0	1	0.0	-3.7	YES
998	1	0	1	0.0	-3.2	YES
999	1	0	1	0.0	-2.2	YES

NFM-08: River & Drain Assignment Analysis

DEFINITIONS		
Layer-3 (k=3) represents the upper Floridan aquifer		
GOM = indicates assignment is within Gulf of Mexico drainage area		
Report analyses are for discharging non-boundary Layer-3 assignments		
Drain assignments represent discharge to springs		
River Assignments represent discharge to rivers between springs		
Stage-Head = deviation between simulated and observed river stage		
Negative Stage-Head values indicate simulated head is higher than river stage		
Positive Stage-Head values indicate simulated head is lower than river stage		
There should be no positive values of Stage-Head for Drain assignments		
Stage=Elevation for Drain assignments		
Discharge = identifier marking discharging assignments (Stage-Head <0)		
Cell count = # unique cells containing Drain or River assignments		
Cell Neg Count = # unique cells containing discharging Drain or River assignments		
# Cell Assignments = # of Drain or River assignments in a given unique cell		
Max Cell Deviation = most negative Stage-Head value listed for a unique cell		
STATISTICS ON ALL ASSIGNMENTS		
# of non-boundary unconfined UFA Drain assignments	148	
# cells containing those Drain assignments	122	
# of discharging Drains (negative Stage-Head)	147	
# cells containing those discharging Drain assignments	121	
# of non-boundary unconfined UFA River assignments	1230	
# cells containing the River assignments	930	
# of discharging River assignments (negative Stage-Head)	831	
# cells containing those discharging River assignments	620	
Max Stage-Head for Drains (head below stage)	0.8607686	
Min Stage-Head for Drains (head above stage)	-19.05929	
Avg Stage-Head for discharging Drains	-6.409036	
Avg Stage-Head for cells with discharging Drains	-7.13821	
Max Stage-Head for Rivers (head below stage)	47.46137	
Min Stage-Head for Rivers (head above stage)	-28.76724	
Avg Stage-Head for discharging Rivers	-6.285769	
Avg Stage-Head for cells with discharging Rivers	-6.623057	
STATISTICS ON DISCHARGING ASSIGNMENTS		
# Drain assignments where Stage-Head <-3	109	74.15%
# Drain assignments where Stage-Head <-5	74	50.34%
# Drain assignments where Stage-Head <-10	33	22.45%
# Drain assignments where Stage-Head <-15	15	10.20%
# Drain assignments where Stage-Head <-20	0	0.00%
# cells with Drain assignments where Stage-Head <-3	94	77.69%
# cells with Drain assignments where Stage-Head <-5	65	53.72%
# cells with Drain assignments where Stage-Head <-10	32	26.45%
# cells with Drain assignments where Stage-Head <-15	14	11.57%
# cells with Drain assignments where Stage-Head <-20	0	0.00%

STATISTICS ON DISCHARGING ASSIGNMENTS CONT.		
# River assignments where Stage-Head <-3	576	69.31%
# River assignments where Stage-Head <-5	397	47.77%
# River assignments where Stage-Head <-10	198	23.83%
# River assignments where Stage-Head <-15	65	7.82%
# River assignments where Stage-Head <-20	7	0.84%
# cells with River assignments where Stage-Head <-3	380	61.29%
# cells with River assignments where Stage-Head <-5	260	41.94%
# cells with River assignments where Stage-Head <-10	133	21.45%
# cells with River assignments where Stage-Head <-15	52	8.39%
# cells with River assignments where Stage-Head <-20	7	1.13%
# assignments where Stage-Head <-3	685	70.04%
# assignments where Stage-Head <-5	471	48.16%
# assignments where Stage-Head <-10	231	23.62%
# assignments where Stage-Head <-15	80	8.18%
# assignments where Stage-Head <-20	7	0.72%
# cells with assignments where Stage-Head <-3	474	63.97%
# cells with assignments where Stage-Head <-5	325	43.86%
# cells with assignments where Stage-Head <-10	165	22.27%
# cells with assignments where Stage-Head <-15	66	8.91%
# cells with assignments where Stage-Head <-20	7	0.94%
# assignments where abs(deviation) > 5 feet	648	47.02%
# Drain assignments where abs(deviation) > 5 feet	74	50.00%
# River assignments where abs(deviation) > 5 feet	397	32.28%
CALIBRATION STATISTICS USING DRAIN & RIVER ASSIGNMENTS		
Count	1512	
Max	34.1	
Min	0.0	
Average	5.6	
# >5	618	40.9%
# >10	285	18.8%
# >20	19	1.3%

Appendix 5

Correlation of recharge assigned in the NFM-08 to precipitation, ground surface slope and land use within the NFM-08 domain: recharge polygon assignments, hydrologic parameters, and Pearson correlation coefficient determinations

