NATIONAL PARK SERVICE
EVERGLADES NATIONAL PARK

Cape Sable Dams Restoration – Phase II
Topographic and Bathymetric Survey Report

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INTRODUCTION AND BACKGROUND

INTRODUCTION

AECOM was contracted by the National Park Service (NPS) to conduct a National Environmental Policy Act (NEPA) assessment for the potential damming of four waterways in the Cape Sable region of Everglades National Park (EVER). This project is hereinafter referred to as the Cape Sable Dams Restoration – Phase II Project. Limited bathymetric and topographic surveys were conducted of the proposed barge routes in shallow areas primarily to determine whether dredging will be required and if the tentative dam locations are being placed in the optimal areas in regards to existing topography and canal width. The purpose of this report is to document the results of the aforementioned topographic and bathymetric surveys.

PROJECT BACKGROUND

Everglades National Park was established in 1947 and is one of 408 units of the National Park System administered by the NPS, US Department of the Interior. Historically, the interior wetlands of the Cape Sable region in the Park were isolated from both Florida Bay and the Gulf of Mexico by a marl ridge known as the Flamingo Embankment. Early in the 20th century, canals were dug through the Marl Ridge in attempts to drain and reclaim the interior marsh areas for development, agriculture, and cattle grazing. These canals opened up the interior wetlands to tidal influence and the inflow of saltwater from the Gulf of Mexico and Florida Bay. The canals were subsequently plugged with earthen dams at the Marl Ridge during the 1950s, but most of the earthen dams have either been breached or severely compromised by the forces of weathering and erosion over the intervening years.

At present, five major ditch/canal dams are known to exist in the Cape Sable region:

- Homestead Canal Dam – a 100-foot long fill dam bounded by sheet pile on each end and reinforced with rip-rap armoring; constructed in 2011
- East Cape Extension Canal Dam – a 100-foot long fill dam bounded by sheet pile on each end and reinforced with rip-rap armoring; constructed in 2011
- House Ditch Dam – an earthen dam; constructed in the 1950s
- Slagle Ditch Dam – an earthen dam; constructed in 1950s
- Raulerson Canal Dam – a former sheet pile dam; the dam has completely failed

Additionally, East Side Creek, a natural waterway in the Cape Sable region, is currently experiencing similar tidal influence and erosional processes as the canals and ditches in the area. The saltwater intrusion via this creek is similarly contributing to the degradation of the interior freshwater and brackish marshes of the Cape Sable region. Based on the available historical evidence, the Park believes that these processes occurring in the waterway may be due, at least in part, to the presence and widening of the human-created canals in the region. Therefore, this waterway is being included for consideration as part of this project.

The House Ditch, Slagle Ditch, Raulerson Canal, and East Side Creek waterways are the subject of the proposed EA (Figure 1, Location Map).

FIGURE 1 – LOCATION MAP

DRAFT PROJECT PURPOSE, NEEDS, AND OBJECTIVES

DRAFT PURPOSE STATEMENT

The purpose of this project is to provide sustainable solutions to canal-induced saltwater intrusion and degradation of the interior freshwater and brackish marshes in order to reestablish the natural function of the Marl Ridge and restore the Cape Sable region to a more natural state.

DRAFT NEEDS STATEMENTS

The needs of this project are to:

- Reestablish the natural function of the Marl Ridge in the Cape Sable region
- Reduce the impacts of the canal-induced breaching of the Marl Ridge, which is allowing unnatural intrusion of saltwater into freshwater and brackish marshes north of the marl ridge
- Reduce the erosional processes currently occurring in House and Slagle Ditches, Raulerson Canal, and East Side Creek
- Reduce sediment transport to/from Florida Bay and the interior mashes
- Protect the freshwater and brackish interior marshes and surrounding areas, which serve as habitat for fish and wildlife
- Improve the qualities of wilderness character in the Marjory Stoneman Douglas Wilderness Area

DRAFT OBJECTIVES STATEMENTS

Natural Resources

- Reduce the flow of saltwater into freshwater and brackish interior marshes of the Cape Sable region through House and Slagle Ditches, Raulerson Canal, and East Side Creek, thereby restoring a more natural hydrology to the region
- Reducing saltwater seepage around House and Slagle Ditch Dams, by repairing and improving existing plugs.
- Reduce freshwater loss from freshwater and brackish interior marshes through House and Slagle Ditches, Raulerson Canal, and East Side Creek
- Promote ecological resilience to climate change and sea level rise in the interior marshes of the Cape Sable region
- Improve habitat for juvenile crocodiles, wading birds, forage fish and other wildlife within the interior freshwater and brackish marshes of the Cape Sable region
- Reduce the loss of sediment and nutrients from the interior freshwater and brackish marshes of the Cape Sable region
- Reduce/eliminate adverse impacts to marine resources in the Cape Sable region

Wilderness

- Design project features to maximize compatibility with the qualities of wilderness character

Cultural Resources

- Avoid adverse impacts to cultural and archeological resources and historic features through project design or mitigation measures

Engineered Features

- Design engineered features, when necessary, to last at least 50 years (barring severe damage by catastrophic hurricane events) with annual/bi-annual maintenance

Visitor Use and Experience

- Provide safe passage into the Marjory Stoneman Douglas Wilderness Area for canoeists/kayakers
- Improve the wilderness visitor experience by reducing the opportunity for illegal motorized access into the Marjory Stoneman Douglas Wilderness Area

DRAFT PROJECT ALTERNATIVES

HOUSE AND SLAGLE DITCHES

Due to the similar nature of the House and Slagle Ditches and the similar nature of the current earthen dams, the same suite of alternatives is being considered for each of the waterways. [Note: Hereinafter referred to as House and Slagle Alternatives #1 through #3.]

The No Action Alternative would involve taking no action, whereby allowing the earthen dam to function in its current state.

1. Re-backfill the eroded areas back to the anticipated original widths with a coarse grained limestone rock fill, place a sand drain for seepage control, backfill the ditch up to 10 feet outward from the dam, and place erosion protection along the downslope areas of the dam and end sloping ditch backfill.
2. Re-backfill the eroded areas of the existing earthen dam, place erosion protection along the downslope areas of the existing dam, and construct a new dam structure at the mouth of the ditch.
3. Restore the natural function of the Marl Ridge by constructing a new dam the width of the Marl Ridge.

RAULERSON CANAL

[Note: Hereinafter referred to as Raulerson Alternatives #1 through #4.]

The No Action Alternative would involve taking no action, whereby allowing the canal to continue to function in its current state without a dam (Note: the former dam structure has completely failed).

1. Construct a new sheet pile only dam with rip-rap erosion protection at the former failed dam location, with options for a flow discharge structure and/or a canoe ramp.
2. Restore the natural function of the Marl Ridge by constructing a new sheet pile only dam at the center of the Marl Ridge, with options for a flow discharge structure and/or a canoe ramp.
3. Construct a new sheet pile and fill dam with rip-rap erosion protection at the former failed dam location, with the option for a canoe ramp.
4. Restore the natural function of the Marl Ridge by constructing a new sheet pile and fill dam the width of the Marl Ridge, with the option for a canoe ramp.

EAST SIDE CREEK

[Note: Hereinafter referred to as East Side Alternatives #1 and #2.]

The No Action Alternative would involve taking no action, whereby allowing the creek to continue to function in its current condition.

1. Restore the natural function of the Marl Ridge by constructing a new sheet pile only dam at the center of the Marl Ridge, with options for a flow-through structure, weir, and/or a canoe ramp.
2. Restore the natural function of the Marl Ridge by constructing a new sheet pile and fill dam the width of the Marl Ridge, with the option for a canoe ramp.

SURVEY LOCATIONS AND METHODOLOGY

SURVEY LOCATIONS

Topographic Survey Locations

A limited topographic survey was conducted at each of the potential dam sites identified during the internal scoping for this project and noted in the "Draft Alternatives" section of this report. This report presents the alternatives that were carried forward from the *Engineering Analysis and Feasibility of Repairing or Replacing Failed Dams and Limiting Salt Water Intrusion in Cape Sable Everglades National Park* (URS Corporation 2012), as refined during the Internal Scoping Meeting and subsequent follow-up meetings. The alternatives were presented during the agency/public scoping process.

The primary purpose of this topographic survey was to ensure that proposed dam structures are sited in the most appropriate location regarding the surrounding topography and canal width while considering the least amount of site disturbance. The survey boundaries, cross section locations, and elevation intervals were chosen based on the original scope of work for this project and refined during and following the internal scoping period. The project team provided input on where to place the transect locations based on the best available topographic data (i.e., topographic maps and LiDAR maps). Width measurements of the waterways could be developed from the cross sectional data collected, using the existing vegetation as the top of bank limits.

Based on the aforementioned Draft Alternatives, the locations for the topographic survey along each waterway included the following (see Sheet 1 of Appendix A for a key sheet depicting the survey locations):

House and Slagle Ditches Alternatives.

- House and Slagle Alternative #1 – topographic survey conducted at the location of the existing eroding earthen plug on the House and Slagle ditches
- House and Slagle Alternative #2 – topographic survey was conducted at the locations noted in Alternative #1 and at the mouth of the House and Slagle ditches leading to Florida Bay
- House and Slagle Alternative #3 – topographic survey was conducted at the location of the apparent former Marl Ridge (apparent topographic high) on the House and Slagle ditches

Raulerson Canal Alternatives.

- Raulerson Alternatives #1 and #3 – topographic survey was conducted at the location of the former failed dam on the Raulerson Canal
- Raulerson Alternatives #2 and #4 – topographic survey was conducted at the location of the apparent former Marl Ridge (apparent topographic high) on the Raulerson Canal

East Side Creek Alternatives.

- East Side Alternatives #1 and #2 – topographic survey was conducted at the location of the apparent former Marl Ridge (apparent topographic high) on the East Side Creek

Bathymetric Survey Locations

A limited bathymetric survey was conducted in the northwest Lake Ingraham and Middle Cape Canal areas for the primary purpose of identifying channelized routes for the movement of barges into the existing access creeks leading to the Raulerson Canal. Light Detection and Ranging (LiDAR) data was

provided by the NPS. Potential dam locations were discussed and reviewed during the Internal Scoping Meeting, and reviewed, refined, and approved by NPS Project Manager Dewitt Smith prior to commencement of the survey.

