Appendix 3.21-A

Revised Navigational Risk Assessment

Revised Navigational Risk Assessment

CAPE WIND PROJECT
NANTUCKET SOUND

PREPARED FOR

Cape Wind Associates, LLC
75 Arlington Street
Boston, Massachusetts

PREPARED BY

ESS Group, Inc.
888 Worcester Street, Suite 240
Wellesley, Massachusetts 02482

Project No. E159-501.16

November 16, 2006

www.essgroup.com

ESS Group, Inc.

Engineers
Scientists
Consultants

888 Worcester Street
Suite 240
Wellesley
Massachusetts
02482
p 781.431.0500

REVISED NAVIGATIONAL RISK ASSESSMENT
Cape Wind Project
Nantucket Sound

Prepared For:

Cape Wind Associates, LLC
75 Arlington Street, Suite 704
Boston, Massachusetts 02116

Prepared By:

ESS Group, Inc.
888 Worcester Street, Suite 240
Wellesley, Massachusetts 02482

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ESS Group Inc.

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EXECUTIVE SUMMARY

Cape Wind Associates (CWA) is proposing to construct and operate a 130-turbine Wind Park in central Nantucket Sound along with a submarine electrical transmission cable system interconnecting the Wind Park with the onshore electrical grid. Each wind turbine generator (WTG) will have a tower diameter of approximately 16 feet (FT), and will be installed in a grid with a minimum spacing of 0.34 nautical miles (NM) by 0.54 NM. Inner-array cables connecting each WTG to an electrical service platform located within the Wind Park and the submarine electrical transmission cable system to shore will be embedded into the bottom of Nantucket Sound through the use of a jet plow.

As part of the Environmental Impact Statement preparation process, the US Coast Guard (USCG) requested that a qualitative assessment be prepared of navigational risks related to the proposed Project. The analyses required by the USCG were outlined in a letter to the US Army Corps of Engineers (USACE) dated February 10, 2003. ESS Group, Inc. (ESS) prepared the Navigational Risk Assessment per request of the USACE. The document prepared by ESS for CWA satisfied the requirements set for the document by the USCG in a letter dated February 10, 2003 as demonstrated by the USCG's letter of July 31, 2003, which stated that the Navigational Risk Assessment "appears to have sufficiently addressed the issues raised in MSO Providence's letter…of February 10, 2003." As part of the Draft Environmental Impact Statement (DEIS) review process, comments on the navigational risk assessment were received by the USACE and provided to the USCG. This Revised Navigational Risk Assessment includes updated information to address topics requested by the USCG in its letter of February 14, 2005.

The Revised Navigational Risk Assessment includes descriptions of the Nantucket Sound environment, vessel traffic types and operating areas, the effects of the proposed Wind Park on navigation, an analysis of vessel impacts on the WTGs, historic search and rescue operations in and around the Wind Park, the effects of the proposed Wind Park on search and rescue operations, and the effects of the proposed Wind Park on communications.

In the three years since the initial Navigational Risk Assessment was provided to the USCG and USACE for review, several design changes have been made to the WTGs and the Wind Park. These changes were made in response to comments received during the permitting process, changes in the Submerged Lands Act boundary of Nantucket Sound, and technological advancements in WTG design. These changes are described in Section 1.1. The Revised Navigational Risk Assessment incorporates these changes into the assessments.

Nantucket Sound is a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha's Vineyard. In general, the hydrography in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this glacially formed basin. Currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-generated significant wave heights in Nantucket Sound generally range from less than one foot to nearly four FT, with relatively short spectral peak wave periods between two and four seconds. Weather conditions in Nantucket Sound are highly variable and present hazards in the form of high winds and waves and fog.

Vessel traffic in Nantucket Sound is a mix of commercial and recreational vessels. Recreational traffic is most prevalent in the warmer months (typically May through October), and commercial vessels use

Nantucket Sound throughout the year. ESS and CWA collected information on the types and characteristics of the vessels that use Nantucket Sound from a variety of sources. The vessels identified as using Nantucket Sound were divided into categories for further analysis. Each category was further divided into one or more types based on vessel draft. Vessel observations made during extensive field investigations at various times throughout the year on and around Horseshoe Shoal to support the regulatory permitting and design of the Project have reported few vessels operating on Horseshoe Shoal during both aerial and marine operations in the area.

The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel's draft. Approximately 91% of Horseshoe Shoal has charted water depths of 30 FT Mean Lower Low Water (MLLW) or less. The existing water depths at Horseshoe Shoal physically limit the categories of vessels (as defined in Section 3.1) that can operate in this area, as well as where vessels in each category will ground if adrift. Only one-quarter of Horseshoe Shoal has depths that allow the majority of the vessel types described above to operate or drift based on the charted water depths. In addition, the dramatic changes in water depths over short distances tend to create steep waves that break on the shoal making operation in these waters difficult, causing many vessels to avoid the area.

The presence of the Wind Park at Horseshoe Shoal is not expected to create negative impacts to navigational safety. The spacing between the WTGs, in combination with National Oceanic and Atmospheric Administration (NOAA) chart revisions and establishment of private aids-to-navigation, will provide adequate watersheet area for unrestricted and safe navigational access in and around the Wind Park. However, the presence of the Wind Park will require that mariners be more attentive to their vessel's position and the proximity of other vessels and the WTGs to their own vessel as they navigate in and around the Wind Park. It is important to note that the mariner is responsible for safe operation of the vessel regardless of the navigational situation. It is possible that some recreational boaters may choose not to go out in the area of Horseshoe Shoal due to the combined presence of fog and the Wind Park.

The presence of the Wind Park will not result in large-scale changes to vessel movements on Horseshoe Shoal. The majority of the Wind Park is located on the shallow portions of the Horseshoe Shoal area. Approximately 78% of the Wind Park area is located in areas with charted water depths of 30 FT MLLW or less. The shallow water depths that naturally exist at Horseshoe Shoal physically restrict the operation of most vessels (especially larger vessels) over at least half of the shoal. Therefore, the presence of the Wind Park will not restrict large vessel movements in the area since they are naturally restricted from the area by the charted water depths. The physical water depth restrictions will also limit the distance that larger vessels can drift towards the Wind Park before grounding.

The WTGs will be constructed in a grid pattern (minimum 0.34 by 0.54 NM spacing) rather than randomly scattered throughout the Wind Park area. This will provide mariners with the ability to navigate through the area by maintaining a straight course that passes easily between the WTGs. The large spacing will allow those vessels not restricted by depth to navigate between the WTGs with large spaces between the vessel and the WTGs. The 0.34-by-0.54-NM spacing between the WTGs is far wider than the widths of existing channels in the Nantucket Sound area routinely used by commercial vessels. Therefore, the minimum spacing of 2,066 feet (0.34 NM) between WTGs would not present conditions more restrictive to navigation than presently exist in these channels.

Based on the estimated maximum fluke tip penetration for anchors likely to be used in the Wind Park area and the proposed cable burial depth and the continued ability for vessels to anchor in and around the Wind Park, vessel anchoring within the Wind Park will not be affected by the presence of the cables. The ability of smaller vessels to anchor within the Wind Park area will remain unchanged. Smaller vessels typically have smaller anchors that result in shallower fluke-tip penetration than large anchors.

The risk of a vessel colliding with a WTG is low given the Wind Park's location away from typical vessel routes, the small diameter of the towers (approximately 16 FT) and the large spacing between the WTGs (minimum of 0.34 by 0.54 NM). When the WTG blade is in its lowest position, it will be approximately 72 FT above the water surface (at Mean High Water), and approximately 23 FT from the WTG tower. Therefore, vessels with mast or structure heights less than 72 FT will pass under the WTG blade should they get within 23 FT of the WTG.

While the location of the Wind Park relative to established vessel routes, physical water depth restrictions on Horseshoe Shoal, and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG, CWA has analyzed the possibility for damage to a WTG and to the impacting vessel in the unlikely event of a vessel-to-WTG collision. The revised ship impact analysis includes analysis of additional vessels requested by the USCG, updates the 2003 analysis results, and brings them in line with American Petroleum Institute (API) recommended practices. It is concluded that impact of a drifting vessel of the size that frequents the Wind Park area would not result in collapse of a WTG after impact. It is possible that a collision of an underway vessel the size of the M/V *Eagle* or larger with a WTG could result in collapse of the WTG. In the event that an impact resulted in collapse of the WTG, the nacelle would remain attached to the tower during the collapse. A moored vessel of the size to be used for construction of the Wind Park will not result in damage or collapse of a WTG after impact. The revised impact analysis provides inherently conservative results. Since the analysis does not take into account the transfer of kinetic energy to the impacting vessel, it may overestimate the threshold for vessel impacts that could result in collapse of the WTG. Therefore, it is also possible that an impact of an underway vessel may not result in the collapse of the WTG.

Each WTG will essentially serve as an aid-to-navigation (ATON) simply by its presence in Nantucket Sound. The WTGs will be marked on NOAA navigation charts, and will serve as points of reference for mariners navigating in and around Horseshoe Shoal. Each WTG will be clearly marked with an alphanumeric designation that will also assist mariners in determining their position within the Wind Park. In addition, CWA has committed to providing private ATONs within the Wind Park to assist mariners when navigating in and around the Wind Park. Provided that mariners transit in and around the Wind Park area in a prudent manner and in accordance with the COLREGS, additional search and rescue (SAR) cases resulting from collisions with the WTGs will not be required.

The USCG provided ESS with a compilation of SAR data from its database of missions that occurred from October 1991 to September 2002. There were 94 sortie records in the data within the Wind Park's vicinity. Multiple sorties occurred at the same date and time in many locations in the data, resulting in a total of 50 incidents in the Wind Park area.

After compiling and evaluating the SAR data, ESS consulted with staff from USCG District One, USCG Sector Southeastern New England (formerly MSO Providence), and USCG Air Station Cape Cod. The Wind Park is not anticipated to have negative effects on SAR operations in the area of Horseshoe Shoal or result in the USCG not meeting required response times. A representative of USCG Air Station Cape Cod indicated to ESS that USCG aircraft will be able to operate in and around the Wind Park during periods of good visibility, including nighttime operations. The representative indicated that aircraft would not likely conduct operations in the area during times of very low cloud ceilings or dense fog, and a vessel-based response would be more appropriate during those times.

The Wind Park's presence will actually assist SAR operations. Each WTG will be clearly marked with an alphanumeric designation on the tower; CWA will provide the USCG, other local, state, and federal agencies, and commercial salvors with a plan showing designations for each WTG. The USCG will also be able to use these alphanumeric designations to coordinate and direct the SAR operations. Persons in the water could swim to the WTG and hold on to a safety line attached to each WTG until assistance arrives. During Wind Park operations, CWA will have work vessels in the Wind Park conducting routine monitoring and maintenance during daylight hours when the seas are less than 6 FT. These work vessels will be able to assist vessels in distress within the Wind Park during these times and will do so either upon receipt of a request for assistance from the vessel or from the USCG.

CWA analyzed potential interference to VHF marine radios, ship-based radar, and positioning systems from the Wind Park. VHF radio interference in and around the CWA Wind Park are not anticipated. The large vertical extent of the CWA WTGs may result in similar marine radar performance effects as have been observed at the North Hoyle Wind Farm. However, prediction of the exact effects on marine radar use the presence of the WTGs in Nantucket Sound will have, prior to their construction, is complicated. Local factors affect radar performance such as WTG construction materials, type(s) of marine radar in use, radar position relative to the WTGs, radar position relative to a ship's superstructure and other antennas, and the proficiency of the radar operator. Mariners utilizing the areas in and around the Wind Park will require guidance on the potential effects of the WTGs on radar. To avoid collisions with the WTGs, the mariner will need to combine data obtained from the vessel's radar with its positioning systems and marine charts to interpret the radar data. As stated in Section 4.7, CWA will work with NOAA and the USCG to incorporate WTG locations onto the local navigational charts. To avoid collisions with other vessels in and around the Wind Park, mariners will need to scrutinize more closely radar data received to identify vessels that may be temporarily masked by radar echoes (either true or false) from WTGs. CWA will work with the USCG to develop information that could be provided to local mariners to educate them regarding the potential effects of the WTGs on marine radar.

There will be no measurable compass deflection effects on vessels transiting over the cables since the earth's magnetic field is a direct current (DC) field.

Since the operating WTGs will be nearly inaudible, mariners traveling near the Wind Park will be able to hear the sound signals, just as they now hear the various gongs and bells on floating ATONs in Nantucket Sound.

1.0 INTRODUCTION

Cape Wind Associates (CWA) is proposing to construct and operate a 130-turbine Wind Park in central Nantucket Sound along with a submarine electrical transmission cable system interconnecting the Wind Park with the onshore electrical grid (see Figure 1-1). Each wind turbine generator (WTG) will have a tower diameter of approximately 16 feet (FT), and will be installed in a grid with a minimum spacing of 0.34 nautical miles (NM) by 0.54 NM. Inner-array cables connecting each WTG to an electrical service platform located within the Wind Park and the submarine electrical transmission cable system to shore will be embedded into the bottom of Nantucket Sound through the use of a jet plow.

As part of the Environmental Impact Statement preparation process, the US Coast Guard (USCG) has requested that a qualitative assessment be prepared of navigational risks related to the proposed Project. The analyses required by the USCG were outlined in a letter to the US Army Corps of Engineers (USACE) dated February 10, 2003. ESS Group, Inc. prepared the Navigational Risk Assessment per request of the USACE. The document prepared by ESS for CWA satisfied the requirements set for the document by the USCG in a letter dated February 10, 2003 as demonstrated by the USCG's letter of July 31, 2003, which stated that the Navigational Risk Assessment "appears to have sufficiently addressed the issues raised in MSO Providence's letter…of February 10, 2003." As part of the Draft Environmental Impact Statement (DEIS) review process, comments on the navigational risk assessment were received by the USACE and provided to the USCG. This Revised Navigational Risk Assessment includes updated information to address topics requested by the USCG in its letter to the USACE of February 14, 2005 commenting on the DEIS/DEIR. Responses to the McGowan Group report are provided in Attachment C.

The Navigational Risk Assessment includes descriptions of the Nantucket Sound environment, vessel traffic types and operating areas, the effects of the proposed Wind Park on navigation, an analysis of vessel impacts on the WTGs, historic search and rescue operations in and around the Wind Park, the effects of the proposed Wind Park on search and rescue operations, and the effects of the proposed Wind Park on communications. Various marine interests in Nantucket Sound, including the USCG and the Steamship Authority (SSA), and the proposed WTG vendor (General Electric) have provided information to assist in the preparation of the Navigational Risk Assessment.

1.1 Project Changes Since 2003 Navigational Risk Assessment

In the three years since the initial Navigational Risk Assessment was provided to the USCG and USACE for review, several design changes have been made to the WTGs and the Wind Park. These changes were made in response to comments received during the permitting process, changes in the Submerged Lands Act boundary of Nantucket Sound, and technological advancements in WTG design. This section summarizes those changes. The remaining portions of this revised Navigational Risk Assessment incorporate these changes into the assessments.

Subsequent to the publication and issuance of the DEIS/DEIR in November 2004, the Minerals Management Service (MMS) determined that the Submerged Lands Act boundary of Nantucket Sound was to be revised based on recent survey information. The effect of the change expanded further into Nantucket Sound the 3-nautical-mile (NM) state territorial boundary, resulting in ten proposed

WTG locations and an additional 1 mile of the 115 kV submarine cable system falling within the newly determined Massachusetts state waters. In response to the boundary change and in compliance with the Massachusetts Secretary of Environmental Affairs Certificate (March 3, 2005) and the Massachusetts Energy Facilities Siting Board's Final Decision (May 11, 2005) approving the 115 kV transmission cables (that portion of the project within state jurisdiction), CWA has relocated the 10 proposed WTG sites affected by the boundary change to locations in federal waters.

In addition to the 10 WTG sites that have been relocated as a result of the change in the state territorial boundary, 20 other WTG sites have been relocated in order to avoid or minimize impacts as identified through studies or agency/public comments. These include:

- Avoidance of areas determined through marine archeological study to be archeologically sensitive for potential submerged prehistoric or historic resources. In some instances, this required the shifting of sites by 100 to 300 feet along the established grid transects, and in other instances, the WTG site was relocated to an alternative location.
- In order to minimize or avoid impacts to commercial fishermen who use mobile gear, a number of proposed WTG sites that were in deeper water along the eastern portion of the array have been relocated to shallow water locations in the northwestern portion of Horseshoe Shoal. Commercial fishermen who use mobile gear had identified the deeper water as an area they frequently fish.
- Several of the southernmost WTGs have been relocated from sites adjacent to the Main Channel to sites in the northwestern portion of Horseshoe Shoal, an area with significantly less deep-draft commercial vessel traffic.

Figure 1-1 illustrates the revised configuration of the 130 WTG array and the adjusted submarine electrical transmission cable system route.

As a result of WTG manufacturers' continuing technological modifications and advancements in design, it is likely that the Project will utilize a larger rotor blade system than originally proposed. Rather than the 341 foot rotor diameter presented in the 2003 Navigational Risk Assessment, it is likely that the rotor diameter will approach 364 feet in diameter. As a result, the overall maximum height of the WTG will increase from 417 feet to 440 feet.

At the present time, the navigational lighting (both Federal Aviation Administration [FAA] aviation and USCG marine) remains unchanged. However, the FAA has adopted new national guidelines for the lighting of wind turbine arrays that will result in a substantial reduction in the number and types of FAA lights required for pilot safety. CWA has consulted with the FAA regarding this issue, and expects to propose changes to the FAA lighting that will be in accordance with the new FAA guidelines.

2.0 NANTUCKET SOUND ENVIRONMENT

Nantucket Sound is a broad passage of water that separates the south shore of the Cape Cod mainland and the islands of Nantucket and Martha's Vineyard. It is approximately 23 miles long (east-west direction), and between 6 and 22 miles wide.

2.1 Hydrography

In general, the hydrography in Nantucket Sound is irregular, with a large number of shoals present in various locations throughout this glacially-formed basin. Charted water depths in the Sound range between 1 and 70 FT at Mean Lower Low Water (MLLW). Water depths between Horseshoe Shoal[1] and the Cape Cod shoreline are variable, with an average depth of approximately 15 to 20 FT at MLLW. Along the transmission line interconnection, depths vary from about 16 to 40 FT at MLLW, with an average depth of approximately 30 FT at MLLW.

2.2 Currents

Currents in Nantucket Sound are driven by strong, reversing, semidiurnal tidal flows. Wind-driven currents are only moderate because of the sheltering effect of Nantucket and Martha's Vineyard. The tidal range and diurnal timing are variable because of the semi-enclosed nature of the Sound and the regional variations in bathymetry. Typical tidal heights are in the range of 1 to 4 FT with tidal surges of up to approximately 10 FT recorded during hurricanes (Bumpus et al., 1973; Gordon and Spaulding, 1979). Times of high and low tides vary across the Sound by up to two hours.

Tidal flow and circulation within the Sound generate complex currents, the directions of which form an ellipse during the two tidal cycles each day. The tidal current flows to the east during the flood tide (incoming) and to the west during the ebb tide (outgoing). Peak tidal currents often exceed 2.0 knots (Bumpus et al., 1973).

Flood currents on the shoals are generally directed easterly, and ebb currents are generally directed westerly. Local changes in tidal current direction occur on the shoals due to the nearby shoreline shape and bathymetric features. For example, tidal currents at Handkerchief Shoal are directed around Monomoy Island and have more of a southeast (flood)/northwest (ebb) tendency. Currents at Horseshoe Shoal are diverted slightly around the shallowest portion of the shoal. Flood currents also are generally stronger than ebb currents, and spring tidal currents are approximately 15 to 20 percent stronger than mean tidal currents. Tidal current velocities were calculated to be approximately 2 FT/second (1.2 knots) at Horseshoe Shoal. Wind-driven current velocities modeled at Horseshoe Shoal were found to be much lower than tidal velocities and are concentrated over the crest of the shoal.

2.3 Waves

There is no extensive source of historical wave data within Nantucket Sound. CWA's Scientific Measurement Devices Station (SMDS), designated as USCG private aid-to-navigation "MT", has been operational since April 2003 and gathered previously unavailable data for use during project design. In the absence of site-specific historical wave data, available wind data and analytical models were used to characterize wind-generated waves at the Project Site (WHG, 2003).

[1] In this navigational risk assessment, the U-shaped shoal between Broken Ground and Halfmoon Shoal (inclusive) will be referred to as Horseshoe Shoal.

Fetch is restricted within Nantucket Sound due to surrounding landforms including Cape Cod, Monomoy Island, Nantucket Island, and Martha's Vineyard. Generally, the model indicates that Horseshoe Shoal is exposed to the largest waves from the east. Wind-generated significant wave heights in Nantucket Sound generally range from less than 1 foot to nearly 4 FT, with relatively short spectral peak wave periods between two and four seconds. Individual wave heights can be higher, and substantially higher waves will be present during storms. Generally, wave height changes in the shallow portions of Horseshoe Shoal due to wave shoaling and breaking while wave period remains constant. (WHG, 2003)

It is also possible that longer period waves enter Nantucket Sound from the Atlantic Ocean. Therefore, a conservative estimate of long period swell conditions was developed for the Horseshoe Shoal area. The average wave height of offshore waves approaching from easterly through southeasterly directions east of Monomoy within the Atlantic Ocean was used for this analysis. The average height for these offshore waves is 4.5 FT and the average wave period is eight (8) seconds. A shoaling coefficient was used to modify the ocean swell and to estimate resulting wave heights and distribution at Horseshoe Shoal. Offshore waves are also likely to be modified substantially by the complex and shallow shoal structure separating Nantucket Sound from the Atlantic Ocean, as well as by the relatively narrow gaps between Monomoy Island and Nantucket Island to the east and between Nantucket Island and Martha's Vineyard to the south. (WHG, 2003)

In open waters, wave heights of 12 FT or greater can be expected approximately 5 to 15 percent of the time between November and February (NOAA, 2004). However, these large waves often break before reaching the shoals due to the shallow water depths.

Wave data collected at the SMDS between May 2003 and May 2004 indicates that the maximum recorded significant wave height was 6.6 feet, and the maximum recorded wave height was 8.2 feet. The wave period varied widely depending on whether wind generated waves (two (2) to six (6) second periods) or swell (longer periods) determined the shape of an individual wave spectrum. Wave periods of 2.6 to 3.4 seconds were most frequently recorded. The wind and wave directions recorded correlated well with a tendency for waves to propagate along the axis of Nantucket Sound (WHG, 2004).

2.4 Weather

Weather conditions in Nantucket Sound are highly variable, and present hazards in the form of high winds and waves, and fog.

Gale force winds occur typically about three (3) to six (6) percent of the time between October and March, with the predominant wind directions being between west and northwest (NOAA, 2004).

The annual cycle of surface and bottom water temperatures in Nantucket Sound encompasses a range of about 45° F (7° C) to about 30° F (-1° C) in the winter, and as high as 75° F (24° C) in the late summer (Bumpus et al., 1973).

Fog resulting from the presence of warm air over cool water is common in Nantucket Sound from April through August. Visibility is reduced below 2 miles in fog 10 to 18 percent of the time during these months, with May, June, and July being the worst months (NOAA, 2004). The *Coast Pilot* advises caution when navigating through Nantucket Sound in fog due to the reduced visibilities, the presence of shoals throughout the Sound, and distortion of sound.

Thunderstorms often occur during the spring and summer months. Strong, gusty winds often precede the storms, and gusts can reach 60 knots (NOAA, 2004).

Weather data collected at the SMDS between April 2003 and September 2004 indicates that the 18 month average wind speed varied from 19 mph at 197 foot level to 18 mph at 135 foot level and 16.6 mph at 66 foot level. During the day the winds were stronger in the afternoon (15:00 – 16:00 EST) and weaker in the morning (around 10:00 EST). The magnitude of daily variations of the wind speed was about 1.6 mph. The wind rose analysis utilizing a 17-month long dataset shows that, on average, prevailing winds had a southwesterly direction and the most energetic winds had westerly direction, due to the severe storm event that occurred in December 2003. Winds having south-southwesterly to west-southwesterly direction occurred approximately 31% of the time of observation. Mean wind direction was in the range from 241° at the top level to 246° for the middle and 242° for the low-level sensor. (WHG, 2004)

3.0 VESSEL TRAFFIC IN NANTUCKET SOUND

Vessel traffic in Nantucket Sound is a mix of commercial and recreational vessels. Recreational traffic is most prevalent in the warmer months, typically mid-May through October. Commercial vessels use Nantucket Sound throughout the year. According to USACE data for the 1998-2003 timeframe, an annual average of 1,276 trips of vessels engaged in waterborne commerce were reported as passing Cross Rip Shoal, which is to the south of Horseshoe Shoal and the Main Channel (USACE, 1998-2003).

This assessment of vessel traffic in Nantucket Sound provides information on the types of vessels using the Sound, their typical operating areas and routes, seasonal traffic variations, and special marine events. The information presented below uses readily available information, and provides a general sense of the vessel traffic characteristics in Nantucket Sound. However, it is not possible to identify the characteristics and routes of every vessel that uses, or could potentially use, Nantucket Sound because marine vessel traffic is not closely regulated and routes are not generally restricted to designated corridors.

3.1 Vessel Types

The January 2004 USCG Waterway Analysis and Management Survey (WAMS) Review of Nantucket Sound Main Channels describes the users of Nantucket Sound as follows (USCG, 2004):

- Commercial vessels include the Steamship Authority (from Woods Hole, Martha's Vineyard, and Nantucket), Falmouth Ferries, Hy-Line Cruises, Patriot Party Boats, The *Endeavor*, Freedom Cruise Lines, Hyannis Cruise Lines, The *Island Queen*, Tisbury Towing (transiting New Bedford, Martha's Vineyard, and Nantucket), and Shearwater Excursions.

- Recreational traffic is heaviest during mid-May to October. The heaviest concentrations of traffic occur in the approaches to Nantucket, Edgartown, Oak Bluffs, Vineyard Haven, and Woods Hole.
- The Woods Hole Oceanographic Institute and the National Oceanic and Atmospheric Administration (NOAA) have several large research vessels homeported in Woods Hole.
- There are many small commercial fishing vessels homeported in many of the harbors surrounding Nantucket Sound. However, the largest concentration consists of fishing vessels transiting Nantucket Sound to and from New Bedford, Massachusetts.
- CGC *Juniper* and CGC *Ida Lewis* maintain the majority of the buoys in Nantucket Sound, and thus transit the channel regularly. CG ANT Woods Hole, CG Station Woods Hole, CG Station Brant Point, CGC *Sanibel*, CGC *Monomoy*, and CGC *Hammerhead* are located within the vicinity of Nantucket Sound and also transit frequently.

ESS and CWA collected information on the types and characteristics of the vessels that use Nantucket Sound from a variety of sources. These sources included the USCG; the Woods Hole, Martha's Vineyard & Nantucket Steamship Authority; conversations with vessel owners; the online USCG Vessel Documentation Database; and various Internet pages describing vessels. For the identified vessels, information was collected on the overall length, beam, draft, tonnage, operating speed, and passenger capacity (where applicable). However, all of this information was not available for each vessel.

The vessels identified as using Nantucket Sound were divided into categories for further additional analysis. Each category was further divided into one or more types based on vessel draft. These vessel categories and types are described below, and will be used throughout this Navigational Risk Assessment. Tables containing the vessel data obtained are provided in Attachment A.

3.1.1 Cruise Ships/Research Vessels (Category A)

Category A vessels include cruise ships and research vessels that commonly transit through Nantucket Sound. Data on the types and characteristics of the vessels was obtained from various Internet sources. Category A is divided into two types based on draft.

- Type A1 vessels have a draft of 10 to 15 FT. The average length overall (LOA) of these vessels is 177 FT, and the average draft is 10 FT. The average tonnage is approximately 435 gross register tons (GRT)[2].
- Type A2 vessels have a draft of 15 to 25 FT. The average LOA of these vessels is 363 FT, and the average draft is 21 FT. The average tonnage is approximately 44,000 GRT. These vessels only utilize Nantucket Sound waters occasionally.

The M/V *Clipper Adventurer* is cruise ship that occasionally makes port calls at Martha's Vineyard and/or Nantucket, and is a Type A2 vessel. The *Clipper Adventurer* has been chosen as one of the design vessels for the impact calculations described in Section 4.3.3.

[2] Vessel "tonnage" is a measure of volume, not weight. GRT under the USCG standard measurement system are expressed in ton units, with each unit representing 100 cubic feet. A change in vessel weight affects its displacement, but not its gross register tonnage.

3.1.2 Passenger Ferries (Category B)

Category B vessels include passenger ferries that commonly transit through Nantucket Sound while bringing passengers to and from Cape Cod and the Islands. Data on the types and characteristics of the vessels was obtained from the Steamship Authority, Hy-Line, Patriot Party Boats, and Internet sources. Category B is divided into two types based on draft.

- Type B1 vessels have a draft of 10 FT or less. The average LOA of these vessels is 120 FT, and the average draft is 7 FT. The average tonnage is approximately 190 GRT.
- Type B2 vessels have a draft of 10 to 15 FT. The average LOA of these vessels is 224 FT, and the average draft is 12 FT. The average tonnage is approximately 520 GRT.

The Steamship Authority's M/V *Eagle* is their largest vessel, and it is primarily assigned to the route between Hyannis and Nantucket. The *Eagle* is 233 FT LOA, has a beam of 61.5 FT, and a design draft of 10.2 FT, making it a Type B2 vessel. The *Eagle*'s lightship displacement is 1,368.6 long tons (LT)[3]. The height of the *Eagle* above the waterline is approximately 69 FT. Since the *Eagle* is most likely the largest vessel to routinely operate near Horseshoe Shoal and the Project, it has been chosen as one of the design vessels for the impact calculations described in Section 4.3.3.

3.1.3 Bulk Goods Carriers (Category C)

Category C vessels include vessels that carry both dry and liquid bulk materials in Nantucket Sound. Category C was divided into three types based on draft. Type C1 and C2 vessels are typically non self-propelled vessels such as barges. Tisbury Towing and Transport provided the types and characteristics of these vessels. Type C3 vessels are self-propelled tankers. The characteristics of these vessels were based on the T/V *Great Gull*, which makes regular trips in the area. The *Great Gull* has been chosen as one of the design vessels for the impact calculations described in Section 4.3.3.

- Type C1 vessels have a draft of 10 FT or less. The average LOA of these vessels is 80 FT, and the average draft is 7 FT. The average tonnage is approximately 150 GRT.
- Type C2 vessels have a draft of 10 to 15 FT. The average LOA of these vessels is 125 FT, and the average draft is 11 FT. The average tonnage is approximately 280 GRT.
- Type C3 vessels have a draft of 15 to 20 FT. The average LOA of these vessels is 276 FT, and the average draft is 17 FT. The average tonnage is approximately 1,729 GRT.

3.1.4 US Coast Guard Vessels (Category D)

Category D vessels include USCG vessels that are commonly operated in Nantucket Sound and those that transit through Nantucket Sound occasionally. The USCG provided the types and characteristics of the vessels. Category D is divided into three types based on draft.

[3] Lightship displacement is the weight of a vessel without passengers and cargo. Displacement is measured in Long Tons (2,240 pounds per long ton).

- Type D1 vessels have a draft of 5 FT or less. The average LOA of these vessels is 40 FT, and the average draft is 4 FT. The average displacement is approximately 20 tons.
- Type D2 vessels have a draft of 5 to 10 FT. The average LOA of these vessels is 124 FT, and the average draft is 7 FT. The average displacement is approximately 370 tons.
- Type D3 vessels have a draft of 10 to 15 FT. The average LOA of these vessels is 235 FT, and the average draft is 13 FT. The average displacement is approximately 1,650 tons.

3.1.5 Fishing Vessels (Category E)

Category E vessels include commercial and charter fishing vessels that are commonly operated in Nantucket Sound and those that transit through Nantucket Sound. The types and characteristics of the vessels were obtained from dockside interviews, the USCG, and various Internet sources. Category E is divided into three types based on draft.

- Type E1 vessels have a draft of 5 FT or less. The average LOA of these vessels is 38 FT, and the average draft is 4 FT. The average tonnage is approximately 12 GRT.
- Type E2 vessels have a draft of 5 to 10 FT. The average LOA of these vessels is 55 FT, and the average draft is 8 FT. The average tonnage is approximately 60 GRT.
- Type E3 vessels have a draft of 10 to 15 FT. The average LOA of these vessels is 67 FT, and the average draft is 11 FT. The average tonnage is approximately 90 GRT.

3.1.6 Recreational Vessels (Category F)

Category F vessels include recreational vessels that are commonly operated in Nantucket Sound. Recreational vessels come in all shapes and sizes, from small runabouts to large megayachts. For the purposes of this Navigational Risk Assessment, only small craft (those with LOA less than or equal to 65 FT) are considered in the recreational vessel category since they are less likely to be operated by licensed Captains. One or more of the previously described vessel categories (A through E) contain vessel characteristics that would be similar to larger yachts. To determine the general types and characteristics of recreational vessels, design guidance for marinas (Tobiasson et al, 1991) was used since recreational vessels are typically stored at local marinas. Tobiasson et al, 1991 provides a table with minimum recommended water depths in marinas that is based on representative deepest draft vessels for various boat lengths (both power and sail). This table was used to divide Category F into three types based on required water depth.

- Type F1 vessels require a minimum water depth of 5 FT or less to operate. The LOA of these vessels is less than 30 FT.
- Type F2 vessels require a minimum water depth of 5 to 10 FT to operate. Sailboats of this type have LOAs less than 35 FT. Powerboats of this type have LOAs less than or equal to 65 FT.
- Type F3 vessels require a water minimum depth of 10 to 16 FT to operate. These vessels are sailboats with LOAs between 35 and 65 FT.

3.1.7 Vessel Height

To estimate mast heights for the recreational sailing vessel types described in Section 3.1.6, design guidance for marinas (Tobiasson et al, 1991) was used since recreational vessels are typically stored at local marinas. Tobiasson et al, 1991 provides a graph of representative sailboat mast heights versus sailboat length, and includes an added four (4) foot clearance to the upper limit of the mast heights presented. This figure was used to estimate sailboat mast heights and minimum vertical clearance above the waterline for the Category F vessel types (see Figure 3-1).

- Type F1 vessels have typical mast heights less than or equal to 56 FT above the waterline, and require a minimum clearance of 60 FT or less (depending on mast height).
- Type F2 vessels have typical mast heights between 56 FT and 60 FT above the waterline, and require a minimum clearance between 60 FT and 64 FT (depending on mast height).
- Type F3 vessels have typical mast heights between 60 FT and 88 FT above the waterline, and require a minimum clearance between 64 FT and 92 FT (depending on mast height).

As described in Section 3.1.2, the M/V *Eagle* is most likely the largest commercial vessel that routinely operates near Horseshoe Shoal. The height of the *Eagle* above the waterline is approximately 69 FT.

The vessel heights for the vessels included in the Vessel Impact Analysis (Section 4.3.3) are provided in Table 3.1.

Table 3.1: Vessel Heights for Vessel Impact Analysis Scenarios

Vessel Type	Section 3.1 Type	Dead Weight Tonnage (Metric Tons)*	LOA (FT)	Beam (FT)	Vessel Height above Waterline (FT)
Passenger Ferry	Type B2	1,500	233	61	69
Barge	Type C2	1,200	150	60	40
Fishing Vessel	Type E3	300	90	30	63
Yacht	Type F3	20	46	14	71
Work Vessel	N/A	75	60	28	75
T/V *Great Gull*	Type C3	3,800	276	55	41
M/V *Clipper Adventurer*	Type A2	1,465	330	54	85

*A metric ton is approximately 2,200 pounds

3.2 Typical Operating Areas and Routes

The vessel's points of origin and destination as well as the numerous shoals located throughout the Sound primarily determine operating areas and routes in Nantucket Sound. The *Coast Pilot* urges mariners to exercise caution when navigating in Nantucket Sound because of the numerous shoals.

Coastwise and recreational vessels tend to use the Main Channel (south of Horseshoe Shoal) when transiting Nantucket Sound for points within Nantucket Sound and for the Atlantic Ocean. The Main

Channel also serves as an inside passage for medium-draft vessels to avoid Nantucket Shoals (south and east of Nantucket in the Atlantic Ocean). This channel is marked with aids-to-navigation, and has a least depth of approximately 30 FT. However, the drafts of vessels using the Main Channel seldom exceed 24 FT (NOAA, 2004).

In information provided to CWA and ESS in January 2004, Captain Larry Palmer, an experienced local harbor pilot, stated that pilots do not take vessels with drafts of 24 FT or greater east of a point located at 41°28.7’ N, 70°32.6’ W, which is located just northeast of East Chop on Martha’s Vineyard (approximately 7.0 NM west of the nearest WTG). Captain Palmer stated that passenger vessels (cruise ships) destined for Oak Bluffs and Edgartown always approach these areas from the west near Cuttyhunk and Gay Head, and depart toward the west.

The North Channel (north of Horseshoe Shoal) is used by vessels bound for the Cape Cod shore and by vessels transiting the Sound during northerly winds. This channel is marked with aids-to-navigation, and has a least depth of approximately 16 FT (NOAA, 2004).

The numerous shoals in Nantucket Sound limit the operating areas for vessels depending on the vessel’s draft. Charted water depths on Horseshoe Shoal range from one (1) to 45 FT at MLLW, with the majority of the shoal being between 20 and 30 FT deep at MLLW. Table 3.2 shows the percentage of Horseshoe Shoal less than or equal to various depths (note that total of the percentages is greater than 100 percent because areas at a given depth are also shallower than the next deepest depth).

Table 3.2: Hydrographic Contour Areas on Horseshoe Shoal

Charted Water Depth	Percentage of Horseshoe Shoal
≤ 5 FT MLLW	0.3%
≤ 10 FT MLLW	6.1%
≤ 15 FT MLLW	21.9%
≤ 20 FT MLLW	50.6%
≤ 25 FT MLLW	71.7%
≤ 30 FT MLLW	91.2%
≥ 30 FT MLLW	8.8%

Approximately 91 percent of Horseshoe Shoal has charted water depths of 30 FT or less at MLLW. The existing water depths at Horseshoe Shoal physically limit the categories of vessels (as defined in Section 3.1) that can operate in this area as well as where vessels in each category will ground if adrift. Figures 3-2 through 3-7 illustrate the areas of existing depth restrictions for each vessel category. Table 3.3 shows how the charted water depth restricts the operation and drifting of the various vessel categories at Horseshoe Shoal.

Table 3.3: Existing Depth Restrictions on Horseshoe Shoal by Vessel Category

Charted Water Depth	Vessel Categories Restricted by Depth
≤ 5 FT MLLW	A1, A2, B1, B2, C1, C2, C3, D1, D2, D3, E1, E2, E3, F1, F2, F3
≤ 10 FT MLLW	A1, A2, B1, B2, C1, C2, C3, D2, D3, E2, E3, F2, F3
≤ 15 FT MLLW	A1, A2, B2, C2, C3, D3, E3, F3
≤ 20 FT MLLW	A2, C3
≤ 25 FT MLLW	A2
≤ 30 FT MLLW	-

From Tables 3.2 and 3.3, it is clear that the shallow water depths that exist naturally at Horseshoe Shoal restrict the operation and drifting of most vessels to just over one-quarter of Horseshoe Shoal. Only one-quarter of Horseshoe Shoal has depths that allow the majority of the vessel types described above to operate or drift based on the charted water depths. In addition, the dramatic changes in water depths over short distances tend to create steep waves that break on the shoal making operation in these waters difficult, causing many vessels to avoid the area.

During the past three years, ESS and CWA have conducted extensive field investigations at various times throughout the year on and around Horseshoe Shoal to support the regulatory permitting and design of the Project. During these investigations, field personnel have observed relatively few vessels operating on Horseshoe Shoal during both aerial and marine operations in the area, as well as during summer weekend visits with the sole purpose of observing vessel movements in the area.

3.2.1 Steamship Authority Vessels

CWA met with representatives of the Steamship Authority (SSA) in February 2003. The SSA representative provided CWA with SSA vessel routes between Cape Cod and the Islands, which are illustrated in Figure 3-8a. In August 2004, the SSA provided ESS with a chart marked with SSA vessel base courses between Cape Cod and the Islands, which are illustrated in Figure 3-8b. These base courses differed slightly from the vessel routes provided to CWA in 2003, and the SSA did not provide an explanation as to the reason for the difference. SSA vessels do not transit over Horseshoe Shoal.

The reconfiguration of the WTG locations described in Section 1.1 has also had the added benefit of increasing the distance between the SSA Hyannis-Nantucket vessel routes and the Wind Park by approximately 0.6 NM to 1.4 NM.

3.2.1.1 Steamship Authority Vessel Routes Provided in 2003

SSA vessels traveling between Hyannis and Woods Hole or Martha's Vineyard use the North Channel between the Hyannis sea buoy ("HH") and green can "11", and pass to the north and west of Horseshoe Shoal. At its closest point, this vessel route is approximately 0.9 NM from the nearest WTG (see Figure 3-8a).

Vessels on the Hyannis to Nantucket route pass to the east of Horseshoe Shoal. After exiting the Hyannis Federal Channel, the vessels proceed to the Hyannis sea buoy ("HH"). They then set a course of 154°[4] to the green "17" buoy in the Main Channel. After passing the green "17" buoy, the vessels head for the Nantucket Harbor sea buoy ("NB"), and then proceed into Nantucket Harbor via the Nantucket Federal Channel. The vessel traveling to Nantucket passes the Hyannis-bound vessel at a distance of approximately 0.5 NM somewhere between the green "17" and the "HH" buoys. At its closest point, this vessel route is approximately 1.4 NM from the nearest WTG (see Figure 3-8a).

Vessels traveling between Martha's Vineyard and Nantucket use the Main Channel, and pass to the south of Horseshoe Shoal. At its closest point, this vessel route is approximately 0.9 NM from the nearest WTG (see Figure 3-8a).

3.2.1.2 Steamship Authority Vessel Base Courses Provided in 2004

The SSA provided a chart with base courses marked on it in August 2004. The SSA notes that the courses shown on the chart (reproduced in Figure 3-8b) represent base courses and that actual courses steered during transit may vary from the base course.

Vessels on the Hyannis to Nantucket route pass to the east of Horseshoe Shoal. After exiting the Hyannis Federal Channel, the vessels proceed to the Hyannis sea buoy ("HH"). They then set a course of 154° to the green "17" buoy in the Main Channel. After passing the "17" buoy, the vessels head for the Nantucket Harbor sea buoy ("NB"), and then proceed into Nantucket Harbor via the Nantucket Federal Channel. The base course information provided in 2004 does not provide details on where, or at what separation distance, the Nantucket-bound and Hyannis-bound vessels pass each other. At its closest point, this base course is approximately 1.6 NM from the nearest WTG (see Figure 3-8b).

Vessels traveling between Martha's Vineyard and Nantucket use the Main Channel, and pass to the south of Horseshoe Shoal. At its closest point, this base course is approximately 0.5 NM from the nearest WTG (see Figure 3-8b).

Vessels traveling between Hyannis and Woods Hole or Martha's Vineyard use the North Channel between the Hyannis sea buoy ("HH") and green can "11", and pass to the north and west of Horseshoe Shoal. Vessels travel from the "HH" buoy to the green "5" buoy, then proceed to the red "10" buoy, and then turn towards the Main Channel and proceed to the red "22" before turning west in the Main Channel. At its closest point, this base course is approximately 0.4 NM from the nearest WTG (see Figure 3-8b).

[4] Headings provided by the SSA are referenced to True North.

3.2.1.3 SSA Steamship Authority Vessel Tacking Maneuvers

In a June 29, 2004 comment letter to MSO Providence, the SSA stated that its Captains often use tacking maneuvers on the route between Hyannis and Nantucket to provide a smoother ride and to protect vehicles and cargo onboard the ferries. In response to this comment, MSO Providence requested that a detailed description of tacking tracklines actually used in the past, the frequency of use of these maneuvers, and the rationale for using tacking maneuvers be included in the Navigational Risk Assessment.

In July 2004, ESS requested that the SSA provide charts and actual vessel trackline data for every SSA vessel voyage past Horseshoe Shoal during the previous three year period. In August 2004, the SSA provided the chart marked with the base courses described in Section 3.2.1.2. The SSA did not provide actual vessel trackline data. Their August 2004 letter stated that their electronics maintenance vendor advised them that the procedure to download three years of vessel trackline data was complicated. The SSA stated that the SSA does not use paper charts and, if they did, the actual course of the vessel would be erased after each voyage.

Given the lack of actual vessel trackline data, the assessment of the tacking maneuvers and their proximity to the Wind Park cannot be performed.

3.3 Seasonal Traffic Variations

Nantucket Sound is used for navigation by recreational vessels and commercial vessels engaged in waterborne commerce. There is a general increase in vessel traffic in Nantucket Sound during the warmer months (typically mid-May through October). Increased recreational, ferry, charter fishing, touring, and cruise vessel traffic is common during these months.

Many of the ESS and CWA field investigations and dedicated vessel observation surveys for the Project have been performed during the warmer months of the year, and field personnel have reported seeing few vessels operating on Horseshoe Shoal.

3.4 Marine Events

Special marine events (such as regattas and fireworks displays) must be registered with the local USCG District Office at least 30 days prior to the event. The USCG Marine Safety Office in Providence provides a partial list of marine events within its area of jurisdiction (including Nantucket Sound) on its website. This list contains several events in the Nantucket Sound area; however, they are mostly located near shore and in the various harbors of the Cape and the Islands. There is one event, the Figawi Race, that appears to occur in the offshore portions of Nantucket Sound.

The Figawi Race between Hyannis and Nantucket and back is held every year on Memorial Day Weekend. This race involves sailboats with LOAs of 20 FT and over. The course varies every year, but typically starts to the north of, and proceeds around or over portions of, Horseshoe Shoal. Figure

3-9 shows the course traveled by the S/V *Dark Star* (a 38-foot sailboat) during the 2001 Figawi race. Figure 3-10 shows the six (6) courses published in the 2003 Figawi Race Sailing Instructions (Figawi, 2003). These courses are the same as those published for the 2005 Figawi Race.

