PELICAN BAY SERVICES DIVISION
Municipal Service Taxing and Benefit Unit

NOTICE OF PUBLIC MEETING **OCTOBER 27, 2020**

THE CLAM BAY COMMITTEE OF THE PELICAN BAY SERVICES DIVISION WILL MEET AT 1:30 PM ON TUESDAY, OCTOBER 27 AT THE COMMUNITY CENTER AT PELICAN BAY, 8960 HAMMOCK OAK DRIVE, NAPLES, FLORIDA 34108.

AGENDA

1. Roll call
2. Agenda approval
3. Approval of 03/12/2020 meeting minutes
4. Audience comments
5. Clam Pass
    a. Station 14 tidal gauge repair update
    b. Clam Bay Management Plan Dredging Policy
    c. Tidal ratio data for 2016-2020
    d. Bathymetric survey report May 2020
    e. Aerial photos from 2017 and 2018
    f. Timeline to dredge Clam Pass
    g. Intervention strategies
6. Water Quality
    a. 2019 annual WQ report
    b. 2020 WQ report for April, May & June
    c. Copper results
7. Clam Bay
    a. Update on spring and fall mangrove monitoring
    b. Update on hand-dug channel maintenance
    c. Canoe trail marker 6 signage
    d. Scaevola treatment proposal
    e. County boater safety signage
8. Dates for annual reports
    a. Clam Bay: December 18
    b. Clam Pass Physical and Tidal monitoring: December 18
    c. Water Quality: March 12, 2021
9. Next meeting
10. Adjournment

ANY PERSON WISHING TO SPEAK ON AN AGENDA ITEM WILL RECEIVE UP TO THREE (3) MINUTES PER ITEM TO ADDRESS THE BOARD. THE BOARD WILL SOLICIT PUBLIC COMMENTS ON SUBJECTS NOT ON THIS AGENDA AND ANY PERSON WISHING TO SPEAK WILL RECEIVE UP TO THREE (3) MINUTES. THE BOARD ENCOURAGES YOU TO SUBMIT YOUR COMMENTS IN WRITING IN ADVANCE OF THE MEETING. ANY PERSON WHO DECIDES TO APPEAL A DECISION OF THIS BOARD WILL NEED A RECORD OF THE PROCEEDING PERTAINING THERETO, AND THEREFORE MAY NEED TO ENSURE THAT A VERBATIM RECORD IS MADE, WHICH INCLUDES THE TESTIMONY AND EVIDENCE UPON WHICH THE APPEAL IS TO BE BASED. IF YOU ARE A PERSON WITH A DISABILITY WHO NEEDS AN ACCOMMODATION IN ORDER TO PARTICIPATE IN THIS MEETING YOU ARE ENTITLED TO THE PROVISION OF CERTAIN ASSISTANCE.

PELICAN BAY SERVICES DIVISION
CLAM BAY COMMITTEE MEETING
MARCH 12, 2020

The Clam Bay Committee of the Pelican Bay Services Division met on Thursday, March 12 at 1:30 p.m. at the SunTrust Bank Building, 801 Laurel Oak Drive, Suite 302, Naples, Florida 34108. In attendance were:

Clam Bay Committee
Susan O'Brien, Chairman
Denise McLaughlin
Rick Swider

Pelican Bay Services Division Staff
Neil Dorrill, Administrator *(absent)*
Chad Coleman, Operations Manager
Sarah Hamilton, Operations Analyst *(absent)*
Lisa Jacob, Project Manager
Barbara Shea, Admin. Assistant *(absent)*

Also Present
Mohamed Dabees, Humiston & Moore
Tim Hall, Turrell, Hall & Associates
Jeremy Sterk, Earth Tech
Dave Tomasko, Environ. Science Assoc.

APPROVED AGENDA (AS AMENDED)

1. Roll call
2. Agenda approval
3. Approval of 01/09/2020 meeting minutes
4. Audience comments
5. Water Quality
    a. Copper results
    b. Second and third water quality report
    c. 2019 Annual Water Quality Report
    d. Water Quality Report *(add-on)*
6. Clam Pass
    a. February tidal ratio report
    b. Video of H&M report
    c. Timeline for dredging-related activities
    d. Bathymetric survey *(add-on)*
7. Clam Bay
    a. Update on monitoring
    b. Hand-dug channel maintenance
    c. Canoe trail marker 6 signage
    d. Scaevola treatment proposal
    e. Update on County boater safety signage
8. Beach Renourishment
    a. County Survey Results
    b. Update on County Beach Resiliency program
9. Draft of FY2021 Clam Bay Budget

9.5. Ms. McLaughlin's Beach Renourishment article *(add-on)*
10. Next meeting: May 12 or 14, 2020
11. Adjournment

ROLL CALL

All members were present and a quorum was established

AGENDA APPROVAL

Items #5D, #6D, and #9.5 were added to the agenda.

APPROVAL OF 01/09/2020 MEETING MINUTES

Ms. McLaughlin motioned, Ms. O'Brien seconded to approve the 01/09/2020 meeting minutes as presented. The motion carried unanimously.

AUDIENCE COMMENTS

None

WATER QUALITY

COPPER RESULTS

Ms. O'Brien commented that we are seeing steady improvement in our Clam Bay copper results (the copper table was included in the agenda packet).

SECOND AND THIRD WATER QUALITY REPORT

Ms. O'Brien commented that the major takeaway from the second and third quarter water quality report is the high level of phosphorus in Clam Bay.

2019 ANNUAL WATER QUALITY REPORT

After committee discussion, Dr. Tomasko, consultant with Environmental Science Associates, agreed that his 2019 Annual Water Quality Report (that he is working on) would include all of the 2019 calendar months plus the last three months of 2018.

CLAM BAY PHOSPHORUS LEVELS

Ms. O'Brien commented on the recent history of phosphorus levels in Clam Bay including (1) in 2016, phosphorus levels were not a problem, (2) in 2017, phosphorus levels were a little bit worse, and (3) in 2018 and 2019, phosphorus levels have continued to increase. Dr. Tomasko commented that higher levels of phosphorus in 2017 were a result of Hurricane Irma. He explained that a high level of phosphorus is not necessarily dangerous if it is not causing a related chlorophyll problem or water clarity problem. Dr. Tomasko suggested further analysis to determine whether our chlorophyll and/or water clarity are being affected by the phosphorus levels. His first focus will be to look at the data from berm stations and then each specific Clam Bay station. Dr. Tomasko emphasized that we need to determine whether our high phosphorus levels are really a problem. He will provide his report to the committee in 30-60 days.

Dr. Dabees, consultant with Humiston & Moore, commented that Outer Clam Bay is a completely different system from Inner Clam Bay as they each have very different flushing timelines. Dr. Tomasko noted that the two key factors to maintaining good water quality in Clam Bay are (1) keep tannin levels high, by maintaining trees and vegetation around our lakes, and (2)

keep Clam Pass open. Dr. Tomasko commented that the main problem with a process to remove phosphorous from County reclaimed water, is the disposal of the phosphorus waste. He also noted that in the State of Florida all bodies of water must be monitored. Dr. Tomasko commented that Florida DEP does not see the water quality along the Southwest Coast of Florida as problematic.

CLAM PASS

FEBRUARY TIDAL RATIO REPORT

The February tidal ratio report was included in the agenda packet.

