

AQUIFER STORAGE AND RECOVERY

Aquifer Storage and Recovery IV

April 16, 2004

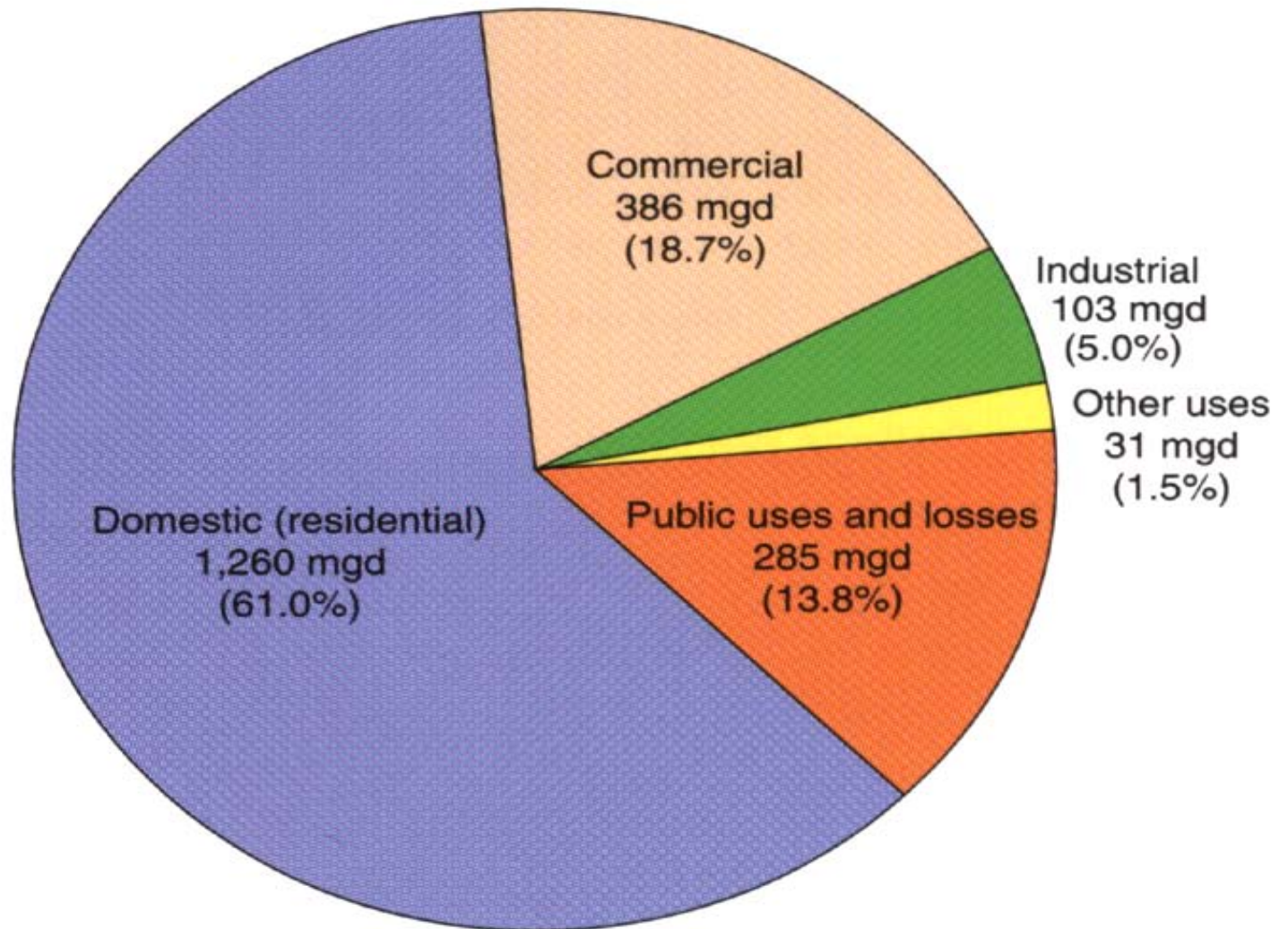
Legal Environmental Assistance Foundation

Scott Randolph, J.D.



