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TITLE: Water Table Buffering in Florida's Green Swamp

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ABSTRACT: Surface water and water table elevations in Central Florida's Green Swamp area are strongly influenced by a water table buffering mechanism, which is somewhat analogous to the chemical concept of buffered solutions. The degree of drawdown or mounding of the water table resulting from small changes in rates of pumping or recharge are significantly limited due to interaction with an underlying confined aquifer through a leaky confining unit. Because typical head differences between the two aquifers are very small, rates and directions of leakage through the confining unit that separates them are sensitive to relatively small changes in potential of either aquifer. Leakage counteracts deviations from the buffered head relationship between the two aquifers by producing water from, or draining water into, the confined aquifer, which is a much larger and more transmissive reservoir than the unconfined aquifer.

Observations of anomalous head relationships at sand mines in the region indicate the significance of the water table buffering mechanism, which forces water table elevations to track water potentials in the underlying confined Floridan Aquifer System much more closely in the Green Swamp area than in other places. The region's extensive wetland systems have developed in an environment characterized by limited range of water table fluctuation maintained by water table buffering. The extreme sensitivity of surface water levels in the Green Swamp area to Floridan Aquifer System drawdown should be carefully considered in planning for water supply development in the region.

Water Table Buffering In Florida's Green Swamp

By Marc V. Hurst, P.G.

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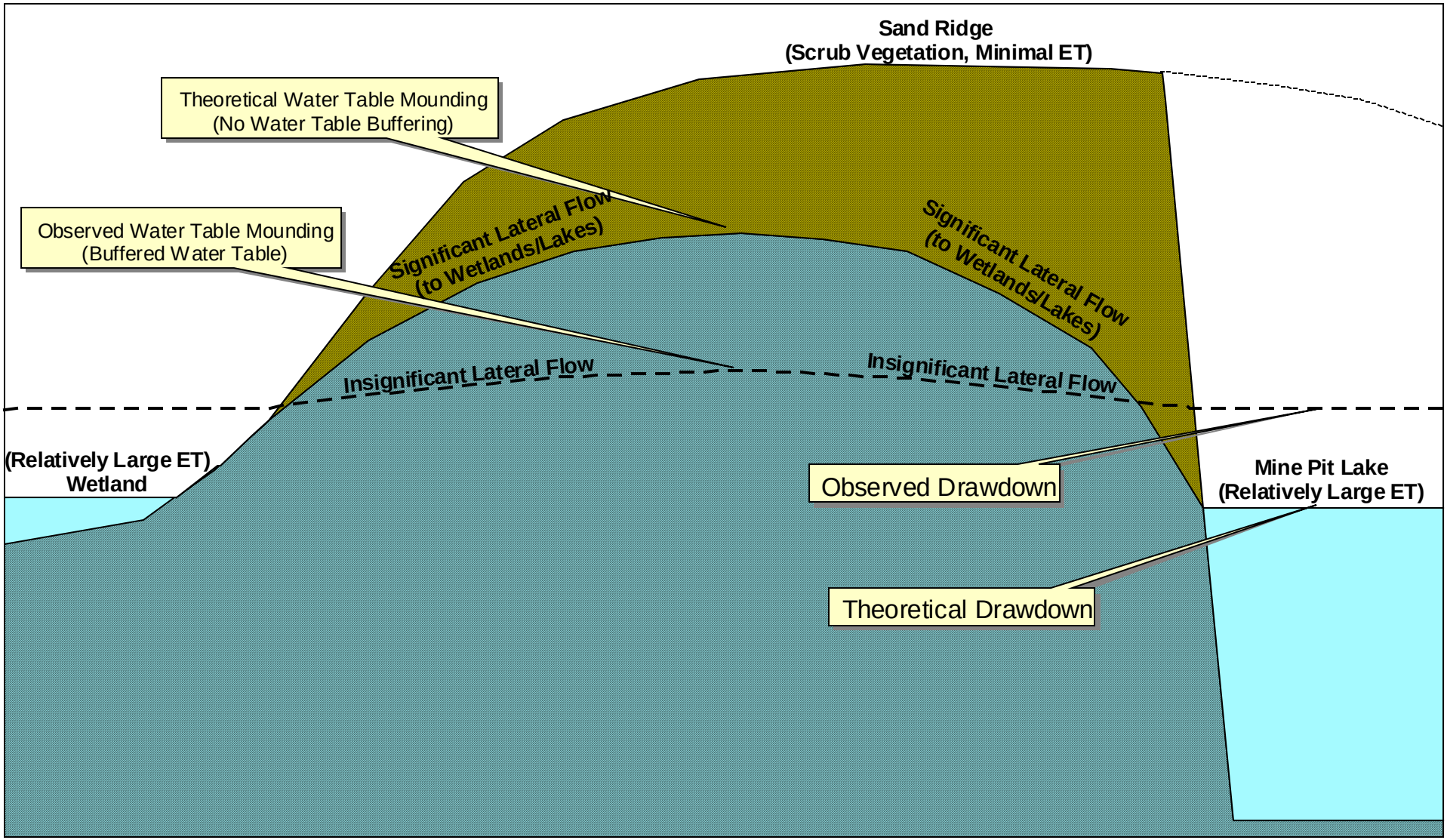

