Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Marine Electric

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National Oceanic and
Atmospheric Administration

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Photo: Photograph of *Marine Electric*
Source: http://www.mlaus.org/content/ItemContent/10431Events.pdf

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Project Background

The past century of commerce and warfare has left a legacy of thousands of sunken vessels along the U.S. coast. Many of these wrecks pose environmental threats because of the hazardous nature of their cargoes, presence of munitions, or bunker fuel oils left onboard. As these wrecks corrode and decay, they may release oil or hazardous materials. Although a few vessels, such as USS *Arizona* in Hawaii, are well-publicized environmental threats, most wrecks, unless they pose an immediate pollution threat or impede navigation, are left alone and are largely forgotten until they begin to leak.

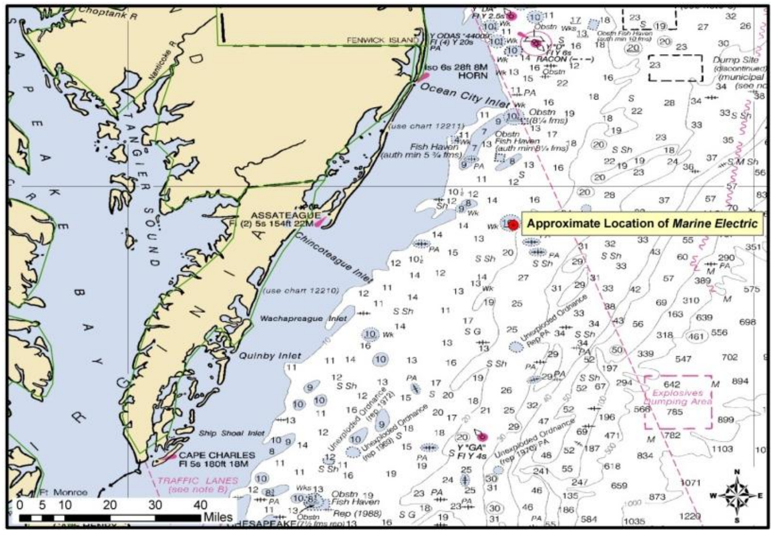
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the Regional Response Teams as well as NOAA in prioritizing threats to coastal resources while at the same time assessing the historical and cultural significance of these nonrenewable cultural resources.

The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

Initial evaluations of shipwrecks located within American waters found that approximately 600-1,000 wrecks could pose a substantial pollution threat based on their age, type and size. This includes vessels sunk after 1891 (when vessels began being converted to use oil as fuel), vessels built of steel or other durable material (wooden vessels have likely deteriorated), cargo vessels over 1,000 gross tons (smaller vessels would have limited cargo or bunker capacity), and any tank vessel.

Additional ongoing research has revealed that 87 wrecks pose a potential pollution threat due to the violent nature in which some ships sank and the structural reduction and demolition of those that were navigational hazards. To further screen and prioritize these vessels, risk factors and scores have been applied to elements such as the amount of oil that could be on board and the potential ecological or environmental impact.

Executive Summary: *Marine Electric*



The freighter *Marine Electric*, sunk after breaking up in rough seas off the coast of Virginia in 1983, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Marine Electric*, the results of environmental impact modeling composed of different release scenarios, the ecological and socio-economic resources that would be at risk in the event of releases, the screening-level risk scoring results and overall risk assessment, and recommendations for assessment, monitoring, or remediation.

Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Marine Electric* scores Medium with 12 points; for the Most Probable Discharge (10% of the Worse Case volume), *Marine Electric* scores Low with 11 points. Given these scores, NOAA recommends that this site be noted in Area Contingency Plans and considered for an assessment if the resources at risk are underrepresented in this assessment. Outreach efforts with the technical and recreational dive community, as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Low	Low
	3B: Water Surface Resources	Med	Med
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	Med	Med
	4C: Shore Resources	Med	Med
Summary Risk Scores		12	11

The determination of each risk factor is explained in the document. This summary table is found on page 40.

SECTION 1: VESSEL BACKGROUND INFORMATION: REMEDIATION OF UNDERWATER LEGACY ENVIRONMENTAL THREATS (RULET)

Vessel Particulars

Official Name: *Marine Electric*

Official Number: 245675

Vessel Type: Freighter

Vessel Class: Modified T-2 Tanker

Former Names: *Gulf Mills; Musgroves Mills*

Year Built: Modified in 1962

Builder: Retained bow and stern of *Gulf Mills,* built at Sun Shipbuilding & Dry Dock, Chester, PA with midships built by Bremer-Vulkan, Bremen Germany; completed in 1962 at Bethlehem Steel Co., East Boston, MA

Builder's Hull Number: Unknown

Flag: American

Owner at Loss: Marine Coal Transport Corporation 100 West 10th St. Wilmington, DE 19801

Controlled by: N/A **Chartered to:** N/A

Operated by: Marine Transport Management Inc. 5 Hanover Square New York, NY 10004

Homeport: Wilmington, DE

Length: 588 feet **Beam:** 75 feet **Depth:** 47 feet

Gross Tonnage: 13,757 **Net Tonnage:** 9,226

Hull Material: Steel **Hull Fastenings:** Welded **Powered by:** Oil-fired steam

Bunker Type: Heavy Fuel Oil (Bunker C) **Bunker Capacity (bbl):** Unknown

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): N/A **Dry Cargo Capacity:** 24,830 net tons

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Norfolk, VA

Destination Port: Brayton Point, MA

Date Departed: February 10, 1983

Date Lost: February 12, 1983

Number of Days Sailing: ≈ 2

Cause of Sinking: Storm

Latitude (DD): 37.8797

Longitude (DD): -74.7667

Nautical Miles to Shore: 23

Nautical Miles to NMS: 173

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 125

Bottom Type: Sand

Is There a Wreck at This Location? Yes, wreck has been positively located and identified

Wreck Orientation: Resting on its port side

Vessel Armament: None

Cargo Carried when Lost: Coal

Cargo Oil Carried (bbl): 0

Cargo Oil Type: N/A

Probable Fuel Oil Remaining (bbl): 3,600

Fuel Type: Heavy Fuel Oil (Bunker C)

Total Oil Carried (bbl): 3,600

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: Unknown

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

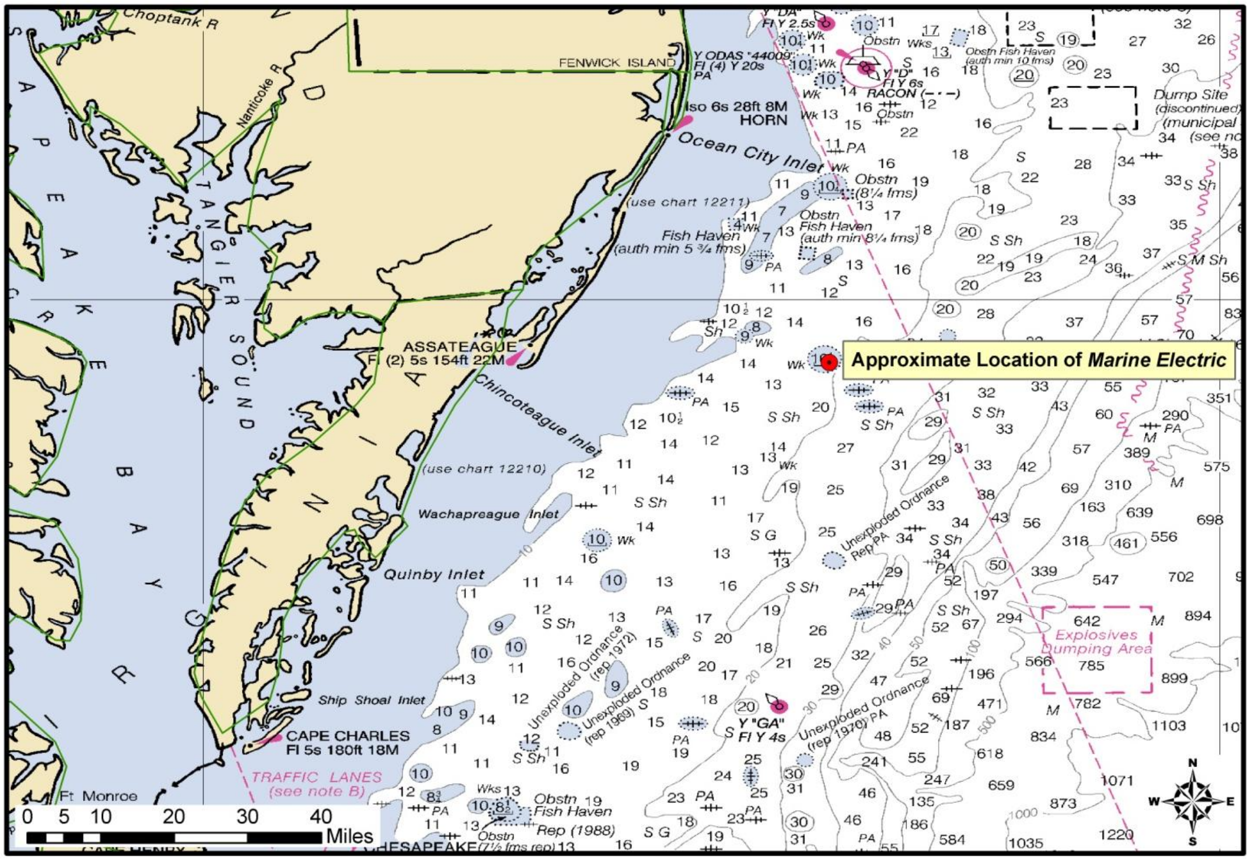


Chart Number: 13003

Casualty Narrative

"The *Marine Electric* was a coal carrier. She was originally built in 1944 and then refitted in 1962 to be 607 feet long. The vessel left Norfolk, VA on February 10, 1983 carrying a cargo of 25,000 tons of coal. Seas were rough and skies were overcast. The air and water temperature was cold and the wind was blowing in excess of 40 knots. The ship carried a crew of 34.

As the ship cruised off Virginia's east shore, the weather deteriorated. By the next morning, the seas were between 20 and 40 feet, with winds up at 60 knots. By the nightfall, the ship began to founder. An inspection revealed that the holds were filling with sea water. Around 4PM a distress call was sent and acknowledged by the U.S. Coast Guard. A rescue helicopter from Coast Guard Air Station Elizabeth City was immediately dispatched to the scene. Upon arrival the helicopter found that the ship had sunk and 34 people were in the water.

The wreck is in two major pieces in about 125 feet of water at roughly 37 52.896N 74 46.558W. It sits on the 20 fathom line about 30 miles east of Chincoteague Inlet. The wreck is heavily visited by divers, commercial fishermen and recreational anglers."
-http://www.daybreakfishing.com/MarineElectricWreck.html

General Notes

NOAA Automated Wreck and Obstruction Information System (AWOIS) Data:
HISTORY

CL298/83--5TH CGD TO AMC; S/S MARINE ELECTRIC SUNK ON 2/12/83 IN APPROX. POS. LAT. 37-52-47N, LONG. 74-46-00W IN APPROX. 118 FT. (APPROX. 30 NM OFF COAST OF CHINCOTEAGUE, VA). VESSEL OF U.S. REGISTRY, 605 FT. L, 75 FT. BEAM. INVEST. BY CG 2/16/83, DIVERS AND SIDE SCAN SONAR. VESSEL BROKEN IN TWO PARTS, SCATTERED DEBRIS. LD APPROX. 70 FT. ON MAIN PORTION. SSS SUGGESTS SHOALER LD. REQUESTS NOS WIRE DRAG, EARLIEST CONVENIENCE.

