GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Most Recent Revised Groundwater Plan Modeling

Lower Flint-Ochlockonee Region

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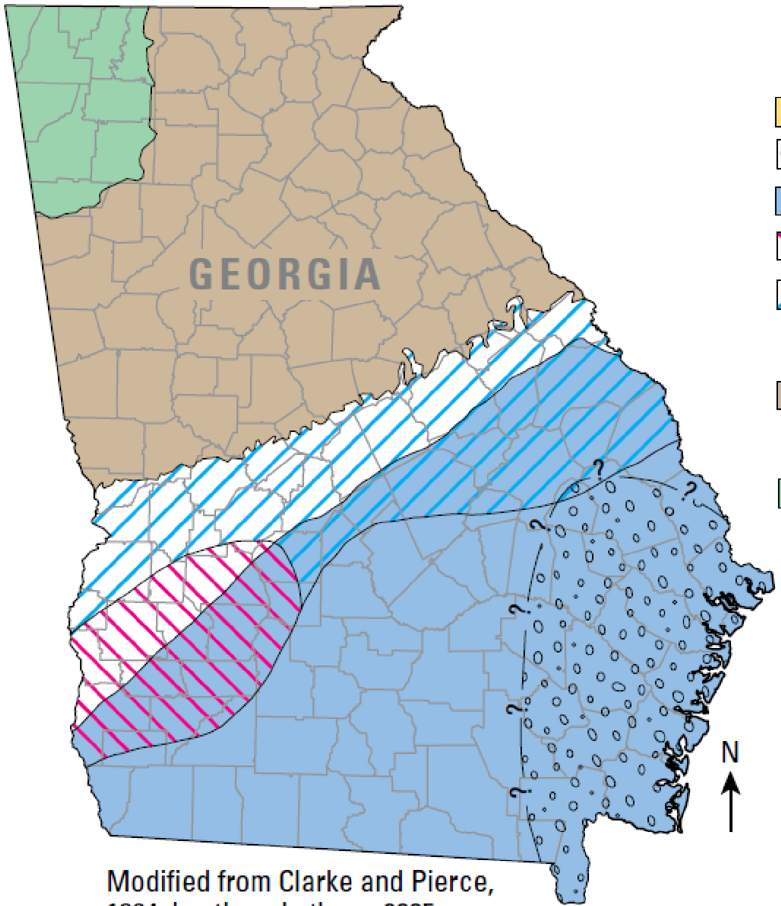
Lower Flint-Ochlockonee Regional Council Meeting
11 December 2019

GEORGIA'S AQUIFERS



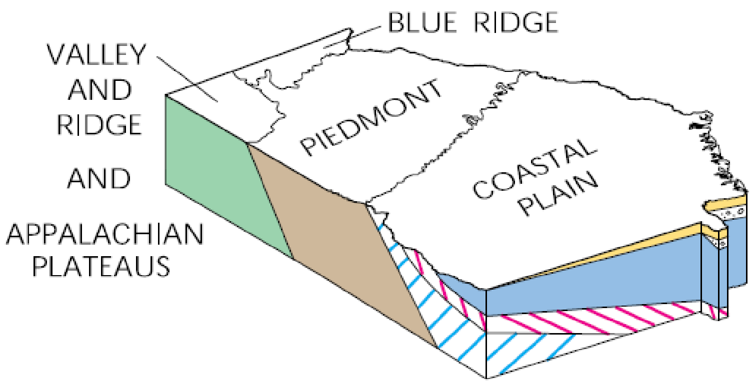
Modified from Clarke and Pierce, 1984; Leeth and others, 2005

EXPLANATION

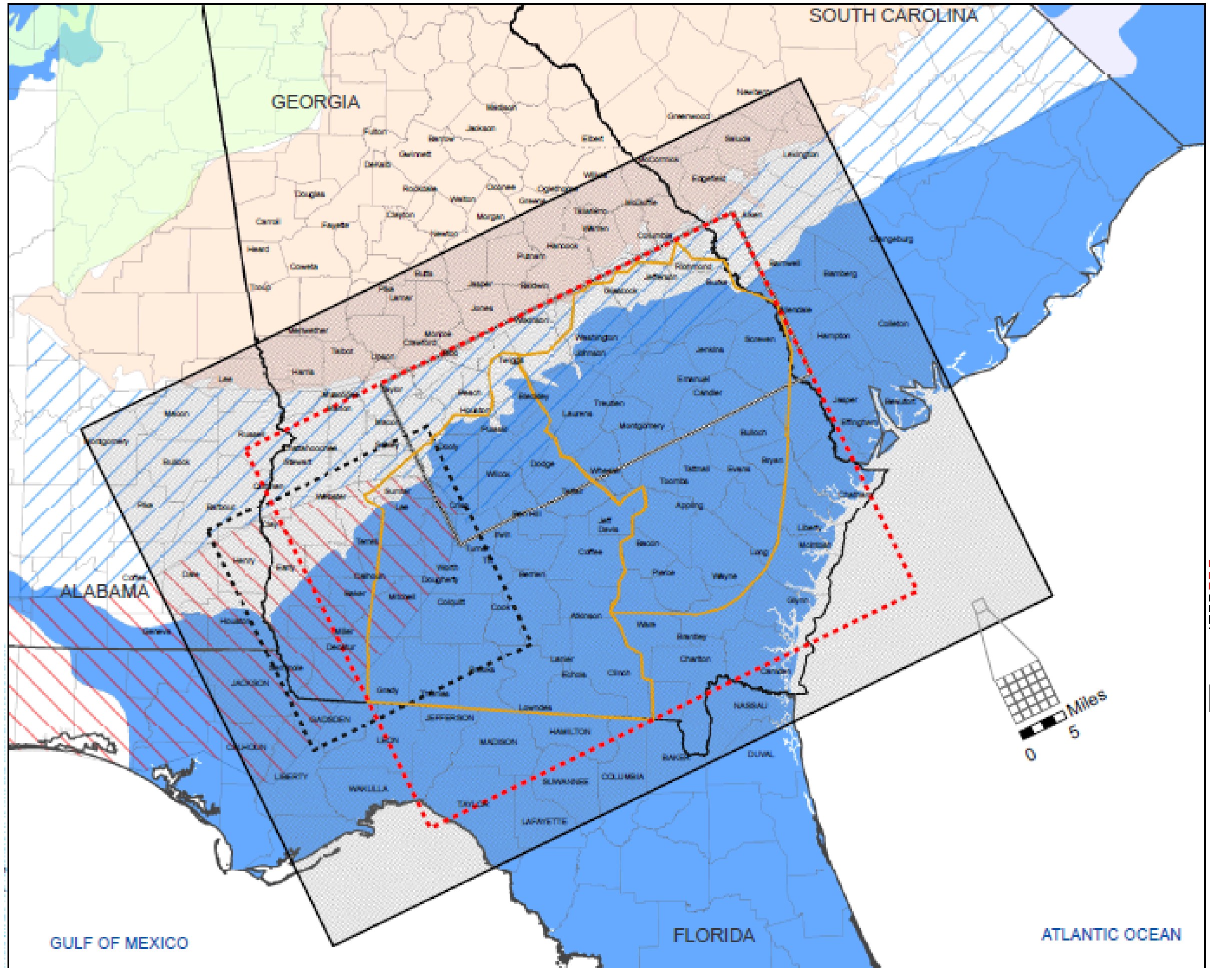
Coastal Plain aquifers
- Surficial aquifer system (not a principal aquifer)
- Brunswick aquifer system
- Floridan aquifer system
- Claiborne, Clayton, and Providence aquifers
- Cretaceous aquifer system

Piedmont and Blue Ridge aquifers
- Crystalline-rock aquifers

Valley and Ridge and Appalachian Plateau aquifers
- Paleozoic-rock aquifers



PREVIOUS STATE WATER PLAN REGIONAL AND SUB-REGIONAL MODELS



N
W E
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0 20 40 Miles

These are the domains of the 2010 State Water Plan regional and sub-regional models; use the same domain for recent models.