In June 2002, a powerboat race was held off of the Yarmouth shoreline, near the Parkers River. The course was located approximately 5.4 NM northeast of the nearest proposed WTG location. Therefore, the Wind Park will have no effect on this racecourse.

4.0 POTENTIAL EFFECTS OF THE WIND PARK ON NAVIGATIONAL SAFETY

The presence of the Wind Park at Horseshoe Shoal is not expected to create negative impacts to navigational safety. The spacing between the WTGs, in combination with NOAA chart revisions and establishment of private aids-to-navigation, will provide adequate watersheet area for unrestricted and safe navigational access in and around the Wind Park. However, the presence of the Wind Park will require that mariners be more attentive to their vessel's position, weather conditions, and the proximity of other vessels and the WTGs to their own vessel as they navigate in and around the Wind Park.

Vessels operating in Nantucket Sound operate under the International Regulations for Preventing Collisions at Sea 1972 (COLREGS). Rule 1 of the COLREGS requires that all vessels operating in the area comply with the regulations, and duly regard all dangers of navigation and collision.

In preparing this Navigational Risk Assessment, it is assumed that all mariners will adhere to the COLREGS as required, and will operate their vessels in a safe and prudent manner. Rule 2 states that nothing in the COLREGS exonerates any vessel, owner, master, or crew member from the consequences of failure to comply with the COLREGS or to take the necessary precautions required by ordinary practice or special circumstances. In other words, the mariner is responsible for safe operation of the vessel regardless of the navigational situation. Risks associated with failure to comply with the COLREGS or unsafe vessel operation cannot be evaluated and are beyond the scope of this assessment. Therefore, they are not incorporated.

4.1 Vessel Movement

The presence of the Wind Park will not result in large-scale changes to vessel movements on or around Horseshoe Shoal.

The majority of the Wind Park is located on the shallow portions of the Horseshoe Shoal area. Approximately 78.4 percent of the Wind Park area is located in areas with charted water depths of 30 FT or less at MLLW. The portions of the Wind Park that are located in waters deeper than 30 FT at MLLW are in the central and easterly portions of the Wind Park, which are bounded on three sides by shallow water. Therefore, it is unlikely that a larger vessel would knowingly enter this area as it transits through Nantucket Sound in either an east-west or north-south direction, since grounding on the shoal is likely.

Table 4.1 shows the percentage of the Wind Park area that is less than or equal to various depths and the number of WTGs that are proposed to be located in each depth range. As in Table 3.1, adding the percentages together results in a total that is greater than 100 percent because areas at a given depth are also shallower than the next deepest depth.

Table 4.1: Hydrographic Contour Areas within the Wind Park

<table>
<tr><th>Charted Water Depth</th><th>Percentage of Wind Park Area</th><th colspan="2">Number of Proposed WTG Locations</th></tr>
<tr><td>≤ 5 FT MLLW</td><td>0.2%</td><td colspan="2">0</td></tr>
<tr><td>≤ 10 FT MLLW</td><td>6.2%</td><td colspan="2">0</td></tr>
<tr><td>≤ 15 FT MLLW</td><td>24.1%</td><td colspan="2">9</td></tr>
<tr><td>≤ 20 FT MLLW</td><td>53.7%</td><td colspan="2">34</td></tr>
<tr><td>≤ 25 FT MLLW</td><td>69.9%</td><td colspan="2">71</td></tr>
<tr><td>≤ 30 FT MLLW</td><td>78.4%</td><td>85</td><td rowspan="2">Total = 130 WTGs</td></tr>
<tr><td>≥ 30 FT MLLW</td><td>21.6%</td><td>42</td></tr>
</table>

Figures 4-1 through 4-6 illustrate the areas of existing depth restrictions for each vessel category within the Wind Park boundary as well as the proposed WTG locations.

As described in Section 3.2, the shallow water depths that naturally exist at Horseshoe Shoal physically restrict the operation of most vessels (especially larger vessels) over at least half of the shoal. Therefore, the presence of the Wind Park will not restrict large vessel movements in the area since they are naturally restricted from the area by the charted water depths. Horseshoe Shoal protects the deeper portions of the Wind Park from large vessels on three sides. Medium draft vessels could physically enter the Wind Park from the east, but it is unlikely that those vessels would transit such a course since Horseshoe Shoal prevents these vessels from continuing on to western portions of Nantucket Sound.

The physical water depth restrictions will also limit the distance that larger vessels can drift toward the Wind Park before grounding. The vessel's position relative to the Wind Park, the wind strength and direction, and the current strength and direction will also be contributing factors. With the exception of the perimeter and the east side of the Wind Park, most of the WTGs are protected from larger vessels drifting into them by the physical water depth restrictions. Adrift vessels that do not run aground before entering the Wind Park could potentially tie-up to one of the WTGs to stop drifting, miss the WTGs entirely, or impact a WTG. The effects of impacts from drifting vessels on the WTGs are minimal, and are described in detail in Section 4.3.3.

It is possible that a vessel with a draft of 24 FT could exit the Main Channel and impact some of the WTG locations on the Wind Park's west, south, and east sides before running aground. Several of the southernmost turbines shown in the 2003 Navigational Risk Assessment have been relocated from sites adjacent to the Main Channel to sites in the northwestern portion of Horseshoe Shoal; an area with significantly less deep-draft commercial vessel traffic. This relocation further reduces the chance for deep-draft vessel interaction as the nearest WTG is now sited approximately 1,190 feet (0.2 NM) from the charted edge of the Main Channel, which represents a separation distance increase of approximately 515 feet (0.08 NM) from that presented in the 2003 report.

The separation distance between the WTGs and the Main Channel is slightly less than that of the Middelgrunden Wind Farm from a shipping channel in Copenhagen, Denmark. The Middelgrunden Wind Farm is located approximately 1,500 feet (0.25 NM) from this shipping channel. According to the Royal Danish Administration of Navigation and Hydrography, between 25,000 and 30,000 ships navigate this shipping channel annually and there have been no reported incidents of collisions of ships in this channel with the WTGs (Nielsen, 2005).

The WTGs will be constructed in a grid pattern (minimum 0.34 NM by 0.54 NM spacing) rather than randomly scattered throughout the Wind Park area. This will provide mariners with the ability to navigate through the area by maintaining a relatively straight course that passes between the WTGs. The large spacing will allow those vessels not restricted by depth to navigate between the WTGs with large distances between the vessel and the WTGs. As an example, Figure 4-7 illustrates that 14 M/V *Eagle*s (233 FT LOA) laid stem-to-stern could fit between adjacent WTGs along the 0.54 NM spacing rows, and that 8.8 M/V *Eagle*s could fit between adjacent WTGs along the 0.34 NM spacing rows. Figure 4-8 illustrates that 71.5 sailboats (45 FT LOA) laid stem-to-stern could fit between adjacent WTGs along the 0.54 NM spacing rows, and 45.2 sailboats (45 FT LOA) could fit between adjacent WTGs along the 0.34 NM spacing rows.

The 0.34 NM by 0.54 NM spacing between the WTGs is far wider than the widths of existing channels in the Nantucket Sound area routinely used by commercial vessels as shown in Table 4.2. Mariners are currently able to safely navigate commercial and recreational vessels through these commonly accepted narrow corridors. Therefore, the minimum spacing of 2,066 feet would not present conditions more restrictive to navigation than presently exist in these channels. Figure 4-9 illustrates how the proposed WTG spacing is significantly wider than existing Federal Channels in the Nantucket Sound area.

Table 4.2: Comparison of Existing Channel Widths to Minimum WTG Spacing

Federal Channel	Charted Clear Width	WTG Spacing Distance
Hyannis Harbor	240 to 320 feet	2,066 feet by 3,281 feet
Nantucket Harbor	300 feet	
Hog Island Channel	500 feet	
Cleveland Ledge Channel	700 feet	
Cape Cod Canal	480 feet	

During nighttime, inclement weather, or restricted visibility conditions, the presence of the WTGs could potentially result in complications to vessel movements as well as provide assistance to vessel movements. The time of year that experiences the heaviest fog conditions in Nantucket Sound (May through June) coincides with the months when vessel traffic in the Sound is increased due to more prevalent recreational vessel traffic. It is possible that some recreational boaters may choose not to go out in the area of Horseshoe Shoal due to the combined presence of fog and the Wind Park. The presence of the WTGs would require mariners to maintain vigilant watches and control of their vessels' courses to avoid colliding with a WTG or another vessel. However, the presence of the WTGs would also provide additional points-of-reference and aids-to-navigation in the Horseshoe Shoal area as described in Section 4.6.

Fishing vessels will still be able to trawl within the Wind Park. However, their operators will have to take the presence of the WTGs into account as they steer their courses. WTGs on the east side of the Wind Park (as shown in the 2003 Navigational Risk Assessment) have been relocated to the northwest corner of the Wind Park in response to comments received from commercial fishermen who use mobile gear stating that the deep water to the east of Horseshoe Shoal is where they work most.

The Wind Park will be constructed in phases, and marine traffic will only be restricted in the immediate vicinity of ongoing construction activities (estimated to be one to two WTG locations at any one time) for protection of public safety. The remaining areas of the Wind Park will be open to unrestricted navigational access. The WTG that is closest to the Main Channel is approximately 1,190 feet from the charted Main Channel edge and approximately 6,900 feet east of the Main Channel's narrowest point. The work vessels used to construct the WTG are approximately 400 feet long. This leaves ample room for vessels to transit past any ongoing construction. These work vessels will not need to occupy or block the Main Channel during construction. Therefore, no restrictions or closures of the Main Channel to transiting vessels are anticipated. The USCG routinely deconflicts waterways and channels around marine construction activities, and it is anticipated that such procedures could be implemented in Nantucket Sound during construction of the Wind Park.

CWA has no intention or authority to prohibit vessels from entering or operating in the Wind Park area or to establish exclusionary zones in the Wind Park area. CWA believes that it is unlikely that such a prohibition will be conditioned by the USACE or USCG due the wide WTG spacing and 6 foot cable burial depth. Vessel restrictions (if any) will be determined by the USCG.

4.2 Vessel Anchoring

The area between the Main Channel and the Cape Cod shoreline, including Horseshoe Shoal, is designated as an anchorage ground, known as "Anchorage I." Vessels are allowed to anchor throughout the area. Floats or buoys for marking anchors or moorings in place are allowed, but fixed mooring piles or stakes are prohibited in this area. The 2004 WAMS report notes that "there is little or no reported commercial use of the anchorages due to the dangerous shoal water in the vicinity coupled with adequate harbors of refuge capable of accommodating most waterway users" and that "it is apparent these anchorages are disproportionate to the waterway and pose a myriad of safety issues as they relate to providing a safe, navigable waterway for the user". As a result, the WAMS report recommends that the USCG reevaluate the necessity and size of these anchorages. The proposed change in Anchorage I would result in it being partially located within the easterly portion of the Wind Park. Anchorage H would be relocated to the west of the Wind Park (see Figure 4-10).

Large vessels such as cruise ships generally do not anchor near the Wind Park location. In January 2004, Captain Larry Palmer provided the following information to CWA and ESS on the locations that cruise ships visiting Nantucket Sound use to anchor. Ships going to Oak Bluffs on Martha's Vineyard anchor at 41°28.7' N, 70°32.6' W, which is located just northeast of East Chop on Martha's Vineyard (approximately 7.0 NM west of the nearest WTG). Ships going to Edgartown on Martha's Vineyard (drafts up to 16 FT) anchor at 41°23.9' N, 70°29.3' W, which is located in the middle of Edgartown Harbor (approximately 6.9 NM southwest of the nearest WTG). Ships going to Nantucket anchor at 41°19.3' N, 70°06.2' W, which is located just north of the red and white "NB" buoy that marks the entrance to the Nantucket Harbor channel (approximately 10.5 NM southeast of the nearest WTG). Captain Palmer also noted that ships going to the Nantucket anchor position approach from, and depart to, the west.

4.2.1 Anchor Penetration

The U.S. Navy has conducted considerable research on the performance of large vessel anchor systems in various bottom type conditions. As part of this research, the Navy has developed estimates of maximum fluke-tip penetration for various anchor types and bottom conditions. Anchor penetration is dependent on the type of anchor, the anchor weight, and the bottom type. Based on their research, the Navy has established fluke-tip penetration depth estimates of all anchor types studied that are equal to the fluke length in sands and stiff clays. In muds, such as soft silts and clays, Stockless anchors are estimated to penetrate to a depth equal to three (3) times the fluke length, and Danforth anchor fluke-tips are estimated to penetrate to a depth equal to 4.5 times the fluke length (NAVFAC, 1985).

In sands and stiff clays, the crown of a Navy Stockless anchor rests on the bottom rather than burying itself as the anchor sets (NFESC, 2002). Since the crown of Navy Stockless anchors usually rest on the bottom in sands and stiff clays, the fluke-tip penetration is a function of both the fluke angle and fluke length, and is determined by the following formula:

*Fluke-tip penetration = Fluke length * sine (fluke angle)*

The Navy estimates by themselves provide a basis for making initial estimates of anchor penetration. However, to better estimate anchor penetration in a specific area, local sediment characteristics must also be considered.

ESS estimated anchor penetration in the Wind Park area for the vessels that will install the inner array and submarine cable interconnections. These vessels typically use 10,000 pound Danforth anchors with 7.2 FT long flukes, which are larger than those used by the vessel types that are capable of operating on Horseshoe Shoal given the existing depth restrictions. Using Navy guidance documents on anchor behavior and site-specific surface and subsurface sediment conditions, ESS estimated the maximum fluke tip penetration for the 10,000 pound Danforth anchor to be approximately 4 FT in and around the Wind Park. This is 2 FT less than the minimum 6 FT burial depth proposed for the inner array cables and submarine cable interconnection.

The SSA's M/V *Eagle* has two 2,000 pound Stockless anchors with 34-inch-long flukes onboard (SSA, May 2003). Using US Navy guidance documents on anchor behavior and site-specific surface and subsurface sediment conditions, ESS estimated the maximum fluke tip penetration for the *Eagle*'s anchor to be approximately 3 FT in and around the Wind Park. This is 3 FT less than the minimum 6 FT burial depth proposed for the inner array cables and submarine cable interconnection.

The SSA's M/V *Nantucket* and M/V *Martha's Vineyard* each have two 2,000-pound Danforth anchors with 52-inch-long flukes onboard (SSA, May 2003). Using Navy guidance documents on anchor behavior, ESS estimated the maximum fluke tip penetration for these anchors to be approximately 4.5 FT in and around the Wind Park. This is 1.5 FT less than the minimum 6 FT burial depth proposed for the inner array cables and submarine cable interconnection.

Since large vessel operations in the Wind Park are naturally restricted by existing water depths, it is unlikely that anchors larger than those on the installation vessel will be used in the Wind Park area.

The ability of smaller vessels to anchor within the Wind Park area will remain unchanged. Smaller vessels typically have smaller anchors that result in shallower fluke-tip penetration than large anchors. Therefore, anchors from smaller vessels will not penetrate to depths close to the cable burial depths. Mariners setting anchors within the Wind Park will need to take into account their position relative the WTGs and the cables; their desired anchor scope; current and anticipated wind, wave, and tidal current conditions; potential for anchor drag; and the boat's swing radius when determining appropriate locations to set anchor when in or around the Wind Park as any prudent mariner would in the vicinity of any structures.

CWA has no intention or authority to prohibit vessels from anchoring within the Wind Park area. Vessel restrictions (if any) will be determined by the USCG. CWA will request that the Project's cables (including all inner array cables) be marked on the nautical charts for the area by NOAA. Mariners will have the ability to anchor anywhere within the Wind Park, but as with any other location, mariners are advised not to anchor over cables. Prudent mariners will not anchor over the cables.

Therefore, based on the estimated maximum fluke tip penetration for anchors likely to be used in the Wind Park area, the proposed cable burial depth, and the continued ability for vessels to anchor in and around the Wind Park; vessel anchoring within the Wind Park will not be affected by the presence of the cables.

4.3 Risk of Collision

4.3.1 WTG Size and Spacing

The risk of a vessel colliding with a WTG is low given the Wind Park's location away from typical vessel routes, the small diameter of the towers (approximately 16 to 18 FT), and the large spacing between the WTGs (minimum of 0.34 NM by 0.54 NM). Figure 4-11 illustrates the large WTG spacing compared to the size of the WTGs in three dimensions. Sufficient watersheet will exist between each WTG to allow vessels to navigate safely through the Wind Park. Three 45 FT LOA sailboats are shown to scale in Figure 4-11 to further illustrate this point. The presence of the WTGs in Nantucket Sound would likely reduce vessel-on-vessel collisions by serving as a navigational point of reference. Commercial vessels (fishing vessels are not considered commercial vessels under the USCG definition) will likely not transit through the Wind Park given the existing natural draft limitations on Horseshoe Shoal and the presence of the charted channels around Horseshoe Shoal.

The small diameter of the WTGs will prevent all but the smallest vessels (those with LOA of 16 to 18 FT) from being shielded from view of another vessel by a WTG. ESS calculated the amount of time a 16 FT LOA vessel would be shielded from view as it travels behind a WTG. To be conservative, ESS assumed that the vessel must completely pass behind the WTG such that its stern is visible (i.e., the vessel must travel 32 FT). At a speed of 1 knot, it will take approximately 19 seconds for the vessel to be totally visible. At a speed of 5 knots, it will take approximately 4 seconds for the vessel to be totally visible. If the vessel is traveling at a speed of 19 knots or greater, the vessel will be totally visible in 1 second or less.

For collision between two vessels to be avoided, the mariners on each vessel must perceive that there may be a risk of collision, make a decision about the appropriate response, and make the response. The time it takes for a human to work through this process is known as perception-reaction time. This is the same process that automobile drivers go through on roadways. The American Association of State Highway and Transportation Officials (AASHTO) has set design standards for roadways based on a perception-reaction time of 2.5 seconds, which was derived from human factors research on driver response times to anticipated braking (ITE, 1992). This same perception-reaction time can easily be applied to mariners in a crossing situation since the same decision-making process is involved.

As an example, assume two power vessels moving at a constant speed of 10 knots are in a crossing situation with the vessel passing behind the WTG in the "stand-on" vessel position (i.e., approaching from the other vessel's starboard side). In the 2.5 seconds required for perception-reaction time for the "give-way" vessel, each vessel will travel 42.3 FT, which provides the "give-way" vessel with sufficient time to recognize the approaching vessel and take action to avoid collision, unless both vessels are traveling extremely close to the WTG (which is not safe at that speed) or very close to each other. This same concept applies to larger commercial vessels; however, the time required for the vessel to react to the avoidance maneuver will likely be increased due to the vessel's size.

When the WTG blade is in its lowest position, it will be approximately 72 FT above Mean High Water (MHW), and approximately 23 FT from the WTG tower. Therefore, vessels with mast or structure heights less than 72 FT will pass under the WTG blade should they get within 23 FT of the WTG (see Figure 4-12). Figure 4-13 illustrates a 45 FT LOA sailboat next to a WTG. At MHW, the sailboat's mast is 16.4 FT below the WTG blade's lowest point of rotation. Figure 4-12 also illustrates the M/V *Eagle* next to a WTG. At MHW, the *Eagle*'s highest point (its stern navigation light pole, which is located along the vessel's centerline) is 3.6 FT below the WTG blade's lowest point of rotation. Under normal operating conditions, such vessels should not be so close to a WTG that it is located directly under the blade (i.e., within 23 FT of the WTG). If a vessel with a mast or structure height of 72 FT or higher is in distress and drifting towards a WTG, the WTGs in the path of the vessel can be remotely shut down by CWA upon receipt of a request to do so by the USCG. After initiating WTG shutdown, it takes approximately one (1) to two (2) minutes for the rotor to come to a complete stop. Shutting down the WTG prior to the distressed vessel coming close to a WTG will eliminate the potential of the vessel being struck by the rotating blade.

4.3.2 Navigation Rules

A vessel's risk of collision with a WTG can be further minimized by adhering to the COLREGS (the basis for the USCG Navigation Rules), which provide specific guidance on safe vessel operation and avoiding collisions as described below. While marine casualties have and may continue to occur in spite of the safeguards afforded by the COLREGS, the proper use and application of these safeguards provides a means of reducing the potential for vessels to collide with a WTG or another vessel while underway.

- Rule 5, "Lookout" states that "Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision."
- Rule 6 states in part that "every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid a collision and be stopped within a distance appropriate to the prevailing circumstances and conditions." The proximity of other vessels, structures, as well as other factors must be taken into account when determining a safe speed. Therefore, vessels within and around the Wind Park must operate at speeds that allow the vessel to stop or avoid collision with another vessel or a WTG.
- Rule 7a states "every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist." The vessel is therefore required to continually assess the potential for collision with another vessel or a WTG while navigating in the Wind Park.
- Rule 8e requires that if more time is necessary to assess the situation or avoid collision, a vessel shall slow down or stop. As with Rule 7a, the vessel is therefore required to continually assess the potential for collision with another vessel or a WTG while navigating in the Wind Park.

- Rule 8a states "any action to avoid a collision shall, if the circumstances of the case admit, be positive, made in ample time, and with due regard to the observance of good seamanship." The vessel is required to take appropriate action to prevent collision with another vessel or a WTG.
- Rule 19b states that every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. Even in daylight with clear weather, the presence of the WTGs will present a momentary condition of restricted visibility by shielding small vessels as described in Section 4.3.1. Under this rule, the vessels must take the presence of the WTGs into account as a momentary restricted visibility condition, and must adjust the vessel's safe speed and distance from the WTG accordingly.

These rules make it very clear that properly assessing the potential risk of collision, operating at safe speeds, and taking necessary action to avoid collision is the responsibility of the vessel's captain. The mariner must remain cognizant of the presence of the WTGs, and adjust operation of his or her vessel accordingly to be in compliance with the COLREGS.

The COLREGS, therefore, assist in minimizing the potential risk of collisions with a WTG.

4.3.3 Vessel Impact Assessment

While the location of the Wind Park relative to established vessel routes, physical water depth restrictions on Horseshoe Shoal, and the large WTG grid spacing combine to limit the potential for a vessel to collide with a WTG, CWA has analyzed the possibility for damage to a WTG in the unlikely event of a vessel-WTG collision. The analysis was prepared using available preliminary design data for the WTG. The results will be refined during final design of the WTGs, but the vessel impact guidelines described in the analysis will be maintained.

The 2003 Navigational Risk Assessment contained a Ship Impact Analysis prepared by General Electric (GE). That analysis utilized a three (3) degree of freedom dynamic impact analysis computer program that solves Newton's Second Law (i.e., Force equals Mass times Acceleration) over time. As part of its comments on the DEIS, the USCG requested that the Ship Impact Analysis be revised to include the T/V *Great Gull* and the M/V *Clipper Adventurer*. The revised GE Ship Impact Analysis includes these vessels, updates the 2003 analysis results, and brings them in line with American Petroleum Institute (API) recommended practices. A summary of the methods and results of the revised analysis are presented in this Section. The revised Ship Impact Analysis report prepared by GE is provided in Attachment B.

The largest potential for vessel impacts with a WTG occurs during construction. During this process, large installation and support vessels are moored very close to WTGs. The potential for vessel impacts from normal vessel traffic passing in and around the Wind Park is low as described in other Sections of this Navigational Risk Assessment. However, the potential for impacts from stray or drifting vessels is somewhat higher because the vessel's Captain often does not have the ability to maneuver the ship away from the WTG (because of malfunctions or other human factors).

Vessel impacts with WTGs can be divided into three scenarios:

1. Impact from a drifting vessel;
2. Impact from a cruising vessel; and
3. Impact from vessels moored to the WTG.

A vessel impact with a WTG includes the following basic mechanics. The vessel moves toward the WTG at a given speed and impacts the WTG tower or its foundation. The impact then causes the vessel to change speed and direction. As the impact occurs, some amount of the vessel's kinetic energy is converted into strain energy in both the vessel and the WTG as the vessel and the WTG absorb the vessel's kinetic energy. The strain energy results in damage such as displacements, indentations, cracking, or fracture of the vessel, the WTG, or both, as well as deformation of the soil around the WTG. The weight and speed of the impacting vessel, the alignment of the impact, the impacting vessel's stiffness, the relative dimensions of the vessel and the WTG (particularly at the point of impact), and the interaction between the WTG pile and the surrounding soil are critical factors in assessing damage from vessel impact. (GE, 2003; GE, 2006; and LIC, 1999)

A vessel impact is considered to have "dangerous" structural consequences if major structural damage, such as the WTG collapsing or the vessel taking on water or sinking, occurs as a result. Damage such as sub-critical denting of the vessel or WTG and damage to the WTG access platform is considered not to have "dangerous" structural consequences. Major structural damage to the WTG due to cross-sectional yielding is considered in terms of a "utilization factor", which is the maximum overturning moment on the WTG at the critical cross-section due to impact normalized by the maximum sustainable moment capacity (collapse load). When the utilization factor is equal to 1.0, the WTG is considered to have fully yielded (i.e., failed structurally). A utilization factor less than 1.0 means the impact did not result in a full yielding of the WTG's cross-section.

The vessel impact analysis for the Wind Park used vessel characteristics for vessels that frequent Nantucket Sound. Impact analyses were performed for these vessels for the three impact scenarios described above. Table 4.3 summarizes the vessel types and impact scenarios analyzed.

Table 4.3: Vessel Impact Analysis Scenarios

Vessel Type	Section 3.1 Type	Dead Weight Tonnage (Metric Tons)	LOA (FT)	Beam (FT)	Impact Scenario and Impact Speed
Passenger Ferry	Type B2	1,500	233	61	• Drifting at 3 knots. • Cruising at 12 knots.
Barge	Type C2	1,200	150	60	• Drifting at 3 knots. • Cruising at 12 knots.
Fishing Vessel	Type E3	300	90	30	• Drifting at 3 knots. • Cruising at 12 knots.
Yacht	Type F3	20	46	14	• Drifting at 3 knots. • Cruising at 15 knots.
Work Vessel	N/A	75	60	28	• Drifting at 3 knots. • Cruising at 3 knots.
T/V *Great Gull*	Type C3	3,800	276	55	• Drifting at 3 knots. • Cruising at 12 knots.
M/V *Clipper Adventurer*	Type A2	1,465	330	54	• Drifting at 3 knots. • Cruising at 12 knots.

*A metric ton is approximately 2,200 pounds

4.3.3.1 Comparison of 2003 and Revised Analysis Methods

The revised Ship Impact Analysis (GE, 2006) updates the 2003 analysis results and brings them in line with API Recommended Practice 2A-WSD Section C18.9.2. The use of the more conservative API analysis method is now required to meet Minerals Management Service design requirements and to include the use of sediment information that is now available for the WTG locations. The revised analysis uses an elasto-plastic finite element model of the tower-monopile-sediment configuration with the maximum impact load computed from the kinetic energy of the impacting vessel to analyze the impact. This section provides a comparison between the methods used in the 2003 and revised analyses.

In the 2003 analysis, the NORSOK Standards N-004 guidelines on “Accidental Limit State” and “Force Indentation Curve”, which assume that a portion of the kinetic energy of the impact goes into plastic deformation of the impact vessel, were used. The revised analysis uses an API force indentation model that assumes that the entire energy of the impact is transferred to the WTG. In a real-life impact, a portion of the kinetic energy is likely to be consumed in the plastic deformation and resulting damage to the impacting vessel itself. Therefore, the results presented in the following sections should be interpreted as an upper bound on the damage to the WTG pile.

In the 2003 analysis, the “Force Indentation” curve was specific to each collision event. The revised analysis assumes a universal indentation model as recommended in API 2A-WSD Section C18.9.2. This provides a more conservative method for modeling the impact event than was used in the 2003 analysis since assumptions for each vessel impact are uncertain.

In the 2003 analysis, a torsional linear foundation spring was used to model the interaction between the WTG and surrounding sediments. The revised analysis models the WTG pile-sediment response in the finite element model through the Winkler p-y spring model with representative parameters derived from site-specific geotechnical borings for the Wind Park. This results in a better resolution of the monopile deformation below the mud line wherein the maximum bending moments due to impact arise.

The revised analysis models the WTG pile cross-section as an elastic-perfectly plastic material, which limits the maximum WTG indentation load experienced prior to full collapse of the WTG pile. As a result, the estimates of maximum WTG indentation loads are more realistic than those in the 2003 analysis.

In summary, the revised analysis provides inherently conservative results. Since the analysis does not take into account the transfer of kinetic energy to the impacting vessel, it may overestimate the threshold for vessel impacts that could result in collapse of the WTG. Therefore, the results reported in the revised analysis provide an upper bound estimate for the utilization factor.

4.3.3.2 Revised Analysis Methods

The modeling of the various ship impact scenarios in the revised analysis required the following steps:

1. Using API 2A-WSD Section 18.9.2, a universal ship impact load-pile indentation model was created to model the impact loads on the WTG monopile foundation.
2. For each vessel analyzed, impact load-indentation curves were obtained for both broadside (drifting speed) and head-on (cruising speed) impact scenarios. These curves incorporated the use of added mass factors to account for the added weight of water that will move with the impacting vessel as it impacts the WTG.
3. The impact of the vessel with the WTG was modeled with commercially available finite element software (ANSYS) using a non-linear spring as the contact element between the vessel and the WTG monopile. The point of impact on the WTG monopile was assumed to be 13.1 FT above mean sea level as was done in the 2003 analysis.
4. Using the results of the 2002 Cape Wind Geotechnical Survey report and the conceptual design of the WTG monopile, the sediment-structure interaction was modeled using a Winkler p-y spring model as required by API 2A-WSD Section 6.3.3.
5. The ANSYS software was used to develop an elasto-plastic beam and shell model of the WTG. This model was used to determine the stress distribution in the WTG monopile.
6. The effect of the modeled ship impact scenarios was evaluated using the utilization factor.

4.3.3.3 Drifting Vessel Impact

A drifting vessel will drift with the wind and the current since the vessel is not under propulsion. When analyzing drifting vessel impact, it is customary to use the 50 year return maximum tidal current speed in the area of interest. WHG (2003) estimated the maximum tidal current at Horseshoe Shoal to be 2.85 FT/sec (1.7 knots), and the 50-year return wind-generated current to be between 4.5 and 5.5 FT/sec (2.7 to 3.3 knots). In the GE vessel impact analysis, a drifting vessel speed of 3 knots (5.1 FT/sec) was used.

Results of the revised ship impact analysis for drifting vessels are shown in Table 4.4.

Table 4.4: Drifting Vessel Impact Calculation Results

Vessel Type	Nature of Collision	Peak Impact Force (Tons)	Utilization Factor
Passenger Ferry	Broadside	1,439	0.61
Barge	Broadside	1,338	0.56
Fishing Vessel	Broadside	843	0.36
Yacht	Broadside	337	0.16
Work Vessel	Broadside	528	0.23
T/V *Great Gull*	Broadside	1,956	0.82
M/V *Clipper Adventurer*	Broadside	1,428	0.60

The results indicate that a WTG as proposed for the Wind Park can withstand the drifting (broadside) impact of each of the analyzed vessels. Drifting impact of a vessel of similar size to the T/V *Great Gull* could result in more significant damage to the WTG than the other vessels analyzed, but would not result in WTG collapse.

As stated above, the revised analysis conservatively assumed that all of the impact force was absorbed by the WTG. It is likely the impacting vessel would experience damage that deflects portions of the ship's structure (and thus absorbs a portion of the impact force) before coming to a complete stop or being deflected in another direction. As a result, the peak impact force and utilization factor values provided in Table 4.4 are conservative.

The USCG requirement for the use of double-hulled barges will minimize the potential for barge leakage in the very unlikely event of a barge puncture.

In summary, it can be concluded that a drifting vessel of the size that frequents the Wind Park area would not result in collapse of a WTG after impact.

4.3.3.4 Cruising Vessel Impact

A vessel that impacts a WTG while underway will do so at its cruising speed at the time the impact occurs. In the GE vessel impact analysis, the vessels were assumed to be cruising at a speed of 12 knots, with the exception of the yacht which was assumed to be cruising at a speed of 15 knots. Since the work vessels would only be operating in the Wind Park area during construction and would be moving at a low cruising speed during these operations, the work vessel was assumed to be cruising at a speed of 3 knots.

Results of the revised ship impact analysis for cruising vessels are shown in Table 4.5.

Table 4.5: Cruising Vessel Impact Calculation Results

Vessel Type	Nature of Collision	Peak Impact Force (Tons)	Utilization Factor
Passenger Ferry	Head-on	3,338	1.39
Barge	Head-on	3,102	1.29
Fishing Vessel	Head-on	1,956	0.82
Yacht	Head-on	922	0.39
Work Vessel	Head-on	483	0.22
T/V *Great Gull*	Head-on	4,552	1.89
M/V *Clipper Adventurer*	Head-on	3,316	1.38

The results indicate that a WTG as proposed for the Wind Park can withstand the cruising (head-on) impact of a yacht, a 300 metric ton fishing vessel, or a work vessel used during Wind Park installation. The impact of a 1,500 metric ton passenger ferry, a 1,200 metric ton barge, the T/V *Great Gull*, or the M/V *Clipper Adventurer* would possibly result in tubular collapse of the WTG pile below the mudline, which would result in the overall collapse of the WTG. As stated above, the analysis method used assumes a direct impact in which all of the kinetic energy of the impact is transferred to the WTG pile rather than being divided between the WTG and the impacting vessel. Therefore, the utilization factor results are very conservative, and collapse of the WTG may not occur in the event of an actual collision. According to GE, 2006, the point of yielding below the mudline would be on the opposite side of the monopile from the point of impact.

GE also analyzed the potential for the nacelle to detach from the WTG monopile if the WTG were to collapse as a result of a vessel impact. The nacelle is attached to the monopile via bolted connections on three flanges. Based on an impact load of 2,360 tons, which leads to a utilization factor of 1.0, the bolt in the three flanges would not undergo catastrophic shear failure. Therefore, the nacelle would remain attached to the tower during the collapse.

As described in Section 3.2.1.2, SSA vessels such as the M/V *Eagle* do not travel over Horseshoe Shoal and their typical route between Hyannis and Nantucket is approximately 1.6 NM away from the nearest WTG. Thus, the likelihood of a cruising passenger ferry impacting a WTG is very low.

In summary, it can be conservatively concluded that the impact of a moving vessel, including and larger than the size of a 1,200 metric ton barge, with a WTG could possibly result in collapse of a WTG after impact. It is likely the impacting vessel would experience damage and persons onboard could sustain some form of injury.

4.3.3.5 Moored Vessel Impact

The moored vessel impact analysis was not updated in the 2006 revised analysis. The results presented below reflect the results of the 2003 GE analysis.

Since work vessels used during installation will be moored on or adjacent to the WTGs, the potential for the moored vessel impacting the WTG exists. In the GE vessel impact analysis, a 60 FT LOA, 75 metric ton work vessel was analyzed. Since landings and fixtures on the WTG and fenders on the vessel and/or WTG absorb impact energy, they were not included in the analysis to provide conservative results.

A moored vessel impact with a WTG includes the following basic mechanics. A force that affects the moored vessel is developed by hydrodynamic pressure differential and wave kinetic energy, which oscillate following the wave length and frequency. The developed force accelerates the moored vessel into movement (i.e., the vessel acquires kinetic energy) (GE, 2003). The vessel then impacts the WTG and the impact mechanics described in Section 4.3.3 occur.

The GE analysis used linear wave theory to evaluate the impact forces from a moored vessel at a WTG in the shallow portions of the Wind Park (depth of 14.8 FT), since the wave forces will be at a maximum in such a location. The analysis used a significant wave height[5] of 5.9 FT and conservatively assumed that the full wave force acts throughout the entire wave period. These conservative assumptions resulted in a calculated vessel impact speed of 31 knots, which is very high.

The resulting maximum utilization factor is 0.28, which is significantly less than the WTG's yield onset value of 0.75, meaning that little or no damage to the WTG will result.

In summary, it can be concluded that a moored vessel of the size to be used for construction of the Wind Park would not result in damage or collapse of a WTG after impact.

4.3.3.6 Summary of Results

The methods and assumptions used for the revised ship impact analysis are inherently conservative. Consequently, the results are inherently conservative. The potential for a vessel collision with a WTG to result in damage or collapse of the WTG depends on the vessel's size and speed at impact. A drifting vessel of the size that frequents the Wind Park area or a moored vessel of the size to be used for construction of the Wind Park would not likely result in collapse of a WTG after impact. It is possible that a collision of a cruising vessel the size of the M/V *Eagle* or larger with a WTG could result in collapse of the WTG. In the event that an impact resulted in collapse of the WTG, the nacelle would remain attached to the tower during the collapse. It should be assumed that a collision of a large vessel with a WTG would

[5] Significant wave height is defined as the average height of the one-third highest waves of a given wave group.

likely result in some form of damage to the impacting vessel and some form of injury to persons onboard.

4.4 Ice Events and Build-up

There do not appear to be historical records on the frequency of sea ice events in Nantucket Sound. The National Weather Service in Taunton, Massachusetts stated they do not keep sea ice records, and are not aware of other agencies that maintain such records for Nantucket Sound (NWS, 2003). The *Coast Pilot* makes one passing reference to ice in Nantucket Sound when it mentions that northerly winds keep the north shore of the Sound free from drift ice (NOAA, 2004), which further suggests that sea ice events in Nantucket Sound do not occur with any regular frequency. Anecdotal evidence suggests that large-scale sea ice events have occurred less frequently in Nantucket Sound during the past decade; however, sea ice was common in Nantucket Sound during the winters of 2002-2003 and 2003-2004.

During the winter of 2003-2004, an extensive sea ice event occurred in Nantucket Sound. While the majority of the icing took place in and around Hyannis Harbor and Nantucket Harbor, ice was reported throughout most of Nantucket Sound during the event (Blount, 2005). According to USCG records of the ice event provided to ESS by the USCG, fast ice was present in Hyannis Harbor, the Nantucket Harbor entrance channel, and in Nantucket Harbor between January 16, 2004 and February 17, 2004. The heaviest icing took place in the harbors between January 26, 2004 and February 3, 2004. During this period, ice thicknesses were approximately 12 inches in Hyannis Harbor, 18 inches in Nantucket Harbor, and 30 to 48 inches in the entrance channel to Nantucket Harbor. The exact extent and location of sea ice in Nantucket Sound during that time was not recorded. However, ESS has been told that there was a period of about one week during the ice event when most of the Sound, including the Main Channel, was affected by ice (Blount, 2005). Both commercial and USCG ice breakers were used during this time to escort vessels (including ferries and fuel barges) in and out of the harbors, and in some cases, across Nantucket Sound. Wave measurements at the SMDS were significantly affected by floating ice between mid-January and mid-February 2004 (WHG, 2004). This would indicate that the ice extended to the north of the Main Channel as least far as the location of the SMDS.

Figure 4-14 shows the extent of the sea ice in Nantucket Sound on February 14, 2003 as observed by ESS personnel. Using NOAA's *Observer's Guide to Sea Ice*, ESS estimated the sea ice's characteristics as being a "belt" of "close pack, young (6-12 inch thick) pancake" sea ice. Figure 4-15 shows CWA's SMDS at the Wind Park site on February 14, 2003. Note that the ice is "open drift grease (a thin, soapy-looking surface layer of coagulated frazil ice) ice" at this location in the Sound. By February 24, 2003, the amount of sea ice in Nantucket Sound was observed by ESS personnel to have decreased significantly.

Figure 4-16 illustrates a WTG located in Sweden that is surrounded by sea ice. Using NOAA's *Observer's Guide to Sea Ice*, ESS estimates the sea ice's characteristics as being a "strip" (less than 1 kilometer wide) of "close pack, gray-white young (approximately 4 to 12 inches thick) ice". In the photo it is evident, from the breaks in the ice, that the ice has flowed around the WTG rather than rafting up on it.

As described previously, the WTGs will be constructed in a grid pattern with a minimum spacing of 0.34 NM by 0.54 NM. This large spacing between WTGs, combined with the natural tidal circulation in Nantucket Sound, will prevent rafting of ice between WTGs. Localized rafting of sea ice around individual WTGs may occur if weather conditions permit. However, such events are expected to be infrequent.

The WTG monopiles will be constructed of two (2) inch thick steel, and will be designed to withstand the forces of up to six (6) inch thick ice floes impacting the monopile. Given the currents and wave conditions in the area of the Wind Park, ice floes thicker than six (6) inches are not expected in the area of the WTGs. Ice floes that do occur in the area of the WTGs will likely break apart and flow around the WTGs as shown in Figure 4-16. Damage to the monopiles that could result from impact of ice floes would likely be superficial in nature (e.g., scratching or removal of corrosion protection coatings). Accessory components that will be attached to the monopile at the water level, such as the J-tube that contains the electric cable, ladders, and fenders, could sustain more significant damage from ice floe impact.

Although rotor blades will have a slick surface for aerodynamic efficiency, which will allow most ice to slide off prior to any significant buildup, ice may collect on the WTG structure and blades under certain meteorological conditions (i.e., a combination of high relative humidity, freezing temperatures, and overcast or nighttime sky). This ice usually takes the form of a thin sheet as it attaches to wind turbines (similar to how ice attaches to an airplane's wings during flight). Temporary icing of a rotor blade would activate vibration sensors causing turbine shutdown in order to prevent rotor damage or hazard to Project maintenance staff or others from falling ice. Conditions conducive to icing will be evaluated by continuous monitoring of meteorological conditions and by monitoring the WTGs remotely (via camera). If conditions warrant, manual shutdown of the WTG(s) experiencing icing conditions will be initiated. The ice will remain attached until meteorological conditions allow it to melt. If the WTG is no longer operating due to icing, the melting ice will break apart into fragments in the same manner as ice falls off buildings, trees, and power lines, and will fall down to the water surface under the WTG. If the WTG is operating, it is possible that the ice sheet attached to the WTG blade could be thrown from the blade as it rotates. However, as the ice sheet pieces are thrown from the blade, wind resistance will work to break them into much smaller fragments as they fall.

The risk of ice fragments being thrown from a turning rotor and causing injury is relatively small when the following points are considered:

- Icing can only occur during the winter months when navigational activity within the Wind Park is reduced to few vessels other than Project maintenance vessels.
- Specific meteorological conditions must exist simultaneously for icing conditions to occur and these conditions only occur periodically during the course of a winter.

- Mechanisms are in place for automatic or manual shutdown of turbines during icing events or when meteorological conditions suggest icing is likely.
- The most frequent navigation taking place during the winter months (i.e., ferry traffic and commercial vessels) occurs in the Main Channel and along the Steamship Authority's SSA's route to the east of Horseshoe Shoal. The Main Channel is located approximately 1,200 feet from the nearest WTG. The distance between the SSA's base courses and the WTG nearest to each base course is as follows:
  - Hyannis to Nantucket – Approximately 9,730 feet
  - Woods Hole to Nantucket (through Main Channel) – Approximately 3,130 feet
  - Hyannis to Woods Hole (through North Channel) – Approximately 2,580 feet

  It is unlikely that the falling fragments of sheet ice will travel such distances before reaching the water surface.

4.5 Seabed Conditions

Seabed elevations in the vicinity of the WTGs and cables would be modified slightly as a result of sediment displacement. Changes in seabed elevation around each WTG would be limited to localized scour around each WTG. In the DEIR/DEIS, the maximum estimated scour distance from a WTG was described as being approximately 60 feet (18.3 meters) (2.9% of the minimum distance between WTGs), with an associated estimated scour depth of approximately 8 feet (2.4 meters). The Scour Analysis report prepared by ESS in January 2003 (Appendix 4.0-A of the DEIR/DEIS) has been revised by making use of additional hydrographic survey information, sediment bulk physical analysis results, and estimates of wave and current conditions in Nantucket Sound obtained after publication of the original report, and by incorporating revisions to the layout of the Wind Park. The 2006 Scour Analysis report (ESS, 2006) estimates that the maximum scour distance from a WTG is approximately 94 feet (28.7 meters) (4.6% of the minimum distance between WTGs), with an associated estimated scour depth of approximately 14.7 feet (4.5 meters). Even though the scour around each WTG would be minimal and localized, scour mitigation measures would be implemented. CWA will employ either Seabed Scour Control Mats or rock armor for scour protection. The selection of the scour protection type to be employed will be made during the final design process, and will be based on local conditions expected at each WTG. It is possible that both methods will be used in the Wind Park. The limited scour expected, the use of scour protection measures, and the deep embedment depth of the WTG monopile will prevent changes in seabed conditions from affecting the stability of the WTGs.

Concern has been raised about the potential effects of the array of WTG monopiles on currents and waves and ultimately on sediment transport on Horseshoe Shoal and Nantucket Sound. This area experiences active sediment transport based both on the presence of coarse grain sediments found and the presence of bedforms such as sand waves on portions of Horseshoe Shoal. In response to comments received on the DEIR/DEIS, CWA contracted with ASA to perform evaluations to determine the potential zone of influence of the WTG piles (ASA, 2005). ASA assessed the zone of influence of a single pile and then used this information to evaluate the potential interaction of multiple piles to determine the cumulative zone of influence. The zone of influence of the WTG pile on wave and current conditions are estimated to be limited to an area of 5 pile diameters long (87 feet) by 2 piles diameters wide (35 feet) at most. In reality, only a very small portion of this area will be really affected since the effects dissipate rapidly away from the WTG pile, thus effects on sediment transport will be limited to the zone of influence. In addition, the large spacing between the WTGs and the small WTG pile diameter will prevent the effects of each WTG pile on wave and current conditions from affecting adjacent piles. Therefore, the WTGs will not act as a pile group.

The limited predicted scour extent and limited zone of influence of each pile are both substantially less than the separation of the WTGs from the Main Channel and the SSA ferry routes. Therefore, changes to bottom contours in the Main Channel or along the SSA ferry routes resulting from the presence of the WTGs are not expected to occur.

