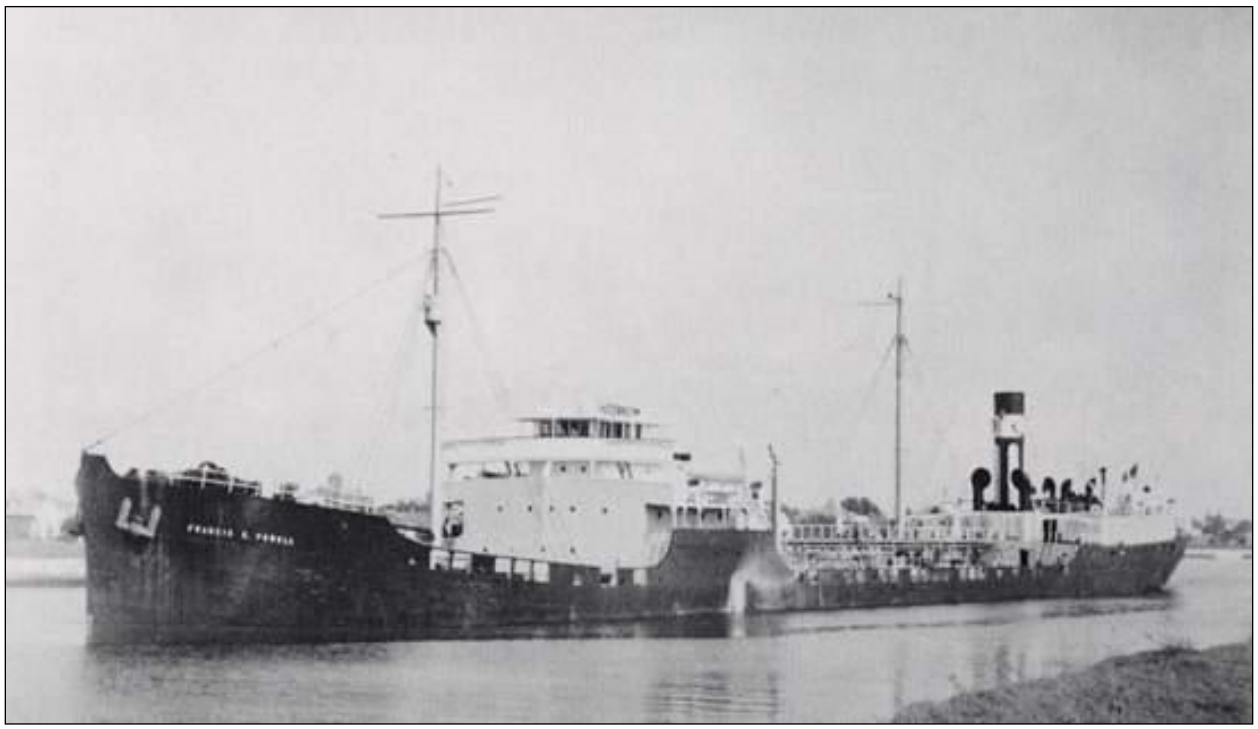
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Francis E. Powell



RPI asa ENVIRONMENTAL RESEARCH CONSULTING

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National Oceanic and
Atmospheric Administration

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Photo: Photograph of *Francis E. Powell*
Source: http://www.uboat.net:8080/allies/merchants/ships/1299.html (Image from the Peabody and Essex Museum, Salem MA)

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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.

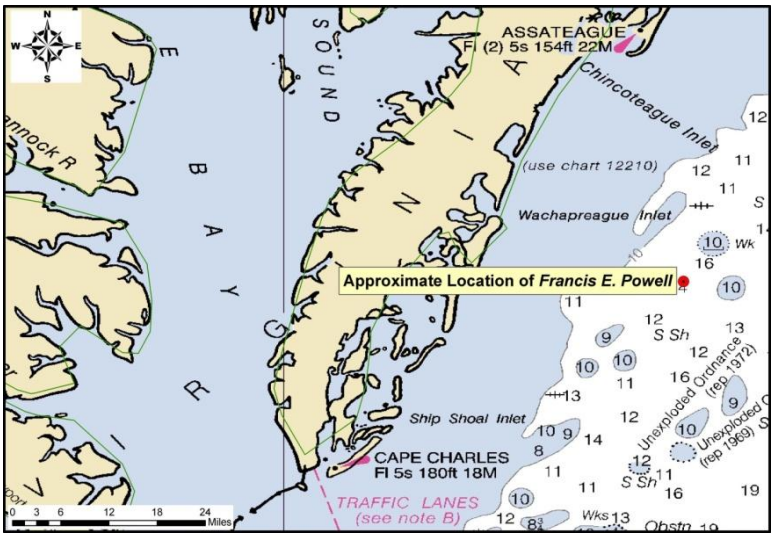
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *Francis E. Powell*

The tanker *Francis E. Powell*, torpedoed and sunk during World War II off the coast of Virginia in 1942, 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 *Francis E. Powell*, 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, *Francis E. Powell* scores High with 17 points; for the Most Probable Discharge (10% of the Worse Case volume), *Francis E. Powell* scores Medium with 13 points. Given these scores, NOAA recommends that this site be noted within the Area Contingency Plans and be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. At a minimum, an active monitoring program should be implemented. 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 changes in the site.

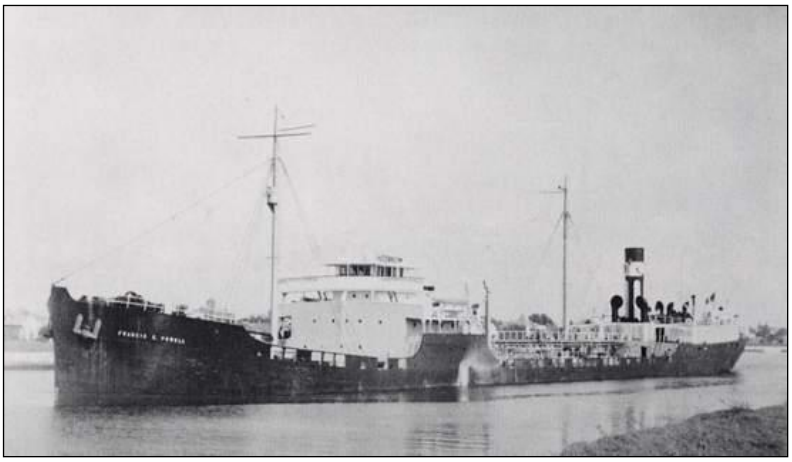
Given the relatively shallow depth of the site, a simple reconnaissance survey using divers or remote sensing equipment would provide valuable information about how much of the bow section remains and which tank(s) might still contain oil.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	
	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	High	Med
	3B: Water Surface Resources	High	Med
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	High	Med
	4B: Water Surface Resources	High	High
	4C: Shore Resources	Med	Med
Summary Risk Scores		17	13

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: *Francis E. Powell*

Official Number: 221868

Vessel Type: Tanker

Vessel Class: Unknown

Former Names: *Macy Willis*

Year Built: 1922

Builder: Baltimore Dry Dock and Shipbuilding Company, Baltimore, MD

Builder's Hull Number: 126

Flag: American

Owner at Loss: Atlantic Refining Company

Controlled by: Unknown **Chartered to:** Unknown

Operated by: Unknown

Homeport: Philadelphia, PA

Length: 431 feet **Beam:** 59 feet **Depth:** 33 feet

Gross Tonnage: 7,096 **Net Tonnage:** 4,325

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

Bunker Type: Heavy Fuel Oil (Bunker C) **Bunker Capacity (bbl):** 9,074

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): 81,000 **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Vessel had 9 cargo tanks divided port and starboard by an oil-tight longitudinal bulkhead

Casualty Information

Port Departed: Port Arthur, TX

Destination Port: Providence, RI

Date Departed: Unknown

Date Lost: January 27, 1942

Number of Days Sailing: Unknown

Cause of Sinking: Act of War (torpedoes)

Latitude (DD): 37.4844

Longitude (DD): -75.2858

Nautical Miles to Shore: 20

Nautical Miles to NMS: 148

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 95

Bottom Type: Sand

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

Wreck Orientation: Bow is inverted (turtled), the orientation of the stern is not currently known

Vessel Armament: None

Cargo Carried when Lost: 81,000 bbl of furnace oil and gasoline (furnace oil amidships, gasoline fore and aft)

Cargo Oil Carried (bbl): 81,000

Cargo Oil Type: Light fuel oil

Probable Fuel Oil Remaining (bbl): < 9,074

Fuel Type: Heavy Fuel Oil (Bunker C)

