Big Carlos Pass Inlet Management Plan

Office of Resilience and Coastal Protection

Florida Department of Environmental Protection

October 2024

Final Order Adopting
Big Carlos Pass Inlet Management Plan

WHEREAS, pursuant to section 161.161, Florida Statutes (F.S.), the Florida Department of Environmental Protection (department or DEP) shall "evaluate each improved, modified or altered inlet and determine whether the inlet is a significant cause of beach erosion. With respect to each inlet determined to be a significant cause of beach erosion, the plan shall include the extent to which such inlet causes beach erosion and recommendations to mitigate the erosive impact of the inlet, including, but not limited to, inlet sediment bypassing; improvement of infrastructure to facilitate sand bypassing; modifications to channel dredging, jetty design and disposal of spoil material; establishment of feeder beaches; and beach restoration and beach nourishment."

WHEREAS in 2008, the Florida Legislature amended section 161.142, F.S., finding, "The Legislature recognizes the need for maintaining navigation inlets to promote commercial and recreational uses of our coastal waters and their resources. The Legislature further recognizes that inlets interrupt or alter the natural drift of beach-quality sand resources, which often results in these sand resources being deposited in nearshore areas or in the inlet channel, or in the inland waterway adjacent to the inlet, instead of providing natural nourishment to the adjacent eroding beaches. Accordingly, the Legislature finds it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced and for each level of government to undertake all reasonable efforts to maximize inlet sand bypassing to ensure that beach-quality sand is placed on adjacent eroding beaches. Such activities cannot make up for the historical sand deficits caused by inlets but shall be designed to balance the sediment budget of the inlet and adjacent beaches and extend the life of proximate beach restoration projects so that periodic nourishment is needed less frequently;" and

WHEREAS in 2021-2023, the Lee County sponsored an inlet management study of Big Carlos Pass, which compiled new survey data and information regarding its coastal processes and inlet and shoreline dynamics and updated its sediment budget; and

WHEREAS, in October 2024, the department finalized the development of an inlet management plan that contains corrective measures to mitigate the identified inlet erosion impacts to adjacent beaches; and

WHEREAS, Lee County is responsible for dredging and sand bypassing at Big Carlos Pass and, therefore, responsible for implementation of the inlet management plan; and

WHEREAS, this inlet management plan (attached) is consistent with the department's program objectives under Chapter 161, F.S.

THEREFORE:

The department does hereby adopt the following implementation strategies, as set forth in the attached **Big Carlos Pass Inlet Management Plan**. Future inlet management activities conducted by Lee County, shall be consistent with the following four strategies:

1) **A comprehensive beach and inlet hydrographic monitoring program** shall be conducted to evaluate the performance and impact of existing sand bypassing and nourishment projects and to periodically update the inlet sediment budget. Beach and nearshore surveys between DEP Range/Reference Monuments R201 to R222 shall be conducted for Big Carlos Pass. Periodic inlet hydrographic surveys to include the inlet channel and the ebb shoal shall also be conducted. Specific surveys shall be conducted of the four historic borrow areas in order to determine their recovery rates. Along with topographic and hydrographic surveys of the inlet system and adjoining beaches, dredge records shall be maintained for all sand bypassing activities.

2) **Except for routine navigation channel maintenance dredging, natural sand bypassing shall be continued for the Big Carlos Pass inlet system.**

3) **On an average annual basis, the target inlet sand bypassing quantity shall be 11,500 cubic yards per year to balance losses to the offshore. Monitoring per strategy #1 shall be used to inform placement on the adjacent eroded beaches of Estero Island and Lovers Key.** This target quantity may be modified or updated based on a minimum of four years of additional monitoring data indicating a change in the sediment budget. However, the sediment budget should cover a time period of at least 10 years. Additional sediment volumes may be placed to enhance the beach volume or restore the historic ebb shoal borrow areas.

4) **The source of sediment for meeting the target sand bypassing quantities in Strategy #3 shall be acceptable offshore sources or inland sand mines, or as otherwise authorized by permit.** Acceptable beach quality sand may also be obtained from routine maintenance dredging of the existing navigation channel within the Big Carlos Pass system.

Inlet management actions conducted by Lee County that implement the strategies contained in this plan are subject to further evaluation and subsequent authorization or denial, as part of the department's permitting process. Activities that implement these adopted strategies shall be eligible for state financial participation pursuant to section 161.143, F.S., subject to department approval of a funding request and an appropriation from the Legislature. The level of state funding shall be determined based on the activity being conducted and the department's rules. The department may choose not to participate financially if the proposed method of implementation is not cost effective or fails to meet the intent of section 161.142, F.S., and this final order. Activities ineligible for cost sharing include, but are not limited to navigational construction, operation, and maintenance activities, except those elements whose purpose is to place or keep sand on adjacent beaches. Nothing in this plan precludes the evaluation and potential adoption of other strategies for the effective management of Big Carlos Pass and the adjacent beaches.