Legend

Model Domains

- Proposed South Georgia Coastal Plain Model
- Tift and Extension Upper Floridan Aquifer Model Area
- UFA Model Boundary
- Local-Scale Claiborne Aquifer Model Boundary
- Local-Scale Cretacious Aquifer Model Boundary

Aquifers

- Floridan Aquifer System
- Claiborne Aquifer
- Cretaceous Aquifer System
- Paleozoic-rock Aquifers
- Crystalline-rock Aquifers

Figure 1
Proposed Regional Groundwater Flow Model Domain and Model Grid System

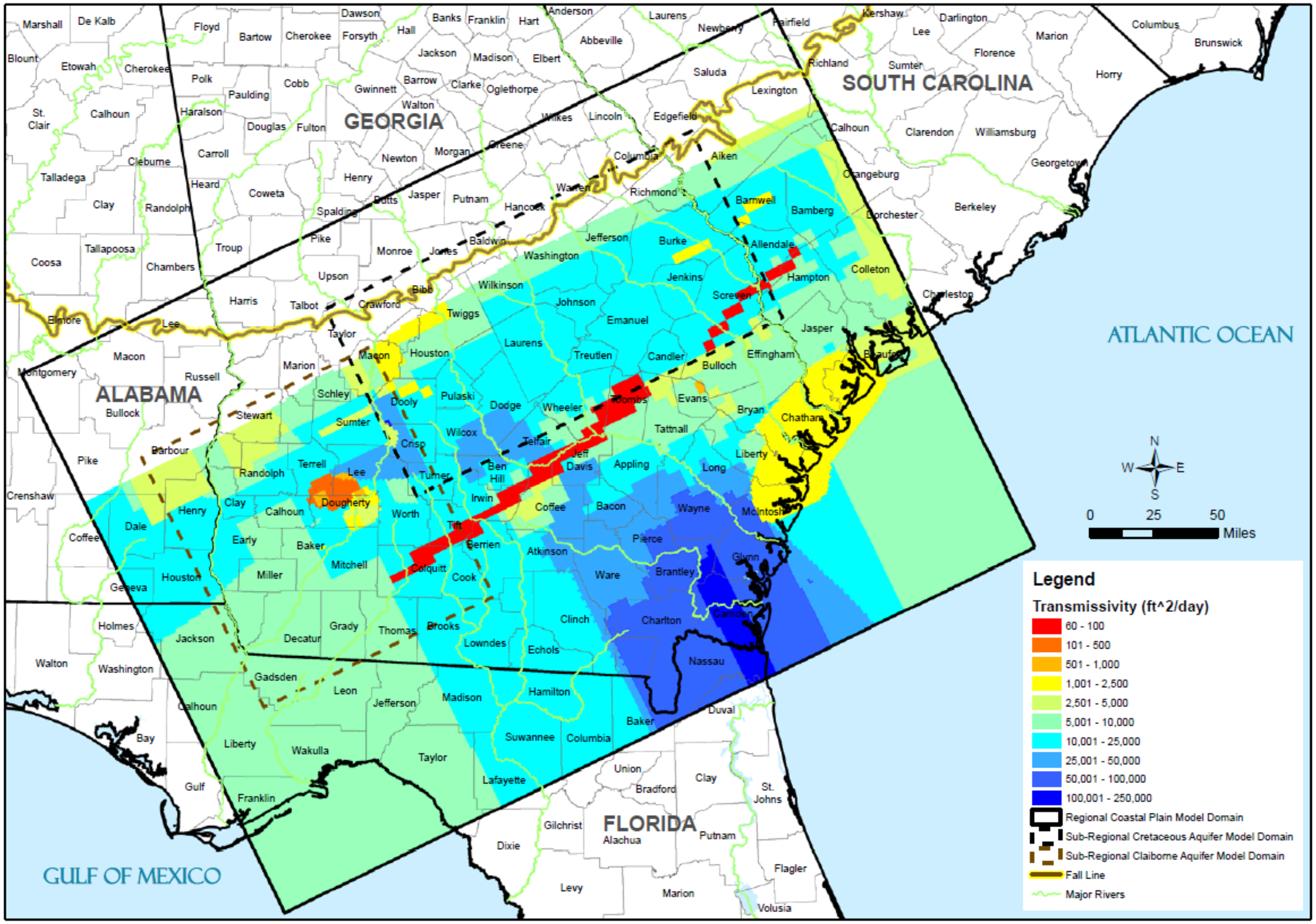
LOWER FLINT-OCHLOCKONEE WATER PLANNING REGION

ADDITIONAL MODELING WORK IN THE LOWER FLINT-OCHLOCKONEE REGION

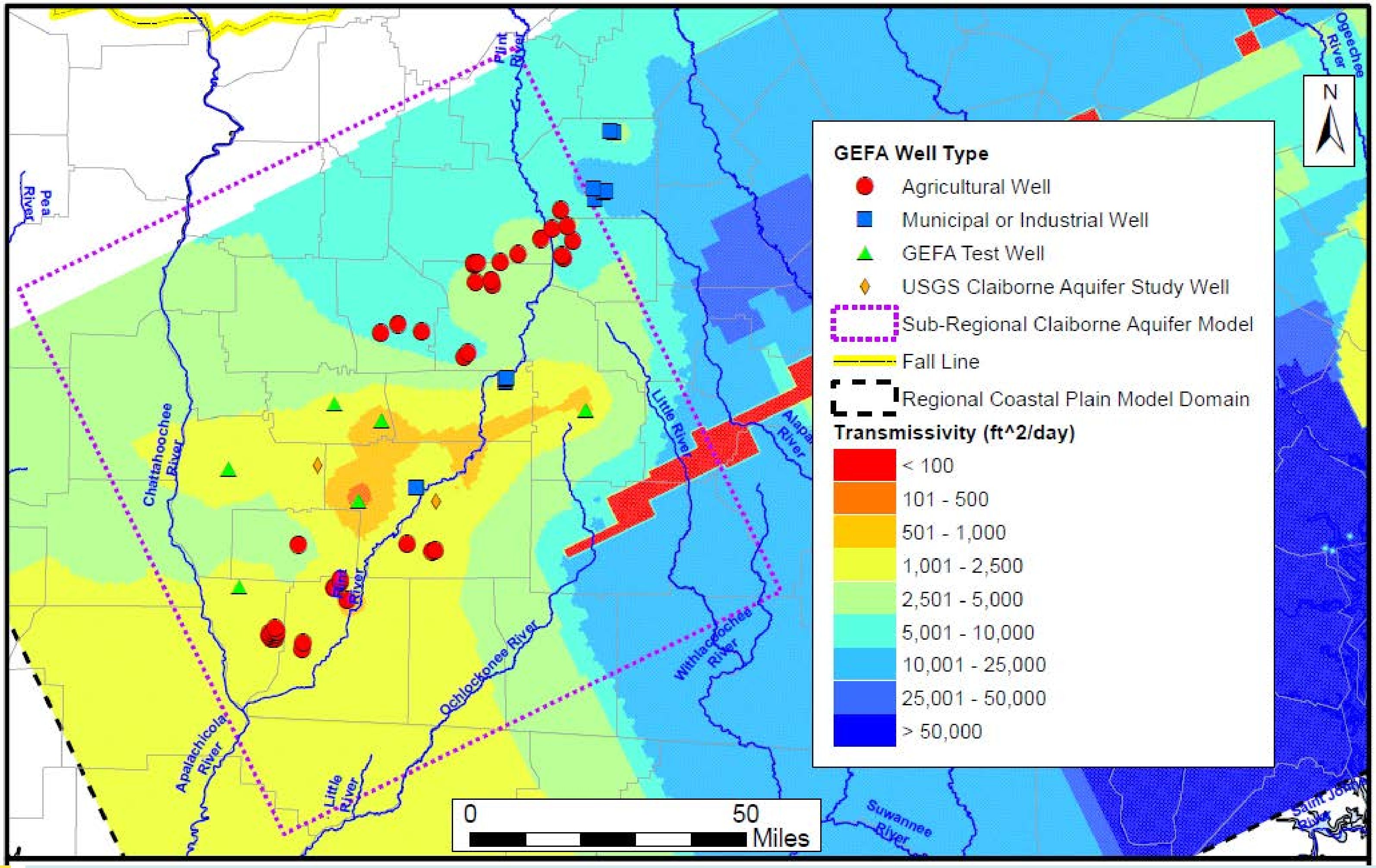
Additional modeling was done:

- By CDM Smith because studies by the Georgia Environmental Finance Agency (GEFA) and the U.S. Geological Survey (USGS) showed that specific capacities (gallons per minute divided by water level drawdown in the well) and transmissivities (hydraulic conductivity times aquifer saturated thickness) of the Claiborne aquifer were overall lower than the values used in the 2012 State Water Plan modeling (addressed in Part 1 of the talk)
- To address the Lower Flint-Ochlocknee council's request to investigate the feasibility of replacing surface water withdrawals in the Ichawaynochaway and Spring Creek water sheds with groundwater withdrawals from the Claiborne aquifer where it is confined and from the Cretaceous aquifer where the Claiborne aquifer is not confined (addressed in Part 2 of the talk)