Total Oil Carried (bbl): ≤ 90,074

Dangerous Cargo or Munitions: N/A

Munitions Carried: None

Demolished after Sinking: Yes, partially

Salvaged: No

Cargo Lost: Yes, partially

Reportedly Leaking: Yes (personal communication 8/5/2011)

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

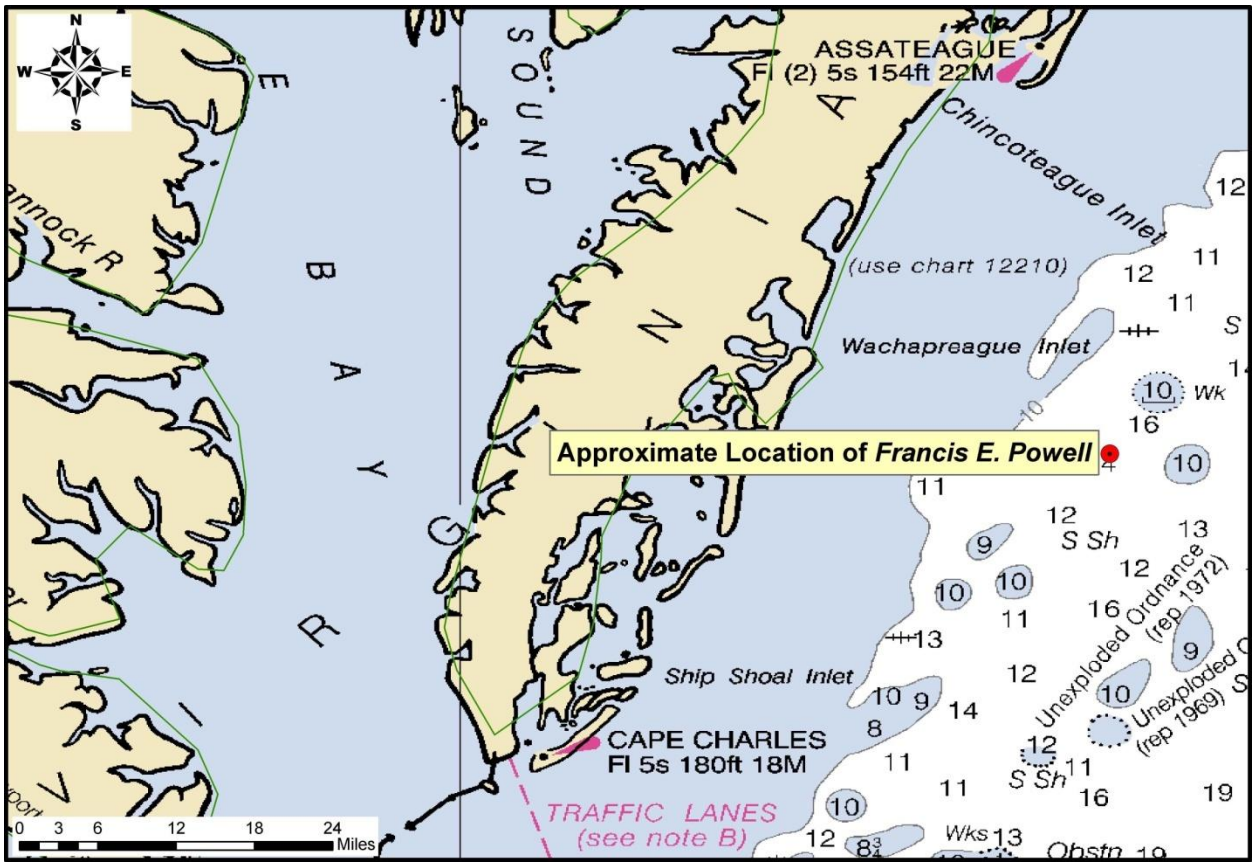


Chart Number: 13003

Casualty Narrative

"At 09.43 hours on 27 Jan, 1942, the unarmed and unescorted *Francis E. Powell* (Master Thomas J. Harrington) was hit by the last torpedo from U-130 about eight miles northeast of the Winter Quarter Light Vessel, while proceeding completely blacked out at 10.5 knots. The torpedo struck on the port side aft of the midships house, between the #4 and #5 tanks. The explosion started a small fire in the pump room and destroyed the radio antenna. Then the U-boat was sighted a few hundred yards away which had planned to attack with the deck gun but gave up when other vessels came into sight. The eight officers and 24 crewmen abandoned ship in two lifeboats. The master was crushed to death when he slipped and fell between the boat and the ship. The same boat was lifted back on the ship by a wave and the occupants had to launch another boat. Another officer and two men were also lost. The tanker later broke in two, caught fire and sank at about 14.00 hours.

After five hours, 17 men in one of the boats were picked up by the American steam tanker *W.C. Fairbanks* and landed at Lewes, Delaware. The remaining eleven survivors in the other boat were picked up by a U.S. Coast Guard boat from the Assateague Station and landed at Chincoteague, Virginia."
-http://www.uboat.net:8080/allies/merchants/ships/1299.html

General Notes

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

HISTORY
CHARTING SOURCE NOT DETERMINED--POSSIBLY CLEARED TO 84 FT.

DESCRIPTION-
NO.396; TKR; 7096 GT; SUNK 1/27/42 BY SUBMARINE. LOCATED 5/16/44 BY YP499 AND IDENTIFIED BY DIVERS AS THE BOW OF THE *FRANCIS E. POWELL*. COVERED 60 FT IN 87 FT, POS. ACCUR. 1 MILE; REPORTED THRU ESF 5/20/44. ITEM NO.265; SAME AS DOC.24. ITEM NO.19; TKR, 7096 TONS;TORPEDOED 1/27/42 IN 60 FT. POSITION LAT.37-29.8N, LONG.75-16.7W. (NAME FRANCIS POWELL)

SURVEY REQUIREMENTS INFORMATION
TKR; 4325 NT SANK 1/27/42. LIES IN 87 FT 17 MILES OFF PARRAMORE ISLAND
TKR; 7096 TONS, TORPEDOED JAN. 27, 1942; 60 FT OVER WRECK. (PART OF WK)

Wreck Condition/Salvage History

"The wreck is broken into at least two sections. The stern section is off of Parramore Island in 90 fsw. The section frequently dived off of Virginia Beach is almost unrecognizable as either the bow or midship section. If, in fact, the wreck is in more than two sections, one section remains to be found. The stern sank quickly with the bow staying afloat until the U.S. Coast Guard later sank it. Many consider this the best wreck dive in Virginia."
-http://members.cox.net/scubavab/wrecks.htm

"There are two sections identified as the Powell that are dove today. One section is off Virginia Beach in 80' of water and consists of a medium sized area of hull plates, machinery, and other debris. Not much in identifying artifacts has been found at this location as this section is most likely the remains of the amidships area and pumping equipment for the tanks. The other section resides off the Eastern Shore of Virginia in ~90' of water. There are many hull plates flattened in the sand as well as one high section, draped with large sections of netting, that appears to be the very stern. Rows of portholes have been located here, most likely sheared off from the stern superstructure. It would appear that there should be another section that has yet to be found."
-http://www.connect2diving.com/Travel/virginia_beach_diving.htm

The bow of the wreck is inverted and droplets of oil still bubble out and rise to the surface. If you shine a light into the interior of the wreck, it is possible to see oil trapped in the inverted holds of the wreck. (Personal communication with local diver 8/5/2011)

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

The wreck of the tanker *Francis E. Powell* rests in multiple parts off Virginia Beach, VA. The stern and midships sections of the wreck are reportedly entirely broken apart and are not capable of retaining a liquid cargo. The bow section is also reported as mostly destroyed, but it settled in an inverted orientation, which effectively trapped some oil in the structurally robust underside of the vessel. A recreational diver (interviewed on August 5, 2011) reported that there is a bulkhead in the bow section that one can swim under into a relatively intact tank section. In this section, there is still some trapped oil that can be seen by shining a dive light upwards. This same diver also reports that occasionally a few drops of oil can be seen rising from the wreck. Unfortunately the diver could not determine the amount or the type of oil.

