3.0 PROJECT ALTERNATIVES

Based on the project purpose and need stated in Section 2.0, the USACE, in consultation with the PRT, developed several alternatives for consideration in this DEIS. These alternatives include a variety of methods to meet the objectives of this project. The preliminary list of alternatives was screened during the scoping process, with input from the PRT. One alternative identified during this scoping process, but not advanced further in the DEIS assessment, included consideration of terminal groin construction without beach nourishment. Because this alternative is not compliant with the provisions of SB 151 (Appendix B) and is not preferred from an engineering standpoint, it was not considered to be practicable and therefore was eliminated from further consideration. Discussion related to other alternatives that were eliminated from further consideration is provided in Section 5.1. Six alternatives are carried forward and fully evaluated in this document (Table 3.1). Economic analyses (costs and benefits) of each alternative are discussed in Section 5.0.

Table 3.1. Project alternatives.

Alternative #1	No Action (Status-Quo)
Alternative #2	Abandon and Retreat
Alternative #3	Beach Nourishment
Alternative #4	Inlet Management and Beach Nourishment
Alternative #5	Short Terminal Groin and Beach Nourishment
Alternative #6	Intermediate Terminal Groin and Beach Nourishment

3.1 What Alternatives are Evaluated in this DEIS?

3.1.1 Alternative 1: No Action

Under the No-Action Alternative (Alternative 1), the Town would continue to rely solely on the USACE's beneficial use projects for shore protection of the East End of Holden Beach. East End Beneficial Use Projects are conducted under the authority of Section 145 of the Water Resources Development Act (WRDA) of 1976 as amended by the WRDA of 1986 (Section 933), the WRDA of 1992 (Section 207), and the WRDA of 1999 (Section 217). Section 145 authorizes the USACE to place suitable dredged material from navigation channels and inlets on local beaches at the request of a local government sponsor (e.g., the Town). As stipulated by Section 217, East End Beneficial Use Projects are funded under a cost-sharing ratio of 65 percent federal and 35 percent local. Since 2002, the East End has been nourished nine times with dredged material derived from the AIWW Lockwood Folly Inlet Crossing (LFIX) navigation channel. On average, these nourishment events placed ~77,000 cy of dredged material on the

East End of Holden Beach at two-year intervals (Figure 2.1). The most recent beneficial use dredging project took place in the winter of 2014 (February – March), in which the Town and the USACE collaboratively placed a total of 188,000 cy between Stations 00 + 18 and 00 + 73, a length of approximately 6,000 feet (ft) (Figure 2.1). Figure 3.1 presents the typical LFIX borrow area and East End placement footprint of the USACE project. The seven USACE projects conducted prior to 2014 placed volumes of beach-compatible material ranging from approximately 25,000 to 140,000 cy on an annual or bi-annual basis (although this is subject to funding).

The federally authorized LFIX Navigation Project encompasses ~7,500 ft of the main AIWW channel [12 ft deep mean low water (MLW) by 90 ft wide] and a seaward-adjoining 400-ft-wide bend widener (Figures 3.2 and 3.3). Due to federal budget constraints, the 400-ft-wide bend widener was not dredged in conjunction with beneficial use projects prior to 2010. However, through the use of local and alternate federal sources of funding, the bend widener was dredged in conjunction with beneficial use projects in 2010 and 2014. Beneficial use projects involving only material from the main 90-ft-wide channel have placed between 32,000 and 113,000 cy of material on the East End of Holden Beach whereas inclusion of the 400-ft bend widener in 2010 and 2014 resulted in placement volumes of ~140,000 cy and ~188,000 cy, respectively. Local funding efforts for the bend widener are expected to continue, subject to the availability of funds. Furthermore, the state has recently passed legislation (H 707/S.L. 2013-138) that directs the NCDENR to pursue strategies that will aid local governments in the attainment of USACE and state CAMA permits for channel dredging and beach disposal of dredged materials. Therefore, although the exact frequency is not known, it is anticipated that the 400-ft bend widener would be included in beneficial use projects with some regularity under Alternative 1.

Although the long-term (30-year) status of federal Section 145 funding appears to be precarious, it is assumed for impact analysis purposes that East End Beneficial Use Projects under Alternative 1 would continue at an average frequency of every two years. Beach fill placement volumes would vary according to channel shoaling rates and the availability of funding for inclusion of the 400-ft bend widener. However, for impact analysis purposes, projects using only material from the main channel would presumably place ≤100,000 cy of material on the East End whereas projects using sand from both the main channel and the bend widener would place ~150,000 cy of material. Dredging and beach fill placement methods would be similar to those associated with current operations. Sand from the LFIX/bend-widener channel would be extracted by cutterhead pipeline dredges and pumped directly to the east end via submerged pipelines. Temporary containment berms would be constructed at the beach discharge points to allow for dewatering and suspended sediment redeposition, and bulldozers operating on the beach would distribute and grade the dewatered fill according to the beach profile design specifications. Front-end loaders would be used to transport and position emergent sections of the discharge pipeline on the beach (Photos 3.1 and 3.2). As nourishment activities progress, the emergent pipeline would be extended along the beach through the addition of extra sections of pipe.

Source: ATM 2013

Figure 3.1. USACE LFIX AIWW Dredging and Beach Placement Schematic.

Figure 3.2. LFIX Federal Navigation Project (includes bend widener and AIWW).

