
COLLIER CREEK MANAGEMENT PLAN ALTERNATIVES REFINEMENT

ENGINEERING REPORT

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COASTAL ZONE MANAGEMENT DEPARTMENT
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1.0 Executive Summary

The goal of this study was to provide assurances that the new structure at Marco Point and its potential effects are acceptable. It was shown that physical processes in the project area are generally tidally dominated, except when features are sheltered from tidal currents. It was also shown that navigational benefits increase when the channel width and depth increases, but at the expense of land loss. However, proper siting and design of a new structure in the area was shown to provide navigational benefits while stabilizing the shoreline, realizing a net positive land area change, and providing better sediment management.

The baseline scenario simulation results (i.e. No Action and Alternative 1, which represents the current management practice) demonstrate that channel dredging negligibly effects the adjacent/updrift shoreline. However, project benefits with respect to navigable channel width last only 1 year. Moreover, as discussed in the November 2018 Management Plan, Alternative 1 does not address the hydraulics that harm navigation. The flood tide flow concentration and interaction with the seawall along the eastern margin is driven by system setup on a larger scale – namely the strong flood tide currents in Marco River along the east end of Hideaway Beach and the sharp curvature of this flow field when entering Collier Creek. These processes are only marginally affected by the dredging. It was shown that solely removing the terminal jetty would result in the loss of land that is currently stabilized by the structure and would further impair navigation.

Alternative 15 represents the Tentatively Selected Plan derived from the 2018 Management Study modeling. Variations of this alternative were tested to refine the understanding of individual project components.

- Alternative 15 without the groin results in net land loss and faster channel infilling. Therefore, the groin stabilizes the updrift and immediately downdrift shorelines while reducing channel infilling rates.
- Alternative 15 with a permeable groin reduces land loss on the downdrift side without negatively affecting the channel or its infilling rate; it was shown that this option results in positive net land area change as opposed to the net loss caused by the solid groin.
- Dredging a wider deposition basin significantly improves project performance in terms of navigable channel width while slightly increasing land loss between the groin and the terminal jetty. This option can potentially be refined to realize a zero net state land loss.

Considering these results, Alternative 15 with a permeable groin addresses navigational concerns while stabilizing the shoreline and realizing no net land loss.



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5.0 Introduction

Aptim Environmental & Infrastructure, LLC (APTIM) was contracted by Collier County Coastal Zone Management to prepare a Management Plan for Collier Creek. The draft report, dated November 2018, was submitted to the Florida Department of Environmental Protection (FDEP) for review and comment. After submitting the draft report, discussions were held with County Staff and a Tentatively Selected Plan (TSP) was developed. This TSP aims to balance performance and cost by combining features that performed well in the modeling study while addressing comments and concerns from stakeholders and permitting agencies. After defining the TSP, APTIM conducted additional analyses and prepared a supplemental document, dated March 2019, that provided further details on the features and benefits of the TSP relative to the current planned management.

In response to APTIM's request to review and comment on the draft Management Plan, the FDEP detailed their comments and recommendations in a letter dated March 11, 2019. APTIM followed-up with an email March 19, 2019 to request a teleconference to discuss and better understand items detailed in the FDEP letter. Representatives from Collier County, APTIM, the FDEP, and the Rookery Bay Aquatic Preserve (RBAP) participated in a teleconference April 5, 2019 to discuss the TSP and action items that will help identify and permit a long-term solution for Collier Creek. In summary, FDEP engineering approves all components of the TSP (revised dredging template, adjustment to existing terminal jetty) except for the proposed new groin at Marco Point; FDEP needs further assurances that this new structure and its potential effects are justified. This report provides additional assurances by expanding upon information included within previously submitted reports, though previously submitted reports remain unchanged.

5.1 Study Objectives

The goal of this study is to provide assurances that the new structure at Marco Point and its potential effects are justified. The following objectives were identified to achieve this goal:

1. Describe the major physical processes around the inlet;
2. Clarify structural needs to address navigation requirements;
3. Estimate state land change; and
4. Consider larger scale sand management alternatives.

Although a concave shape between structures is generally expected, the area downdrift of the proposed groin historically had a natural/equilibrium convex shape. This convex shape, which



balances incoming and outgoing currents in this tide-dominated area, was present prior to the construction of the terminal jetty in 2005 (Figure 1). A detailed description of the major physical processes around the inlet using historical data and modeling results is presented in Section 6.0.

Collier County favors the addition of a new groin because it provides better assurances that the project will meet both sand management and navigational requirements. Additional alternatives were simulated to refine the TSP; refinements considered included: permeable, impermeable, and no groin systems. TSP refinement effects on various hydraulic processes (i.e. currents, sediment transport, scour, shoreline change, and bathymetry) are detailed in Section 7.0.

Currently FDEP's goal is zero net loss of state land as measured landward of the ECL. Collier County and APTIM anticipate that some state lands are needed to improve the safety of Collier Creek. For example, safety would be improved by reshaping Marco Point to something similar to the pre-1999 conditions. Therefore, a state land change analysis, which projects state land change caused by the existing and proposed alternatives, is presented in Section 8.0. It is anticipated that this state land change analysis will facilitate mitigation negotiations between FDEP and Rookery Bay and help determine easement type.

Although it was not completed as part of this study, the County is coordinating with Hideaway Beach and Rookery Bay to develop a comprehensive sand management plan. An updated sand management plan is summarized in Section 10. After finalizing the sand management plan, coordination will continue with local stakeholders, such as boaters, City of Marco Island, Villa de Marco West (VDMW), and Hideaway Beach.

5.2 Study Methods

Additional alternatives were simulated to further evaluate structural need and refine the TSP. Refinements considered included: permeable, impermeable, and no groin systems. Refinement simulations were completed using the Delft3D morphology model developed as part of the Management Plan. TSP refinement effects on various hydraulic processes (i.e. currents, sediment transport, scour, shoreline change, and bathymetry) are detailed in Section 7.0. Specifically, evaluations focus on 1) the position of the Mean Low Water (MLW) contour line after 4-years of simulation and 2) the navigable channel width over time.

The MLW contour represents a more consistent model outcome when compared to the Mean High Water (MHW) line as the Delft3D morphology model is limited in its ability to represent swash zone and dry beach processes. Since the ECL is based on 2003 MHW line, direct comparisons between simulated shorelines and the ECL are not possible. Instead, relative changes between the simulated MLW contour for the baseline and alternative refinement scenarios are evaluated as they are extracted within model applicability limits. Although shoreline changes were not used to



calibrate the model, overall trends simulated by the model are similar to those observed. This consistency provides confidence that the model is accounting for all relevant processes, which justifies the feasibility of using relative comparisons between scenarios to evaluate alternative performance.

The navigable channel width is defined as a minimum distance of 80 feet between the tip of the finger piers along eastern margin of Collier Creek and the -6.0 feet NAVD contour across the channel. It is highlighted that the channel is naturally deeper in the eastern half, as the bed elevation is generally deeper than -10.0 feet NAVD in this area.



6.0 Hydraulic Processes

Hydraulic processes in the vicinity of Collier Creek are tide dominated. Although a concave shape between structures is generally expected for a wave dominated system, the area downdrift of the proposed groin historically had a natural/equilibrium convex shape (see shorelines east of H14 in the bottom of Figure 1). This convex shape, which balances incoming and outgoing currents in this tide dominated area, was present prior to the construction of the terminal jetty in 2005. Model simulations show that currents are stronger during flood tides, which is why the shoreline bulge at Marco Point extends toward the finger piers along eastern margin of Collier Creek.

