APPENDIX D

Oil Spill Trajectory Modelling Report

Global Wells Organization

Newfoundland Orphan Basin Exploration Drilling Program:

Fate and Effects Oil Spill Trajectory Modelling

Contents

1 Executive summary

BP Canada Energy Group ULC (BP) proposes to conduct exploration drilling activities within the areas of its existing offshore exploration licences (ELs) in the Orphan Basin, ranging from approximately 270 and 470 km northeast of St. John's, Newfoundland and Labrador, in the Northwest Atlantic Ocean. The Newfoundland Orphan Basin Exploration Drilling Program (the Project) may involve drilling up to 20 exploration wells over the term of the ELs (2017 to 2026) with an initial well proposed to be drilled in 2020 pending regulatory approval. Water depths in the ELs range from 970 m to nearly 3,000 m. Major currents, including the Labrador Current and the Gulf Stream, influence the circulation and biological productivity in this region.

Oil spill trajectory and fate modelling has been performed to support an Environmental Assessment for the Project.

Well locations have not yet been finalised. Therefore, two tentative locations (West Orphan (WO) and East Orphan (EO)) representing likely drilling targets were selected for modelling on the basis of preliminary seismic data processing and interpretation. Both locations represent viable drilling prospects for the Project and represent different geographical areas and water depths in the Project Area. The possible spill events selected for modelling include large scale, worst case credible discharge (WCCD) deep water subsea blowouts at the well head and smaller batch spills of marine diesel at the surface representing accidental spill events from the Mobile Offshore Drilling Unit (MODU) associated with hose or tank failure scenarios. The scenarios are summarised in Table E1.

Table E1 Modelled oil spill scenarios

Oil Spill Scenario				Initial Release Rate (Day 1)		Final Release Rate (Day 30/120)		GOR	Cumulative volume of oil released		Release Duration
No.	Description	Well Site Location	Type of Hydrocarbon Release	Oil (bpd)	Water (bpd)	Oil (bpd)	Water (bpd)	(scf/bbl)	Oil (MMbbls)	Water (MMbbls)	
1	Well blowout – relief well	WOB	Crude Oil	128,000	118,000	Day 120: 47,000	Day 120: 25,000	1,800	9.88	7.33	120 days
2	Well blowout – capping stack	WOB	Crude Oil	128,000	118,000	Day 30: 101,000	Day 30: 81,000	1,800	3.44	2.98	30 days
3	Well blowout – relief well	EOB	Crude Oil	39,000	216,000	Day 120: 12,000	Day 120: 1,000	260	3.27	4.49	120 days
4	Well blowout – capping stack	EOB	Crude Oil	39,000	216,000	Day 30: 38,000	Day 30: 30,000	260	1.15	3.68	30 days
5	Batch spill - tank failure	WOB	Marine Diesel	---	---	---	---	n/a	100	---	6 hours
6	Batch spill - hose failure	WOB	Marine Diesel	---	---	---	---	n/a	10	---	1 hour
7	Batch spill - tank failure	EOB	Marine Diesel	---	---	---	---	n/a	100	---	6 hours
8	Batch spill - hose failure	EOB	Marine Diesel	---	---	---	---	n/a	10	---	1 hour

Oil spill trajectory and fate modelling was conducted using the SINTEF Oil Spill Contingency And Response model (OSCAR). OSCAR is a 3-dimensional model that calculates and records the distribution (as mass and concentrations) of contaminants on the water surface, on shorelines, in the water column, and in sediments. The model allows multiple release sites, each with a specified beginning and end to the release. This allows time-variable releases at a given location, as well as throughout the study area. For subsurface releases (e.g. blowouts or pipeline leakages), the near field part of the simulation is conducted with a multi-component integral plume model that is embedded in the OSCAR model. The near field model accounts for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross flow on the dilution and rise time of the plume.

Using the multivariate analysis best fit approach developed by SINTEF, YME (IKU), a light crude with low viscosity, was the best oil analogue match for the WO Tertiary prospect (estimated specific gravity [SG] = 0.835). In contrast the fluid associated with the EO Jurassic play is expected to be slightly heavier (SG = 0.855) and similar to Bay du Nord (BdN) crude oil. VARG 2004 was the analogue oil selected and matches well on SG and volatiles when compared to BdN.

The 3-D current dataset used in OSCAR modelling to drive oil dispersion and transport was comprised of 3 hourly HYCOM current speeds with Bedford Institute Tides linearly superimposed. The HYCOM currents are from the Navy Research Laboratory experiment 19.1 (HYCOM GLBu0.08) for the period 1st January 2006 to 31st December 2010. The spatial resolution is 1/12.5 degrees and the results were extracted onto a domain that spans: longitude 30 to 70 degrees West and latitude 35 to 65 degrees North. The HYCOM currents were provided on forty depth levels, from the surface to 5,000m. Three hourly wind speed and direction data was obtained from the National Centre for Atmospheric Research (NCAR) / National Centre for Environmental Protection (NCEP) Climate Forecast System Reanalysis (CFSR). Daily sea ice data used in the modelling was obtained from the National Snow and Ice Data Centre (NSIDC) datasets

Utilising these models and inputs stochastic simulations were conducted for the following weather seasons:

- Winter season (November - April)
- Summer season (May to October)

Ice cover in the region is present in specific regions from November through April, while May through October is mostly ice-free. The simulations were run at varying start times to cover each 6 month season using data for winds and currents from January 2006 through December 2010, thus ensuring that the predicted transport and oil weathering for each oil spill simulation is subjected to a range of prevailing wind, current and ice conditions that is historically representative of the time period in question.

The OSCAR model is able to track oil on the sea surface, on the shoreline and water column to levels that have little relevance from a response or environmental impact perspective. Therefore, threshold levels were applied in the modelling of each of these impact compartments as follows:

- surface oil thickness > 0.04 µm (barely visible or silver sheen on the water surface)
- stranded oil thickness > 1 µm (equivalent to 1.0 g/m^2) (stain/film oiling)
- In-water total hydrocarbon (dispersed and dissolved oil) concentrations > 58 ppb

120 day and 30 day unmitigated subsea oil releases were modelled for each wellsite location over 160 day and 90 day periods respectively. The WO scenarios involve a higher rate and total volume release of oil in shallower water (128,282 bpd at a water depth of 1,360 m) in comparison to the EO scenarios (39,195 bpd) which occur in deeper water (2,785 m).

The stochastic model output does not represent the extent of any one oil spill event (which would be significantly smaller) but rather provides a summary of the total individual simulations for a given scenario or oil type. Stochastic models are used for planning purposes.

While the modelling demonstrates a potentially large affected area, it is important to note that many of the areas delineated through the modelling have low probabilities of occurrence and that results are based on unmitigated relief well and capping stack response scenarios with no other response measures implemented. In an actual incident, emergency response measures inclusive of containment and recovery operations are likely to have some effect on limiting the magnitude and duration of the spill event, thereby limiting the geographic extent and potential environmental effects of a blowout.

<u>Subsea Well Blowout Scenarios</u>

Trajectories for the WO blowout scenarios were predicted to drift in all directions, but extended out more towards the east from the release location. For example for the relief well scenario the extent of the sea surface area with greater than 5% probability of sea surface oil contact exceeding the 0.04

µm (Bonn Agreement Oil Appearance Code [BAOAC] Sheen) thickness threshold extended 270 km westward from the release location but 1,350 km to the east. This is attributable to the predominantly westerly winds throughout the year. However, there was a notable seasonal variation in the movement of oil, with a higher potential for surface oil contamination to the south and east of Newfoundland and east of Nova Scotia during winter months. This was especially true for the Avalon Peninsula where the probability of sea surface oil contact exceeding the 0.04 µm BAOAC sheen thickness threshold in near coastal waters was 0% during the summer season but increased to 5% in the winter months. The west to north westerly winds and higher frequency and strength of surface currents towards the south and south-southeast (SSE) during the winter months transports the oil further south during the winter season, whereas the predominant south westerly winds transports the oil away from the Avalon coastline in the summer months. In the event that surface oil was to enter the near-shore area of Newfoundland during the winter season, it would take a minimum of 50 days to arrive.

The stronger winds and currents during the winter months transported the surface oil further away from the release site, resulting in a larger trajectory footprint. For example the predicted cumulative footprint of locations where there is a > 50% probability of surface oil thicknesses exceeding the 0.04 micron BAOAC Sheen threshold was 1,173,820 km^2 for the winter season compared to 721,520 km^2 for the summer season.

The same trajectory and seasonal trends were observed for the capping stack scenarios, however the footprints were considerably smaller due to the smaller release volumes. For example the predicted cumulative footprint of locations where there is a > 50% probability of surface oil thicknesses exceeding the 0.04 micron BAOAC Sheen threshold was 296,910 km^2 for the winter season and 228,590 km^2 for the summer season.

The duration of surface exposure for near shore waters of Newfoundland was 0 to 1 day. The low surface exposure times suggests that the complex coastal circulation patterns and the turbulent nature of the sea in the region are continually mixing any surface oil into the upper water column reducing exposure time on surface. Exposure times increase on approaching the release site. For example, in the worst exposure scenario (relief well, winter season) the area where oil might be present on the surface for > 20 days measures 615 km by 320 km in the respective NW to SE and SW – NE directions at its maximum extent.

The higher wind speeds and associated waves in winter result in significantly more entrainment, reducing the spatial extent of thick oil (BAOAC Dark (or True) colour) on the sea surface.

The smaller volume release at EO and the more southern easterly release location resulted in predicted oil trajectories to the north and east, attributable to the easterly bias in surface currents at the EO location. In addition, as a result of the deeper well location, oil travels further in the water column and is dispersed more widely before surfacing. Hence, the footprint around the EO release location (relief well scenario) of high (>50%) probability surface oiling occurrences exceeding the 0.04 micron BAOAC Sheen threshold was larger than that predicted for the WO location. For example, 1,296,256 km^2 for the winter season and 1,056,102 km^2 for the summer season compared to 1,173,823 km^2 and 721,520 km^2 for the equivalent WO scenarios. Similarly, the area where oil might be present on the surface for > 20 days was also larger, typically measuring circa 1,100 km by 800 km in the respective NW to SE and SW – NE directions at its maximum extent.

The resulting surface oil slick was also predicted to be thinner for the EO scenarios with no thick oil (BAOAC Dark (or True) colour) occurrences on the sea surface. The same seasonal variation in the movement of oil was predicted, with a higher potential for surface oil contamination to the south during winter months. In addition, as the EO well location is further offshore, the probability of sea surface oil contact exceeding the 0.04 µm BAOAC Sheen threshold only exceeded 1% at distance >

225 km from the coast for the relief well scenario during the summer season (compared to 40 km for the equivalent WO case). However, there was a 1% probability of surface oil being present in the near-coastal waters of the Avalon Peninsula during the winter months and it would take a minimum of 70 days to arrive. The duration of surface exposure was < 1 day.

The stochastic results also demonstrated the potential locations for spill effects exceeding threshold levels beyond the RAA boundary, and in some cases, beyond Canadian jurisdiction (Saint-Pierre and Miquelon - France, Greenland and the Azores. See Section 7.3 and Annex D). However, average probabilities are low (<10%) and arrival times > 50 days.

The in-water dispersed and dissolved oil threshold exceedance of 58 ppb for total hydrocarbons (THC) is expected to remain in offshore waters with a much smaller areal extent than for surface oil. The modelling results indicate that the in-water oil exceedance will not reach the near shore waters of mainland Newfoundland. The only exception was the WO relief well, winter season scenario where some localised THC concentrations above the 58 ppb threshold occurred, albeit at probabilities < 5%. For WO scenarios, the in-water dispersed and dissolved oil trajectories extend predominantly towards the south and SSE, whereas for the EO scenarios it is predominantly towards the east, indicating that transport is controlled by the dominant surface current flow direction at both locations.

Concentrations of dissolved and total hydrocarbons are predicted to be highest around the release site and dissipate as the oil moves away and disperses within the water column. While the highest concentrations of THC are predicted near the release site at the plume trap height, the majority of the predicted THC concentrations are within tens of meters of the surface. This is due to the majority of the predicted THC being the result of entrained oil from wind-induced surface breaking waves.

Analysis of vertical cross sections through the water column at the WO and EO release sites show that the subsea probability of oil exceeding the 58 ppb THC threshold is limited to a maximum radius from the wellsite of circa 70 km for probabilities > 1%. The WO scenarios have higher THC concentrations and larger cumulative footprints than for the corresponding EO scenarios due to the larger release volume. In addition, the plume trap height occurs at much greater water depth than for the EO well blowout scenarios, therefore the oil is dispersed and diluted more readily to concentrations below the threshold level, reducing the footprint. This is evident in the exposure time footprints. For example for the unmitigated relief well scenarios, the predicted distance from the well site where exposure to in-water concentrations of oil > 58 ppb may exceed 14 days extends up to 600 km away from the well site for the WO scenarios, compared to 240 km for the EO scenarios.

Shoreline contact is unlikely from releases at either the WO or EO sites. The highest shoreline contact probabilities occurred for the WO relief well scenario during the winter months, with 31 km of coastline potentially at risk from contact probabilities of 5 - 7%. The predicted maximum amount of oil accumulating on the shoreline was circa 400 tonnes with peak oiling occurring between 90 and 120 days. This amount of oil represents 0.04% of the total amount of oil released. However, there was a wide range in the maximum amount of oil accumulated on the shoreline, with no stranded oil occurring in 72% of the simulations and <1 tonne beaching in 85% of the cases during the winter season. The maximum length of coastline potentially at risk from stranded oil exceeding the minimum film or sheen thickness threshold of 1 micron (1 g/m^2) was 270 km .

No shore contacts were predicted for the WO and EO capping stack scenarios during the summer seasons with maximum probabilities of 1 - 2% for the capping stack winter scenarios and the WO relief well summer scenarios.

The EO relief well, winter scenario gave rise to the second highest amount of accumulated oil on the shoreline (270 tonnes) with potentially 205 km of coastline at risk from stranded oil film or sheen thicknesses > 1 micron (1 g/m^2). Peak oiling occurred between 30 and 60 days, but with no stranded oil occurring in 86% of the simulations and <1 tonne beaching in 88% of the cases.

This scenario also produced the earliest arrival time of oil to shore (27 days) of all the scenarios modelled. The earliest arrival times for shoreline oiling ranged from 27 to 145 days for the scenarios where beaching of oil occurred.

Individual or deterministic trajectories were identified and selected from the stochastic results that represented the maximum shoreline oiling for each well site and season. These representative worst credible case scenarios were then rerun deterministically to establish near-field and far-field fate and transport. The deterministic simulations provide insight to the individual trajectories, oil weathering behavior, the mass of oil in each environmental compartment (air, water, surface, land and sediment) and other information (area of oil slick, length of shoreline oiled etc.) related to each single spill at a given location and time which cannot be assessed using stochastic models.

Near-field deterministic simulations of the WO blowout event using the 3-D plume model in OSCAR indicate that the high exit velocity cause the plume to rise rapidly before it terminates after about 10 minutes at a water depth of 535 m. The oil droplet size model in OSCAR predicts an initial d95 droplet size of 4.3 mm and d50 (median) droplet size of 2.0 mm for the WO release. The model predicts it will take the largest oil droplets (4.1 mm) another 2 hours to rise to the surface, with 50% having arrived after 4 hours.

In contrast, the outlet velocity of the EO release is 3 times less than that of the release at WO. Although the oil droplet sizes are larger in the EO release due to the smaller release rate, the decrease in outlet velocity means that plume does not rise as rapidly at EO and terminates at a much deeper water depth (2,435 m below sea-level). Consequently the oil droplets on leaving the plume take far longer to reach the sea surface, are dispersed more by cross currents as they rise, resulting in much thinner oil slick at the sea surface than was the case for the WO blowout scenarios.

The oil droplet size model in OSCAR predicts an initial d95 droplet size of 9.8 mm and d50 (median) droplet size of 4.6 mm for the EO release. The model predicts it will take the largest oil droplets (9.8 mm) 8 hours to rise to the surface, with 50% having arrived after 23 hours.

Far-field deterministic modelling results for the WO worst shoreline oiling simulation for the winter season, indicated that at the end of the simulation (after 160 days), 36% of the oil released is biodegraded, 27% evaporated, 0.19% is reported on the surface and 34% in the water column; with that remaining in the water column dispersed to negligible concentrations (< 58 ppb THC dispersed oil). Shoreline oiling exceeding the minimum film or sheen thickness threshold of 1 micron (1 g/m^2) is expected to be limited to the Avalon Peninsula with occurrences of moderate, light and stain oiling. The maximum length of shoreline impacted would occur after 119 days with 20 km of coastline being affected. The maximum mass of oil on the shoreline occurs slightly earlier (after 107 days) and is associated with 403 tonnes of oil accumulated on the shoreline.

Far-field deterministic modelling results for the EO “worst” shoreline oiling simulation for the winter season, indicated that at the end of the simulation (after 160 days), 46% of the oil released is biodegraded, 37% evaporated, 0.65% is reported on the surface and 25% in the water column; with that remaining in the water column dispersed to negligible concentrations (< 58 ppb THC dispersed oil). Shoreline oiling exceeding the minimum film or sheen thickness threshold of 1 micron (1 g/m^2) is also expected to be limited to the Avalon Peninsula with occurrences of light and stain oiling. The maximum length of shoreline impacted would occur after 132 days with 27 km of coastline being affected. The maximum mass of oil on the shoreline occurs slightly earlier (after 98 days) and is associated with 271 tonnes of oil accumulated on the shoreline.

Accidental Surface Release of Diesel Scenarios

Modelling results indicated that the accidental batch release of marine diesel would have limited effects. The results show that the location of threshold exceedances for surface effects are expected to occur over a greater area if a spill occurs during the summer than for winter. For a 100 bbl spill, there is a less than 1% probability of surface oiling in excess of the BAOAC sheen (0.04 µm thickness) threshold, extending > 25 km from either release location in the summer season and > 15 km in the winter months. The cumulative footprint of locations where there is a >1% probability of exceeding this threshold ranged between 209 - 238 km^2 for the summer season compared to 121 - 133 km^2 for the winter season.

The maximum time-averaged emulsified oil thickness on the sea surface exceeding the 0.04 µm threshold for both spill scenarios ranged from BAOAC sheen to metallic (0.04 µm to 50 µm oil thickness).

The predicted THC concentrations and dissolved oil concentrations were within tens of meters of the surface, as they are the result of entrained oil from wind-induced surface breaking waves within the surface mixed layer.

The duration of exposure to either surface oil or oil in the water column that exceeded thickness or oil in water concentration threshold levels was < 6 hours for the 10 bbl releases and for the 100 bbl releases ranged from 12 - 18 hours in the immediate vicinity of the release location to < 6 hours at the majority of locations further away

Deterministic simulations indicate that approximately 60% of the spill evaporates from the surface within 3 days following the release, with remaining proportions dispersing or biodegrading within the same period.

2 Introduction

BP Canada Energy Group ULC (BP) proposes to conduct exploration drilling activities within the areas of its existing offshore exploration licences (ELs) in the Orphan Basin, ranging from approximately 270 and 470 km northeast of St. John's, Newfoundland and Labrador, in the Northwest Atlantic Ocean. The Newfoundland Orphan Basin Exploration Drilling Program (the Project) may involve drilling up to 20 exploration wells over the term of the ELs (2017 to 2026) with an initial well proposed to be drilled in 2020 pending regulatory approval. Water depths in the ELs range from 970 m to nearly 3,000 m. Major currents, including the Labrador Current and the Gulf Stream, influence the circulation and biological productivity in this region.

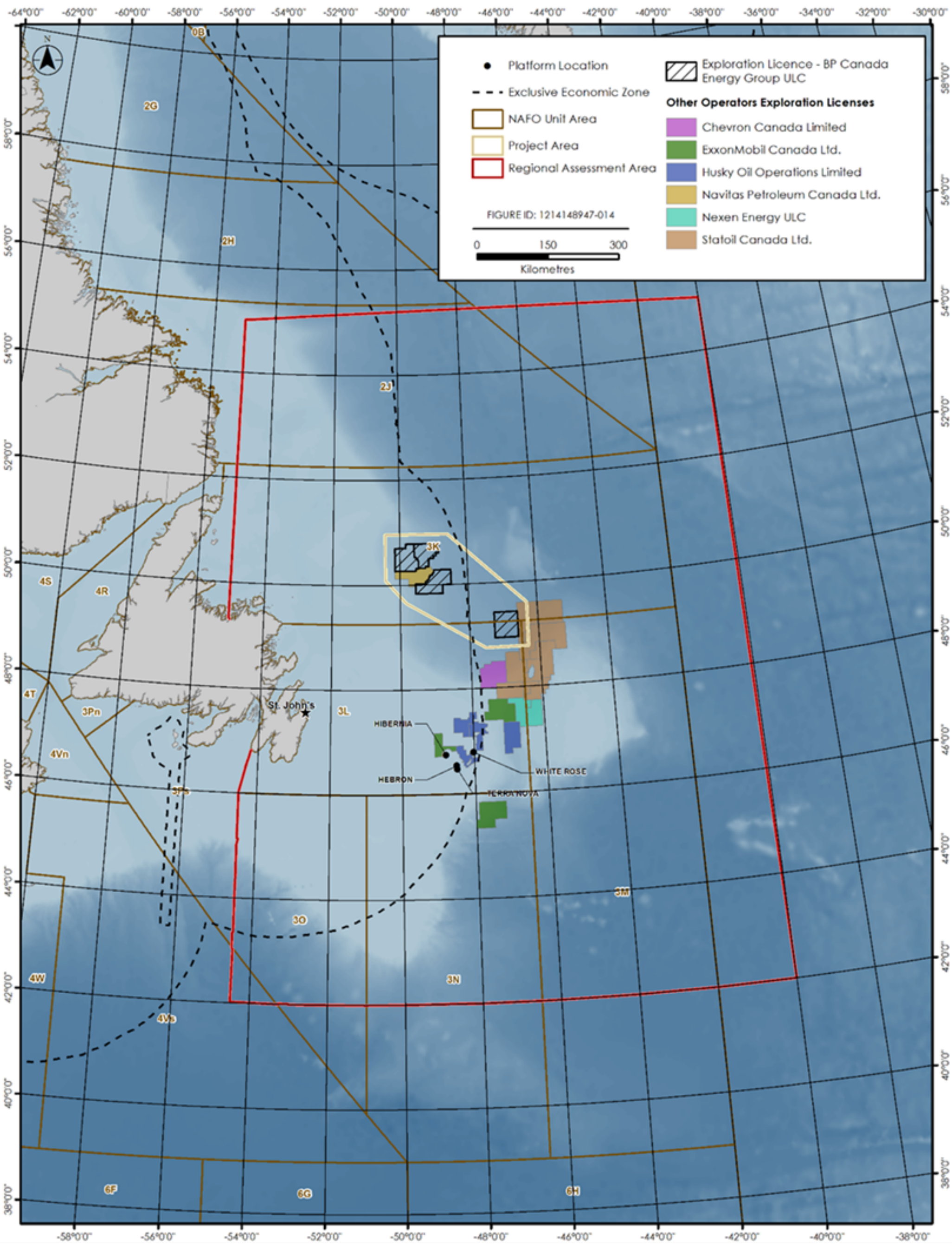


Figure 2.1 BP Canada Energy Group offshore exploration licenses in the Orphan Basin

2.1 Scope of Work

Environmental and social screening for the Newfoundland Orphan Basin Exploration Drilling Program, carried out in June 2017 to conform with the requirements of GDP 3.6-0001 (Environmental and Social Requirements for New Access Projects, Major Projects, International Protected Area Projects and Acquisition Negotiations) [(1)], identified that an unintended release of oil during drilling, has the potential to affect Internationally Protected Areas (IPAs) in the Newfoundland region. As a follow up action to better define the potential to affect IPAs, oil spill modelling of an unintended release associated with a potential loss of well control has been carried out to gain a better understanding of the fate and potential environmental and social impacts so that appropriate response strategies can be defined. Group Guide (GG) 3.6-0004, ("International Protected Area Projects" [(2)]), provides additional guidance in relation to interpreting and implementing the requirements of Section 5.6 of GDP 3.6-0001.

In addition, as part of the oil spill contingency planning process, GP 10-90 ("Oil Spill Preparedness and Response for Deepwater Operations") [(3)] requires that any BP entity drilling a well in deep-water carries out oil spill fate and effects modelling of worst credible case discharge scenario(s) selected by a multidisciplinary team. This is to conform with the requirements of Section 8.1 (Identify, assess and prioritise oil spill planning scenarios), which is aimed at gaining a better understanding of the fate and potential environmental and social impacts of an unintended release so that appropriate response strategies can be defined. Section 8.1i also specifies that modelling is conducted using either the SINTEF OSCAR oil spill model or an alternate that is endorsed by the BP Technical Authority for oil spill preparedness and response in addition to any other modelling programme required by applicable country-specific legal and regulatory requirements.

The results of this study will also be used in support of an Environmental Assessment for the Project, which must be accepted by the Minister of Environment under the Canadian Environmental Assessment Act, 2012 and by the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) under the Accord Acts before drilling activities can commence.

The possible spill events selected for modelling include large scale, worst case credible discharge (WCCD) deep water subsea blowout events at the well head and smaller batch spills of marine diesel at the surface representing accidental spill events from the Mobile Offshore Drilling Unit (MODU) associated with hose or tank failure scenarios (see Section 4).

The scope of work for oil spill trajectory modelling included the following components:

- Use spatial wind data, current data and specific hydrocarbon properties as input into OSCAR, to predict the movement and weathering of the oil originating from the oil spill release site;

- Use stochastic (or probabilistic) modelling to predict the fate of the spilled oil (crude or diesel) over time, including the probability of contamination and travel time of oil on the sea surface, water column and shoreline;

- Determine the maximum exposure time, concentration / thickness of weathered oil on the sea surface and in the water column for each scenario;

- Calculate the probability of shoreline contact, the shortest arrival time and degree of oiling on the shoreline for each scenario;

- Deterministic modelling to show the single spill trajectory with the highest amount of oil reaching the shore for each scenario;
- Quantify the exposure of sensitive receptors in and around the Project Area in the event of an accidental spill.

In line with the precautionary principle, all model simulations were run unmitigated, (i.e., without any oil spill tactical response methods such as surface mechanical recovery or chemical dispersant application). Simulations were run until the amount of oil within the modelling domain fell below the significance thresholds described in Section 5.5.

3 The Oil Spill Contingency and Response (OSCAR) Model

The SINTEF Oil Spill Contingency And Response model (OSCAR) is the Segment preferred oil spill fate and trajectory model for Upstream. The use of this model is mandatory for deep-water operations as defined in GDP 4.6-0002 Annex 2 [(3)].

OSCAR is a 3-dimensional model that calculates and records the distribution (as mass and concentrations) of contaminants on the water surface, on shorelines, in the water column, and in sediments. The model allows multiple release sites, each with a specified beginning and end to the release. This allows time-variable releases at a given location, as well as throughout the study area. For subsurface releases (e.g. blowouts or pipeline leakages), the near field part of the simulation is conducted with a multi-component integral plume model that is embedded in the OSCAR model. The near field model accounts for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross flow on the dilution and rise time of the plume.

The model output is recorded in three physical dimensions plus time. The model databases supply values for water depth, sediment type, ecological habitat, and shoreline type. The system has an oil physical-chemical database that supplies physical and chemical parameters required by the model.

The model computes surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and shoreline interactions to determine oil drift and fate at the surface. In the water column, horizontal and vertical transport by currents, dissolution, adsorption, settling and degradation are simulated. An Ekman model integrated into OSCAR computes a wind-driven current which transports entrained oil on the surface. The varying solubility, volatility, and aquatic toxicity of oil components are accounted by representing the oil in terms of a number of pseudo-components. By modelling the fate of individual pseudo-components, changes in the oil composition due to evaporation and degradation may be accounted for in the toxicity of the dissolved oil fraction.

OSCAR may compute oil weathering from crude assay data, although results that are more reliable are produced if the target oil has been through a standardized set of laboratory weathering procedures established by the SINTEF laboratories. Alternatively, the model may use oil weathering properties from oils for which data already exists, selecting the crude oil in the oil database that most closely matches the composition of the oil of concern.

3.1 Input Data to run OSCAR

OSCAR accepts as input both 2- and 3-dimensional current data from hydrodynamic models, and single point or gridded wind data from meteorological models. The surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and shoreline interactions processes that determine oil drift and fate are linked to the oil properties database within OSCAR. Each oil stored in the database is characterised by 25 key hydrocarbon component groups analysed in accordance with the SINTEF oil weathering protocols. This ensures accurate representation of physical, chemical and biological behaviour of each hydrocarbon as it is released into the model.

3.2 Outputs from OSCAR

3.2.1 Types of Output

There are two types of model simulations that can be generated: stochastic simulations and deterministic simulations. Both simulation types are used in different ways during the modelling process to inform the various stages of assessing the severity and risk posed by the scenarios. Together the two model types give an indication of both likelihood and magnitude of any potential effects.

3.2.1.1 Stochastic Modelling Simulations

Stochastic modelling is used to predict the probability of sea surface, shoreline or water column contact that may occur following an oil spill event. It accounts for the variability of meteorological and oceanographic conditions in the study area over the anticipated operational period to provide an insight into the probable behaviour of the potential spills.

It involves running numerous individual spill trajectory simulations using a range of prevailing wind and current conditions that are historically representative during which the spill event may occur. The set of individual simulations may be performed within a specified time period (seasonal single year statistics), or by specifying the number of simulations to be run each year in a specified season (seasonal multiyear statistics). The trajectory results are then combined to produce statistical outputs that include the probability of where oil might travel and the time taken for the oil to reach a given shoreline. The stochastic model output does not represent the extent of any one oil spill event (which would be significantly smaller) but rather provides a summary of the total individual simulations for a given scenario or oil type. Stochastic models are used for planning purposes.

3.2.1.2 Deterministic Modelling Simulations

Deterministic modelling (or single spill trajectory analysis) is used to predict the fate (transport and weathering behaviour) of spilled oil over time under predefined hydrodynamic and meteorological conditions.

When carrying out deterministic modelling, BP typically selects the conditions that gave rise to the simulation with the worst environmental effects from the stochastic modelling (i.e. meteorological conditions).

3.2.2 Stochastic modelling and probabilistic results

The following section describes some of the technical details regarding the statistical output from OSCAR.

The notion of a grid cell will be used, referring to the two-dimensional surface or shoreline grid, or the three-dimensional concentration grid. Each of these grids consists of cells, which represent the smallest area (highest spatial resolution) on which OSCAR operates when producing statistics.

Statistics

OSCAR produces a set of statistics in its output, including a) maximum or minimum, b) time-averaged, c) maximum time-averaged and d) probability. The metrics are defined in terms of exceeding certain threshold values for oil concentration, thickness or mass and presented as maps for different environmental compartments (sea surface, water column or shoreline).

A map of **maximum or minimum** values can be produced from a stochastic simulation (for example maximum accumulated oil or minimum arrival time). This means that for all time steps and for all simulations, OSCAR has kept a record of the maximum or minimum for that particular value in each grid cell.

For example, the maximum accumulated shoreline oil map, the oil mass in every shoreline cell is checked every time step for every simulation. Whenever OSCAR detects that a shoreline cell has more oil than previously recorded, it will record this new value as the maximum. After all simulations have been performed, this maximum can then be reported for each cell.

Time-averaged statistics are used to produce an average value for a variable. For each simulation, OSCAR monitors each grid cell and records its value unless it has no impact (for example no surface oil or no total concentration). At the end of the simulation, these values are then averaged to produce the time-average. Whenever thresholds are applied pre-processing, the time-average will also exclude values below these specified thresholds.

Maximum time-averaged values can be presented as maps (such as the maximum time-averaged value total concentration). This means that for each grid cell, the value from the simulation with the largest time-average is selected and reported.

Probability maps can also be produced by the stochastic simulation. These maps indicate in the fraction or percentage of the stochastic simulations that reported the specified event (for example oil thicker than some threshold) for each cell. This can be oil on the surface, oil on the shoreline etc.

For example, the shoreline impact probability records each simulation that has some oil that hits a specific grid cell. If then three out of a total of ten simulations record oil hitting this shore cell, the probability for shoreline impact for this cell is 30%. Here there is no weighting for the frequency of oil coming ashore within each scenario.

3.2.2.1 Threshold calculations

OSCAR has two ways of applying thresholds to statistical model output, pre-processing thresholds and post-processing thresholds.

Pre-processing thresholds consist of applying lower thresholds for simulation outputs before statistical simulations are performed. OSCAR will then, for each time step, filter out values to output based on these thresholds.

For example, using a 5 μm thickness as a minimum surface limit will ensure that no thickness below 5 μm will be included and used in any of the statistics.

The disadvantage of this approach is that it has to be applied before running stochastic simulations. This can be time-consuming if this limit has later to be revised, since the entire set of simulations needs to be re-run. This is also the method used when filtering out threshold values in deterministic simulations.

Post-processing thresholds are applied to simulation outputs after the statistical simulations are performed. OSCAR will then, for each grid cell in a simulation, compute a time-averaged value for the entire simulation. This average value is then compared to the threshold and the statistical contribution for this simulation is either removed or accepted.

For example, using a 5 μm thickness limit post-processing will ensure that no surface grid cell with an average thickness less than 5 μm will contribute to the statistics. Note, however, that lower thicknesses can still contribute to the statistics as long as the average value is above the threshold.

The disadvantage of this approach is that although it is less time-consuming to apply, it can under-estimate the actual impact in particular where the average values are close to the threshold values.

4 Oil Spill Scenarios

Two key oil spill scenarios were modelled as part of this study representing both a low probability, large scale event (i.e. a subsea well blowout) and an instantaneous, small scale spill scenario (i.e. a surface release of diesel). For all scenarios, the OSCAR model (a module within the SINTEF Marine Environmental Modelling Workbench (MEMW) 8.0.1 software package) was run until the amount of oil in the system fell below the significance thresholds described in Section 5.4.

4.1 Model Scenarios

Well locations have not yet been finalised. Therefore, two tentative locations (West Orphan (WO) and East Orphan (EO)) representing likely drilling targets were selected for modelling on the basis of preliminary seismic data processing and interpretation. Both locations represent viable drilling prospects for the Project and represent different geographical areas and water depths in the Project Area (see Table 4.1 and Figure 4.1).

Table 4.1 Oil spill release modelling locations

Location	EL	Water Depth (m)	UTM Easting	UTM Northing
Site 1 (West Orphan Basin)	EL 1145	1360	168454.17	5,608,064
Site 2 (East Orphan Basin)	EL 1149	2785	352,231	5,471,024

The scenarios that were modelled are described below and summarized in Table 4.2.

Table 4.2 Oil Spill Scenarios

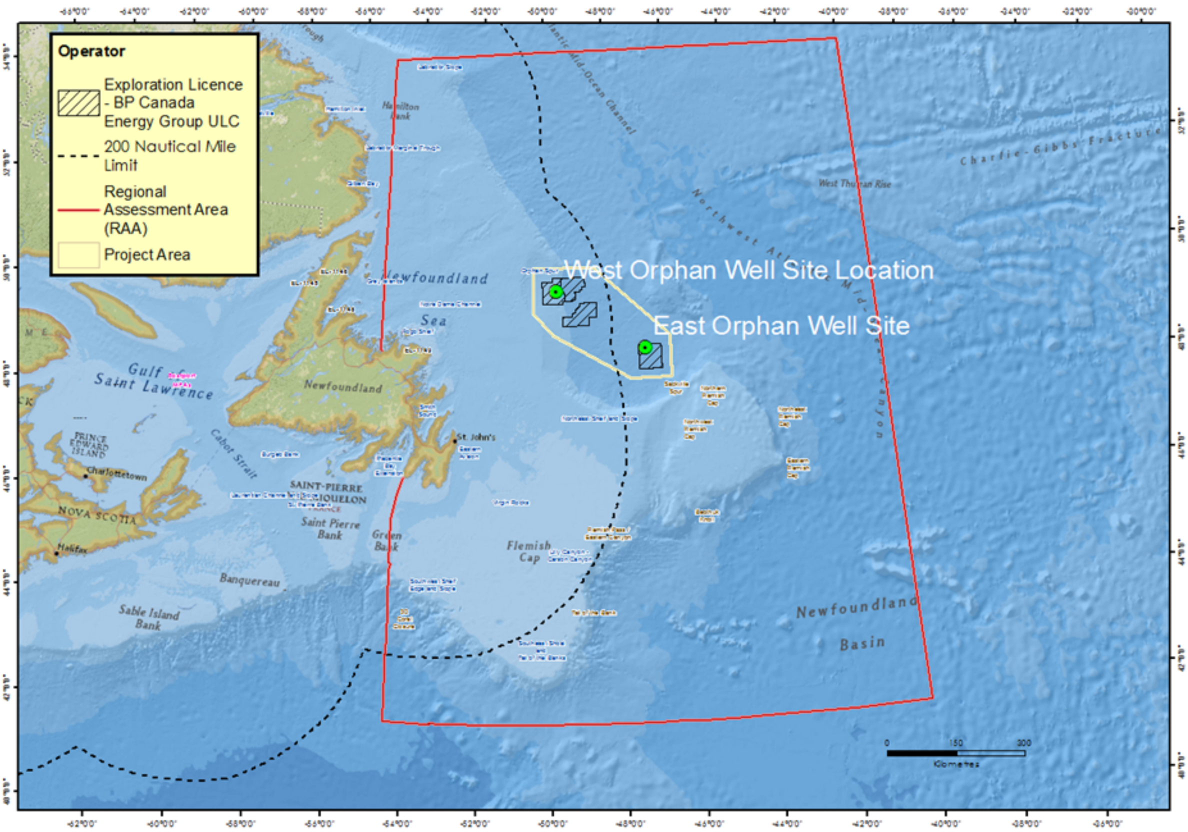
Oil Spill Scenario				Initial Release Rate (Day 1)		Final Release Rate (Day 30/120)		GOR	Cumulative volume of oil released		Release Duration
No.	Description	Well Site Location	Type of Hydrocarbon Release	Oil (bpd)	Water (bpd)	Oil (bpd)	Water (bpd)	(scf/bbl)	Oil (MMbbls)	Water (MMbbls)	
1	Well blowout – relief well	WOB	Crude Oil	128,000	118,000	Day 120: 47,000	Day 120: 25,000	1,800	9.88	7.33	120 days
2	Well blowout – capping stack	WOB	Crude Oil	128,000	118,000	Day 30: 101,000	Day 30: 81,000	1,800	3.44	2.98	30 days
3	Well blowout – relief well	EOB	Crude Oil	39,000	216,000	Day 120: 12,000	Day 120: 1,000	260	3.27	4.49	120 days
4	Well blowout – capping stack	EOB	Crude Oil	39,000	216,000	Day 30: 38,000	Day 30: 30,000	260	1.15	3.68	30 days
5	Batch spill - tank failure	WOB	Marine Diesel	---	---	---	---	n/a	100	---	6 hours
6	Batch spill - hose failure	WOB	Marine Diesel	---	---	---	---	n/a	10	---	1 hour
7	Batch spill - tank failure	EOB	Marine Diesel	---	---	---	---	n/a	100	---	6 hours
8	Batch spill - hose failure	EOB	Marine Diesel	---	---	---	---	n/a	10	---	1 hour

4.1.1 Subsea blowout of crude oil

Steady state uncontrolled well discharge modelling was undertaken to assess the potential worst credible case (WCC) discharge rates and volumes that could arise as a result of a subsea blowout event.

The WCC discharge rate calculations were carried out according to BP Segment guidelines [(4)]. Production forecasts were performed using a reservoir material balance calculation (MBAL from Petroleum Experts Ltd). Individual steady state uncontrolled well discharge rates were calculated in accordance with the methodology described in EP SG 4.6-0001[(4)] using the approved BP application "Prosper" developed by Petroleum Experts Ltd.

Figure 4.1 Release Locations



These calculations have been made based on data and inferences from available 2D seismic data in the Orphan Basin and on the provisional well designs presented in Figures 4.2 and 4.3. It has been assumed that if sands are exposed at either location then it will be in 12 ¼" open hole with a casing pipe outlet diameter of 13.273"at the seabed.