CL583/83--RU/HE TO 5TH CGD;
HIGHEST POINT OF WRECKAGE OF MARINE ELECTRIC

“In the early morning hours of Feb. 12, 1983, the bulk transport ship *Marine Electric* was lost in a terrible tragedy while transporting 24,800 tons of coal in her holds 30 miles off the coast of the barrier islands of Virginia. The ship was battered for hours by huge seas, some of them 35 feet high. Slowly, the 38 year old and seemingly not seaworthy ship began to give-way. In poor condition with rusting and cracking decks, this ship was more than twice the age for de-commissioning and retirement. Hatch covers designed to keep water from entering the ship, sealing her cargo were worn thin and not secure. Even the ship's pumps to remove water from her holds were inoperative. Hull damage was hastily and crudely patched - this ship was a tragedy waiting to happen. The ship foundered at 4:10 am, after hours of distress calls and attempts to weather the storm. The men abandoned ship in a desperate attempt to save themselves but when help finally arrived nearly two hours later, thirty-one men had been lost to the sea. A riveting novel, "Until the Sea Shall Free Them" tells this sad tale - more information can be found here.”
-http://www.untilthesea.com/shipwreck.shtml

Wreck Condition/Salvage History

"The wreck is in two major pieces in about 125 feet of water at roughly 37 52.896N 74 46.558W. It sits on the 20 fathom line about 30 miles east of Chincoteague Inlet. The wreck is heavily visited by divers, commercial fishermen and recreational anglers. It holds sea bass and is visited by shark fishermen often. Occasionally a bite of bluefin tuna develops there.
-http://www.daybreakfishing.com/MarineElectricWreck.html

“Today, the *Marine Electric* lies on her port side in 160' of water. The bow and stern section are separated by about 200' and both are worth checking out. A veritable maze awaits inside the wreck as the intact structure affords extensive penetration and exploration.”
-http://www.northernatlanticdive.com/2004_expeditions/ocean_city_2004.htm"

Archaeological Assessment

The archaeological assessment provides additional primary source based documentation about the sinking of vessels. It also provides condition-based archaeological assessment of the wrecks when possible. It does not provide a risk-based score or definitively assess the pollution risk or lack thereof from these vessels, but includes additional information that could not be condensed into database form.

Where the current condition of a shipwreck is not known, data from other archaeological studies of similar types of shipwrecks provide the means for brief explanations of what the shipwreck might look like and specifically, whether it is thought there is sufficient structural integrity to retain oil. This is more subjective than the Pollution Potential Tree and computer-generated resource at risk models, and as such provides an additional viewpoint to examine risk assessments and assess the threat posed by these shipwrecks. It also addresses questions of historical significance and the relevant historic preservation laws and regulations that will govern on-site assessments.

In some cases where little additional historic information has been uncovered about the loss of a vessel, archaeological assessments cannot be made with any degree of certainty and were not prepared. For vessels with full archaeological assessments, NOAA archaeologists and contracted archivists have taken photographs of primary source documents from the National Archives that can be made available for future research or on-site activities.

Assessment

No archaeological assessment was prepared for *Marine Electric*. This shipwreck is not a historical shipwreck, and records relating to the loss of the vessel were not part of the National Archives record groups examined by NOAA archaeologists. This means that the best assessment on the sinking of the ship probably still comes from the U.S. Coast Guard's Marine Board of Investigation Report written about the sinking of this vessel.

It should be noted, however, that a local SCUBA diver that was interviewed for this study is relatively certain that there is no oil remaining inside this wreck and that the bunker tanks were damaged when the ship's boilers exploded as it sank.

Background Information References

Vessel Image Sources: http://www.mlaus.org/content/ItemContent/10431Events.pdf

Construction Diagrams or Plans in RULET Database? No

Text References:
http://www.uscg.mil/hq/cg5/docs/boards/marineelectric.pdf
http://www.mlaus.org/content/ItemContent/10431Events.pdf
AWOIS database

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Marine Electric* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This analysis reflected in Figure 1-1 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment. This assessment ***does not*** take into consideration operational constraints such as depth or unknown location, but rather attempts to provide a replicable and objective screening of the historical date for each vessel. SERT reviewed the general historical information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High values for each vessel.

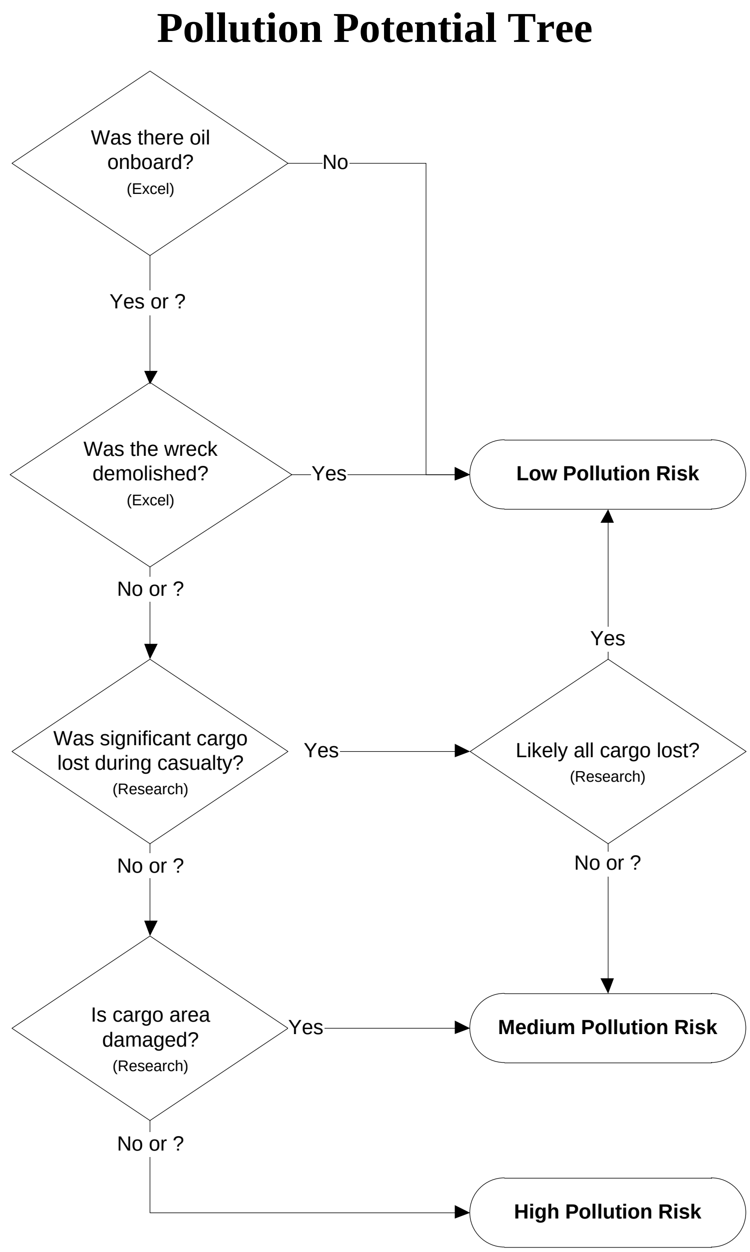


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

In some instances, nuances from the archaeological assessment may provide additional input that will amend the score for Section 1. Where available, additional information that may have bearing on operational considerations for any assessment or remediation activities is provided.

Each risk factor is characterized as High, Medium, or Low Risk or a category-appropriate equivalent such as No, Unknown, Yes, or Yes Partially. The risk categories correlate to the decision points reflected in Figure 1-1.

Each of the risk factors also has a "data quality modifier" that reflects the completeness and reliability of the information on which the risk ranks were assigned. The quality of the information is evaluated with respect to the factors required for a reasonable preliminary risk assessment. The data quality modifier scale is:

- **High Data Quality:** All or most pertinent information on wreck available to allow for thorough risk assessment and evaluation. The data quality is high and confirmed.
- **Medium Data Quality:** Much information on wreck available, but some key factor data are missing or the data quality is questionable or not verified. Some additional research needed.
- **Low Data Quality:** Significant issues exist with missing data on wreck that precludes making preliminary risk assessment, and/or the data quality is suspect. Significant additional research needed.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Marine Electric* is provided, both as text and as shading of the applicable degree of risk bullet.

Pollution Potential Factors

Risk Factor A1: Total Oil Volume

The oil volume classifications correspond to the U.S. Coast Guard spill classifications:

- **Low Volume: Minor Spill** <240 bbl (10,000 gallons)
- **Medium Volume: Medium Spill** ≥240 – 2,400 bbl (100,000 gallons)
- **High Volume: Major Spill** ≥2,400 bbl (≥100,000 gallons)

The oil volume risk classifications refer to the volume of the most-likely Worst Case Discharge from the vessel and are based on the amount of oil believed or confirmed to be on the vessel.

The *Marine Electric* is ranked as High Volume because it is thought to have a potential for up to 3,600 bbl (based on the amount of oil the vessel was carrying when it sank), although some of that was lost at the time of the casualty. Data quality is medium.

The risk factor for volume also incorporates any reports or anecdotal evidence of actual leakage from the vessel or reports from divers of oil in the overheads, as opposed to potential leakage. This reflects the history of the vessel's leakage. There are no reports of leakage from the *Marine Electric*.

Risk Factor A2: Oil Type

The oil type(s) on board the wreck are classified only with regard to persistence, using the U.S. Coast

Guard oil grouping[1]. (Toxicity is dealt with in the impact risk for the Resources at Risk classifications.) The three oil classifications are:

- **Low Risk: Group I Oils** – non-persistent oil (e.g., gasoline)
- **Medium Risk: Group II – III Oils** – medium persistent oil (e.g., diesel, No. 2 fuel, light crude, medium crude)
- **High Risk: Group IV** – high persistent oil (e.g., heavy crude oil, No. 6 fuel oil, Bunker C)

The *Marine Electric* is classified as High Risk because the bunker oil is heavy fuel oil, a Group IV oil type. Data quality is high.

Was the wreck demolished?

Risk Factor B: Wreck Clearance

This risk factor addresses whether or not the vessel was historically reported to have been demolished as a hazard to navigation or by other means such as depth charges or aerial bombs. This risk factor is based on historic records and does not take into account what a wreck site currently looks like. The risk categories are defined as:

- **Low Risk:** The wreck was reported to have been entirely destroyed after the casualty
- **Medium Risk:** The wreck was reported to have been partially cleared or demolished after the casualty
- **High Risk:** The wreck was not reported to have been cleared or demolished after the casualty
- **Unknown:** It is not known whether or not the wreck was cleared or demolished at the time of or after the casualty

The *Marine Electric* is classified as High Risk because there are no known historic accounts of the wreck being demolished as a hazard to navigation. Data quality is high.

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

This risk factor addresses any burning that is known to have occurred at the time of the vessel casualty and may have resulted in oil products being consumed or breaks in the hull or tanks that would have increased the potential for oil to escape from the shipwreck. The risk categories are:

- **Low Risk:** Burned for multiple days
- **Medium Risk:** Burned for several hours
- **High Risk:** No burning reported at the time of the vessel casualty
- **Unknown:** It is not known whether or not the vessel burned at the time of the casualty

[1] Group I Oil or Nonpersistent oil is defined as "a petroleum-based oil that, at the time of shipment, consists of hydrocarbon fractions: At least 50% of which, by volume, distill at a temperature of 340°C (645°F); and at least 95% of which, by volume, distill at a temperature of 370°C (700°F)."
Group II - Specific gravity less than 0.85 crude [API° >35.0]
Group III - Specific gravity between 0.85 and less than .95 [API° ≤35.0 and >17.5]
Group IV - Specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]

The *Marine Electric* is classified as High Risk because there was no report of fire at the time of casualty. Data quality is high.