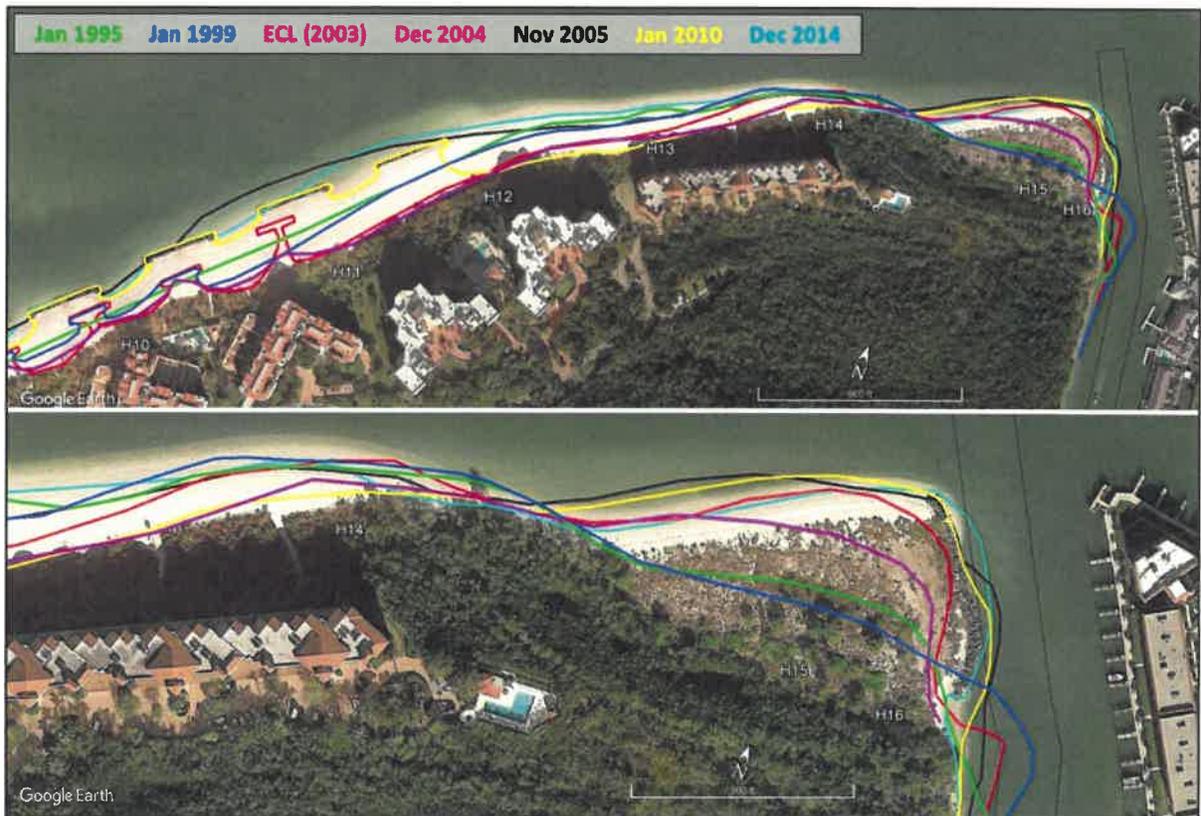


Figure 1: Historical Shoreline Comparison

Additional convex and concave shoreline response examples are provided in Figure 2. The December 2008 convex shoreline, shown on the top of Figure 2, extends seaward of the terminal jetty, which suggests that it is strongly influenced by tidal processes. In contrast, the January 2018 concave shoreline, shown on the bottom of Figure 2, is landward of the terminal jetty, which suggests that it is less influenced by the tidal processes that dominate within and adjacent to the channel and is more influenced by wave processes.



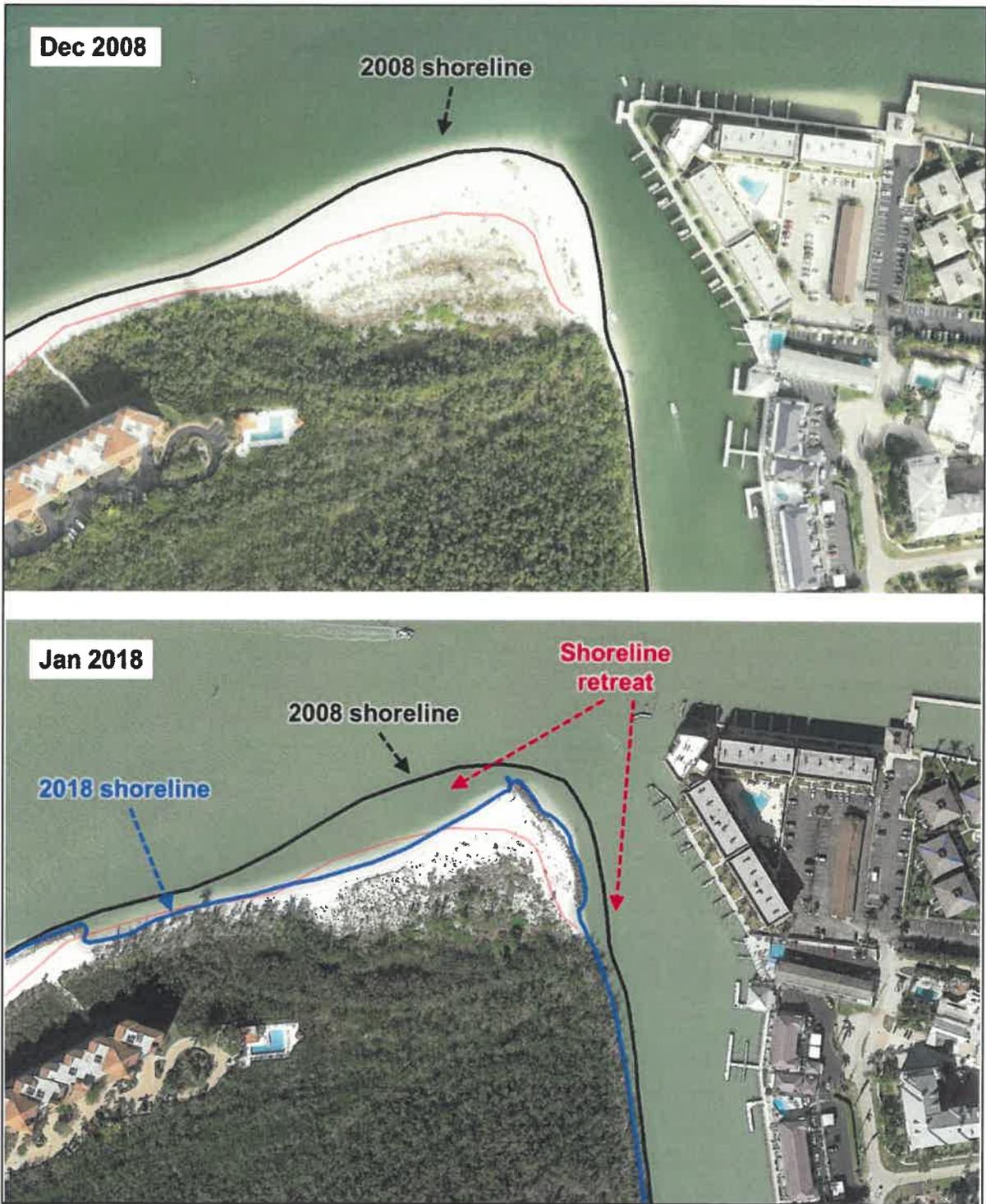


Figure 2: Recent Shoreline Comparison



7.0 Tentatively Selected Plan Refinement

Alternative 6 and Alternative 12 detailed in the November 2018 Management Plan both performed well based on the hydraulic criteria related to navigation. However, Collier County favors the addition of a new groin, similar to that included within Alternative 12, because it provides better assurances that the project will meet both sand management and navigational requirements. Major changes to the coastal system have occurred in the recent past and may continue into the future. Leaving a slug of sand on Marco Point without a structure is risky as accumulated sand will suddenly be available for release after jetty removal/modification. On the longer term, the new groin is expected to direct the eastward sand transport from Hideaway Beach into the Marco River tidal channel, with increased bypassing across Collier Creek's entrance. This provides better assurance that the project will meet objectives when considering future regional coastal changes and the variable sand supply regime (i.e. the structure will stabilize the gradually curved incoming current approach channel).

Additional simulations were completed to further evaluate structural need. These simulation results were compared with those obtained when simulating the existing inlet configuration. Evaluations include the numerical ranking scheme employed in the Management Plan and an illustration of hydraulic process effects. Refinements and their associated hydraulic effects (i.e. current, sediment transport, scour, shoreline change, and bathymetry) are discussed in the following sections.

7.1 Baseline Scenarios: No Action and Alternative 1

Simulation results for the No Action and Alternative 1 scenarios (i.e. baseline scenarios) are provided in Figure 3. Alternative 1 represents the current management practice of dredging the existing channel template to -12.3 feet NAVD, which results in the removal of 7,300 cubic yards when using the 2017 bathymetric surface to define the pre-construction condition (historical dredge volumes typically exceed 10,000 cubic yards as projects are generally constructed later in the accretion cycle to minimize the number of maintenance operations). It should be highlighted that the existing terminal jetty extends into the channel template, which limits the ability to dredge the full channel template during maintenance operations.

The upper plot in Figure 3 shows that the MLW line retreats significantly during the 4-year simulation (i.e. comparison of solid black line and blue/red lines). Results for the No Action and Alternative 1 scenarios are similar, which suggests that the current channel dredging operation negligibly affects updrift shorelines. Overall, model simulations show that the shoreline recedes west and south of the existing jetty.



Regarding navigable channel width, the benefits of channel dredging last approximately 1 year. After that, the channel width generally narrows to less than 80 feet for both the No Action and Alternative 1 scenarios. Considering safety buffers on both sides of the channel, 80 feet is extremely narrow for a two-way navigation channel, especially considering the extreme current and turbulence regime at the Collier Creek entrance.

7.2 *Alternative 1 without Terminal Jetty*

Simulation results for Alternative 1 without the existing Terminal Jetty are provided in Figure 4. The model suggests that sand will be lost west and south of the removed jetty, as sediments contained by the structure are exposed to transport and erosion processes. Consequently, the navigable channel width further decreases when compared to the Alternative 1 simulation with the jetty. These simulation results are consistent with general expectations, indicating that removing the jetty results in negative effects both in terms of land loss west of the jetty and navigation safety.