VIDEO OF H&M REPORT

Not discussed

TIMELINE FOR DREDGING-RELATED ACTIVITIES

A flowchart of the timeline for a project to dredge Clam Pass was included in the agenda packet. Dr. Dabees suggested that it may be beneficial for the PBSD to have funding available for quick mechanical interventions (lasting a few days) to make minor corrections to the inlet, which would enable the system to recover quickly from weather events. The ability to make quick interventions may eliminate or delay a potential full dredge project. Ms. O'Brien suggested that we may see pushback from the community if we use our own funds for dredging activities, instead of requesting funding from the TDC. She also suggested that small interventions are not included in the Clam Bay Management Plan. Dr. Dabees commented that quick interventions are included in our permitted activities. Mr. Swider suggested that the Budget Committee would be able to set up a reserve of $25,000 for these types of interventions (if the board agreed). The committee agreed that this suggestion should be explored further.

BATHYMETRIC SURVEY *(ADD-ON)*

Dr. Dabees commented that a bathymetric survey of the Clam Pass inlet will be done in May, and will provide information on our metrics which will allow us to determine whether there is a need for pre-emptive maintenence. If necessary, a maintenance project would be completed between November and April, which would have no adverse effects on sea turtle nesting season. Dr. Dabees commented that in the past, the TDC (Tourist Development Council) has always approved funding for our dredging projects.

CLAM BAY

UPDATE ON MONITORING AND HAND-DUG CHANNEL MAINTENANCE

Mr. Sterk, consultant with Earth Tech, commented that Earth Tech will begin mangrove monitoring work next week. This work will include an evaluation to determine what areas to focus on for hand-dug channel maintenance.

CANOE TRAIL MARKER 6 SIGNAGE

Mr. Sterk commented that he will follow up with County personnel on the repair of Marker #6 signage.

SCAEVOLA TREATMENT PROPOSAL

Ms. O'Brien suggested that we need a ballpark opinion of cost for a scaevola removal project, so that we can put in a request to the Budget Committee for FY2021 funding. Mr. Sterk

commented that he will work with Ms. Jacob to calculate an opinion of cost within 30 days. He noted that Earth Tech has already mapped the scaevola throughout Pelican Bay. Mr. Sterk commented that the County Coastal Zone Management Division has discussed a possible county-wide scaevola treatment project. He noted that if left untreated, the scaevola will begin to impact the gopher tortoise habitat and the beach dune habitat.

UPDATE ON COUNTY BOATER SAFETY SIGNAGE

Ms. Jacob commented that she has no new updates on the County boater safety signage. Mr. Tim Hall, consultant with Turrell, Hall & Assoc., does not expect the County to address this issue until after three County dredging projects are completed.

BEACH RENOURISHMENT

COUNTY SURVEY RESULTS

Ms. O'Brien expects that the committee will have the County's beach width survey results to review at our May committee meeting.

UPDATE ON COUNTY BEACH RESILIENCY PROGRAM

Ms. O'Brien is hopeful that a representative from the County's Coastal Zone Management Division will provide an update on the County's proposed resiliency program at our May committee meeting.

DRAFT OF FY2021 CLAM BAY BUDGET

Ms. O'Brien included a draft of the FY2021 Clam Bay budget in the agenda packet; the budget is very similar to the FY2020 budget.

MS. MCLAUGHLIN'S BEACH RENOURISHMENT ARTICLE *(ADD-ON)*

Ms. McLaughlin provided a draft of her article on beach renourishment to the committee (to be included in a future PB Post edition), and requested clarification on whether we would ever take on a beach renourishment project on our own. Mr. Hall commented that if we were to renourish an area of PB beach on our own, that the sand would migrate over time to other beaches, and therefore, would not be effective. He suggested that the PBSD might consider its own beach renourishment project, only in the event of structures being jeopardized from short beach widths. Ms. O'Brien suggested that we could only consider a small PB beach renourishment project if our beaches were critically eroded. After discussion, Ms. McLaughlin summarized (for the article) that a small PB beach renourishment project would not be effective unless the entire stretch of beach was included in a larger beach renourishment project.

NEXT MEETING:

By consensus, the committee agreed that the next meeting of the committee would be held on May 14, 2020 at 1:30 p.m.

ADJOURNMENT

The meeting was adjourned at 2:46 p.m.

_____
Susan O'Brien, Chairman

Minutes approved [___] *as presented* OR [___] *as amended* ON [_____] *date*

5.0 Clam Pass Dredging

A. Dredging Policy

There are two circumstances that could necessitate dredging Clam Pass.

1. Clam Pass closes or is in imminent danger of closure following a weather driven event. In this situation the inlet should be dredged as soon as possible.

2. The inlet has lost hydraulic efficiency and is jeopardizing the long-term health of floral and faunal communities of the Clam Bay NRPA. The scope and timing of any proposed dredging activity will be determined by reviewing and comparing current and past hydraulic, bathymetric and ecological monitoring data.

In both cases the PBSD Board would, after consultation with and advice from qualified coastal engineers and biologists, approve and recommend an appropriate set of construction drawings for the dredging event to the BCC for its approval prior to the submittal to the regulatory agencies.

Dredging will only be done for the health of the Clam Bay NRPA, not for navigation or beach renourishment. Beach-compatible sand removed as part of the dredging event will be spread on adjacent area beaches, as required by the permitting agencies.

B. Hydraulic and Bathymetric Dredging Criteria

The purpose of regular hydraulic and physical monitoring is to evaluate inlet characteristics on a comprehensive long term basis with less emphasis on short term or seasonal changes.

To monitor the stability of Clam Pass, data on the variables listed below will be regularly collected and reviewed by qualified engineers. If data are not within the identified target ranges for the variables, further monitoring and/or intervention will be considered in conjunction with current ecological data. See Appendix 5 for additional information on the dredging criteria.

1. Bay Tide Range

Tidal range data have been collected annually since 1999 and will continue to be collected and reported to the consulting engineer at least quarterly. An annual tidal analysis report will be included with the annual report.

Data are collected from gauges at four locations (Clam Pass Park Boardwalk, Pelican Bay South Boardwalk, Pelican Bay North Boardwalk, and Upper Clam Bay). These gauges provide a record of the tidal range within Clam Bay and are one indication of the tidal prism or volume of water flowing through Clam Pass at each tidal cycle.

Based on an analysis of data from the gauges at the South Boardwalk and Clam Pass Park Boardwalk from 1998 to the present when the inlet was hydraulically stable, the ratio between Clam Bay and Gulf tide was between 0.6 and 0.7 over 90% of the time. Therefore, if the ratio between Clam Bay and the Gulf tide falls below 0.6, but above 0.5, further monitoring will be considered once it has been established that other types of blockage are not causing the problem. If the tidal range ratio falls below 0.5, physical monitoring of, or interventions to, potential shoaling areas that could be impeding flow will be considered.

2. Cross Section of Flow Area and Volume of Shoaled Material

Annual bathymetric surveys and reports were completed from 1999 to 2008. Bathymetric surveys provide data on the physical conditions of the inlet channel, ebb shoal and flood shoal. Post-dredging bathymetric surveys and reports were completed at 3-month, 6-month, and 12-month intervals following the opening of Clam Pass in April 2013. Beginning in 2014, bathymetric surveys and reports will be issued at least annually. Additional surveys will be considered if the hydraulic efficiency falls below target levels.

To establish benchmarks or targets for flow area and volume of shoaled materials, the data analysis included evaluation of the flow cross-section areas in the three main sections of the dredging region. Section A represents the inlet channel, Section B the seaward part of the flood shoal, and Section C the bay side part of the flood shoal.