Approval of Adoption

Alex Reed

Director of the Office of Resilience and Coastal Protection

Florida Department of Environmental Protection

Filing and Acknowledgement

FILED, on this date with the designated Deputy Clerk, pursuant to section 120.52, F.S., receipt of which is hereby acknowledged.

Deputy Clerk

10/28/2024

Date

Electronic Copies Furnished to:

STATE OF FLORIDA - DEPARTMENT OF ENVIRONMENTAL PROTECTION
Lainie Edwards, Ph.D., Deputy Director, Office of Resilience and Coastal Protection
2600 Blair Stone Road, Tallahassee, Florida 32399-2400
Crystal Anderson, Office of General Counsel
Greg Garis, Beaches, Inlets and Ports Program
Guy Weeks, Beaches, Inlets and Ports Program
Ralph Clark, Coastal Engineering and Geology Group
Michael Isaacson, Beaches Funding Program
DEP Agency Clerk

Lee County – Steve Boutelle
Moffatt & Nichol – Jacqueline Brower
Kevin Bodge – Foth/Olsen

Notice of Rights

This action is final and effective on the date filed with the clerk of the department unless a petition for an administrative hearing is timely filed under sections 120.569 and 120.57, F.S., before the deadline for filing a petition. On the filing of a timely and sufficient petition, this action will not be final and effective until further order of the department. Because the administrative hearing process is designed to formulate final agency action, the hearing process may result in a modification of the agency action or even denial of the request for a variance or waiver.

Petition for Administrative Hearing

A person whose substantial interests are affected by the department's action may petition for an administrative proceeding (hearing) under sections 120.569 and 120.57, F.S. Pursuant to Rule 28-106.201, Florida Administrative Code (F.A.C.), a petition for an administrative hearing must contain the following information:

(a) The name and address of each agency affected and each agency's file or identification number, if known;

(b) The name, address, telephone number and any e-mail address of the petitioner; the name, address, telephone number and any email address of the petitioner's representative, if any, which shall be the address for service purposes during the course of the proceeding; and an explanation of how the petitioner's substantial interests are or will be affected by the agency determination;

(c) A statement of when and how the petitioner received notice of the agency decision;

(d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate;

(e) A concise statement of the ultimate facts alleged, including the specific facts that the petitioner contends warrant reversal or modification of the agency's proposed action;

(f) A statement of the specific rules or statutes that the petitioner contends require reversal or modification of the agency's proposed action, including an explanation of how the alleged facts relate to the specific rules or statutes; and

(g) A statement of the relief sought by the petitioner, stating precisely the action that the petitioner wishes the agency to take with respect to the agency's proposed action.

The petition must be filed (received by the clerk) in the Office of General Counsel of the department at 3900 Commonwealth Blvd., Mail Station 35, Tallahassee, Florida 32399-3000. Also, a copy of the petition shall be mailed to the applicant at the address indicated above at the time of filing.

Time Period for Filing a Petition

In accordance with Rule 62-110.106(3), F.A.C., petitions for an administrative hearing must be filed within 21 days of receipt of this written notice. The failure to file a petition within the appropriate time period shall constitute a waiver of that person's right to request an administrative determination (hearing) under sections 120.569 and 120.57, F.S., or to intervene in this proceeding and participate as a party to it. Any subsequent intervention (in a proceeding initiated by another party) will be only at the discretion of the presiding officer upon the filing of a motion in compliance with Rule 28-106.205, F.A.C.

Extension of Time

Under Rule 62-110.106(4), F.A.C., a person whose substantial interests are affected by the department's action may also request an extension of time to file a petition for an administrative hearing. The department may, for good cause shown, grant the request for an extension of time. Requests for extension of time must be filed with the Office of General Counsel of the department at 3900 Commonwealth Blvd., Mail Station 35, Tallahassee, Florida 32399-3000, before the applicable deadline for filing a petition for an administrative hearing. A timely request for extension of time shall toll the running of the time period for filing a petition until the request is acted upon.

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Introduction

Pursuant to Subsection 161.101(2), F.S., the Florida Department of Environmental Protection (department or DEP) is the beach and shore preservation authority for the state of Florida. As part of the department's statewide beach management plan adopted pursuant to section 161.161, F.S., the department is adopting this inlet management plan for Big Carlos Pass in Lee County, Florida.

"Big Carlos Pass Inlet Management Plan" updates strategies for Big Carlos Pass that were adopted 2008 in the "Strategic Beach Management Plan" (DEP, 2008) to be consistent with current statutes and observed erosion[1] conditions. The current "Strategic Beach Management Plan" (DEP, 2023a) calls for "Monitor and complete inlet management study; develop a sediment budget for the adoption of an inlet management plan to guide the future dredging and beach placement of inlet material."