Risk Factor C2: Reported Oil on the Water

This risk factor addresses reports of oil on the water at the time of the vessel casualty. The amount is relative and based on the number of available reports of the casualty. Seldom are the reports from trained observers so this is very subjective information. The risk categories are defined as:

- **Low Risk:** Large amounts of oil reported on the water by multiple sources
- **Medium Risk:** Moderate to little oil reported on the water during or after the sinking event
- **High Risk:** No oil reported on the water
- **Unknown:** It is not known whether or not there was oil on the water at the time of the casualty

The *Marine Electric* is classified as Medium Risk because oil was reported to have spread across the water after the vessel went down. Data quality is high.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

This risk factor addresses the means by which the vessel sank. The risk associated with each type of casualty is determined by the how violent the sinking event was and the factors that would contribute to increased initial damage or destruction of the vessel (which would lower the risk of oil, other cargo, or munitions remaining on board). The risk categories are:

- **Low Risk:** Multiple torpedo detonations, multiple mines, severe explosion
- **Medium Risk:** Single torpedo, shellfire, single mine, rupture of hull, breaking in half, grounding on rocky shoreline
- **High Risk:** Foul weather, grounding on soft bottom, collision
- **Unknown:** The cause of the loss of the vessel is not known

The *Marine Electric* is classified as Medium Risk because it broke apart before sinking, and the wreck is broken into two sections. Data quality is high.

Risk Factor D2: Structural Breakup

This risk factor takes into account how many pieces the vessel broke into during the sinking event or since sinking. This factor addresses how likely it is that multiple components of a ship were broken apart including tanks, valves, and pipes. Experience has shown that even vessels broken in three large sections can still have significant pollutants on board if the sections still have some structural integrity. The risk categories are:

- **Low Risk:** The vessel is broken into more than three pieces
- **Medium Risk:** The vessel is broken into two-three pieces
- **High Risk:** The vessel is not broken and remains as one contiguous piece
- **Unknown:** It is currently not known whether or not the vessel broke apart at the time of loss or after sinking

The *Marine Electric* is classified as Medium Risk because it is broke into two pieces at the time of casualty. Data quality is high.

Factors That May Impact Potential Operations

Orientation (degrees)

This factor addresses what may be known about the current orientation of the intact pieces of the wreck (with emphasis on those pieces where tanks are located) on the seafloor. For example, if the vessel turtled, not only may it have avoided demolition as a hazard to navigation, but it has a higher likelihood of retaining an oil cargo in the non-vented and more structurally robust bottom of the hull.

The *Marine Electric* is resting on its port side. Data quality is high.

Depth

Depth information is provided where known. In many instances, depth will be an approximation based on charted depths at the last known locations.

The *Marine Electric* is 160 feet deep. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

This factor takes into account what the physical status of wreck site as confirmed by remote sensing or other means such as ROV or diver observations and assesses its capability to retain a liquid cargo. This assesses whether or not the vessel was confirmed as entirely demolished as a hazard to navigation, or severely compromised by other means such as depth charges, aerial bombs, or structural collapse.

The location of the *Marine Electric* is a popular technical dive site and was examined after it sank by U.S. Coast Guard divers. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board

This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released, causing impacts to ecological and socio-economic resources at risk.

There are no reports of hazardous materials onboard. Data quality is high.

Munitions on Board

This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released or detonated causing impacts to ecological and socio-economic resources at risk.

The *Marine Electric* did not carry any munitions. Data quality is high.

Vessel Risk Factors Summary

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *Marine Electric*.

Table 1-1: Summary matrix for the vessel risk factors for the *Marine Electric* color-coded as red (high risk), yellow (medium risk), and green (low risk).

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 3,600 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker oil is heavy fuel oil, a Group IV oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Rough weather	
	D2: Structural Breakup	High	The vessel broke in two at the time of sinking	
Archaeological Assessment	Archaeological Assessment	Low	The shipwreck is not a historic wreck, no archaeological assessment was prepared, the best analysis of the wreck likely comes from the U.S. Coast Guard Marine Board of Inquiry Report	**Not Scored**
Operational Factors	Wreck Orientation	High	Resting on its port side	**Not Scored**
	Depth	High	160 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	Wreck is a popular technical dive site	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	No	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

To help evaluate the potential transport and fates of releases from sunken wrecks, NOAA worked with RPS ASA to run a series of generalized computer model simulations of potential oil releases. The results are used to assess potential impacts to ecological and socio-economic resources, as described in Sections 3 and 4. The modeling results are useful for this screening-level risk assessment; however, it should be noted that detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Marine Electric* this would be about 4,000 bbl (rounded up from 3,600 bbl) based on current estimates of the maximum amount of oil remaining onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Marine Electric*, is a small, episodic release that may be precipitated by disturbance of the vessel in storms. Each of these episodic releases may cause impacts and require a response. **Episodic** releases are modeled using 1% of the WCD. Another scenario is a very low chronic release, i.e., a relatively regular release of small amounts of oil that causes continuous oiling and impacts over the course of a long period of time. This type of release would likely be precipitated by corrosion of piping that allows oil to flow or bubble out at a slow, steady rate. **Chronic** releases are modeled using 0.1% of the WCD.

The **Most Probable** scenario is premised on the release of all the oil from one tank. In the absence of information on the number and condition of the cargo or fuel tanks for all the wrecks being assessed, this scenario is modeled using 10% of the WCD. The **Large** scenario is loss of 50% of the WCD. The five major types of releases are summarized in Table 2-1. The actual type of release that occurs will depend on the condition of the vessel, time factors, and disturbances to the wreck. Note that, the episodic and chronic release scenarios represent a small release that is repeated many times, potentially repeating the same magnitude and type of impact(s) with each release. The actual impacts would depend on the environmental factors such as real-time and forecast winds and currents during each release and the types/quantities of ecological and socio-economic resources present.

The model results here are based on running the RPS ASA Spill Impact Model Application Package (SIMAP) two hundred times for each of the five spill volumes shown in Table 2-1. The model randomly selects the date of the release, and corresponding environmental, wind, and ocean current information from a long-term wind and current database.

When a spill occurs, the trajectory, fate, and effects of the oil will depend on environmental variables, such as the wind and current directions over the course of the oil release, as well as seasonal effects. The magnitude and nature of resource impacts will also generally have a strong seasonal component (e.g., timing of bird migrations, turtle nesting periods, fishing seasons, and tourism seasons).

Table 2-1: Potential oil release scenario types for the *Marine Electric*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	4 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	40 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	400 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	2,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	4,000 bbl	One-time release	Over several hours or days	Least likely	Tier 3

The modeling results represent 200 simulations for each spill volume with variations in spill trajectory based on winds and currents. The spectrum of the simulations gives a perspective on the variations in likely impact scenarios. Some resources will be impacted in nearly all cases; some resources may not be impacted unless the spill trajectory happens to go in that direction based on winds and currents at the time of the release and in its aftermath.

For the large and WCD scenarios, the duration of the release was assumed to be 12 hours, envisioning a storm scenario where the wreck is damaged or broken up, and the model simulations were run for a period of 30 days. The releases were assumed to be from a depth between 2-3 meters above the sea floor, using the information known about the wreck location and depth. It is important to acknowledge that these scenarios are only for this screening-level assessment. Detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Oil Type for Release

The *Marine Electric* contained a maximum of 3,600 bbl of heavy fuel oil (a Group IV oil) as bunker fuel. Thus, the oil spill model was run using heavy fuel oil.

Oil Thickness Thresholds

The model results are reported for different oil thickness thresholds, based on the amount of oil on the water surface or shoreline and the resources potentially at risk. Table 2-2 shows the terminology and thicknesses used in this report, for both oil thickness on water and the shoreline. For oil on the water surface, a thickness of 0.01 g/m^2, which would appear as a barely visible sheen, was used as the threshold for socio-economic impacts because often fishing is prohibited in areas with any visible oil, to prevent contamination of fishing gear and catch. A thickness of 10 g/m^2 was used as the threshold for ecological impacts, primarily due to impacts to birds, because that amount of oil has been observed to be enough to mortally impact birds and other wildlife. In reality, it is very unlikely that oil would be evenly distributed on the water surface. Spilled oil is always distributed patchily on the water surface in bands or tarballs with clean water in between. So, Table 2-2a shows the number of tarballs per acre on the water surface for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches. A thickness of 100 g/m^2 was used as the threshold for ecological impacts based on a synthesis of the literature showing that shoreline life has been affected by this degree of oiling.[2] Because oil often strands onshore as tarballs. Table 2-2b shows the number of tarballs per m^2 on the shoreline for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

Table 2-2a: Oil thickness thresholds used in calculating area of water impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Sheen Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen	Barely Visible	0.00001 mm	0.01 g/m^2	~5-6 tarballs per acre	Socio-economic Impacts to Water Surface/Risk Factor 4B-1 and 2
Heavy Oil Sheen	Dark Colors	0.01 mm	10 g/m^2	~5,000-6,000 tarballs per acre	Ecological Impacts to Water Surface/ Risk Factor 3B-1 and 2

Table 2-2b: Oil thickness thresholds used in calculating miles of shoreline impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m^2	~0.12-0.14 tarballs/m^2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m^2	~12-14 tarballs/m^2	Ecological Impacts to Shoreline Habitats/Risk Factor 3C-1 and 2

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Marine Electric* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water column volume oiled using the five volume scenarios, which is shown in Figure 2-1. Using this figure, the water column impacts can be estimated for any spill volume.

[2] French, D., M. Reed, K. Jayko, S. Feng, H. Rines, S. Pavignano, T. Isaji, S. Puckett, A. Keller, F. W. French III, D. Gifford, J. McCue, G. Brown, E. MacDonald, J. Quirk, S. Natzke, R. Bishop, M. Welsh, M. Phillips and B.S. Ingram, 1996. The CERCLA type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Vol. I - V. Office of Environmental Policy and Compliance, U.S. Dept. of the Interior, Washington, DC.

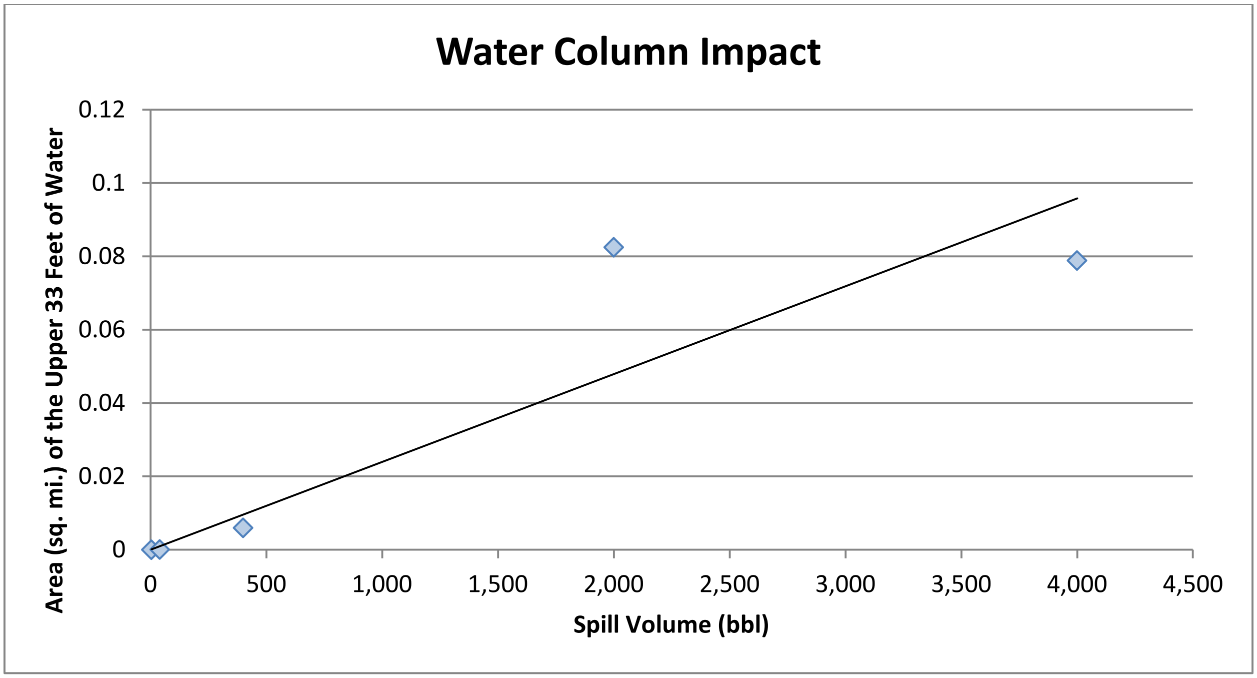


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Marine Electric*.