Some concern has been expressed by EVER personnel regarding the potential existence of a shoal area exterior to the Middle Cape Canal similar to that at the entrance to the East Cape Canal. Such a shoal would potentially limit barge access. This is a substantially sandy island, especially at low tide. Access may be gained through the Middle Cape Canals with a barge, and exited during high tide. The survey also included a center profile along each of the four waterways (as identified during the internal scoping for this project and noted in the Draft Alternatives section of this report) and exploration of the East Side Creek cutoff to ascertain its suitability for barge passage. Refer to Sheet 1 of Appendix A for a key sheet depicting the survey locations.

SURVEY METHODOLOGY

The limited topographic and bathymetric surveys were conducted by a crew of three survey personnel from AMEC Foster Wheeler (AMEC) (a subcontractor to AECOM) between November 10, 2014, and January 23, 2015. The field personnel typically conducted activities from daylight (approximately 6:30 am) to dusk (approximately 6:30 pm).

The topographic and bathymetric survey tasks were completed as follows:

- November 10 and 11, 2014 – bathymetric survey of the approach to Lake Ingraham
- November 11 to November 13, 2014 – site reconnaissance (January 7 to January 10, 2015 –topographic and bathymetric surveys at Raulerson Canal and East Side Creek
- January 9, 2015 – additional bathymetric survey of the approach to Lake Ingraham
- January 19 to January 23, 2015 – topographic and bathymetric surveys at House and Slagle Ditches

Survey Vessels. The following vessels were utilized in the course of performing the topographic survey, as noted on sheets 2 through 5 in appendix A:

- 16-foot long by 6-foot wide G3 model 1652 john boat with 50 horsepower Yamaha engine. Draft +/- 1.2 feet.
- 15.3-foot long by 5.4-foot wide Polarcraft john boat with 25 horsepower Nissan engine. Draft +/- 0.9-foot.

Survey Equipment. The topographic survey of the approach to Lake Ingraham was performed utilizing Global Positioning System (GPS) technology using Trimble Navigation, Ltd. Model R8 receivers operating in base-rover Real Time Kinematic (RTK) mode in conjunction with an automated bathymetric survey system consisting of an Odom CV-100 echo-sounder with a 200kHz 3 degree transducer and HYPAK navigation software.

The canal/ditch profiles and site topographic survey data was collected utilizing GPS technology using Trimble Navigation, Ltd Model R6-4 and R8 receivers operating in base-rover RTK mode.

Survey Control Points. The topographic survey is based on the use of the three-dimensional control points shown in table 1.

Survey Notes. The horizontal datum for the topographic survey is the North American Datum of 1983 (NAD83) and the vertical datum is the North American Datum of 1988 (NAVD88). Elevations are expressed in feet.

Horizontal positioning is expressed in U.S. Survey Feet and projected in the Florida State Plane Coordinate System, East Zone 901.

TABLE 1 – SURVEY CONTROL POINTS

Designation	Northing	Easting	Elevation (feet)	Description and Comments
1	310,420.18	612,268.27	0.71	1 ½-inch iron pipe with notch in east rim located 12 feet southeast of USGS monitoring station at east end of Raulerson Canal. Values shown provided by NPS and verified by NGS OPUS solution and ties to existing NPS Cape Sable Dams Restoration Phase 1 control network.
CS03	299,071.14	625,090.37	0.23	8-inch diameter concrete monument with disc stamped “CS03 LB6969 2009”
CS05	292,130.85	634,262.51	1.29	8-inch diameter concrete monument with disc stamped “CS05 LB6969 2009”
CS06	291,995.79	634,268.39	2.18	8-inch diameter concrete monument with disc stamped “CS06 LB6969 2009”
CS07	292,041.29	634,868.55	1.13	8-inch diameter concrete monument with disc stamped “CS07 LB6969 2009” Note: CS03-CS07 were established by predecessor firm MACTEC Engineering and Consulting, Inc. under contract to NPS as part of the NPS Cape Sable Dams Restoration Phase 1 control network.
13A	291,176.57	639,537.76	2.2	5/8-inch diameter iron rod with cap stamped “AMEC WITNESS” set flush with ground near existing House’s Ditch plug. Values shown established by NGS OPUS solution.
15A	290,457.44	647,466.93	1.0	5/8-inch diameter iron rod with cap stamped “AMEC WITNESS” set flush with ground just east of the intersection of Slagle’s Ditch and existing creek. Values shown established by NGS OPUS solution.

SURVEY RESULTS

Weather conditions, tide conditions, and gage heights were observed at the time that the survey events were conducted. Tide conditions and gage height data are included as reference points, as they relate to the NAVD (1988) vertical project datum. Tide conditions along with minimum and maximum water elevations are shown to convey the best times for suitable water depth needed to navigate project watercraft to the project site to mobilize equipment and supplies.

WEATHER CONDITIONS

The following general weather conditions were observed in the field during the survey events:

- November 10 through November 13, 2014 – mostly clear and sunny, air temperatures ranged from 75° to 80°F, light to moderate breeze
- January 7 to 10, 2015 – mostly sunny, air temperatures ranged from 58° to 85° F
- January 19 to 22, 2015 – partly cloudy, air temperatures ranged from 65° to 85° F
- January 23, 2015 – sunny, air temperatures ranged from 70° to 85° F, breezy with gusts to 15 MPH

TIDE CONDITIONS

Table 2 shows the tide conditions in the Cape Sable area at the time of the survey events.

TABLE 2 – CAPE SABLE TIDE DATA

Date	Height (feet, inches)	Type	Time
11/10/2014	4'2"	H	2:29 AM
	-0'1"	L	10:13 AM
	3'4"	H	4:31 PM
	1'7"	L	10:14 PM
11/11/2014	3'11"	H	3:13 AM
	0'2"	L	10:59 AM
	3'3"	H	5:23 PM
	1'8"	L	11:04 PM
11/12/2014	3'7"	H	4:11 AM
	0'5"	L	11.49 AM
	3'2"	H	6:16 PM
11/13/2014	1'8"	L	12:09 AM
	3'4"	H	5:30 AM
	0'7"	L	12:47 PM
	3'2"	H	7:10 PM
I/07/2015	3'7"	H	2:01 AM
	-0'5"	L	9:25 AM
	3'0"	H	3:29 PM
	0'11"	L	9:30 PM
1/8/2015	3'5"	H	2:38 AM
	-0'3"	L	10:00 AM
	3'0"	H	4:07 PM
	0'11"	L	10:09 PM
1/9/2015	3'2"	H	3:19 AM
	-0'0"	L	10:34 AM
	3'0"	H	4:47 PM
	0'11"	L	10:52 PM
1/10/2015	2'11"	H	4:08 AM
	-0'2"	L	11:09 AM
	3'0"	H	5:29 PM
	0'10"	L	11:44 PM
1/19/2015	-1'0"	L	7:13 AM
	3'0"	H	1:36 PM
	0'11"	L	7:10 PM
1/20/2015	4'1"	H	12:33 AM
	-1'1"	L	7:57 AM
	3'2"	H	2:14 PM
	0'9"	L	7:58 PM
1/21/2015	4'2"	H	1:18 AM
	-1'1"	L	8:40 AM
	3'3"	H	2:53 PM
	0'7"	L	8:45 PM

Date	Height (feet, inches)	Type	Time
1/22/2015	4'0"	H	2:05 AM
	0'1"	L	9:24 AM
	3'4"	H	3:33 PM
	0'5"	L	9:34 PM
1/23/2015	3'9"	H	2:58 AM
	-0'8"	L	10:07 AM
	3'4"	H	4:15 PM
	0'3"	L	10:27 PM

H=High Tide; L=Low Tide
Source: http://tidesandcurrents.noaa.gov

GAGE HEIGHTS

Table 3 shows the record Minimum and Maximum Gage Heights in feet relative to NAVD88 at the two closest locations to the Cape Sable area from March 5, 2014, to March 5, 2015, as recorded by the U.S. Geological Survey (USGS) National Water Information System. The USGS "East Side Creek near Lake Ingraham" monitoring station is shown on Sheet 3 of Appendix A.

TABLE 3 – USGS GAGE HEIGHT DATA

USGS Hydrological Unit	Maximum Gage Height (feet)	Minimum Gage Height (feet)
East Side Creek near Lake Ingraham Latitude: N 25 08'13.09" Longitude: W 81 03'51.77" Unit #03090203 Site #250802081035500	1.37' (9/8/2014) (approved)	-2.98' (5/13/2014) (approved)
Raulerson Brothers Canal at Cape Sable Latitude: N 25 11'15.55" Longitude: W 81 07'58" Unit #03090203 Site #251115081075800	0.69' (10/7/2014) (approved)	-2.38' (3/27/2014) (approved)

Source: http://waterdata.usgs.gov

TOPOGRAPHIC AND BATHYMETRIC DATA

House Ditch

Based on the bathymetric data collected along the House Ditch, the ditch bottom elevation ranges from -3.7 feet to -6.1 feet between the mouth of the ditch at Florida Bay and the northern point at which the ditch becomes impassable by boat and must be accessed by foot, as shown on Sheet 4 of Appendix A. The access width of the ditch ranged from approximately 15 to 20 feet with low overhanging mangroves along the length of the ditch. The width measurements of the waterway were developed from the cross sectional data collected, using the existing vegetation as the top of bank limits.

Based on bathymetric data collected at the mouth of the House Ditch at Florida Bay, the bottom elevations range from -0.5 feet to -2.0 feet. Further out from the mouth of the ditch, bottom elevations range from -1.2 feet to -3.2 feet (see Sheet 4 of Appendix A).

Topographic data at the current earthen dam location on the House Ditch show an elevation

of +2.0 at the approximate topographic high point of the existing dam (see Sheet 4 of Appendix A).

Slagle Ditch

Based on the bathymetric data collected along the Slagle Ditch, the ditch bottom elevation ranges from -8.8 feet to -10.6 feet between the mouth of the ditch at Florida Bay and the northern point at which the ditch becomes impassable by boat and must be accessed by foot, as shown on Sheet 5 of Appendix A. The access width of the ditch was approximately 50 feet wide up to the northern point at which the ditch becomes impassable by boat. The width measurements of the waterway were developed from the cross sectional data collected, using the existing vegetation as the top of bank limits.