See the general location of Big Carlos Pass in **Figure 1**.

[1] As used in this document, the term "erosion" means wearing away of land or the removal of consolidated or unconsolidated material from the coastal system by wind or wave action, storm surge, tidal or littoral currents or surface water runoff. As used in this document, the term "accretion" means the buildup of land or accumulation of unconsolidated material within the coastal system caused by wind and wave action, storm surge, or tidal or littoral currents. The descriptions of coastal processes in this document are not intended to affect title to real property or real property boundaries.

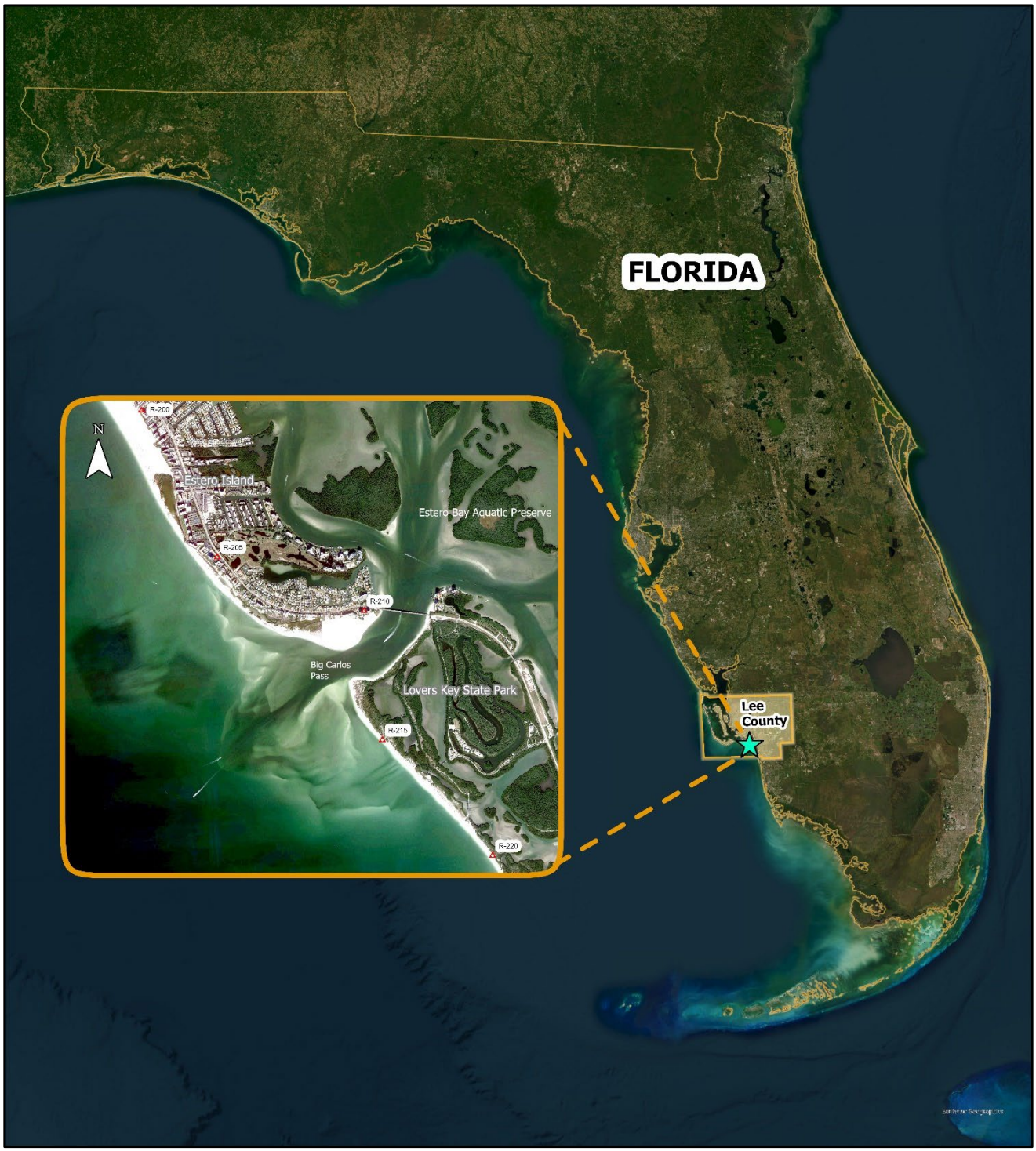

Figure 1. 2017 aerial photograph showing the location of Big Carlos Pass, Earthstar Geographics.