If the tank inspected by the diver was one of the forward cargo tanks, then the petroleum product remaining in the tank is certainly gasoline since the vessel was carrying gasoline in the fore and aft cargo tanks and furnace oil amidships. It is possible, however, that the tank explored by the diver is a forward deep tank that could have been used to carry additional bunker oil. If this is the case, then the oil observed by the diver is likely Bunker C fuel oil. Regardless of the type of oil remaining, there is recent evidence to suggest that this vessel does still contain some oil. Unfortunately, since NOAA does not have photographs, video documentation, or site plans of this shipwreck site, an estimate of the remaining oil cannot be made with any degree of certainty.

Should proactive assessment of this wreck be conducted, it should be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) and possibly the Sunken Military Craft Act (SMCA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Historic Register. The site is also considered a war grave and appropriate actions should be undertaken to minimize disturbance to the site.

Background Information References

Vessel Image Sources: http://www.uboat.net:8080/allies/merchants/ships/1299.html (Image from the Peabody and Essex Museum, Salem MA)

Construction Diagrams or Plans in RULET Database? No

Text References:

-Office of the Chief of Naval Operations
1942 Brief of Statements of Survivors from the American Tanker "*Francis E. Powell*", Atlantic Refining Company. Tenth Fleet ASW Analysis & Stat. Section Series XIII. Report and Analyses of U. S. and Allied Merchant Shipping Losses 1941-1945 Fiske - Franklin P. Mall, Records of the Office of the Chief of Naval Operations, Box 226, Record Group 38, National Archives at College Park, College Park, MD.

-United States Coast Guard
1944 Report on U.S. Merchant Tanker War Action Casualty, S/S *Francis E. Powell*. War Casualty Section, Casualty Reports 1941 to 1946, Records of the United States Coast Guard, Entry 191, Box 5, Record Group 26, National Archives Building, Washington, DC.

-http://www.uboat.net/allies/merchants/1299.html

-AWOIS database

-NIMA database

-Global Wrecks database

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Francis E. Powell* 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.

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

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.

Pollution Potential Tree

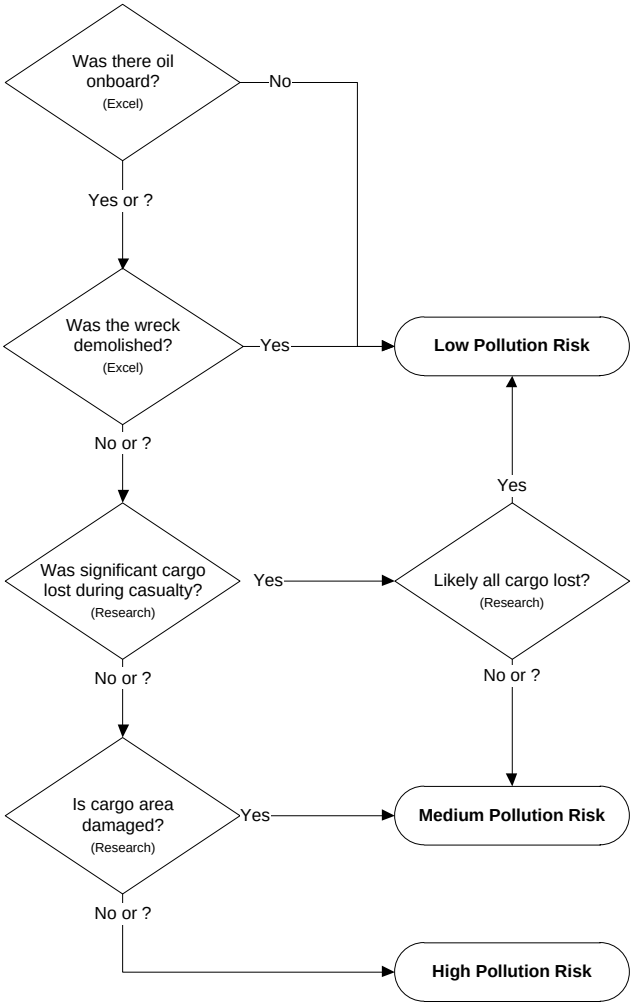


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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 Data:** 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 *Francis E. Powell* 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 *Francis E. Powell* is ranked as High Volume because it is thought to have a potential for up to 90,074 bbl, although some of that was lost at the time of the casualty due to the explosion and breakup of the vessel. 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 reports of oil in the overheads and some leakage as recently as 2011 from the *Francis E. Powell*.

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 *Francis E. Powell* is classified as Medium Risk because the cargo is believed to be either furnace oil or gasoline. Since furnace oil is a more persistent Group II oil, it was used for the environmental models. It is possible, however, that the oil reported by divers is in a forward deep tank and may be additional Bunker C fuel oil, a Class IV oil type. Data quality is low.

Was the wreck demolished?

[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]

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 *Francis E. Powell* is classified as Medium Risk because it was mostly cleared and is in at least two sections. Only a small section of the bow is reported to be intact. 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

The *Francis E. Powell* is classified as Medium Risk because there was an initial fire in the pump room and then later over both halves of the ship. 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 *Francis E. Powell* is classified as High Risk because no oil was reported to have spread across the water as 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 *Francis E. Powell* is classified as Medium Risk because there was one torpedo detonations, and the vessel is broken into at least 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 *Francis E. Powell* is classified as Medium Risk because it was broken into at least 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 bow of the *Francis E. Powell* is inverted, the amidships area is broken apart in a debris field. The stern section of the hull has not been located. 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 *Francis E. Powell* is approximately 95 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 two identified sections of the *Francis E. Powell* are well documented as a recreational dive site. 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 *Francis E. Powell* had no munitions onboard. Data quality is high.

Vessel Pollution Potential Summary

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *Francis E. Powell.* Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Francis E. Powell* 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)	High	Maximum of 90,074 bbl, leaking reported in 2011	**Low**
	A2: Oil Type	Low	The exact type of oil remaining is unknown	
	B: Wreck Clearance	High	Appears to have been partially cleared	
	C1: Burning of the Ship	High	Burned prior to sinking	
	C2: Oil on Water	Medium	No oil reported on the water	
	D1: Nature of Casualty	High	One torpedo	
	D2: Structural Breakup	High	In two sections, stern yet to be located	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Bow inverted, amidships broken up	**Not Scored**
	Depth	High	95 feet	
	Visual or Remote Sensing Confirmation of Site Condition	High	Two sections are well known recreational dive site	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	Yes	

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 of the discharges would tend 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 *Francis E. Powell* this would be about 93,000 bbl based on current estimates of the maximum amount of oil onboard the wreck at the time the models were run.

The likeliest scenario of oil release from most sunken wrecks, including the *Francis E. Powell*, 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 potential impacts to resources 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 *Francis E. Powell*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	93 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	930 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	9,300 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	46,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	93,000 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 *Francis E. Powell* could contain a maximum of 90,074 bbl of furnace oil (a Group II oil) and gasoline (a Group I oil) as cargo and bunker fuel oil (a Group IV oil). Because the bulk of the oil likely remaining on board is the cargo, the oil spill model was run using a light 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 *Francis E. Powell* 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 square miles (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. Interior, Washington, DC.

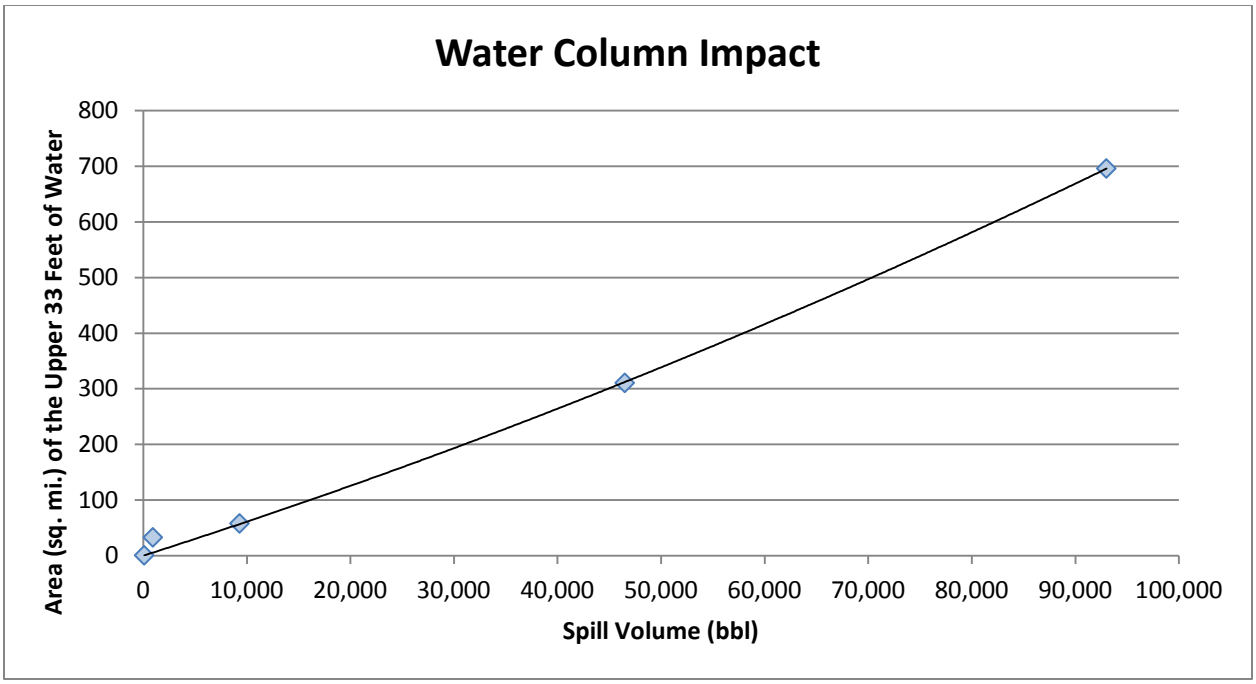


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Francis E. Powell*.