Two subsea blowout scenarios (relief well and capping stack response) were modelled at each location. BP has assumed a release duration of 30 days to simulate a capping stack response scenario and 120 days to simulate a relief well response scenario. Current (P50) estimates indicate that the well can be capped between 9 and 17 days after an incident but 30 days is used for modelling purposes to be more conservative. All modelled scenarios were run without applying any oil spill tactical response methods such as surface mechanical recovery or chemical dispersant application, with the use of a capping stack or drilling a relief well the only mitigations considered for the blowout incident scenarios. In reality, spill mitigation measures such as oil spill containment, recovery and shoreline protection measures would be implemented in the event of a spill to reduce adverse effects to marine and coastal resources, thereby mitigating the full impact of a spill.

Fluid flow rates and cumulative volume profiles for the four WCC subsea well blowout scenarios are shown in Figures 4.4 - 4.7. The model predicted the Day 1 WCCD oil rate for West Orphan (WO) site (EL 1145) would be 128,019 bpd and the Day 1 WCCD oil rate for East Orphan (EO) site (EL 1149) would be 39,251 bpd.

A Technical File Note (TFN) has been written which documents in more detail all the input parameters and assumptions used in the rate calculations [5].

Figure 4.2 Provisional casing design and predicted geology used in the WCC discharge modelling for West Orphan well location

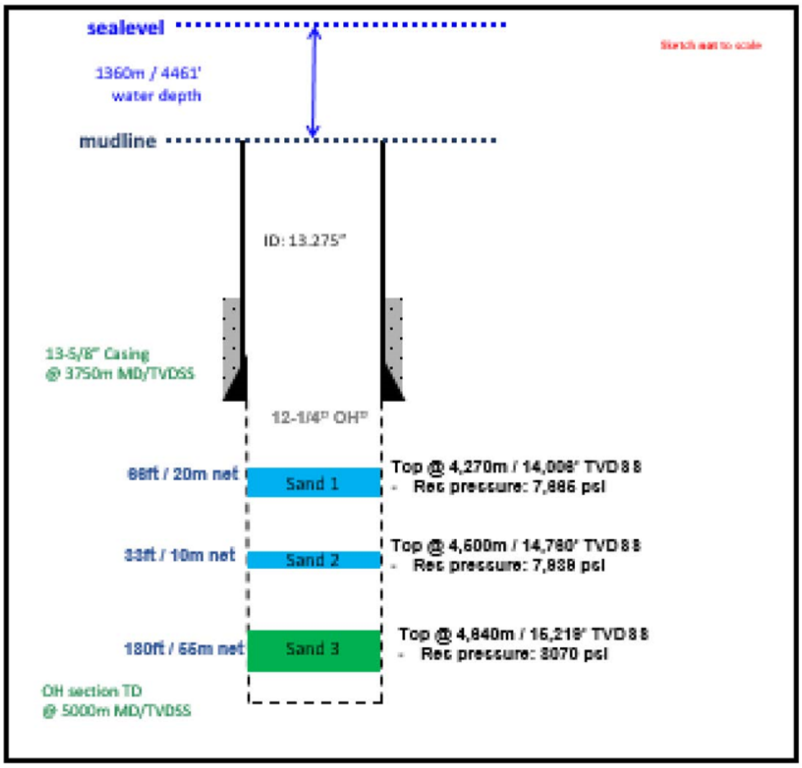


Figure 4.3 Provisional casing design and predicted geology used in the WCC discharge modelling for East Orphan well location

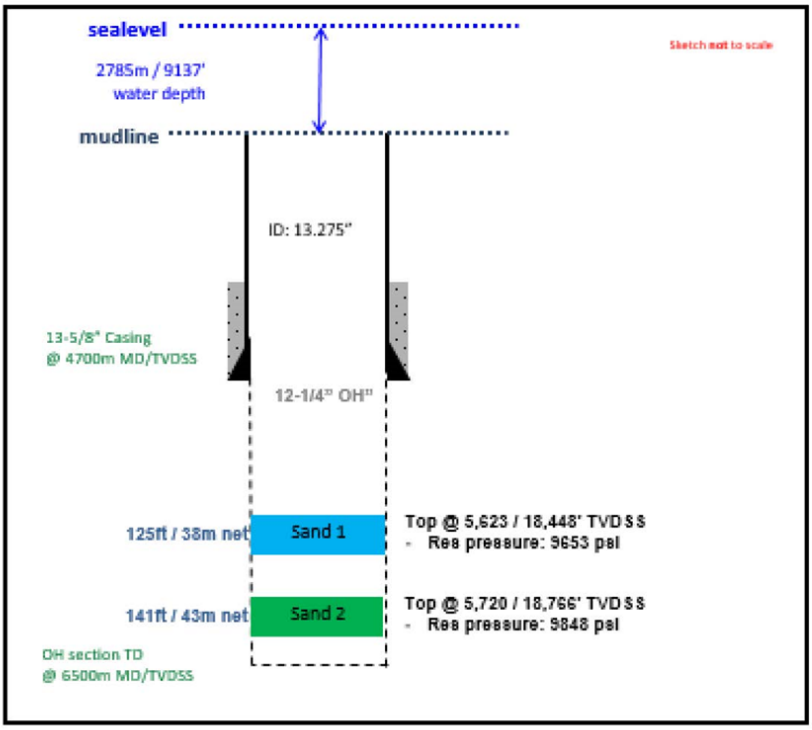


Figure 4.4 Steady state uncontrolled discharge rates for the West Orphan subsea well blowout scenarios over the 30 days estimated to cap and contain the well and 120 days to drill a relief well.

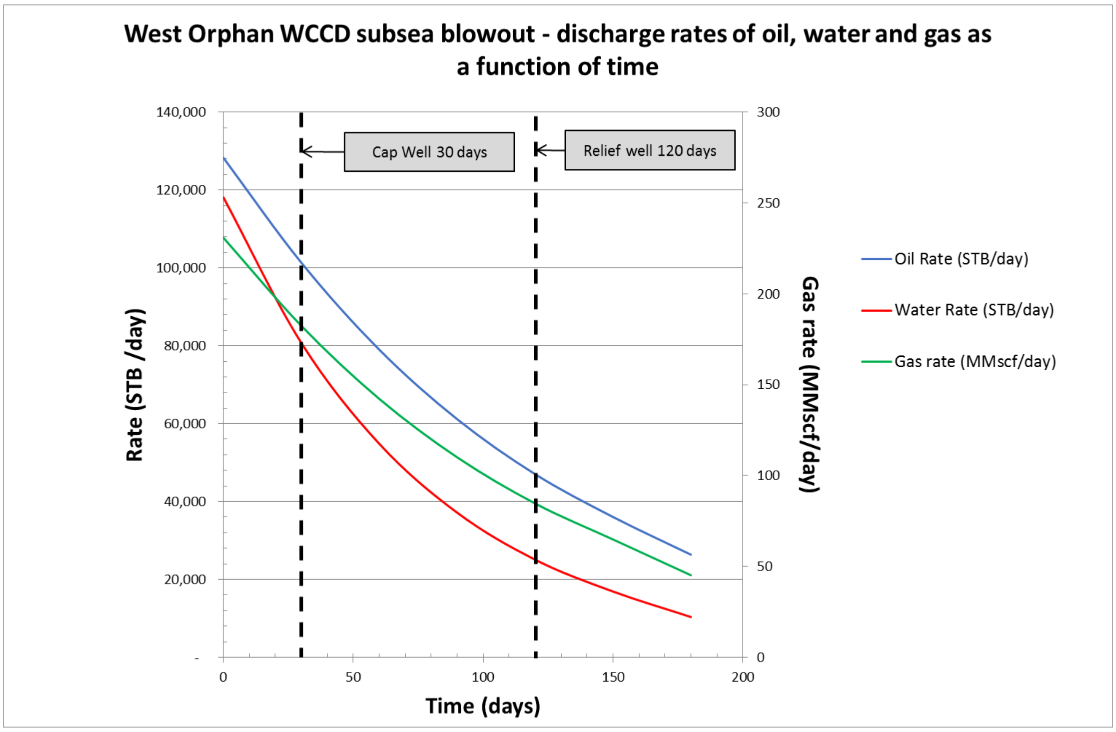


Figure 4.5 Cumulative production forecasts for the West Orphan subsea well blowout scenarios over the 30 days estimated to cap and contain the well and 120 days to drill a relief well.

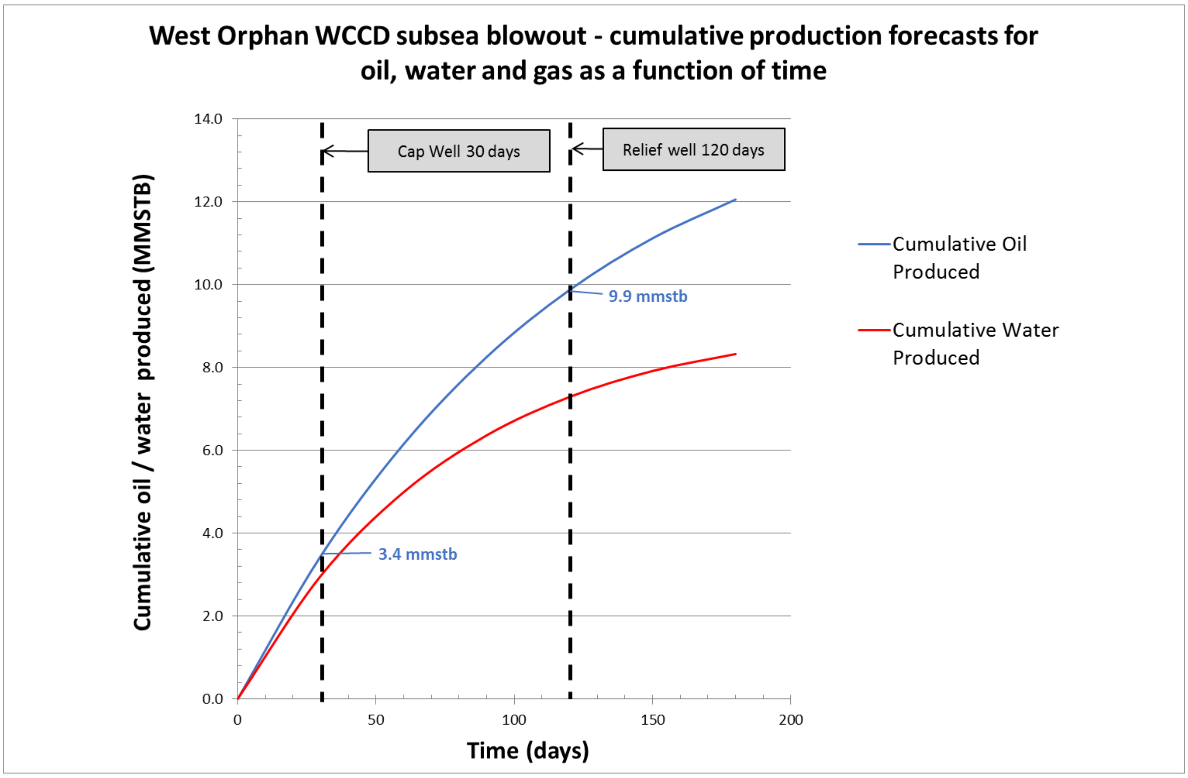


Figure 4.6 Steady state uncontrolled discharge rates for the East Orphan subsea well blowout scenarios over the 30 days estimated to cap and contain the well and 120 days to drill a relief well.

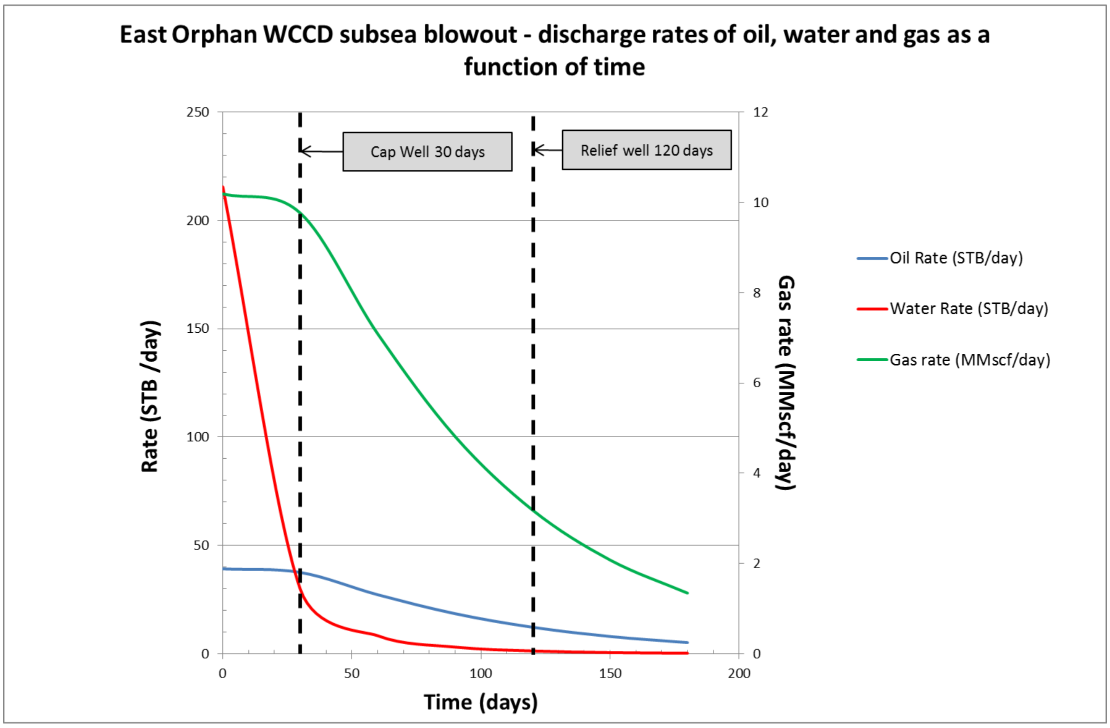
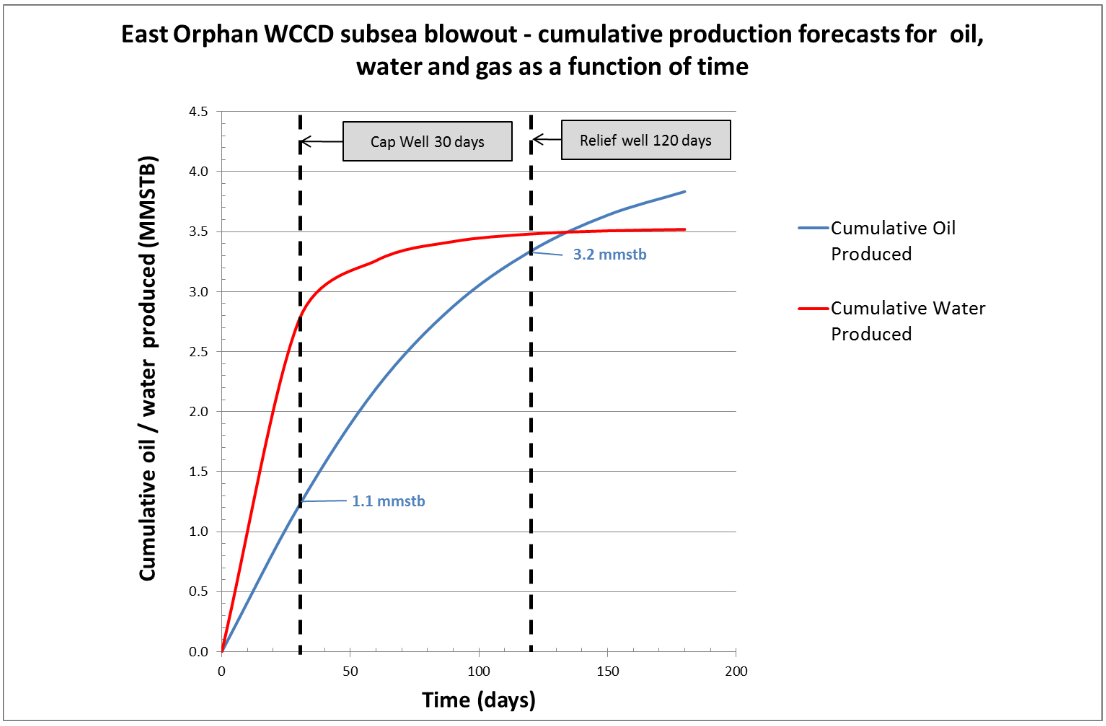


Figure 4.7 Cumulative production forecasts for the East Orphan subsea well blowout scenarios over the 30 days estimated to cap and contain the well and 120 days to drill a relief well.



4.1.2 Surface release of diesel

Two surface diesel release scenarios have been modelled to represent a loss of containment at the MODU.

The spill volumes modelled included 10 bbl, to represent a hose failure (i.e., an operational and maintenance spill, and 100 bbl, to represent a tank failure (i.e., a bulk spill). These scenarios represents the most likely spill scenarios that could occur on the MODU. Both scenarios were modelled from both spill modelling locations (in EL 1145 and EL 1149).

To be conservative, all modelled scenarios were run without applying any oil spill tactical response methods such as surface mechanical recovery or chemical dispersant application.

5 Data Inputs and model set-up parameters

The following sections detail the OSCAR set-up used to complete modelling run for the release scenarios outlined in Section 4.

5.1 Oil spill release rate, release volume and release duration

The release conditions for the oil spill modelling scenarios are presented in Tables 5.1 and 5.2.

5.2 Predicted fluid characteristics and analogue oil selection for modelling

The oil types modelled include crude oil and marine diesel.

Oil and chemical databases supply chemical and toxicological parameters required by the OSCAR model. A unique strength of the model is its foundation on an observational database of oil weathering properties. The laboratory and field methods developed at SINTEF for weathering of crude oils and petroleum products are described in Daling et al. (1990, 1997)[6,7]. Numerous field tests have verified the reliability of weathering predictions based on this methodology, in order to avoid unrealistic results.

The oil database contains complete weathering information for more than 50 crude oils and petroleum products. It also contains crude assay data for approximately 150 other crude oils. These latter data are derived from the HPI database [8]. Since no empirical observations of weathering are available for these oils, model estimates of oil weathering are less reliable than for oil for which oil weathering studies have been carried out.

SINTEF (Aamo et al.[9] and Daling et al.[7]) uses a multivariate approach to group oil types based on a limited data set available from crude oil assays (wax/asphaltene content, viscosity, density, pour point and the true boiling point curve). This approach can be used to match new oil types to oils where their weathering properties are already mapped or characterised to select analogue oils for OSCAR modelling.

5.2.1 Crude Oil

Given that the wells to be drilled for this project are exploratory, the exact nature of the well hydrocarbon fluids that may be encountered is unknown. The crude oil characteristics were selected to align with the expected reservoir characteristics using a bottom up petroleum system analysis approach. Specific properties of the petroleum fluid will depend on the richness, quality and thermal maturity of the source rocks. Where available, top down observations on petroleum fluid analogues from offset wells or nearby areas were used to further constrain expected fluid properties.

Tables 5.3 and 5.4 summarize the predicted fluid properties for the WO and EO Basin prospects as well as the analogue oils selected using the multivariate analysis best fit approach developed by SINTEF (described above) that provided the best overall match of oil properties to those predicted for these prospects. The Tables show the 25 “pseudo-component” groups used to specify the composition of each oil in the OSCAR oil database.

YME (IKU), a light crude with low viscosity, was the best oil analogue match for the WO Tertiary prospect. In contrast the fluid associated with the EO Jurassic play is expected to be slightly heavier (SG = 0.855) and similar to Bay du Nord (BdN) crude oil[10]. VARG 2004 was the analogue oil selected and matches well on SG and volatiles when compared to BdN.

Table 5.1 Release information for WO and EO subsea well blowout scenarios

Well Name:	Newfoundland Orphan Basin Exploration Wells

Release Site:		West Orphan Site 1	East Orphan - Site 2
Well Location:	Geographic Latitude:	50 deg	34 deg
		31 min	56 min
		11.78 sec	30.73 sec
		North	N North/South
	Geographic Longitude:	49 deg	130 deg
		41 min	42 min
		24.78 sec	48.59 sec
		West	E East / West
Water depth:		4,462 ft	9,137 ft
		1,360 m	2,785 m

Release Information:		Scenario 1 - WO Well Blowout Relief Well	Scenario 2 - WO Well Blowout Capping Stack	Scenario 3 - EO Well Blowout - Relief Well	Scenario 4 - EO Well Blowout - Capping Stack
		128,000 bpd (Initial oil release rate) / 120 days duration	128,000 bpd (Initial oil release rate) /30 days duration	39,000 bpd (Initial oil release rate) / 120 days duration	39,000 bpd (Initial oil release rate) /30 days duration
"Pipe" ID diameter of the last casing string at the seabed release point for the WCD (14" OD):		0.337 m	0.337 m	0.337 m	0.337 m
		13.275 ins	13.275 ins	13.275 ins	13.275 ins
Release duration:		120 days	30 days	120 days	30 days
Time window for blowout event:	"Summer" season	May - October	May - October	May - October	May - October
	"Winter Season"	November - April	November - April	November - April	November - April
Temperature of release as it leaves wellbore:		94.3 deg C	94.3 deg C	94.3 deg C	94.3 deg C
Salinity of release as it leaves wellbore:		60 ppt	60 ppt	60 ppt	60 ppt
		1.05 g/cm^3	1.05 g/cm^3	1.05 g/cm^3	1.05 g/cm^3
Air temperature:	"Summer" season	8 deg C	8 deg C	9 deg C	9 deg C
	"Winter Season"	1 deg C	1 deg C	2 deg C	2 deg C
Oil volume release rate:	Initial worst credible case discharge rate (WCCD):	128,282 bpd	128,282 bpd	39,195 bpd	39,195 bpd
		20,395 m^3/d	20,395 m^3/d	6,232 m^3/d	6,232 m^3/d
	Release rate after 120 days (RW) / 30 days (CS) for worst credible case discharge (WCCD):	47,047 bpd	101,348 bpd	12,247 bpd	37,563 bpd
		7,480 m^3/d	16,113 m^3/d	1,947 m^3/d	5,972 m^3/d
Total oil released:		9,875,000 bbls	3,444,000 bbls	3,272,000 bbls	1,151,000 bbls
		1,570,002 m^3	547,553 m^3	520,207 m^3	182,995 m^3
		1,310,964 tonnes	457,267 tonnes	444,752 tonnes	156,511 tonnes
Water volume release rate:	Initial worst credible case discharge rate (WCCD):	118,134 bpd	118,134 bpd	215,514 bpd	215,514 bpd
		18,782 m^3/d	18,782 m^3/d	34,264 m^3/d	34,264 m^3/d
	Release rate after 120 days (RW) / 30 days (CS) for worst credible case discharge (WCCD):	25,068 bpd	80,730 bpd	1,293 bpd	29,818 bpd
		3,986 m^3/d	12,835 m^3/d	206 m^3/d	4,741 m^3/d
Total water released:		7,330,000 bbls	2,983,000 bbls	4,489,000 bbls	3,680,000 bbls
		1,165,379 m^3	474,260 m^3	713,695 m^3	585,074 m^3
		1,217,821 tonnes	495,595 tonnes	745,887 tonnes	444,752 tonnes
Gas-Oil Ratio:	GOR	1,800 scf/bbl	1,800 scf/bbl	1,800 scf/bbl	1,800 scf/bbl
		321 sm^3/m^3	321 sm^3/m^3	321 sm^3/m^3	321 sm^3/m^3
Gas density:		0.9 kg/Sm^3	0.9 kg/Sm^3	0.9 kg/Sm^3	0.9 kg/Sm^3
Calculated gas volume release rate:	Initial worst credible case discharge rate (WCCD):	230.9 MMscf/d	230.9 MMscf/d	10.2 MMscf/d	10.2 MMscf/d
		6.54 $MMsm^3$/d	6.54 $MMsm^3$/d	0.29 $MMsm^3$/d	0.29 $MMsm^3$/d
	Release rate after 120 days (RW) / 30 days (CS) for worst credible case discharge (WCCD):	84.7 MMscf/d	182.4 MMscf/d	3.2 MMscf/d	9.8 MMscf/d
		2.40 $MMsm^3$/d	5.17 $MMsm^3$/d	0.09 $MMsm^3$/d	0.28 $MMsm^3$/d
Calculated mass flow rate of gas released:	Initial worst credible case discharge rate (WCCD):	68.1 kg/s	68.1 kg/s	3.0 kg/s	3.0 kg/s
	Release rate after 120 days (RW) / 30 days (CS) for worst credible case discharge (WCCD):	25.0 kg/s	53.8 kg/s	0.9 kg/s	2.9 kg/s
Total gas released:		17,775 MMscf	6,200 MMscf	851 MMscf	299 MMscf
		503 $MMsm^3$	176 $MMsm^3$	24 $MMsm^3$	8 $MMsm^3$
		452,999 tonnes	158,008 tonnes	21,688 tonnes	7,620 tonnes

Table 5.2 Release information for WO and EO accidental hydrocarbon (diesel) spill scenarios

Well Name:	Newfoundland Orphan Basin Exploration Wells

Release Site:		West Orphan Site 1	East Orphan - Site 2	
Well Location:	Geographic Latitude:	50 deg	34 deg	
		31 min	56 min	
		11.78 sec	30.73 sec	
		North	N	North/South
	Geographic Longitude:	49 deg	130 deg	
		41 min	42 min	
		24.78 sec	48.59 sec	
		West	E	East / West
Water depth:		4,462 ft	7,349 ft	
		1,360 m	2,240 m	

Release Information:		Scenario 5 - WO Surface Batch Release (Tank Failure)	Scenario 6 - WO Surface Batch Release (Hose Failure)	Scenario 7 - EO Surface Batch Release (Tank Failure)	Scenario 8 - EO Surface Batch Release (Hose Failure)
		100 bbls diesel release	10 bbls diesel release	100 bbls diesel release	10 bbls diesel release
Release duration:		6 hours	1 hour	6 hours	1 hour
Time window for blowout event:	"Summer" season	May - October	May - October	May - October	May - October
	"Winter Season"	November - April	November - April	November - April	November - April
Temperature of release as it leaves wellbore:		20 deg C	20 deg C	20 deg C	20 deg C
Air temperature:	"Summer" season	8 deg C	8 deg C	9 deg C	9 deg C
	"Winter Season"	1 deg C	1 deg C	2 deg C	2 deg C
Total oil released:		100 bbls	10 bbls	100 bbls	10 bbls
		16 m^3	2 m^3	16 m^3	2 m^3
		13.4 tonnes	1.3 tonnes	13.4 tonnes	1.3 tonnes

Table 5.3 Oil property predictions for the West Orphan well prospect and fluid properties for the best oil analogue match from the SINTEF OSCAR oil database

Fluid Properties:	Estimated West Orphan prospect Fluid Properties	Analogue YME (IKU)	Units
API Gravity	38.0	38.4	
Specific gravity	0.835	0.833	
Pour Point	0 ± 10 deg C	6	deg C
Wax Content	8 ± 2	6	wt%
Asphaltene Content	<4	0.3	wt%
Dead oil viscosity at reference temperature	2.95	4	cP
Reference temperature	13	13	deg C

YME IKU

Number	Abbr.	Description	SG	Boiling point (°C)	Volume Fraction in Oil (%)	Total Hydrocarbons Volume Fraction in Oil (%)	Aromatic Hydrocarbons Volume Fraction in Oil (%)
1	C1-C4	C1-C4 gases (dissolved in oil)	0.615	-161	3.62	30.30	7.66
2	C5-sat	C5-saturates (n-/iso-/cyclo)	0.673	27-60	5.28		
3	C6-sat	C6-saturates (n-/iso-/cyclo)	0.697	60-80	3.36		
4	**Benzene**	**Benzene**	**0.884**	**80**	**0.44**		
5	C7-sat	C7-saturates (n-/iso-/cyclo)	0.7115	80-100	2.87		
6	**C1-Ben**	**C1-Benzene (Toluene)**	**0.88**	**110**	**0.78**		
7	C8-sat	C8-saturates (n-/iso-/cyclo)	0.753	105-130	3.58		
8	**C2-Benz**	**C2-Benzene (xylenes)**	**0.8745**	**135-145**	**0.84**		
9	C9-sat	C9-saturates (n-/iso-/cyclo)	0.764	140-155	3.93		
10	**C3-Ben**	**C3-benzenes**	**0.875**	**150-170**	**5.60**		
11	C10-Sats	C10-saturates (n-/iso-/cyclo)	0.7725	170-190	3.59	16.02	0.38
12	**C4-Ben**	**C4-Benzenes**	**0.8795**	**170-205**	**0.11**		
13	C11-C12 Sat	nC11+nC12 alkanes	0.8095	190-220	6.41		
14	Phenols	C0-C5 phenols	0.986	181-250	0.01		
15	**Naph-1**	**C0-C1 naphthalenes**	**1.015**	**218-244**	**0.28**		
16	C13-C14 Sat	nC13+nC14 alkanes	0.8155	235-255	5.62		
17	Unresolved	UCM; C10-C36 (TEOC minus sum of n-alkanes and SVOC)	1.015	150-500	0.06		
18	**Naph-2**	**C2-C3 naphthalenes**	**1.016**	**265-280**	**0.30**	20.32	0.50
19	C15-C16 Sat	nC15+nC16 alkanes	0.8225	270-290	5.24		
20	**PAH-1**	**C4-naphthalenes; 3-ring non-alkylated PAH**	**0.98**	**250-340**	**0.19**		
21	C17-C18 Sat	nC17+nC18 alkanes	0.8275	300-320	5.14		
22	C19-C20 Sat	nC19+nC20 alkanes	0.8175	330-345	3.37		
23	C21-C25 Sat	nC21+nC25 alkanes	0.8225	350-390	6.07		
24	**PAH-2**	**3-ring alkylated PAH; 4-5 ring PAH**	**0.98**	**350-450**	**0.01**	33.36	0.01
25	C25+	The sum of nC26 to nC36 alkanes	0.95	400,500	33.29		
				Total	**100.00**	**100.00**	**8.55**

	Characteristic	Volatiles (%)	Semi-volatiles (%)	Low volatiles (%)	Residual (%)	
		Volume %				
	Boiling point (°C)	**<180**	**180–265**	**265–380**	**>380**	**Total**
YME IKU	Aliphatic Hydrocarbons	22.64	15.63	13.76	39.42	**91.45**
	Aromatics Hydrocarbons	7.66	0.38	0.50	0.01	**8.55**
	Total Hydrocarbons	30.30	16.02	14.25	39.43	**100.00**

Table 5.4 Oil property predictions for the East Orphan well prospect and fluid properties for the best oil analogue match from the SINTEF OSCAR oil database

Fluid Properties:	Estimated EO Fluid Properties	BdN Crude Oil (Statoil)	Analogue VARG 2004	Units
API Gravity	34.0	35.85 (16 deg C) 33.42 (0 deg C)	35.6	
Specific gravity	0.855	0.846(16 deg C) 0.858 (0 deg C)	0.847	
Pour Point	0 ± 10 deg C	-9	9	deg C
Wax Content	8 ± 2	NA	5.6	wt%
Asphaltene Content	<6	NA	1.5	wt%
Dead oil viscosity at reference temperature	4.63	5	36	cP
Reference temperature	13	20	13	deg C

VARG 2004

Number	Abbr.	Description	SG	Boiling point (°C)	Volume Fraction in Oil (%)	Total Hydrocarbons Volume Fraction in Oil (%)	Aromatic Hydrocarbons Volume Fraction in Oil (%)
1	C1-C4	C1-C4 gases (dissolved in oil)	0.615	-161	1.68	21.44	3.48
2	C5-sat	C5-saturates (n-/iso-/cyclo)	0.673	27-60	1.57		
3	C6-sat	C6-saturates (n-/iso-/cyclo)	0.697	60-80	2.63		
4	**Benzene**	**Benzene**	**0.884**	**80**	**0.44**		
5	C7-sat	C7-saturates (n-/iso-/cyclo)	0.7115	80-100	3.07		
6	**C1-Ben**	**C1-Benzene (Toluene)**	**0.88**	**110**	**0.95**		
7	C8-sat	C8-saturates (n-/iso-/cyclo)	0.753	105-130	4.70		
8	**C2-Benz**	**C2-Benzene (xylenes)**	**0.8745**	**135-145**	**1.21**		
9	C9-sat	C9-saturates (n-/iso-/cyclo)	0.764	140-155	4.31		
10	**C3-Ben**	**C3-benzenes**	**0.875**	**150-170**	**0.87**		
11	C10-Sats	C10-saturates (n-/iso-/cyclo)	0.7725	170-190	3.92	17.64	0.30
12	**C4-Ben**	**C4-Benzenes**	**0.8795**	**170-205**	**0.07**		
13	C11-C12 Sat	nC11+nC12 alkanes	0.8095	190-220	5.55		
14	Phenols	C0-C5 phenols	0.986	181-250	0.05		
15	**Naph-1**	**C0-C1 naphthalenes**	**1.015**	**218-244**	**0.23**		
16	C13-C14 Sat	nC13+nC14 alkanes	0.8155	235-255	7.82		
17	Unresolved	UCM; C10-C36 (TEOC minus sum of n-alkanes and SVOC)	1.015	150-500	0.00		
18	**Naph-2**	**C2-C3 naphthalenes**	**1.016**	**265-280**	**0.34**	18.84	0.58
19	C15-C16 Sat	nC15+nC16 alkanes	0.8225	270-290	7.01		
20	**PAH-1**	**C4-naphthalenes; 3-ring non-alkylated PAH**	**0.98**	**250-340**	**0.23**		
21	C17-C18 Sat	nC17+nC18 alkanes	0.8275	300-320	5.35		
22	C19-C20 Sat	nC19+nC20 alkanes	0.8175	330-345	5.90		
23	C21-C25 Sat	nC21+nC25 alkanes	0.8225	350-390	4.12	42.08	0.25
24	**PAH-2**	**3-ring alkylated PAH; 4-5 ring PAH**	**0.98**	**350-450**	**0.25**		
25	C25+	The sum of nC26 to nC36 alkanes	0.95	400,500	37.71		
				Total	**100.00**	**100.00**	**4.60**

	Characteristic	Volatiles (%)	Semi-volatiles (%)	Low volatiles (%)	Residual (%)	
		Volume %				
	Boiling point (°C)	**<180**	**180–265**	**265–380**	**>380**	**Total**
VARG 2004	Aliphatic Hydrocarbons	17.96	17.34	18.27	41.83	**95.40**
	Aromatics Hydrocarbons	3.48	0.30	0.58	0.25	**4.60**
	Total Hydrocarbons	21.44	17.64	18.84	42.08	**100.00**

Predictions of the surface oil weathering behaviour of the YME and VARG 2004 analogue oils under a range of wind and sea temperature conditions were carried out using the SINTEF Oil Weathering Model. The results are presented in Annex A.

5.2.2 Marine Diesel:

Marine diesel is a standard diesel used widely in offshore activity including shipping and oil and gas activity. It has a low viscosity and high aromatic content. Its characteristics are well known and tested. The oil properties of marine diesel derived from the SINTEF OSCAR oil database are as follows:

Table 5.5 Fluid properties of Marine Diesel extracted from the SINTEF OSCAR oil database

Fluid Properties:	Marine Diesel	Units
API Gravity	36.4	
Specific gravity	0.843	
Pour Point	-36	deg C
Dead oil viscosity at reference (surface)	3	cP
Reference temperature	13	deg C

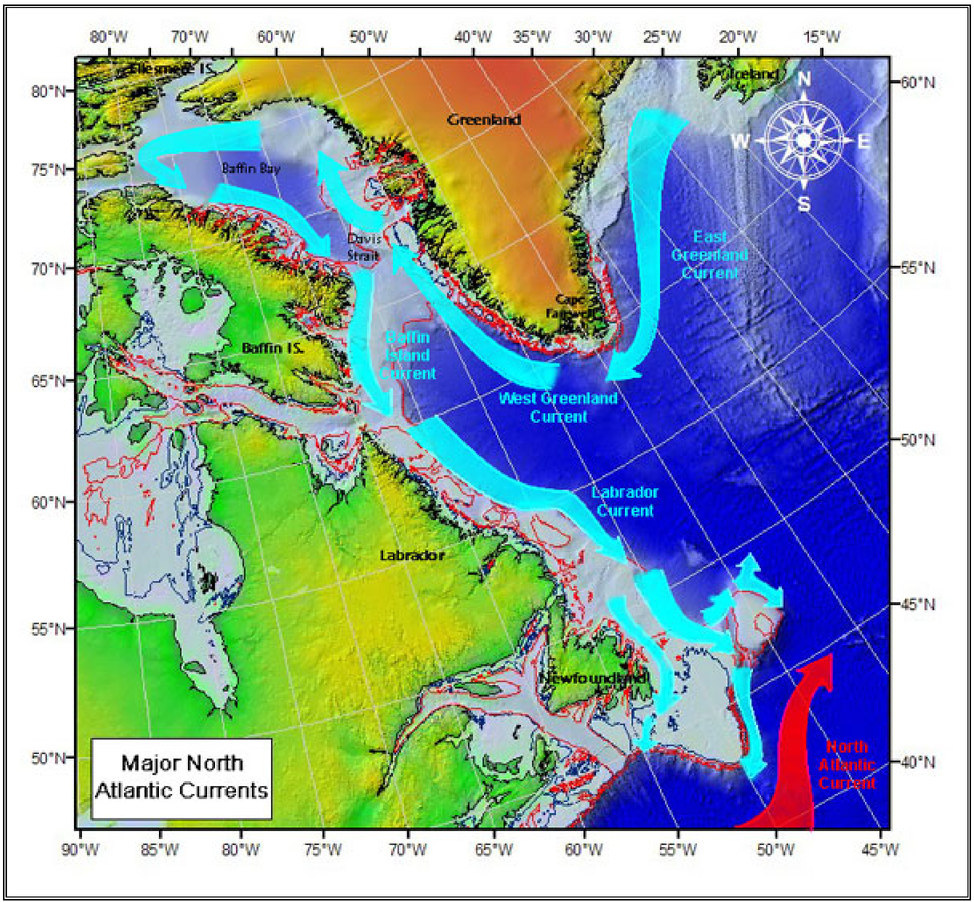
5.3 Environmental Data

5.3.1 Hydrodynamic and Wind Data

Currents, winds and other meteorological and oceanographic factors are critical parameters which can influence drill cutting dispersion and pollutant transport. Meteorological and oceanographic data is available from a number of sources and can be formatted to work in the OSCAR model.

5.3.1.1 Newfoundland currents

Figure 5.1 Regional Circulation Scheme near the Newfoundland Orphan Basin



The Labrador Current (Figure 5.1) is the dominant current in the Newfoundland Orphan Basin. The Labrador Current is composed of the West Greenland, Baffin Island Currents and Irminger Current. The Labrador Current originates from the Hudson Strait at 60°N and flows southward over the Labrador and Newfoundland Shelf and Slope to the tail end of the Grand Banks at 43°N (Lazier and Wright 1993[11]). The Labrador Current becomes two branches on the southern Labrador Shelf: an inshore branch with approximately 15% of the transport and a main offshore branch, with approximately 85% of the transport (Lazier and Wright 1993[11]). The main branch of the offshore Labrador Current typically flows along the Continental Slope between 300 and 1,500 m (Lazier and Wright 1993[11]). The inshore branch is a weaker flow, not well defined, except in specific regions where bathometry effects are dominate such as in the Avalon Channel (Narayanan et al. 1996[12]). The mean surface water velocities of the offshore branch typically range from 25 to 50 cm/s, and those of the inshore branch are weaker and range from 5 to 20 cm/s (Fissel and Lemon 1991[13]; Lazier and Wright 1993[11]; Colbourne 2000[14]). The currents on the Newfoundland Slope are highly variable due to the influences of strong atmospheric forcing, large inflows of sea ice, and interactions with the Gulf Stream and North Atlantic Current (Han and Li 2004[15]). This results in the Labrador Current having seasonal and interannual variations in velocity and transport. Typically, the upper waters of the Labrador Current are stronger in fall and winter and weaker in spring (Lazier and Wright 1993[11]; Han and Tang 1999[16]; Han and Li 2004[15]). Lazier and Wright (1993[11]) found seasonal variations in the upper 400 m level circulation and no significant variations deeper than the 1,000 m level.