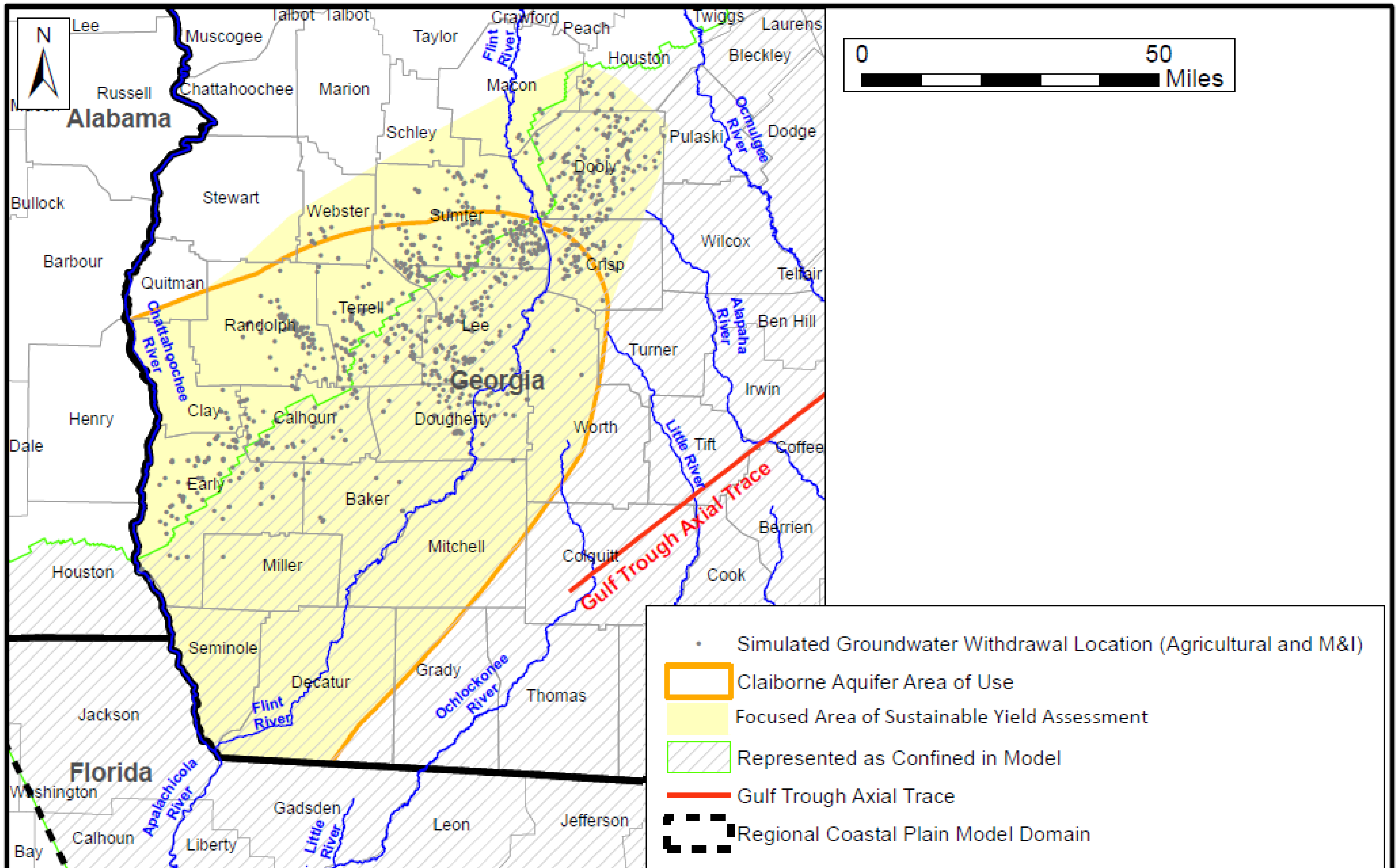
CLAIBORNE AQUIFER TRANSMISSIVITY FROM THE SEPTEMBER 2012 TECHNICAL MEMORANDUM ON THE CLAIBORNE AQUIFER (PART 1)



UPDATED CLAIBORNE AQUIFER TRANSMISSIVITY MEASURED BY GEFA AND USGS AND USED IN RECENT MODELING



UPDATED AREA OF CLAIBORNE AQUIFER STEADY STATE SUSTAINABLE YIELD ASSESSMENT



CLAIBORNE AQUIFER SIMULATED STEADY STATE SUSTAINABLE YIELD FROM THE SEPTEMBER 2012 TECHNICAL MEMORANDUM ON THE CLAIBORNE AQUIFER

Simulation	Condition	Pumping in Claiborne Aquifer	Increased Pumping		Modeling Results	
					Max Drawdown	Reduced GW Contribution to River Baseflow [1]
		(mgd)	(mgd)	(%)	(ft)	
SIM 1	Baseline	93			-	-
SIM 2	Uniformly increased existing well pumping (low end of SY)	140	47	51%	30	2%
SIM 3	Non-uniformly increased existing well pumping	439	346	372%	30	12%
SIM 4	Uniformly increased simulated new well pumping with baseline pumping in existing wells (93 mgd)	149	56	60%	30	2%
SIM 5	Non-uniformly increased simulated new well pumping with baseline pumping in existing wells (93 mgd)	444	351	377%	30	12%
SIM 6	Non-uniformly increased existing and simulated new well pumping (high end of SY)	635	542	583%	30	18%

UPDATED CLAIBORNE AQUIFER SIMULATED STEADY STATE SUSTAINABLE YIELD AFTER AQUIFER TRANSMISSIVITY WAS ADJUSTED AND THE AQUIFER AREA WAS INCREASED

Condition	Pumping from Claiborne Aquifer	Increased Pumping		Modeling Results			
				Max Drawdown	Reduced GW Contribution to River Baseflow		
	(mgd)	(mgd)	(%)	(ft)	Model-wide	Focused Area of SY Assessment	Flint River
Baseline	120						
Uniformly increased existing well pumping (low end of SY)	141	20	17%	30	< 1 %	< 2 %	< 1 %
Existing and new well pumping (high end of SY)	803	682	564%	30	7.5%	5.4%	24%

Compare to previous sustainable yields from the 2012 model of 140 mgd (low end) and 635 mgd (high end)

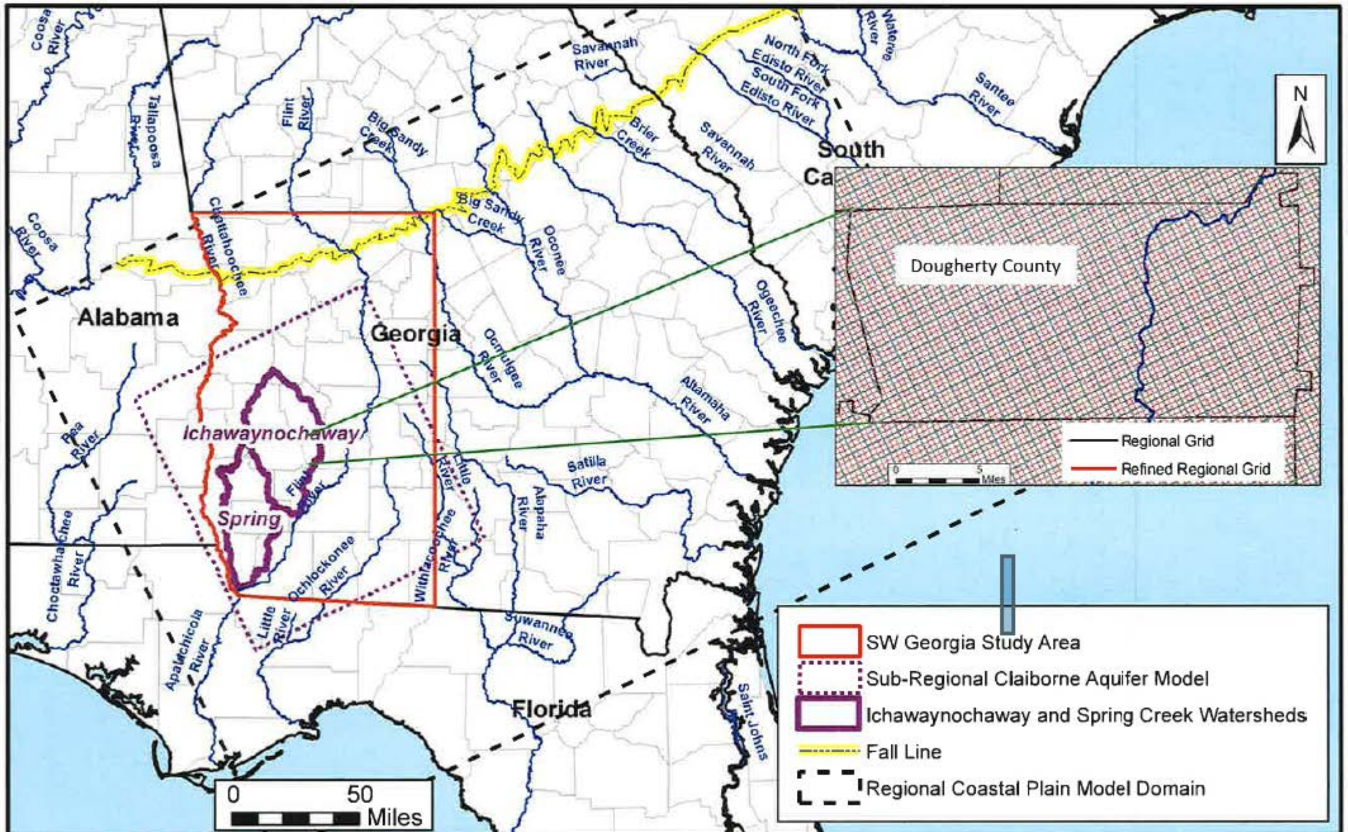
2017 STUDY OF THE TRANSMISSIVITY OF THE CLAIBORNE AQUIFER ON STEADY STATE SUSTAINABLE YIELD (PART 1)

- A study of the Claiborne aquifer transmissivity showed that the aquifer overall was less than used in the 2012 State Water Plan model, although portions of the aquifer had a higher transmissivity
- The extent of the Claiborne aquifer modeled in 2012 was smaller than the extent of the more recently modeled aquifer, with the more recently modeled aquifer extending to the northeast of the 2012 model extent where the transmissivities were generally higher
- The low end of the Claiborne aquifer sustainable yield for uniformed increased existing well pumping determined in 2012 model was 140 mgd versus 141 mgd in the more recent model
- The high end of the Claiborne aquifer sustainable yield for existing and hypothetical new well pumping determined in 2012 model was 635 mgd versus 803 mgd in the more recent model