Potential Water Surface Slick

The slick size from an oil release from the *Marine Electric* is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area "swept" by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs. Note that this is an estimate of total water surface affected over a 30-day period. In the model, the representative heavy fuel oil used for this analysis spreads to a minimum thickness of approximately 975 g/m^2, and is not able to spread any thinner. As a result, water surface oiling results are identical for the 0.01 and 10 g/m^2 thresholds. The slick will not be continuous but rather be broken and patchy due to the subsurface release of the oil. Surface expression is likely to be in the form of sheens, tarballs, and streamers.

Table 2-3: Estimated slick area swept on water for oil release scenarios from the *Marine Electric*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	4	200 mi^2	200 mi^2
Episodic	40	640 mi^2	640 mi^2
Most Probable	400	2,100 mi^2	2,100 mi^2
Large	2,000	4,600 mi^2	4,600 mi^2
Worst Case Discharge	4,000	6,600 mi^2	6,600 mi^2

The location, size, shape, and spread of the oil slick(s) from an oil release will depend on environmental conditions, including winds and currents, at the time of release and in its aftermath. The areas potentially affected by oil slicks, given that we cannot predict when the spill might occur and the range of possible wind and current conditions that might prevail after a release, are shown in Figure 2-2 and Figure 2-3 using the Most Probable volume and the socio-economic and ecological thresholds.

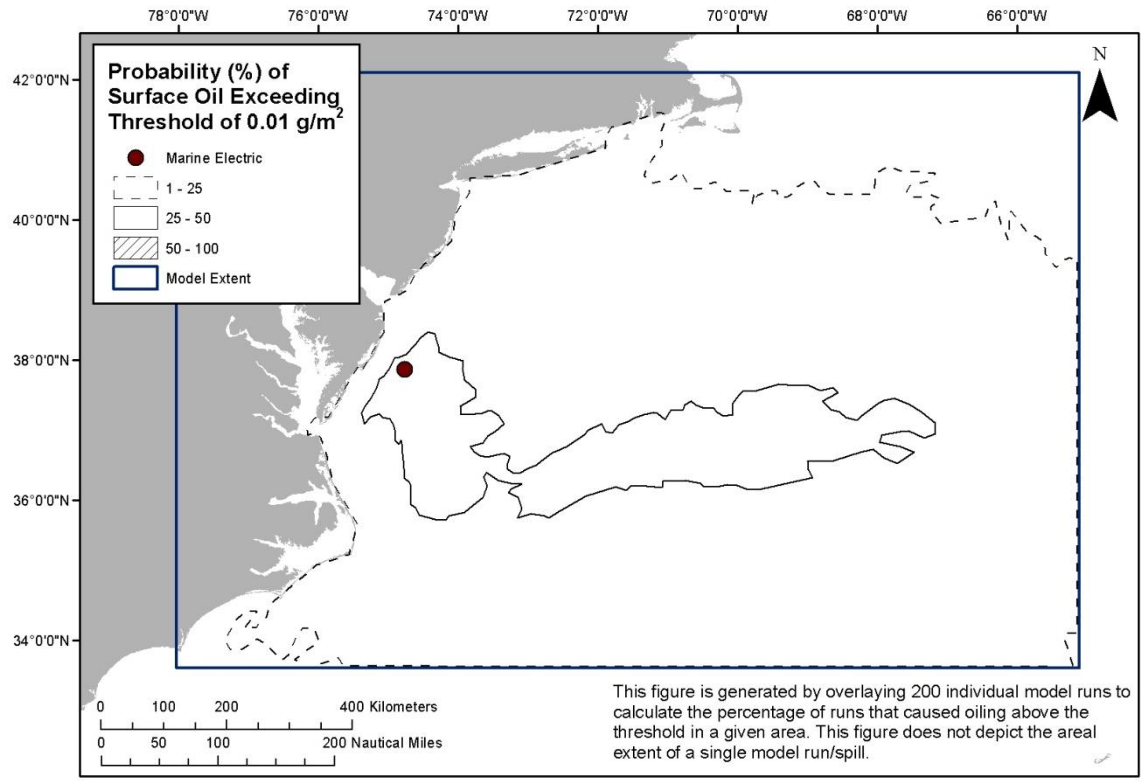


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m²) from the Most Probable spill of 400 bbl of heavy fuel oil from the *Marine Electric* at the threshold for socio-economic resources at risk.

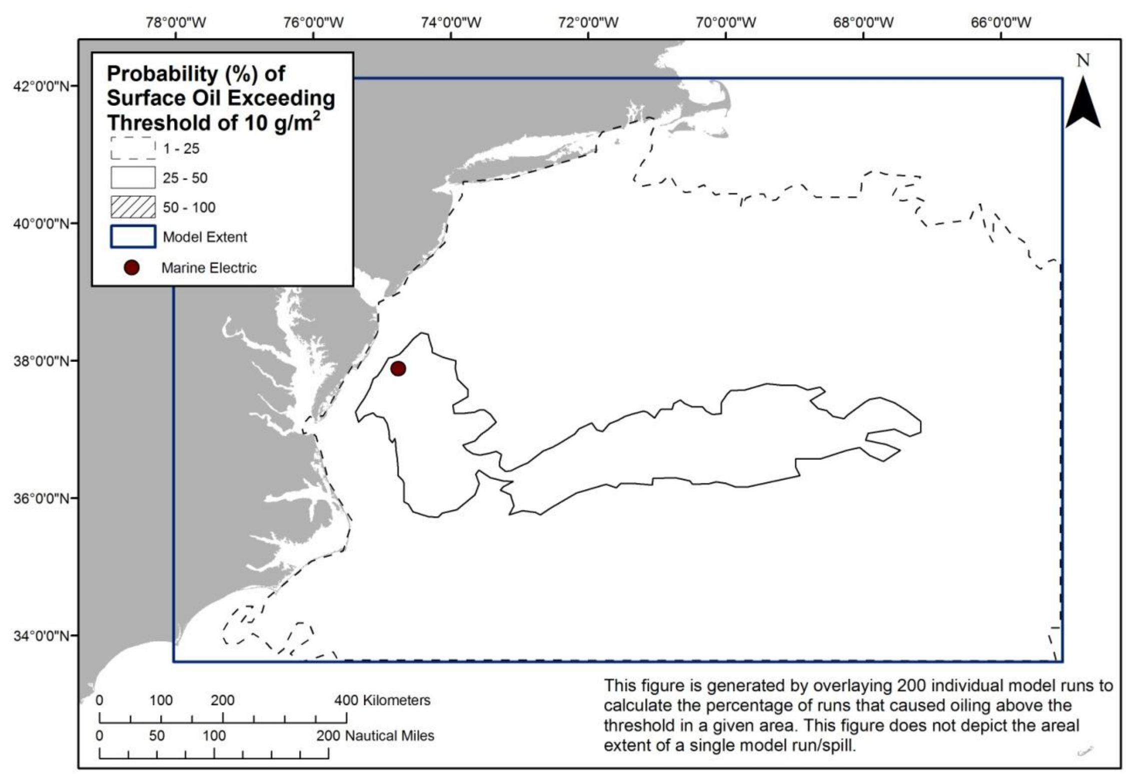


Figure 2-3: Probability of surface oil (exceeding 10 g/m²) from the Most Probable spill of 400 bbl of heavy fuel oil from the *Marine Electric* at the threshold for ecological resources at risk.

The maximum potential cumulative area swept by oil slicks at some time after a Most Probable Discharge is shown in Figure 2-4 as the timing of oil movements.

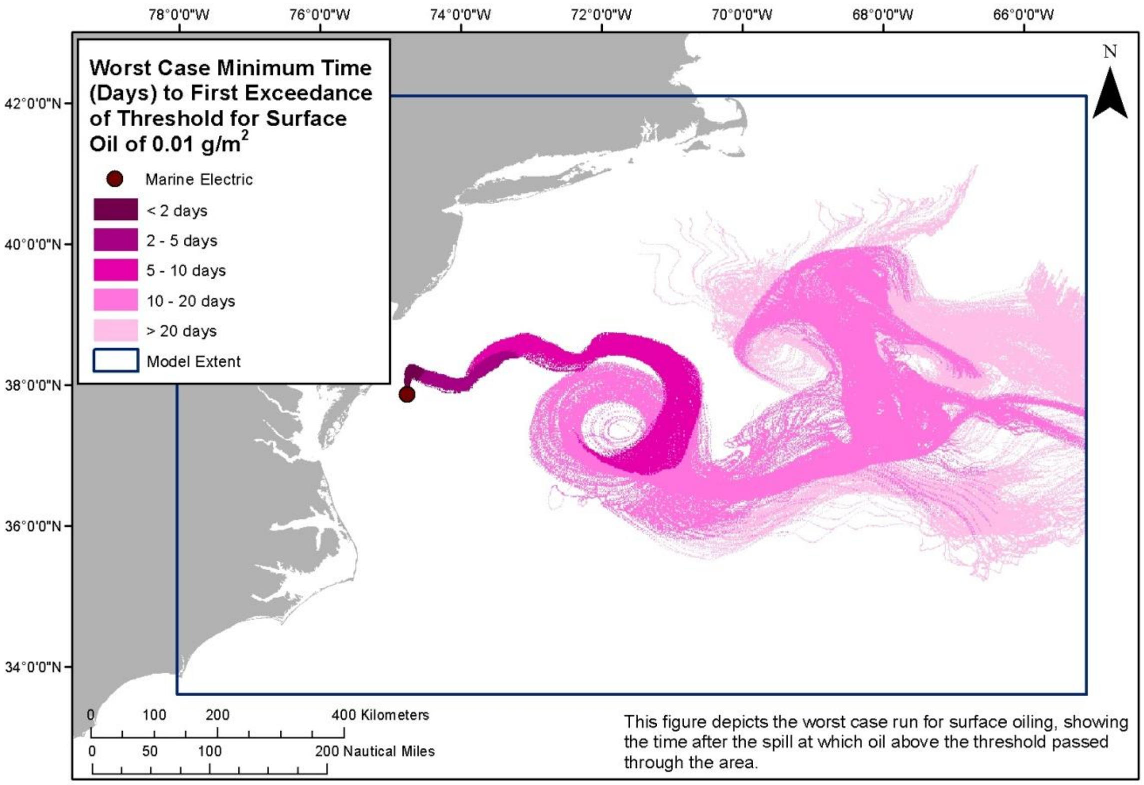


Figure 2-4: Water surface oiling from the Most Probable spill of 400 bbl of heavy fuel oil from the *Marine Electric* shown as the area over which the oil spreads at different time intervals.

The actual area affected by a release will be determined by the volume of leakage, whether it is from one or more tanks at a time. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water surface area oiled using the five volume scenarios, which is shown in Figure 2-5. Using this figure, the area of water surface with a barely visible sheen can be estimated for any spill volume.

