Hebron Project Report Cover:Layout 1 6/7/10 3:10 PM Page 1

Hebron

HEBRON PROJECT

Comprehensive Study Report:
Sections 14.2 and 14.3 (revised)
February 2011

ExxonMobil Chevron SUNCOR ENERGY Statoil nalcor energy

TABLE OF CONTENTS

14 ACCIDENTAL HYDROCARBON SPILL EVENTS 14-1

14.1 Hydrocarbon Spill Probabilities 14-1

14.2 Fate and Behaviour of Hebron Hydrocarbon Spills in the Nearshore Study Area (Trajectory Modelling) 14-1

14.3 Fate and Behaviour of Hebron Hydrocarbon Spills from a Platform of Subsea Blow-out in the Offshore Study Area (Trajectory Modelling) 14-1

14.3.1 Model Inputs and Spill Scenarios 14-1

14.3.2 Model Output 14-4

14.3.2.1 Stochastic Model Results 14-4

14.3.2.2 Deterministic Model Results 14-14

14.3.3 Batch Spills 14-16

14.3.4 Trajectory Modelling Summary 14-19

LIST OF FIGURES

Figure 14.1 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Summer 14-5

Figure 14.2 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Winter 14-6

Figure 14.3 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Winter (ice present) 14-6

Figure 14.4 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Summer 14-7

Figure 14.5 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Winter 14-7

Figure 14.6 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Winter (ice present) 14-8

Figure 14.7 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 100-day Period during Summer 14-8

Figure 14.8 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 120-day Period during Winter 14-9

Figure 14.9 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 120-day Period during Winter (with ice present) 14-9

Figure 14.10 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 30-Day Extended (60-day) Run Winter 14-11

Figure 14.11 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 100 Days Summer 14-11

Figure 14.12 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 120 Days Winter 14-12

Figure 14.13 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 120 Days Winter (with ice present) 14-12

Figure 14.14 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 100 Days Summer 14-13

Figure 14.15 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 120 Days Winter 14-13

Figure 14.16 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 120 Days Winter (with ice present) 14-14
Figure 14.17 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Summer 14-16
Figure 14.18 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Winter 14-17
Figure 14.19 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Winter (with ice present) 14-17
Figure 14.20 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Summer 14-18
Figure 14.21 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Winter 14-18
Figure 14.22 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Winter (with ice present) . 14-19

LIST OF TABLES

Table 14.1 Characteristics of Oil used in Spill Trajectory Modelling 14-3
Table 14.2 Newfoundland Stochastic Model Shoreline Contact Summary 14-10
Table 14.3 Summary of Offshore Deterministic Model Results 14-15
Table 14.4 Spill Trajectory Model Results Summary 14-20

14 ACCIDENTAL HYDROCARBON SPILL EVENTS

14.1 Hydrocarbon Spill Probabilities

14.2 Fate and Behaviour of Hebron Hydrocarbon Spills in the Nearshore Study Area (Trajectory Modelling)

Separate file

14.3 Fate and Behaviour of Hebron Hydrocarbon Spills from a Platform of Subsea Blow-out in the Offshore Study Area (Trajectory Modelling)

Hydrocarbon spill trajectory analysis for the Grand Banks has been previously carried out for environmental assessments for offshore exploration drilling and production programs. The present exercise provides an analysis using recent environmental data inputs and presents results in the context of the Hebron setting and neighbouring oil production platforms. ASA (2010b) provides a discussion of the spill trajectory analysis.

The SIMAP model was used to simulate crude oil spills at the Hebron offshore site. The model scenarios use wind data obtained from model hindcasts and field measurements, and current data from multiple hydrodynamic models. The SIMAP model was used in stochastic and deterministic modes to determine the range of possible water surface, subsea and shoreline oiling predicted to occur. The ASA blow-out model simulates the near-field dynamics of the plume of gas / oil mixture discharged from the subsea well blow-out, and the SIMAP model simulates the far-field transport and weathering of the oil released into the water column or at the surface (see ASA 2010b for a complete description of the model and its results).

14.3.1 Model Inputs and Spill Scenarios

There are two types of spill events that may occur during production operations at the Hebron Platform: batch spills and blow-outs. Blow-outs are uncontrolled releases of crude oil. Batch spills are instantaneous or short-duration discharges of hydrocarbons that could occur from the handling and/or transfer of hydrocarbons (ie loading of diesel).

The Hebron Project modelled a number of scenarios related to a potential blow-out occurring either at the Hebron Platform or from a mobile offshore drilling unit (MODU) under a possible future subsea tie-back to the Hebron Platform. The scenarios used to model spill trajectories consider the rates at which oil could flow from Hebron wells. These rates were derived based on existing knowledge of well properties and reservoir data for the Hebron field. A potential blow-out from the platform (at approximately 70 m above mean sea level) was modelled at a rate of 5,600 m^3/d (approximately 35,000 bbl/d). A potential subsea blow-out from a MODU was modelled at a rate of 3,200 m^3/d (approximately 20,000 bbl/d).

ExxonMobil's well control philosophy is focused on prevention using safety and risk management systems, management of change procedures, and global standards. ExxonMobil has a mature Operations Integrity Management System (OIMS) that emphasizes relentless attention to Safety, Well Control, and Environmental Protection. This includes proper preparation for wells (well control equipment inspections / tests), detecting the influx early, closing-in the well efficiently (personnel training / drills), and circulating out the kick with kill weight mud in a controlled manner.

In the event of a blow-out, ExxonMobil's primary objective would be to stop the flow as quickly as possible. For both surface and subsea wells, this would involve shutting in at the wellhead and killing the well through the wellhead. Relief well drilling, and the subsequent dynamic kill, is considered a back-up strategy in the event shut-in and/or killing through the wellhead is not possible or is unsuccessful.

Two blow-out scenarios were included in the spill trajectory modelling: a platform case and a subsea case. In developing these scenarios the following factors were considered.

Platform Blow-out:

- For a blow-out through a surface wellhead, multiple options are available to stop the flow, depending on the magnitude and composition of the flow, configuration of the blow-out preventer (BOP), and the accessibility of the wellhead. If the wellhead is accessible, capping the well would result in a relatively short flow duration, as surface capping equipment, such as safety valves for inside pipe flow, are maintained on the rig and manual BOP closing is possible. Depending on the scenario, the duration to cap the well and stop flow may be within just a few hours, or if initial attempts are unsuccessful, is estimated at two to three weeks. If a fire renders the platform inaccessible, the most appropriate method to access the well would be evaluated given the condition of the platform and surrounding wells.
- If Platform-based well interventions were not successful, the time it would take to secure a drilling unit locally, secure the required well equipment, mobilize the unit to the Hebron location, and drill a relief well is estimated to be 100 days in the summer months and 120 in the winter months. If a MODU was sourced internationally additional time would be required.

Subsea Blow-out

- If the subsea wellhead is accessible and the drilling rig on the MODU is intact, operational, and can work over the wellhead, the rig would be used to cap or kill the well. In this scenario, multiple options exist to kill the well, including wellbore intervention to perform a dynamic kill or to set a packer. In addition, using the existing BOP stack or a capping BOP stack to shut-in the well is also possible. If the drilling rig is intact and the wellbore is accessible, a dynamic kill could take place within days of the blow-out. If it is necessary to assemble and mobilize a capping stack and a second MODU then a time period of approximately 60 days would be required. If a MODU is available locally and the rig stack can be used as a capping stack, this time period is reduced to 30 days.

- If it is not possible to work over the wellhead, or if the wellhead is inaccessible, then a relief well will be required to kill the well. If a MODU was sourced locally, the time it would take to secure a drilling unit locally, secure the required well equipment, mobilize the unit it to the Hebron location, and drill a relief well is estimated to be 100 days in the summer months and 120 in the winter months. If a MODU was sourced internationally additional time would be required.

As stated above, the probability of a blow-out from development drilling or production operations resulting in the need to drill a relief well is low. Therefore, for the purposes of environmental assessment, the environmental impact analysis will focus on a 30-day platform blow-out at a rate of 5,600 m^3/d, and a 100-day subsea blow-out at 3,200 m^3/d. The batch spills modelled include an instantaneous release of 800m^3 of diesel, and a batch release of 5,000 m^3 crude from the offshore loading system. Additional information on the spill trajectory modelling results can be found in the spill trajectory report completed by Applied Science Associates, Inc. (ASA 2010b).

Note that the 30 day duration blow-out scenarios were also run using a 60-day duration in order to track the oil for an additional 30 days. These extended simulations use the same blow-out duration, rate of release and total release volume as the 30 days scenarios; however, the model run time was extended to 60 days.

The characteristics of the oil types used in the spill simulations are listed in Table 14.1.

Table 14.1 Characteristics of Oil used in Spill Trajectory Modelling

Oil	Spill	API Gravity	Density (g/cm^3)	Viscosity (cP)
Hebron D-94 Crude	Platform blow-out Batch OLS Transfer	20.1	0.92691 @ 25° C	265.374 @ 25° C
Ben Nevis L55 Well	Subsea blow-out	30.8	0.8711 @ 15° C	15.556 @ 25° C
Marine Diesel Fuel	Batch Transfer Spills	37.6	0.82910 @ 25° C	4.0 @ 25° C

Wind data for offshore model simulations were obtained from two sources: MSC50 Wind Hindcast (Swail *et al.* 2006), a model reanalysis product that provides hindcast winds for the North Atlantic for the period 1954 through 2008 at sites clustered around the Hebron Platform; and National Centers for Environmental Prediction (NCEP) at multiple locations (more widely spaced) across the North Atlantic. Annual wind directions and speeds from the MSC50 model hindcast data were obtained for Grid Point M6010632 (adjacent to the Hebron Platform). The wind comes from all directions at this site but it comes most frequently from the northwest through the south. There is seasonality in the wind at this location that differentiates the summer and winter seasons. Winter wind speeds are higher than in summer and more frequently from the west and north. Oil spill simulations were run using summer and winter season winds in order to capture the seasonal differences. Currents for the North Atlantic region were acquired from the HYbrid Coordinate Ocean Model (HYCOM) circulation model, an ocean general circulation model that evolved from the Miami Isopycnic-Coordinate Ocean Model (MICOM) (Halliwell *et al.* 1998, 2000; Bleck 2002). Hindcast currents from the HYCOM model were obtained for the period November 2003 through September 2010 for the North Atlantic region. These currents were used in SIMAP for modeling oil spills originating at the Hebron platform and from the seafloor blow-out.