4.6 Proposed Aids-to-Navigation

Each WTG will essentially serve as an aid-to-navigation (ATON) simply by its presence in Nantucket Sound. CWA will request that each of the WTGs and cables be marked individually on NOAA navigation charts so they may serve as points of reference for mariners navigating in and around Horseshoe Shoal. Each WTG will be clearly marked with an alphanumeric designation that will also assist mariners in determining their position within the Wind Park. During clear conditions, when visual sight navigation would be appropriate, the presence of the WTGs will assist mariners in navigating by sight in and around the Wind Park.

In addition, CWA has committed to providing private ATONs within the Wind Park to assist mariners when navigating in and around the Wind Park. These private ATONs will add to the existing network of USCG-maintained ATONs, and will provide more navigational references for mariners. CWA will receive a Permit to Establish and Operate a Fixed Aid-to-Navigation pursuant to 33 CFR 66.0 prior to constructing the ATONs.

Based on USCG requirements for ATONs on fixed structures (33 CFR 66) and pre-application consultations with USCG First District staff, the following measures are proposed to aid navigation by mariners:

- The location of the Wind Park will be published in the Notice to Mariners and noted on all applicable NOAA navigation charts. The size and steel composition of the turbine structures will make them clearly visible to radar during poor visibility conditions (refer to Section 6.2 for more detail).
- A USCG-approved lighting scheme is proposed to ensure safe passage in proximity to the turbine array. The following preliminary lighting scheme is proposed to ensure safe passage in proximity to the Wind Park:
    - Two flashing amber ATON lights, each with 360° lens, will be installed on opposite sides of each WTG tower.
    - Lights will be strobe or LED bulbs, where possible, (as opposed to incandescent bulbs) and will flash at a rate of 20 flashes per minute.
    - WTGs located on the outer perimeter of the Wind Park and the Electrical Service Platform (ESP) will be equipped with ATON lights of intensity visible to approximately 2 NM.

- o WTGs located within the perimeter of the Wind Park will be equipped with ATON lights of lower intensity, visible between approximately 0.25 and 0.5 NM. This lower intensity lighting is adequate to allow a vessel within the Wind Park to navigate from WTG to WTG, a maximum distance of 0.54 NM.
- o Lights will be installed on the WTG access platform at a height of approximately 35 FT above the MHW elevation.

- Sound signals that are audible to 0.5 NM will be installed on the four WTGs located at the corners of the Wind Park array to assist mariners navigating in fog conditions. These will be controlled by fog sensors and only operational during periods of poor visibility.

In addition to the proposed private ATONs, each WTG will be equipped with lighting that meets FAA standards for aircraft avoidance. These lights may provide another point of reference for mariners. Based on FAA requirements for lighting WTGs, and pre-application consultations with FAA staff, the following measures are proposed to aid navigation for aircraft.

- Two flashing red FAA L-810 low intensity lights will be installed on the top of each WTG within the perimeter of the Wind Park, and on every other WTG located on the outer perimeter of the Wind Park.
- Two flashing dual white/red FAA L-864/L-865 medium intensity lights will be installed on the top of every other WTG located on the outer perimeter of the Wind Park.

However, the FAA has adopted new national guidelines for the lighting of wind turbine arrays that will result in a substantial reduction in the number and types of FAA lights required for pilot safety. CWA has consulted with the FAA, and expects to propose changes to the FAA lighting that will be in accordance with the new FAA guidelines.

Figure 4-17 illustrates the preliminary ATON lighting and sound scheme in the Wind Park.

4.7 Nautical Charts

Once constructed, the Wind Park and associated submarine cables will be shown on the NOAA nautical charts covering the area. NOAA nautical charts that would be revised to show the Wind Park would include:

- No. 13229: South Coast of Cape Cod and Buzzards Bay
- No. 13233: Martha's Vineyard
- No. 13237: Nantucket Sound and Approaches
- No. 13241: Nantucket Island
- No. 13246: Cape Cod Bay

In October 2005, CWA met with representatives of USCG MSO Providence, USCG First District Aids to Navigation Branch, and NOAA's Northeast Region to discuss potential methods for illustrating the Wind Park on the NOAA nautical charts. NOAA's Northeast Region Navigation Manager also solicited input from NOAA's Marine Chart Division prior to and after this meeting. The outcome of this meeting was a list of items that would ideally be shown on the revised nautical charts to depict the Wind Park. These items included:

- Charting the location of each WTG individually with a notation for each WTG's alphanumeric designation. The symbol used for the WTGs would either be a black square or a black circle. The choice of symbol used would be made by NOAA's Marine Charting Division.
- Charting the Wind Park as a "Cable Area" rather than illustrating the routes of all the inner array cables.
- Charting the submarine cable to the shore using the standard submarine cable symbol.
- Including a note describing the location of the Wind Park, the WTG spacing, and contact information.
- Potentially including a more detailed inset on the charts that illustrates the Wind Park (including location of inner array cables) and the characteristics of the private aids-to-navigation ATONs that would be established on each WTG.

NOAA prepared examples of potential charting options based on the list of items described above for discussion purposes. NOAA and the USCG presented the charting options to both the Rhode Island and Southeast Massachusetts Port Safety and Security Forums in November 2005. Figure 4-18 shows one of the charting options prepared by NOAA.

Since other offshore wind parks have been proposed in other parts of the United States, NOAA will be working with the USCG and others to establish charting guidelines for including offshore wind parks on NOAA nautical charts. Inclusion of CWA's Wind Park on the local nautical charts would be in accordance with NOAA requirements.

CWA has committed to continue coordinating with the USCG and NOAA regarding charting of the Wind Park.

5.0 SEARCH AND RESCUE OPERATIONS

The USCG provided ESS with a compilation of search and rescue (SAR) data from its database of missions. This data was used to evaluate the frequency, types, and times of SAR missions in Nantucket Sound, with particular emphasis on the area including the Wind Park (the SAR Study Area). The results of these evaluations, along with review of USCG SAR operational guidelines and discussions with USCG personnel involved in SAR operations, were used to assess the potential for impacts to SAR operations as a result of construction and operation of the Wind Park.

SAR data is a strong indicator of casualty history since when a casualty occurs; a SAR case is usually generated. ESS reviewed the last three WAMS reports for Nantucket Sound (prepared in 2004, 1996, and 1990). Only the 2004 WAMS report included information on marine casualties. The 2004 WAMS report states that the only incident of significance occurred just outside of Nantucket Sound, but does not provide additional information on that incident. It further stated that there were 33 incidents in Nantucket Sound during calendar years 2001, 2002, and 2003. Of the 33 incidents, the M/V *Flying Cloud* was involved in 15 of those incidents. In addition, ESS solicited input on marine casualties from staff at USCG

Sector Southeastern New England. According to Sector Southeastern New England, the SAR database is the most reliable source of data relative to marine casualties.

5.1 SAR Operations

The data provided includes the period October 1991 to September 2002, and covers an area between 41°04' N to 41°32' N and 69°35' W to 70°54' W (an area of approximately 1,845 square NM). There are 2,861 records in the data provided, which includes the date, time, and reported location (rounded to the nearest minute of latitude and longitude) of each sortie. The majority of the incidents occurred during daylight hours, with only 28 percent occurring between sunset and sunrise. Figure 5-1 illustrates the locations of the SAR sorties and incidents provided by the USCG.

The proposed Wind Park is within an area between 41°27' N to 41°32' N and 70°14' W to 70°23' W (a "SAR Study Area" of approximately 35 square NM). There are 94 sortie records in the data within the SAR Study Area. Multiple sorties occurred at the same date and time in many locations in the data, resulting in a total of 50 incidents in the Wind Park area. These incidents occurred between November 1991 and August 2002. The majority of the incidents occurred during daylight hours, with only 22 percent occurring between sunset and sunrise. Figure 5-2 illustrates the locations of the 94 sortie records in the SAR Study Area.

Table 5.1 contains the USCG SAR data records for the 50 incidents that occurred in the Wind Park SAR Study Area. Incidents highlighted in blue occurred during nighttime hours. Table 5.2 summarizes the response type, responder type, and time of day for each of these 50 incidents. Figures 5-3 and 5-4 illustrate the data in Table 5.2 in graphical form. The majority (81 percent) of the responses to SAR incidents in the SAR Study Area were made by sea. Aircraft were only used to respond to four (4) incidents in the SAR Study Area during the ten-year study period. In some cases, multiple responders were required for an incident.

5.1.1 U.S. Coast Guard

After compiling and evaluating the SAR data, ESS consulted with staff from USCG District One, USCG MSO Providence, and USCG Air Station Cape Cod in May 2003. The USCG personnel assisted ESS in determining the specifics of several SAR incidents so they could be properly classified. In addition, USCG personnel from USCG Air Station Cape Cod provided ESS with an understanding of their procedures for air operations in Nantucket Sound and how the presence of the Wind Park might affect their operations.

The USCG responds to SAR incidents in Nantucket Sound by both sea and air, and often renders communications assistance to mariners. USCG vessels are homeported at several USCG Stations on Cape Cod and the Islands. These vessels transit to SAR incidents from either their USCG Station or their present location at the time the USCG is made aware of the incident. USCG aircraft typically transit to SAR incidents from USCG Air Station Cape Cod.

5.1.1.1 Vessel Operations

Vessel-based USCG SAR operations use a wide variety of vessels, from 22 FT Utility Lifeboats (UTLs) to 270 FT Medium Endurance Cutters (WMECs), in Nantucket Sound. Vessels 110 FT long and shorter are typically stationed at the USCG Stations along Cape Cod and the Islands, and are the primary responders to incidents in Nantucket Sound. The larger USCG cutters are typically based at larger USCG facilities such as Boston, but will patrol in Nantucket Sound occasionally.

USCG vessels operate in the same manner as other vessels, except at higher speeds when responding to an incident that requires a quick response. USCG vessels are equipped with global positioning system (GPS), radar, VHF radios, and other equipment necessary to conducting SAR operations.

USCG vessels responded to 23 out of the 50 incidents (46 percent) in the SAR Study Area.

5.1.1.2 Aircraft Operations

Aircraft-based USCG SAR operations use both helicopters and fixed-wing aircraft stationed at USCG Air Station Cape Cod. Aircraft based there include the HH-60J "Jayhawk" helicopter and the HU-25 "Guardian" jet.

The altitudes used by USCG aircraft vary depending on weather conditions and their mission. Aircraft cruising between two points typically fly about 500 to 1,000 FT above the water (when cloud ceilings permit). When searching for persons in the water, aircraft will fly about 100 to 300 FT above the water in good weather. Higher altitudes are required in poor weather. USCG aircraft are equipped with various radars and aviators use night-vision goggles when flying missions at night. (USCG, May 2003). The SAR "Rule 500" states that aircraft involved in SAR operations are to maintain a minimum of 500 FT above the surface, 500 FT below the ceiling, and 500 FT between aircraft.

USCG aircraft responded to four (4) out of the 50 incidents (8%) in the SAR Study Area. Only one (1) of the USCG aircraft responses occurred during the night.

Figure 5-5 illustrates the locations of aircraft SAR sorties in Nantucket Sound, Vineyard Sound, and the Atlantic Ocean. Most of the sorties illustrated occurred outside of the SAR Study Area. Aircraft responding to incidents in these locations would be cruising at an altitude of 500 to 1,000 FT.

5.1.1.3 Communications

The USCG sometimes only provides communications assistance to mariners. This assistance can be in the form of relaying communications between a mariner and another USCG unit or a commercial salvor. Communications assistance is handled by the USCG asset or location receiving the call, or by a Rescue Coordination Center (RCC) such as USCG District One in Boston, Massachusetts.

Communications assistance only was rendered during 12 of the 50 incidents (24 percent) in the SAR Study Area.

5.1.2 Commercial Salvors

The USCG database included five incidents in which commercial salvors were listed as the resource type for the SAR Study Area. Three of these incidents occurred during daylight hours, and two occurred during nighttime. These incidents, which are 10% of the reported incidents, only represent those that involved the USCG. It is common for mariners to contact commercial salvors such as Sea/Tow and BoatUS directly when a tow back to port is required.

ESS contacted both Sea/Tow and BoatUS to request information on the number of vessels they have assisted in or around Horseshoe Shoal. The representatives contacted from both organizations stated that compiling this data represented a large effort, and would not agree to provide this information as requested. Therefore, ESS cannot assess the extent of commercial salvor operations in and around Horseshoe Shoal.

5.1.3 Other Responders

In some cases, private mariners are able to render assistance to a vessel in distress. The USCG typically broadcasts a general message to mariners on VHF Channel 16 that includes the location of the vessel in distress, the nature of the vessel's problem, a request that all mariners keep a sharp lookout for the distressed vessel, and a request that mariners close to the vessel render assistance if possible. Often, the only assistance required is a tow back to shore. Private mariners responded to three (3) of the 50 incidents (6 percent) in the SAR Study Area.

The USCG will sometimes request that other local, state, or federal agencies (such as police departments, fire departments, harbormasters, and the Navy) respond to an incident. The response can be either by sea or air, depending on the nature of the incident. Other agencies responded to 12 out of the 50 incidents (24 percent) in the SAR Study Area.

5.2 Effects of the Wind Park on Search and Rescue

The Wind Park is not anticipated to have negative effects on SAR operations in the area of Horseshoe Shoal. In fact, Section 5.3 describes ways that the Wind Park's presence will assist SAR operations.

Provided that mariners transit in and around the Wind Park area in a prudent manner and in accordance with the COLREGS, additional SAR cases resulting from collisions with the WTGs should not occur. A determination of how many collision-related SAR cases will result from failure to comply with the COLREGS, unsafe vessel operation, or mechanical failure is beyond the scope of this assessment.

As described previously, the WTGs will be constructed in a grid pattern (minimum 0.34 NM by 0.54 NM spacing) rather than randomly scattered throughout the Wind Park area. This spacing will allow those USCG vessels that are not restricted by the existing water depths to continue to operate within the Wind Park.

This spacing and pattern will also allow USCG helicopters to operate between the WTGs with sufficient space between the helicopter and the WTGs, as shown in Figure 5-6. The SAR "Rule 500" states that aircraft involved in SAR operations with other aircraft are to maintain a minimum of 500 FT above the surface, 500 FT below the ceiling, and 500 FT between aircraft. At their highest point, the tips of the WTG rotors will be 443 FT above MLLW, providing approximately 57 FT of vertical clearance between the rotor tip and the minimum altitude under the Rule of 500. Figure 5-7 illustrates the height differential between the WTG rotor tip and the helicopter search altitude. The large spacing between WTGs will also allow USCG aircraft conducting searches for persons in the water to fly below 500 FT within the Wind Park. Aircraft responding to incidents south of the Wind Park will either cruise over or around the Wind Park when necessary. A representative of USCG Air Station Cape Cod indicated this would not adversely affect USCG responses (USCG, May 2003).

A representative of USCG Air Station Cape Cod indicated to ESS that USCG aircraft will be able to operate in and around the Wind Park during periods of good visibility, including nighttime operations. Each WTG location can be entered into the aircraft's navigation system to provide points of reference for the aviator flying the aircraft. The representative indicated that aircraft would not likely conduct operations in the area during times of very low cloud ceilings or dense fog, and a vessel-based response would be more appropriate during those times. USCG aircraft responding to incidents south of the Wind Park will either cruise over or around the Wind Park depending on their destination (USCG, May 2003).

The presence of turning WTG rotors may present difficulty to USCG aviators conducting SAR operations. The operation of the WTGs will be monitored continuously from CWA's control center on land. CWA will have the capability to remotely shutdown any or all of the WTGs at a moment's notice. CWA will commit to immediately shutdown all or a portion of the WTGs upon notification from the USCG that SAR aircraft have been ordered to respond to an incident within or immediately adjacent to the Wind Park. After initiating WTG shutdown, it takes approximately one to two minutes for the rotor to come to a complete stop. The USCG Air Station Cape Cod representative indicated that this would prove helpful to aircraft operations in the Wind Park, should they be required (USCG, May 2003).

The presence of the WTGs will not eliminate the USCG's ability to conduct helicopter hoists within the Wind Park. The representative from USCG Air Station Cape Cod indicated that if the WTG rotors are stopped, USCG helicopters could hover as close as 10 FT from the rotor in the same manner as is done with buildings and topographic features (USCG, May 2003). Therefore, the only areas where the helicopters will not be able to conduct hoisting are within 192 FT of each WTG tower since the radius of the rotors is 182 FT. Persons in the water can still be hoisted to the helicopter near the WTGs, but the helicopter's rescue swimmer can bring persons in the water that are within 192 FT of the WTG to the helicopter hoist basket.

In May 2005, United Kingdom's Maritime and Coastguard Agency (MCA) conducted helicopter SAR trials at the North Hoyle wind farm. These trials found that helicopter SAR operations were not affected by the presence of the WTGs during dry weather conditions, but noted that use of a helicopter during foggy conditions would likely not be possible. Helicopter pilots would need to be advised that the WTG blades are locked prior to approaching a WTG to make a rescue. MCA notes that possession of a chart depicting the wind farm layout would be extremely helpful to the radar operator to accurately interpret radar returns. (MCA, 2005) These findings agree with the information provided to CWA by representatives of USCG Air Station Cape Cod as described above.

5.3 Proposed Aids to Search and Rescue Operations

Each WTG will be clearly marked with an alphanumeric designation on the tower, and the USCG; other local, state, and federal agencies; and commercial salvors will be provided with a plan showing the designations for each WTG. This designation could be used by mariners in distress as a primary or secondary positional reference to provide to the USCG when requesting assistance. By receiving these additional, easily readable positional references from mariners in distress, the USCG will be able to focus its efforts on rescuing the mariner in distress rather than searching for them first. The USCG will also be able to use these alphanumeric designations to coordinate and direct the SAR operations.

Each WTG will have a safety line with a loop at the end from the platform to the water. While tying up to WTGs under normal circumstances will be prohibited, mariners in distress will be allowed to tie up to a WTG, either by their own choice or by direction from the USCG, until assistance arrives. In addition, persons in the water could swim to the WTG and hold on to the safety line until assistance arrives. There will be an access ladder from the platform to a point approximately 4 FT above the water line that could potentially be used by persons in the water to climb out of the water depending on the water level and sea state at the time of the incident.

The Wind Park's grid pattern and WTG spacing will provide the USCG with the opportunity to establish air and sea search grids that align with the turbines if desired. The WTGs will provide points of reference to USCG personnel as SAR missions are performed.

During Wind Park operations, CWA will have work vessels in the Wind Park conducting routine monitoring and maintenance during daylight hours when the seas are less than 6 FT. These work vessels will be able to assist vessels in distress within the Wind Park during these times, and will do so either upon receipt of a request for assistance from the vessel or from the USCG. CWA personnel on these vessels will be trained in first aid, CPR, and marine survival skills.

The ESP will have a helipad for emergency access by CWA personnel. USCG aircraft may also use this helipad in the performance of their duties. CWA has committed to designing the helipad such that it can be used by USCG HH-60 Jayhawk and HH-65 Dolphin helicopters if requested to do so by the USCG.

6.0 EFFECTS OF THE WIND PARK ON COMMUNICATION

6.1 Communications

As part of the DEIS/DEIR preparation process, CWA has analyzed potential interference to VHF marine radios from the Wind Park. To determine if an offshore wind park results in VHF radio interference, observations of radio use during the construction and operation of the Horns Rev Wind Park in the North Sea, off of the Danish coast, were made. The Horns Rev wind farm contains 80 WTGs in a grid pattern that are 230 FT tall, and are spaced approximately 0.30 NM apart. No difficulties with VHF communications were observed:

- Between vessels in and around the Horns Rev wind park;
- Between vessels in and around the Horns Rev wind park and Esbjerg Harbor (approximately 21 NM from the wind park's center);
- Between vessels in and around the Horns Rev wind park and the traffic coordination center in Esbjerg; or
- Between vessels in and around the Horns Rev wind park and the Coast Guard/Rescue Center.

The Wind Park location on Horseshoe Shoal is within VHF coverage area of the antennas at both Nobska Point (approximately 14.3 NM west of the Wind Park's center) and Nantucket (approximately 15.7 NM southeast of the Wind Park's center). Both of these antennas are connected to USCG Group Woods Hole (USCG NAVCEN, 2003).

In November 2004, the MCA and QinetiQ jointly published results of investigations of VHF radio system performance in and around the North Hoyle wind farm in the United Kingdom, which is comprised of 30 offshore WTGs that are located off the North Wales Coast at Prestatyn. The WTG spacing at North Hoyle is 0.19 NM by 0.43 NM. The investigations included performance evaluations of both ship-to-shore and ship-to-ship communications. The conclusions provided in MCA/QinetiQ, 2004 are as follows:

- The wind farm structures had no noticeable effects on any voice communications system. These included vessel-based, shore-based, and handheld VHF transceivers and mobile telephones. Digital selective calling (DSC) was also satisfactorily tested.
- The VHF Direction Finding equipment carried in the Royal National Lifeboat Institution lifeboats did not function correctly when within about 165 feet of a WTG and the telemetry or short range radio link to and from a deployed rigid inflatable boat was similarly reported to suffer interruptions.

Given the relative similarities between the Horns Rev wind park, North Hoyle wind farm, and the CWA Wind Park (in WTG size, spacing, and location from shore-based VHF receivers) and the reported absence of VHF radio interference at both Horns Rev and North Hoyle, VHF radio interference in and around the CWA Wind Park is not anticipated.

6.2 Radar

As part of the DEIS/DEIR preparation process, CWA has analyzed potential interference to ship-based radar from the Wind Park. This analysis included observations of radar use as well as review of results of radar performance investigations prepared by others. The results of these analyses provide information on the possible effects to radar use in the area of the CWA Wind Park. Prediction of the exact effects the presence of the WTGs will have on marine radar use prior to construction of the WTGs is complicated since local factors such as WTG construction materials, type(s) of marine radar in use, radar position relative to the WTGs, radar position relative to the ship's superstructure and other antennas, and the proficiency of the radar operator affect radar performance. The results of several studies of marine radar in the area of wind farms located in Europe are provided in this Section.

6.2.1 Horns Rev Wind Farm

To determine if an offshore wind park results in radar interference or shadows, observations of radar use during the construction and operation of the Horns Rev Wind Park in the North Sea, off of the Danish coast, were made. Typical radar onboard the work vessels at Horns Rev were 24-mile radar sets manufactured by Furuno. No radar shadows from the rotating WTG blades were observed. It was also noted that vessels in the middle of the Horns Rev wind farm could distinguish the 80 individual WTGs as well as the 12 buoys marking the working area on their radars. The only radar shadows that were observed were on small vessels when they were alongside much larger work vessels.

6.2.2 North Hoyle Wind Farm

In November 2004, the MCA and QinetiQ jointly published results of investigations of radar system performance in and around the North Hoyle wind farm. The investigations included performance evaluations of small vessel radar, shore-based radar, and large vessel radar. Since there are no shore-based radar stations that cover Horseshoe Shoal for the purposes of monitoring marine vessel traffic, the summary of the MCA and QinetiQ trials provided in this Section is limited to those trials pertaining to vessel based radar.

The MCA conducted radar trials using both small and large vessels in and around the North Hoyle wind farm. The MCA determined that the North Hoyle WTGs can have a vertical plane radar signal returning area of approximately 3,230 square feet.

MCA Small Vessel Trials: The small vessel trials investigated radar shadowing, range and bearing discrimination, down and across range target discrimination, and clutter effects using two MCA lifeboats. Weather conditions at the time of the radar trials were light winds, calm seas, and clear visibility. The radar shadowing trials found that blind and shadow sectors existed behind the WTGs that limited detection of the target vessel. MCA noted that this would only be a significant problem if the search vessel or target were not able to move to an area where the target was not in these sectors or if the target was located within poor down and across range discrimination areas. The target discrimination trials found that a stationary target behind the WTG could not be seen separate from the WTGs radar return, but that full separation of the target and WTG radar returns was achieved at an angle of 4 degrees at the observation range of 3 NM. The clutter effect trial found that spurious echoes and side lobe echoes were present, but could be reduced by reducing the radar's gain setting.

MCA Large Vessel Trials: The large vessel trial investigated the effects of the WTGs on type-tested radars that use larger scanner sizes than those on small vessels. Weather conditions at the time of the radar trials were light winds, calm seas, and clear visibility. Results similar to the small vessel trials were obtained on both S band and X band radar, with better definition being observed on X band radar.

QinetiQ Trials: The QinetiQ radar trials investigated clutter effects on vessel based radar and radar shadowing using shore-based radar, and were designed to test the theoretical results previously calculated by Qinetiq. Weather conditions at the time of the radar trials were light winds, calm seas, and clear visibility. The clutter effects trial found that spurious echoes and side lobe echoes were present, but their presence was more frequent for the trials when the vessel was located in the center of the North Hoyle wind farm. Fewer spurious and side lobe echoes were observed as the vessel moved toward the edges of the wind farm. The spurious echoes and side lobe echoes could be reduced in size or eliminated by reducing the radar systems' gain setting. The QinetiQ radar shadowing trials observed radar shadowing that was less than predicted in the theoretical study, and provided "little evidence that shadowing of targets would present any significant problems."

The conclusions provided in MCA/QinetiQ, 2004 related to vessel-based radar are as follows:

Small Vessel Radar Performance

- The WTG produced blind and shadow areas from which other WTGs and vessels could not be detected unless the observing vessel was moving.
- Detection of targets within the wind farm was also reduced by the cross and down-range responses from the WTGs, which limited range and bearing discrimination.
- The large displayed echoes of WTGs were due to the vertical extent of the turbine structures.
- These returned strong responses from sectors of the main beam outside the half power (-3dB) points and the side lobes outside 10° from the main beam.
- Although such spurious echo effects can be limited to some extent by reducing receiver amplification (gain), this will also reduce the amplification of other targets, perhaps below their display threshold levels.
- Sea and rain clutter will present further difficulties to target detection within and close to wind farms. Weather conditions at the time of the trials were such that these effects could not be examined. (MCA/Qinetiq, 2004)

Large Vessel Radar Performance

- As with the small vessel radars, range and bearing discrimination were affected by the response from the WTGs. Definition was less on S band radar than on X band radar. Numerous spurious echoes from side lobes and reflections were reported starting at a range of 1.5 NM. (MCA/Qinetiq, 2004)

MCA/QinetiQ, 2004 notes concerns about the use of vessel-based and shore-based radar as an effective aid to both vessel and mark detection, and consequently, for ship-to-ship collision avoidance in the proximity of wind farms.

In May 2005, United Kingdom's Maritime and Coastguard Agency (MCA) conducted helicopter SAR trials at the North Hoyle wind farm (MCA, 2005). As stated above in Section 6.2.2, the MCA estimates in this report that the radar reflecting area of the North Hoyle WTGs is approximately 3,230 square feet. During the trials, the MCA found that side lobe returns extended approximately 330 FT to either side of each WTG with the side lobe depth estimated to be less than 164 FT. The hovering helicopter was able to track the target vessel on its radar between 0.25 and 0.5 NM from the sides of the wind farm. In addition, the helicopter's radar was able to track the target vessel to within approximately 330 FT of each WTG. As a result, MCA, 2005 estimates that the minimum radar detection range from a WTG is approximately 330 FT. The report notes that possession of chart of the wind farm layout would be of assistance to the radar operator during interpretation of radar returns.

6.2.3 Kentish Flats Wind Farm

In March 2005, the Port of London Authority (PLA) published a report on radar interference observed during construction of the Kentish Flats Wind Farm. Reports of radar interference experienced by pilots in January and February 2005 are briefly summarized in the report. It is important to note that during this period only the WTG foundations and transition pieces were in place, and the observations therefore do not provide information on the potential effects of complete and operating WTGs on marine radar. The reports indicated variations of the common phenomena of multiple images (false echoes) as well as side lobe interference were experienced. The Port of London Authority states that the presence of the partially completed WTGs has amplified and exacerbated the existence of a well known radar characteristic (false echoes). However, it also states that the introduction of ordered patterns of radar targets has made the phenomenon more obvious to the observer by increasing the number of false echoes. The false echoes usually are shown astern of the vessel (resulting from reflections of the radar mast) or on the opposite side of the vessel from the true echoes (resulting from reflections of the WTGs).

The Port of London Authority solicited additional radar observation reports in late 2005, and additional surveys were performed in early 2006. As of July 2006, the data collection phase of this investigation had been completed, and the data was being analyzed and reviewed prior to preparation of a report of the investigation's findings. The results of these surveys will provide information on interference after completion of the WTGs. (PLA, 2005; Stanbrook, 2005; Stanbrook, 2006)

6.2.4 Potential Marine Radar Impacts from the Wind Park

The large vertical extent of the CWA WTGs may result in similar marine radar performance effects as observed by MCA/QinetiQ at North Hoyle. However, prediction of the exact effects the presence of the WTGs will have on marine radar use prior to construction of the WTGs is complicated since local factors such as WTG construction materials, type(s) of marine radar in use, radar position relative to the WTGs, radar position relative to the ship's superstructure and other antennas, and the proficiency of the radar operator affect radar performance.

If such effects occur, the ordered pattern of the spurious echoes would provide the radar operator with a sign that false radar returns are being observed.

Mariners utilizing the areas in and around the Wind Park will require guidance on the potential effects of the WTGs on radar. CWA will work with the USCG to develop information that could be provided to local mariners to educate them regarding the potential effects of the WTGs on marine radar. To avoid collisions with the WTGs, the mariner will need to combine data obtained from the vessel's radar with its positioning systems and marine charts to interpret the radar data. As stated in Section 4.7, CWA will work with NOAA and the USCG to incorporate the WTG locations onto the local navigational charts. To avoid collisions with other vessels in and around the Wind Park, mariners will need to more closely scrutinize radar data received to identify vessels that may be temporarily masked by radar echoes (either true or false) from the WTGs.

There are no shore based radar stations around Nantucket Sound for the purposes of monitoring marine vessel traffic. As a result, the Cape Wind Project will have no impact on shore based marine radar stations.

6.2.5 Potential Aviation Radar Impact from the Wind Park

An assessment of potential impacts to Air Traffic Control systems was provided in Section 5.14 of the DEIS/DEIR. The FAA conducted an aeronautical study for each of the 130 WTGs. The FAA's study focused on potential impacts to air navigation, and included an analysis of the potential for the WTGs to affect aviation radar. Based on its aeronautical study, the New England Regional Office of the FAA issued a "Determination of No Hazard to Air Navigation" in April 2003 which was reviewed, affirmed, and finalized by the Washington, DC office of the FAA on August 2, 2005. Based on the FAA's findings, no adverse impacts to air traffic control systems are anticipated from development of the Project.

The PAVE/PAWS radar installation is located in the northeastern portion of the Massachusetts Military Reservation. In 2004, the U.S. Air Force (USAF) reviewed the proposed location of the Wind Park with respect to the operation of the PAVE/PAWS radar. In a letter dated March 21, 2004, the USAF determined that the CWA Wind Park "poses no threat to the operation of the PAVE/PAWS radar". The USAF further stated that at the nearest proposed WTG location, the main PAVE/PAWS radar beam will clear the WTGs by more than 4,500 feet (USAF, 2004). Based on the USAF's findings, no adverse impacts to the PAVE/PAWS radar system are anticipated from development of the Project.

6.3 Positioning Systems

The inner array cables and submarine cable interconnection will be an alternating current (AC) system. Therefore, there will be no measurable compass deflection effects on vessels transiting over the cables since the earth's magnetic field is a direct current (DC) field. Additionally, there will be no electrical interference with radio, GPS, or radio-beacon navigational equipment from the inner array cables or the submarine cable interconnection.

Each WTG is a tall, slender object that will not block signals from multiple satellites. Tall and wide objects such as buildings or mountains can block signals from satellites depending on the location of the GPS antenna in relation to the object and the position of the satellite in the sky. Since each WTG is no wider than 16 to 18 FT at its base and the WTG are spaced in a 0.34 NM by 0.54 NM grid, even GPS antennas located next to a WTG should not experience degraded GPS information as a result of not acquiring sufficient satellite signals.

In November 2004, the MCA and QinetiQ jointly published results of investigations of positioning system performance in and around the North Hoyle wind farm. The investigations included performance evaluations of GPS systems. MCA/QinetiQ, 2004 reports that no problems with basic GPS reception or positional accuracy were found.

Therefore, GPS positioning systems are not expected to be affected by the presence of the Wind Park.

6.4 Sound Signals

As part of the DEIS/DEIR preparation process, CWA has analyzed potential noise impacts from the Wind Park. The air acoustic environment near the Wind Park results from wind and wave sound as well as from sound from vessels, recreational boats, and over-flying aircraft. For operational effects, acoustic modeling was performed for two wind conditions:

1. The WTG cut-in wind speed (8 miles per hour at hub height); and
2. The WTG design wind speed (30 miles per hour at hub height).

Event 1 represents the Project operating condition when existing sound levels will be lowest, and Event 2 represents the maximum sound levels from the Project. Sound source data for the WTGs were provided by GE Wind Energy from recent tests performed at a GE 3.6 MW unit operating near Barrax, Spain. Since fog conditions generally form only with low wind speeds, Event 1 is the most applicable for determining if the operation of the WTGs will have an effect on the ability of mariners to hear the sound signals.

Short-term existing daytime sound level measurements were made at green buoy No. 5 in the North Channel (approximately 0.7 NM north of the Wind Park), and at red buoy No. 20 at the edge of the Main Channel (approximately 0.2 NM south of the Wind Park). The above-water baseline background sound levels were 35 and 37 decibels (dBA)[6], respectively. At green buoy No. 5 and red buoy No. 20, the corresponding above-water L_{eq} levels (a uniform method for comparing time varying sound levels) were 46 and 51 dBA.

In the case of Event 1 (when it is most likely that fog conditions may be present), existing sound levels are 46 to 51 dBA at green buoy No. 5 and red buoy No. 20, and represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind when the average surface wind speed is about 5 miles per hour (occupants of a sailboat tacking upwind or on a motorboat would experience higher baseline sound levels). For such mariners, Wind Park operational sound levels of 30 to 34 dBA are well below existing sound levels of 46 to 51 dBA, and the spectrum formed by adding the Wind Park to the existing baseline levels contains no pure tones in the vicinity of the 80 Hertz (Hz) band where the Wind Park has an energy peak. Therefore, the WTGs will be inaudible to passing mariners. The results also reveal that low-frequency sound from the Wind Park (<63 Hz) is below the threshold of human hearing and would be inaudible regardless of the baseline sound levels).

The WTGs will also be inaudible regardless of baseline sound levels in the case of Event 2.

Since the operating WTGs will be inaudible, mariners traveling near the Wind Park will be able to hear the sound signals just as they now hear the various gongs and bells on floating ATONs in Nantucket Sound.

More detailed information on the analysis of potential noise impacts from the Wind Park can be found in Section 5.11 of the DEIS/DEIR.

7.0 SUMMARY OF PROPOSED MITIGATION MEASURES

Throughout this document, CWA has committed to various measures to mitigate potential navigational impacts of, or to improve navigational conditions in and around, the Wind Park. This section summarizes CWA's commitments in this regard.

- CWA has no intention or authority to prohibit vessels from entering, operating, or anchoring in the Wind Park area or to establish exclusionary zones in the Wind Park area.
- CWA will implement procedures outlined by the USCG to deconflict the areas around ongoing construction activities.

[6] Sound levels that are A-weighted (the frequency spectrum of sound levels are filtered as the human ear does naturally) to reflect human response are presented as dBA.

- CWA has committed to designing the WTG monopiles to withstand the forces of up to six (6) inch thick ice floes impacting the monopile.
- CWA has committed to initiate manual shutdown of WTG(s) experiencing icing conditions if conditions warrant such a shutdown.
- CWA will employ either Seabed Scour Control Mats or rock armor for scour protection to limit changes to bottom contours in the vicinity of the WTGs.
- CWA has committed to providing private ATONs (lights and sound signals) within the Wind Park to assist mariners when navigating in and around the Wind Park.
- CWA has committed to marking each WTG with its alphanumeric designation to serve as a point of reference for mariners.
- CWA has committed to providing the USCG; other local, state, and federal agencies; and commercial salvors with a plan showing the designations of each WTG.
- CWA has committed to continue coordinating with the USCG and NOAA regarding inclusion of the Wind Park on NOAA nautical charts covering the area.
- CWA has committed to immediately shutting down all or a portion of the WTGs upon notification from the USCG that SAR aircraft have been ordered to respond to an incident within or immediately adjacent to the Wind Park.
- CWA has committed to have its work vessels that are working in the area assist vessels in distress within the Wind Park upon receiving a request for assistance from the vessel or the USCG.
- CWA has committed to designing the helipad on the ESP such that it can be used by USCG HH-60 Jayhawk and HH-65 Dolphin helicopters if requested to do so by the USCG.
- CWA will work with the USCG to develop information that could be provided to mariners to educate them regarding the potential effects of the WTGs on marine radar.

8.0 REFERENCES

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Tables

Table 5.1
USCG SAR Data Records Occurring In and Around Horseshoe Shoal
November 1991 - August 2002

INCIDENT	DAY	MONTH	YEAR	TIME	SUNRISE	SUNSET	NIGHT/DAY	SMC_OPFAC	SORTIE_NBR	RESPOND_OPFAC	RESOURCE_TYPE	REPORT_LAT	REPORT_LON	LOC_LAT	LOC_LON	WIND_SPEED	VISIBILITY	SCENE_DIST
1	9	11	1991	1440	0637	1624	Day	30107	1	30107	UTB	41.30 N	070.19 W	None Reported	None Reported	25	7	3
2	24	7	1992	1225	0522	2021	Day	30109	1	30109	UTB	41.27 N	070.20 W	None Reported	None Reported	11	8	4
3	22	8	1992	1131	0553	1947	Day	30107	1	30107	UTB	41.30 N	070.16 W	None Reported	None Reported	0	9	1
4	25	10	1992	0658	0618	1641	Day	30124	1	30124	MLB	41.30 N	070.16 W	None Reported	None Reported	25	2	3
5	30	5	1993	1930	0525	2000	Day	30107	1	30107	Field Unit (other than RCC)	41.27 N	070.22 W	None Reported	None Reported	0	0	3
6	5	6	1993	1255	0509	2024	Day	30109	1	30109	Communications facilities	41.28 N	070.18 W	None Reported	None Reported	0	0	2
6	5	6	1993	1255	0509	2024	Day	30109	2	30109	Private boater	41.28 N	070.18 W	None Reported	None Reported	0	0	2
7	6	6	1993	0311	0509	2024	Night	30109	2	30109	Commercial towing/salvage firm	41.27 N	070.19 W	None Reported	None Reported	0	0	2
7	6	6	1993	0311	0509	2024	Night	30109	1	30109	Field Unit (other than RCC)	41.27 N	070.19 W	None Reported	None Reported	0	0	2
8	6	6	1993	1641	0509	2024	Day	30107	1	30107	UTB	41.32 N	070.14 W	None Reported	None Reported	20	1	3
9	2	7	1993	1735	0522	2021	Day	30107	1	30107	UTB	41.31 N	070.22 W	None Reported	None Reported	15	5	3
10	7	7	1993	2310	0522	2021	Night	30107	1	30107	RCC coordination	41.28 N	070.16 W	None Reported	None Reported	0	0	2
11	25	7	1993	1443	0522	2021	Day	30107	1	30107	Communications facilities	41.32 N	070.20 W	None Reported	None Reported	0	0	3
12	15	8	1993	1501	0553	1947	Day	30107	1	30107	UTB	41.28 N	070.14 W	None Reported	None Reported	10	3	2
13	20	9	1993	0805	0626	1856	Day	30109	1	30109	UTB	41.27 N	070.17 W	None Reported	None Reported	10	8	3
14	6	1	1994	1548	0713	1639	Day	36215	1	36215	Field Unit (other than RCC)	41.27 N	070.19 W	None Reported	None Reported	0	0	1
14	6	1	1994	1548	0713	1639	Day	20115	1	20115	Other Aircraft	41.27 N	070.19 W	None Reported	None Reported	0	9	1
14	6	1	1994	1548	0713	1639	Day	71101	1	71101	RCC coordination	41.27 N	070.19 W	None Reported	None Reported	0	0	1
14	6	1	1994	1548	0713	1639	Day	30107	1	30107	UTB	41.27 N	070.19 W	None Reported	None Reported	0	7	1
14	6	1	1994	1548	0713	1639	Day	13278	1	13278	WPB	41.27 N	070.19 W	None Reported	None Reported	0	4	1
15	15	6	1994	1540	0509	2024	Day	30124	1	30124	Field Unit (other than RCC)	41.30 N	070.17 W	None Reported	None Reported	0	0	3
15	15	6	1994	1540	0509	2024	Day	30124	2	30124	Other non-ship's boat	41.30 N	070.17 W	None Reported	None Reported	10	0	3
16	31	7	1994	1413	0522	2021	Day	30109	1	30109	Field Unit (other than RCC)	41.27 N	070.17 W	None Reported	None Reported	0	0	3
16	31	7	1994	1413	0522	2021	Day	30109	2	30109	UTB	41.27 N	070.17 W	None Reported	None Reported	10	7	3
17	29	8	1994	1715	0553	1947	Day	30107	2	30107	Commercial towing/salvage firm	41.27 N	070.20 W	None Reported	None Reported	10	8	3
17	29	8	1994	1715	0553	1947	Day	30107	1	30107	Field Unit (other than RCC)	41.27 N	070.20 W	None Reported	None Reported	0	0	3
18	30	8	1994	1450	0553	1947	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.22 W	None Reported	None Reported	0	0	3
18	30	8	1994	1450	0553	1947	Day	30107	2	30107	UTB	41.31 N	070.22 W	None Reported	None Reported	10	7	3
19	2	9	1994	1045	0626	1856	Day	30107	1	30107	Field Unit (other than RCC)	41.29 N	070.23 W	None Reported	None Reported	0	0	3
19	2	9	1994	1045	0626	1856	Day	30107	2	30107	UTB	41.29 N	070.23 W	None Reported	None Reported	15	9	3
20	16	9	1994	1440	0626	1856	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.22 W	None Reported	None Reported	0	0	1
21	1	6	1995	1347	0509	2024	Day	36215	1	36215	Field Unit (other than RCC)	41.28 N	070.15 W	None Reported	None Reported	0	0	2
21	1	6	1995	1347	0509	2024	Day	20115	1	20115	Field Unit (other than RCC)	41.28 N	070.15 W	None Reported	None Reported	0	0	2
21	1	6	1995	1347	0509	2024	Day	20115	2	20115	HH52	41.28 N	070.15 W	None Reported	None Reported	10	9	2
22	8	6	1995	1453	0509	2024	Day	30107	1	30107	Field Unit (other than RCC)	41.32 N	070.20 W	None Reported	None Reported	0	0	3
22	8	6	1995	1453	0509	2024	Day	30107	2	30107	UTB	41.32 N	070.20 W	None Reported	None Reported	10	3	3
23	23	8	1995	1245	0553	1947	Day	30124	1	30124	Field Unit (other than RCC)	41.32 N	070.15 W	None Reported	None Reported	0	0	3
23	23	8	1995	1245	0553	1947	Day	30124	2	30124	Other non-ship's boat	41.32 N	070.15 W	None Reported	None Reported	9	9	3
24	16	9	1995	1540	0626	1856	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.23 W	None Reported	None Reported	0	0	3
24	16	9	1995	1540	0626	1856	Day	30107	2	30107	Other non-ship's boat	41.31 N	070.23 W	None Reported	None Reported	5	7	3
25	20	9	1995	1945	0626	1856	Night	30107	2	30107	Commercial towing/salvage firm	41.32 N	070.19 W	None Reported	None Reported	0	0	2
25	20	9	1995	1945	0626	1856	Night	30107	1	30107	Field Unit (other than RCC)	41.32 N	070.19 W	None Reported	None Reported	0	0	2
26	19	7	1996	1334	0522	2021	Day	36215	1	36215	Field Unit (other than RCC)	41.27 N	070.14 W	None Reported	None Reported	0	0	3
26	19	7	1996	1334	0522	2021	Day	30109	1	30109	Field Unit (other than RCC)	41.27 N	070.14 W	None Reported	None Reported	0	0	3
26	19	7	1996	1334	0522	2021	Day	20115	1	20115	Field Unit (other than RCC)	41.27 N	070.14 W	None Reported	None Reported	0	0	3
26	19	7	1996	1334	0522	2021	Day	20115	2	20115	HH52	41.27 N	070.14 W	None Reported	None Reported	25	0	3
26	19	7	1996	1334	0522	2021	Day	30109	2	30109	UTB	41.27 N	070.14 W	None Reported	None Reported	25	1	3
27	7	7	1997	0924	0522	2021	Day	30107	1	30107	Field Unit (other than RCC)	41.32 N	070.23 W	None Reported	None Reported	0	0	3
27	7	7	1997	0924	0522	2021	Day	30107	2	30107	UTB	41.32 N	070.23 W	None Reported	None Reported	5	6	3
28	11	7	1997	2035	0522	2021	Night	30124	1	30124	Field Unit (other than RCC)	41.29 N	070.15 W	None Reported	None Reported	0	0	4
28	11	7	1997	2035	0522	2021	Night	30124	2	30124	Other non-ship's boat	41.29 N	070.15 W	None Reported	None Reported	10	9	4
29	8	8	1997	1620	0553	1947	Day	30109	1	30109	Field Unit (other than RCC)	41.28 N	070.15 W	None Reported	None Reported	0	0	2
29	8	8	1997	1620	0553	1947	Day	30109	2	30109	Private boater	41.28 N	070.15 W	None Reported	None Reported	0	0	2
30	9	8	1997	1821	0553	1947	Day	36215	1	36215	Field Unit (other than RCC)	41.30 N	070.15 W	None Reported	None Reported	0	0	3
31	12	8	1997	1329	0553	1947	Day	30107	1	30107	Field Unit (other than RCC)	41.29 N	070.14 W	None Reported	None Reported	0	0	2
31	12	8	1997	1329	0553	1947	Day	30107	2	30107	Private boater	41.29 N	070.14 W	None Reported	None Reported	0	0	2
32	14	8	1997	0812	0553	1947	Day	30124	2	30124	Commercial towing/salvage firm	41.29 N	070.20 W	None Reported	None Reported	10	9	3
32	14	8	1997	0812	0553	1947	Day	30124	1	30124	Field Unit (other than RCC)	41.29 N	070.20 W	None Reported	None Reported	0	0	3
33	15	1	1998	1630	0713	1639	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.14 W	None Reported	None Reported	0	0	1
33	15	1	1998	1630	0713	1639	Day	30107	2	30107	MLB	41.31 N	070.14 W	None Reported	None Reported	20	5	1
34	25	5	1998	1340	0525	2000	Day	36215	1	36215	Field Unit (other than RCC)	41.31 N	070.14 W	None Reported	None Reported	0	0	3
34	25	5	1998	1340	0525	2000	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.14 W	None Reported	None Reported	0	0	3
34	25	5	1998	1340	0525	2000	Day	71101	1	71101	RCC coordination	41.31 N	070.14 W	None Reported	None Reported	0	0	3
34	25	5	1998	1340	0525	2000	Day	30107	2	30107	UTB	41.31 N	070.14 W	None Reported	None Reported	25	8	3
35	13	7	1998	1140	0522	2021	Day	30107	1	30107	Field Unit (other than RCC)	41.32 N	070.21 W	None Reported	None Reported	0	0	3
35	13	7	1998	1140	0522	2021	Day	30107	2	30107	Other non-ship's boat	41.32 N	070.21 W	None Reported	None Reported	10	5	3
36	31	7	1999	1218	0522	2021	Day	30107	2	30107	Commercial towing/salvage firm	41.31 N	070.19 W	None Reported	None Reported	0	0	1
36	31	7	1999	1218	0522	2021	Day	30107	1	30107	Field Unit (other than RCC)	41.31 N	070.19 W	None Reported	None Reported	0	0	1
37	13	5	2000	1910	0525	2000	Day	36215	1	30107	Utility Boat - Big (41')	41.30 N	070.22 W	41.30N	070.32W	1	5	2
38	25	6	2000	0428	0509	2024	Night	36215	None Reported	None Reported	None Reported	41.30 N	070.20 W	None Reported	None Reported	None Reported	None Reported	None Reported
39	8	7	2000	0046	0522	2021	Night	36215	1	36215	Communications station	41.31 N	070.21 W	None Reported	None Reported	None Reported	None Reported	None Reported
39	8	7	2000	0046	0522	2021	Night	36215	2	36215	Communications station	41.31 N	070.21 W	None Reported	None Reported	None Reported	None Reported	None Reported
40	10	7	2000	2006	0522	2021	Day	36215	1	71101	RCC	41.30 N	070.21 W	None Reported	None Reported	None Reported	None Reported	None Reported

SAR data provided by the USCG.

