Georgia Coastal Sound Science Initiative 2005—What have we learned?

John S. Clarke
USGS
Georgia Water
Science Center

Coastal Georgia

USGS

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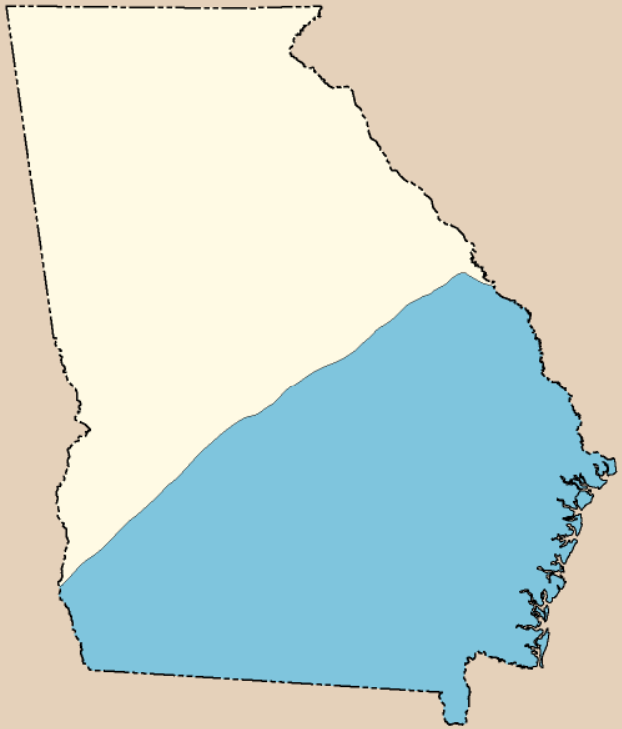
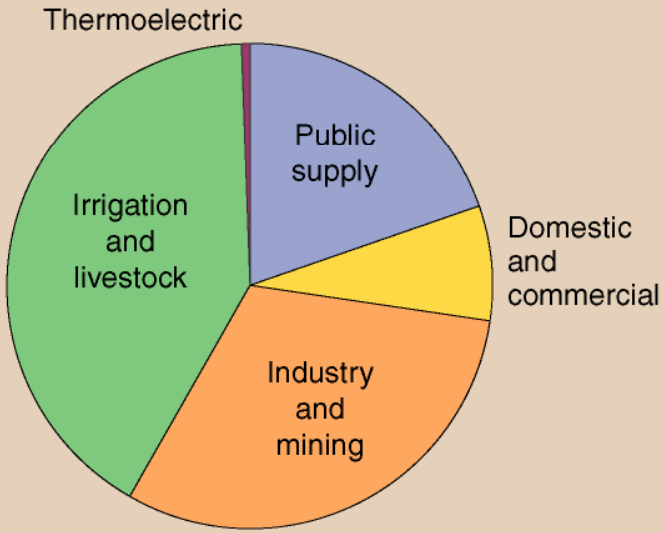
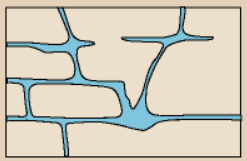
Floridan aquifer system



Depth: 40–900 feet
Yield: 1,000 to 5,000 gal/min
May exceed 11,000 gal/min





Limestone, dolomite

1995 Water Use
701 Million gal/day

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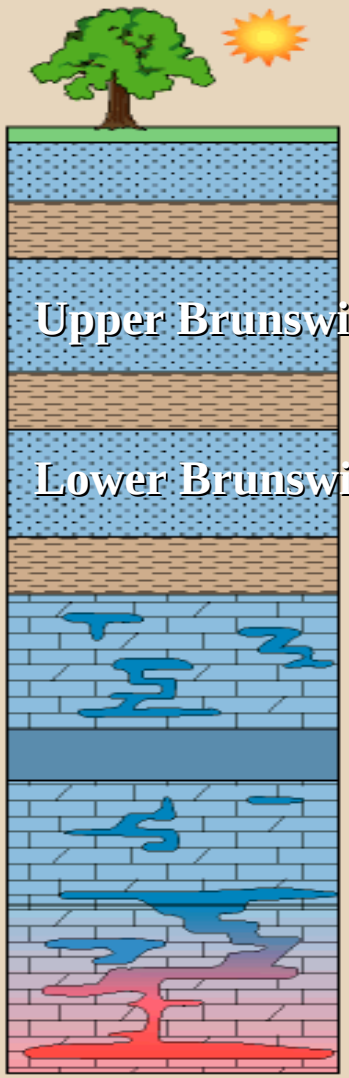
Hydrogeologic Units



Land surface	
Surficial aquifer	Sand
Miocene aquifers and confining layers	Sand and clay
Upper Floridan aquifer	Carbonate rocks—limestone and dolomite
Confinement	
Lower Floridan aquifer	
Fernandina Permeable zone	

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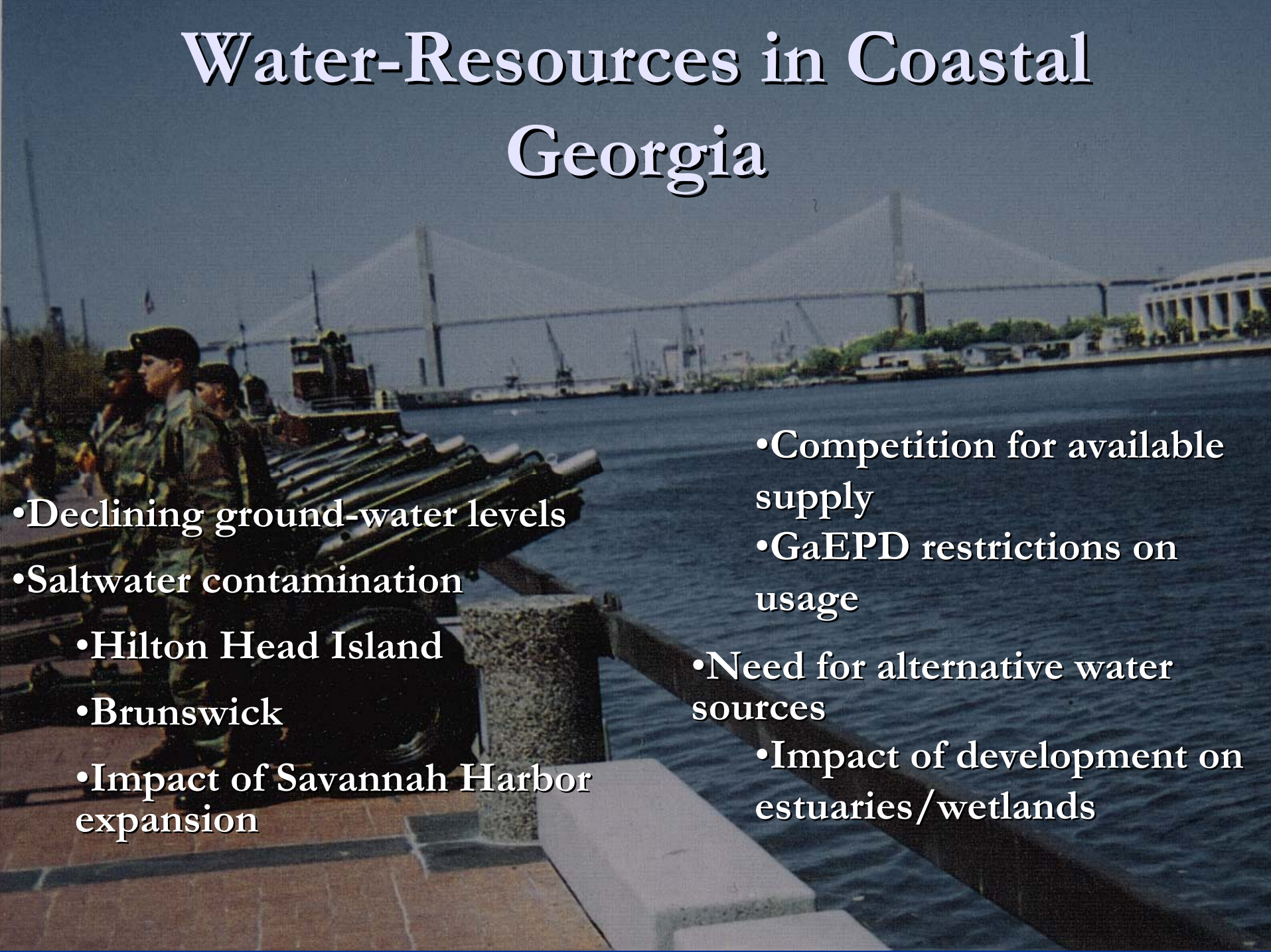
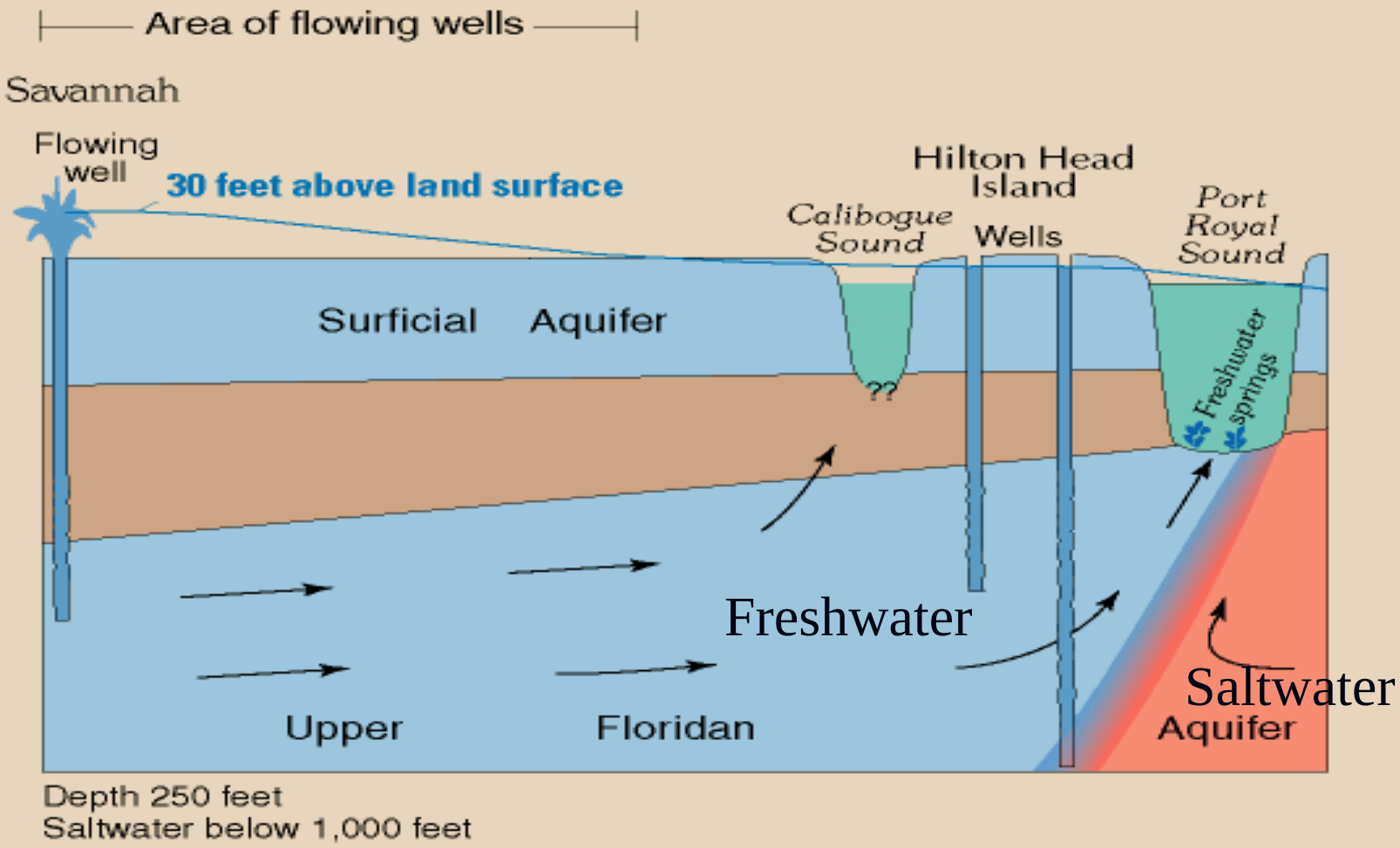
Water-Resources in Coastal Georgia



- Declining ground-water levels
- Saltwater contamination
  - Hilton Head Island
  - Brunswick
  - Impact of Savannah Harbor expansion
- Competition for available supply
- GaEPD restrictions on usage
- Need for alternative water sources
  - Impact of development on estuaries/wetlands