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0 400

Horizontal Scale (ft)
Vertical Exaggerated 50 Times
February 20, 2010

Schematic Cross Section of Water Table Mounding


LAKE
Green Swamp
POLK
INDEPENDENT
GEO
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GEOLOGICAL
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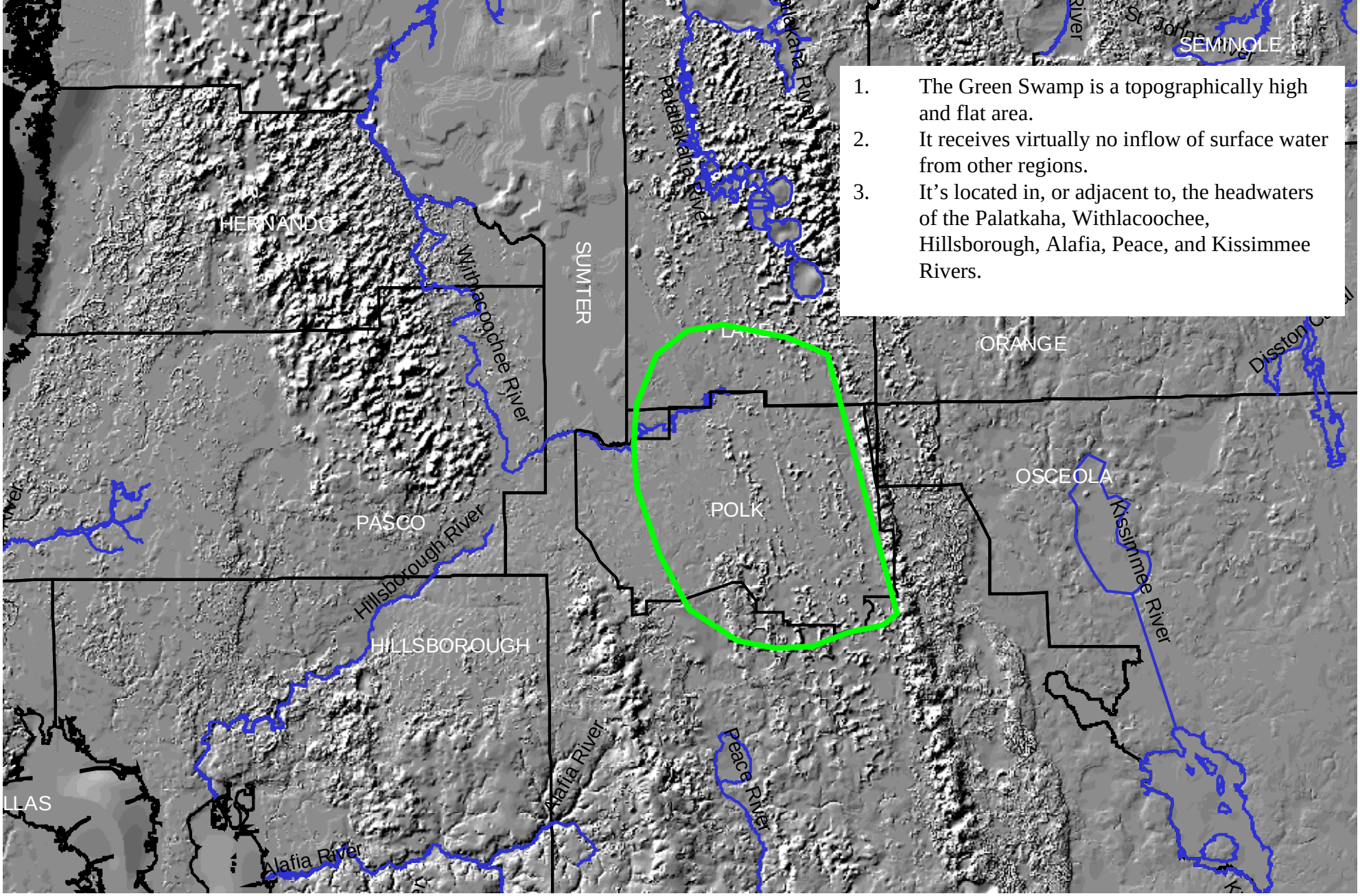
N
0
50
Miles
February 19, 2010
Location Map