Table 5.1
USCG SAR Data Records Occurring In and Around Horseshoe Shoal
November 1991 - August 2002

INCIDENT	DAY	MONTH	YEAR	TIME	SUNRISE	SUNSET	NIGHT/DAY	SMC_OPFAC	SORTIE_NBR	RESPOND_OPFAC	RESOURCE_TYPE	REPORT_LAT	REPORT_LON	LOC_LAT	LOC_LON	WIND_SPEED	VISIBILITY	SCENE_DIST
41	14	12	2000	1653	0708	1614	Night	36215	1	30107	Motor Lifeboat (Misc)	41.27 N	070.18 W	None Reported	None Reported	0	0	0
41	14	12	2000	1653	0708	1614	Night	36215	2	30107	Motor Lifeboat (Misc)	41.27 N	070.18 W	None Reported	None Reported	0	0	0
42	18	3	2001	2155	0558	1752	Night	36215	2	36215	Field unit (other than RCC)	41.28 N	070.20 W	None Reported	None Reported	None Reported	None Reported	None Reported
42	18	3	2001	2155	0558	1752	Night	36215	1	71101	RCC	41.28 N	070.20 W	None Reported	None Reported	None Reported	None Reported	None Reported
43	8	4	2001	1747	0605	1927	Day	36215	1	36215	Field unit (other than RCC)	41.30 N	070.15 W	None Reported	None Reported	None Reported	None Reported	None Reported
44	11	8	2001	0030	0553	1947	Night	36215	2	30107	Rigid Hull Inflatable Boat - Medium (16'-21'11")	41.30 N	070.15 W	41.31N	070.41W	5	1	1
44	11	8	2001	0030	0553	1947	Night	36215	3	30109	Rigid Hull Inflatable Boat - Medium (16'-21'11")	41.30 N	070.15 W	None Reported	None Reported	15	2	None Reported
44	11	8	2001	0030	0553	1947	Night	36215	4	30109	Rigid Hull Inflatable Boat - Medium (16'-21'11")	41.30 N	070.15 W	None Reported	None Reported	10	3	None Reported
44	11	8	2001	0030	0553	1947	Night	36215	1	30107	Utility Boat - Big (41')	41.30 N	070.15 W	None Reported	None Reported	15	5	1
45	13	2	2002	2100	0643	1718	Night	36215	3	36215	Field unit (other than RCC)	41.32 N	070.23 W	None Reported	None Reported	20	10	None Reported
45	13	2	2002	2100	0643	1718	Night	36215	4	20115	Medium Range Recovery Helicopter	41.32 N	070.23 W	None Reported	None Reported	20	10	None Reported
45	13	2	2002	2100	0643	1718	Night	36215	2	30107	Motor Lifeboat (Misc)	41.32 N	070.23 W	None Reported	None Reported	20	10	None Reported
45	13	2	2002	2100	0643	1718	Night	36215	1	30124	Utility Boat - Medium (25'-40'11")	41.32 N	070.23 W	None Reported	None Reported	20	8	7
46	21	4	2002	1400	0543	1944	Day	36215	1	36215	Communications Assistance Only	41.28 N	070.21 W	None Reported	None Reported	None Reported	None Reported	None Reported
46	21	4	2002	1400	0543	1944	Day	36215	2	71101	RCC	41.28 N	070.21 W	None Reported	None Reported	None Reported	None Reported	None Reported
47	22	5	2002	1559	0525	2000	Day	36215	1	36215	Field unit (other than RCC)	41.30 N	070.15 W	41.30N	070.15W	None Reported	None Reported	None Reported
47	22	5	2002	1559	0525	2000	Day	36215	2	36215	Field unit (other than RCC)	41.30 N	070.15 W	41.30N	070.15W	None Reported	None Reported	None Reported
47	22	5	2002	1559	0525	2000	Day	36215	3	71101	RCC	41.30 N	070.15 W	None Reported	None Reported	None Reported	None Reported	None Reported
48	13	7	2002	1858	0522	2021	Day	36215	1	30107	Utility Boat - Big (41')	41.32 N	070.15 W	41.32N	070.15W	20	7	8
49	16	8	2002	2322	0553	1947	Night	36215	1	30107	Utility Boat - Big (41')	41.27 N	070.23 W	41.27N	070.23W	2	3	12
50	18	8	2002	1934	0553	1947	Day	36215	1	71101	RCC	41.30 N	070.22 W	None Reported	None Reported	None Reported	None Reported	None Reported

Highlight indicates response occurred between sunset and sunrise.

Abbreviations:

SMC_OPFAC Operational facility responsible for coordinating SAR operations.
SORTIE_NBR Number of assets dispatched to a SAR incident.
REPORT_LAT Reported SAR incident latitude (rounded to the nearest minute).
REPORT_LON Reported SAR incident longitude (rounded to the nearest minute).
LOC_LAT Actual SAR incident latitude (rounded to the nearest minute). [Not always recorded by USCG.]
LOC_LON Actual SAR incident longitude (rounded to the nearest minute). [Not always recorded by USCG.]
RCC Rescue Coordination Center

Notes:

1. Times of sunrise and sunset determined from predicted times for the middle of a given month.
2. Wind speed, visibility, and scene distance not always recorded by USCG.

	Total	%
Night Sorties	23	24.47%
Day Sorties	71	75.53%

Commercial towing/salvage firm	5
Communications Assistance Only	1
Communications facilities	2
Communications station	2
Field Unit (other than RCC)	34
HH52	2
Medium Range Recovery Helicopter	1
MLB	2
Motor Lifeboat (Misc)	3
None Reported	1
Other Aircraft	1
Other non-ship's boat	5
Private boater	3
RCC	5
RCC coordination	3
Rigid Hull Inflatable Boat - Medium (16'-21'11")	3
UTB	15
Utility Boat - Big (41')	4
Utility Boat - Medium (25'-40'11")	1
WPB	1
Total	94

Vessel Assist	76
Air Assist	4
Communications Assist	5
Rescue Coordination Center	8

Table 5.2

Responses to SAR Incidents In and Around Horseshoe Shoal
November 1991 - August 2002

	Response Type				Responder Type							Time of Day	
Incident	**Sea**	**Air**	**Communications**	**RCC Coord.**	**USCG Vessel**	**USCG Air**	**USCG RCC**	**Comm. Salvor**	**Private**	**Other**	**None**	**Day**	**Night**
1	X				X							X	
2	X				X							X	
3	X				X							X	
4	X				X							X	
5	X									X		X	
6	X		X						X		X	X	
7	X							X					X
8	X				X							X	
9	X				X							X	
10				X			X						X
11			X								X	X	
12	X				X							X	
13	X				X							X	
14	X	X		X	X		X			X		X	
15	X									X		X	
16	X				X							X	
17	X							X				X	
18	X				X							X	
19	X				X							X	
20	X									X		X	
21	X	X				X						X	
22	X				X							X	
23	X									X		X	
24	X									X		X	
25	X							X					X
26	X	X			X	X						X	
27	X				X							X	
28	X									X			X
29	X								X			X	
30	X									X		X	
31	X								X			X	
32	X							X				X	
33	X				X							X	
34	X			X	X		X					X	
35	X									X		X	
36	X							X				X	
37	X				X							X	
38	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		X
39			X								X		X
40				X			X					X	
41	X				X								X
42	X			X			X			X			X
43	X									X		X	
44	X				X								X
45	X	X			X	X							X
46			X	X			X				X	X	
47	X			X			X			X		X	
48	X				X							X	
49	X				X								X
50				X			X					X	
TOTAL	**43**	**4**	**4**	**8**	**23**	**3**	**8**	**5**	**3**	**12**	**4**	**39**	**11**
Day	**35**	**3**	**3**	**6**									
Night	**8**	**1**	**1**	**2**									

NR = Not Reported.

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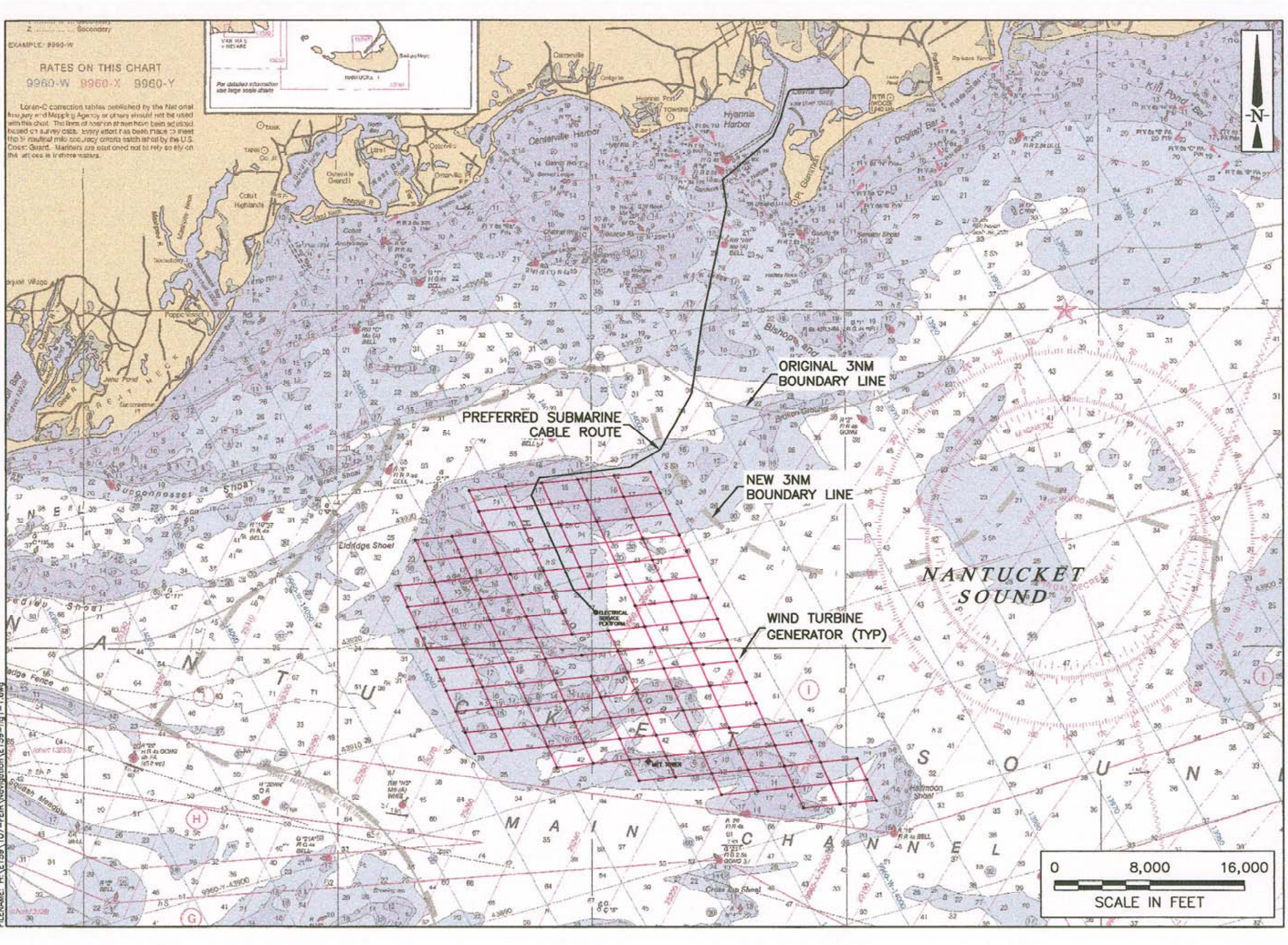
Figures



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CAPE WIND PROJECT

Proposed 130 Turbine Array Location

Figure 1-1

Source: NOAA Chart #13237, Nantucket Sound & Approaches
MMS, Outer Shelf Official Protraction OPD No. NK19-07, Block No.'s 6481 & 6531

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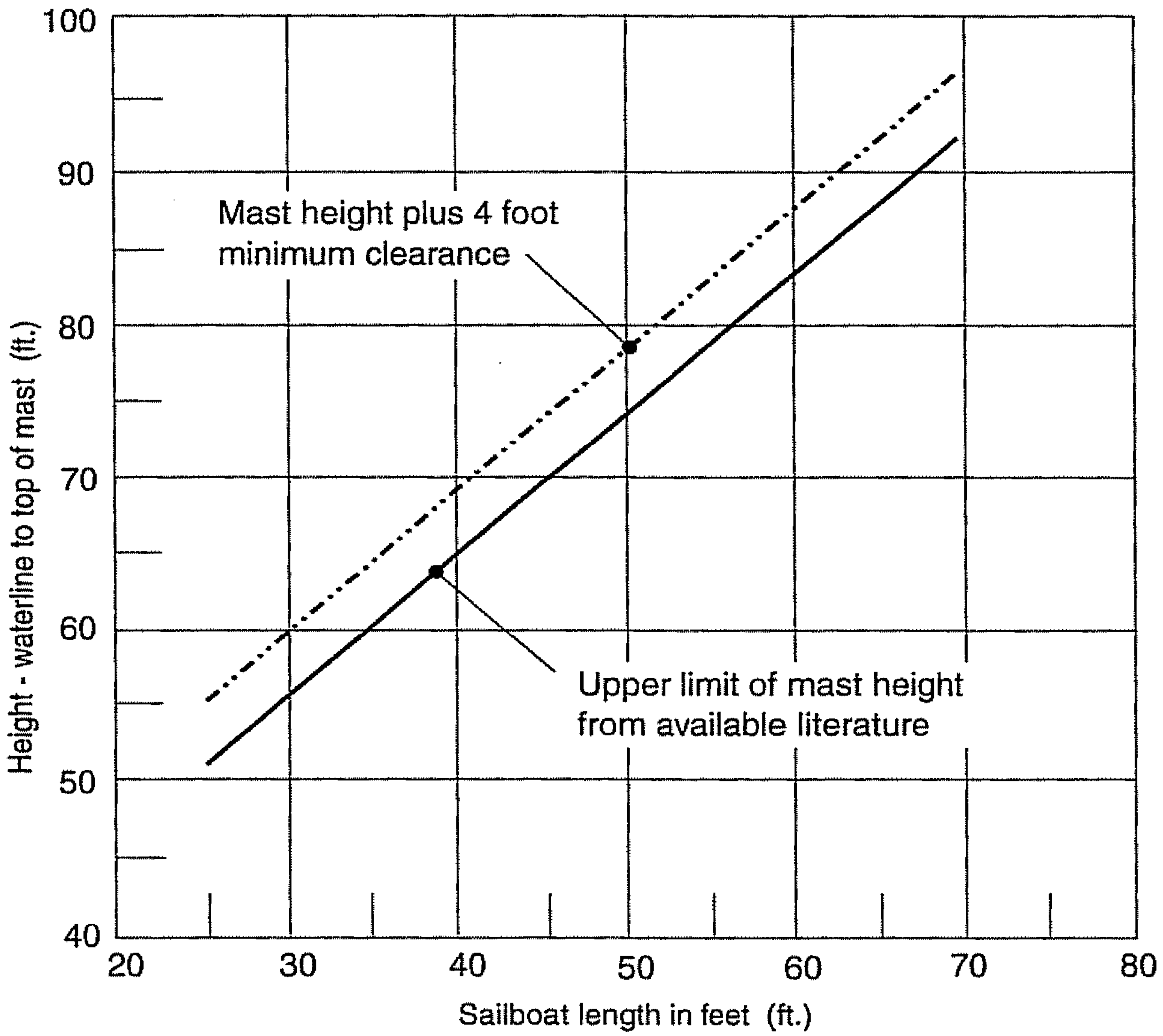
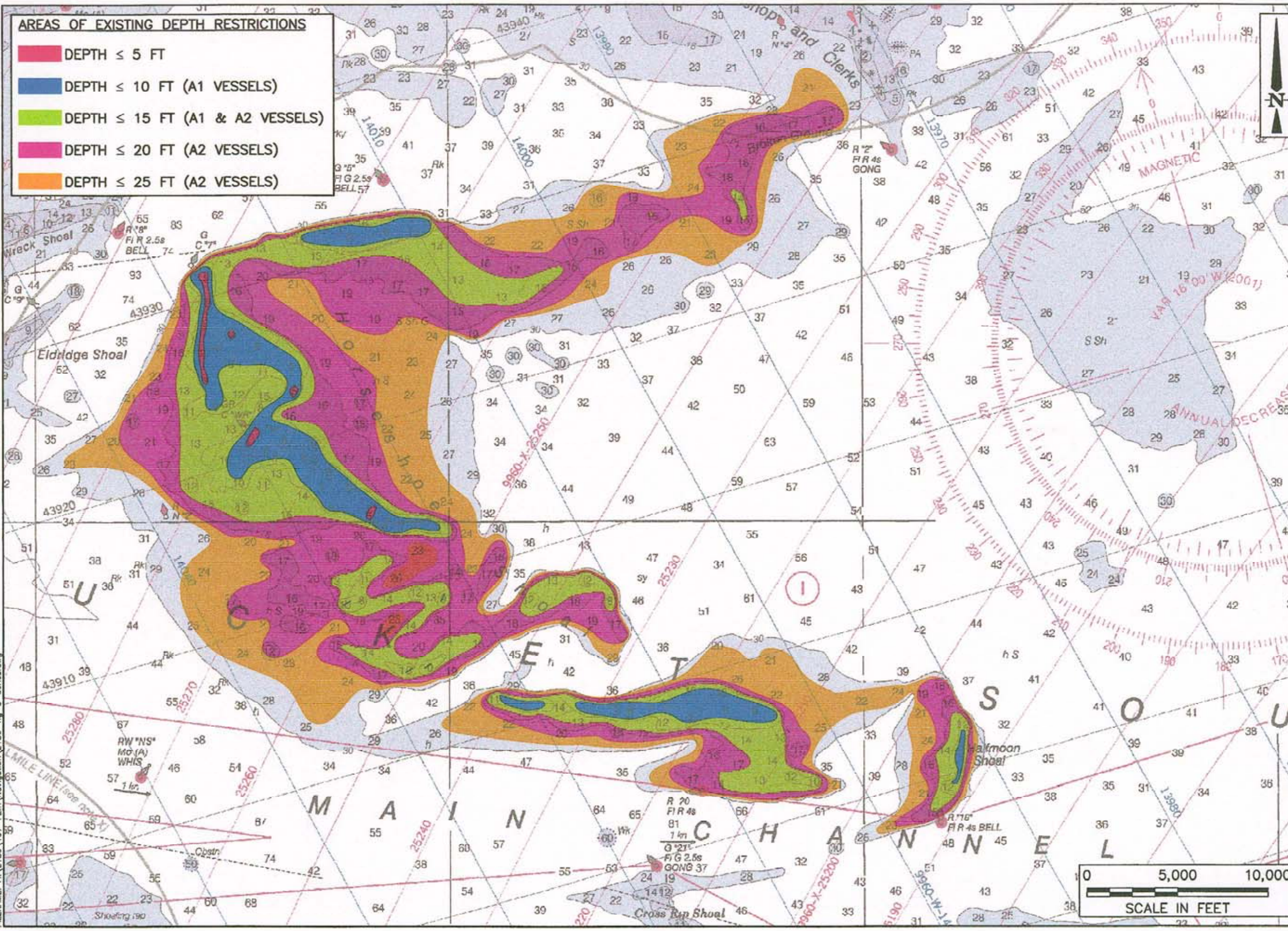


Figure 10-5. Sailboat mast height from waterline vs. sailboat length.



Cruise Ships/Research Vessels (Category A) Existing Depth Restrictions

Figure 3-2

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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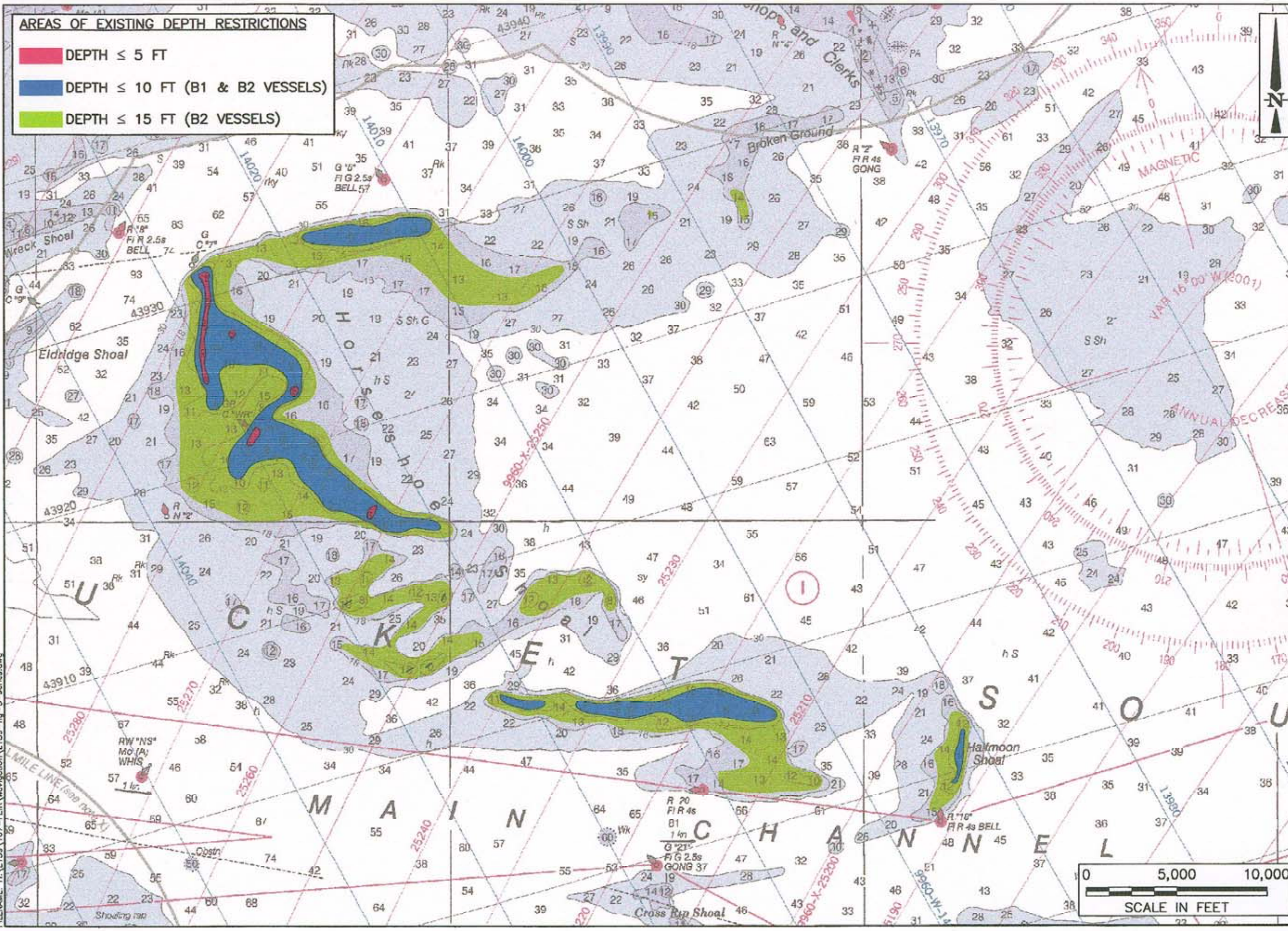

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Passenger Ferries (Category B)
Existing Depth Restrictions

Figure 3-3

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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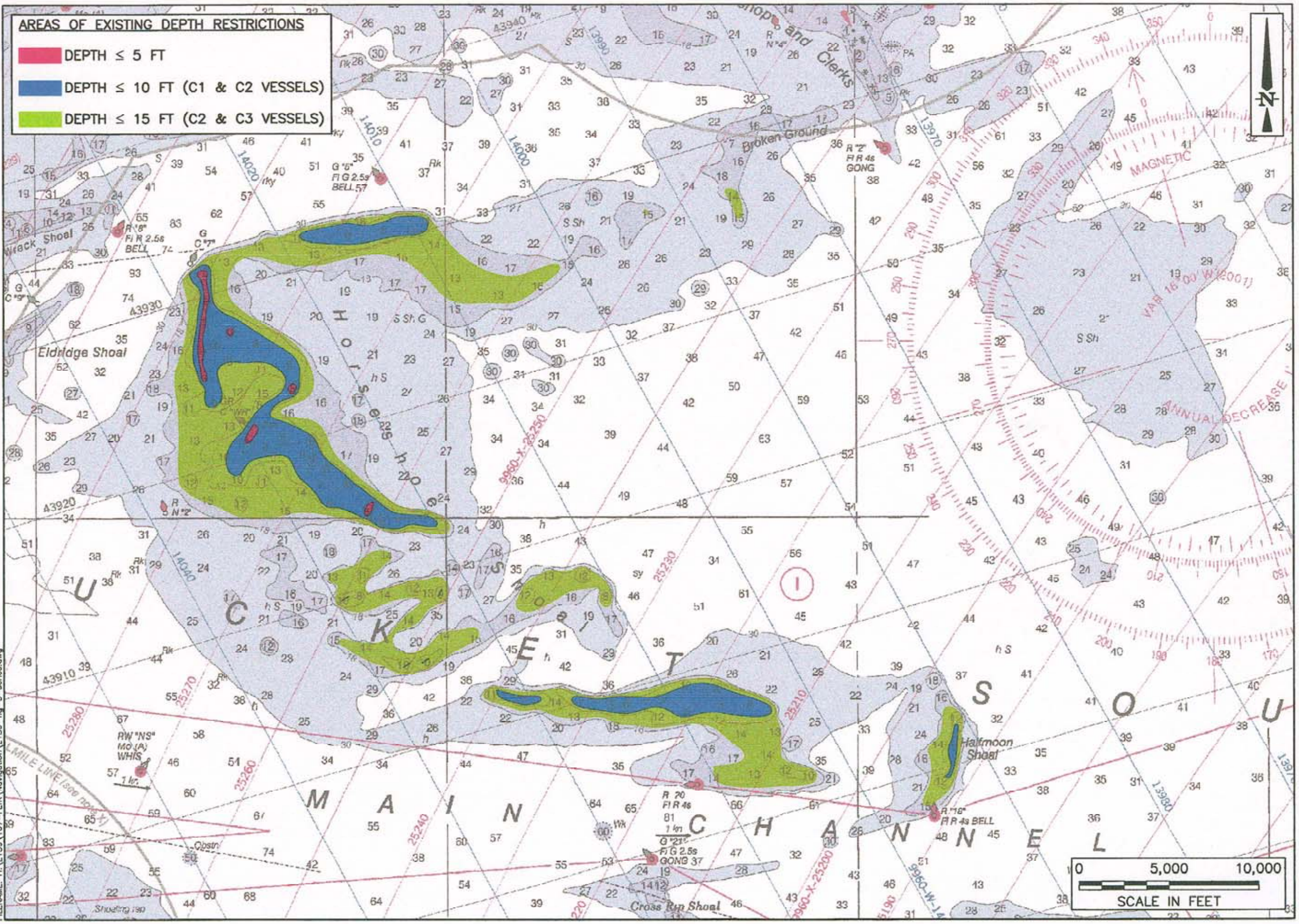

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Bulk Goods Carriers (Category C)
Existing Depth Restrictions

Figure 3-4

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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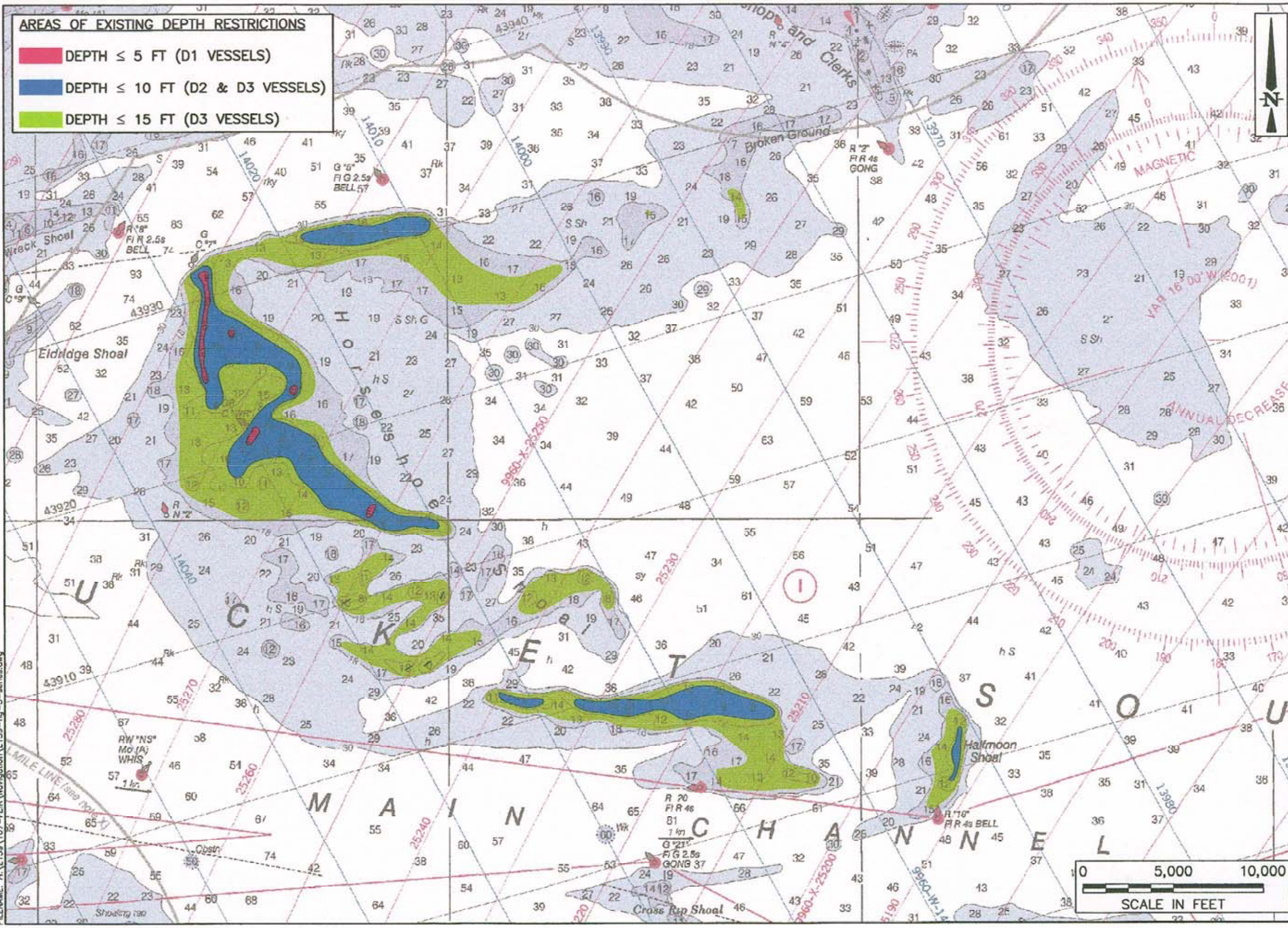

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US Coast Guard Vessels (Category D) Existing Depth Restrictions

Figure 3-5

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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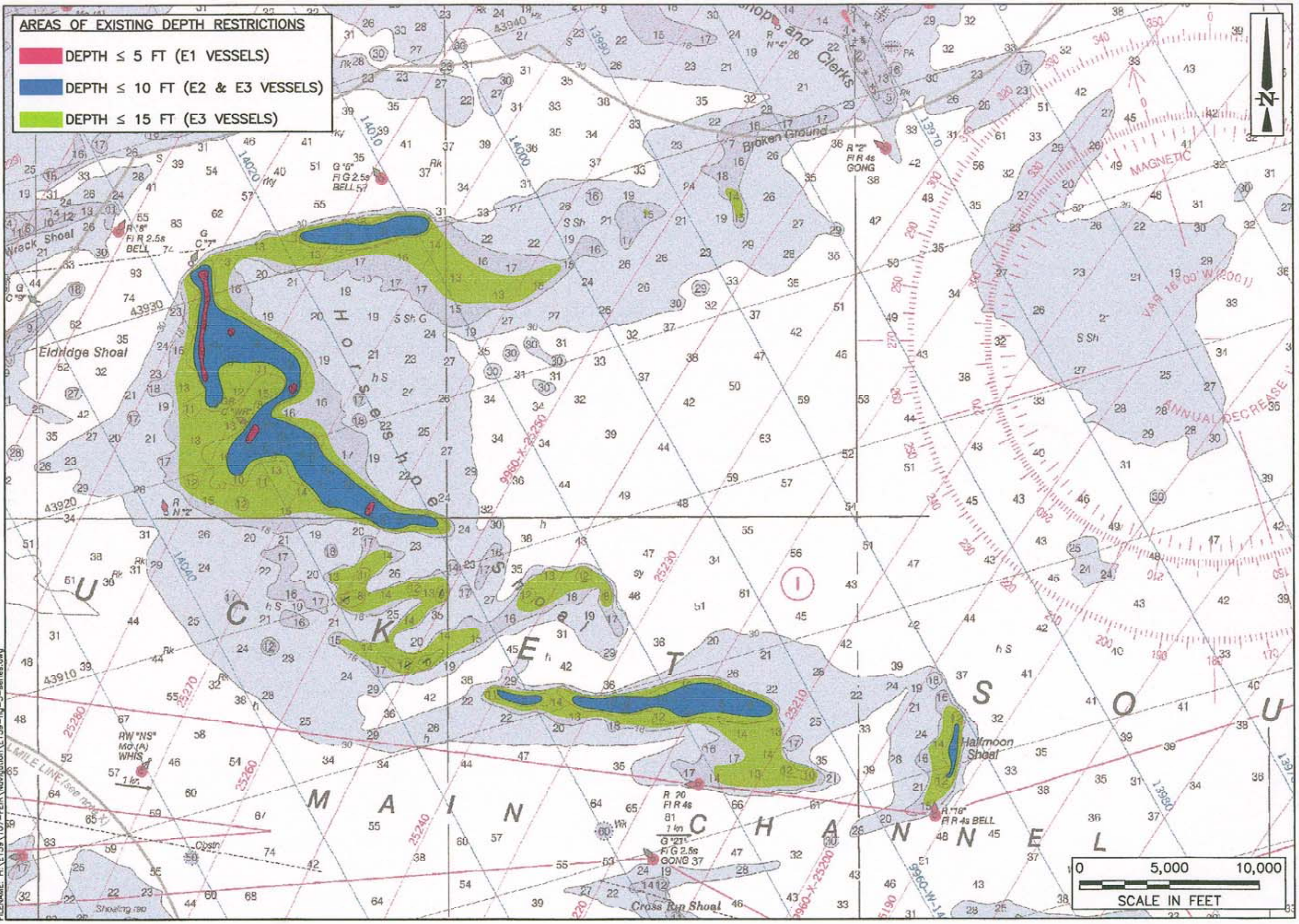

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CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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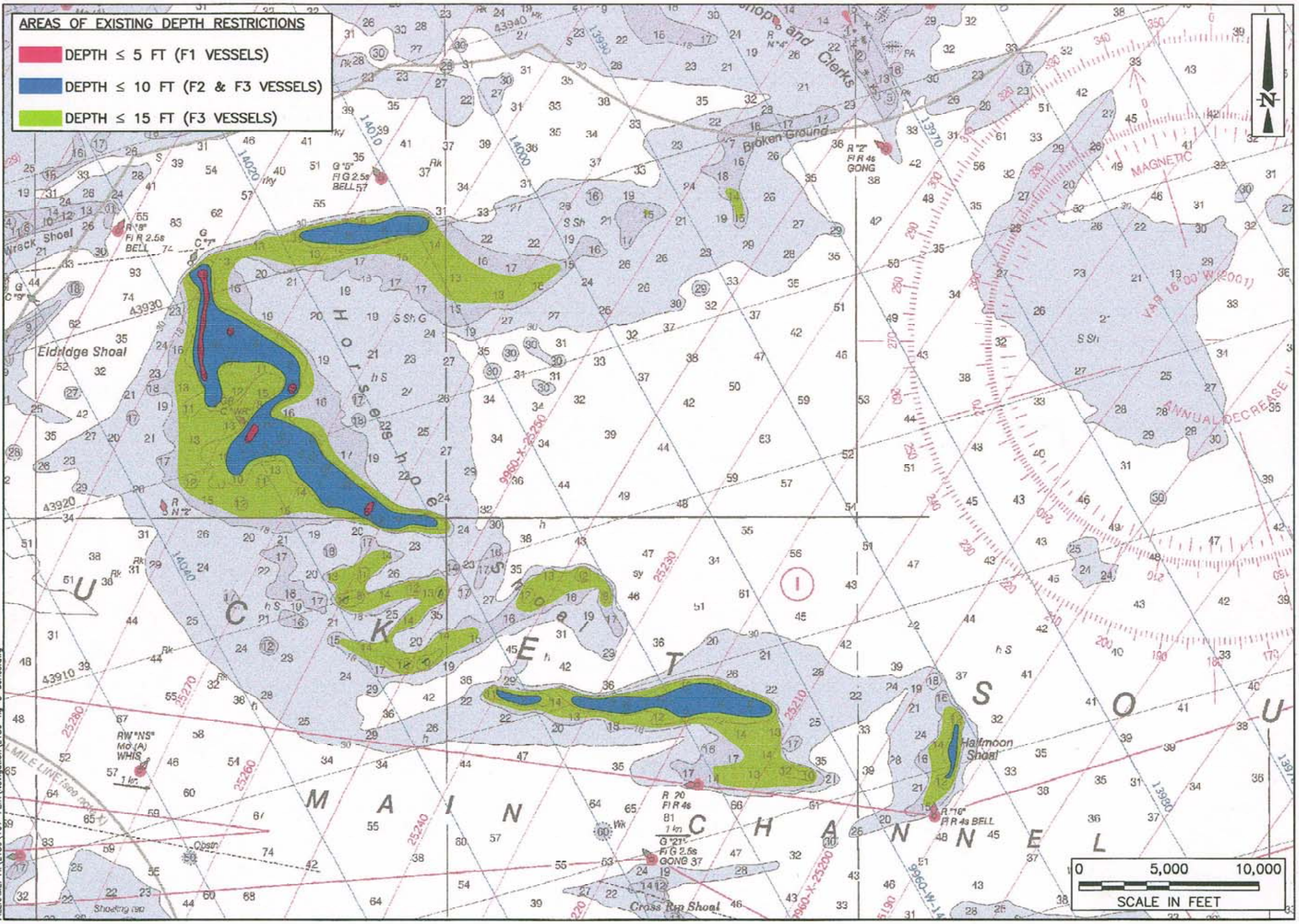
Fishing Vessels (Category E) Existing Depth Restrictions

Figure 3-6



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Recreational Vessels (Category F) Existing Depth Restrictions

Figure 3-7

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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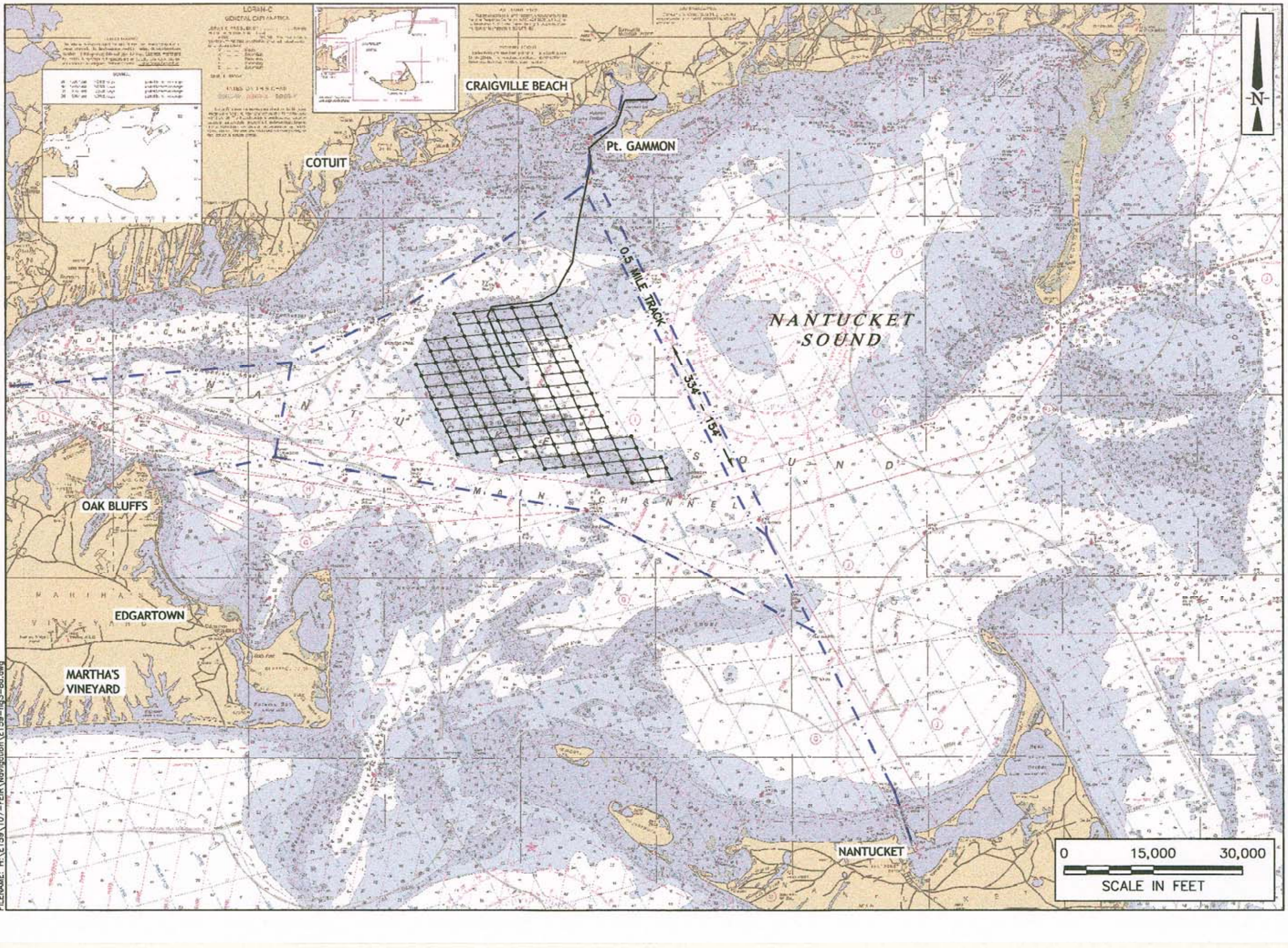