Savannah – Hilton Head Island

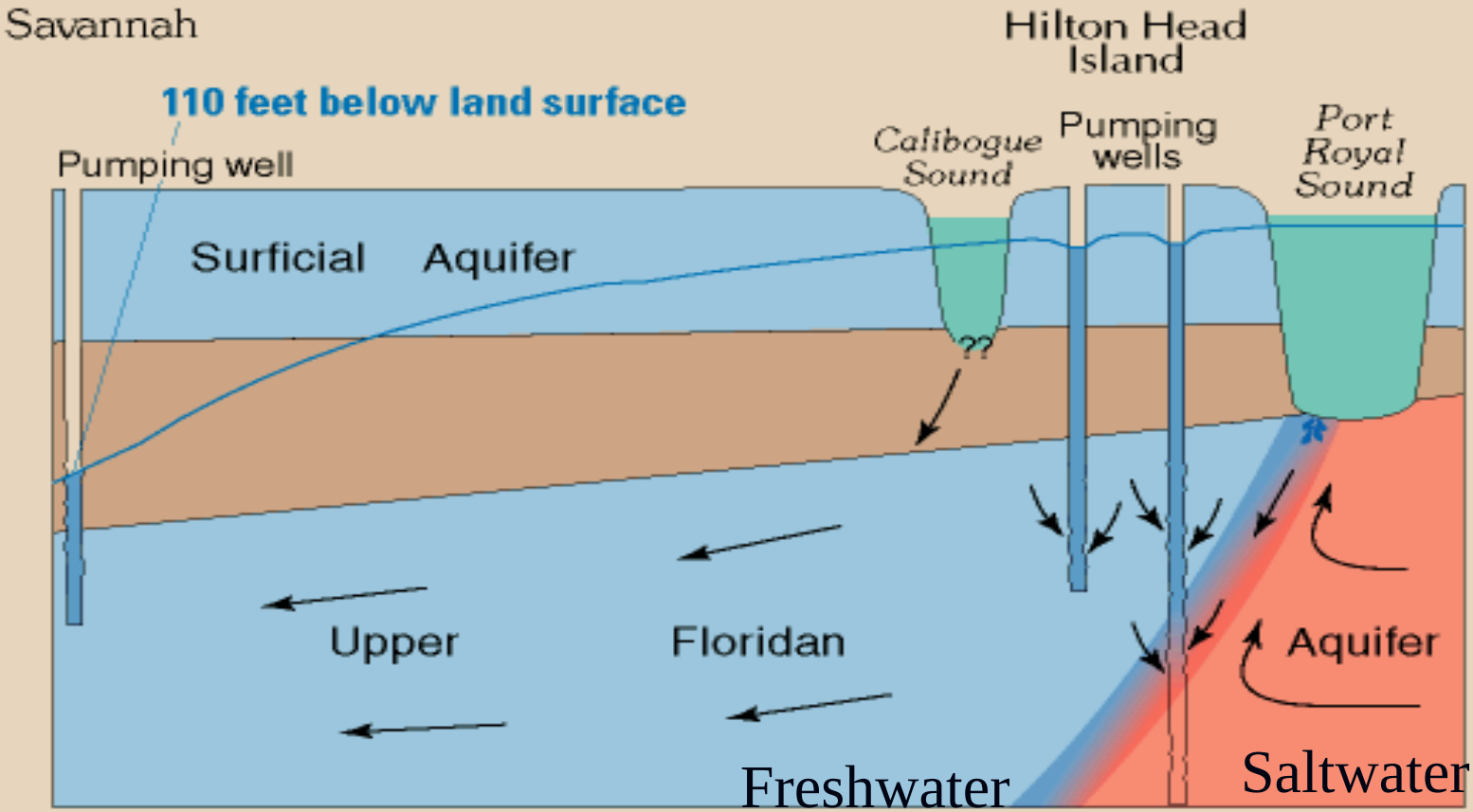
Prior to Development



From Krause and Clarke, 2001

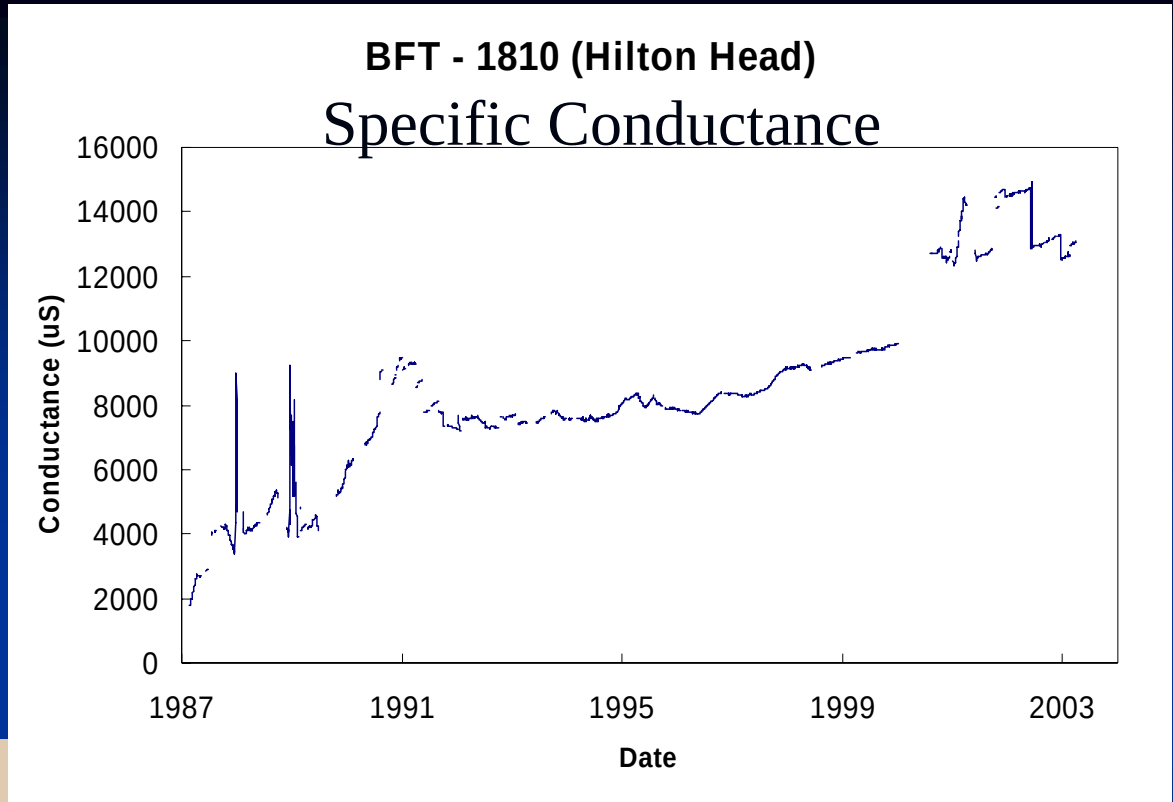
Savannah – Hilton Head Island

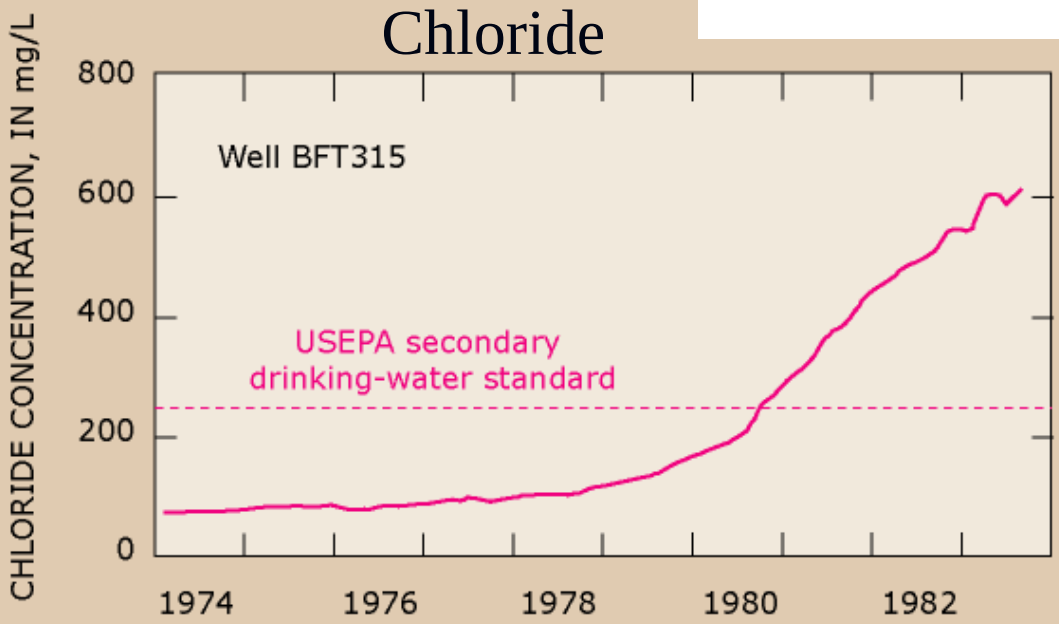
Modern Day



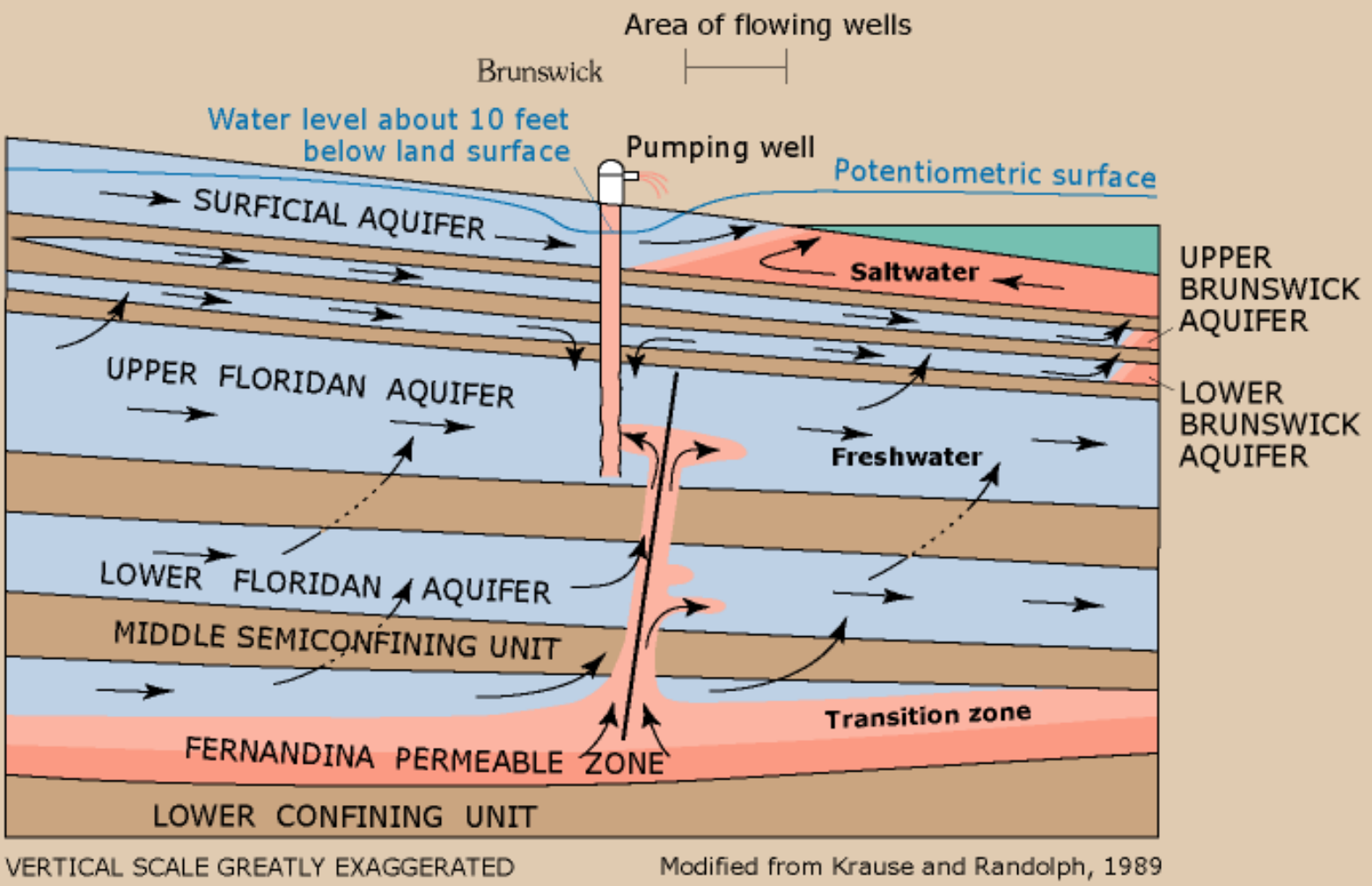
From Krause and Clarke, 2001

Hilton Head Island





Brunswick *Modern Day*



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Georgia Coastal Sound Science Initiative 1999-2005

1. Determine salt water entrance locations
2. Solute-transport modeling
3. Scenario development
4. Impact analysis
5. Assess alternative sources of fresh water
6. Data Management
7. Feasibility studies

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Joint Coastal Study Committee 1997

COASTAL GEORGIA SOUND SCIENCE INITIATIVE—*Integrated Science*

- Georgia Geologic Survey
- USGS—Multiple offices
- Georgia Water Resources Research Institute
- University of Georgia—cooperative extension service
- U.S. Army Corps of Engineers
- Georgia Southern University & Skidaway Institute
- Private consulting firms

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COASTAL GEORGIA SOUND SCIENCE INITIATIVE—*Technical Advisory Committee*

- South Carolina DHEC
- University of Georgia
- City of Savannah
- City of Brunswick
- Pulp and Paper Industry
- Georgia Conservancy (environmental)

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Current Status of the Sound Science Initiative

- All field studies have been completed
- Approximately 45 peer-reviewed scientific reports have been published to date
- A comprehensive ground and surface water-monitoring network and database have been established
- Ground-water models simulating the impact of pumping on flow and salt-water intrusion have been developed and a variety of water-management scenarios have been run (ongoing)

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Georgia Coastal Sound Science Initiative

Determine salt water entrance locations:

- ✓ Where are the known locations where saltwater is entering the Upper Floridan aquifer and why is saltwater entering these locations?
- ✓ Are there any other areas where saltwater is entering the aquifer that we don't know about?

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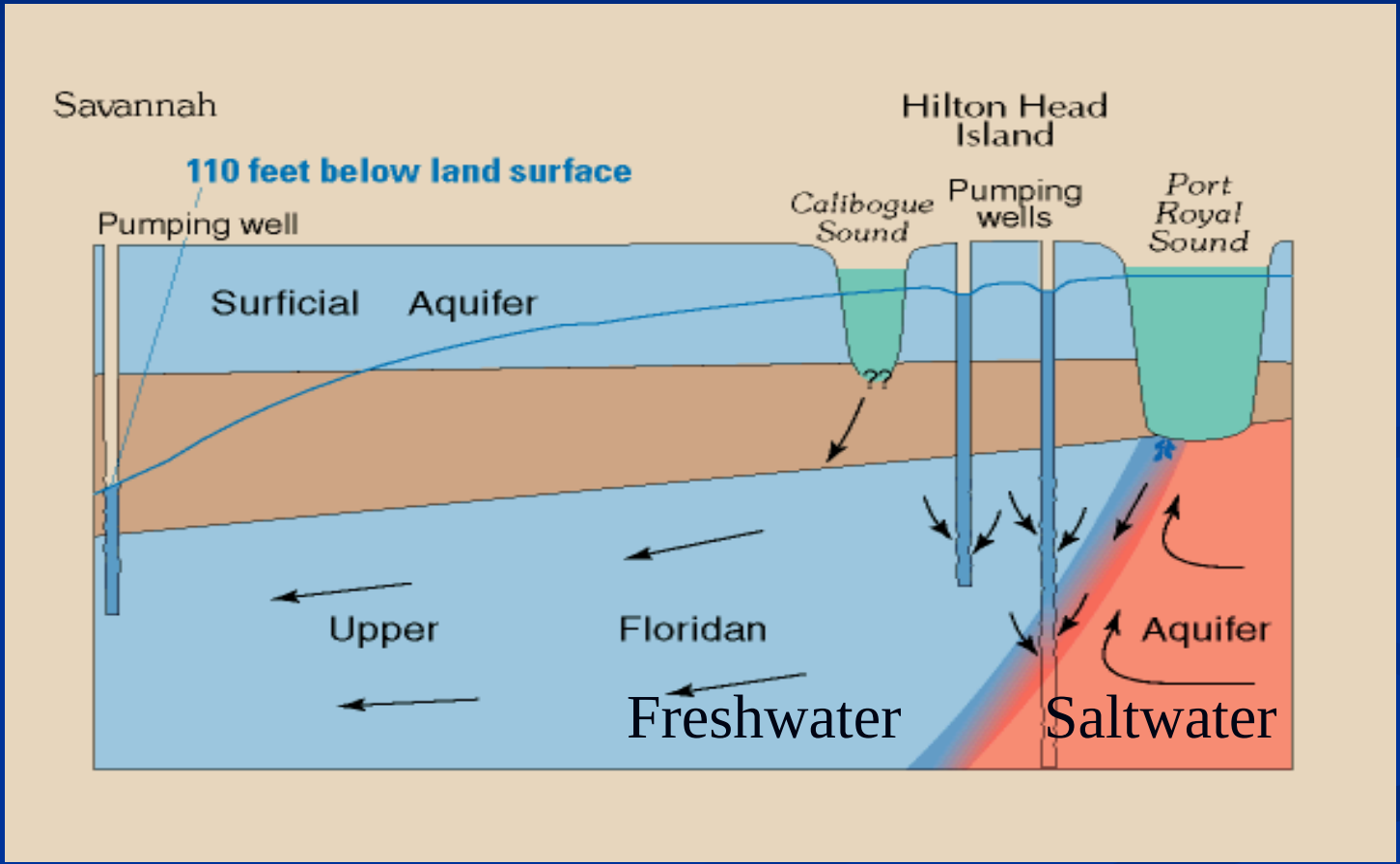
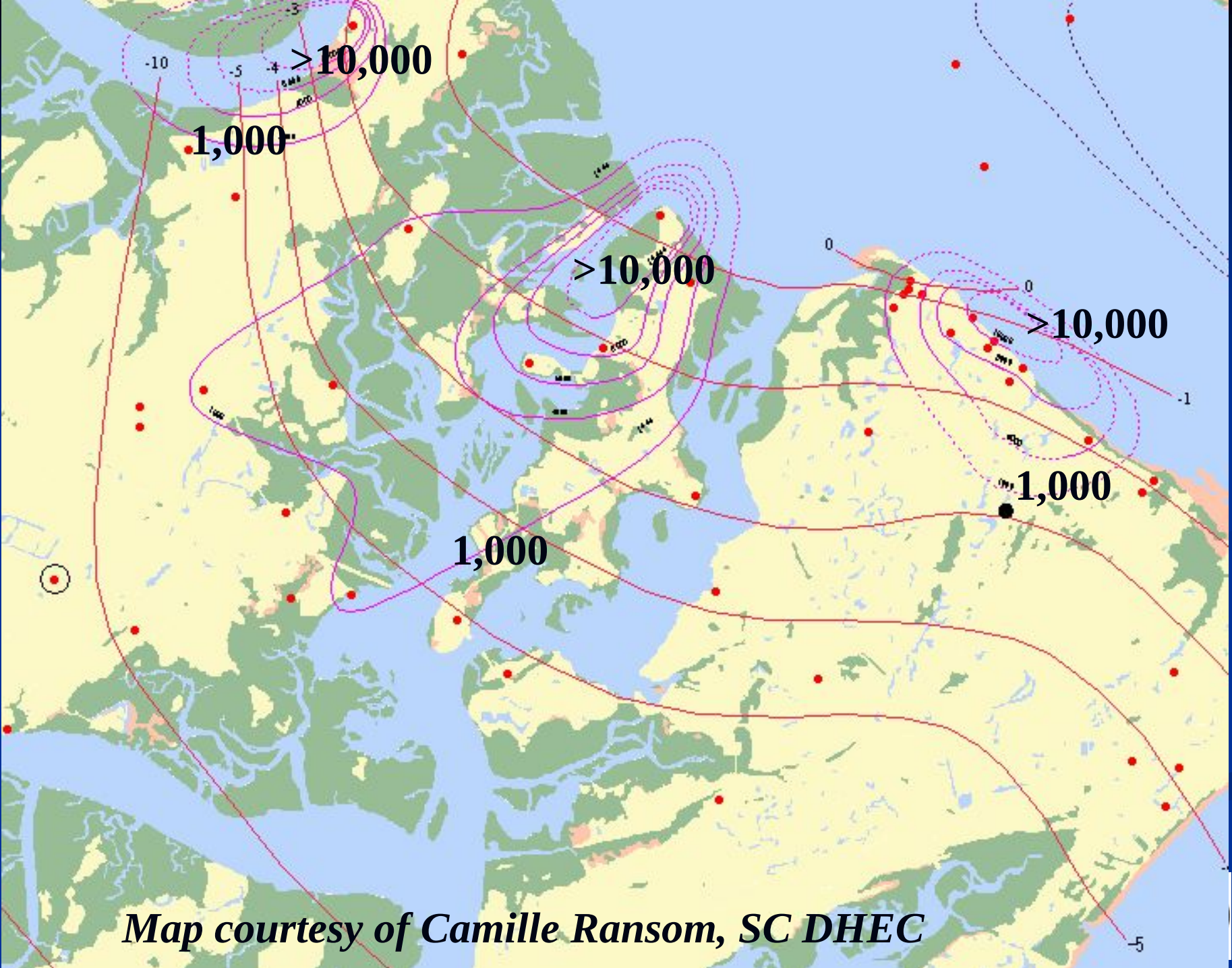
Savannah – Hilton Head Island
Modern Day



From Krause and Clarke, 2001

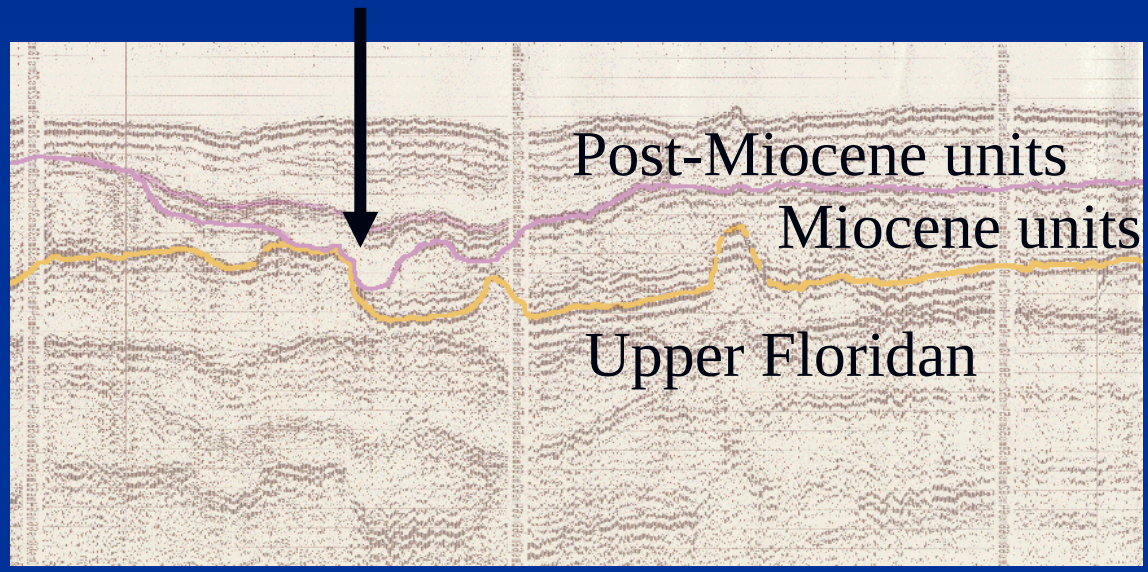


Map courtesy of Camille Ransom, SC DHEC

Offshore Marine Seismic Surveys

Tony Foyle and Jim Henry
Skidaway Institute

Infilled paleo-channel



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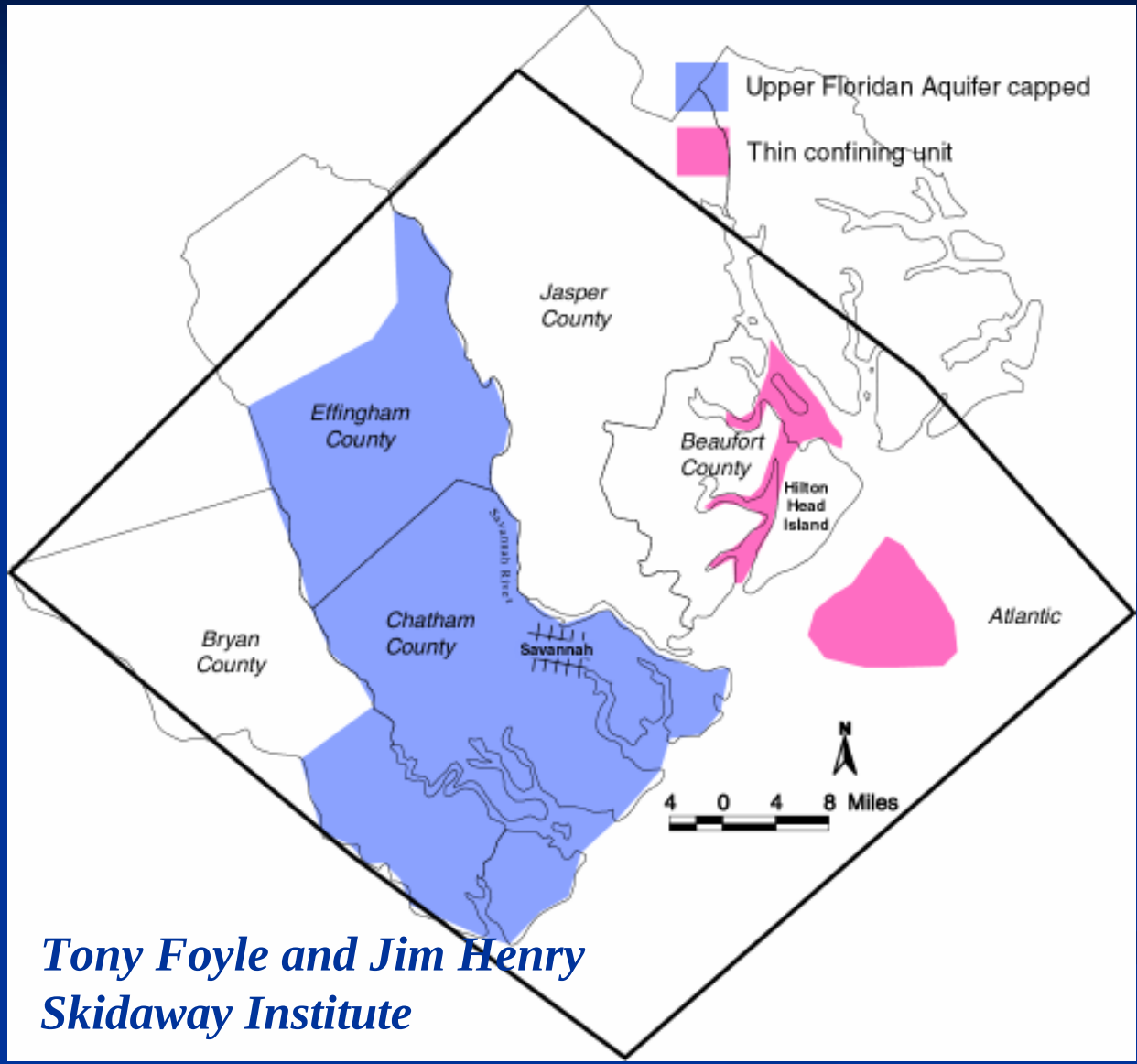
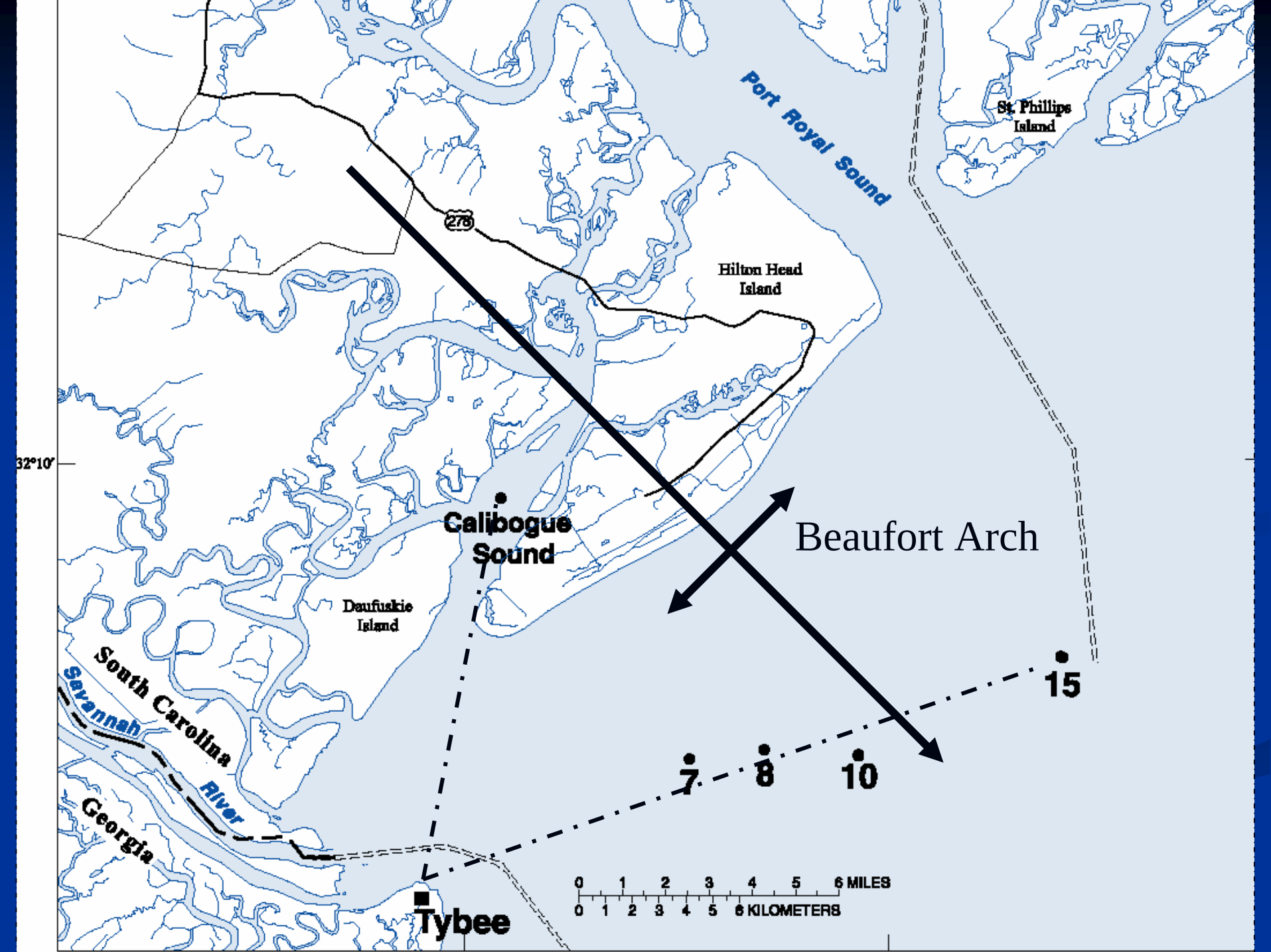
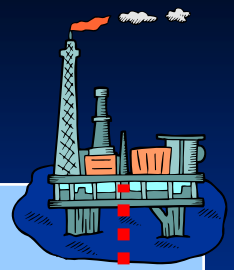
Areas of Thin or Absent Confining Unit