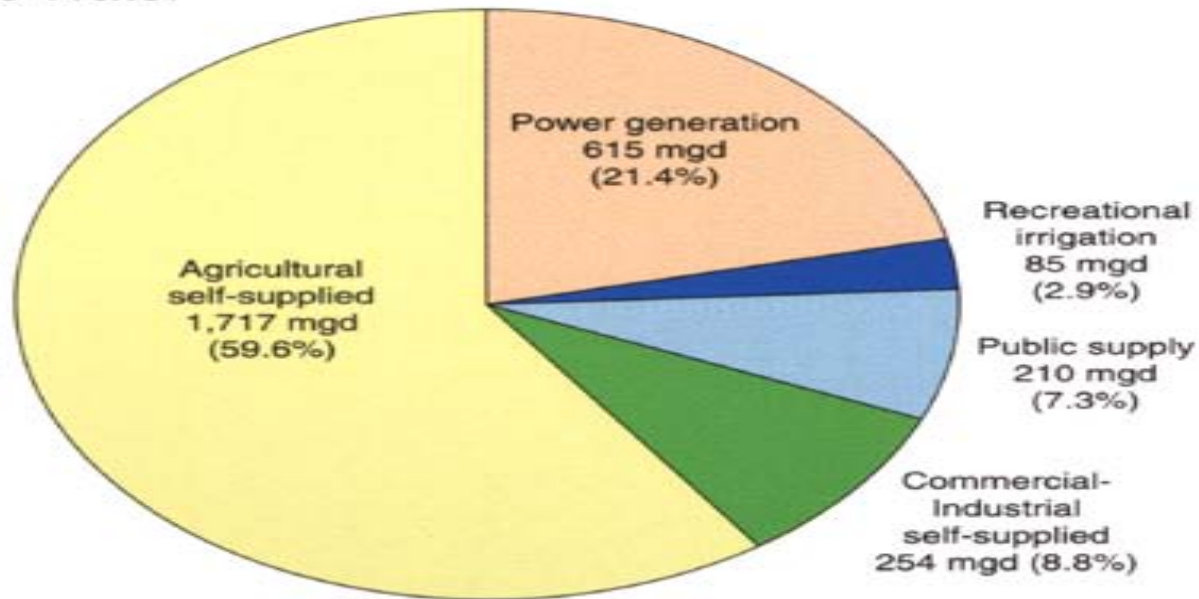
Florida's Water Challenges

- **Population of 20.7 million by 2020.**
- **More than 40 million visitors per year.**
- **47% agriculture; 33% public water supply; 8% industrial; 8% recreational irrigation; and 4% domestic self-supply.**