The Labrador Current flows southward until it reached the southern part of Orphan Basin, where it is diverted eastward by the bathymetry. Upon reaching the entrance to Flemish Pass, the current divides into two branches. One branch continues to flow eastward north of Flemish Cap and the other branch flows southward through Flemish Pass.

East of the Tail of the Grand Banks, the Gulf Stream loses its characteristics and divides into branches. One of these branches flows northward (Figure 5.1) on the eastern side of Flemish Cap to the Orphan Basin region. Greenan et al. (2010[17]) found that the waters in the Orphan Knoll region of Orphan Basin were warmer in 2009 than in 2008 from an incursion of a filament from a meander of the North Atlantic Current.

5.3.1.2 Newfoundland Wind

The Project Area experiences predominately southwest to west flow throughout the year. There is a strong annual cycle in the wind direction. West to northwest winds which are prevalent during the winter months begin to shift counter-clockwise during March and April, resulting in a predominant southwest wind by the summer months. As autumn approaches, the tropical-to-polar temperature gradient strengthens, and the winds shift slightly, becoming predominately westerly again by late fall and into winter. Low pressure systems crossing the area are more intense during the winter months. As a result, mean wind speeds tend to peak during this season.

In addition to mid-latitude low pressure systems crossing the Grand Banks, tropical cyclones often move northward out of the influence of the warm waters of the Gulf Stream, passing near the Island of Newfoundland. Once the cyclones move over colder waters they lose their source of latent heat energy and often begin to transform into a fast-moving and rapidly developing extratropical cyclone producing large waves and sometimes hurricane force winds.

Low pressure systems crossing the area are more intense during the winter months, with mean wind speeds tending to peak during this season.

5.3.1.3 Metocean input data for the OSCAR Model

The 3-D current dataset used in OSCAR modelling to drive oil dispersion and transport was comprised of 3 hourly HYCOM current speeds with Bedford Institute Tides linearly superimposed. The HYCOM currents are from the Navy Research Laboratory experiment 19.1 (HYCOM GLBu0.08) for the period 1st January 2006 to 31st December 2010. The spatial resolution is 1/12.5 degrees and the results were extracted onto a domain that spans: longitude 30 to 70 degrees West and latitude 35 to 65 degrees North. The HYCOM currents were provided on forty depth levels, from the surface to 5,000m. HYCOM uses General Bathymetric Chart of the Oceans (GEBCO) 30 minute bathymetry, Climate Forecast System Reanalysis (CFSR) atmospheric forcing and assimilates data from a variety of sources. The tidal currents have been derived from the constituents in the Bedford Institute WebTide module and the profile through depth was reconstructed by assuming a 1/7 power law.

The NOAA/NSIDC climate data record of passive microwave sea ice concentration (version 3) have also been used to drive the OSCAR model. This data set provides a Climate Data Record (CDR) of sea ice concentration from passive microwave data. It provides a consistent, daily and monthly time series of sea ice concentrations from 09 July 1987 through the most recent processing for both the north and south polar regions. All data are on a 25 km x 25 km grid.

Snapshot maps showing examples of the wind, current and ice fields generated from the National Centre for Atmospheric Research (NCAR) / National Centre for Environmental Protection (NCEP) Climate Forecast System Reanalysis (CFSR), HYCOM and National Snow and Ice Data Centre (NSIDC) datasets respectively are presented in Figures 5.2 – 5.5.

Table 5.6 Metocean Data Parameter Inputs

	Input Data	Temporal Resolution	Reference
Bathymetry	GEBCO-1 minute	n/a	http://www.gebco.net/
Current velocity	HYCOM	3 hrly	https://hycom.org/
Temperature	World Ocean Atlas	Monthly	https://www.nodc.noaa.gov/OC5/woa13/
Salinity	World Ocean Atlas	Monthly	https://www.nodc.noaa.gov/OC5/woa13/
Tides	Bedford Institute Tides	3 hrly	http://www.bio.gc.ca/
Winds	NCAR /NCEP (CFSR)	3 hrly	http://rda.ucar.edu/pub/cfsr.html
Atmospheric forcing	NCAR/NCEP (CFSR)	3 hrly	http://rda.ucar.edu/pub/cfsr.html
Sea ice	National Snow and Ice Data Centre	daily	http://nsidc.org/
Wave heights	Calculated in OSCAR	n/a	n/a
Wind induced current	Calculated in OSCAR	n/a	n/a

Figure 5.2 Snapshot map showing an example of the 2-dimensional wind field generated from the NCAR / NCEP (CFSR) dataset

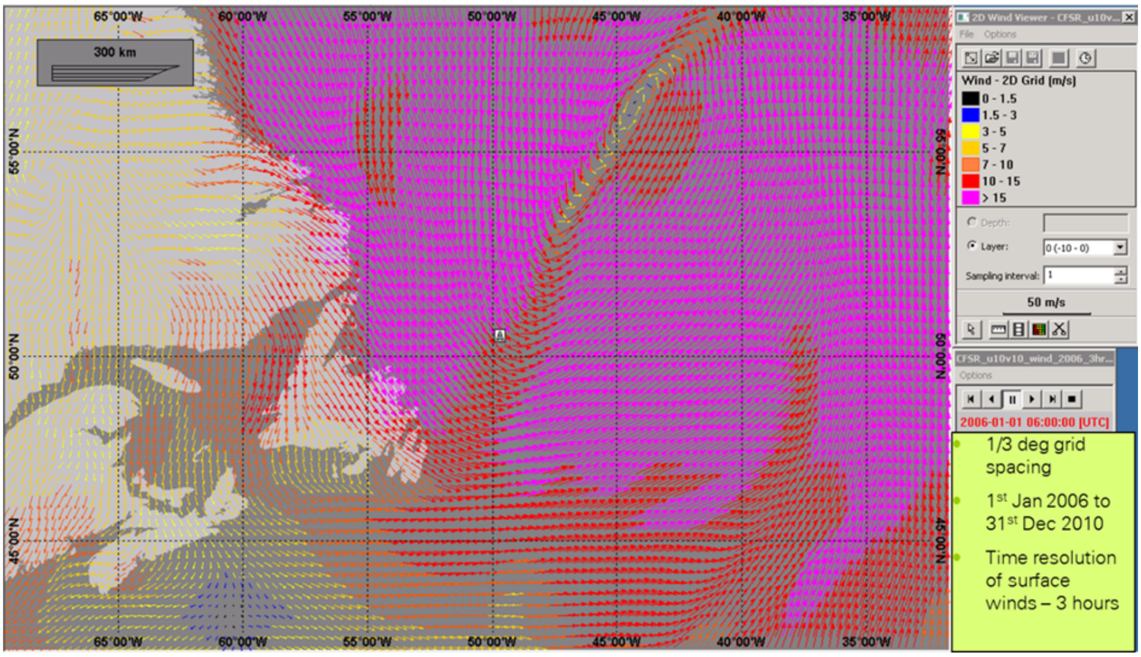


Figure 5.3 Snapshot map showing an example of the surface current field from 3-dimensional HYCOM generated dataset

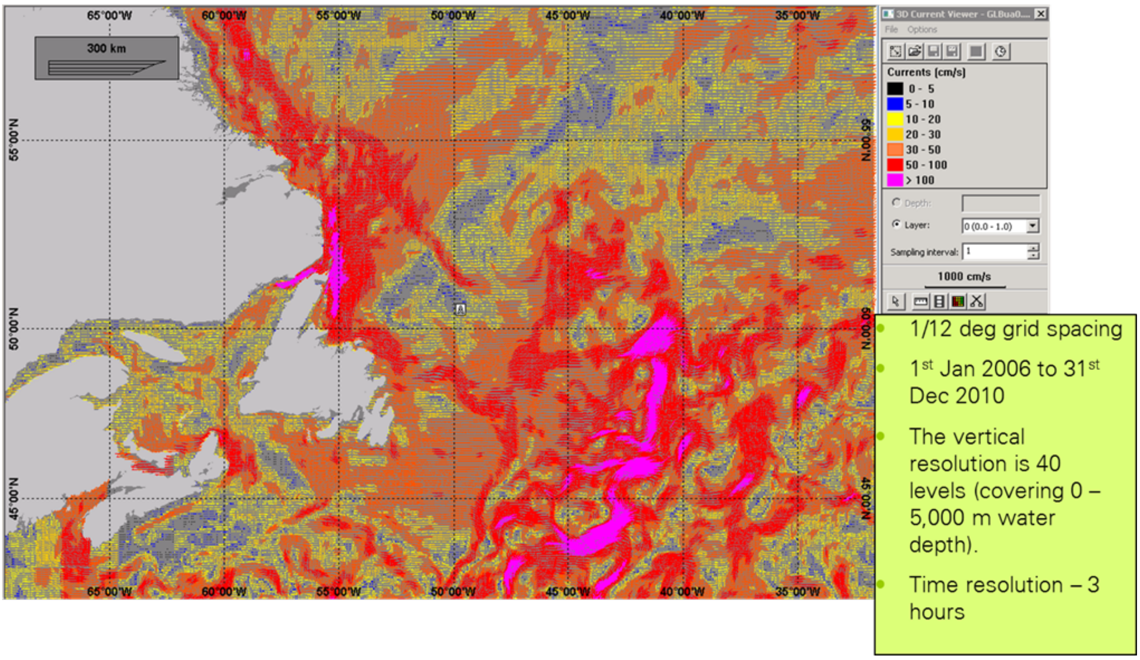


Figure 5.4 Snapshot map showing an example of the current field for the water depth range 950 - 1,125 m extracted from the 3-dimensional HYCOM generated dataset

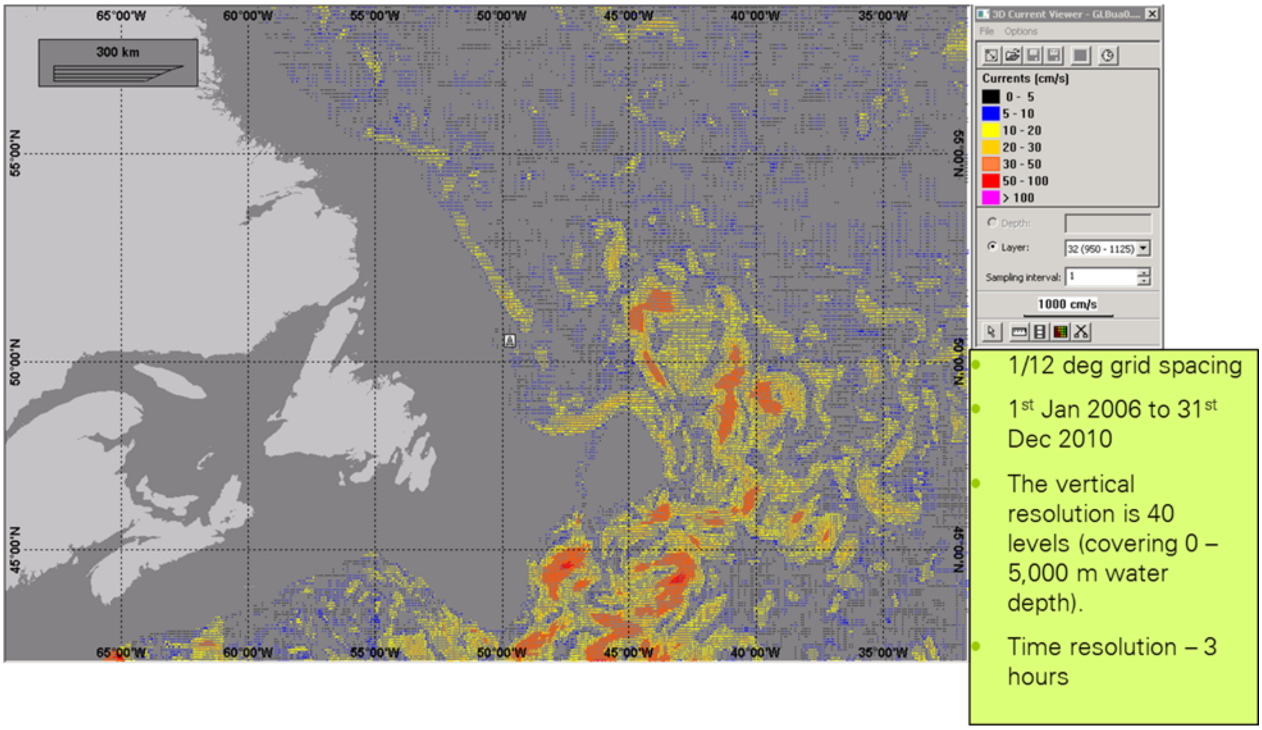
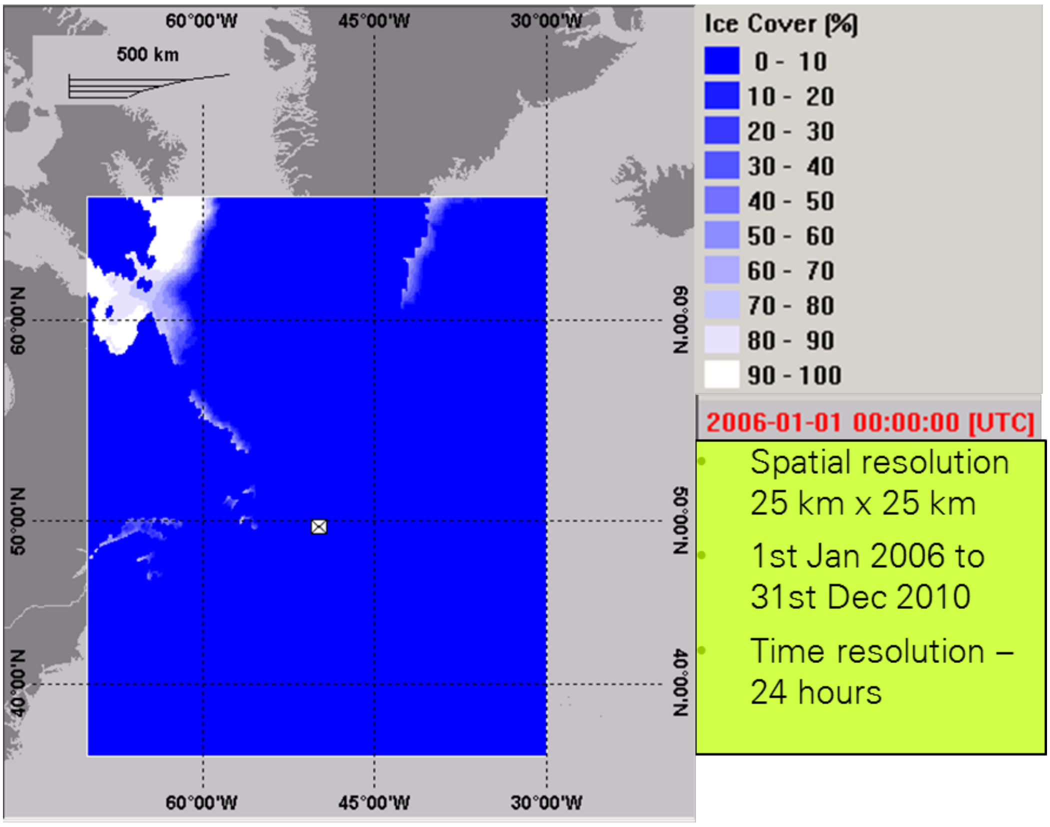


Figure 5.5 Snapshot map showing an example of the sea ice data extracted from the National Snow & Ice Data Center (NSIDC)



5.3.1.4 Predicted winds and currents at the West Orphan and East Orphan well locations

Hindcast model predictions of surface wind and currents at the WO and EO well locations are presented in Annex B.

The current intensity decreases with water depth in the water column as shown in Figures 5.3 and 5.4, with average currents speeds < 5 cm/s near the seabed at the both well locations. Surface currents are highly variable at both well locations (see Figures B.1.1 - B.1.4). However, seasonal current roses indicate stronger currents at the WO wellsite location with the flow predominantly towards the SSE direction especially in the winter season. At the EO wellsite location the surface currents are more evenly distributed with an Easterly bias especially during the winter months (November – April, see Figure B.1.3). About 70% of the mean surface water velocities at both wellsite locations fall in the range from 10 to 50 cm/s (Figure B.1.4), with no significant seasonal variation at EO. At the WO location, there is a 10% increase in currents within this range during the winter season.

According to the CFSR model, wind speeds at the WO and EO well sites averaged around 7.6 ms^{-1} (15 knots) and 8.4 ms^{-1} (16 knots) respectively during the summer season (April – October) and 10.6 ms^{-1} (21 knots) and 11.4 ms^{-1} (22 knots) during the winter season (November - March) over the entire 2006 – 2010 time period. Maximum wind speeds at both well locations were much higher, with a maximum daily average wind speed at WO of 29.9 ms^{-1} (58 knots) in the summer and 28.1 ms^{-1} (55 knots) in the winter. Maximum wind speeds at EO were similar, with a maximum daily average of 27.4 ms^{-1} (54 knots) in the summer and 29.2 ms^{-1} (57 knots) in the winter.

Seasonal wind roses showed very similar wind directions and at both well locations (Figure B.2.1), with stronger wind speeds during the winter, when compared to the summer (Figure B.2.2). In winter, winds were predominantly from the W (Figure B.2.3) and in the summer from the SW.

5.3.2 Hydrographical profiles

Average monthly temperature and salinity vs. depth profiles (over the period 2006 to 2010) for each well location was extracted from the World Ocean Atlas 2013 version 2 [(18)]. The data was then used to produce hydrographical profiles for each "seasonal" time period employed in the stochastic simulations (see Annex C).

5.3.3 Bathymetry

The MEMW system refers to several internal depth data sources for building depth grids. (Sea Topo 8.0, IBCAO, beta version).

5.4 Model set-up parameters

5.4.1 Model area

To confirm that the simulations captured both the physical extent and time duration of each oil spill event, the simulations were set up as follows:

1. The user-defined habitat grid for the release area (i.e. the physical geography boundary conditions) used in both stochastic and deterministic modelling was created to retain at least 95% of the total mass of the release within the grid boundary during any given simulation (see Figures 5.6 - 5.8 for geographical maps).

2. The model simulation period for a given scenario was selected so that the amounts of oil exceeding the threshold limit values for surface oil thickness and total dispersed oil concentration in the water column were negligible at the end of the simulation.

Figure 5.6 Map showing habitat grid boundaries used in stochastic / deterministic simulations for the WO and EO subsea well blowout scenarios

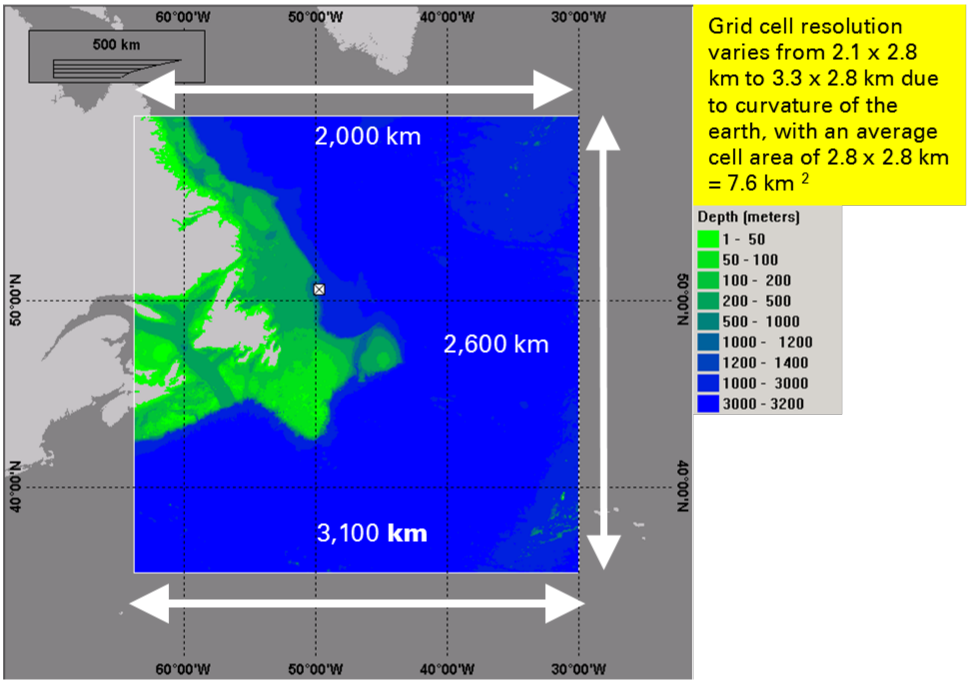


Figure 5.7 Map showing habitat grid boundaries used in stochastic / deterministic simulations for the surface release of diesel (tank/hose failure) scenarios from the WO wellsite location

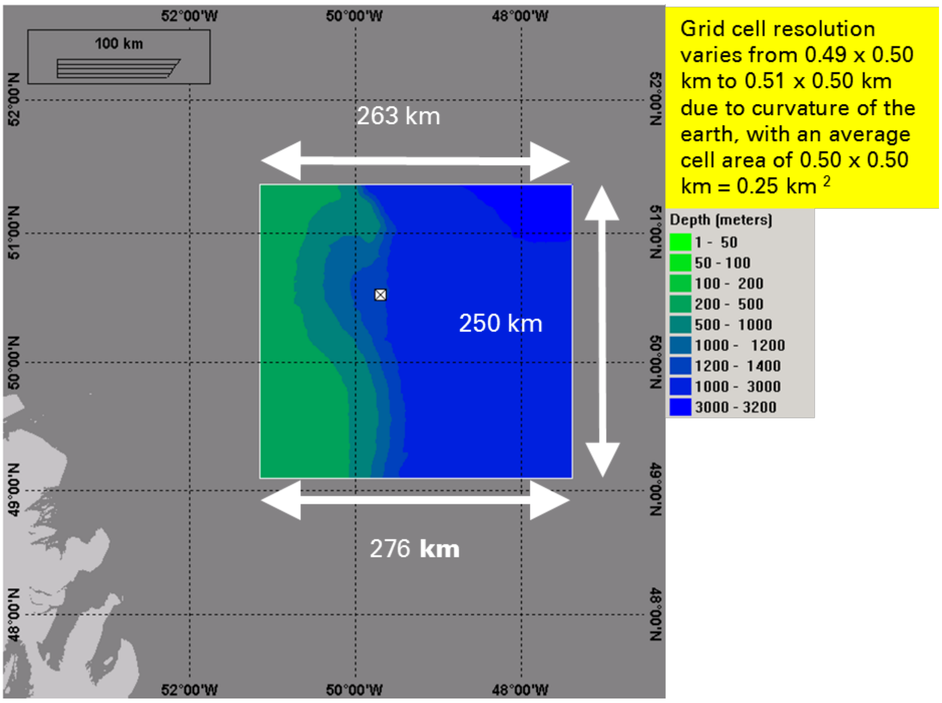
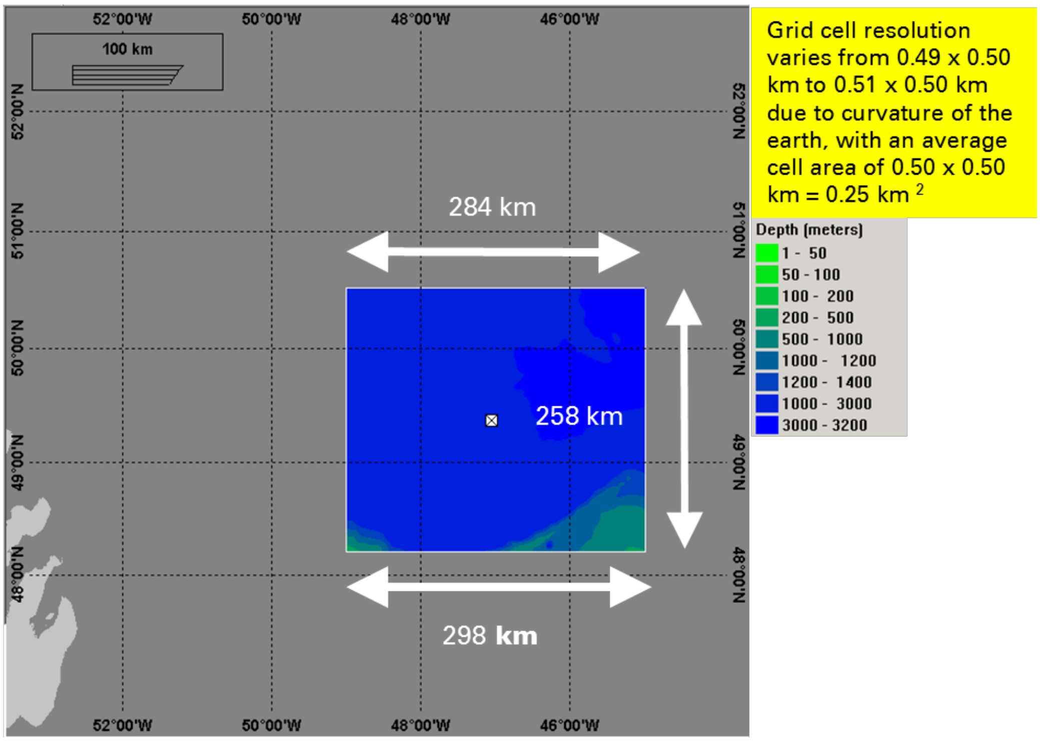


Figure 5.8 Map showing habitat grid boundaries used in stochastic / deterministic simulations for the surface release of diesel (tank/hose failure) scenarios from the EO Orphan wellsite location



5.4.2 Model settings and assumptions

Tables 5.7 and 5.8 provide a summary of the model settings and assumptions used in the stochastic and deterministic simulations.

5.4.2.1 Film thickness

The default initial film thickness was set to the default of 4 mm and the oil was tracked on the sea surface to a terminal thickness of 0.04 µm.

5.4.2.2 Simulation time

The simulation periods for blowout and diesel release scenarios we set to 160 days and 50 / 15 days respectively (see section 5.2.2.1).

5.4.2.3 Particle number

The number of particles representing oil droplets and dissolved contaminants was set to 10.000 for both the stochastic and deterministic simulations to provide good resolution.

Table 5.7 Summary of the model settings and assumptions used in the stochastic and deterministic simulations for the WO and EO subsea well blowout scenarios

Model Parameters:		Scenario 1 - Well Blowout - Relief Well	Scenario 2 - WO Well Blowout Capping Stack	Scenario 3 - EO Well Blowout - Relief Well	Scenario 4 - EO Well Blowout - Capping Stack
		128,000 bpd (Initial oil release rate) / 120 days duration	128,000 bpd (Initial oil release rate) /30 days duration	39,000 bpd (Initial oil release rate) / 120 days duration	39,000 bpd (Initial oil release rate) /30 days duration
Number of particles	Droplet	10,000	10,000	10,000	10,000
	Dissolved	10,000	10,000	10,000	10,000
Habitat Grid dimensions	Average Grid Width	2,585 km 1,606 miles	2,585 km 1,606 miles	2,585 km 1,606 miles	2,585 km 1,606 miles
	Grid height	2,585 km 1,606 miles	2,585 km 1,606 miles	2,585 km 1,606 miles	2,585 km 1,606 miles
The spatial resolution of the Habitat Grid	Average Resolution in the x-direction (longitude)	2.8 km	2.8 km	2.8 km	2.8 km
	Resolution in the y-direction (latitude)	2.8 km	2.8 km	2.8 km	2.8 km
The spatial resolution of the concentration grid in the horizontal and vertical	Average Resolution in the x-direction (longitude)	2.8 km	2.8 km	2.8 km	2.8 km
	Resolution in the y-direction (latitude)	2.8 km	2.8 km	2.8 km	2.8 km
	Resolution in the z-direction (depth)	10 m	10 m	10 m	10 m
The spatial resolution of the surface grid	Average Resolution in the x-direction (longitude)	2.8 km	2.8 km	2.8 km	2.8 km
	Resolution in the y-direction (latitude)	2.8 km	2.8 km	2.8 km	2.8 km
Depth for concentration grid	Min:	0 m	0 m	0 m	0 m
	Max	100 m	100 m	100 m	100 m
Lower concentration limit:		1 ppb	1 ppb	1 ppb	1 ppb
Terminal surface film thickness:		0.04 microns	0.04 microns	0.04 microns	0.04 microns
The oil droplet size distribution min / max and median droplet size	Min:	10 µm	10 µm	10 µm	10 µm
	Median:	2,019 - 4,118 µm	2,019 - 2,656 µm	4,244 - 4,586 µm	4,244 - 4,586 µm
	Max	4,342 - 8,857 µm	4,342 - 5,712 µm	9,126 - 9,862 µm	9,126 - 9,862 µm
Computation time-step and output time-step	Time-step	20 min	20 min	20 min	20 min
	Output interval	1 day	1 day	1 day	1 day
Simulation period:		160 days	90 days	160 days	90 days
Number of stochastic simulations:	"Summer" season	112 (2006 - 2010)	121 (2006 - 2010)	112 (2006 - 2010)	121 (2006 - 2010)
	"Winter Season"	116 (2006 - 2010)	116 (2006 - 2010)	116 (2006 - 2010)	116 (2006 - 2010)

Table 5.8 Summary of the model settings and assumptions used in the stochastic and deterministic simulations for the WO and EO accidental hydrocarbon (diesel) discharge scenarios

Model Parameters:		Scenario 5 - WO Surface Batch Release (Tank Failure)		Scenario 6 - WO Surface Batch Release (Hose Failure)		Scenario 7 - EO Surface Batch Release (Tank Failure)		Scenario 8 - EO Surface Batch Release (Hose Failure)	
		100 bbls diesel release		10 bbls diesel release		100 bbls diesel release		10 bbls diesel release	
Number of particles	Droplet	10,000		10,000		10,000		10,000	
	Dissolved	10,000		10,000		10,000		10,000	
Habitat Grid dimensions	Average Grid Width	269 km 167 miles		252 km 157 miles		2,585 km 1,606 miles		2,585 km 1,606 miles	
	Grid height	250 km 155 miles		250 km 155 miles		2,585 km 1,606 miles		2,585 km 1,606 miles	
The spatial resolution of the Habitat Grid	Average Resolution in the x-direction (longitude)	0.5 km		0.5 km		2.8 km		2.8 km	
	Resolution in the y-direction (latitude)	0.5 km		0.5 km		2.8 km		2.8 km	
The spatial resolution of the concentration grid in the horizontal and vertical	Average Resolution in the x-direction (longitude)	0.5 km		0.5 km		2.8 km		2.8 km	
	Resolution in the y-direction (latitude)	0.5 km		0.5 km		2.8 km		2.8 km	
	Resolution in the z-direction (depth)	10 m		10 m		10 m		10 m	
The spatial resolution of the surface grid	Average Resolution in the x-direction (longitude)	0.5 km		0.5 km		2.8 km		2.8 km	
	Resolution in the y-direction (latitude)	0.5 km		0.5 km		2.8 km		2.8 km	
Depth for concentration grid	Min:	0 m		0 m		0 m		0 m	
	Max	100 m		100 m		100 m		100 m	
Lower concentration limit:		1 ppb		1 ppb		1 ppb		1 ppb	
Terminal surface film thickness:		0.04 microns		0.04 microns		0.04 microns		0.04 microns	
Computation time-step and output time-step	Time-step	20 min		10 min		20 min		10 min	
	Output interval	6 hours		3 hours		6 hours		3 hours	
Simulation period:		50 days		15 days		50 days		15 days	
Number of stochastic simulations:	"Summer" season	125	(2006 - 2010)	125	(2006 - 2010)	125	(2006 - 2010)	125	(2006 - 2010)
	"Winter Season"	118	(2006 - 2010)	122	(2006 - 2010)	118	(2006 - 2010)	122	(2006 - 2010)

5.5 Response and environmental thresholds

The OSCAR model is able to track oil on the sea surface, on the shoreline and water column to levels that have little relevance from a response or environmental impact perspective. Therefore, threshold levels have been specified for each of these impact compartments as follows:

5.5.1 Surface: thickness of emulsified oil on the water surface

The minimum thickness of oil that may result in harm to seabirds through ingestion from preening of contaminated feathers, or loss of thermal protection from their feathers, has been estimated by different researchers to range between 10 µm (10 g/m^2) to 25 µm (25 g/m^2) (French-McCay, 2009[(19)]). However, visible sheens on the water surface can have a socio-economic impact as commercial resources can be affected. For example, fisheries are closed when a visible sheen is detected. Therefore, a conservative surface thickness threshold of 0.04 µm was used in the modelling, which relates to a barely visible or silver sheen on the water surface[(20)].

5.5.2 Shoreline: volume of oil reaching the shoreline

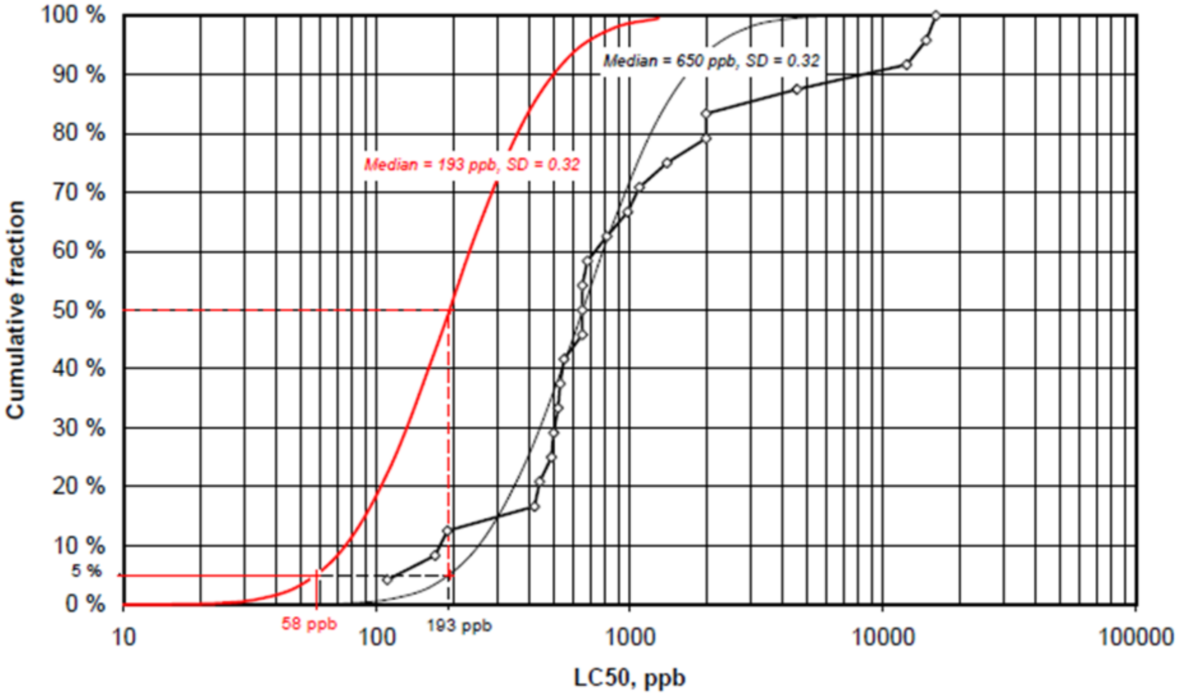
Oil on the shoreline can have an impact on environmental and socio-economic receptors. French-McCay (2011 [(19)]) review paper quotes shoreline impact lethal thresholds of 1 kg/m^2 (1 mm) for vegetation growing along flat shorelines with soft sediments and 100 g/m^2 (0.1 mm) for epifaunal invertebrates (mussels, crabs, starfish etc.). However, a conservative stranded oil threshold 1.0 g/m^2 was used in the stochastic modelling as that amount of oil would conservatively trigger the need for shoreline clean-up. This is equivalent to a density of 1" diameter tar balls of @ 0.12 – 0.14 tar balls per m^2 of shoreline [(21)].

5.5.3 Water column concentration: concentration of oil in the water column

Carls et al (2002 [(22)]) found that the acute toxicity of water-soluble fraction of oil (LC50) varies from 200 to 5,000 ppb Total Hydrocarbons (THC). Based on extensive toxicity tests of crude oils and oil components on marine organisms, the OLF (the Norwegian Oil Industry Association Guideline for risk assessment of effects on fish from acute oil pollution (2008)[(23)] concluded that threshold concentration for an expected No Observed Effect Concentration (NOEC) for acute exposure for THC ranges from 50 - 300 ppb. Work undertaken by Neilson et al (2005, as reported in OLF, 2008 [(23)]) proposed a value for acute exposure to dispersed oil of 58 ppb, based on the toxicity of chemically dispersed oil to various aquatic species, which showed the 5% effect level is 58 ppb (see Figure 5.9). The 58 ppb threshold for the NOEC for oil dissolved and entrained oil in the water column was thus selected for stochastic modelling based on the conclusion in the OLF guideline.

In this study all thresholds were applied pre-processing as described in Section 3.2.2.1).

Figure 5.9 LC50 values from toxicity studies on dispersed oil on various aquatic species. The red line is the cumulative distribution curve of interest. This sensitive species dose-response curve shows the 5 % percentile LC50 value and SD = 0.32. From this dose-response curve, the threshold value (5 % lethal risk) is found to be 58 ppb.



6 Protected and Environmentally Sensitive Areas

Newfoundland and Labrador has several areas that are protected under federal, provincial, international, and/or other legislation or programs because they are considered to be important for ecological, historical, or socio-economic reasons. The potential impact of an oil release from the WO and EO well locations was assessed by geospatial analysis using ArcGIS to identify where probabilistic outputs from OSCAR (exceeding the oil thickness and concentration threshold values detailed in Section 5.5) overlap with special areas within the Project Areas and Regional Assessment Area (RAA)

6.1 Protected Areas

Protected Areas (PAs) included in the geospatial analysis were as follows:

- IUCN Category Ia: Strict Nature Reserves
- IUCN Category Ib: Wilderness Areas
- IUCN Category II: National Parks
- IUCN Category III: Natural Monument or Feature
- IUCN Category IV: Habitat/Species Management Areas
- IUCN Category V: Protected Landscape/Seascape
- IUCN Category VI: Protected Areas with Sustainable Use of Natural Resources
- RAMSAR Sites
- World Heritage Sites
- UNESCO-MAB Biosphere Reserve

Designated Protected Areas present in the region are shown in Figure 6.1, Funk Island Ecological Reserve (IUCN IA) is the closest PA, located 267 km from the WO wellsite location. Coastal PAs such as the Witless Bay Ecological Reserve (IUCN II) and Cape St. Mary's Ecological Reserve (IUCN II) are > 400 km from either well location

6.2 Environmentally Sensitive Areas

In addition to the PAs, there are a number of environmentally sensitive areas located near to the Project Area. These include Marine Protected Areas (MPAs), Marine Refuges and Lobster Area Closures, Migratory Bird Sanctuaries, Important Bird and Biodiversity Areas (IBAs) and Ecologically and Biologically Sensitive Areas (EBSAs) identified by the Fisheries and Oceans Canada (DFO).

All the environmentally sensitive areas considered in the assessment are listed in Table D.1 (Annex D).

Figure 6.1 Map showing Protected Areas in the RAA

Please note the well locations have not been finalised. Therefore, the well sites shown in the map are tentative locations representing likely drilling targets based on preliminary seismic data processing and interpretation.