Program Objectives and Statutory Responsibilities for Inlet Management

In 2008, the Florida Legislature amended section 161.142, F.S., finding,

> "The Legislature recognizes the need for maintaining navigation inlets to promote commercial and recreational uses of our coastal waters and their resources. The Legislature further recognizes that inlets interrupt or alter the natural drift of beach-quality sand resources, which often results in these sand resources being deposited in nearshore areas or in the inlet channel, or in the inland waterway adjacent to the inlet, instead of providing natural nourishment to the adjacent eroding beaches. Accordingly, the Legislature finds it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced and for each level of government to undertake all reasonable efforts to maximize inlet sand bypassing to ensure that beach-quality sand is placed on adjacent eroding beaches. Such activities cannot make up for the historical sand deficits caused by inlets but shall be designed to balance the sediment budget of the inlet and adjacent beaches and extend the life of proximate beach restoration projects so that periodic nourishment is needed less frequently."

Pursuant to section 161.143, F.S.,

> "Studies, projects and activities for the purpose of mitigating the erosive effects of inlets and balancing the sediment budget of the inlet and adjacent beaches must be supported by separately approved inlet management plans or inlet components of the statewide comprehensive beach management plan."

Lee County has been the entity responsible for dredging Big Carlos Pass and consequently, mitigating the extent of beach erosion caused by the inlet, as specified in Subsection 161.142 (6), F.S.

History of Big Carlos Pass

Big Carlos Pass is in southern Lee County on the southwest Gulf Coast of Florida between Estero Island to the north and Black Island and Lovers Key State Park to the south and is located between DEP range/reference monuments R210 and R211 (**Figure 2**). Big Carlos Pass along with New Pass and Big Hickory Pass to the south connect the Gulf of Mexico with Estero Bay. The largest of the three inlets, Big Carlos Pass, has remained essentially unchanged over the past century with a width of approximately 1,600 feet and depths which exceed 20 feet.

It is important to understand the history of Big Carlos Pass, its evolution and prior inlet management activities, and beach erosion control activities along the adjacent beaches, to gain a perspective on the inlet's dynamics and the need to change inlet management strategies over time. The coastal area of southwest Florida has been inhabited by pre-Colombian tribes referred to as the Calusa for at least the past two thousand years. Early Spanish references and archeological investigations provide the current state of knowledge about these people who likely used the local inlets for small craft navigation. Mound Key lying east of Big Carlos Pass is one of the largest Calusa sites in the region and was reportedly the stronghold of Carlos, the Calusa chief, and its temple mound was used for religious activities. The Calusa were reportedly extinct by the early 19th century and had been displaced by the Seminoles who were gradually pushed southward during the Seminole wars.

Development in the area began in the late 19th century with scattered homesteads. Dr. Cyrus Teed received a deed to 300 acres on the south end of Estero Island and established the Koreshan Unity's College of Life (a communal pioneer society) (C.P. Jones, 1980). Many of the homesteaders around Estero Bay were Koreshans. In 1921, a road and bridge were initiated to connect the north end of Estero Island with the mainland. The 1921 hurricane that made landfall further north near Clearwater brushed the Lee County coast causing storm surge flooding across Estero Island. Another hurricane in 1926 caused severe flooding which was reportedly shoulder deep along Estero Island (USACE, 1970). The bridge at the island's north end was severely damaged and the southern tip of the island was eroded away.

Figure 2. Google Earth aerial image of Big Carlos Pass from January 2022, before Hurricane Ian made landfall.

In 1945, the U.S. Congress authorized construction of the West Coast Intracoastal Waterway between the Caloosahatchee River (Lee County) and the Anclote River (Pinellas County). In June 1960, dredging for this project began and was completed in the late 1960's. Also in 1960, Hurricane Donna made a direct impact on the area causing extensive damage and erosion at Big Carlos Pass. In 1961, a federal navigation project was completed north of Estero Island at Matanzas Pass for a length of 2.1 miles. Between 1963 and 1965, a 4.3-mile-long causeway with bridges was constructed from south Estero Island across Big Carlos Pass southward to Bonita Beach.

Lovers Key to the south of Big Carlos Pass originated as a shoal that emerged with the passage of Hurricane Donna. Dredging of wetlands and bay bottoms created additional uplands. The state of Florida purchased Lovers Key in 1983 and merged it with additional acquisition of Lee County owned lands on Black Island, Long Key and Inner Key in 1996 to create Lovers Key State Park. East of Big Carlos Pass, lands owned by the Koreshan Unity on Mound Key, Black Island, and the community of Estero along the Estero River were deeded to the state of Florida in 1961 and make up much of the Koreshan State Historic Site.

