Pilot Project Tests for Supplemental Water Deliveries to Biscayne Bay

After-Action Assessment

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Supplemental Water Deliveries to Biscayne Bay Pilot Project Tests

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Table of Contents

Table of Figures

Background

The South Florida Water Management District (District) conducted two experimental operational pilot projects during the 2012-2013 dry season in southern Miami-Dade County to test the effectiveness of passing supplemental water flows into central Biscayne Bay. Objectives of the tests included the feasibility and effectiveness of rerouting water flows among basins, and to gauge effects on salinity within Biscayne Bay and coastal groundwater. Additional water inflow to Biscayne Bay has the potential to lower or maintain salinity within a range that is healthy for the ecosystem nearshore.

One test was conducted from November 20, 2012 through December 4, 2012. Water was released from Water Conservation Area 3A (WCA 3A) into the South Miami-Dade Conveyance System (i.e. L-31N Canal), and into the western C-1 Canal, ultimately discharging at the coastal outfall, S-21, near Black Point (Figure 1). This area of Biscayne Bay is within Biscayne National Park.

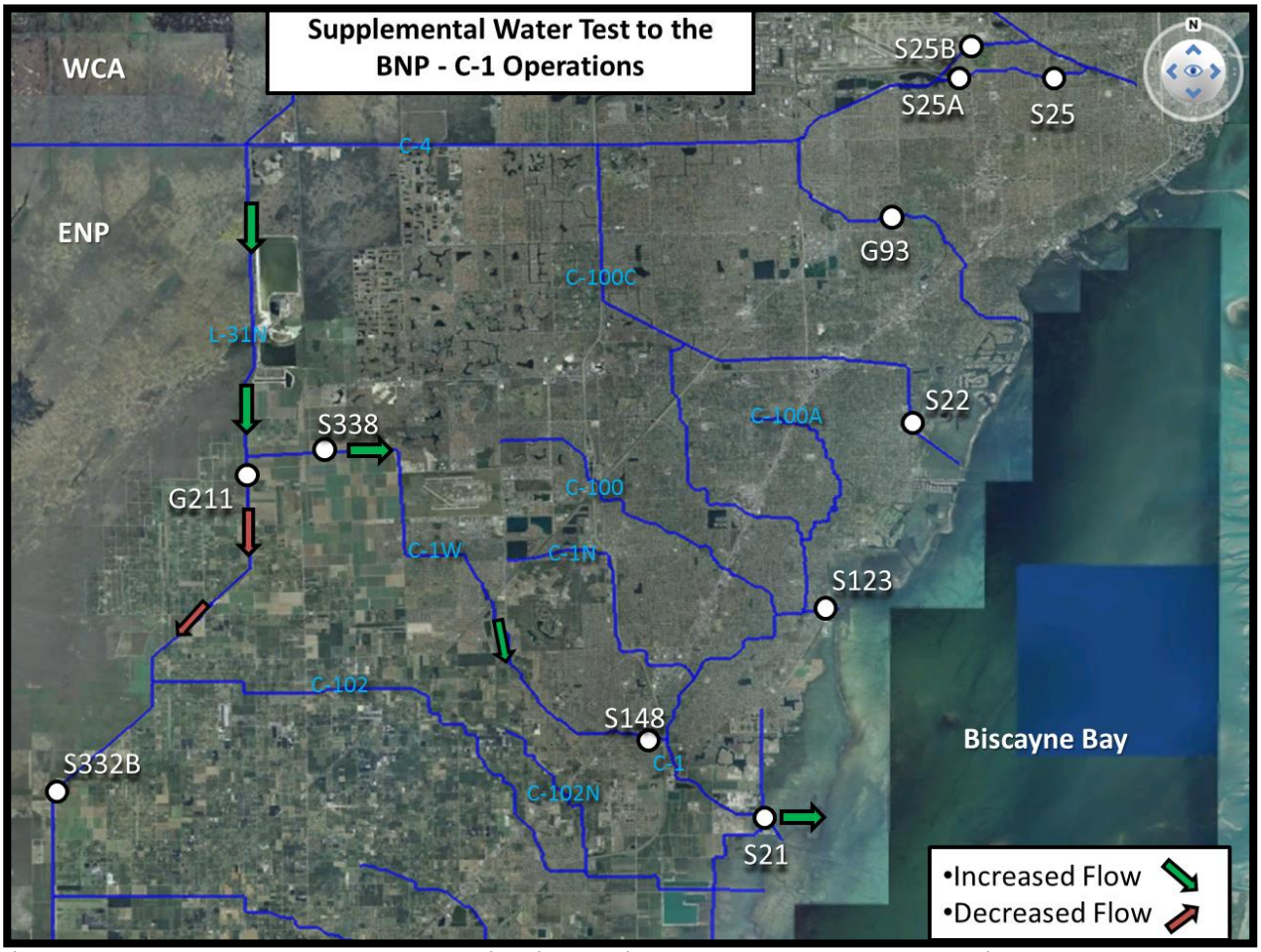

Figure 1. Path of supplemental water deliveries to Biscayne Bay used for the C-1 pilot test.

A second test was conducted from December 18, 2012 through March 12, 2013. In this case, water from the C-2 and C-3 basins was rerouted into the C-100 basin through the C-100C Canal, ultimately discharging at the S-700 pump station into Cutler Creek and the slough within the Deering Estate (Figure 2). The S-700 pump station was recently constructed by the District as part of an expedited Comprehensive Everglades Restoration Plan Biscayne Bay Coastal Wetlands Project. The area of Biscayne Bay adjacent to the Deering Estate is just north and west of Biscayne National Park's boundary. Additional deliveries of water continued into the C-100 basin after the pilot test period when conditions were suitable.

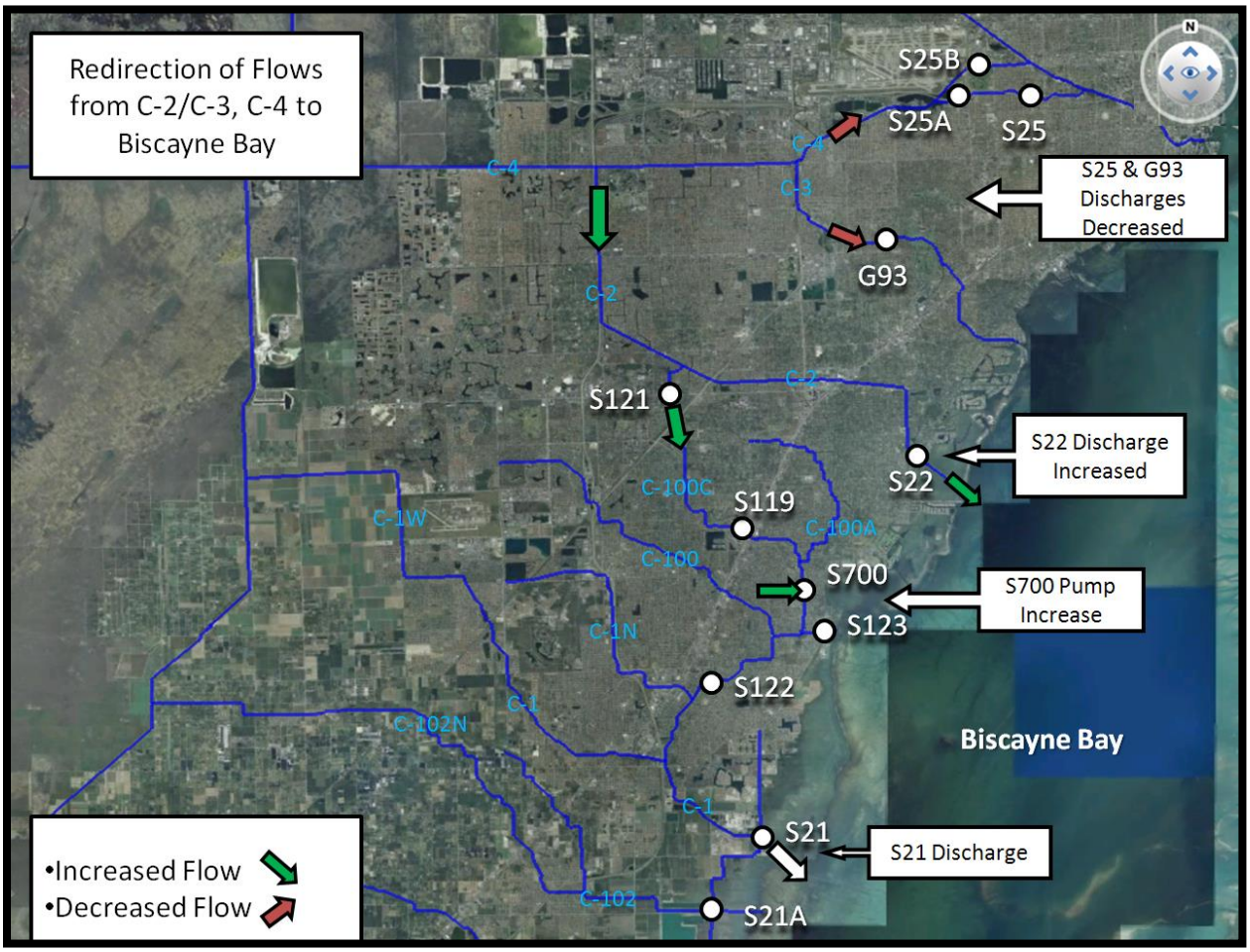

Figure 2. Path of supplemental water deliveries to Biscayne Bay used for the C-100 pilot test.