Based on bathymetric data collected at the mouth of the Slagle Ditch at Florida Bay, the bottom elevations range from -3.0 feet to -8.1 feet. Further out from the mouth of the ditch, bottom elevations range from -3.4 feet to -8.1 feet (see Sheet 5 of Appendix A).

Topographic data at the current earthen dam location on the Slagle Ditch show an elevation of +1.0 to +1.8 at the approximate topographic high point of the existing dam (see Sheet 5 of Appendix A). The topographic survey was conducted in this area, as it was assumed (based on anecdotal accounts from NPS) that the dam location is aligned with the crest of the Marl Ridge. Boring samples were not obtained to identify the presence of calcium carbonate, to verify that this area is the crest of the Marl Ridge, as this was not a requirement of the survey. Also, there was a shoal at the mouth of the creek at Slagle's Ditch. This was included in the survey to provide an accurate depiction of the offshore conditions to the entrance of the tributary, which should be taken into account when navigating watercraft to the project site.

Raulerson Canal

Based on the bathymetric data collected along Little Sable Creek leading into the Raulerson Canal, the creek bottom elevation ranges from -6.8 feet to -10.8 feet between the mouth of the creek at Lake Ingraham and the point at which the creek joins the Raulerson Canal, as shown on Sheet 2 of Appendix A. The access width of the creek was approximately 35 to 40 feet wide. The width measurements of the waterway were developed from the cross sectional data collected, using the existing vegetation as the top of bank limits.

Similarly, the bottom elevation of the Raulerson Canal ranges from approximately -8 feet to approximately -11 feet between the connection from Little Sable Creek to the end of the survey area beyond the former failed dam structure, as shown on Sheet 2 of Appendix A. The access width of the canal was approximately 25 to 30 feet wide between Little Sable Creek and the bend of the canal and approximately 35 to 40 feet wide beyond the bend of the canal.

Topographic data at the proposed location of the Raulerson Canal dam shows an elevation of +1.1 feet on the north side of the canal and +0.9 feet on the south side of the canal. On the north side of the canal, 90 feet east of the proposed location is, there is a topographic point high point that is 1/10 of a foot higher; which is not a significant elevation change.

The topographic survey was conducted in this area, and the site is proposed, as it was assumed (based on anecdotal accounts from NPS) that the dam location is aligned with the crest of the Marl Ridge. Boring samples were not obtained to identify the presence of calcium carbonate, to verify that this area is

the crest of the Marl Ridge, as this was not a requirement of the survey.

East Side Creek

Based on the bathymetric data collected along access cutoff creek leading into East Side Creek, the creek bottom elevation ranges from -8.4 feet to -11.7 feet between the mouth of the creek at East Cape Canal and the point at which the cutoff creek joins East Side Creek, as shown on Sheet 3 of Appendix A. The access width of the creek was approximately 30 to 45 feet wide up to the first bend and approximately 25 to 30 feet beyond the bend. The width measurements of the waterway were developed from the cross sectional data collected, using the existing vegetation as the top of bank limits. Neither mouths of the creek were surveyed, as they are not aligned with the Marl Ridge.

Similarly, the bottom elevation of East Side Creek in the survey area ranges from approximately -5 feet to approximately -11 feet between the connection from the cutoff creek to the end of the survey area, as shown on Sheet 3 of Appendix A. The access width of the creek was approximately 40 to 50 feet wide.

Topographic data at the proposed location of the East Side Creek dam is +0.9 feet on the north side of the canal and +0.5 feet on the south side of the canal. This is the topographic high elevation location.

The topographic survey was conducted in this area, and the site is proposed, as it was assumed (based on anecdotal accounts from NPS) that the dam location is aligned with the crest of the Marl Ridge. Boring samples were not obtained to identify the presence of calcium carbonate, to verify that this area is the crest of the Marl Ridge, as this was not a requirement of the survey.

Lake Ingraham Approach

Based on the bathymetric data collected in the area of the approach to Lake Ingraham from Florida Bay, the bottom elevation ranges from -5.0 feet in the shallowest areas to greater than -11 feet in the deeper surveyed areas in Florida Bay, as shown on Sheet 6 of Appendix A.

RECOMMENDATIONS AND NEXT STEPS

The following preliminary recommendations and next steps are based solely on the limited topographic and bathymetric surveys conducted along each of the four waterways (House and Slagle Ditches, Raulerson Canal, and East Side Creek).

HOUSE AND SLAGLE DITCHES

Barge Access

A standard modern jumbo hopper type barge, similar to that utilized for the Cape Sable Dam Restoration Phase I project (Phase I project), measures approximately 200 feet long by 35 feet wide by 12 feet deep with an empty draft of 1.5 feet. The Environmental Resource Permit (ERP) issued by the South Florida Water Management District (SFWMD) for the Phase I project had a special condition requiring that “all barge activity shall occur only in areas where at least one-foot bottom clearance is maintained at all times.” Therefore, a barge of this type would need a clearance of at least 2.5 feet from bottom elevation for passage while empty. For this project, a smaller and more specialized type barge could be used than was used for the Phase I project; such a barge would necessitate more trips to carry materials, but potentially less trimming of mangrove and either less or potentially no dredging of access channels, dependent upon access depths and barge draft requirements.

The bathymetric data collected at the entrance to House Ditch from Florida Bay shows a shallow shoal area of less than -2 feet bottom elevation, which would not allow for passage of a barge without significant dredging of the area. The bathymetric data for the entrance to Slagle Ditch shows a slightly deeper area, with bottom elevations in the -3-foot to -4-foot range.

Barge passage would likely require dredging even for a smaller shallow draft barge. It is estimated that approximately 6,500 cubic yards of dredge material would be required to be removed at House Ditch and 3,700 cubic yards of material would be required to be removed at Slagle Ditch in order to provide a suitable accessway for a 20-foot wide barge. Approximately 1.52 acres (66,000 square feet) of impacts to coastal mangrove habitat would result along House Ditch and approximately 0.69 acres (30,000 square feet) of impacts to coastal mangrove habitat would result along Slagle Ditch, if dredging would need to occur. For House Ditch, the location to be dredged would include the area from the mouth at Florida Bay to the proposed dam site at the Coastal Prairie Trail. For Slagle Ditch, the location to be dredged would include the area from the northern limits of open water where the ditch veers to the east (approximately 1,000 feet north of the mouth at Florida Bay) to the proposed dam site at the Coastal Prairie Trail. The awarded contractor would be required to dispose of the material at a suitable offsite disposal site or at a location chosen by the NPS.

The most appropriate barge staging locations for House and Slagle Ditches would likely be the near shore areas in Florida Bay near the mouth of each ditch. Materials could be transported from these staging areas via a smaller vessel since at least a -4-foot bottom elevation exists along the House Ditch and at least a -8-foot bottom elevation exists along the Slagle Ditch. An outboard powered skiff, which can operate in 2 feet to 3 feet of water, would be one option to bring equipment from the barge staging area to the project site.

The point at which each of these ditches become impassable by boat is noted on Sheets 4 and 5, respectively, of Appendix A. Materials transport by a non-marine method will be required from the point that the ditches become impassable. Or, if determined to be less environmentally damaging and/or more cost effective, materials could be transported solely via non-marine methods, such as pack mules (i.e., originating from Flamingo Campground or Club House Beach).

Analysis of potential environmental impacts and costs associated with both marine and non-marine transport methods should be conducted and documented as part of the EA for this project. Those analyses will assist with determination of the most appropriate, least environmentally damaging, and/or most cost effective transport methods.

Further bathymetric and benthic surveys of an appropriate barge staging area should also be conducted during the permitting stage of the project to select an appropriate staging site. At that time, an appropriate sized barge should be selected based on the job site, site restrictions, and necessary water depth based on bathymetric conditions.

Alternatives to Barge Use

Due to the restricted barge access directly to the dam site, additional staging in the Flamingo Marina area of EVER will likely be necessary for construction of any of the dam alternatives for the House and Slagle Ditches. A helicopter utilized for materials transport to the House and Slagle Ditch dam sites could be staged from an existing helicopter landing site just northwest of the Flamingo Marina. All of these areas (with the exception of the marina itself) are located in existing, cleared upland areas within EVER. In addition, pack mules are also being considered as an option for transporting equipment and supplies from the Flamingo Campground to the House and Slagle Dam Restoration sites.

Dam Location

Based on the topographic survey data collected along the House and Slagle Ditches, it appears that the existing earthen dams are located at the approximate topographic high point in the area associated with what is assumed to be the Marl Ridge (see Sheets 4 and 5, respectively, of Appendix A). Therefore, these areas (see Figures 2a and 2b for House Ditch and Figures 3a and 3b for Slagle Ditch) would be an appropriate selection for future dam locations, contingent upon a full NEPA analysis of the dam alternatives.

RAULERSON CANAL

Barge Access

As discussed above, a shallow draft barge similar to that used for the Phase I project construction would need a clearance of at least 2.5 feet from bottom elevation for passage while empty. A smaller barge that requires less clearance, based on bathymetric conditions at the cross sectional location of the project site, is also being considered.

The bathymetric data collected along the Raulerson Canal and Little Sable Creek (up to the connection to the Raulerson Canal) to the point of the previous failed dam structure shows a bottom elevation of at least -6.8 feet (and at least -8 feet in almost all locations) in the shallowest areas and a canal width ranging from 25 to 40 feet wide (see sheet 2 of appendix A). While it seems that this would potentially allow for barge passage up to the point of the previous failed dam structure, it was noted during the survey that the tide is especially strong and fast moving through some portions of the canal along with a

substantial amount of mangrove branch overgrowth. The current overgrowth of the mangroves would make navigation of the creek and canal very challenging and would require significant trimming to allow for barge navigation of the waterway (see note on Sheet 2 of Appendix A). Additionally, during the survey, it was noted that an obstruction appears to exist just below the surface at low tide conditions in the location of the former failed dam. This obstruction would not allow for passage beyond this point without removal of the material (see note on Sheet 2 of Appendix A). However, it is possible to remove the obstruction so that the barge can pass through or over the area during construction of the dam. If the new dam is constructed in the same location as the previous failed dam, all remnants of the dam would need to be removed. Based on field observations, the previous dam has completely failed. Therefore, it would not be sound engineering practice to use remnants of the failed dam for the basis of construction; it is recommended that appropriate construction methods and suitable materials be used to ensure the structural integrity of the new dam.