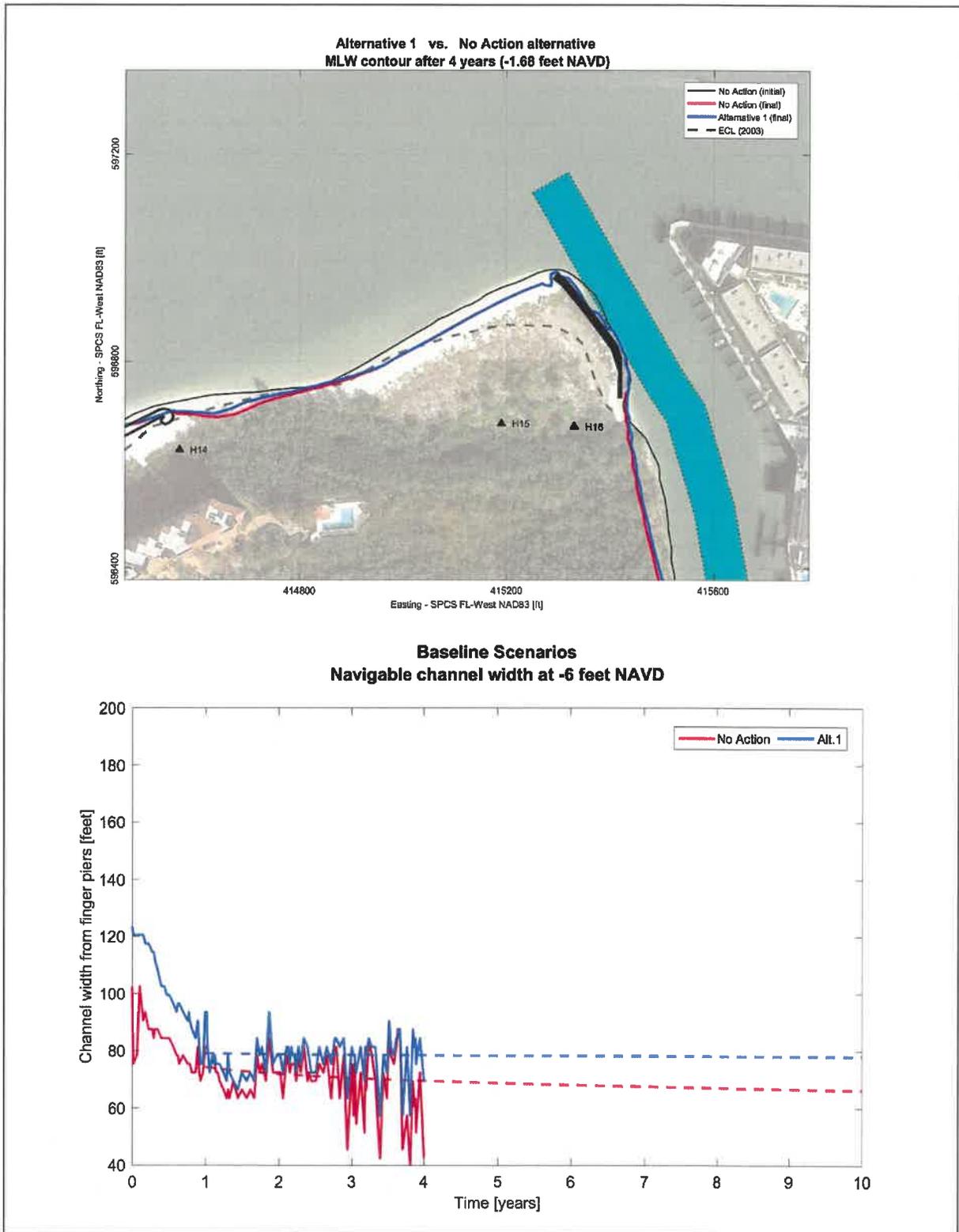


Figure 3: Baseline Scenario Model Results



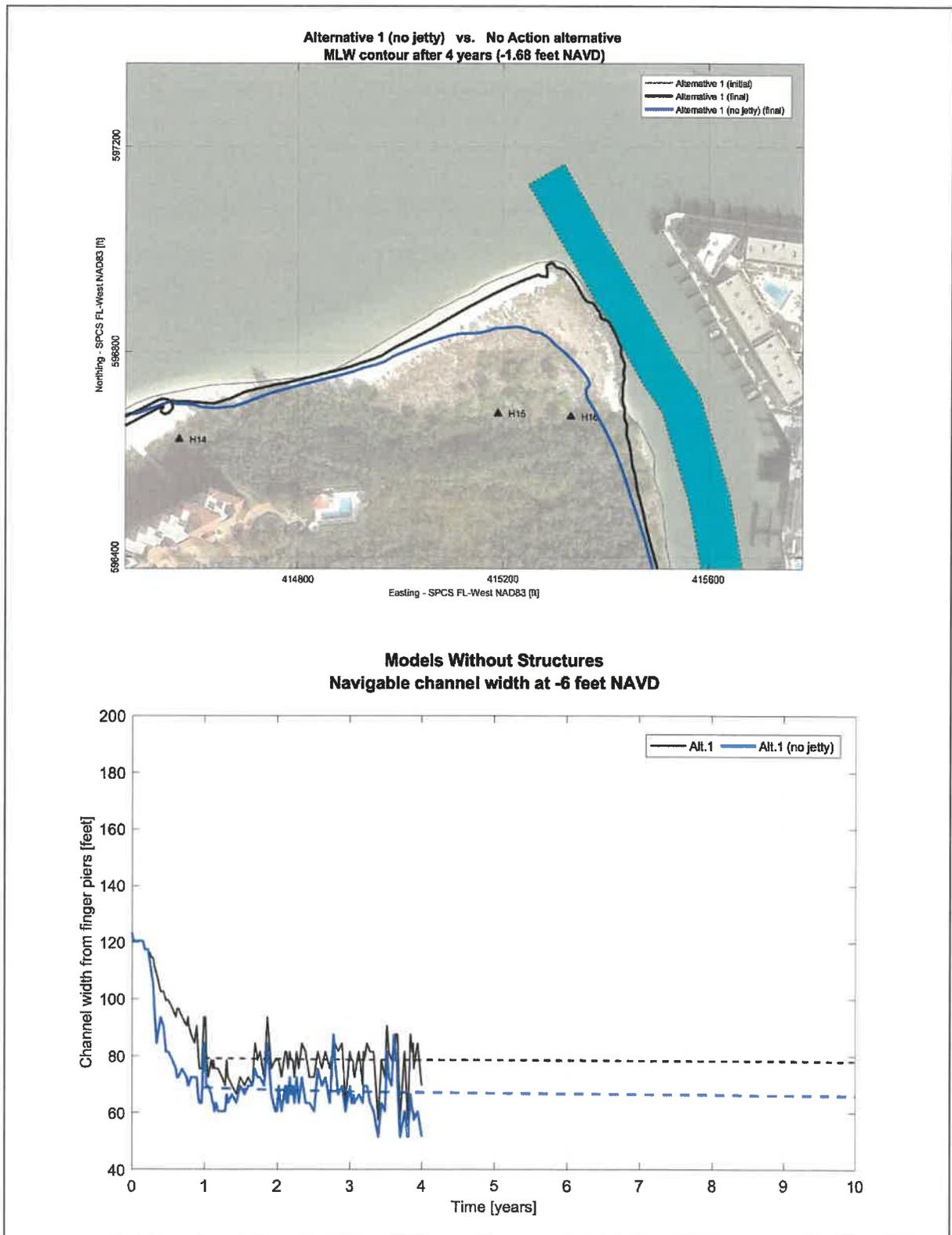


Figure 4: Alternative 1 without Terminal Jetty Model Results



7.3 Alternative 15

A new alternative (Alternative 15 – as shown in Figure 5) was developed using model results presented in the November 2018 Management Plan. Alternative 15 results in the removal of 22,500 cubic yards when using the 2017 bathymetric surface to define the pre-construction condition.

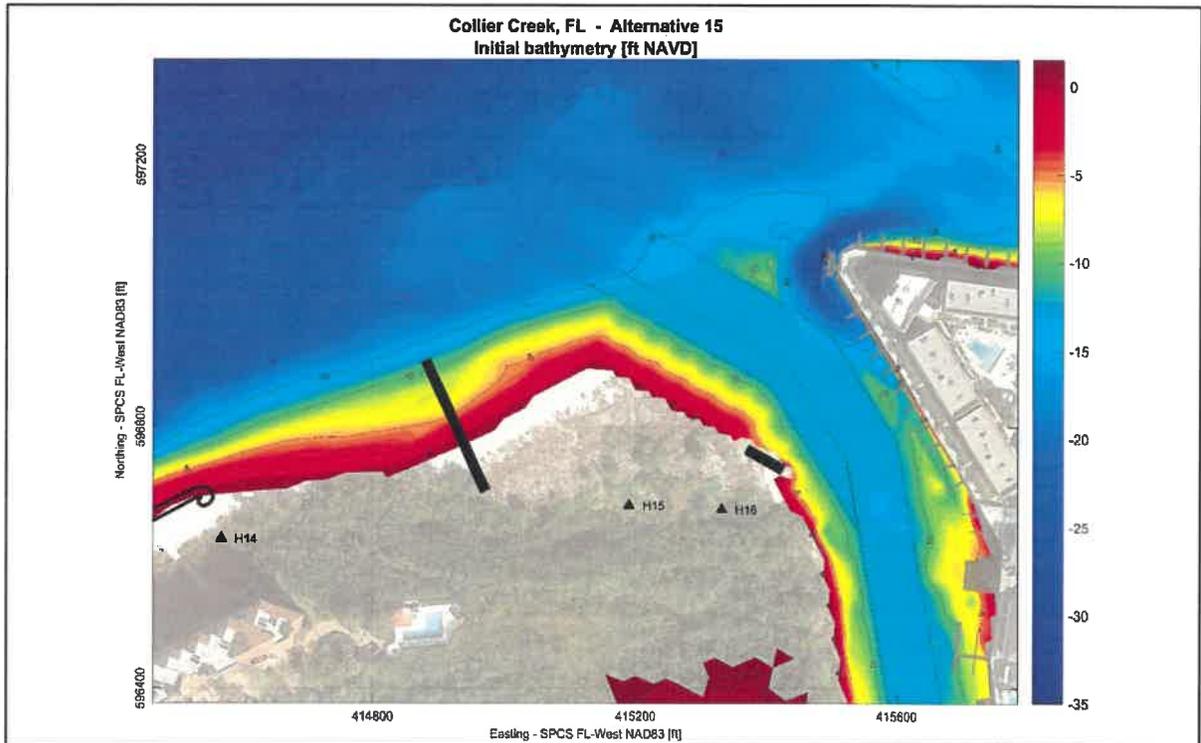


Figure 5: Alternative 15 Initial Model Bathymetry

Design components associated with Alternative 15 are summarized below:

- Navigation Channel: 80 feet wide at -12.3 feet NAVD (over dredge depth) that maintains a minimum buffer of 30 feet from the tips of finger piers (i.e. shifts the channel east to naturally deeper waters);
- Approach Channel: bends the channel at the Marco River and Collier Creek connection to smooth and improve flood-tide hydraulics by aligning the channel with the flood current;
- Channel Width: 40 feet wider at the entrance to secure navigation through the curved channel, which extends the project life by buffering the fast accretion observed in this area;



- Channel Slope: adjusted between the dredging template and the western shoreline north of the jetty (1V:10H slope) to reduce equilibration losses associated with structure removal and dredging (also improves flood tide curvature from Marco River into Collier Creek);
- Terminal Jetty: shortened to 50 feet and modified to protect the shoreline immediately south and transitioning river facing shoreline;
- Groin: protrudes 130 feet from 2017 MHW line and aligns with the Hideaway Beach breakwaters (advances the shoreline more than 40 feet within the sparse vegetation area, which is needed to account for shoreline retreat since 2017).

The purpose of the groin is to redirect tidal currents and sediment transport into Marco River and away from the Collier Creek entrance, which improves and extends the life of navigation benefits.

The upper plot in Figure 6, which shows the MLW contours after the 4-year simulation, demonstrates improved performance at the Collier Creek beach southwest shoreline when compared with the No Action scenario (i.e. less erosion). However, land loss occurs along the Collier Creek northeast shoreline when compared with the No Action scenario. As highlighted by the hydrodynamic model tests detailed in the November 2018 Management Plan, the realignment of the channel entrance westward over part of the accreted land mass west of the existing terminal jetty is needed to improve flood tide hydraulics at the channel entrance (**i.e. smooth flow curvature and reduce flow interaction/concentration at the eastern seawall**).

The model shows that Alternative 15 results in positive shoreline effects on both sides of the groin when compared with the No Action scenario (i.e. Alternative 15 results in updrift accretion and less downdrift erosion). The positive effects on the downdrift side of the groin are due to tidal current sheltering provided by the structure and the bi-directionality of the tidal forcing, which represent the primary driving processes; this effect is expected in current dominated areas, whereas effects would differ in a wave dominated environment.

Alternative 15 also considered a shorter groin (i.e. 100 feet as opposed to 130 feet) with both sloping and vertical seaward ends. The sloping end increases structure effects relative to a vertical end. Model test results presented in the bottom of Figure 6 indicate that the structure slope “compensates” for the groin shortening as similar navigation channel benefits were realized when comparing the 100-foot sloping groin with the 130-foot vertical groin. The simulation completed using a shorter structure length with a vertical end reduces performance capabilities due to the decreased flow and sediment transport deflection into Marco River and away from the Collier Creek’s entrance.



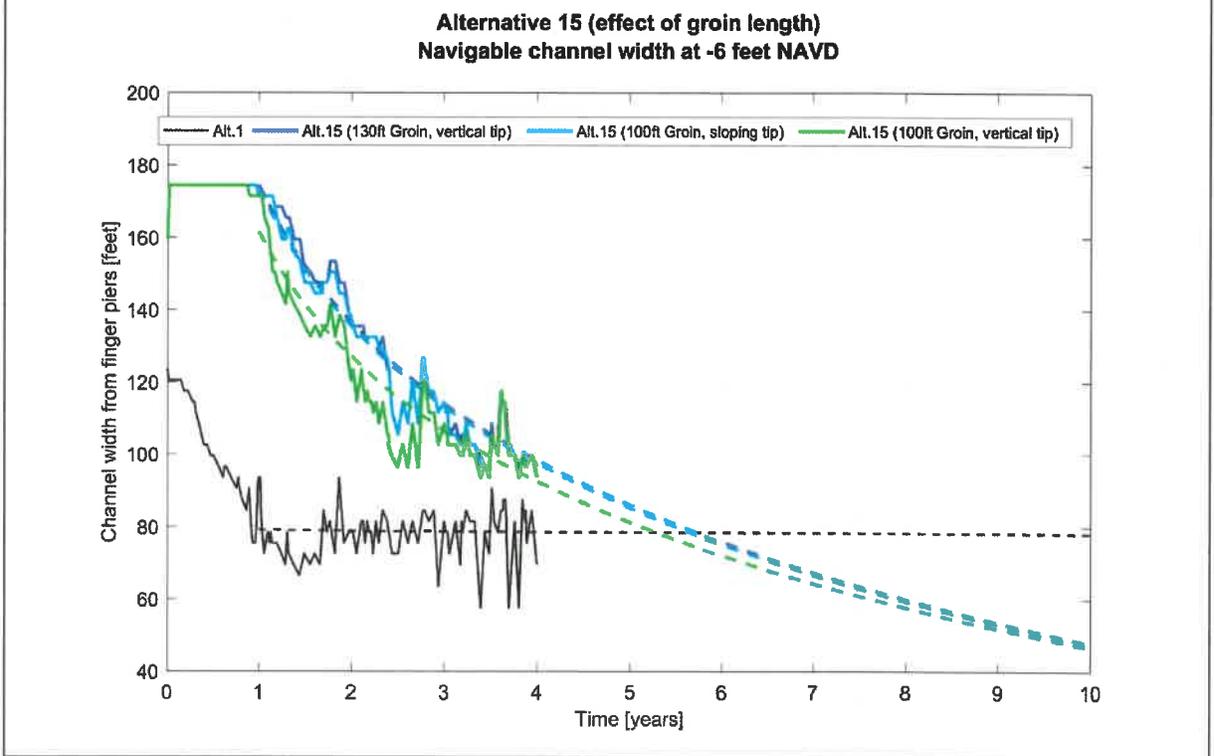
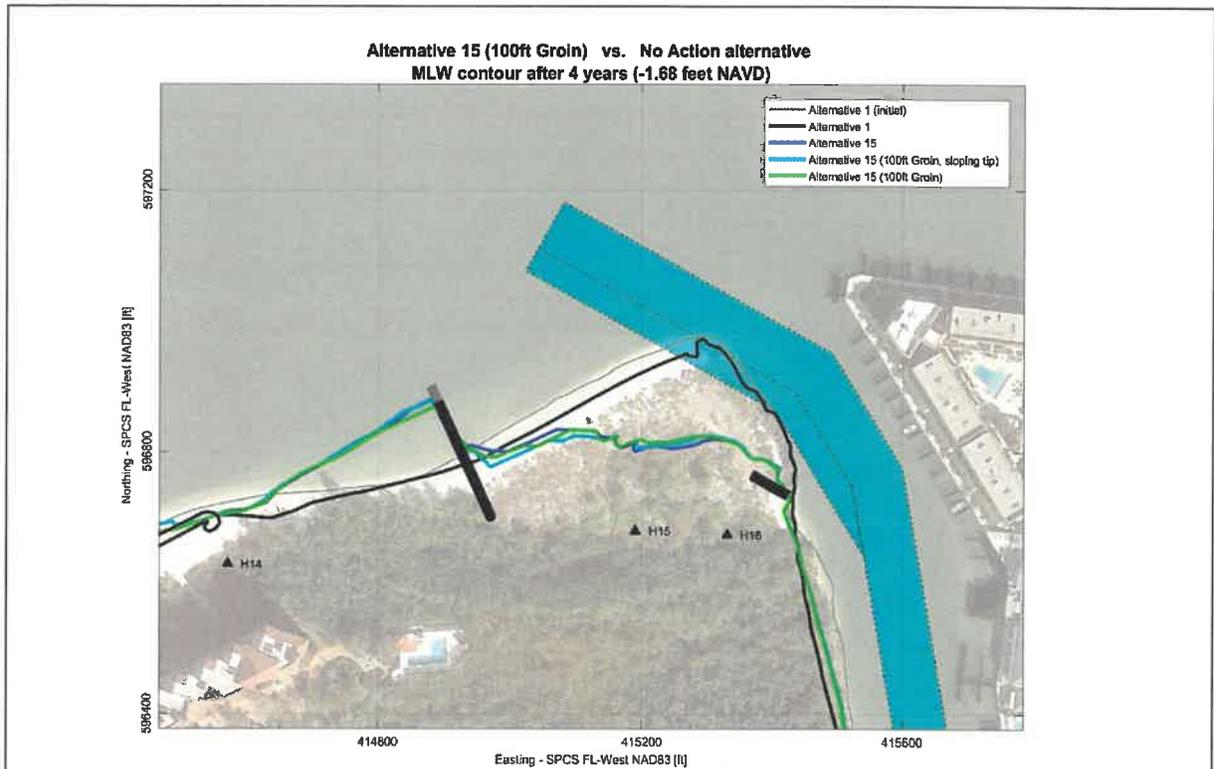


Figure 6: Alternative 15 Model Results



7.4 Alternative 15 without Groin

To evaluate the effects of the groin, Alternative 15 was simulated without including the groin. The results of this simulation are presented in Figure 7.