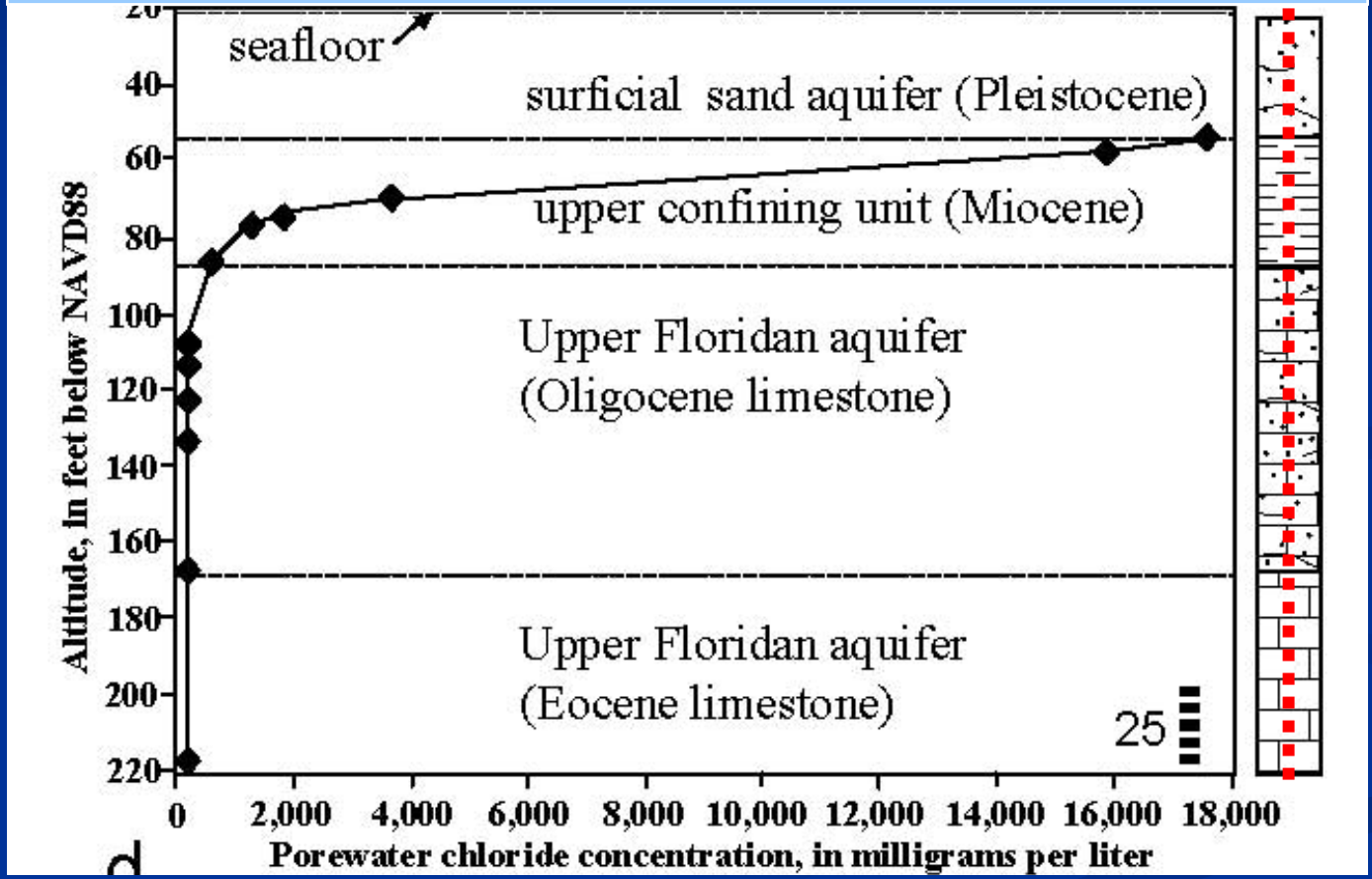
Tony Foyle and Jim Henry
Skidaway Institute


Port Royal Sound
St. Phillips Island
278
Hilton Head Island
32°10'
Calibogue Sound
Beaufort Arch
Daufuskie Island
South Carolina
Savannah River
Georgia
15
7
8
10
Tybee
0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 6 KILOMETERS

Porewater Profile
10-Mile Drill Site



Seafloor



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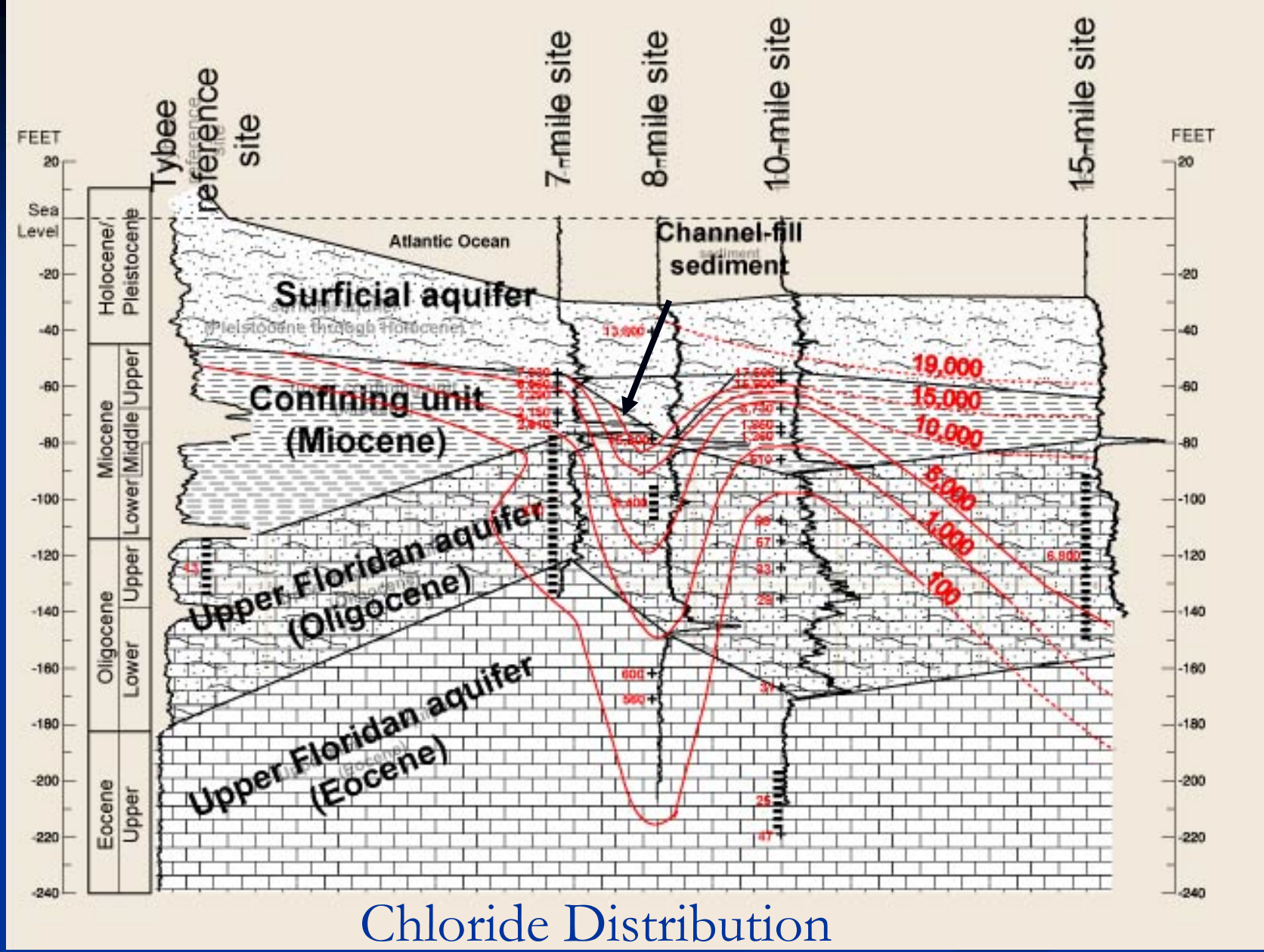
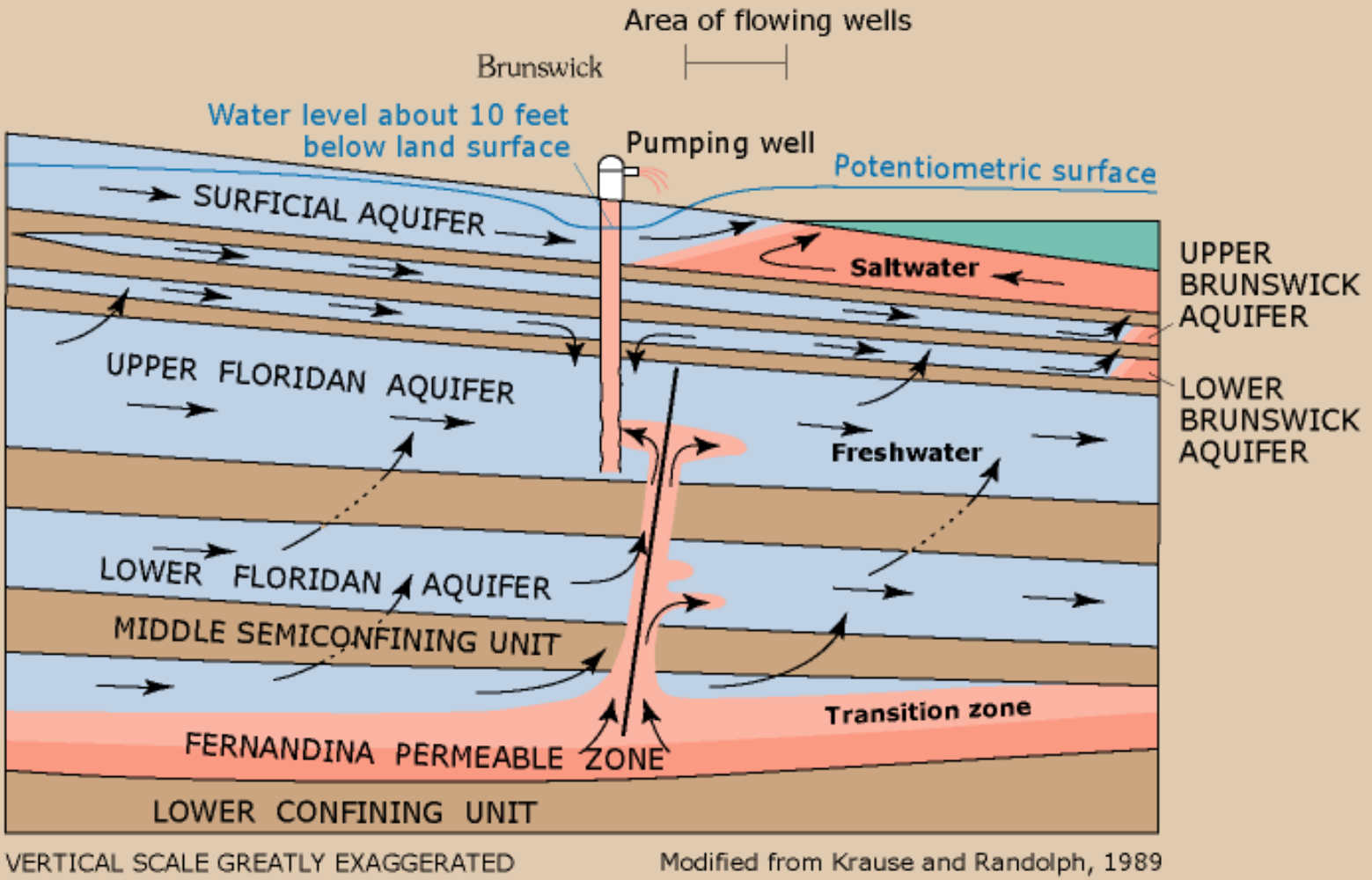
From W.F. Falls, USGS, Personal Commun., 2005



Chloride Distribution

From W.F. Falls, USGS, Personal Commun., 2005

Brunswick *Modern Day*



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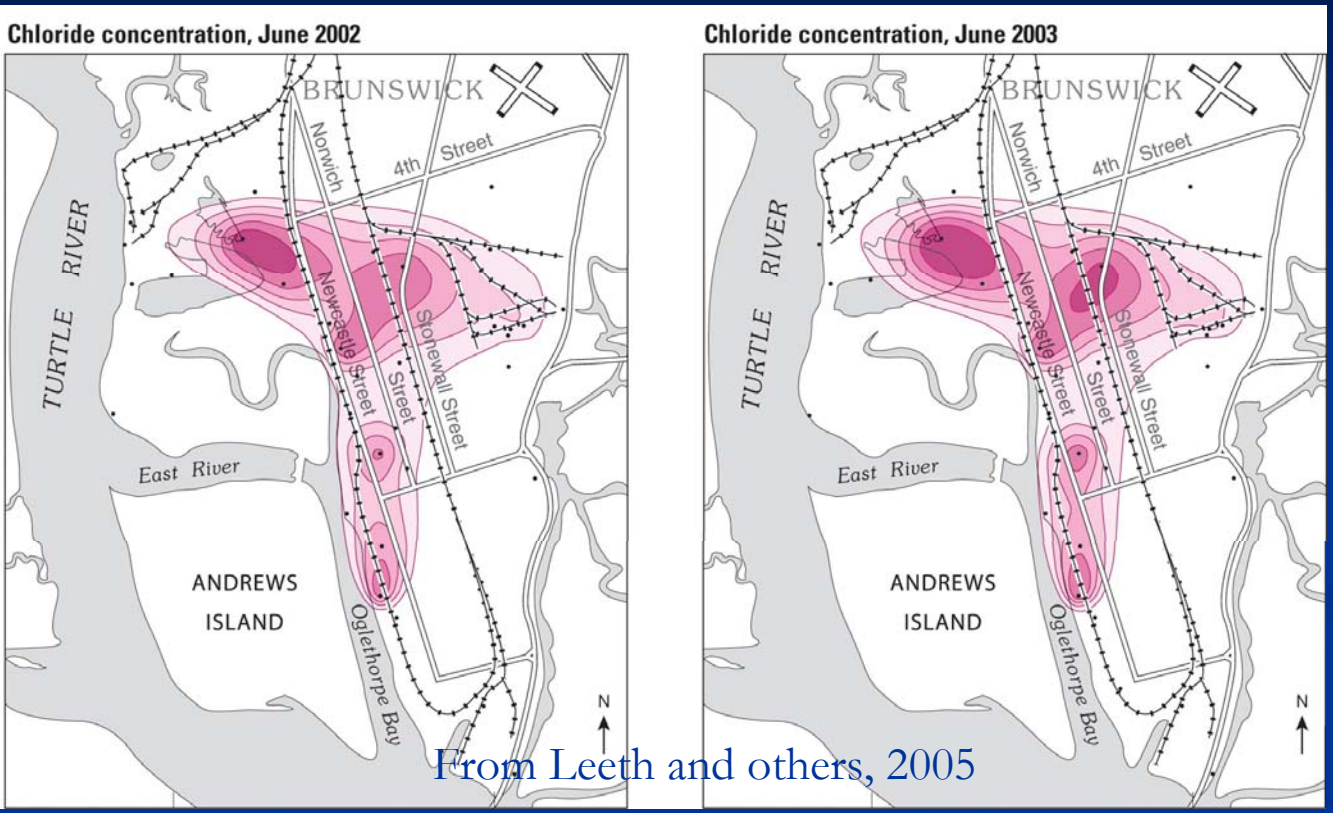
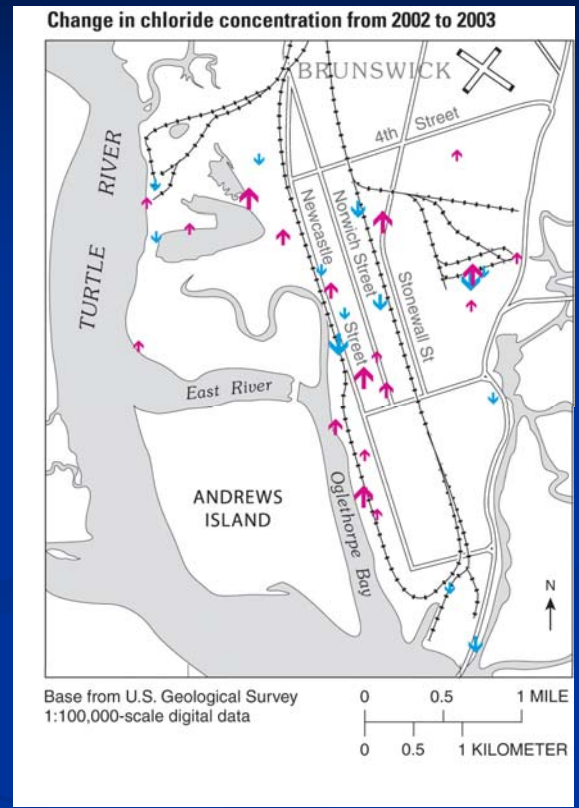
Brunswick—Chlorides





From Leeth and others, 2005

- 5 New Test Wells
  - 4 Downtown
  - 1 St Simons Island
- 2 sites—continuous monitoring

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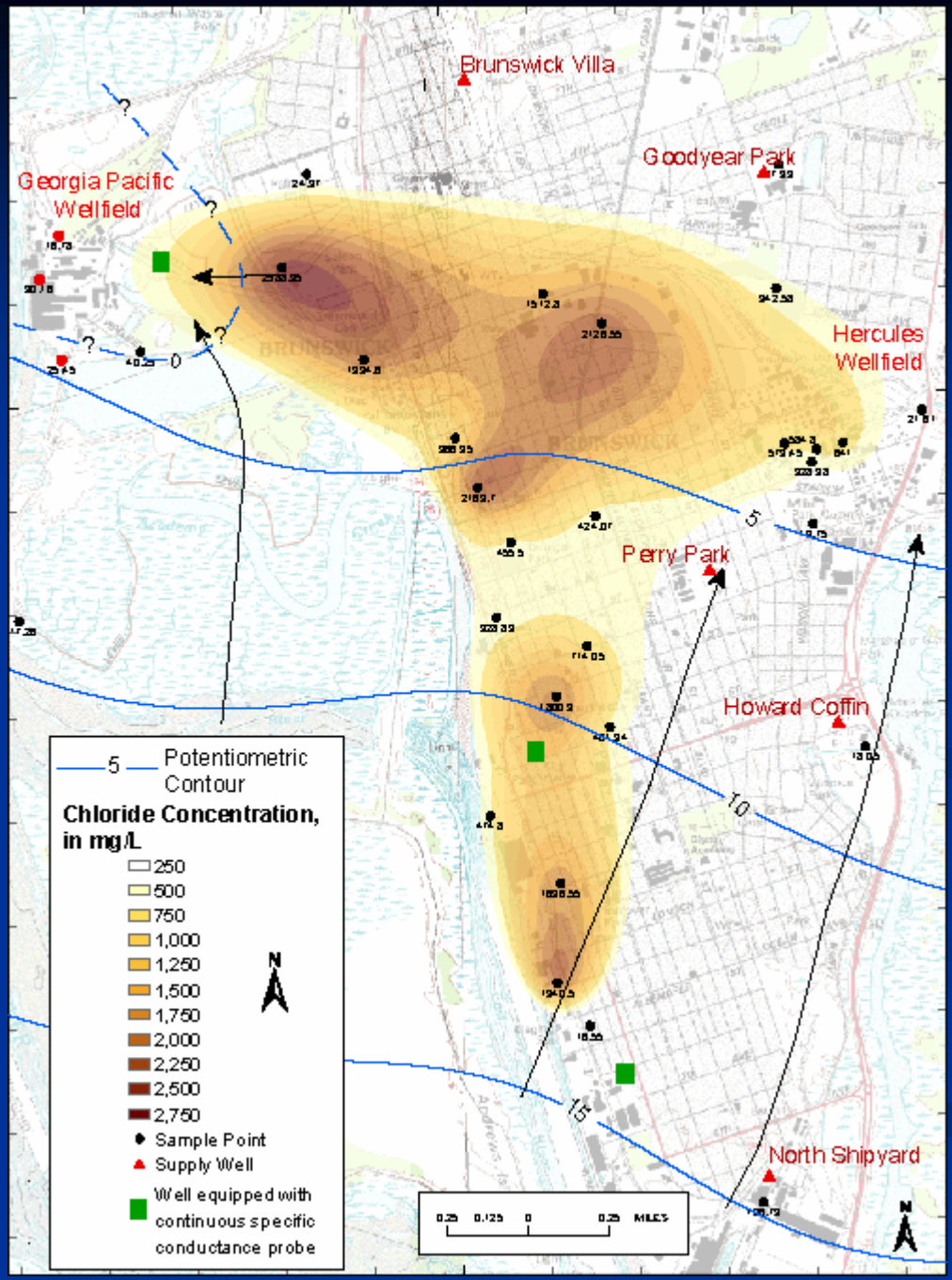
Extent of plume at Brunswick appears to have mostly stabilized (ongoing monitoring critical)



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Georgia Coastal Sound Science Initiative

Solute-transport modeling:

- How fast is the saltwater traveling?
- How does pumping affect the rate and direction of saltwater travel?
- What is the life expectancy of the aquifer?