Canal C-1 Pilot Test

During the start of the dry season in 2012, water level within WCA 3A exceeded regulation. As a result, the excess water was being routed out of the Conservation Area into Everglades National Park and toward the coast. Based on an earlier request from the National Park Service to the District for additional water into Biscayne National Park during the dry season, a test was conducted to route some of the excess water from WCA 3A to the coast and into Biscayne Bay. The route chosen for the test was the C-1 Canal since the C-1 basin was not subject to the annual agricultural seasonal drawdown. The annual agricultural drawdown affects the C-102 and C-103 basins to the south, and is part of normal operations. Water levels are held lower within the eastern sub basins to facilitate the growing of certain crops beginning in October and ending in April. Adding water into these basins during this time would have unknown consequences.

Operations

From November 20, 2012 through December 4th, 2012, the District made temporary changes in the South Dade Conveyance System (SDCS). Discharges conveyed through the L-31N Canal toward the south were reduced by adjusting the G-211 and S-332BN structures, and an in kind amount of flow was sent to the east through the S-338 structure into the C-1W canal (Figure 1). The S-148 structure on the C-1 Canal was opened to allow water into the C-1 Canal and finally discharge through the S-21 coastal structure.

This operation was possible because water level within WCA 3A was above the regulation schedule (Figure 3) and operations were in "Column 2". Therefore, excess water, over and above what could be sent directly into Shark River Slough (SRS) via the S-12 structures or into northeast SRS via the L-29 culverts was routed to the South Dade Conveyance System. Coincidently, on October 19, 2012 the U.S. Army Corps of Engineers Record of Decision for the Everglades Restoration Transition Plan (ERTP) was signed. Criteria for the ERTP lowered the WCA 3A Zone A (maximum flood control release line). As a result, higher releases to the SDCS would likely continue longer than had occurred under the Interim Operations Plan (IOP). The District initiated coordination with the Department of Interior (DOI) and facilitated the discussion of possible operations that could direct to Biscayne National Park (BNP), some of the excess water from WCA 3A that would normally be entering Everglades National Park (ENP) via the Rocky Glades and Taylor Slough system. With the concurrence of ENP, the C-1 operations described in this section were implemented by the District.

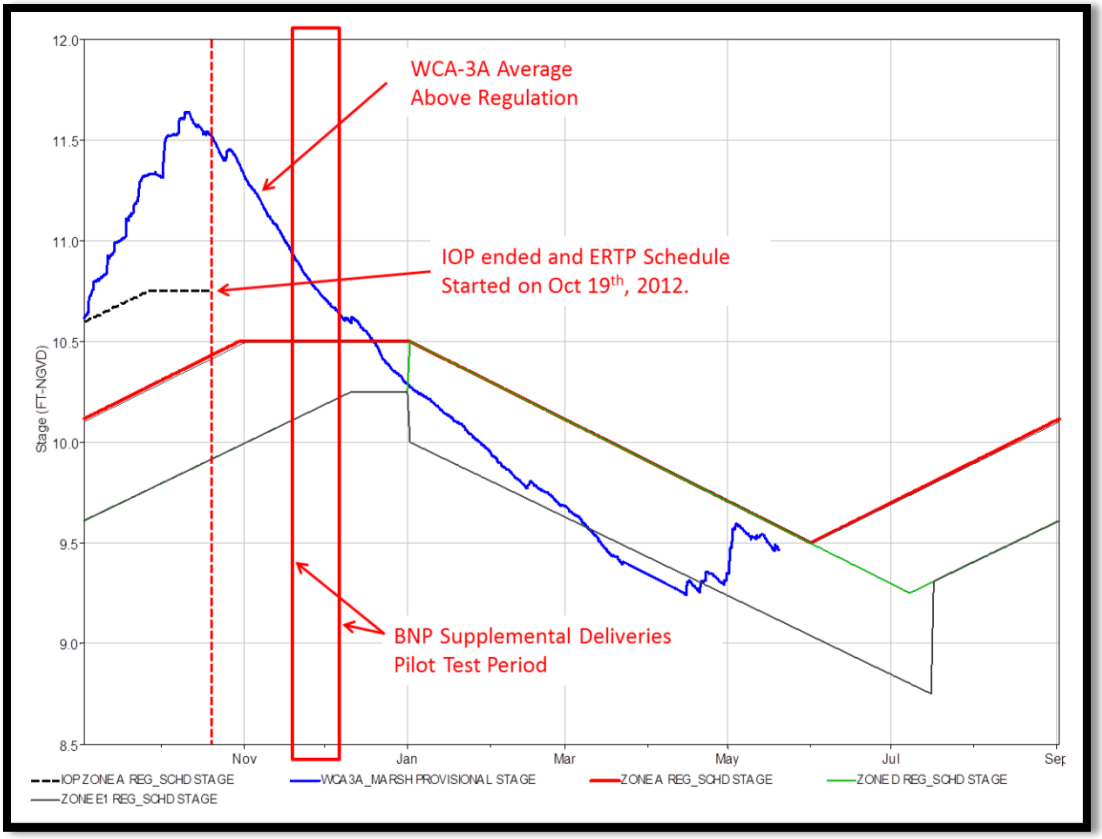

Figure 3. Water level (blue line) in Water Conservation Area 3A compared to the Everglades Restoration Transition Plan regulation criteria.

Results and Findings

During the two week test period, discharges through S-21 increased, with a total volume of about 6,337 acre-feet (Figure 4). During the two-week period prior to the pilot test period, discharge from S-21 was averaging about 47 cfs with a median flow rate of zero (Table 1). During the test, the S-21 flow rate averaged about 227 cubic feet per second (cfs) with a median of 172 cfs. During the two-week period after the test, the flow rate at S-21 averaged about 51 cfs with a median of zero.

In addition to the increased discharges from S-21 during the pilot project, water also discharged from coastal outfalls to the south, specifically S-21A on the C-102 Canal and S-20F on the C-103 Canal under normal operations for the period (Figure 5). Discharges from S-21A and S-20F averaged about the same before, during and after the test period (Table 1).

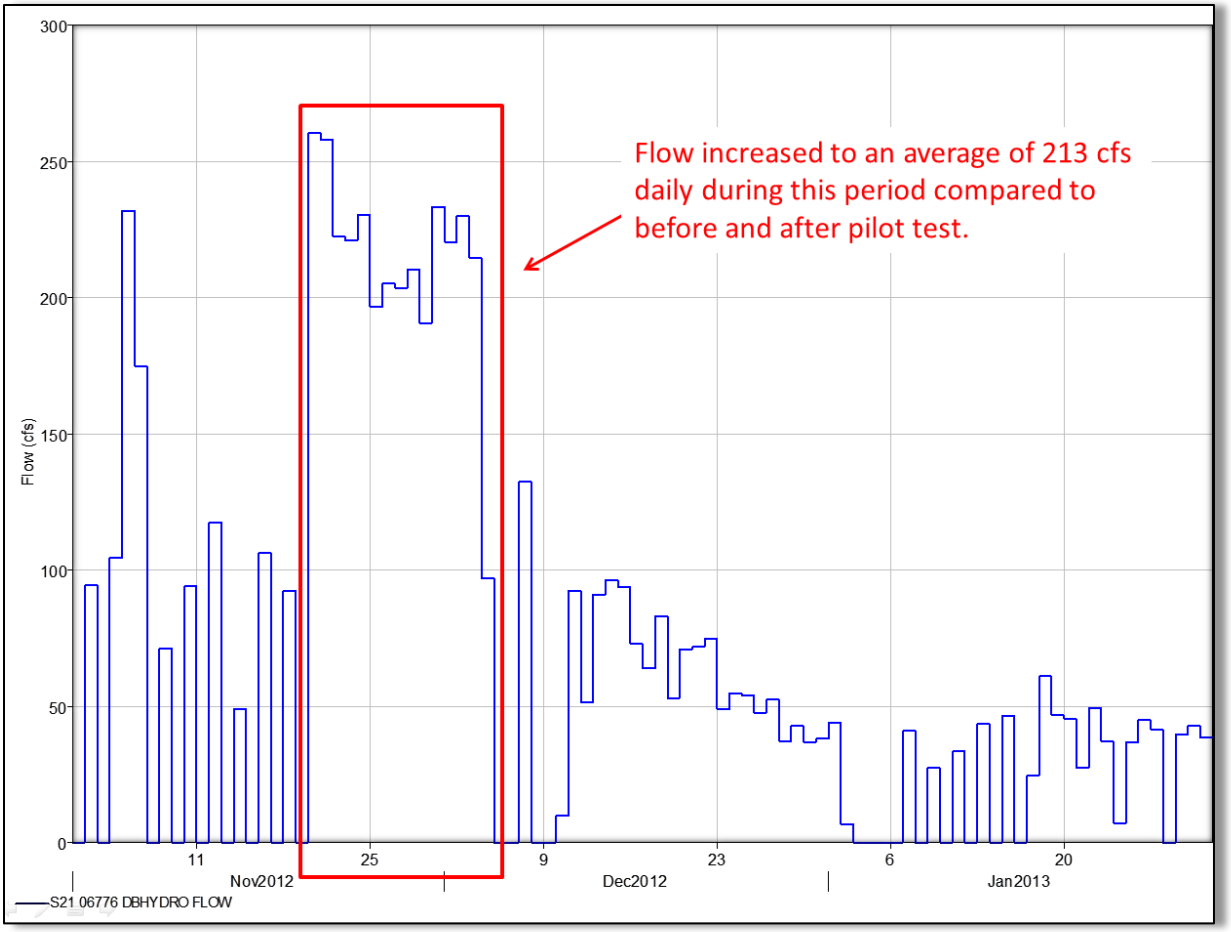

Figure 4. Mean daily hydrograph of S-21 flow before and after test.