2017 STUDY OF THE TRANSMISSIVITY OF THE CLAIBORNE AQUIFER ON STEADY STATE SUSTAINABLE YIELD (PART 1)

- The sustainable yield of the more recent model increased over the 2012 model even though the transmissivity of the Claiborne aquifer generally decreased
- The increase in sustainable yield was not for the lower end of sustainable yield (141 mgd versus 140 mgd) but for the higher end of sustainable yield (803 mgd versus 635 mgd)
- The lower end of the sustainable yield remained about the same because the decrease in existing well yield in portions of the Claiborne aquifer with lower transmissivity were offset by the increased footprint of the modeled aquifer to the northeast where existing wells were in areas with generally higher transmissivities
- The higher end of the sustainable yield increased because the room for hypothetical new wells increased to the northeast where the transmissivities were generally higher

CDM SMITH REFINED GRID SPACING AND COVERAGE FOR TRANSIENT MODELING OF CLAIBORNE AND CRETACEOUS AQUIFERS (PART 2)

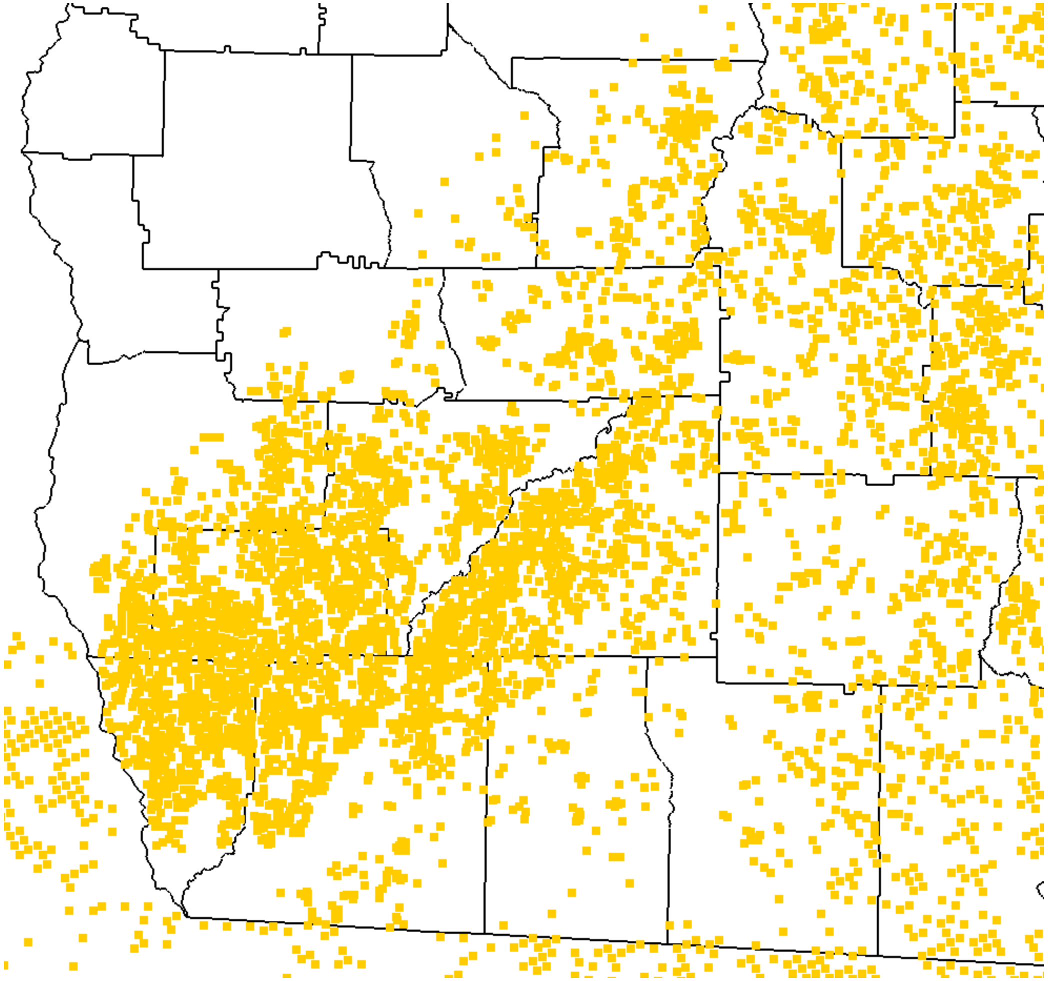


CDM Smith

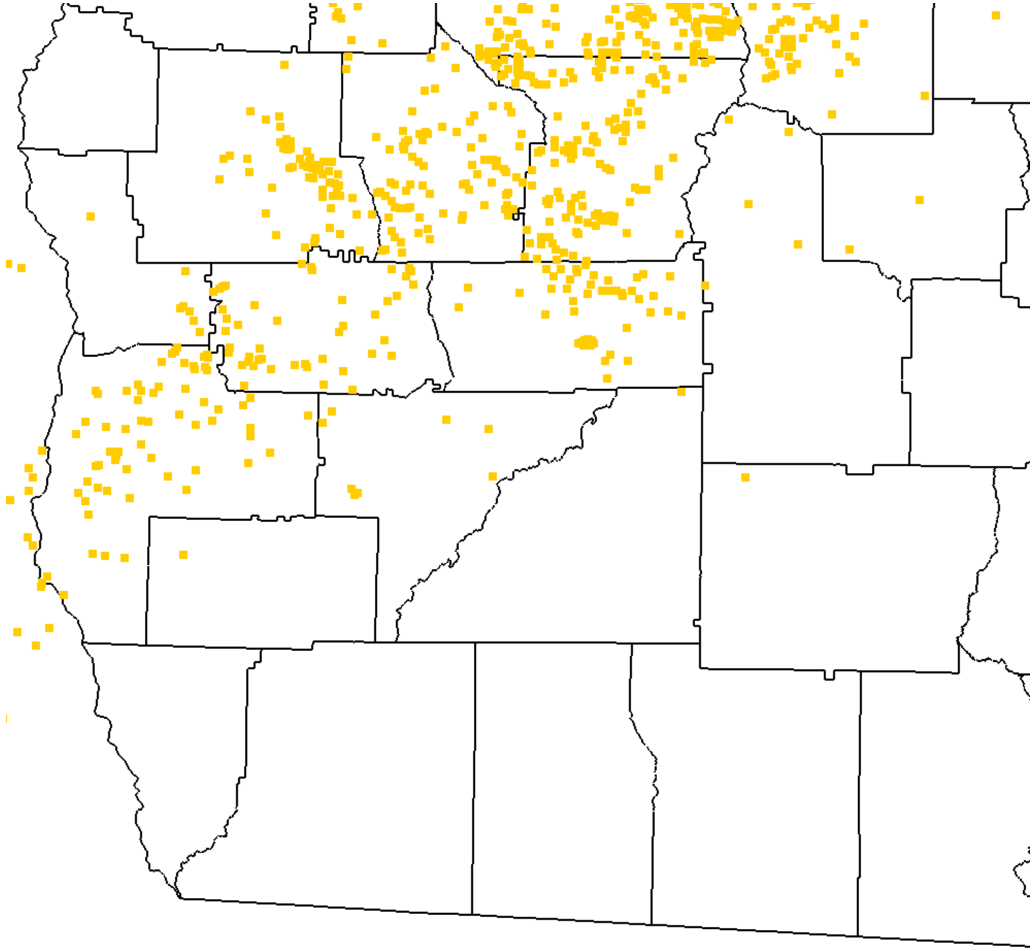
Figure 3-1
Refined Regional Model Domain

Grid spacing in the original regional model was 5,280 feet (one mile). Grid spacing in the revised model is 1,760 feet (1/3 mile) so that each of the original grid squares is now occupied by nine grid squares (3 x 3 = 9). The grid spacing of 1,760 feet in the revised model is less that the 2,000 feet grid spacing used in the original sub-regional models.