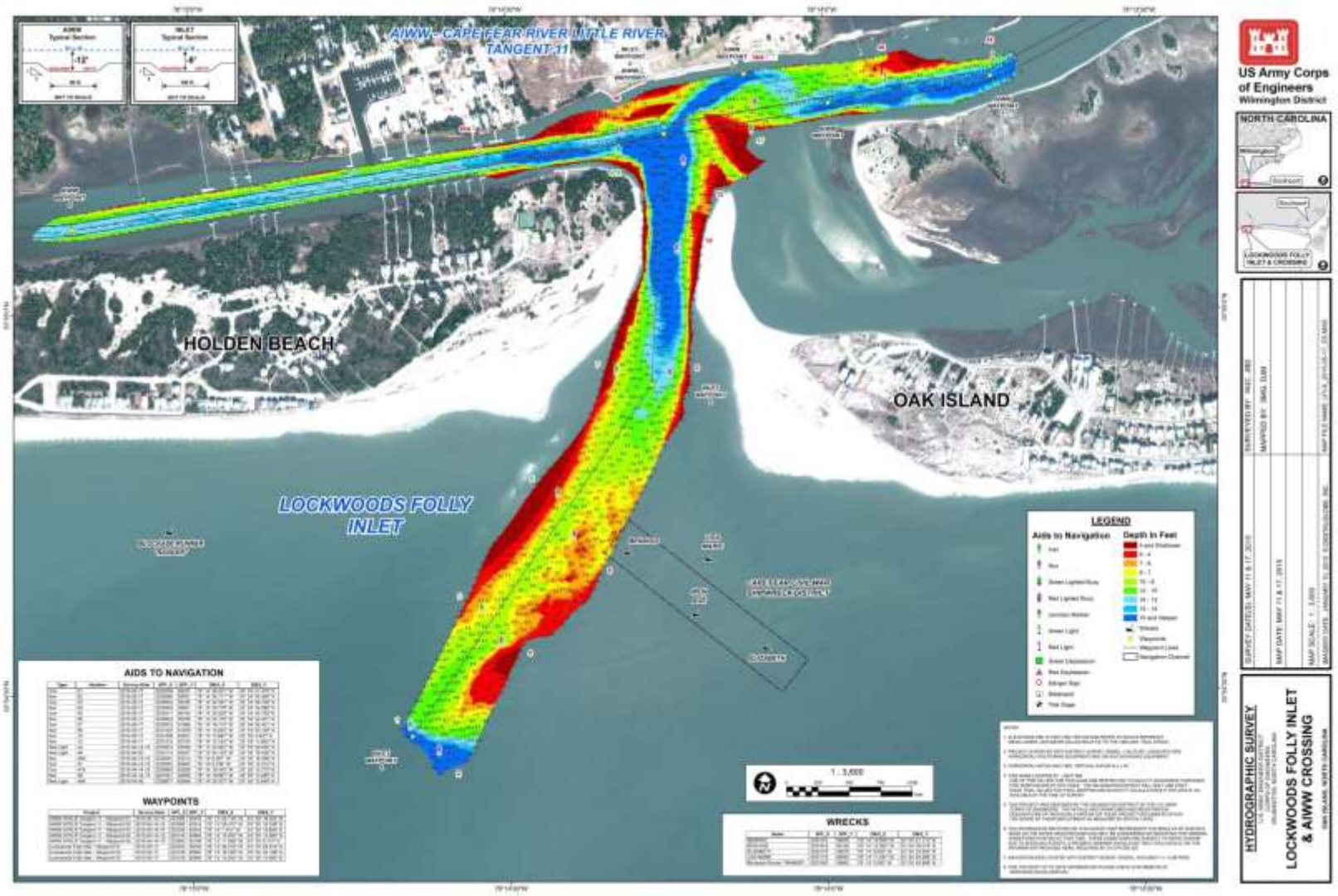

Figure 3.3. 2015 Hydrographic Survey of the LFIX and AIWW Crossing

Photo 3.1. View of temporary containment berm during the 2014 beneficial use project on the East End.

Photo 3.2. Equipment utilized during the 2014 beneficial use project on the East End.

3.1.2 Alternative 2: Abandon and Retreat

Under Alternative 2, the Town would not pursue a long-term management plan, and there would not be any federally implemented or federally permitted actions undertaken to mitigate erosion along the East End of Holden Beach. Thus, the USACE would not conduct any East End Beneficial Use Projects, and the Town would not implement any actions, such as beach nourishment, beach scraping, dune restoration, temporary sandbag placement, and inlet dredging, which require a federal dredge and fill permit.

Instead, the Town would develop and implement a 30-year managed retreat plan under which structures that are threatened with erosional damage would be either relocated to unimproved interior lots or demolished. This plan would establish an erosional threshold that would trigger preemptive relocations or demolitions prior to the point of imminent structural failure. In the absence of shore protection measures, East End shoreline recession would progress based on natural background erosion rates and storm-related losses. As described by the NC Beach and Inlet Management Plan (2011), the Brunswick County area has the highest storm surge potential along the North Carolina coast.

Although no new dredging would occur under Alternative 2, it is assumed that USACE maintenance dredging of the federal navigation channels within the Permit Area (i.e., LFIX and LFI channels) would continue under a regime similar to that of current operations; including pipeline dredging of the LFIX channel and side-cast dredging of the LFI Outer Bar ebb channel (Photo 3.3). However, in the absence of a local sponsor for beneficial use disposal, it is assumed that the USACE would place dredged material from LFIX in an approved facility such as the adjacent Sheep Island CDF.

Outer channel dredging is typically performed four times a year (quarterly) by side-caster, when funds are available. No federal funding was available for the fiscal year of 2012; however, the State, Brunswick County, Holden Beach, and Oak Island have collectively been able to fund interim USACE dredging of the outer channel through a memorandum of agreement (MOA) with the Wilmington District (Appendix F).

Photo 3.3. View of sidecast dredge, the Merritt, working within the outer bar channel of LFI.

3.1.3 Alternative 3: Beach Nourishment

Under Alternative 3, the Town would assume responsibility for East End shore protection through the implementation of an independent, 30-year nourishment-only beach management plan. Under the proposed plan, the East End of Holden Beach would be nourished with ~100,000 to 150,000 cy of sand every two years. The conceptual beach fill placement area encompasses ~3,700 linear ft of the East End oceanfront beach between Blockade Runner Drive (~Station 00 + 40) and LFI (~Station 00 + 10) (Figure 3.4). Based on the preliminary beach profile design (Figure 3.5), nourishment events would include construction of a +9-ft-high [North American Vertical Datum (NAVD)] dune with a 50-ft-wide dune, a +7-ft-high (NAVD), 200-ft-wide berm, and a 90- to 170-ft-wide transition with a 15 percent slope that intersects ("toes in") with existing bathymetry.

The preferred source of beach fill under Alternative 3 would be the LFIX navigation channel and associated 400-ft bend widener (as shown in Figure 3.1). The LFIX has been a borrow area for beach nourishment since the 1970's. The dredged material is beach compatible (Table 3.2), and Station 20+00 on the East End (beginning of the beach fill placement) is conveniently less than 4,000 ft away. Based on dredging and survey data from 2012, there is approximately 110,000 cy of sedimentation available from the LFIX borrow area with inclusion of the 400-ft bend widener. Additional sedimentation or shoaling is anticipated prior to project construction. Accounting for losses during dredging and beach construction, ~120,000 to 180,000 cy of sand would be extracted from the LFIX/bend widener channel every two years. The most recent AIWW and 400-ft bend widener project in spring 2014 placed ~188,000 cy of sand.

The LFIX borrow area is the preferred borrow area due to beach-compatible quality and sustainable quantities. However, in the case of a volumetric shortfall, supplemental beach fill would be acquired first from the inland segment of the LFI navigation channel and then from the Central Reach offshore borrow site (Figure 3.6). The Central Reach offshore borrow area (-33 to -39 ft NGVD29) is approximately 590 ac and is located 1.8 to 3 miles offshore of western Oak Island and southeast of the LFI. Estimated volume yield of compatible beach sand for a cut depth of 3.5 ft is 3.3 million cubic yards (mcy). Assuming the permitted volume of 1.31 mcy is placed on the Central Reach of Holden Beach, sufficient volume will be available for two to three more large (greater than 500,000 cy) projects. Although this offshore borrow area has a significant amount of compatible sediment (Table 3.2), it is not the preferred source by the Town due to the high costs of mobilizing an "ocean-certified" dredge. Only very large beach nourishment projects (greater than 500,000 cy) would justify its use.

