APPENDIX C

INLET MANAGEMENT PLAN

DRAFT INLET MANAGEMENT PLAN
LOCKWOODS FOLLY INLET, NC

1.0 INTRODUCTION

The Town of Holden Beach (herein referred to as the "Town") has proposed the construction of a terminal groin and a concurrent 150,000 cubic yard (cy) beach nourishment at the east end of Holden Beach, adjacent to Lockwoods Folly (LWF) Inlet, as part of its ongoing beach management activities. Projects involving terminal groins are required to include an inlet management plan to monitor impacts on coastal resources, among other things. Specifically, Senate Bill 110 § 113A-115.1(e)(5) calls for:

> "A plan for the management of the inlet and the estuarine and ocean shorelines immediately adjacent to and under the influence of the inlet. The inlet management plan shall do all of the following relative to the terminal groin and its accompanying beach fill project:
>
> a. Describe the post-construction activities that the applicant will undertake to monitor the impacts on coastal resources.
> b. Define the baseline for assessing any adverse impacts and the thresholds for when the adverse impacts must be mitigated.
> c. Provide for mitigation measures to be implemented if adverse impacts reach the thresholds defined in the plan.
> d. Provide for modification or removal of the terminal groin if the adverse impacts cannot be mitigated."

2.0 PHYSICAL MONITORING

2.1 EXISTING MONITORING

As part of its ongoing beach management plan, the town of Holden Beach routinely monitors the shoreline from Shallotte Inlet to LWF Inlet with annual bathymetric surveys dating back to 2000. These surveys encompass LWF Inlet and ebb shoal areas. Beginning with the April 2012 survey, an additional six transects were included on western Oak Island "in order to more closely monitor inlet-related effects and establish more consistent baseline data" (Holden Beach Annual Monitoring Report, ATM, 2012). Figure D-1 shows an overview of the latest Town survey from April 2012. The U.S. Army Corps of Engineers (USACE) also performs routine bathymetric surveys of LWF Inlet, the Atlantic Intracoastal Waterway (AIWW) inlet crossing (LWFIX), and the bend widener section of the AIWW inlet crossing (see Figures D-2 and D-3).

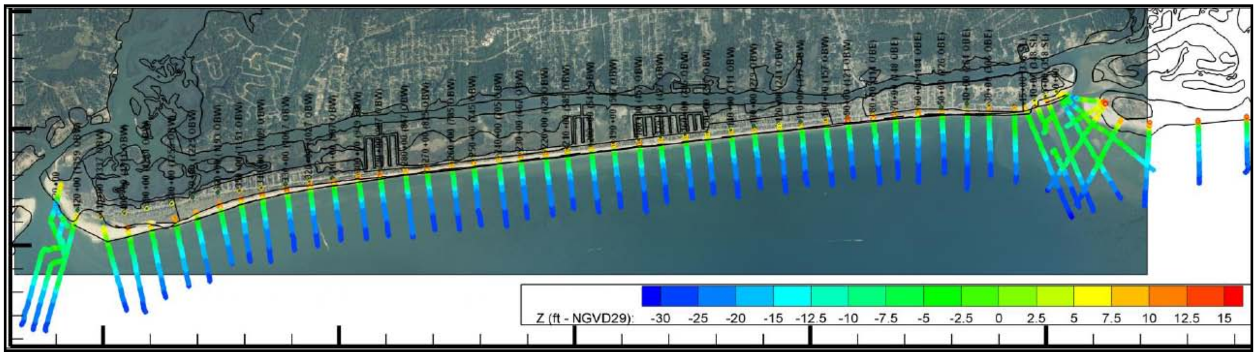

Figure D-1. Town of Holden Beach Annual Bathymetric Survey, April 2012 (2008 Aerial).

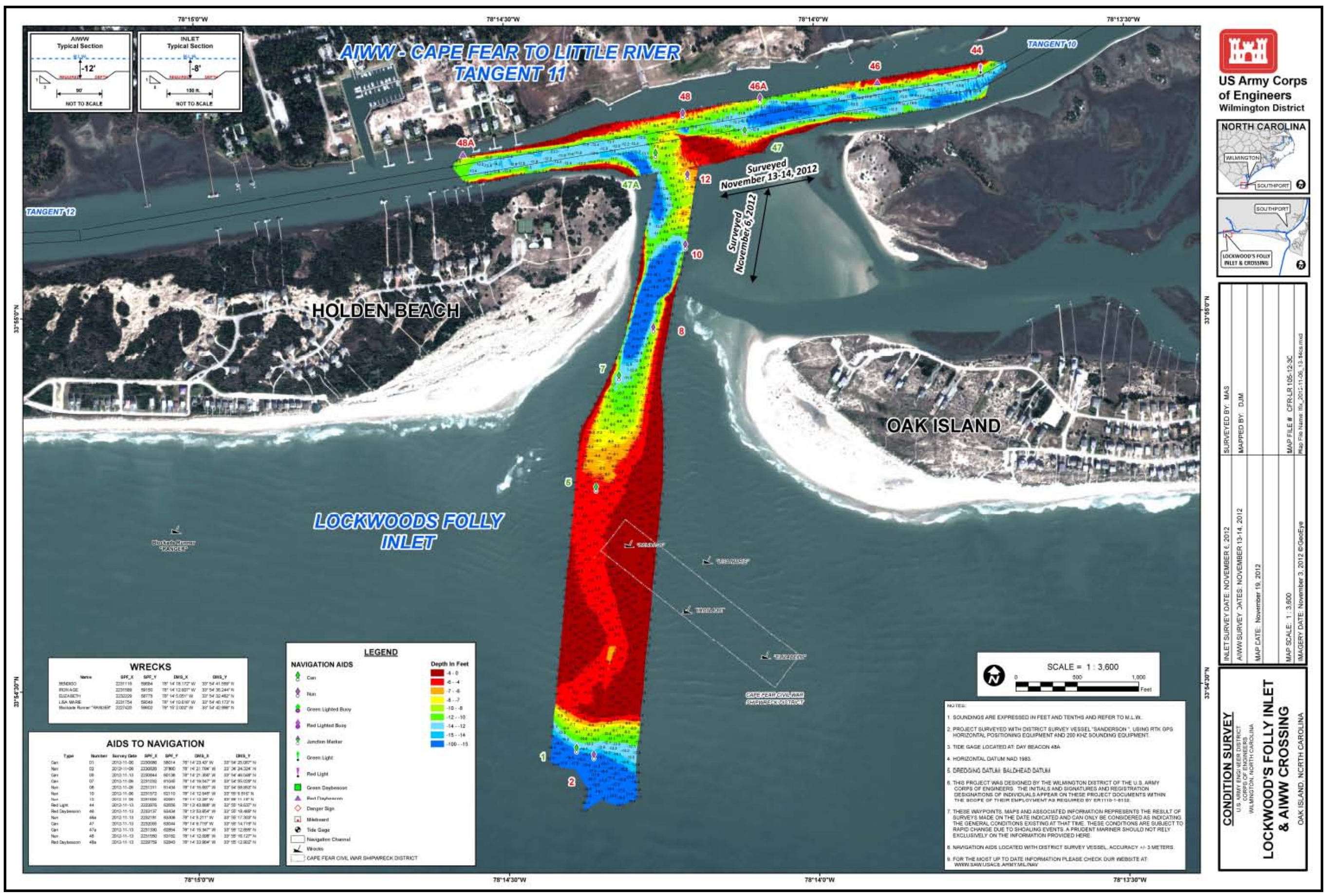

Figure D-2. USACE LWF Inlet, AIWW Inlet Crossing, and Bend Widener November 2012 Survey (source: Wilmington USACE Navigation Branch).