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CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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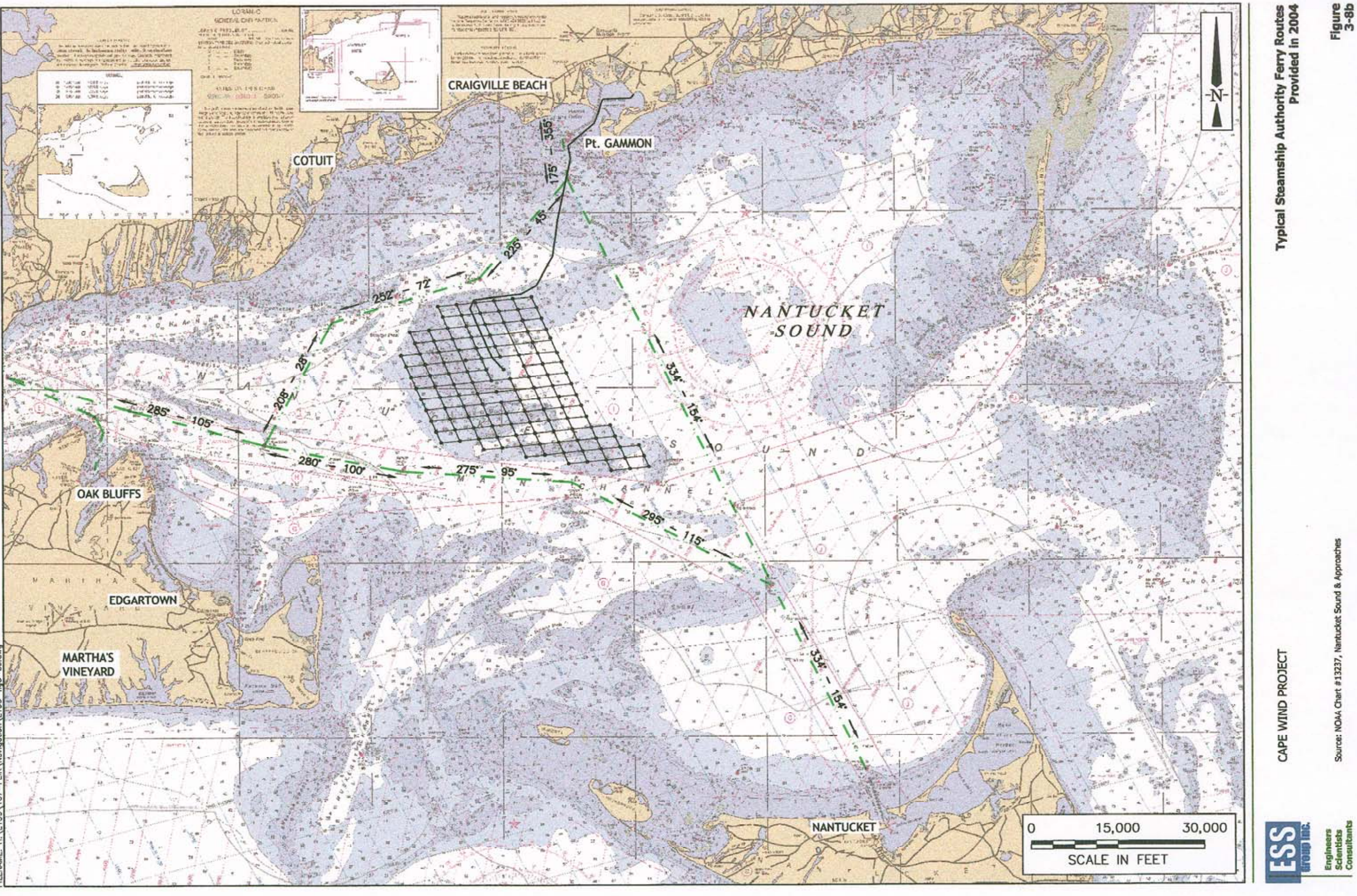
Typical Steamship Authority Ferry Routes Provided in 2003

Figure 3-8a



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Typical Steamship Authority Ferry Routes Provided in 2004

Figure 3-8b

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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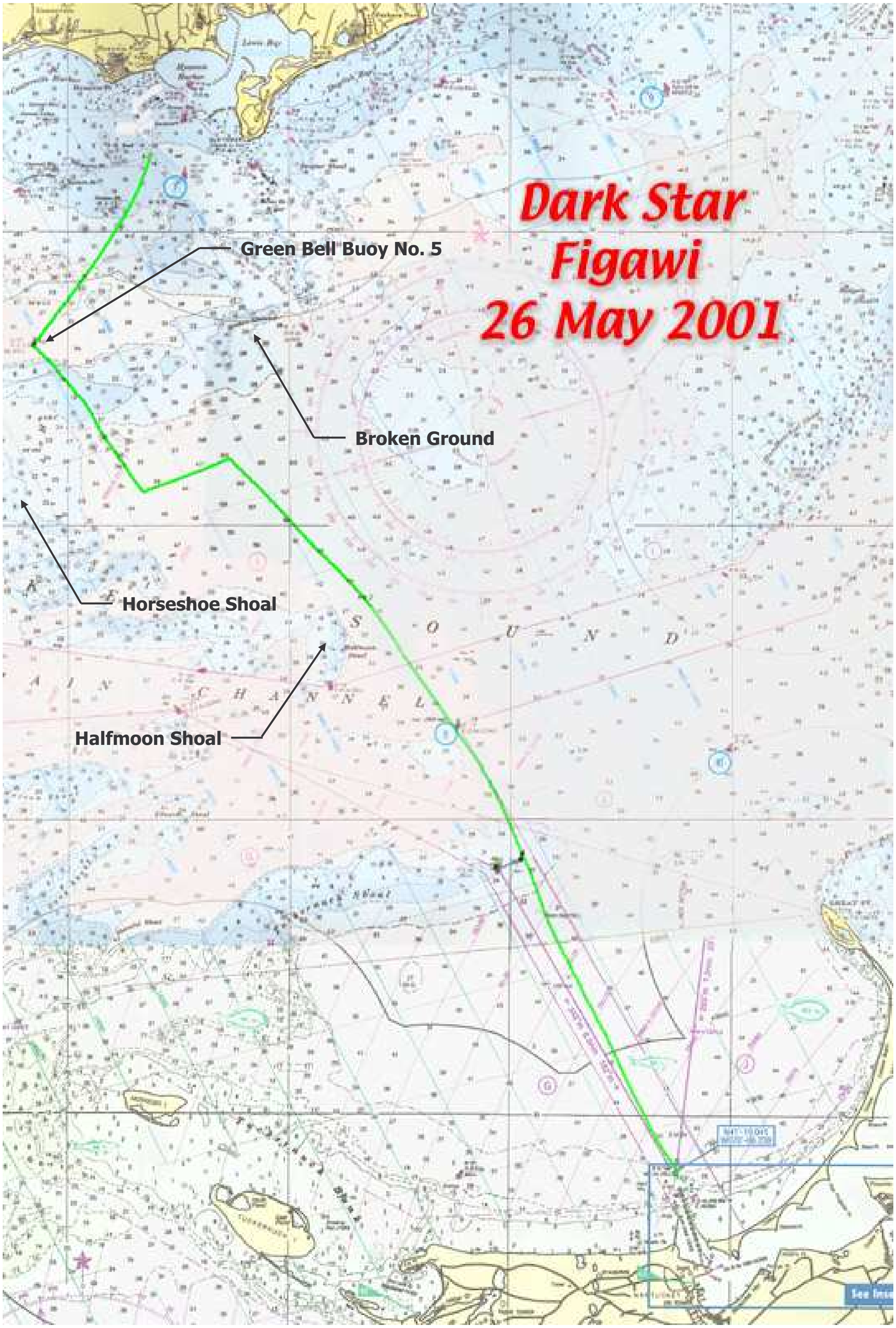

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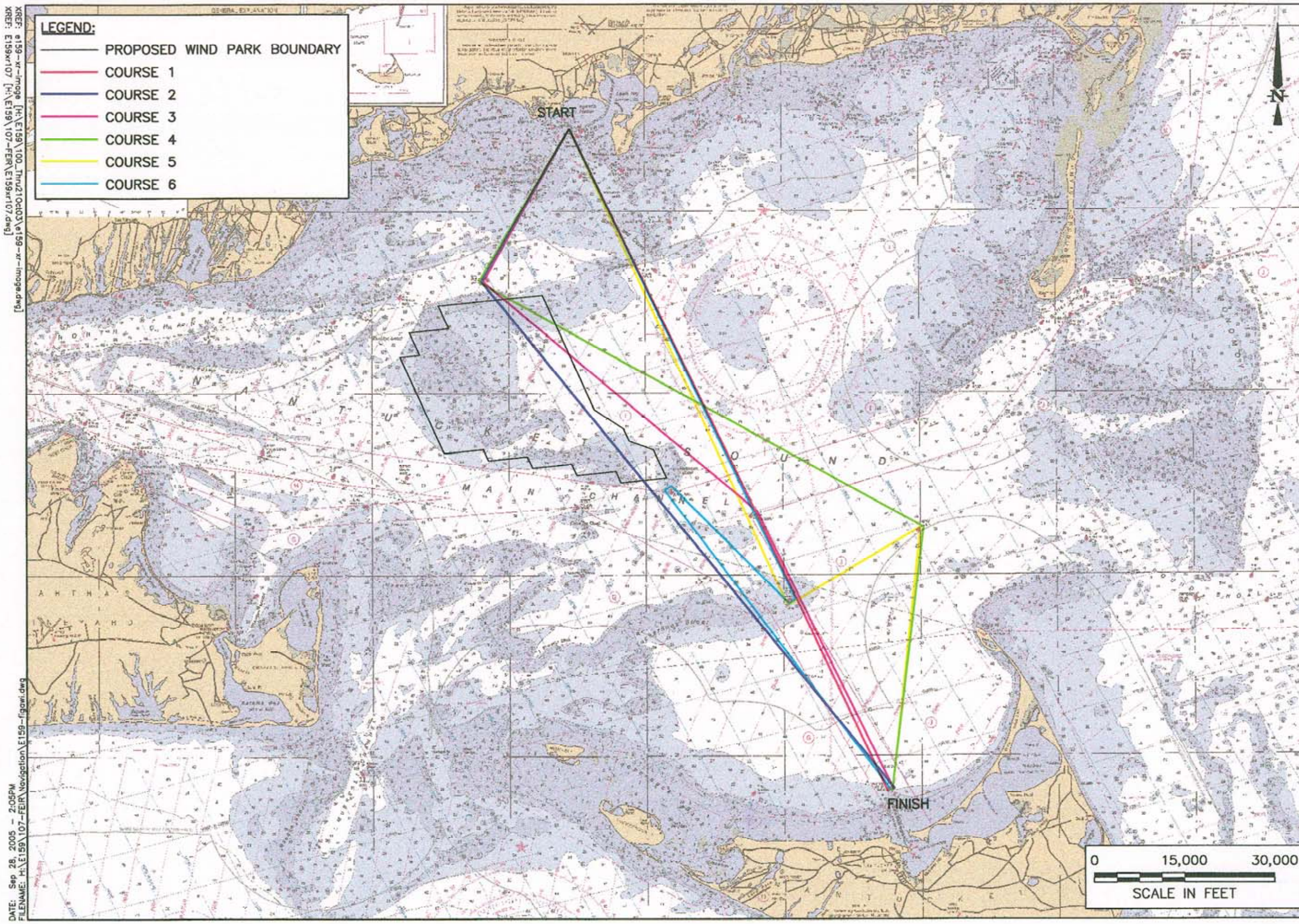
Cape Wind Project

Nantucket Sound

Source: www.the-hurds.com/sailing/DarkStar

Course of S/V *Dark Star* during 2001 Figawi Race

Figure 3-9



Published Figawi Race Courses

Figure 3-10

Cape Wind Project
Nantucket Sound

Source: 2003 & 2005 Figawi Race Sailing Instructions

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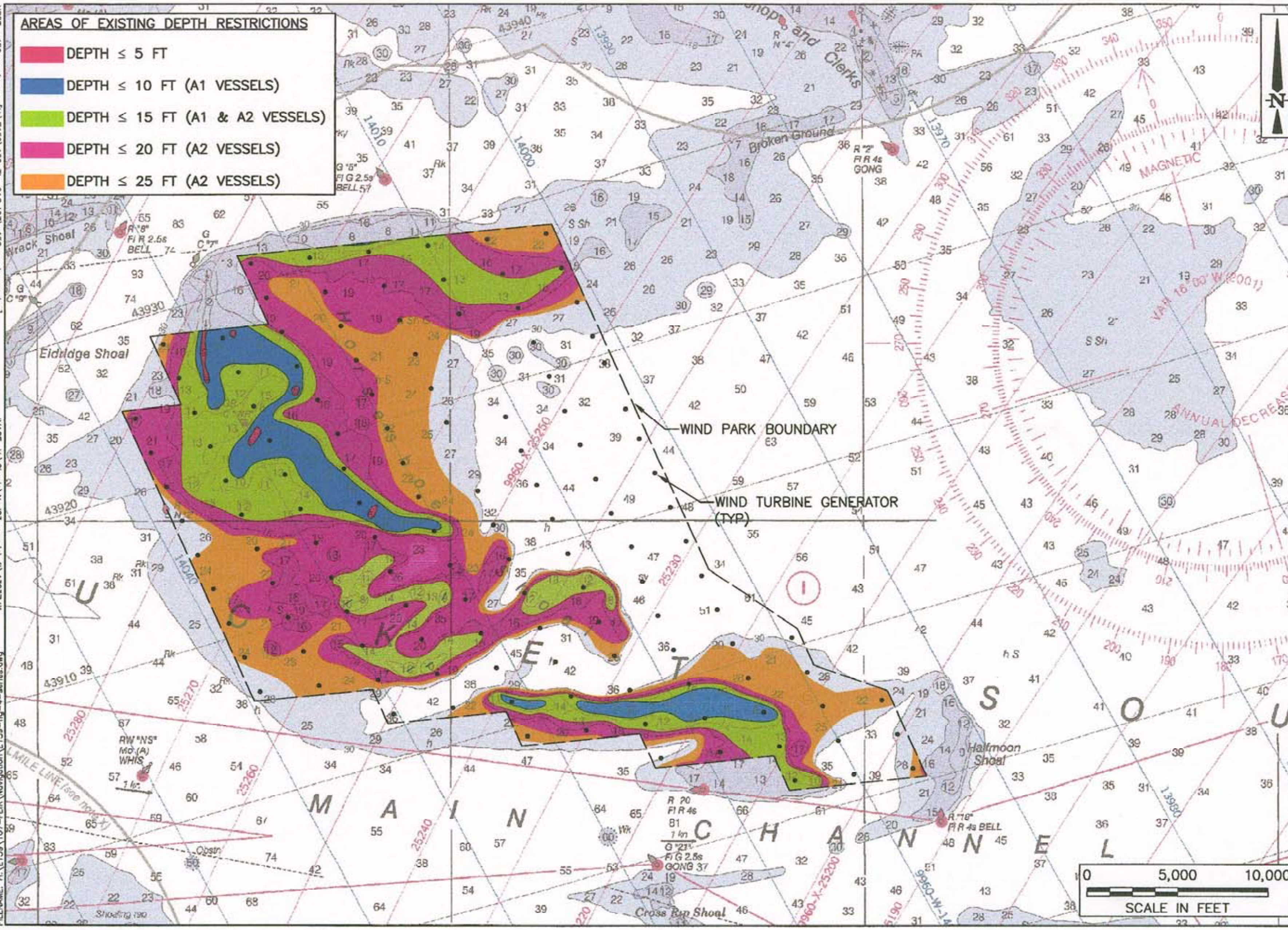

Cruise Ships/Research Vessels (Category A) Existing Depth Restrictions Within Wind Park Boundary

Figure 4-1

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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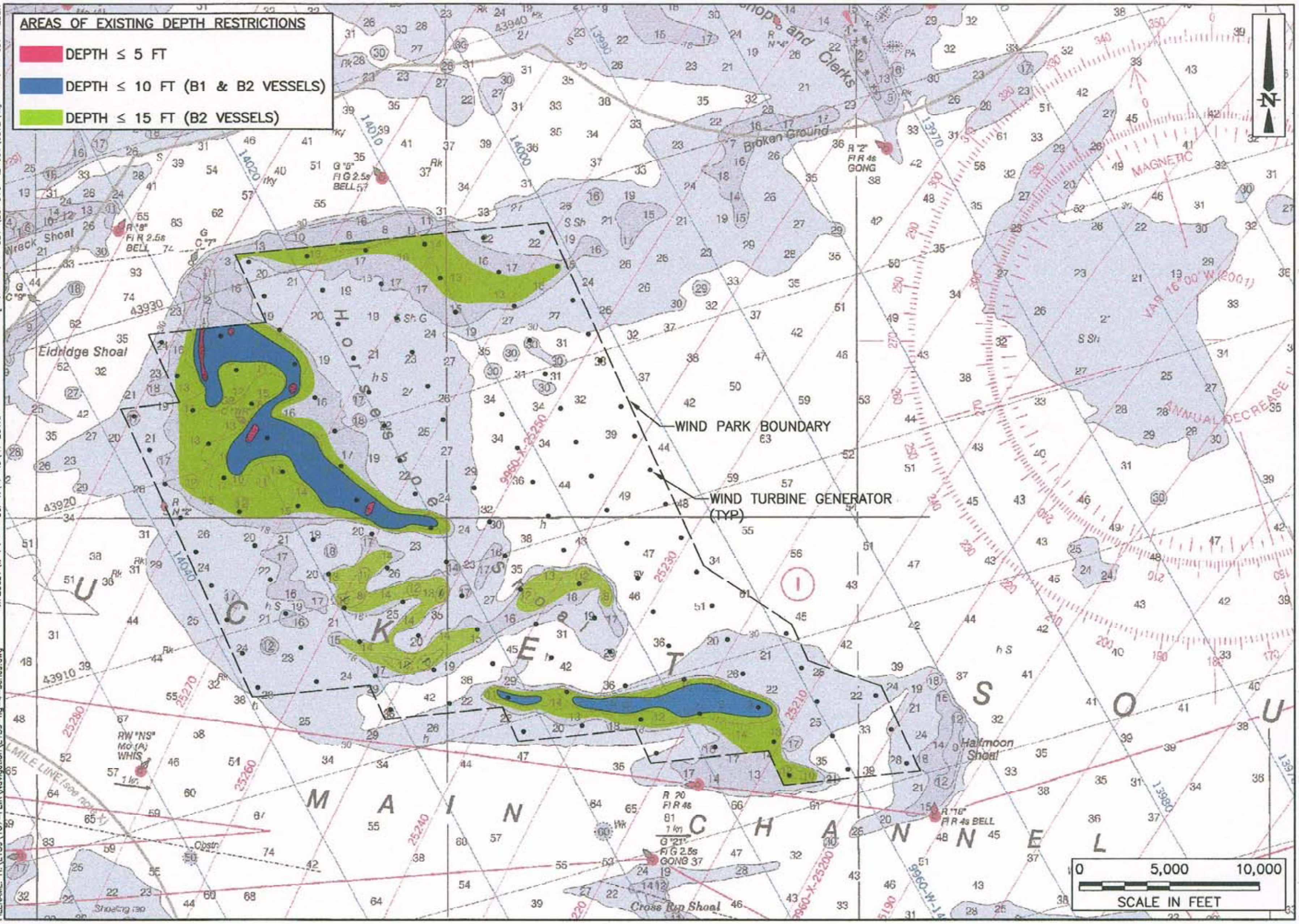

Passenger Ferries (Category B) Existing Depth Restrictions Within Wind Park Boundary

Figure 4-2

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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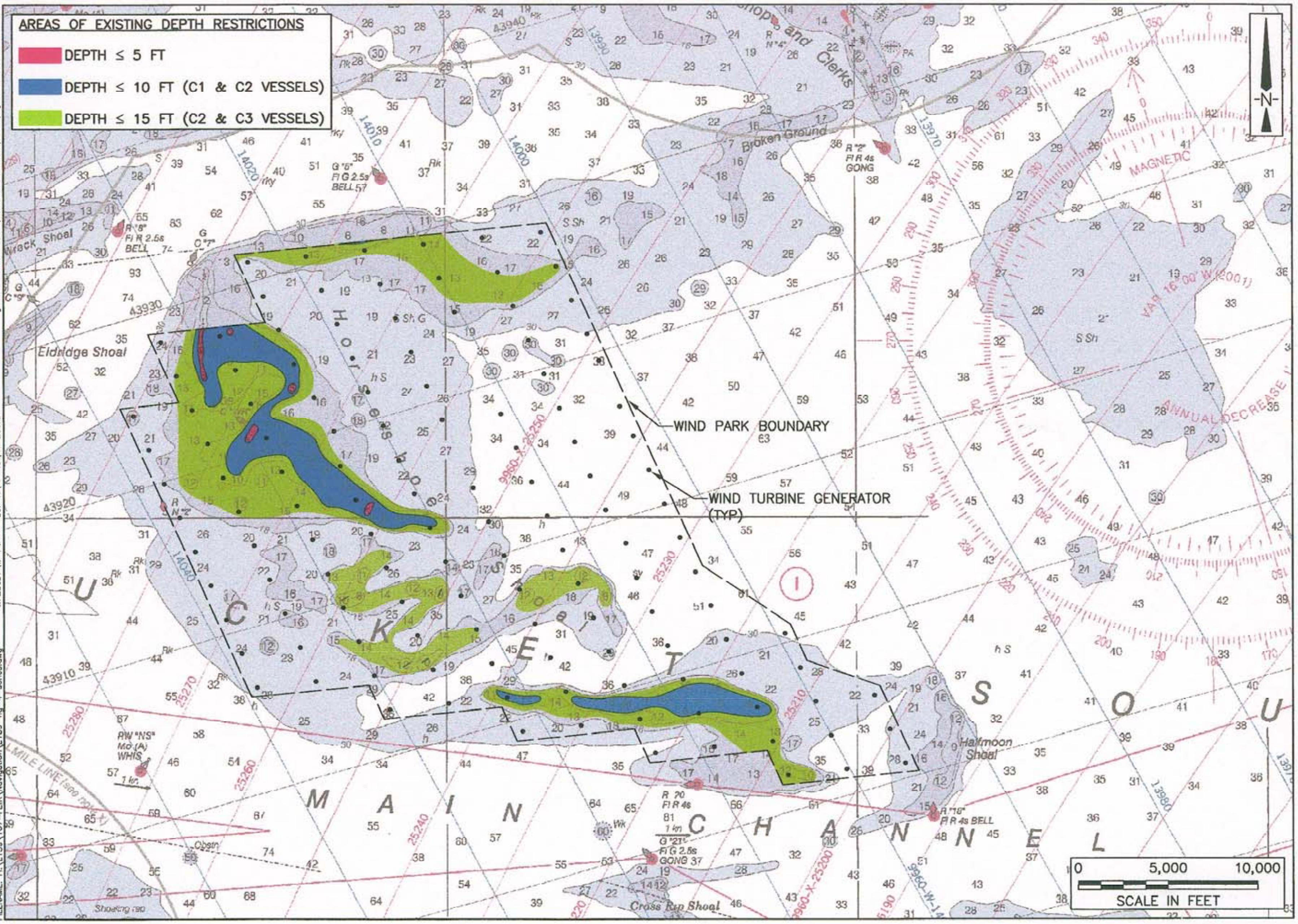

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Figure 4-3

Bulk Goods Carriers (Category C)
Existing Depth Restrictions Within Wind Park Boundary

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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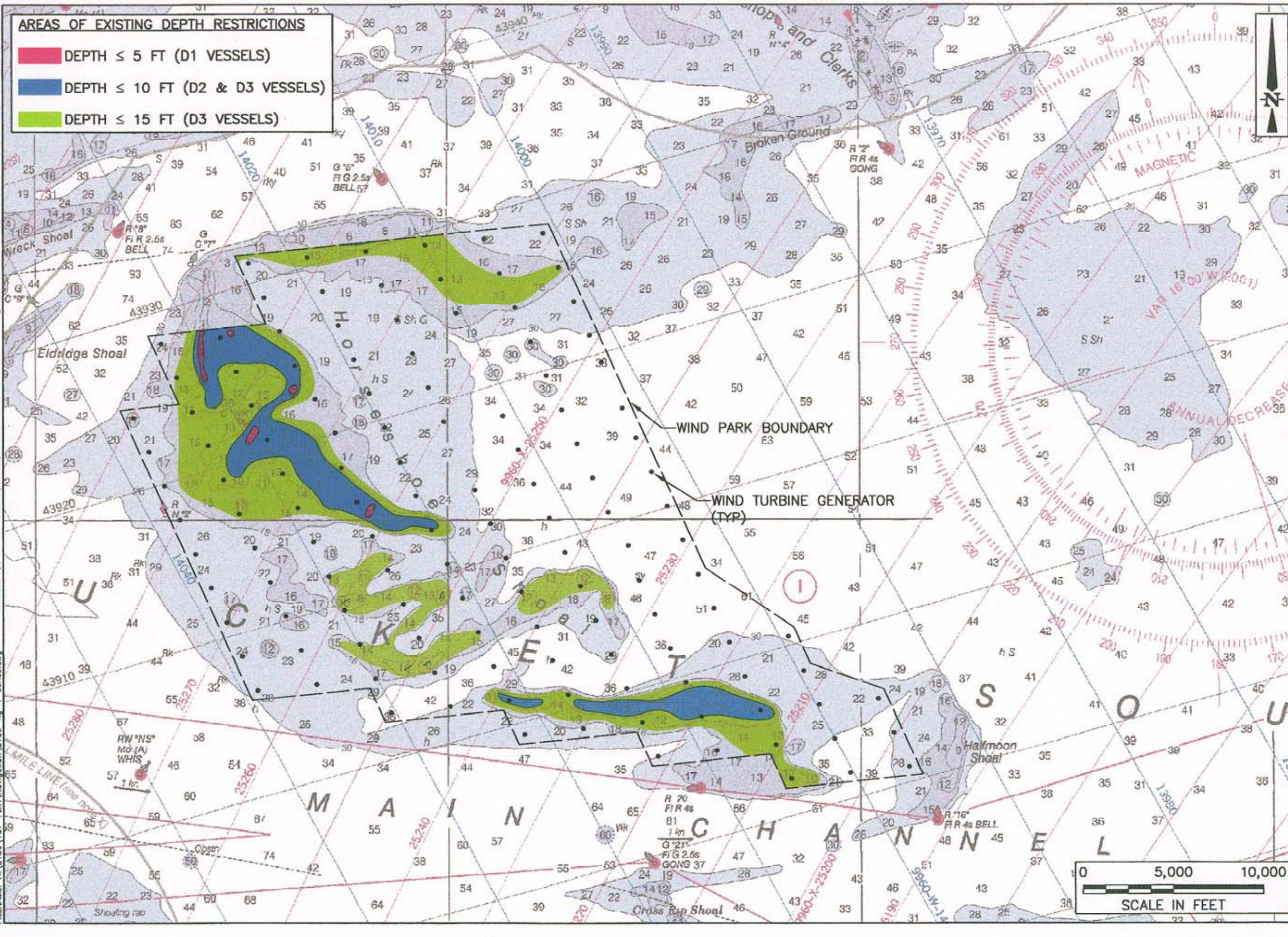

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Figure 4-4

US Coast Guard Vessels (Category D)
Existing Depth Restrictions Within Wind Park Boundary

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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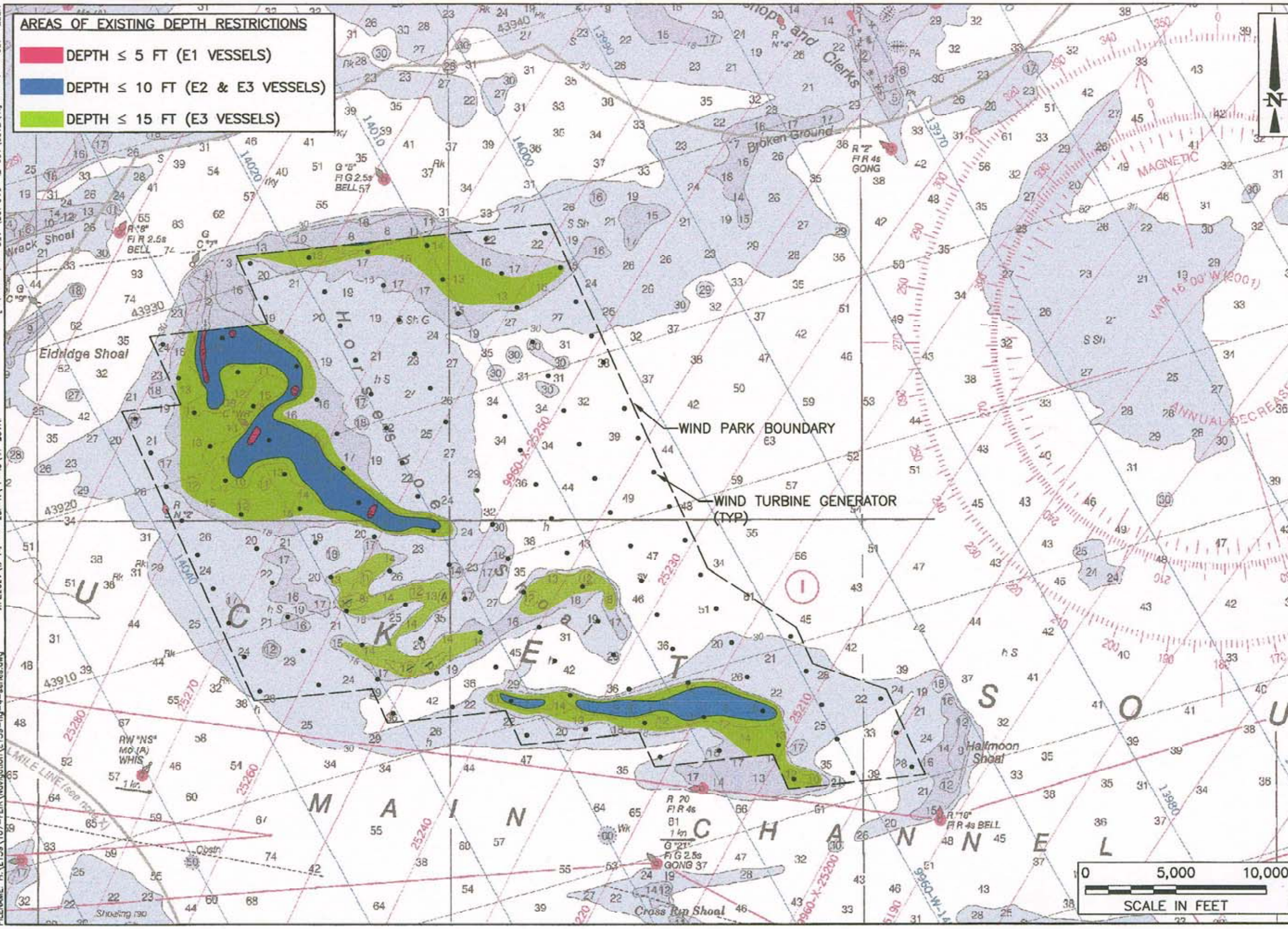

Fishing Vessels (Category E)
Existing Depth Restrictions Within Wind Park Boundary

Figure 4-5

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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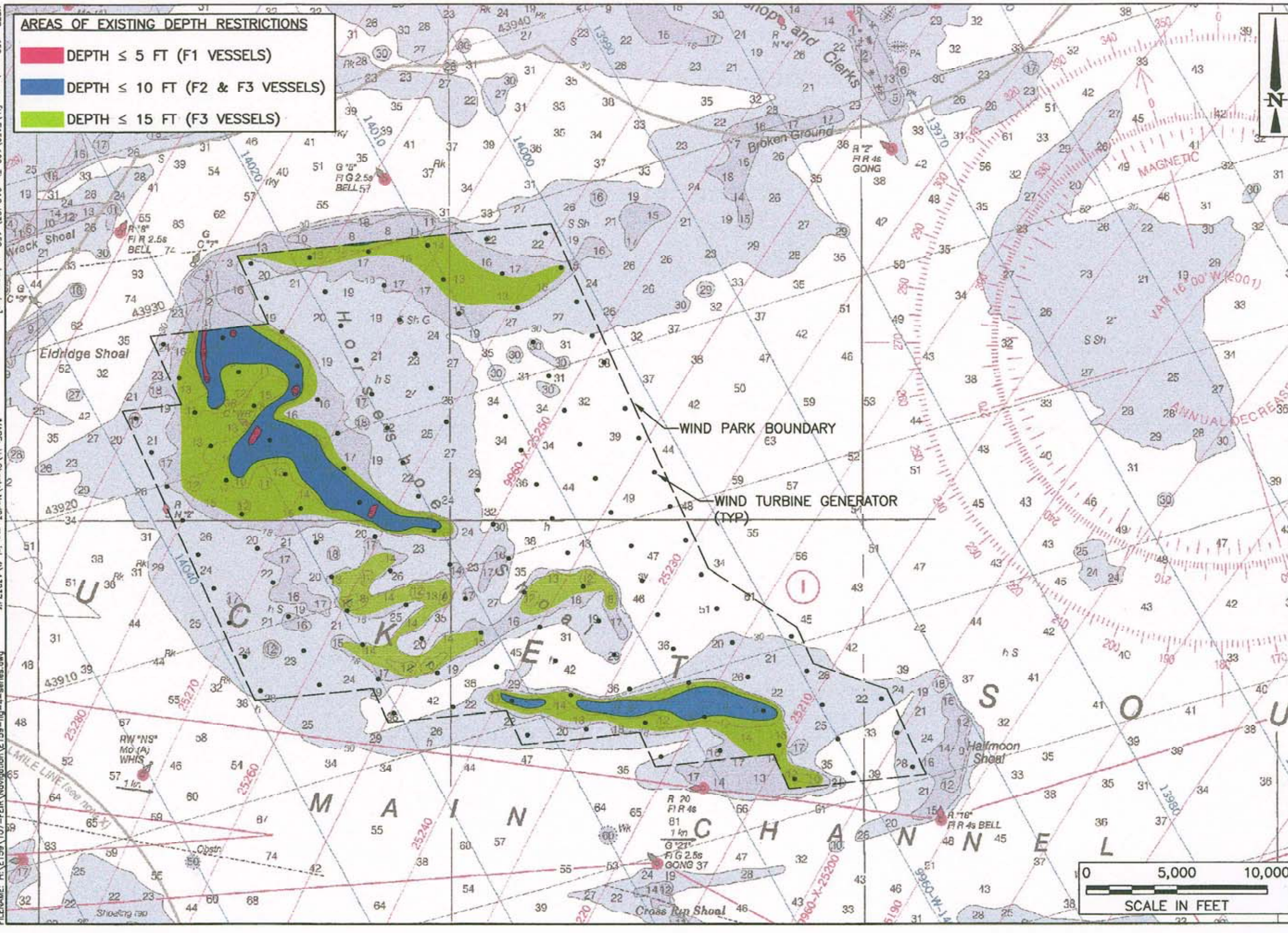

Figure 4-6

Recreational Vessels (Category F)
Existing Depth Restrictions Within Wind Park Boundary

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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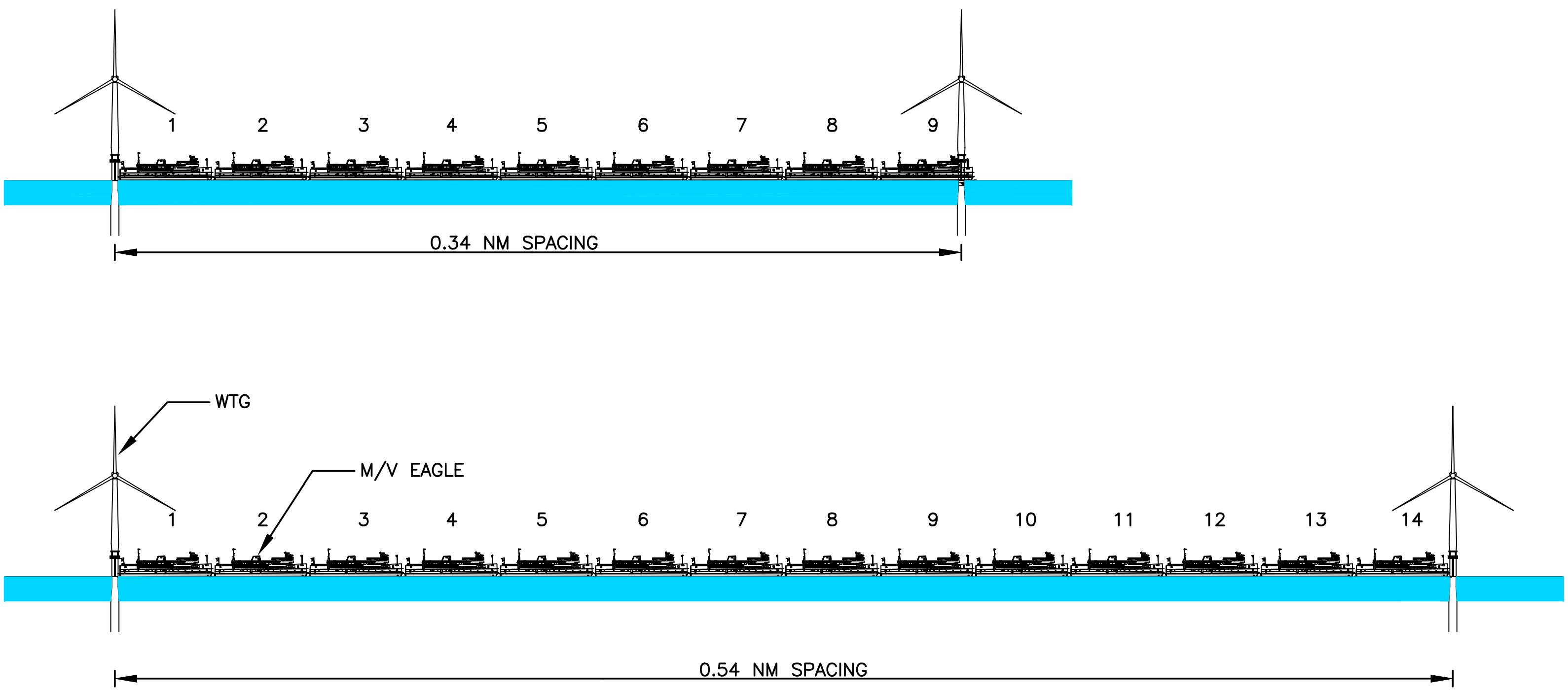

NOTES:
1. M/V EAGLE IS 233 FT LONG OVERALL.
2. M/V EAGLE PLAN PROVIDED BY THE STEAMSHIP AUTHORITY
3. 1 NAUTICAL MILE (NM) = 6,076 FT

0 300 600
SCALE IN FEET

DATE: Sep 28, 2005 – 2:14PM
FILENAME: H:\E159\107–FEIR\Navigation\e159–fig4–7.dwg

CAPE WIND PROJECT

Comparison of M\V Eagle to WTG Spacing

Figure 4-7

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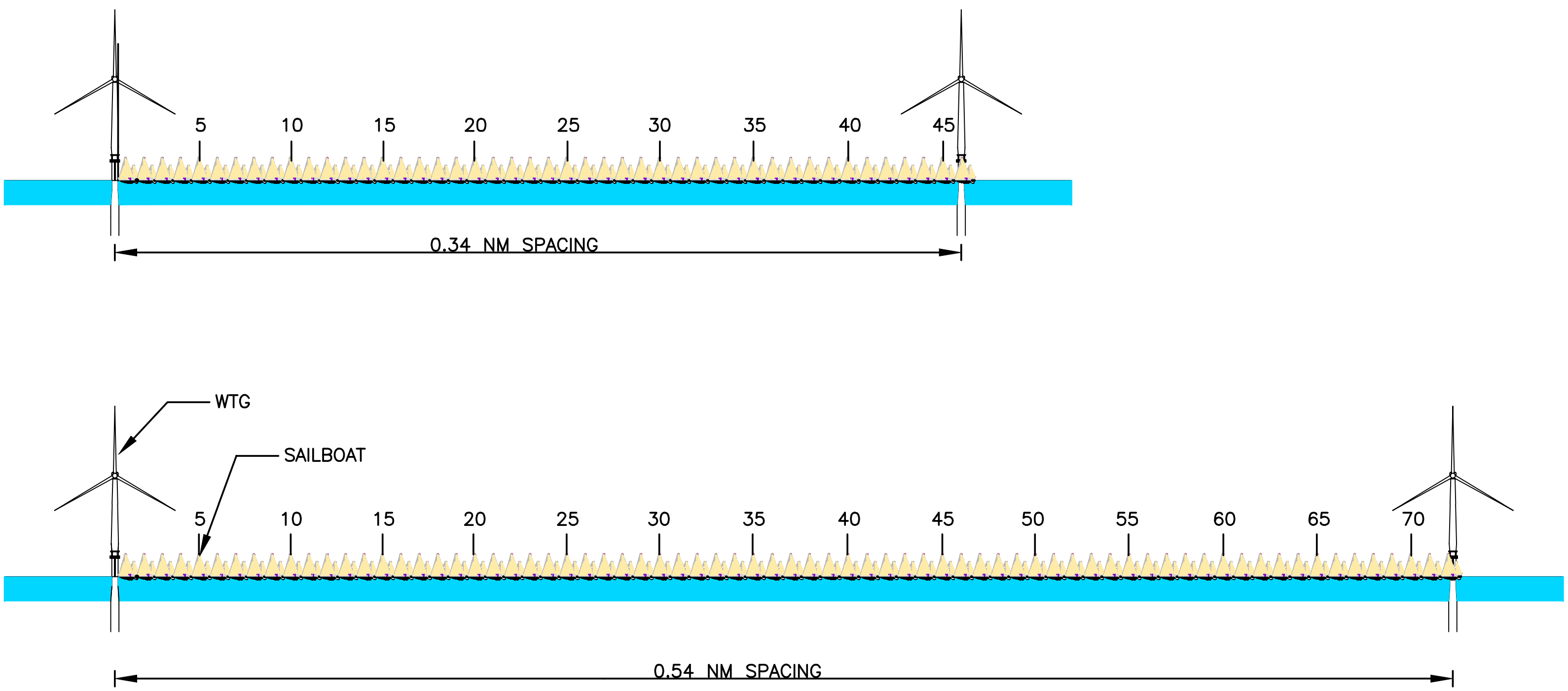

NOTES:
1. SAILBOAT IS 45 FT LONG OVERALL.
2. 1 NAUTICAL MILE (NM) = 6,076 FT

0 300 600
SCALE IN FEET

DATE: Sep 28, 2005 - 2:17PM
FILENAME: H:\E159\107-FEIR\Navigation\e159-fig4-8.dwg

Comparison of 45 Foot LOA Sailboat to WTG Spacing

CAPE WIND PROJECT

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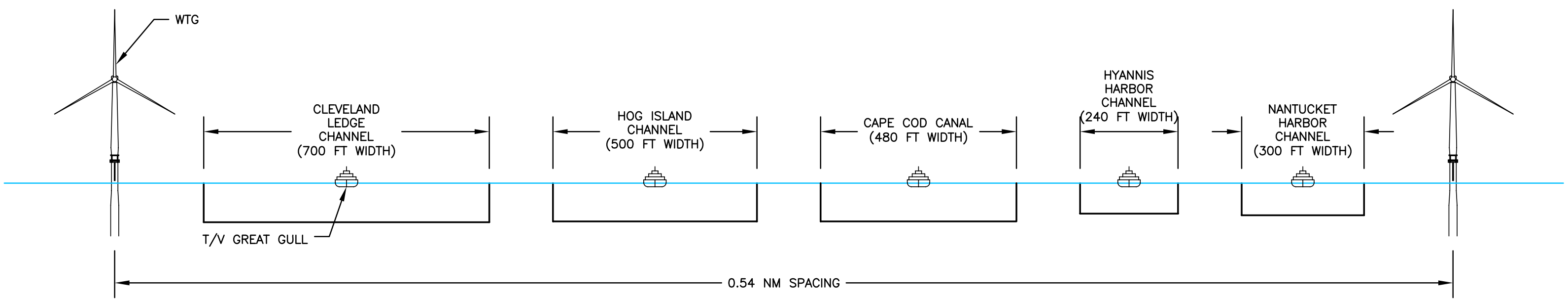
Figure 4-8



NOTE:
CHANNEL LIMITS SHOWN REPRESENT AUTHORIZED FEDERAL CHANNEL LIMITS AS SHOWN ON NOAA NAUTICAL CHARTS.