Sand from the LFIX, bend widener, and inland LFI navigation channels would be extracted by cutterhead pipeline dredges and pumped directly to the east end of Holden Beach via submerged pipelines. Supplemental operations at the Central Reach offshore borrow site would employ trailing suction hopper dredges in which case sand would be placed in hoppers onboard the dredges and transported to nearshore pump-out stations where the material would be discharged through a submerged pipeline leading to the east end. Temporary containment berms would be constructed at the beach discharge points to allow for dewatering and sediment

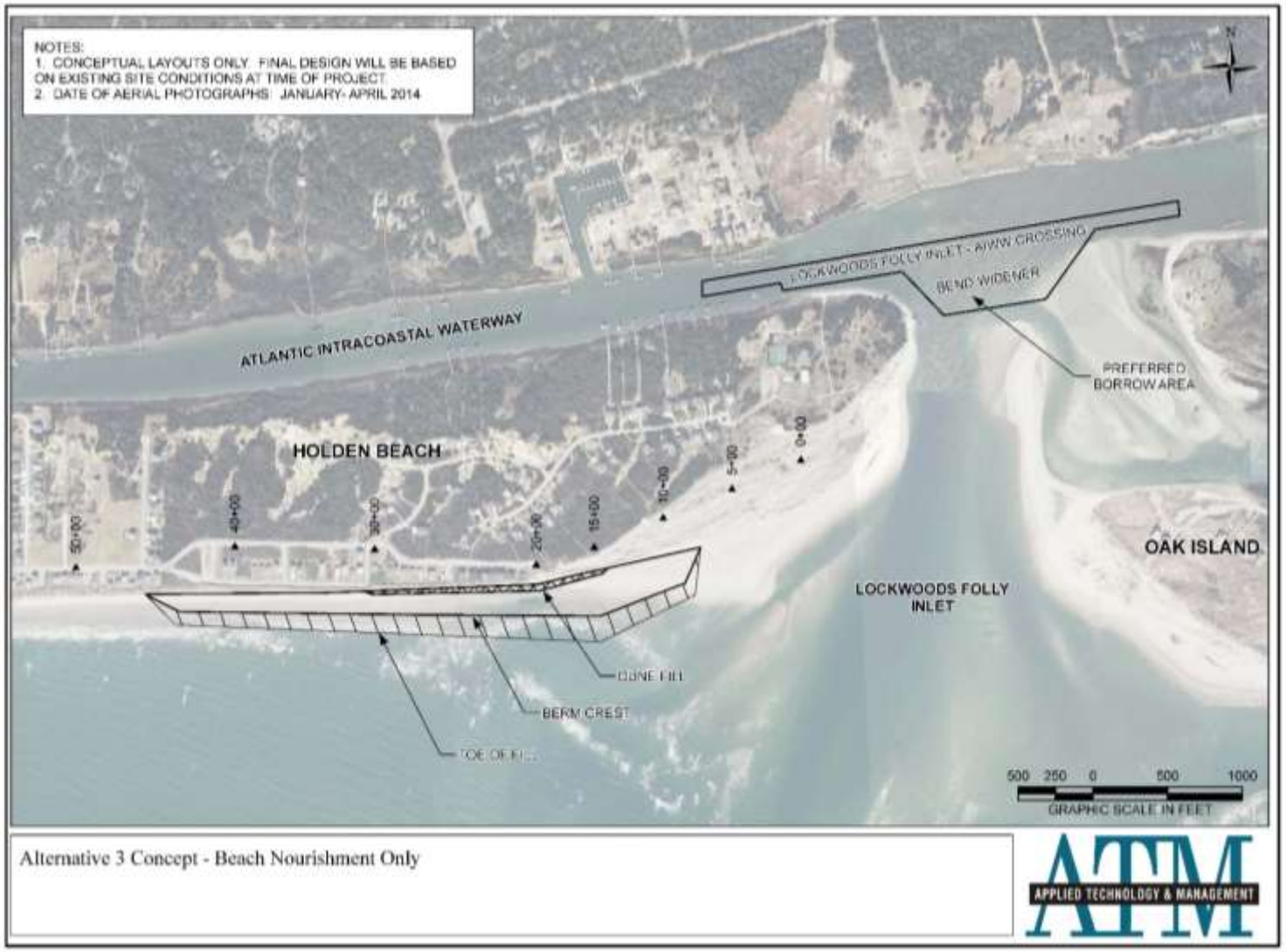

Figure 3. 4. Alternative 3 – Conceptual East End Beach Fill Footprint

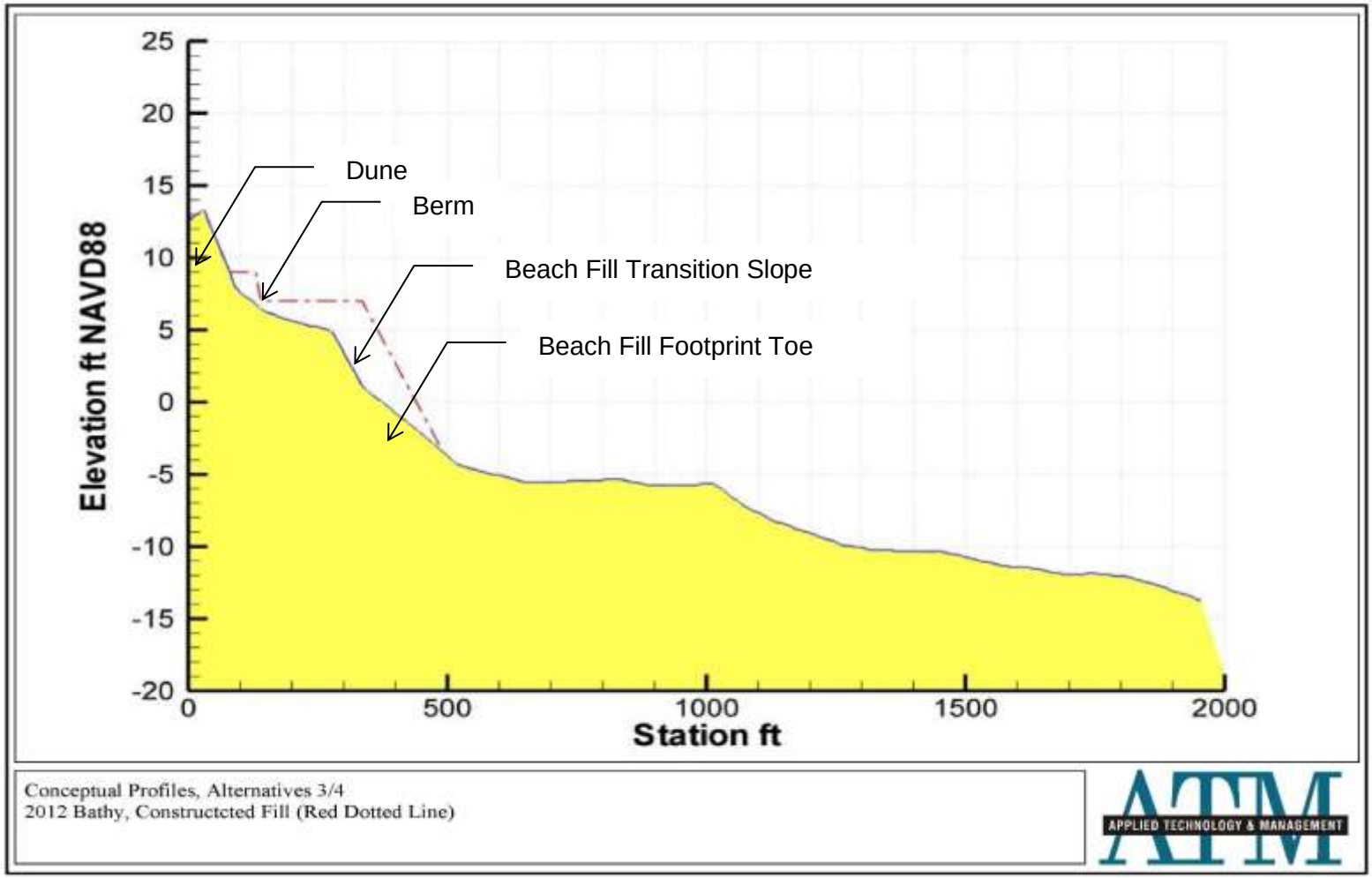

Figure 3.5. Alternative 3 – Conceptual East End Beach Fill Profile (Dune ~50 ft wide, Berm ~200 ft wide

Figure 3.6. Alternative 3 – Preferred and Potential Borrow Sites

Table 3.2. Summary of borrow area alternatives with NCDCM sediment compatibility criteria.

	Mean Ave (mm)	Sorting	Percent Gravel	Percent Granular	Percent Fines	Percent Carbonate	Volume Available (mcy)
Native Beach	0.24	0.72	0.6	N/A	2	2.7	N/A
NCDCM Sediment Criteria	N/A	N/A	Native + 5%	Native + 5%	Native + 5%	Native + 15%	N/A
NCDCM Threshold	N/A	N/A	5	5	7	17.7	N/A
Borrow Sites							
LFIX	0.41	0.81	2.7	1.1	6.1	10.9	0.11
Central Reach Offshore	0.35	1.26	2.1	3.4	5.0	12.4	3.3

redeposition, and bulldozers operating on the beach would distribute and grade the dewatered fill according to the beach profile design specifications. Front-end loaders would be used to transport and position emergent sections of the discharge pipeline on the beach. As nourishment activities progress, the emergent pipeline would be extended along the beach through the addition of extra sections of pipe.

3.1.4 Alternative 4: Inlet Management and Beach Nourishment

Under Alternative 4, the Town would assume responsibility for shore protection of the East End of Holden Beach through the implementation of an independent, 30-year inlet management and beach nourishment plan. The anticipated management regime, as defined by iterative modeling runs described in the Holden Beach ATM Engineering Analysis (Appendix F), would involve periodic relocations of the LFI outer ebb channel and concurrent East End nourishment events approximately every two years. Outer inlet channel relocation events would involve the construction of a new wider and deeper outer channel with a more westerly alignment towards the inlet shoulder of Holden Beach (Figure 3.7). The new 0.5-mile-long channel would extend seaward from the inlet throat across the LFI ebb tidal delta to the 14-ft (MLW) isobath. The new channel would be dredged to a uniform depth of 14 ft (MLW) and would have a variable width ranging from ~350 ft at the inlet throat to ~850 ft at the 14-ft isobath. Excavation of the new outer channel would require the extraction of ~500,000 cy of sediment from the ebb tidal delta. Approximately 120,000 to 180,000 cy of the total volume would be extracted by a cutterhead or hopper dredge for placement on the East End of Holden Beach, and the remaining ~320,000 to

Figure 3.7. Alternative 4 – Conceptual Beach Fill and Outer Inlet Channel Footprint