Additional physical monitoring beyond the ongoing efforts by the Town of Holden Beach and USACE will be necessary to fully observe any potential project-related effects to surrounding areas as part of the inlet management plan.

2.2 PROPOSED BEACH FILL AND INLET AREA MONITORING

Pre-project and post-project beach profile surveys will be performed at the 16 control reference transects depicted in Figure D-3. These transects coincide with ongoing annual survey transects performed by the Town of Holden Beach. Figure D-3 also shows zones of special interest within the inlet area specific to potential groin impacts. The proposed transects cover all areas except for the flood shoal, AIWW inlet crossing, and bend widener. The USACE routinely surveys the AIWW inlet crossing and bend widener. The latest surveys available will be used as the pre-project conditions for these areas. Additional surveying will occur to accurately define conditions of the flood shoal.

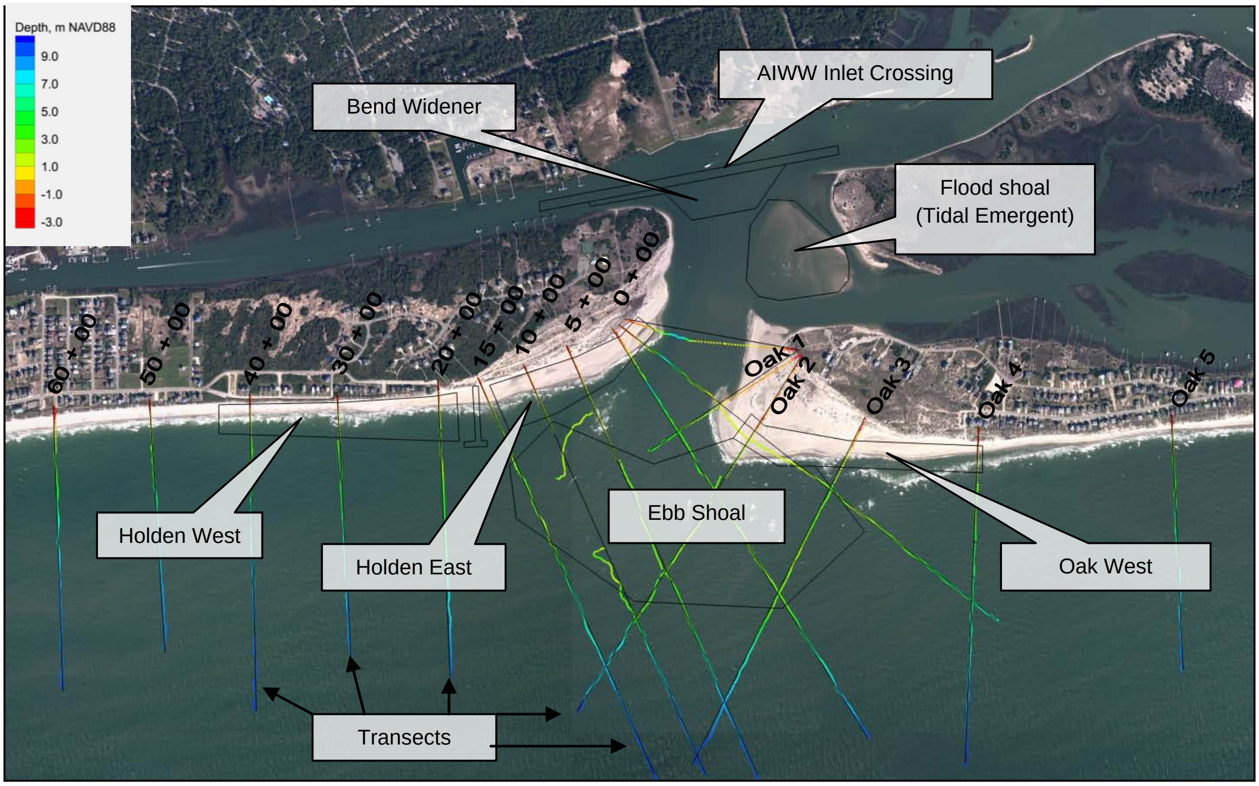

Figure D-3. Pre- and Post-Project Physical Monitoring Transects and Zones. Survey transects shown are from 2012; the aerial is from 2011.

Immediate pre-project and immediate post-project and annual surveys thereafter will be performed from the primary dune (or equivalent) to a minimum elevation of -25 ft referenced to the North American Vertical Datum of 1988 (NAVD88). This elevation typically occurs within 2,500 ft from the shoreline. All survey lines will be terminated if a distance of 2,500 ft is reached prior to the target depth. Landside spot elevations will be measured at a maximum of 25 ft intervals, with higher density in areas of significant features such as escarpments or any notable change in elevation. Hydrographic soundings (vessel survey portion) will be reported at a minimum of approximately 25 ft intervals. All profiles will be surveyed approximately along and parallel to the monitoring transects as shown on Figure D-3 (note latest survey transect at station 10+00 shown was disrupted by a shoal/sandbar). These transects can extend landward or seaward as needed to meet established minimum depths. Due to the natural migratory nature of LWF Inlet, survey transect extents may vary from survey to survey. Annual surveys will also include “flood shoal” surveys extended to wading depth (i.e., no vessel survey component), with spot measurements at a maximum of 25-ft grid spacing with higher density in areas of significant features such as escarpments, or any notable change in elevation.

Semi-annual profile surveys will be extended to wading depth only (i.e., no vessel survey component). Surveys will include the primary dune (or equivalent) and extend to -6 ft NAVD88 (i.e., wading depth at low tide).

2.3 BEACH PROFILE AND INLET AREA MONITORING SCHEDULE

A pre-construction survey will be performed within 4 weeks prior to the commencement of beach fill placement. This survey will document the baseline conditions immediately prior to construction. Similarly, an immediate post-construction survey will be performed within approximately 4 weeks following completion of beach fill and groin construction. It is assumed that beach nourishment will occur either before or concurrent with groin construction. This will more easily allow the groin to be constructed from land. Table D-1 presents the proposed surveying timeline for the inlet management plan.

Semi-annual surveys are proposed to occur in the first through fifth years following construction. The ongoing annual survey schedule will resume in Year 6 of the project and continue into the foreseeable future. Annual surveys will include transects along all of Holden Beach shown in Figure D-1 as part of the Town’s ongoing monitoring.

Table D-1. Physical Monitoring Survey Schedule

Survey*	Timeline	Beach Survey Extents
Pre-Project Survey	within 4 weeks of project initiation	Dune to -25 ft NAVD88+Flood Shoal
Post-Project Survey	within 4 weeks of project completion	Dune to -25 ft NAVD88
Semi-annual	6 months post-project	Dune to -6 ft NAVD88
Annual	1 yr post-project	Dune to -25 ft NAVD88+Flood Shoal
Semi-annual	1.5 yr post-project	Dune to -6 ft NAVD88
Annual	2 yr post-project	Dune to -25 ft NAVD88+Flood Shoal
Semi-annual	2.5 yr post-project	Dune to -6 ft NAVD88
Annual	3 yr post-project	Dune to -25 ft NAVD88
Semi-annual	3.5 yr post-project	Dune to -6 ft NAVD88
Annual	4 yr post-project	Dune to -25 ft NAVD88+Flood Shoal
Semi-annual	4.5 yr post-project	Dune to -6 ft NAVD88
Annual	5 yr post-project	Dune to -25 ft NAVD88+Flood Shoal
Semi-annual	5.5 yr post-project	Dune to -6 ft NAVD88
Annual (ongoing)	Ongoing surveys resume annually	Dune to -25 ft NAVD88+Flood Shoal

*The most recent available USACE AIWW inlet crossing, bend widener, and LWF inlet surveys will be used in conjunction with annual surveys. All annual surveys will include survey of flood shoal.