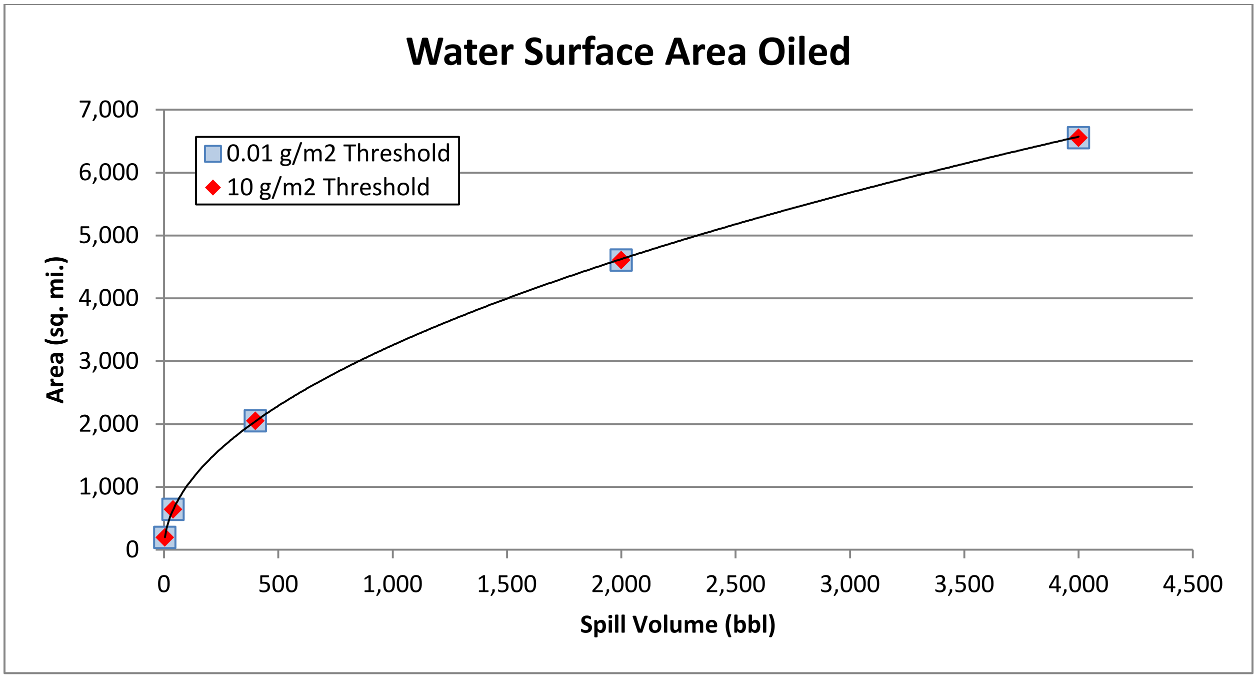


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Marine Electric*, showing both the ecological threshold of 10 g/m² and socio-economic threshold of 0.01 g/m2. The curves are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines from as far north as Narragansett Bay, Rhode Island, to as far south as Cape Lookout, North Carolina, are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release of 400 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

Table 2-4: Estimated shoreline oiling from leakage from the *Marine Electric*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m²			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	4	2	1	0	3
Episodic	40	2	14	0	16
Most Probable	400	3	26	2	31
Large	2,000	3	28	5	36
Worst Case Discharge	4,000	3	29	5	36

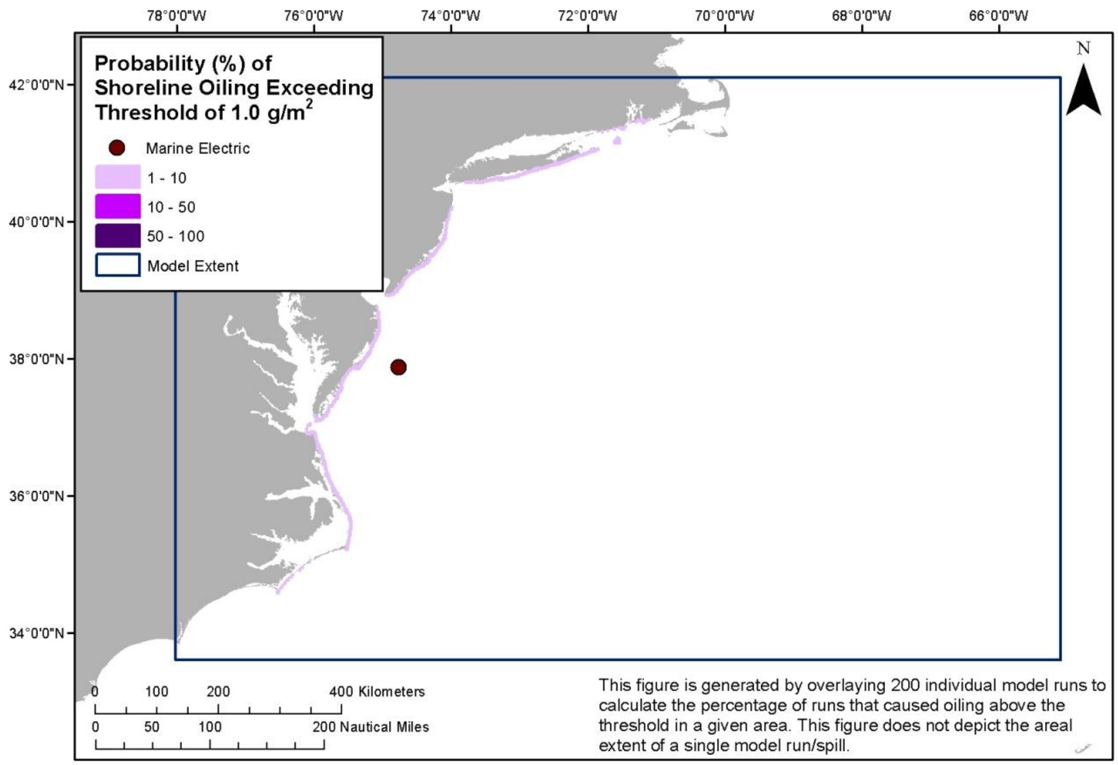


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 400 bbl of heavy fuel oil from the *Marine Electric*.

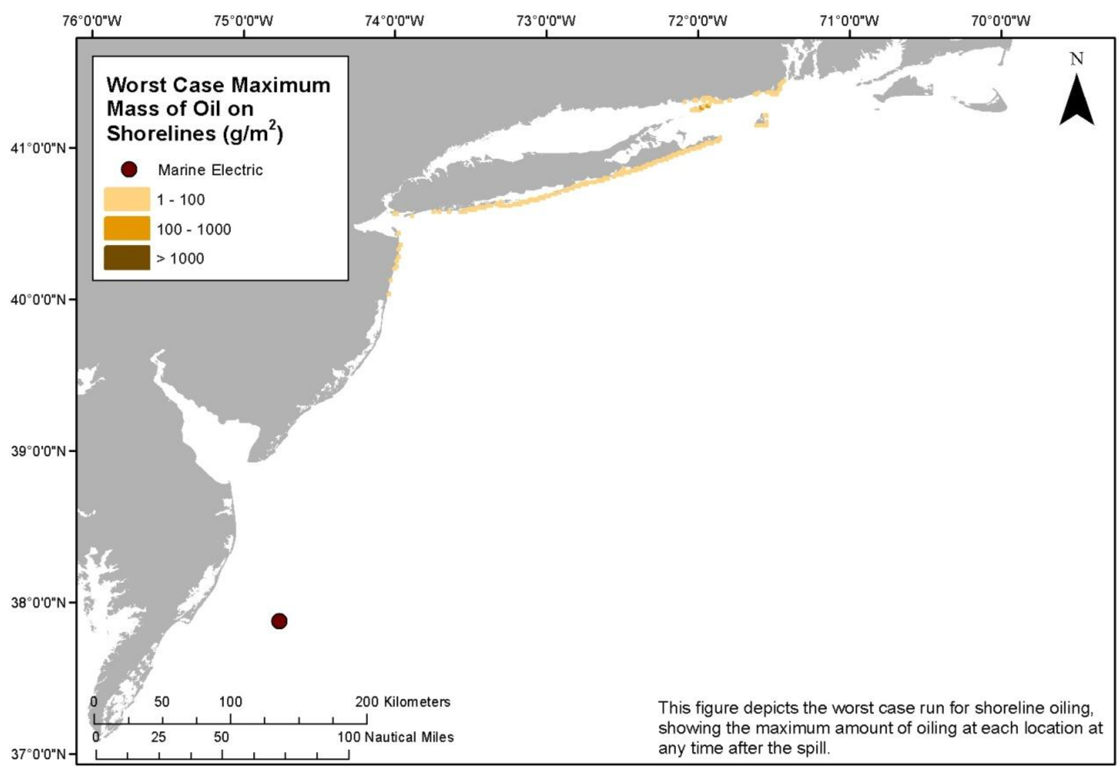


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 400 bbl of heavy fuel oil from the *Marine Electric* that resulted in the greatest shoreline oiling.

The actual shore length affected by a release will be determined by the volume of leakage and environmental conditions during an actual release. To assist planners in scaling the potential impact for different leakage volumes, a regression curve was generated for the total shoreline length oiled using the five volume scenarios, which is shown in Figure 2-8. Using this figure, the shore length oiled can be estimated for any spill volume.

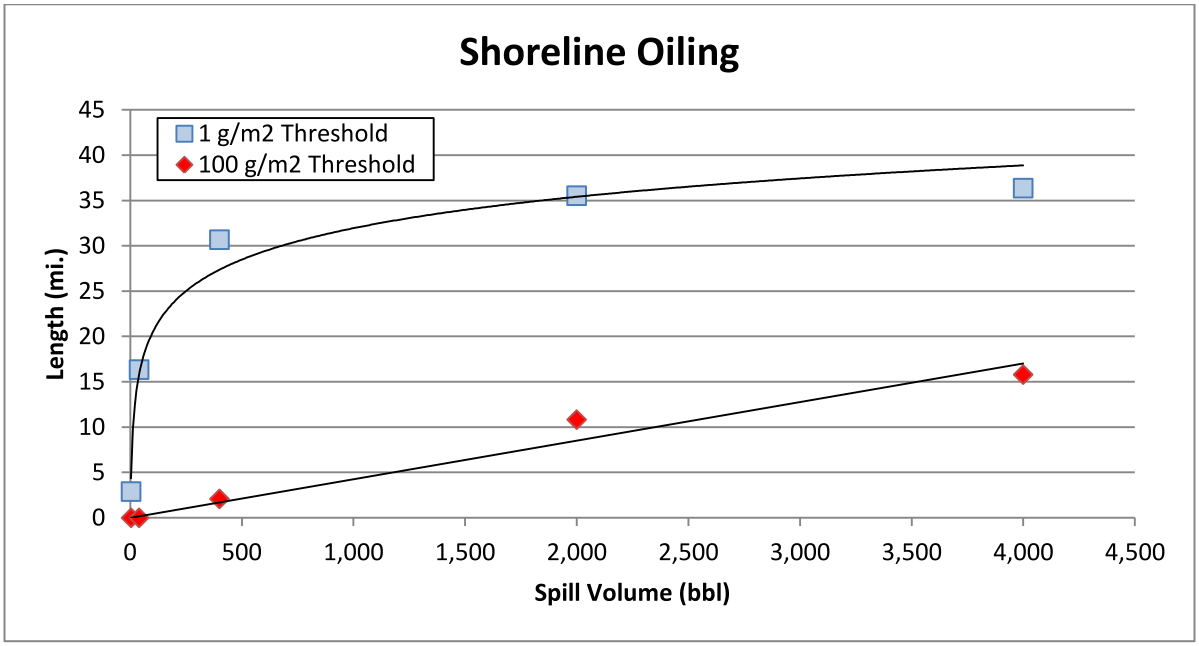


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Marine Electric*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) and the Most Probable volume (Table 2-6) consists primarily of sand beaches, gravel beaches, and artificial shores. Salt marshes and tidal flats near inlets are at risk of lighter oiling.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 4,000 bbl from the *Marine Electric.*

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m^2	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m^2
Rocky and artificial shores/Gravel beaches	40 miles	16 miles
Sand beaches	106 miles	47 miles
Salt marshes and tidal flats	36 miles	0 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 400 bbl from the *Marine Electric.*

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m^2	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m^2
Rocky and artificial shores/Gravel beaches	30 miles	2 miles
Sand beaches	94 miles	0 miles
Salt marshes and tidal flats	22 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Marine Electric* include numerous guilds of birds (Table 3-1), particularly those sensitive to surface oiling while rafting or plunge diving to feed, that are present in nearshore/offshore waters. In addition, this region is important for nesting loggerhead sea turtles, migrating marine mammals, and commercially important fish and invertebrates, including sensitive hard-bottom habitats used by these species.