Potential Water Surface Slick

The slick size from an oil release from the *Francis E. Powell* 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 median result of the 200 model runs. Note that this is an estimate of total water surface affected over a 30-day period. 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 and streamers; light fuel oils do not readily emulsify or form tarballs.

Table 2-3: Estimated slick area swept on water for oil release scenarios from the *Francis E. Powell*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m²	10 g/m²
Chronic	93	1,440 mi²	120 mi²
Episodic	930	4,700 mi²	540 mi²
Most Probable	9,300	13,900 mi²	2,870 mi²
Large	46,500	27,200 mi²	8,700 mi²
Worst Case Discharge	93,000	36,000 mi²	13,300 mi²

The location, size, shape, and spread of the oil slick(s) from an oil release from the *Francis E. Powell* 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.

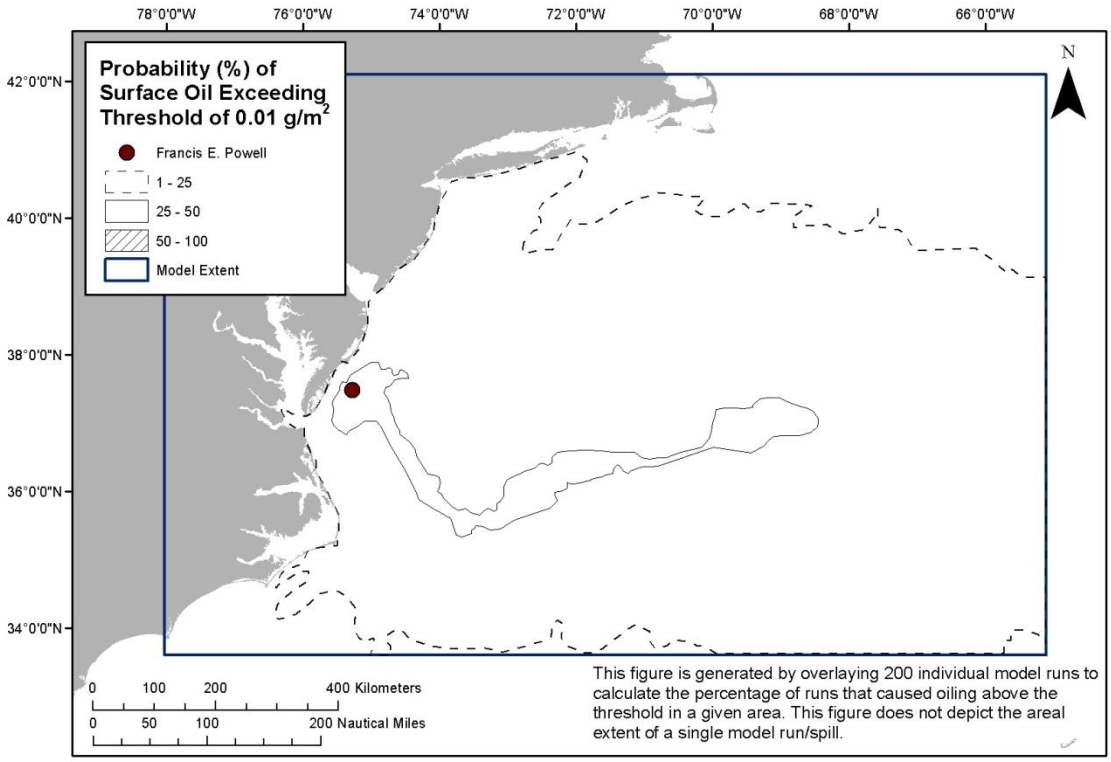


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 9,300 bbl of a light fuel oil from the *Francis E. Powell* at the threshold for socio-economic resources at risk.

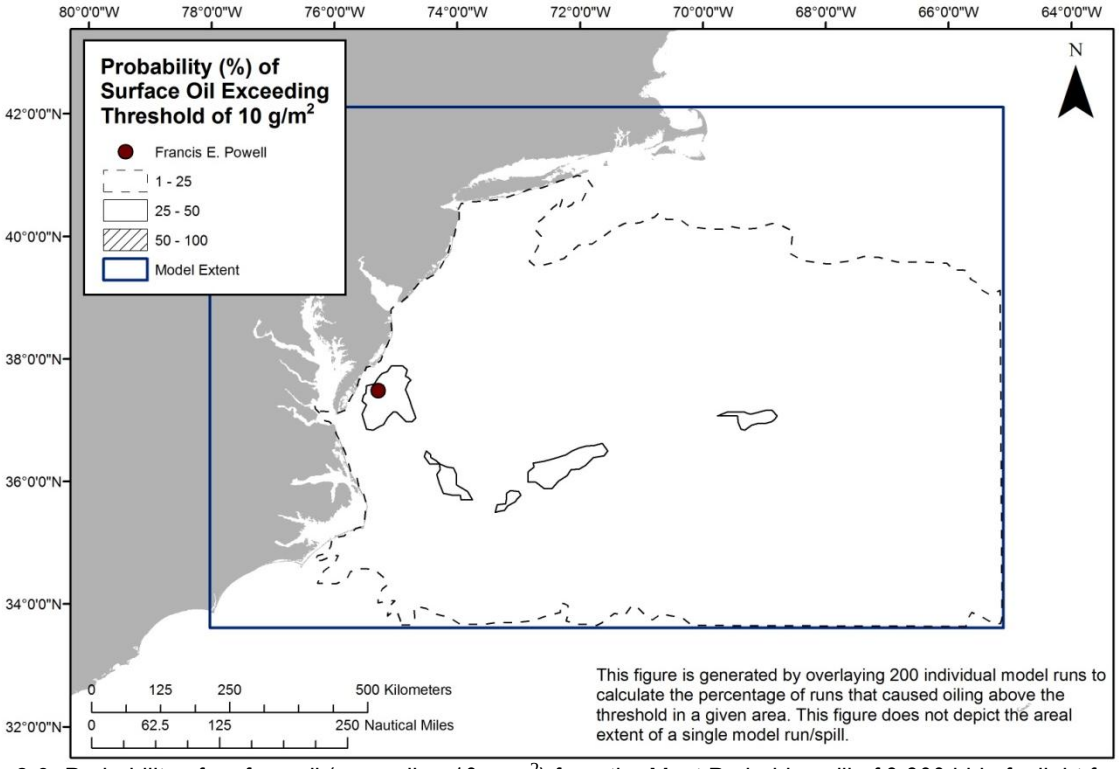


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 9,300 bbl of a light fuel oil from the *Francis E. Powell* at the threshold for ecological resources at risk.

The behavior of light fuel oils to spread into thin sheens is demonstrated by the comparison of Figures 2-2 and 2-3, which show the probability of surface oil at different thicknesses. At the socio-economic threshold of a barely visible sheen (0.01 g/m^2), the overlay of all 200 models generates a map showing the probability of 1-25% oil in each model grid that covers a very large area. At the ecological threshold of a heavy sheen with dark colors (10 g/m^2), the 1-25% probability area of oil presence is much smaller.

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.