Additionally, the bathymetric data collected in the area of the approach to Lake Ingraham from Florida Bay, indicates that the bottom elevation ranges from -5.0 feet in the shallowest areas to greater than -11 feet in the deeper surveyed areas in Florida Bay (as shown on Sheet 6 of Appendix A). This would likely allow for barge passage into Lake Ingraham for access to the Raulerson Canal and no dredging would be required.

As discussed above, a helicopter utilized for materials transport to the Raulerson Canal dam site could also be staged from an existing helicopter landing site just northwest of the Flamingo Marina.

Dam Location

Based on the topographic survey data collected along the Raulerson Canal, it appears that the former failed dam was located at the approximate topographic high point in the area associated with what is assumed to be the Marl Ridge (see Sheet 2 of Appendix A). Therefore, this area (see Figure 4) would be an appropriate selection for a future dam location, contingent upon a full NEPA analysis of the alternatives.

EAST SIDE CREEK

Barge Access

As discussed above, a shallow draft barge similar to that used for the Phase I project construction would need a clearance of at least 2.5 feet from bottom elevation for passage while empty.

The bathymetric data collected along East Side Creek and the East Side Creek cutoff show a bottom elevation of at least -8 feet in the shallowest areas and a width ranging from 25 to 40 feet wide (see Sheet 3 of Appendix A). While it seems that this would potentially allow for barge passage up to a potential dam location without any dredging being required, it was noted during the survey that the tide is fairly strong and fast moving through the cutoff creek along with a substantial amount of mangrove branch overgrowth. The current overgrowth of the mangroves would make navigation of the cutoff creek very challenging and would require significant trimming to allow for barge navigation of the waterway (see note on Sheet 3 of Appendix A).

As discussed above, a helicopter utilized for materials transport to the East Side Creek dam site could also be staged from an existing helicopter landing site just northwest of the Flamingo Marina.

Dam Location

Based on the topographic survey data collected along East Side Creek, an approximate topographic high point was identified in an area associated with what is assumed to be the Marl Ridge (see Sheet 3 of Appendix A). Therefore, this area (Figure 5) would be an appropriate selection for a future dam location, contingent upon a full NEPA analysis of the alternatives.

NEXT STEPS

Further analysis of the engineering feasibility and environmental impacts of the alternatives will need to be conducted as part of the NEPA process, including review from the Wilderness Committee. The NEPA process will also include an analysis of the construction means and methods including materials transport options, barge access, and staging areas. No selection of alternatives or construction means and methods should be based solely on this analysis prior to completion of the NEPA process. Additional detailed topographic and bathymetric studies may also be required during the design and permitting phases of the project.