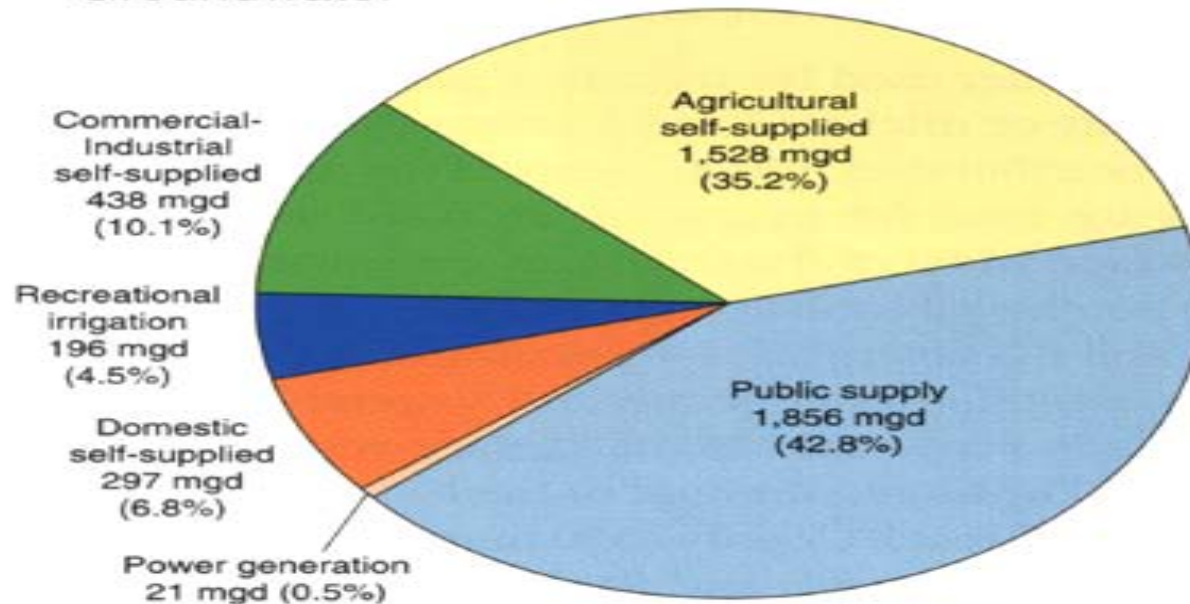
Total water withdrawn: 2,065 mgd

Surface Water



Total surface water use: 2,879 mgd

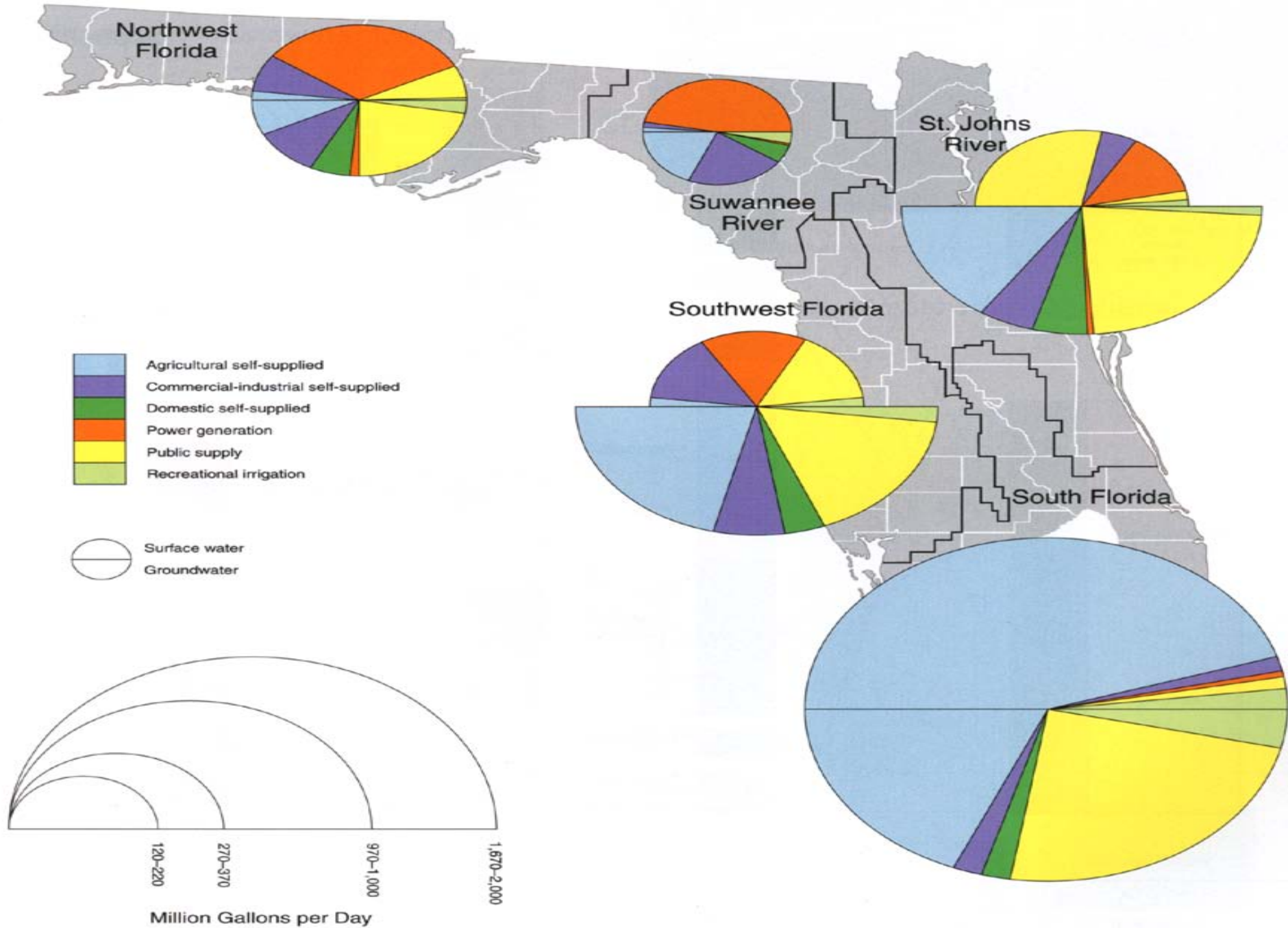
Groundwater



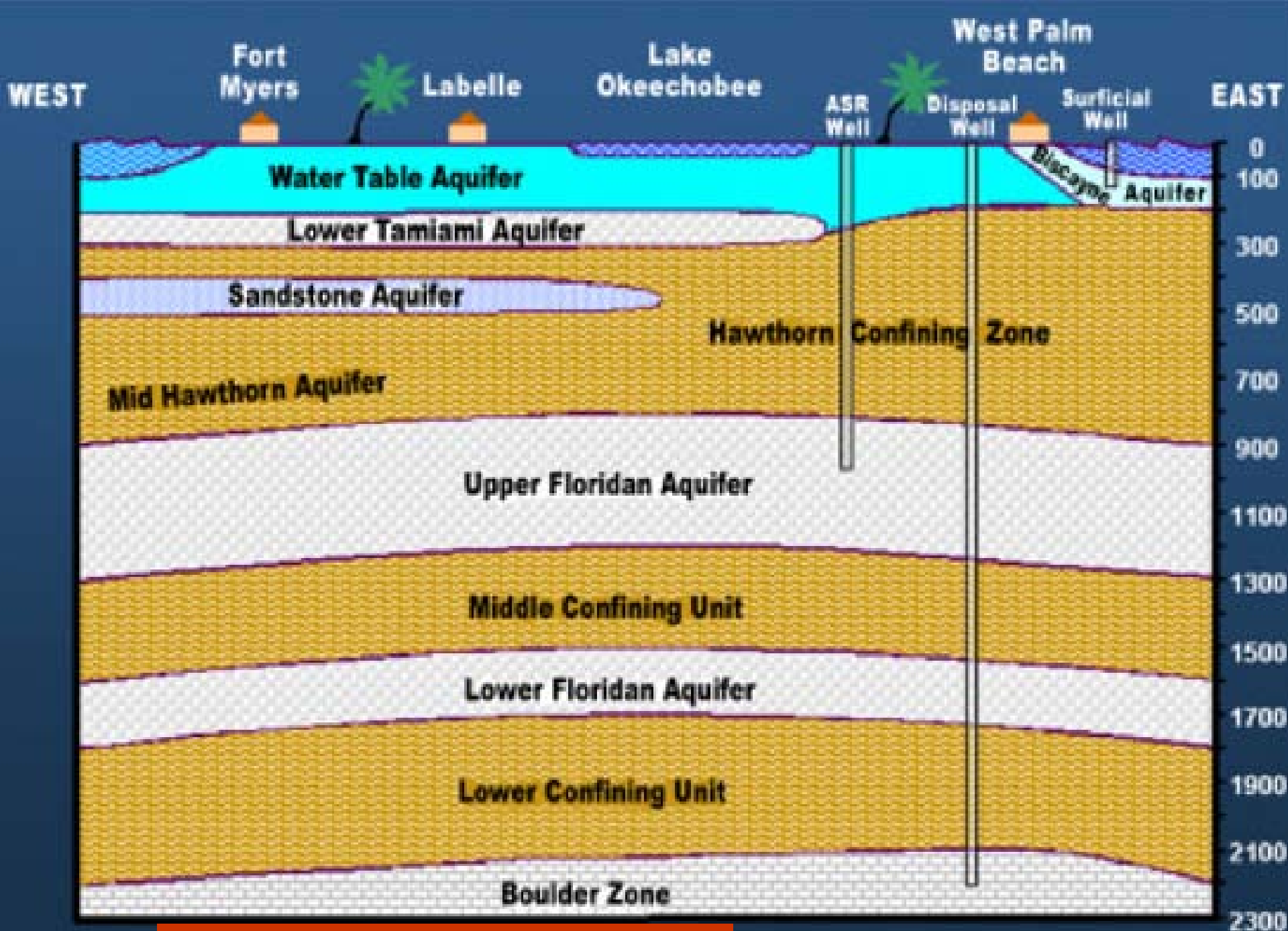
Total groundwater use: 4,336 mgd

Florida's Water Future

- >90 of Florida's drinking water is supplied by Groundwater Resources.
- 205% of Floridians use groundwater from private wells without any treatment.
- More water is withdrawn and used in Florida than in any other state east of the Mississippi.
- 41% of all water used for agricultural irrigation in the east is used in Florida.



(from: Fernald and Purdum 1998)



(from: COE/SFWMD Executive Summary 2002)

FUNDAMENTAL CONCERNS

- **Protection of human health from waterborne diseases.**
- **Prevention of contamination of drinking water supplies.**
- **Protection of geophysical properties.**
- **Precaution when operating in. sphere of scientific uncertainty.**

PROTECTION OF HUMAN HEALTH

Nature of Injectate

- Concerns with injected water – urban storm water, agricultural runoff and reclaimed water:
 - microbial contaminants
 - heavy metals
 - oxygen-robbing nutrients
 - pharmaceuticals

Agricultural Run-Off

Example: Dairy CAFOs

- 56 CAFOs in Florida—more than 25 in Lake Okeechobee Basin;
 - Each CAFO produces more than 1,000,000 gpd of untreated wastewater;
 - Wastewater contains high levels of bacteria, phosphorus and nitrogen
- Lake O Dairy CAFOs





Risks to Public Health

1. Health effects from exposure to contaminants in injectate.

- Human and animal waste:
 - More than 100 different types of disease-causing bacteria, viruses and protozoa in contaminated water.
 - More than 120 types of pathogenic viruses can be excreted by humans.