380,000 cy would be removed by a side-cast dredge and returned to the adjacent ebb tidal delta via open water disposal. It is anticipated that sand derived from the outer inlet channel relocation events would meet all of the beach fill requirements under Alternative 4. The beach nourishment footprint, beach profile design, fill placement volumes, and methods of construction would be the same as those described under Alternative 3.

3.1.5 Alternative 5: Short Terminal Groin and Beach Nourishment

Under Alternative 5, the Town would assume responsibility for shore protection of the East End of Holden Beach through the construction of an ~800-ft-long "short" terminal groin at the eastern end of the oceanfront beach between Stations 10+00 and 20+00 (Figure 3.8) and the implementation of an independent, 30-year beach nourishment plan. The proposed lengths of the groins were largely dictated on shoreline location and the need to protect the East End. The accompanying beach nourishment also varies with each structure, with more fill needed for longer structures (Appendix F).

In general, the length of the terminal groin is dictated by the size of the inlet, the configuration of the end of the island, and the length of shoreline the groin is designed to stabilize (ATM 2013; Appendix F). The design groin length is based on modeling as well as on existing structures within Long Bay and other nearby areas. Long Bay extends approximately 100 miles from Bald Head Island, NC down to North Island, South Carolina (SC) and displays a similar geology as well as similar tides and waves. Existing groin structures in Long Bay include Bald Head Island and Garden City, SC (Photo 3.4) and Pawleys Island, SC. Additional analysis on existing groins in other areas of the state (e.g., Oregon Inlet, Hatteras, and Fort Macon) and the region were also assessed. The North Carolina Terminal Groin Report also contains significant information on this topic.

The main stem of the short terminal groin would include a 550-ft-long segment extending seaward from the toe of the primary dune and a ~250-ft-long anchor segment extending landward from the toe of the primary dune. The groin would also include a 250-ft-long shore-parallel T-Head segment centered on the seaward terminus of the main stem. As discussed in the PRT meeting in May 2013, this design feature is consistent with sound engineering practices and is recommended by NC licensed engineer Fran Way of ATM (Appendix A). The purpose behind the T-Head feature on the seaward end of the short groin (~250 feet total) is included to enhance fillet formation of the beach fronting the eastern shoreline area. The short groin features a larger T-Head since a shorter groin in this location would be expected to have less of a stabilizing effect on the shoreline than the intermediate groin alternative (Alternative 6, described below). T-Heads also help to minimize formation of potential offshore rip currents and sand losses during extreme wave conditions (ATM 2013, Appendix F). While the design does feature a T-Head, it is much smaller than traditional T-Head structures found in Florida and elsewhere. Photo 3.5 presents a Hunting Island, SC groin built in 2006/2007 with a smaller T-Head feature (similar to what is proposed for Alternative 5).