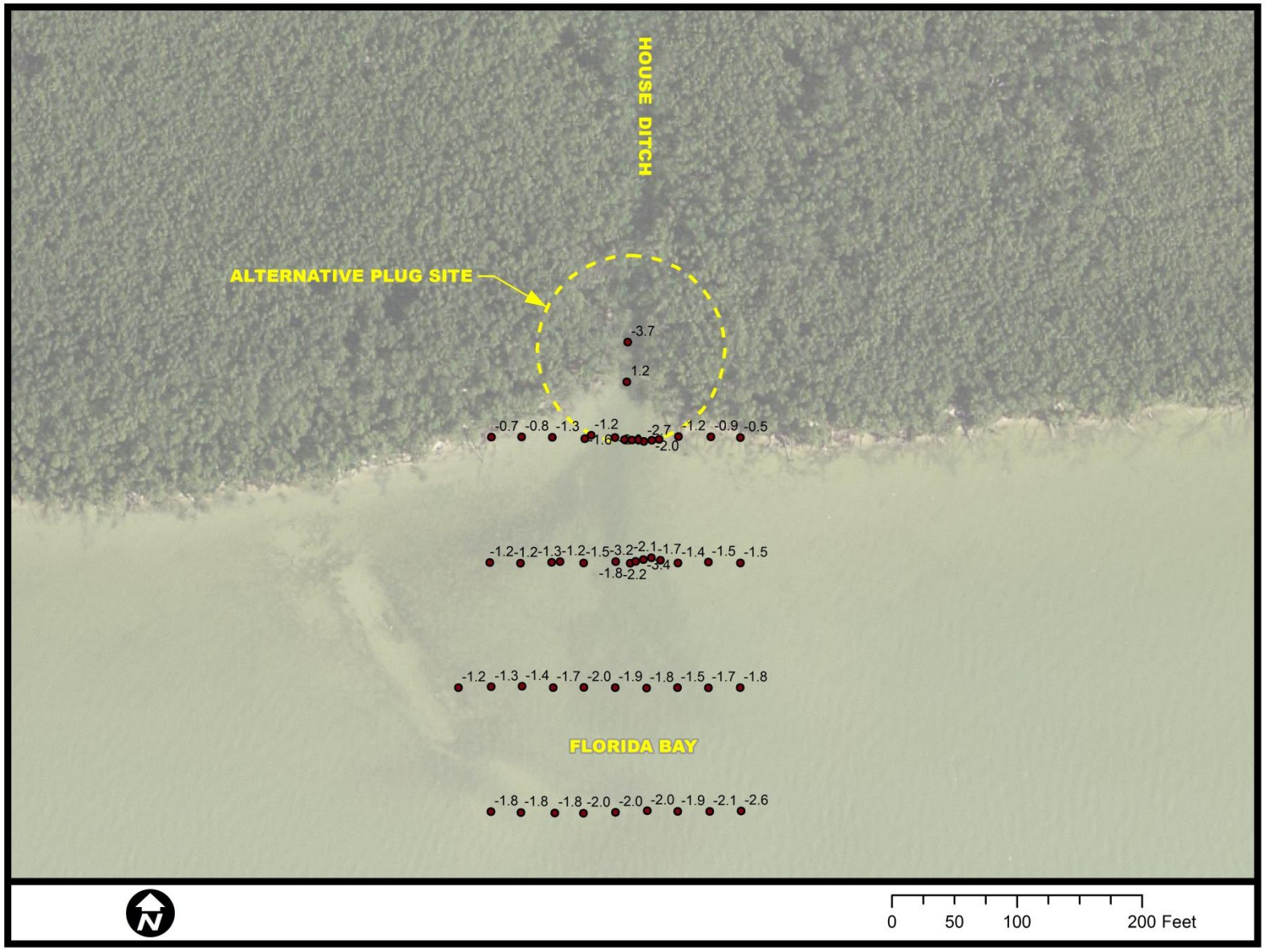


FIGURE 2A – HOUSE DITCH PROPOSED DAM AND POTENTIAL BARGE STAGING AREA AT THE MOUTH OF BAY - LOCATION MAP

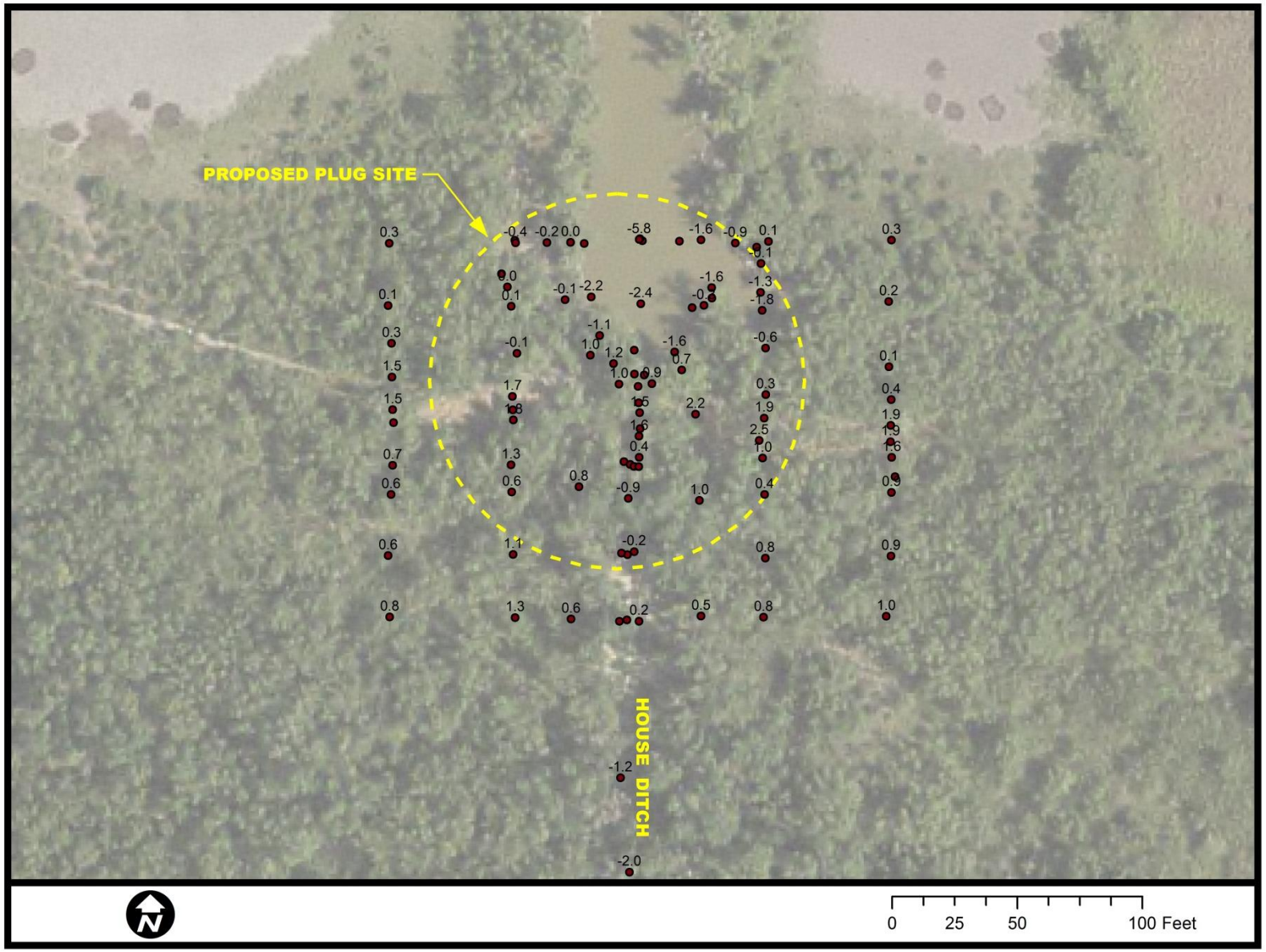


FIGURE 2B – HOUSE DITCH PROPOSED DAM AT FAILED DAM - LOCATION MAP

FIGURE 3A – SLAGLE DITCH PROPOSED DAM AND POTENTIAL BARGE STAGING AREA AT THE MOUTH OF BAY - LOCATION MAP

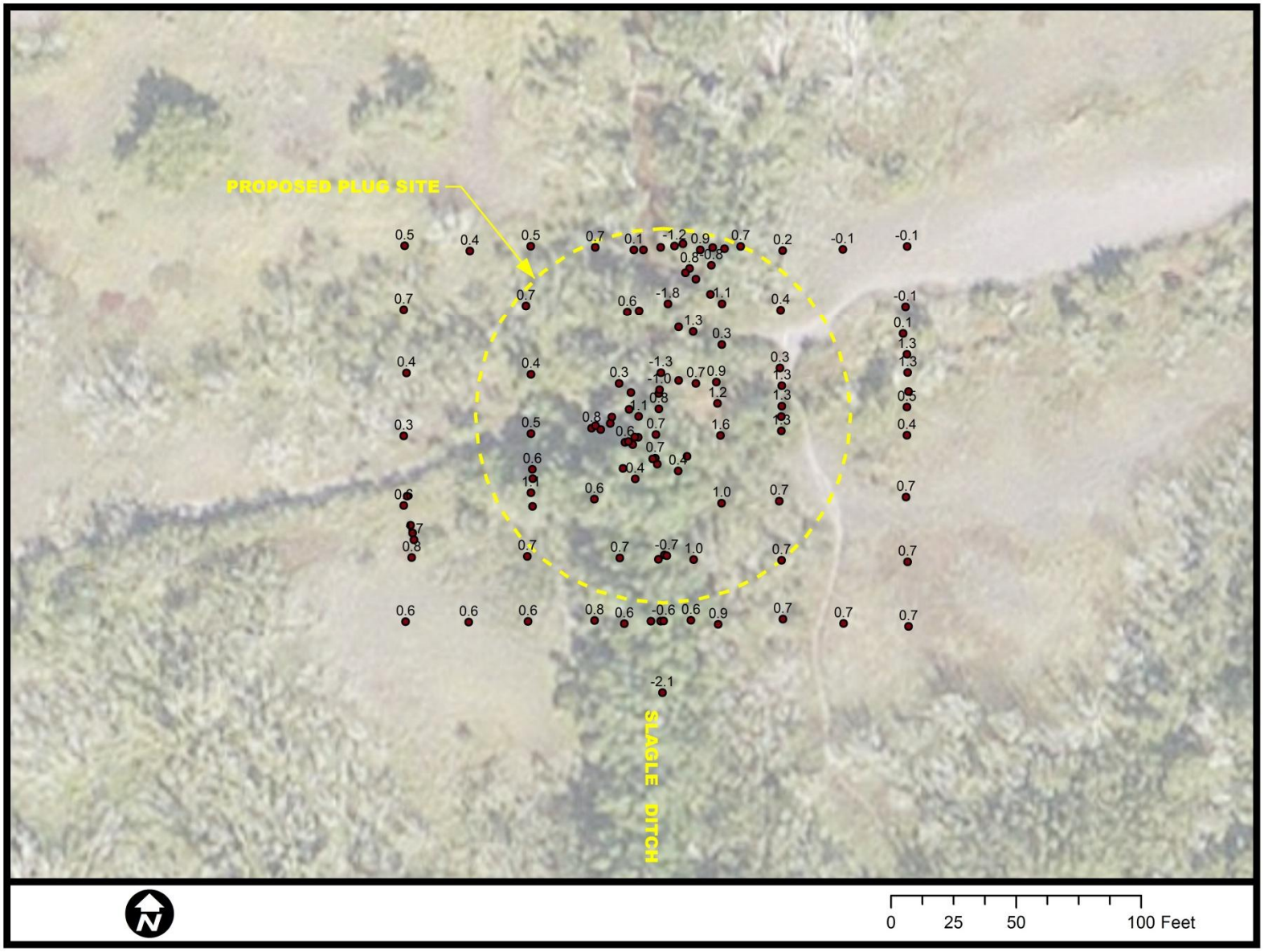


FIGURE 3B – SLAGLE DITCH PROPOSED DAM AT FAILED DAM - LOCATION MAP

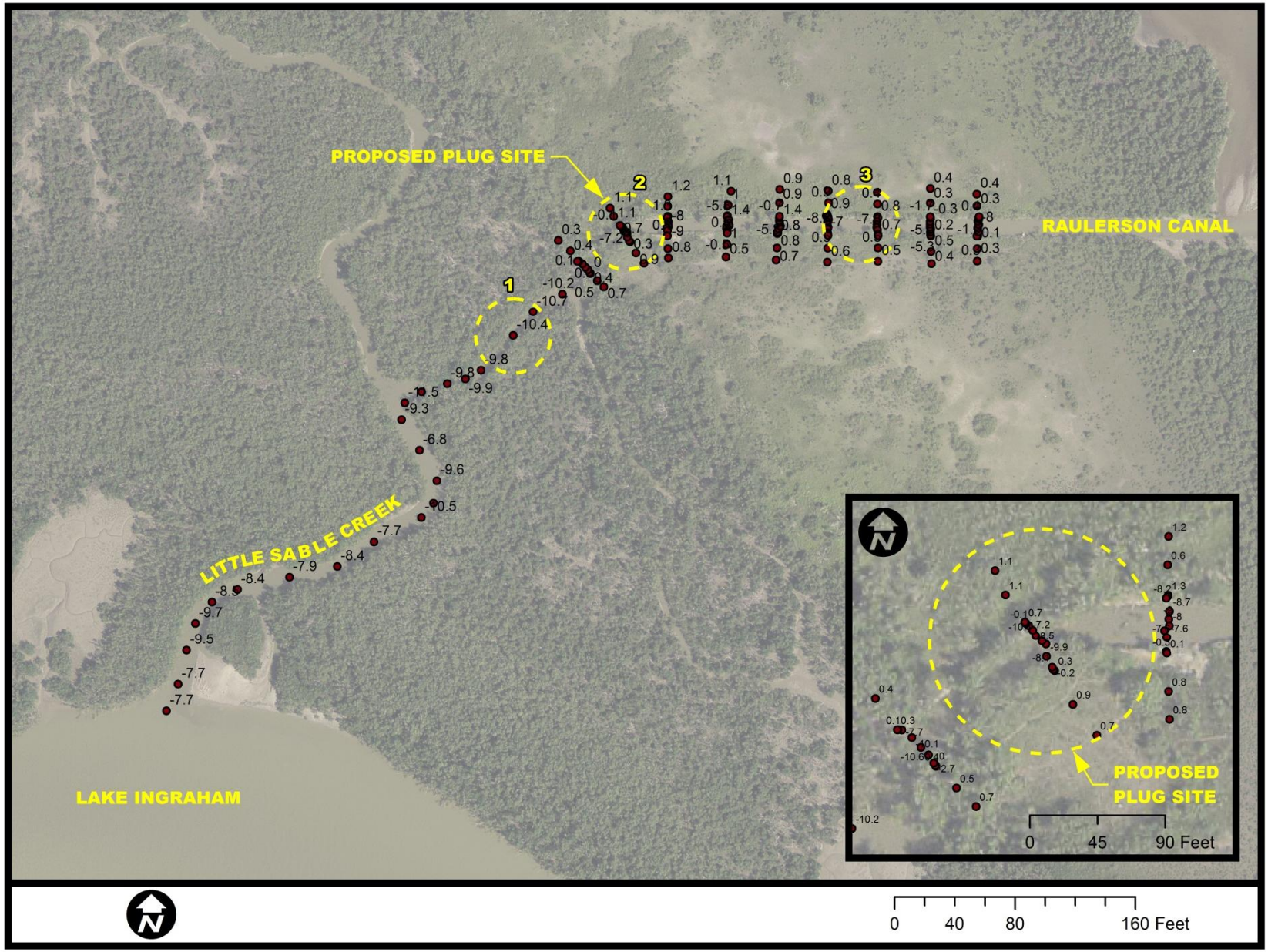


FIGURE 4 – RAULERSON CANAL PROPOSED DAM LOCATION MAP

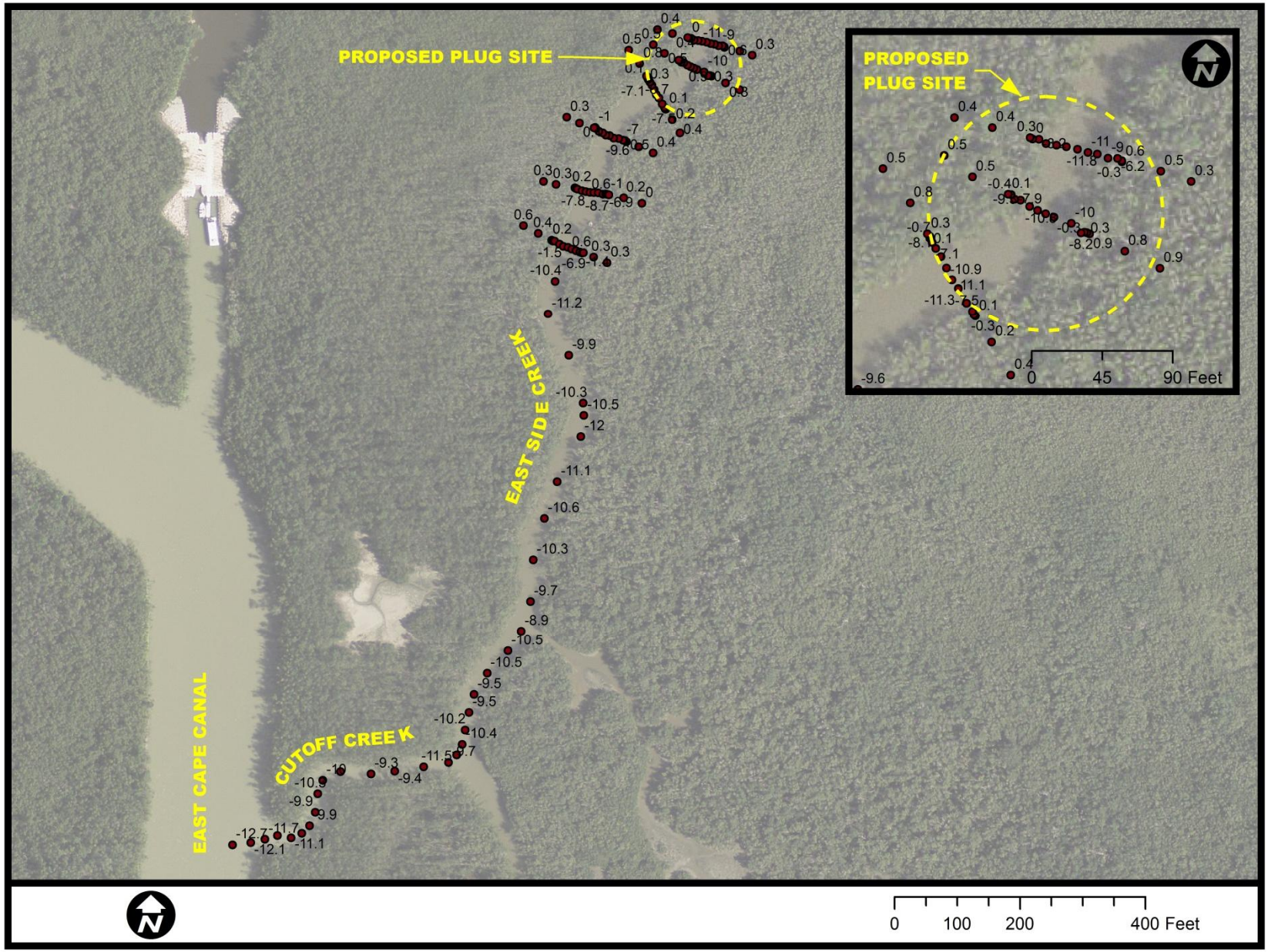


FIGURE 5 – EAST SIDE CREEK PROPOSED DAM LOCATION MAP

APPENDIX A

Topographic and Bathymetric Survey Maps (Sheets 1 through 6)

Surveyor's Notes / Report:

1) This map of Topographic survey is not valid without the signature and the original raised seal of the signing Florida licensed surveyor and mapper.

2) The purpose of this Topographic Survey is to map certain topographic features and elevations within the areas shown hereon and specified by the client.

3) This Topographic Survey does not address the identification and location of jurisdictional wetlands or sovereign lands that may lie within or adjacent to the lands surveyed.

4) The horizontal datum for this Topographic Survey is the North American Datum of 1983 (NAD83) and the vertical datum is the North American Vertical Datum of 1988 (NAVD88). Elevations are expressed in Feet. Horizontal positioning is expressed in US Survey Feet and projected in the Florida State Plane Coordinate System, East Zone 901.

The Topographic Survey is based upon the use of the following three –dimensional control points.

Designation	Northing	Easting	Elevation	Description and Comments
1	310,420.18	612,268.27	0.71	1 ½" Iron Pipe with notch in east rim located 12' SE of USGS monitor station at east end of Raulerson Canal. Values shown provided by NPS and verified by NGS OPUS solution and ties to existing NPS Cape Sable Dams Restoration Phase 1 control network
CS03	299,071.14	625,090.37	0.23	8" diameter concrete monument with disc stamped "CS03 LB6969 2009"
CS05	292,130.85	634,262.51	1.29	8" diameter concrete monument with disc stamped "CS05 LB6969 2009"
CS06	291,995.79	634,268.39	2.18	8" diameter concrete monument with disc stamped "CS06 LB6969 2009"
CS07	292,041.29	634,868.55	1.13	8" diameter concrete monument with disc stamped "CS07 LB6969 2009" Note: CS03– CS07 were established by predecessor firm MACTEC Engineering and Consulting, Inc. under contract to NPS as part of the NPS Cape Sable Dams Restoration Phase 1 control network