Spill trajectory modelling in the winter months was run with and without ice present. The presence of sea ice in Newfoundland and Labrador waters was below normal during the winter of 2009-2010 (CIS 2010). The total accumulated ice coverage in east Newfoundland waters set a new record low during last year's winter season. Ice data used for oil spill modelling were obtained from the National Snow and Ice Data Center for the months of February and March, 1990 to define the ice coverage for these months. The SIMAP model accounts for the presence of ice at 0 to 30 percent, 30 to 80 percent and 80 to 100 percent when calculating surface oil advection, evaporation, entrainment into the water column and surface oil spreading.

14.3.2 Model Output

14.3.2.1 Stochastic Model Results

The stochastic model is used to determine the probability of finding oil on the water surface, the shoreline and in the water column based on specified thickness and concentration thresholds. The thresholds used for the stochastic model simulations in this study include:

- Average thickness >0.01 mm (10 µm)
- Shoreline oil average thickness over the shore segment (length of one grid cell times typical width for the shoreline type) >0.01 mm (10 µm)
- Subsea oil (entrained in water) average over the water cell >10 ppb

Winds and currents at the Hebron Platform are such that the majority of spills are predicted to travel eastward. The distance traveled is controlled by the blow-out duration. Simulations of blow-outs of 100 days or longer duration and without any response or interdiction are predicted to oil large areas of the North Atlantic.

Winter wind speeds are higher than in summer and more frequently from the west and north, which drives oil greater distances to the east than summer winds. Both summer and winter spill simulations of greater than 30 days duration are predicted to reach segments of the Newfoundland shoreline.

Both of the crude oils used in the simulations are persistent and do not disperse into the water column readily from natural processes. This characteristic, combined with the long duration release of oil into the water, result in most of the oil remaining on the sea surface. The area of sea surface oiled increases linearly with an increase in total spill volume.

The probability for surface oiling exceeding the above thresholds for the 30-day Hebron Platform blow-out scenario in the summer and winter and winter in ice seasons are depicted in Figures 14.1 to 14.3. The probability for surface oiling exceeding the above thresholds for the 30-day / 60-day extended Hebron Platform blow-out scenario in the summer, winter and winter (with ice) seasons are depicted in Figures 14.4 to 14.6. The probability for surface oiling exceeding the above thresholds for the Hebron subsea blow-out scenario for 100 days in summer and 120 days winter (with and without ice) are depicted in Figures 14.7 to 14.8. The probability for surface oiling exceeding the above thresholds for the Hebron Platform blow-out 100 and 120 days scenarios are very similar to the subsea 100-day and 120-day cases; these figures can be found in ASA 2010b. It should be noted that the maps do not show that oil will cover the entire area depicted, only the probability that surface oil will enter the area in excess of the given threshold (i.e., > 0.01 mm thickness).

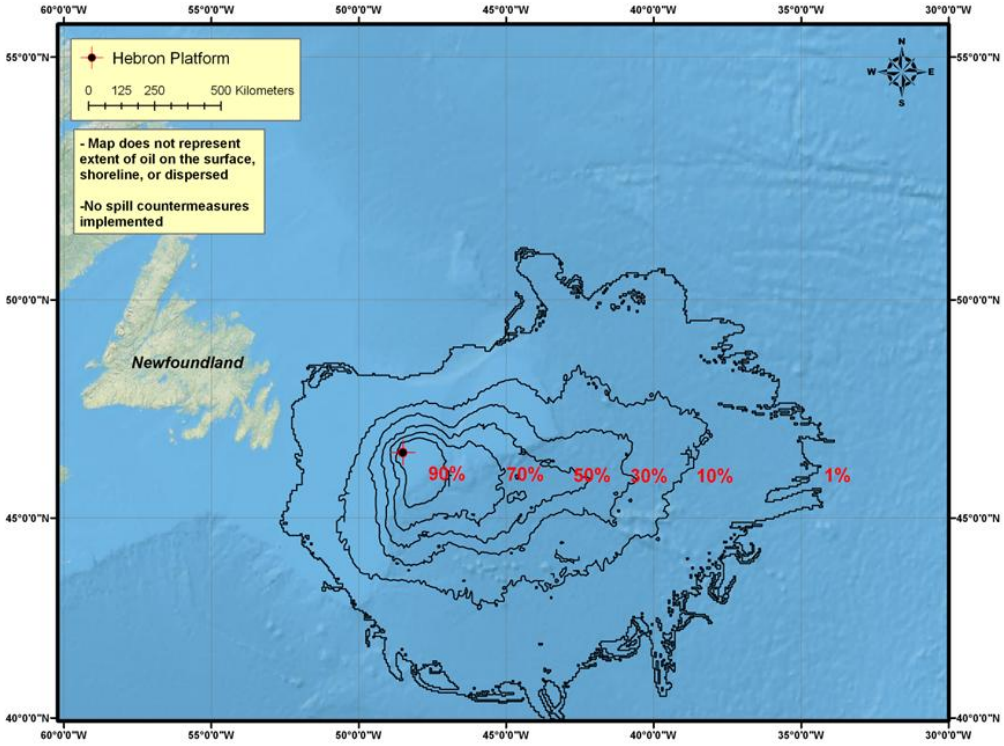


Figure 14.1 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Summer

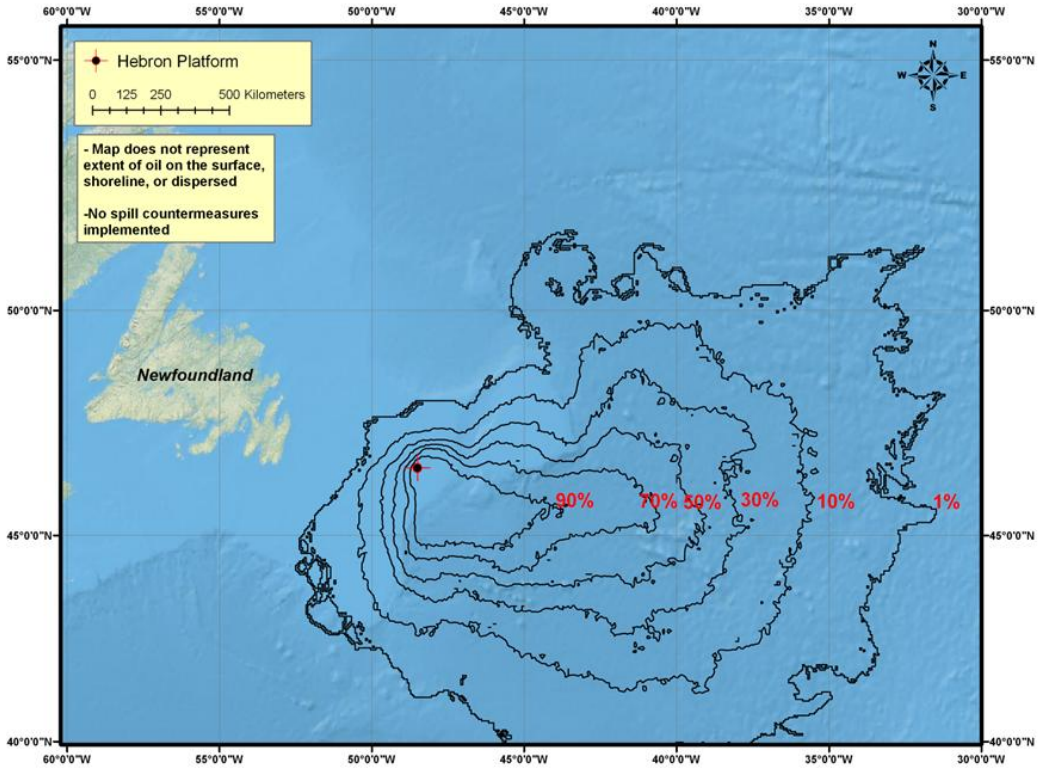


Figure 14.2 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Winter

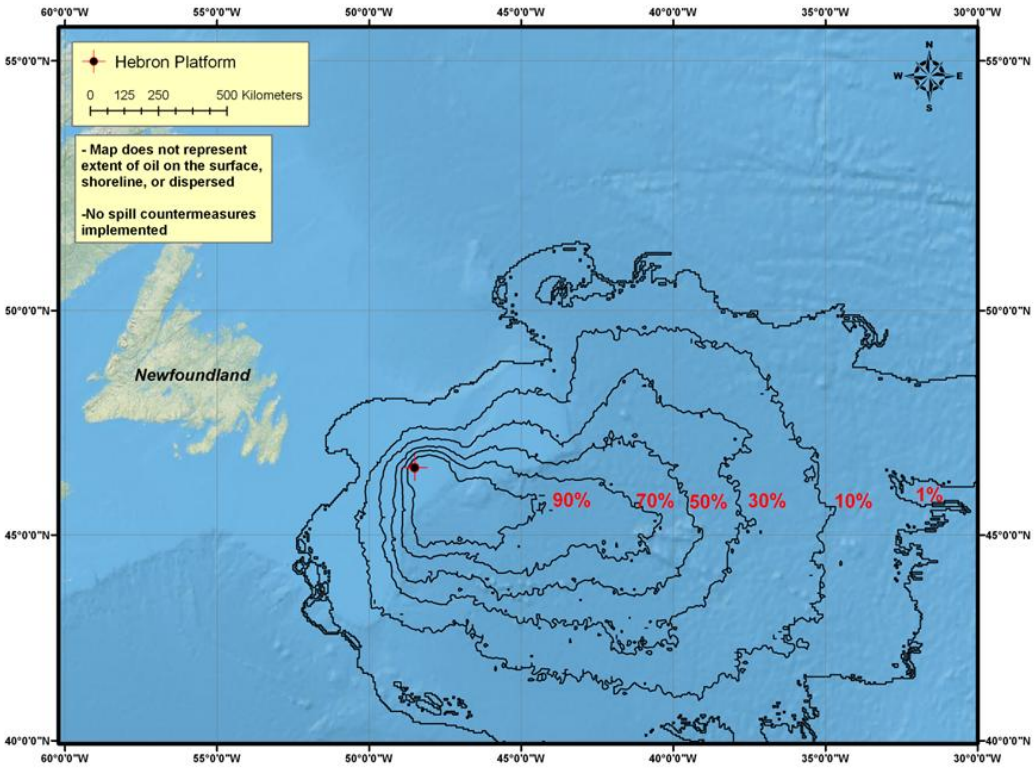


Figure 14.3 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period during Winter (ice present)