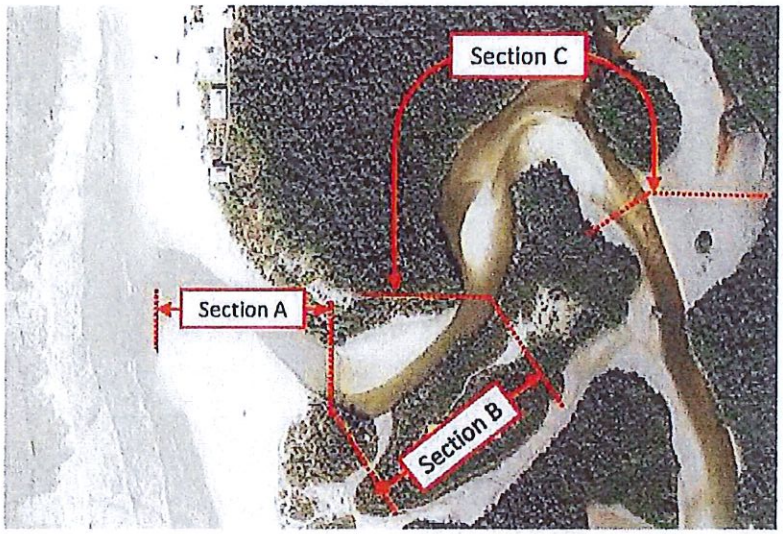


Figure 20: Sections A, B and C of Clam Pass

The analysis included evaluation of the cross-section of flow between mean high water and the volume of sand within each segment. The cross-section of flow was computed at each survey station spaced approximately 50 feet apart. The average and minimum cross-section areas were used as indicators of

the physical condition of the flow area of the three segments. The cross-sections were compared to the design cross-section area of the 2013 dredging and the inlet conditions in 2004 and 2008 when inlet conditions were near equilibrium 24 months and 16 months, respectively, following dredging events.

Targets for the average cross-section of flow areas below MHW:
Section A greater than 300 sq. ft.
Section B greater than 450 sq. ft.
Section C greater than 450 sq. ft.

Targets for the minimum cross-section of flow areas below MHW:
Section A greater than 250 sq. ft.
Section B greater than 350 sq. ft.
Section C greater than 350 sq. ft.

Targets for volume of shoaled materials:
Section A less than 3000 cu. yds.
Section B less than 2500 cu. yds.
Section C less than 4000 cu. yds.

Therefore, if the average cross-section of flow area falls below these numbers or the volume of shoaled material exceeds these numbers, further monitoring or intervention may be needed.

3. Inlet Channel Length

The channel length is an important factor in inlet stability. A longer inlet channel will provide greater resistance to flow. Higher flow resistance will reduce the tidal range and increase the phase lag with the Gulf tide that reduces the tidal prism and flow through Clam Pass.

To establish a benchmark for channel length a selection of aerial photos of Clam Pass from 2004 to 2013 was studied as well as data on the approximate length of the channel following dredging events in 2002, 2007, and 2013.

Based on this analysis, the benchmark for inlet channel is to stay under 400 feet in length. Inlet channel length will be recorded at least annually and included in the annual report.

4. Ebb Shoal

The size and shape of the ebb shoal is a key factor to the stability of the inlet that, in turn, supports the stability of Clam Pass. The ebb shoal helps to keep the inlet open when facing storms and big wave events. The ebb shoal provides sheltering to the channel and a sand bypass pathway around the inlet without filling in the Pass. The shape and volume of the ebb shoal are additional indicators of the stability of the inlet. Critical conditions include onshore collapse of the ebb shoal that can be indicated by significant change in ebb shoal offshore distance, volume, and increase in dry beach areas adjacent to the inlet.

To determine a target for the ebb shoal delta, data from April 2013 to April 2014 were reviewed. The ebb shoal position offshore is measured from a line connecting the north and south channel banks at mean high water out to the -4.0 foot contour line.

The recommended length of the seaward extent of the ebb shoal is at least than 250 feet. The ebb shoal distance from shore will be recorded at least annually and included in the annual report.

A summary of criteria for dredging is presented in the table below.

Dredging Criteria Parameter Summary			
	Location	Target	Description
Bay Tide Range Ratio		> 0.6	ratio comparison of the interior and Gulf tidal ranges
Cross Sectional Area	A	Average >300 sq ft Not less than 250 sq ft	area in different locations of the Pass through which water can flow
	B	Average >450 sq ft Not less than 350 sq ft	
	C	Average >450 sq ft Not less than 350 sq ft	
Volume of Shoaled Material	A	< 3000 cu yds	quantity of sand and sediments within channel that can restrict flow
	B	< 2500 cu yds	
	C	< 4000 cu yds	
Inlet Channel Length		< 400 feet	distance water must flow through the beach and ebb shoal areas
Ebb Shoal		> 250 feet	distance from shore to the outer ebb shoal limits

C. Ecological Considerations

A critical consideration in all dredging decisions is to ensure the ecological health of the Clam Bay NRPA. Before any dredging event, the direct and indirect impacts on the flora and fauna of the NRPA including mangroves, benthic communities (including seagrass), and other important species, such as fish and birds, will be considered. Every effort will be made to minimize any negative impact to the flora and fauna. The pros and cons of dredging will be weighed in regards to both hydrologic and ecological consequences.

D. Dredging Construction

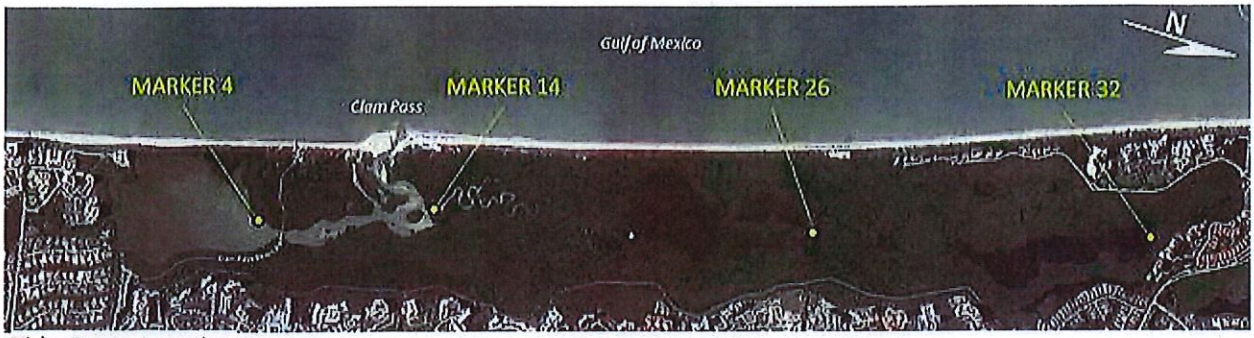
1. Typical Cross-Sections for Dredging

Typical cross-sections for the suggested dredge design are provided below. When dredging is deemed necessary, the design cross-section area as stated in the design range, with consideration to existing conditions, will be followed. Minor modifications to this dredging template may be needed for future permitting. Typical cross-sections are shown for open areas in Sections B and C where the waterway

" Restoring Beaches as Natural Coastal Systems "

HUMISTON & MOORE ENGINEERS
Consulting Coastal Engineers

CLam Pass Tide Monitoring - *Click here for Maintenance Dredging Project details*