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CAPE WIND PROJECT

Comparison of Existing Channel Widths to Minimum WTG Spacing

Figure 4-9

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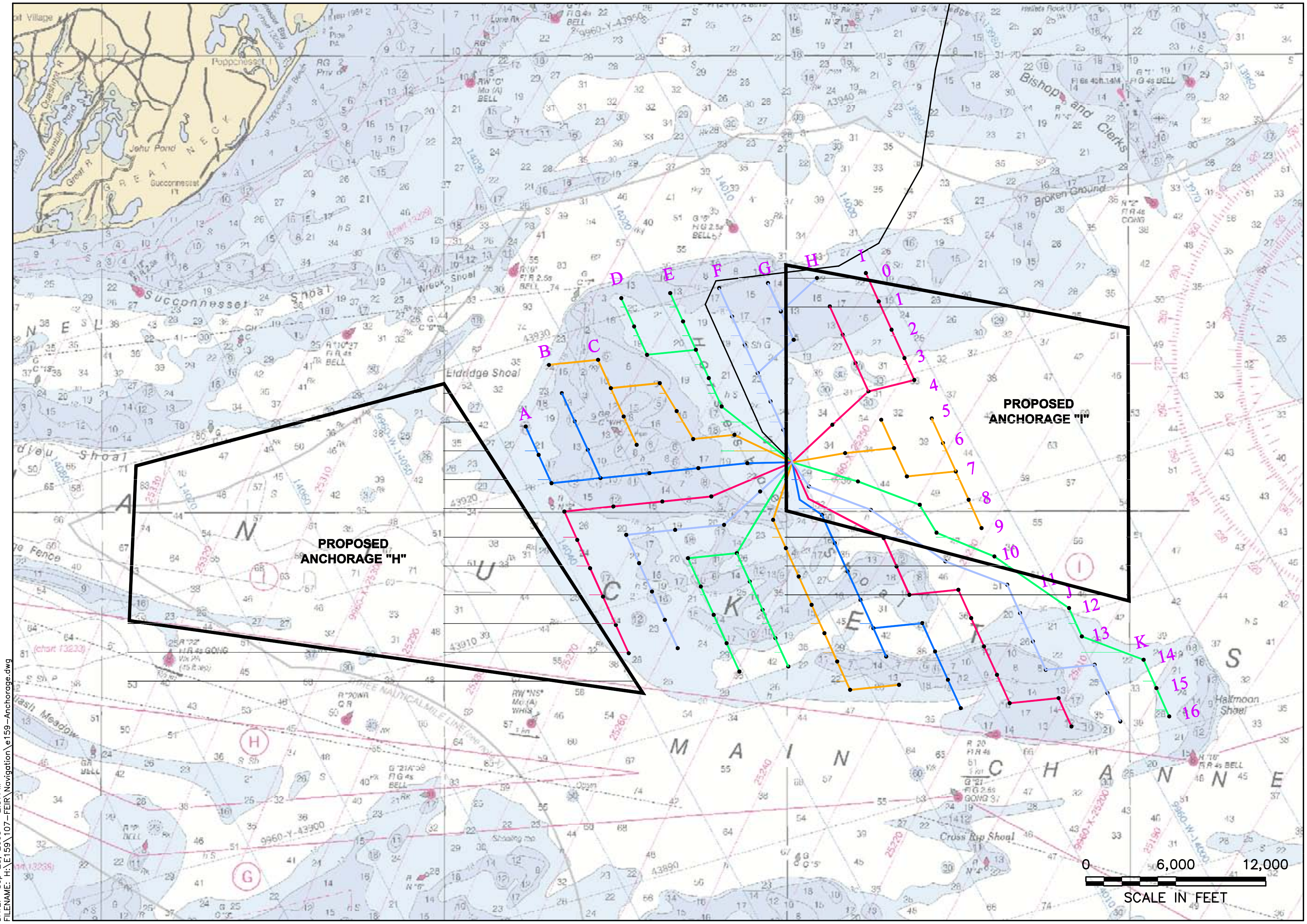

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Recommended Changes to Anchorage Areas from 2004 WAMS Analysis

Figure 4-10

Cape Wind Project
Nantucket Sound

Scale: 1"=6,000'

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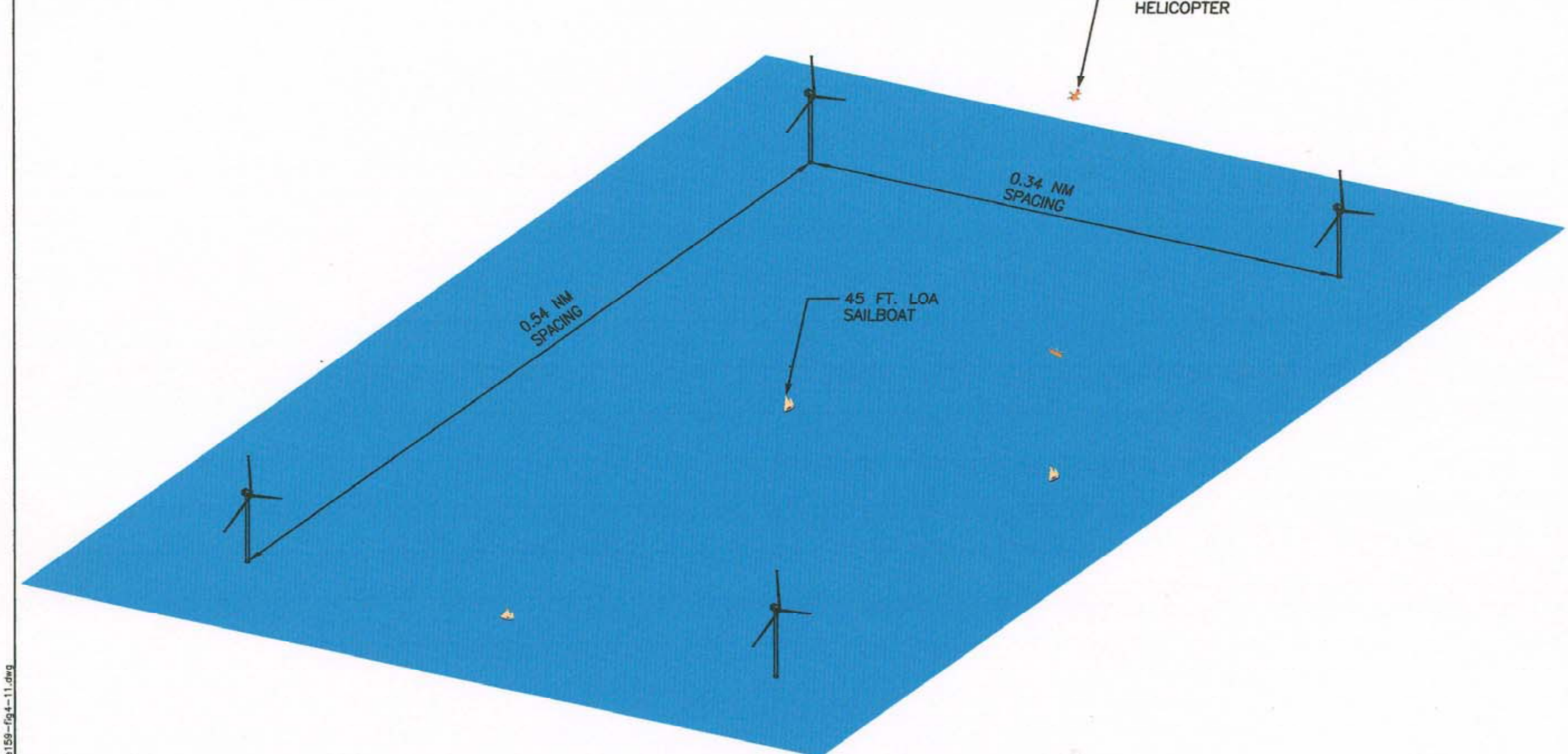

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WTG Grid Spacing in Isometric View

CAPE WIND PROJECT

Figure 4-11

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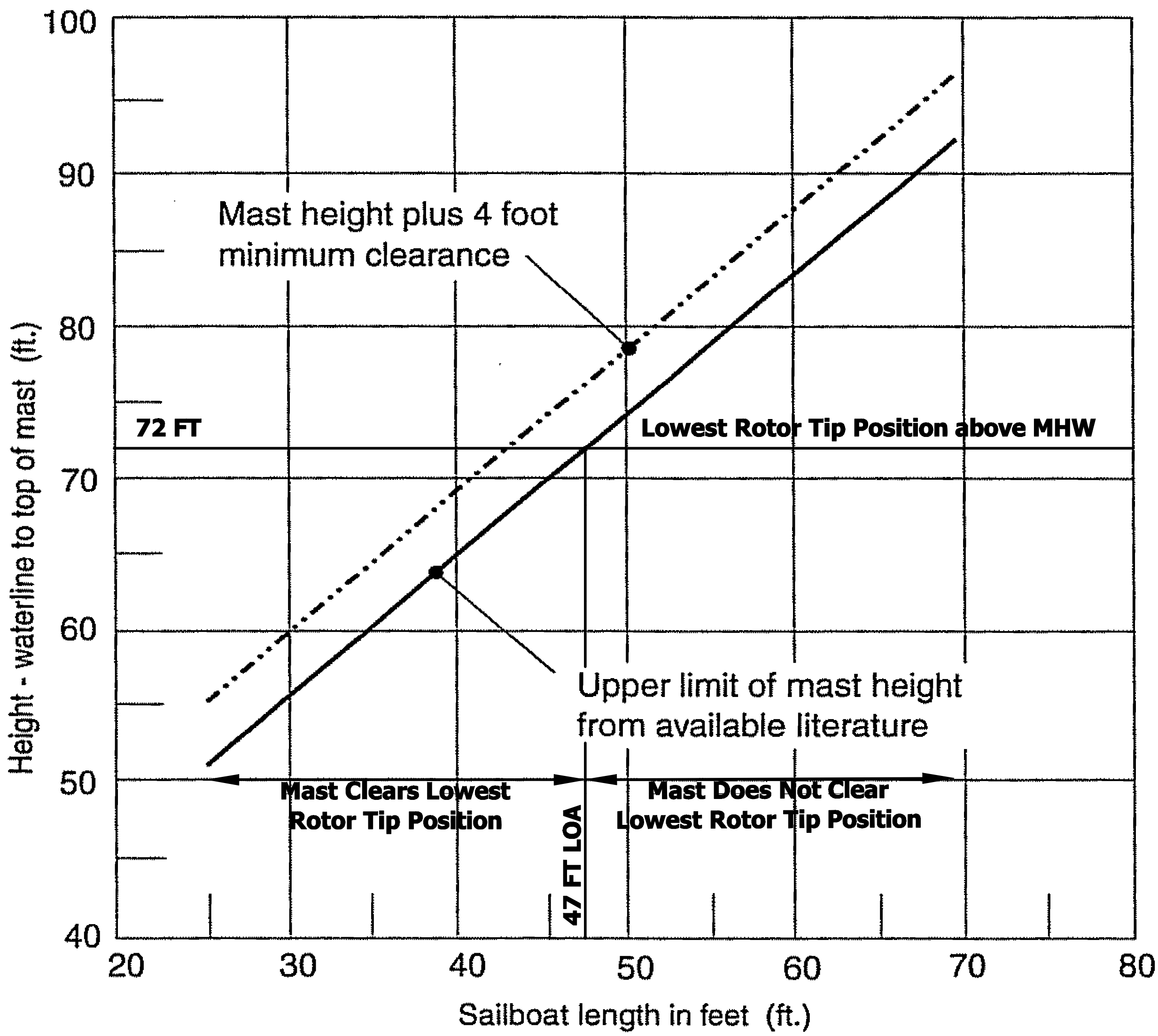

Figure 10-5. Sailboat mast height from waterline vs. sailboat length.

Cape Wind Project
Nantucket Sound

Estimated Vertical Clearance Below WTG Rotor Blade

Source: Tobiasson, "Marinas and Small Craft Harbors", 1991

Figure 4-12

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IMAGE: H:\E159\107–FEIR\Navigation\20050713165405286_0001.tif

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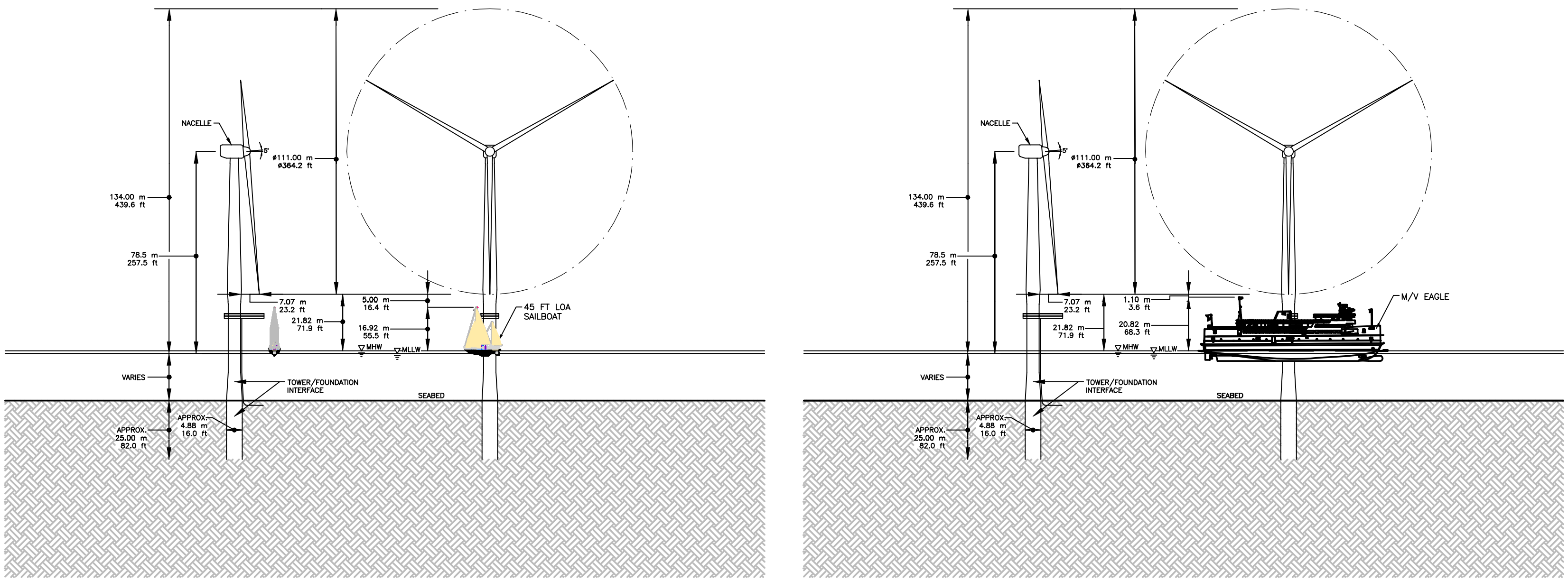

NOTE: MHW = ±3.5 FEET MLLW

0 150 300

SCALE IN FEET

Comparison of WTG to Vessel Height

Figure 4-13

Cape Wind Project
Nantucket Sound

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DATE: Sep 28, 2005 – 2:56PM
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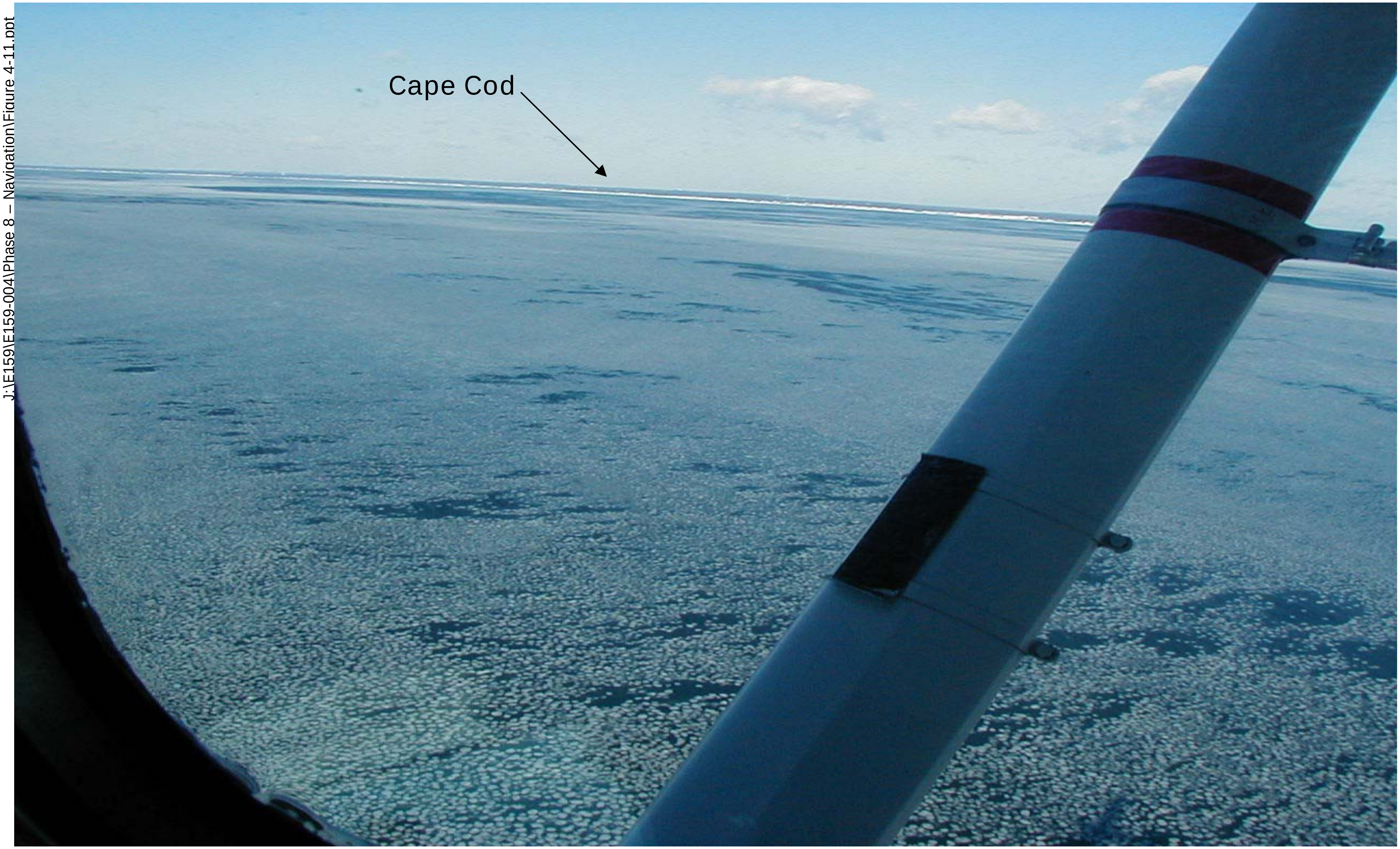

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Cape Wind Project

Nantucket Sound

Close Pancake Ice in Nantucket Sound

February 14, 2003

Figure 4-14

J:\E159\E159-004\Phase 8 – Navigation\Figure 4-12.ppt

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Cape Wind Project

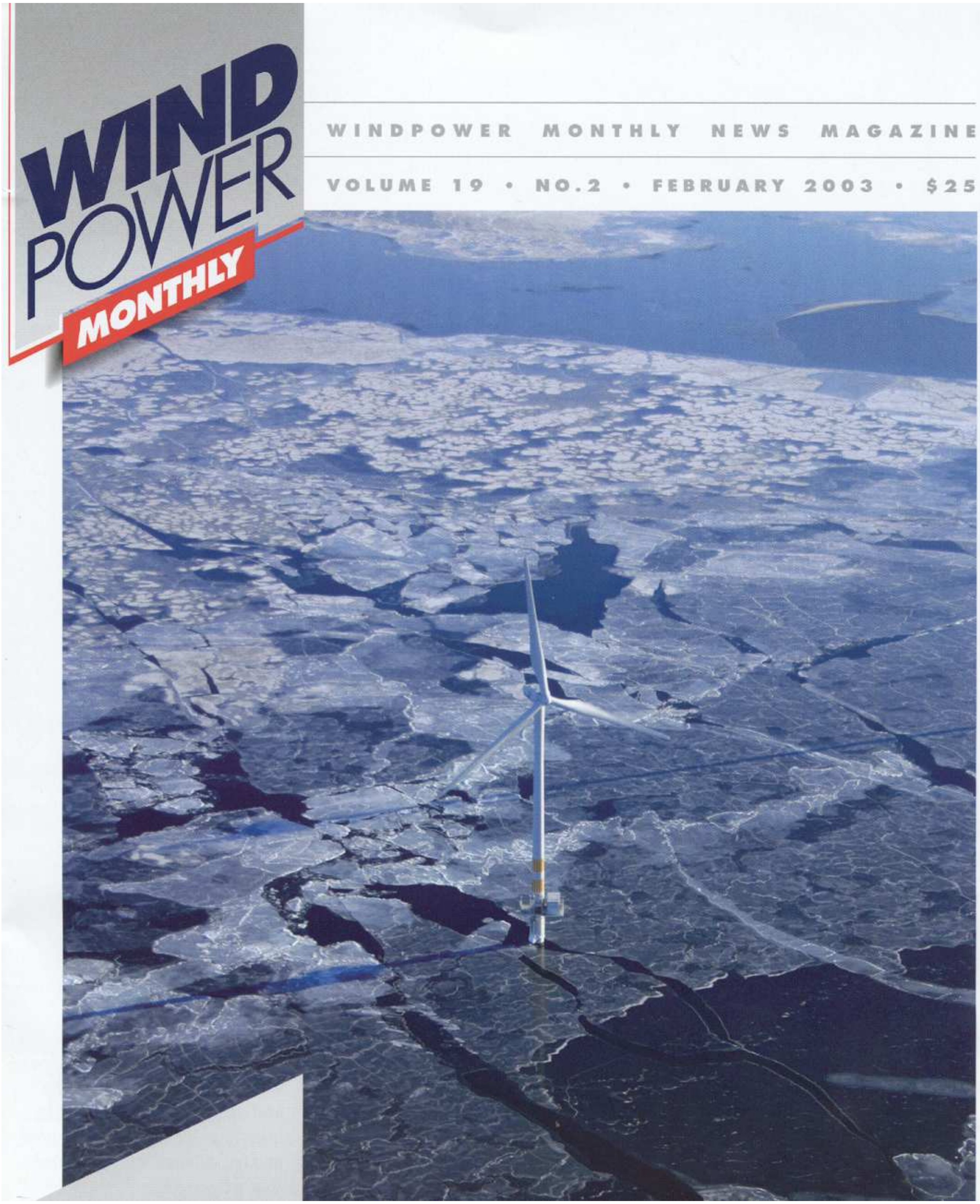
Nantucket Sound

Open Drift Grease Ice Near Cape Wind SMDS

February 14, 2003

Figure
4-15

J:\E159\E159-004\Phase 8 – Navigation\Figure 4-13.ppt



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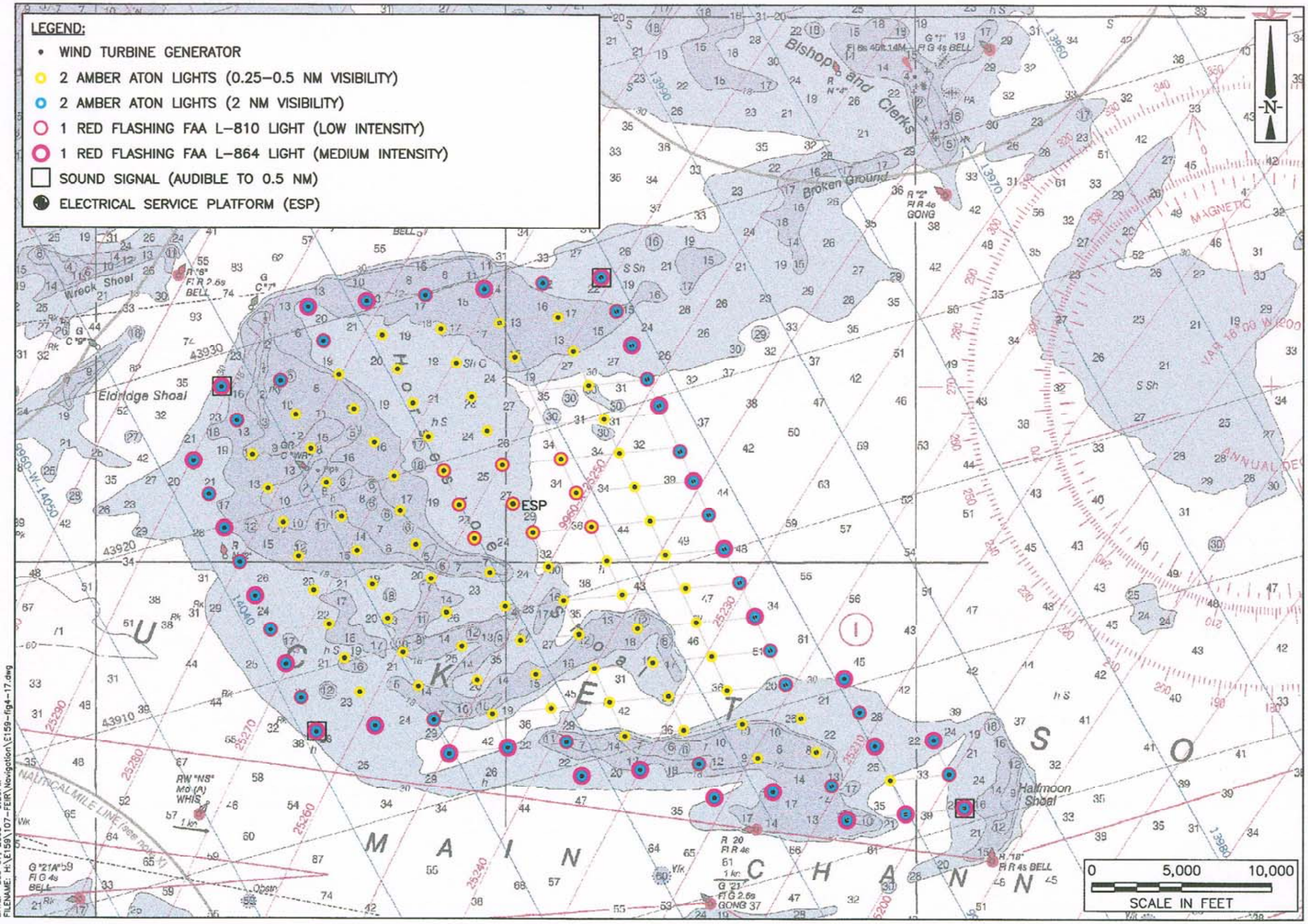
Cape Wind Project

WTG in Close Pack Young Ice Sweden

Source: Wind Power Monthly, February 2003

Figure 4-16



DATE: Dec 07, 2005 - 3:50PM
FILENAME: H:\E159\107-FEIR\Navigation\E159-fig4-17.dwg

Figure 4-17

Preliminary ATON Lighting and Sound Scheme

CAPE WIND PROJECT

Source: NOAA Chart #13237, Nantucket Sound & Approaches

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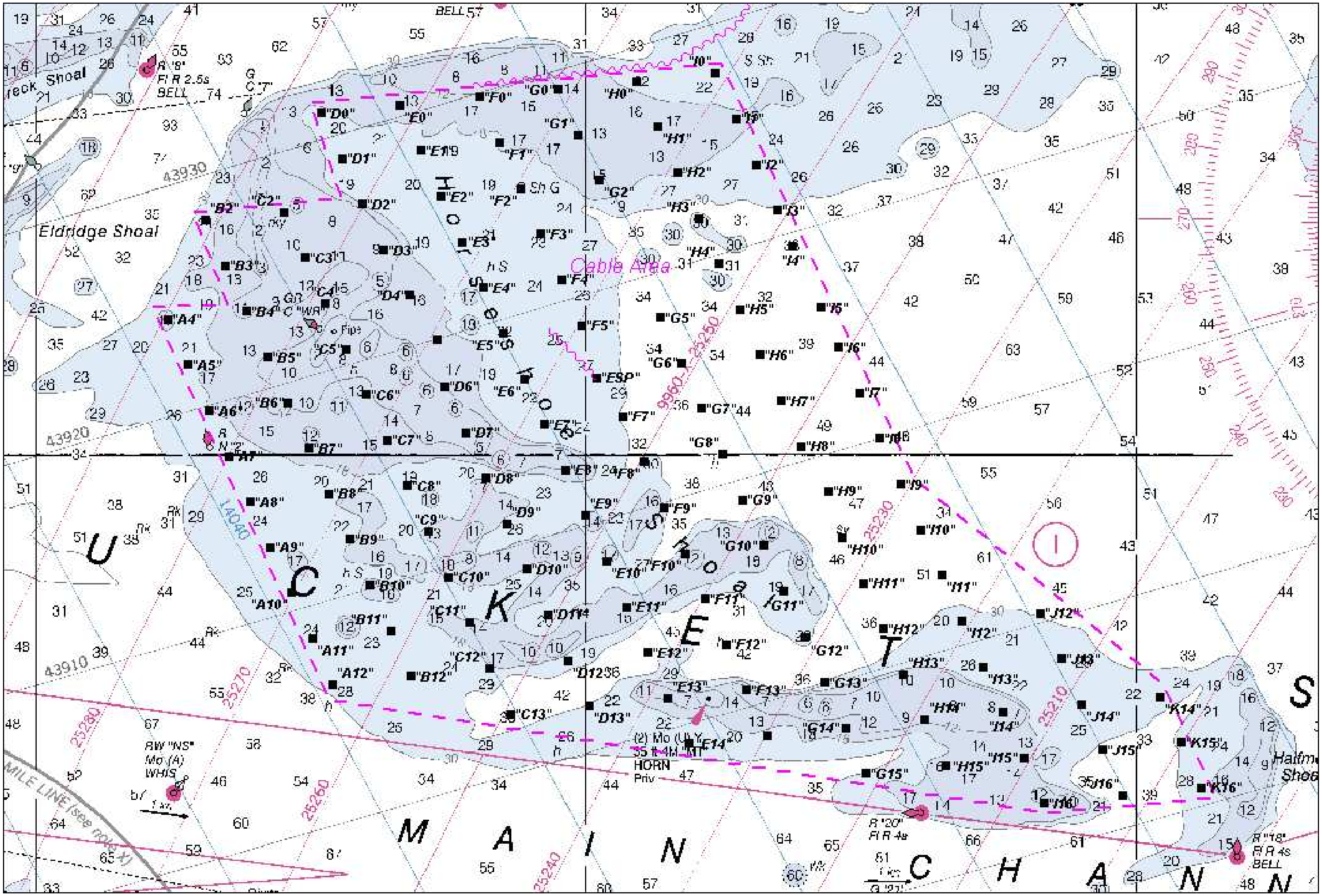

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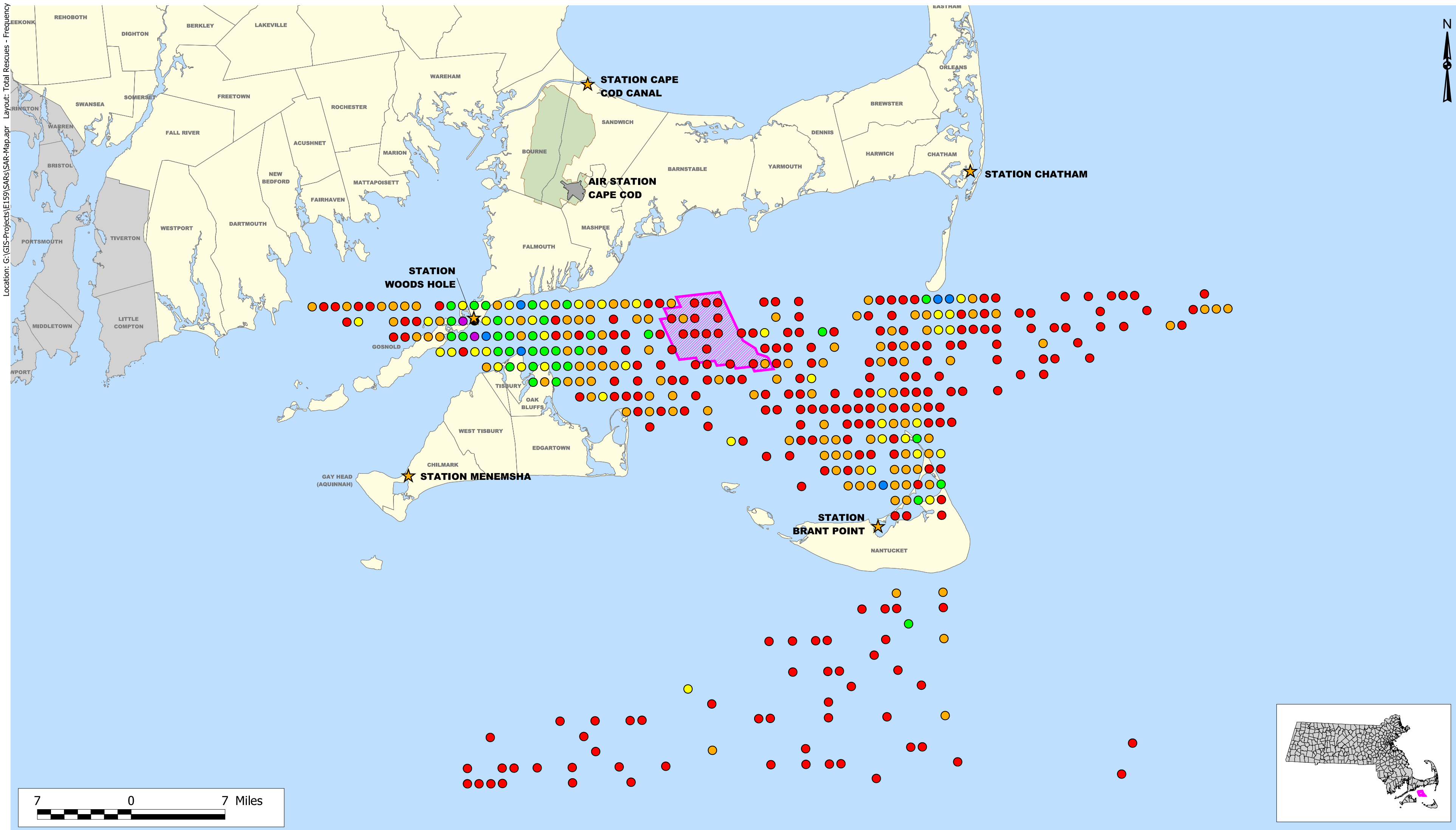
Cape Wind Project

Nantucket Sound

Example of Potential NOAA Chart For CWA Wind Park

Figure 4-18



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CAPE WIND
Nantucket Sound, Massachusetts

Scale: As Shown

Source: 1) MassGIS, Towns with Coastline, 2002
2) MassGIS, Military Boundaries, 1988
3) USCG, SAR Data, 1991-2002
4) RIGIS, Towns, 1997

- USGS Stations
- Wind Park Boundary
- Military Runway
- Otis Military Base Boundary
- Towns of Massachusett
- Towns of Rhode Island

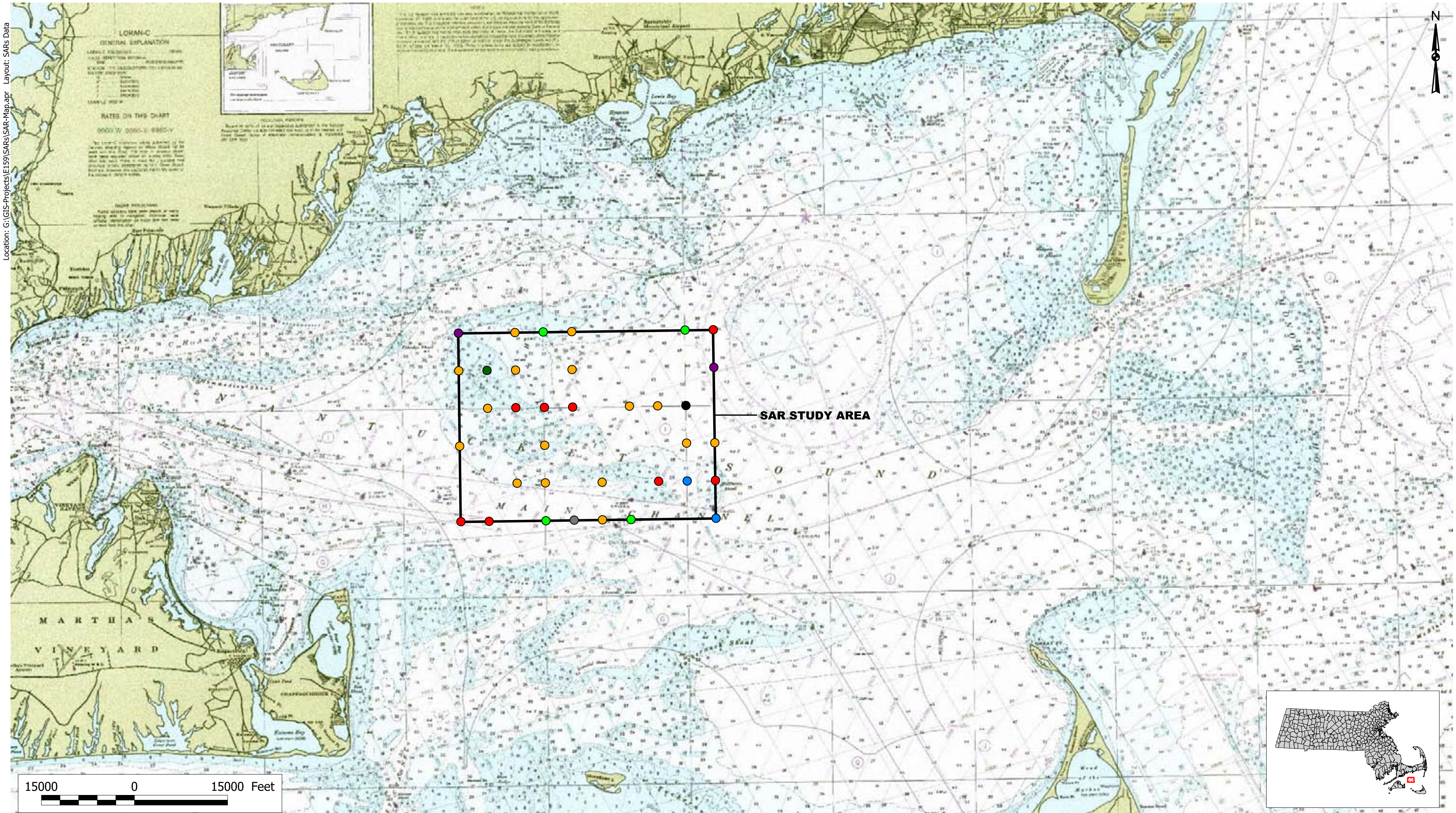
Number of Rescue Sorties by Coast Guard and Civilians at Specific Locations

- 1 - 3
- 4 - 8
- 9 - 15
- 16 - 28
- 29 - 57
- 58 - 152
- 153 - 271

SAR Sorties Provided By USCG October 1991 to September 2002

Figure 5-1

Location: G:\GIS-Projects\E159\SARs\SAR-Map.apr Layout: SARs Data



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CAPE WIND
Nantucket Sound, Massachusetts

Scale: As Shown

Source: 1) MassGIS, NOAA Chart, 1989
2) USCG, SAR Data, 1991-2002

Number of Sorties by Coast Guard and Civilians at Specific Locations

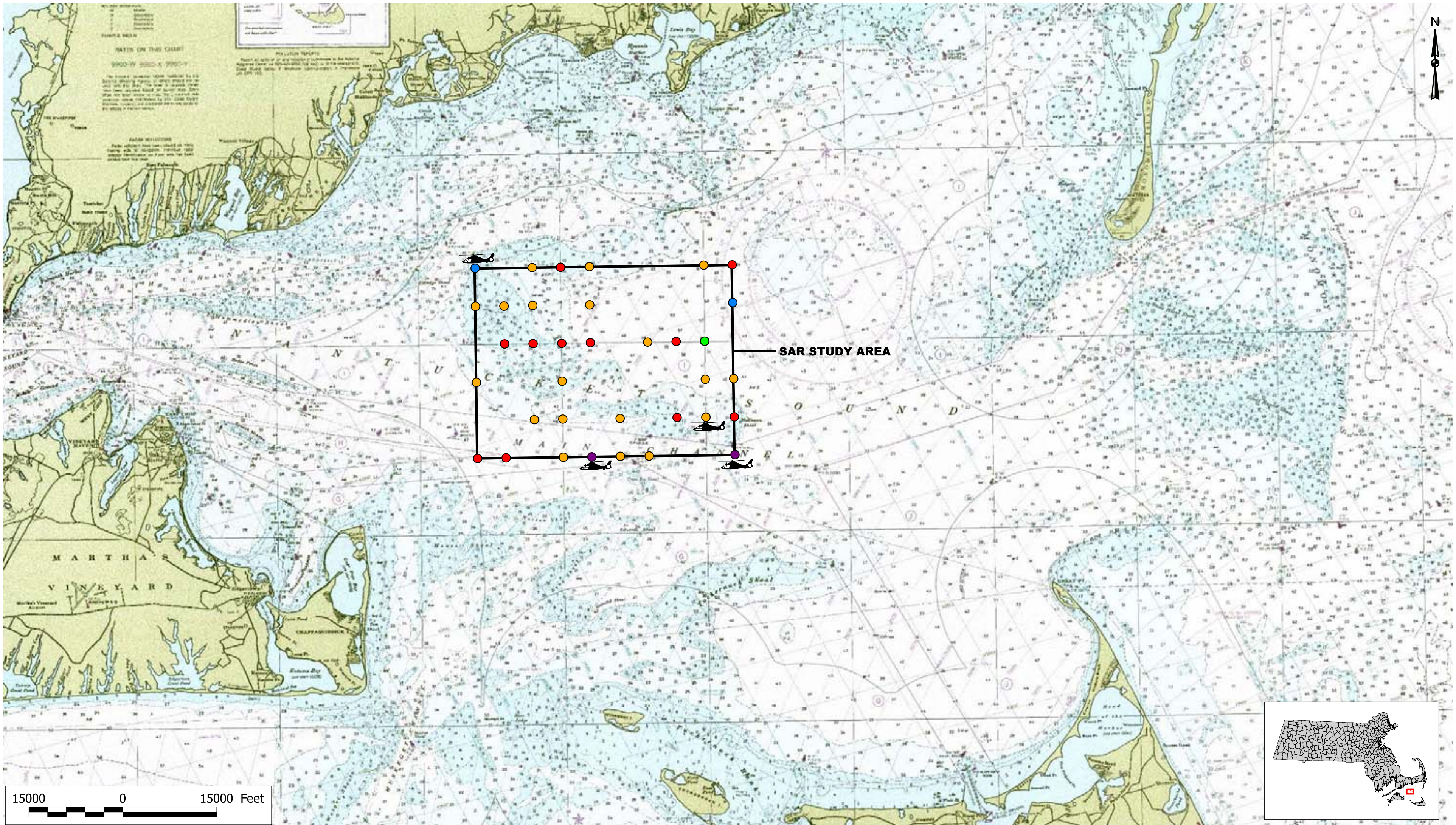
- 1 (red)
- 2 (orange)
- 3 (light green)
- 4 (dark green)
- 5 (blue)
- 6 (purple)
- 7 (grey)
- 9 (black)

Rescue Methods

Commercial Towing/Salvage Firm, Communications Assistance Only, Communications Facilities, Communications Station, Field Unit (Other Than RCC), HH52, MLB, Medium Range Recovery Helicopter, Motor Lifeboat (Misc), None Reported, Other Aircraft, Other Non-ship's Boat, Private Boater, RCC, RCC Coordination, Rigid Hull Inflatable Boat (Medium (16'-21'11"), UTB, Utility Boat - Big (41'), Utility Boat - Medium (25'-40'11"), WPB

SAR Sorties in SAR Study Area
November 1991 to August 2002

Figure 5-2A



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CAPE WIND
Nantucket Sound, Massachusetts

Scale: As Shown

Source: 1) MassGIS, NOAA Chart, 1989
2) USCG, SAR Data, 1991-2002

Number of Incidents by Coast Guard and Civilians at Specific Locations

1
2
3
4
5

Indicates assistance by aircraft response

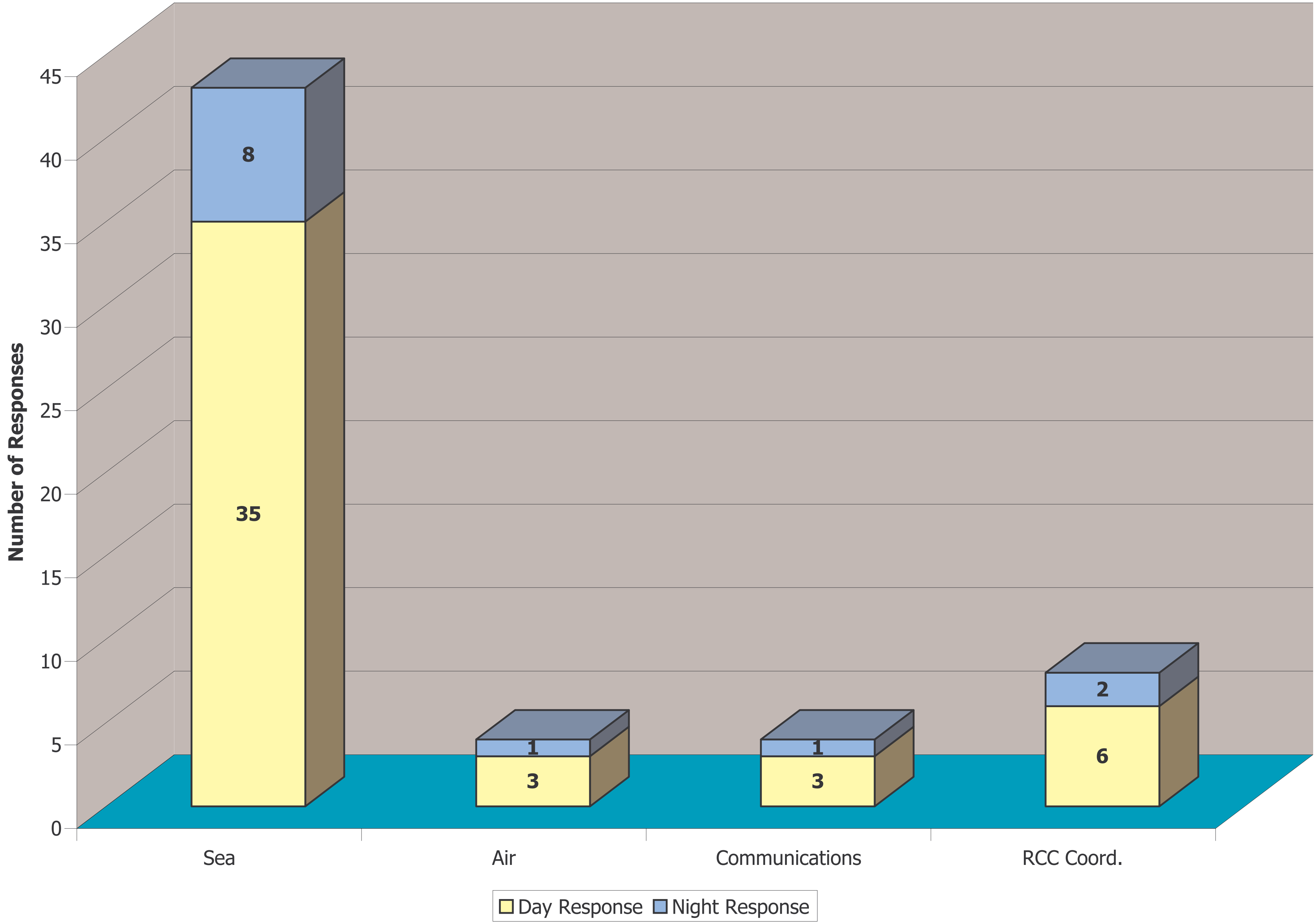
Rescue Methods

Commercial Towing/Salvage Firm, Communications Assistance Only, Communications Facilities, Communications Station, Field Unit (Other Than RCC), HH52, MLB, Medium Range Recovery Helicopter, Motor Lifeboat (Misc), None Reported, Other Aircraft, Other Non-ship's Boat, Private Boater, RCC, RCC Coordination, Rigid Hull Inflatable Boat (Medium (16'-21'11"), UTB, Utility Boat - Big (41'), Utility Boat - Medium (25'-40'11"), WPB

