Data Reduction and Analysis of Hydrologic Data for Selected Tree Islands (3AN1, 3AS3, and 3BS1)

SFWMD Purchase Order 4500026695

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September 2008

1 EXECUTIVE SUMMARY

Tree islands are tear-shaped topographic features in the relatively flat, low-lying landscape of southern Florida. Tree islands are only slightly (a few feet) elevated above the surrounding wetland, but are an important habitat for plants and animals. Tree islands are sensitive to changes in their hydrologic conditions; hence, a better understanding of the factors affecting the hydrology of tree islands is needed in the efforts to protect and restore the Everglades.

In 2000, South Florida Water Management District began monitoring meteorological data and groundwater and surface-water levels at selected tree islands as part of a 5-year, multidisciplinary study conducted in cooperation with the Florida Fish and Wildlife Conservation Commission, the Florida Center for Environmental Studies, the U.S. Geological Survey, and several universities. The three selected tree islands—3AN1, 3AS3, and 3BS1—are all located in Water Conservation Area 3. A total of four well pairs were installed at each of the three tree islands. Well pairs, consisting of a shallow piezometer (depths from 4.1 to 15 ft below land surface) and a deep groundwater well (depths from 25 – 49.6 ft below land surface), were installed just northwest, northeast, and south of each island. A well pair also was installed within each island. A stilling well was installed at one well pair at each of the three islands to monitor surface-water stage. A meteorological station also was established at tree island 3AS3.

This two-volume report summarizes the results of a data-analysis project conducted in 2008 by staff at Adamski Geological Consulting, LLC. The project consisted of three components, the first of which was to assess the quality assurance of the site information and time-series data. The second component included analysis of seasonal fluctuations in groundwater and surface-water levels, and determination of factors affecting water levels. Finally, the third component was an analysis of the vertical and horizontal flow of groundwater at each of the tree islands. Results of component 1 are published in volume 1, and results of components 2 and 3 are published in volume 2.

The site and time-series data from the 23 wells, 3 stilling wells, and 1 meteorological station were reviewed for quality assurance. The location, depth, and construction information were thoroughly reviewed during this project and during two previous groundwater quality-assurance projects conducted in 2006 and 2007. In general, the site information for the wells appeared to be accurate; however, new ground-elevation surveys of the three tree islands were conducted in 2007 (Keith and Schnars, 2007). As a result, the reference elevations (elevation of the measuring point at the top of the well casing) and land-surface elevations were revised for 25 of the 26 stations.

The time-series data (groundwater level, surface-water stage, and selected meteorological data) were reviewed for accuracy according to SFWMD protocols. All analyses were conducted using daily values. The objective of this part of the project was to produce sets of preferred time-series data for use by SFWMD scientists and engineers, consultants, and the general public. The review included analyzing the data for outliers,

anomalies, and missing values. Overall, the time-series data were valid and accurately represented water levels at the sites. However, the groundwater and surface-water data from the three tree islands were corrected based on the new reference elevations.

The water-level and meteorological data from the tree islands were analyzed for seasonal fluctuations and factors affecting water levels. Water-level data from the monitor wells also were analyzed to assess horizontal and vertical flow of groundwater. These analyses were primarily conducted using daily averages of the incremental data.

Groundwater and surface-water levels exhibited seasonal and temporal fluctuations related to meteorological conditions. Water levels in the wells and stilling wells generally reached minimum values toward the end of the dry season, around May of each year, and peaked in late September or October at the end of the wet season. Groundwater and surface-water levels were statistically higher at the end of the wet season compared to water levels at the end of the dry season. Evapotranspiration and photosynthetic radiation also affected groundwater and surface-water levels at the tree islands. In general, water levels in wells and stilling wells declined as evapotranspiration and photosynthetic radiation increased.

The abundant rainfall in southern Florida results in the areas around the islands, and even the islands themselves, to be periodically or frequently inundated. Water-level data indicate the areas surrounding 3AS3 were inundated 85 to 100 percent of time during the period of record, while the island itself was inundated up to 24 percent of the time. The island at 3AN1 was inundated nearly 18 percent of the time, but the island at 3BS1 was never inundated, possibly from the higher topographic relief at that island.

At any one time, the difference in water levels between well pairs installed at the same island was small, usually less than a tenth of a foot. The difference in water levels between the shallow piezometer and deep well in the same well pair was equally small. Small differences in water levels indicate a flat water table with low gradients, and result from the high hydraulic conductivity of the aquifer.

Groundwater flow at each island varied over time, and generally was higher at 3AN1 than at the other two islands. The direction of horizontal groundwater flow varied widely during the period of record, possibly from changing gradients with seasonal fluctuations in water levels. However, water levels indicated mounding of groundwater under all three islands. Mounding indicates that groundwater is flowing laterally away from each island to the areas underlying the surrounding wetland. In contrast, water levels during May 2007 indicate a depression formed in the groundwater underlying the island 3AN1.

Differences between water levels in the deep wells and water levels in the adjacent piezometers or stilling wells indicated the direction of vertical groundwater flow. Vertical groundwater flow was upward 60 to 70 percent of the time in the areas surrounding 3AN1. Groundwater flow also was upward 84 to 90 percent of the time in areas north of 3AS3; however, vertical groundwater was downward 47 and 56 percent of the time underlying the island and areas just south at 3AS3. Vertical groundwater flow was downward at 56 to 76 percent of the time in and around 3BS1.

Groundwater withdrawals and operation of nearby canals could be affecting the hydrology of the tree islands. Surface-water levels at the three tree islands strongly correlated with water levels at several of the structures on nearby canals.

In summary, the hydrology of the tree islands is complex, with considerable interaction between groundwater and surface. Mounding of groundwater indicates local lateral flow is away from the islands to areas underlying the surrounding wetlands, with direction of regional flow varying over time and with seasonal conditions. Groundwater generally flows downward at the islands and discharges in areas underlying the wetlands.

Additional analysis of the water-level data is recommended to further quantify meteorological and other factors affecting vertical and horizontal groundwater flow. These analyses can be coupled with existing water-quality data collected from the wells to better understand flow paths in the groundwater underlying the three tree islands.