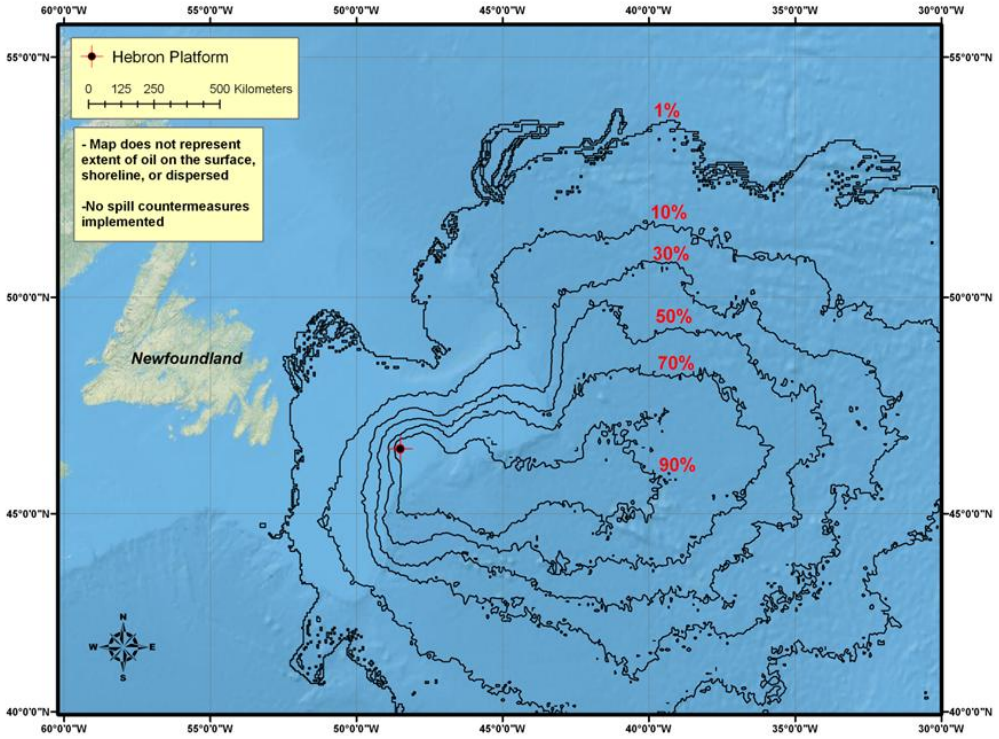


Figure 14.4 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Summer

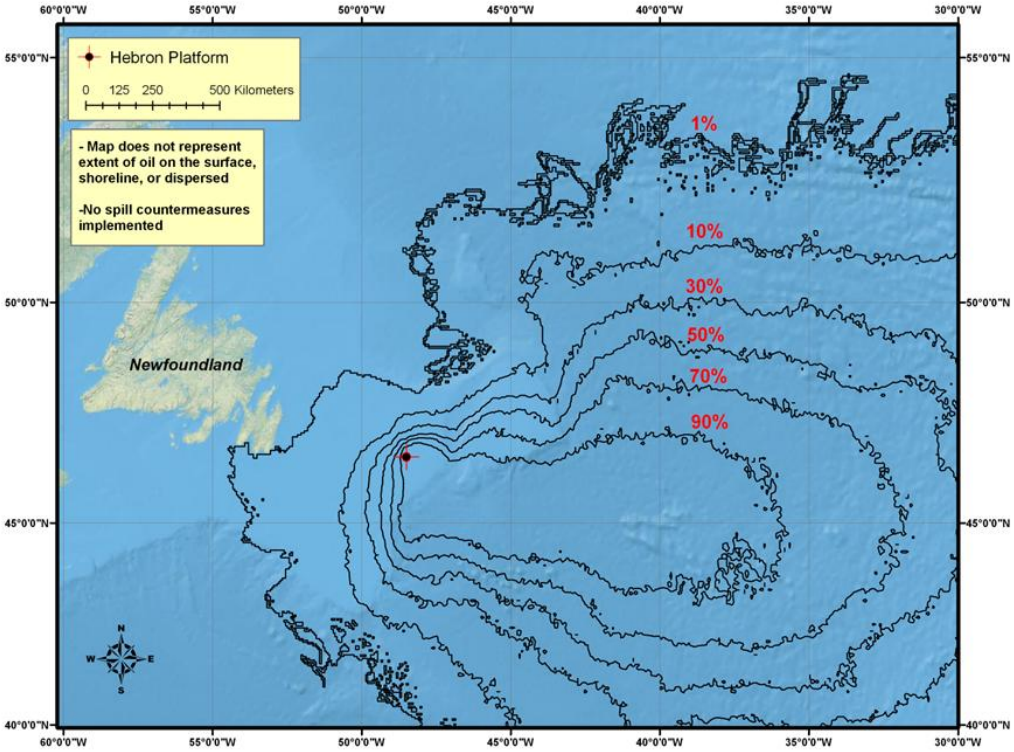


Figure 14.5 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Winter

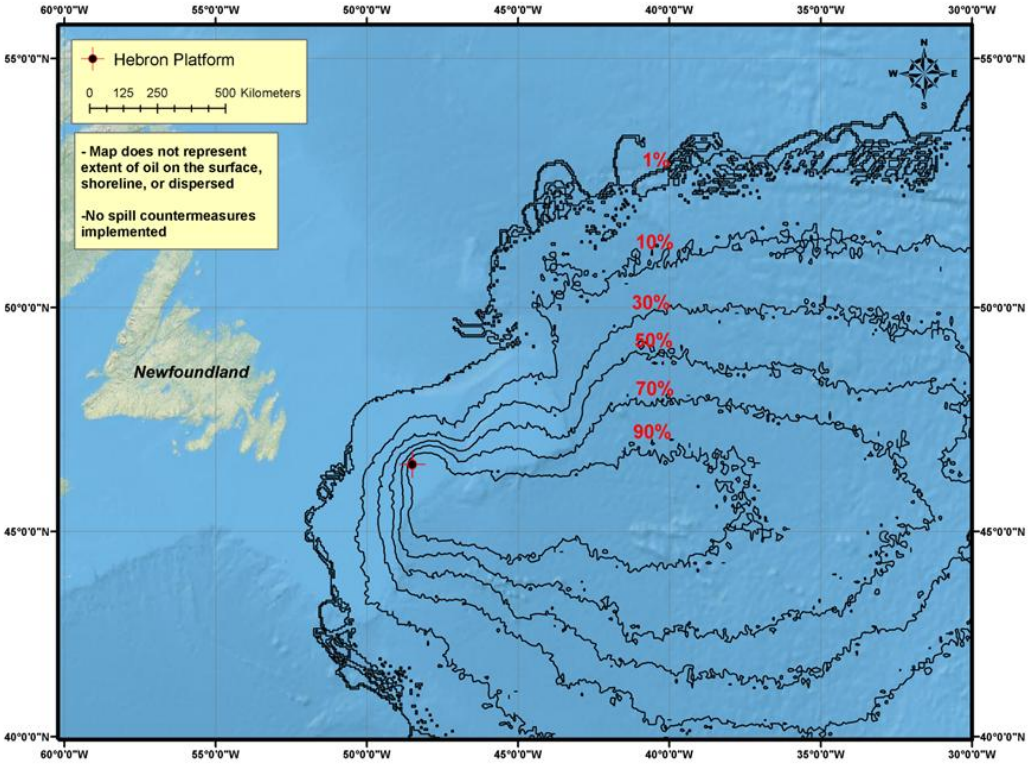


Figure 14.6 Surface Oiling Probabilities Greater than 0.01 mm from a Hebron Platform Blow-out of 5,600 m^3/day over a 30-day Period Simulated for 60 Days during Winter (ice present)