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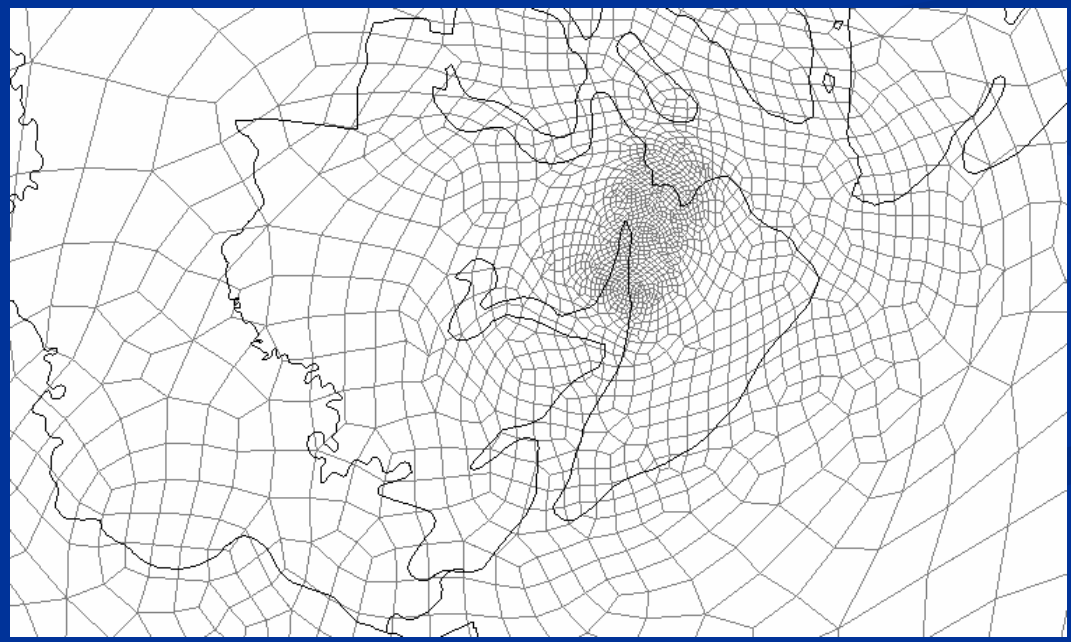
Ground Water Models

- All data are being synthesized into flow and solute transport models
- Models are being used to evaluate pumping scenarios for a variety of water-management alternatives



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A Ground-Water Model Is:

- A mathematical tool to help analyze ground-water problems and improve understanding of ground-water conditions
- A means to synthesize field data and provide a mathematical approximation of complex field conditions
- A simplified version of reality

Ground-Water Modeling

Regional model boundary
96,600 km²

Focus zones for saltwater intrusion models

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Scenario development:

- ✓ Other than Savannah and Brunswick, are there other areas in coastal Georgia where saltwater intrusion can be reasonably expected?
- When will Georgia, South Carolina, and Florida drinking water wells in the Upper Floridan aquifer no longer meet water quality standards? [model]

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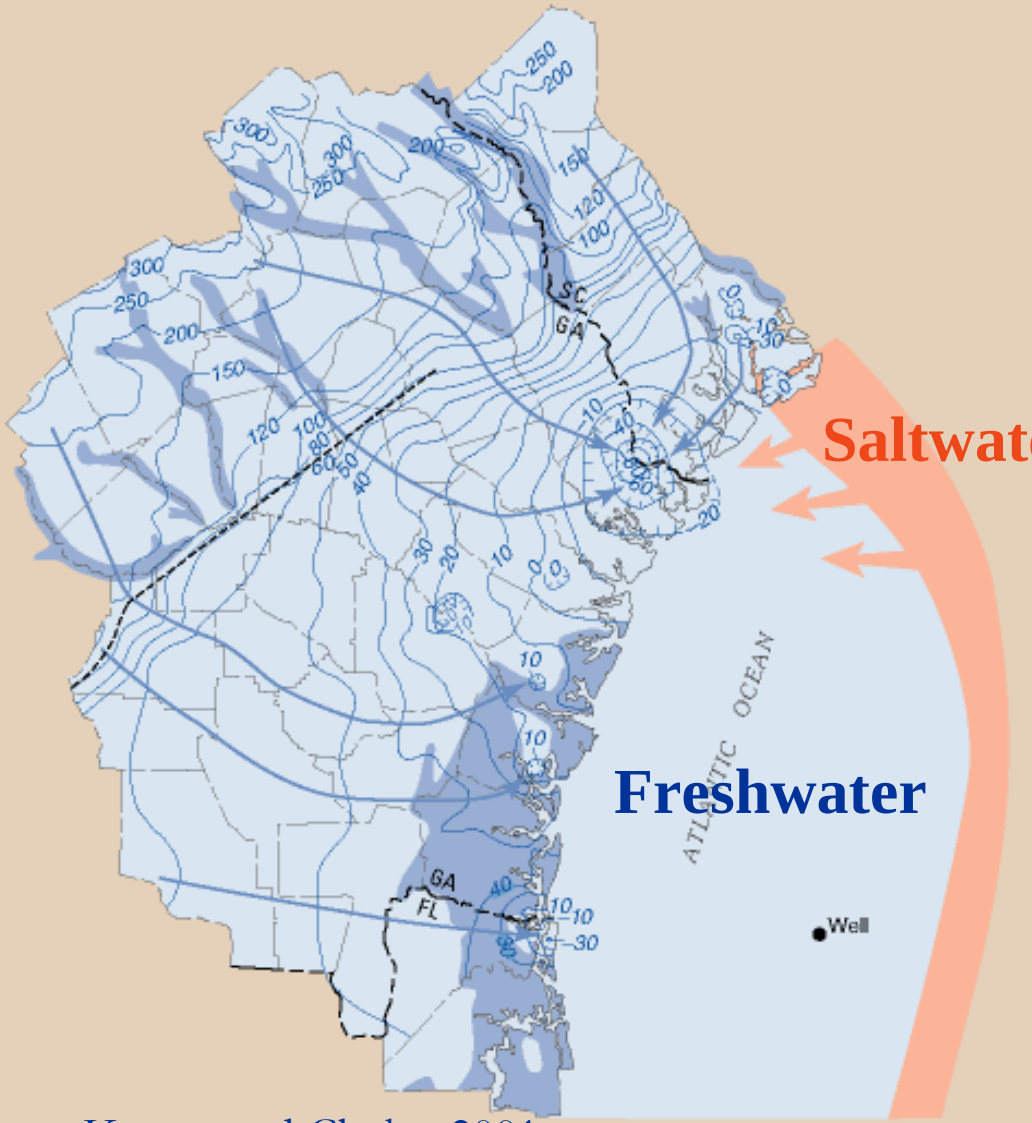
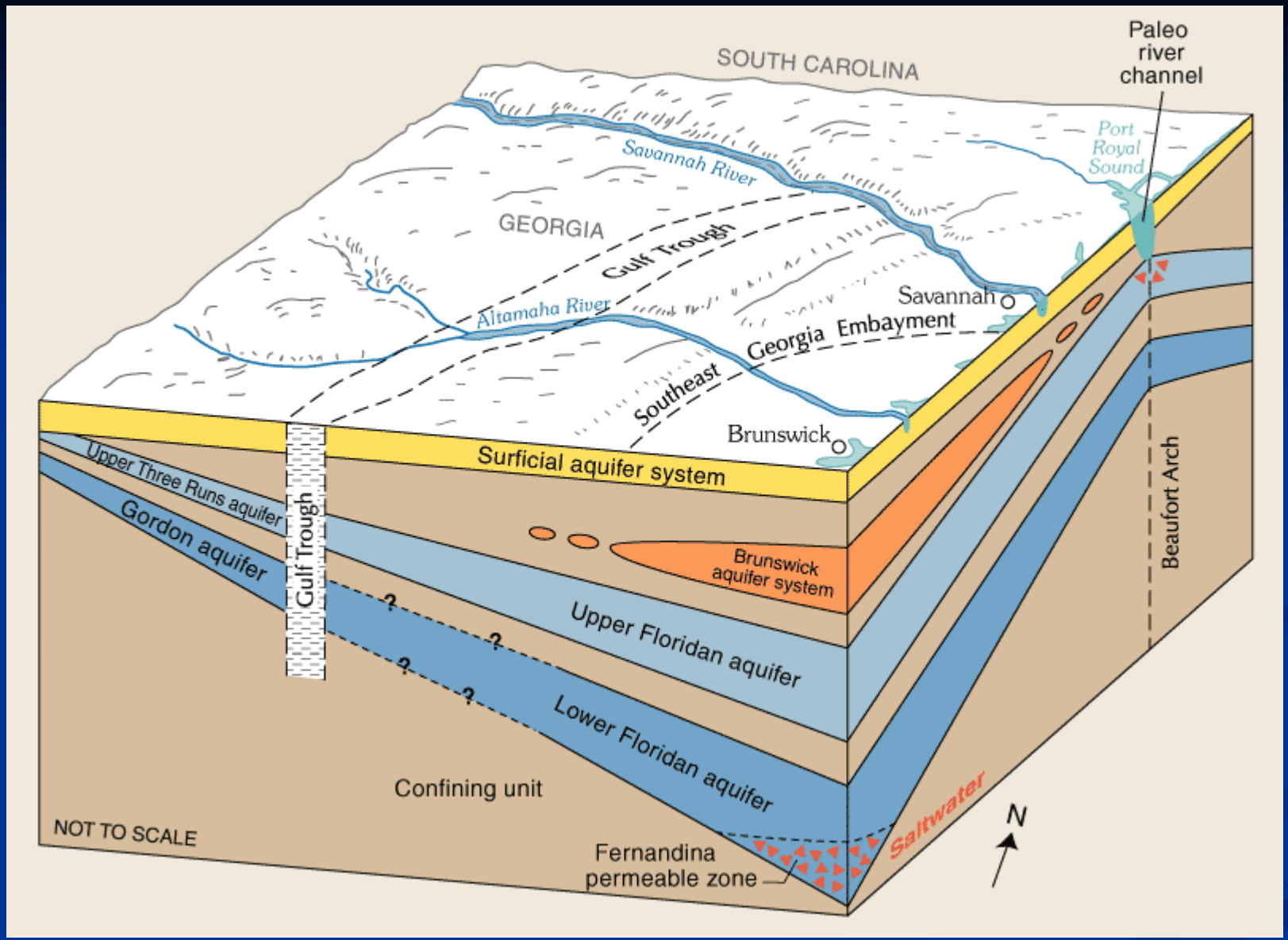
Upper Floridan Aquifer, Potentiometric Surface,Modern Day



From Krause and Clarke, 2001



From Payne and others, 2005

Deep Well Test Drilling Program

USGS
science for a changing world

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Georgia Coastal Sound Science Initiative

Impact analysis:

- ✓ Can areas having minimal impact on saltwater intrusion be identified and separated from areas having significant impact?
- Can some counties or portions of counties be eliminated from the Final Strategy?

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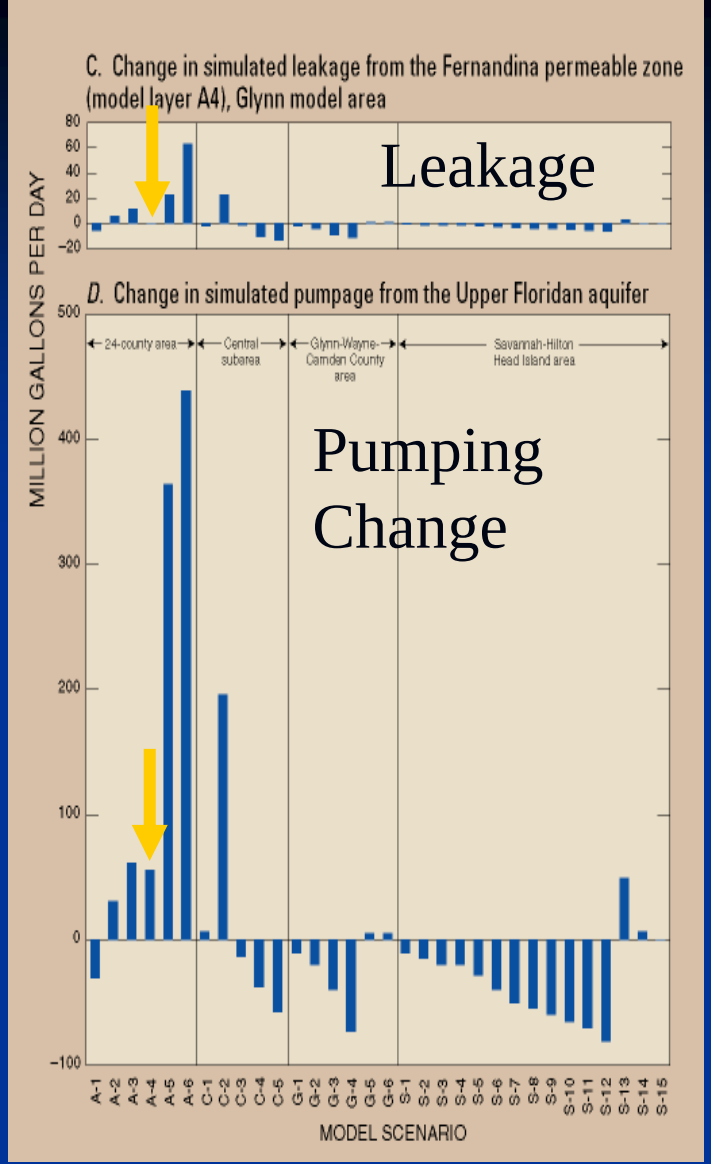
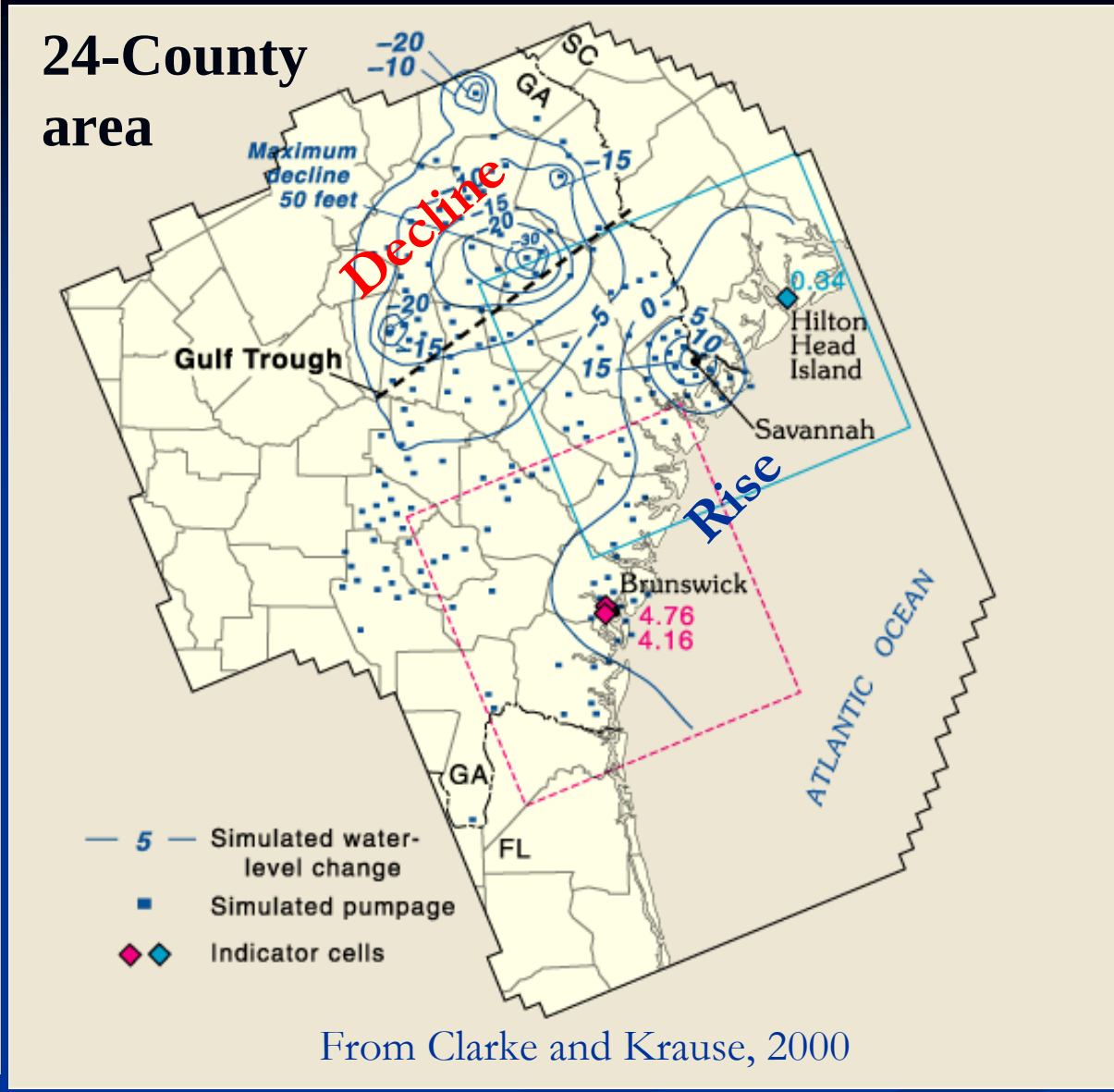
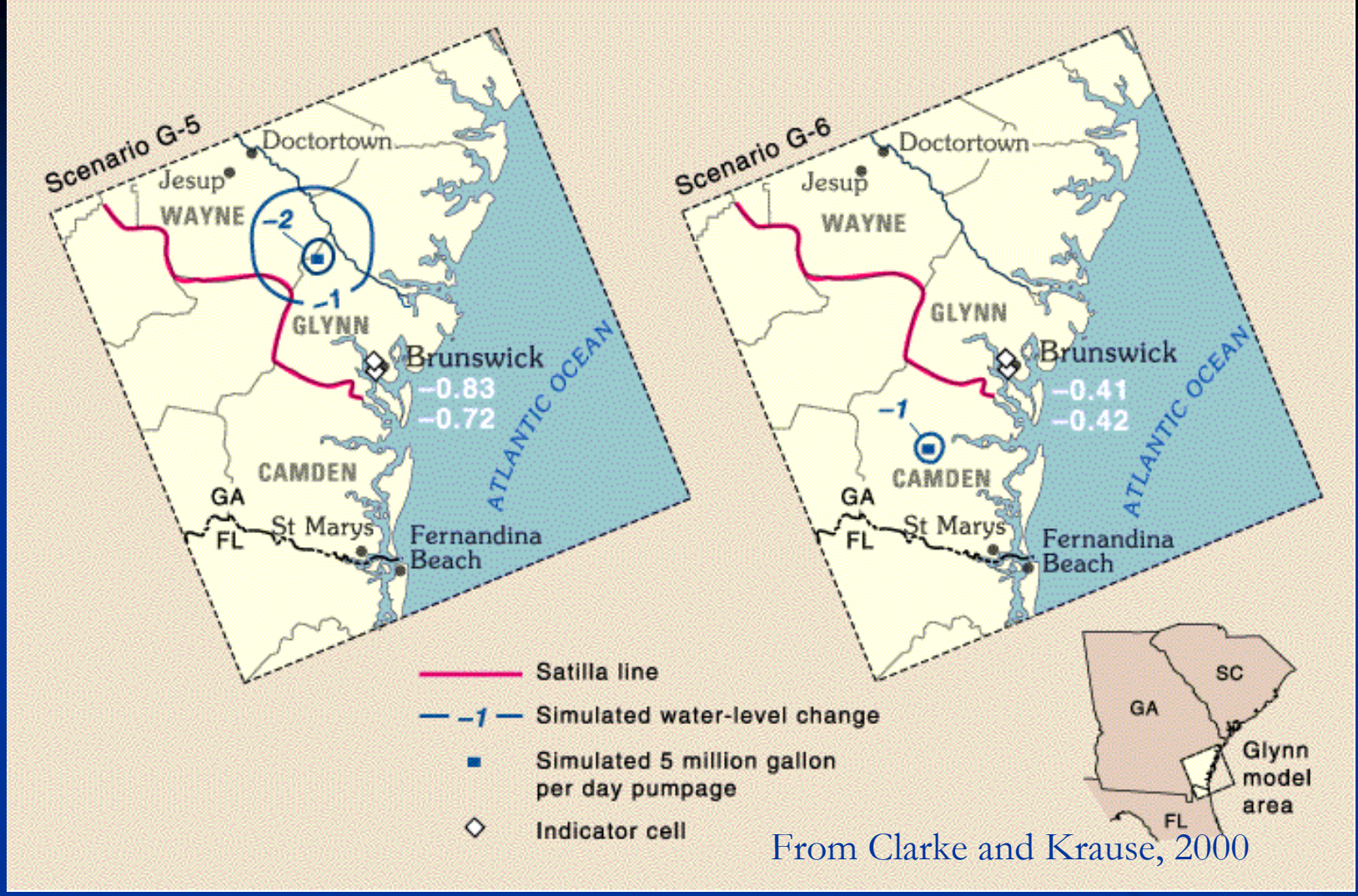




From Clarke and Krause, 2000

Scenario A-4: Redistribution of pumpage away from coast (+65 MGD)



From Clarke and Krause, 2000

Scenarios G-5 and G-6:

Test influence of Satilla Line on ground-water flow (+5 MGD)