Analysis of Recharge Assigned in the SDII North Florida Model - 2008

	RECHAR	PRECIP	SLOPE	LANDUSE DISTRIBUTION (% of polygon area)							PCC CALCULATIONS		
POLY #	in/yr	in/yr	% rise	UR	AG	RL	UF	WA	WL	BL	# in GROUP	PRECIP	SLOPE
1	13.55	48.37	na	na	na	na	na	na	na	na	na	na	na
2	10.16	43.91	na	na	na	na	na	na	na	na	na	na	na
3	8.90	43.93	na	na	na	na	na	na	na	na	na	na	na
4	8.76	46.85	na	na	na	na	na	na	na	na	na	na	na
5	9.20	51.00	na	na	na	na	na	na	na	na	na	na	na
6	9.20	53.85	na	na	na	na	na	na	na	na	na	na	na
7	0.00	46.34	na	na	na	na	na	na	na	na	na	na	na
8	0.00	52.24	na	na	na	na	na	na	na	na	na	na	na
9	14.02	50.48	na	na	na	na	na	na	na	na	na	na	na
10	13.14	51.56	na	na	na	na	na	na	na	na	na	na	na
11	13.14	55.50	0.80	75%	1%	1%	5%	11%	7%	0%	0	na	na
12	13.14	46.61	0.50	8%	9%	2%	50%	5%	24%	3%	19	0.62	0.12
13	10.07	46.38	na	na	na	na	na	na	na	na	na	na	na
14	6.57	47.78	na	na	na	na	na	na	na	na	na	na	na
15	6.57	57.30	na	na	na	na	na	na	na	na	na	na	na
16	6.57	46.91	2.30	9%	36%	3%	42%	0%	9%	0%	9	-0.62	0.13
17	15.06	47.78	na	na	na	na	na	na	na	na	na	na	na
18	6.13	48.03	0.50	9%	7%	2%	52%	1%	30%	0%	23	0.03	-0.25
19	6.13	47.95	1.20	5%	5%	2%	60%	5%	22%	0%	13	0.70	0.20
20	15.33	47.63	na	na	na	na	na	na	na	na	na	na	na
21	7.88	47.83	na	na	na	na	na	na	na	na	na	na	na
22	8.32	56.59	2.90	11%	23%	1%	43%	1%	20%	0%	10	0.01	-0.22
23	8.32	42.38	0.70	4%	17%	5%	57%	1%	16%	0%	12	0.06	-0.22
24	4.61	43.86	2.30	4%	25%	2%	44%	1%	24%	0%	9	0.30	-0.13
25	11.83	61.34	2.30	12%	9%	1%	41%	2%	35%	0%	20	0.01	0.19
26	20.59	52.00	2.00	5%	20%	2%	39%	1%	33%	0%	9	0.42	-0.12
27	20.59	63.31	3.90	49%	5%	3%	29%	2%	12%	0%	2	-0.48	-0.36
28	3.50	44.58	1.60	6%	30%	5%	56%	0%	3%	0%	9	-0.17	0.04
29	10.95	51.92	0.50	32%	6%	2%	32%	3%	23%	0%	1	na	na
30	10.95	51.59	1.00	17%	5%	4%	51%	2%	20%	1%	13	0.67	0.11
31	10.95	44.13	1.30	5%	42%	2%	46%	1%	3%	0%	6	-0.62	0.10
32	10.95	43.97	1.10	15%	12%	2%	41%	4%	26%	0%	20	-0.02	-0.16
33	10.95	48.37	0.30	2%	0%	1%	52%	0%	45%	0%	12	-0.18	-0.24
34	15.76	38.94	2.40	11%	32%	3%	46%	1%	7%	0%	13	-0.40	0.04
35	11.65	41.91	0.90	7%	26%	4%	58%	1%	3%	0%	9	-0.12	0.42
36	11.39	50.54	0.90	7%	5%	2%	61%	1%	25%	0%	17	0.65	0.12
37	11.39	53.87	0.50	49%	1%	1%	12%	20%	17%	0%	0	na	na
38	11.39	53.24	0.30	17%	10%	3%	39%	2%	30%	0%	11	0.16	0.07
39	5.47	48.44	1.80	23%	14%	4%	48%	2%	8%	0%	4	-0.16	0.43
40	8.85	42.03	0.70	1%	11%	2%	38%	0%	47%	0%	11	-0.16	-0.22
41	31.97	62.51	1.20	18%	3%	4%	58%	1%	16%	0%	10	0.74	0.09
42	10.18	48.81	0.30	3%	4%	1%	47%	0%	45%	0%	12	-0.18	-0.24
43	5.69	46.02	1.90	15%	33%	3%	44%	0%	3%	1%	12	-0.63	-0.12
44	9.64	53.46	0.70	14%	4%	3%	53%	1%	25%	0%	16	0.64	0.10
45	9.64	50.28	0.40	7%	17%	3%	44%	0%	28%	0%	20	0.19	-0.17
46	16.94	48.90	0.60	7%	5%	2%	57%	1%	27%	0%	19	0.59	0.06
47	9.92	50.95	0.50	8%	7%	3%	54%	0%	27%	0%	22	0.45	0.02
48	4.82	55.58	0.40	1%	2%	0%	42%	1%	53%	0%	10	-0.31	-0.20
49	18.61	47.48	1.90	12%	21%	3%	51%	1%	12%	1%	11	-0.26	0.13
50	3.56	47.51	1.90	21%	30%	2%	39%	1%	7%	1%	8	-0.71	0.33
51	7.97	50.41	0.30	17%	5%	2%	37%	2%	37%	0%	5	0.11	0.21
52	15.77	45.78	1.60	7%	34%	4%	50%	0%	4%	0%	10	-0.58	-0.09
53	15.77	47.80	1.70	25%	11%	2%	33%	9%	21%	0%	2	-0.69	0.48
54	19.60	45.60	0.10	1%	2%	0%	43%	0%	54%	0%	10	-0.31	-0.20
55	16.41	48.54	0.60	4%	9%	1%	56%	2%	28%	0%	21	0.11	-0.22
56	12.26	49.18	0.40	14%	8%	2%	57%	0%	18%	0%	15	0.61	0.25
57	12.26	44.92	1.60	11%	23%	7%	51%	1%	6%	1%	9	-0.12	0.42
58	12.21	43.84	0.60	4%	16%	2%	48%	0%	30%	0%	20	0.20	-0.23