Table 1. Mean and median discharge rates before, during and after the pilot project.

Outfall	Mean (cfs) per Period			Median (cfs) per Period		
	11/6-19/12	11/20-12/4/12	12/4-18/12	11/6-19/12	11/20-12/4/12	12/4-18/12
S-21	47	227	51	0	172	0
S-21A	116	113	106	0	0	0
S-20F	191	201	202	0	0	2

Beside the discharges from S-21, discharges from the S-21A and S-20F outfalls can influence nearshore salinity in the area of Black Point due to a generally northward current along shore. The greatest effect on salinity from the seasonal agricultural drawdown occurs in October, when excess water is discharged to lower the water table within the eastern C-102 and C-103 basins. During the pilot project test period, near the end of November, the flows from these basins had moderated, so the flows were relatively constant and reacted typically to rainfall events. A rainfall event occurred

during the two week test on November 28-29, 2012 resulting in roughly 0.5 inches of precipitation on the bay.

The National Park Service (NPS) maintains a series of salinity monitoring stations within the nearshore area of discharge (Figure 6). In addition, the Park Service conducted transect monitoring near the area of discharge using shipborne instruments. Results can be used to assess the effects of the pilot project on salinity in the bay.

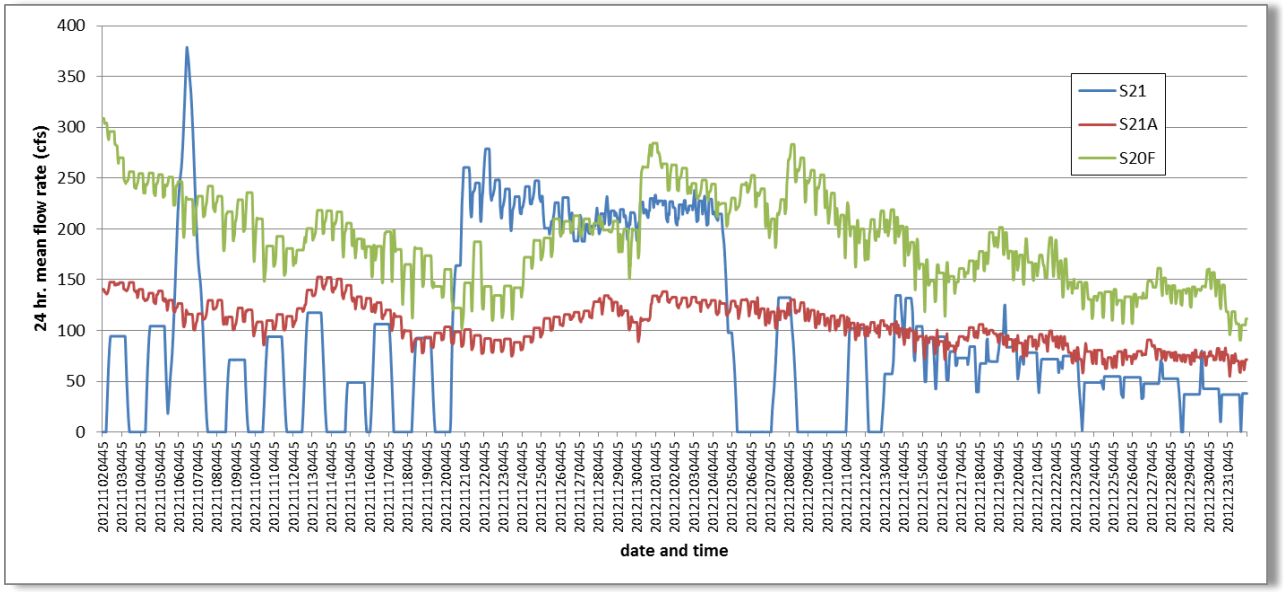

Figure 5. Mean flow at three coastal structures that discharge to the south central area of Biscayne Bay before during and after the C-1 pilot test period.

Salinity data are available from Biscayne National Park's marine monitoring network (MMN) throughout the test release period. Salinity results (practical salinity scale) at the nearest fixed monitoring stations to S-21 (Figure 7) indicated changes in trends. Salinity was trending upward at stations B6, B8, 44 and 46 since about November 1st at roughly 0.5 per day until November 22nd (Figure 8). After which, salinity began decreasing suggesting a lag effect in the relationship between discharge and salinity response. The highest mean daily salinity at B6 during the test was about 27.1, and at B8, 28.5. At stations 44 and 46, salinity peaked at about 30.2. Salinity generally declined throughout the test period. At the end of the test plus two days (lag), salinity was about 11.9 at B6, a total decrease of 15.2. At station B8, salinity decreased to 26.0, a total of 2.5. At stations 44 and 46 the decrease was about 4.3 and 3.2, respectively. The greater decrease at station B6 can likely be attributed to increasing discharges at S-20F during the test period, probably in response to the rainfall event. Salinity continued to decrease after the test until around the middle of December, but it is not clear if the effect was due solely to water discharged from the C-1 Canal during the test period,

because some higher discharges from S-20F continued until about December 7th. Salinity continued to remain lower than the maxima observed through the end of December.

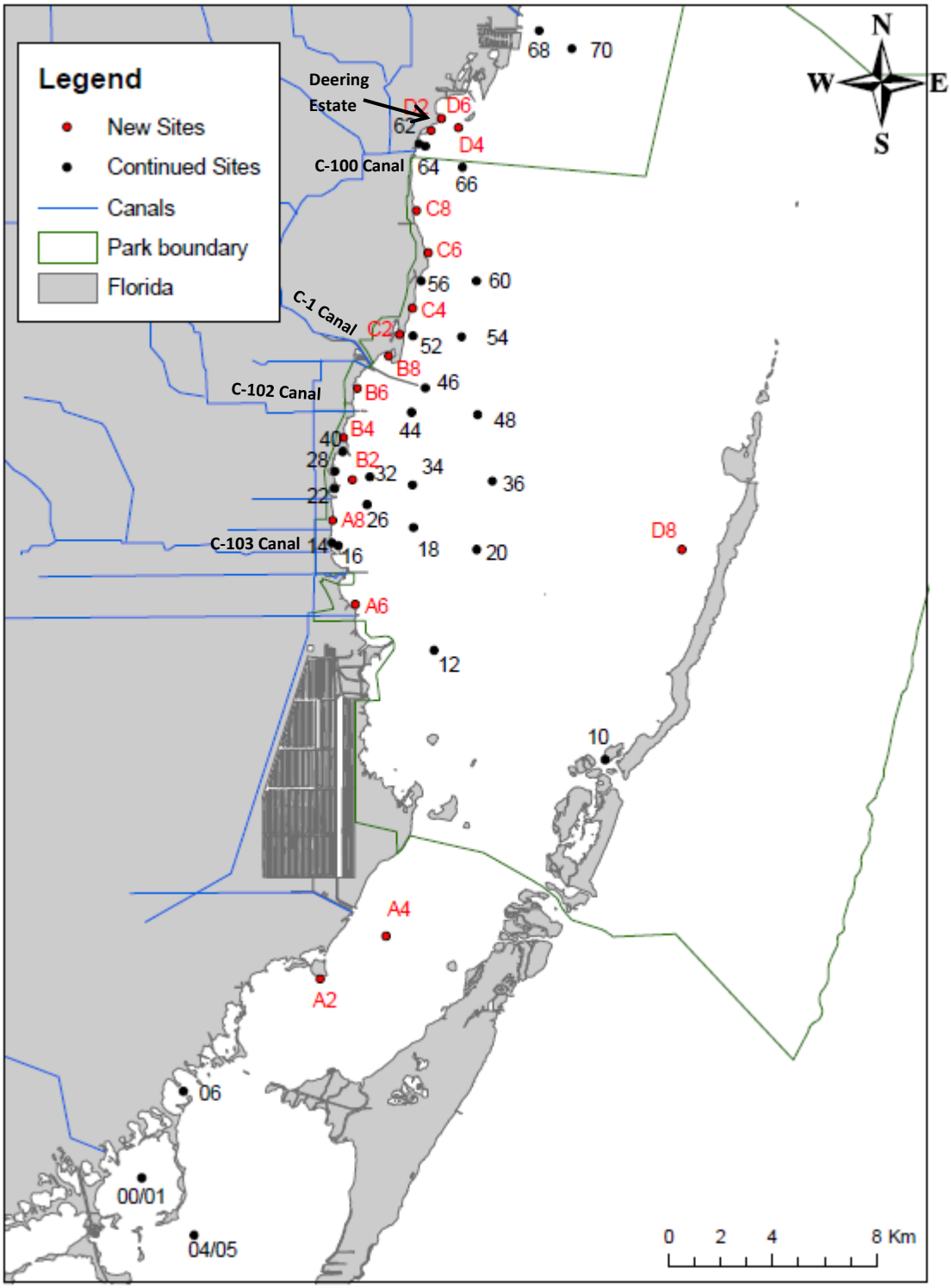

Figure 6. Biscayne National Park salinity monitoring sites. Sites indicated in red were added to the network recently.