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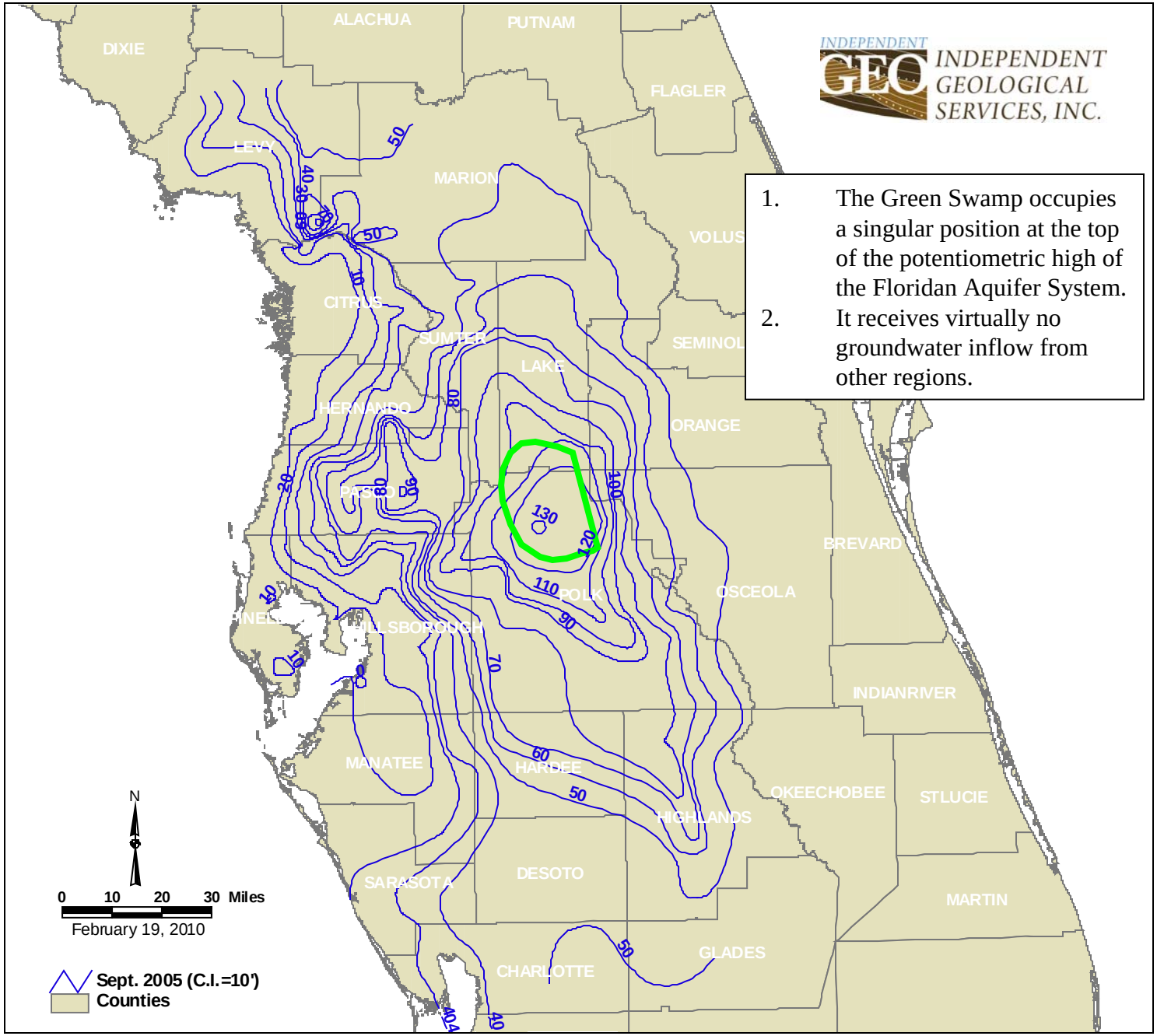
Surface Water Setting of the Green Swamp