SAR Incidents in SAR Study Area
November 1991 to August 2002

Figure 5-2B

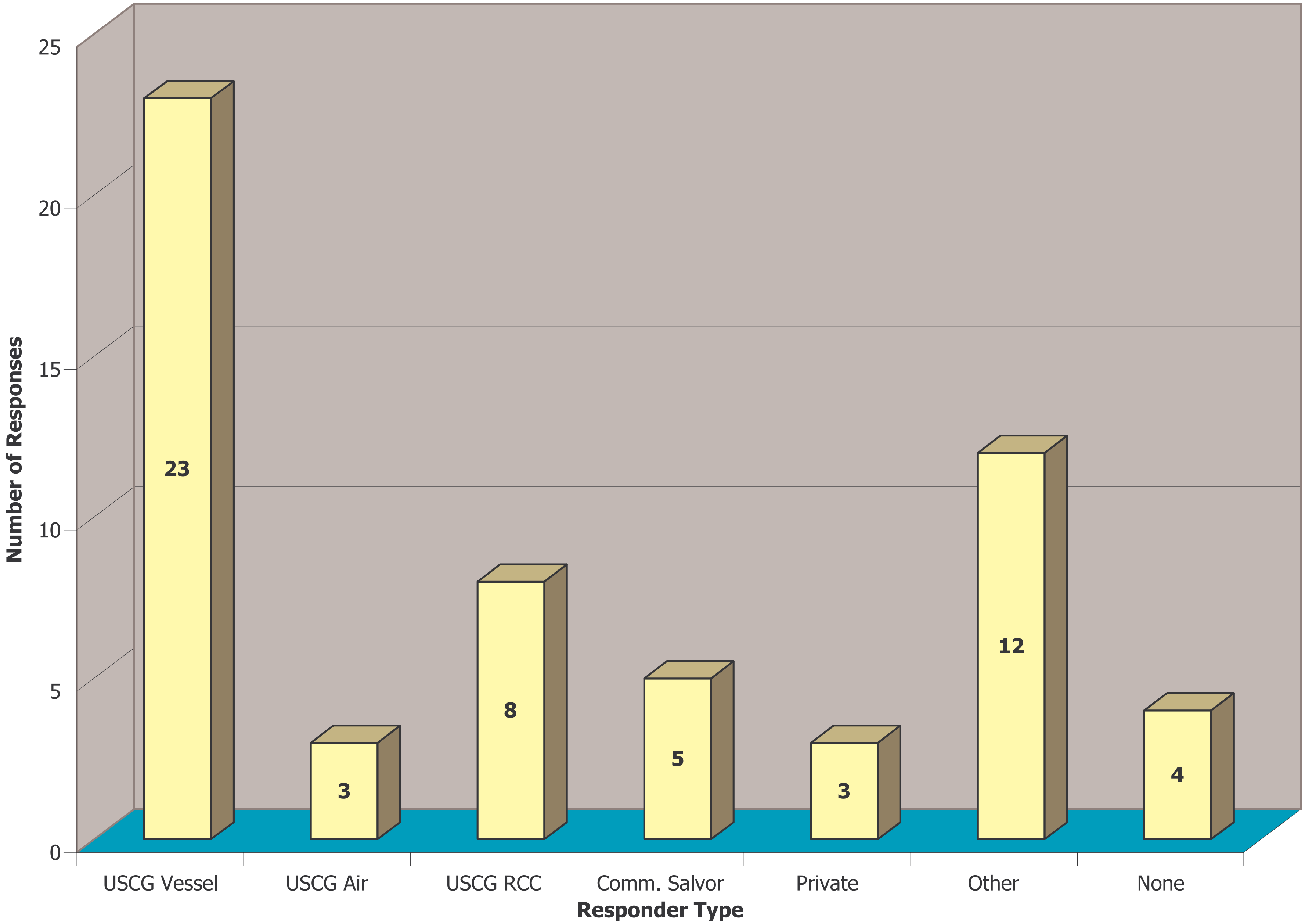
Figure 5-3
Types of SAR Responses to Incidents In and Around Horseshoe Shoal
November 1991 - August 2002



SAR Data Provided by USCG

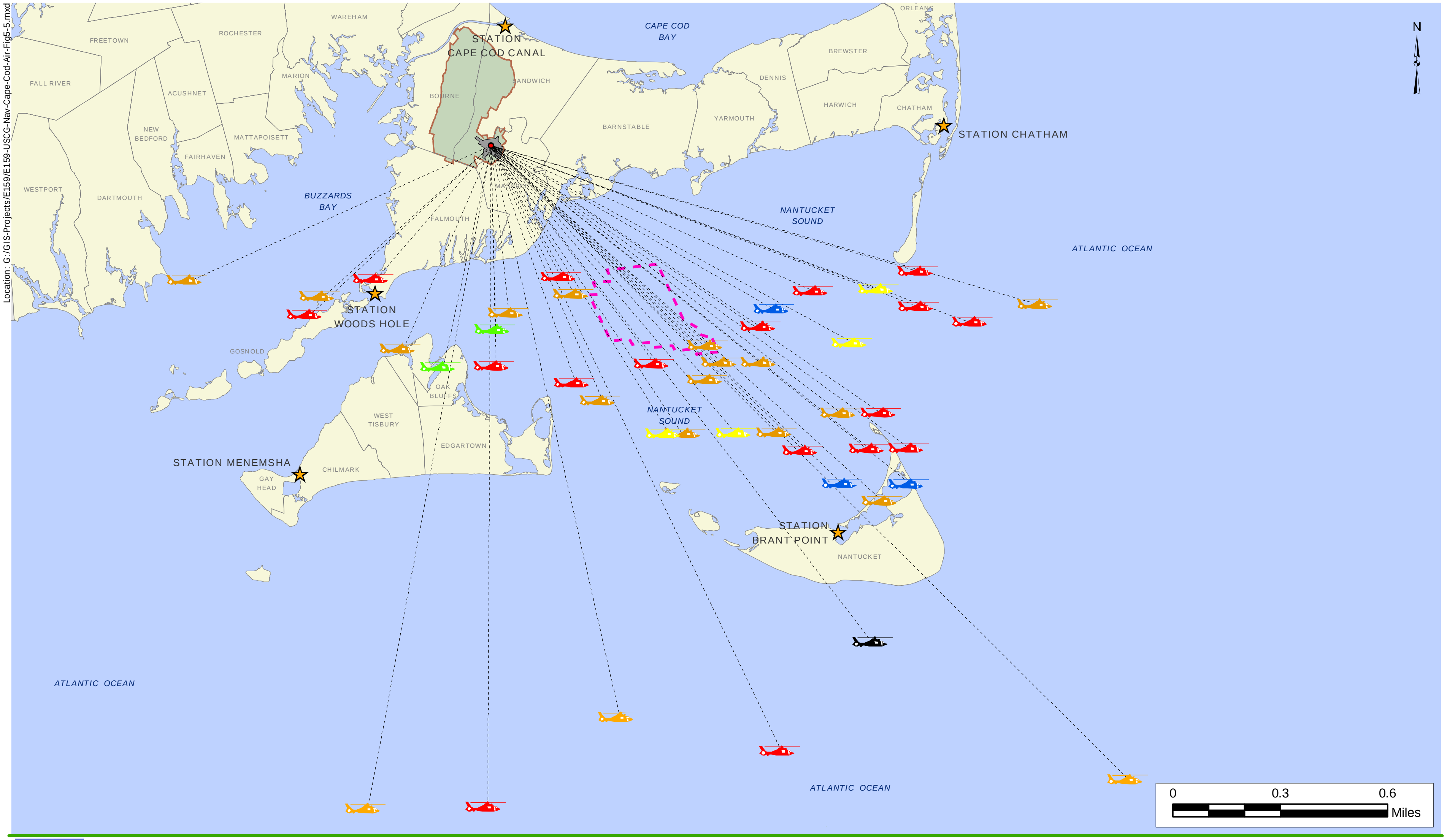
J:\E159\FEIS\Navigation\Tables\USCG_SAR_data_WindPark.xls-Response Type Chart

Figure 5-4
Types of SAR Responders to Incidents In and Around Horseshoe Shoal
November 1991 - August 2002



SAR Data Provided by USCG

J:\E159\FEIS\Navigation\Tables\USCG_SAR_data_WindPark.xls-Responder Type Chart



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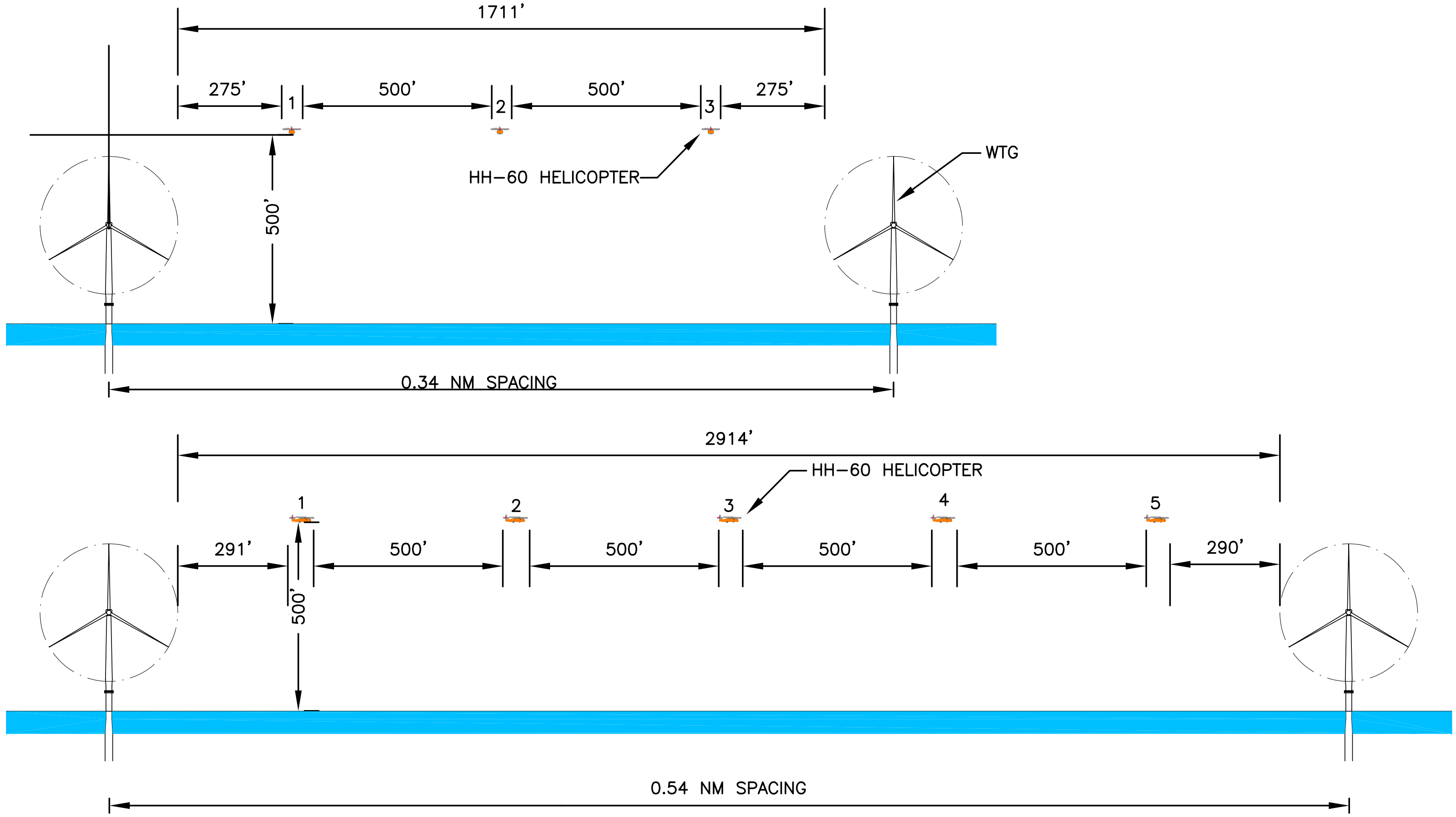
CAPE WIND
Nantucket Sound, Massachusetts

Scale: As Shown

Source: 1) MassGIS, Town Boundaries with Coastline, 2002
2) USCG, Rescue Data, 1991-2002

USCG Search and Rescue Sorties
Coordinated by USCG Air Station Cape Cod
(October 1991 - September 2002)

Figure
5-5



NOTES:

1. HH-60 "JAYHAWK" HELICOPTER IS 65 FT LONG OVERALL. THE HEIGHT IS 17 FEET AND THE ROTOR DIAMETER IS 54 FEET.
2. 1 NAUTICAL MILE (NM) = 6,076 FT

SAR "RULE OF 500":

WHEN UTILIZING MORE THAN ONE AIRCRAFT, AND CLOUD CEILING PERMITS, MAINTAIN...
500 FT ABOVE THE SURFACE
500 FT BELOW CEILING
500 FT BETWEEN AIRCRAFT

0 300 600

SCALE IN FEET

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Comparison of HH-60 Helicopter to WTG Spacing

Figure 5-6

CAPE WIND PROJECT

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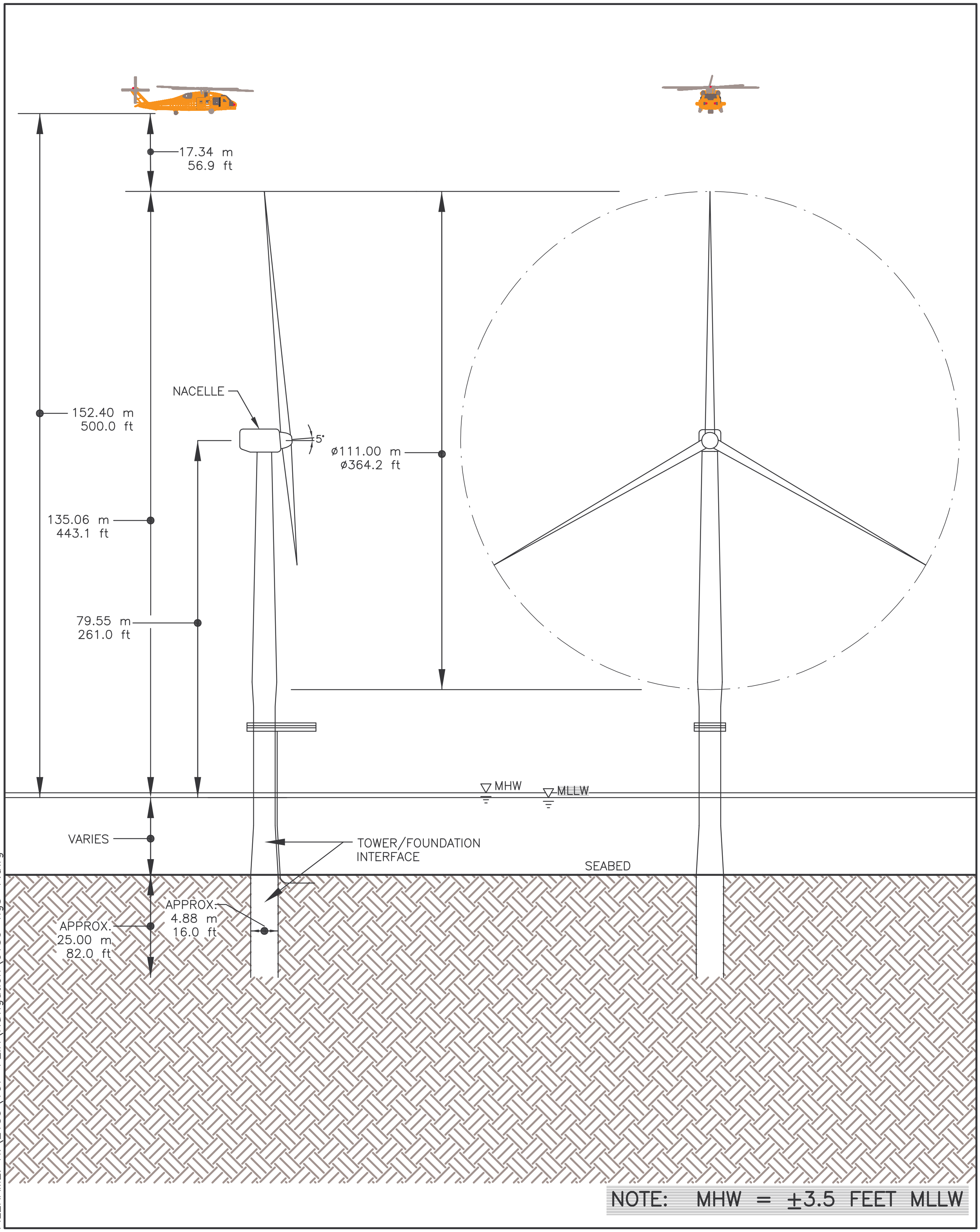

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CAPE WIND PROJECT

Scale: 1"=100'

Proposed Wind Turbine Generator with HH-60 "Jayhawk" Helicopter

Figure 5-7

Attachment A

Vessel Survey for Nantucket Sound

Vessel Survey for Nantucket Sound
Research Vessels

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Registered Tons)	Displacement (Long Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity
Gemma	MBL	50	16	6			10	13	0
R/V Asterias	WHOI	46.2	15.3	5.2			9.5		0
R/V Oceanus	WHOI/NSF	177	33	17.5	298	960	10	14	0
R/V Atlantis	WHOI/U.S. Navy	274	53	17	3200	3510	12	15	0
R/V Knorr	WHOI/U.S. Navy	279	46	16.5	2518	2685	12	14.5	0
Albatross IV	NOAA	187	33	18	1100		12		0
Category A, Type 1	Average Values	46.2	15.3	5.2					
Category A, Type 2	Average Values	229.3	41.3	17.3	1779	2385			

Source: Internet

Vessel Survey for Nantucket Sound
Cruise Ships

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Deadweight Tonnage (Metric Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity
American Eagle	American Cruise Lines	165	40	10	86		12.5		49
American Glory	American Cruise Lines	168	43	10	87		12.5		49
Arabella	Classic Cruises of Newport	160	24	12	91				42/149
Nantucket Clipper	Clipper Cruise Line	207	37	8	1470				100
Crystal Symphony	Crystal Cruises	781	99	25	51044		22	23	940
Prinsendam	Holland America	669	95	23	38000		18.5	21.8	793
Rotterdam	Holland America	780	106		62000			25	1316
Norwegian Sea	Norwegian Cruise Line	700	93	22	42000		22		630
Regal Empress	Regal Cruises	612	79		21909		17		1068
Clipper Adventurer	Clipper Cruise Line	330	54	16	4364 (ITC)	1465	14		
Grande Caribe	American Canadian Caribbean Line	183	40	7					
Lone Ranger	Private Yacht	254	44	19					
Category A, Type 1	Average Values	177	37	9	434				
Category A, Type 2	Average Values	496	77	21	43681				

Source: Internet

Vessel Survey for Nantucket Sound
Passenger Ferries

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Lightship Displacement (Long Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity	Route
Freedom	Freedom Cruise Line	65	24	8	80					
Brant Point	Hy-Line	134	27	7	97				602	
East Chop	Hy-Line	108	27	5.5	99				515	
Great Point	Hy-Line	185	35	8.5	71				803	
Grey Lady II	Hy-Line	106	30	4	74		30		149	
Patience	Hy-Line	72	20	6.5	90				149	
Quickwater	Patriot Party Boats	47	15	6	28				40	Falmouth-Oak Bluffs
Eagle	Steamship Authority	233	61.5	10.2	276	1368.6	14		789	Hyannis-Nantucket
Flying Cloud	Steamship Authority	134.48	34.44	6.23	674	126.8	36		295	
Gay Head	Steamship Authority	234	40	14	99	1137.0	13.5		142	
Governor	Steamship Authority	242	46.1	11.3	678	841.0	12		241	
Islander	Steamship Authority	201	58	11.7	855	953.0	11.5		788	
Katama	Steamship Authority	234	40	14	99	1162.8	13.5		142	
Martha's Vineyard	Steamship Authority	230	60	10.5	1297	1142.0	14		1287	
Nantucket	Steamship Authority	230	60	10	1152	1105.2	14		789	
Sankaty	Steamship Authority	197	40	14	351	655.7	12.5		293	
Schamonchi	Steamship Authority	135	29	7	91	267.2	15		512	
Island Queen	Island Commuter Corp.	101	27	7	99				600	Falmouth-Oak Bluffs
Category B, Type 1	Average Values	120	30	7	248	499.7				
Category B, Type 2	Average Values	224.4285714	49	12	522	1037.1				

Sources: Steamship Authority/Hy-Line/Internet

Vessel Survey for Nantucket Sound
Bulk Goods Carriers

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity
	Mobil Fuel Oil							N/A
Alcaid/Barge	Tisbury Towing & Transportation, Inc.	130	35.1	8.6	290			N/A
Algol/Barge	Tisbury Towing & Transportation, Inc.	130	35.1	8.6	290			N/A
Capella/Barge	Tisbury Towing & Transportation, Inc.	80	30.2	9				N/A
Corvus/Workboat	Tisbury Towing & Transportation, Inc.	34.1	11.1	4.8	17			N/A
Hydra/Barge	Tisbury Towing & Transportation, Inc.	154	40	9	530			N/A
Meropa/Barge	Tisbury Towing & Transportation, Inc.	125	33	10.8	277			N/A
Rando/Barge	Tisbury Towing & Transportation, Inc.	78.7	20	6.5	85			N/A
Regal/Barge	Tisbury Towing & Transportation, Inc.	36	14	3.7	15			N/A
Sirius/Tug	Tisbury Towing & Transportation, Inc.	56	20	6.2	64			N/A
Taurus/Tug	Tisbury Towing & Transportation, Inc.	42.6	14.5	6.9	26			N/A
Thuban/Tug	Tisbury Towing & Transportation, Inc.	53.9	22	8.1	69			N/A
Great Gull/Tanker	K-Sea Tranportation	276	55	17	1729			
Category C, Type 1	Average Values	80	24	7	154			
Category C, Type 2	Average Values	125	33	11	277			
Category C, Type 3	Average Values	276	55	17	1729			

Sources: Tisbury Towing Transportation/Harbor Fuel/K-Sea

Vessel Survey for Nantucket Sound
US Coast Guard Vessels

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Displacement (Gross Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity
UTL	Coast Guard	22	10	2	2		35	N/A
UTM	Coast Guard	27	10	2	5		45	N/A
UTB	Coast Guard	41	14	4	15		26	N/A
MLB	Coast Guard	47	15	4	20		25	N/A
BUSL	Coast Guard	49	17	5	32		10	N/A
ANB	Coast Guard	55	17	4	34		23	N/A
WPB 87	Coast Guard	87	19	6	100	10	25	N/A
WPB 110	Coast Guard	110	21	7	165	12.8	29.5	N/A
WLM	Coast Guard	175	36	8	840		13	N/A
WMEC 210	Coast Guard	210	34	11	1110	13	18	N/A
WLB	Coast Guard	225	46	13	2000	12	15	N/A
WMEC 270	Coast Guard	270	38	14	1820	12	19.5	N/A
Category D, Type 1	Average Value	40	14	4	18			
Category D, Type 2	Average Value	124	25	7	368			
Category D, Type 3	Average Value	235	39	13	1643			

Source: US Coast Guard

Vessel Survey for Nantucket Sound
Touring Vessels

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Rregister Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity	Harbor
Eventide	Cat Boat Rides Inc.	34	10	3				22	Hyannisport
Bounder	Bob Barker	36	12.5	4.5				6	Falmouth
Cashmere		30	10	5.25					Chatham
Dreamer	Argonaut Ocean Services, Inc.	39	12	5.5		6.5			Pocasset
Prudence	Hy-Line	64	18	6	44			150	Hyannis
Viking	Hy-Line	65	22	6	48			197	Hyannis
Infanta	First Light Seaventures	54	12	6.7					Chatham
Liberte	Patriot Boats, Inc.	74		7				49	Falmouth
Shenandoah	Coastwise Packet Company	152	23	11	170			35/30	Vineyard Haven
Alabama	Coastwise Packet Company	126	21	12.5	150			49/27	Vineyard Haven
Ayuthia	Ayuthia Charters, Inc.	45	11.6	3.5/6	13.2				Vineyard Haven
Sol Adventura	Sail Eco-Charters	34	10.2	3.9/8.5				6	Chatham
Odin	Argonaut Ocean Services, Inc.	45.4	13.3	4.5/10.1		6.5			Pocasset
Snug	Argonaut Ocean Services, Inc.	38				7.5			Pocasset
	Cape Cod Bareboat Charters								Chatham
Sabbatical	Cape Sail	35						6	Brewster
Ambiance	Chafee Sailing Charters	34							Nantucket
Christina	Christina Sailing Excursions								Nantucket
Heart's Desire	First Light Seaventures	43							Chatham
Little Dipper	First Light Seaventures	30							Chatham
Perseverance	Freedom Cruise Line								Harwichport
	Gosnold Cruise Tour & Charter								Oak Bluffs
	Hesperus Sailing Cruises								Hyannis
Sheer Magic	Hyannis Yacht Charters	40	12.75						Hyannis
	Island Sailing School	19							Edgartown
	Island Sailing School								Edgartown
	Kingman Yacht Charter								Falmouth
Mad Max	Mad Max	60	25						Edgartown
Malabar	Malabar Charters	65							Hyannisport
Perseverance	Monomoy Island Excursions, Inc.								Chatham
	PC Yacht Charter								N. Falmouth
Argonaut	Sayles Seafood							6	Nantucket
Shearwater	Shearwater Excursions	26							Nantucket
Endeavor									Nantucket
Laissez Faire									Vineyard Haven
When and If									Vineyard Haven
Category E, Type 1	Average Values	35	11	4					
Category E, Type 2	Average Values	68	16	7	85				
Category E, Type 3	Average Values	45	13	10					

Source: Internet

Vessel Survey for Nantucket Sound
Charter Fishing Vessels

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity	Harbor
	Captain Toms Charters	24		1.3					Nantucket
T.G.	Patriot Party Boats	29		2.5				6	Falmouth
Just Do It Too	Just Do It Too Charters	34	12	3	8			16	Nantucket
Unforgiven	Unforgiven Sportfishing Charters	32	12	3			27	6	Hyannis
Sea Swan II	Hy-Line	58	16	4	25			59	Hyannis
Sea Queen II	Hy-Line	64	21	4.5	59			99	Hyannis
Banjo	Banjo Sportfishing	32	12	5	11			6	Oak Bluffs
The Big Eye	Big Eye Charters	30	11	5	10				Edgartown
Patriot 2	Patriot Party Boats	50		5				49	Falmouth
Fishtale	Fishtale Sportfishing	33	12	8	19			6	Harwich Port
Minuteman	Patriot Party Boats	40	13	8	19			35	Falmouth
Helen H	Helen H Deep Sea Fishing	100	22	9	98				Hyannis
	ABC Atta Boy Charters								Tisbury
	Absolute Sportfishing								Nantucket
Albacore	Albacore Charters	35						6	Nantucket
	Alloverit Fishing Guide Service								Nantucket
	Althea K Charter Fishing								Nantucket
	Ananta Sport Fishing Charters								Falmouth
Dazed and Confused	Atlantic Sport Fishing Co.	36							Oak Bluffs
	Atlantic Sport Fishing Co.	24	9						Oak Bluffs
	Backlash Charters								Edgartown
	Captain Bob's Deep Sea Fishing								Hyannis
The Banshee	Captain Ron McVickar	31						6	Chatham
	Captain Toms Charters	30						6	Nantucket
	Captain Toms Charters	30						6	Nantucket
	Clean Sweep Charters								Falmouth
Relentless II	Cool Running Charters	30						6	Falmouth
	Cygnet Sport Fishing								Falmouth
Eastwind	Eastwind Sportfishing	35						6	Falmouth
	Flicka Sportfishing								Nantucket
Herbert T	Herbert T Sportfishing								Nantucket
High Hopes	High Hopes Fishing	31						6	Falmouth
Lee Marie	Lee Marie Sport Fishing	31						6	Falmouth
Roseleen	Local Ocean Charters	23	8				35	6	Orleans?
Machaca	Machaca Charters	31						6	Edgartown
McWhelan	Mcwhelan Sport Fishing	26							
Blitz	Mestiza Sportfishing	20						6	Cotuit
Mestiza	Mestiza Sportfishing	31						6	Cotuit
	Orion Charters								Oak Bluffs
	Rusty Fly Fishing Charters								Nantucket
	Sankaty Head Charters								Nantucket

Sources: Hy-Line/Internet

Vessel Survey for Nantucket Sound
Charter Fishing Vessels

Vessel Name/Type	Owner	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Passenger Capacity	Harbor
SeaFox	Sea Fox Sport Fishing	31						6	Falmouth
	Sea Store								Woods Hole
	Sharks Landing Charter								Oak Bluffs
	Starr Fish Charters								Nantucket
Fish Hawk	Steve Stevens	38						6	Hyannis
	Striper-Charters	20							Bass River
	Striper-Charters	22							Bass River
	Summer's Lease Fishing Charters								Oak Bluffs
	Tightlines Sport Fishing Service								Hyannis
Topspin	Topspin Sportfishing Charters	30						6	Nantucket
The Coof	Tuna Tales, Inc.	31						6	Nantucket
The Coof II	Tuna Tales, Inc.	22						6	Nantucket
Skipper	Vineyard Sound Charters, Inc.						10		Oak Bluffs
Booby Hatch		33						6	Chatham
Brandi Ellen		23						6	Chatham
Golden Eagle									Harwichport
Hob Knob Inn		27						6	Edgartown
Lori-Ann									Hyannis
Magellan		33						6	Harwich Port
Sue-Z		33						6	Harwichport
Yankee									Harwichport
Category E, Type 1	Average Values	40	15	3	31				
Category E, Type 2	Average Values	48	14	7	11				
Category E, Type 3	Average Values								

Sources: Hy-Line/Internet

Vessel Survey for Nantucket Sound
Commercial Fishing Vessels

Vessel Name/Type	Registration No.	LOA (FT)	Beam (FT)	Draft (FT)	Tonnage (Volume) (Gross Register Tons)	Cruising Speed (Knots)	Maximum Speed (Knots)	Type	Harbor
Angeline	228279	37.7	12	4.7	12			Squid boat	
Mill Point	272808	42	14.8	5.6	26			Squid boat	Fairhaven
Ann Marie	604396	38.4	14.4	6	26			Squid boat	Sandwich
Carole R II	602299	49	17	6.6	37			Squid boat	
Betty B	244430	46.3	14	6.9	22			Squid boat	
Absolute	563981	47.2	14.1	7	34			Squid boat	Fairhaven
Four Kids	573996	43.7	17	7.1	33			Squid boat	
Nancy Christine	594179	37.1	12.8	7.3	24			Shellfish	Hyannis
Karen Ann	579982	39.8	14.7	7.6	34			Squid boat	Woods Hole
Jenna Lee	1090556	78	21.5	8	89			Shellfish	Hyannis
Lady Jane	652109	34.6	13.3	8.4	22			Squid boat	Brant Rock
Hunter	612318	65	16	8.5	59			Squid boat	
Nauset	666529	61	19.3	9.5	78			Squid boat	Provincetown
Unknown	Unknown	33	12	10	10	15-17			
Rachel Leah	940212	77	22	11	124			Shellfish	Hyannis
Scallop dragger/herring seiner	Various			14					
DONA MARTITA	651751	150	38	13	394				
FRIENDSHIP	623188	99	25	13	173				
KATHY MARIE	941590	87	26	13	196				
Category E, Type 1	Average Values	38	12	5	12				
Category E, Type 2	Average Values	49	16	7	40				
Category E, Type 3	Average Values	89	25	12	179				

Sources: Dockside Interviews/US Coast Guard

Attachment B

Ship Impact Analysis

Ship Impact Analysis

Cape Wind Associates Wind Park

Revised Version Sep 07, 2006, 2005
Vasanth Kothnur, David Anderson and Mohamed Ali

General Electric Co., Global Research Center
Niskayuna, NY 12309

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1. Makes any warrant or representation, express or implied, with respect to use of any information contained in this Ship Impact Study, or that the use of any information apparatus, method, or process disclosed in the report may not infringe privately owned rights and
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Objectives

The objectives of this revised Ship Impact Analysis document is to update the prior study results presented in the 2003 report and bring them inline with API Recommended Practice 2A-WSD Section C18.9.2[(1)] regarding various vessel collision scenarios. Specifically, we analyze the impact in an elasto-plastic finite element model of the tower-monopile-soil configuration with the maximum impact load computed from the kinetic energy of the vessel.

Comparison with 2003 Ship Impact Model Assumptions

Several assumptions were listed in the 2003 Ship Impact report. These are listed below and contrasted with the API 2A recommendations:

- In the 2003 report, the NORSOK Standards N-004[(2)] guidelines on “Accidental Limit State” and “Force Indentation Curve” were utilized. In this report, the API force-indentation model which assumes that the entire energy of impact is utilized in the deformation of the tubular WTG monopile foundation structure is utilized.

- The “Force Indentation” curve in the 2003 report was specific to each collision event; whereas, in this report, we assume a universal indentation model as per O. Furnes (section

API 2A[1] C18.9.2). Since assumptions for each vessel impact are uncertain, this provides a conservative route to modeling the impact event.

- A torsional linear foundation spring was used to model the soil-structure interaction response in the 2003 report. The current report models the pile-soil response in ANSYS through the Winkler p-y spring model with representative parameters derived from the soil geotechnical report for the Cape Wind farm. This will also result in a better resolution of the monopile deformation below the mudline wherein the maximum bending moments arise due to the impact.

- Modeling of the WTG monopile cross-section as an elastic-perfectly plastic material (current report) limits the maximum indentation load prior to full collapse of the pile. Therefore the loads reported in this study are a more realistic estimate when compared to the 2003 report.

Analysis of Accidental Ship Impact – Steps Involved in the Current Model

- The universal ship impact load vs. pile indentation depth is computed as per API 2A[1] Section 18.9.2 (model of O. Furnes). The relationship is computed for a reference WTG monopile of 5.5 m diameter and 55 mm thickness (which is representative of the conceptual design for the turbine location with 17 m water depth). Turbine locations with the highest water depth have; a) a higher likelihood of larger vessels being in a nearby path and b) any impact could have a larger impact due to the larger overturning moments on the mudline. Figure 1 shows the load-indentation model as utilized in the current report to model the impact loads on the WTG monopile foundation.

- For a given vessel with a known weight and velocity of impact (cruising/drifting), impact load-indentation curve is obtained for two scenarios – broadside & bow/stern side (head-on collision). For broadside impact, we incorporate an additional added mass factor of 1.4 (i.e. the effective mass is 1.4 X weight of vessel). Similarly, for head-on impact, we include an added mass factor of 1.1. These added mass factors are similar to what was assumed in the prior 2003 report.

- The impact of the ship is modeled using a non-linear spring as the contact element between the vessel and the tower/pile model in commercial finite element software - ANSYS. The point of impact on WTG monopile is assumed at 4 m above mean sea level as was done in the 2003 impact analysis report.

- The soil-structure interaction is modeled using a Winkler p-y spring model as per API 2A Section 6.3.3 using representative parameters from the Cape Wind Geotechnical Survey report of 2002 and the design basis utilized for conceptual design of the monopile.

- An elasto-plastic ANSYS beam & shell element model of the tower/pile structure is utilized to obtain the stress distribution in the pile. The yield strength of the pile is assumed as 345 MPA (as per the Cape Wind Farm Conceptual Design Basis[3]). The onset of plastic yielding at the outer section of the pile results in the formation of a local plastic hinge in the pile at or below the mudline (irrespective of the fidelity in modeling the actual impact and the local indentation). With increasing kinetic energy of impact, the zone of plastic yielding spreads – leading to a plateau in the maximum load of impact and the onset of tubular collapse at the critical section.

- Results from the ANSYS model are shown in Figure 3 for impact loads between 12 MN and 20 MN. With increasing impact load, the lateral deflection at the tower bottom flange and the cross-section effective Von Mises stress increase. Note that the maximum Von Mises stress is reached below the mudline. For instance, with a 12 MN impact load, the maximum Von Mises stress is reached at a depth of approximately 8 m below the mudline. This highlights the importance of modeling the WTG pile-soil interaction within a finite element framework. Under an impact load of between 17-20 MN, a zone of plastic deformation onsets in the WTG pile from 4-12 m below the mudline . At this stage, the pile undergoes catastrophic collapse due to extensive yielding and buckling at this plastic hinge location.

- The effect of the accidental impact load is evaluated through a metric such as the overall Utilization Factor – UF. The Utilization factor UF is defined as the maximum overturning moment at the critical cross-section compared to maximum sustainable moment capacity (collapse load). The collapse load is computed as

$$Moment\_Capacity = Y * D^2 t$$

  where Y is the yield strength (345 MPA), D is the WTG pile diameter (5.5 m) and t is the WTG pile thickness (55 mm). For the 17 m water depth pile design, the moment capacity is estimated to be as 574 MN-m.

- The UF values obtained in this report can be directly compared to the values predicted in the 2003 report (which used a less conservative approach; and hence obtained lower UF values). The bending moment distribution for various impact loads and the corresponding UF are shown in Figures 4 and 5 respectively.

- A regression relationship has been developed between the impact load I (in MN) and the Utilization Factor (UF) at the critical cross-section. Note that the critical cross-section is below the mudline (thereby, necessitating a need for a representative soil-pile interaction model to capture this effect). This is given by

$$UF = 0.04631I + 0.0155$$

- Based on the relationship between the kinetic energy of impact and impact load, and between the utilization factor UF at the critical cross-section and the impact load, the effect of an accidental ship impact can be evaluated. A summary for various scenarios is shown in Table 1. A graphical summary of the various impact scenarios is also shown in Figure 6. As can be seen from Figure 6, a ferry with a deadweight tonnage of 1500 metric tons impacting at 12 knots head-on is predicted to result in a tubular collapse of the pile below the mudline. Even though the WTG tubular pile collapse initiates at around 8 m below the mudline, we can conservatively assume that this is likely to result in the overall collapse of the WTG itself (inspite of the surrounding soil).

- The increase in utilization factor (UF) with Impact load can be seen by correlating the results shown in Table 1 with Figure 3. For the case of a drifting 1200 Ton barge impacting broadside at 3 Knots, Table 1 lists the UF as 0.56 and the impact load as 11.9 MN. Correspondingly, in Figure 3, we see that the distribution of the Von Mises Effective stress along the pile is significantly lower than yield stress of the monopile (345 MPa). For the case of the 300 Ton Ferry impact head-on at 12 Knots, Table 1 lists the UF as 0.82 and the impact load as 17.4 MN. Correspondingly, in Figure 3, we see that the outer pile sections (opposite to impacting location) between 4-10 m below mudline is close to yielding. Increase in impact loads beyond 20 MN results in state of rapid collapse of the pile cross-section (thereby, reaching the UF =1 collapse condition).

- Note that the critical section as predicted by the model is 4-10 m below the mudline i.e. atleast 25 m below the actual impact location. Therefore, it is not necessary to model the actual indentation event itself in great detail in order to identify the appropriate overturning moment distribution below the mudline (and from it, the Von Mises effective stress distribution).

- Note that the key assumption here is that the entire energy of the impact is assumed to be transferred to the monopile. This is a conservative assumption as the impacting vessel itself would absorb a portion of the impact energy. Therefore, the reported results here are a strict upper bound estimate for the utilization factor under an accidental ship impact event.

- The model predicts that the Great Gull cruising at 12 knots results in a collapse load situation (i.e. UF >> 1). The cross-section of the Great Gull is characterized by 55-feet breadth, 17-feet draft, a deck-plate of 0.418 inches and a hull plate thickness of 0.38 inches. Assuming a head-on impact, the average normal stress across this cross-section due to an impact load of 40 MN is ~ 95 MPA – i.e. well within the elastic range. While there may be some local plastic deformation and buckling near the impact zone, the bulk of the energy is dissipated by the plastic collapse of the monopile. Similar results were obtained upon reviewing the cross-section of the Clipper Adventurer.

- Figure 3 shows the distribution of the Von Mises effective stress for 3 impact events with progressively higher impact loads (11.9 MN, 17.4 MN and 19.4 MN respectively). For the case of the cruising Great Gull/Clipper Adventurer, the impact energy is sufficient to generate impact loads higher than the collapse load (approximately 20 MN). The ANSYS model of the monopile (as currently constructed) does not model the post-collapse deformation and load evolution. Prior to onset of the collapse event, the distribution of the Von Mises effective stress during the impact of the Great Gull or the Clipper Adventurer would be quite similar to the 3 test cases shown with smaller impact loads.