Table 3-1: Ecological resources at risk from a release of oil from the *Marine Electric*.
(FT = Federal threatened; FE = Federal endangered; ST = State threatened; SE = State endangered

Species Group	Species Subgroup and Geography	Seasonal Presence
Seabirds	• Outer Continental Shelf (OCS) offshore of Cape Hatteras, NC: greatest diversity of seabirds in SE U.S.; greatest density of tropical seabirds in SE U.S. Species include shearwaters, storm petrels • Audubon's shearwaters (50-75% of population) concentrate along the Continental Shelf edge off NC, extending northward to the VA border (~3,800 pairs) • Seabird species groups using Mid-Atlantic U.S. waters include boobies (~300K) and alcids (tens of thousands)	OCS: Ranges by species but Mar-Nov peak Shearwaters off NC/VA in late summer

Sea Ducks	Sea ducks (includes mean and max distance of flocks to shore, 2009-2010 data)
	• Surf scoter - 2 nm/8 nm/Black scoter – 2 nm/13 nm:
	  ○ Chesapeake Bay: 19-58K surf scoter, 3-27K black scoter
	  ○ Off MD/DE: 16-22K surf scoter, 3-61K black scoter
	  ○ Off NC: 0-41K surf scoter, 3.5-13K black scoter
	• Long-tailed duck (2 nm/25 nm)
	  ○ Chesapeake Bay: 17-31K
	  ○ Off MD/DE: 2K
	• Bufflehead, mergansers, goldeneyes (<1 nm/7-14 nm)
	  ○ Off NC: 12K
	  ○ Chesapeake Bay: 14-35K
	  ○ Off MD/DE: 3K
	• Mouths of DE Bay and Chesapeake Bay (especially) have high concentrations of species that are abundant over shoals (loons, pelicans, cormorants, sea ducks, gulls, terns, alcids); scoters are 10X more abundant than other species on shoals and large numbers concentrate off of VA/Chesapeake Bay
		Sea ducks surveyed in winter (peak abundances); Migration from Oct-Apr
		
		Winter use of shoals (Dec-Mar); Summer use of shoals likely farther north

Shorebirds and Colonial Nesting Birds	• RI and MA: Numerous important sites for beach and salt marsh habitats, including many National Wildlife Refuges (NWRs) that support breeding (e.g., least tern and piping plover) and migratory stopover points • Great Gull Island, Long Island Sound: one of the most important tern nesting sites in the world (1,600 pairs of roseate terns (FE), 10K common terns) • Barrier islands on south shore of Long Island: beach nesters (e.g., piping plovers), nesting wading birds, raptors, migrating shorebirds, wintering waterfowl • NJ: Edwin B. Forsythe NWR and Sandy Hook: essential nesting/foraging habitat for imperiled beach nesters (piping plover, American oystercatcher, black skimmer, least tern) • Assateague Island, MD: globally important bird area due to 60+ pairs of nesting piping plovers; largest colony of nesting least terns in MD;	Colonial and beach nesters peak Apr-Aug Migration typically spring/fall, but varies by species and location and ranges from Feb-Jun/Aug-Dec

Species Group	Species Subgroup and Geography	Seasonal Presence
	important for migratory shorebirds • VA Barrier Island/Lagoon System: most important bird area in VA and one of most along Atlantic coast: piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer (many of these species are state listed or special concern in VA); most significant breeding wader population in state; marsh nesters have center of abundance here; internationally significant stopover point for whimbrel, short-billed dowitcher, red knot • Western Shore VA marshes: extensive low marshes support significant populations of many marsh nesting species • Outer Banks and Cape Hatteras: regionally important for coastal birds with 365+ species including piping plovers, willets, black skimmers, American oystercatchers	
Raptors and Passerines	Lower Delmarva (Cape Charles area of VA): 20-80K raptors and over 10 million migrating passerines	Fall
Sea Turtles	Estuaries are summer foraging grounds for adult and juvenile green (FE) and loggerhead (FT) sea turtles, especially Chesapeake Bay and Long Island Sound Leatherback (FE), loggerhead, Kemp's ridley (FE) present offshore from spring-summer in the area of most probable impact. Greens occur in VA, NJ, and DE but are rare further north Nesting (annual counts along shorelines with most probable impacts). Mostly occurs in North Carolina but loggerheads can nest as far north as Delaware • 650+ Loggerhead (FT) • < 20 Green (FT) • < 10 Leatherback (FE) Distribution: • Offshore hot spots not well known • Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)	Nesting season: Adults: May-Sep Hatching: May-Dec In water: Year round with Apr-Dec peak
Marine Mammals	*Baleen whales*: North Atlantic right whale (FE), humpback whale (FE), fin whale (FE), and minke whale • Right whales are critically endangered (<400 individuals left); coastal waters in the area are used as a migratory pathway and border the northern extent of calving grounds *Inshore cetaceans:* Bottlenose dolphin and harbor porpoise use coastal waters out to the shelf break *Offshore cetaceans*: Pilot whale, Risso's dolphin, common dolphin, Atlantic spotted dolphin, spinner dolphin • Often associated with shelf edge features and convergence zones (fronts) *Pinnipeds*: 100s of gray seals and harbor seals are common during winter, with Block Island, Plum Island, Fishers Island, and Great Gull Island serving as important haul out locations. They can also occur as far south as NC. Harp, hooded, and gray seals have also been observed but are rare	Baleen whales present fall-spring. Adults migrate from feeding grounds in North Atlantic to calving grounds further south Juvenile humpbacks forage offshore during the winter Bottlenose dolphin present year round Harbor seals present during winter
Fish and Inverts	Coastal ocean waters support many valuable fisheries and/or species of concern in the region: • *Benthic or bottom associated*: Sea scallop, scup, black sea bass, butterfish, goosefish, scamp, horseshoe crab, tilefish, other reef species	Estuarine dependent fish migrate offshore in fall/ winter to spawn; Juveniles and adults use estuaries during spring/summer

Species Group	Species Subgroup and Geography	Seasonal Presence
	• *Midwater*: Atlantic mackerel, Spanish mackerel, shortfin squid, bluefish, menhaden, spiny dogfish, smooth dogfish • *Pelagic*: Bluefin tuna, yellowfin tuna, wahoo, dolphinfish, bigeye tuna, swordfish • *Diadromous*: Alewife, blueback herring, American shad, hickory shad, Atlantic tomcod, American eel, Atlantic sturgeon (Fed. species of concern), shortnose sturgeon (FE), striped bass • *Estuarine dependent*: Southern flounder, spotted seatrout, blue crab, Atlantic croaker, spot, weakfish, shrimp • *Estuarine resident*: Eastern oyster, northern quahog Important concentration/conservation areas are: • Pelagic species can be more concentrated around the shelf break and at oceanographic fronts • The Point – Essential Fish Habitat/Habitats Areas of Particular concern (EFH/HAPC) for coastal migratory pelagics and dolphin/wahoo • Primary nursery areas in NC bays for estuarine dependent species	Anadromous fish migrate inshore to spawn in fresh water in spring American eel migrate offshore to spawn in winter Bluefin tunas present fall-spring
Benthic Habitats	Submerged aquatic vegetation is extremely critical to numerous species and occurs inside of bays and sounds Scattered hard-bottom sites are located off NC and considered HAPC for reef-associated fishes (including the areas listed above)	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Marine Electric* are generally available at each U.S. Coast Guard Sector. They can also be downloaded at: http://response.restoration.noaa.gov/esi. These maps show detailed spatial information on the distribution of sensitive shoreline habitats, biological resources, and human-use resources. The tables on the back of the maps provide more detailed life-history information for each species and location. The ESI atlases should be consulted to assess the potential environmental resources at risk for specific spill scenarios. In addition, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on the nearshore and shoreline ecological resources at risk and should be consulted.

Ecological Risk Factors

Risk Factor 3: Impacts to Ecological Resources at Risk (EcoRAR)

Ecological resources include plants and animals (e.g., fish, birds, invertebrates, and mammals), as well as the habitats in which they live. All impact factors are based on a Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for ecological resources at risk (EcoRAR) are divided into three categories:

- Impacts to the water column and resources in the water column;
- Impacts to the water surface and resources on the water surface; and
- Impacts to the shoreline and resources on the shoreline.

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there is an impact. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three ecological resources at risk categories, risk is defined as:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be an impact to ecological resources over a certain minimal amount); and
- The **degree of oiling** (the magnitude or amount of that impact).

As a reminder, the ecological impact thresholds are: 1 ppb aromatics for water column impacts; 10 g/m^2 for water surface impacts; and 100 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Marine Electric* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 4,000 bbl and a border around the applicable degree of risk bullet for the Most Probable Discharge of 400 bbl.

Risk Factor 3A: Water Column Impacts to EcoRAR

Water column impacts occur beneath the water surface. The ecological resources at risk for water column impacts are fish, marine mammals, and invertebrates (e.g., shellfish, and small organisms that are food for larger organisms in the food chain). These organisms can be affected by toxic components in the oil. The threshold for water column impact to ecological resources at risk is a dissolved aromatic hydrocarbons concentration of 1 ppb (i.e., 1 part total dissolved aromatics per one billion parts water). Dissolved aromatic hydrocarbons are the most toxic part of the oil. At this concentration and above, one would expect impacts to organisms in the water column.

Risk Factor 3A-1: Water Column Probability of Oiling of EcoRAR

This risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause ecological impacts. The three risk scores for water column oiling probability are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3A-2: Water Column Degree of Oiling of EcoRAR

The degree of oiling of the water column reflects the total volume of water that would be contaminated by oil at a concentration high enough to cause impacts. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level

- **Medium Impact**: impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Marine Electric* is classified as Low Risk for oiling probability for water column ecological resources for the WCD of 4,000 bbl because 4% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 400 bbl, the *Marine Electric* is classified as Low Risk for oiling probability for water column ecological resources because 0.5 % of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

Ecological resources at risk at the water surface include surface feeding and diving sea birds, sea turtles, and marine mammals. These organisms can be affected by the toxicity of the oil as well as from coating with oil. The threshold for water surface oiling impact to ecological resources at risk is 10 g/m^2 (10 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to birds and other animals that spend time on the water surface.

Risk Factor 3B-1: Water Surface Probability of Oiling of EcoRAR

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to ecological resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3B-2: Water Surface Degree of Oiling of EcoRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Marine Electric* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 84% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 6,560 mi^2. The *Marine Electric* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 76% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 2,050 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

The impacts to different types of shorelines vary based on their type and the organisms that live on them. In this risk analysis, shorelines have been weighted by their degree of sensitivity to oiling. Wetlands are the most sensitive (weighted as "3" in the impact modeling), rocky and gravel shores are moderately sensitive (weighted as "2"), and sand beaches (weighted as "1") are the least sensitive to ecological impacts of oil.