Comparing simulated MLW contours for this alternative with the No Action scenario results clearly demonstrate the groin's purpose given the net loss throughout the project area. Modifications to the existing terminal jetty result in erosion immediately west of the modified structure, which is also observed when simulating Alternative 1 without the jetty (see Figure 4). Without including the groin, these effects are not offset (as observed in Figure 6), which demonstrate the benefits the groin provides to the region immediately west of the Collier Creek entrance and to the east end of Hideaway Beach. Considering the No Action scenario simulation results, these structural benefits are important for regional sediment management as current erosive trends are expected to continue.

A comparison of navigable channel width over time considering Alternative 15 with and without the groin suggest that the maintenance dredging cycle may be drastically extended when including the groin. Although a projection of the no groin scenario simulation results suggest that the design channel width of 80 feet may be realized for nearly 5 years, the minimum channel width reduces to the design channel width within 2 years; fluctuations about the design channel width, which are shown in the model simulations, could result in safety issues given anticipated variability. Without the groin, sediments coming from Hideaway Beach are transported into the Collier Creek entrance. Conversely, including the groin redirects flow and sediment transport from Hideaway Beach into deeper areas of the Marco River channel, thus reducing erosion immediately east of the groin by sheltering this area from flood tide currents. In other words, the groin slows channel accretion, thus extending the life of navigation benefits and the maintenance dredging cycle.



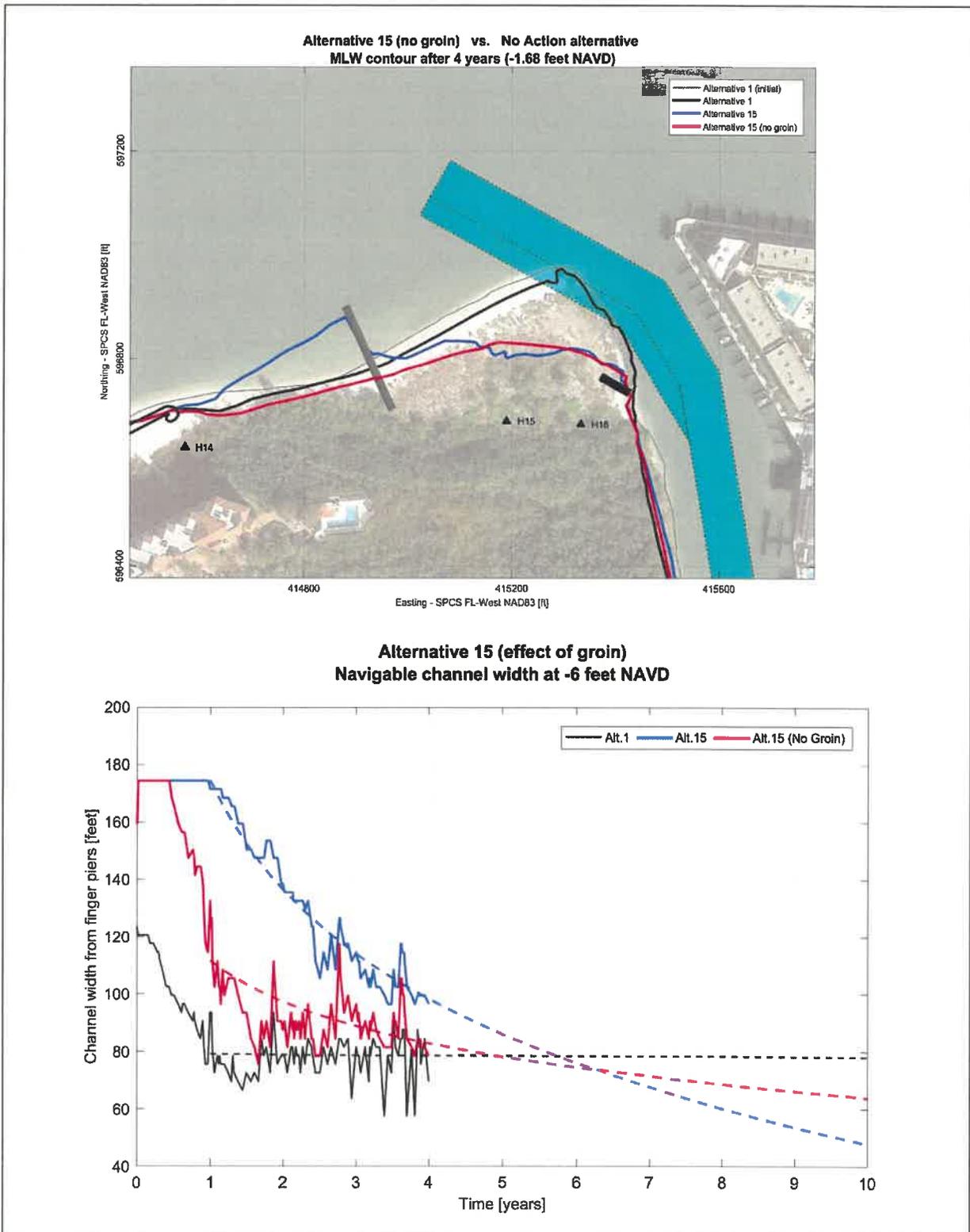


Figure 7: Alternative 15 without Groin Model Results



7.5 Alternative 15 with Permeable Groin

Alternative 15 was simulated with a permeable (50%) groin. A permeable groin can take three forms: 1) a stone structure with no core, 2) piles with adjustable panels, or 3) a permeable adjustable groin (PAG). Model results are provided in Figure 8. The original simulation of Alternative 15 and its variations presented in Section 7.3 considered a solid/impermeable structure, representing a structure with a core made of finer gradations, a solid core, or a sheet pile wall along the structure's axis. Regardless of the groins permeability, the structure will need a very durable foundation as the existing jetty lost 30 feet of length due to severe scour that occurred during Hurricane Irma (based on Hurricane Irma damage assessment).

Simulation results suggest that a permeable structure would provide additional shoreline response benefits, especially in the area immediately east of the groin. Comparing Figure 8 with Figure 6 and Figure 7, it is observed that the permeable groin results do not "average" the solid structure and without groin results. Instead, the permeable structure provides a more optimized response. This optimization rational is a function of the adjacent shoreline's exposure: the reduced flow slows erosion while allowing material to be transported towards and accumulate next to the structure during incoming/outgoing tides. Moreover, it was determined that groin permeability minimally affects navigable channel width.