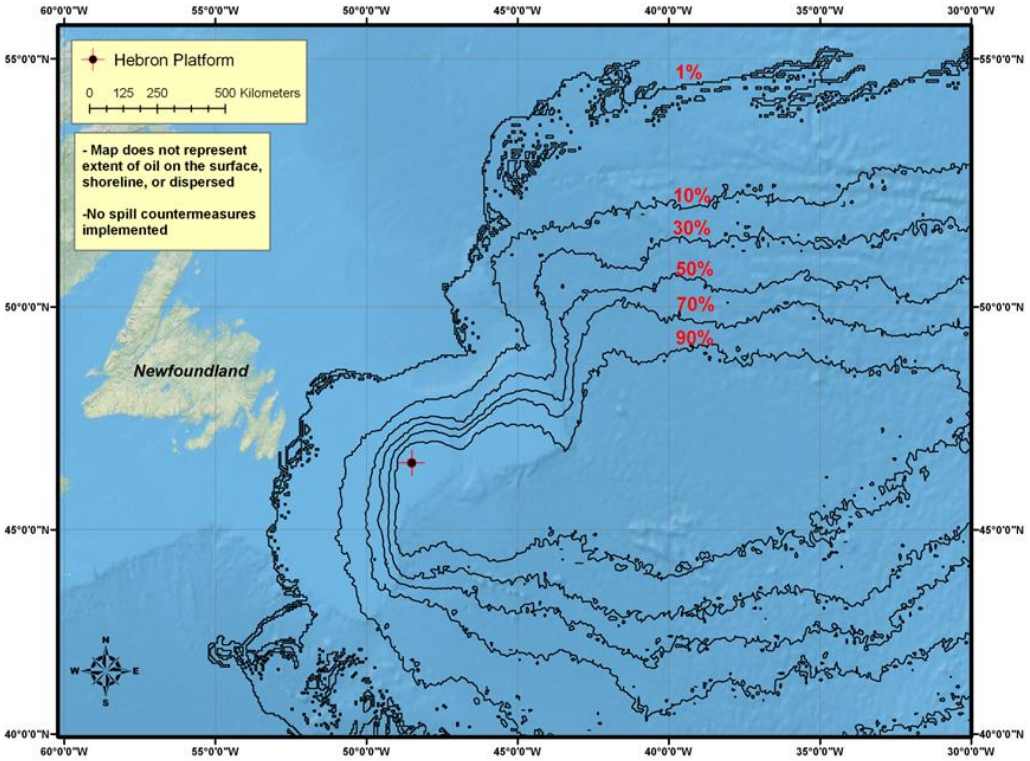


Figure 14.7 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 100-day Period during Summer

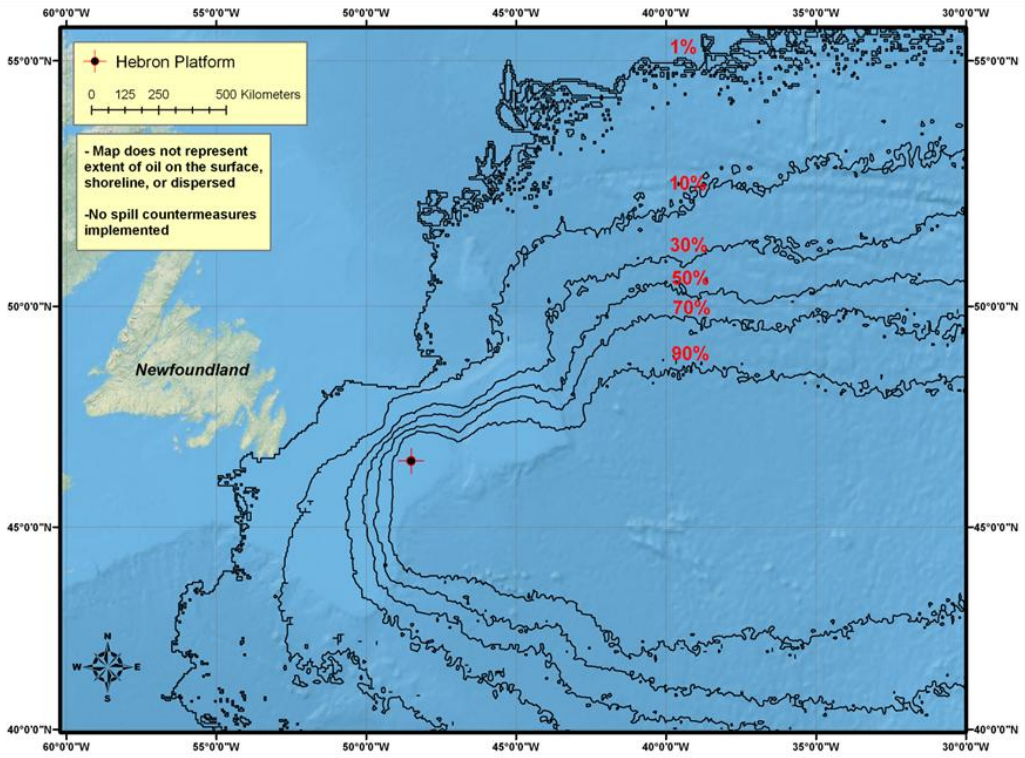


Figure 14.8 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 120-day Period during Winter

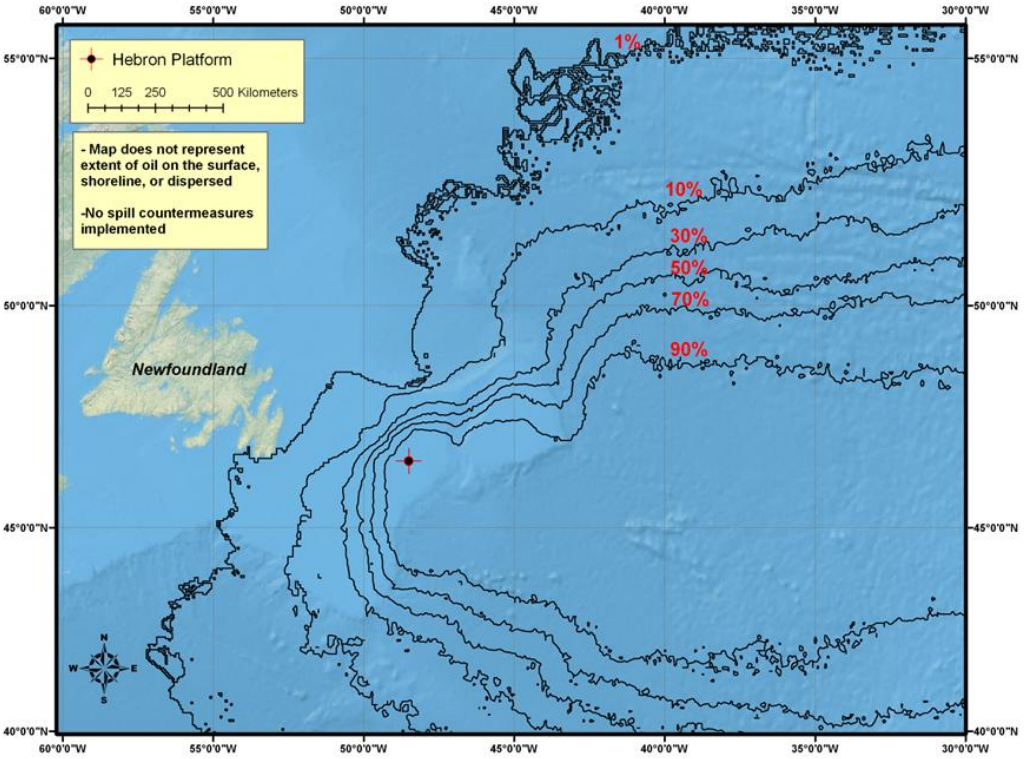


Figure 14.9 Surface Oiling Probabilities Greater than 0.01 mm from a Subsea Blow-out over a 120-day Period during Winter (with ice present)

Not all of the stochastic model simulations predict oil will hit the Newfoundland coast. For those simulations where shoreline contact is predicted, there is a less than 5 percent probability that oil from either a platform or subsea blow-out will reach the Newfoundland shore without the implementation of spill countermeasures. The stochastic model shoreline contact summary is provided in Table 14.2. The values listed in the table are from the individual spill from each stochastic model scenario that resulted in the maximum amount of oil on the Newfoundland shore, and therefore represent a worse possible outcome. A zero probability of contact means that none of the 100 spills completed in the stochastic model scenario reached the Newfoundland coastline; a one percent probability of shoreline contact means that one of the 100 runs reached the shoreline. The predicted affected shoreline during summer and winter from a Hebron Platform and subsea blow-out is illustrated in Figures 14.10 to 14.16.

Table 14.2 Newfoundland Stochastic Model Shoreline Contact Summary

Scenario	Probability of Oiling (%)	First Arrival of Oil (days)	Shoreline Length Oiled (km)	Shoreline Area Oiled (m^2)	Expected Mean Mass (g/m^2)
Hebron Platform Blow-out					
Surface 30 day Summer	0	-	-	-	-
Surface 30 day Winter	0	-	-	-	-
Surface 30 day Extended Run Summer	0	-	-	-	-
Surface 30 day Extended Run Winter	1	41	142.7	428,100	20
Surface 30 day Extended Run Winter w/ice	0	-	-	-	-
Surface 100 day Summer	1	23	5.3	15,900	0.2
Surface 120 day Winter	1	108	285.5	856,500	20
Surface 120 day Winter w/ice	3	21	137.8	413,500	60
Subsea Blow-out					
Subsea 100 day Summer	1	39	5.3	15,900	0.8
Subsea 120 day Winter	3	21	127.2	381,600	39
Subsea 120 day Winter w/ice	1	40	116.6	349,900	20
Batch Spills					
Marine Diesel Batch Transfer Summer	0	-	-	-	-
Marine Diesel Batch Transfer Winter	0	-	-	-	-
Diesel Mairne Batch Transfer Winter – w/ice	0	-	-	-	-
Crude Oil Batch OLS Transfer Summer	0	-	-	-	-
Crude Oil Batch OLS Transfer Winter	0	-	-	-	-
Crude Oil Batch OLS Transfer Winter – w/ice	0	-	-	-	-
Note: Values listed are from the individual spill within each stochastic scenario that resulted in the largest volume of oil stranded on the shore					