The most recent available USACE AIWW inlet crossing, bend widener, and LWF Inlet surveys will be used in conjunction with this monitoring schedule. The USACE typically surveys these areas several times a year. However, if USACE surveys have not occurred within 4 months of the annual survey, these areas will be surveyed during the Town's survey collection effort. This additional surveying area is presented in Figure D-4.

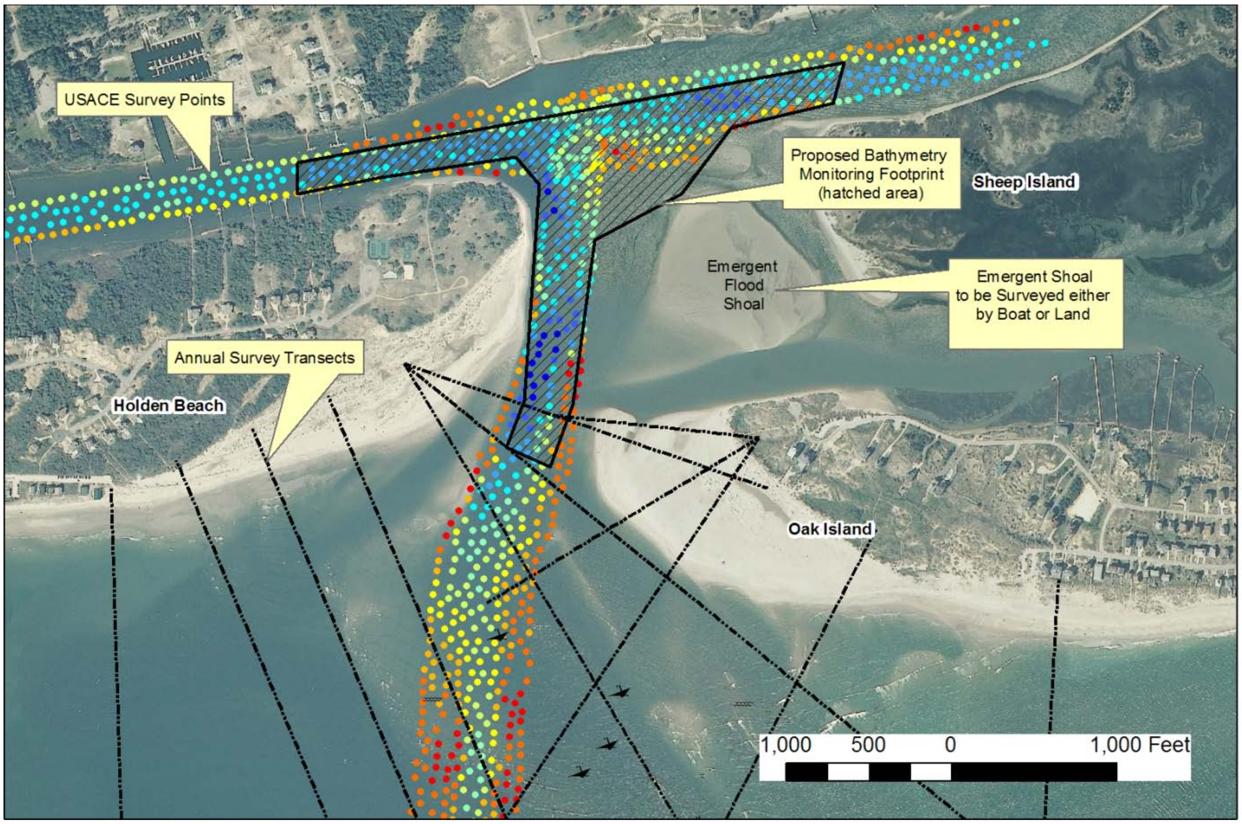

Figure D-4. Proposed Bathymetric Data Collection, if No Recent USACE Survey Data are Available. Bathymetry footprint may vary based on shoaling/navigable depths.

2.4 AERIAL PHOTOGRAPHY

Aerial photographs of the study area that include the survey transects in Figure D-3 will be obtained twice a year in the first 2 years after groin construction. During Years 3 through 5 following construction, aerial photographs will be taken once per year. At the end of 5 years, the applicant will coordinate with regulatory agencies to determine whether additional annual aerial photographs are required.

2.5 SURFICIAL SEDIMENT SAMPLING

Surface beach sediment samples will be collected along two transects within the project construction limits and along three transects outside of the project footprint during survey events from pre-construction to 2 years post-construction. These locations are identified in Figure D-3 as Station 60+00 (west control), Oak 3 (east control), 20+00/30+00 (project), and 10+00 (inlet control). Samples at each of these transect profiles will be collected at three cross-shore locations. The sample locations correspond approximately to the +6 ft, +3 ft, and -3 ft elevation contours referenced to NAVD88. Sediment samples will be analyzed using standard ASTM procedures for grain size distribution, percent fines, color, and visually for shell content. In addition, these samples will be used in support of biological monitoring discussed in subsequent sections.

2.6 PHYSICAL MONITORING DATA ANALYSIS

The monitoring data collected will be analyzed to determine volume and shoreline changes in the project area and the adjacent beaches, and to assess project performance. The following analyses will be performed, at a minimum:

- Beach profile comparison plots: The current survey for each profile will be graphically compared to the previous survey(s).
- Shoreline change analysis: The shoreline (typically the mean high water line) positions between consecutive surveys will be compared, plotted, and analyzed for mean and extreme changes.
- Volume change analysis: Project placement volumes will be compared with volume remaining in the active profile at the time of each survey. Estimates of cross-shore and longshore sediment volume changes will be calculated and compared with each subsequent survey, to the extent possible.
- Sediment grain size distribution: Sediment samples will be analyzed and compared to the composite mean grain size of the native beach material.
- Storm events: Any significant storm events that affect the project beach will be described based on available local meteorological data.
- Performance assessment: An overall project performance assessment will be based on the design goals and current state of the project determined through the data collection and analysis efforts described above.

3.0 BIOLOGICAL MONITORING

The following macro-invertebrate monitoring plan is proposed to monitor the subsequent effects of the beach fill and terminal groin project on selected burrowing macro-invertebrate species that have been shown to be indicators of the ecological response of the beach system. The Town's biological sampling program currently includes the coquina or bean clam (*Donax variabilis* and *Donax parvula*), mole crab (*Emerita talpoida*), and ghost crab (*Ocypode quadrata*), which are three often-used indicators of beach ecological health (Greene, 2002).

The bean clam and mole crab primarily inhabit the swash zone, whereas the ghost crab primarily inhabits the dune area. The purpose of the monitoring plan is to provide statistical data to evaluate any effects of the biological system within the project area footprint to control areas. A standard Before After Control Impact (BACI) protocol will be implemented.

The proposed biological monitoring program will build upon the existing program. The Town completed a similar biological monitoring survey in 2010 as part of its post-nourishment monitoring plan for the beach nourishment completed in 2009. This survey included transects 30+00 and 60+00, transects also proposed in this monitoring plan. This existing data will be helpful in statistical analysis and biological assessment.

3.1 BIOLOGICAL MONITORING METHODS

Primary components of the monitoring plan will consist of collecting sampling cores within the intertidal region to monitor mole crab and bean clam abundances. In addition, recovery of the ghost crab will be observed by the number of active ghost crab burrow holes on the upper portion of the beach. Monitoring will be conducted along two transects (Figure D-3) within the project reach (20+00 and 30+00) and along three transects outside the project footprint, one to the west (60+00), one on the inlet shoulder (10+00) and one to the east (Oak 3). Surficial sand samples will also be obtained at the same transects to correlate macro-invertebrate recovery with sediment characteristics.