References

1. API RP 2A-WSD. Recommended Practice for Planning Designing and Constructing Fixed Offshore Platforms – Working Stress Design. 21st edition. December 2000.
2. NORSOK Standards N004 – Design of Steel Structures (Rev 1, December 1998)
3. Cape Cod Offshore Wind Park – Foundation Design Basis. GE Wind Energy (November 2003)

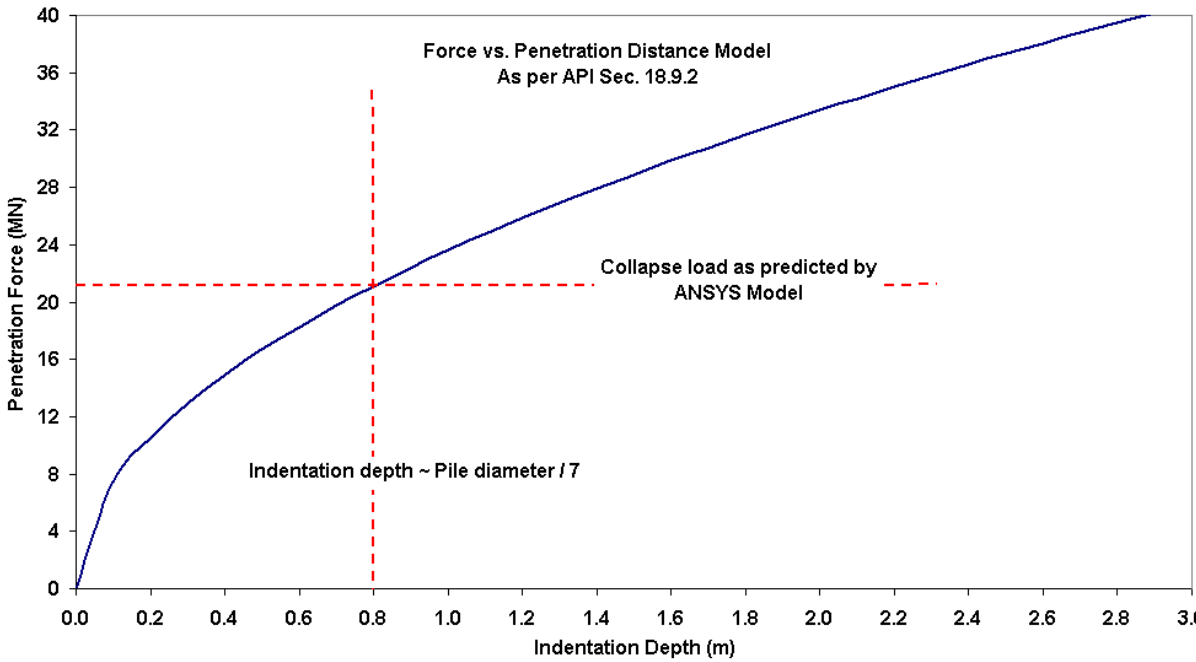

Figure 1: Load-indentation model utilized to model ship impact

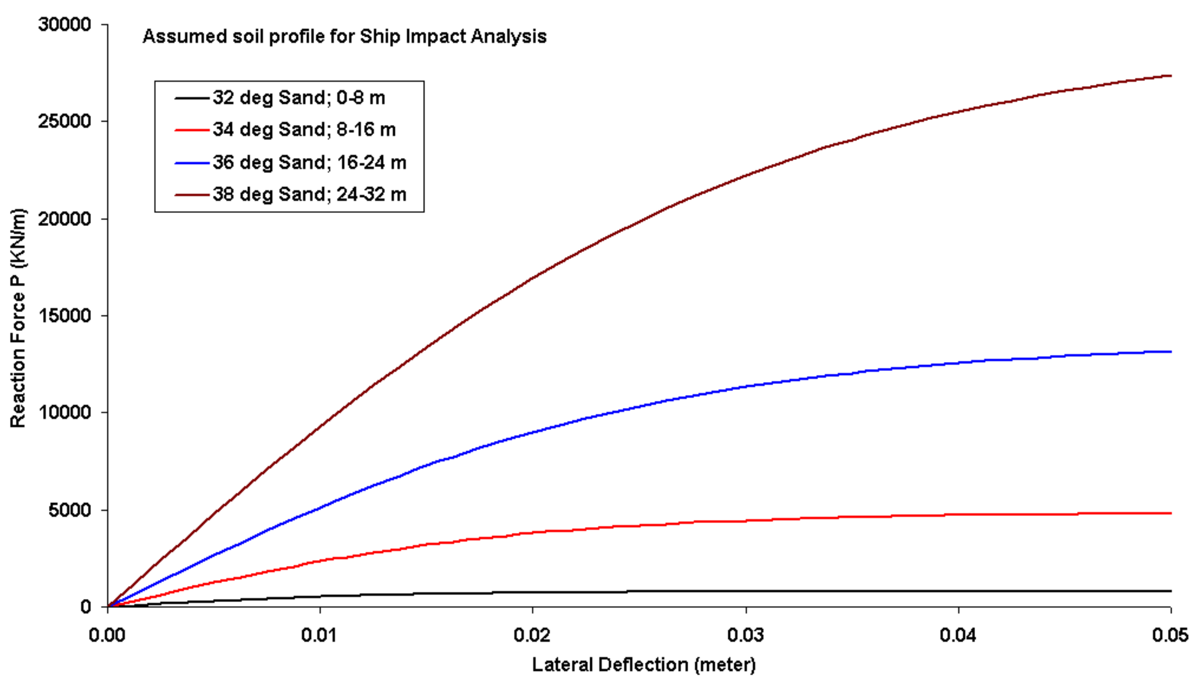

Figure 2: Assumed soil profile for the ANSYS model

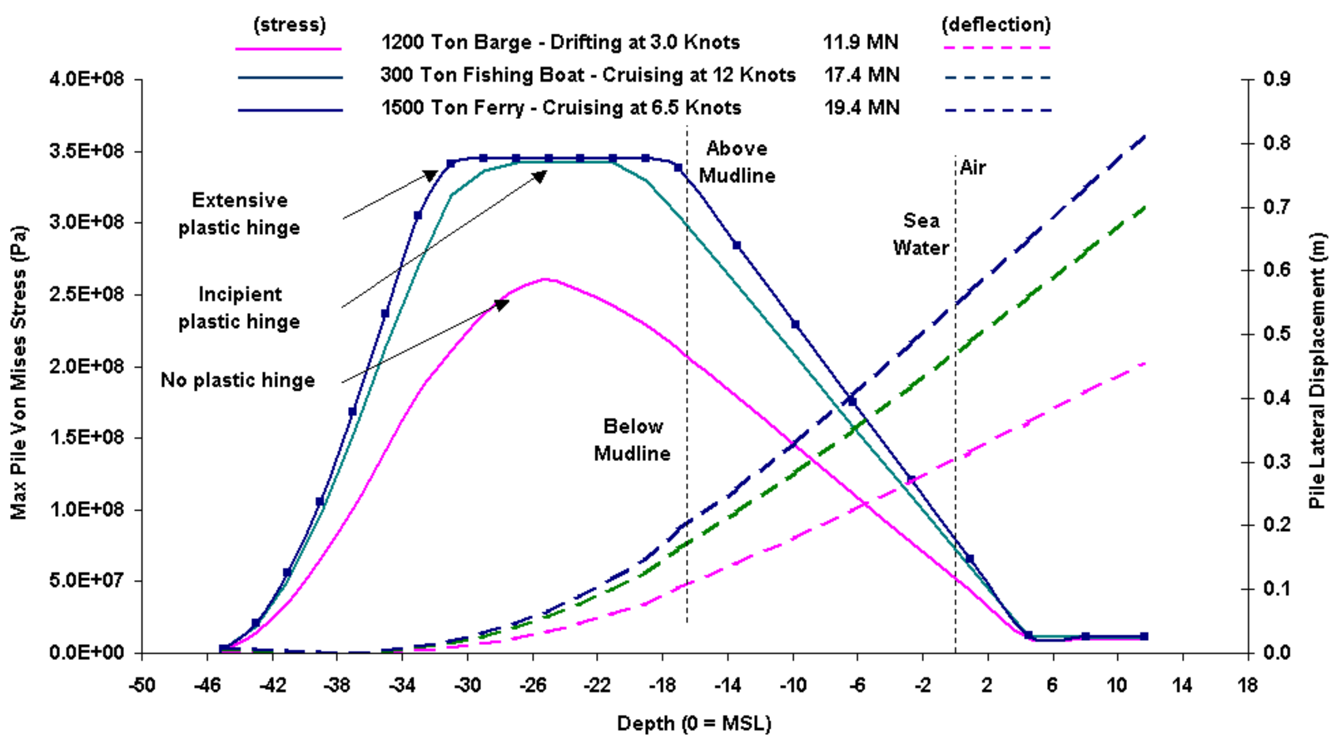

Figure 3: Von Mises Effective Stress and Lateral Deflection of the Pile

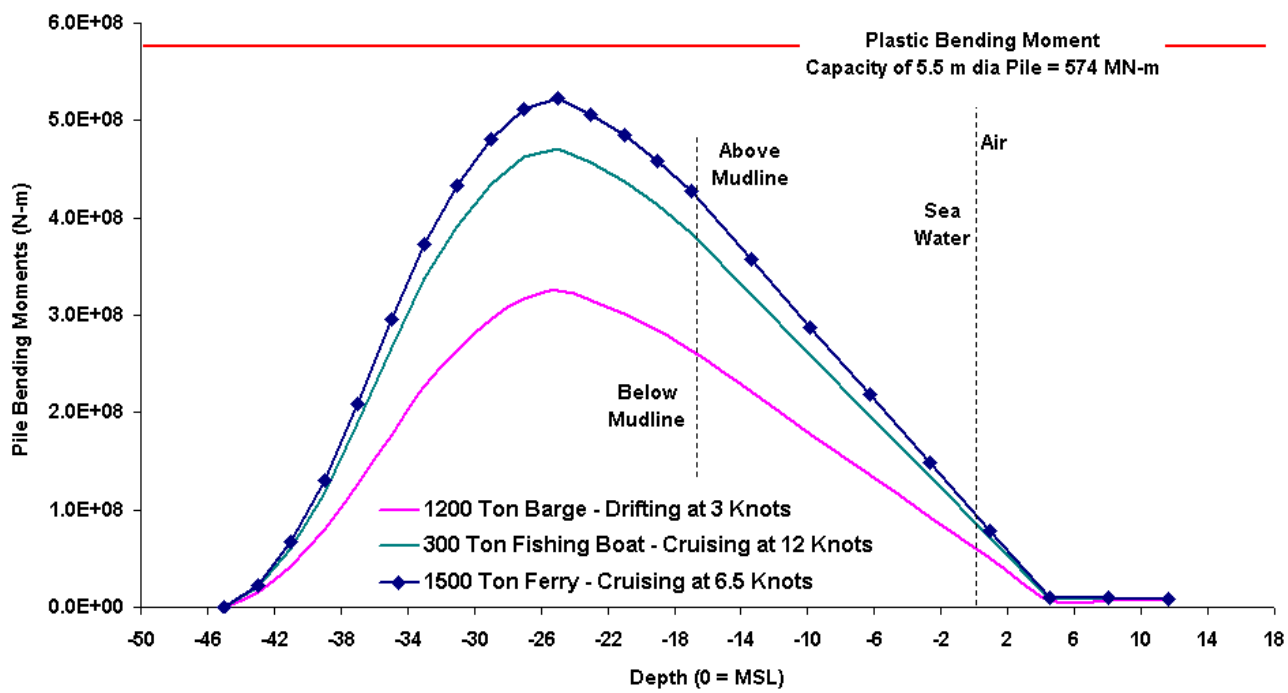

Figure 4: Distribution of the Bending Moments in the Pile under Impact

	Name of Vessel	Nature of Collision	Added Mass Factor	Vessel Mass	Impact Velocity	Impact Load (Maximum)	Utilization Factor
				metric tons	knots	MN	UF
1	Great Gull Drifting	Broadside	1.4	3800	3	17.4	0.82
2	Great Gull Cruising	Head-on	1.1	3800	12	40.5	1.89
3	Clipper Adventurer Drifting	Broadside	1.4	1465	3	12.7	0.60
4	Clipper Adventurer Cruising	Head-on	1.1	1465	12	29.5	1.38
5	Ferry Drifting	Broadside	1.4	1500	3	12.8	0.61
6	Ferry Cruising	Head-on	1.1	1500	12	29.7	1.39
7	Fishing Boat Drifting	Broadside	1.4	300	3	7.5	0.36
8	Fishing Boat Cruising	Head-on	1.1	300	12	17.4	0.82
9	Barge Drifting	Broadside	1.4	1200	3	11.9	0.56
10	Barge Cruising	Head-on	1.1	1200	12	27.6	1.29
11	Yacht Drifting	Broadside	1.4	20	3	3.0	0.16
12	Yacht Cruising	Head-on	1.1	20	15	8.2	0.39
13	Service Vessel Drifting	Broadside	1.4	75	3	4.7	0.23
14	Service Vessel Cruising	Head-on	1.1	75	3	4.3	0.22

Table 1: Summary of Utilization Factors for Various Impact Scenarios

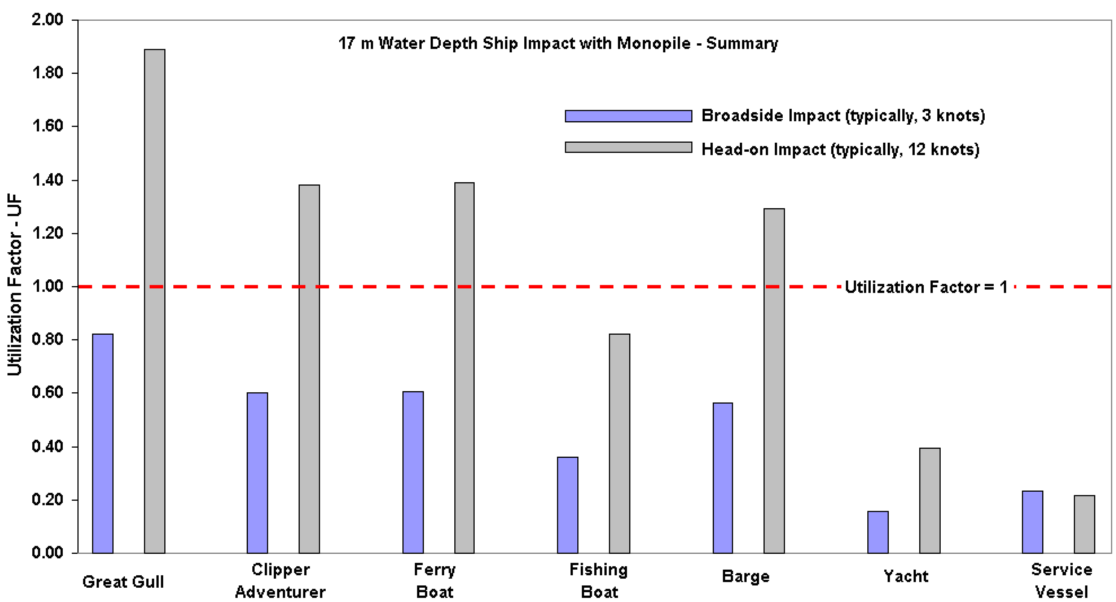

Figure 6: Summary of Utilization Factors under various ship impact scenarios

Attachment C

Response to April 2004 McGowan Group Report

The 2003 Navigational Risk Assessment was prepared to meet the scope requested by the USCG in their letter dated February 10, 2003. Several meetings were held with CWA, ESS, and USCG staff to discuss USCG expectations for the assessment, methods to be used in the evaluations, anticipated aids-to-navigation needs, potential project impacts, and preliminary results. The USCG's review of the initial draft of the document resulted in two comments for minor revisions to the document and a determination that the document adequately addressed the scope that was provided in February 2003.

This Attachment provides CWA's response to comments on the 2003 Navigational Risk Assessment contained in the April 26, 2004 report prepared by The McGowan Group, LLC. The headings and subheadings in this Attachment are taken directly from The McGowan Group report. Comments from The McGowan Group report are repeated in this Attachment in *italics* with CWA's responses provided in plain text. Where appropriate, the CWA response has also been incorporated into the main text of the Revised Navigational Risk Assessment (2006).

INTERNATIONAL STANDARDS

This section of the report describes regulatory standards, licensing processes, suggested guidelines for navigational risk assessments, and mitigation strategies used by various countries in Europe when reviewing proposed offshore wind parks. This section does not appear to be directly relevant to CWA's Navigational Risk Assessment, but is more of a description about how other countries review similar projects.

RISK ASSESSMENT "BEST PRACTICES"

This section of the report describes statistical modeling methods to calculate the frequency of collisions expected with offshore WTGs and the probability and extent of marine pollution resulting from a vessel collision with a WTG. The report describes the methodologies used for the Horns Rev wind farm.

During meetings with USCG staff in January 2003, the USCG verbally instructed CWA and ESS to "characterize" rather then calculate usage and impact probabilities as part of the Navigational Risk Assessment.

This section does not appear to be directly relevant to CWA's Navigational Risk Assessment, but is more of a description about practices used in other countries for similar projects.

OVERVIEW OF UNITED STATES STANDARDS AND BEST PRACTICES

This section of the report describes the scoping process for Cape Wind's Navigational Risk Assessment. It then compares the Navigational Risk Assessment standards required in the United Kingdom to the scope provided to CWA by the USCG. The section demonstrates that there are definitive guidelines in the UK for preparing navigational risk assessments and for various design components to be included in projects.

It is the understanding of both CWA and ESS that no such guidelines for the preparation of Navigational Risk Assessments exist in the United States. CWA and ESS were told verbally by USCG First District representatives that they had requested information or guidelines for preparing such documents from other USCG Districts around the country, and found that other Districts did not have guidance to provide. CWA and ESS proceeded with the development of the Navigational Risk Assessment following consultation with the USCG, and general agreement on the overall approach to the assessment.

This section does not appear to be directly relevant to CWA's Navigational Risk Assessment, but is more of a discussion how the USCG developed the scope for the document.

A REVIEW OF A NAVIGATION SAFETY RISK ANALYSIS

This section of the report contains The McGowan Group's assessment of the adequacy of CWA's Navigational Risk Assessment. The CWA assessment is compared in Table 3 of The McGowan Group report to a combination of UK and USCG requirements, with the conclusion being that "the assessment would have failed to meet or only partially satisfied the majority of the MCA standards and US Coast Guard requirements."

In CWA's opinion, this is an inappropriate characterization of the CWA Navigational Risk Assessment. The document prepared by ESS for CWA satisfied the requirements set for the document by the USCG in a letter dated February 10, 2003 as demonstrated by the USCG's letter of July 31, 2003, which stated that the Navigational Risk Assessment "appears to have sufficiently addressed the issues raised in MSO Providence's letter…of February 10, 2003". Reviewing a document for a project located in the United States against requirements set by the UK's Maritime and Coastguard Agency (MCA), which has no jurisdiction over the project, is misleading.

Marine Traffic

…commercial ships were identified as users of the Main Channel in Nantucket Sound that were both greater in number and size than those considered by the Cape Wind assessment…There are several important issues associated with these newly identified vessels as well as others that the Cape Wind assessment did identify. The first and most obvious issue is that a larger number of vessels present within or adjacent to the wind farm facility significantly increase the chance of vessel collision(s) with a wind turbine generator structure.

Additional vessels have been added to Attachment A—Vessel Survey for Nantucket Sound. ESS' research indicates that the *Yorktown Clipper* (a vessel identified in the McGowan Report) is assigned to cruises on the U.S. and Canadian West Coasts and the southern Caribbean rather than the U.S. northeast coast. Therefore, the *Yorktown Clipper* was not added to the survey.

The McGowan Report seems to imply that the identification of additional ships that have used Nantucket Sound, regardless of frequency of use, results in a larger number of vessels present near the Wind Park, and consequently an increase in vessel collision potential. The identification of these vessels does not mean that vessel traffic numbers in Nantucket Sound are greater than described in the Navigational Risk Assessment, but rather that these vessels have been in Nantucket Sound at some point in the past. Therefore, CWA believes that the identification of these vessels does not necessarily result in an increase in the potential for a vessel to collide with a WTG.

The Ship Impact Analysis is a critical step in validating the structural design for the sixteen-foot diameter wind tower base. For an unknown reason, the Cape Wind assessment identified another vessel (M/V ATLANTIS) whose size also exceeds that of the EAGLE, yet failed to use the larger ATLANTIS as the worst case for ship impact.

The characteristics of a vessel similar to the M/V *Eagle* were used in the Vessel Impact Analysis because the *Eagle* makes several trips per day between Hyannis and Nantucket that pass the proposed Wind Park. Given the number and regularity of trips the *Eagle* makes, it was determined that the potential for collision of the *Eagle* with a WTG was much greater than that of a vessel that may be larger than the *Eagle* transiting Nantucket Sound through the Main Channel on a less routine basis. Therefore, the effects of impact of the *Eagle* were evaluated in the 2003 Vessel Impact Analysis. It is not practical to perform analysis for every type of ship that could conceivably transit the Main Channel. At a meeting with USCG staff in May 2003, ESS presented our assessment methods and preliminary findings using the *Eagle*. The USCG staff indicated that use of the *Eagle* in the assessment was appropriate.

At the request of the USCG (February 14, 2005 comment letter), the revised Navigational Risk Assessment includes ship impact analyses for the T/V *Great Gull* and the M/V *Clipper Adventurer*, which are both larger than the *Eagle*.

A conservative approach in defining a marine traffic profile would be to choose a vessel with a draft of thirty feet as the "model" or worst-case vessel.

The use of vessel characteristics for a vessel with a draft of 30 feet seems overly conservative given the vessels that use the Main Channel in the vicinity of the Wind Park. The *Coast Pilot* states that the "draft of the vessels using it [the Main Channel] seldom exceeds 24 feet" (*Coast Pilot 2*, 2004, p. 195). In information provided to CWA and ESS in January 2004, Captain Larry Palmer stated that pilots do not take vessels with drafts of 24 feet or greater east of a point located at 41°28.7' N, 70°32.6' W, which is located just northeast of East Chop on Martha's Vineyard (approximately 7.0 NM west of the nearest WTG). Captain Palmer stated that passenger vessels (cruise ships) destined for Oak Bluffs and Edgartown always approach these areas from the west near Cuttyhunk and Gay Head. In light of Captain Palmer's experience piloting vessels in Nantucket Sound, the use of vessel characteristics for a vessel with a draft of 16 feet, such as the M/V *Clipper Adventurer*, would be more appropriate.

At the request of the USCG (February 14, 2005 comment letter), the revised Navigational Risk Assessment includes ship impact analyses for both the T/V *Great Gull* and the M/V *Clipper Adventurer*.

Risk Assessment Process

This review of the Cape Wind navigation risk assessment revealed that it did not apply a methodology or practice that determined the frequency of collisions in an analytical way.

During meetings with USCG staff in January 2003, the USCG verbally instructed CWA and ESS to "characterize" rather than calculate usage and impact probabilities as part of the Navigational Risk Assessment. This type of quantitative analysis of frequency of collisions was not requested by the USCG.

Cape Wind's assessment fails to examine or acknowledge the actual marine casualty history of vessels transiting Nantucket Sound.

In the 2003 Navigational Risk Assessment, a review of SAR cases using information from the USCG's SAR database was provided. SAR data is a strong indicator of casualty history since when a casualty occurs, a SAR case is usually generated. Between November 1991 and August 2002, there were a total of 50 incidents in the Wind Park area.

In response to this comment, ESS reviewed the last three Waterways Analysis and Management Survey (WAMS) reports for Nantucket Sound (prepared in 2004, 1996, and 1990). Only the 2004 WAMS report included information on marine casualties. The 2004 WAMS report states that the only incident of significance occurred just outside of Nantucket Sound. It further stated that there were 33 incidents in Nantucket Sound during calendar years 2001, 2002, and 2003. Of those 33 incidents, the M/V *Flying Cloud* was involved in 15 of those incidents.

In addition, ESS solicited input on marine casualties from staff at USCG Sector Southeastern New England. According to Sector Southeastern New England, the SAR database is the most reliable source of data relative to marine casualties.

Finally, no examples were found of an operating or planned wind farm in Europe that located the proposed facility directly adjacent to active shipping channels.

The Middelgrunden Wind Farm near Copenhagen, Denmark, which has been operational since May 2001, is located approximately 0.25 NM from a shipping channel. According to the Royal Danish Administration of Navigation and Hydrography, between 25,000 and 30,000 ships navigate this shipping channel annually and there have been no reported incidents of collisions of ships in this channel with the WTGs.

The Nysted Offshore Wind Farm near Rødsand, Denmark, which has been operational since 2004, is located approximately 1.0 NM from the main shipping channel between the North Sea and the Baltic Sea. According to the Royal Danish Administration of Navigation and Hydrography, approximately

60,000 ships navigate this shipping channel annually and there have been no reported incidents of collisions of ships in this channel with the WTGs.

There is no barrier based upon the waterway's capacity or from an examination of its depth profile, given the wind farm's proposed location, which would prevent vessels with drafts in the range of 20 to 30 feet from leaving the Main Channel at any one of several locations and striking a wind turbine tower.

Similarly, no barrier can be found that would discourage deeper-draft vessels from entering the wind farm's proposed location from the east and striking a tower.

CWA agrees that it is possible that a vessel with a draft of 24 feet could exit the Main Channel and impact some of the WTG locations on the Wind Park's west, south, and east sides before running aground. Several of the southernmost turbines shown in the 2003 Navigational Risk Assessment have been relocated from sites adjacent to the Main Channel, to sites in the northwestern portion of Horseshoe Shoal, an area with significantly less deep-draft commercial vessel traffic. This relocation further reduces the chance for deep-draft vessel interaction as the nearest WTG is now sited approximately 1,190 feet from the charted edge of the Main Channel.

The Cape Wind assessment's marine traffic survey failed to identify a larger body of vessels that use the proposed wind farm's waters as well as vessels with significantly deeper drafts and significantly larger full load displacements.

As described above, additional vessels have been added to Attachment A—Vessel Survey of Nantucket Sound. In addition, descriptions of waterway users from the 2004 WAMS report have been incorporated in Section 3.0 of the Revised Navigational Risk Assessment.

Finally, Cape Wind's assessment may overemphasize the safety benefit of common safeguards such as the COLREGS and their burden on vessel operators, of navigation systems and of navigational aids both electronic and physical.

CWA agrees that marine casualties have and may continue to occur in spite of the safeguards afforded by the COLREGS, navigation systems, and navigational aids. As noted in the Navigational Risk Assessment, the proper use and application of these safeguards provide a means for reducing the potential for vessels to collide with a WTG or another vessel while underway.

There was no use found of wind or fog as aggravating factors in the Cape Wind risk assessment.

CWA recognizes that the time of year that experiences the heaviest fog conditions in Nantucket Sound (May through June) coincides with the months when vessel traffic in the Sound is increased due to more prevalent recreational vessel traffic. CWA acknowledges that it is possible that some recreational boaters may choose not to go out in the area of Horseshoe Shoal due to the combined presence of fog and the Wind Park.

As stated in the Navigational Risk Assessment, CWA will establish private aids-to-navigation on each of the WTGs. These private aids-to-navigation will be established under authorizations from the USCG. It is important to note that USCG aids-to-navigation requirements take into account fog conditions.

Collision Consequence

The Cape Wind navigation risk assessment evaluated the consequence of a collision by a vessel, modeled after the ferry EAGLE, against the structural failure limit of a wind turbine tower only. It did not present or explore damage to the colliding vessel or to its cargo.

Such an analysis would require detailed structural design information for the vessel as well as information pertaining to locations and methods of equipment and cargo tie-downs. This information was not available to CWA. It should be assumed that collision of a large vessel with a WTG would likely result in some form of damage to the impacting vessel.

These examinations, as driven by collision frequency, should include injury to passengers aboard, as well as holing of a ferry, cruise vessel, fishing vessel and of a large tank vessel carrying heating or fuel oil.

Such an analysis would be theoretical in nature since the analysis would largely depend on assumptions regarding collision type, passenger load, passenger location during collision, etc. It should be assumed that collision of a large vessel with a WTG would likely result in some form of injury to persons onboard.

Simply put, any vessel larger than the EAGLE colliding with a tower at twelve knots or higher speed would cause complete failure of the tower and blade and/or its foundation structure.

CWA acknowledges that it is possible that a collision of a vessel the size of the *Eagle* or larger with a WTG while underway could result in collapse of the WTG.

Cape Wind's assessment that a vessel would survive a collision with a tower without flooding and sinking is unsubstantiated.

The assessment was described in the Navigational Risk Assessment, and used various assumptions regarding size of the vessel and speed at collision.

Vessel-on-Vessel Collisions

Cape Wind's analysis of high-speed, small boat maneuvering around wind tower bases while interesting, contributes little to a navigation safety risk assessment. Effort would be better spent in *an analysis of commercial vessel-on-vessel collisions since this wind energy's placement abuts a shipping lane.*

The concepts described in the analysis of small boat maneuvering can also be applied to larger commercial vessels. However, the time required for the vessel to react to the avoidance maneuver initiated by the crew will likely be increased due to the vessel's size.

The presence of the WTGs in Nantucket Sound would likely reduce vessel-on-vessel collisions by serving as a navigational point of reference. Commercial vessels (fishing vessels are not considered commercial vessels under the USCG definition) will likely not transit through the Wind Park given the existing natural draft limitations on Horseshoe Shoal and the presence of the charted channels around Horseshoe Shoal.

The Coast Guard issued a specific requirement for the Cape Wind's assessment to perform "An analysis of any increased danger of vessels colliding with each other or grounding due to the installations."…Ferry operations, in particular, are reported to be pressured towards or into the propose wind farm area by easterly and northeasterly winds. The Cape Wind assessment doe not contain such an analysis.

The revisions to the Wind Park grid have moved the locations of the WTGs away from the Hyannis-Nantucket ferry route. At its closest point, the base course for SSA ferries on this route is approximately 1.6 NM from the nearest WTG.

In a June 29, 2004 comment letter to MSO Providence, the SSA stated that its Captains often use tacking maneuvers on the route between Hyannis and Nantucket to provide a smoother ride and to protect vehicles and cargo onboard the ferries. In response to this comment, MSO Providence requested that a detailed description of tacking tracklines actually used in the past, the frequency of use of these maneuvers, and the rationale for using tacking maneuvers be included in the Navigational Risk Assessment.

In July 2004, ESS requested that the SSA provide charts and actual vessel trackline data for every SSA vessel voyage past Horseshoe Shoal during the previous three year period. In August 2004, the SSA provided the chart marked with the base courses described in Section 3.2.1.2 of the revised Navigational Risk Assessment. The SSA did not provide actual vessel trackline data. The letter stated that their electronics maintenance vendor advised them that the procedure to download three years of vessel trackline data was complicated. The SSA stated, that the SSA does not use paper charts, and if they did the actual course of the vessel would be erased after each voyage.

Given the lack of actual vessel trackline data, the assessment of the tacking maneuvers and their proximity to the Wind Park cannot be performed.

Operating Limits and Mitigation & Protection Measures

With the exception of traditional navigation aids, there are no recommendations in Cape Wind's navigation risk assessment regarding operating limits and mitigation measures that would apply during the project's design, construction (1½ -2 years) or operating phases.

The applicability and need for operating restrictions in and around the Wind Park (if any) will be determined by the USCG—not CWA. CWA is not proposing any vessel restrictions in the Wind Park given the large spacing between the WTGs and since the cables will be buried to a minimum depth of 6 feet below present bottom. CWA and ESS preliminary consultations with USCG staff from both the First USCG District and MSO Providence have indicated that the additional private aids-to-navigation described in the Navigational Risk Assessment will be required for the WTGs.

…operating limits and mitigation measures should have been identified and announced at the earliest stages of Cape Wind's energy facility's design.

CWA has not proposed operating limits or mitigation measures (other than nautical chart revisions, establishment of private aids-to-navigation, and providing assistance to the USCG during SAR incidents) because the applicability and need for operating restrictions in and around the Wind Park and mitigation measures to be employed (if any) will be determined by the USCG—not CWA.

The most significant design factor that will drive operating limits and mitigation measures in the Cape Wind project is the proposal to locate the wind energy facility directly adjacent to shipping channels and ferry routes. The need for waterway use limits is driven further by the decision to place the wind farm in the center of an area known to be an active fishing ground and the locus of a substantial concentration in recreational boating.

CWA has no intention of requesting waterway use limits in the Wind Park area. Vessel restrictions required (if any) will be determined by the USCG or by natural draft limitations of individual vessels.

The Cape Wind navigation risk assessment fails to fully account for the following realties that are likely to require mitigation actions to be taken at some point in the wind energy facility's development and operation:

1. *Construction of the tower structures along the boundary of the Main Channel in Nantucket Sound may require channel use to be restricted or closed for deep-draft vessels for an extended period of time impeding marine transportation including fuel and supplies to the Nantucket Sound islands.*

   The WTG that is closest to the Main Channel is approximately 1,190 feet from the charted Main Channel edge and approximately 6,900 feet east of the Main Channel's narrowest point. The work vessels used to construct the WTG are approximately 400 feet long. This leaves ample room for vessels to transit past any ongoing construction. These work vessels will not need to occupy or block the Main Channel during construction. Therefore, no restrictions or closures of the Main Channel to transiting vessels are anticipated.

The USCG routinely deconflicts waterways and channels around marine construction activities, and it is anticipated that such procedures could be implemented in Nantucket Sound during construction of the Wind Park.

2. *During construction of the wind energy facility, all marine traffic (except for construction vessels) may be restricted from the twenty-four square mile confines of the entire facility;*

   No such prohibition has been or will be proposed by CWA, and it is very unlikely that any such prohibition will be conditioned by the USACE or USCG due to the wide WTG spacing and the 6 foot cable burial depth. The Wind Park will be constructed in phases, and marine traffic will only be restricted in the immediate vicinity of ongoing construction activities (estimated to be one to two WTG locations at any one time) for protection of public safety. The remaining areas of the Wind Park will be open to unrestricted navigational access.

   The USCG routinely deconflicts waterways and channels around marine construction activities, and it is anticipated that such procedures could be implemented in Nantucket Sound during construction of the Wind Park.

3. *During and after construction trawling or dragging activity by fishing vessels may be prohibited for the life of the project;*

   No such prohibition has been or will be proposed by CWA, and based on the lack of documentation of trawling activities in the area, CWA believes it is unlikely that any such prohibition will be conditioned by the USACE or USCG due to the wide WTG spacing and the 6 foot cable burial depth.

4. *During and after construction all vessels with mast heights exceeding seventy-four feet may be prohibited from entering the wind energy facility for the life of the project;*

   CWA has no intention or authority to prohibit such vessels from entering the Wind Park area. Vessel restrictions required (if any) will be determined by the USCG.

5. *After construction the wind energy facility may be required to maintain a continuous on-site control room presence with an active radar and radio watch to initiate or pass emergency transmissions, such as an emergency stop order for turbine blades and the transmission of electricity, for the life of the project;*

   CWA will be maintaining an operations center that will be manned 24/7 with the ability to remotely shutdown WTGs as previously described in Section 5.2 of the 2003 Navigational Risk Assessment.

6. *After construction or during periods of high vessel activity, the wind energy facility may be required to maintain a continuous radar, radio and or boat guard capability to assist vessels in distress and/or to maintain vigilance over any operational boating restrictions;*

   As stated in Section 5.3 of the Navigational Risk Assessment, CWA will have a work vessel in the Wind Park during daylight hours when the seas are less than 6 FT that will render assistance when requested.

   CWA will be maintaining an operations center that will be manned 24/7 with the ability to remotely shutdown WTGs as described in Section 5.2 of the Navigational Risk Assessment.

7. *During and after construction, anchoring may be prohibited within the wind farm boundaries as well as adjacent to the paths of transmission cables for the life of the project to preclude the possibility of large vessels dragging anchor in high winds or in low visibility conditions;*

   The cables will be buried a minimum of 6 FT below present bottom. The Navigational Risk Assessment estimated the maximum fluke tip penetration for the 10,000 pound Danforth anchor used on the construction vessels, which is the largest anchor likely to be used over the cables, is approximately 4 FT using US Navy guidance on fluke tip penetration. CWA has no intention or authority to prohibit vessels from anchoring within the Wind Park area. Vessel restrictions required (if any) will be determined by the USCG.

   CWA will request that the Project's cables (including all inner array cables) be marked on the nautical charts for the area by NOAA. Mariners will have the ability to anchor anywhere within the Wind Park, but as with any other location, mariners are advised not to anchor over cables. Prudent mariners will not anchor over the cables.

8. *After construction, exclusionary zones may be required throughout the wind farm or around the base of each tower for the life of the project.*

   CWA has no intention to request or the authority to establish exclusionary zones in the Wind Park area or around each WTG. Vessel restrictions required (if any) will be determined by the USCG.

Likely Impacts on Waterway Users

All who drag or trawl for their catch will be impacted by the construction and operation of the wind farm on this active fishing ground. The Cape Wind assessment is silent about future fishing activity within or adjacent to the wind energy facility.

WTGs on the east side of the Wind Park (as shown in the 2003 Navigational Risk Assessment) have been relocated to the northwest corner of the Wind Park in response to comments received from commercial fishermen who use mobile gear stating that the deep water to the east of Horseshoe Shoal is where they work most.

An assessment of potential impacts to commercial and recreational fisheries was included in the DEIS/DEIR, and will be updated in the FEIS/FEIR.

Given the restrictions on fishing activities commonly imposed at the majority of existing European wind energy facilities, the likelihood of similar restrictions being imposed at Cape Wind facility is high.

No such restrictions have been or will be proposed by CWA, and CWA believes it is unlikely that any such restrictions will be conditioned by the USACE or USCG due to the wide WTG spacing and the 6 foot cable burial depth. It is important to note that many of the operating international offshore wind farms have surface laid cables (in contrast to CWA's proposed embedded cables).

Imposing a fifty-meter [exclusion] zone has become standard practice at existing wind energy facilities and is mentioned in the UK's MCA standards for even medium risk wind energy facilities. Given the length of trawl, the practice of following bottom contours, the wind and current conditions in Nantucket Sound, as well as the basic navigating methods employed by most older fishing vessels, this shrinkage will effectively eliminate all trawling/dragging within the entire confines of the wind farm.

CWA has neither the intention to request or the authority to establish exclusionary zones in the Wind Park area or around each WTG. Vessel restrictions required (if any) will be determined by the USCG. Fishing vessels will still be able to trawl within the Wind Park. However, their operators will have to take the presence of the WTGs into account as they steer their courses.

WTGs on the east side of the Wind Park (as shown in the 2003 Navigational Risk Assessment) have been relocated to the northwest corner of the Wind Park in response to comments received from commercial fishermen who use mobile gear stating that the deep water to the east of Horseshoe Shoal is where they work most.

All vessels in a marine traffic survey should be examined for mast height. Mitigation action should then be identified and proposed to address the danger faced by vessels with large mast heights.

The mast heights for the vessels included in the Vessel Impact Analysis are provided in Table 3.1 of the revised Navigational Risk Assessment.

Outright exclusion of all vessels with large mast heights may be necessary for the life of the Cape Wind project. A live radio "watch", a radar system monitored by the wind energy facility operator, and emergency communication system and security boats operated by the wind farm may also need to be employed to ward off or to respond to vessels with large heights of mast.

CWA has no intention to request or the authority to establish exclusionary zones in the Wind Park area or around each WTG. Vessel restrictions required (if any) will be determined by the USCG. CWA will be maintaining an operations center that will be manned 24/7 with the ability to remotely shutdown WTGs as described in Section 5.2 of the Navigational Risk Assessment.

The Cape Wind assessment examined the ability of vessels to anchor in and around the wind park after construction, and concluded that no restrictions to anchoring would be needed…While this outcome may sound favorable for vessel operations in the area, it is at odds with the anchoring restrictions encountered at many of the operating, international offshore wind farm locations.

No such restrictions have been or will be proposed by CWA, and it is unlikely that any such restrictions will be conditioned by the USACE or USCG due to the wide WTG spacing and the 6 foot cable burial depth. It is important to note that many of the operating international offshore wind farms have surface laid cables (in contrast to CWA's proposed embedded cables).

CWA will request that the Project's cables (including all inner array cables) be marked on the nautical charts for the area by NOAA. Mariners will have the ability to anchor anywhere within the Wind Park, but as with any other location, mariners are advised not to anchor over cables. Prudent mariners will not anchor over the cables.

It appears that the Cape Wind conclusion regarding anchoring was reached without examining the impact of vessel anchoring maneuvers on collision frequency.

During meetings with USCG staff in January 2003, the USCG verbally instructed CWA and ESS to "characterize" rather then calculate usage and impact probabilities as part of the Navigational Risk Assessment. This type of quantitative analysis of frequency of collisions, with or without the impacts of vessel anchoring maneuvers, was not requested the USCG.

The wind energy facility location proposed by Cape Wind is virtually surrounded by the general anchorages "I", "G", "H", and "J" indicated on maritime charts and described in the Coast Pilot…Anchoring restrictions need to be examined in the context of mitigating damage to vessels either in colliding with a wind tower or being struck by a turning wind turbine blade…

The Wind Park is located within the charted Anchorage "I" and in the same waterbody as the other anchorage mentioned in the comment. The 2004 WAMS report notes that "there is little or no reported commercial use of the anchorages due the dangerous shoal water in the vicinity coupled with adequate harbors of refuge capable of accommodating most waterway users" and that "it is apparent these anchorages are disproportionate to the waterway and pose a myriad of safety issues as they relate to providing a safe, navigable waterway for the user". As a result, the WAMS report recommends that the USCG reevaluate the necessity and size of these anchorages.

The recommendations in the WAMS report include significantly reducing the size of Anchorage "I" and relocating it such that it is partially located within the easterly portion of the Wind Park. Anchorage "H" is recommended to be reduced in size and moved to the west of the Wind Park. Figure 4-10 illustrates the recommended changes to the anchorages in the area of the Wind Park that were included in the WAMS report.

CWA has no intention or authority to prohibit vessels from anchoring within the Wind Park area. Vessel restrictions required (if any) will be determined by the USCG. CWA will request that the Project's cables (including all inner array cables) be marked on the nautical charts for the area by NOAA. Mariners will have the ability to anchor anywhere within the Wind Park, but as with any other location, mariners are advised not to anchor over cables. Prudent mariners will not anchor over the cables.

Little stock can be placed in the "wide" 640-yard by 1080-yard spacing between towers or the premise that boats and ships can steer in straight lines between the rows of towers. Experience in marine casualty investigation has demonstrated that straight course lines or intentions can be instantaneously erased when a mechanical failure occurs, or when wind, wave, current or poor visibility adversely affect vessel navigation.

The 640 yard by 1080 yard (1,920 foot by 3,240 foot) spacing between the WTGs is far wider than the widths of existing channels in the Nantucket Sound area routinely used by commercial vessels as shown in the table below. Mariners are currently able to safely navigate commercial and recreational vessels through these commonly accepted narrow corridors. Therefore, the minimum spacing of 1,920 feet would not present conditions more restrictive to navigation than presently exists in these channels. Figure 4-9 illustrates the how the proposed WTG spacing is significantly wider than existing Federal Channels in the Nantucket Sound area.

Federal Channel	Charted Clear Width	WTG Spacing Distance
Hyannis Harbor	240 to 320 feet	2,066 feet by 3,281 feet
Nantucket Harbor	300 feet	
Hog Island Channel	500 feet	
Cleveland Ledge Channel	700 feet	
Cape Cod Canal	480 feet	

In addition, existing natural depth limitations restrict deep-draft vessels from entering the Wind Park area to transit through Nantucket Sound. Mariners will maintain the ability to anchor within the entire Wind Park area.

Electronic Interference

No information is offered with regard to the impact on surface to air radar or Air Traffic Control (ATC) radar systems.

An assessment of potential impacts to Air Traffic Control systems was provided in Section 5.14 of the DEIS/DEIR. The FAA conducted an aeronautical study for each of the 130 WTGs. The FAA's study focused on potential impacts to air navigation, and included an analysis of the potential for the WTGs to affect aviation radar. Based on its aeronautical study, the FAA New England Regional Office issued a "Determination of No Hazard to Air Navigation" in April 2003, which was reviewed, affirmed, and finalized by the Washington, DC office of the FAA on August 2, 2005. Based on the FAA's findings, no adverse impacts to air traffic control systems are anticipated from development of the Project.

The PAVE/PAWS radar installation is located in the northeastern portion of the Massachusetts Military Reservation. In 2004, the US Air Force (USAF) reviewed the proposed location of the Wind Park with respect to the operation of the PAVE/PAWS radar. In a letter dated March 21, 2004, the USAF determined that the CWA Wind Park "poses no threat to the operation of the PAVE/PAWS radar". The USAF further stated that at the nearest proposed WTG location, the main PAVE/PAWS radar beam will clear the WTGs by more than 4,500 feet (USAF, 2004). Based on the USAF's findings, no adverse impacts to the PAVE/PAWS radar system are anticipated from development of the Project.

No mention is made or assessment offered regarding the proposed wind energy facility's impact on Sonar systems.

No assessment of the Project's impact on sonar systems was included in the Navigational Risk Assessment because it is unlikely that vessels would use sonar as a means of navigation in the area given the shallow water depths in Nantucket Sound.

No mention is made or assessment offered regarding the proposed wind energy facility's impact on UHF, Microwave communication systems or television systems.

Since these technologies do not directly affect navigational safety, an assessment of potential impacts on UHF, microwave, and television systems is beyond the scope of the Navigational Risk Assessment. An assessment of potential impacts to telecommunications systems was provided in Section 5.14 of the DEIS/DEIR, including a licensed microwave search and a worst case Fresnel zone analysis. Based on the results of that analysis, no adverse impacts to telecommunications systems is anticipated from development of the Project.

…the assessment is silent on the potential electromagnetic impact of the wind turbine generators and/or structures on other vessel positioning systems such as the maritime Differential Global Positioning Service [sic] *(DGPS).*

An analysis of potential impacts from electrical and magnetic fields was provided in Section 5.13 of the DEIS/DEIR. The analysis found that such fields, if they exist outside of the project components, would dissipate within 10 feet or less of the WTGs, ESP, and cables.

In November 2004, the MCA and QinetiQ jointly published results of investigations of radar system performance in and around the North Hoyle wind farm. The investigations included performance evaluations of GPS systems. MCA/QinetiQ, 2004 reports that no problems with basic GPS reception or positional accuracy were found. Therefore, GPS positioning systems are not expected to be affected by the presence of the Wind Park.

No mention is made or assessment offered regarding the proposed wind farm's impact on visual sight navigation.

During clear conditions when visual sight navigation would be appropriate, the presence of the WTGs will assist mariners in navigating by sight in and around the Wind Park. As described in Section 4.5, the WTGs will be marked individually on NOAA navigation charts to allow navigators to reference their positions to the WTGs by sight (including the alphanumeric designation for each WTG). The private ATONs to be established on each WTG will assist mariners with visual sight navigation during nighttime conditions.

The presence of the WTGs could potentially shield other small vessels from view of vessels navigating in and around the Wind Park. However, the small diameter of the WTGs (approximately 16 feet) would prevent all but the smallest vessels (those with LOA of 16 feet or less) from being completely shielded from view.

Environmental Influences and Impact

The Cape Wind assessment also fails to explore sediment transport and its potential impact on wind farm substructure stability.

An assessment of sediment transport and its potential impact on the stability of the WTGs is beyond the scope of the Navigational Risk Assessment. This topic is evaluated in the Environmental Impact Statements. Section 4.5 of the Revised Navigational Risk Assessment describes the limited extent of changes to the bottom expected from the presence of the WTGs.

The Coast Guard required an evaluation of ice buildup on navigation. Cape Wind's assessment concerning ice provided anecdotal information only based on limited, informal observations in February 2003 without commenting directly on the impact to the "Main Channel."

The 2003/2004 winter brought severe and sustained cold weather to the Nantucket Sound area.

Section 4.4 of the Navigational Risk Assessment has been updated to include descriptions of the icing events during the winter of 2003-2004, which occurred after publication of the 2003 Navigational Risk Assessment. This updated section is based on ice records information obtained from the USCG.

The USCG did not specifically require Cape Wind's assessment to cover the likelihood, frequency, size and results of a marine environmental pollution incident from a vessel collision with a wind tower. The CG did require an evaluation of the "… likely consequences of a collision (What-if) analysis" that could include the impact of marine pollution resulting from a collision.

As part of the FEIS submittal, CWA will present an oil spill probability analysis and an oil spill trajectory analysis to determine the transport and fate of insulating oil stored in the Electric Service Platform (ESP). In the unlikely event of a marine pollution incident that results from collision with a WTG, the fate and transport patterns of the spilled product is expected to be similar to that of the insulating oil evaluated.

CONCLUSIONS

The McGowan Group report makes 11 conclusions based on the information in its report.

The first three conclusions pertain to the lack of specific guidance available in the U.S. regarding wind energy, navigational standards for wind parks, and apply the UK standard to state that the Wind Park would receive a "Higher Risk" designation.

Direct application of the standards of European countries to a project in the U.S. without direction from the USCG or MMS to hold the Project to those standards is not justified.

The fourth conclusion contends that the wind park "threatens disruption of the Main Channel as a marine transportation route." The fifth conclusion restates the previous conclusion as applicable to the other Nantucket Sound alternatives.

Given the width of the Main Channel and the distance of the nearest WTG from the Main Channel, no such disruption will occur during construction and it is unlikely that any such disruption would occur during normal operation and maintenance of the Wind Park.

The sixth conclusion reiterates the exclusionary zones used in the UK, and that the only mitigation proposed in the Navigational Risk Assessment is the establishment of private aids-to-navigation.

The use of exclusionary zones has not been brought up by the USCG in discussions with the USCG staff about the Project. The need for implementation of such zones, if necessary, will be determined by the USCG.

The seventh conclusion states that the assessment is fatally flawed for a variety of reasons.

The 2003 Navigational Risk Assessment was determined by the USCG to adequately address the scope that they requested.

The eighth conclusion regards interference with UHF, microwave, and television signals.

The Project's effects on these types of communications are beyond the scope of the Navigational Risk Assessment and have been evaluated in the DEIS/DEIR.

The ninth conclusion states that the effects of ice loading and other environmental factors be addressed.

Additional information on ice loading on the structures could be provided if requested by the USCG. The other environmental factors mentioned have been evaluated in the DEIS/DEIR.

The tenth conclusion states that the pollution consequences of collisions with WTGs and other vessels must be evaluated.

This was not requested by the USCG in the scope for the Navigational Risk Assessment; however, an oil spill trajectory analysis that will provide information pertinent to this issue will be provided in the FEIS.

The last conclusion states the USCG should evaluate the impact of maritime security measures for the wind park on maritime transportation in Nantucket Sound.

CWA has not discussed security for the Wind Park with the USCG. The determination of the need for such an evaluation is best left to the USCG.