	RECHAR	PRECIP	SLOPE	LANDUSE DISTRIBUTION (% of polygon area)							PCC CALCULATIONS		
POLY #	in/yr	in/yr	% rise	UR	AG	RL	UF	WA	WL	BL	# in GROUP	PRECIP	SLOPE
59	10.19	53.99	1.00	17%	5%	2%	44%	10%	21%	0%	13	0.70	0.17
60	11.07	45.36	1.70	13%	26%	8%	48%	2%	3%	0%	10	-0.31	0.19
61	7.01	43.08	0.60	4%	19%	2%	39%	0%	35%	0%	10	0.47	-0.09
62	17.08	47.19	1.00	4%	22%	2%	46%	0%	26%	0%	11	0.42	-0.25
63	17.92	46.32	0.10	0%	1%	1%	43%	0%	55%	0%	9	-0.40	-0.50
64	18.40	49.59	0.30	3%	2%	3%	51%	0%	41%	0%	14	-0.19	-0.19
65	11.21	48.61	1.80	20%	7%	4%	43%	7%	18%	1%	8	0.72	-0.03
66	10.06	51.25	0.50	13%	10%	4%	37%	11%	26%	0%	14	-0.08	-0.06
67	12.04	42.13	1.00	5%	22%	3%	51%	1%	19%	0%	9	0.18	-0.37
68	8.58	46.05	2.20	18%	31%	2%	42%	0%	6%	0%	10	-0.62	0.19
69	12.95	46.64	0.10	5%	6%	1%	49%	0%	39%	0%	22	-0.03	0.11
70	0.44	47.00	1.80	17%	36%	5%	41%	0%	0%	0%	8	-0.69	-0.03
71	7.41	47.25	1.70	23%	24%	2%	41%	0%	9%	0%	6	-0.30	0.03
72	6.33	48.64	0.80	7%	34%	2%	39%	0%	18%	0%	4	-0.45	0.27
73	6.71	47.47	0.60	20%	20%	2%	48%	2%	7%	0%	8	-0.35	0.05
74	16.36	52.38	0.90	8%	7%	2%	37%	19%	26%	0%	1	na	na
75	17.52	50.14	0.10	1%	1%	0%	39%	1%	59%	0%	7	-0.47	-0.58
76	16.64	51.61	0.40	4%	9%	2%	51%	1%	32%	0%	22	0.18	0.13
77	16.29	54.28	0.30	4%	19%	2%	49%	0%	26%	0%	17	0.35	-0.18
78	5.68	52.26	1.20	18%	26%	2%	37%	0%	16%	0%	4	0.18	0.52
79	18.47	47.88	2.30	24%	48%	1%	21%	2%	4%	0%	0	na	na
80	25.84	47.41	1.60	40%	15%	2%	28%	1%	14%	0%	2	-0.48	-0.36
81	7.25	52.39	0.10	1%	2%	6%	33%	2%	56%	0%	5	-0.48	-0.58
82	10.83	53.12	0.70	16%	15%	1%	38%	2%	27%	0%	8	0.18	0.36
83	29.78	50.75	2.00	37%	31%	1%	24%	1%	6%	0%	1	na	na
84	27.17	48.34	1.90	41%	29%	2%	21%	0%	6%	0%	1	na	na
85	18.90	50.90	1.80	46%	10%	2%	32%	1%	10%	0%	2	-0.48	-0.36