3.1.1 MOLE CRAB AND BEAN CLAM

Sampling cores for mole crab and bean clam will be collected at three stations along each transect; three cores at the mid-tide level, three cores at the low tide mark, and three cores taken in shallow water. From a timing perspective, sample collection shall occur as close to low tide as possible. Cores will be obtained using a cylindrical core with inside diameter of 10 centimeters (cm) and a depth of 15 cm. Samples will be passed through a 0.5 millimeter (mm) stainless steel sieve to separate sediment from infauna. Biological samples will be photographed and measured, then returned to the sampling location.

3.1.2 GHOST CRAB

Active ghost crab burrow hole counts will be performed along the upper portion of each transect, between the mid-tide mark and the toe of dune. Swaths 4 meter (m) wide will be laid out along each transect and active burrow holes will be identified by the observation of fresh ghost crab tracks around each hole. From a timing perspective, ghost crab counts shall occur as close to low tide as possible.

3.1.3 SURFICIAL SEDIMENT SAMPLES AND COMPATIBILITY

Five physical factors predominantly control the distribution and abundance of biota in the intertidal zone: wave energy, bottom type (substrate), tidal exposure, temperature, and salinity (Dethier and Schoch, 2000; Ricketts and Calvin 1968). Surface beach samples will be obtained to correlate any potential invertebrate effects with the placed material. Surface beach sediment samples will be collected as described in Section 2.5.

3.2 BIOLOGICAL MONITORING DATA ANALYSIS

Statistical comparison between species abundances (mole crab and bean clam) and burrow hole counts (ghost crab) within the project reach and within the control areas will occur to assess any potential effects of the project on the macro-invertebrate community. Sampling will be conducted immediately prior to construction, within 60 days following completion of construction, and again at 6 months post-construction. A 1-year and 2-year post construction sampling survey will also occur while additional surveys following the 2-yr post-construction event may be required, depending on previous results. The following analyses will be performed, at a minimum:

- Macro-invertebrate abundances comparison plots: A comparison between macro-invertebrate abundances within the project reach versus the control areas for each species. Comparisons to previous sampling events where applicable.
- Sediment compatibility analysis: Statistical native and fill grain size analyses will be performed.

4.0 MONITORING REPORT

A monitoring report summarizing the physical and biological data collected and the analyses described in Sections 2 and 3 will be submitted to the Town and regulatory agencies within 90 days of completion of each field survey. The report will also include an assessment of post-project macro-invertebrate recovery and overall project performance. The first report will be completed following project construction and will include pre- and immediate post-construction survey data.

5.0 POST-PROJECT ANALYSIS AND MITIGATION

Mitigation work required due to documented adverse impacts resulting from groin construction may include renourishment of the beach adversely affected by the groin; reconfiguration, notching or shortening of the groin; and/or complete removal of the groin. The exact form of mitigation required will depend on the location, type, and extent of the adverse impact. When mitigation work is required, it will be completed as soon as possible after the permitting agencies determine need for the action, typically within 3 months. However, a longer time may be allocated to avoid impacts during sea turtle nesting season or other natural resources concerns. The Town has independently maintained a regular source of funding [i.e., the Beach Preservation/Access & Recreation/Tourism (BPART) Fund] for, among other things, its beach management activities. This fund has regularly financed the Town's nourishments and accompanying projects for the past decade. If it is required, the BPART fund would be available to finance any mitigation. The subsequent sections describe the methodology for determining adverse impacts, establishing thresholds required for mitigation, and the mitigation methods and alternatives.

5.1 EFFECTS OF LOCKWOODS FOLLY INLET

According to the [North Carolina Beach and Inlet Management Plan (NC BIMP)], between 1858 and 1938, LWF Inlet migrated westward approximately 2,300 ft to its present location (NC BIMP, 2011). Cleary and Marden (2001) estimate that the midpoint of LWF Inlet has migrated approximately 500 ft west since 1938. Several other studies have analyzed the movement of LWF Inlet over the last century, including Cleary (1996, 2008) and CSE (2009). The North Carolina Department of Environment and Natural Resources (NCDENR) also developed a shoreline analysis using historical aerials shown in Figure D-5. As Cleary (1996) states, "Although the inlet has been locationally stable, there has been considerable morphologic change within the inlet, its shoals and along adjacent shorelines." A chronic erosion trend exists along the east end of Holden Beach, up to 2 kilometers (km) from LWF Inlet. The approximate influence of LWF Inlet is 2 km in both the eastern (Oak Island) and western (Holden Beach) directions (Cleary, 1996; Cleary, 1998).

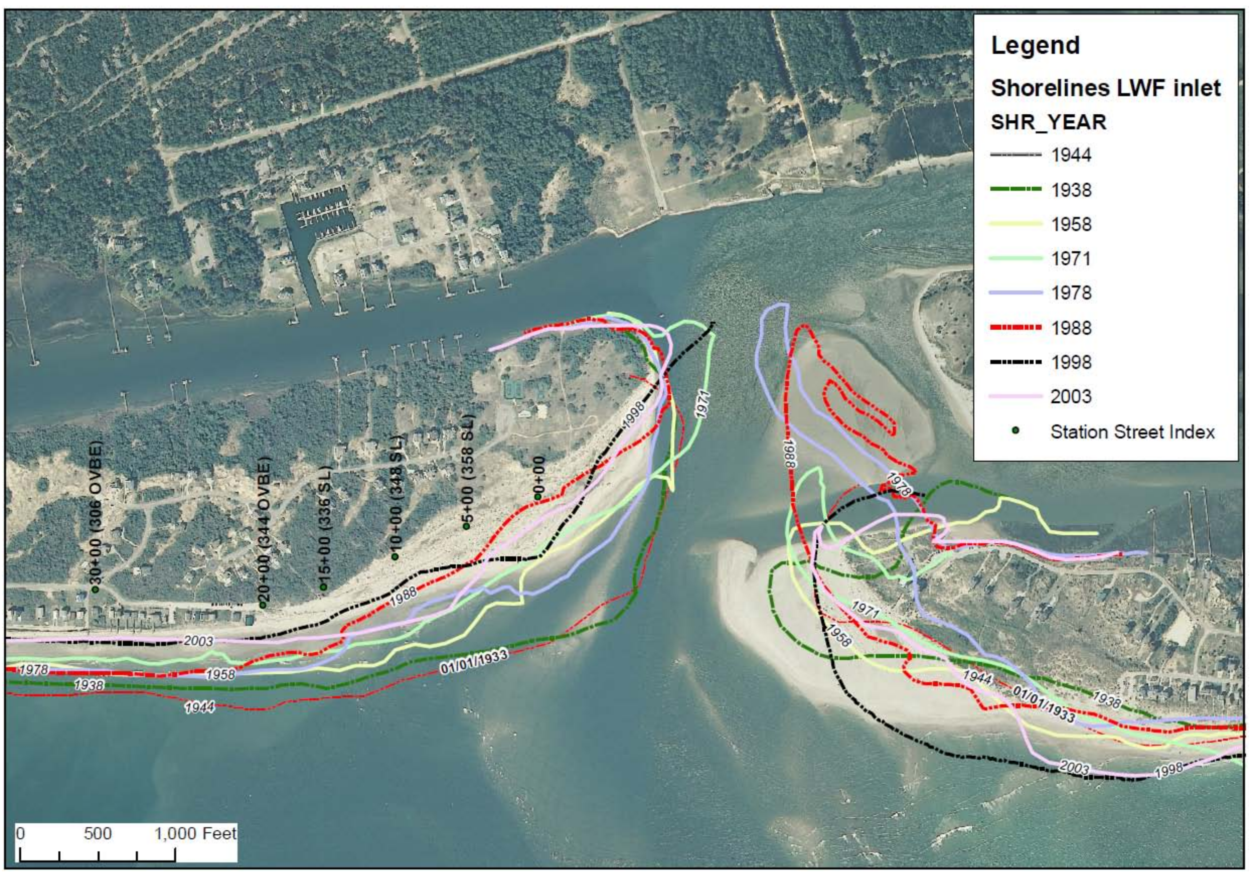

Figure D-5. Historical Shoreline Change of Lockwoods Folly Inlet Area.