Impact of Durango Shutdown on Ground Water Conditions

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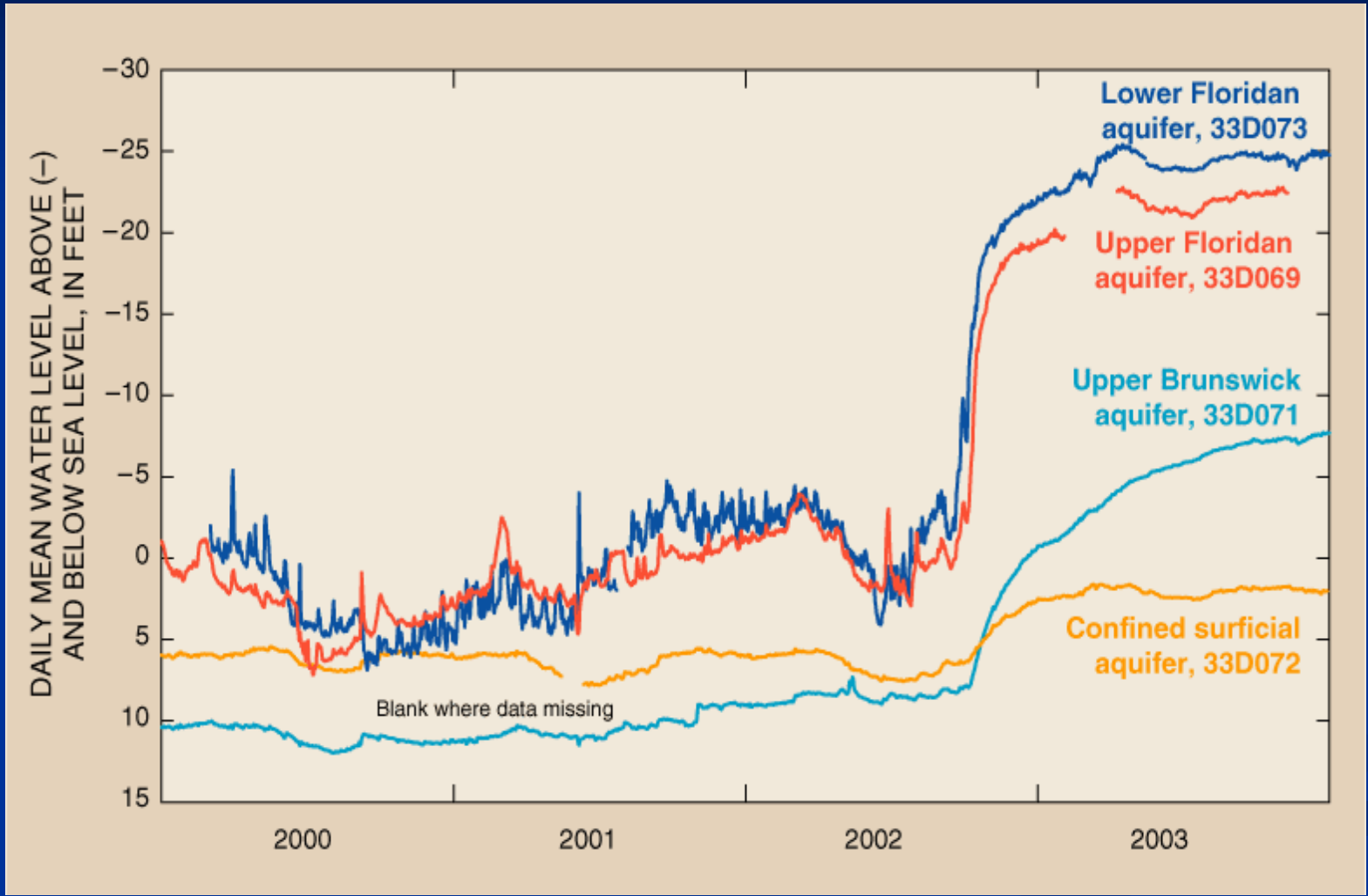
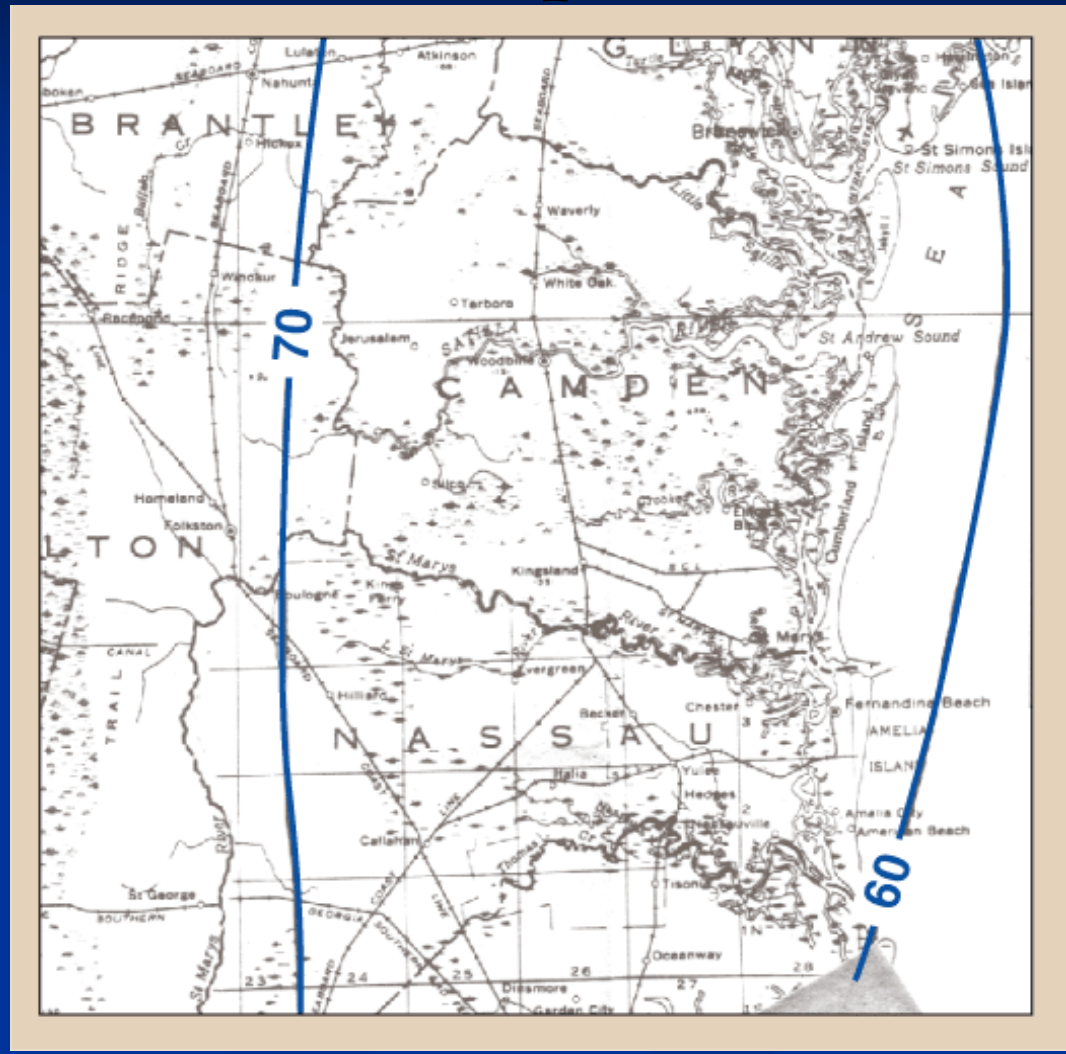
St. Marys Water Levels



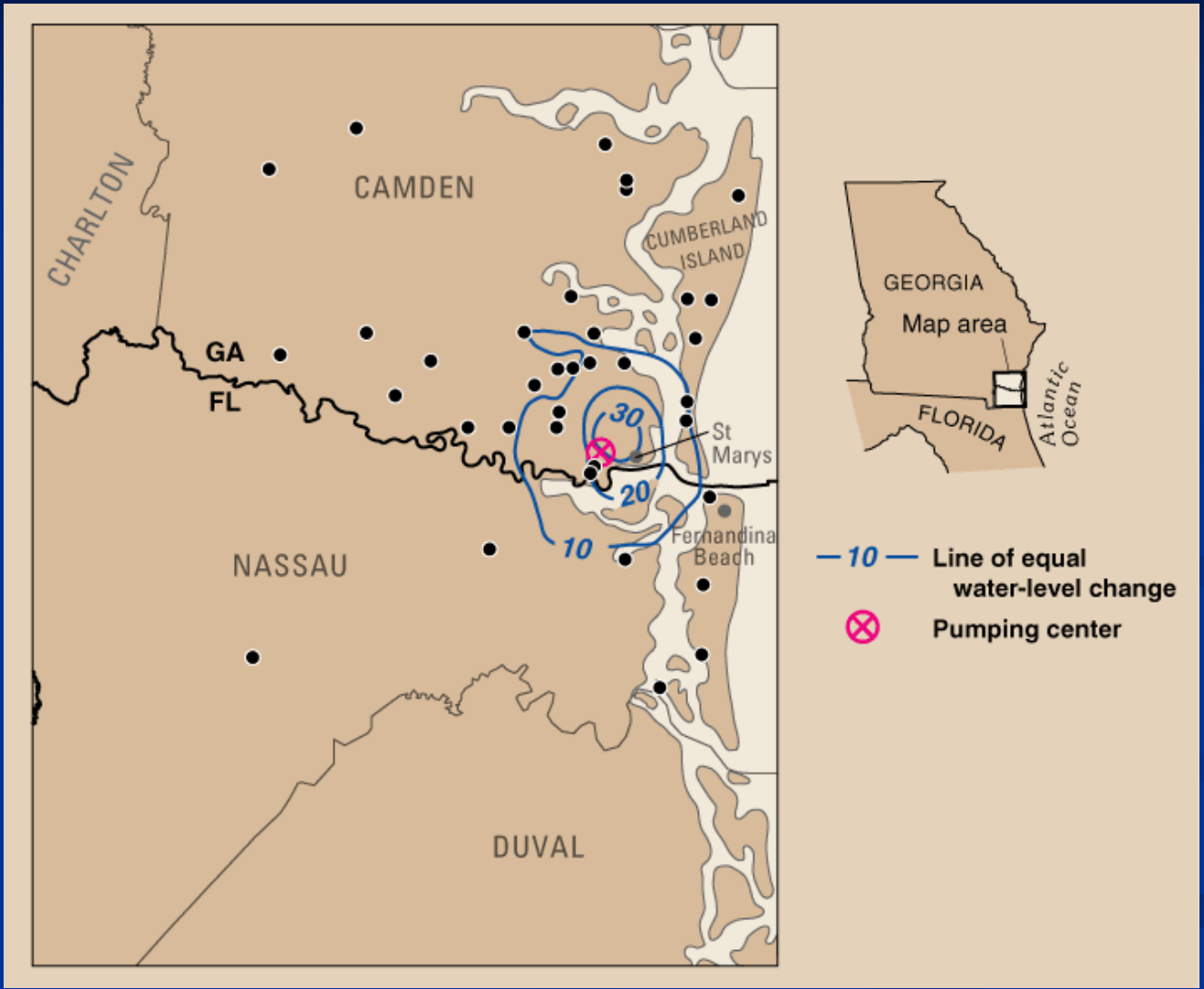
From Peck and others, 2005

Predevelopment Potentiometric Surface Upper Floridan Aquifer



(modified from Johnston and others, 1980)

Observed Water-Level Change from September 2001 through May 2003



From Peck and others, 2004

Georgia Coastal Sound Science Initiative

Assess alternative sources of fresh water:

- ✓ What are the other fresh water resources of coastal Georgia and what amount of water can be obtained from them?
- × What would be the approximate costs of these alternative sources of water to the Upper Floridan aquifer?

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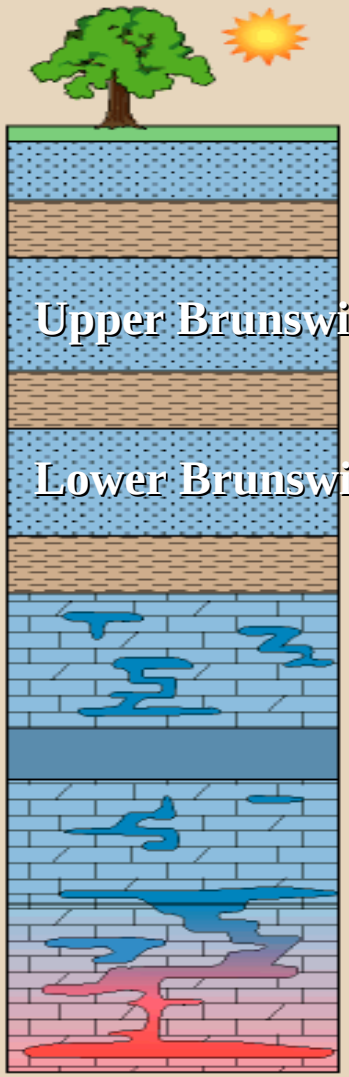
Alternative Ground Water Sources



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Lower Floridan aquifer	
Fernandina Permeable zone	

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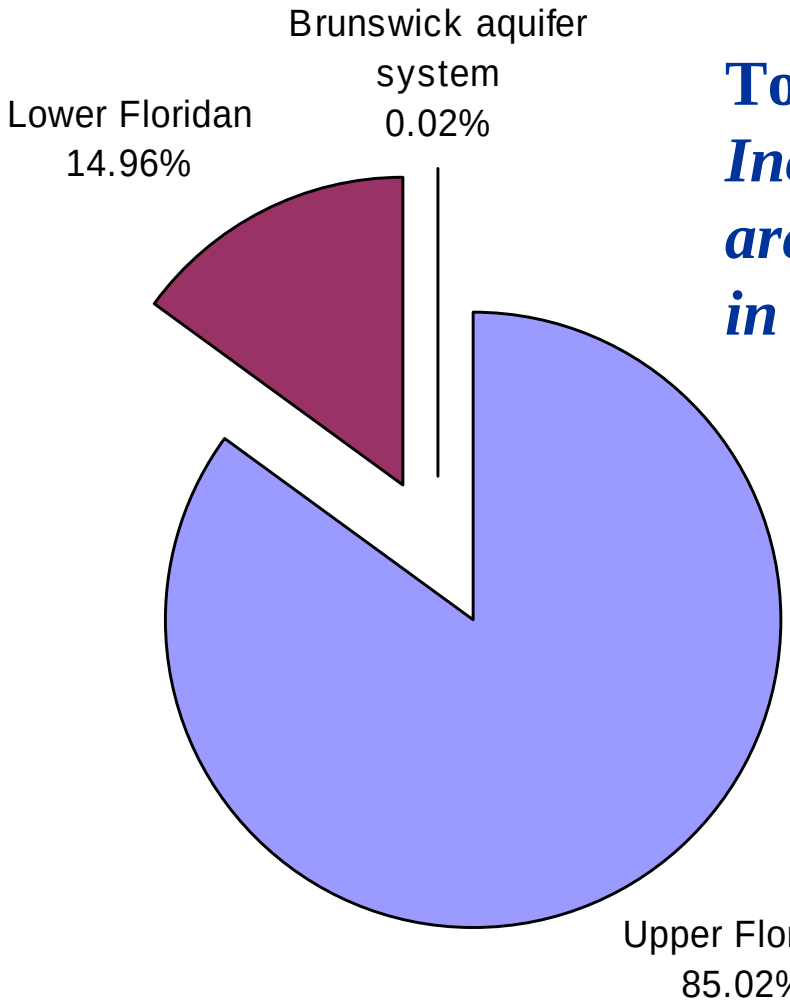
2000 GW Water Use—Model Area



Total GW Use = 909 MGD

Includes 24-county coastal area and adjacent 40 counties in Ga, SC, and Fl

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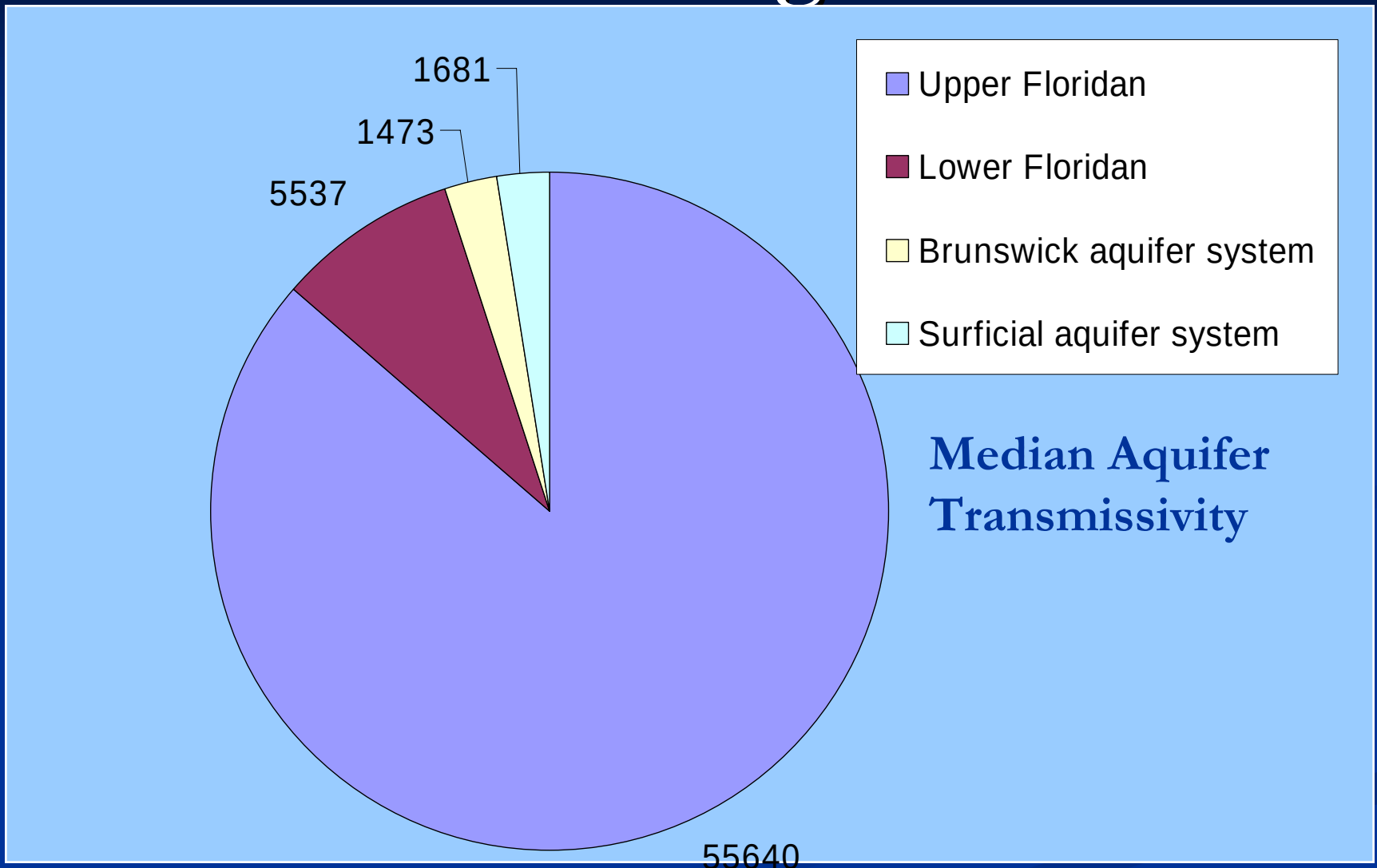
Water-Bearing Potential