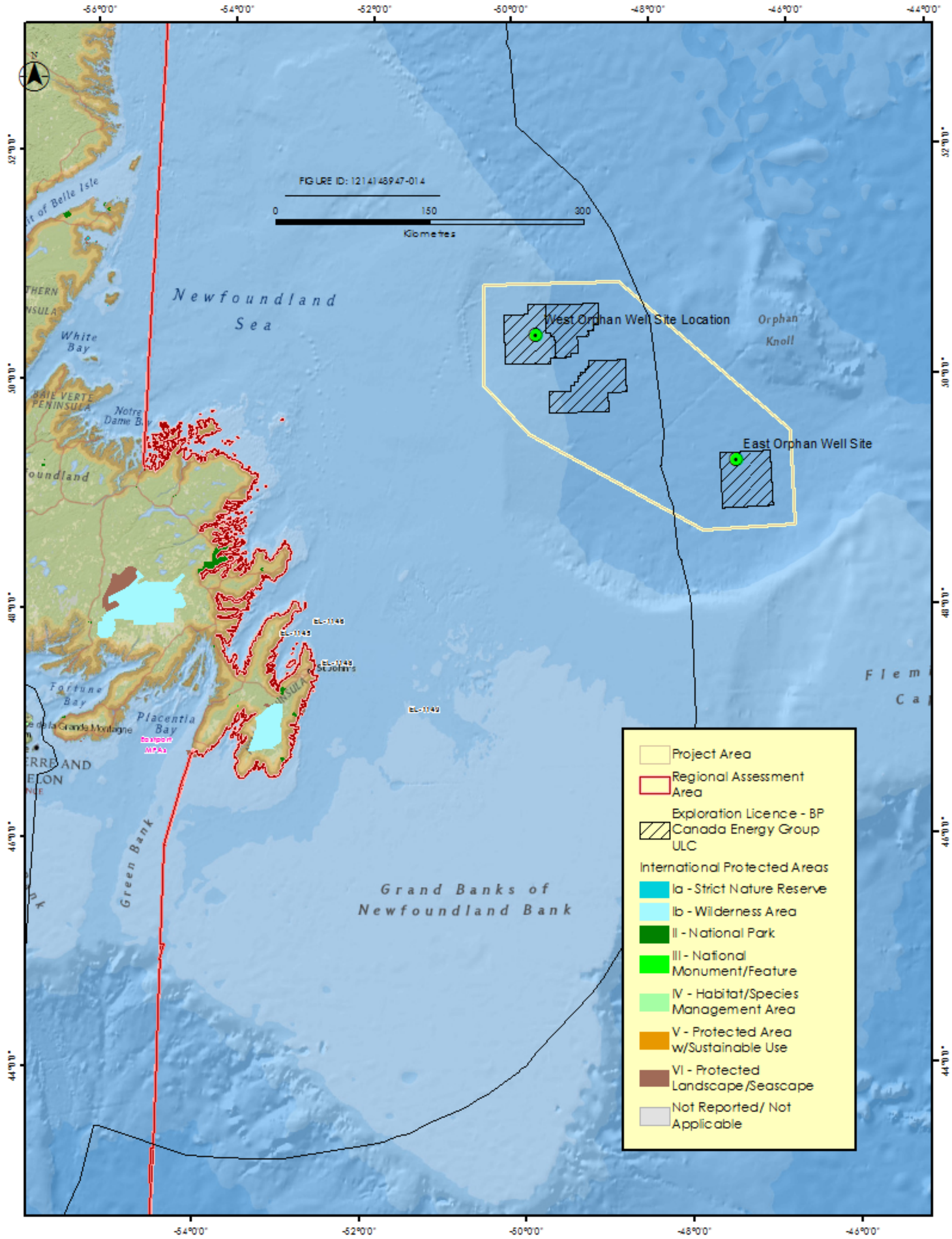
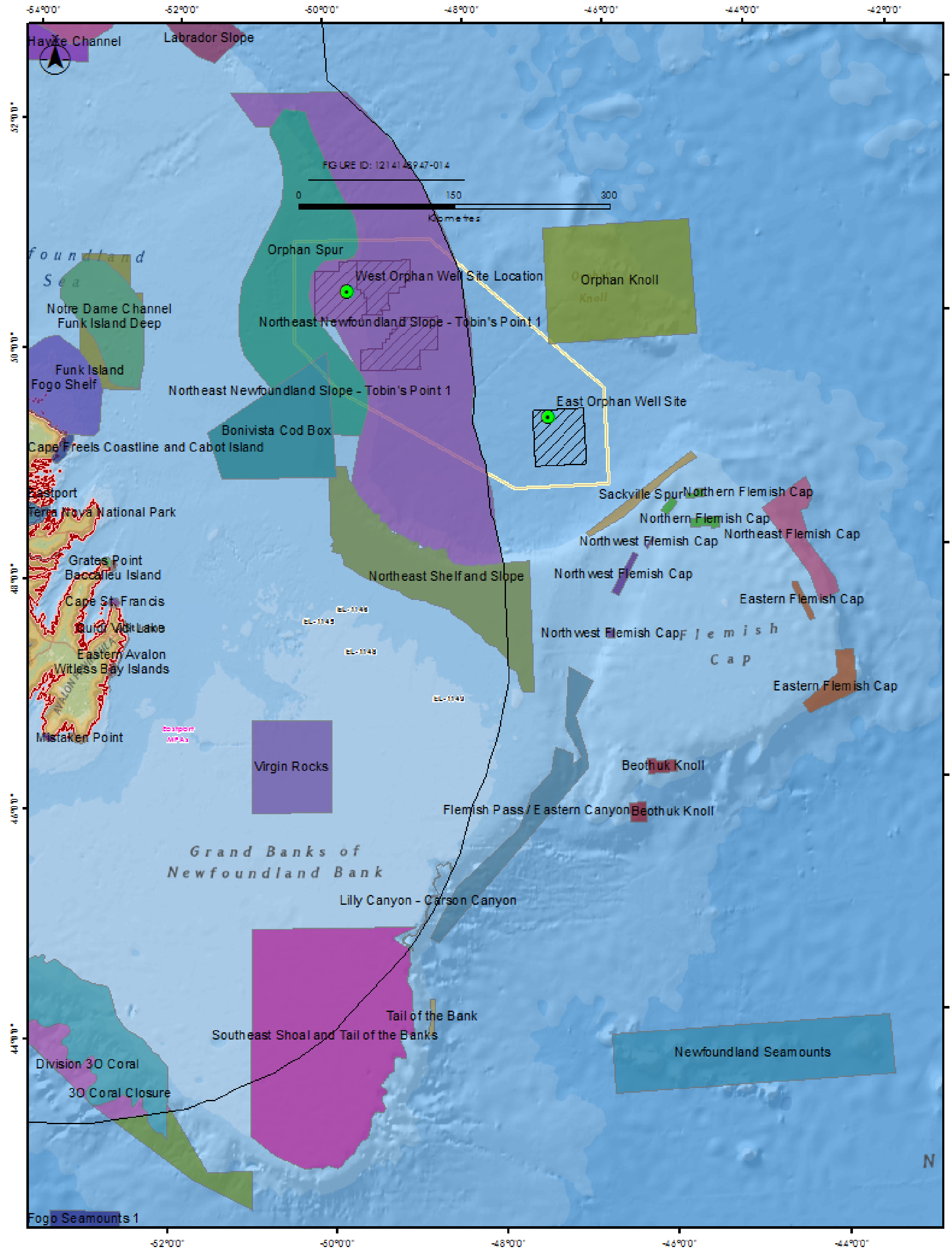


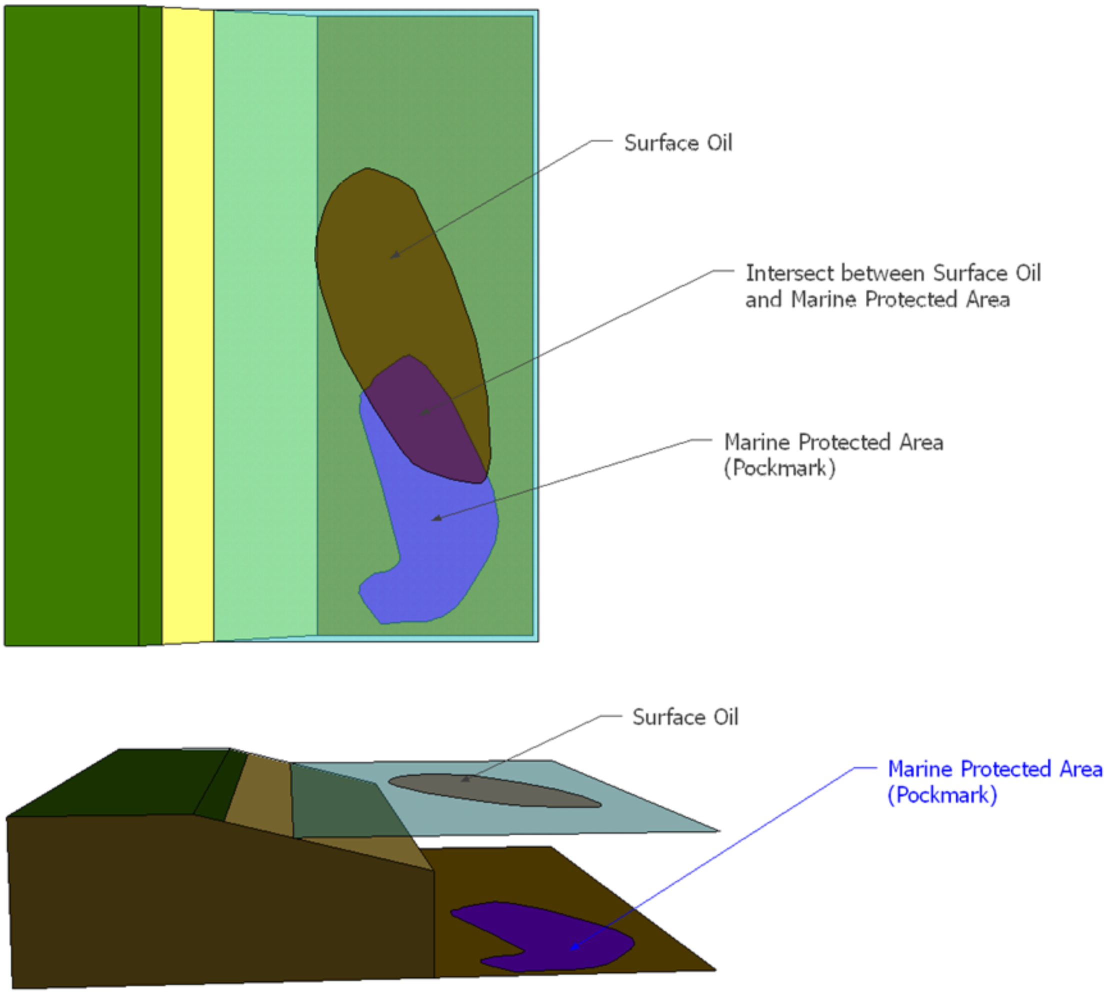
Figure 6.2 Environmentally Sensitive Areas within the Project Area and RAA



6.3 GIS Analysis

It should be noted that the approach for identifying marine protected/sensitive areas potentially at risk from contact with oil on the sea surface or oil entrained in the upper water column is conservative. Some of the marine protected/sensitive areas may be designated for seabed features (such as pockmarks, trenches, corals etc.) and will therefore not be directly impacted by surface oil or oil entrained in the upper water column. However, the intersection routines used in the GIS analysis show all locations where surface oil and oil in the water outputs from oil spill modelling spatially overlap with protected/sensitive areas (designated by latitude and longitude), even when the oil spill outputs are vertically separated from the Marine protected / sensitive area. (see Figure 6.3).

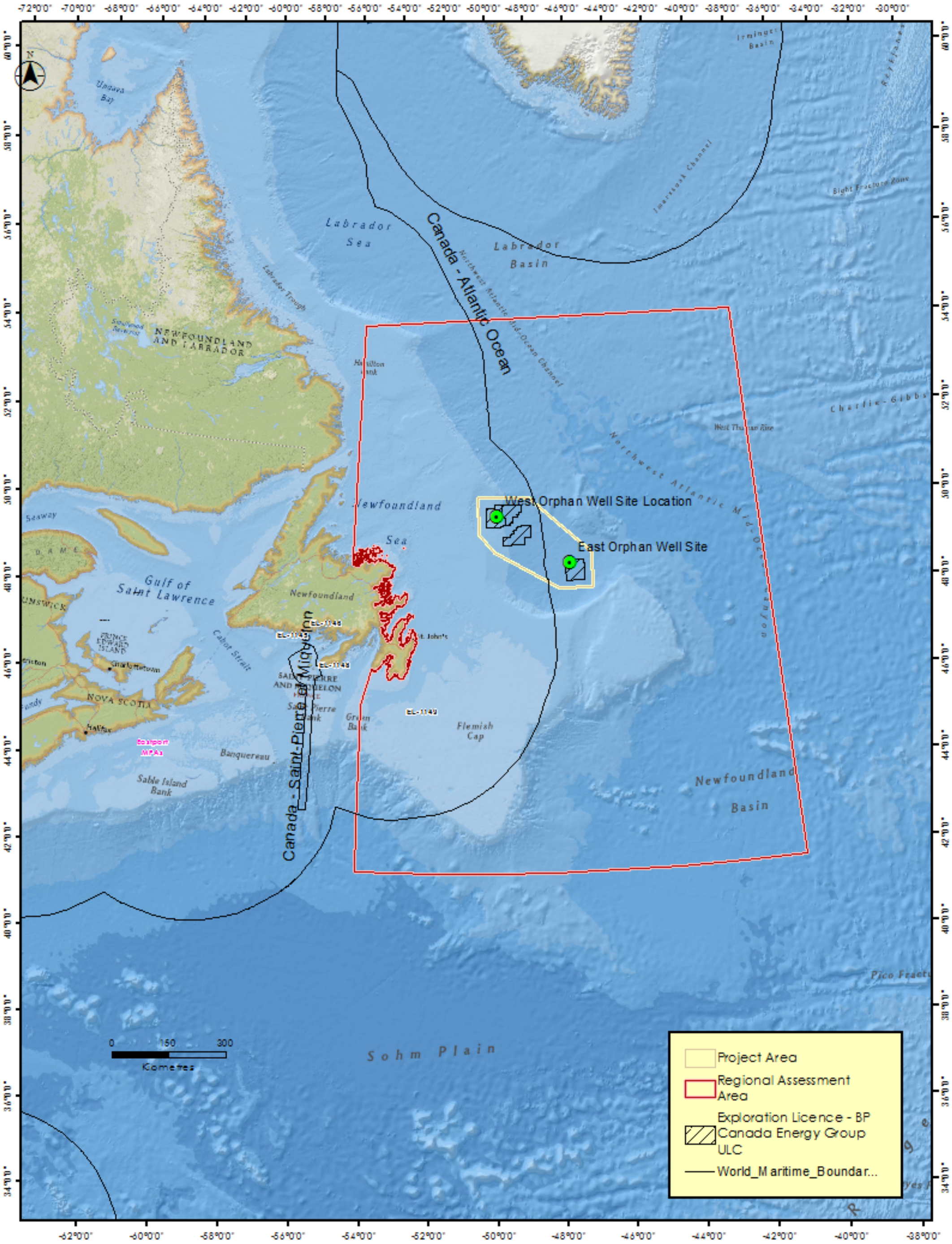
Figure 6.3 Diagram showing the representation of intersection function between surface oil and marine protected areas (top) and possible errors due to vertical separation between surface oil and marine protected areas on the seabed (bottom



6.4 World Maritime Boundaries

A map showing the location of all relevant World Maritime Boundaries (WMBs) is provided in Figure 6.4.

Figure 6.4 Map showing Maritime Boundaries



7 Subsea well blowout modelling results

7.1 Stochastic results

120 day and 30 day unmitigated subsea oil releases were modelled for each wellsite location over 160 day and 90 day periods respectively.

The WO scenarios involve a higher rate and total volume release of oil in shallower water (128,282 bpd at a water depth of 1,360 m) in comparison to the EO scenarios (39,195 bpd) which occur in deeper water (2,785 m).

Separate stochastic simulations were carried out to represent the following weather seasons:

- Winter season (November - April)
- Summer season (May to October)

Ice cover in the region is present in specific regions from November through April, while May through October is mostly ice-free. The simulations were run at varying start times to cover each 6 month season using data for winds, currents and ice from January 2006 through December 2010, thus ensuring that the predicted transport and oil weathering for each oil spill simulation is subjected to a range of prevailing wind current and ice conditions that is historically representative of the time period in question. Although each simulation has the same release information, they have differing trajectory paths, due to the varying start times and associated conditions.

During each simulation, the model records the grid cells contacted by the oil spill trajectory, as well as the time elapsed. Once the stochastic modelling is complete, OSCAR produces statistical outputs (see Section 3.2.2) that includes:

- Probability of sea surface, shoreline, or water column contact that may occur at a given grid cell;
- Minimum time before contact could occur at a given a grid cell;
- Exposure time - duration of oil presence within a given grid cell; and
- Maximum mass / thickness / concentration of oil within a given grid cell

The stochastic figures presented in this study do not imply that the entire contoured area would be covered with oil in the event of a single release. Additionally, these figures do not provide the likelihood of a blowout occurring in any given year. Rather, these stochastic figures denote the probability of oil exceeding identified thresholds at any modelled time step (over 160 days, or 90 days), for each point within the modelled domain, assuming a release were to occur at some point in time.

The minimum time footprints correspond with the associated probability of oil exposure map. Each figure illustrates the shortest amount of time required (from the initial release) for each point within the footprint to exceed the defined threshold. The time reported is the minimum value for each point considering the entire ensemble of trajectories. Together, probability and minimum time figures can be interpreted together to read: "There is a X% probability that oil is predicted to exceed the identified threshold at a specific location, and this exceedance could occur in as little as Y days".

In addition, stochastic maps depicting water column concentrations of total hydrocarbons (dispersed and dissolved oil) or dissolved hydrocarbons only do not specify the depth at which the threshold exceedance occurred. The maps depict the vertical maximum at any time during or after the release. Thus, images do not imply that the entire water column (i.e., from surface to bottom) will experience a concentration above the identified threshold, but rather a concentration may be exceeded at a specific depth (typically within the surface few meters) in the mapped location.

Lower threshold limits on the surface thickness (0.04 µm), total hydrocarbon concentration in the water column (58 ppb) and shoreline concentration (0.001 litres per sq. m) were applied pre-processing, i.e. thresholds were applied to each stochastic simulation output before statistical calculations were performed.

The following sections present a variety of statistical results from the simulations. Seasonal summaries of the stochastic analyses of potential surface oiling (Section 7.1.1) and water column dispersed and dissolved oil concentrations (Section 7.1.2) illustrate the locations of potential oil contamination in Canadian waters surrounding Newfoundland and Nova Scotia, French waters to the south of Newfoundland (Saint-Pierre and Miquelon), as well as Greenland to the North East and International waters (Atlantic) to the east of both sites. Seasonal summaries of potential shoreline oiling statistics are presented in Section 7.1.3. Table 7.1 summarises the predicted areas and lengths exceeding the thresholds for surface oil thickness, water column THC concentration and mass of oil per unit area on shorelines for each of the well blowout scenarios.

While the modelling demonstrates a potentially large affected area, it is important to note that many of the areas delineated through the modelling have low probabilities of occurrence and that results are based on unmitigated relief well and capping stack release scenarios with no other response mitigation measures implemented. In an actual incident, emergency response measures inclusive of containment and recovery operations are likely to have some effect on limiting the magnitude and duration of the spill event and thereby limiting the geographic extent and potential environmental effects of a blowout event.

7.1.1 Surface oil exposure results

Statistical results from the stochastic simulations are presented in the following statistical maps based on all at least 220 runs completed for the summer and winter scenarios):

- Probability of Surface Oiling (Figures 7.1, 7.2, 7.11 and 7.12)
    - Contour map showing the probability of emulsified oil being present on the sea surface at the sheen thickness threshold >0.04 µm (lower limit of visible oil on the sea surface).
- Minimum Travel Time of Surface Emulsified Oil (Figures 7.3, 7.4, 7.13 and 7.14)
    - Contour map showing the quickest time (from all the stochastic trajectories) before emulsified oil is present on the sea surface at thicknesses > 0.04µm.
- Maximum Exposure Time of Surface Emulsified Oil (Figures 7.5, 7.6, 7.15 and 7.16)
    - Contour map showing the longest time (from all the stochastic simulations) that emulsified oil is present within a surface grid cell at thicknesses > 0.04 µm.

- Maximum Emulsified Oil Thickness (Figures 7.7, 7.8, 7,17 and 7.18)
    - Contour map showing the maximum of time-averaged emulsified oil thicknesses calculated for each surface grid cell at the end of each stochastic trajectory (only surface oil thickness values exceeding the 0.04 µm thickness threshold are included in the time-average calculation. Thicknesses are presented as groups accounting to the Bonn Agreement Oil Appearance Code (BAOAC).
- Average of Time-Averaged Emulsified Oil Thickness (Figures 7.9, 7.10, 7.19 and 7.20)
    - Contour map showing the average of time-averaged emulsified oil thicknesses calculated for each surface grid cell at the end of each stochastic trajectory (only surface oil thickness values exceeding the 0.04 µm thickness threshold are included in the time-average calculation. Thicknesses are presented as groups accounting to the Bonn Agreement Oil Appearance Code (BAOAC).

Table 7.1 Predicted areas and lengths exceeding the thresholds for surface oil thickness, water column THC concentration and mass of oil per unit area on shorelines for each of the well blowout scenarios. Areas and lengths are reported for each season and for different probability contours or probability ranges.

Stochastic Scenario Parameters		Scenario 1 - WO Well Blowout - Relief Well 128,000 bpd (Initial oil release rate) / 120 days duration		Scenario 2 - WO Well Blowout - Capping Stack 128,000 bpd (Initial oil release rate) /30 days duration		Scenario 3 - EO Well Blowout - Relief Well 39,000 bpd (Initial oil release rate) / 120 days duration		Scenario 4 - EO Well Blowout - Capping Stack 39,000 bpd (Initial oil release rate) /30 days duration	
Compartment and Threshold	**Probability Contour or Bin**	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)
Surface Compartment: sea surface area (km^2) where emulsified oil thicknesses exceed 0.04 microns	1%	2,938,316 km^2	3,700,143 km^2	1,559,949 km^2	1,946,817 km^2	2,644,358 km^2	3,193,766 km^2	1,720,159 km^2	1,907,078 km^2
	10%	1,781,650 km^2	2,497,608 km^2	810,509 km^2	1,028,453 km^2	1,786,561 km^2	2,129,016 km^2	1,094,638 km^2	1,158,318 km^2
	50%	721,520 km^2	1,173,823 km^2	228,586 km^2	296,911 km^2	1,056,102 km^2	1,296,256 km^2	484,450 km^2	454,614 km^2
	90%	194,157 km^2	450,429 km^2	56,420 km^2	77,292 km^2	528,734 km^2	615,339 km^2	182,826 km^2	137,200 km^2
Water Column Compartment: sea surface area (km^2) where total hydrocarbon concentrations (dispersed and dissolved oil) exceed 58 ppb threshold at some depth within the top 100 m of water column	1%	584,747 km^2	686,049 km^2	436,524 km^2	379,065 km^2	577,890 km^2	447,629 km^2	270,188 km^2	181,573 km^2
	10%	328,796 km^2	369,766 km^2	222,605 km^2	207,265 km^2	220,956 km^2	163,520 km^2	82,414 km^2	56,347 km^2
	50%	147,394 km^2	187,807 km^2	89,026 km^2	97,349 km^2	53,296 km^2	36,348 km^2	20,441 km^2	11,606 km^2
	90%	76,627 km^2	98,571 km^2	36,319 km^2	38,763 km^2	12,264 km^2	7,971 km^2	4,209 km^2	1,546 km^2
Shoreline Compartment: length (km) of shoreline where sea surface area (km^2) where stranded oil thickness exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m2)	<1%	58 km	270 km	0 km	69 km	38 km	205 km	0 km	39 km
	1 - 2%	0 km	66 km	0 km	8 km	21 km	91 km	0 km	0 km
	2 - 5%	0 km	66 km	0 km	0 km	4 km	24 km	0 km	0 km
	5 - 7%	0 km	31 km	0 km	0 km	0 km	0 km	0 km	0 km
	>7%	0 km	0 km	0 km	0 km	0 km	0 km	0 km	0 km
Worst (100th percentile) case: maximum accumulated mass of oil on shoreline		2 tonnes	403 tonnes	0 tonnes	52 tonnes	6 tonnes	271 tonnes	0 tonnes	9 tonnes
Shortest arrival time for stranded oil		145 days	35 days	n/a days	28 days	133 days	27 days	n/a days	34 days

7.1.1.1 West Orphan release site

Figure 7.1 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold for probabilities > 5%

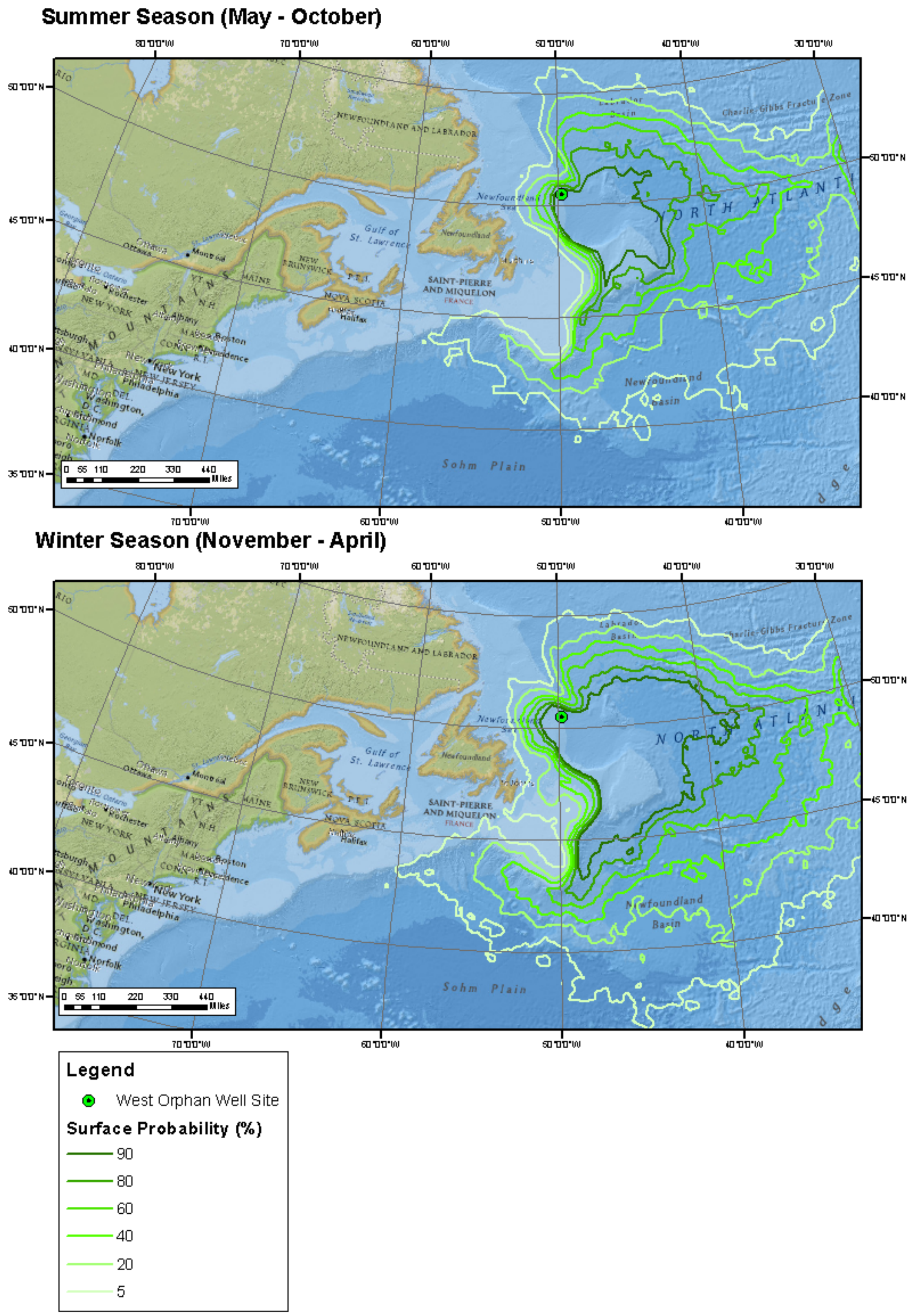
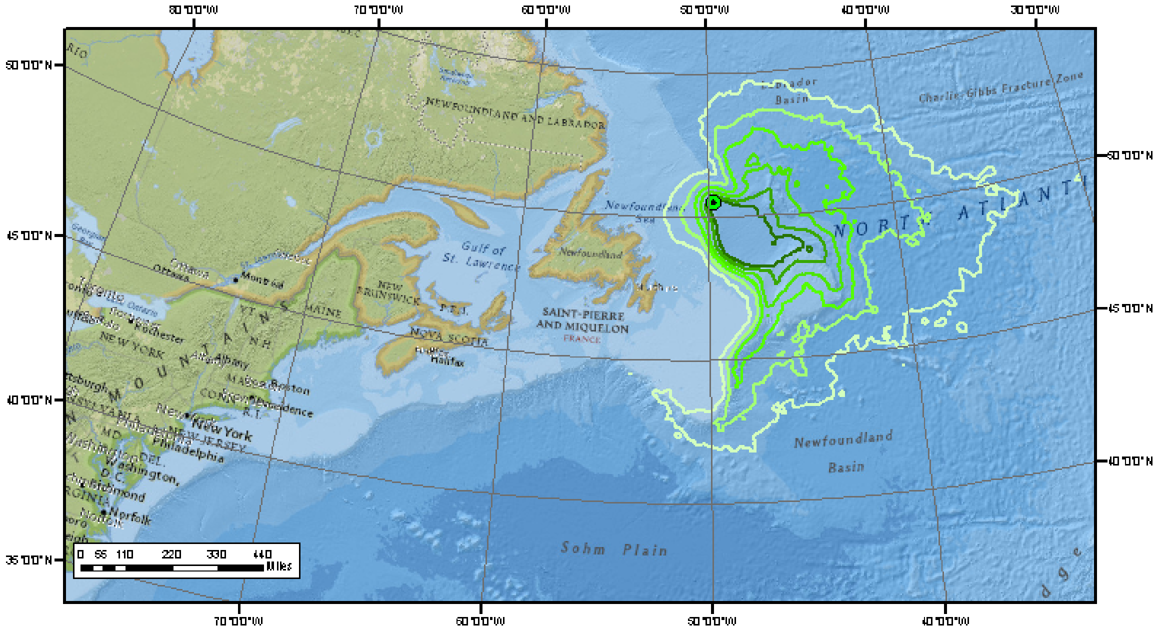


Figure 7.2 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold for probabilities > 5%

Summer Season (May - October)



Winter Season (November - April)

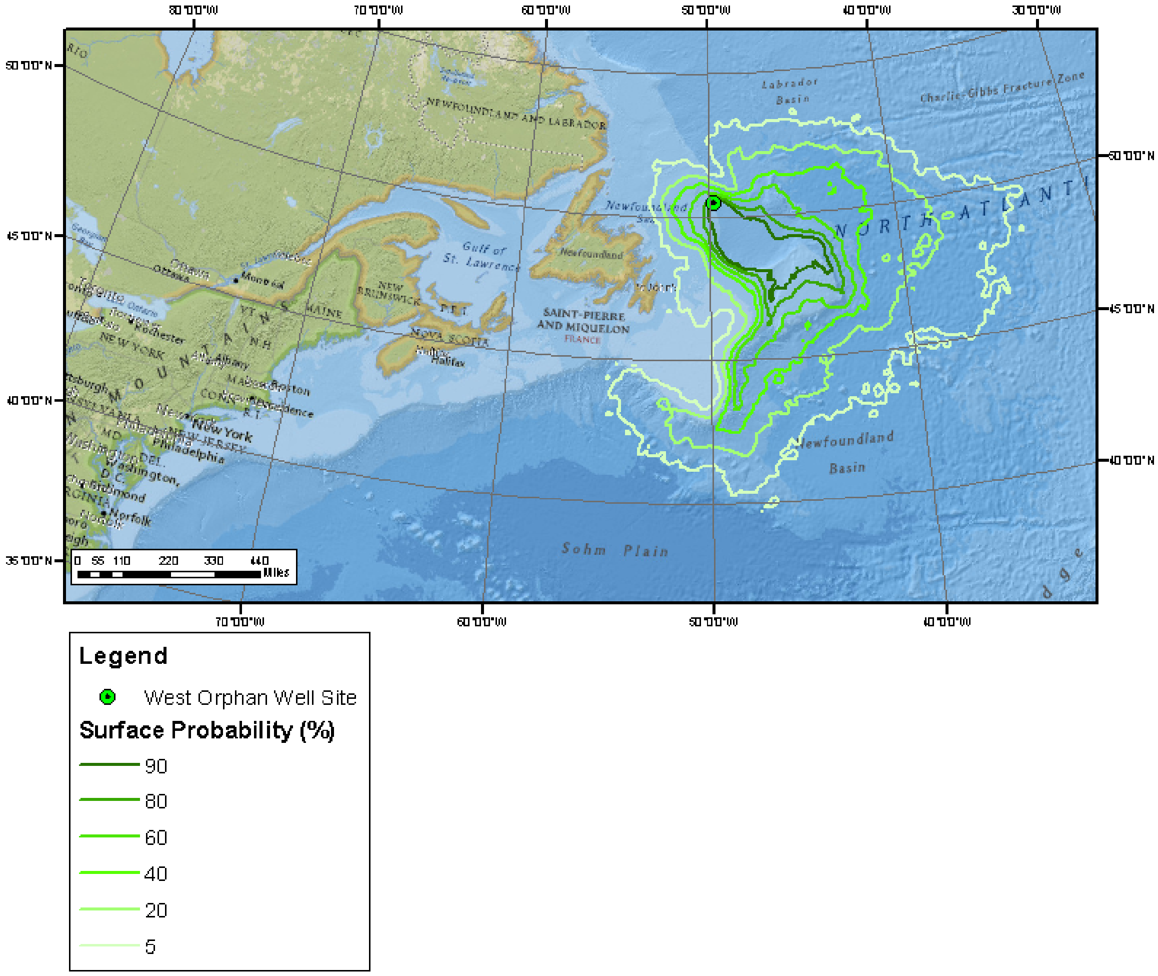


Figure 7.3 Scenario 1: West Orphan relief well scenario (120 day duration), Statistical contour maps showing the minimum travel time before the emulsified oil thicknesses on the sea surface exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR.

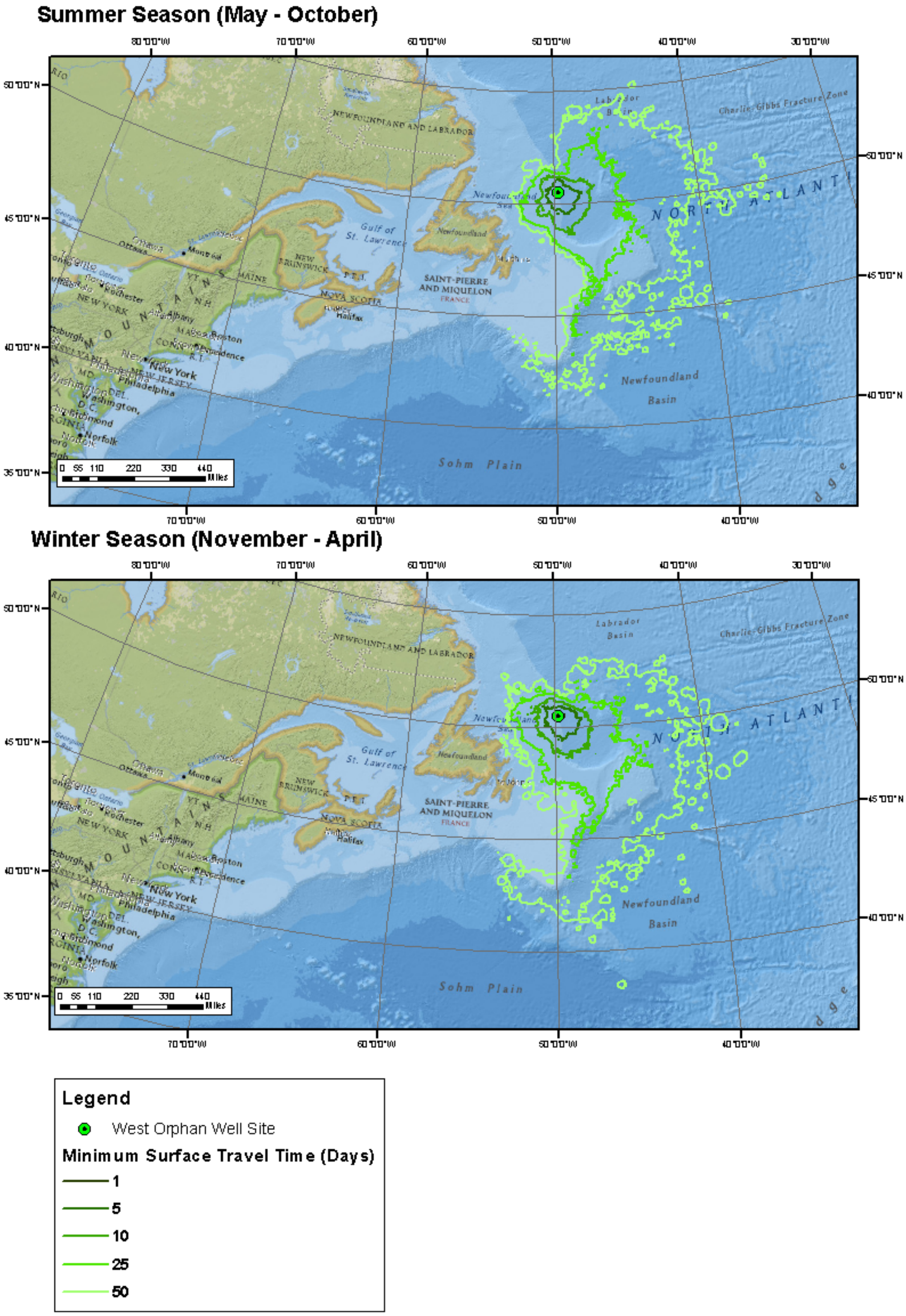


Figure 7.4 Scenario 2: West Orphan capping stack containment scenario (30 day duration), Statistical contour maps showing the minimum travel time before the emulsified oil thicknesses on the sea surface exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR.

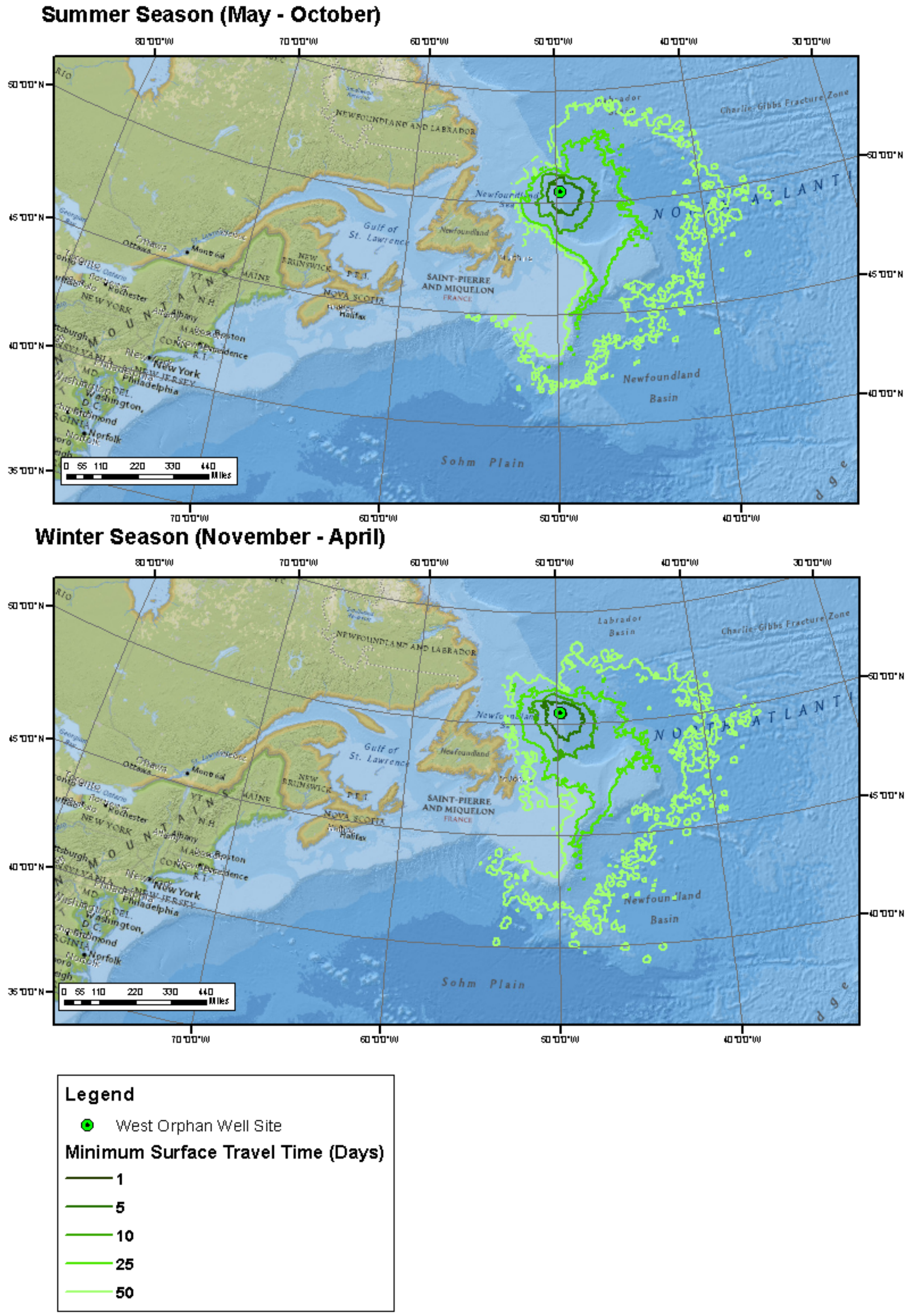


Figure 7.5 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.