Lockwoods Folly Inlet outer channel orientation/alignment has also been documented to affect shoreline erosion intensity (Cleary, 1996; 2008). The USACE Navigation Branch conducts outer channel dredging and follows deep water. Over the last century, channel alignment has been closer to the Oak Island shoreline, which has been cited as favorable for Oak Island, while increased erosion occurs on Holden Beach. This effect results from the alignment affecting wave propagation and flood channels.

Concerning inlet area shoreline morphology, Cleary (1996) states:

> Within 100 m of LWF Inlet, the Holden Beach shoreline has eroded 260 meters during the past 58 years, at an average of 4.5 meters per year. For a brief period during the late 1970s, accretion took place along this reach due to reorientation of the ebb channel, but today erosion continues along much of the eastern margin of the island.
>
> The most dramatic changes to Long Beach [Oak Island] have occurred within 400 meters of the inlet. Since 1938, this area has experienced an average net accretion of 1 meter per year, though it was plagued by serious erosion in the 1970s and 1980s. Almost 100 meters of shoreline eroded between 1974 and 1986, at an average of 8 meters per year. During this time, the flood channel was positioned along the Long Beach shoulder, causing rapid erosion, but since 1986 the shoreline has built up again by 185 meters.

Warren and Richardson (2010) performed a statistical shoreline analysis (standard deviation of shoreline position and average rate of shoreline change) that identified Transect 530 as the point along the oceanfront where LWF Inlet processes were no longer dominant [see Figure D-6 for North Carolina Division of Coastal Management (NCDCM) and Town stationing]. Figure D-7 shows the same analysis for Oak Island. The 2011 setback factors (SBF) as determined by DCM are also presented in Figures D-6 and D-7. Note that the western Oak Island SBF is 2 ft, which is the state minimum and generally denotes stable/accretional shoreline conditions for the period of analysis (1944 to 2009).

Figure D-6. Current and Proposed IHA Boundaries. 2011 setback factors (SBF) and 2004 erosion rates also pictured.

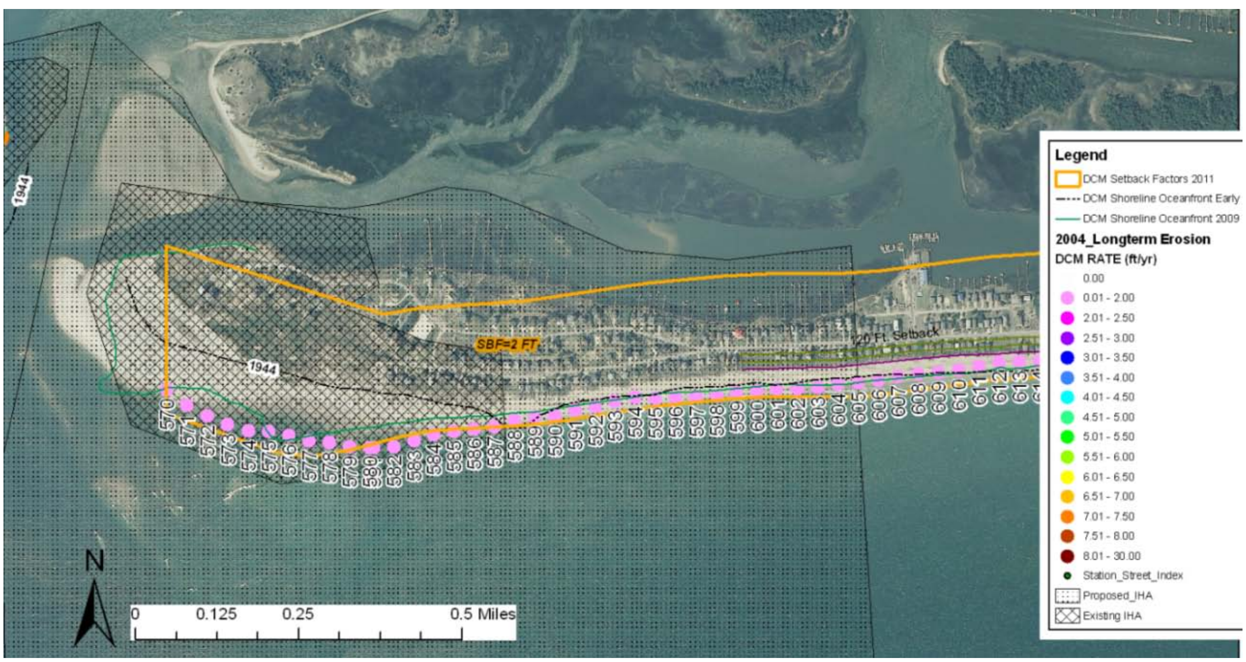

Figure D-7. Oak Island Existing Inlet Hazard Area (IHA) and Proposed IHA. The IHA areas indicate areas of inlet influence.

Terminal groins, as with all groins, typically hold sand on the updrift side (forming a “fillet”), with potential affects to downdrift beaches under extremely erosional conditions. In a regional net transport sense, Holden Beach is downdrift of the proposed eastern end terminal groin. However, locally (where the net transport is to the east), the inlet throat itself is downdrift of any groin placed along the inlet margin (see Figure D-8).

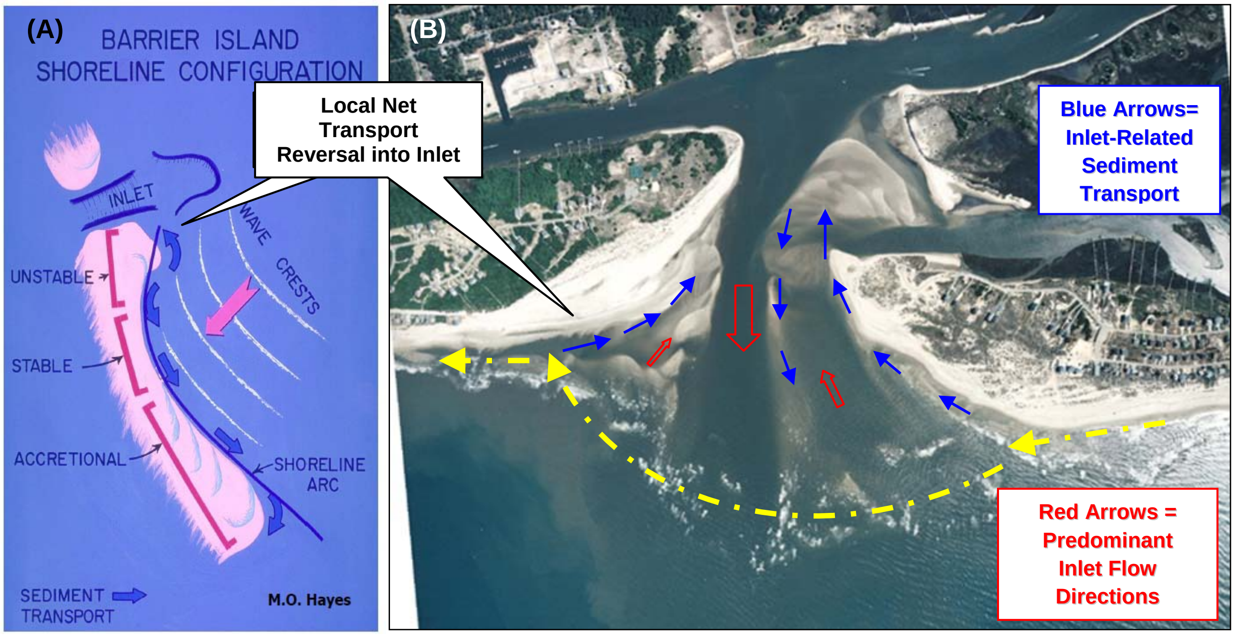

Figure D-8. (A) Generalized Net Sand Transport near an Inlet (Source: Hayes). Note that net transport reverses to the south of the inlet. (A) very closely resembles (B), typical net transport trends at LWF Inlet and on Holden Beach.