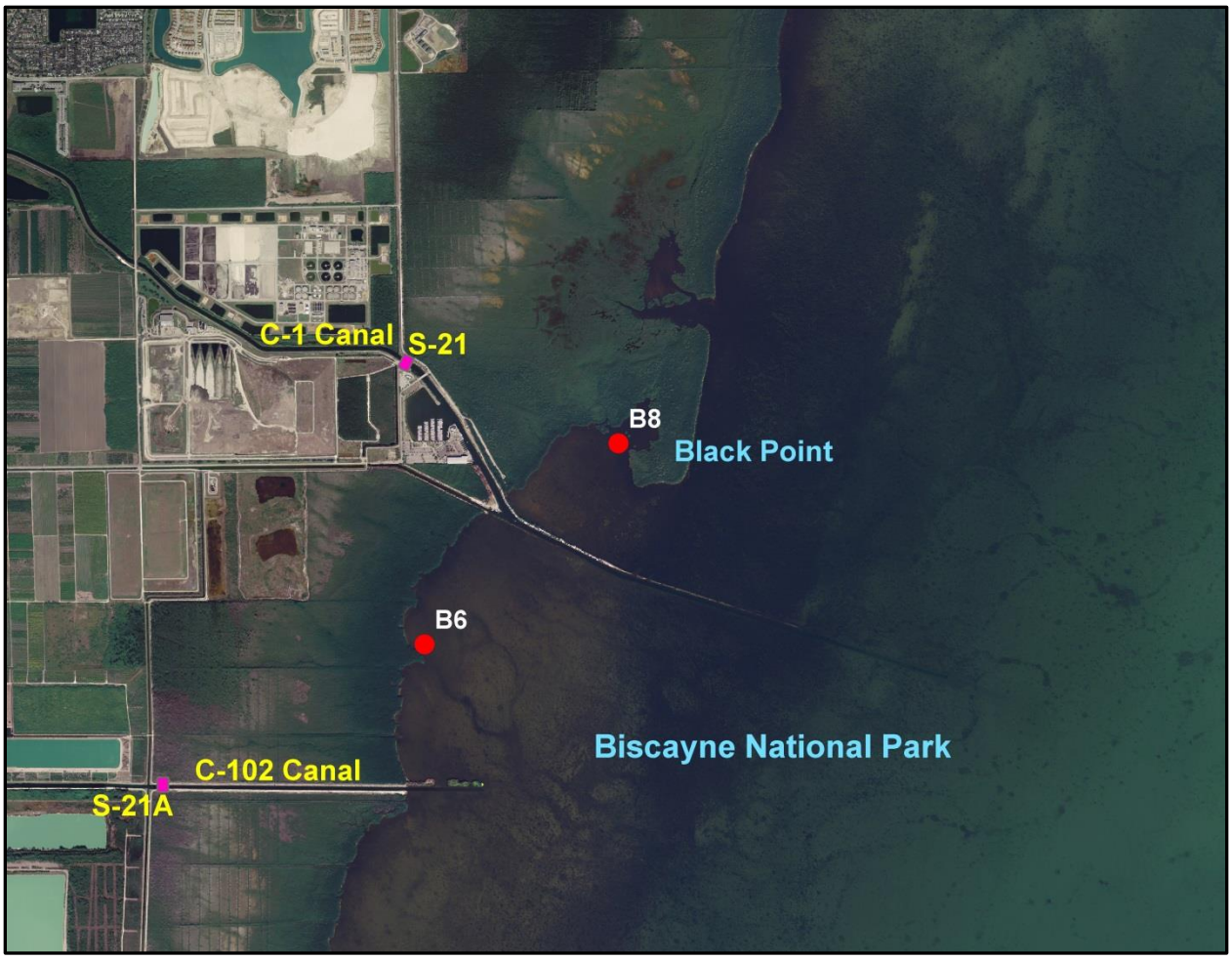

Figure 7. Salinity monitoring stations (red) nearest to the S-21 outfall.

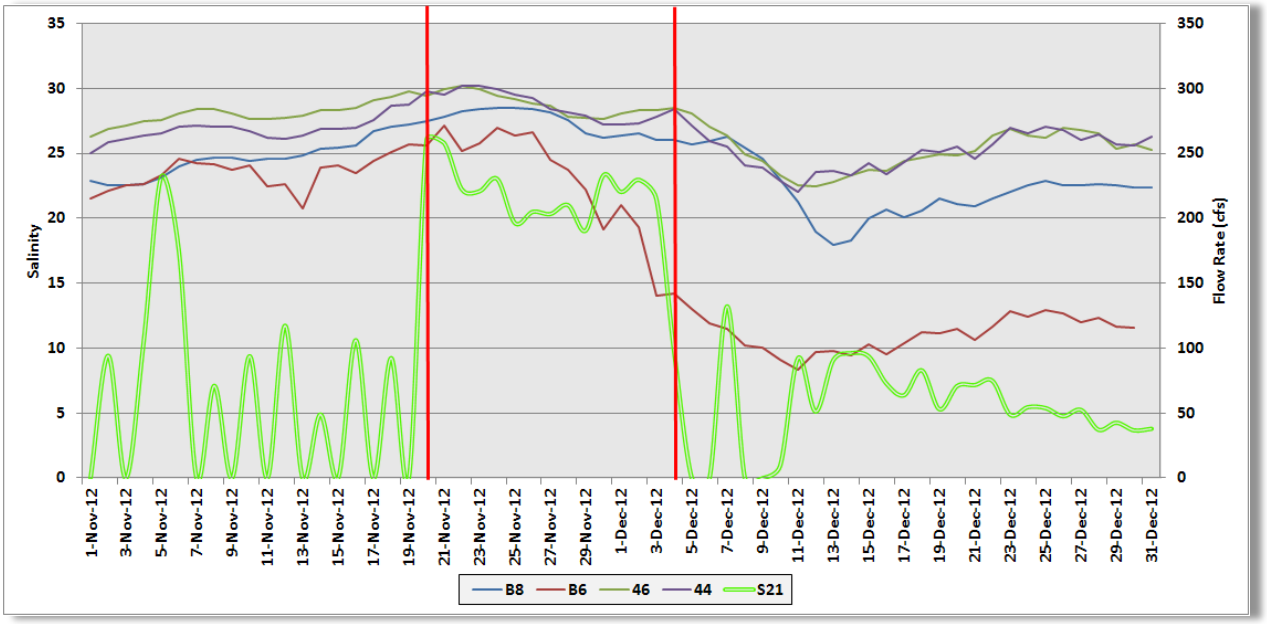

Figure 8. Time series plot of daily mean salinity at stations near the S-21 coastal outfall. The vertical red lines indicate the approximate test period of increased discharges.

Figures 9, 10, and 11 are isohaline contour maps of weekly average salinity values at the MMN stations. On Nov. 4, 2012 (Figure 9), the map shows that lower salinity water, in the 20 – 25 range, existed in some of the shallow areas along the shore. On Dec. 2, 2012 (Figure 10), the area of lower salinity water expanded, with regions in the 10 – 15 range along the coast from roughly S-21 to S20F with the lowest salinity areas in close proximity to the outfalls. The test releases at S-21 ended on Dec. 4, 2012, however the impact of the increased discharge was still observable in the salinity data out through Jan. 20, 2013 (Figure 11). It is believed that the lower salinity regions observed were not only due to the flow rate of freshwater releases from the coastal outfalls but also to the hydrodynamics of the nearshore area. Here, shoreline points just north of S-21 (Black Point) and a slight point extending into the bay at S-21A, create a region with longer residence time than other, more open areas of the bay's shoreline.