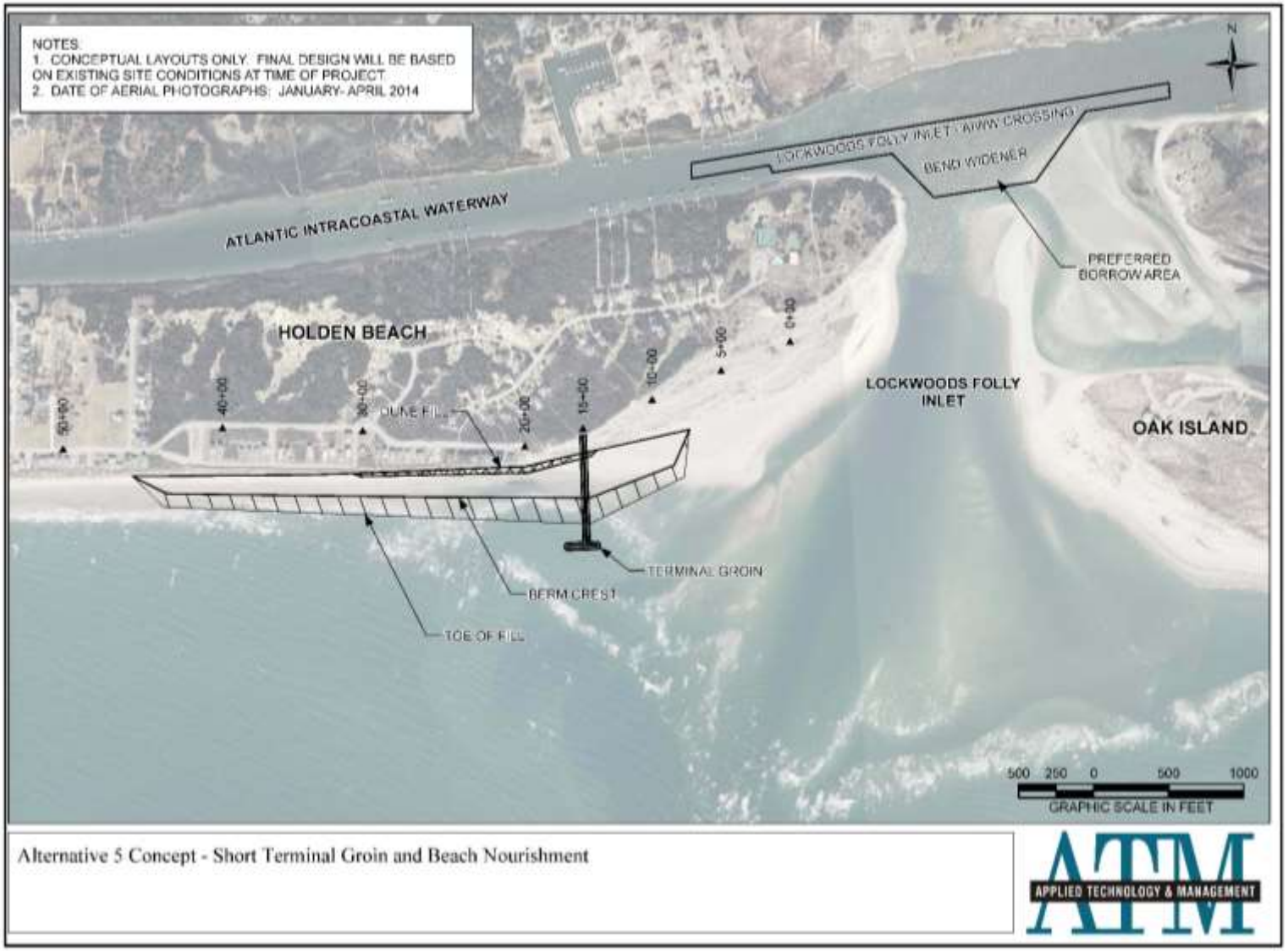

Figure 3.8. Alternative 5 – Conceptual Beach Fill and Short Terminal Groin Footprint

Photo 3.4. Garden City, SC, sheet-pile groin after construction during low tide

Photo date: January 2003

Photo 3.5. Hunting Island SC groin at low tide.

The 250-ft anchor segment is designed to prevent flanking of the groin in the event of shoreline migration landward of the primary dune. In this regard, flanking is defined as erosion around the landward end of a structure which ultimately exposes the normally “dry” side of the structure to the water. The anchor segment would be entirely buried at the completion of groin construction and would remain buried so long as the position of the MHW line remains seaward of the initial post-construction primary dune line. The short groin is designed to be a relatively low-profile structure (Figure 3.9) to maximize sand overpassing and to minimize impacts to beach recreation and aesthetics. In addition to the 250-ft anchor segment, a portion of the adjoining groin segment across the upper dry beach would also be completely buried thus maintaining recreational beach access across the groin. The relatively low profile of the groin is designed to allow some sand overpassing even under eroded conditions at the end of the four-year nourishment cycle.

The short terminal groin would be constructed of 4- to 5-ft-diameter granite armor stone and, unlike conventional jetties/breakwaters/groins, would not have a core component of smaller diameter stone. The use of only larger armor stone would allow for construction of the groin to the 25 percent void design ratio thus providing the “leaky” characteristic that allows sand to pass through the structure (Appendix F). To prevent settlement of the stone and, if necessary, to facilitate modification or removal of the groin, a base layer of geo-textile matting (1 ft thick) would be installed below grade prior to the armor stone placement. The rubble mound (i.e., armor stone) component of the short groin would have a crest width of ~5 ft and a base width of ~40 ft while the underlying geo-textile base layer would have a slightly greater width of ~45 ft (Figures 3.9 and 3.10). The relatively short length of the groin and the large tidal range at Holden Beach would allow for construction of the groin entirely from shore. The final design of the structure is subject to change given conditions near the time of actual construction. It is anticipated that the East End public access parking lot would provide the necessary beach access, staging, and storage areas for construction activities.