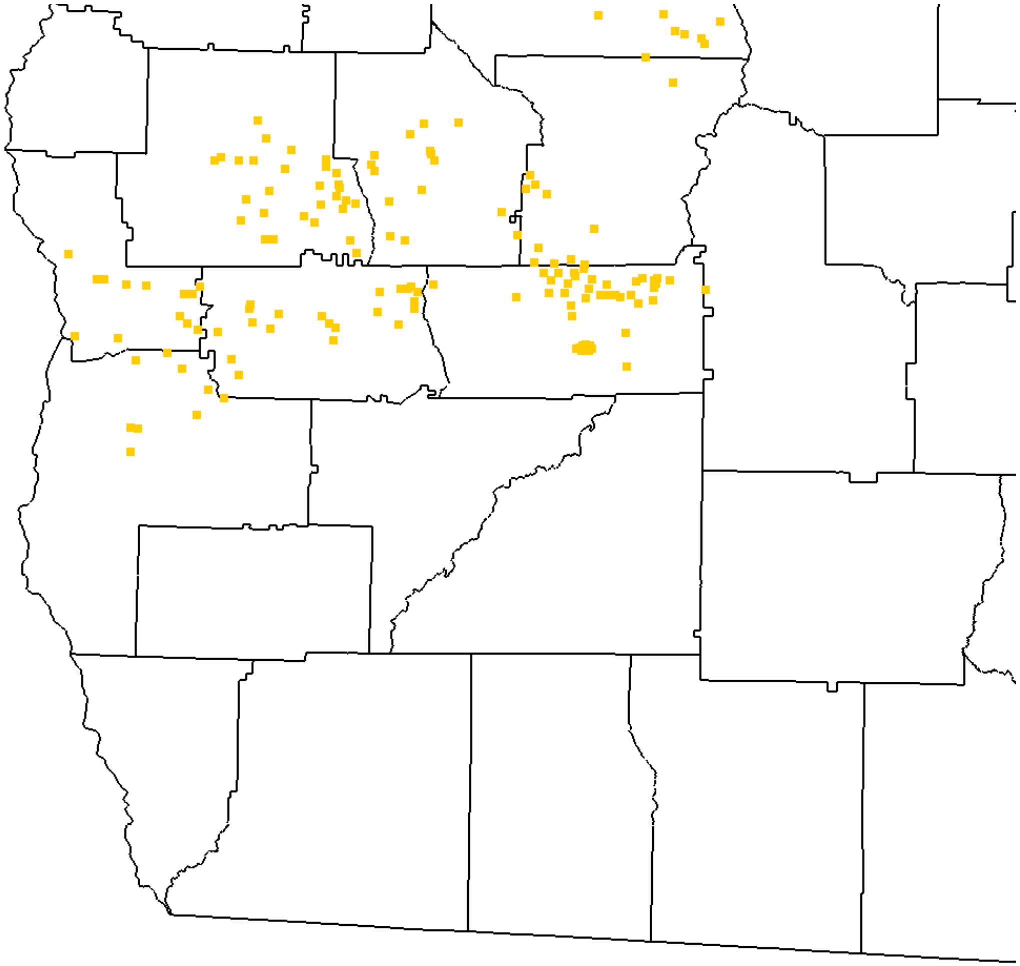
LAYER 2 WELLS (FLORIDAN AQUIFER) MODELED IN THE LOWER FLINT-OCHLOCKONEE



LAYER 3 WELLS (CLAIBORNE AQUIFER) MODELED IN THE LOWER FLINT-OCHLOCKONEE



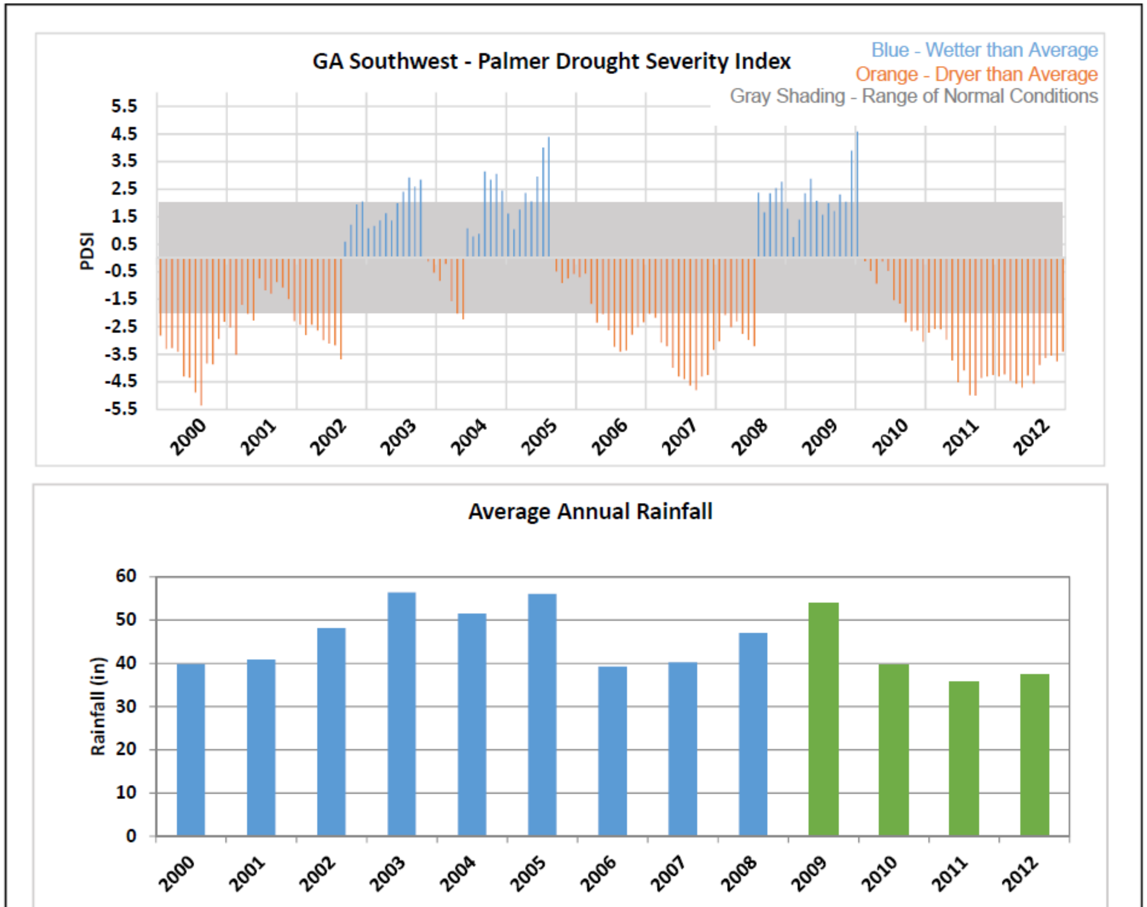
LAYER 5 WELLS (CRETACEOUS AQUIFER) MODELED IN THE LOWER FLINT-OCHLOCKONEE



TRANSIENT MODELING OF THE CLAIBORNE AND CRETACEOUS AQUIFERS

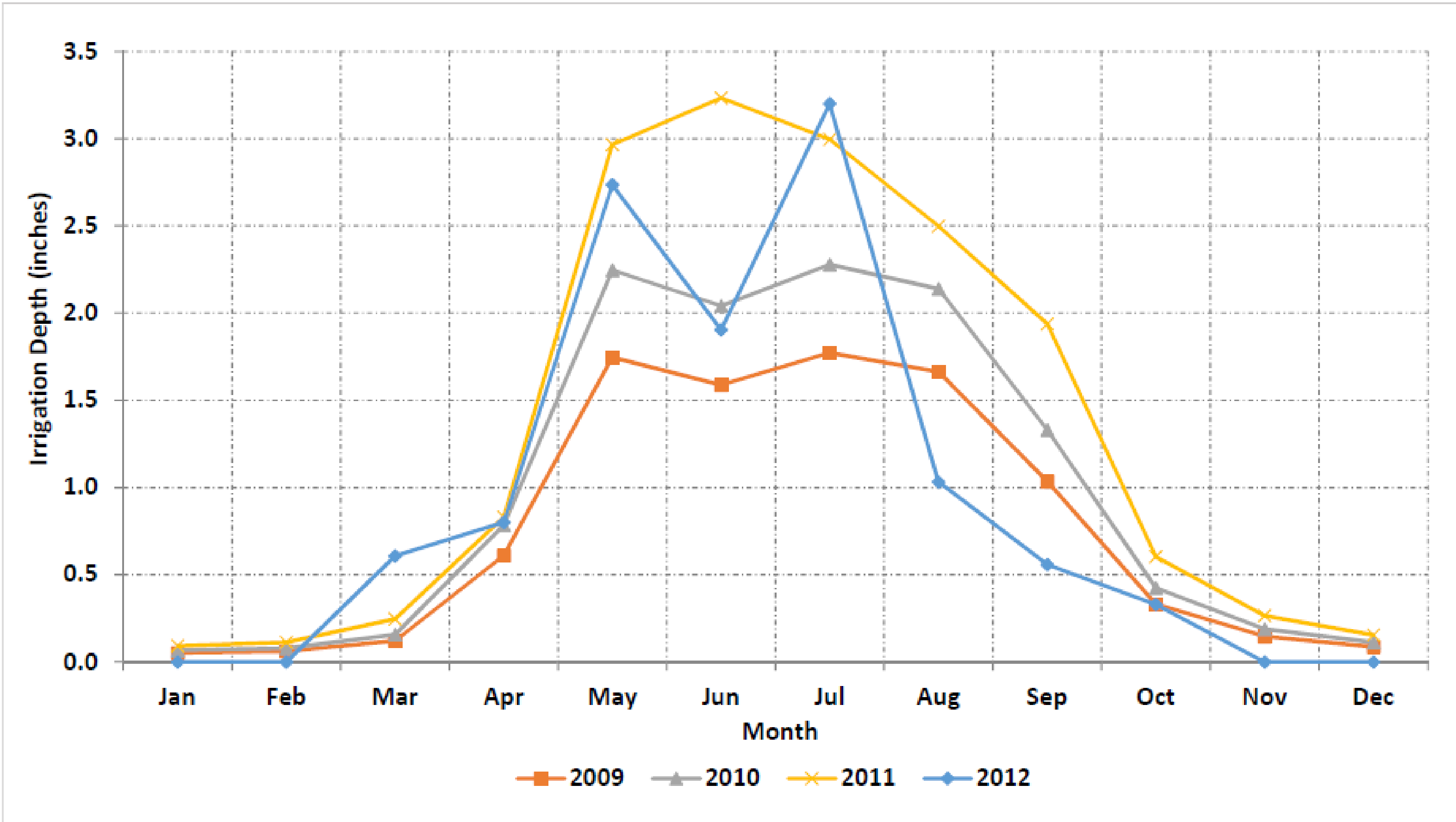
- Transient modeling was used so that time-varying pumping rates could be applied to some wells such as agricultural irrigation wells
- Well pumping rates were assigned at one month intervals so that a transient well would be assigned twelve pumping rates over one year
- Municipal—industrial wells were assigned the same pumping rate each month while irrigation wells were assigned a higher rate during the growing season and a lower rate during the non-growing season
- Transient simulations also allowed for time-varying groundwater recharge, more during the winter and early spring months and less during the summer and early fall months; simulate the years 2009 to 2012 with 2009 being a wet year, 2010 being an average year, and 2011 and 2012 being dry years
- With twelve time steps per year the models became much bigger and required more time to complete a successful model run