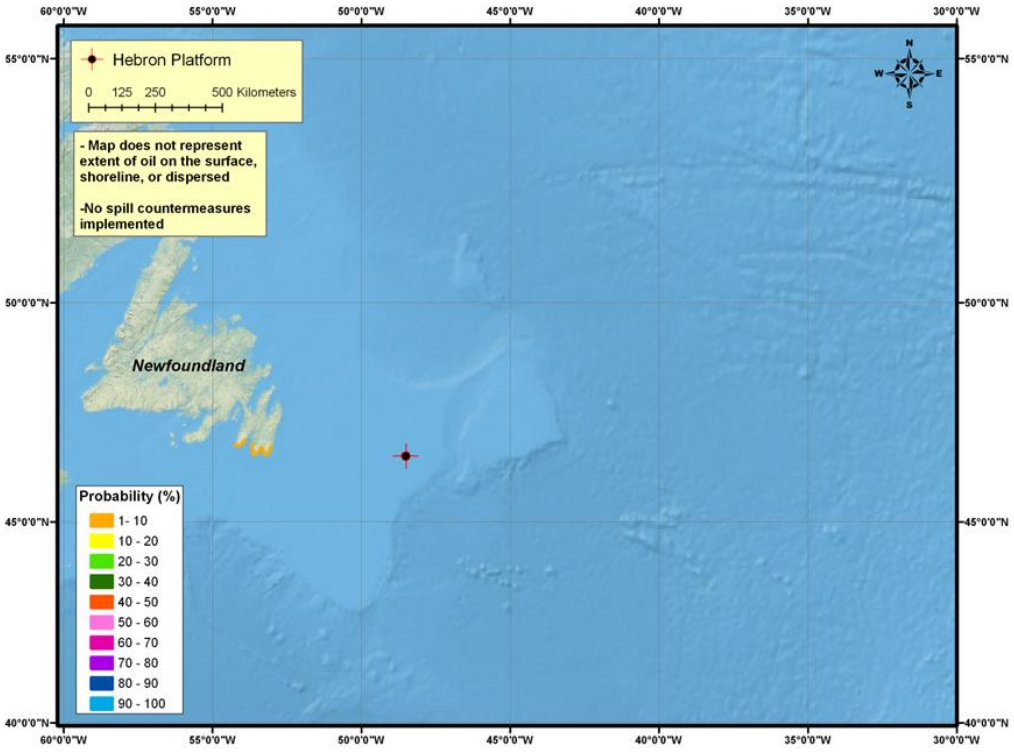


Figure 14.10 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 30-Day Extended (60-day) Run Winter

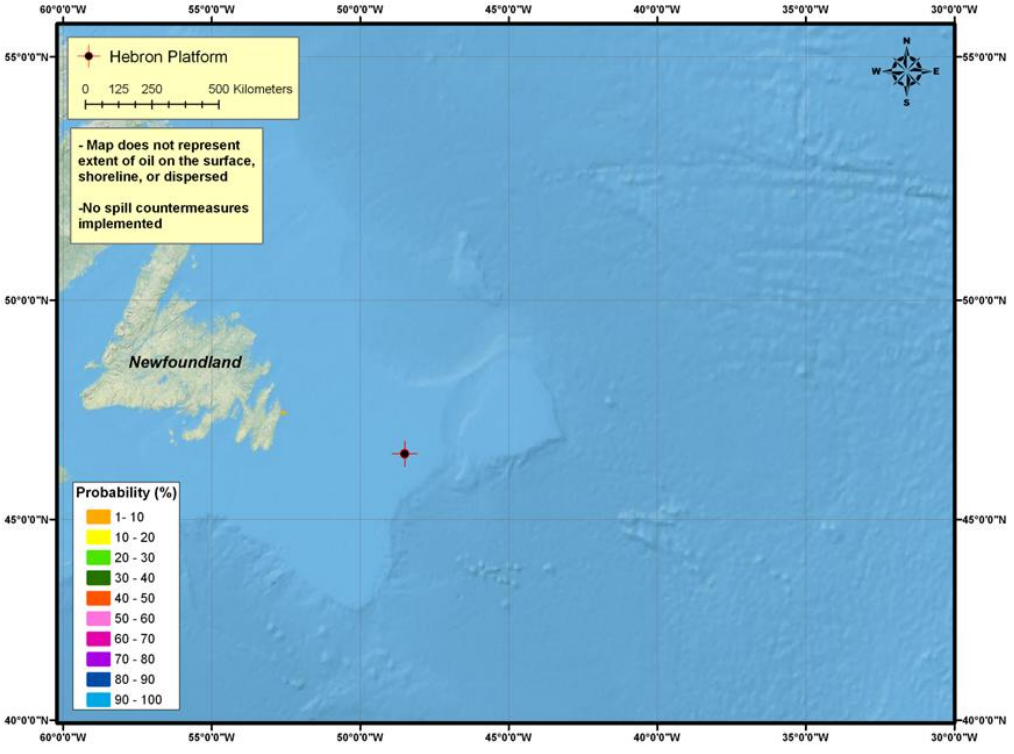


Figure 14.11 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 100 Days Summer

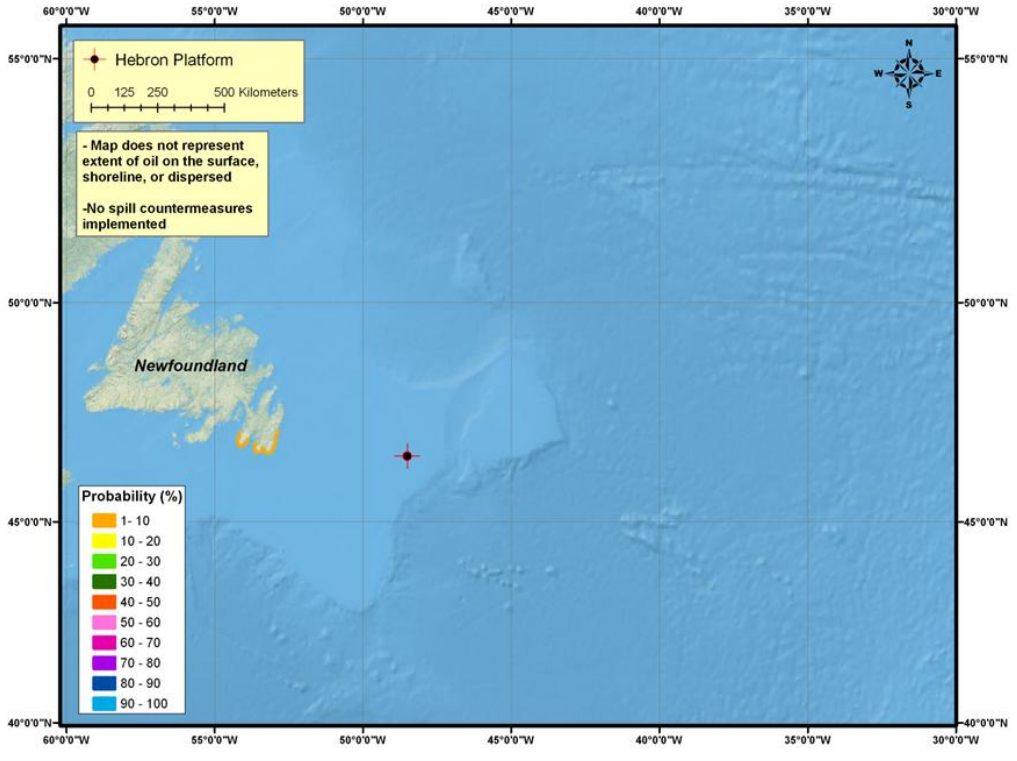


Figure 14.12 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 120 Days Winter

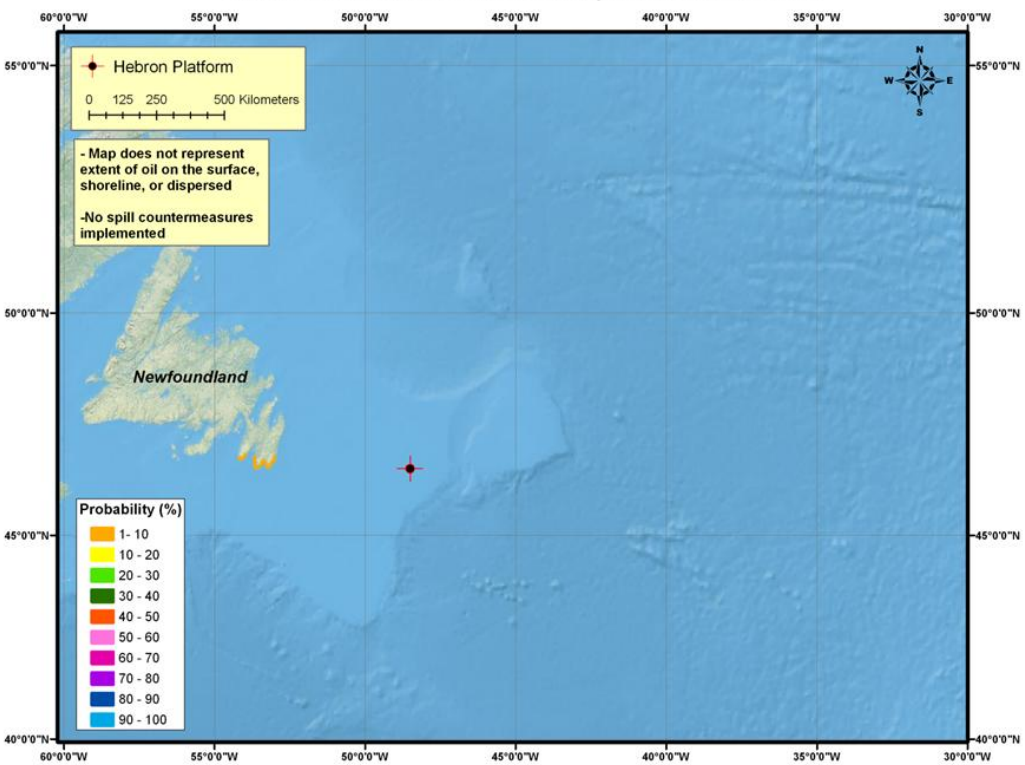


Figure 14.13 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Surface Blow-out, 120 Days Winter (with ice present)