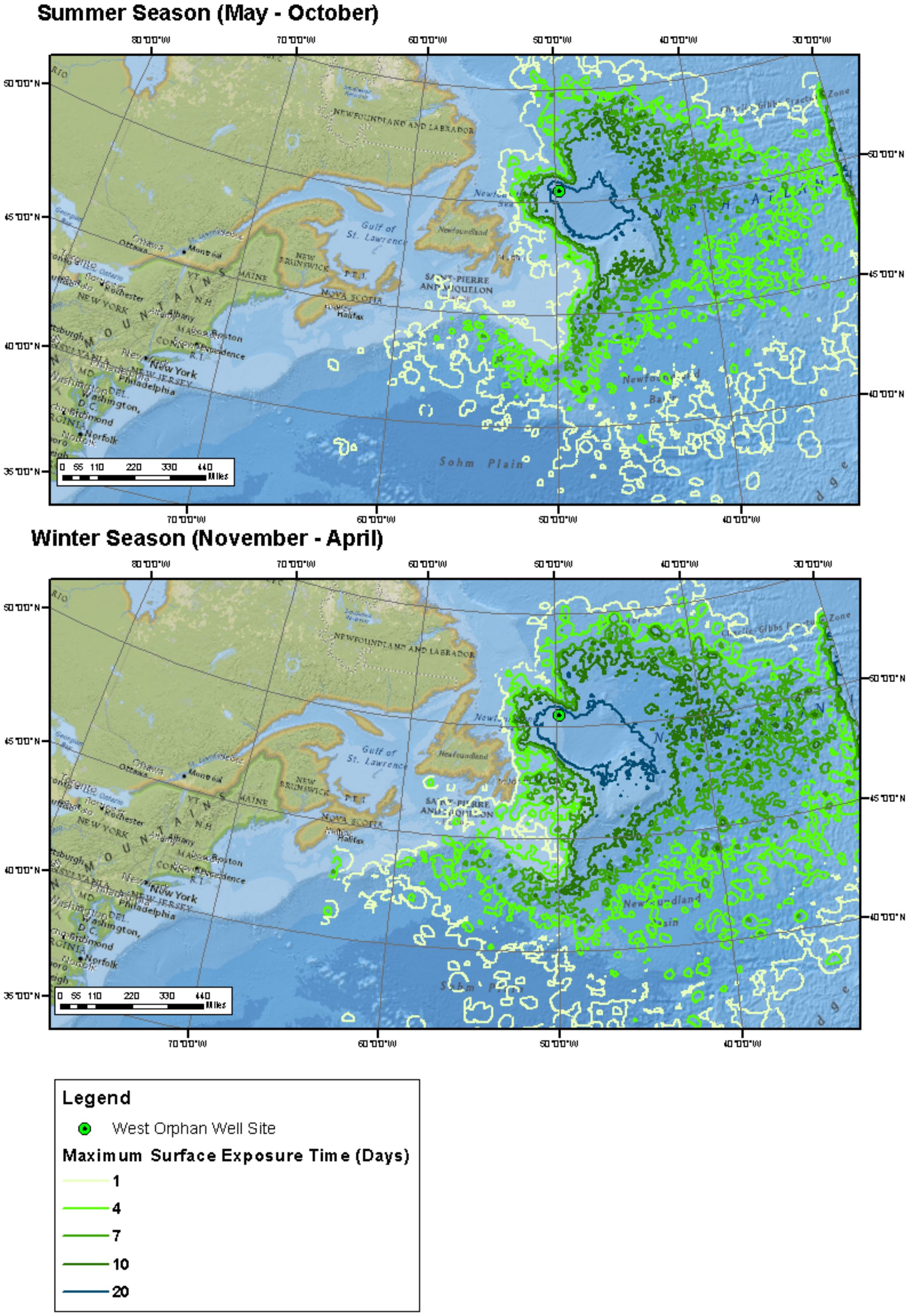


Figure 7.6 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.

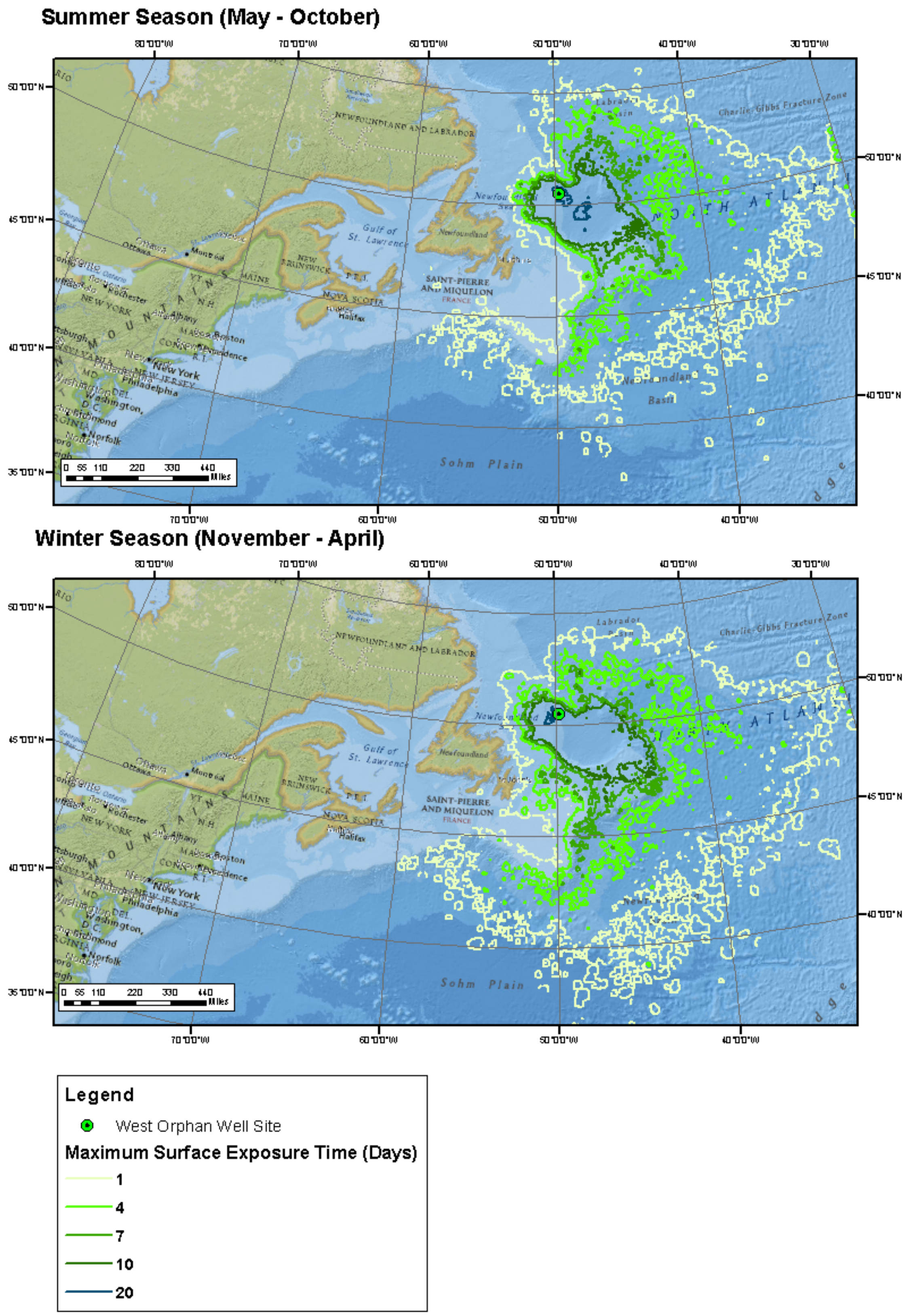


Figure 7.7 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.

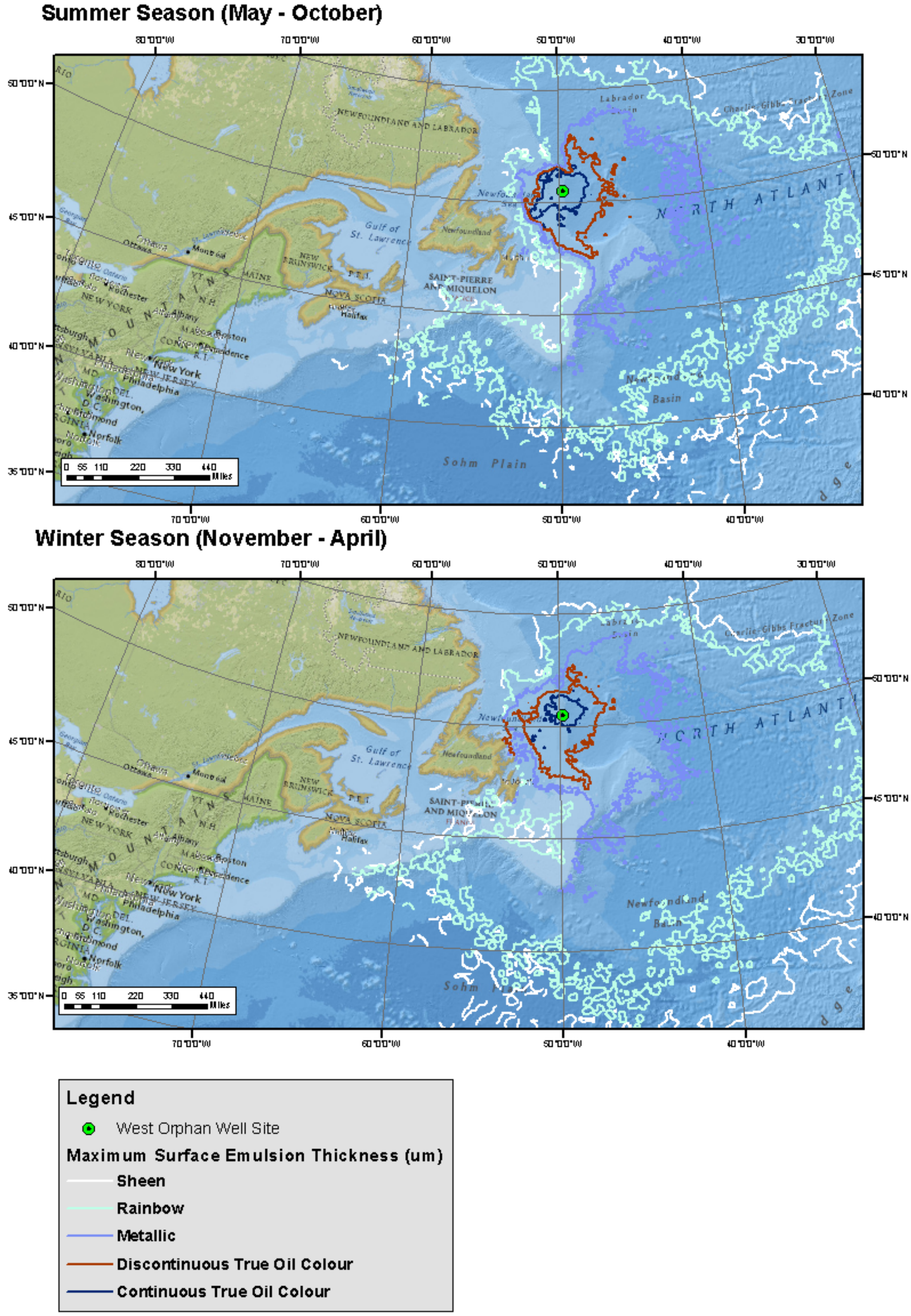


Figure 7.8 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.

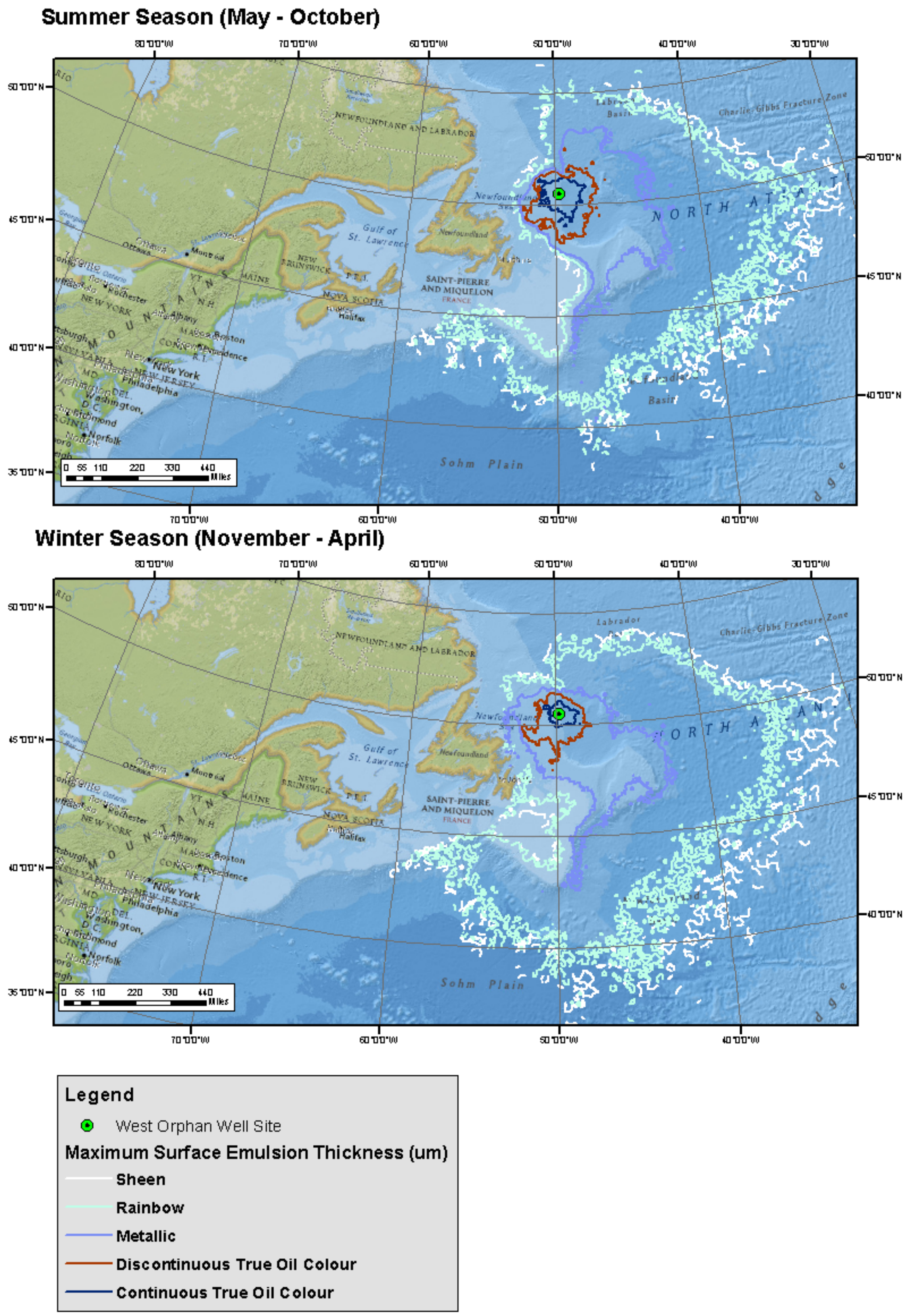


Figure 7.9 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the average of time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.

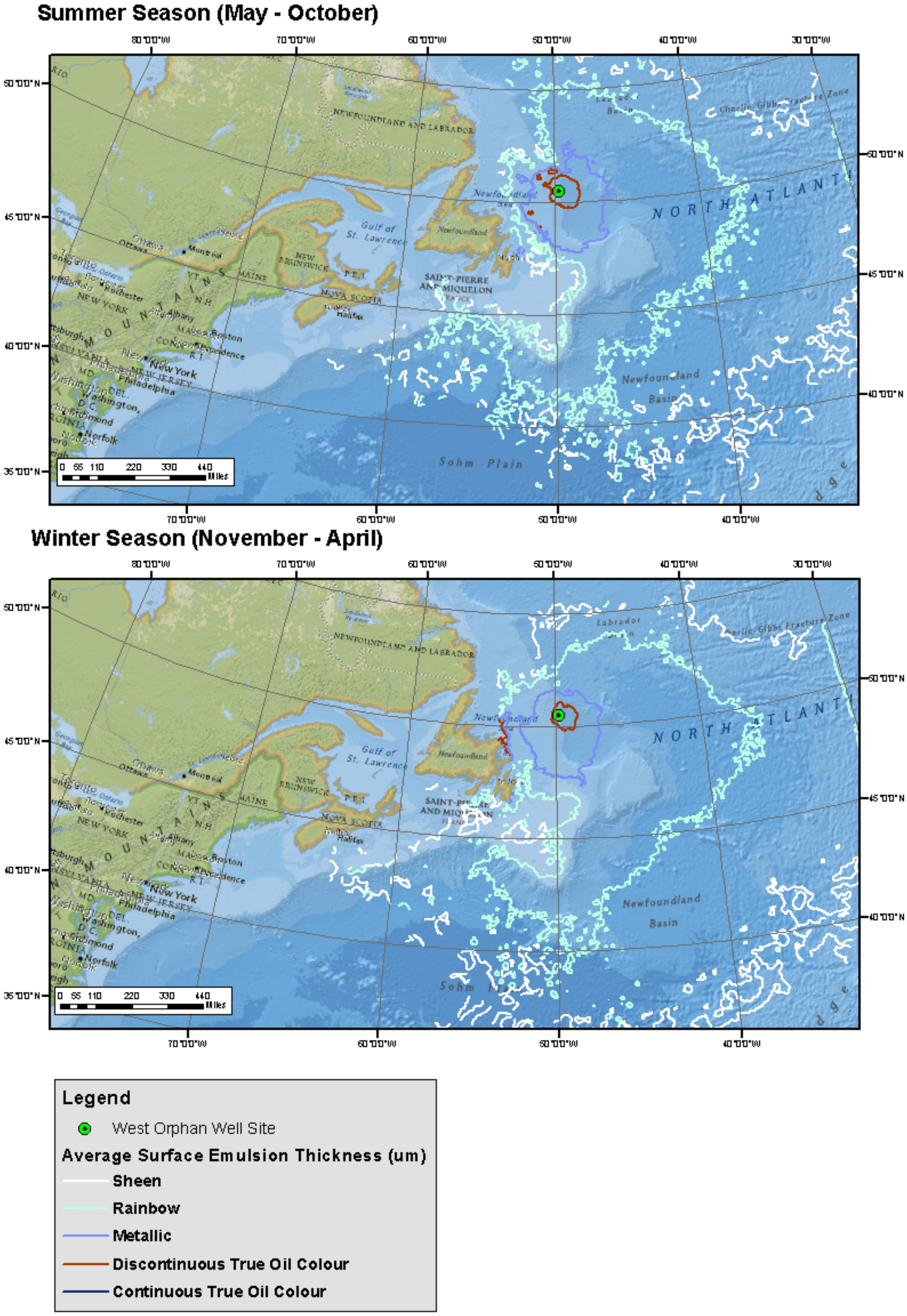
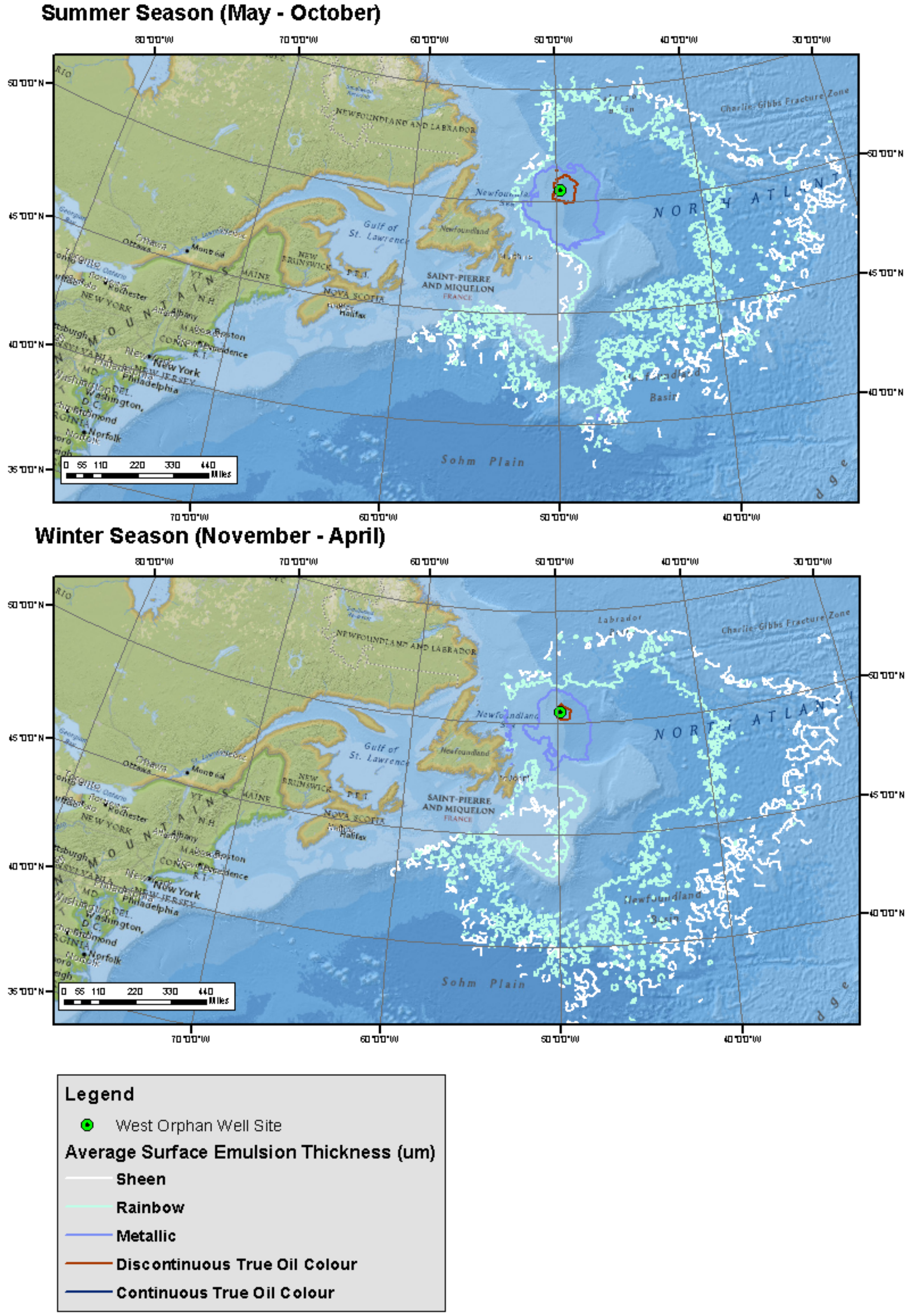


Figure 7.10 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the average of time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps.



7.1.1.2 East Orphan release site

Figure 7.11 Scenario 3: East Orphan relief well scenario (120 day duration), Statistical contour maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold for probabilities > 5%

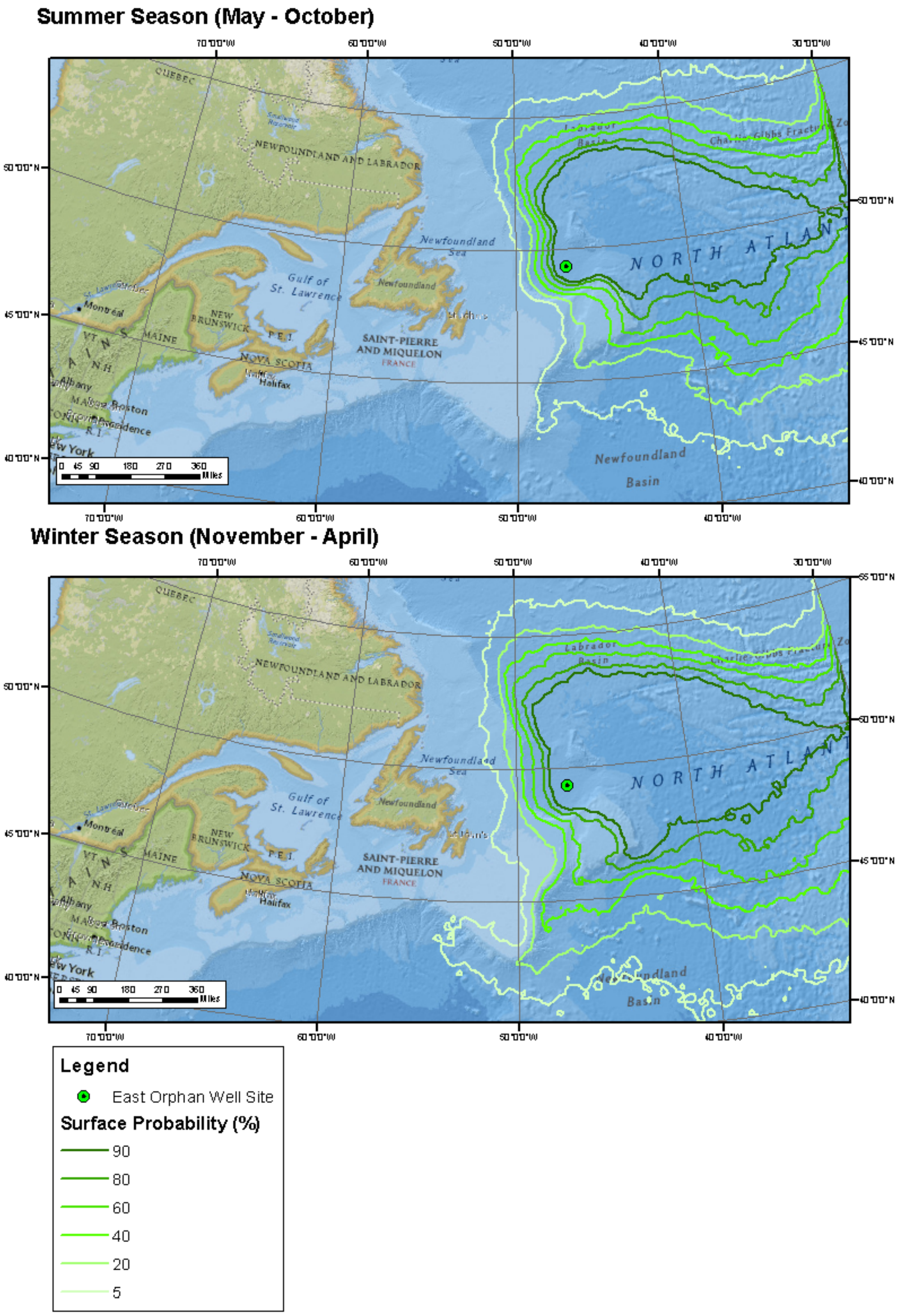


Figure 7.12 Scenario 4: East Orphan capping stack containment scenario (30 day duration), Statistical contour maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold for probabilities > 5%

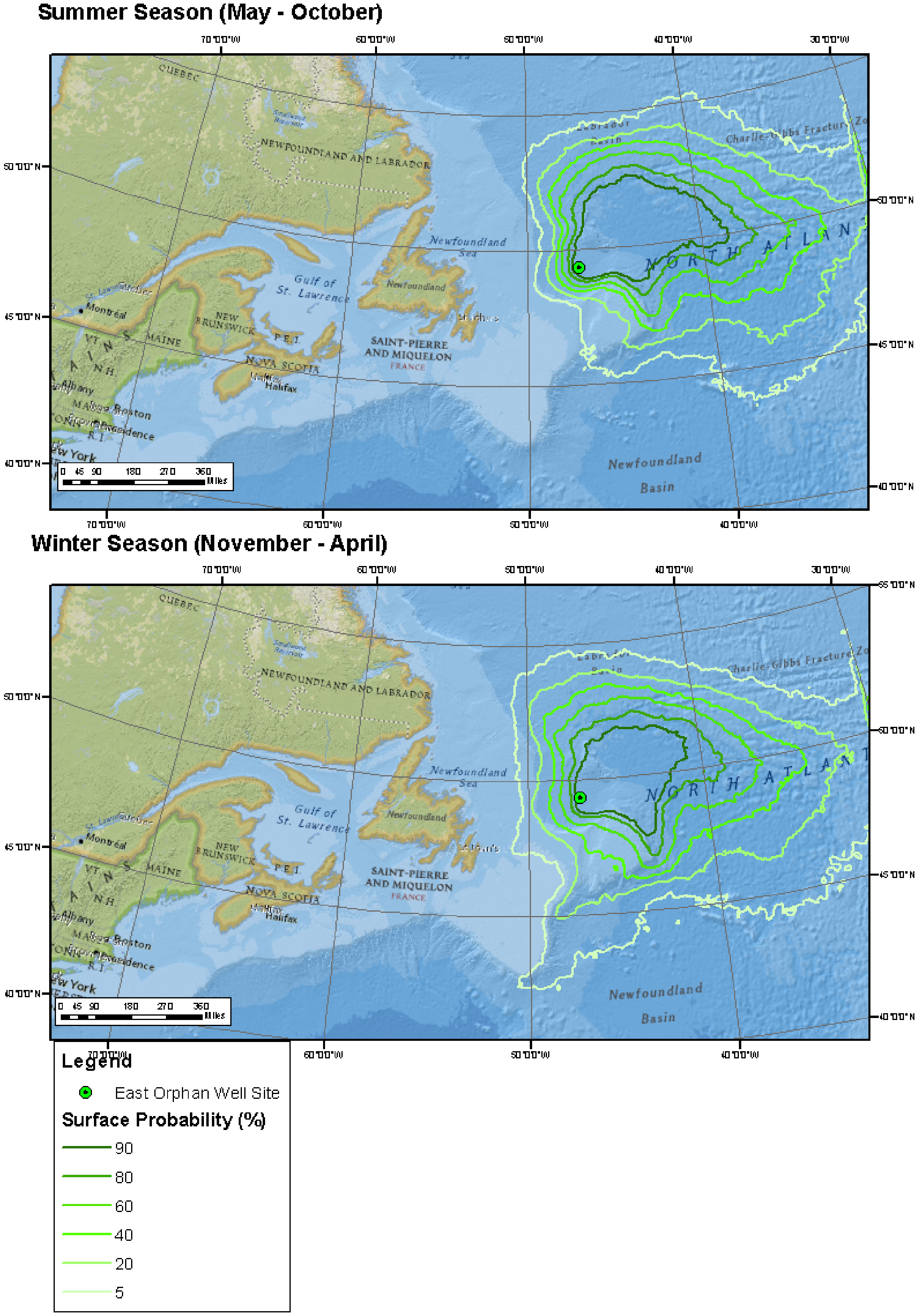
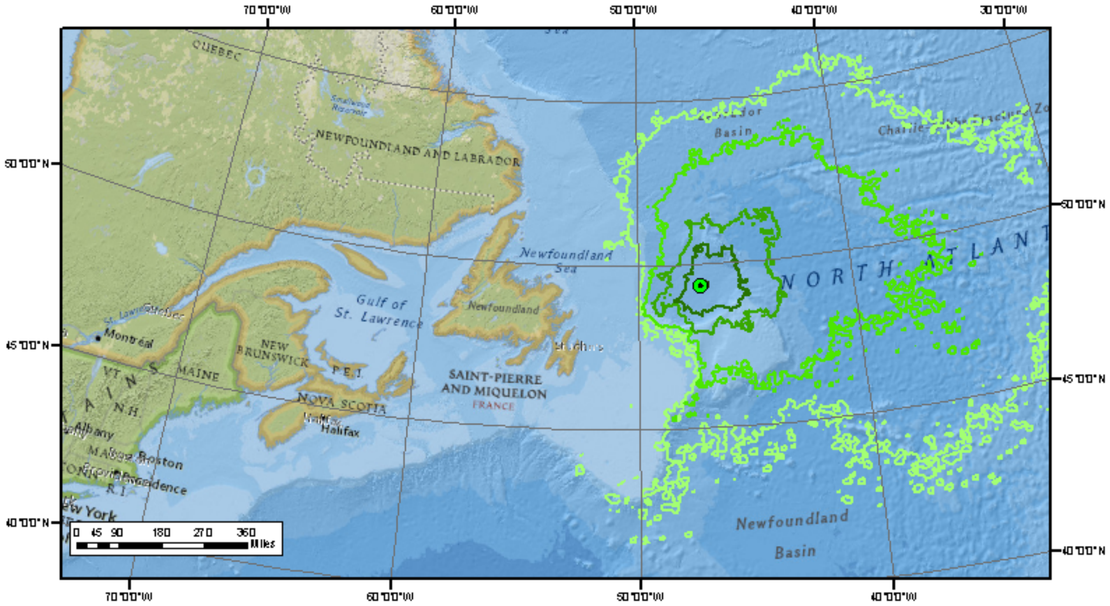
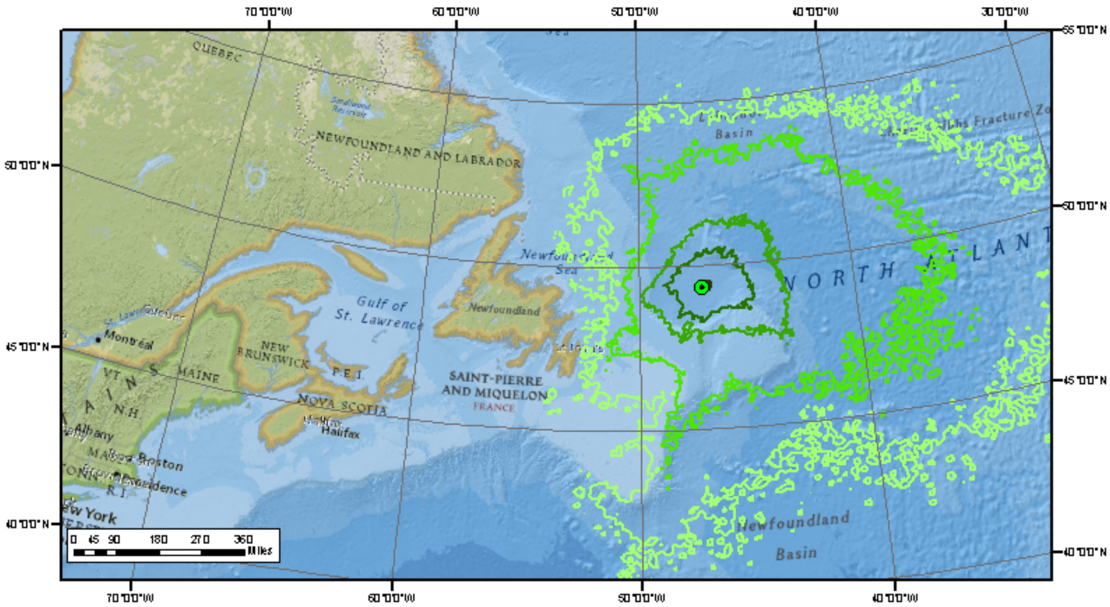


Figure 7.13 Scenario 3: East Orphan relief well scenario (120 day duration), Statistical contour maps showing the minimum travel time before the emulsified oil thicknesses on the sea surface exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

Summer Season (May - October)



Winter Season (November - April)



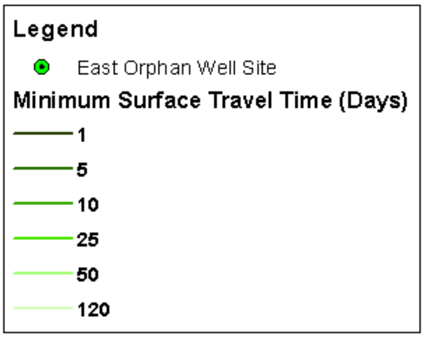


Figure 7.14 Scenario 4: East Orphan capping stack containment scenario (30 day duration), Statistical contour maps showing the minimum travel time before the emulsified oil thicknesses on the sea surface exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