Risks to Public Health

2.

Illnesses	Pathogens
Peptic ulcers & stomach cancer	H. Pylori
Brain inflammation & degenerative heart disease	Coxsackievirus
Liver infection	Hepatitis A
Severe diarrhea	Rotavirus
Kidney failure	E. coli

Risks to Public Health

Center for Disease Control report published in Nov. 2002 states that “the reported occurrences of waterborne disease outbreak during 1999 and 2000 more than doubled over the previous two-year reporting period.”

Risks to Public Health

- CDC also reported 18% increase nationally in drinking water outbreaks associated with surface water.
- 87% increase nationally in drinking water outbreaks associated with groundwater sources.
 - 60% of these associated with consumption of untreated groundwater.

Risks to Public Health

- 29.1% increase in Florida in waterborne disease outbreaks from public water supply systems supplied by groundwater.

Risks to Public Health:

Concerns with Injecting Untreated Surface Water

- The EPA has identified polluted runoff from agricultural as the largest source of water pollution.
- But, the EPA reports that “[W]ithout substantially increasing investment and treatment efficiency, by 2525 U.S. waters will again suffer from sewage-related pollutant loadings that are as high as they were in 1968—the highest in our nation’s history.”

Risks to Public Health

Concerns with Injecting Untreated Surface Water

- U.S. sewer pipes carry about 50 trillion gallons of raw sewage daily.
- EPA estimates that 1.3 trillion gallons of raw sewage are dumped by combined sewer systems into waterways every year.

Risks to Public Health

Concerns with Injecting Untreated Surface Water

- 339 million pounds of toxic chemicals were discharged to sewer systems in 2001.
- 20% of groundwaters nationwide are contaminated with viruses that are found in sewage.

Risks to Public Health

Concerns with Injecting Untreated Surface Water

- In 2001, 63 major facilities in Florida were consistently exceeding their hazard chemical permit limits.
- 12 facilities were exceeding their Effluent Permit Levels for High Hazard Chemicals by at least 1000% (Tenfold).

Risks to Public Health

Additional health concerns:

- Distribution system impacts:
 - Mixing of pumped ASR water and brackish water increases the levels of chloride ion and TDS in the blended finished water;
 - Aggravates corrosion which leads to lead/copper problems in distribution system.

Risks to Public Health

Additional health concerns (cont.):