Dredging of Big Carlos Pass has been limited to the excavation of four borrow areas within the ebb shoal for beach nourishment projects in 2004 and 2014. Navigation channel maintenance dredging was also conducted in 2017. In 2004, 587,746 cubic yards of sand was excavated from the northern most of the four borrow areas and placed on Lovers Key to the south. Another 145,100 cubic yards of sand was obtained from a borrow site closer to the inlet channel and placed on Bonito Beach located three islands to the south. In 2014, 236,000 cubic yards of sand was excavated from a borrow area between the two 2004 borrow areas and placed on both Lovers Key and Bonito Beach. Another 225,000 cubic yards of sand was obtained from a borrow site at the seaward terminus of the inlet channel and placed on Lovers Key. In 2017, 54,675 cubic yards of sand was maintenance dredged from the inlet navigation channel and placed along the southern end of Estero Island on what may be referred to as the Little Estero Island complex between DEP reference monuments R203.5 and R2006.

The impact of Hurricane Donna in 1960 likely affected the dynamics of the shoals within the ebb tidal delta of Big Carlos Pass. Clark (2022) evaluates the emergence of Little Estero Island from

the Big Carlos Pass ebb shoal and its migration and attachments to the southern two miles of Estero Island. The 1968 aerial shows numerous submerged shoals exist as part of the ebb tidal delta of Big Carlos Pass in the Gulf of Mexico. By 1975, Little Estero Island had completely emerged as an island off southern Estero Island (**Figure 3**).

Figure 3. Estero Island and Big Carlos Pass in 1968 (left photo) and Little Estero Island completely emerged in 1975 (right photo).

A subtropical storm in June 1982, called the No Name Storm, caused substantial erosion to the beaches adjacent to Big Carlos Pass. The southern half of Little Estero Island dissintegrated above the tide levels by erosion and remained existant as a swash bar only exposed at low tide. Emergence of a nearshore sand bar and southward longshore transport resulted in the natural restoration of Little Estero Island and spit growth continued southward resulting in multiple attachments with Estero Island. Aerial photography in 2002 shows Little Estero Island's final attachment on the Big Carlos Pass shoreline near or to the east of R209 (**Figure 4**).

Figure 4. Aerial photo (2002) showing the southeastern attachment of Little Estero Island to Estero Island at Big Carlos Pass (from Clark, 2022).

In August 2004, category 4 Hurricane Charley made landfall in Lee County causing major erosion and storm surge flooding to the beaches adjacent Big Carlos Pass. In October 2004, the Lovers Key beaches were nourished from the Big Carlos Pass ebb shoal that placed 570, 240 cubic yards between R214.5 and R220.5. Erosion of the beaches adjacent to Big Carlos Pass continued and Lovers Key was nourished in December 2014 from the previously mentioned ebb

shoal borrow areas and south Estero Island was nourished in 2017 from the inlet channel maintenance project that placed 55,465 cubic yards of material between R203.5 and R205.2 (**Figure 5**).

Figure 5. The 2017 fill placement at R-204 during Big Carlos Pass channel maintenance project (photo provided by Humiston & Moore, Inc.).

In September 2022, category 4 Hurricane Ian inflicted catastrophic damage and erosion to Lee County. Major morphological changes were incurred along the beaches adjacent to Big Carlos Pass (**Figure 6**).

Figure 6. Big Carlos Pass and adjacent beaches on Sept. 30, 2022. Image is post Hurricane Ian's landfall.

In summer 2024, southern Estero Island was nourished between R203 and R207 with approximately 141,000 cubic yards of sand from an offshore borrow source.

In 2008, the department adopted inlet management strategies for Big Carlos Pass in the "Strategic Beach Management Plan," which were to "Monitor and complete inlet management study; develop a sediment budget for the adoption of an inlet management plan to guide the future dredging and beach placement of inlet material." (DEP, 2008).

Estero Barriers Regional Inlet Management Study

A regional inlet management study was initiated by Lee County in 2019 to study Big Carlos Pass, New Pass and Big Hickory Pass. The study was completed, and all documents and data were submitted to the department in April 2023 by the county's consultant, Moffatt & Nichol (M&N, 2021a, 2021b, 2022a, 2022b, 2023; OAI, 2022). During the study, six technical advisory committee meetings were held to track the study's progress and develop recommendations for continued study efforts to include developing modeling alternatives for inlet management strategies.

M&N conducted a data and literature review compiling available beach profiles, bathymetry, shoreline positions, aerial photos, sediment grain size data, resource surveys, wind and wave data, sediment transport computations and dredging records. A field data collection effort was conducted that updated bathymetry of the study area. Water levels, waves and currents were obtained through Acoustic Doppler Current Profiler (ADCP) transects across the inlet channels and through a 30-day deployment of five bottom-mounted ADCP's at each of the three inlets as well as one nearshore and one offshore location. Forty hours of current measurements were also obtained from Matanzas Pass north of Estero Island. ADCP data was obtained in both November 2020 and June-August 2021.