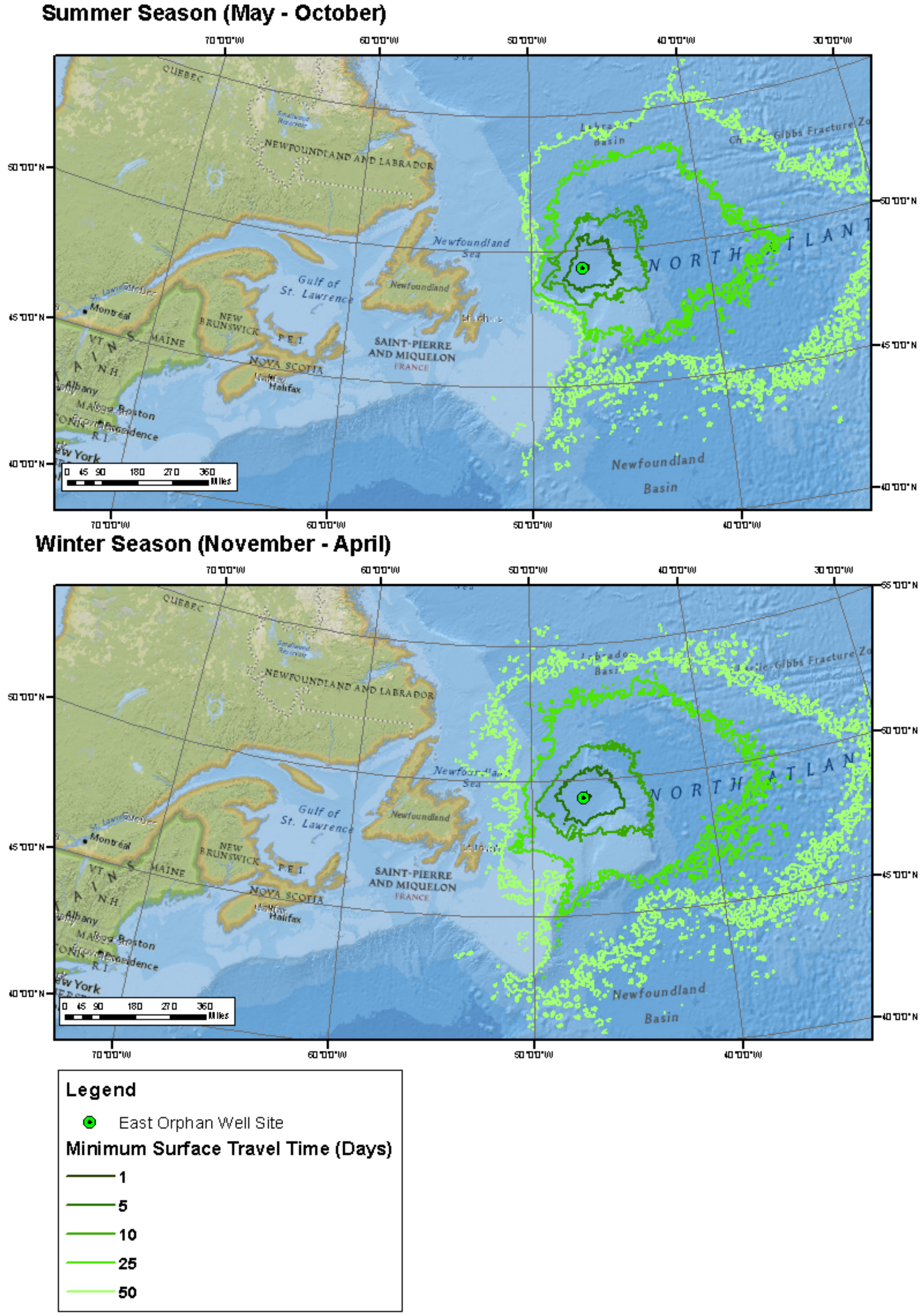


Figure 7.15 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

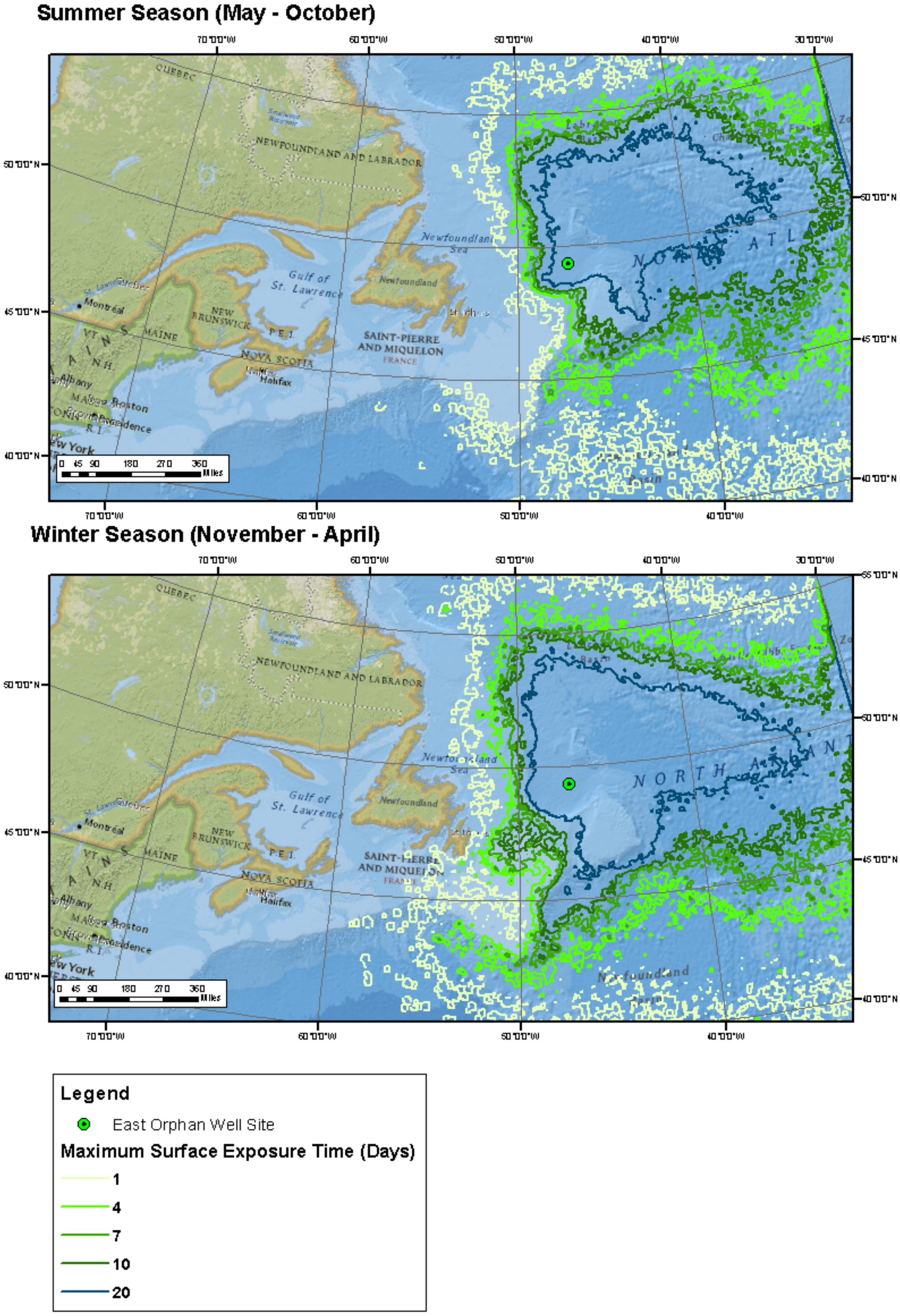


Figure 7.16 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold. No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

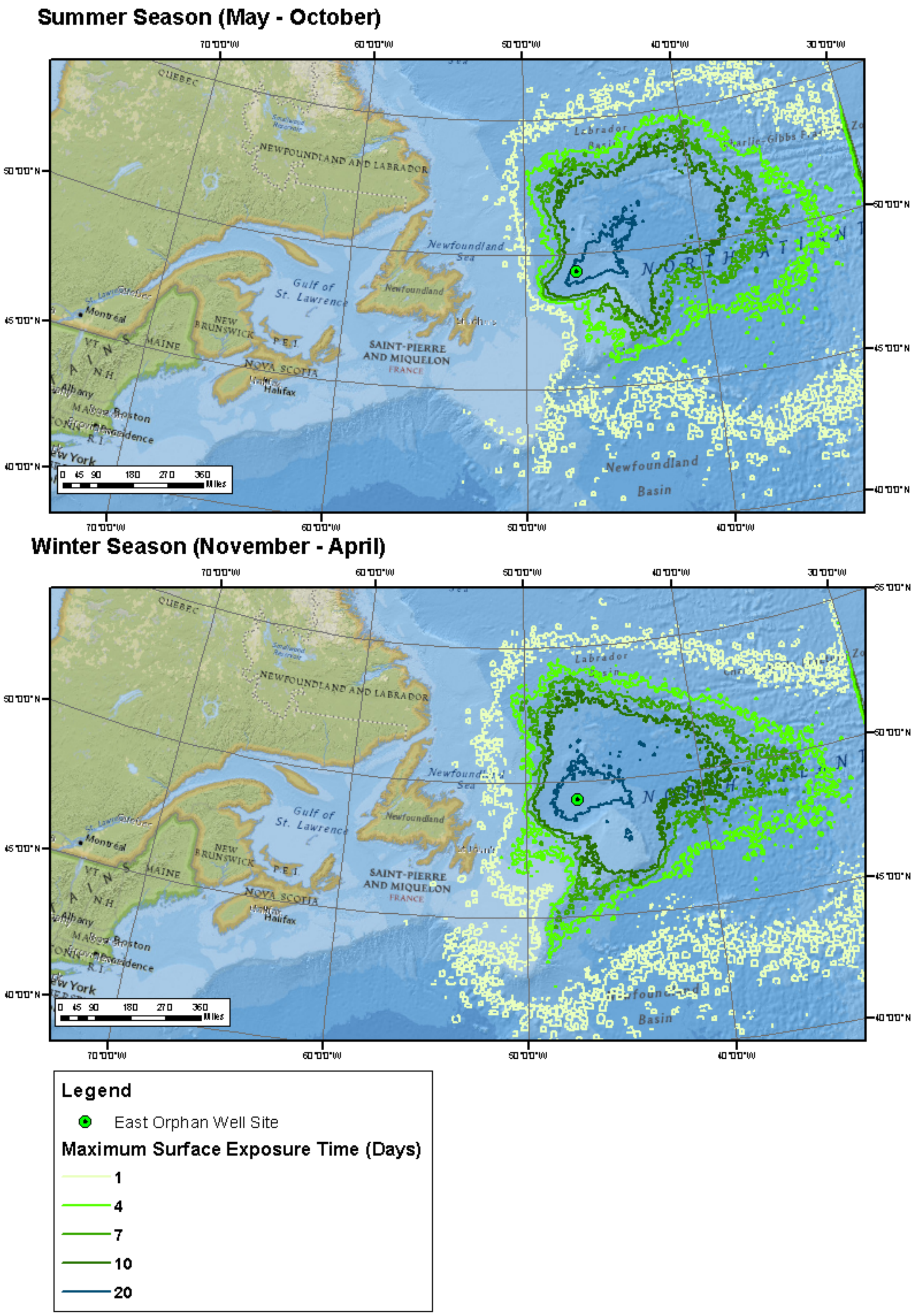


Figure 7.17 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

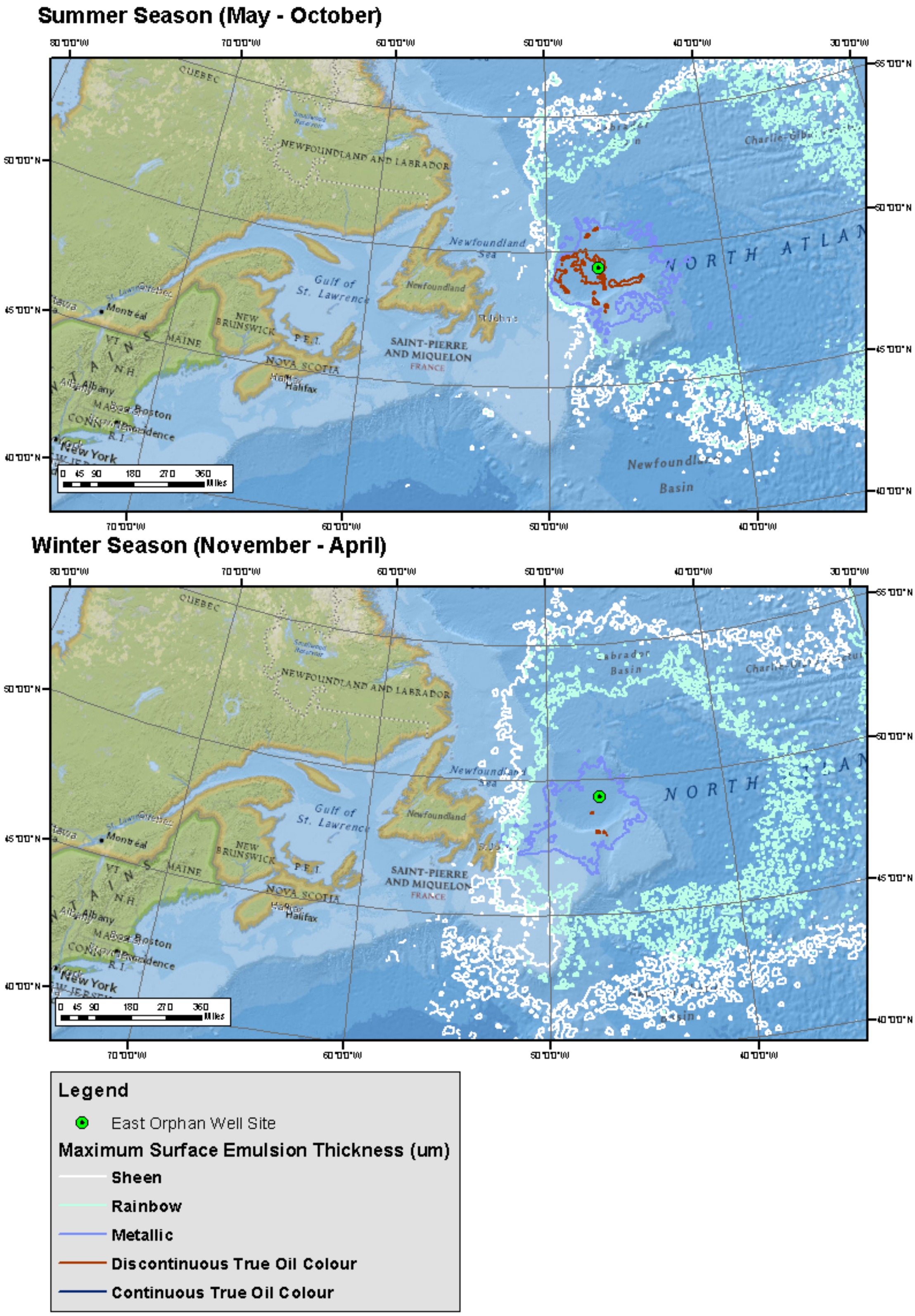
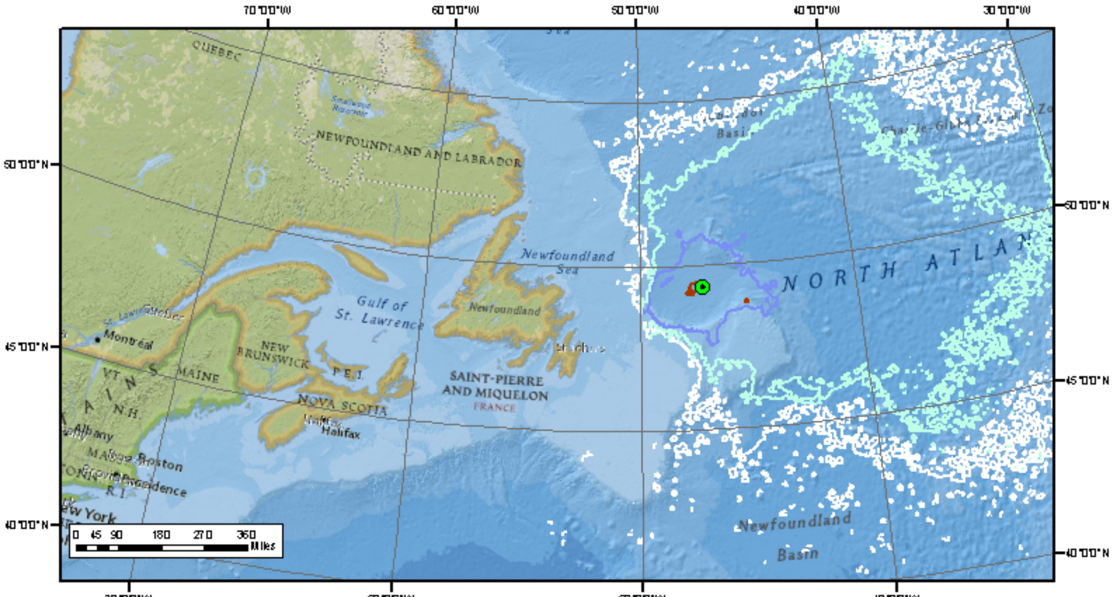
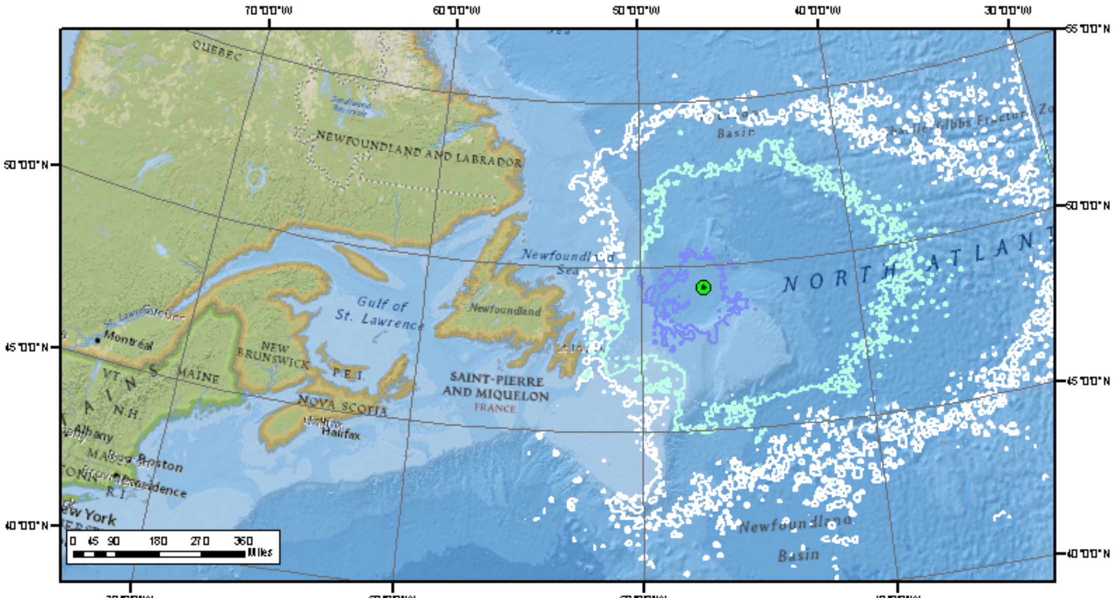


Figure 7.18 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

Summer Season (May - October)



Winter Season (November - April)



Legend

East Orphan Well Site

Maximum Surface Emulsion Thickness (um)

- Sheen
- Rainbow
- Metallic
- Discontinuous True Oil Colour
- Continuous True Oil Colour

Figure 7.19 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical contour maps showing the average of time-averaged emulsified oil thickness on the sea surface (0.04μm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps

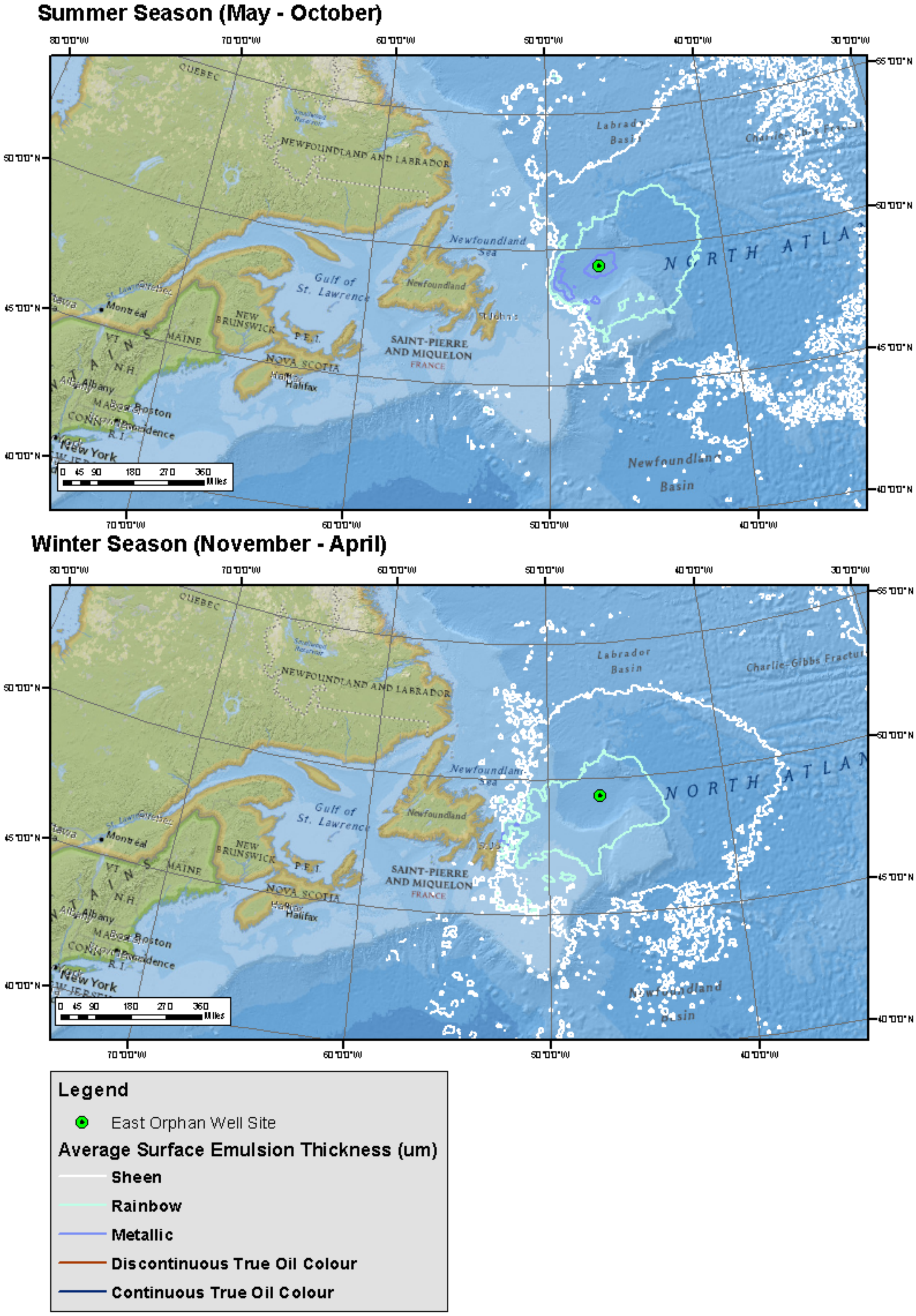
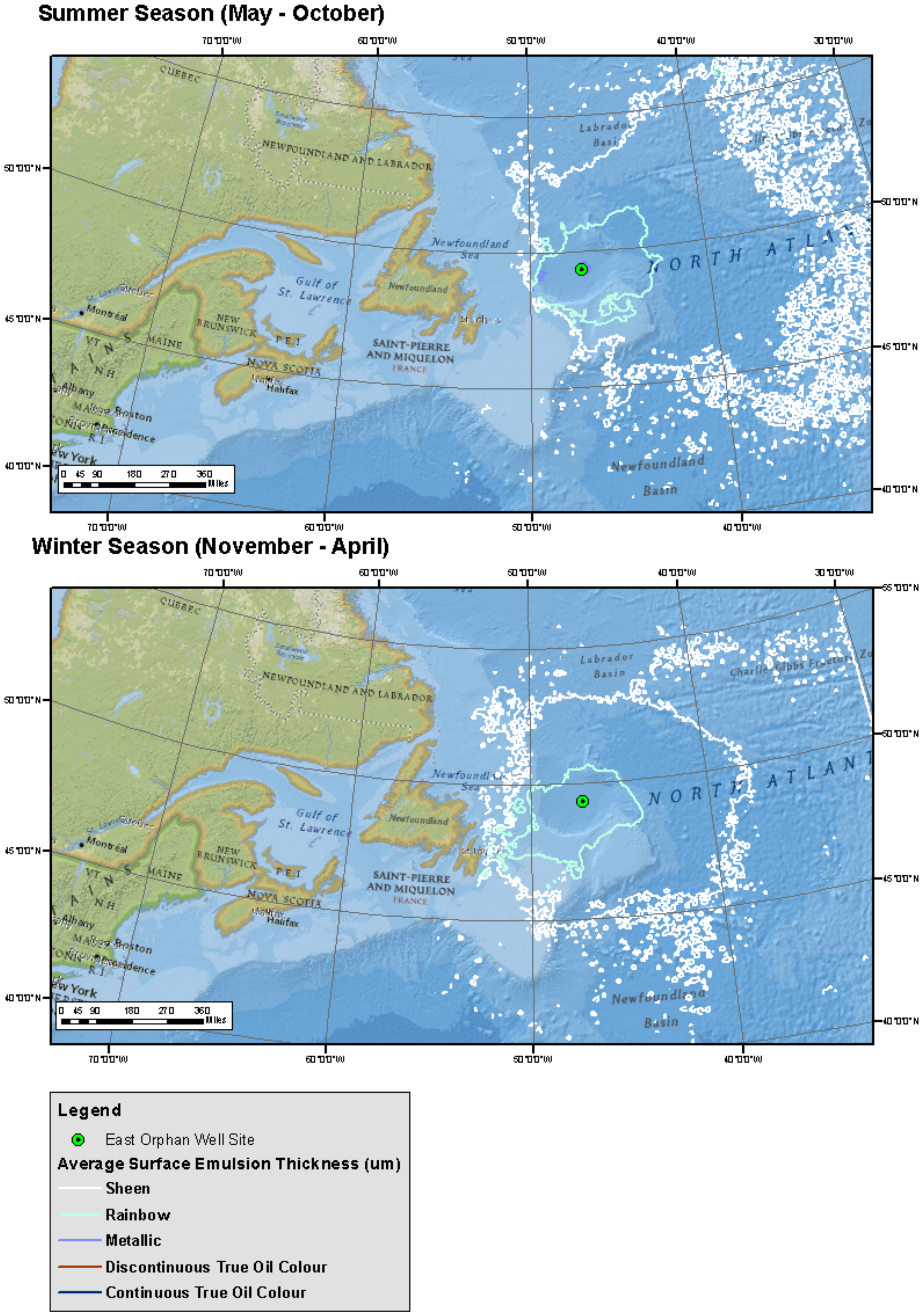


Figure 7.20 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the average of time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied). No probability threshold is applied due to limited functionality in OSCAR. This explains the slightly larger extent than shown in the surface emulsified oil probability maps



7.1.1.3 Summary of stochastic surface oil exposure results

West Orphan

Trajectories for the WO blowout scenarios were predicted to drift in all directions, but extended out more towards the east from the release location. For example for the relief well scenario the extent of the sea surface area with greater than 5% probability of sea surface oil contact exceeding the 0.04 µm (Bonn Agreement Oil Appearance Code (BAOAC) Sheen) thickness threshold extended 270 km westward from the release location but 1,350 km to the east (Figure 7.1). This is attributable to the predominantly westerly winds throughout the year. However, there was a notable seasonal variation in the movement of oil, with a higher potential for surface oil contamination to the south and east of Newfoundland and east of Nova Scotia during winter months (Figure 7.1). This was especially true for the Avalon Peninsula where the probability of sea surface oil contact exceeding the 0.04 µm Sheen BAOAC threshold in near coastal waters was 0% during the summer season but increased to 5% in the winter months. The west to north westerly winds and higher frequency and strength of surface currents towards the south and SSE during the winter months transports the oil further south during the winter season, whereas the predominant south westerly winds transports the oil away from the Avalon coastline in the summer months. In the event that surface oil was to enter the near-shore area of Newfoundland during the winter season, it would take a minimum of 50 days to arrive (Figures 7.3).

The stronger winds and currents during the winter months transported the surface oil further away from the release site, resulting in a larger trajectory footprint. For example the predicted cumulative footprint of locations where there is a > 50% probability of surface oil thicknesses exceeding the 0.04 micron BAOAC Sheen threshold was 1,173,820 km^2 for the winter season compared to 721,520 km^2 for the summer season (Table 7.1).

The same trajectory and seasonal trends were observed for the capping stack scenarios, however the footprints were considerably smaller due to the smaller release volumes (Figure 7.2). For example the predicted cumulative footprint of locations where there is a > 50% probability of surface oil thicknesses exceeding the 0.04 micron BAOAC Sheen threshold was 296,910 km^2 for the winter season and 228,590 km^2 for the summer season (Table 7.1).

The duration of surface exposure for near shore waters of Newfoundland was 0 to 1 day. The low surface exposure times suggests that the complex coastal circulation patterns and the turbulent nature of the sea in the region are continually mixing any surface oil into the upper water column reducing exposure time on surface. Exposure times increase on approaching the release site. For example, in the worst exposure scenario (relief well, winter season) Figure 7.5 shows that the area where oil might be present on the surface for > 20 days measures 615 km by 320 km in the respective NW to SE and SW – NE directions at its maximum extent.

The higher wind speeds and associated waves in winter result in significantly more entrainment, reducing the spatial extent of thick oil (BAOAC Dark (or True) colour) on the sea surface (Figures 7.7 and 7.9).

East Orphan

The smaller volume release at EO and the more southern easterly release location resulted in predicted oil trajectories to the north and east (Figure 7.11), attributable to the easterly bias in surface currents at the EO location. In addition, as a result of the deeper well location, oil travels further in the water column and is dispersed more widely before surfacing. Hence, the footprint around the EO release location (relief well scenario) of high (>50%) probability surface oiling occurrences exceeding the 0.04 micron BAOAC Sheen threshold was larger than that predicted for the WO location. For example, 1,296,256 km^2 for the winter season and 1,056,102 km^2 for the summer season compared to 1,173,823 km^2 and 721,520 km^2 for the equivalent WO scenarios (Table 7.1). Similarly, the area where oil might be present on the surface for > 20 days was also larger, typically measuring circa 1,100 km by 800 km in the respective NW to SE and SW – NE directions at its maximum extent (Figure 7.15).

The resulting surface oil slick was also predicted to be thinner for the EO scenarios, with no thick oil (BAOAC Dark (or True) colour) occurrences on the sea surface (Figures 7.17 - 7.20).

The same seasonal variation in the movement of oil was predicted, with a higher potential for surface oil contamination to the south during winter months. In addition, as the EO well location is further offshore, the probability of sea surface oil contact exceeding the 0.04 µm BAOAC Sheen threshold only exceeded 1% at distance > 225 km from the coast for the relief well scenario during the summer season (compared to 40 km for the equivalent WO case). However, there was a 1% probability of surface oil being present in the near-coastal waters of the Avalon Peninsula during the winter months and it would take a minimum of 70 days to arrive. The duration of surface exposure was < 1 day.

The stochastic results also demonstrated the potential locations for spill effects exceeding threshold levels beyond the RAA boundary, and in some cases, beyond Canadian jurisdiction (Saint-Pierre and Miquelon - France, Greenland and the Azores. See Section 7.3 and Annex D). However average probabilities are low (<10%) and arrival times > 50 days. The potential for surface oil to intersect Protected Areas and Special Areas is presented in Section 7.3 and Annex D.

7.1.2 Water Column Results

Seasonal summaries from the stochastic simulations are presented in the following statistical maps based on at least 220 runs completed for the summer and winter scenarios:

- Probability of Water Column Contamination (Figures 7.21 - 7.23, 7.32 - 7.34)
  - Contour map showing the probability of oil being present in the water column at total hydrocarbon (THC) concentrations (dispersed and dissolved oil) exceeding the 58 ppb THC threshold level.
- Minimum Travel Time of Oil in the Water Column (Figures 7.24, 7.25, 7.35 and 7.36)
  - Contour map showing the quickest time (from all the stochastic trajectories) before the THC concentration in any water column grid cell exceeds the 58 ppb THC concentration threshold.
- Maximum Exposure Time of Oil in the Water Column (Figures 7.26, 7.27, 7.37 and 7.38)
  - Contour map showing the longest time (from all the stochastic trajectories) that the THC concentration in any water column grid cell exceeds the 58 ppb THC concentration threshold.

- Maximum Time-Averaged THC Concentration in the Water Column (Figures 7.28, 7.29, 7.39 and 7.40)
    - Contour map showing the maximum of time-averaged THC concentration values calculated for each water column grid cell at the end of each stochastic trajectory (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations)
- Maximum Time-Averaged Dissolved Oil Concentration in the Water Column (Figures 7.30, 7.31, 7.41 and 7.42)
    - Contour map showing the maximum of time-averaged dissolved oil concentration values > 1 ppb calculated for each water column grid cell at the end of each stochastic trajectory (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations).

7.1.2.1 West Orphan release site

Figure 7.21 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column over the simulation period based on all simulations for probabilities > 5%

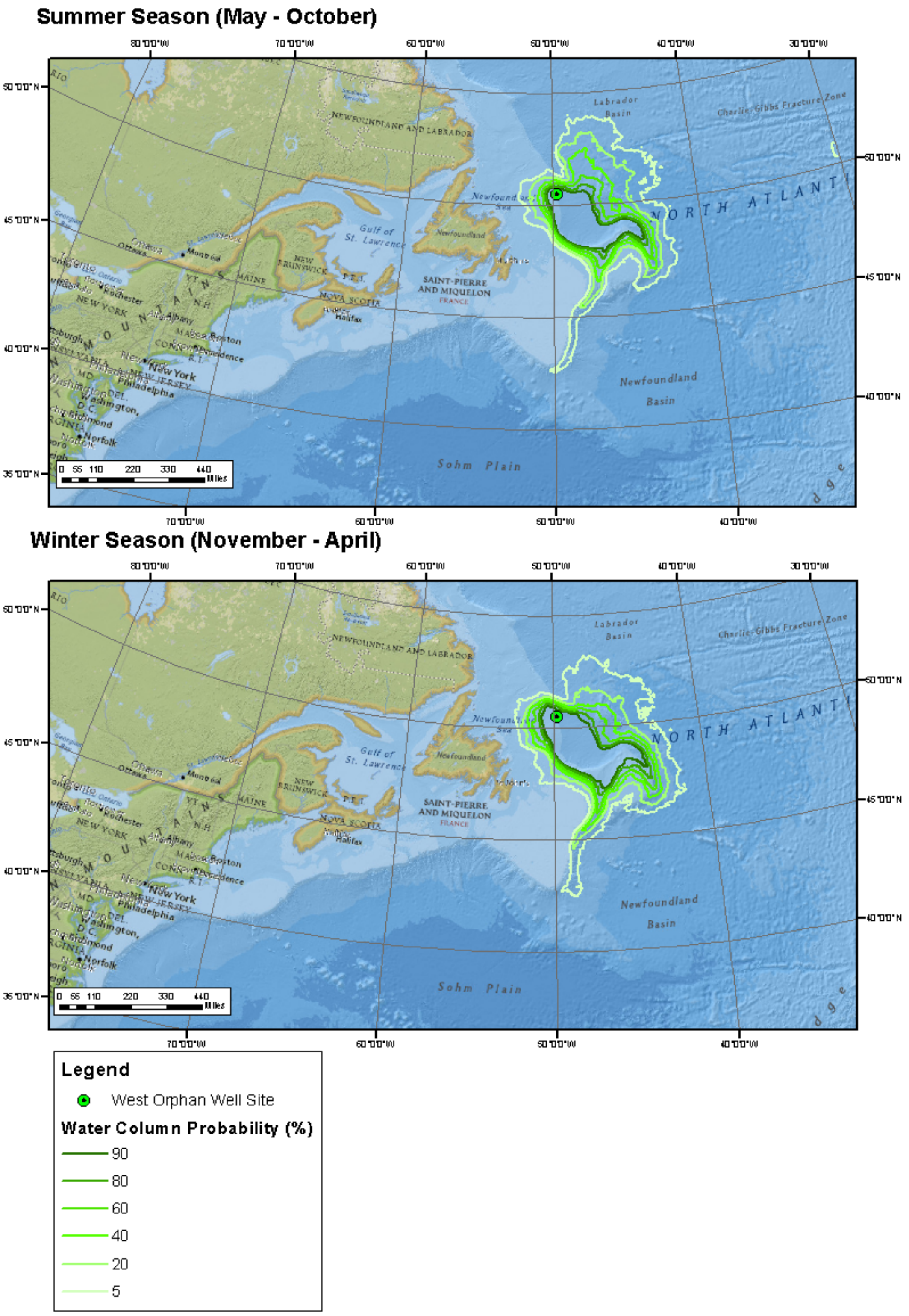


Figure 7.22 Scenario 1: West Orphan relief well scenario - Summer Season (120 day duration). Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the entire water column over the simulation period based on all simulations for probabilities > 5%. Left picture shows a cross section through the water column

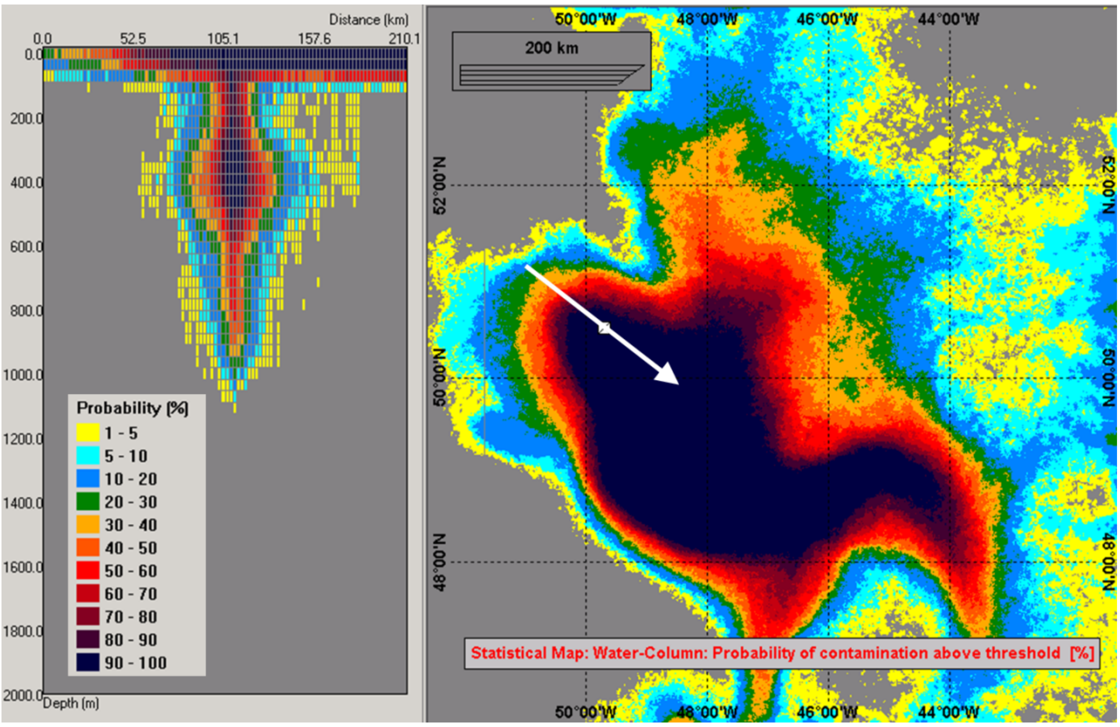


Figure 7.23 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column over the simulation period based on all simulations for probabilities > 5%

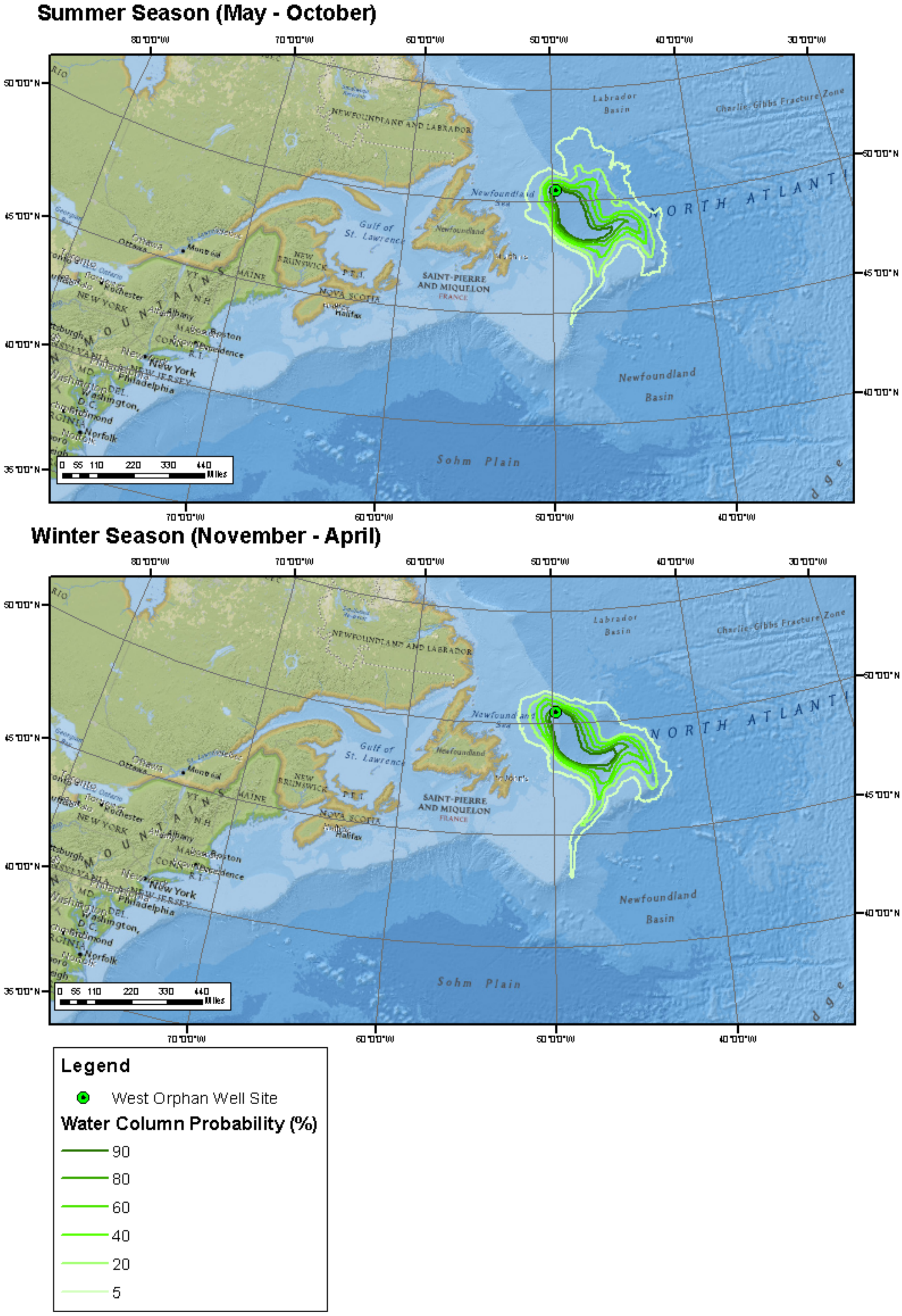


Figure 7.24 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the minimum time before the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).