Median Aquifer Transmissivity

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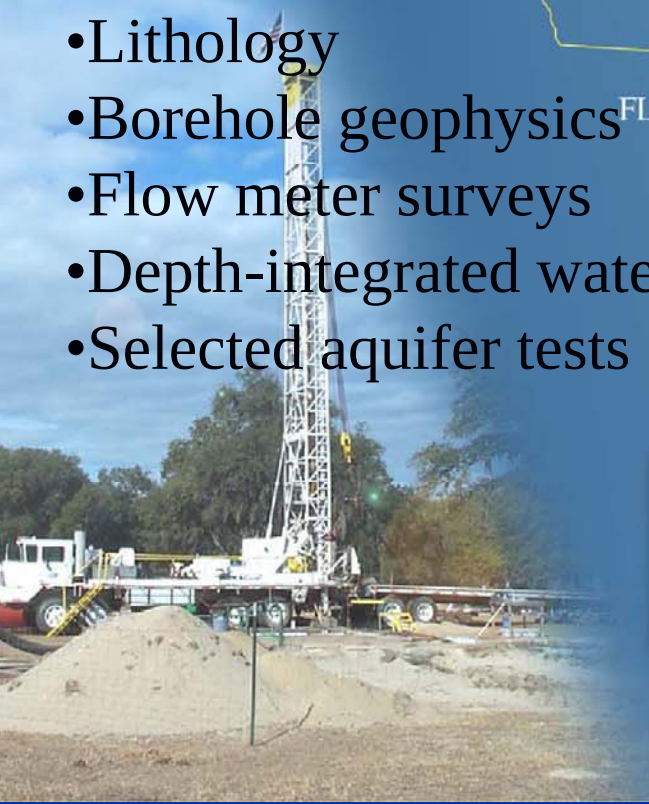
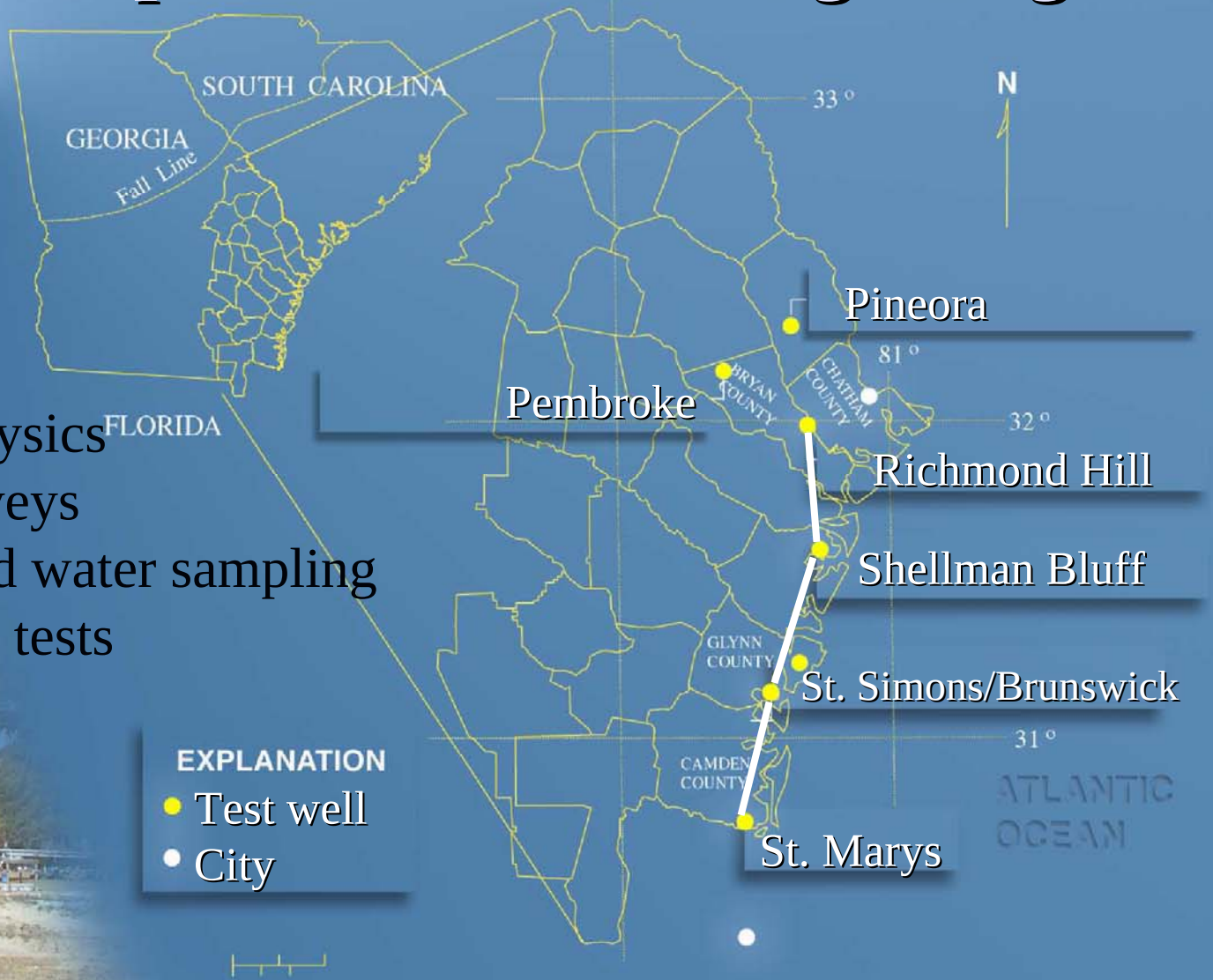
Deep Well Test Drilling Program

USGS science for a changing world

- Lithology
- Borehole geophysics
- Flow meter surveys
- Depth-integrated water sampling
- Selected aquifer tests





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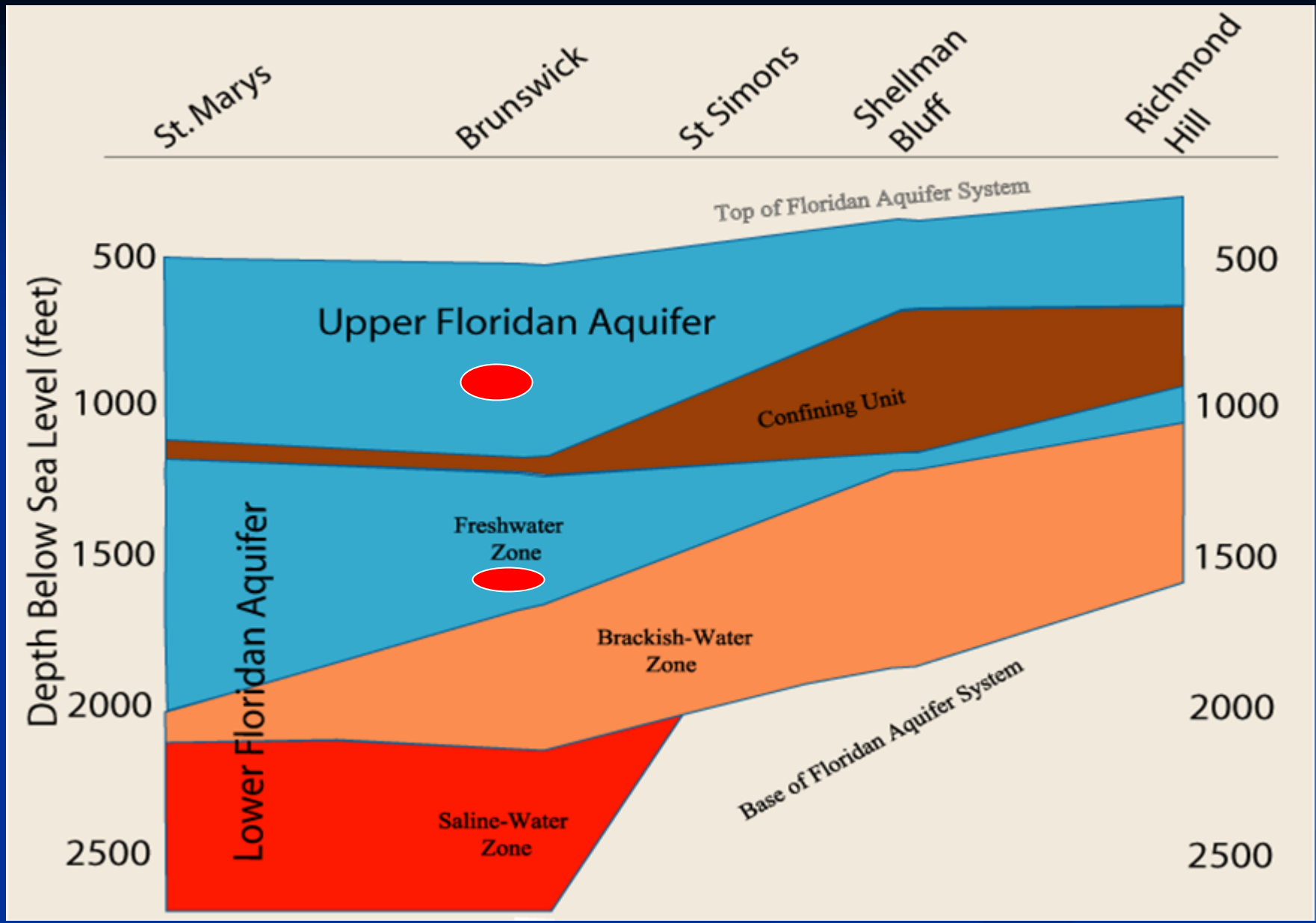
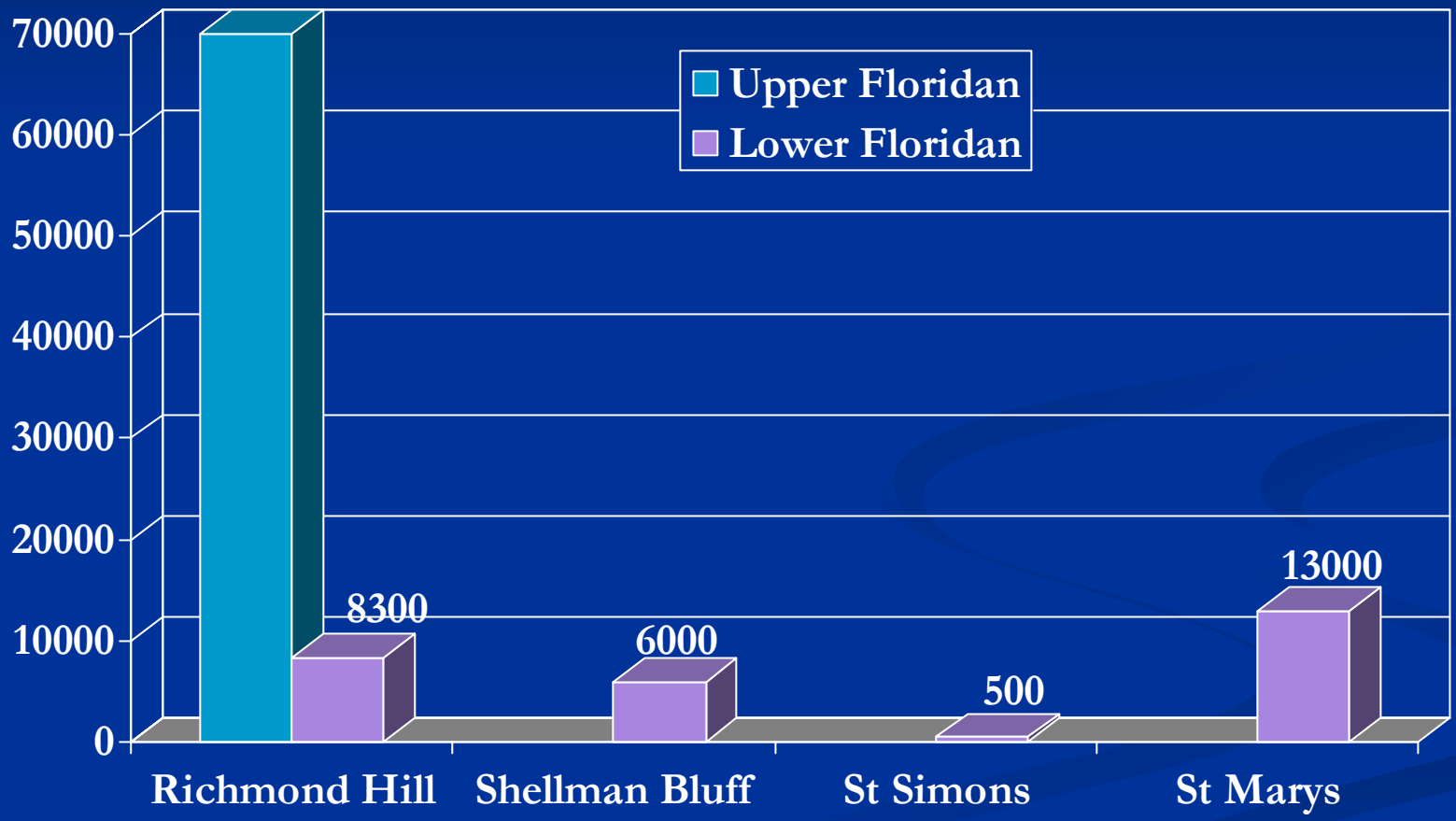

St. Marys
Brunswick
St Simons
Shellman Bluff
Richmond Hill
Top of Floridan Aquifer System
Depth Below Sea Level (feet)
500
1000
1500
2000
2500
Upper Floridan Aquifer
Confining Unit
Lower Floridan Aquifer
Freshwater Zone
Brackish-Water Zone
Saline-Water Zone
Base of Floridan Aquifer System

Lower Floridan Productivity (Transmissivity)



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Georgia Coastal Sound Science Initiative

Data Management:

- What are the current data gaps and what additional data are needed?
- How should existing and future data be organized, integrated, and made available to the public?
- Can a long-term monitoring system be established so that changes in saltwater intrusion can be measured?
- How much water is used by industry, municipal governments, agriculture, and other users and where do these uses occur?

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Ground-Water Monitoring Network

- Evaluate changes in the resource over time
- Develop ground-water models and forecast trends
- Design, implement, and monitor the effectiveness of ground-water management and protection programs

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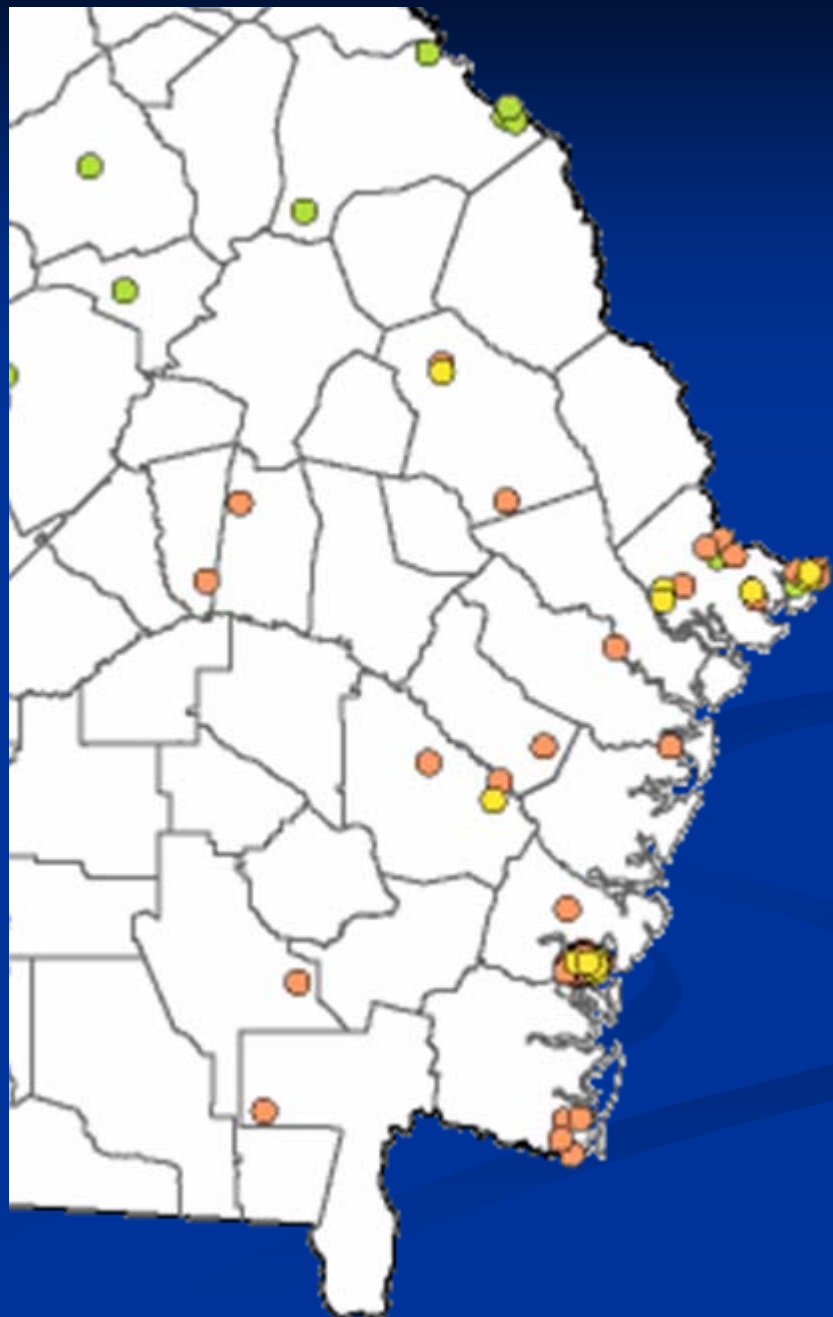
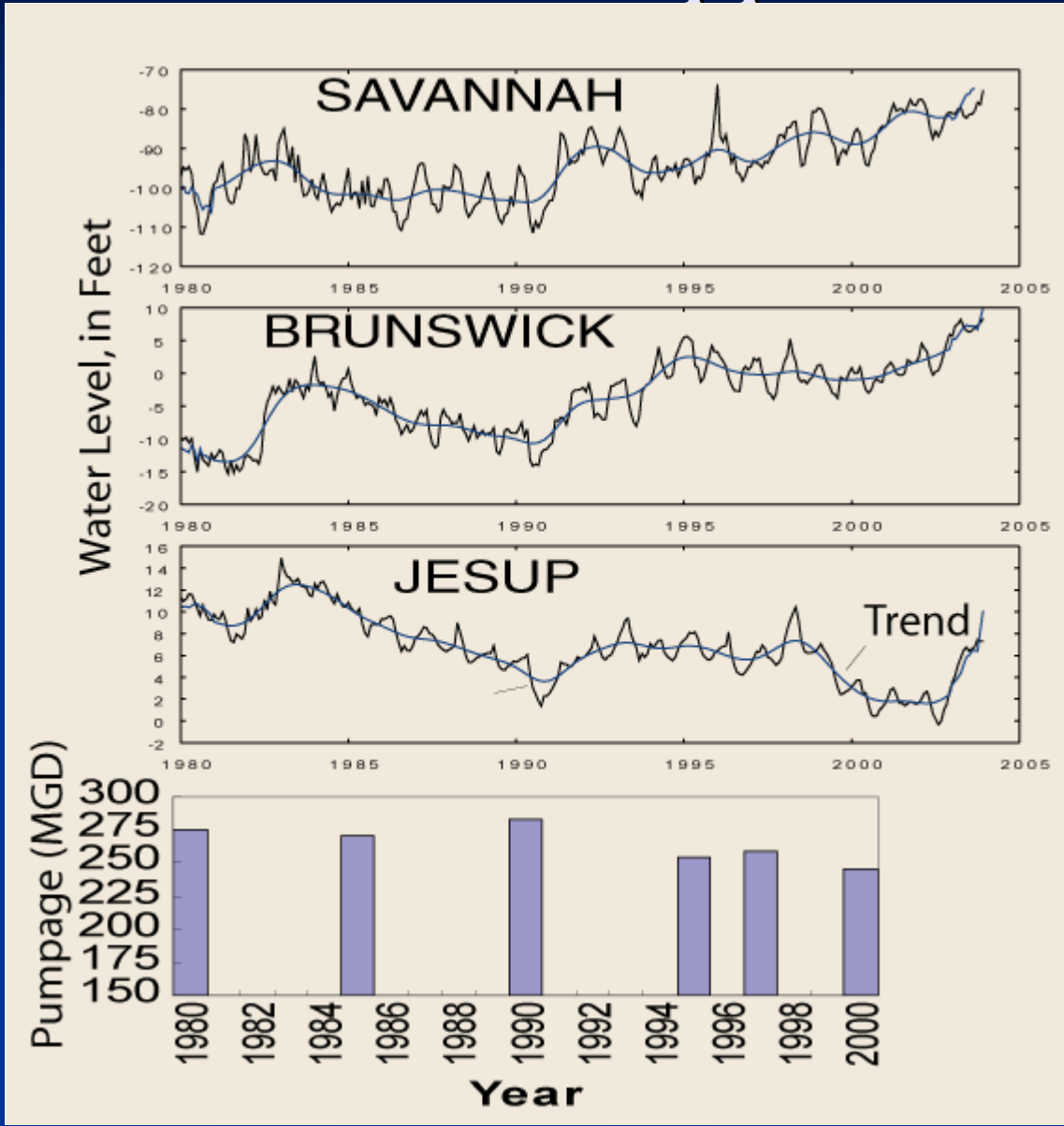
Water-Level Recorder Network