Risk Factor 3C-1: Shoreline Probability of Oiling of EcoRAR

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline organisms. The threshold for shoreline oiling impacts to ecological resources at risk is 100 g/m^2 (i.e., 100 grams of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3C-2: Shoreline Degree of Oiling of EcoRAR

The degree of oiling of the shoreline reflects the length of shorelines oiled by at least 100 g/m^2 in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at the threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at the threshold level
- **High Impact:** more than 100 miles of shoreline impacted at the threshold level

The *Marine Electric* is classified as Medium Risk for oiling probability for shoreline ecological resources for the WCD because 42% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 18 miles. The *Marine Electric* is classified as Medium Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 17% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 2 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 4,000 bbl of heavy fuel oil from the *Marine Electric* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because little to no volume of water column is predicted to be above thresholds for ecological resources
- Water surface resources – Medium, because of the seasonally very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk and importance of offshore water for adult and juvenile sea turtles. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – Medium, because of the primarily sand beaches at risk include important habitats for migratory and nesting shorebirds

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 4,000 bbl** of heavy fuel oil from the *Marine Electric*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	4% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	84% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 6,560 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	42% of the model runs resulted in shoreline oiling of 100 g/m^2	**Med**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 18 mi	

For the Most Probable Discharge of 400 bbl, the ecological risk from potential releases of heavy fuel oil from the *Marine Electric* is summarized as below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because little to no volume of water column is predicted to be above thresholds for ecological resources
- Water surface resources – Medium, because of the seasonally very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk and importance of offshore water for adult and juvenile sea turtles. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – Low, because very few miles of shoreline are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 400 bbl** of heavy fuel oil from the *Marine Electric*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	0.5% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	76% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 2,050 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	17% of the model runs resulted in shoreline oiling of 100 g/m^2	**Low**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 2 mi	

SECTION 4: SOCIO-ECONOMIC RESOURCES AT RISK

In addition to natural resource impacts, spills from sunken wrecks have the potential to cause significant social and economic impacts. Socio-economic resources potentially at risk from oiling are listed in Table 4-1 and shown in Figures 4-1 and 4-2. The potential economic impacts include disruption of coastal economic activities such as commercial and recreational fishing, boating, vacationing, commercial shipping, and other activities that may become claims following a spill.

Socio-economic resources in the areas potentially affected by a release from the *Marine Electric* include very highly utilized recreational beaches from North Carolina to Massachusetts during summer, but also during spring and fall for shore fishing. Hotspots for chartered fishing vessels and recreational fishing party vessels include along the New Jersey shore, off the mouth of Delaware Bay, and off the outer banks of North Carolina. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing.

A release could impact shipping lanes that run through the area of impact from New York east of Cape Cod, and into Narragansett Bay. Coastal waters off Rhode Island and southern Massachusetts are popular sailing locations. A proposed offshore wind farm site is located in Nantucket Sound.

Commercial fishing is economically important to the region. Regional commercial landings for 2010 exceeded $600 million. Cape May-Wildwood, NJ and Hampton Roads, VA were the 6th and 7th nationally ranked commercial fishing ports by value in 2010. The most important species by dollar value present in and around the Mid-Atlantic are sea scallops, surf clams, ocean quahogs, menhaden, striped bass, and blue crab.

In addition to the ESI atlases, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on important socio-economic resources at risk and should be consulted.

Spill response costs for a release of oil from the *Marine Electric* would be dependent on volume of oil released and specific areas impacted. The specific shoreline impacts and spread of the oil would determine the response required and the costs for that response.

Table 4-1: Socio-economic resources at risk from a release of oil from the *Marine Electric*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Ocean City, MD Rehoboth Beach, DE Dewey Beach, DE Indian Beach, DE Bethany Beach, DE Middlesex Beach, DE Fenwick Island, DE Cape May, NJ Wildwood, NJ Avalon, NJ	Potentially affected beach resorts and beach-front communities in Massachusetts, Rhode Island, New York, New Jersey, Delaware, and North Carolina provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state tax income. Much of the east coast of New Jersey, northeastern Delaware, the southern coast of Long Island, New York, the southern coast of Rhode Island, and the southwestern shore of

Resource Type	Resource Name	Economic Activities
	Atlantic City, NJ Ocean City, NJ Absecon Beach, NJ Ludlam Beach, NJ Seven Mile Beach, NJ Margate City, NJ Peck Beach, NJ Ventnor City, NJ Brigantine Beach, NJ Beach Haven, NJ Spray Beach, NJ Brant Beach, NJ Long Beach, NJ Point Pleasant Beach, v Seaside Park, NJ Ortley Beach, NJ Ocean Beach, NJ Normandy Beach, v Ocean Beach, NY Fire Island Pines, NY Southampton, NY East Hampton, NY Westhampton Beach, NY Montauk, NY Block Island, RI East Matunuck State Beach, RI Roger W. Wheeler State Beach, RI Scarborough State Beach, RI Newport, RI Martha's Vineyard, MA	Massachusetts and Martha's Vineyard, Massachusetts, are lined with economically-valuable beach resorts and residential communities. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
National Seashores	Cape Hatteras National Seashore, NC Assateague Island National Seashore, MD and VA Fire Island National Seashore, NY	National seashores provide recreation for local and tourist populations as well as preserve and protect the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area. Assateague Island is known for its feral horses. Cape Hatteras is known for its Bodie Island and Cape Hatteras Lighthouses. Popular recreation activities include windsurfing, birdwatching, fishing, shell collecting, and kayaking. The barrier island provides refuge for the endangered piping plover, seabeach amaranth, and sea turtles. Fire Island, a barrier island south of Long Island, has the historic William Floyd House and Fire Island Lighthouse.
National Wildlife Refuges	Prime Hook NWR (DE) Bombay Hook NWR (DE) Cape May NWR (NJ) Edwin B. Forsythe NWR (NJ) Seatuck NWR (NY) Wertheim NWR (NY) Amagansett NWR (NY) Block Island NWR (RI) Ninigret NWR (RI) Trustom Pond NWR (RI) Sachuest Point NWR (RI) Nomans Land Island NWR (MA)	National wildlife refuges in seven states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.

Resource Type	Resource Name	Economic Activities
	Mashpee NWR (MA) Nantucket Island NWR (MA) Monomoy NWR (MA) Fisherman Island NWR (VA) Eastern Shore of Virginia NWR (VA) Wallops Island NWR (VA) Chincoteague NWR (VA) Back Bay NWR (VA) Mackay Island NWR (NC) Currituck NWR (NC) Pea Island NWR (NC) Cedar Island NWR (NC)	
State Parks	Assateague State Park, Maryland Delaware Seashore State Park, DE Cape Henlopen State Park, DE Cape May Point State Park, NJ Corson's Inlet State Park, NJ Barnegat Lighthouse State Park, NJ Island Beach State Park, NJ Robert Moses State Park, NY Shadmoor State Park, NY Camp Hero State Park, NY Montauk State Park, NY Salty Brine State Park, RI Fishermen's Memorial State Park, RI Beavertail State Park, RI Wetherill State Park, RI Brenton Point State Park, RI Fort Adams State Park, RI Horseneck Beach State Park, MA Demarest Lloyd State Park, MA Fort Phoenix State Park, MA Nasketucket Bay State Park, MA	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). They provide income to the states. State parks in Massachusetts, Rhode Island, New York, New Jersey, Delaware, and Maryland are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Tribal Lands	Shinnecock Indian Reservation, NY	Shinnecock Indian Reservation, New York, is home to over 500 tribal members. (Note this reservation has been recognized by New York State but not by the U.S. Bureau of Indian Affairs)
	Narragansett Indian Reservation, RI	Narragansett Indian Reservation, Rhode Island, is home to 2,400 tribal members.
	Wampanoag Indian Reservation, MA	Wampanoag Indian Reservation, Massachusetts, is home to over 2,000 tribal members.
Commercial Fishing	A number of fishing fleets use the New York Bight area and surrounding waters for commercial fishing purposes.	
	Atlantic City, NJ	Total Landings (2010): $17.3M
	Belford, NJ	Total Landings (2010): $2.2M
	Cape May-Wildwood, NJ	Total Landings (2010): $81M
	Chincoteague, Virginia	Total Landings (2010): $3.5M
	Montauk, NY	Total Landings (2010): $17.7M
	New London, Connecticut	Total Landings (2010): $10.6M
	Newport, RI	Total Landings (2010): $6.9M
	Ocean City, Maryland	Total Landings (2010): $8.8M
	Point Pleasant, NJ	Total Landings (2010): $22.8M
	Stonington, Connecticut	Total Landings (2010): $18.5M
Ports	There are a number of significant commercial ports in the Northeast that could potentially be	

Resource Type	Resource Name	Economic Activities
	impacted by spillage and spill response activities. The port call numbers below are for large vessels only. There are many more, smaller vessels (under 400 GRT) that also use these ports.	
	Camden, NJ	249 port calls annually
	Claymont, DE	19 port calls annually
	Delaware City, DE	211 port calls annually
	Gloucester, NJ	180 port calls annually
	New York/New Jersey	5,414 port calls annually
	Newport, RI	95 port calls annually
	Philadelphia, PA	914 port calls annually
	Providence, RI	128 port calls annually
	Salem, NJ	52 port calls annually
	Wilmington, DE	443 port calls annually
Other Resources	Cape Wind Offshore Wind Farm (proposed), MA	Rated to produce up to 468 megawatts of wind power with average expected production will be 170 megawatts which is almost 75% of the 230 megawatt average electricity demand for Cape Cod and the Islands of Martha's Vineyard and Nantucket.

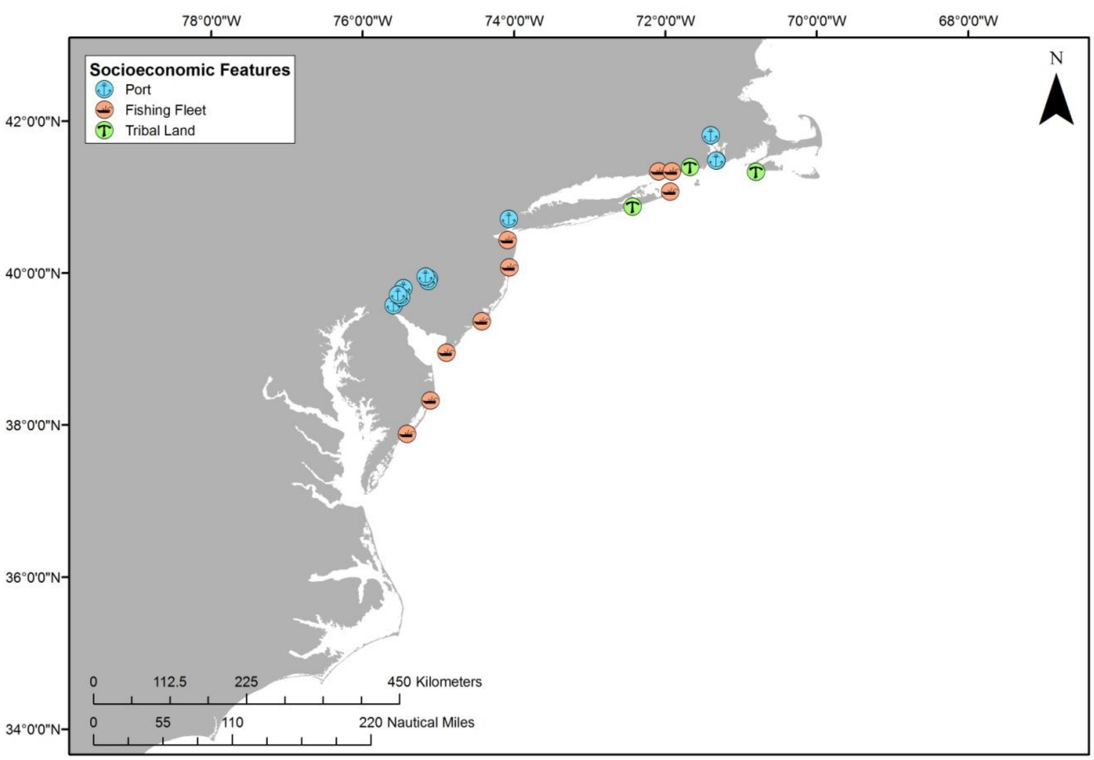


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Marine Electric*.