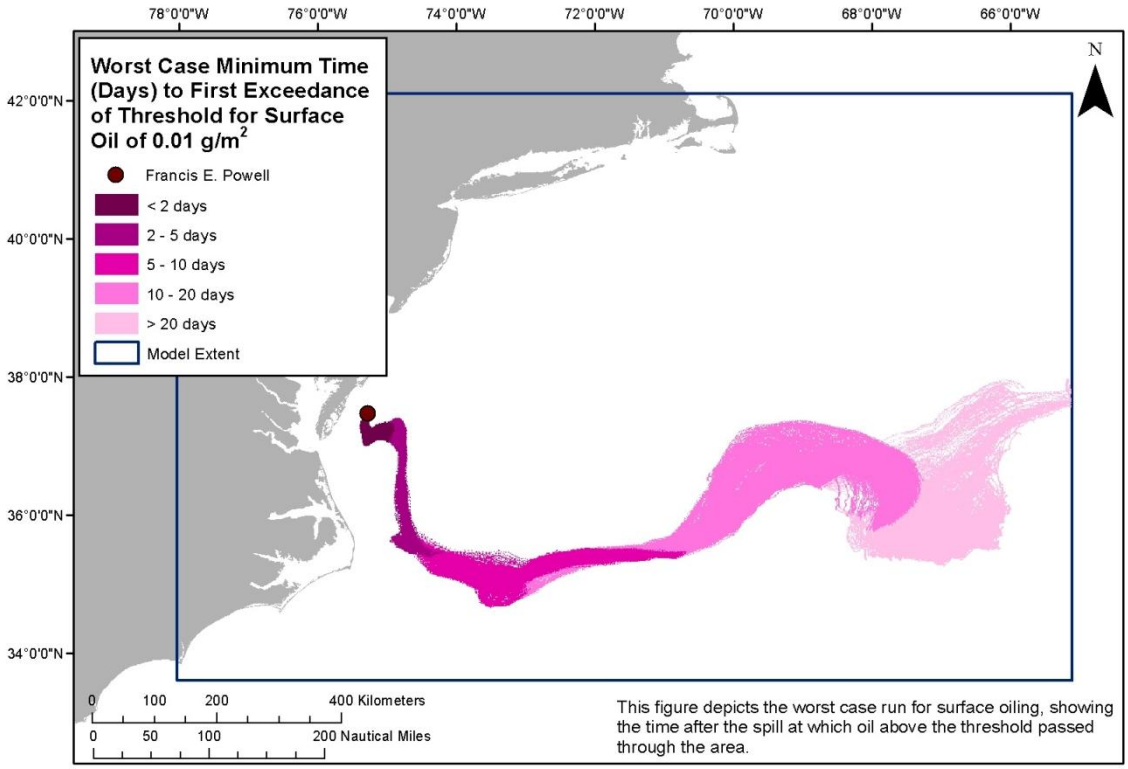


Figure 2-4: Water surface oiling from the Most Probable of 9,300 bbl of a light fuel oil from the *Francis E. Powell* shown as the area over which the oil spreads at different time intervals.

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.

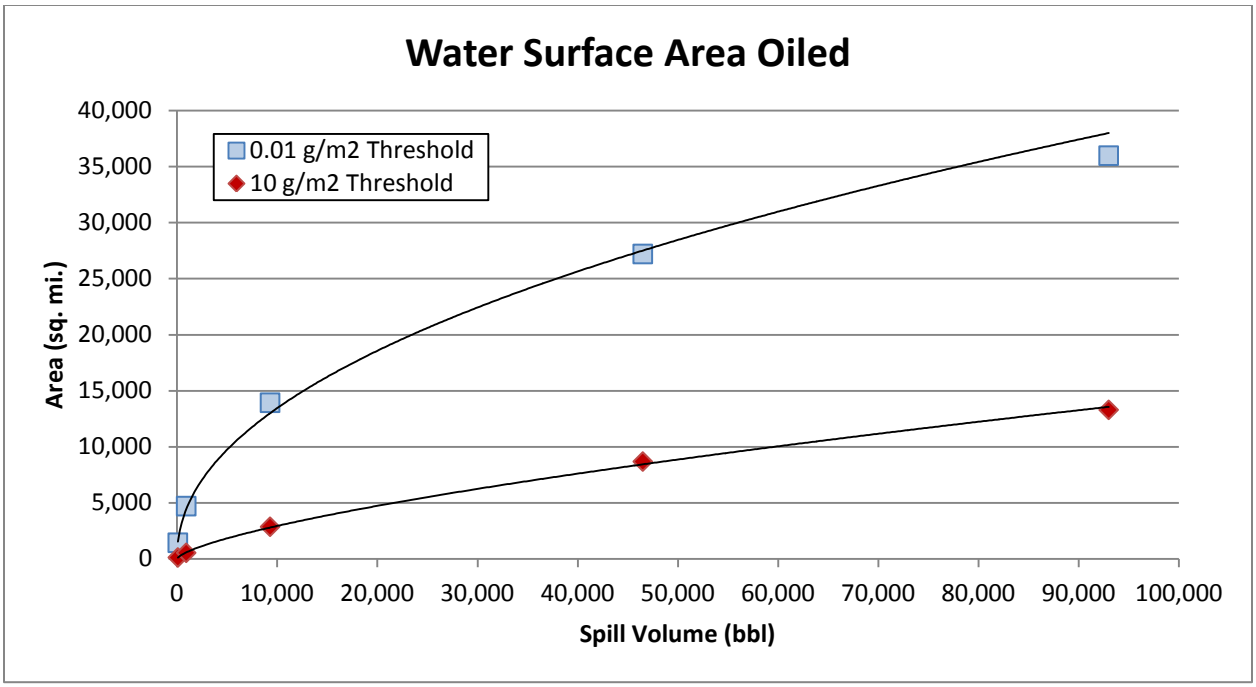


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Francis E. Powell*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2.

Potential Shoreline Impacts

Based on these modeling results, shorelines from as far north as Long Island, New York, to as far south as Onslow Bay, 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 9,300 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. For this single model run, shoreline oiling occurred along the Delmarva Peninsula. 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 *Francis E. Powell*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	93	1	0	0	1
Episodic	930	2	1	0	3
Most Probable	9,300	0	6	1	7
Large	46,500	0	14	2	16
Worst Case Discharge	93,000	1	20	4	25

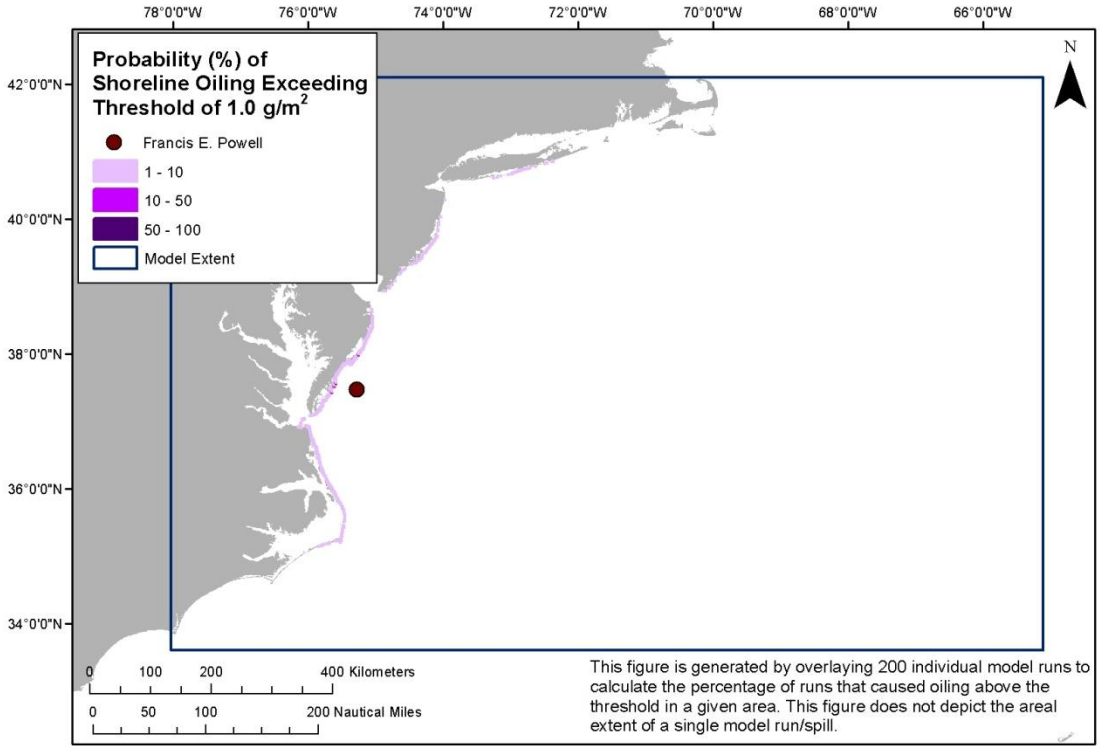


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 9,300 bbl of a light fuel oil from the *Francis E. Powell*.