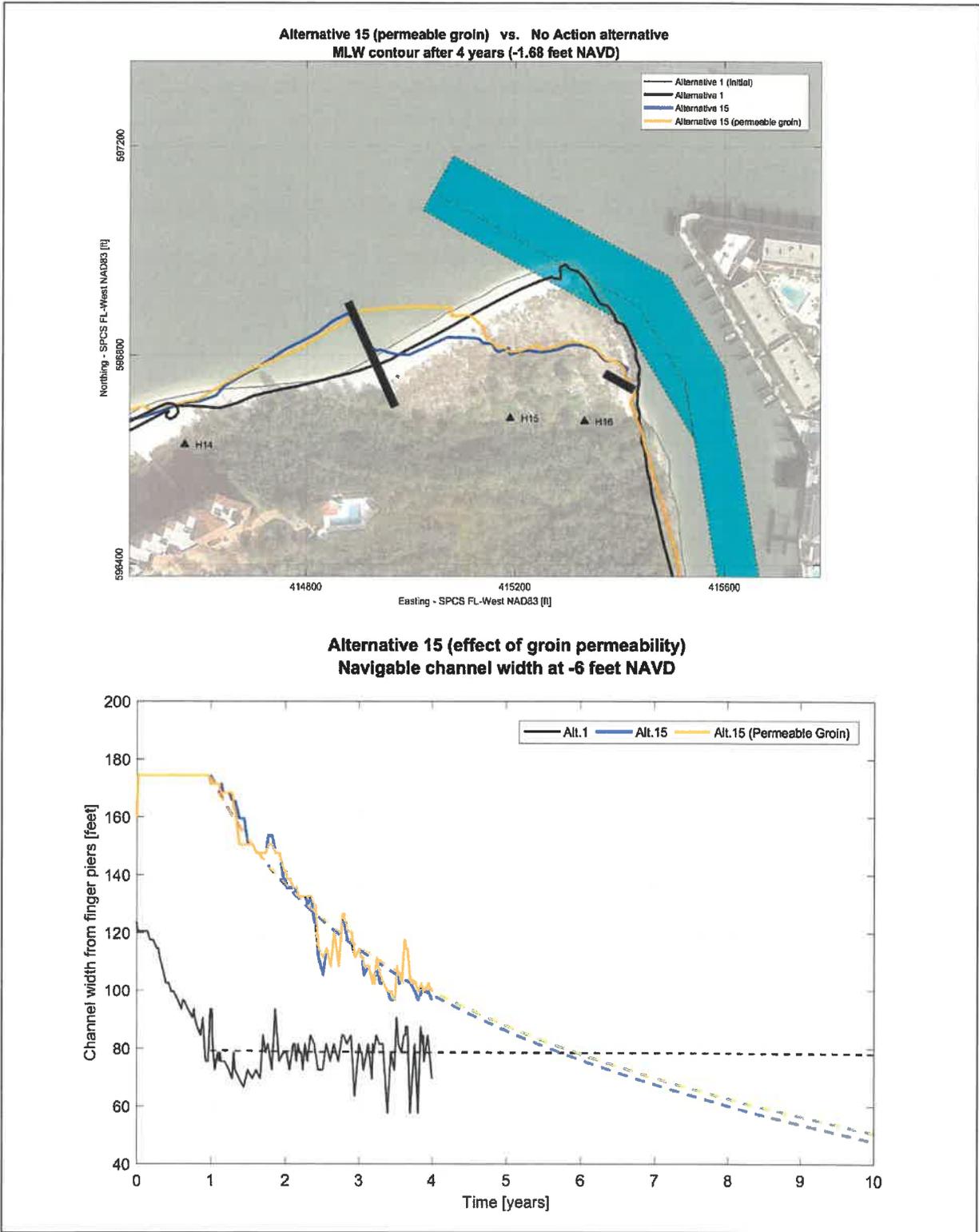


Figure 8: Alternative 15 with Permeable Groin Model Results



7.6 Alternative 15 with Variable Deposition Basin Dimensions

Additional variations of Alternative 15 considered changes to the width and depth of the deposition basin located at the Collier Creek entrance. Alternative 15 includes a deposition basin that is 40 feet wide at -12.3 feet NAVD (22,500 cubic yards). This alternative varies the deposition basin width (i.e. considers a deposition basin 80 feet wide at -12.3 feet NAVD – 29,000 cubic yards), and depth (i.e. considers a deposition basin 80 feet wide at -8.0 feet NAVD – 19,800 cubic yards).

The model results shown in Figure 9 indicate that a wider deposition basin slightly increases shoreline retreat between the jetty and the groin. If dredged to -12.3 feet NAVD, as shown in Figure 9, the wider deposition basin also leads to small positive effects along the western Collier Creek shoreline south of the jetty, which relates to changes in the tidal currents and net sediment transport throughout the system.

Alternative simulations suggest a correlation between the excavated volume and project performance in terms of navigable channel width. The best performance is achieved with the wider basin at -12.3 feet NAVD, while the shallower basin did not perform as well as the deeper basins. Moreover, it should be highlighted that Alternative 15 with the wider deposition basin at -12.3 feet NAVD was the best performing alternative considered in this alternatives refinement study in regards to navigable channel width over time. This emphasizes the importance of the channel design in regards to navigational performance.

The best alternative increases project life (Figure 9) by a factor of 7 when compared to Alternative 1 (existing dredge plan); for example, the project life increases from 1 year to 7 years. Dredging a larger buffer can be used to increase project life further. Project life is the time it takes the channel width to decrease to the minimum channel width of 80 feet as measured between the tip of the finger piers along eastern margin of Collier Creek and the -6.0 feet NAVD contour across the channel. It should be noted that project life can also be influenced by the amount of littoral sand reaching the inlet from Hideaway Beach. Therefore, an effective sand management plan, as detailed in Section 10.0, can extend the project life by reducing this littoral sand supply.



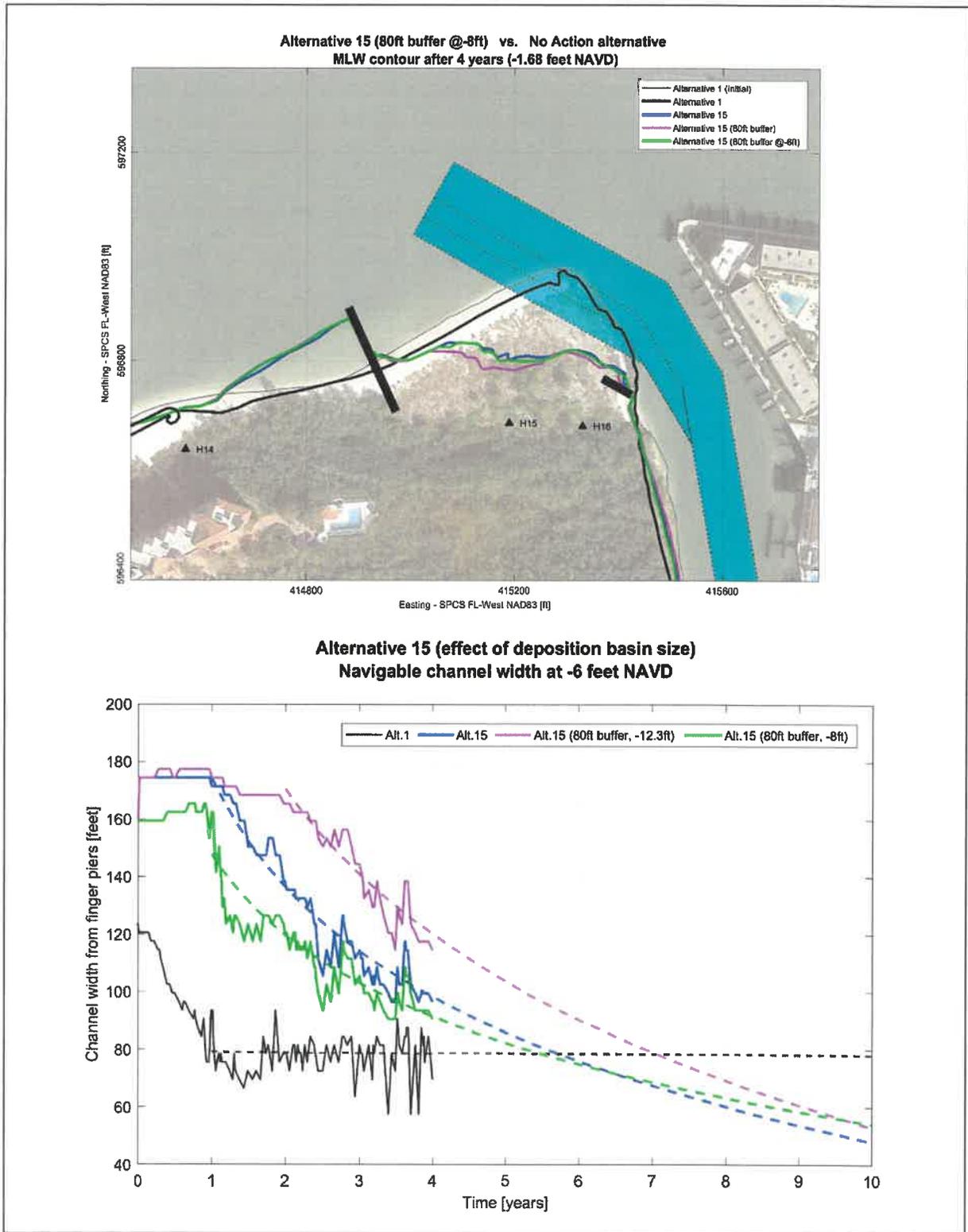


Figure 9: Alternative 15 with Variable Deposition Basin Dimensions Model Results



8.0 State Land Change Analysis

Currently FDEP's goal is zero net state land loss as measured landward of the ECL. Collier County and APTIM anticipate that some state lands may be needed to improve the navigational safety of Collier Creek, which is an effect of jetty removal or modification. However, as detailed within this section, the permeability modification to the TSP better redistributes sand and results in a net gain of state land. Moreover, this projected net gain effectively mitigates state land loss that has already occurred landward of the ECL. Also, some of the state land gained since 2003 was created by the construction of the Jetty in 2005; therefore, the TSP simply re-opens this space for to improve navigation.

The 2019 MHW Shoreline was compared with the 2003 MHW Shoreline (ECL) to better understand recent state land change. The 2019 MHW shoreline, generated using May 2019 survey data and refined using the January 2018 Google Earth aerial, shows that the state has already lost land landward of the ECL. This shoreline comparison, as shown below in Figure 10, indicates that 0.406 acres of land has been gained near the jetty while 0.545 acres of land has been lost downdrift of the eastern-most T-groin. Therefore, this analysis, which is summarized in Table 1, suggests that 0.139 acres of state land has been lost landward of the ECL. It should be noted that most of the land gained is within the terminal jetty footprint.