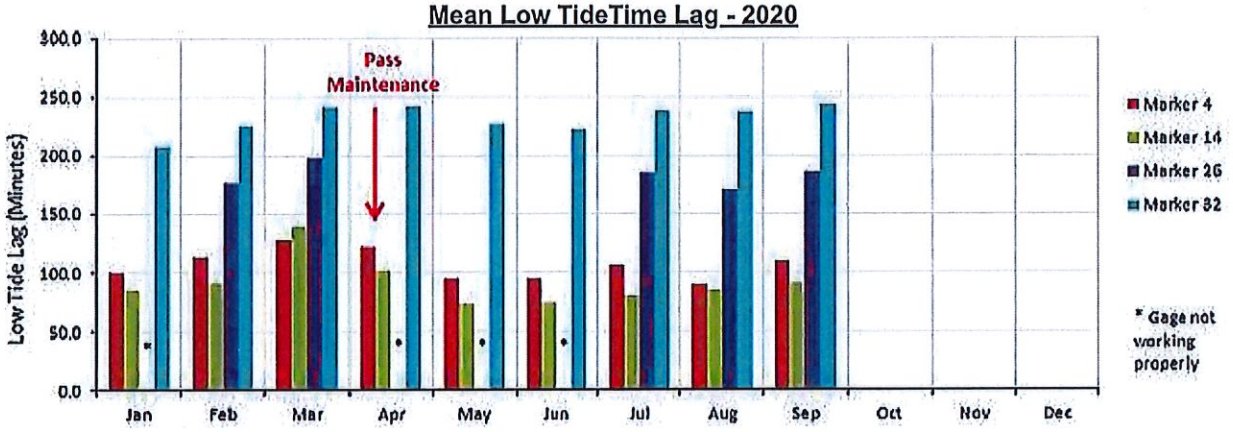


Tide Gages Location

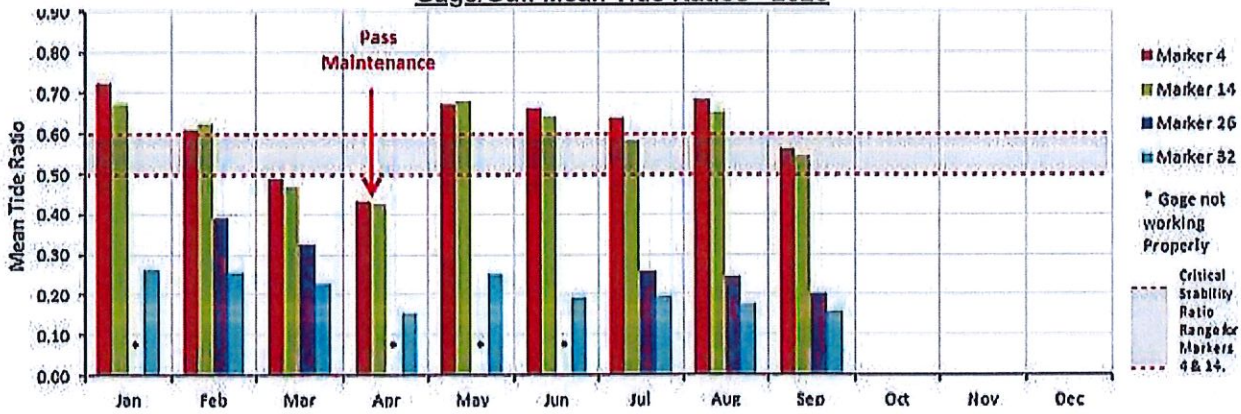
Monthly Time Series 2020 *(Click on Thumbnails to Expand)*

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Mean Low TideTime Lag - 2020



Gage/Gulf Mean Tide Ratios - 2020



Gage/Gulf Mean Tide Ratios - 2019

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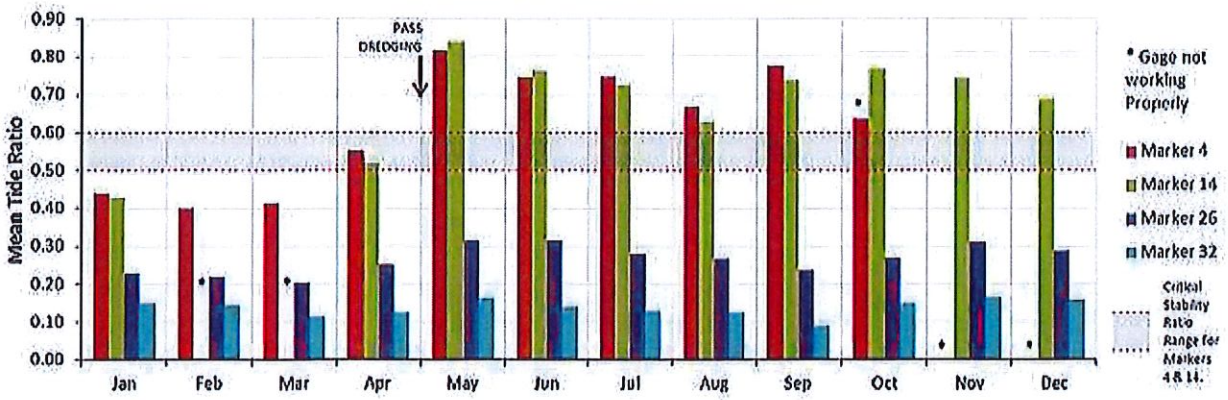
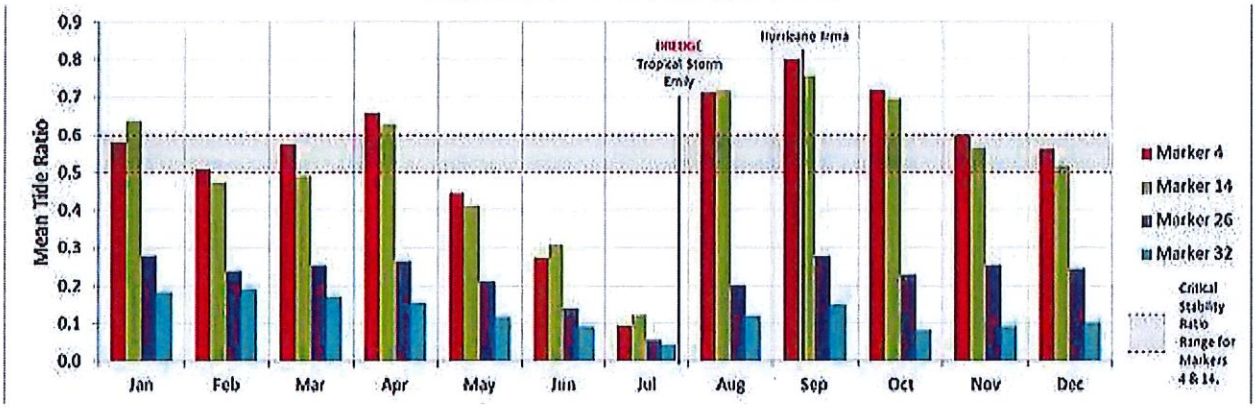
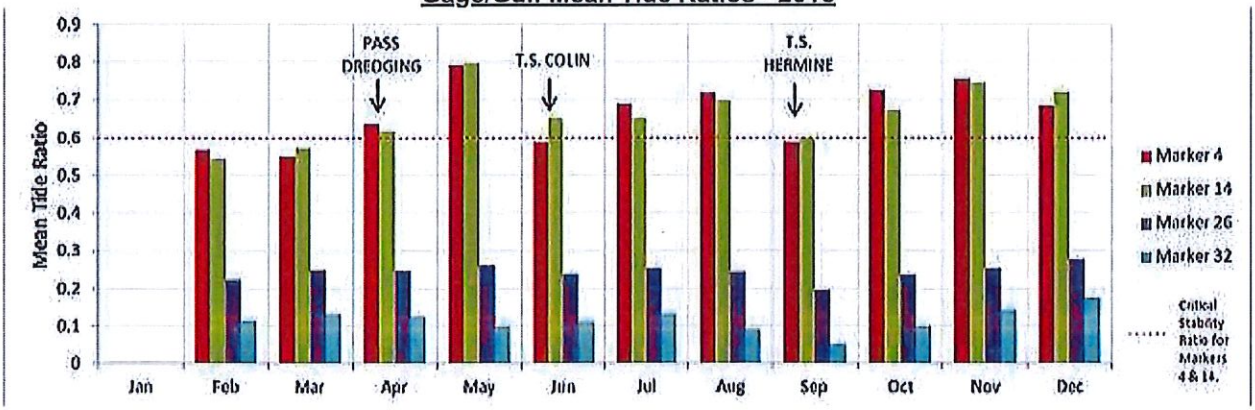
Gage/Gulf Mean Tide Ratios - 2018