13A	291176.57	639537.76	2.2	5/8" diameter iron rod with cap stamped "AMEC WITNESS" set flush with ground near existing House's Ditch plug. Values shown established by NGS OPUS solution
15A	290457.44	647466.93	1.0	5/8" diameter iron rod with cap stamped "AMEC WITNESS" set flush with ground just east of the intersection of Slagle's Ditch and existing creek. Values shown established by NGS OPUS solution

5) The Topographic Survey of the entrance to the Mid Cape Canal was performed utilizing Global Positioning System (GPS) technology using Trimble Navigation, Ltd. Model R8 receivers operating in base–rover Real Time Kinematic (RTK) mode in conjunction with an automated bathymetric survey system consisting of an Odom CV–100 echo–sounder with a 200kHz 3 degree transducer and HYPAK navigation software. The bathymetric survey measurements were collected November10–11, 2014 and January 9, 2015. The map on sheet 6 depicts the results of the survey preformed on the dates listed and only indicate the general conditions existing on these dates.

6) The canal/ditch profiles and site topographic survey data was collected utilizing GPS technology using Trimble Navigation, Ltd. Model R6–4 and R8 receivers operating in base –rover RTK mode. Last day in the field: January 23, 2015.

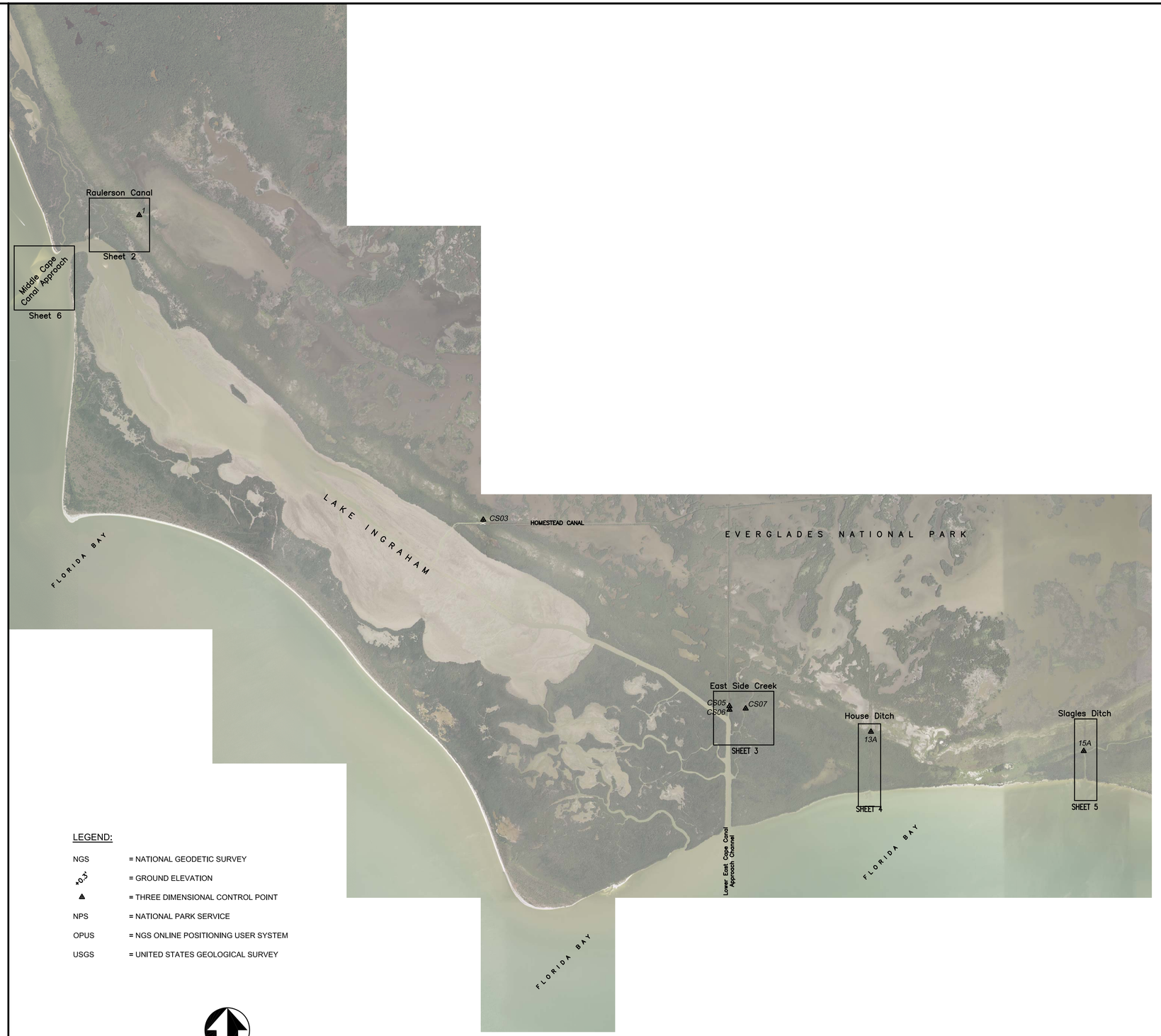
7) Source of Aerial Photography: the Florida Department of Environmental Protection, Division of State Lands, Bureau of Survey and Mapping, Land Boundary Information System website (labins.org). Photo date of 2012.

8) The following record Minimum and Maximum Gage Heights, in feet relative to NAVD88 from 03/05/2015 to 03/05/2014 were taken from United States Geological Survey (USGS) National Water Information System website at http://waterdata.usgs.gov:

USGS Hydrological Unit	Maximum Gage Height	Minimum Gage Height
East Side Creek near Lake Ingraham Latitude: N 25° 08'13.09" Longitude": W 81° 03'51.77" Unit # 03090203 Site# 250802081035500	1.37' (09/08/2014)–approved– 1.55' (11/24/2014)–provisional–	–2.98'(05/13/2014)–approved– –2.79(03/03/2015)–provisional–
Raulerson Brothers Canal at Cape Sable Latitude: N 25° 11' 15.55" Longitude": W 81° 07' 58" Unit # 03090203 Site# 251115081075800	0.69' (10/07/2014)–approved– 0.69' (11/25/2014)–provisional–	– 2.38' (03/27/2014)–approved– –2.37'(02/28/2015)–provisional–

9) This topographic survey is certified to URS Group, Inc. and the National Park Service.