Sound Science Initiative:
Coastal network Expanded by 32 wells



Water-Level Trends Upper Floridan



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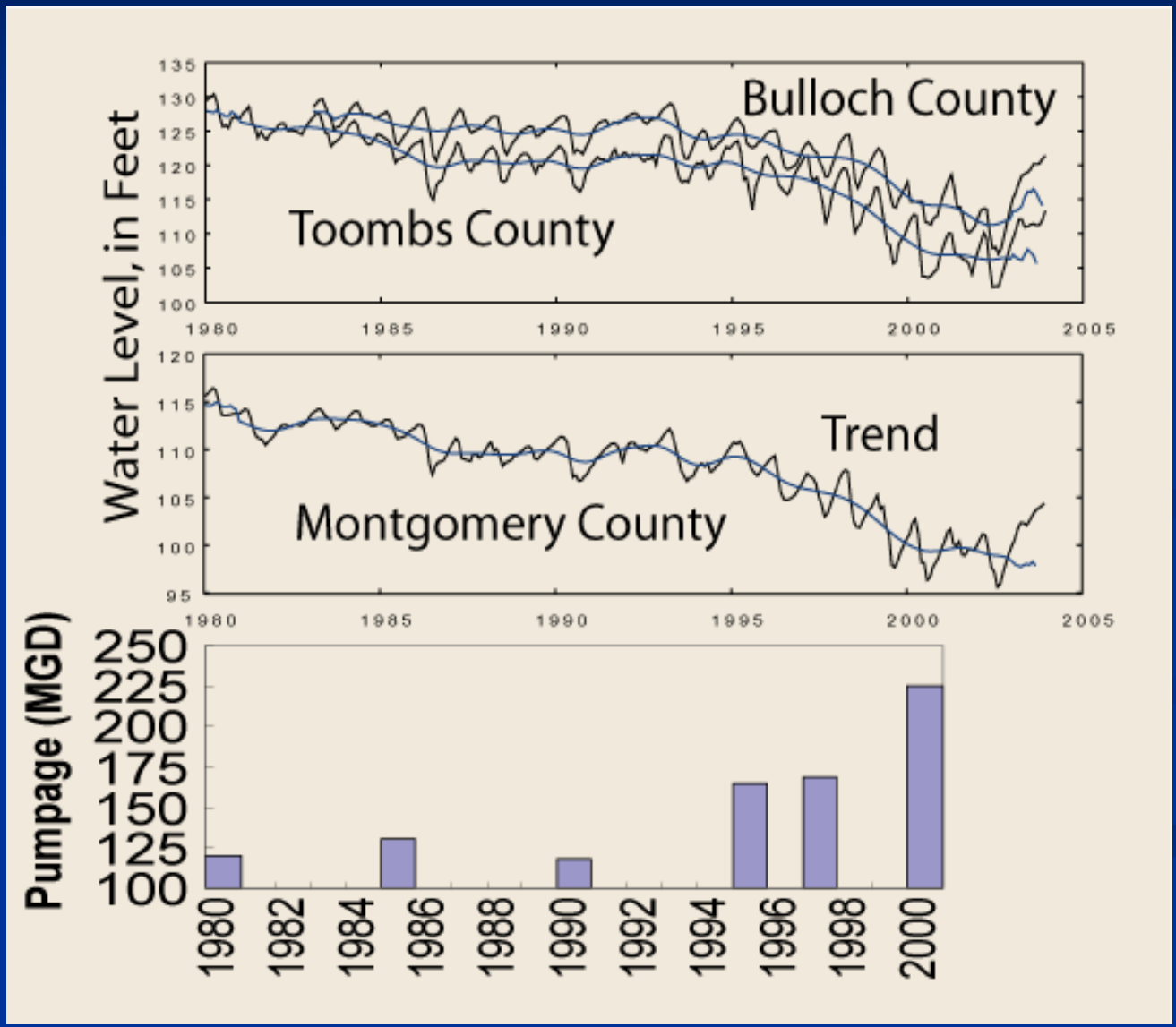
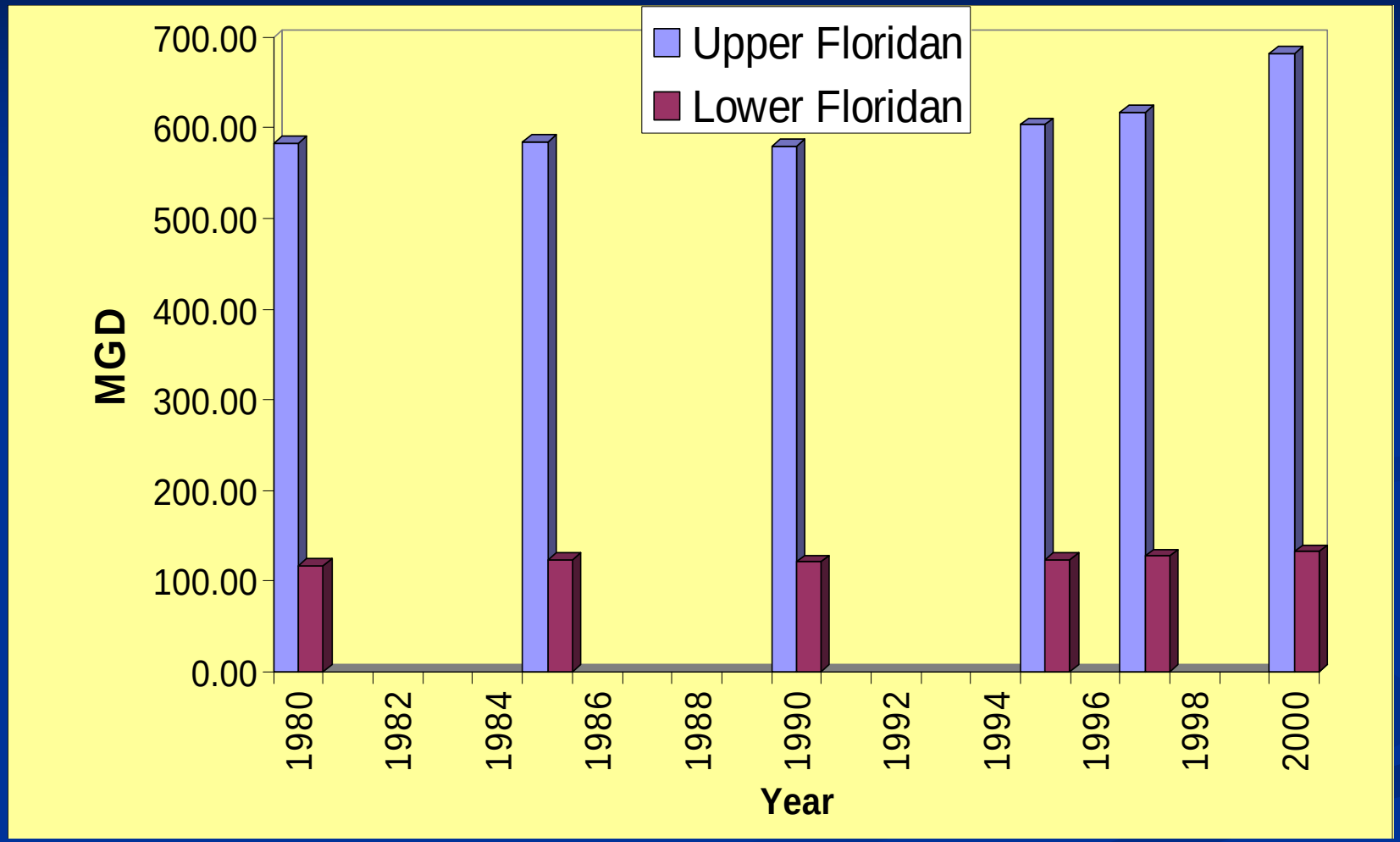
Water-Level Trends Upper Floridan



Water-Use Trends



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Data from Payne and others, 2005

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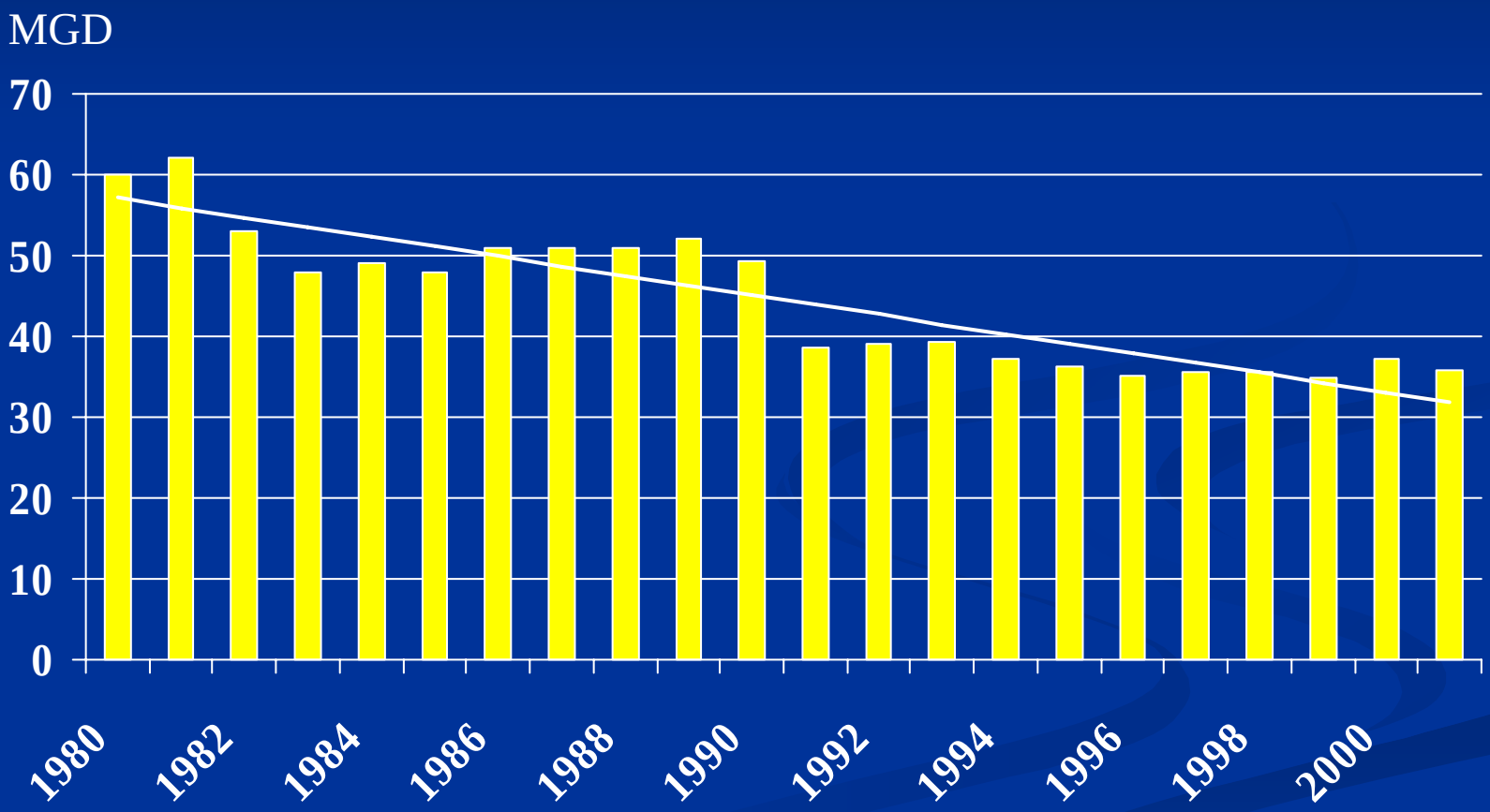
Brunswick Cellulose (former Ga Pacific) Annual Average MGD



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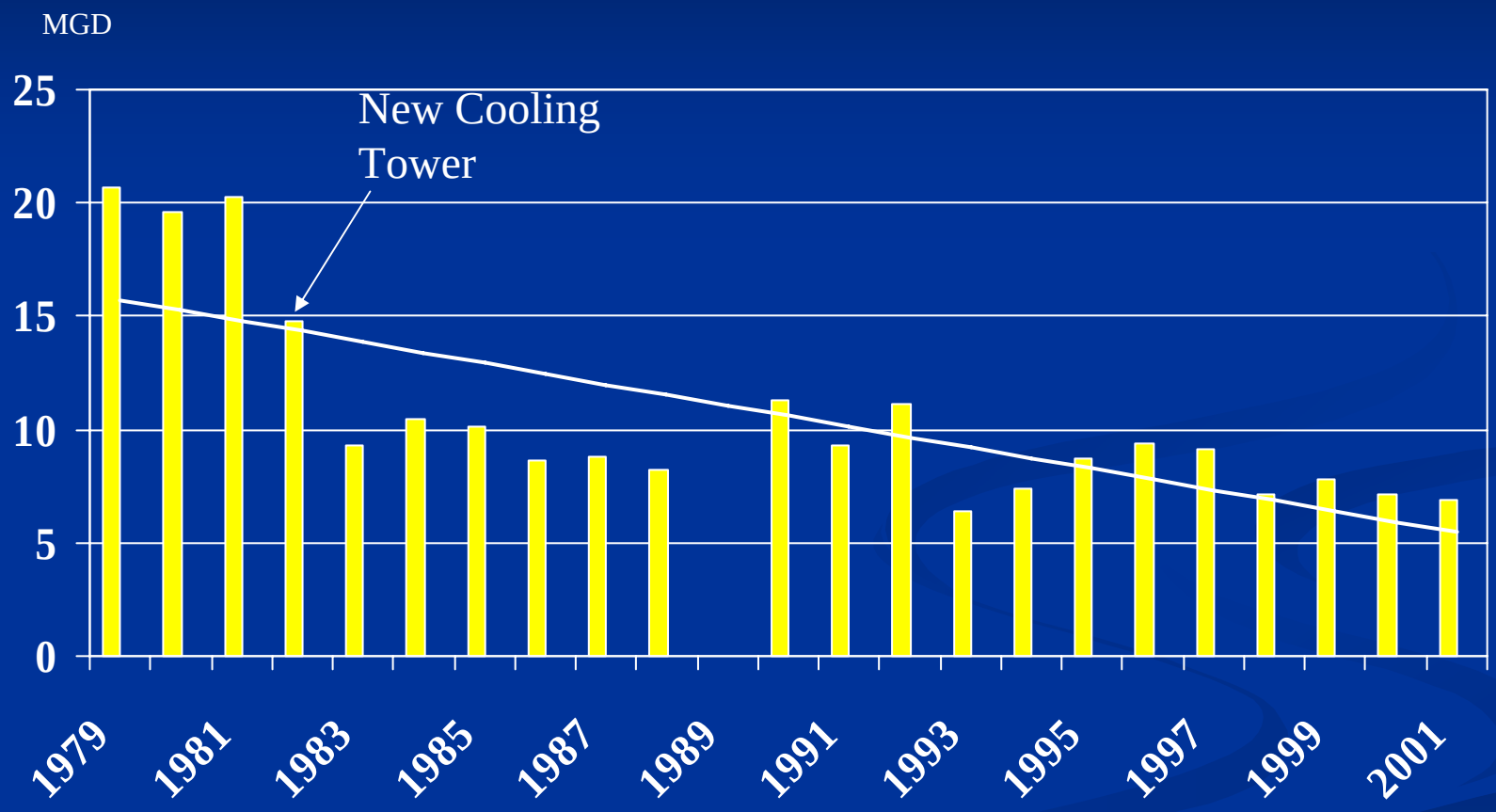
Courtesy of Jim Harris, Ga DNR

Hercules Incorporated Annual Average MGD



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Courtesy of Jim Harris, Ga DNR

Coastal Georgia Sound Science Initiative

Evaluation of ground-water flow, saltwater contamination and alternative water sources

Coastal search

Search for:

Go

Hydrologic conditions

Ground water conditions, 1999

Ground-water levels

Aquifers:

- Surficial
- Upper Brunswick
- Upper Floridan
- Lower Floridan

Chloride in ground water:

- Savannah area
- Brunswick area

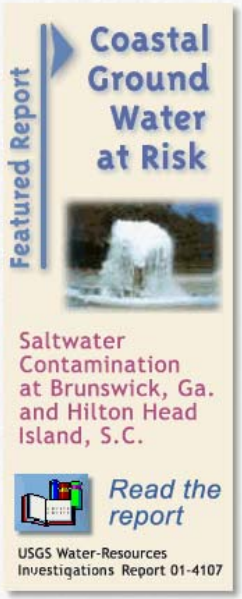
Real time and historical data

- Surface water (opens new window)
- Ground water data (opens new window)

Precipitation

- Precipitation: USGS (opens new window)
- Precipitation: University of Georgia (opens new window)

Other information resources



Coastal Georgia Sound Science Initiative

The Coastal Georgia Sound Science Initiative is a program of scientific and feasibility studies to support development of Georgia Environmental Protection Division's final strategy to protect the Upper Floridan aquifer from saltwater contamination.

- Project description
- Coastal publications
- Project workplan (155 Kb PDF file)
- References
- Project status
- Project staff

Project description

Rapid population growth in coastal Georgia, increased tourism, and sustained industrial activity have adversely affected coastal Georgia's water resources and limited the available water supply. The main source of water supply in the coastal area is the Upper Floridan aquifer, an extremely productive water source, which was first developed in the late 1800's, and has been used extensively in the area ever since. Pumpage from the aquifer has resulted in several problems including:

- substantial water-level declines
- migration of seawater into the aquifer at the northern end of Hilton Head Island, South Carolina;
- contamination of the aquifer from underlying brine-filled strata at Brunswick, Georgia;
- decreased ground-water inflow to springs, freshwater ponds, marshes, and wetlands, which could impact the balance of freshwater and saltwater in tidal rivers and estuaries;

Saltwater contamination has constrained further development of the Upper Floridan aquifer in coastal Georgia and created fierce competing demands for the limited fresh water supply. The Georgia Environmental Protection Division (GaEPD) released an interim strategy in April 1997 to manage saltwater intrusion in the Upper Floridan aquifer. As part of this interim plan, GaEPD has capped

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http://ga2.er.usgs.gov/coastal/

Development of Model Scenarios

- Discussed at
  - Ga Conservancy sponsored stakeholder meetings, February and May 2000
  - SCDHEC meeting, April 2003
  - TAC meeting, April 2003
  - Brunswick WRMAC, May 2003

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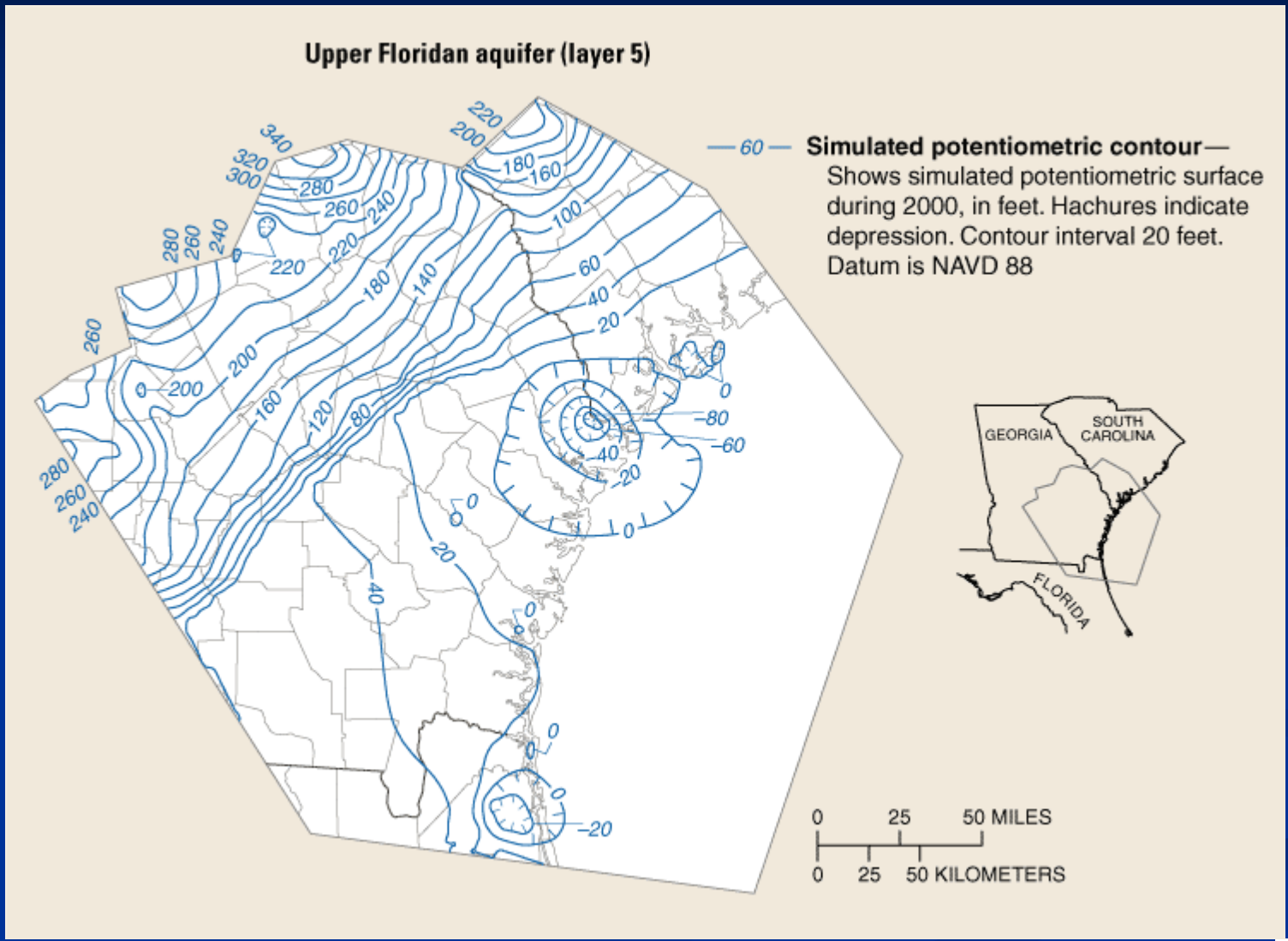
Water-Management Scenarios for Coastal Georgia

- 27 proposed scenarios
- Assess effectiveness of 1997 interim strategy on current-day conditions
- Pumpage growth & reduction
- Shift to alternative water sources
  - Lower Floridan aquifer
  - Brunswick and surficial aquifer systems
- Relative impact of Savannah vs. Hilton Head Island pumpage
- Durango shutdown

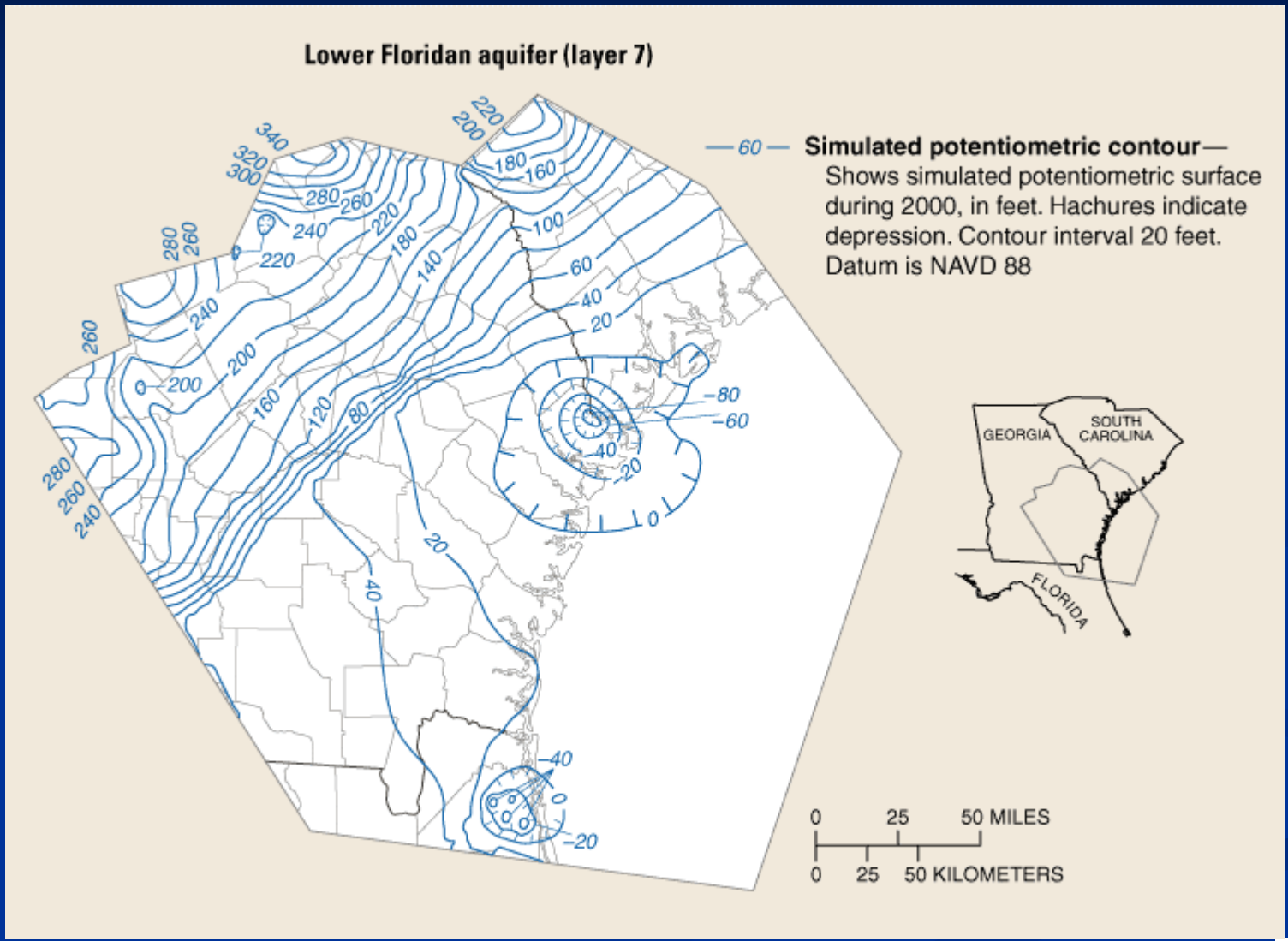
Not all scenarios will be run due to timeline/budget constraints