Nourishment events would place ~0.10 to 0.15 mcy of sand on the east end of Holden Beach every four years. The beach nourishment footprint and the basic dune/berm/toe profile design would be similar to those associated with Alternatives 3 and 4. However, the initial nourishment event would also include the construction of a wedged-shaped “groin fillet” sediment feature that would establish a gradual, transitional shoreline between the western end of the beach fill footprint and the seaward terminus of the short groin. The seaward terminus of the short groin would extend ~300 ft beyond the MHW line position associated with the eroded 2012 East End of Holden Beach which is considerably less than the historical range of seaward shoreline positions at the eastern terminus of the oceanfront beach. Accounting for sand losses during beach construction, the proposed borrow site dredging regime under Alternative 5 would involve the extraction of ~120,000 to 180,000 cy of sand from the preferred LFIX/bend-widener borrow site every four years with the addition of potential supplemental sand acquisition from the inland LFI navigation channel and the Central Reach offshore borrow site.

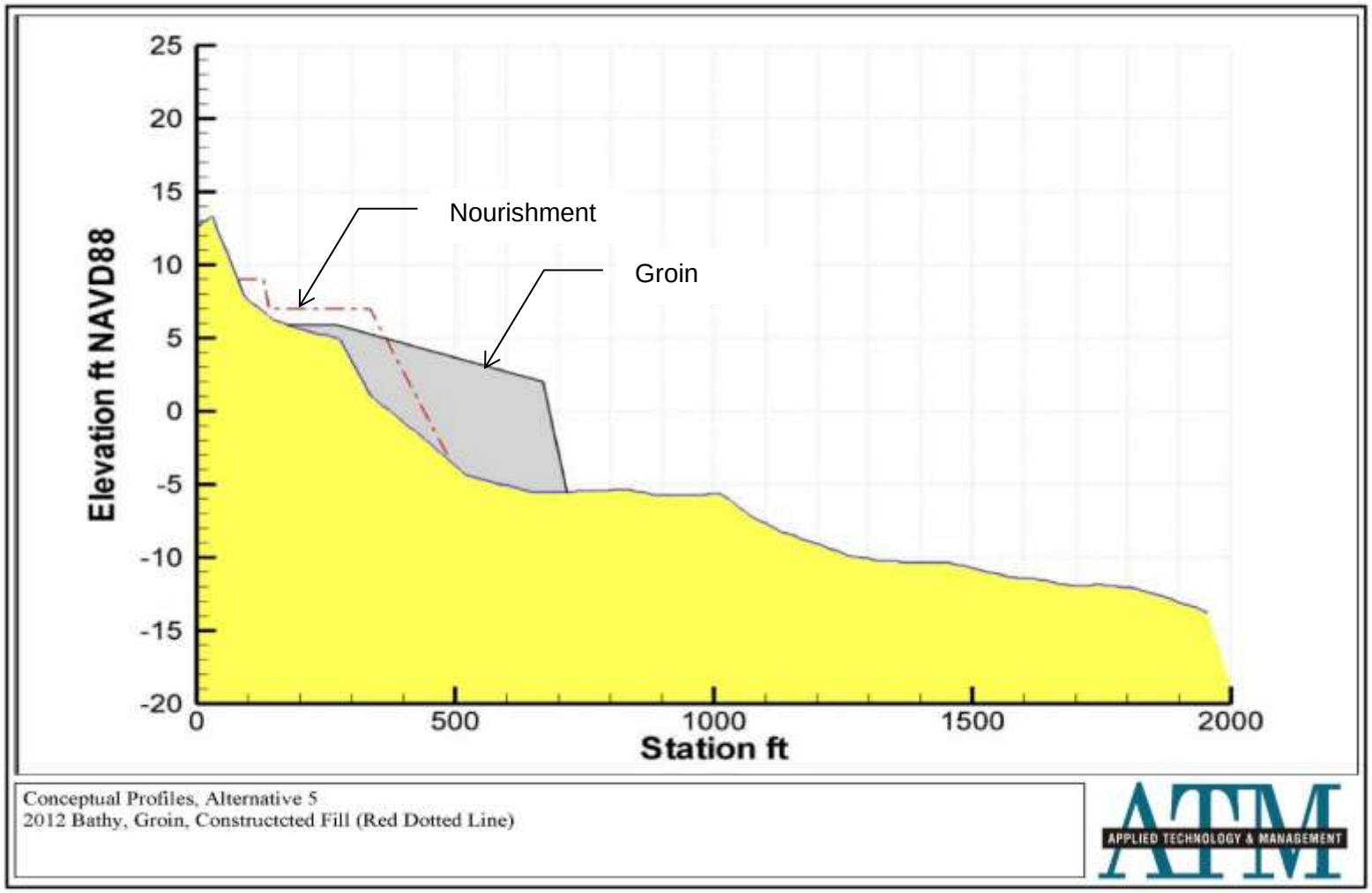

Figure 3.9. Alternative 5 – Short Groin Cross Section and Profile

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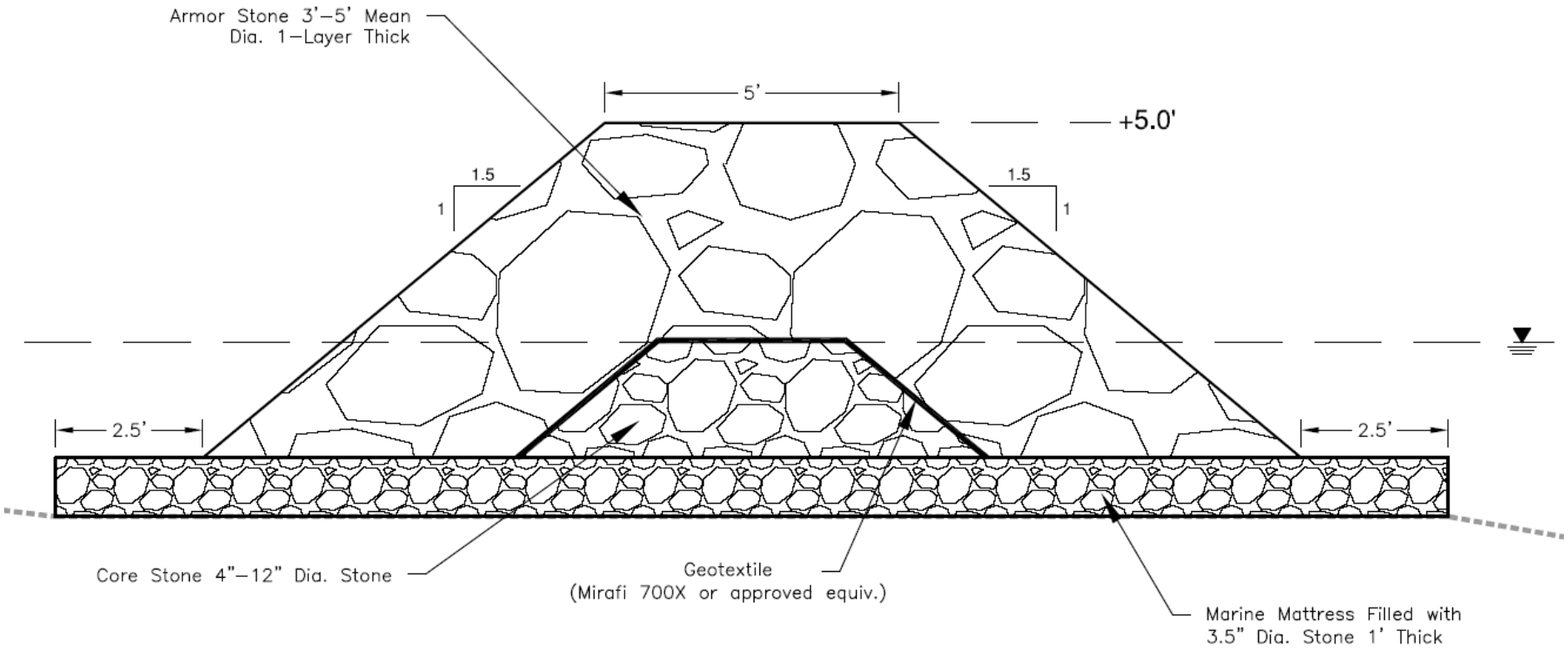