Figure 10: 2019 MHW (Survey) vs 2003 MHW (ECL) Land Change



Table 1: State Land Change Estimate

Land Change	Area Change (acres)		
	2019 Shoreline vs 2003 Shoreline (ECL)	Alternative 15 vs Alternative 1/No Action	Alternative 15 Permeable vs Alternative 1/No Action
Gain	+0.406	+0.591	+0.871
Loss	-0.545	-0.852	-0.747
Net	-0.139	-0.261	+0.124

Considering the net land loss and shoreline reconfiguration that has occurred since ECL establishment due to background erosion and structural effects, model results were compared to estimate future land change. Specifically, simulated Mean Low Water (MLW) shoreline positions for selected alternatives were compared with the simulated MLW shoreline position for the baseline No Action/Alternative 1 scenario (i.e. current management plan) to evaluate project effects. For example, when comparing MLW shorelines extracted from the 4-year Alternative 15 and No Action/Alternative 1 simulations, model results suggest that Alternative 15 may result in a net land loss of 0.261 acres when compared with the No Action/Alternative 1 scenario (see Figure 11). However, when making the groin permeable, model results suggest a net gain 0.124 acres (see Figure 12). Much of the land loss simulated for both versions of Alternative 15 is due to jetty modification and the excavation of the new channel. The jetty removal corresponds to part of these losses

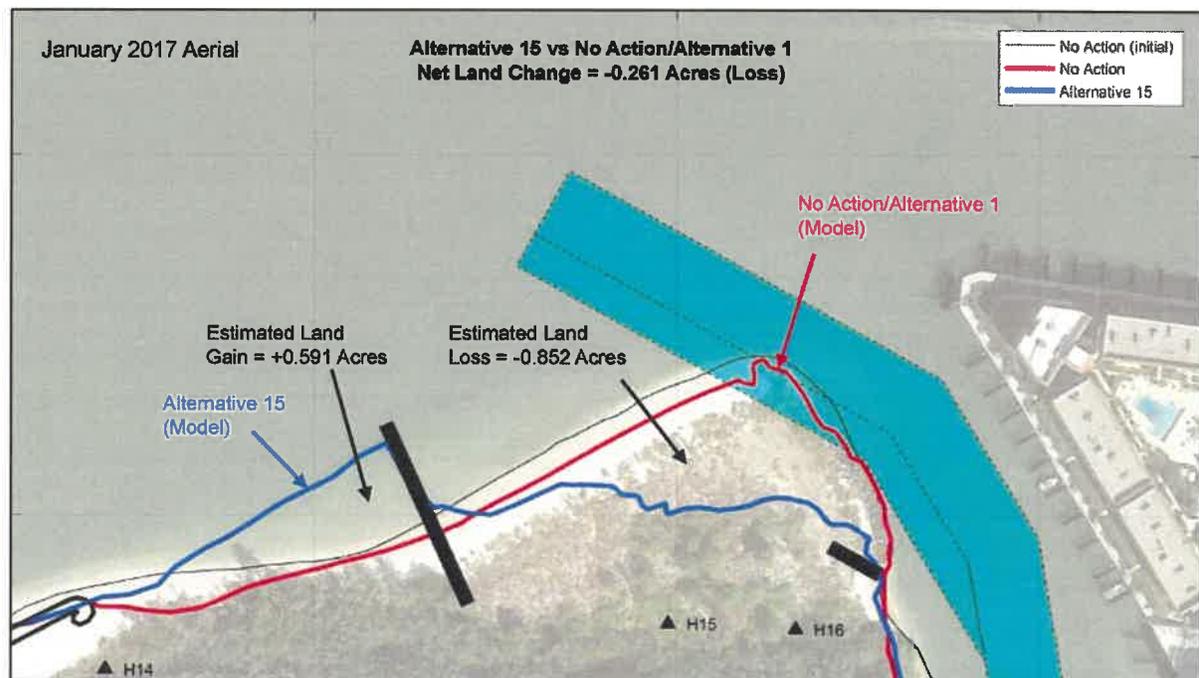


Figure 11: Alternative 15 vs No Action/Alternative 1 Land Change



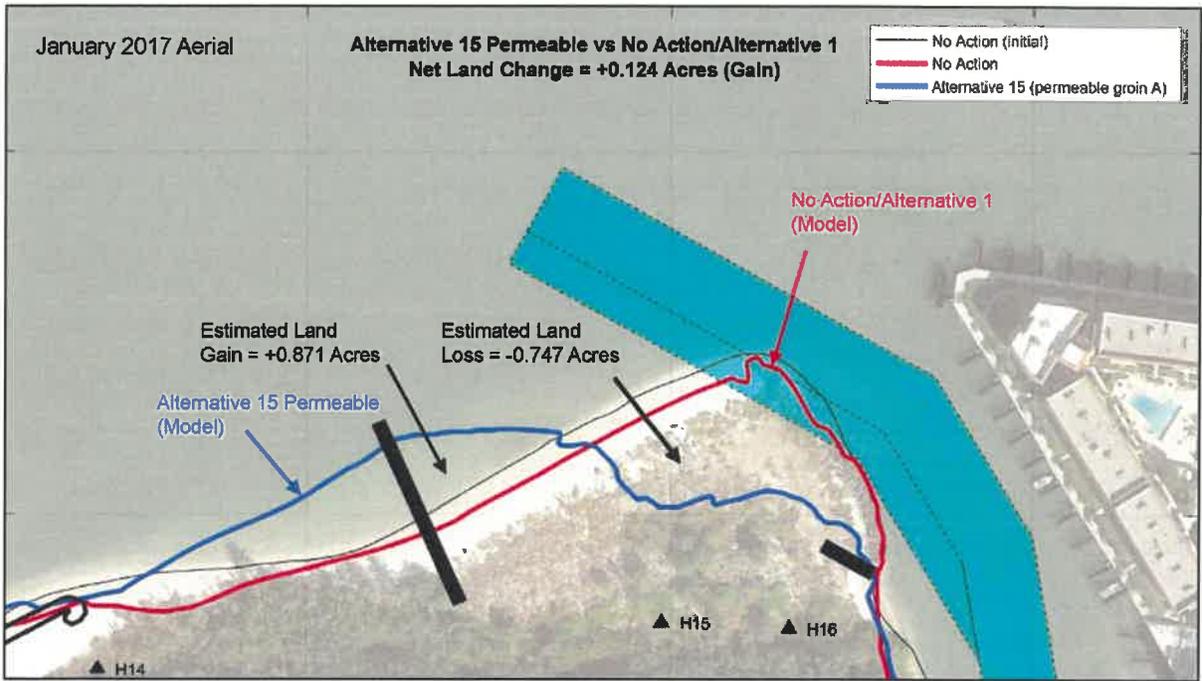


Figure 12: Alternative 15 Permeable vs No Action/Alternative 1 Land Change



9.0 Improved Navigable Waters and Reduced Scour

The hydrodynamic model results indicate that the tentatively selected plan based on Alternative 15 will be significantly more beneficial to navigation when compared with the existing conditions (Alternative 0) and the current management practice (Alternative 1) (Table 2).

Table 2: Tentatively Selected Plan Hydraulic Comparison

Alternative	Pier Speed		Cross-current		Channel Speed		Bottom Turb.	
	ft/s	%	ft/s	%	ft/s	%	1000* m ² /s ²	%
Alt. 0	3.94	0%	2.85	0%	0.26	0%	16.2	0%
Alt. 1	3.71	-6%	2.74	-4%	0.29	13%	14.9	-8%
TSP*	2.85	-28%	2.13	-25%	1.80	605%	10.1	-38%

*Determined based on the results of the “Terminal groin optimization: length and location” (section IV.1.4 of the modeling report).

The blue bars shown in above represent benefits of alternatives relative to the No Action scenario (Alternative 0).

- The maximum currents near the finger piers are reduced 28%. The reduction associated with the Tentatively Selected Plan benefits navigation and docking, and is 4.7 times greater than the improvements provided by Alternative 1.
- Threatening cross-currents at the channel entrance that drift boats sideways towards the piers and seawalls are reduced by 25% with the Tentatively Selected Plan, as the flood currents are more closely aligned with the channel. Reduced cross-currents increase the available response time for boaters and require less steering power to compensate and maintain safe clearance from the piers. The thread reduction provided by the Tentatively Selected Plan is 6.8 times greater than the improvements by Alternative 1.
- The minimum flood-tide current speed along the navigation channel is increased by 7 times compared to the existing conditions (Alternative 0). This increase is due to the reduction of the sheltering effect adjacent to the jetty. As a result, the tidal flow is more evenly distributed across the channel, which is better for navigation, reduce channel infill, and reduce flow concentration against the seawall and consequent bed scour.
- The more gradual flood-tide flow curvature from Marco River into Collier Creek provided by the Tentatively Selected Plan reduces the flow concentration and interaction with the seawall. This attenuates the near-bed turbulence energy by 38%, reducing the turbulence anomaly next to the seawall by 55% (i.e. background turbulence is typically on the order of 5 *1000 m²/s²). Since the observed scour hole is directly related to the exceptional



turbulence levels at this location, the Tentatively Selected Plan is expected to decrease maximum depths. This effect benefits the stability of the VDMW seawall and provides a wider navigable channel when considering a constant equilibrium cross-sectional area.

According to local stakeholders, the benefits of the current management practice (Alternative 1) are relatively mild and last approximately 12 months before the system converges back to pre-project conditions (i.e. Alternative 0). The morphology model results suggest that the benefits associated with the Tentatively Selected Plan will last significantly longer, thus reducing maintenance requirements and providing a wider navigable channel. In combination with the improved hydraulic parameters, this will significantly improve navigation safety at the Collier Creek entrance.



10.0 Proposed Sand Management Plan

A sand management plan was designed to incorporate the considerations described above into actions to protect the Collier Creek navigation project. The purpose of this plan is to minimize impacts to the inlet from updrift sand sources and to dispose sand removed from the inlet in a way that economically conserves this resource while putting the sand to its highest and best use. The recommended sand management principals are listed below in order of priority. Note, when beach placement is specified, it is meant to cover both the sub-aerial (dry) and sub-aqueous (wet) portions of the active beach profile.