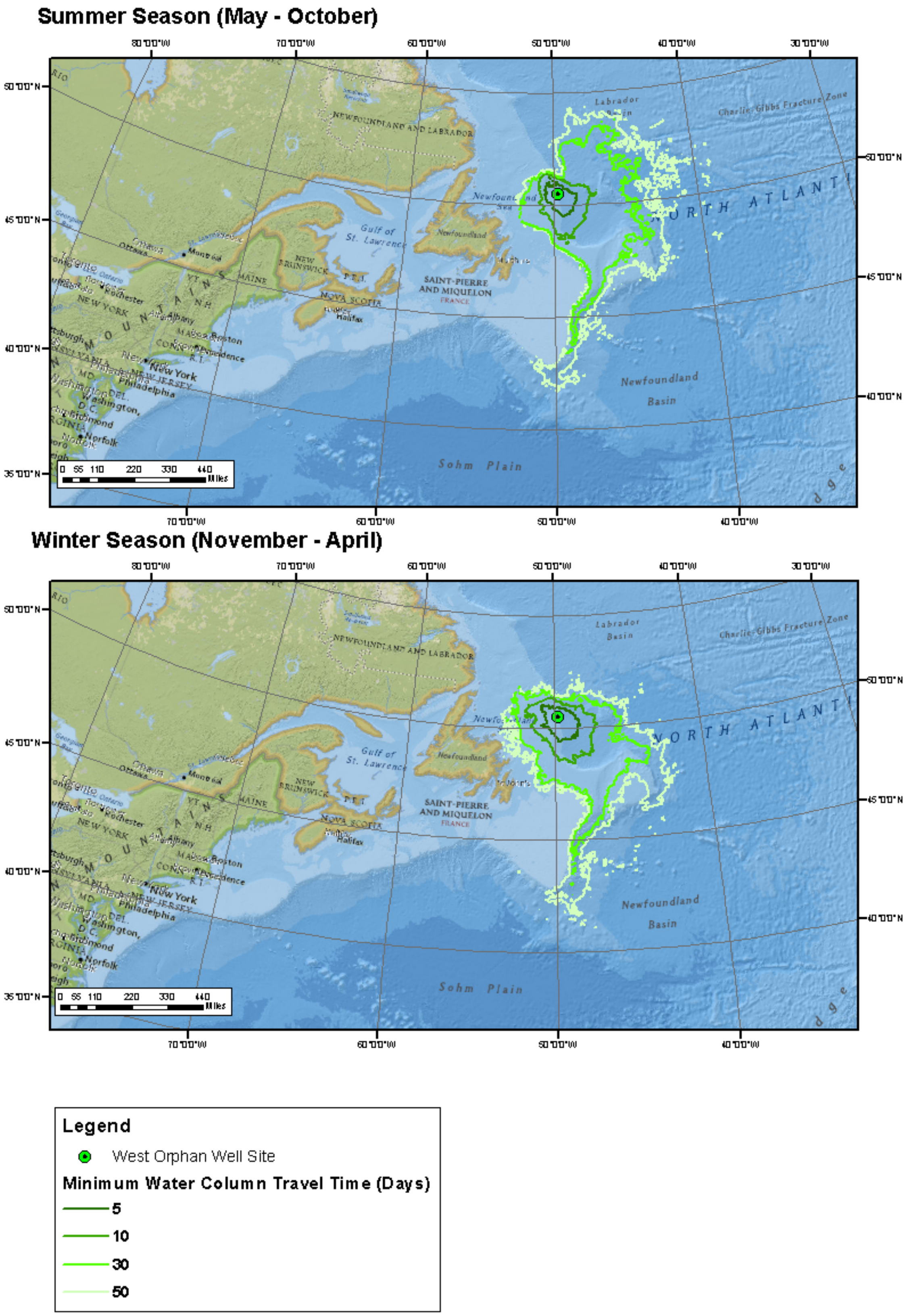


Figure 7.25 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the minimum time before the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).

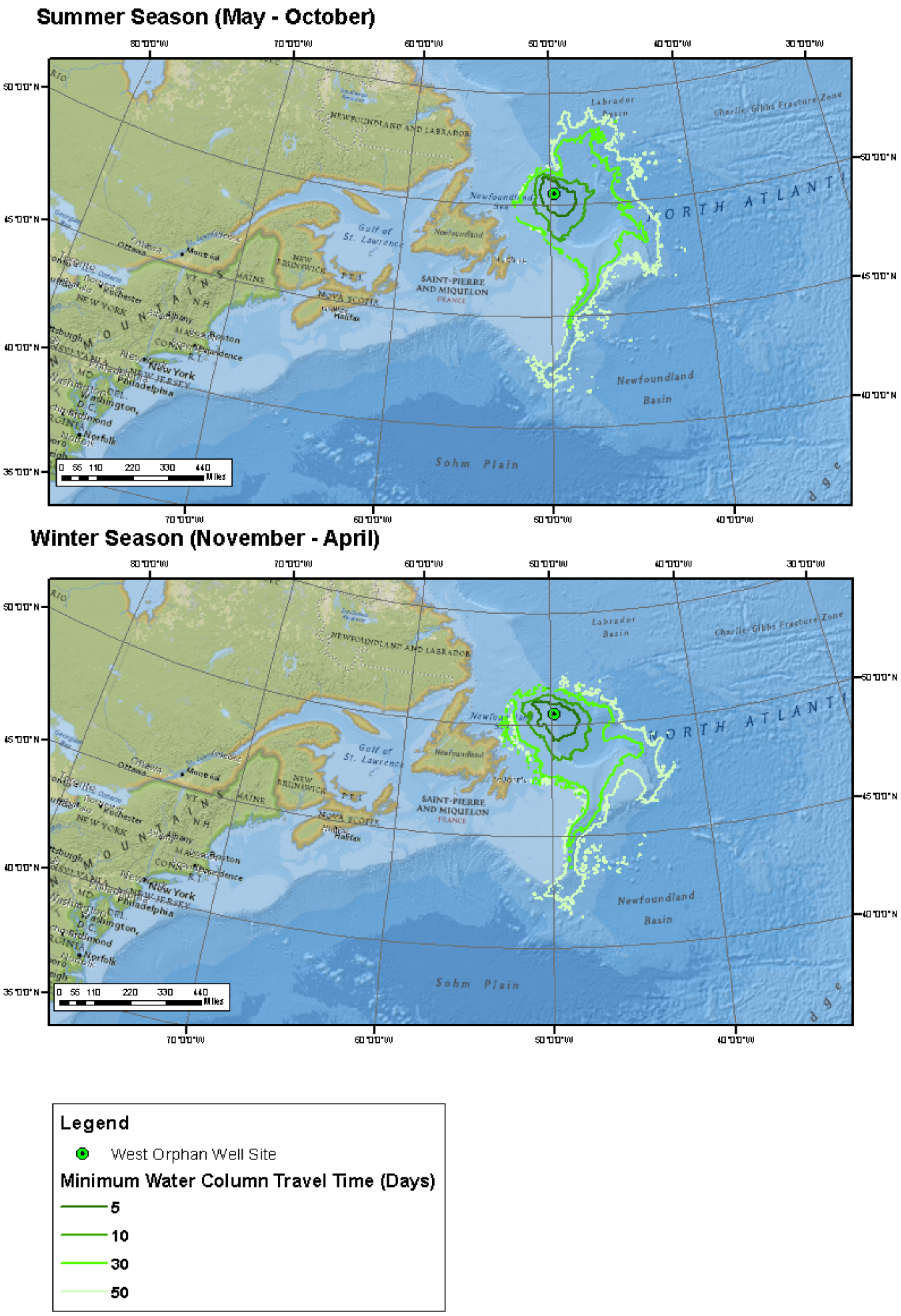


Figure 7.26 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).

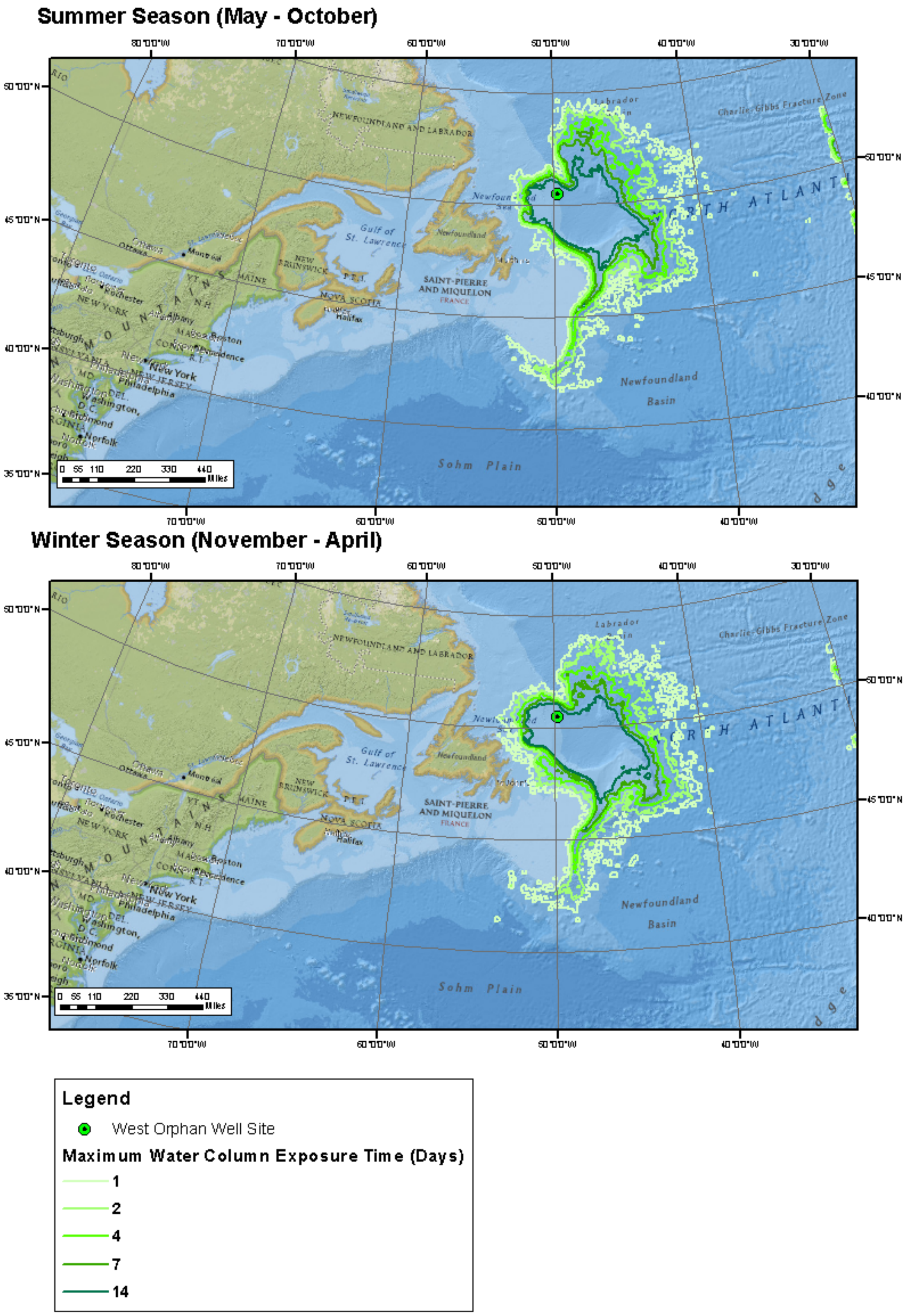
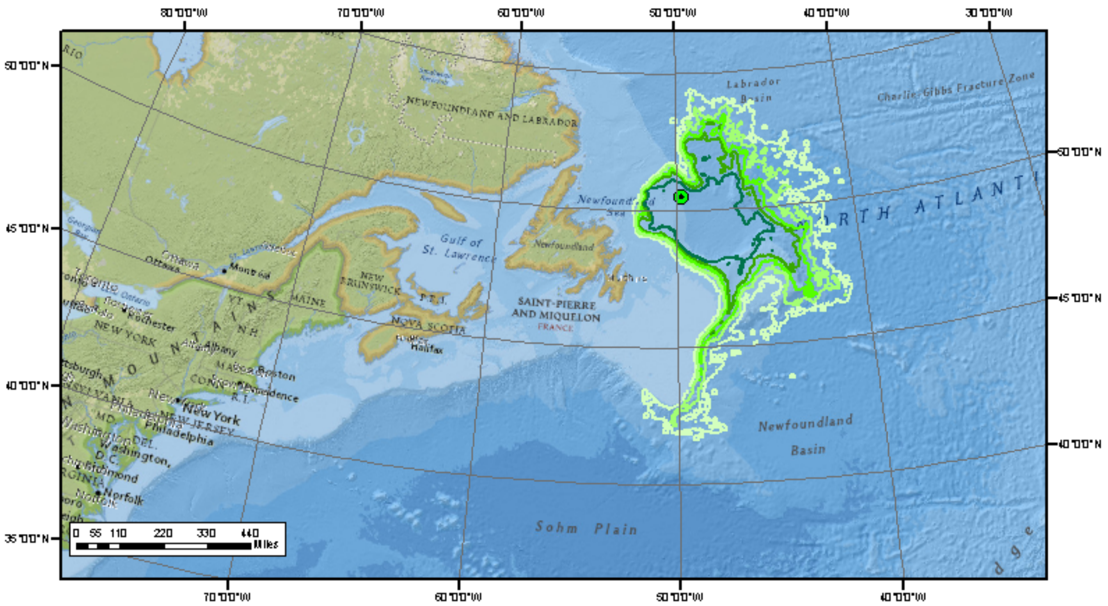
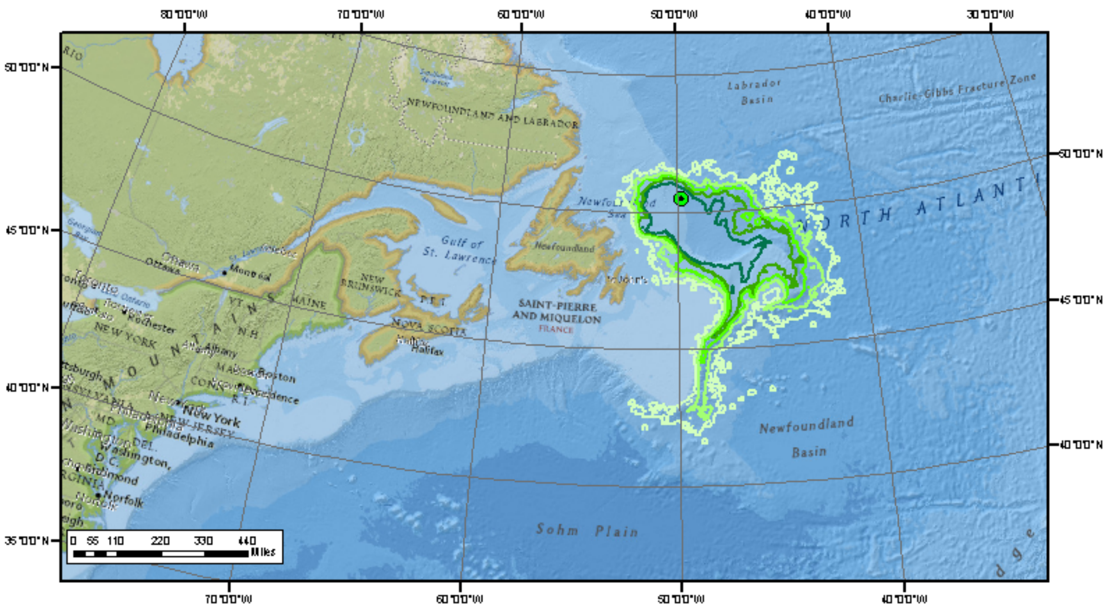


Figure 7.27 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).

Summer Season (May - October)



Winter Season (November - April)



Legend

West Orphan Well Site

Maximum Water Column Exposure Time (Days)

- 1
- 2
- 4
- 7
- 14

Figure 7.28 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical contour maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied).

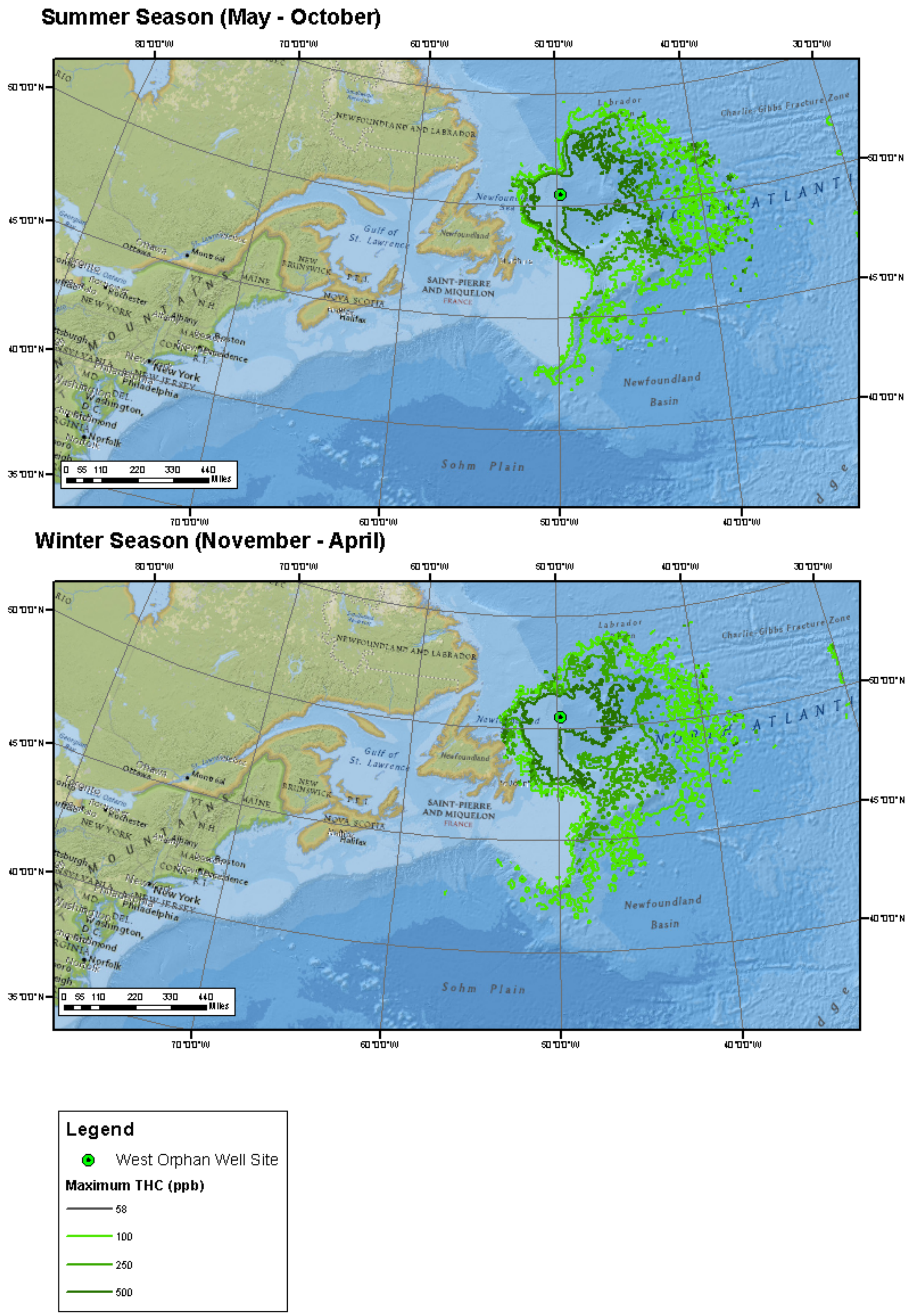
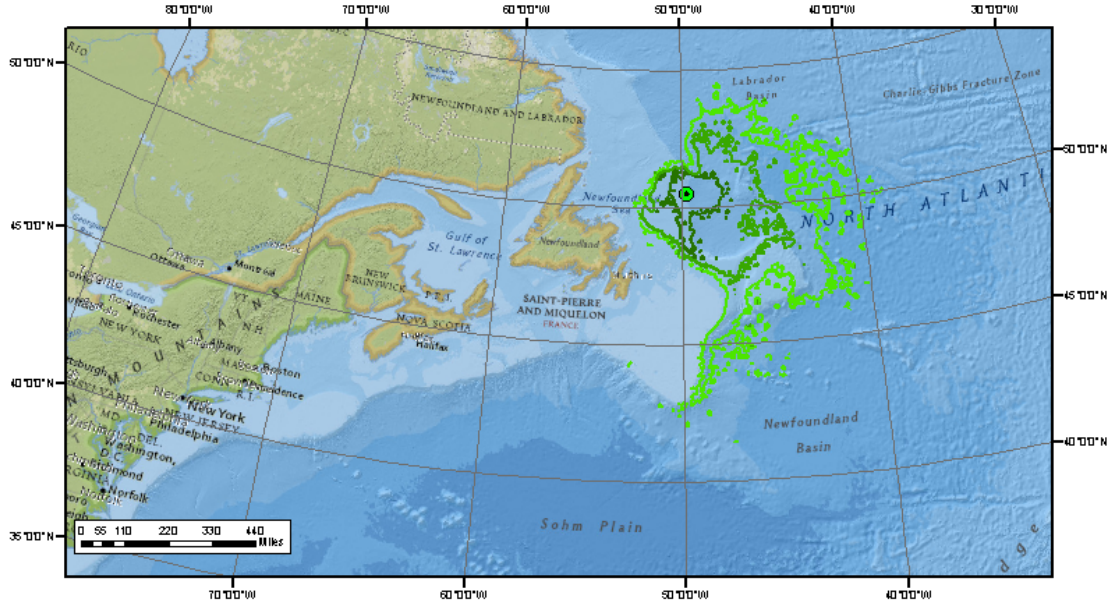
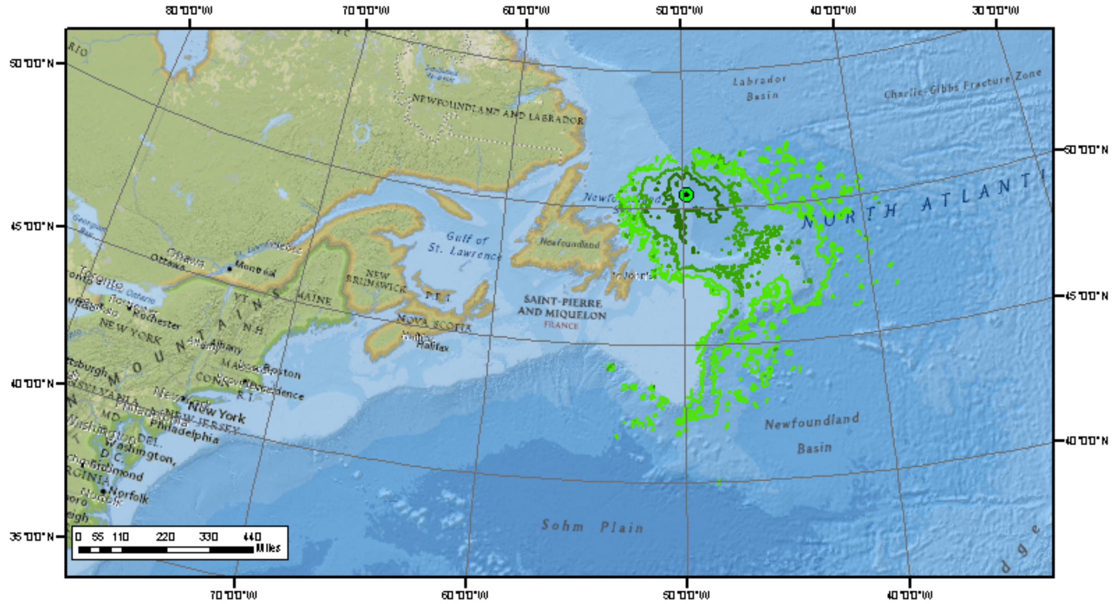


Figure 7.29 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)

Summer Season (May - October)



Winter Season (November - April)



Legend

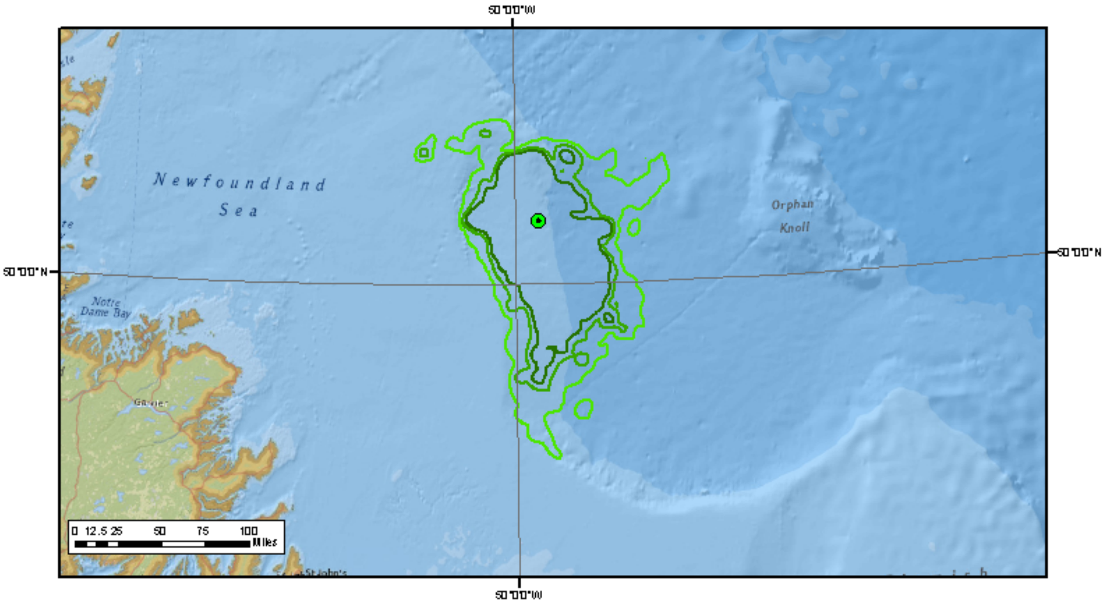
West Orphan Well Site

Maximum THC (ppb)

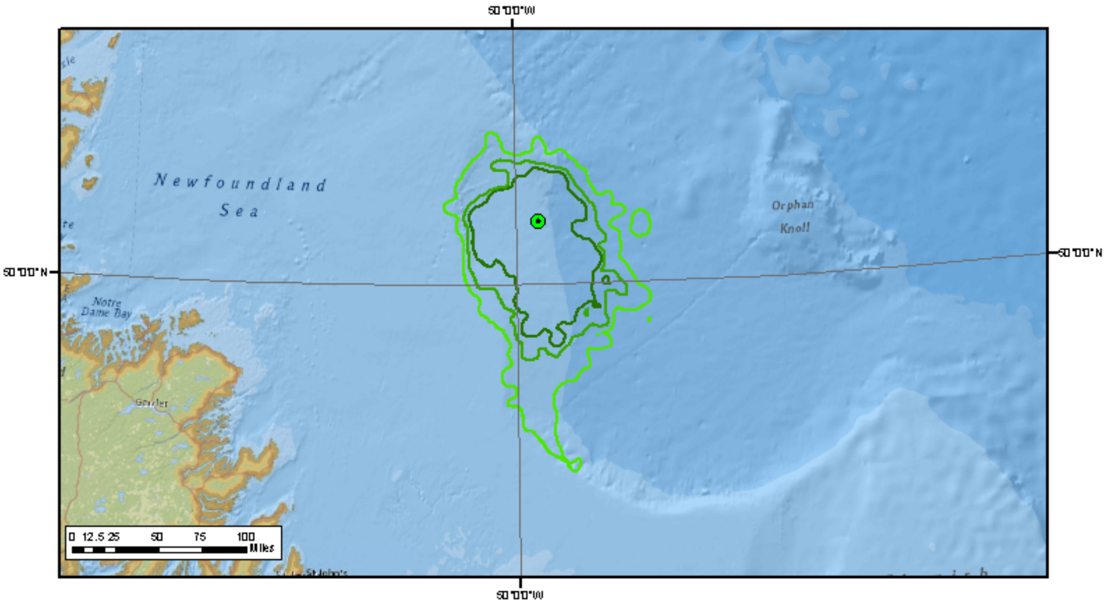
- 58
- 100
- 250
- 500

Figure 7.30 Scenario 1: West Orphan relief well scenario - Summer Season (120 day duration). Statistical contour maps showing maximum time-averaged dissolved oil concentrations > 1 ppb within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)

Summer Season (May - October)



Winter Season (November - April)



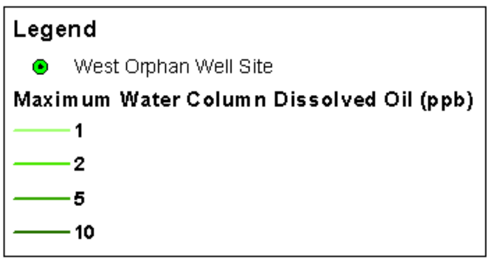
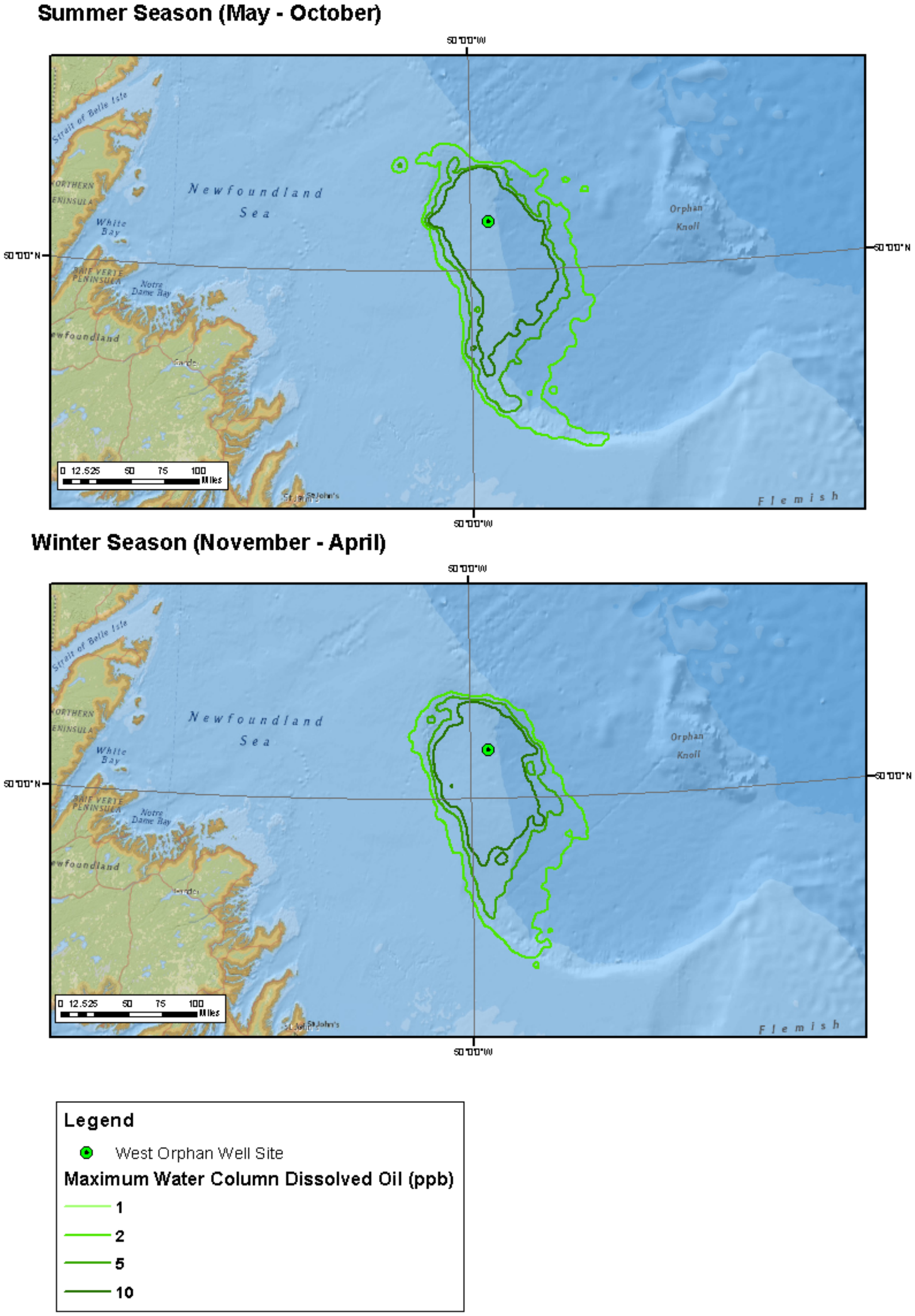


Figure 7.31 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing maximum time-averaged dissolved oil concentrations > 1 ppb within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)



7.1.2.2 East Orphan release site

Figure 7.32 Scenario 3: East Orphan relief well scenario (120 day duration).Statistical contour maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column over the simulation period based on all simulations for probabilities > 5%

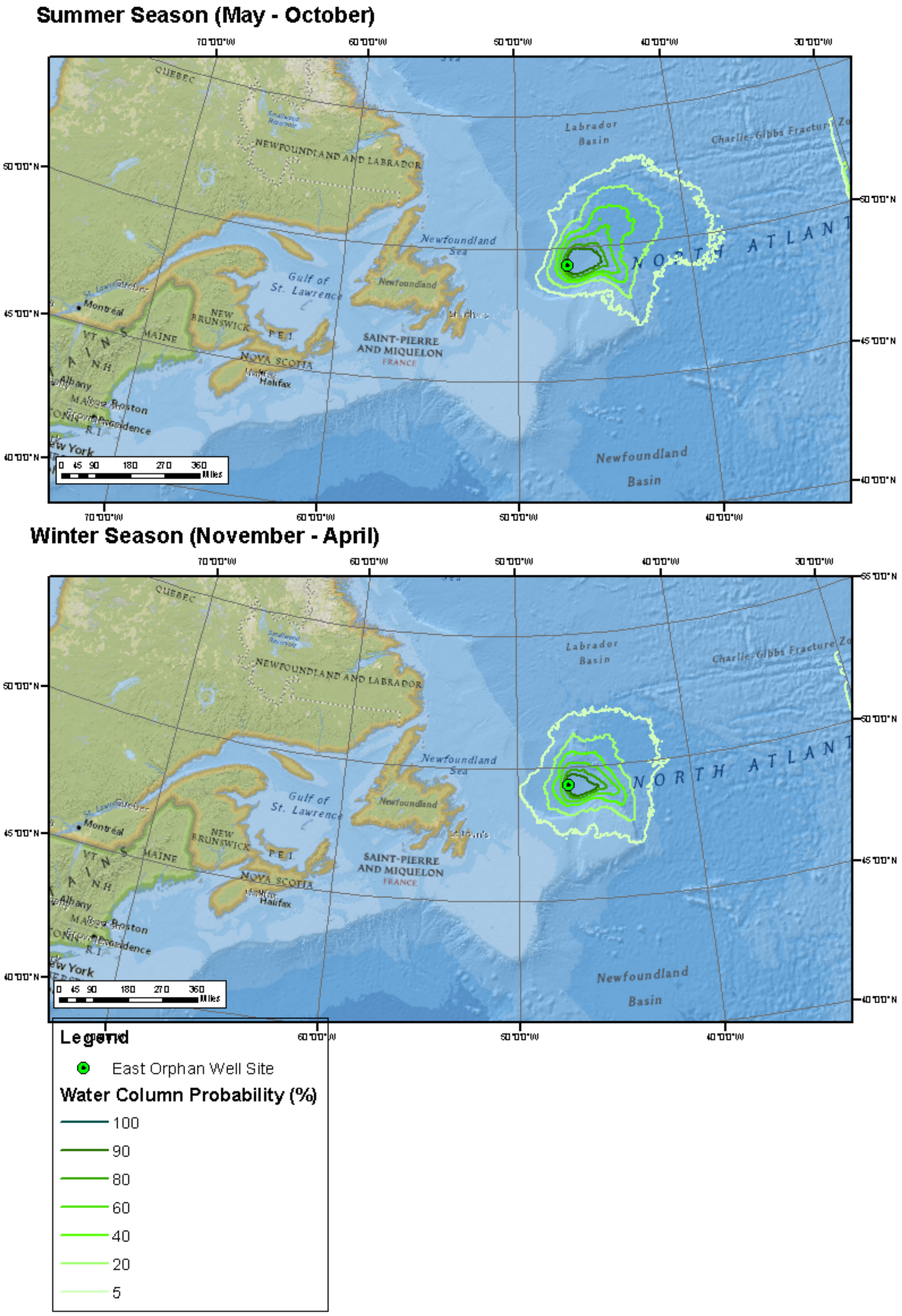


Figure 7.33 Scenario 3: East Orphan relief well scenario - Summer Season (120 day duration). Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the entire water column over the simulation period based on all simulations for probabilities > 1%

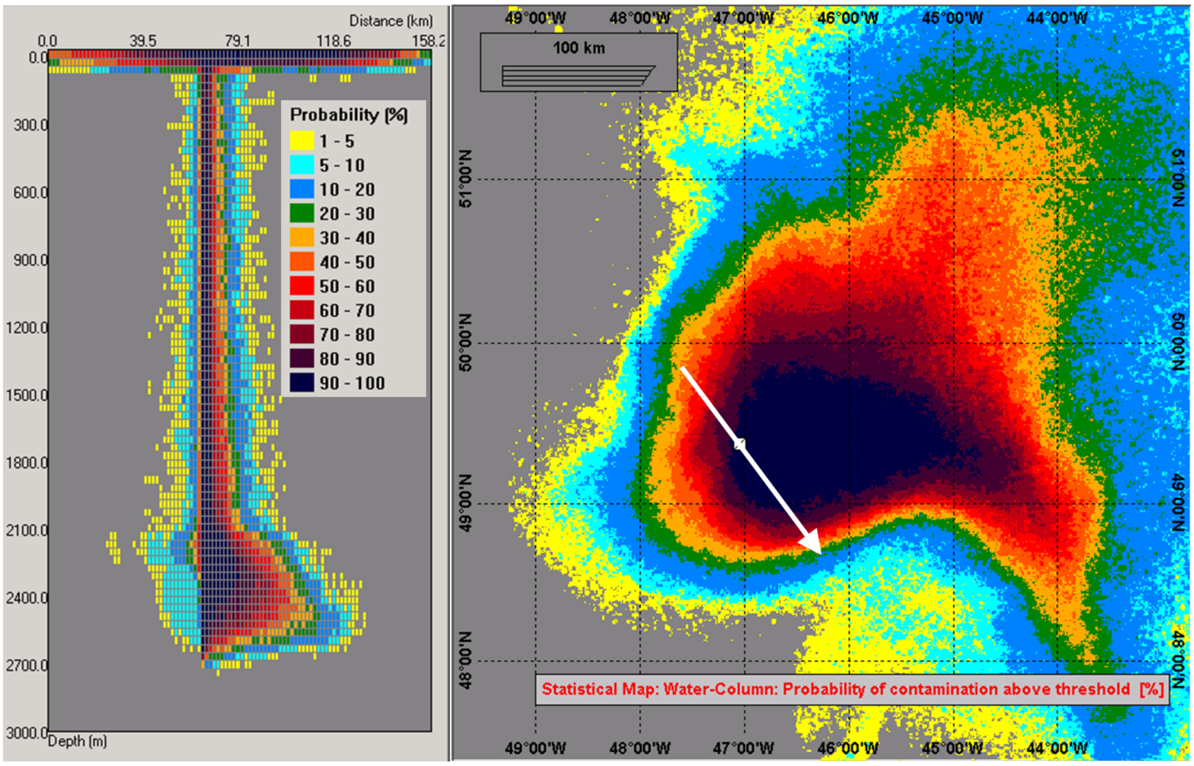


Figure 7.34 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column over the simulation period based on all simulations for probabilities > 5%