Figure 3.10. Typical Groin Cross Section (note that core stones are not proposed)

It is assumed that the combination of nourishment-related dredging events and interim USACE navigation dredging events would maintain dredging regimes in the LFIX and inland LFI channels that are similar to those associated with ongoing federal dredging operations.

3.1.6 Alternative 6: Intermediate Terminal Groin and Beach Nourishment

Under Alternative 6, the Town would assume responsibility for shore protection of the East End of Holden Beach through the construction of a ~1,000-ft-long intermediate terminal groin at the eastern end of the oceanfront beach between Stations 00+00 and 10+00 (Figure 3.11, Appendix G) and the implementation of an independent, 30-year beach nourishment plan. The main stem of the intermediate terminal groin would include a 700-ft-long segment extending seaward from the toe of the primary dune and a ~300-ft anchor segment extending landward from the toe of the primary dune. The groin would also include a 120-ft-long shore-parallel T-Head segment centered on the seaward terminus of the main stem. The intermediate groin features a smaller T-Head since a longer groin in this location would be expected to have more of a stabilizing effect on the shoreline than the shorter groin alternative (Alternative 5). T-Heads also help to minimize formation of potential offshore rip currents and sand losses during extreme wave conditions (Appendix F). This terminal groin design feature is consistent with sound engineering practices and is recommended by NC licensed engineer Fran Way of ATM.

The anchor segment would be designed to prevent flanking of the groin in the event of shoreline migration landward of the primary dune. The anchor segment would be entirely buried at the completion of groin construction and would remain buried so long as the position of the MHW line remains seaward of the initial post-construction primary dune line. Similar to the short groin, the intermediate groin would be designed to be a relatively low-profile structure (Figure 3.11) to maximize sand overpassing and to minimize impacts to beach recreation and aesthetics. In addition to the 300-ft anchor segment, a portion of the adjoining 700-ft segment across the upper dry beach would also be completely buried thus maintaining recreational beach access across the groin. The relatively low profile of the groin is designed to allow some sand overpassing even under eroded conditions at the end of the four-year nourishment cycle.

The intermediate groin would be constructed of 4- to 5-ft-diameter granite armor stone and, unlike conventional groins, would not have a core component of smaller diameter stone (refer to Figure 3.10). The use of only larger armor stone would allow for construction of the groin to the 25 percent void design ratio thus providing the “leaky” characteristic that allows sand to pass through the structure. To prevent settlement of the stone and, if necessary, to facilitate modification or removal of the groin, a base layer of geo-textile matting (1 ft thick) would be installed below grade prior to armor stone placement. The rubble mound (i.e., armor stone) component of the groin would have a crest width of ~5 ft and a base width of ~40 ft while the underlying geo-textile base layer would have a slightly greater width of ~45 ft (Figure 3.12). The relatively short length of the intermediate groin along with the large tidal range at Holden Beach would allow for construction of the groin entirely from shore. It is anticipated that the public