A shoreline change and volumetric analysis were conducted of the beaches, inlets and shoals. Beach volume changes were calculated for three periods between 2010 and 2020 using profile surveys from March 2010, June 2016 and June 2020. Hydrodynamic and wave transformation modeling along with a metocean analysis were conducted to describe the study area. Shoreline change modeling was conducted for the four coastal barriers in the study area using the Danish

Hydraulics Institute (DHI) shoreline evolution model — LITLINE. The four shoreline evaluation models were developed and calibrated utilizing the historical shoreline and volume changes along with an evaluation of the model simulated longshore sediment transport rates. M&N subsequently utilized the Delft3D numerical model using the wave and hydrodynamic model results as boundary conditions for the study area. The Delft3D model runs were calibrated to the field data and produced regional morphological conditions and sediment transport in the study area. The Delft3D model evaluated various study alternatives for the development of recommended inlet management strategies.

Sediment Budget of 2023

Pursuant to section 161.142, F.S., dredging within an inlet system, including its shoals, should result in the placement of all beach quality sand on adjacent eroding beaches to balance the sediment budget between the inlet and adjacent beaches. A sediment budget is a balance of the volumes (or volume rate of change) for sediments entering and leaving a tidal inlet system and its adjacent beaches. A sediment budget quantifies the natural longshore sediment transport by waves and tides to and from the inlet, the entrapment of longshore sediment by the inlet channel and the ebb and flood shoals, and the mechanical "bypassing" of sediment, typically by a hydraulic dredge, from the inlet to the adjacent eroded beaches or nearshore. Sediment transport volumes and pathways are unique to each inlet as influenced by regional geology, morphological characteristics, wave and tide conditions, and sediment characteristics and supply. A sediment budget is determined by comparing two or more surveys of an inlet system, including its channel, ebb and flood shoals, and the adjacent beaches.

In support of the Estero Barriers Regional Inlet Management Study, Olsen Associates, Inc. (OAI) developed a regional sediment budget for the three-inlet system of Big Carlos Pass, New Pass and Big Hickory Pass (OAI, 2022). The interconnectivity between the beaches and inlets was very complex and dominated by inlet shoals resulting in a comprehensive sediment budget with discreet sediment cells representing different dynamic and morphological features within the regional study area. The sediment budget's vectors and magnitudes represent net sediment transport and volume change rates. In describing the methodology used to develop the sediment budget, OAI (2022) notes, "The approaches used to develop the sediment budget include

assessing prior monitoring reports and their evaluations, and prior studies; accounting for the history of dredge and fill activities along the area; using the sediment transport rates and pathways predicted by the 3DCST and Mike21/LITLINE models by M&N along the study area; comparing inlet flow rates measured for the present study; parsing the study area into sub-regions by bathymetry and transport directions that were thence individually evaluated; computing historical volume changes assessed by multiple survey comparisons for each of the subregions; observing the physical changes of the islands and shoals through aerial photographs; and evaluating the shoreline changes along the system through survey data and aerial photographs. All of these techniques together make up the final result of the sediment budget, which cannot be understood considering any one of these techniques alone."

The sediment budget for solely Big Carlos Pass is best represented by the area from R201 on Estero Island at the north end southward to just south of R219 on Lovers Key where there exists a longshore sediment transport reversal. There is also a drift divide on Estero Island between R203 and R204 north of which net transport is northerly and south of which along the historic Little Estero Island the net transport is to the south. **Figure 7** by OAI (2022) graphically presents the sediment budget affecting Big Carlos Pass. Noteworthy, are the beach erosion conditions both north and south of Big Carlos Pass along southern Estero Island and Lovers Key, plus the sediment accretion in the ebb shoals off the entrance to the pass as well as within the inlet navigation channel and the interior flood shoal.

The bathymetric data used in the sediment budget analysis spanned the period between 2005 and 2020. For the entire regional sediment budget of the three-inlet system, 48 surveys from 14 different years made up 13 data sets that computed the volumes and shoreline changes. There was considerable variation in areal extent and density of coverage of survey data from year to year.

Tidal flow rates were measured at each of the three inlets over a 30-day period from Nov. 18 to Dec. 17, 2020. As seen in **Table 1**, Big Carlos Pass as well as the other two inlets were ebb tide dominant. This ebb dominance is visually observed through the existence of the large ebb shoals. The average flow velocities at Big Carlos Pass were 2.2 feet per second over the entire 6.5-hour duration of ebb or flood tide.

Table 1. Average Tidal Flow rates through Inlets (Cubic Meters per Tidal Day).