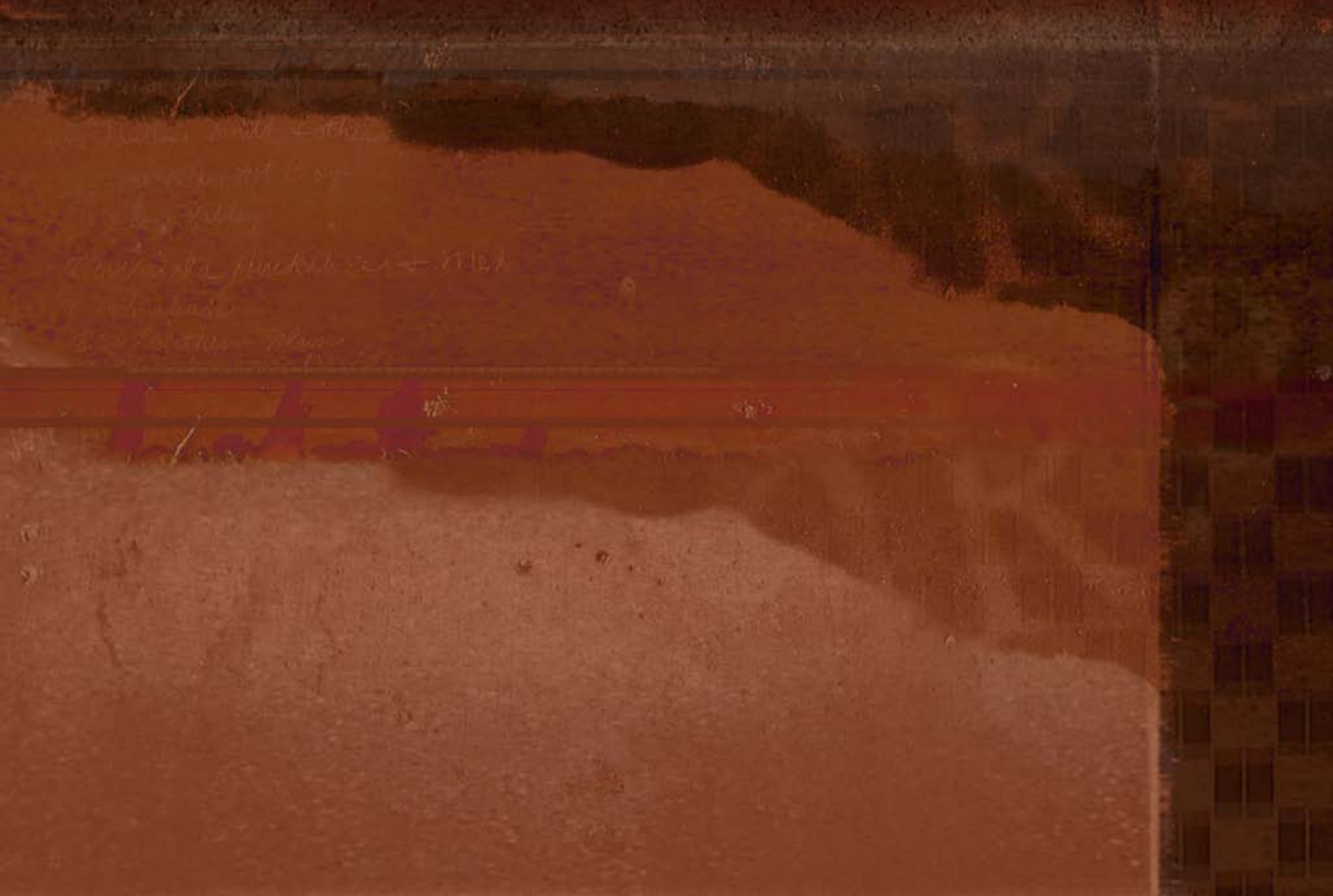
- Geothermal interaction and harmful aquifer transformation products.
 - Water chemistry differences can cause leaching of harmful substances.
 - E.g., uranium/radon; arsenic.
 - CROGEE concerned that heterogeneity of Florida Aquifer may result in significant different reactions among the sites.

Risks to Public Health

Additional health concerns (cont.):

- Mercury bioaccumulation.
 - Rate of bioaccumulation of methylmercury influenced by constituents (e.g., sulfate, chloride) in ASR water.
- Harmful algal blooms.
 - Cyanotoxins found in source water;
 - Serious health problems from exposure (e.g., liver, nervous system);
 - No drinking water standard.

Risks to Public Health



Who Bears the Consequences?

Private well users

	Households	Individuals
Hillsborough	57,447	144,192
Marion	48,359	117,996
Polk	36,578	92,542
Palm Beach	34,835	81,166
State Total	867,600	2,134,296

20% of Florida citizens—more than 2.7 million—obtain drinking water from private or limited use systems.

Who Bears the Consequences?

Small public water supply systems.

- Serve < 10,000 individuals.
- Exempt from many drinking water standards

Low income, minority & rural communities

- Rely on private wells and small water systems
- E.g., Pahokee and South Bay.

Consumers

- Even large PWSs may experience increased treatment costs.

HYDROGEOLOGIC UNKNOWNNS

Fundamental Concern

**Precaution when Operating in
Sphere of Scientific Uncertainty**

Hydrogeologic Unknowns

Unknown conditions

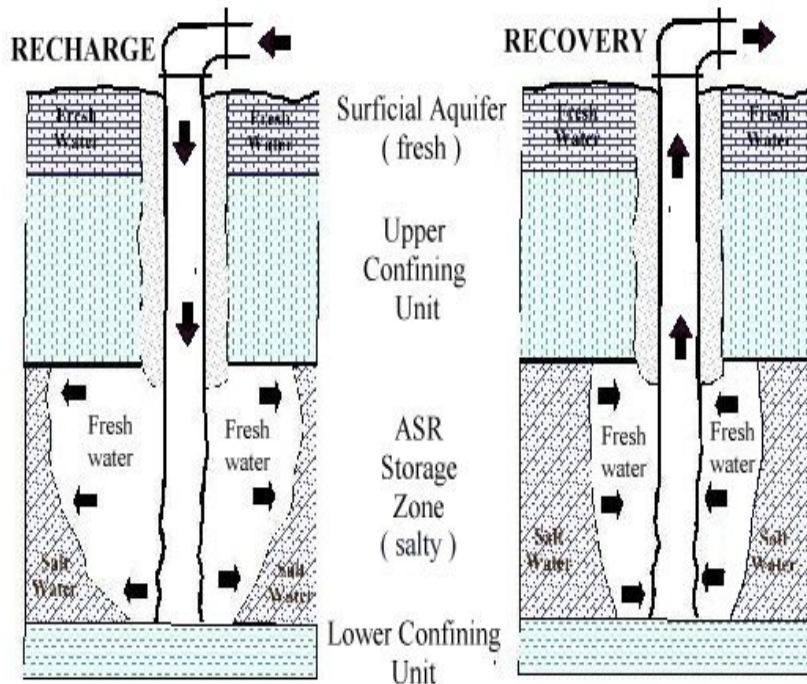
- Limited understanding of the local and regional hydrogeology.
 - Storage intervals; Subsurface flow patterns; Hydraulic interactions.
- Rules do not require extensive study of fluid pathways.
 - Fault lines; fissures; relic sinkholes.
- Poor modeling in CERP
 - Presumes homogeneous and isotropic conditions in Hawthorn Group.