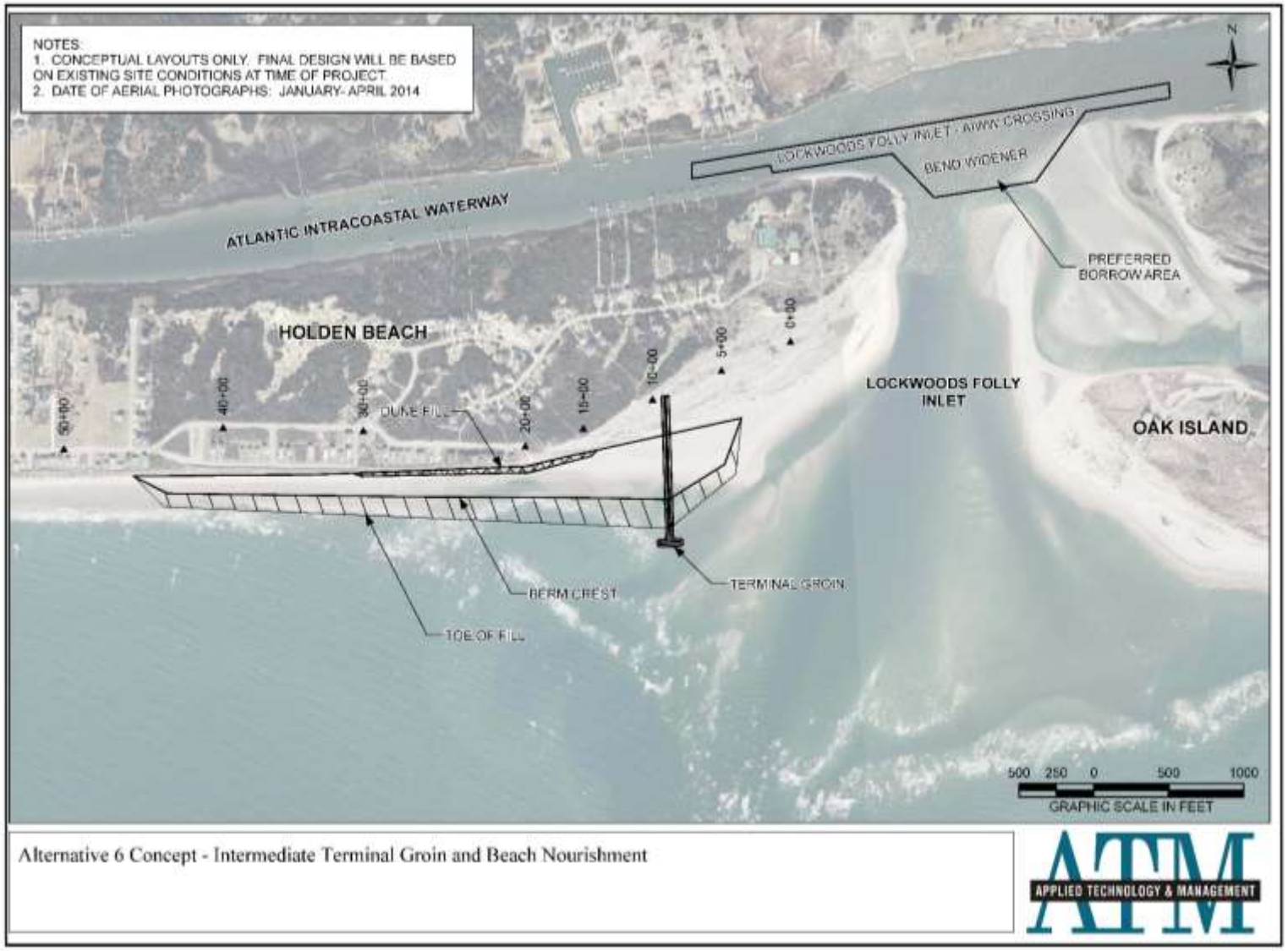

Figure 3.11. Alternative 6 – Beach Fill and Intermediate Terminal Groin Footprints

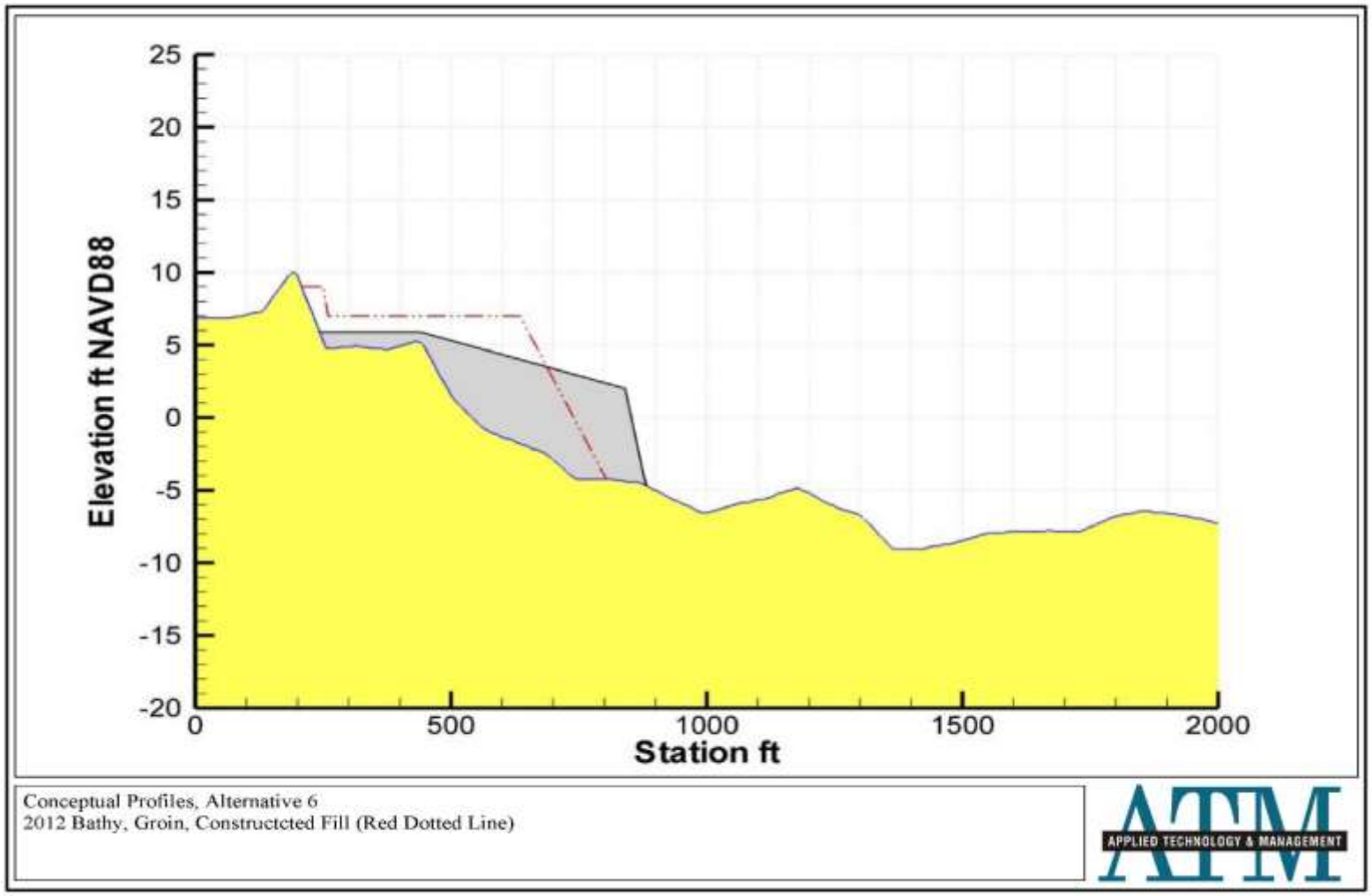

Figure 3.12. Alternative 6 – Intermediate Groin Cross Section and Profile

access parking lot would provide the necessary beach access, staging, and storage areas for construction activities.

The projected beach nourishment regime would involve the placement of ~100,000 to 150,000 cy of sand on the East End of Holden Beach every four years. Compared to the short groin, the intermediate groin would be located ~300 ft farther east, resulting in a corresponding 300-ft relative increase in the lengths of the berm, toe, and groin fillet components under Alternative 6 (Figure 3.12, Appendix G). The greater length of the intermediate groin is designed to account for the landward shift in shoreline position as the east-west oriented oceanfront beach transitions to the north-south oriented inlet shoreline. Relative to the east-west oriented oceanfront shoreline at the proposed short groin location, the intermediate groin does not extend farther seaward. The shore-perpendicular widths of the beach fill toe and groin fillet footprints in the vicinity of the intermediate groin structure would also increase slightly to account for the shift in shoreline position. Otherwise, the beach fill profile design would be similar to that of Alternatives 3, 4, and 5 and include a +9-ft NAVD high dune with a 50-ft-wide crest, a +7-ft NAVD high, 200-ft-wide berm, and a 90- to 200-ft-wide transition with a 15 percent slope. The anticipated borrow sites and dredging regimes would be the same as those described under Alternative 5.

The Town approved a resolution 13 September 2011 to develop an application for a permit to construct a terminal groin on the East End of Holden Beach adjacent to the LFI (Appendix H).