N

0 5 10 Miles

February 19, 2010



Potentiometric High of the Floridan Aquifer System

Surficial Aquifer System

Conductive, but Thin

(Small Horizonal Transmissivity, ~500 sq.ft/day)

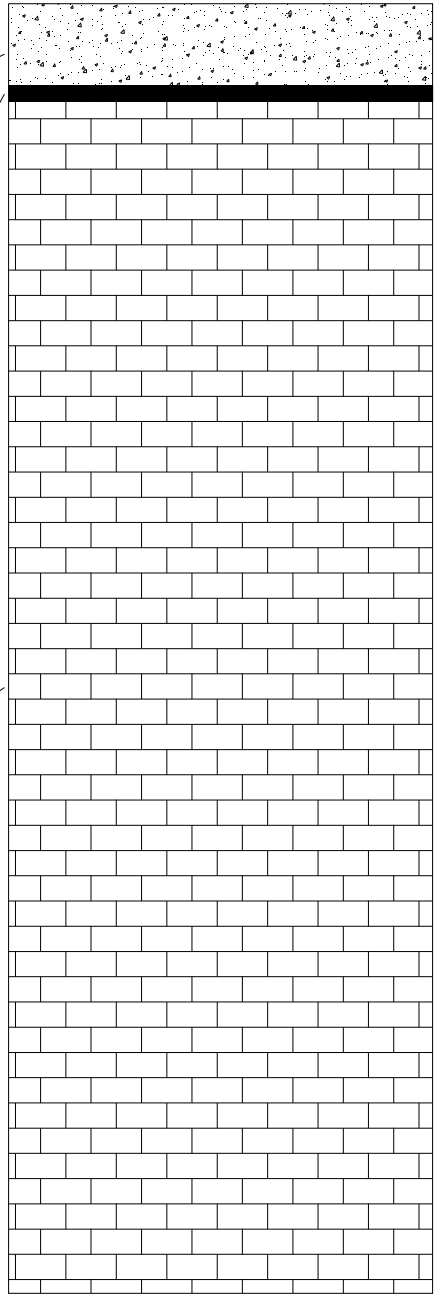
Intermediate Confining Unit

Leaky, Very Thin

Floridan Aquifer System

Very Thick

(Large Horizonal Transmissivity, ~50,000 sq.ft/day)