Inlet	Gross Flood	Gross Ebb	Net	Ebb/Flood
Big Carlos Pass	35,045,100	(36,172,200)	(1,127,100)	1.032
New Pass	15,559,900	(15,638,600)	(78,700)	1.005
Big Hickory Pass	1,818,300	(1,823,700)	(5,400)	1.003

Note: From approximately 30 calendar days (28.5 lunar days) of measured data, 11/18/2020 (01:15) to 12/17/2020 (14:54). One Lunar (Tidal) day = approximately 24.85 hours.

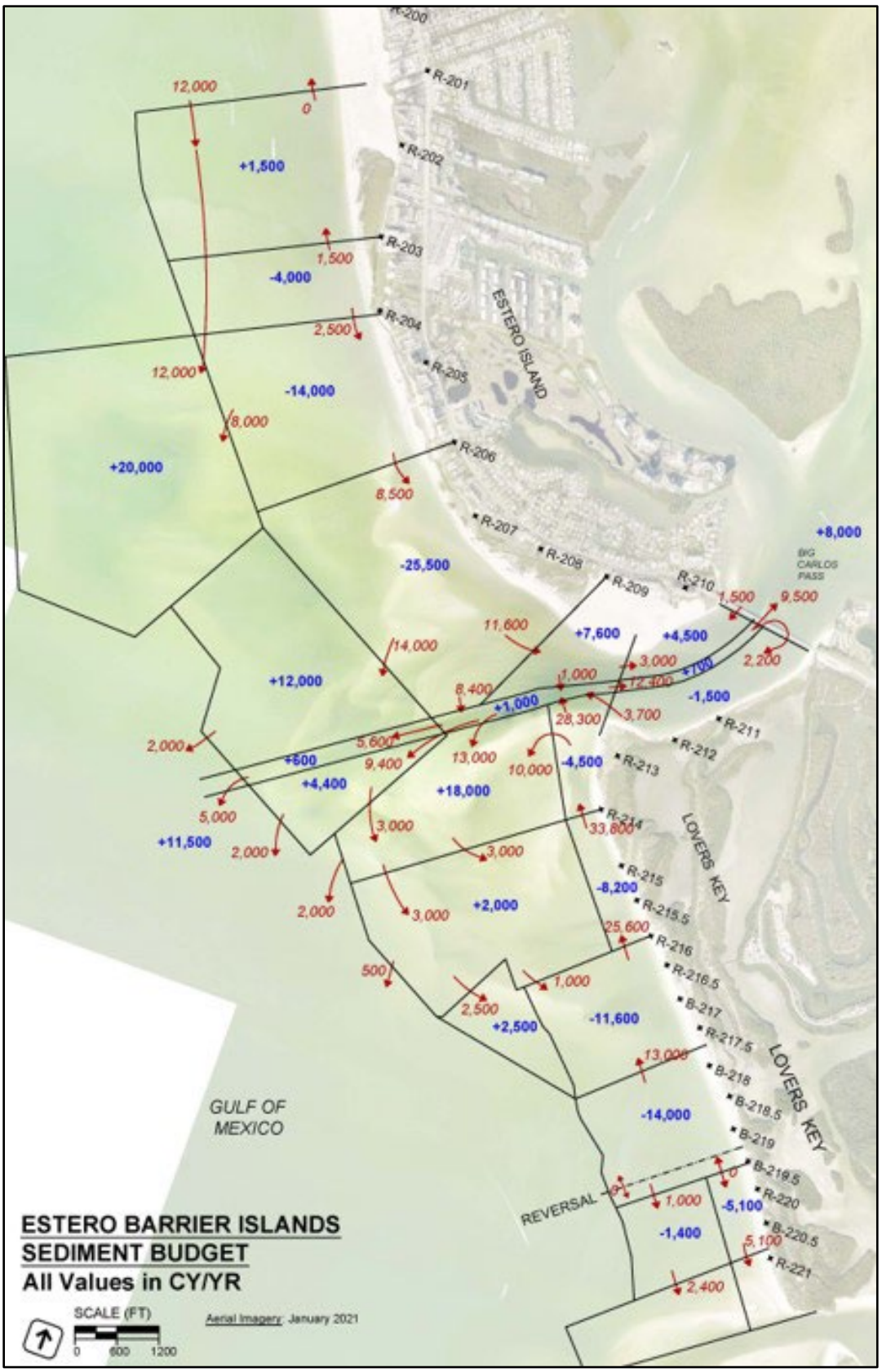

Figure 7. Big Carlos Pass sediment budget (Olsen and Associates, Inc., 2022).

Alternatives Analysis

The regional inlet management study evaluated several alternative management strategies (M&N, 2022b). Alternative 1 was a "no action" alternative that was used for comparison to other alternatives. Alternative 2 was the current beach nourishment maintenance schedule using the same beach fill placement templates as the 2014 project and the same borrow areas within the Big Carlos Pass ebb shoal as were used in the 2004 and 2014 projects. However, because the historic borrow area recovery rates were substantially less than the Lovers Key and Bonita Beach volumetric erosion rates, this alternative was determined not to be a sustainable solution and was not considered further.