Simulated Year 2000 Conditions



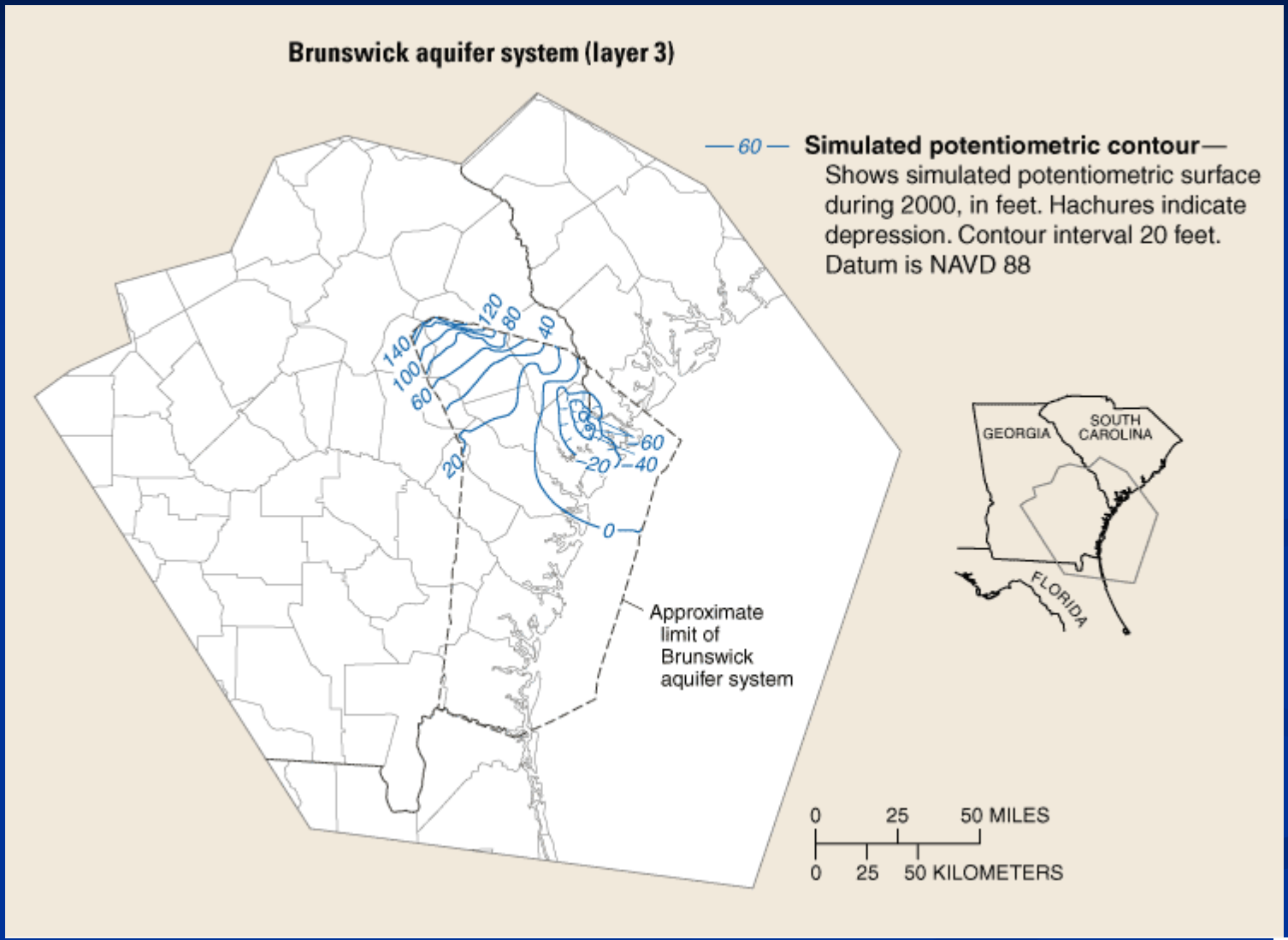
From Payne and others, 2005

Simulated Year 2000 Conditions



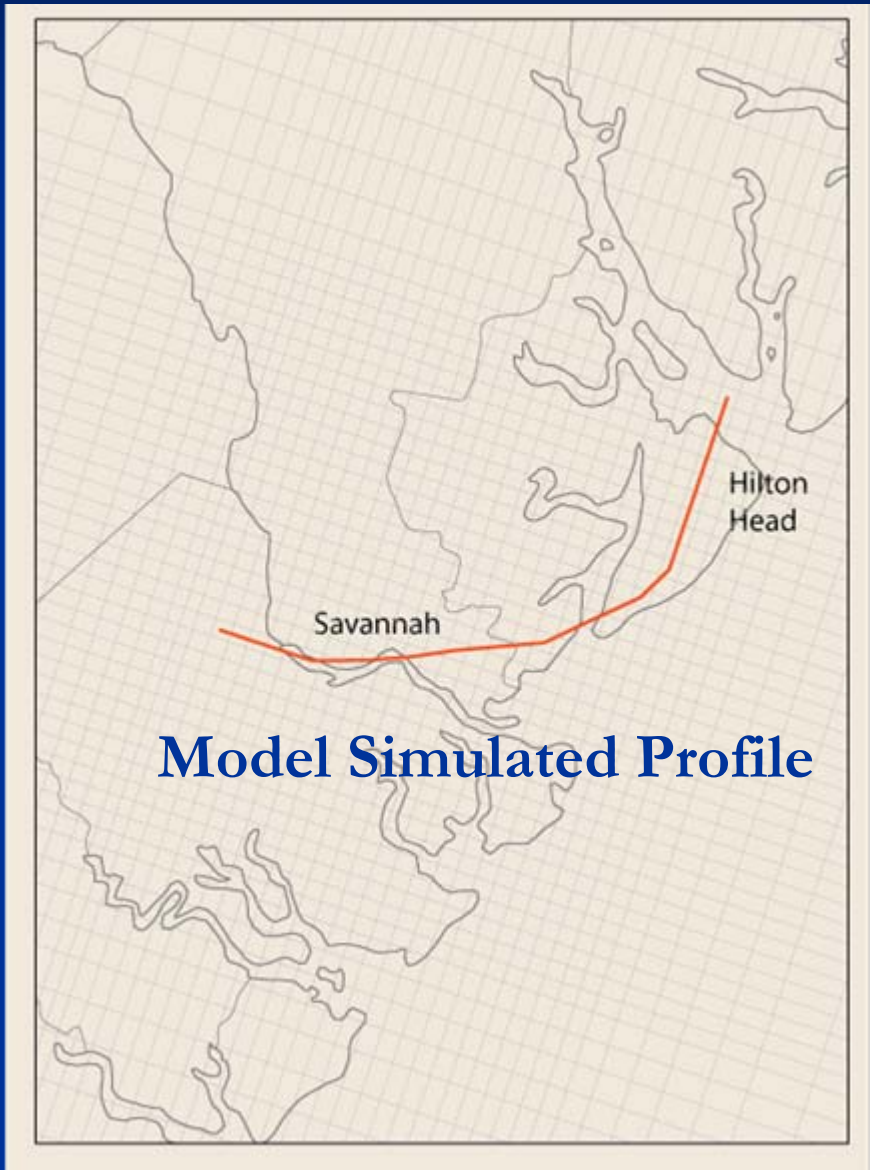
From Payne and others, 2005

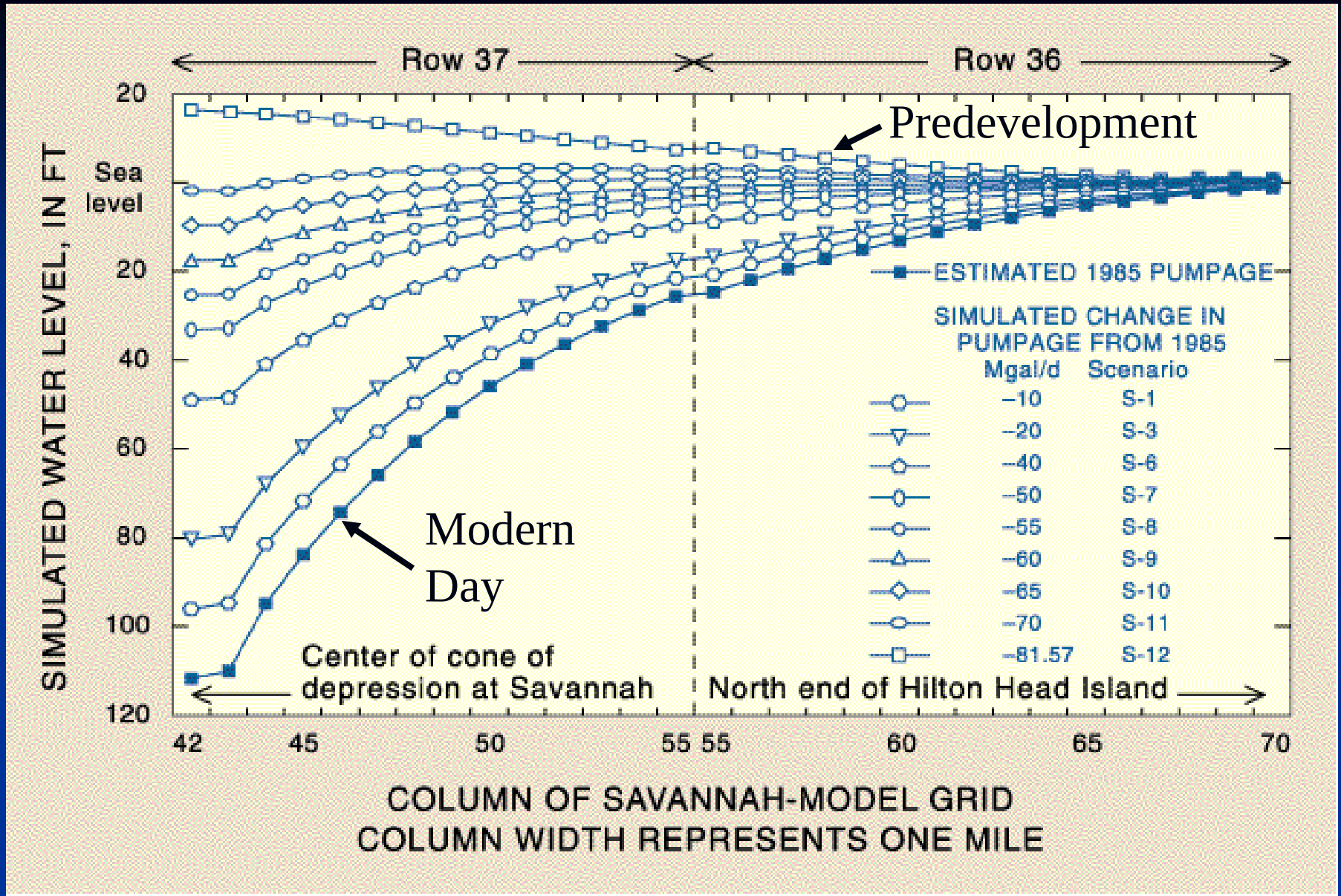
Simulated Year 2000 Conditions



From Payne and others, 2005

Impact of Savannah Pumping





From Clarke and Krause, 2000

Projected Growth in Coastal Georgia

- Each county required to develop Water Management Plan (interim strategy)
- Some County Water Management Plans have unrealistic projections (too high)
- REMI economic forecast model utilized to provide alternative (conservative) estimates of growth
- SJRWMD also provided growth projections

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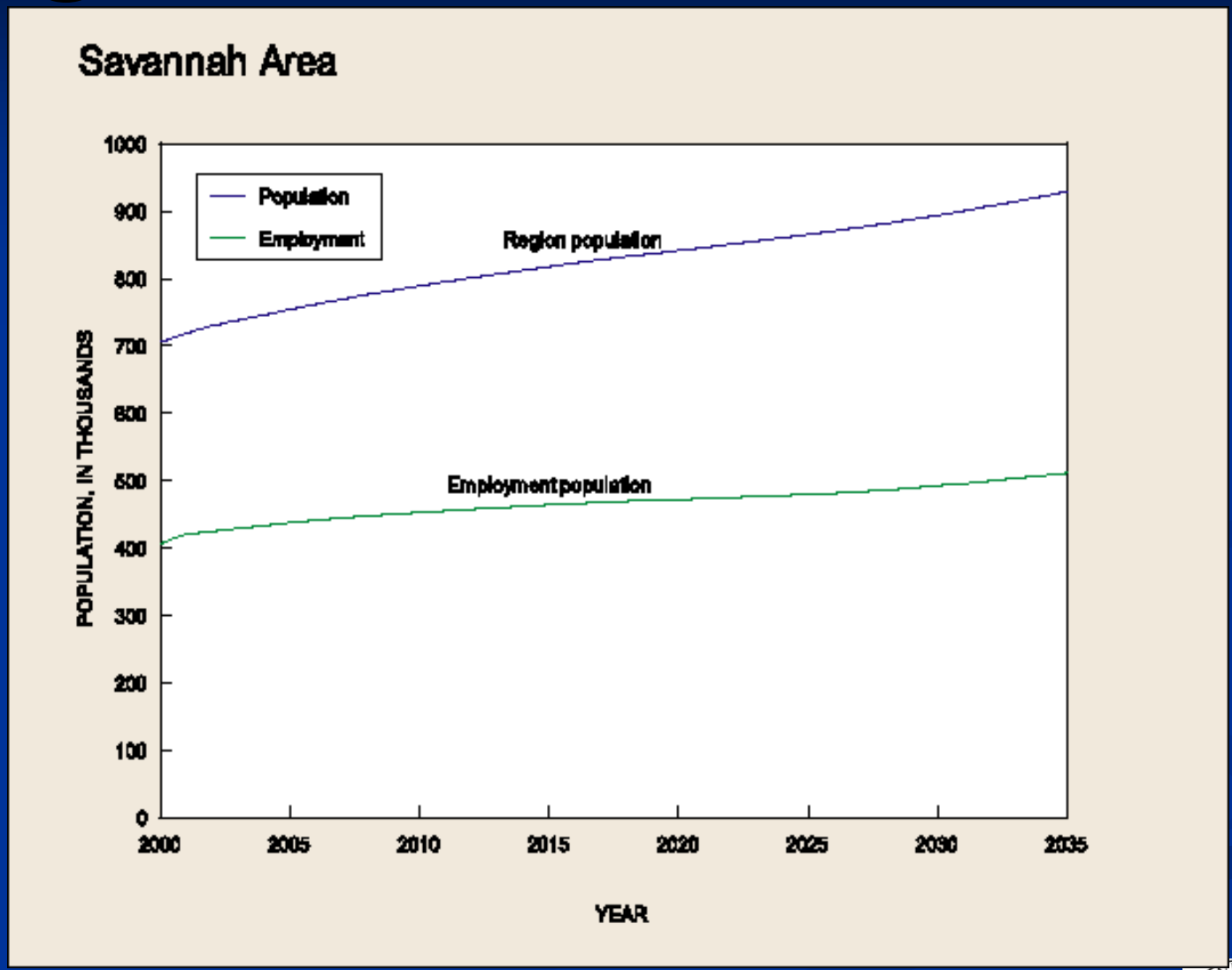
Regional Economic Models Inc.



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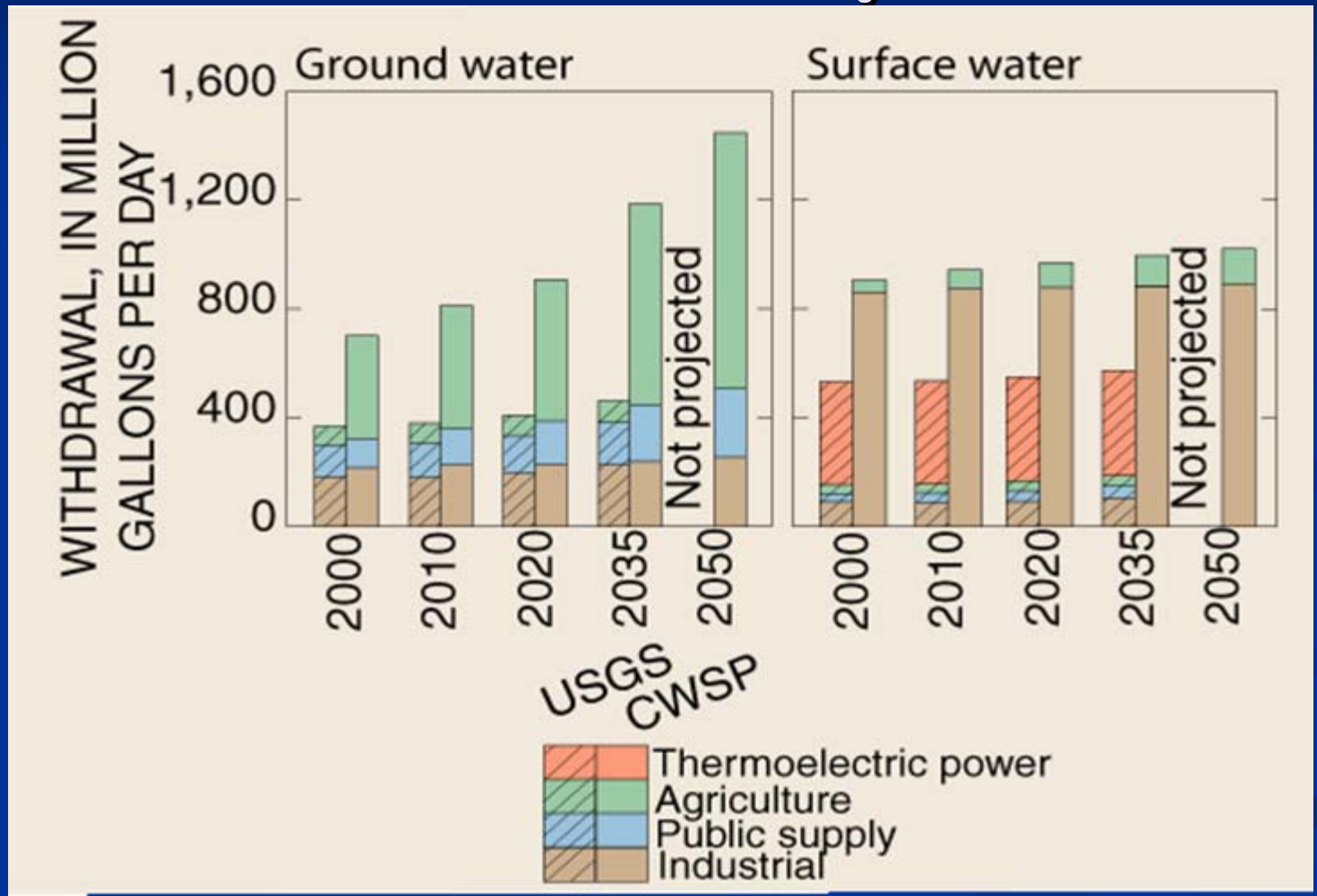
Projected Growth—REMI vs. County Plans



From Fanning, 2005

Georgia Coastal Sound Science Initiative 1999-2005

- ✓ Determine salt water entrance locations
- o Solute-transport modeling
- o Scenario development
- o Impact analysis
- ✓ Assess alternative sources of fresh water
- ✓ Data Management
- ✗ Feasibility studies

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Future Directions: Coastal Sound Science Initiative Phase II

- Refine ground-water models to:
  - Incorporate improved agricultural pumping data
  - Incorporate results of Savannah Harbor studies
  - Incorporate new well data
- Use models to:
  - Run additional water-management scenarios
  - Assess alternative aquifers as water sources and impact of development on saltwater intrusion, streams, and wetlands
  - Incorporate optimization techniques
- Assess the impact of surface-water withdrawal on major streams and ecosystems

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Acknowledgements

•Project coordination: Bill McLemore (GaEPD)
•Modeling: Dorothy Payne, Alden Provost, Greg Cherry (USGS)
•Offshore drilling: Fred Falls and Jim Landmeyer (USGS) Camille Ransom (SCDHEC), Card Smith (USACE), Jim Henry and Tony Foyle (Skidaway Institute)
•Deep well drilling: Fred Falls and Larry Harrelson (USGS)
•Seepage Ponds: Malek Abu-Rumman (Ga Tech)
•Brunswick and Surficial aquifer systems: Lucy Edwards and Rob Weems (USGS), Harold Gill (Carter and Sloope), Jon Radke and Chris Hemmingway (Golder Associates)
•Monitoring and Durango shutdown: Mike Peck (USGS)

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