Gage/Gulf Mean Tide Ratios - 2017



Gage/Gulf Mean Tide Ratios - 2016



Definitions:

Mean Tide Ratio: ratio of tide amplitude of gages over the tide amplitude from the Gulf of Mexico, averaged over a month. This ratio is representative of the pass's effectiveness in flushing water from the bay. The lower the ratio, the less efficient is flushing, indicating material accumualting in the pass.

Mean Low Tide Lag: time difference between low tide in the Gulf of Mexico and at the gage's locations, averaged over a month in minutes. The time lag is also represenattive of the pass's effectiveness in flushing water from the bay. The higher the lag the less efficient is flushing, indicating material accumulating in the pass.

3. Inlet Dredging Cost Analysis

As discussed above, Clam Pass is a small inlet and requires maintenance dredging to maintain the health of the Clam Bay ecosystem and avoid potential for inlet closure. The inlet has been dredged a total of 7 times since the development of the initial NRPA management plan in 1998. The dredging template and methods of dredging varied depending on conditions and timing of each event. Table 2 provides listing of dredging information and costs for each of the 7 events. The record indicates that 5 dredge events used hydraulic dredging equipment which enables dredging the entire dredging template including the interior flood shoal areas. Two events in 2013 and 2017 were limited to mechanical excavation equipment which included partial dredging of the template limited to the inlet channel and small part of section B of the flood shoal area. The limited excavation by mechanical equipment provided cost effective and rapid response to emergency conditions following inlet closure in 2012 and to avoid inlet closure in 2017.

Table 2 Details of dredging events information and costs for Clam Pass

Year		*Pay Quantity (includes grading) (cy)*	*Total Volume (includes grading) (cy)*	*Section A Dredge Width (feet)*	*Dredge Depth (feet)*	*Equipment*	*Construction Cost* based on bid tabulation	*Construction equivalent Cost (2018 $)*
1999	A		32,000	30	-5.0 NGVD	Hydraulic	$ 321,030	$ 484,755
	B				-4.0 NGVD			
	C				-4.0 NGVD			
2002	A	ND	11,725		-4.0 NGVD	Hydraulic	$ 162,125	$ 230,218
	B							
	C	ND						
2007	A		20,603	80	-5.5 NGVD	Hydraulic	$ 376,417	$ 455,465
	B				-4.5 NGVD			
	C				-4.5 NGVD			
2012	*Inlet Closes*							
2013	A	13,008	20,266	45	-5.8 NAVD	Mechanical	$ 233,411	$ 252,084
	B	4,824			-5.3 NAVD			
	C	2,434			-5.3 NAVD			
2016	A	9,366	18,987	50	-5.0 NAVD	Hydraulic	$ 469,000	$ 492,450
	B	3,368			-4.0 NAVD			
	C	6,253			-4.0 NAVD			
2017	A	10,994	10,994	50	-5.0 NAVD	Mechanical	$ 82,818	$ 85,303
	B	ND			-4.0 NAVD			
	C	ND			-4.0 NAVD			
2018	A	6,275	11,685	50	-5.0 NAVD	Hydraulic	$ 235,982	$ 235,982
	B	3,320			-4.0 NAVD			
	C	2,090			-4.0 NAVD			

* ND indicates no dredging occurred in this section.

As discussed in previous sections of this study, the inlet is critically stable under typical conditions and excessive shoaling is directly related to sequence and intensity of storms. The average interval between dredging events is 3 years. The largest interval between dredging events was 6 years between 2007 and 2013 which included inlet closure in 2012. Annualized cost over various time frames are shown in Figure 15.