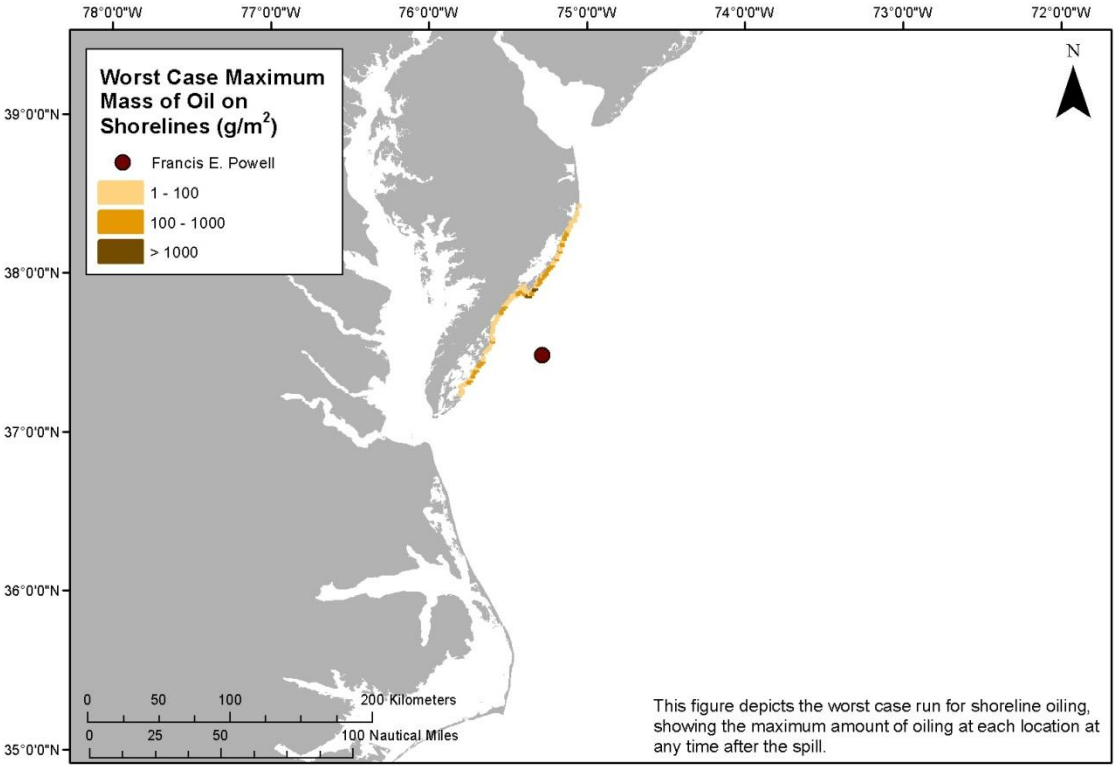


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 9,300 bbl of a light fuel oil from the *Francis E. Powell* that resulted in the greatest shoreline oiling.

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.

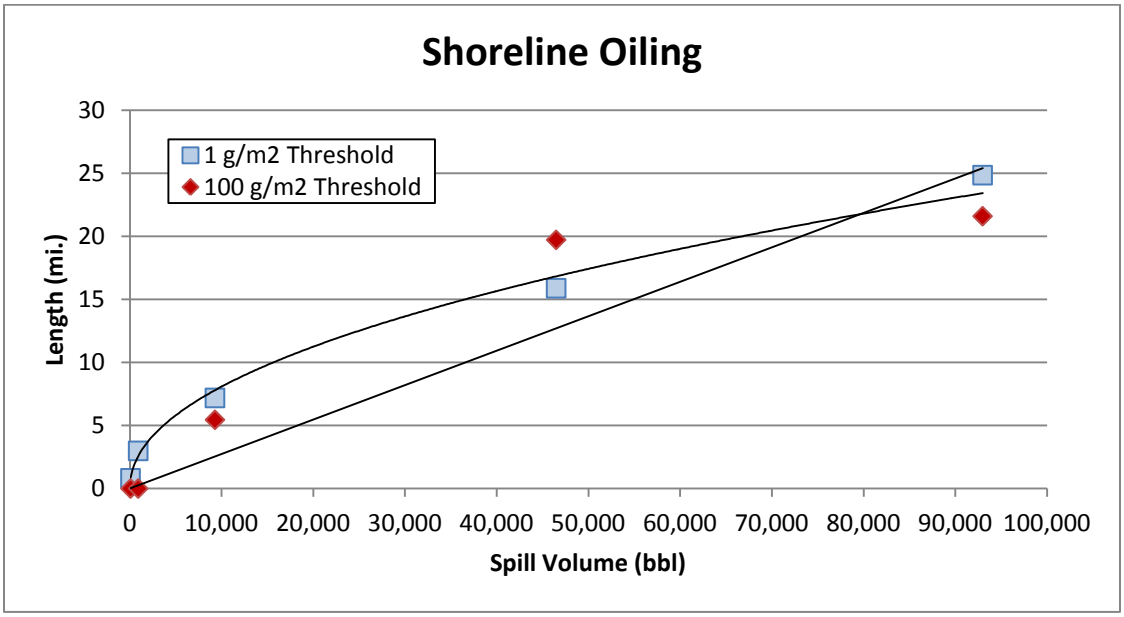


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Francis E. Powell*.

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. Salt marshes and tidal flats near tidal inlets are also at risk.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 93,000 bbl from the *Francis E. Powell*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	10 miles	0 miles
Sand beaches	64 miles	61 miles
Salt marshes and tidal flats	9 miles	2 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 9,300 bbl from the *Francis E. Powell*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	0 miles	0 miles
Sand beaches	20 miles	35 miles
Salt marshes and tidal flats	0 miles	2 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Francis E. Powell* (Table 3-1) include numerous guilds of birds, particularly those sensitive to surface oiling while rafting or plunge diving to feed and are present in nearshore/offshore waters. As can be noted in the table, large numbers of birds winter in both coastal and offshore waters, and many of the beaches are very important shorebird habitat. In addition, this region is important for commercially important fish and invertebrates.

Table 3-1: Ecological resources at risk from a release of oil from the *Francis E. Powell.*
(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 petrel • Audubon's shearwaters (50-75% of population) concentrate along the edge of the Continental Shelf off the coast of NC, extending northward to the VA border (~3800 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 of NC/VA: late summer
Pelagic Birds, Waterfowl, and Diving Birds	• Outer Banks, inshore ccean NC to VA: key foraging area for gulls and terns; key migration corridor for loons and sea ducks; NC's largest population of northern gannet and red-breasted merganser • Back Bay, VA: 10K+ snow geese, tundra swan, and ducks • Mid-Atlantic inshore/offshore waters: 150K loons, 6K pelicans, 100s of thousands of cormorants and terns, millions of gulls • Mouth of Chesapeake: high concentrations of gannets and very high concentrations of red-breasted merganser • Western Delmarva and Bay Islands: Supports significant American black duck populations	Terns, gulls in spring/summer; Loons, sea ducks in spring/fall Waterfowl, gannets and red-breasted mergansers in winter Back Bay: peak of fall migration/winter Bay Islands black ducks: Year round; nesting Mar-Jul

Sea Ducks	Sea ducks (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 (e.g., 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 fall to spring (Oct-Apr)
		
		Winter use of shoals (Dec-Mar); summer use of shoals likely farther north

Shorebirds and Colonial Nesting Birds	• Outer Banks and Cape Hatteras NC: regionally important for coastal birds with 365+ species • VA Barrier Island/Lagoon System: most important bird area in VA and one of most along Atlantic coast of No. America: piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer (many of	Colonial and beach nesters peak Apr-Aug Migration typically spring/fall, but varies by