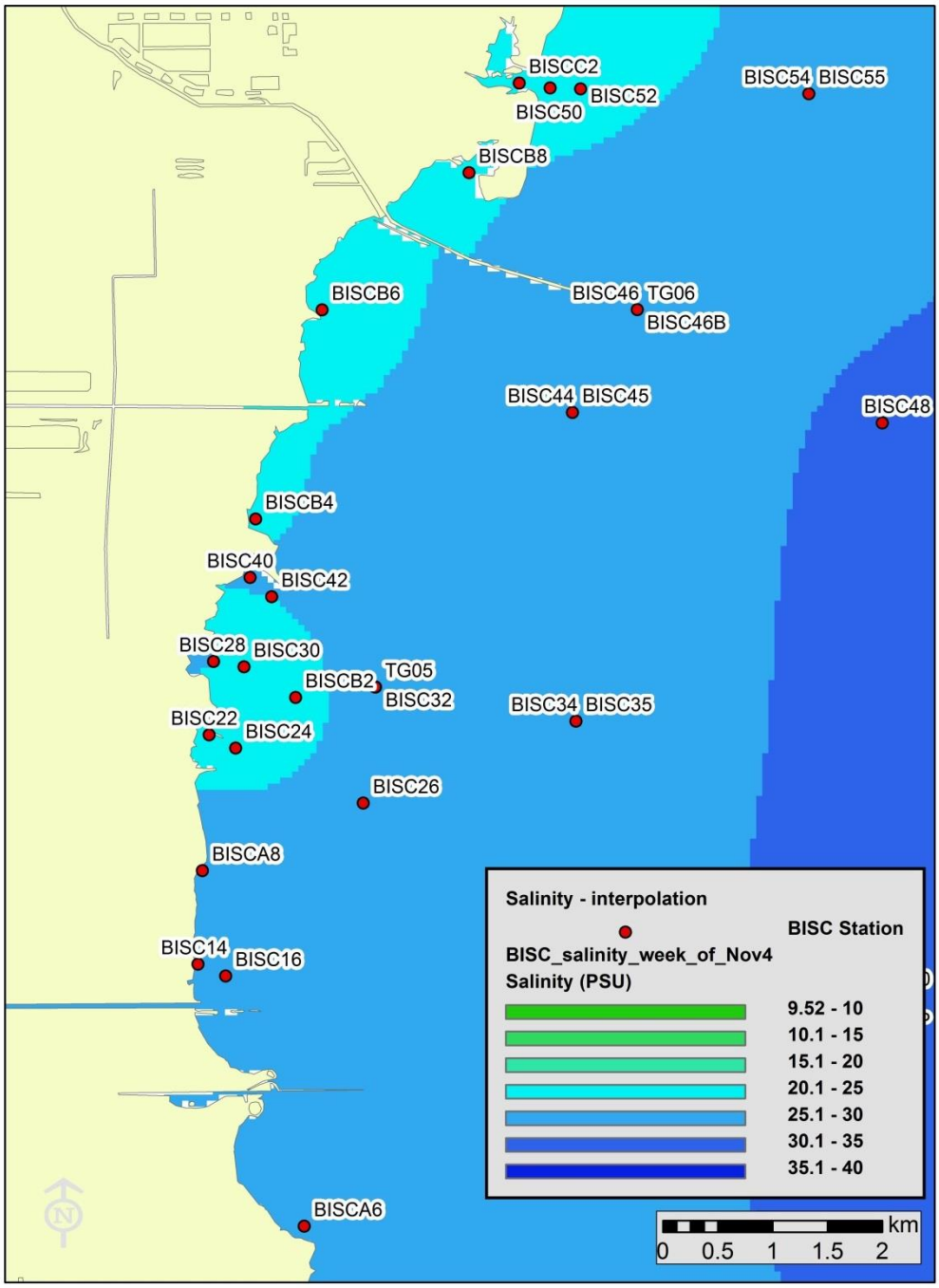

Figure 9. Depiction of salinity in the nearshore area of Biscayne Bay based on weekly average salinity for November 4-10, 2012.

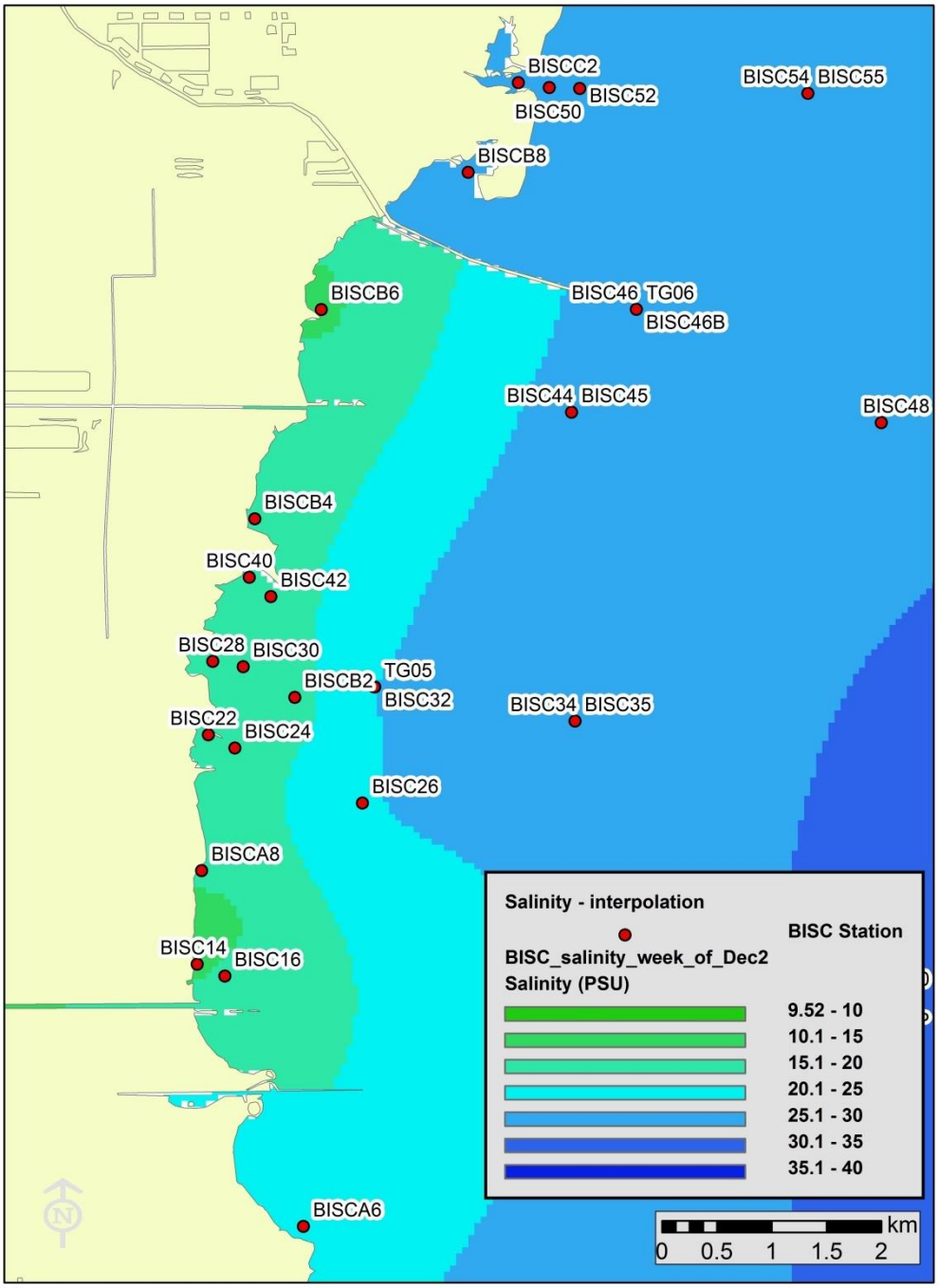

Figure 10. Depiction of salinity in the nearshore area of Biscayne Bay based on weekly average salinity for December 2-8, 2012.