5.2 HURRICANE AND STORM EFFECTS

Hurricanes are typically the most extreme episodic events to affect shorelines in the region. For example, in 2008, Hurricane Hanna significantly affected the Holden Beach shoreline. Hanna made landfall approximately 20 miles west of Holden Beach on September 6, 2008. This subjected the Holden Beach shoreline to the most intense northeast quadrant conditions due to the counter-clockwise storm rotation. As a result, the entire area suffered damage; however, the east end exhibited more erosion than the rest of the island. Table D-2 presents losses per linear foot along the east end from Hurricane Hanna. Up to 21.2 cubic yards per foot (cy/ft) was lost at Station 20+00, while the Central Reach shoreline lost an average of 8 cy/ft. Figure D-9 presents a post-Hanna photo on the east end, showing significant dune and upper beach erosion. Dune unit volumes [above 7 feet referenced to the National Geodetic Vertical Datum (ft NGVD)] on the east end have averaged approximately 6 cy/ft, according to surveys ranging from 2000 through 2012.

Table D-2. Unit Volume Change due to Hurricane Hanna

Station	Unit Volume Change (cy/ft) due to Hurricane Hanna
15+00	-1.6
20+00	-21.2
30+00	-5.3
40+00	-12.3

Figure D-9. Post Hurricane Hanna Image Showing Dune Losses on the East End of Holden Beach (~Station 25+00).

5.3 SHORT-TERM CHANGE (STATION 10+00)

In an effort to characterize short-term change in the locally downdrift zone of the inlet management area (Station 10+00, see Figure D-3), available survey data from Holden Beach surveys were analyzed from 2000 to 2012. Fifteen transects were available at this location for analysis, however, they varied in survey extents (i.e., how far landward and seaward they extend). As a result, only 14 of these transects had sufficient data for a volume calculation of the upper beach down to -8 ft NAVD88. The surveyed transects are presented in Figure D-9.

Data were analyzed using BMAP (Beach Morphology Analysis Package) software and analyzed by volume change down to -9 ft NAVD88 and to MHW contour change (+1.8 ft NAVD88). Table D-3 presents tidal datums for the project site, using the Yaupon Beach, Oak Island NOAA station. Volume and MHW shoreline changes from consecutive surveys are presented in Figures D-10 and D-11. Extreme variability is exhibited from survey to survey. Surveys were taken at variable intervals, where many intervals were less than a year. Surveys also vary by season. The post-Hurricane Irene survey (note extreme MHW erosion in Figure D-11 between May and September 2011) was not included in volume calculations due to survey extents.

Table D-3. Project Site Tidal Datums

NOAA Station: Yaupon Beach, Oak Island	Feet (NAVD88=0)
MHHW	2.2
MHW	1.8
NAVD88	0.0
MSL	-0.5
MTL	-0.6
NGVD29	-1.1
MLW	-2.9
MLLW	-3.1

Table D-4 shows MHW and volume change statistics for Station 10+00. Variation seen from consecutive surveys is large, where a standard deviation for annualized MHW change is 109.3 ft/yr. A standard deviation for annualized volume change is 47.9 cy/ft/yr. Due to the variation, a moving average consisting of three consecutive surveys is included in Figures D-10 and D-11 to smooth individual survey variation. A similar method of using three consecutive surveys for smoothing is proposed for threshold analysis, described in the following section.

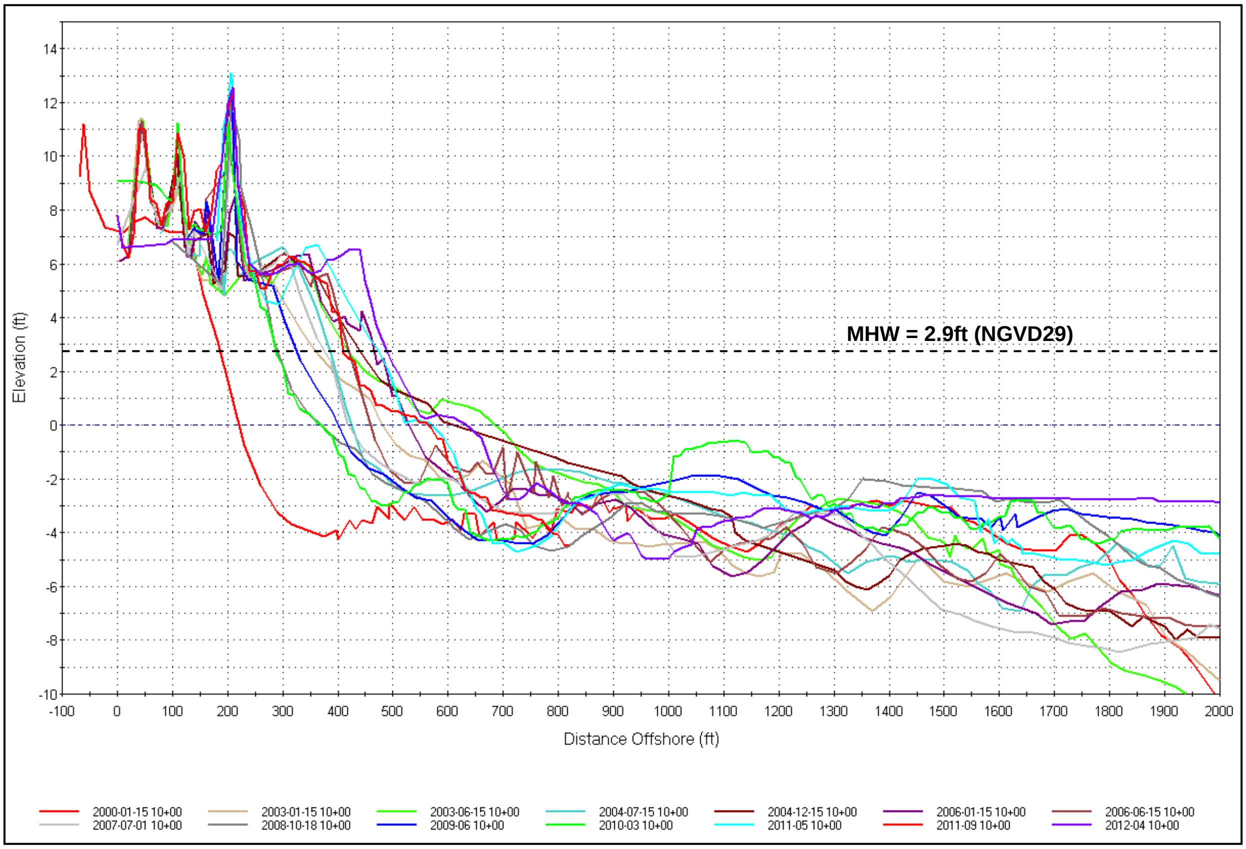

Figure D-10. Station 10+00 Survey Profiles, elevations are feet NGVD29.