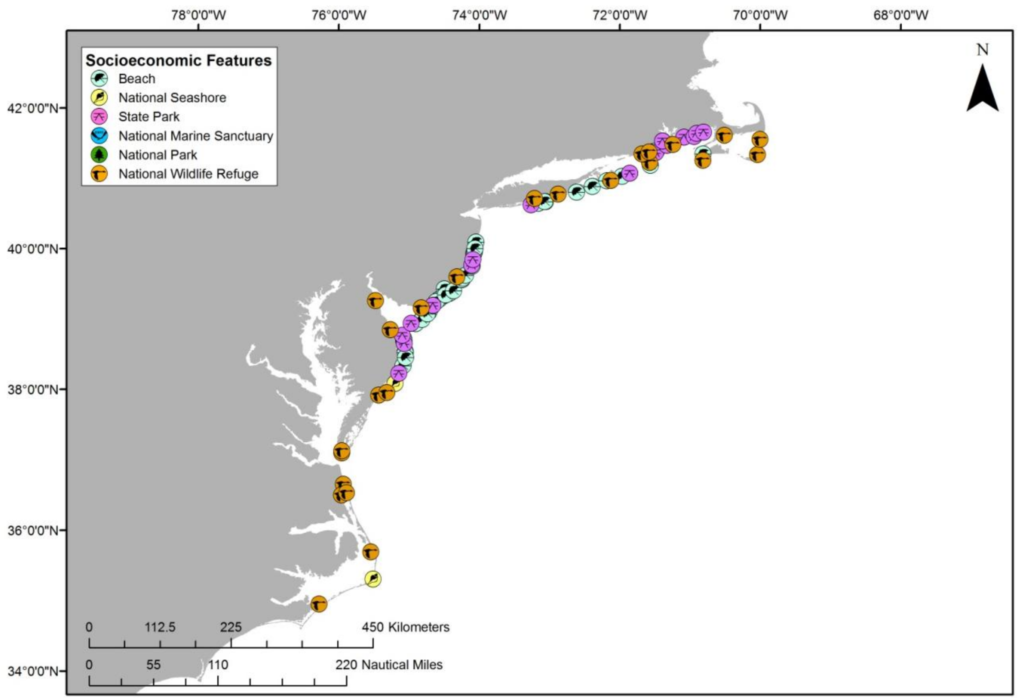


Figure 4-2: Beaches, coastal state parks, and Federal protection areas at risk from a release from the *Marine Electric*.

Socio-Economic Risk Factors

Risk Factor 4: Impacts to Socio-economic Resources at Risk (SRAR)

Socio-economic resources at risk (SRAR) include potentially impacted resources that have some economic value, including commercial and recreational fishing, tourist beaches, private property, etc. All impact factors are evaluated for both the Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for socio-economic resources at risk are divided into three categories:

- **Water Column:** Impacts to the water column and to economic resources in the water column (i.e., fish and invertebrates that have economic value);
- **Water Surface:** Impacts to the water surface and resources on the water surface (i.e., boating and commercial fishing); and
- **Shoreline:** Impacts to the shoreline and resources on the shoreline (i.e., beaches, real property).

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there were one. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three socio-economic resources at risk categories, risk is classified with regard to:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be exposure to socio-economic resources over a certain minimal amount known to cause impacts); and
- The **degree of oiling** (the magnitude or amount of that exposure over the threshold known to cause impacts).

As a reminder, the socio-economic impact thresholds are: 1 ppb aromatics for water column impacts; 0.01 g/m^2 for water surface impacts; and 1 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *Marine Electric* shading indicates the degree of risk for the WCD release of 4,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 400 bbl.

Risk Factor 4A-1: Water Column: Probability of Oiling of SRAR

This risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause socio-economic impacts. The threshold for water column impact to socio-economic resources at risk is an oil concentration of 1 ppb (i.e., 1 part oil per one billion parts water). At this concentration and above, one would expect impacts and potential tainting to socio-economic resources (e.g., fish and shellfish) in the water column; this concentration is used as a screening threshold for both the ecological and socio-economic risk factors.
The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 4A-2: Water Column Degree of Oiling of SRAR

The degree of oiling of the water column reflects the total amount of oil that would affect the water column in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level
- **Medium Impact:** impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Marine Electric* is classified as Low Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 4,000 bbl because 4% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated 0.1 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 400 bbl, the *Marine Electric* is classified as Low Risk for both oiling probability and degree of oiling for water column socio-economic resources because 0.5% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 0 mi^2 of the upper 33 feet of the water column.

Risk Factor 4B-1: Water Surface Probability of Oiling of SRAR

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to socio-economic resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

The threshold level for water surface impacts to socio-economic resources at risk is 0.01 g/m^2 (i.e., 0.01 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to socio-economic resources on the water surface.

Risk Factor 4B-2: Water Surface Degree of Oiling of SRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Marine Electric* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water surface socio-economic resources for the WCD because 84% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2, and the mean area of water contaminated was 6,560 mi^2. The *Marine Electric* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 76% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 2,050 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

The impacts to different types of shorelines vary based on economic value. In this risk analysis, shorelines have been weighted by their degree of sensitivity to oiling. Sand beaches are the most economically valued shorelines (weighted as “3” in the impact analysis), rocky and gravel shores are moderately valued (weighted as “2”), and wetlands are the least economically valued shorelines (weighted as “1”). Note that these values differ from the ecological values of these three shoreline types.

Risk Factor 4C-1: Shoreline Probability of Oiling of SRAR

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline users. The threshold for impacts to shoreline SRAR is 1 g/m^2 (i.e., 1 gram of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 4C-2: Shoreline Degree of Oiling of SRAR

The degree of oiling of the shoreline reflects the total amount of oil that would affect the shoreline in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at threshold level
- **High Impact:** more than 100 miles of shoreline impacted at threshold level

The *Marine Electric* is classified as Medium Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the WCD because 50% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 95 miles. The *Marine Electric* is classified as Medium Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 48% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 83 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 4,000 bbl of heavy fuel oil from the *Marine Electric* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because a relatively small area of the water column would be impacted in important fishing grounds
- Water surface resources – Medium, because a moderate offshore area would be affected in an area of important shipping lanes. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – Medium, because a moderate amount of shoreline would be impacted with tarballs and there are a large number of potentially vulnerable socio-economic resources located along the shoreline

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 4,000 bbl** of heavy fuel oil from the *Marine Electric*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	Medium	High	4% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	**Low**	Medium	High	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	84% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Med
4B-2: Water Surface Degree SRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 0.01 g/m^2 was 6,560 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	**Medium**	High	50% of the model runs resulted in shoreline oiling of 1 g/m^2	Med
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 95 mi	

For the Most Probable Discharge of 400 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Marine Electric* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because a relatively small area of the water column would be impacted in important fishing grounds
- Water surface resources – Medium, because a moderate offshore area would be affected in an area of important shipping lanes. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – Medium, because a moderate amount of shoreline would be impacted with the persistent tarballs, and there are a large number of potentially vulnerable socio-economic resources located along the shoreline

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 400 bbl** of heavy fuel oil from the *Marine Electric*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	0.5% of the model runs resulted in at least 0.2 mi² of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0 mi² of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	76% of the model runs resulted in at least 1,000 mi² of water surface covered by at least 0.01 g/m²	**Med**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m² was 2,050 mi²	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	48% of the model runs resulted in shoreline oiling of 1 g/m²	**Med**
4C-2: Shoreline Degree SRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 1 g/m² was 83 mi	

SECTION 5: OVERALL RISK ASSESSMENT AND RECOMMENDATIONS FOR ASSESSMENT, MONITORING, OR REMEDIATION

The overall risk assessment for the *Marine Electric* is comprised of a compilation of several components that reflect the best available knowledge about this particular site. Those components are reflected in the previous sections of this document and are:

- Vessel casualty information and how the site formation processes have worked on this vessel
- Ecological resources at risk
- Socio-economic resources at risk
- Other complicating factors (war graves, other hazardous cargo, etc.)

Table 5-1 summarizes the screening-level risk assessment scores for the different risk factors, as discussed in the previous sections. The ecological and socio-economic risk factors are presented as a single score for water column, water surface, and shoreline resources as the scores were consolidated for each element. For the ecological and socio-economic risk factors each has two components, probability and degree. Of those two, degree is given more weight in deciding the combined score for an individual factor, e.g., a high probability and medium degree score would result in a medium overall for that factor.

In order to make the scoring more uniform and replicable between wrecks, a value was assigned to each of the 7 criteria. This assessment has a total of 7 criteria (based on table 5-1) with 3 possible scores for each criteria (L, M, H). Each was assigned a point value of L=1, M=2, H=3. The total possible score is 21 points, and the minimum score is 7. The resulting category summaries are:

Low Priority	7-11
Medium Priority	12-14
High Priority	15-21

For the Worst Case Discharge, *Marine Electric* scores Medium with 12 points; for the Most Probable Discharge, *Marine Electric* scores Low with 11 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Marine Electric*. The final determination rests with the U.S. Coast Guard.

Marine Electric	Possible NOAA Recommendations
	Wreck should be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action
	Location is unknown; Use surveys of opportunity to attempt to locate this vessel and gather more information on the vessel condition
	Conduct active monitoring to look for releases or changes in rates of releases
✓	Be noted in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source
✓	Conduct outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area, to gain awareness of changes in the site

Table 5-1: Summary of risk factors for the *Marine Electric*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 3,600 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker oil is heavy fuel oil, a Group IV oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Rough weather		
	D2: Structural Breakup	High	The vessel broke in two at the time of sinking		
Archaeological Assessment	Archaeological Assessment	Low	The shipwreck is not a historic wreck, no archaeological assessment was prepared, the best analysis of the wreck likely comes from the U.S. Coast Guard Marine Board of Inquiry Report		**Not Scored**
Operational Factors	Wreck Orientation	High	Resting on its port side		**Not Scored**
	Depth	High	160 ft		
	Visual or Remote Sensing Confirmation of Site Condition	High	Wreck is a popular technical dive site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	No		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Little to no volume of the water column was predicted to be above thresholds for ecological resources	**Low**	**Low**
	3B: Water Surface Resources	High	Persistent tarballs pose risks to areas of high concentrations of wintering waterfowl and pelagic birds	**Med**	**Med**
	3C: Shore Resources	High	Mostly sand beaches at risk, which can be seasonally important to shorebirds, with risks varying by miles of oiling	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	A relatively small area of the water column would be impacted in important fishing grounds	**Low**	**Low**
	4B: Water Surface Resources	High	A moderate offshore area would be affected in an area of important shipping lanes	**Med**	**Med**
	4C: Shore Resources	High	A moderate amount of shoreline would be impacted with persistent tarballs and there are a large number of potentially vulnerable socio-economic resources located along the shoreline	**Med**	**Med**
Summary Risk Scores				**12**	**11**