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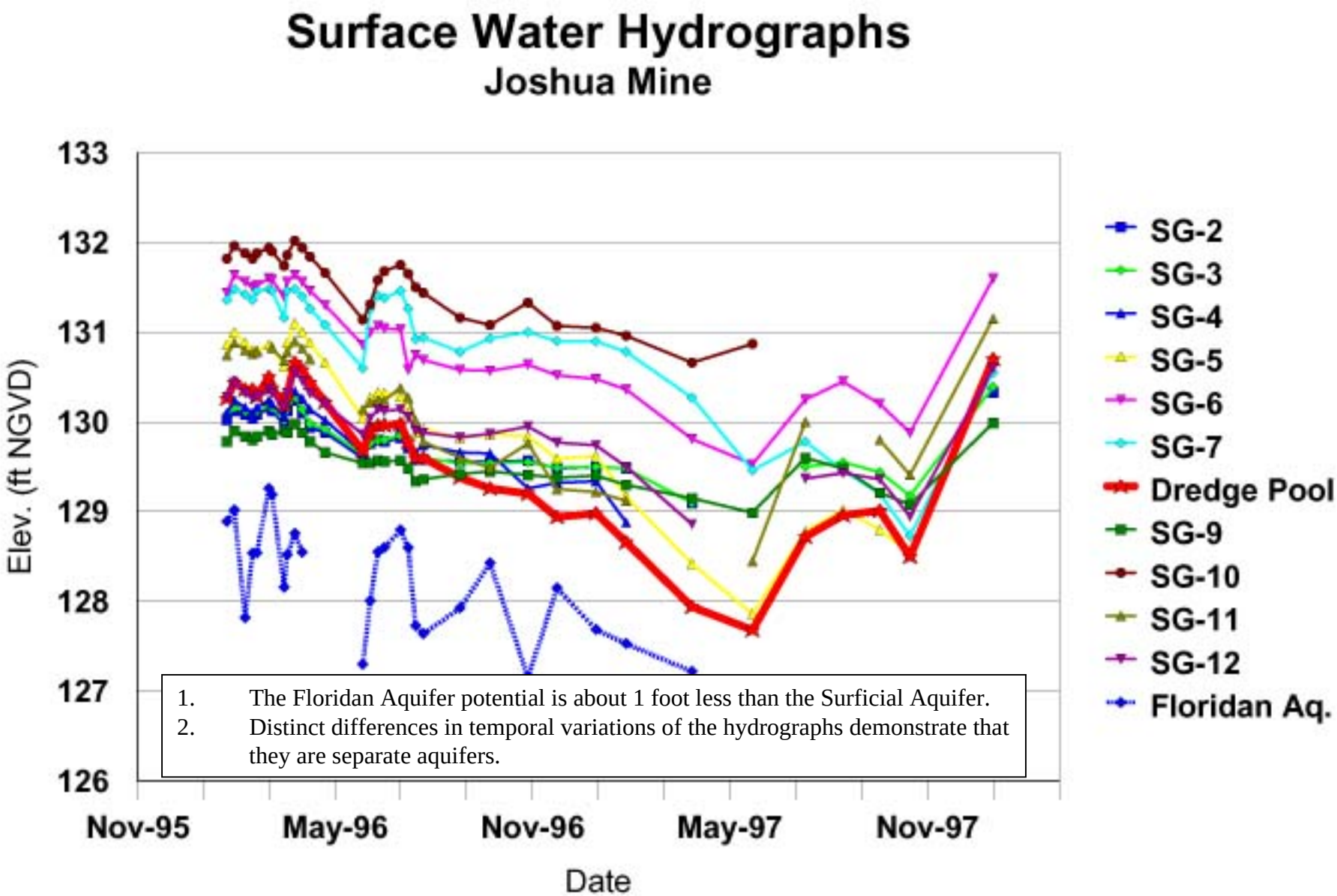
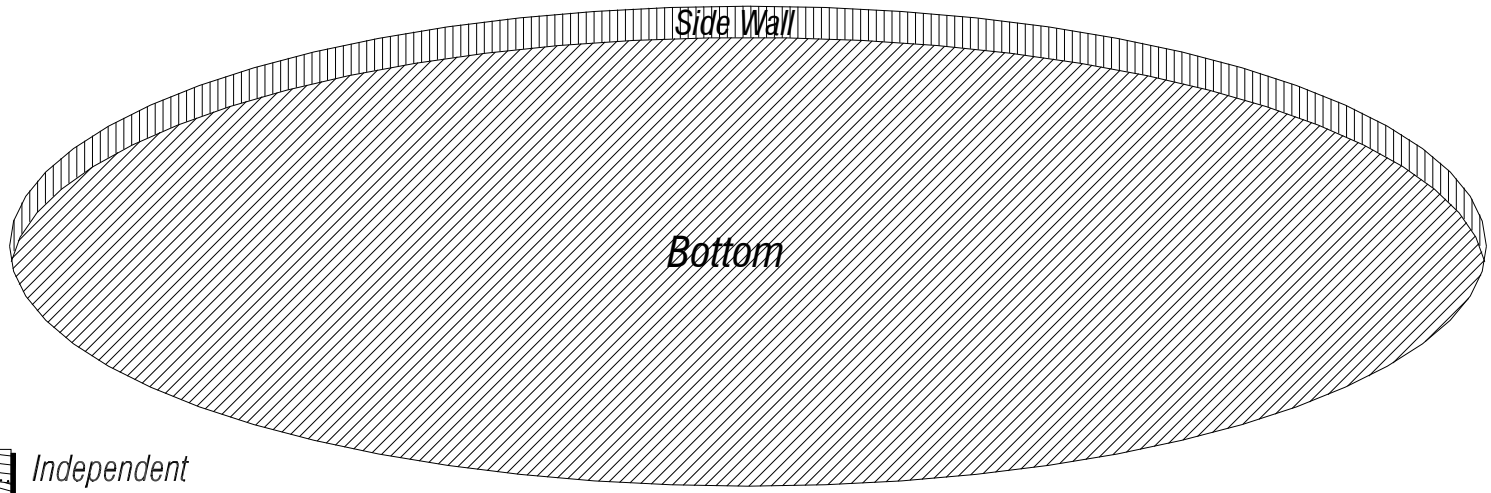