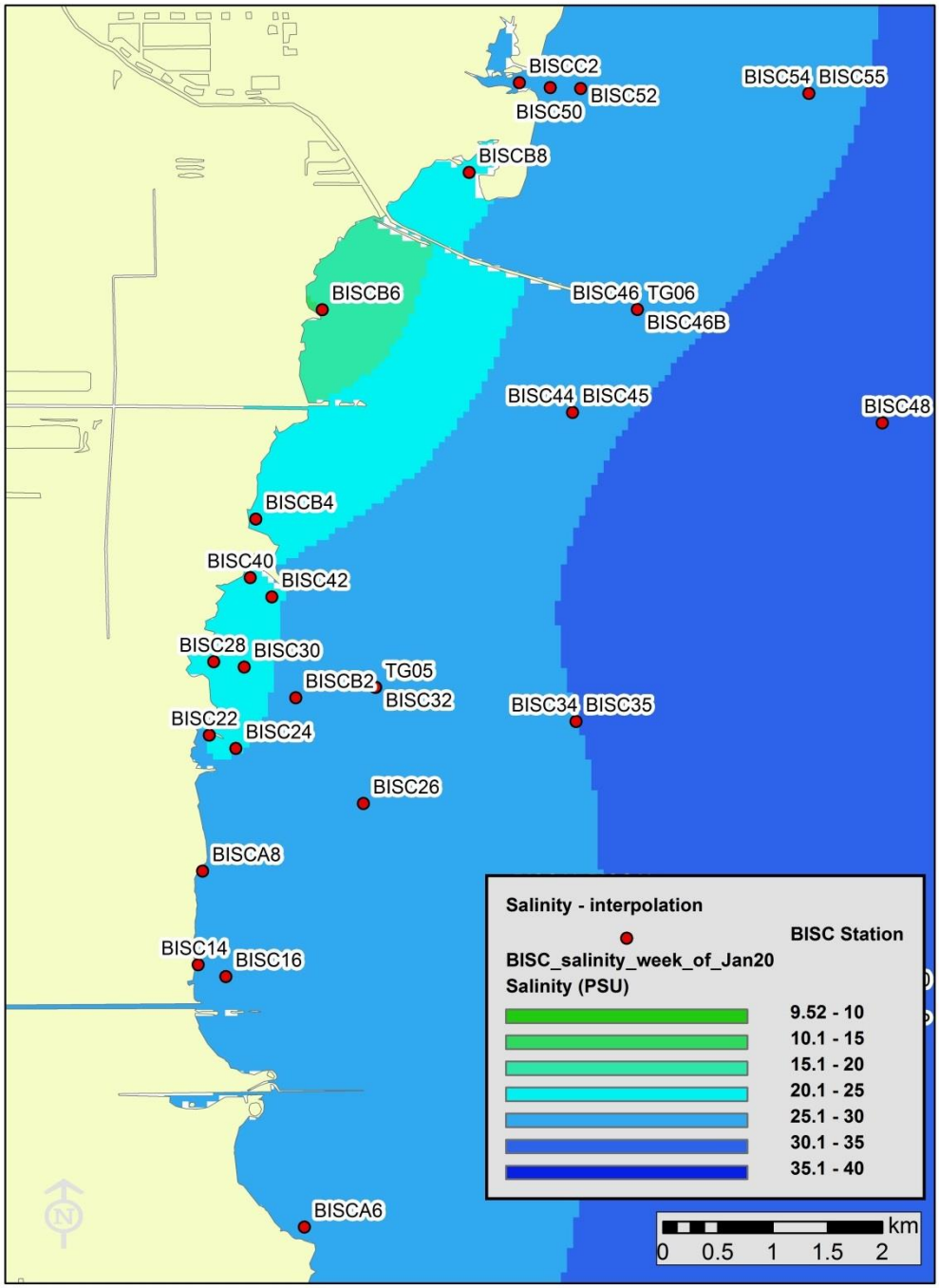

Figure 11. Depiction of salinity in the nearshore area of Biscayne Bay based on weekly average salinity for January 20-26, 2012.

Canal C-100 Pilot Test

The Deering Estate component of the Biscayne Bay Coastal Wetlands Project depends on adequate water levels within the C-100 basin to operate. Water is conveyed to a 100 cfs pump station located at the end of a spur canal associated with C-100A Canal. The water is conveyed under Old Cutler Road and directly into the historical slough that once extended through the coastal ridge into the Everglades. It is intended that water is pumped preferentially into the slough before flowing further south and discharging to the bay at the S-123 coastal outfall. The C-100 basin is connected hydrologically to the C-2 basin to the north via the C-100C Canal, regulated by the divide structure S-121. The C-2 basin is directly connected to the C-4 basin via the C-2 Canal. Since the C-3 basin is also directly connected to the C-4 basin via the C-3 Canal downstream of the C-2 Canal.

Operations

To deliver additional water into the Deering Estate, the District made operational changes to move excess water in the C-2, C-3, and C-4 basins that would normally be discharged east to tide, further south (Figure 2). The operation began on December 18th, 2012 and continued until March 12th, 2013 when there was no more water due to the dry conditions. However, on April 6th, 2013 the operation was re-started and continued as conditions allowed.

These operations conveyed water through the manually operated structure S-121, from the C-2 basin to C-100 basin and then through the local auto-control S-119 structure into the east leg of C-100C, and then into the C-100A canal to pump station S-700. Some water was also passed into the C-1 basin to the south from the C-100 basin through the S-122 divide structure with the intent on also increasing discharge into Biscayne Bay via the S-21 outfall.

Results and Findings

For the period of December 18th to March 12th, the S-700 pump station delivered a daily mean flow of 24 cfs, with a total volume of 4,042 acre-feet into the Deering Estate. Prior to the operational changes, the pump station operated infrequently. The regimen change resulted with very little discharge through S-22 (C-2 basin outfall), S-25B (C-4 basin outfall) and G-93 (C-3 basin outfall), because most of this water was conveyed into the C-100 basin. Since some water was also passed into the C-1 basin via S-122, it was expected that discharges would increase at S-21 coastal structure, but the results were likely too small to be conclusive. After the operation was re-started, from April 6th to May 1st, the pump station has averaged a daily flow rate of 30 cfs. Figure 12 shows the daily mean flow hydrograph at the S-700 pump station.

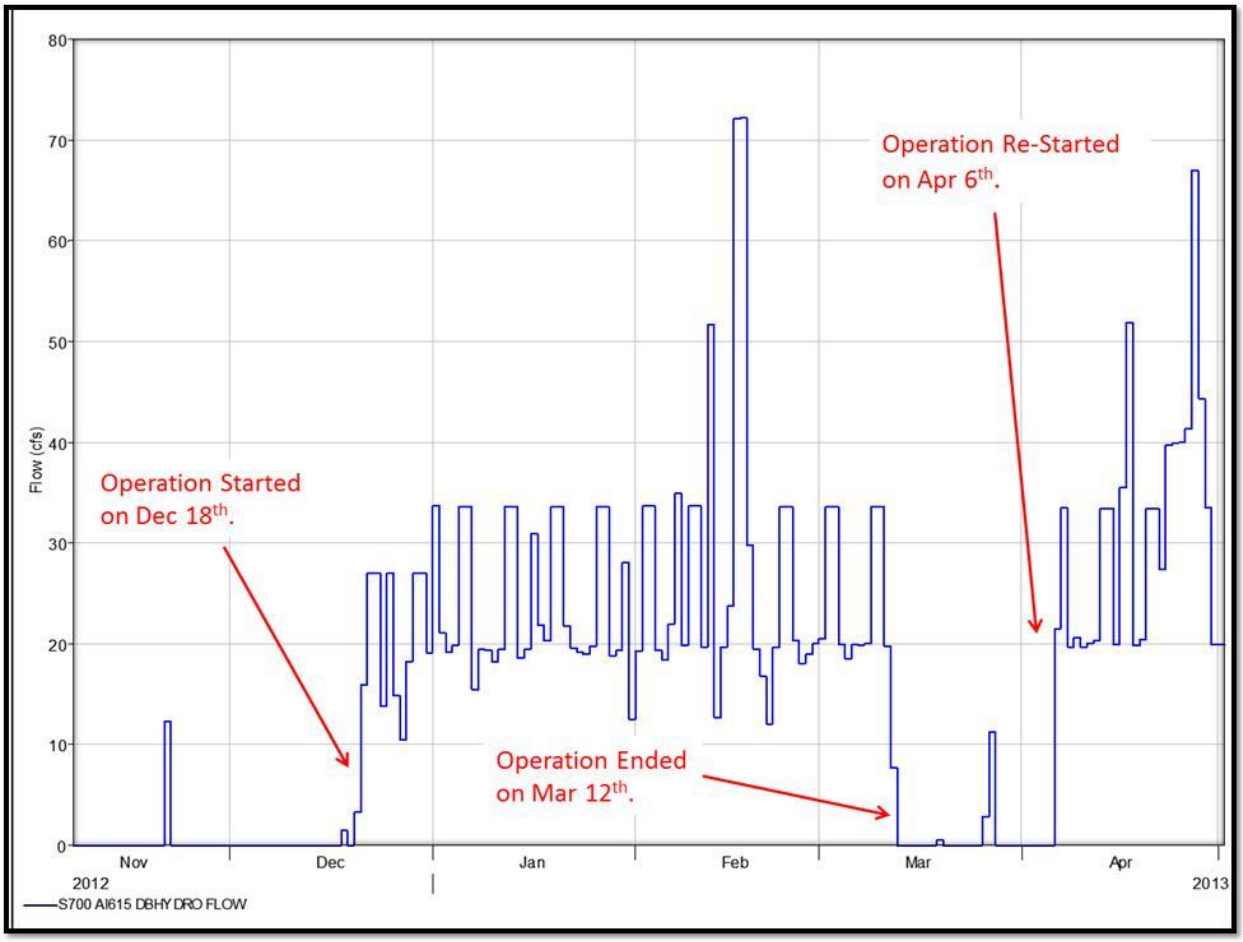

Figure 12. Hydrograph of the S-700 pump station flow rate before, during and after the initial C-100 pilot test period.

Miami-Dade County cooperatively monitors water level and salinity within the slough area (Figure 13). Surface water level within the wetlands increased at the two monitoring locations (No. 1 and 3) after a few days lag once pumping began, and decreased after pumping ceased (Figure 14). The greatest increase in water level occurred at staff gauge no. 1, a maximum average rise of about 1.25 feet. Groundwater also noticeably rose at well no. 2 during the initial test period, and water levels varied according pump operations (Figure 15). Well no. 2 is located about 360 feet downstream of the pump discharge. The response of groundwater level downstream at well no. 5 was muted by comparison, but appeared to rise slightly in response to pumped discharges, and became less variable.