ANNUAL PRECIPITATION AND THE FOUR YEARS CHOSEN FOR THE TRANSIENT SIMULATIONS

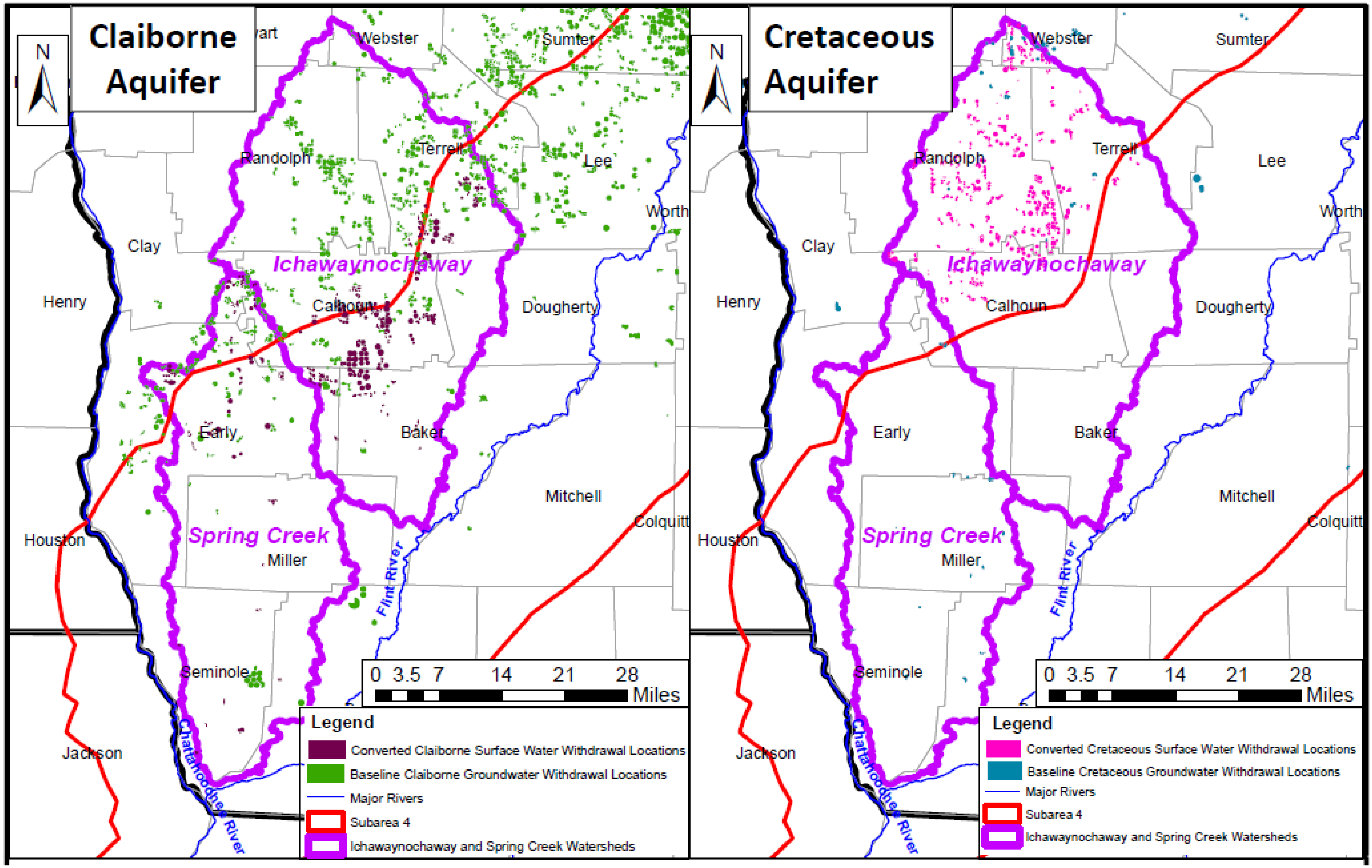


*Green bars show the simulation period for the transient refined regional model.

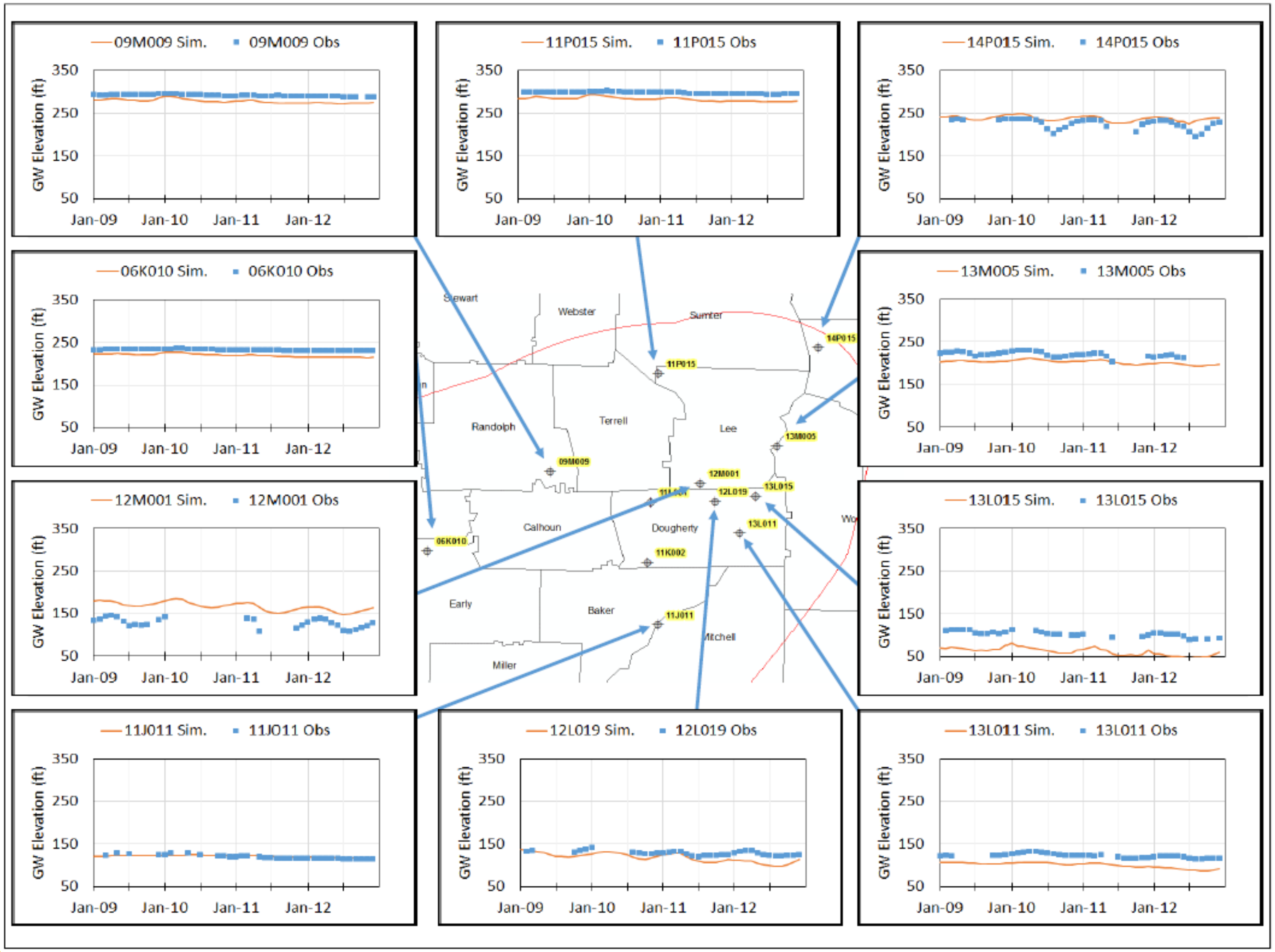
MONTHLY IRRIGATION DEPTHS USED IN TRANSIENT MODEL FROM WELL METER AND IRRIGATED ACREAGE DATA