Alternative 3 considered reduced project areas and templates for Lovers Key and Bonita Beach that may be considered sustainable using only the quantity of sediment that recovers in the ebb shoal borrow areas. Alternative 4 considered full beach restoration projects as conducted in 2014 but utilizing offshore sand sources. Two sub-alternatives were considered; one that used the available sediment from the Big Carlos ebb shoal with supplemental offshore material and a second with solely offshore material used for nourishment.

A fifth alternative was to consider structures such as breakwaters, jetties or groins. Groins already exist along Big Hickory Island and at the terminal north end of Bonita Beach. It was determined that there were no "hot spot" areas of inlet induced erosion that may typically justify the construction of shore-protection structures beyond those that currently exist. The study consultants and the technical advisory committee agreed not to consider additional structures as a management strategy any further at this time.

Not evaluated in the study, but suggested for future analysis was the investigation and development of interior sand traps involving excavation within the flood shoals. Flood shoal dredging projects typically involve greater environmental resource scrutiny, and the volumes projected by the sediment budget are relatively small.

The study concluded that the historic borrow areas within the Big Carlos Pass ebb shoal are not sustainable for the historic large-scale nourishments of nearby beach restoration projects. The volumetric recovery rates are less than the beach erosion rates. Offshore borrow areas should be

utilized to bring additional sand into the system for these beach nourishment projects, and the previously dredged ebb shoal borrow areas should be allowed to recover.

Not discussed in the study is maintenance dredging of the existing navigation channel within Big Carlos Pass. Maintenance of this channel is very infrequent and subject to major storm events. Based upon the sediment budget, placement of this material is recommended for either southern Estero Island or northern Lovers Key depending on which segment of beach is in greatest need at the time of channel maintenance. The quantity of channel maintenance is expected to be small but will supplement the bypassing requirements for these beaches.

Recommended Inlet Management Plan Strategies

The department staff recommends the following inlet management strategies be adopted to meet the requirements of Chapter 161, F.S.

1) **A comprehensive beach and inlet hydrographic monitoring program** shall be conducted to evaluate the performance and impact of existing sand bypassing and nourishment projects and to periodically update the inlet sediment budget. Beach and nearshore surveys between DEP Range/Reference Monuments R201 to R222 shall be conducted for Big Carlos Pass. Periodic inlet hydrographic surveys to include the inlet channel and the ebb shoal shall also be conducted. Specific surveys shall be conducted of the four historic borrow areas in order to determine their recovery rates. Along with topographic and hydrographic surveys of the inlet system and adjoining beaches, dredge records shall be maintained for all sand bypassing activities.

Discussion – A comprehensive beach and inlet hydrographic monitoring program is the most important element to manage the sediment at Big Carlos Pass. Topographic and bathymetric surveys provide reliable data to estimate the volumetric impact of the inlet on adjacent beaches and to establish a sand placement protocol that complies with section 161.142, F.S.

2) **Except for routine navigation channel maintenance dredging, natural sand bypassing shall be continued for the Big Carlos Pass inlet system.**

Discussion – The beaches north and south of Big Carlos Pass are the adjacent eroded beaches directly impacted by the inlet system. The beaches along southern Estero Island north of Big Carlos Pass (R203-R207) and the beaches along Lovers Key south of Big Carlos Pass (R211-R222) are designated critically eroded by the department (DEP, 2023b). However, according to the sediment budget, the Lovers Key beach north of R219 is part of the Big Carlos Pass transport system.

3) **On an average annual basis, the target inlet sand bypassing quantity shall be 11,500 cubic yards per year to balance losses to the offshore. Monitoring per strategy #1 shall be used to inform placement on the adjacent eroded beaches of Estero Island**

and Lovers Key. This target quantity may be modified or updated based on a minimum of four years of additional monitoring data indicating a change in the sediment budget. However, the sediment budget should cover a time period of at least 10 years. Additional sediment volumes may be placed to enhance the beach volume or restore the historic ebb shoal borrow areas.

Discussion – The sediment budget indicates a need to place a total annual quantity of approximately 11,500 cubic yards of sand on the eroded beaches adjacent to the inlet to account for the loss of material into the inlet and then to the offshore.

4) **The source of sediment for meeting the target sand bypassing quantities in Strategy #3 shall be acceptable offshore sources or inland sand mines, or as otherwise authorized by permit.** Acceptable beach quality sand may also be obtained from routine maintenance dredging of the existing navigation channel within the Big Carlos Pass system.

Discussion – Natural bypassing is recommended to continue to occur, with a focus on allowing natural recirculation in the ebb shoal and beach system, supplemented by strategic nourishments using an offshore or upland sand source.

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