Salinity of the groundwater also appeared to respond to the pumped inputs of water into the slough (Figure 16). Salinity rose rapidly at the beginning of the dry season in monitoring well no. 5 near the mangrove wetlands, peaking at well over 20. After pumping began at S-700, salinity decreased to less than 10. Surface water salinity in Biscayne Bay is measured at two nearby locations, but given the distance the stations are

from the freshwater inputs, and small amount of water pumped, the results are inconclusive about effects in the Bay.

During the testing phase of the pump station, District and Miami-Dade County staff determined how much of the freshwater wetlands within the slough (Figure 17) was inundated during different flow rates (Table 2). By interpolation, a flow rate of 24 cfs during the initial test period, would therefore, have been expected to inundate almost 19 acres of wetlands or about 55 percent of the historical total. Typically, these wetlands are dry during this time of year, because they have been recharged only by rainfall since the C-100 Canal was built. The 30 cfs flow rate after April 6th would have likely inundated about 62 percent of the historical wetlands.

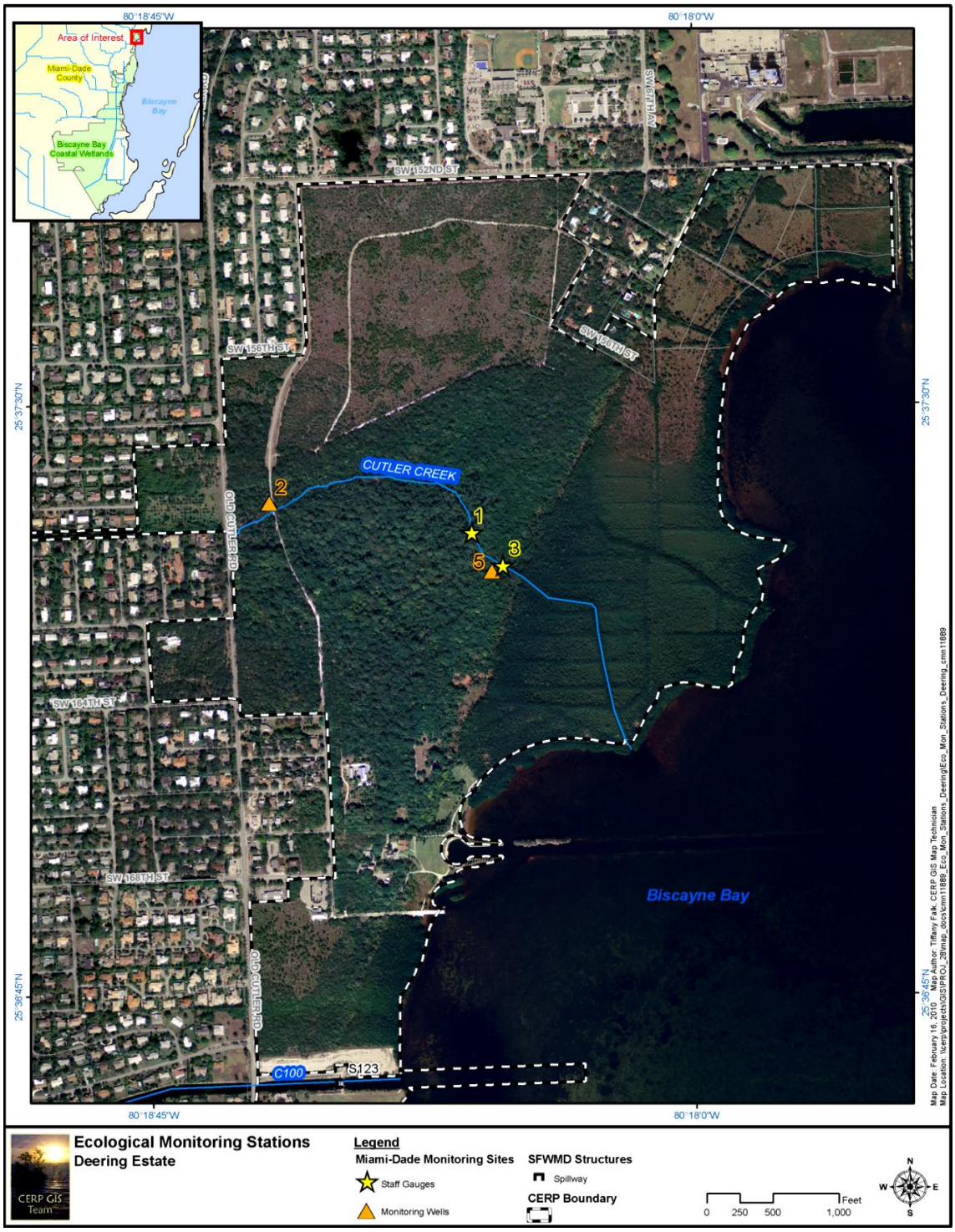

Figure 13. Location of hydrological monitoring sites within the Deering Estate slough.

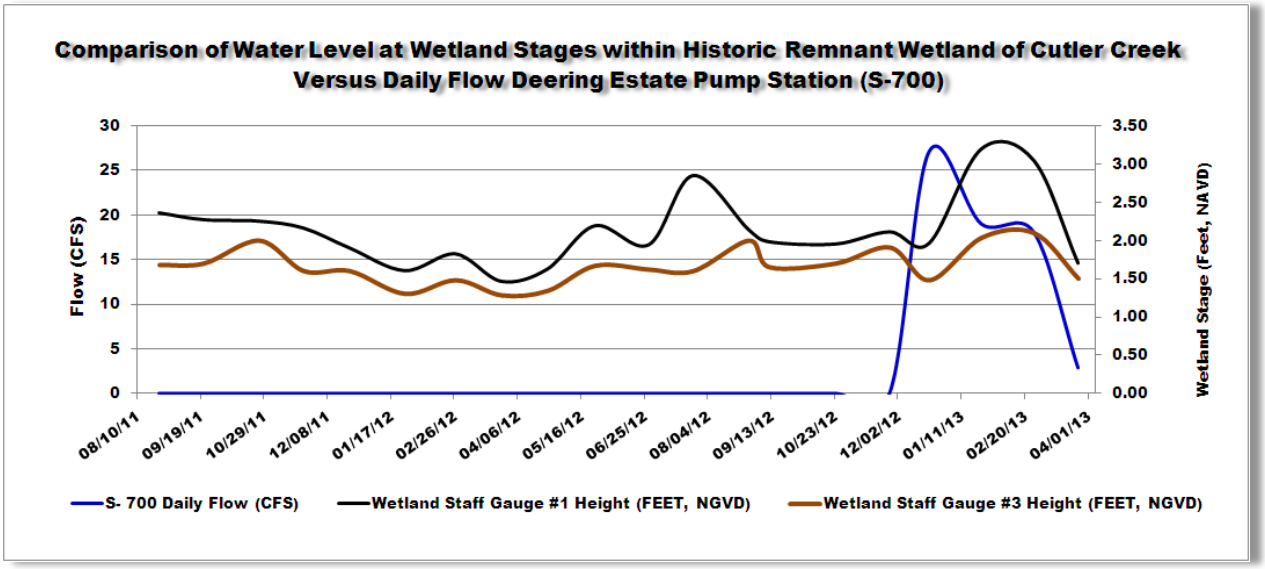

Figure 14. Water level at stations 1 and 3, and discharge rate from S-700.

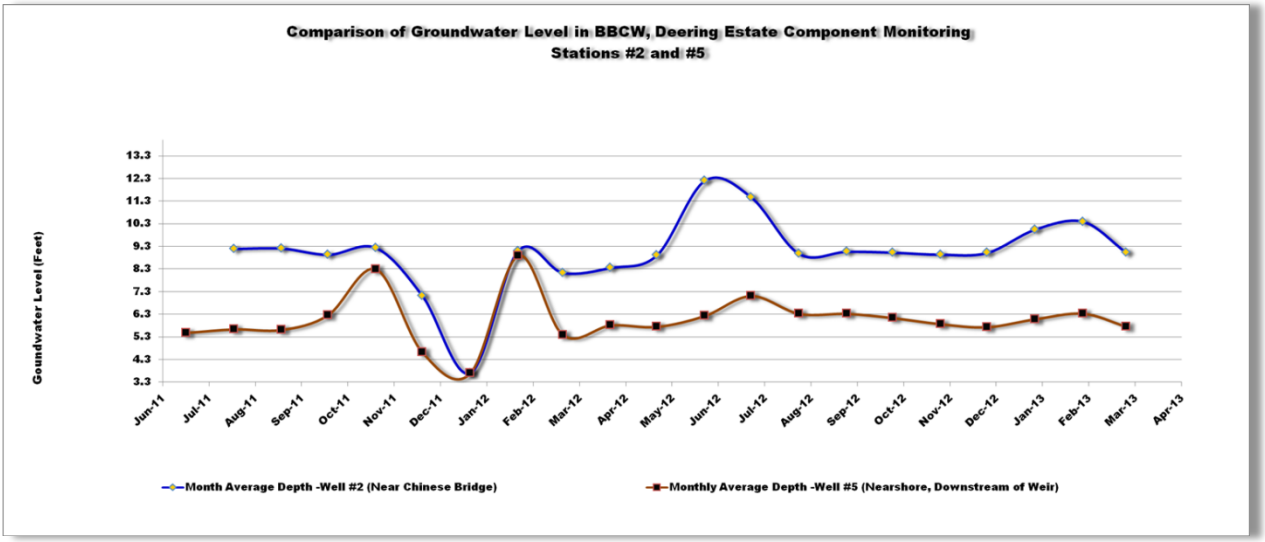

Figure 15. Water level in monitoring wells nos. 2 and 5 in the Deering Estate.