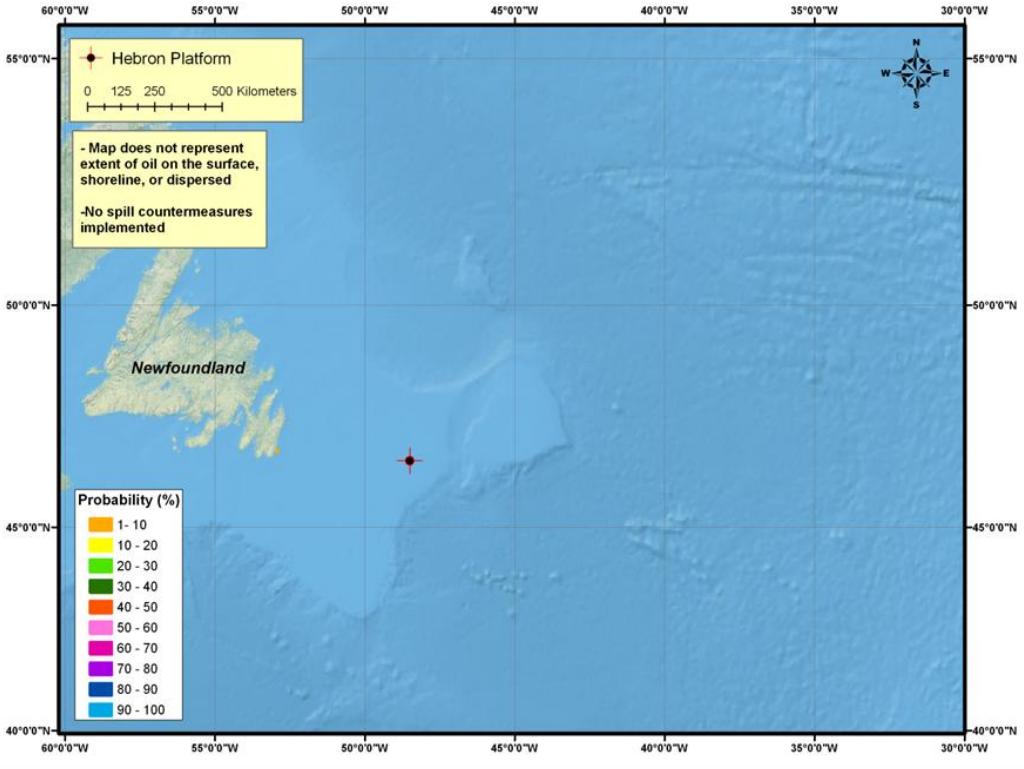


Figure 14.14 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 100 Days Summer

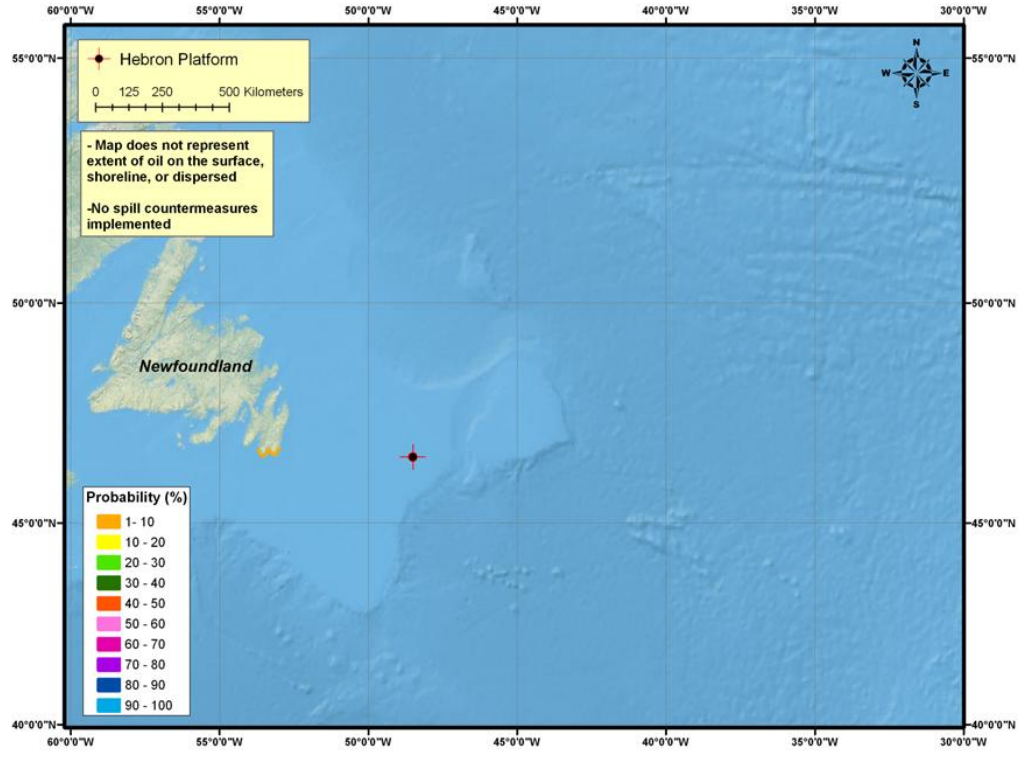


Figure 14.15 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 120 Days Winter

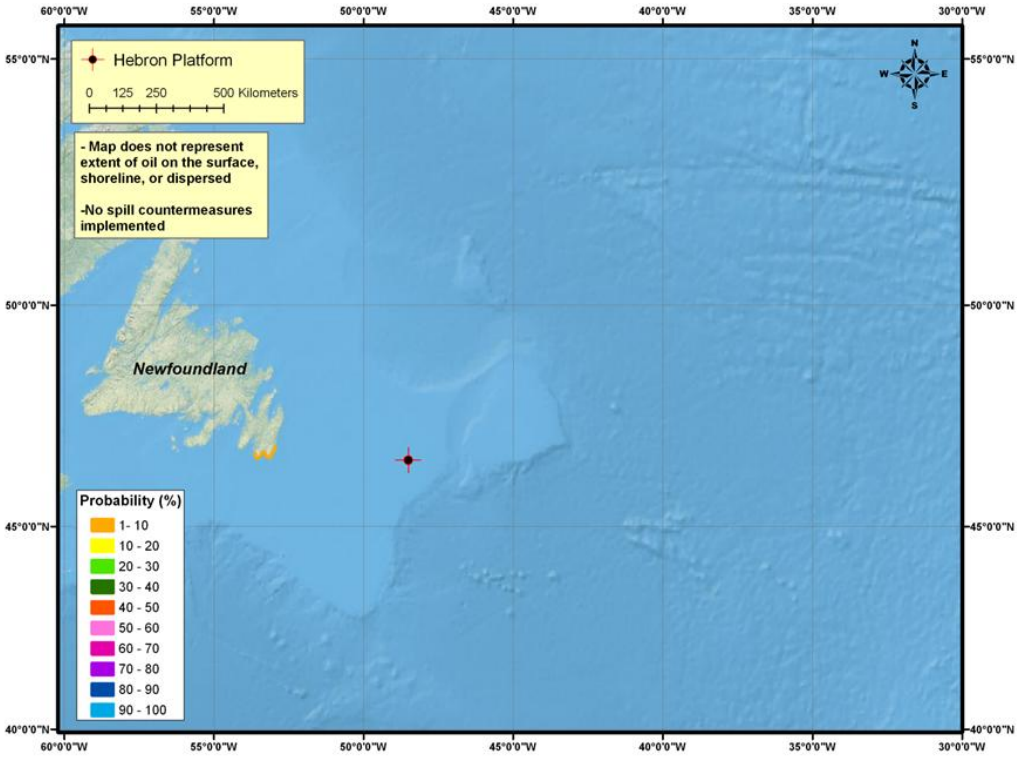


Figure 14.16 Probability of Shoreline Contact for Oil Thickness Greater than 0.01 mm; Subsea Blow-out, 120 Days Winter (with ice present)

14.3.2.2 Deterministic Model Results

The deterministic model results depict the results from one model simulation chosen from the 100 individual simulations completed by the stochastic model. The simulations were selected because they result in the 95th percentile for sea surface oiling area, shoreline oiling length or entrained oil volume. It should be kept mind that each map displays the results from a different simulation.

The deterministic model was used to investigate individual spill events identified in the stochastic model as resulting in the 95th percentile for surface oiling. The deterministic model results show the maximum surface oil thickness for the entire spill period as areas of color corresponding to oil thickness (see Table 14.3).

Table 14.3 Summary of Offshore Deterministic Model Results

Release Type	Spill Scenario	Total Spill Volume (m^3)	Surface Oil (%)	Evap. (%)	Water Column (%)	Oil Ashore (%)	Oil Decayed (%)
Platform Blow-out (5,600 m^3/day (35,000 bpd))	Summer: 30 day	168,000	79	8.2	0.2	0	12.6
	Winter: 30 day	168,000	79	8.3	0.2	0	12.5
	Winter – ice: 30 day	168,000	79	7.8	0.2	0	13
	Summer: 30 / 60 day	168,000	56	11.7	0.3	0	32.0
	Winter: 30 / 60 day	168,000	56	11.3	0.3	0.2	32.2
	Winter – ice 30 / 60 day	168,000	56	11.3	0.3	0.01	32.4
	Summer: 100 day	560,000	56	10.2	0.2	0.02	33.6
	Winter: 120 day	672,000	51	11.4	0.3	0.4	36.9
	Winter – Ice: 120 day	672,000	51	11.2	0.3	0.4	37.1
Subsea Blow-out (3,200 m^3/day (20,000 bpd))	Summer	320,000	35	28.6	9.9	0	26.5
	Winter	384,000	31	29.8	9	0.09	30.1
	Winter - ice	384,000	29	32.3	9.1	0.2	29.4
Batch Transfer (Marine Diesel)	Summer	800	0	45.2	39.6	0	15.2
	Winter	800	0	6.4	69.7	0	23.9
	Winter - ice	800	0	6.2	69.8	0	24.0
Batch OLS Transfer (Crude Oil)	Summer	5,000	64	12.9	0.5	0	22.6
	Winter	5,000	64	12.5	0.5	0	23.0
	Winter - Ice	5,000	64	12.6	0.4	0	23.0

Note: The percentages in the table are the fraction of oil volume in each location or weathering category at the end of the simulation

The volume of oil remaining on the sea surface at the end of each Hebron Platform model simulation ranges from 51 to 79 percent of the total volume released. In general, as the oil release duration increases, the fraction of oil remaining on the sea surface decreases. This relative decrease in surface oil corresponds with an increase in the rate of natural decay. Decay, which accounts for 12 to 37 percent of the total Hebron Platform blow-out spill volume, occurs as the result of photolysis, a chemical process energized by ultraviolet light from the sun, and by biological breakdown from organisms in the water. The decrease in surface oil over time may in some instances correspond to surface oil stranding on the shoreline, reducing the amount of oil on the surface. While the fraction of surface oil volume is predicted to decrease over time, the sea surface area covered by oil thicker than 0.01 mm is predicted to increase as the duration of the blow-out increases. The increase in sea surface area exposed to oil is due to the rapid and continual spreading of the surface slick. The fraction of oil lost to evaporation does not vary greatly, ranging from 7.8 to 11.4 percent of the total volume released. The amount of oil entrained in the water column through natural dispersion processes is less than 0.5 percent for all Hebron Platform blow-out spill scenarios.