ROBERT M. JONES
FLORIDA PROFESSIONAL SURVEYOR AND MAPPER
LICENSE No. LS 4201



LEGEND:

NGS	= NATIONAL GEODETIC SURVEY
+0.3	= GROUND ELEVATION
▲	= THREE DIMENSIONAL CONTROL POINT
NPS	= NATIONAL PARK SERVICE
OPUS	= NGS ONLINE POSITIONING USER SYSTEM
USGS	= UNITED STATES GEOLOGICAL SURVEY

REVISIONS	BY	DATE

HORIZONTAL DATUM: NAD 1983

VERTICAL DATUM: NAVD88

2000 0 2000 4000
SCALE OF FEET 1" = 2000'

PREPARED FOR:
URS GROUP, INC.
7650 CORPORATE CENTER DRIVE
SUITE 400 MIAMI, FL 33126
CONTRACT NO. GSA FSS GS–10F–1057K

A–E FIRM
NAME: AMEC E&I
CITY: ORLANDO, FL
75 E. AMELIA ST. 32801
Phone # 407–522–7570
LB # 7932

FIELD WORK: J.HUDSON
DRAWN: A.WATERS
CHECKED: R.M.JONES

Map of Topographic Survey
Cape Sable Canal Dams Restoration Phase II
Everglades National Park, Flamingo

PKG. NO. _ _ _
SHEET 1 OF 6
DRAWING NO. ———

LITTLE SABLE CREEK

SURVEYOR'S OBSERVATION
At lower tide there is some obstacle just under the surface in the area of the old dam. We had no issues getting past this near the middle of the canal (where we always stayed). We thought it was just a log or tree / tree branch. Only once or twice did we feel contact with the bottom of the boat, like going over a log. For the most part it did seem that the obstacle was in the middle of the canal.

MANGROVES

OPEN GROUND

35'–40' WIDE

TYPICAL CROSS SECTION

OPEN GROUND

Creek 25'–35' WIDE

RAULERSON CANAL

SURVEYOR'S OBSERVATION
The tide is especially strong and fast moving through this portion of canal along with a substantial amount of mangrove branch overgrowth. This makes for very challenging navigation. Many branches will need to be trimmed to open up canal for small barge movement.

Vessels utilized in course of performing topographic survey at this site:

(1) 16' Long x 6' Wide G3 model 1652 john boat with 50 horsepower Yamaha engine. Draft +/– 1.2'

(2) 15.3' Long x 5.4' Wide Polarcraft john boat with 25 horsepower Nissan engine. Draft +/– 0.9'

CREEK BOTTOM ELEVATION (TYPICAL)

LITTLE SABLE CREEK 35'–40' WIDE

SURVEYOR'S OBSERVATION
It seems to us that both Little Sable Creek & Raulerson Canal are deep enough and wide enough for a smaller barge. During periods of time near low tide both were deep enough.

LAKE INGRAHAM

= High points in vicinity of proposed dam location

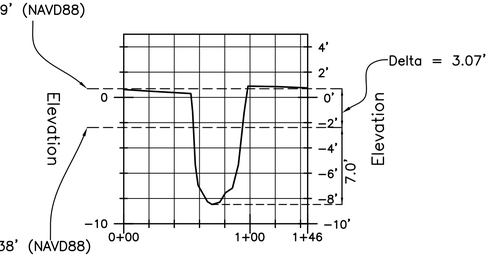
Typical Cross Section

Raulerson PROFILE

Station

Maximum gage height 0.69' (NAVD88)
Approved (9/8/14)

Minimum gage height –2.38' (NAVD88)
Approved (3/27/14)



Station

RAULERSON CANAL

REVISIONS	BY	DATE							
			HORIZONTAL DATUM: NAD 1983 VERTICAL DATUM: NAVD88	60 0 60 120 SCALE OF FEET 1" = 60'	PREPARED FOR: URS GROUP, INC. 7650 CORPORATE CENTER DRIVE SUITE 400 MIAMI, FL 33126 CONTRACT NO. GSA FSS GS–10F–1057K	A–E FIRM NAME: AMEC E&I CITY: ORLANDO, FL 75 E AMELIA ST. 32801 Phone # 407–522–7570 LB # 7932	FIELD WORK: J.HUDSON DRAWN: A.WATERS CHECKED: R.M.JONES	Map of Topographic Survey Cape Sable Canal Dams Restoration Phase II Everglades National Park, Flamingo	PKG. NO. –.– –.– SHEET 2 OF 6 DRAWING NO.

THICK MANGROVES

THICK MANGROVES

CREEK 40'–50' WIDE

TYPICAL CROSS SECTION

USGS EAST SIDE CREEK MONITORING STATION

GS07

40'–50' WIDE

EAST SIDE CREEK

CREEK BOTTOM ELEVATION (TYPICAL)

SURVEYOR'S OBSERVATION
This portion of the creek is very similar to the portion surveyed. Approximately 40' – 50' wide with sufficient depth.

CUTOFF CREEK
25'–30' WIDE

SURVEYOR'S OBSERVATION
This stretch feels more narrow due to overgrown mangrove branches. Also the tide is fairly strong and moves fast through here. Mangrove branches will have to be trimmed for small barge movement.

30'–45' WIDE

Vessels utilized in course of performing topographic survey at this site:

(1) 16' Long x 6' Wide G3 model 1652 john boat with 50 horsepower Yamaha engine. Draft +/– 1.2'

(2) 15.3' Long x 5.4' Wide Polarcraft john boat with 25 horsepower Nissan engine. Draft +/– 0.9'

CS05

CS06

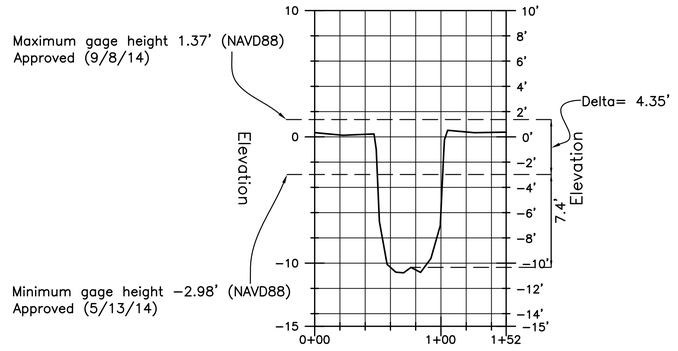
EAST CAPE CANAL DAM

EAST CAPE CANAL

Typical Cross Section

East Side Creek PROFILE

Station



EAST SIDE CREEK

REVISIONS	BY	DATE						
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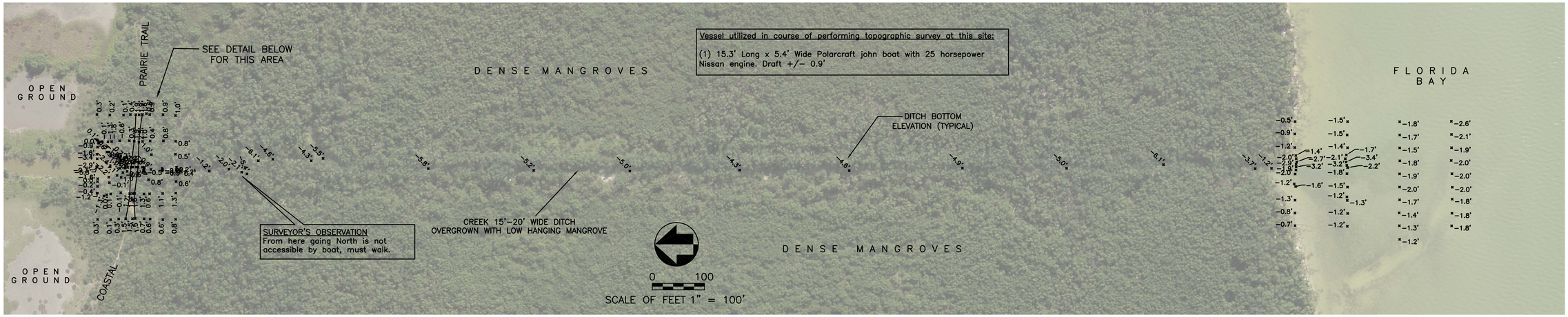
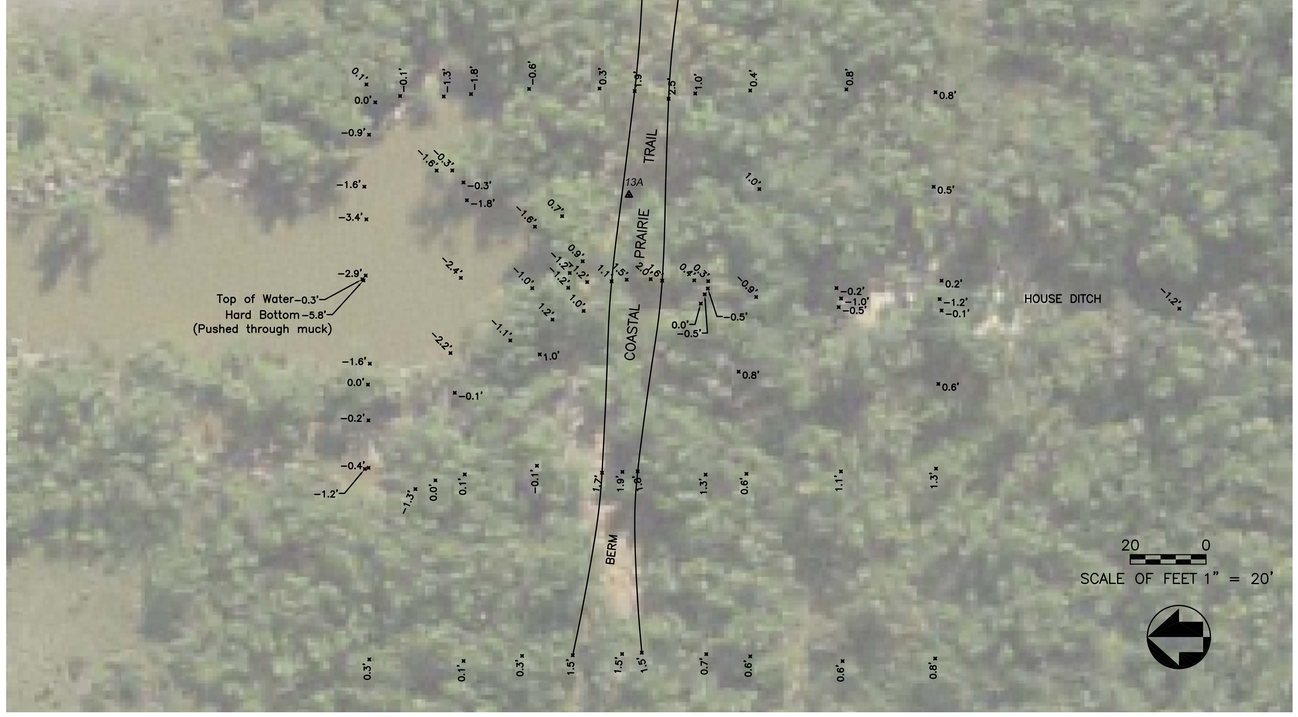
										SHEET 3 OF 6	DRAWING NO. ———