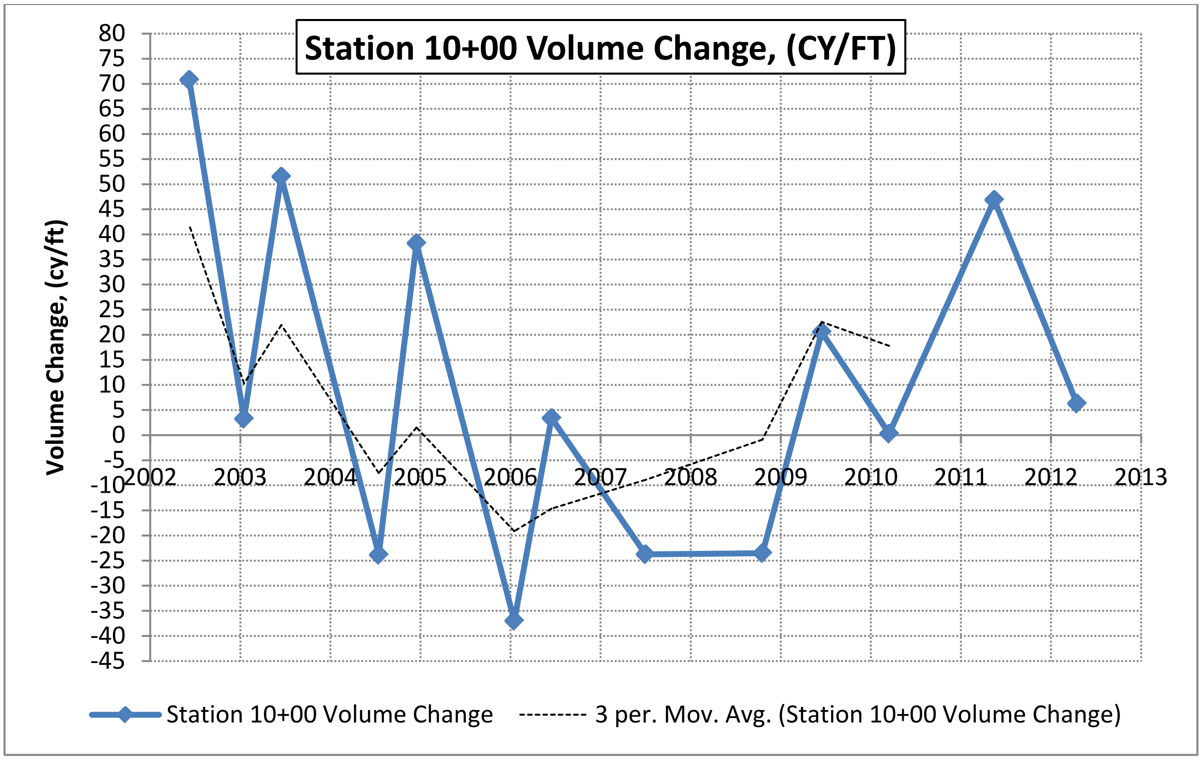

Figure D-11. Station 10+00 Unit Volume Change (cy/ft). A 3 point moving average is also plotted.

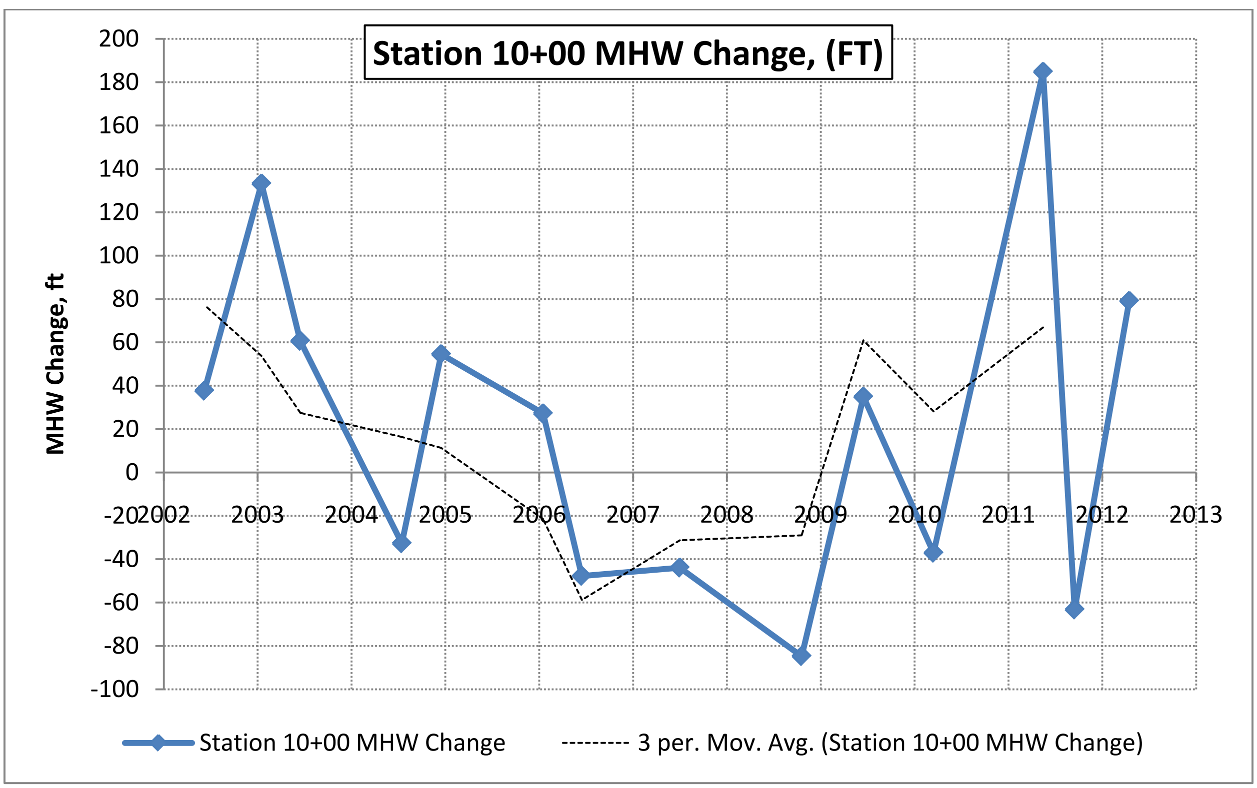

Figure D-12. Station 10+00 MHW Change (MHW=+2.9ft NGVD29). A 3 point moving average is also plotted.

Table D-4. Station 10+00 MHW and Volume Change Statistics				
	MHW Change (ft)	Annualized (ft/yr)	Volume Change (cy/ft)	Annualized (cy/ft/yr)
Minimum	-84.8	-187.9	-37.0	-34.1
Mean	21.6	28.1	10.2	18.5
Maximum	184.8	219.1	70.8	124.6
St. Dev.	78.2	117.9	33.5	46.1

5.4 THRESHOLDS

The information presented in Sections 5.1 through 5.3 indicates that the naturally occurring processes of the inlet channel and shoal migration may overshadow the effects of the proposed groin. Previous studies and the physical history of the project site also reveal a profoundly dynamic morphological environment, specifically within the inlet area and along adjacent shorelines.

While in a regional sense Holden Beach is downdrift of the terminal groin, locally, the sediment transport is directed into LWF Inlet. Since the chief concern of potential terminal groin impacts is downdrift of the structure, it is proposed that Station 10+00 be the monument used for establishing a trigger.