1. The Floridan Aquifer potential is about 1 foot less than the Surficial Aquifer.
2. Distinct differences in temporal variations of the hydrographs demonstrate that they are separate aquifers.

Side Wall = 370,000 sq.ft *8% of Surface Area Communicates with Surficial Aquifer*

Bottom Area = 4,356,000 sq.ft *92% of Surface Area Communicates with Floridan Aquifer*



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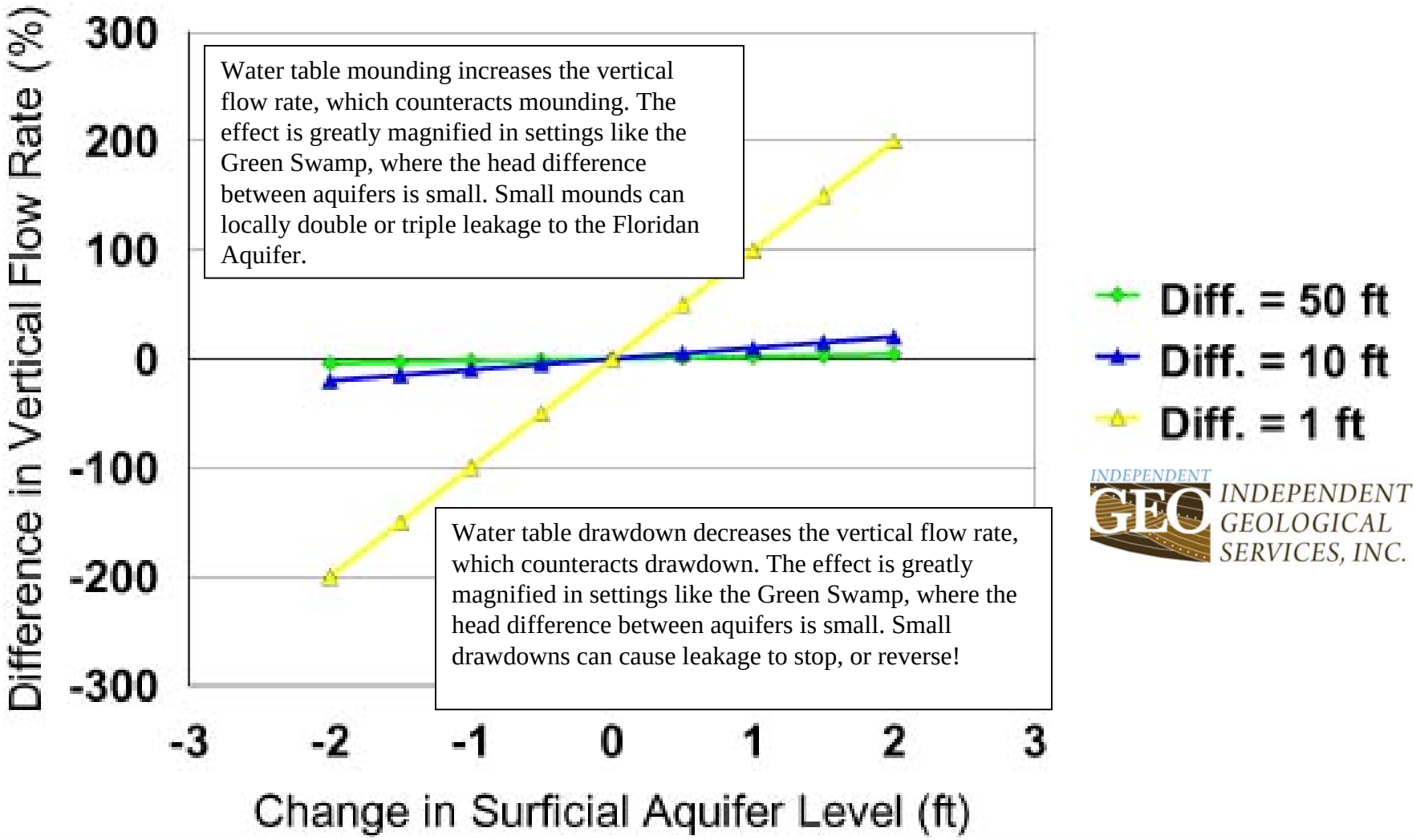
Side Wall Area Vs. Bottom Area of a 50-Ft Deep, 100-Acre Cylindrical Pit