2020 CY sand per bathymetric survey 6/4/20

A 1705

B 2113

C 3139

Total 6956

Clam Bay Copper ug/L

Collection Date	CB1	CB2	CB3	CB4	CB5	CB6	CB7	CB8	CB9	Report Date
6/22/2016	0.862	0.700	0.700	0.700	1.640	2.100	0.700	3.520	1.510	9/8/2016
7/20/2016	0.924	5.330	5.110	5.660	2.470	3.960	4.950	5.710	10.500	9/12/2016
7/20/2016	0.924	6.160	4.700	1.690	2.470	1.830	1.980	1.870	8.360	9/21/2016
8/25/2016	2.000	1.850	1.680	1.470	1.240	1.520	2.250	1.280	8.060	10/4/2016
9/20/2016	1.690	2.280	1.280	1.760	0.751	0.700	0.700	1.030	0.700	11/22/2016
10/12/2016	2.760	2.200	2.130	1.190	2.900	1.860	1.060	0.954	1.310	12/7/2016
11/9/2016	2.340	3.390	2.300	2.250	1.630	1.500	1.180	2.030	1.300	1/16/2017
12/6/2016	2.330	2.930	5.100	2.450	2.390	1.780	1.270	1.880	1.720	3/14/2017
1/19/2017	2.570	3.560	2.110	1.990	0.818	0.800	0.961	1.110	2.020	4/4/2017
2/23/2017	2.510	3.350	1.600	1.120	0.851	0.848	1.500	2.570	2.600	4/24/2017
3/21/2017	7.970	4.080	1.710	1.120	0.894	0.846	1.080	1.090	0.957	6/1/2017
4/18/2017	6.480	8.160	1.620	1.240	0.800	0.956	1.280	1.010	1.100	6/14/2017
5/24/2017	2.840	4.060	4.990	0.800	0.800	0.959	0.800	0.920	0.946	7/6/2017
6/21/2017	3.840	4.240	3.850	0.906	1.200	1.140	1.260	1.110	0.760	8/8/2017
7/13/2017	4.700	2.950	3.800	4.080	2.500	2.440	2.370	2.380	2.210	8/29/2017
8/14/2017	4.290	3.810	3.220	2.650	1.400	1.220	1.470	1.020	0.700	10/10/2017
10/4/2017		2.680	1.270	0.600	0.800	12.600	1.610	0.600	0.600	1/22/2018
11/28/2017	0.700	0.722	2.540	0.700	0.700	0.700	0.700	0.700	0.700	1/22/2018
12/12/2017	1.780	2.250	1.890	0.700	1.210	1.210	1.300	0.728	0.911	3/26/2018
1/8/2018	0.420	1.510	1.690	1.590	0.800	0.809	0.800	0.800	2.400	4/27/2018
2/6/2018	3.400	3.980	2.130	2.420	0.829	1.640	3.920	0.800	0.800	4/30/2018
3/22/2018	5.450	4.890	3.670	2.370	1.010	1.040	1.750	1.010	1.320	5/11/2018
4/4/2018	2.370	3.190	2.380	1.970	1.690	0.848	1.280	1.250	5.160	6/11/2018
5/8/2018	5.490	4.880	2.360	1.090	0.800	1.050	1.270	1.570	1.640	7/2/2018
6/6/2018	3.120	3.320	2.670	0.800	0.800	0.853	0.828	1.080	1.220	7/18/2018
7/17/2018	1.400	1.440	1.600	1.600	2.270	1.600	1.600	1.600	1.600	8/21/2018
8/15/2018	1.500	1.410	1.400	1.400	1.600	1.600	1.600	1.650	1.600	10/8/2018
9/13/2018	1.720	1.960	1.200	1.200	1.400	1.400	1.400	1.600	1.400	10/9/2018
10/15/2018	3.190	4.800	4.400	4.030	1.400	1.400	1.960	1.400	1.400	12/21/2018
11/14/2018	1.750	1.900	1.960	1.600	1.600	1.600	1.600	1.600	1.600	2/28/2019
12/12/2018	4.480	2.790	2.400	1.820	1.600	1.600	1.600	1.600	1.600	2/28/2019
1/14/2019	3.150	2.740	2.100	1.880	1.600	1.600	1.600	1.600	1.600	5/3/2019
2/25/2019	3.420	2.470	2.000	1.940	1.600	1.600	1.600	1.600	1.600	5/3/2019
3/25/2019	1.830	3.090	1.600	2.730	1.600	1.600	1.600	1.600	1.600	5/14/2019
4/11/2019	2.310	2.530	1.720	1.910	1.600	1.600	1.600	1.600	1.600	8/8/2019
5/9/2019	2.290	3.160	2.030	2.720	1.600	1.600	1.600	1.600	1.600	8/8/2019
6/25/2019	3.030	2.460	1.720	1.600	1.600	1.600	1.600	1.400	1.450	8/8/2019
7/24/2019	2.660	2.020	1.770	1.600	1.400	1.400	1.400	1.400	1.660	10/1/2019
8/8/2019	2.760	1.710	2.100	2.090	1.400	1.400	1.400	1.400	1.400	10/1/2019
9/5/2019	2.030	1.410	1.400	1.400	1.400	1.400	1.400	1.400	1.400	10/1/2019
10/21/2019	1.870	2.120	1.950	1.450	1.430	1.600	1.600	1.600	1.600	1/13/2020
11/19/2019	1.400	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1/13/2020
12/16/2019	3.030	3.940	2.310	1.810	1.600	1.600	1.600	1.600	1.600	1/13/2020
1/16/2020	5.090	2.710	2.000	1.670	1.600	1.600	1.600	1.600	1.600	4/14/2020
2/12/2020	2.430	3.580	4.270	2.160	1.600	1.600	2.690	1.600	1.600	4/14/2020
3/2/2020	3.170	4.260	2.080	1.600	1.600	1.600	2.870	1.600	0.200	4/14/2020
4/22/2020	3.040	2.090	1.700	2.000	1.200	1.200	1.450	1.210	1.200	7/29/2020
5/28/2020	2.530	1.870	1.410	1.590	1.200	1.200	1.200	1.200	1.200	7/29/2020
6/11/2020	2.640	2.640	2.140	2.350	1.050	1.050	1.050	1.050	1.050	7/29/2020
7/27/2020	3.220	2.290	1.410	1.200	1.200	1.200	1.200	1.200	1.200	10/12/2020
8/26/2020	1.350	1.840	1.200	1.200	1.200	1.200	1.270	1.200	1.200	10/12/2020
9/8/2020	2.010	2.080	1.910	1.630	1.200	2.000	1.310	1.200	1.500	10/12/2020