Hydrogeologic Unknowns

- Few regional investigations of the hydrogeology of the Floridan aquifer system in southern Florida—and those have focused on issues unrelated to ASR.
- Citing of ASR has been primarily based on factors such as land availability and source-water proximity.

Hydrogeologic Unknowns

“Typical” ASR Well

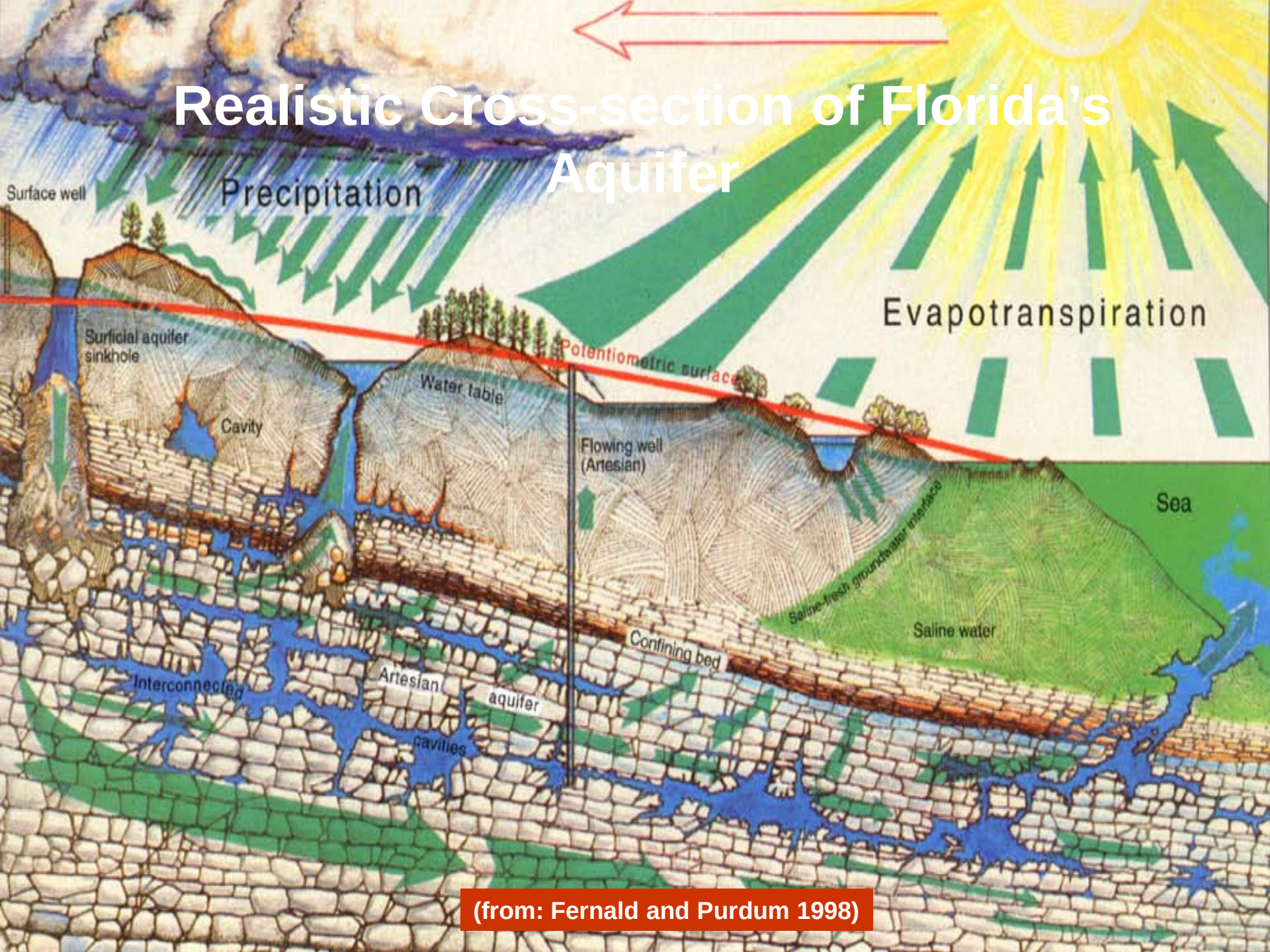


Magic bubble

- The bubble is not an expanding cylinder with a definite top and bottom.
- It's an irregularly shaped mass with various spreading “fingers” of different lengths.

John Vecchioli, Retired
District Chief, Florida
U.S.G.S.

Realistic Cross-section of Florida's Aquifer



(from: Fernald and Purdum 1998)

Hydrogeologic Unknowns

Confinement

- Common understanding of confinement is “to keep within bounds; to restrict.” American Heritage Dict.
- Geologically, full confinement does not occur—instead, equation of transmissivity.
- Higher confinement usually equates to less water that can be injected without increases in cracks and fissures.

Hydrogeologic Unknowns

Recovery Rates

- Fact vs. fiction: recovery is not 100%.
 - USGS Report 02-4036 showed low recovery for ASR wells in south Florida.
 - Highest recovery cycle was 84%;
 - 11 of 16 reported wells never showed a recovery cycle above 50%.
- Restudy modeled at 70% recovery efficiency.

Hydrogeologic Unknowns

- CERP includes plan to utilize ASR on scale 17 times larger than any system in existence—up to 333 wells storing 1.7 bgd of various fluids.
- CERP ASR will include multi-year storage that most likely result in even lower recovery rates.

Regulatory Concerns

Fundamental Concern

**Integrity of the Process:
Adequacy of Statutes and
Regulations**



Regulatory Concerns

Limitations of the Safe Drinking Water Act:

- Less than **100** primary drinking water standards established.
 - Regulations allow economic considerations in setting standards.
- Over **75,000** chemicals in use.
- Even the most basic toxicity testing results cannot be found for nearly **75%** of the top-volume chemicals in commercial use.

Regulatory Concerns

- Required development of alternatives to ASR contained in Restudy and CERP has not been done
- PMP for Regional ASR study does not contain adequate cost-benefit analysis.