The volume of oil remaining on the sea surface at the end of each of the subsea blow-out simulations ranges from 29 to 35 percent, considerably less than the Hebron Platform blow-outs. The subsea blow-out introduces oil directly into the water column where oil makes up 9 to 10 percent of the spilled volume throughout the duration of the blow-out. As with the Hebron Platform blow-out, as the oil release duration increases, the fraction of oil remaining on the sea surface decreases due to an increasing rate of natural decay. Decay accounts for 26 to 30 percent of the released oil. Oil lost to evaporation in the subsea blow-out spills is predicted to be more than twice the amount in the Hebron Platform blow-outs, ranging from approximately 29 to 32 percent. This is due primarily to differences in the physical and chemical makeup of the platform crude oil modelled compared to the subsea crude oil modelled.

14.3.3 Batch Spills

Similar to the blow-out releases of crude oil, marine diesel and crude oil released in batch transfer spills are predicted to travel primarily toward the east away from Newfoundland. The marine diesel fuel is more easily dispersed into the water column than the crude oil and modelling predicts slightly higher entrained oil fractions for these spills. The marine diesel is capable of achieving a smaller minimum thickness than the crude oil, resulting in a relatively higher sea surface area exposed to oil. None of the batch transfer spills are predicted to reach the Island of Newfoundland shoreline (Figures 14.17 to 14.22).

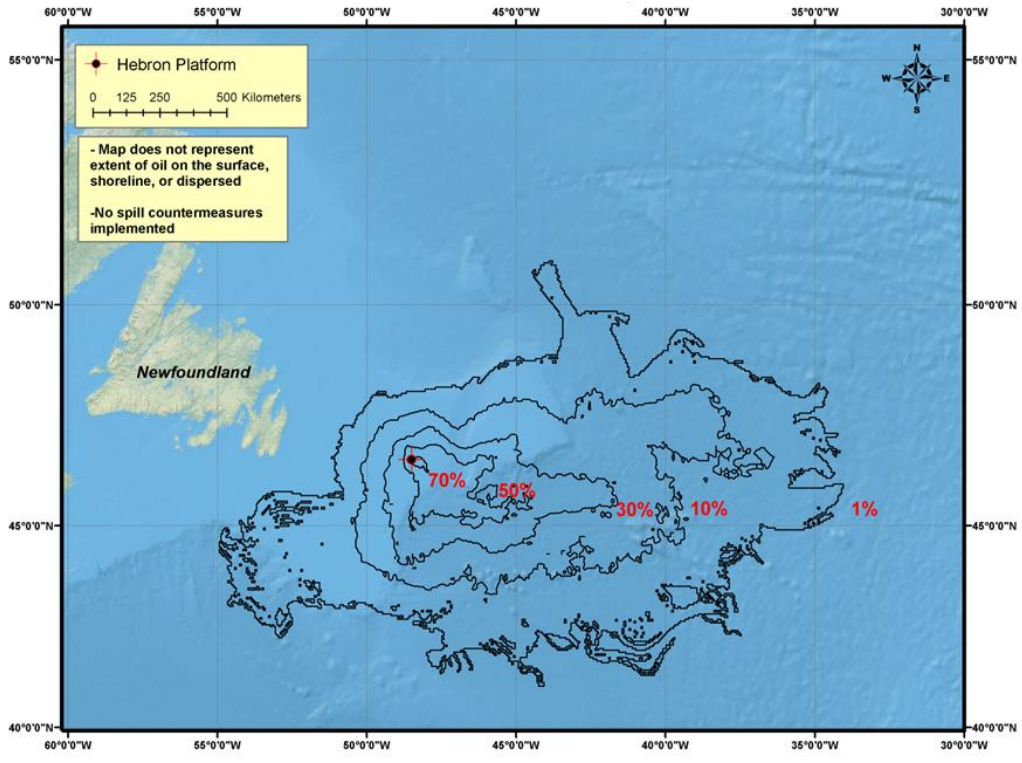


Figure 14.17 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Summer

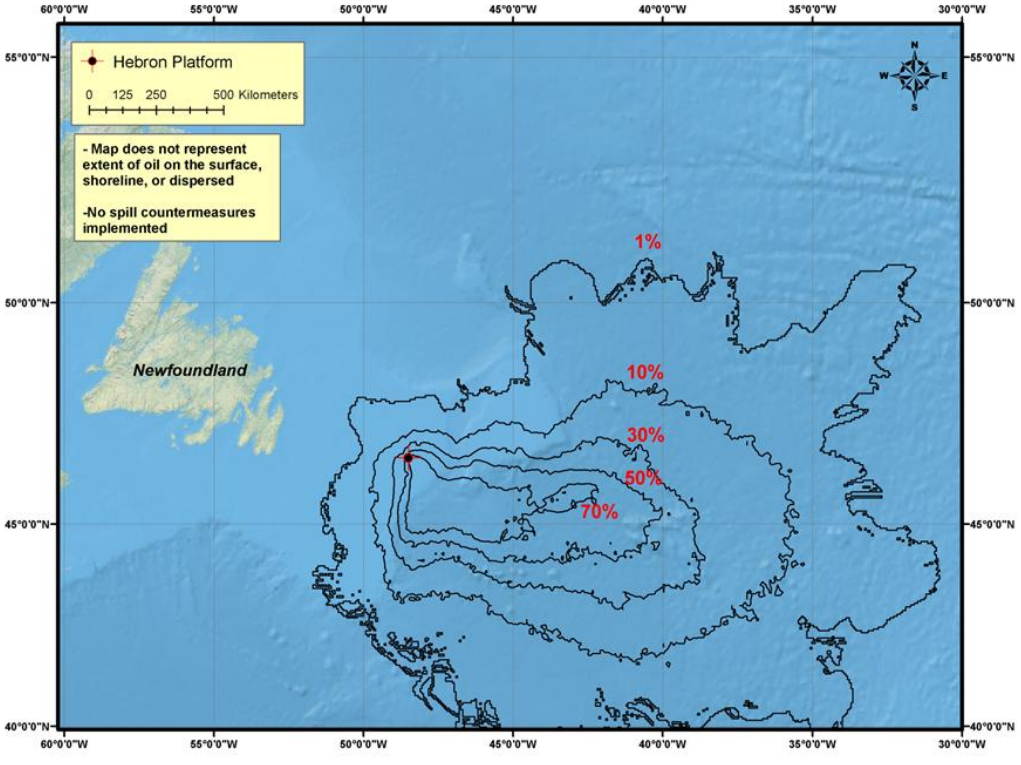


Figure 14.18 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Winter

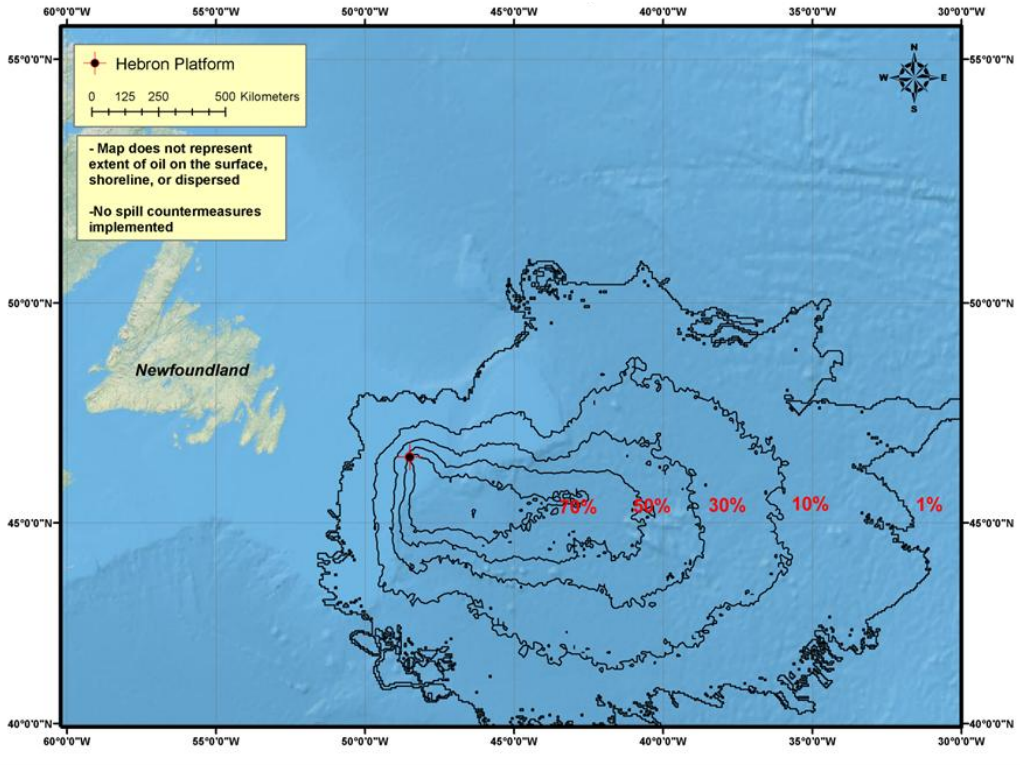


Figure 14.19 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Transfer Release of 800 m^3 of Diesel during Winter (with ice present)