HOUSE DITCH DAM



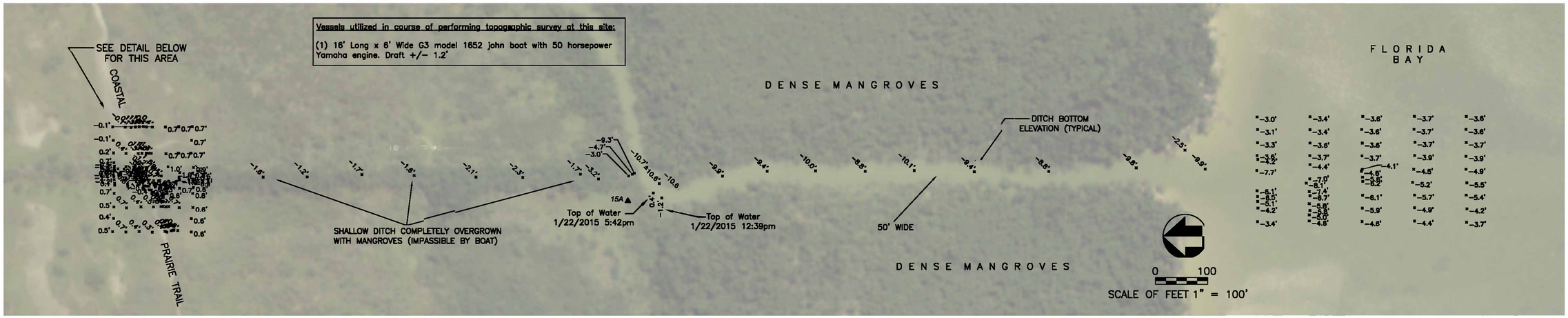
DETAIL DITCH DAM AREA



REVISIONS	BY	DATE						
			HORIZONTAL DATUM: NAD 1983 VERTICAL DATUM: NAVD88	100 0 100 200 SCALE OF FEET 1" = 100'	PREPARED FOR: URS GROUP, INC. 7650 CORPORATE CENTER DRIVE SUITE 400 MIAMI, FL 33126 CONTRACT NO. GSA FSS GS-10F-1057K	A-E FIRM: NAME: AMEC E&I CITY: ORLANDO, FL 75 E AMELIA ST. 32801 Phone # 407-522-7570 LB # 7932	FIELD WORK: J.HUDSON DRAWN: A.WATERS CHECKED: R.M.JONES	Map of Topographic Survey Cape Sable Canal Dams Restoration Phase II Everglades National Park, Flamingo

PKG. NO.	SHEET	DRAWING NO.
- -	4 OF 6	

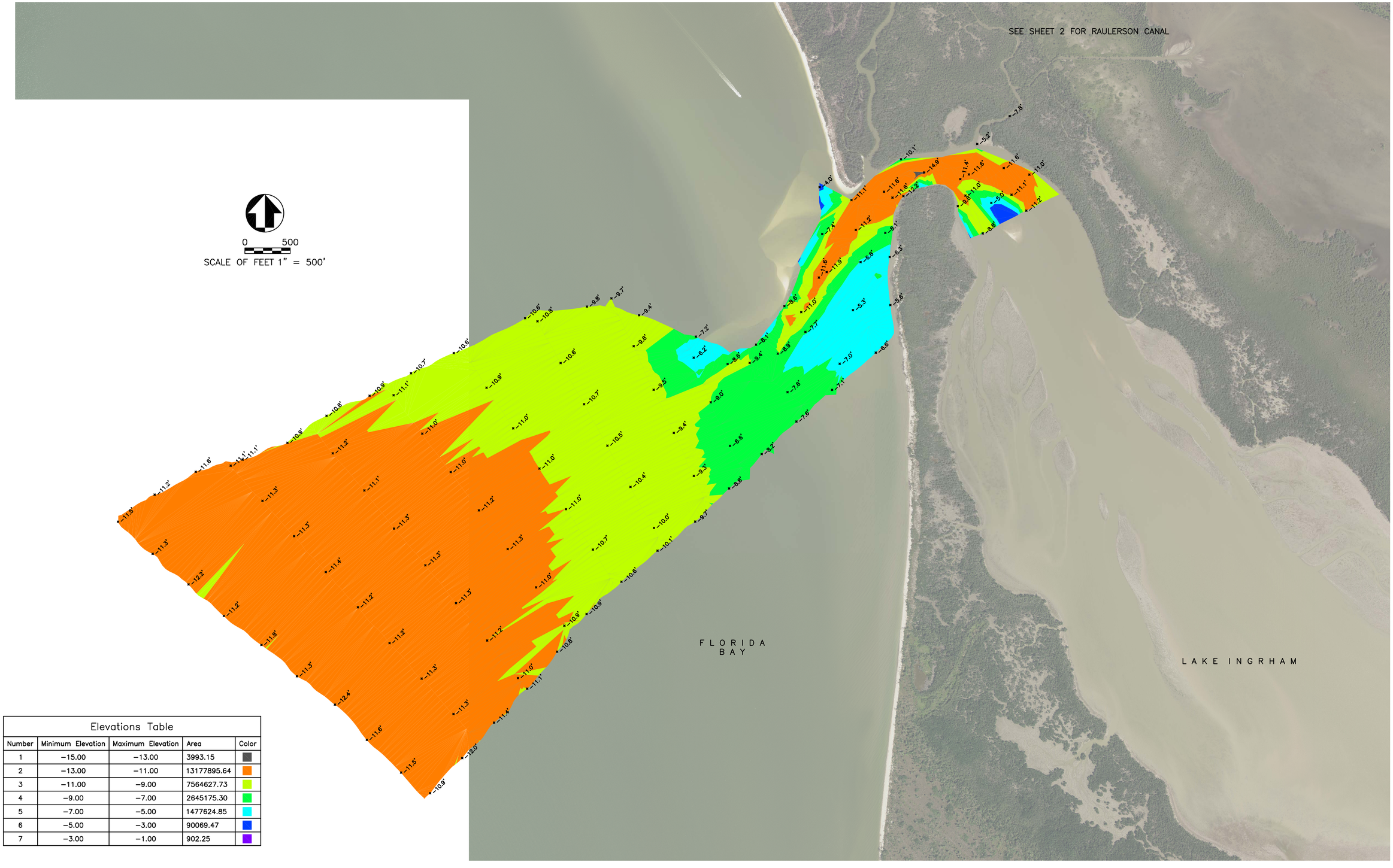
SLAGLE DITCH DAM



DETAIL DITCH DAM AREA

REVISIONS	BY	DATE						
			HORIZONTAL DATUM: NAD 1983 VERTICAL DATUM: NAVD88	100 0 100 200 SCALE OF FEET 1" = 100'	PREPARED FOR: URS GROUP, INC. 7650 CORPORATE CENTER DRIVE SUITE 400 MIAMI, FL 33126 CONTRACT NO. GSA FSS GS-10F-1057K	A-E FIRM NAME: AMEC E&I CITY: ORLANDO, FL 75 E AMELIA ST. 32801 Phone # 407-522-7570 LB # 7932	FIELD WORK: J.HUDSON DRAWN: A.WATERS CHECKED: R.M.JONES	Map of Topographic Survey Cape Sable Canal Dams Restoration Phase II Everglades National Park, Flamingo	PKG. NO. — SHEET 5 OF 6 DRAWING NO. —

MIDDLE CAPE CANAL APPROACH



Elevations Table				
Number	Minimum Elevation	Maximum Elevation	Area	Color
1	−15.00	−13.00	3993.15	
2	−13.00	−11.00	13177895.64	
3	−11.00	−9.00	7564627.73	
4	−9.00	−7.00	2645175.30	
5	−7.00	−5.00	1477624.85	
6	−5.00	−3.00	90069.47	
7	−3.00	−1.00	902.25	

REVISIONS	BY	DATE

HORIZONTAL DATUM: NAD 1983

VERTICAL DATUM: NAVD88

500 0 500 1000
SCALE OF FEET 1" = 500'

PREPARED FOR:
URS GROUP, INC.
7650 CORPORATE CENTER DRIVE
SUITE 400 MIAMI, FL 33126
CONTRACT NO. GSA FSS GS-10F-1057K

A-E FIRM
NAME: AMEC E&I
CITY: ORLANDO, FL
75 E AMELIA ST. 32801
Phone # 407-522-7570
LB # 7932

FIELD WORK: J.HUDSON
DRAWN: A.WATERS
CHECKED: R.M.JONES

Map of Topographic Survey
Cape Sable Canal Dams Restoration Phase II
Everglades National Park, Flamingo

PKG. NO. —.—.—
SHEET 6 OF 6
DRAWING NO. ———