- PMP states that one of the assumptions of the Regional Study is that ASR is the accepted technology for use in the CERP—even before completion of the Study.
- PMP also contains assumption that the “implementation of CERP Regional ASR will not be affected by unanswered issues, recommendations or qualifiers that result from conclusions of the ASR Pilot Projects.”

Regulatory Concerns

Class I UIC Experience

- Monitoring now documents unplanned migration of injection fluid through confining zones into underground sources of drinking water at 24 Class I wells.
- Movement violates the Safe Drinking Water Act.
- EPA's proposed solution is to change the rule to allow the movement.
- Same regulatory system is being used to address movement of fluid into USDW's through ASR wells.

Regulatory Concerns

Class I UIC Experience

DEP's Lack of Enforcement

Example: Miami/Dade

- Daily Injection Rate more than 87 mgd.
- Data showed movement more than 20 years ago.
- Lack of enforcement allowed Miami/Dade to inject water failing to meet standards.
 - Following is data for Miami/ Dade from 1993-1999:

Solving Florida's Water Crisis

- Prevention as Primary Approach
 - EPA's Source Water Contamination Prevention Strategy
 - Decrease public health risk by keeping contaminants *out of the sources* of drinking water;
 - Source water contamination prevention is the first barrier to the outbreak of waterborne illnesses.

Solving Florida's Water Crisis

- Prevention as Primary Approach (continued)
 - Economic Benefits of Prevention:
 - Wages can be lost and medical costs incurred;
 - Alternative water supplies may be required;
 - Treatment systems may have to be expanded or new water sources found;
 - Dealing with contamination of groundwater supply may be 30-40 times more;
 - More expensive to contaminate than prevent.

FUNDING FOR ASRS:

Misuse of Florida Forever Funds

- Voters referendum in 1997 created Florida Forever bond program to purchase vulnerable private land and place in control of the state for protection.
- In 2000, legislature thwarted people's will by allowing funds to be used for "water resource development," including ASR.

FUNDING FOR ASR's:

Misuse of Florida Forever Funds

- St. John's River Water Management District will use \$47 million on ASR systems from 2001-2006