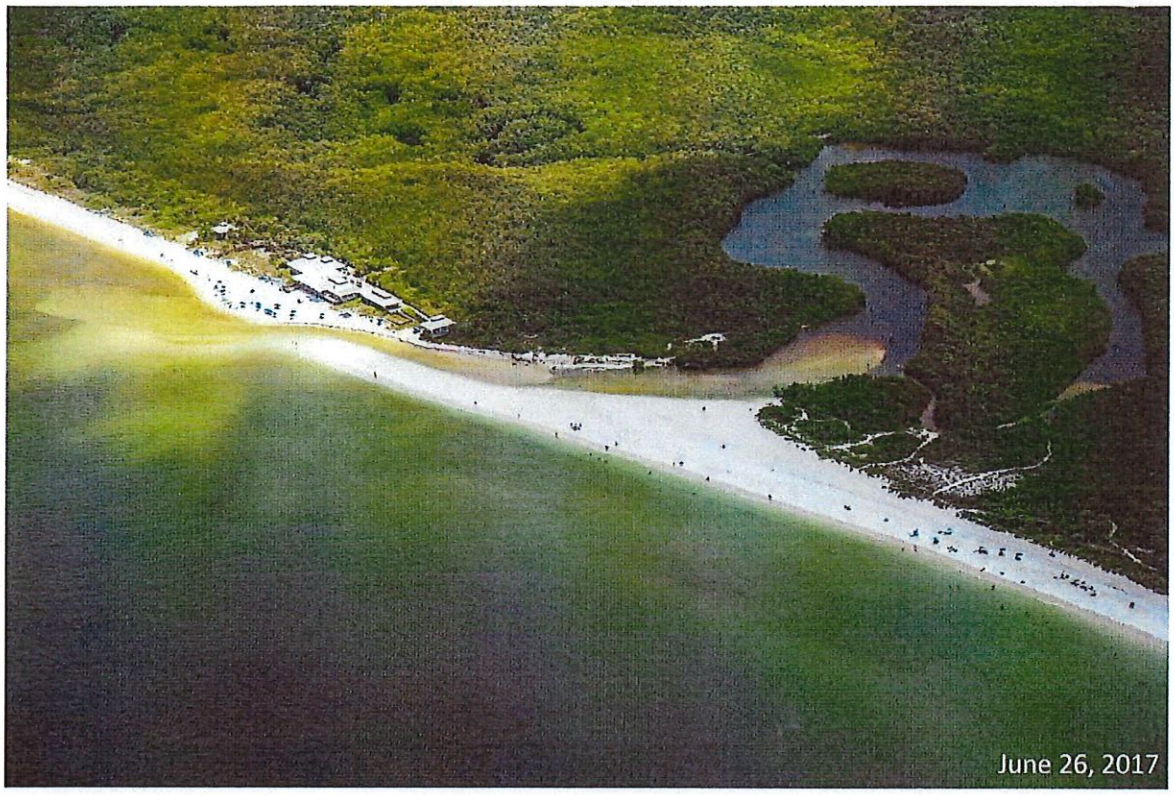
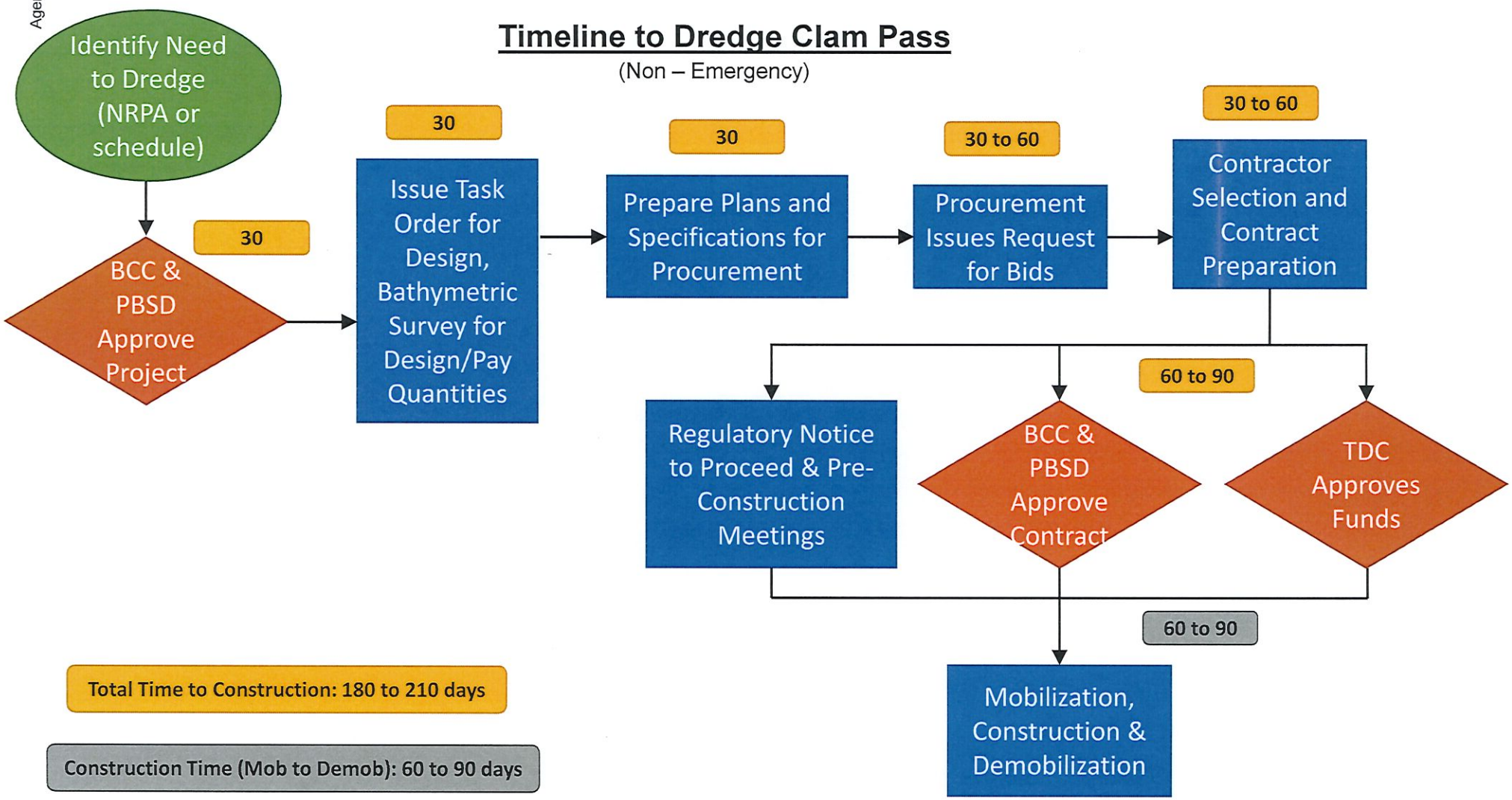


Figure A9 - Clam Pass Aerial Photograph (Photo Taken by Aerial Innovations)

Figure A5 - Clam Pass Aerial Photograph (Photo Taken by Aerial Innovations)

Timeline to Dredge Clam Pass

(Non – Emergency)



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memorandum

date April 29, 2020

to Tim Hall
Turrell, Hall and Associates, Inc.

from David Tomasko, Ph.D.
Emily Keenan, M.S.

subject Annual Report on Clam Bay Numeric Nutrient Concentration (NNC) Criteria

Executive Summary

Water quality data collected from Clam Bay between January 2019 and December 2019 were analyzed to determine the degree to which the waters of Upper, Inner and Outer Clam Bay are in compliance with relevant criteria. For nutrients, it was found that levels of phosphorous were out of compliance with existing site-specific criteria for Clam Bay. Levels of nitrogen were not out of compliance.

The results from these past 12 months were then compared against water quality data going back to March 2015. In general, phosphorus concentrations have increased over recent years in a pattern that suggests that the impacts from Hurricane Irma may have had longer-term consequences than was originally anticipated. A timeline of impacts, activities and water quality suggests that the rainy season of 2018 might have brought more phosphorus into the Clam Bay system than even the hurricane-impacted prior year. This may have been associated with activities that were conducted in 2018 to reestablish tidal channels in the mangrove forests adjacent to Clam Bay. These channels were reestablished in large part due to damage to the forests that occurred in response to the passage of Hurricane Irma in September 2017.

Based on data from throughout the Clam Bay system, there is a positive correlation between phosphorous concentrations and the amount of algae in the water column, and an inverse correlation between phosphorous and levels of dissolved oxygen (DO). These results suggest that phosphorous concentrations are at potentially problematic levels in Clam Bay, and they should be carefully monitored, to ensure that conditions do not deteriorate, and that the recent impairments do not become a long-term condition. Should phosphorous continue to exceed established criteria; the County might wish to consider developing a site-specific phosphorus loading model, to develop appropriate management responses.

Similar trends were found for nitrogen, but phosphorus tended to explain more of the variability in levels of chlorophyll-a and DO than was found for nitrogen. These data suggest that both nitrogen and phosphorus are important for the management of water quality in Clam Bay, but phosphorus might have more of an influence on ecosystem health than nitrogen.

Unfortunately, the trend over the past five years has been of an increase in both nitrogen and phosphorus, at least in Outer Clam Bay. Upper and Inner Clam Bay do not show the same trend of increased nitrogen and phosphorus that was seen in Outer Clam Bay. However, despite the trends of increased nutrient concentrations, the majority of stations did not exhibit a concurrent increase in the amount of algae in the water column, as quantified by concentrations of chlorophyll-a.

The waters of Clam Bay would be considered to be out of compliance with existing DO criteria used by the state of Florida. This conclusion is consistent with the results of the previous annual report which identified sufficient depressed DO concentrations to be considered out of compliance over the 12-month period. However, a formal determination of impairment for DO by FDEP would require the review of data over a 7.5-year period, rather than an individual year. Nonetheless, it would be helpful to better characterize the benthic habitats in Upper and Inner Clam Bay, as it is not that unusual for mangrove-lined creeks to have healthy ecology, even if they "fail" state-designated water quality criteria.

While the amount of copper in the various treatment ponds sampled along the eastern border of Clam Bay exceeded criteria for freshwater water bodies, the open waters of Clam Bay would not be considered to be impaired for copper. That finding seems to represent an improvement in water quality in the bay, most likely associated with reductions in the amount of copper-containing herbicides used in the Pelican Bay stormwater treatment system.