1. Only sand suitable for beach nourishment should be placed on Hideaway Beach between H-9 and H-16. Excessive sand that covers the T-groins and overfills the beach fill template should not be allowed in this beach area.
2. Sand dredged solely to keep the Hideaway Beach Lagoon open should not be used for beach nourishment between H-9 and H-16.
3. Sand dredged from Collier Creek should be used for beach nourishment as a first priority subject to the above conditions and Collier County funding restrictions.
4. As a second priority, sand dredged from Collier Creek should be used to fill approved stockpiles, such as the two-permitted Hideaway Beach borrow areas and any other stockpile area established as a disposal area (Figure 4 and Figure 14 from the November 2018 Sand Management Plan).
5. The inlet channel should be dredged for navigation, while minimizing the dredged amount and encouraging sand transport pathways away from the project area.
6. All disposal areas should be selected to conserve sand within the Marco River/Capri Pass ebb and flood shoal sand sharing system.
7. No sand should be disposed of in a manner that will affect the Collier Creek navigation project, including on the beach between H-9 and H-16, except in accordance with principal 1 above.
8. A third priority for sand use should be for Marco Island Gulf Beach nourishment or nearshore Gulf shoreline disposal.
9. The proposed groin should minimize or mitigate the downdrift impacts of the Hideaway Beach T-Groins.
10. A permeable groin, in conjunction with other project features, should be used to create a net zero land loss condition.



11. Reducing the size of the Hideaway Beach project template east of the lagoon opening may be a viable alternative as it appears that the T-groin field is being overfilled.
12. Allowing Sand Dollar Island to meld onto the beach and eliminate the lagoon is a FDEP suggested alternative for consideration.



11.0 Tentatively Selected Project Description

The tentatively selected plan is based on the updated modeling analysis and plan refinement described in this report. The plan consists of multiple components as listed below and shown in Figure 13. Based on recent surveys, the initial dredge volume to implement this plan is 22,500 cubic yards. Moreover, it is estimated that 9,000 cubic yards will need to be dredged every 6 years to maintain the navigable channel. However, if all plan components are implemented, including sand management plan components summarized in Section 10.0, the maintenance dredging cycle may be extended. The estimated cost to construct the recommended plan is \$2.8 million plus the recurring maintenance dredging cost of \$773,000 which is expected every 6 years

Plan Components:

- Navigation Channel: 80 feet wide at -12.3 feet NAVD (over dredge depth) that maintains a minimum buffer of 30 feet from the tips of finger piers (i.e. shifts the channel east to naturally deeper waters);
- Approach Channel: bends the channel at the Marco River and Collier Creek connection to smooth and improve flood-tide hydraulics by aligning the channel with the flood current;
- Channel Width: 40 feet wider at the entrance to secure navigation through the curved channel, which extends the project life by buffering the fast accretion observed in this area;
- Channel Slope: adjusted between the dredging template and the western shoreline north of the jetty (1V:10H slope) to reduce equilibration losses associated with structure removal and dredging (also improves flood tide curvature from Marco River into Collier Creek);
- Terminal Jetty: shortened to 50 feet and modified to protect the shoreline immediately south and transitioning river facing shoreline;
- Permeable Groin: protrudes 130 feet from 2017 MHW line and 40 feet landward. The seaward tip aligns with the Hideaway Beach breakwaters. Structure needs an additional 40 feet to account for shoreline retreat since 2017, for a total length of 210 feet.

The purpose of the permeable groin is to redirect the tidal currents and sediment transport into Marco River and away from the Collier Creek entrance. A permeable groin can take three forms: 1) a stone structure with no core, 2) piles with adjustable panels, or 3) a permeable adjustable groin (PAG). All three permeable groin types fit into the template described above. The permeable groin will need a very durable foundation as the existing jetty lost 30 feet of length due to severe scour that occurred during Hurricane Irma (based on Hurricane Irma damage assessment). The modified



jetty will be built similar to the 2005 jetty construction. Both structures will use material from the existing jetty.

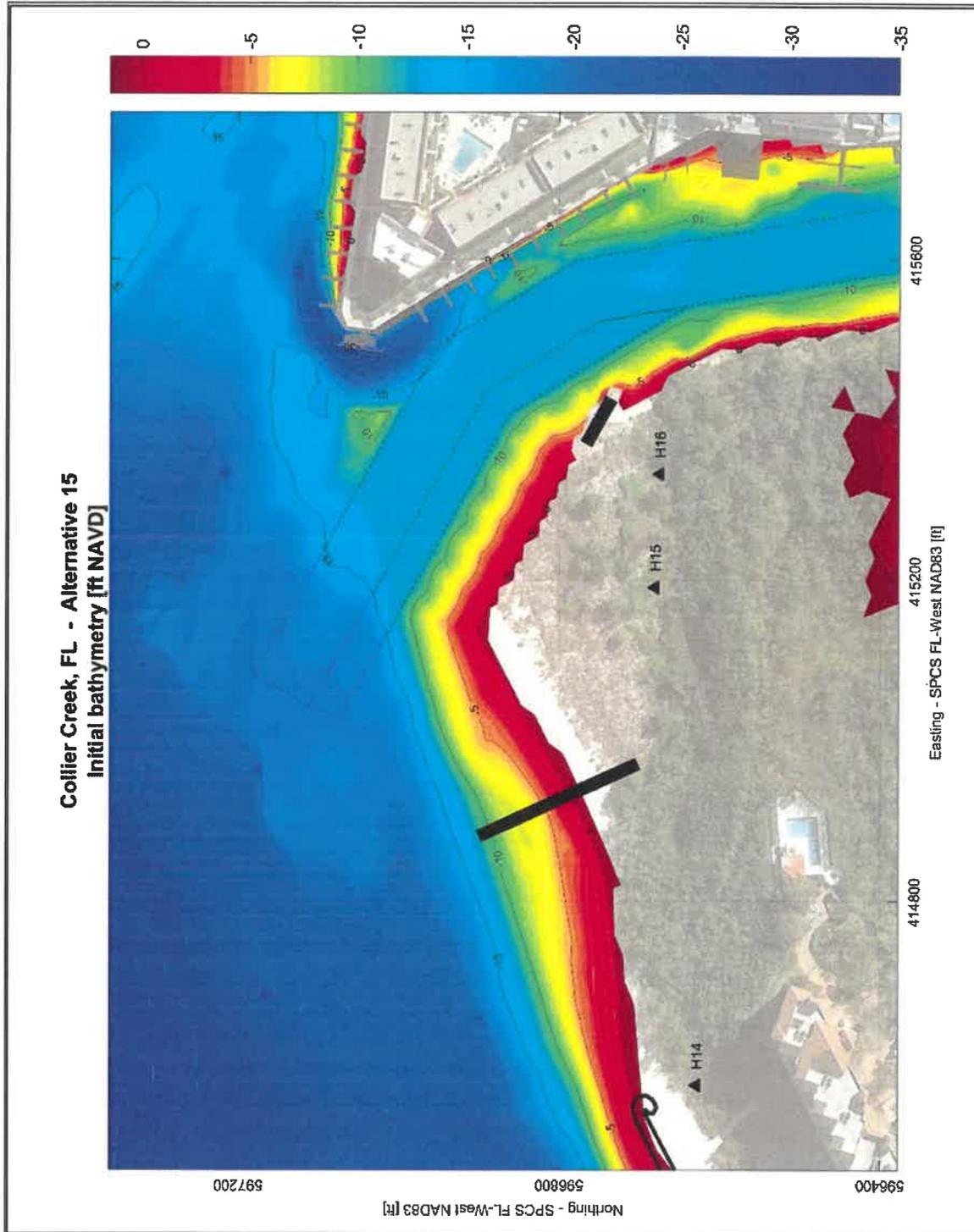


Figure 13: .Tentatively Selected Plan Model Bathymetry



12.0 Conclusions

The goal of this study was to provide assurances that the new structure at Marco Point and its potential effects are acceptable. It was shown that physical processes in the project area are generally tidally dominated, except when features are sheltered from tidal currents. It was also shown that navigational benefits increase when the channel width and depth increases, but at the expense of land loss. However, proper siting and design of a new structure in the area was shown to provide navigational benefits while stabilizing the shoreline, realizing a net positive land area change, and providing better sediment management.

The baseline scenario simulation results (i.e. No Action and Alternative 1, which represents the current management practice) demonstrate that channel dredging negligibly effects the adjacent/updrift shoreline. However, project benefits with respect to navigable channel width last only 1 year. Moreover, as discussed in the November 2018 Management Plan, Alternative 1 does not address the hydraulics that harm navigation. The flood tide flow concentration and interaction with the seawall along the eastern margin is driven by system setup on a larger scale – namely the strong flood tide currents in Marco River along the east end of Hideaway Beach and the sharp curvature of this flow field when entering Collier Creek. These processes are only marginally affected by the dredging. It was shown that solely removing the terminal jetty would result in the loss of land that is currently stabilized by the structure and would further impair navigation.

Alternative 15 represents the Tentatively Selected Plan derived from the 2018 Management Study modeling. Variations of this alternative were tested to refine the understanding of individual project components.

- Alternative 15 without the groin results in net land loss and faster channel infilling. Therefore, the groin stabilizes the updrift and immediately downdrift shorelines while reducing channel infilling rates.
- Alternative 15 with a permeable groin reduces land loss on the downdrift side without negatively affecting the channel or its infilling rate; it was shown that this option results in positive net land area change as opposed to the net loss caused by the solid groin.
- Dredging a wider deposition basin significantly improves project performance in terms of navigable channel width while slightly increasing land loss between the groin and the terminal jetty. This option can potentially be refined to realize a zero net state land loss.

Considering these results, Alternative 15 with a permeable groin addresses navigational concerns while stabilizing the shoreline and realizing no net land loss.