PUMPING FROM AQUIFER DEPENDS ON WHERE IT IS CONFINED AND NOT DIRECTLY CONNECTED TO SURFACE WATER

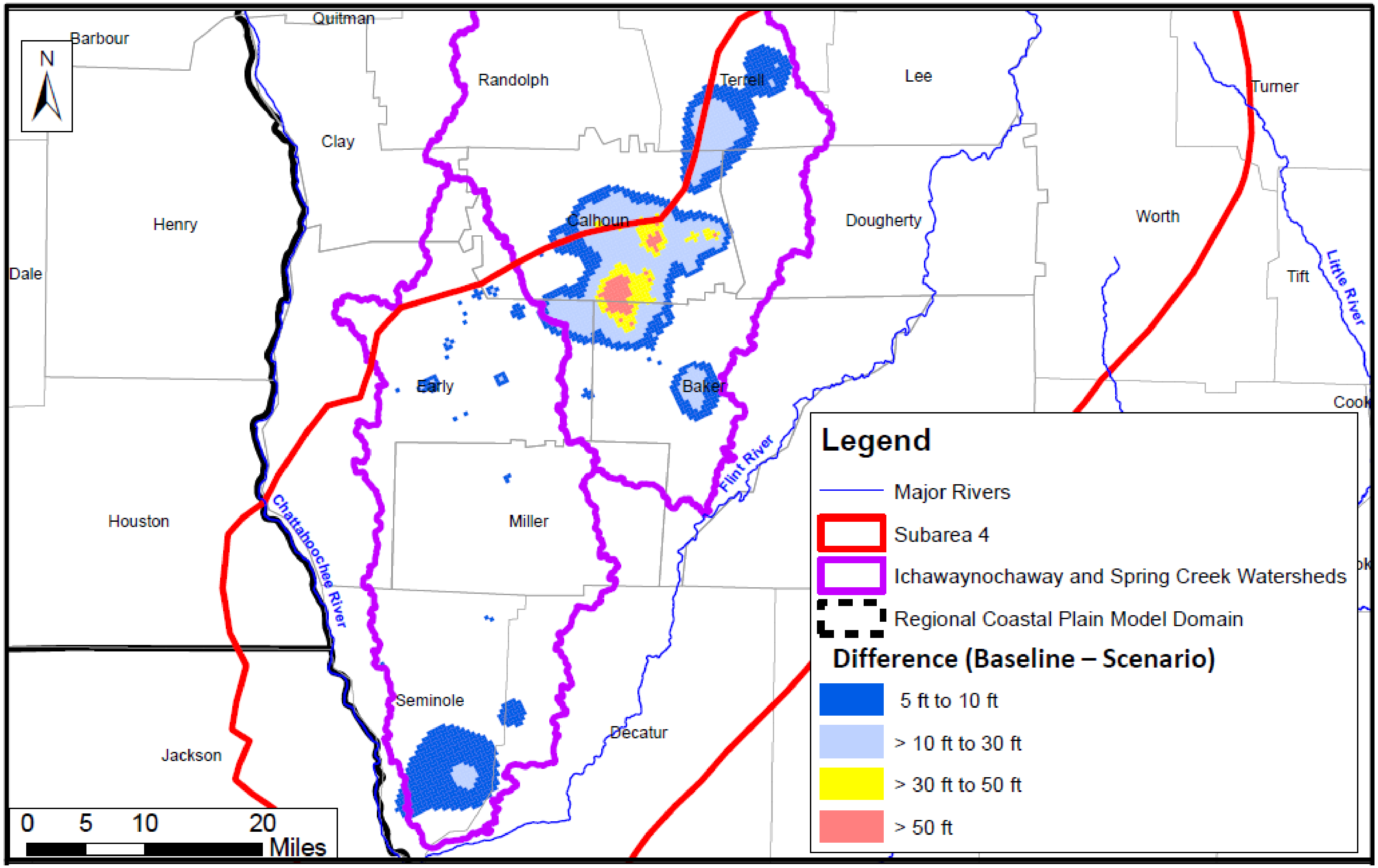


COMPARISON OF SIMULATED TRANSIENT AND OBSERVED MODEL LAYER 3 (CLAIBORNE AQUIFER) WATER LEVELS IN WELLS



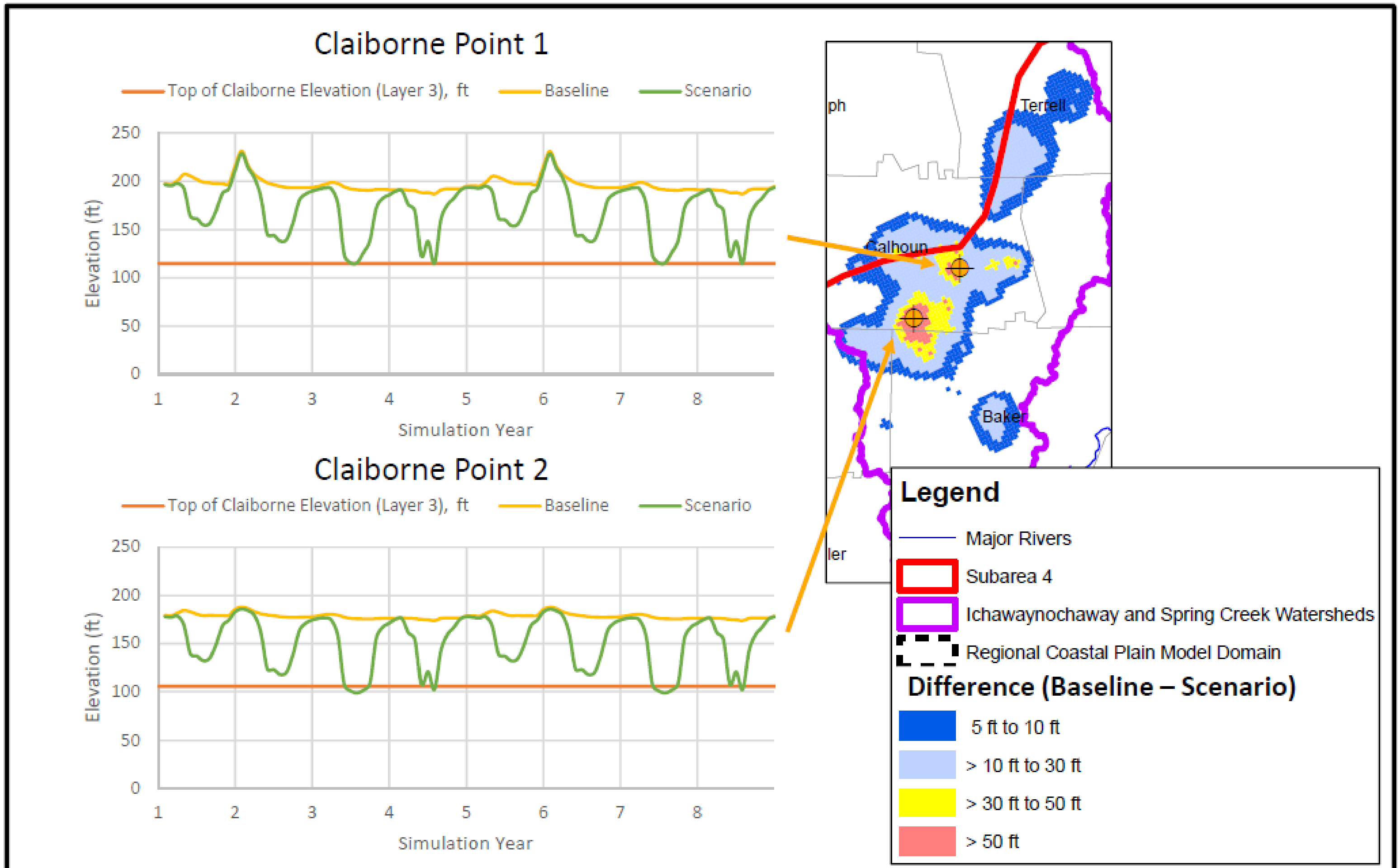
There were also successful transient simulations done to match simulated discharges of groundwater to surface water to calculated stream base flows (when the stream flow is supported for the most part by groundwater discharge). The simulations matched well.

SIMULATED CLAIBORNE AQUIFER (MODEL LAYER 3) DRAWDOWN IN JULY (ADDITIONAL 50 MGD TO REPLACE SURFACE WATER USE)