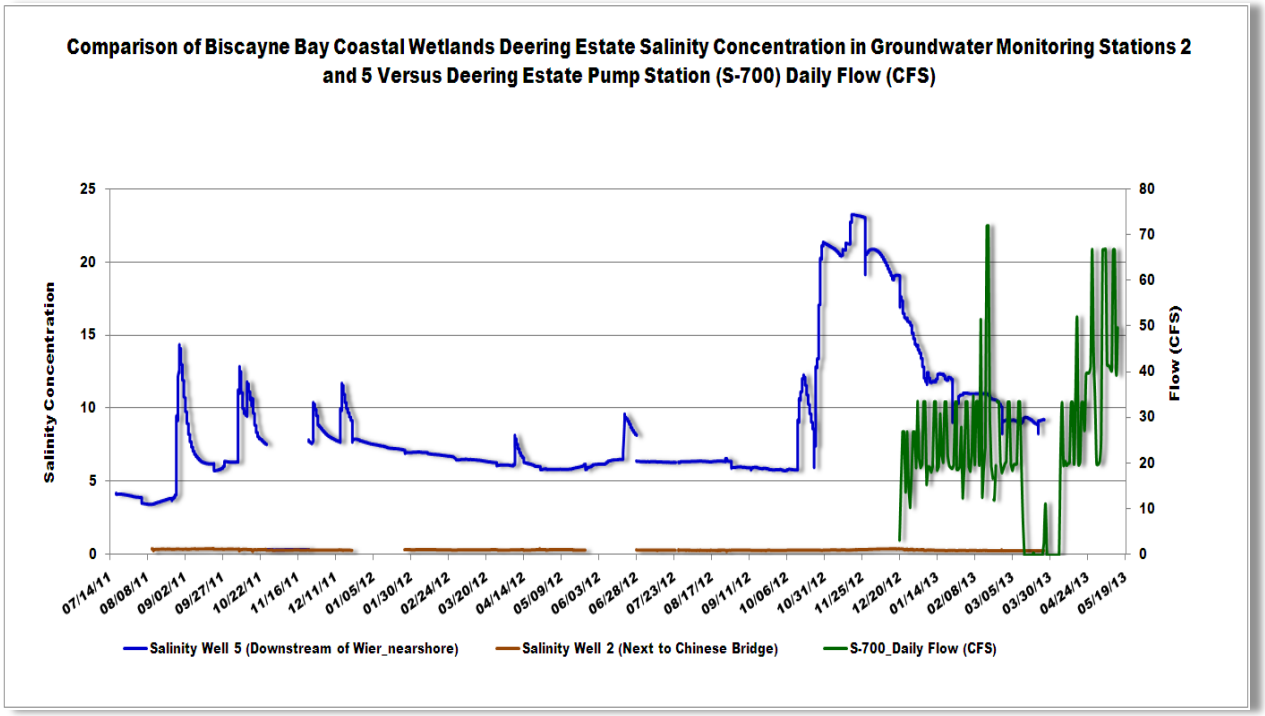

Figure 16. Salinity at stations 1 and 3, and discharge rate from S-700.

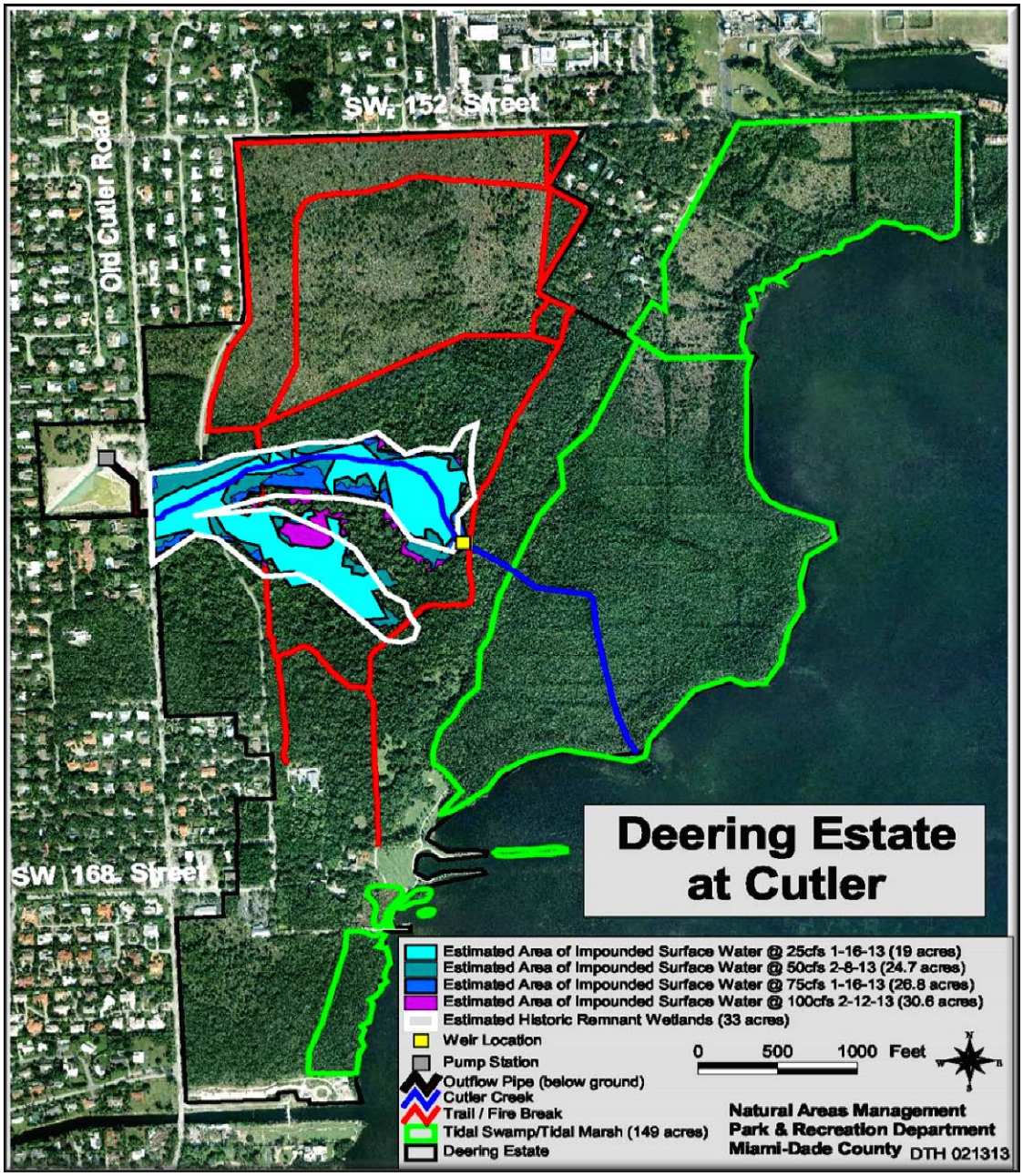

Figure 17. Delineation of the historical freshwater wetland slough in the Deering Estate and areas of inundation at different pump rates.

Table 2. Estimated acreage of impounded surface water under different pumping/flow rates within the Deering Estate.

Test Date	S-700 Pumping Rate (cfs)	Duration of Pumping (hours)	Estimated Acres of Impounded Surface Water
January 16, 2013	25	5	19
February 7, 2013	50	5	25
January 30, 2013	75	5	27
February 28,2013	100	5	31

Conclusions

Both the C-1 and the C-100 pilot project tests were successful in delivering additional water to Biscayne Bay. Results indicate that the C-1 operational test provided additional freshwater inflow into Biscayne Bay during the dry season. The relatively modest increase in discharge rate at S-21 during the two week test period resulted in a clear signal in Biscayne Bay salinity. The additional water reversed a trend of increasing salinity, decreasing salinity within the nearshore area of Black Point. Moderated salinity concentrations continued into January. The direct effects in the area of Black Point may have lasted a few days beyond December 4th, but because of along-shore currents, it is possible that the discharge had a much longer indirect effect as it traveled up the shoreline and continued to disperse into the estuary. The C-100 operational test provided additional water into the Deering Estate during the dry season. The pilot project resulted in more than three months of improved hydroperiod in the wetlands of Cutler slough, rehydrating the majority of the wetlands. The additional water effectively lowered salinity in the groundwater and provided additional fresh water into an area of Biscayne Bay that has been targeted for restoration in the Comprehensive Everglades Restoration Plan.