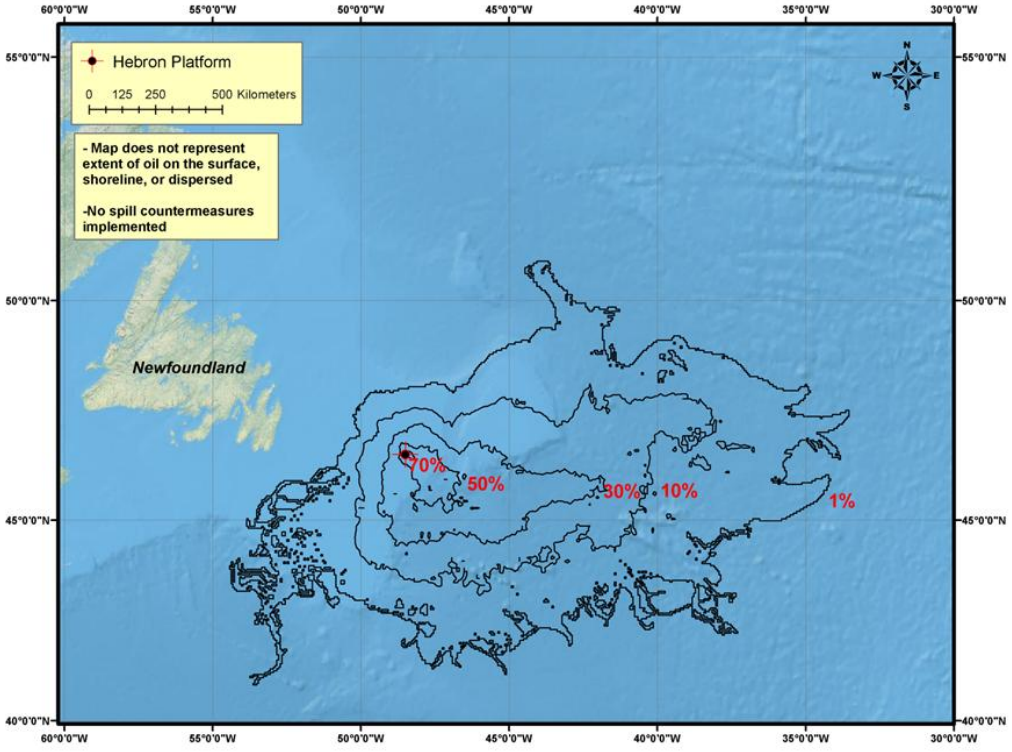


Figure 14.20 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Summer

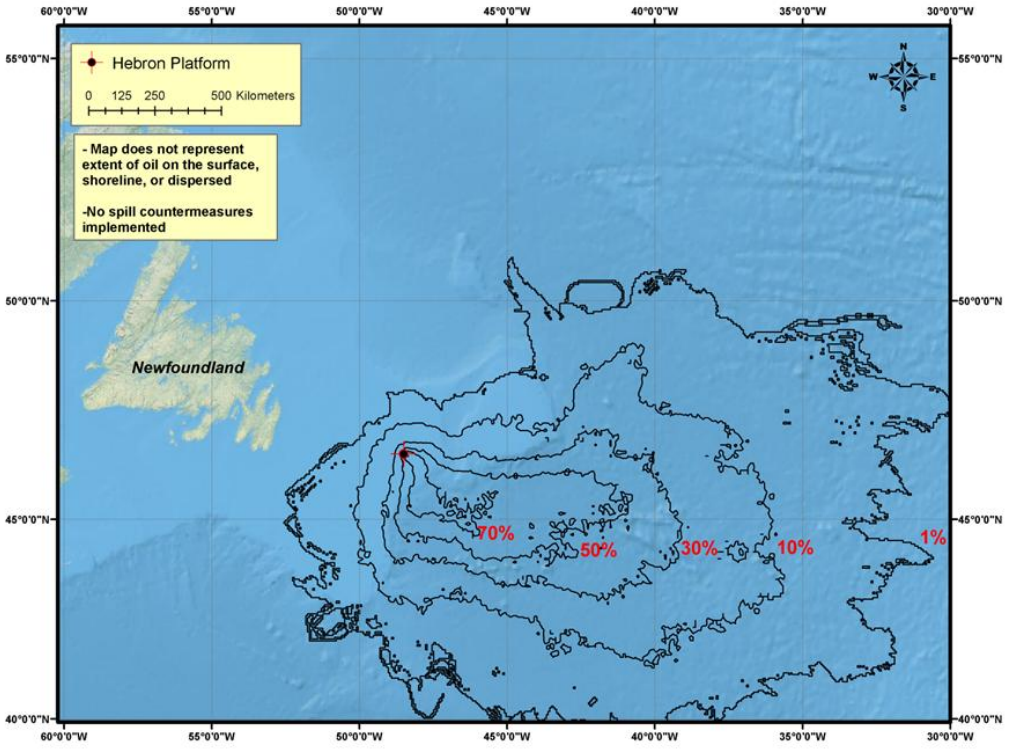


Figure 14.21 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Winter

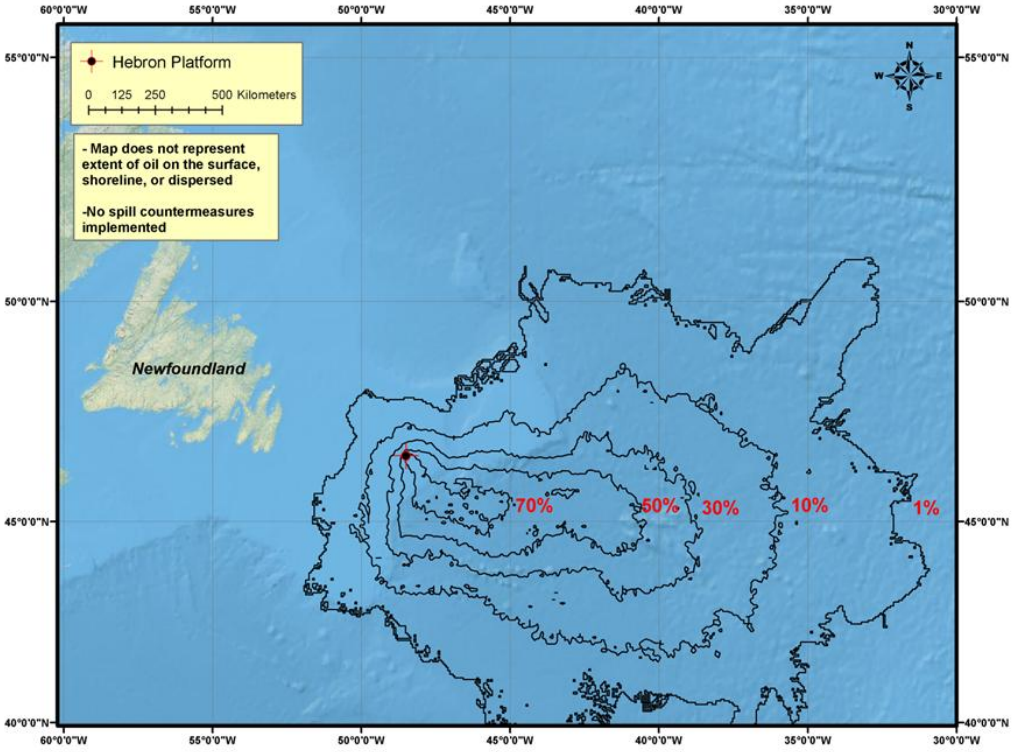


Figure 14.22 Surface Oiling Probabilities Greater than 0.01 mm for a Batch Offshore Loading System Transfer Release of 5,000 m^3 of Crude Oil during Winter (with ice present)

None of the marine diesel oil released in the batch transfer spill remains on the sea surface at the end of the 30-day simulation. This is primarily because the diesel is more readily entrained into the water column than the crude oil and in the summer season has a higher rate of evaporation. Between 40 and 70 percent of the diesel is predicted to become entrained in the water column, while 0.4 to 0.5 percent of the crude will entrain. The model predicts between 15 and 24 percent of the diesel and 22 to 23 percent of the crude will decay.

14.3.4 Trajectory Modelling Summary

The majority of Hebron Platform and subsea blow-out spills at the site are predicted to travel eastward. The distance travelled is generally controlled by the blow-out duration and the season. Winter winds on average are at a higher velocity resulting in greater oil transport. A subset of the summer and winter blow-out spill simulations of greater than 30 days duration are predicted to reach segments of the Newfoundland shoreline. Similar to the blow-out releases of crude oil, marine diesel and crude oil released in batch transfer spills is predicted to travel primarily toward the east away from Newfoundland. None of the batch transfer spills are predicted to reach the Newfoundland shoreline. A summary of the trajectory modelling is provided in Table 14.4.

Table 14.4 Spill Trajectory Model Results Summary

Spill	% Water Surface Contact	% Evaporated	% Decayed	% Entrained in Water Column
Platform Blow-outs	51 to 79%	8 to 12%	12 to 37%	0.2 to 0.3%
Seafloor Blow-outs	29 to 35%	29 to 32%	26 to 30%	9 to 10%
Marine Diesel Batch Transfer	0%	6 to 45%	15 to– 24%	40 to 70%
Crude Batch Transfer	64%	12 to 13%	22 to 23%	0.4 to 0.5%