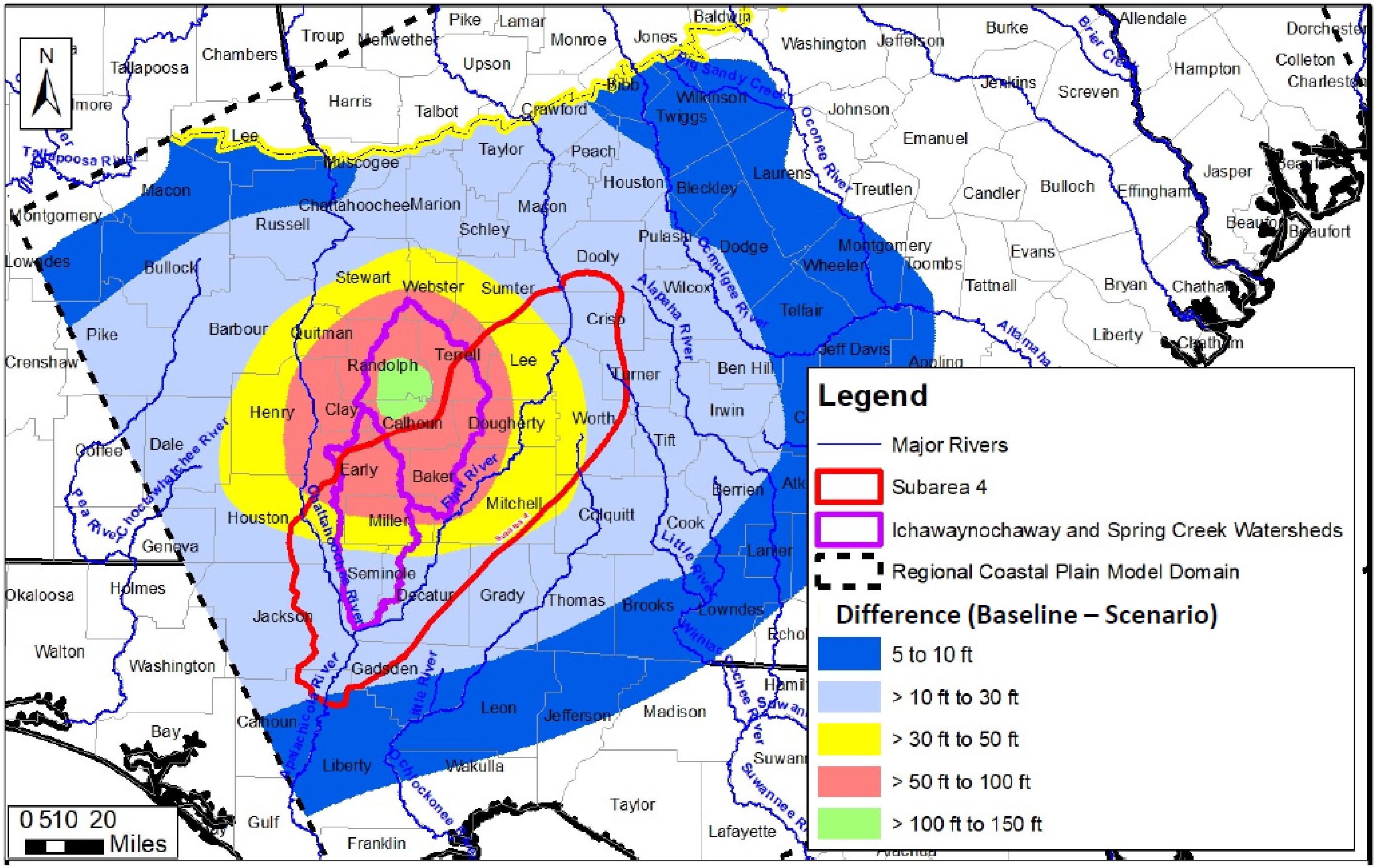
Simulated transient drawdown in the Claiborne aquifer from simulation of an additional 50 mgd of groundwater withdrawal (50 mgd to replace surface water use)

SIMULATED CLAIBORNE AQUIFER (MODEL LAYER 3) TRANSIENT GROUNDWATER ELEVATIONS IN ICHAWAYNOCHAWAY CREEK



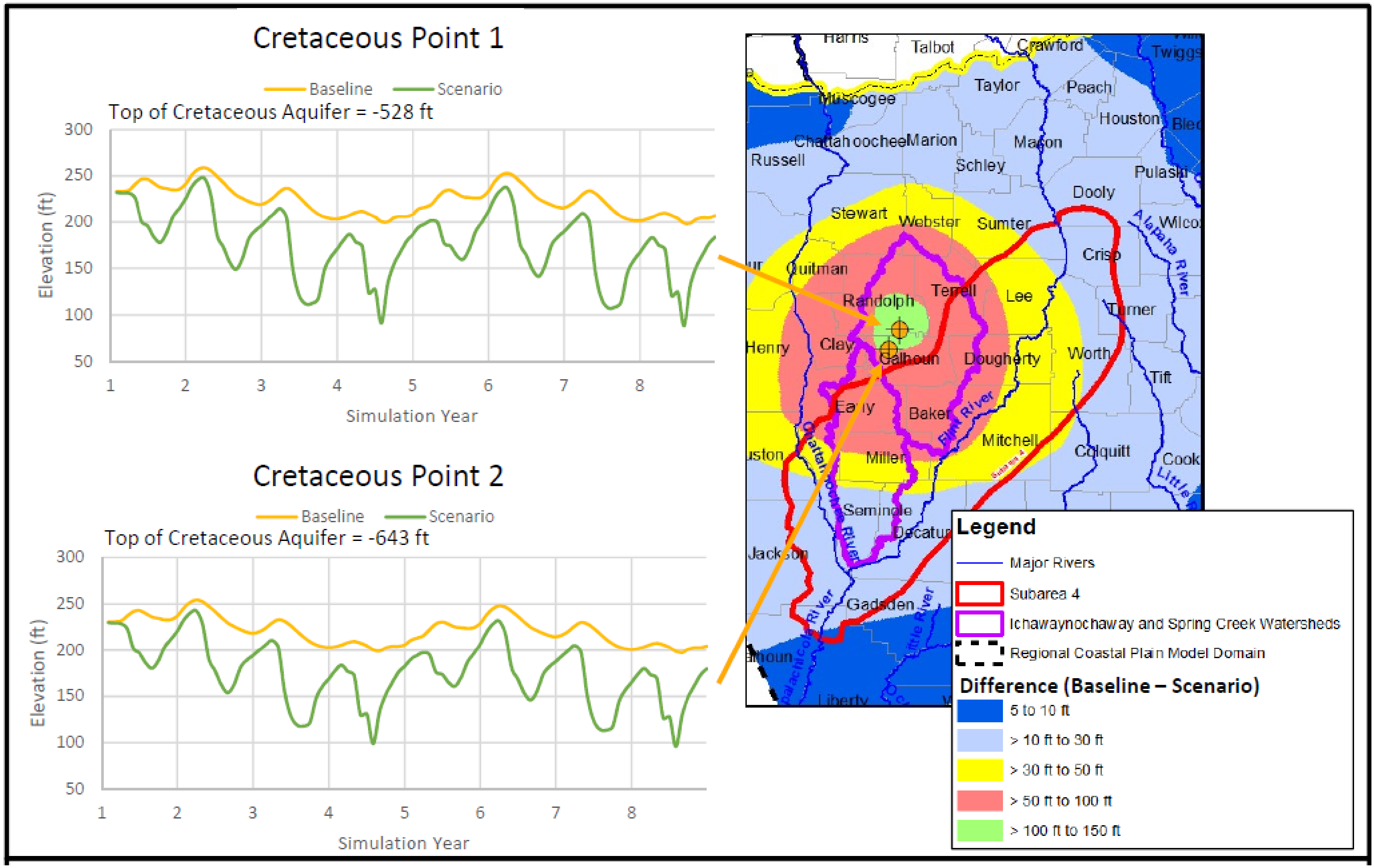
Any drawdown experienced by the Claiborne aquifer during the additional groundwater withdrawal was fully recovered during the non-growing season.

SIMULATED CRETACEOUS AQUIFER (MODEL LAYER 6) DRAWDOWN IN JULY (ADDITIONAL 62 MGD TO REPLACE SURFACE WATER USE)



Simulated transient drawdown in the Cretaceous aquifer from simulation of an additional 62 mgd of groundwater withdrawal (62 mgd to replace surface water use)

SIMULATED CRETACEOUS AQUIFER (MODEL LAYER 6) TRANSIENT GROUNDWATER ELEVATIONS



Most of the drawdown experienced by the Claiborne aquifer during the additional groundwater withdrawal was fully recovered during the non-growing season. There were only a limited number Cretaceous aquifer calibration points available and more data would be useful.

EFFECTS OF INCREASED TRANSIENT GROUNDWATER WITHDRAWALS FROM THE CLAIBORNE AND CRETACEOUS AQUIFERS IN THE LOWER FLINT-OCHLOCKONEE REGION (PART 2)

- Transient pumping of an additional 50 mgd from the Claiborne aquifer in the Ichawaynochaway and Spring Creek basins caused greater than 50 feet of drawdown (more then the 30 feet of drawdown allowed in the steady state State Water Plan models)
- In the Ichawaynochaway Creek basin maximum transient drawdown in the Claiborne aquifer was as much as 100 feet from the baseline level and all of the drawdown recovered during the non-growing season
- In the Spring Creek basin maximum transient drawdown in the Claiborne aquifer was as much as 20 feet from the baseline level and all of the drawdown recovered during the non-growing season
- Transient pumping of an additional 62 mgd from the Cretaceous aquifer in the Ichawaynochaway Creek basin caused 100 to 150 feet of drawdown
- In the Ichawaynochaway Creek basin maximum transient drawdown in the Cretaceous aquifer was as much as 100 feet from the baseline level and all of the drawdown almost fully recovered during the non-growing season

SUMMARY OF RECENT MODELING OF THE CLAIBORNE AND CRETACEOUS AQUIFERS IN THE LOWER FLINT-OCHLOCKONEE REGION

- A study of the Claiborne aquifer transmissivity by GEFA and the USGS showed that the aquifer transmissivity was overall less than used in the 2012 steady state State Water Plan model
- The extent of the more recently modeled Claiborne aquifer was larger than the extent of the aquifer modeled in 2012
- The steady state sustainable yield of the more recent model increased over the 2012 model because the room for hypothetical new wells was increased to the northeast where the transmissivities were generally higher than before
- Transient pumping of an additional 50 mgd from the Claiborne aquifer in the Ichawaynochaway and Spring Creek basins and of an additional 62 mgd from the Cretaceous aquifer in the Ichawaynochaway Creek basin, both to replace the use of surface water, caused greater than 30 feet of drawdown
- The transient drawdown in the Ichawaynochaway and Spring Creek basins almost fully recovered during the non-growing season which means that the transient use of groundwater to replace surface water is possible