NCDENR DCM long-term shoreline erosion rates at Station 10+00 are 7 ft per year (Figure D-5); however the trigger methodology must also take into account short-term shoreline/volume change rates as well because of the frequency of the surveys. Volume change rates (cy/ft/yr) are favored over shoreline change rates (ft/yr) due to the potential for specific shorelines (e.g., MHW, MLW, etc.) to change rapidly under seasonal and storm conditions.

In general, there will be three layers to the methodology for evaluation of potential post-project impacts: 1) comparison of post-project volume change rates to historical (i.e., background) erosion rates, using recent (2000-2012) statistical variations as a guide; 2) comparison of LWF Inlet dynamics and effect on nearby shorelines, and 3) comparison of post-project volume change rates within the monitoring area to adjacent shoreline reach post-project and historical change rates. The third comparison is anticipated to be needed if significant nor'easter(s), tropical system(s), or an extended period of higher wave activity occurs where shorelines over the entire region experience higher than typical erosion rates. More discussion on these components is presented in the following paragraphs.

1. At Station 10+00, survey data can vary significantly from survey to survey, depending on the season and recent wave activity, among other influences. The NCDENR DCM long-term shoreline erosion rate of 7 ft/yr can be equated to a baseline volume loss of 7 cy/ft/yr. Based on the standard deviation of 46.1 cy/ft/yr in Section 5.3, mitigation will be required if an annualized volumetric erosion rate of 53 cy/ft/yr (baseline + annualized standard deviation) is exceeded for three consecutive surveys due to presence of the groin. The statistical method of including the mean (baseline) +/- one standard deviation is commonly used to encompass 68 percent of

possible outcomes, assuming a normally distributed variable (e.g., shoreline change). Outcomes outside of this 68 percent can be considered outliers, or abnormal results (e.g., potential groin effects). This volumetric change will be measured over approximately 960 feet, from 188 ft to 1,148 ft at Station 10+00 as shown in Figure D-13. This zone includes the current dune to approximately -6 ft NGVD88 and was chosen to avoid the majority of inlet/shoal migration influences.

2. Comparison of the configuration of LWF Inlet is of critical importance in assessing groin and nourishment effects. This analysis will use aerial photography and bathymetric data to develop an overview of the LWF Inlet system. Bathymetric data will be summarized by zones (see Figure D-3). Due to LWF Inlet complexities and annual/seasonal variations, no quantitative mitigation zone thresholds are proposed for the project; however, analysis will occur to evaluate potential project effects. Zone volume changes will also be compared to changes as developed for sediment budgets (e.g., 2008 OCTI sediment budget – Figure D-14). Note that volume change within the LWFIX borrow area zone and groin-adjacent zones will be directly related to future nourishment planning/scheduling.

3. In addition to post-project comparisons to historical rates, nor'easters and tropical storms impacts can also affect individual monitoring events, therefore, relative comparisons (between downdrift and control beaches) are needed. The wading-depth surveys do save on costs; however, they do not include the entire active beach profile, and measurements are vulnerable to cross-shore adjustments/variability.

Mitigation may not be required following catastrophic or significant storm events (i.e., with a return period of 5 years or greater). Note that the Federal Emergency Management Agency (FEMA) typically uses the 5-year return period for beach-related storm mitigation; although they will respond to most events where the Governor declares a state of emergency.

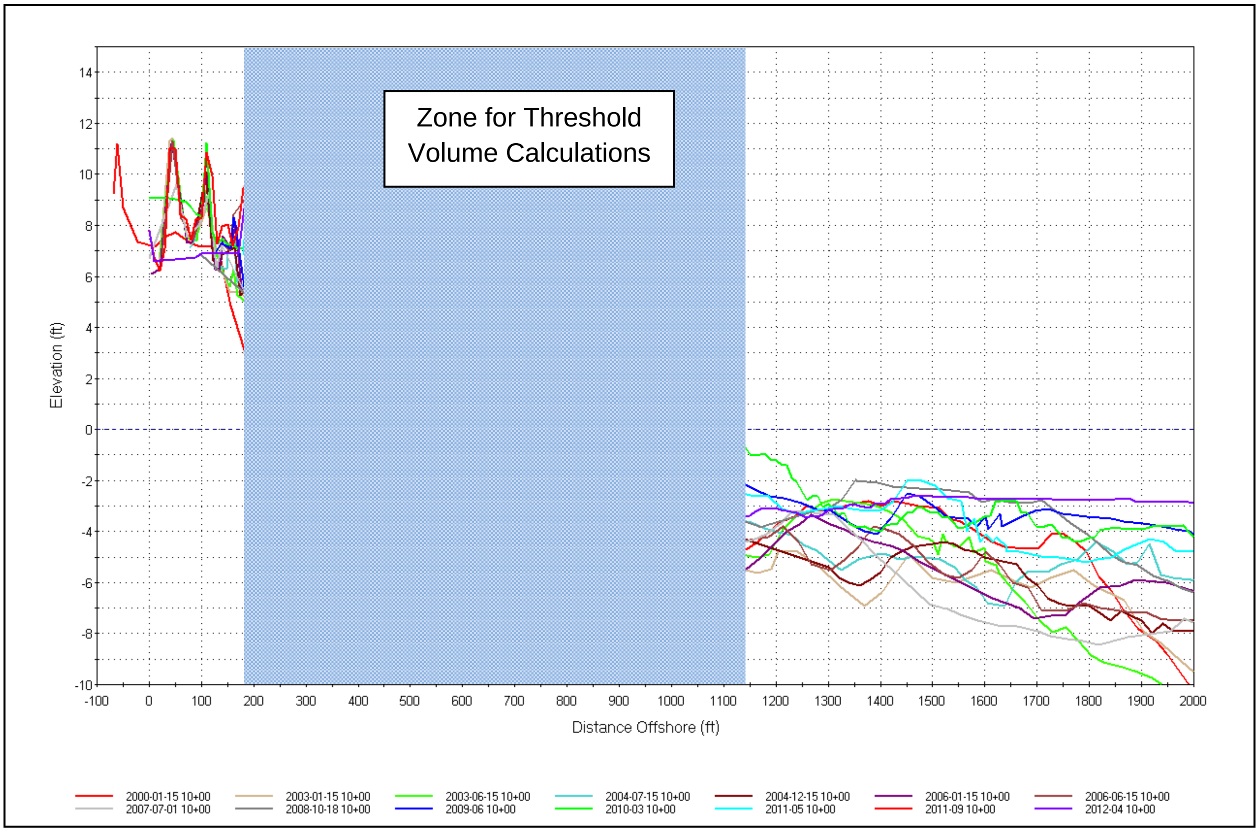

Figure D-13. Station 10+00 Zone for Threshold Volume Calculations, elevations are feet NGVD29.

Figure D-14. LWF Inlet sediment budget as developed by OCTI (2008). All values are 1,000 cubic yards (cy) (e.g., 290=290,000 cy). Black arrows indicate sediment transport in/out of cells. dV=annual volume change, P=annual placement, R=annual removal, Res=annual residual.

6.0 SUMMARY

The Town of Holden Beach remains committed to the successful long-term health of the shoreline in and surrounding the project area. As a result, it will adhere to all monitoring and mitigation as required by regulatory agencies to ensure the success of the proposed project. In this respect, the Town will monitor the project site as well as the inlet management area to document project performance and any potential deviations from what is anticipated to occur. The Town will place nourishment sand when needed and will work in concert with any nourishment activities by the USACE to maintain the health of the project and surrounding inlet management area once the groin has been installed. The Town's inlet management plan will necessarily be adaptive to respond to any issues or concerns that arise over the long term. The proposed monitoring in this document forms the basis of this long-term management plan.

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