Species Group	Species Subgroup and Geography	Seasonal Presence
	these species are state listed or special concern in VA); most significant breeding population in state of waders; marsh nesters have center of abundance here; internationally significant stopover point for whimbrel, short-billed dowitcher, and red knot • Western Shore VA marshes: extensive low marshes support significant populations of many marsh nesting species • Delmarva Bay Side Marshes: Last known breeding site for saltmarsh population of Henslow's sparrow; significant population of black rail	species and location and ranges from Feb.-June/Aug.-Dec. Sparrows and rails nesting Apr-Jul
Raptors and Passerines	Lower Delmarva (Cape Charles area of VA): 20-80K raptors and over 10 million migrating passerines	Fall
Sea Turtles	Nesting (annual counts along shorelines with most probable impacts). Mostly occurs in NC but loggerheads can nest as far north as DE • 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), sei whale (FE) and minke whale • Right whales are critically endangered (<400 individuals left); Coastal waters are used as a migratory pathway and border the northern extent of calving grounds *Inshore cetaceans:* Bottlenose dolphin, harbor porpoise use coastal waters out to the shelf break *Offshore cetaceans*: Pilot whale, Risso's dolphin, striped dolphin, common dolphin, Atlantic spotted dolphin, spinner dolphin • Often associated with shelf edge features and convergence zones *Deep diving whales:* Sperm whale (FE), pygmy sperm whale, beaked whales (5 species present) forage in deep waters along the shelf *Pinnipeds*: Harbor seal can sometimes occur as far south as NC during the winter. Harp, hooded, and gray seals have also been observed but are rare	Baleen whales present fall-spring; Juvenile humpbacks forage offshore during winter Bottlenose dolphins present year round Harbor seals present during the winter
Fish and Invertebrates	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 • *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 in the region	Estuarine dependent fish migrate offshore in the fall/winter to spawn; juveniles and adults use estuaries during the spring/summer Anadromous fish migrate inshore to spawn in fresh water in the spring American eel migrates offshore to spawn in the winter Bluefin tunas present fall-spring

Species Group	Species Subgroup and Geography	Seasonal Presence
	• The Point – Essential Fish Habitat/Habitat Areas of Particular Concern (EFH/HAPC) for coastal migratory pelagics and dolphin/wahoo • Primary nursery areas in NC bays –estuarine dependent species	
Benthic Habitats	Submerged aquatic vegetation is extremely critical to numerous species and occurs inside of bays and sounds throughout the region Scattered hard-bottom sites are located off NC and are 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 *Francis E. Powell* 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 evaluated for both the 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).

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Francis E. Powell* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 93,000 bbl and a border around the Most Probable Discharge of 9,300 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 *Francis E. Powell* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 93,000 bbl because 100% 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 High Risk for degree of oiling because the mean volume of water contaminated was 696 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 9,300 bbl, the *Francis E. Powell* is classified as Medium Risk for oiling probability for water column ecological resources because 24% 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 Medium Risk for degree of oiling because the mean volume of water contaminated was 58 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 *Francis E. Powell* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 91% 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 High Risk for degree of oiling because the mean area of water contaminated was 13,300 mi^2. It is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 70% 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 2,900 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 *Francis E. Powell* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 54% 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 27 miles. The *Francis E. Powell* is classified as Medium Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 32% 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 6 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 93,000 bbl of light fuel oil from the *Francis E. Powell* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – High, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – High, because of the seasonally very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk and winter concentrations of seals. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Medium, because of the lower likelihood of significant amounts of light fuel oil to strand onshore and most of the potentially impacted shorelines are sand/gravel beaches where a light fuel oil would not be as persistent as heavier oils

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 93,000 bbl** of a light fuel oil from the *Francis E. Powell*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	100% 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	High
3A-2: Water Column Degree EcoRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 696 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	91% of the model runs resulted in at least 1,000 $mi^2$of water surface covered by at least 10 g/m^2	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	High	The mean area of water contaminated above 10 g/m^2 was 13,300 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	49% 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 33 mi	

For the Most Probable Discharge of 9,300 bbl, the ecological risk from potential releases of light fuel oil from the *Francis E. Powell* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Medium, because of the likely smaller volume of water column impacts
- Water surface resources – Medium, because the area affected is smaller, but there are still a large number of birds and marine mammals at risk. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Low, because fewer miles of shoreline are at risk

Table 3-3: Ecological risk scores for the **Most Probable Discharge of 9,300 bbl** of a light fuel oil from the *Francis E. Powell*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	**Medium**	High	24% 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	**Med**
3A-2: Water Column Degree EcoRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 58 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	70% 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 2,900 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	**Medium**	High	32% 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 6 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 *Francis E. Powell* include very highly utilized recreational beaches from North Carolina to eastern Long Island 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.

The potentially affected areas of the Atlantic contain a large number of significant ports with over 8,000 port vessel calls annually. Commercial fishing is economically important to the region. Total landings are on the order of $218 million annually.

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 *Francis E. Powell* 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 *Francis E. Powell*.

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 Atlantic City, NJ Ocean City, NJ Absecon Beach, NJ Ludlam Beach, NJ Seven Mile Beach, NJ Margate City, NJ	Potentially affected beach resorts and beach-front communities in New York, New Jersey, Delaware, Maryland, 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, and the southern coast of Long Island 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.

Resource Type	Resource Name	Economic Activities
	Peck Beach, NJ Ventnor City, NJ Brigantine Beach, NJ Beach Haven, NJ Spray Beach, NJ Brant Beach, NJ Long Beach, NJ Point Pleasant Beach, NJ Seaside Park, NJ Ortley Beach, NJ Ocean Beach, NJ Normandy Beach, NJ Ocean Beach, NY Fire Island Pines, NY Southampton, NY East Hampton, NY Westhampton Beach, NY Montauk, NY	
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 islands provide 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	Pea Island NWR (NC) Currituck NWR (NC) Mackay Island NWR (NC) Back Bay NWR (VA) Fisherman Island NWR (VA) Eastern Shore of Virginia NWR (VA) Wallops Island NWR (VA) Chincoteague NWR (VA) Cape May NWR (NJ) Edwin B. Forsythe NWR (NJ) Seatuck NWR (NY) Wertheim NWR (NY)	National wildlife refuges in four states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
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	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 the states of 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.

Resource Type	Resource Name	Economic Activities
	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	
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).
Commercial Fishing	A number of fishing fleets use potentially affected waters for commercial fishing.	
	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
	Ocean City, Maryland	Total Landings (2010): $8.8M
	Point Pleasant, NJ	Total Landings (2010): $22.8M
	Beaufort-Morehead City, NC	Total Landings (2010): $9.2M
	Belhaven-Washington, NC	Total Landings (2010): $3.7M
	Elizabeth City, NC	Total Landings (2010): $5.4M
	Engelhard-Swanquarter, NC	Total Landings (2010): $10.6M
	Oriental-Vandemere, NC	Total Landings (2010): $8.4M
	Sneads Ferry-Swansboro, NC	Total Landings (2010): $5.4M
	Wanchese-Stumpy Point, NC	Total Landings (2010): $22.0M
Ports	There are a number of significant commercial ports along the Atlantic coast that could potentially be 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.	
	Baltimore, MD	2,100 port calls annually
	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
	Salem, NJ	52 port calls annually
	Philadelphia, PA	914 port calls annually
	Wilmington, DE	443 port calls annually
	Morehead City, NC	85 port calls annually
	Wilmington, NC	550 port calls annually