Table 1. Representation of frequency of impairment for TP for different site and date combinations. Green represents samples in compliance with criteria. Red cells indicate exceedance of criteria. Red cells with an "X" represent values that are within 5% of criteria concentrations, suggesting lack of compliance should be interpreted with caution, due to analytical precision. Clear cells represent a lack of data.

Sampling Event	Station								
	1	2	3	4	5	6	7	8	9
Mar-15			X						
Mar-15									
Apr-15									
May-15		X							
Jun-15									
Jul-15									
Aug-15									
Sep-15									
Oct-15									
Nov-15		X							
Dec-15									
Jan-16									
Feb-16		X							
Mar-16									
Apr-16									
May-16									
Jun-16									
Jul-16									
Aug-16									
Sep-16				X					
Oct-16									
Nov-16									
Dec-16									
Jan-17									
Feb-17									
Mar-17			X						
Apr-17									
May-17									X
Jun-17									
Jul-17									
Aug-17									
Oct-17									
Nov-17									
Dec-17									
Jan-18									
Feb-18									
Mar-18					X	X			
Apr-18									X
May-18							X		
Jun-18									
Jul-18									
Aug-18									
Sep-18									
Oct-18									

13/96
14%
17/107
16%
38/99
38%
72/108
67%

Sampling Event	Station								
	1	2	3	4	5	6	7	8	9
Nov-18									
Dec-18									
Jan-19									
Feb-19									
Mar-19			X		X				
Apr-19									
May-19									
Jun-19									
Jul-19							X		
Aug-19									
Sep-19		X							
Oct-19									
Nov-19									
Dec-19									
	37	34	25	23	23	22	24	17	22

89/108
82%

Table 2. Representation of frequency of impairment for TN for different site and date combinations. Green represents samples in compliance with criteria. Red cells indicate exceedance of criteria. Red cells with an "X" represent values that are within 5% of criteria concentrations, suggesting lack of compliance should be interpreted with caution, due to analytical precision. Clear cells represent a lack of data.

Sampling Event	Station								
	1	2	3	4	5	6	7	8	9
Mar-15									
Mar-15									
Apr-15									
May-15									
Jun-15									
Jul-15									
Aug-15									
Sep-15									
Oct-15									
Nov-15									
Dec-15									
Jan-16									
Feb-16									
Mar-16									
Apr-16									
May-16									
Jun-16									
Jul-16									
Aug-16									
Sep-16									
Oct-16									
Nov-16									
Dec-16									
Jan-17									
Feb-17									
Mar-17									
Apr-17									

Table 6. Copper values at sites Clam Bay 1 to 9, in units of µg / liter. Values highlighted in yellow exceed copper criteria for Class II waters (3.7 µg Cu / liter).

Station	1	2	3	4	5	6	7	8	9
1/14/2019	3.2	2.7	2.1	1.9	1.6	1.6	1.6	1.6	1.6
2/25/2019	3.4	2.5	2.0	1.9	1.6	1.6	1.6	1.6	1.6
3/25/2019	1.8	3.1	1.6	2.7	1.6	1.6	1.6	1.6	1.6
4/11/2019	2.3	2.5	1.7	1.9	1.6	1.6	1.6	1.6	1.6
5/9/2019	2.3	3.2	2.0	2.7	1.6	1.6	1.6	1.6	1.6
6/25/2019	3.0	2.5	1.7	1.6	1.6	1.6	1.6	1.4	1.5
7/24/2019	2.7	2.0	1.8	1.6	1.4	1.4	1.4	1.4	1.7
8/8/2019	2.8	1.7	2.1	2.1	1.4	1.4	1.4	1.4	1.4
9/5/2019	2.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
10/21-22/19	1.9	2.1	2.0	1.5	1.4	1.6	1.6	1.6	1.6
11/19/19	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
12/16/19	3.0	3.9	2.3	1.8	1.6	1.6	1.6	1.6	1.6
mean	2.5	2.4	1.9	1.9	1.5	1.6	1.6	1.5	1.6
median	2.5	2.5	1.9	1.9	1.6	1.6	1.6	1.6	1.6
N	12	12	12	12	12	12	12	12	12
#> 3.7	0	1	0	0	0	0	0	0	0
% > 3.7	0%	8%	0%	0%	0%	0%	0%	0%	0%

Of the 108 samples collected for copper, only one of them exceeded the established criteria of 3.7 µg / liter. Based on guidance in Table 3 of FAC 62-303, Clam Bay is not out of compliance for copper for the sampling period evaluated.

The determination of copper exceedances in freshwater sampling sites in the watershed requires the simultaneous collection of data on "hardness". Over this analysis period, all samples from freshwater locations included results on hardness, and those data are analyzed below.

The water quality standard for copper differs between predominately marine waters and freshwater. As classified by FDEP, open waters of Clam Bay have a water quality standard for copper of < 3.7 µg / liter. In contrast, the copper standard for freshwater is more complicated, as it requires the concurrent recording of a value for "hardness" in units of mg $CaCO_3$ / liter. The toxicity of copper is mostly restricted to the abundance of the copper ion, and the greater the abundance of other dissolved compounds, the lower the probability that free copper ions will be available to bind with cell membranes, etc. and cause direct and indirect biological impacts. Briefly stated, the higher the hardness level of a water sample, the lower the probability that a given level of copper will be toxic.

Once the level of hardness is determined, the copper criterion for a sample collected from freshwater is derived as:

Total Phosphorous JAN-June 2020

Table 2. Observed TP Exceedances (marked with an "X") at the ambient Clam Bay surface water sample sites over the period of January 2020 to June 2020. "-" indicates sampling dates without corresponding conductivity data. Boxes with neither an X or a dash are in compliance with existing criteria. *indicates exceedance value was within 5% of criteria.

Station	Sampling event					
	Jan	Feb	Mar	Apr	May	Jun
1	X			X		
2				X		
3	X			X		
4				X		
5				X		
6	X			X		
7	X		X	X		X
8	X			X		X*
9	X					X*

Additionally, water quality data from six of the Clam Bay Outfall monitoring stations were compared to the proposed downstream protective values (DPV) for Clam Bay (PBS&J 2011). Due to concerns related to the Coronavirus pandemic, no samples were collect in April 2020 at the outfall monitoring stations. Outfall TN and TP concentrations were compared to the median and 90th percentile DPV values to determine if elevated concentrations were identified (Appendix B).

The median and 90th percentile DPVs for TN are 1.31 and 1.80 mg/L, respectively (PBS&J 2011). The median and 90th percentile DPVs for TP are 0.10 and 0.25 mg/L, respectively. For TN, 36 and 9 percent of the values exceeded the median and 90th percentile DPV criteria, respectively, during the months of May and June 2020 (Table 3). It should be noted that a "median" value represents a value where 50 percent of samples would be expected to be in exceedance. Similarly, it would be expected by chance alone that 10 percent of values would exceed the 90th percentile DPV, vs. the 36 percent of TN values found here. In comparison, 55 percent of TP values exceeded the median DPV criterion and 9 percent of values exceeded the 90th percentile DPV criterion. For nitrogen and phosphorus, the findings reported here are not far out of line for expectations set out in the "hold the line" approach used to develop NNC criteria for Clam Bay.

Table 3. Percentage of TN or TP concentrations from outfall stations which exceeded the median or 90th percentile DPV values for stormwater runoff.

DPV	*Total Nitrogen*		*Total Phosphorus*	
	Median	90th Percentile	Median	90th Percentile
Percent of values below	64	91	45	91
Percent of values above	36	9	55	9