1. Darcy's Law states that flow is proportional to cross sectional area. Features with this geometry have a strong potential to communicate downward.
2. This schematic was originally drawn to represent a mine pit lake. But the geometry applies equally to natural lakes, wetlands, and water table mounds.

Water Level Buffering Effect



Water table mounding increases the vertical flow rate, which counteracts mounding. The effect is greatly magnified in settings like the Green Swamp, where the head difference between aquifers is small. Small mounds can locally double or triple leakage to the Floridan Aquifer.

Water table drawdown decreases the vertical flow rate, which counteracts drawdown. The effect is greatly magnified in settings like the Green Swamp, where the head difference between aquifers is small. Small drawdowns can cause leakage to stop, or reverse!

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BUFFERED WATER TABLE SYSTEM
SUMMARY OF FACTORS REQUIRED

1. A relatively-thin unconfined aquifer;

2. A relatively-transmissive confined aquifer (perhaps 100X more transmissive than the unconfined aquifer);

3. A very-leaky confining unit separating the unconfined and confined aquifers;

4. Artesian conditions in the confined aquifer with head elevations at least some nominal distance above the top of confining unit;

5. Relatively small flow gradients in both aquifers (lateral flow cannot exceed vertical flow; and

6. Significantly large and relatively constant recharge to Surficial Aquifer.

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THE GREEN SWAMP HAS SEVERAL SINGULAR HYDROLOGIC CHARACTERISTICS

1. It is situated in or between the headwaters of several of Central Florida's major rivers;
2. It straddles the potentiometric high of the Floridan Aquifer System;
3. Rainfall is the region's only significant source of water;
4. Because the region receives virtually no inflow of ground or surface water from other places, it has Central Florida's best water quality;
5. Unique hydrostratigraphic, recharge, and head relationships result in an unusual buffered water table;
6. The region's relatively flat topography, very shallow water table, and unusual water table buffering system combine to make a hydrologic environment that is uniquely suited to large wetland systems.

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CONSIDERATIONS FOR SUSTAINING THE WATER AND ENVIRONMENTAL RESOURCES OF THE GREEN SWAMP

1. Direct rainfall is the source of virtually all of the water in the Green Swamp. And most of it is lost by evaporation from swamps. The surplus of water available to flow out of the region and maintain base flows to rivers and the Floridan Aquifer System, is quite small.
2. Due to the region's unique buffered water table system, there is very little storage of ground or surface water at elevations capable of supplying the region's extensive wetlands. For that reason the Green Swamp is especially intolerant of drought.
3. The Green Swamp is very poorly suited for water supply development. Because the Floridan Aquifer System is so intimately linked with region's water table and surface waters, very little water could be harvested without adversely affecting the region's wetland systems

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