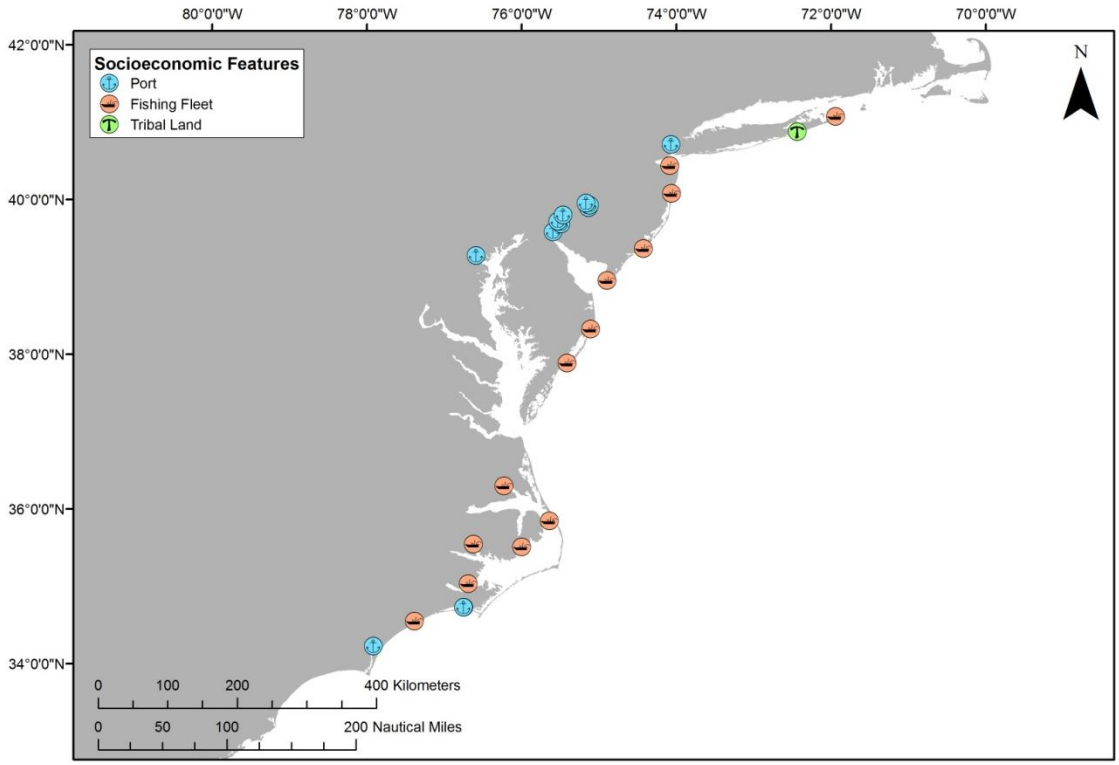


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Francis E. Powell*.

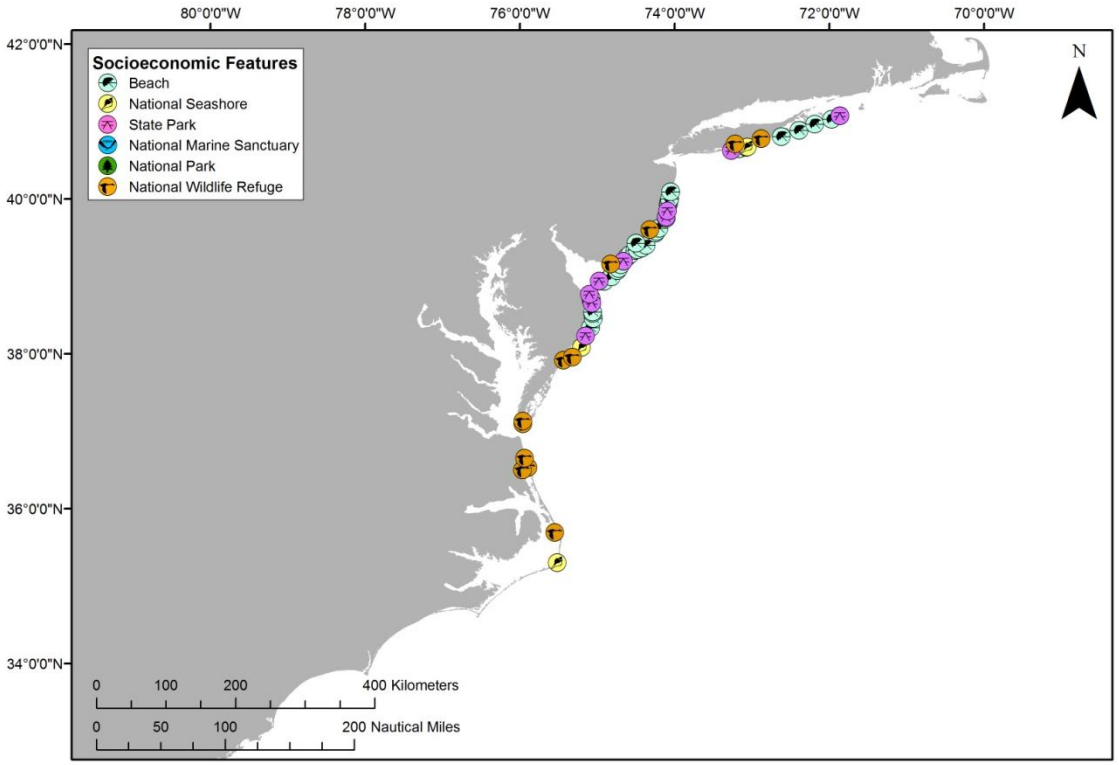


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Francis E. Powell*.

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 *Francis E. Powell* shading indicates the degree of risk, for the WCD release of 93,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 9,300 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 *Francis E. Powell* is classified as High Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 93,000 bbl because 100% 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 700 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 9,300 bbl, the *Francis E. Powell* is classified as Medium Risk for oiling probability for water column socio-economic resources because 24% 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 Medium Risk for degree of oiling because the mean volume of water contaminated was 58 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 *Francis E. Powell* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 94% 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 36,000 mi^2. The *Francis E. Powell* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 82% 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 High Risk for degree of oiling because the mean area of water contaminated was 13,900 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 *Francis E. Powell* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 58% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 65 miles. The *Francis E. Powell* is classified as Medium Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 40% 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 20 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 93,000 bbl of light fuel oil from the *Francis E. Powell* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – High, because a significant area of water column would be impacted in important fishing grounds
- Water surface resources – High, because a large offshore water surface area would be impacted in areas with 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 sheens, tarballs, and streamers
- Shoreline resources – Medium, because a moderate length of shoreline with high-value and sensitive resources would be impacted

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 93,000 bbl** of a light fuel oil from the *Francis E. Powell.*

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	100% 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	**High**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 700 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	94% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**High**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m^2 was 36,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	58% 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 65 mi	

For the Most Probable Discharge of 9,300 bbl, the socio-economic risk from potential releases of light fuel oil from the *Francis E. Powell* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Medium, because a moderate area of water column would be impacted in important fishing grounds
- Water surface resources – High, because a large offshore water surface area would be impacted in areas with 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 sheens, tarballs, and streamers
- Shoreline resources – Medium, because a moderate length of shoreline with high-value and sensitive resources would be impacted

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 9,300 bbl** of a light fuel oil from the *Francis E. Powell*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	**Medium**	High	24% 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	**Med**
4A-2: Water Column Degree SRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 58 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	82% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**High**
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 0.01g/m^2 was 13,900 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	**Medium**	High	28% 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 20 mi	

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

The overall risk assessment for the *Francis E. Powell* 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 particular 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, *Francis E. Powell* scores High with 17 points; for the Most Probable Discharge, *Francis E. Powell* scores Medium with 13 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 *Francis E. Powell*. The final determination rests with the U.S. Coast Guard.

Francis Powell	**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 *Francis E. Powell*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	High	Maximum of 90,074 bbl, leaking reported in 2011		**Low**
	A2: Oil Type	Low	The exact type of oil remaining is unknown		
	B: Wreck Clearance	High	Appears to have been partially cleared		
	C1: Burning of the Ship	High	Burned prior to sinking		
	C2: Oil on Water	Medium	No reported oil on the water		
	D1: Nature of Casualty	High	One torpedo		
	D2: Structural Breakup	High	In two sections, stern yet to be located		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Bow inverted, amidships broken up		**Not Scored**
	Depth	High	95 feet		
	Visual or Remote Sensing Confirmation of Site Condition	High	Two sections are well known recreational dive site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	Yes		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Large spills of a light fuel oil can have significant impacts to water column resources; smaller spills are less persistent in open water	**High**	**Med**
	3B: Water Surface Resources	High	Large area potentially affected, very high use by marine birds	**High**	**Med**
	3C: Shore Resources	High	Light fuel oiling on sand beaches, not persistent, though seasonally important shorebird habitat	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	A significant area of water column would be impacted in important fishing grounds	**High**	**Med**
	4B: Water Surface Resources	High	Large offshore water surface area would be impacted in areas with shipping lanes	**High**	**High**
	4C: Shore Resources	High	Moderate length of shoreline with high-value sensitive resources would be impacted	**Med**	**Med**
Summary Risk Scores				**17**	**13**

Given the relatively shallow depth of the site and ease of access to the site from multiple ports, a simple reconnaissance survey using divers or remote sensing equipment is recommended and would provide valuable information about how much of the bow section remains and which tank or tanks might still contain petroleum products.

Although it is likely that little oil remains inside the ship, the close proximity of the wreck to U.S. Coast Guard and NOAA research vessels and assets suggests that this wreck site may provide a great opportunity for a joint field exercise between the U.S. Coast Guard and NOAA. Such a project would enable the U.S. Coast Guard to definitively assess the potential pollution threat of the wreck and would provide NOAA archaeologists with additional baseline data about another World War II casualty that can be synthesized into the ongoing Battle of the Atlantic Research and Expeditions being conducted by the *Monitor* National Marine Sanctuary.