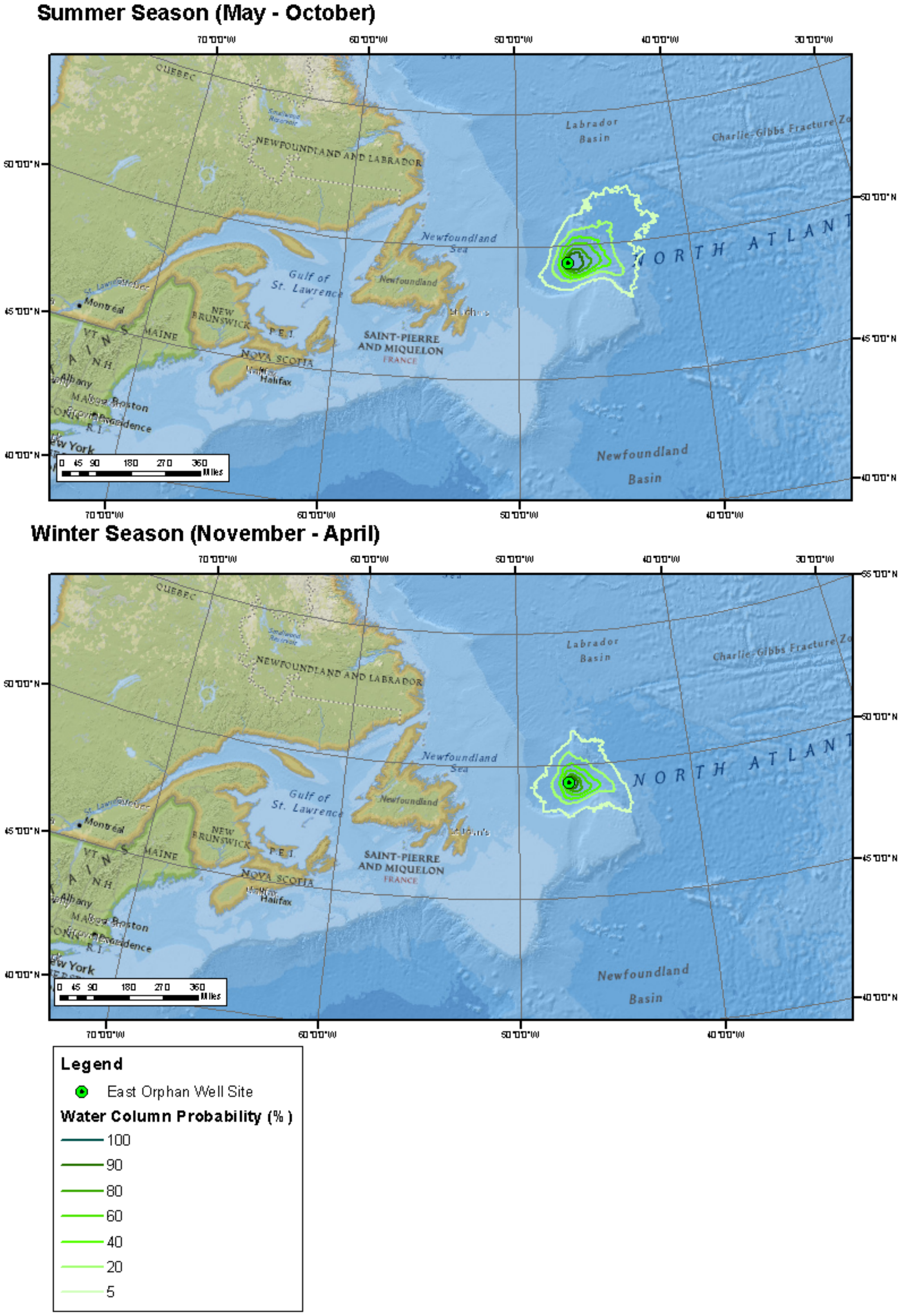


Figure 7.35 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical contour maps showing the minimum time before the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied)

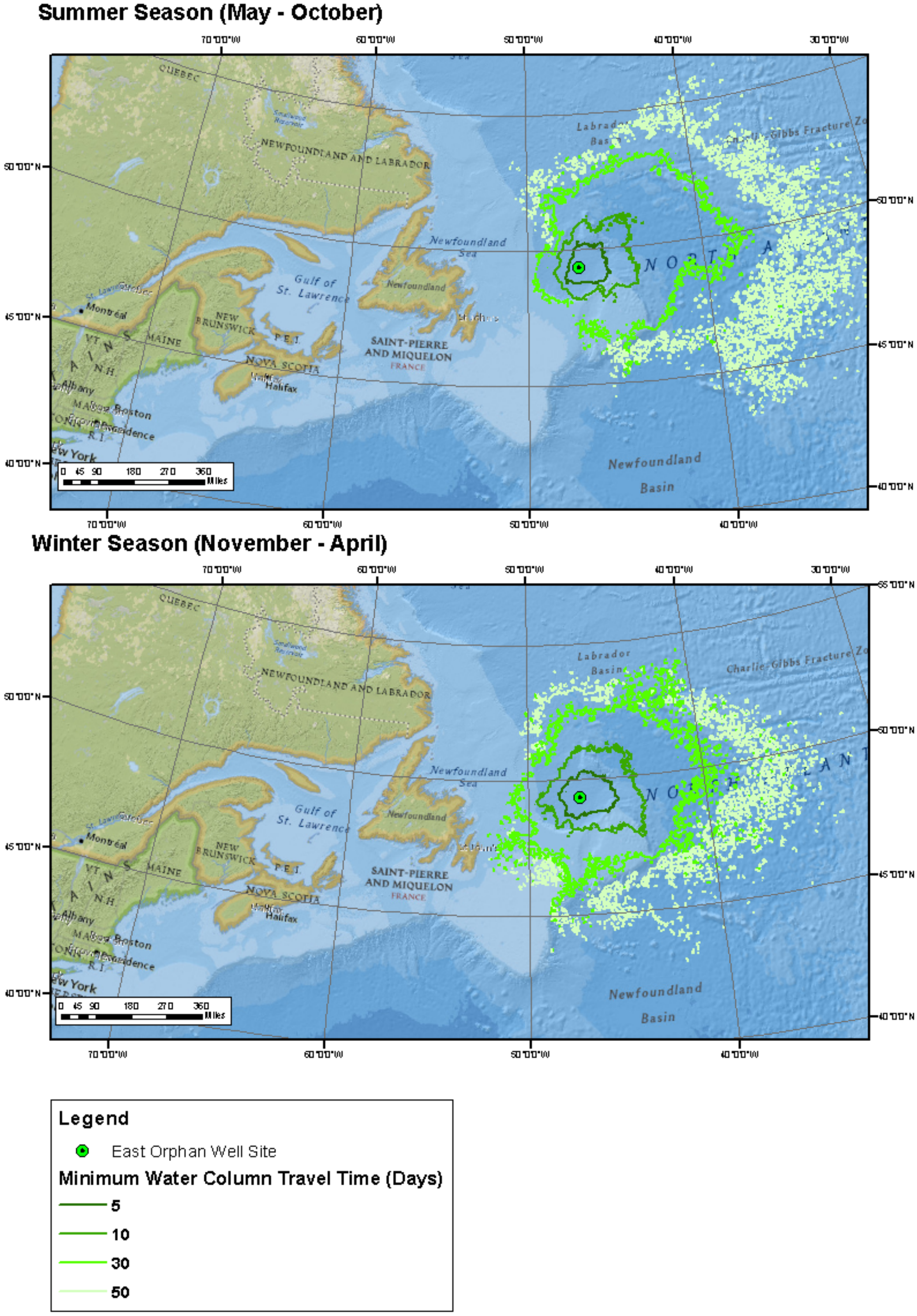


Figure 7.36 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the minimum time before the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied)

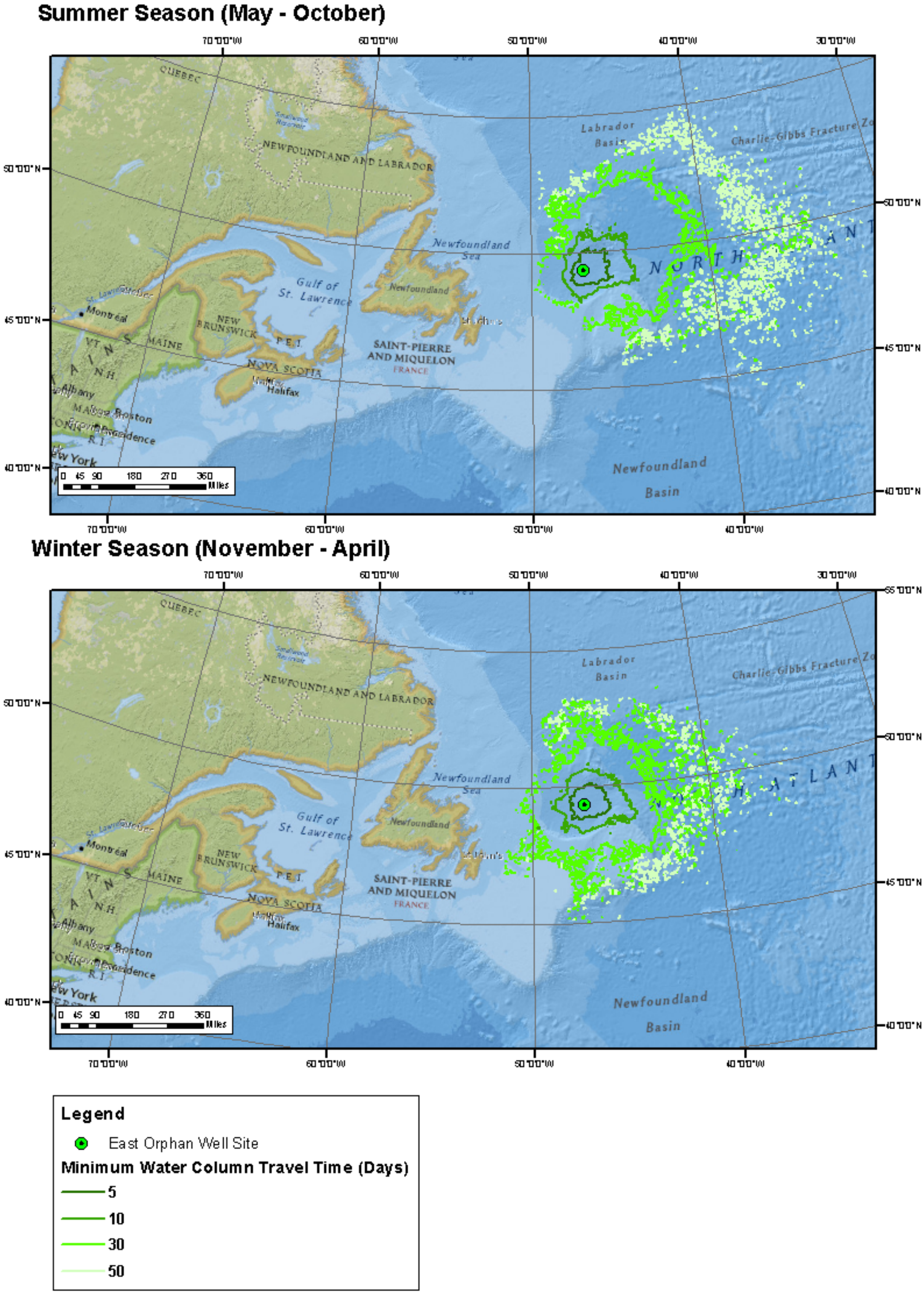


Figure 7.37 Scenario 3: East Orphan relief well scenario (120 day duration).Statistical contour maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied)

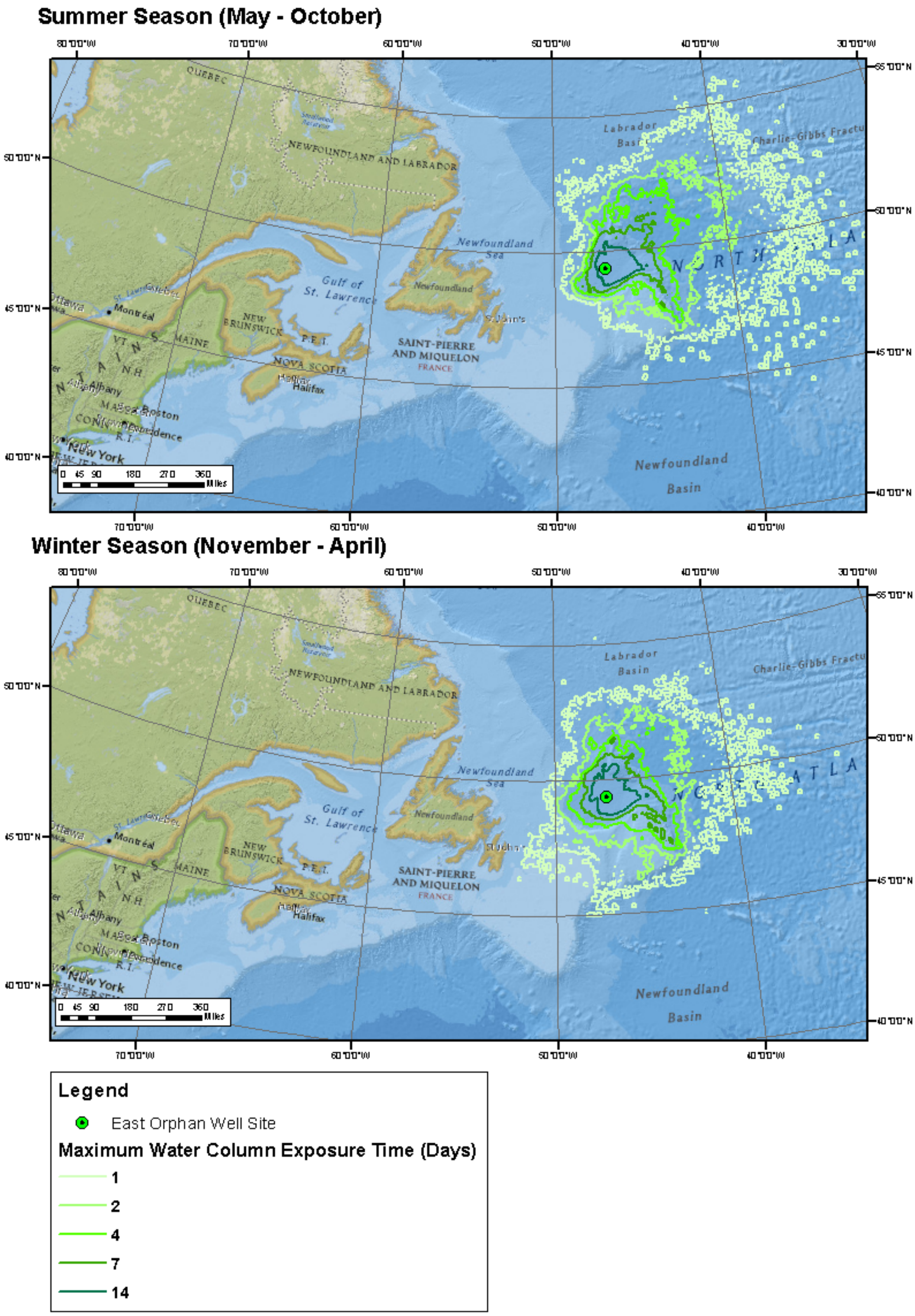


Figure 7.38 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied)

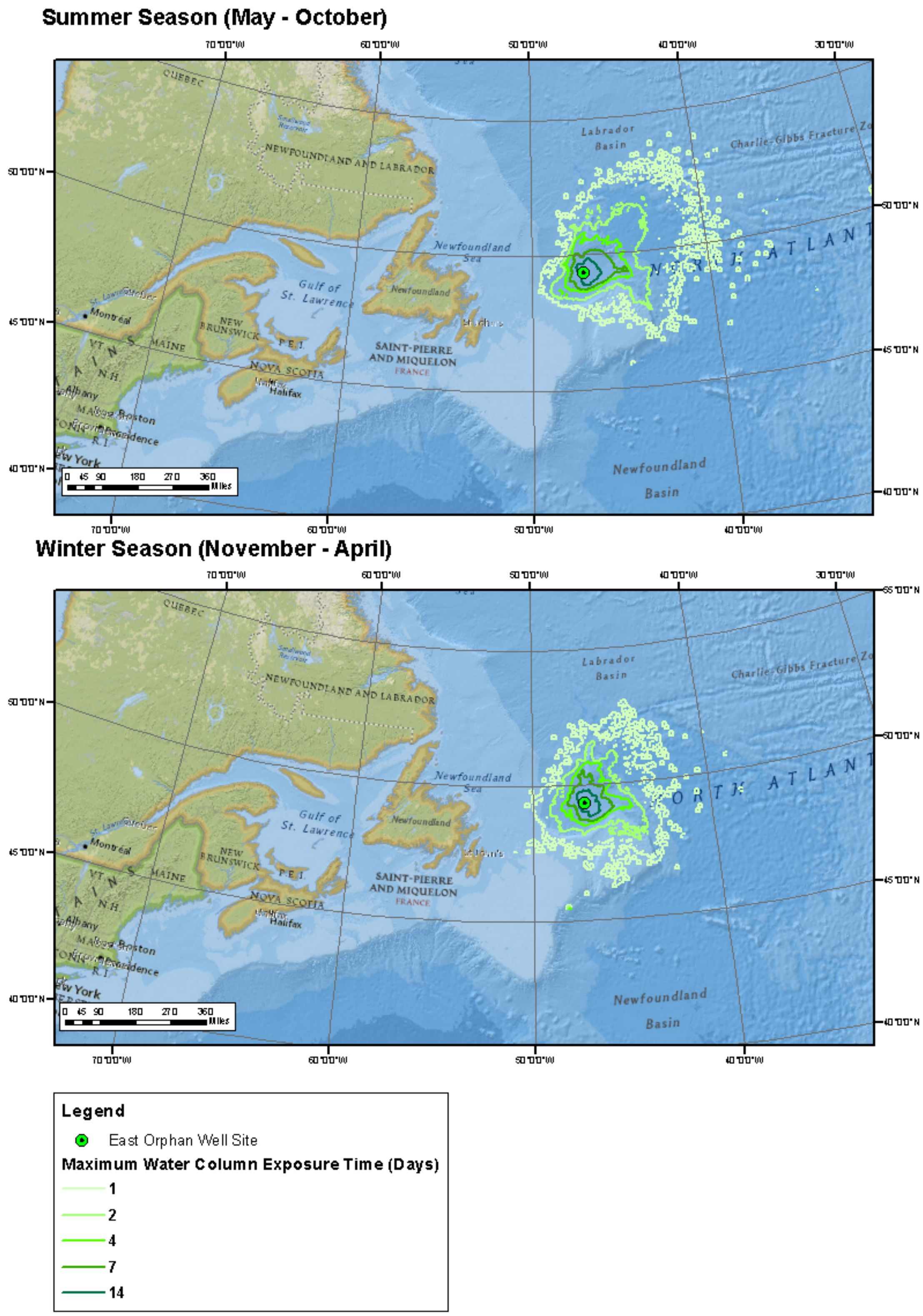
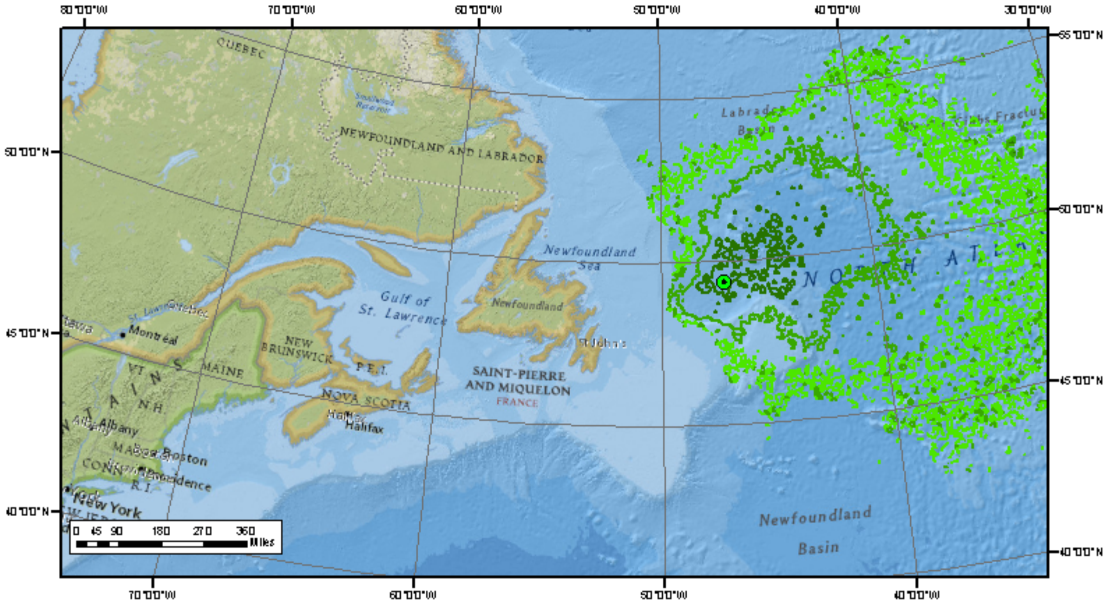
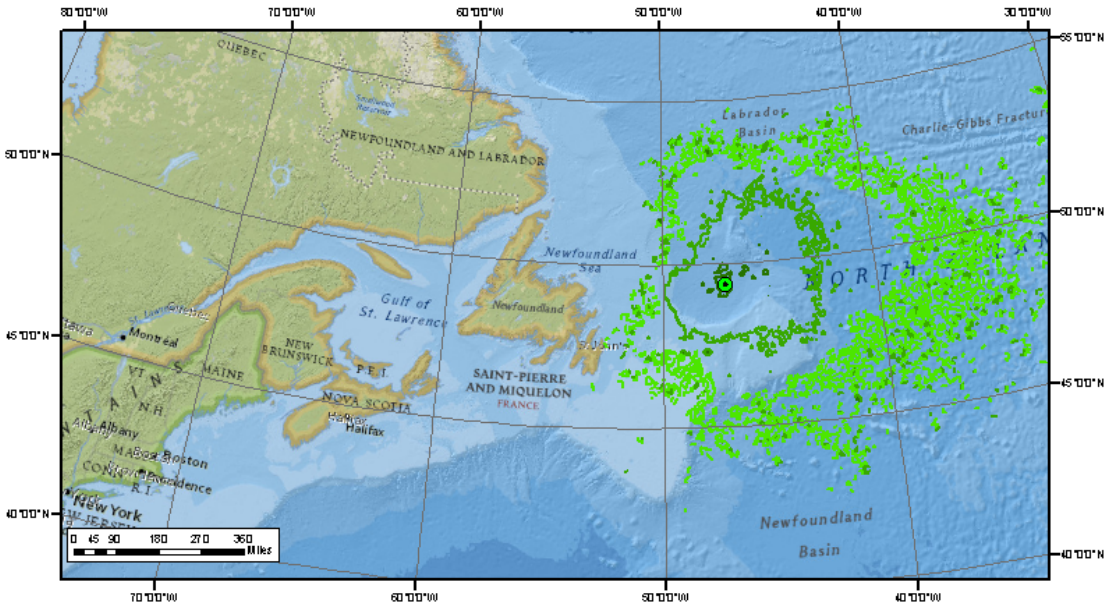


Figure 7.39 Scenario 3: East Orphan relief well scenario (120 day duration).Statistical contour maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)

Summer Season (May - October)



Winter Season (November - April)



Legend

East Orphan Well Site

Maximum THC (ppb)

- 58
- 100
- 250
- 500

Figure 7.40 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)

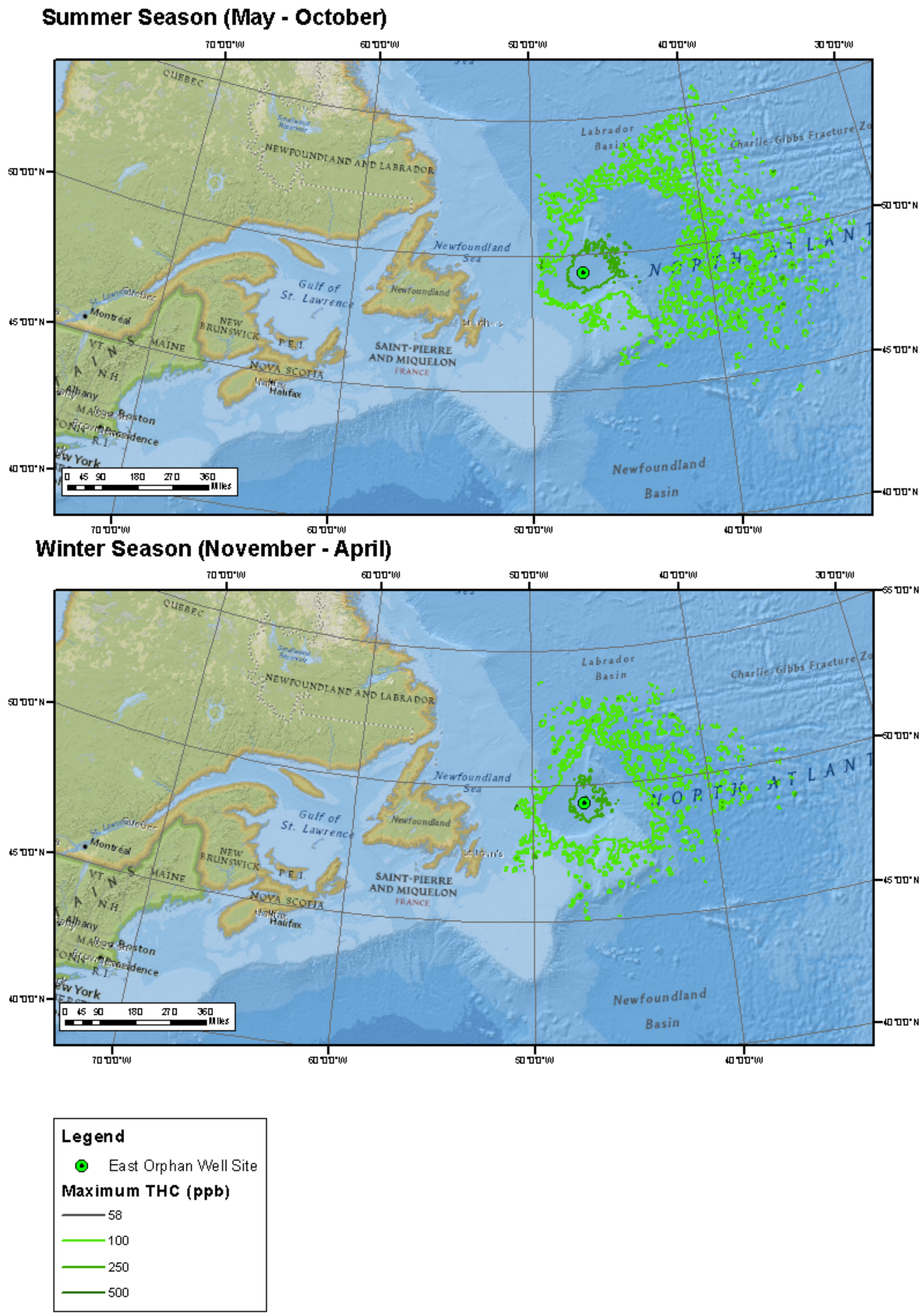


Figure 7.41 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical contour maps showing maximum time-averaged dissolved oil concentrations > 1 ppb within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)

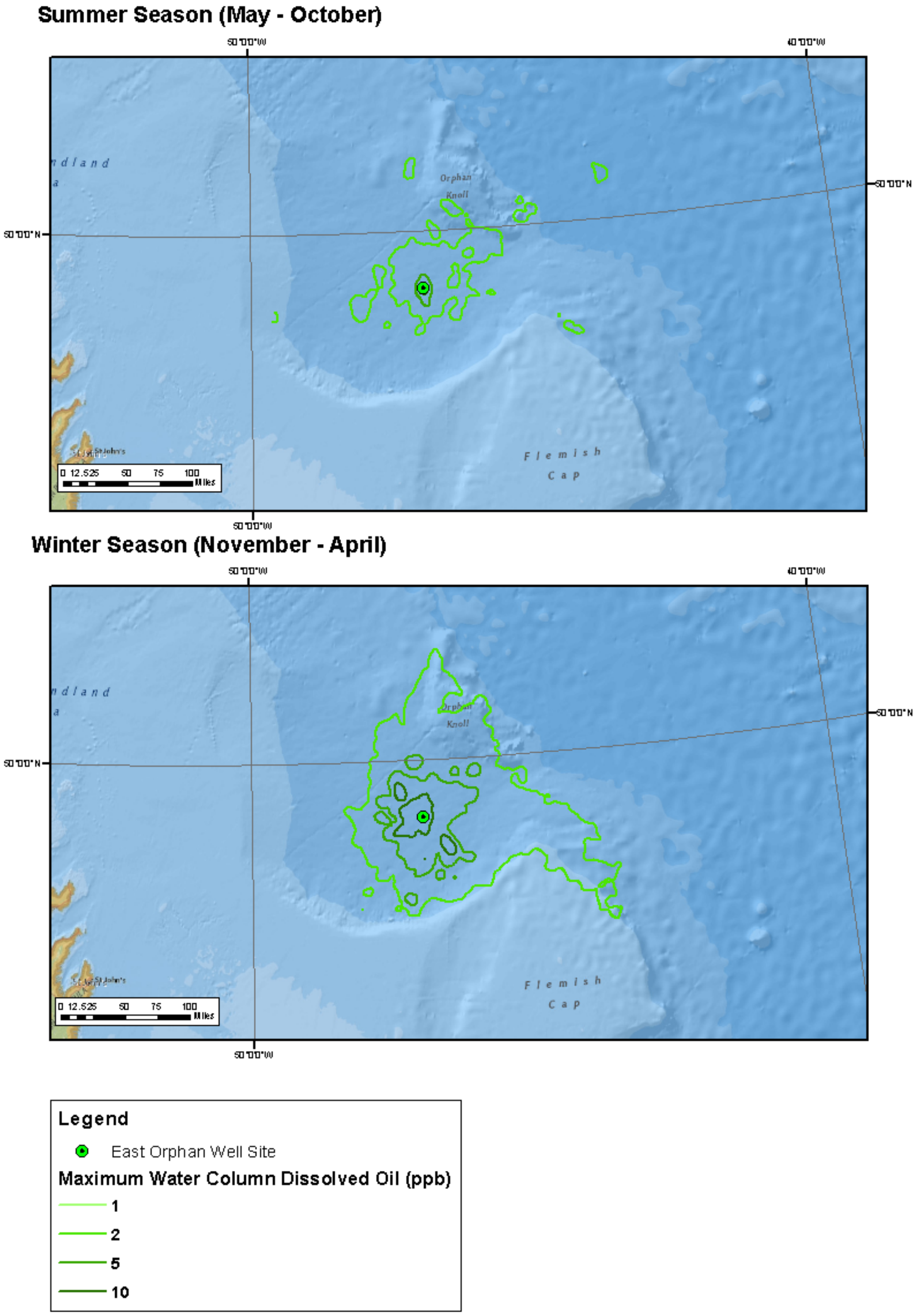
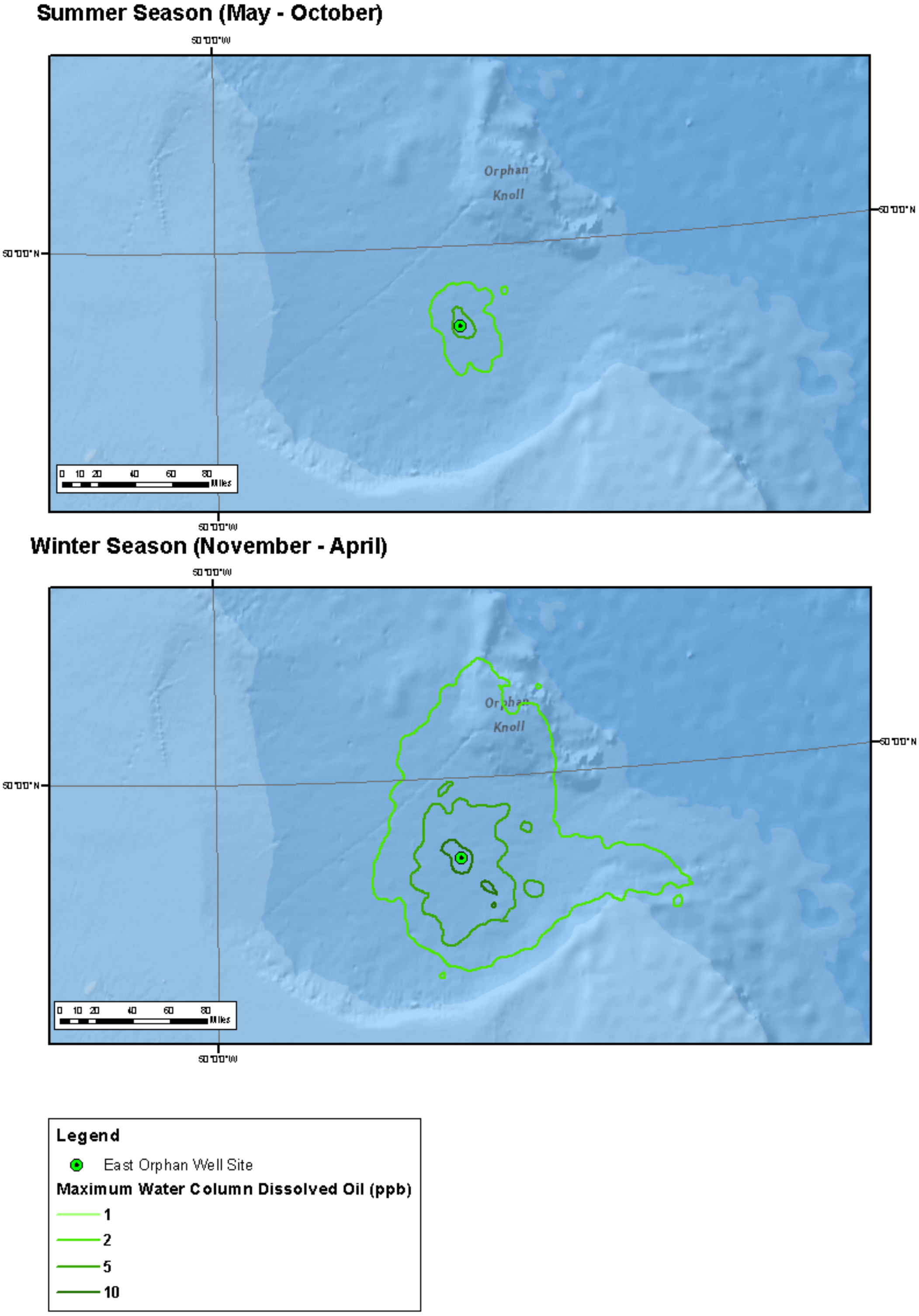


Figure 7.42 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical contour maps showing maximum time-averaged dissolved oil concentrations > 1 ppb within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied)



7.1.2.3 Summary of water column stochastic results

The in-water dispersed and dissolved oil threshold exceedance of 58 ppb for total hydrocarbons (THC) is expected to remain in offshore waters with a much smaller areal extent than for surface oil (Figure 7.21, 7.22, 7.31 and 7.32, Table 7.1). The modelling results indicate that the in-water oil exceedance will not reach the near shore waters of mainland Newfoundland. The only exception was the WO relief well, winter season scenario where some localised THC concentrations above the 58 ppb threshold occurred, albeit at probabilities < 5%. For WO scenarios, the in-water dispersed and dissolved oil trajectories extend predominantly towards the south and SSE, whereas for the EO scenarios it is predominantly towards the east, indicating that transport is controlled by the dominant surface current flow direction at both locations (see Annex B)

Concentrations of dissolved and total hydrocarbons are predicted to be highest around the release site and dissipate as the oil moves away and disperses within the water column. While the highest concentrations of THC are predicted near the release site at the plume trap height (see Section 7.2), the majority of the predicted THC concentrations are within tens of meters of the surface. This is due to the majority of the predicted THC being the result of entrained oil from wind-induced surface breaking waves.

Vertical cross sections through the water column at the WO and EO release sites (relief well scenarios - summer season) are shown in Figures 7.22 and 7.33. These Figures show that the subsea probability of oil exceeding the 58 ppb THC threshold is limited to a maximum radius from the wellsite of circa 70 km for probabilities > 1%.

The WO scenarios have higher THC concentrations and larger cumulative footprints than for the corresponding EO scenarios due to the larger release volume. In addition, the plume trap height occurs at much greater water depth (see Section 7.2) for the EO well blowout scenarios, therefore the oil is dispersed and diluted more readily to concentrations below the threshold level, reducing the footprint. This is evident in the exposure time footprints. For example for the unmitigated relief well scenarios, the predicted distance from the well site where exposure to in-water concentrations of oil > 58 ppb may exceed 14 days extends up to 600 km away from the well site for the WO scenarios, compared to 240 km for the EO scenarios.

7.1.3 Shoreline Results

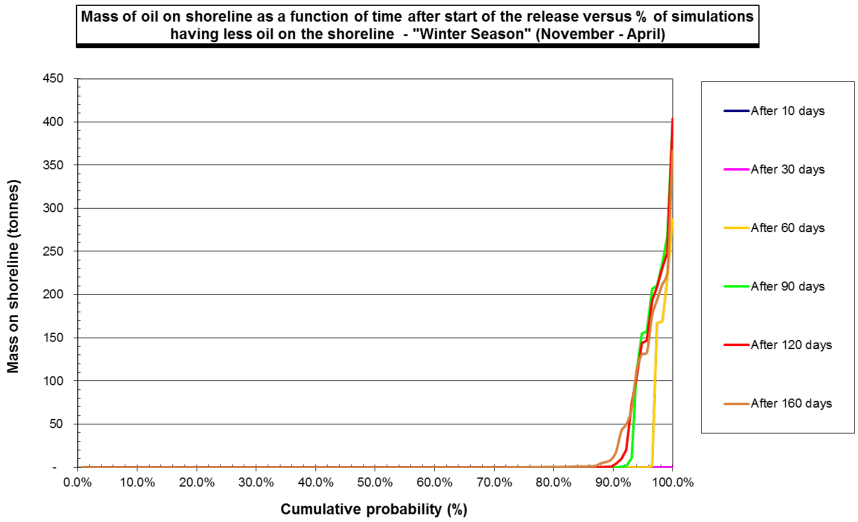
Shoreline contact is unlikely from releases at either the WO or EO sites. The highest shoreline contact probabilities occurred for the WO relief well scenario during the winter months, with 31 km of coastline potentially at risk from contact probabilities of 5 - 7 % Table 7.1). For this scenario, Figure 7.43 shows the total mass of oil on the shoreline for the entire modelling domain as a function time after the start of the release with the corresponding percentage of simulations having less oil on the shoreline. The predicted maximum amount of oil accumulating on the shoreline was circa 400 tonnes with peak oiling occurring between 90 and 120 days. This amount of oil represents 0.04% of the total amount of oil released. However, there was a wide range in the maximum amount of oil accumulated on the shoreline, with no stranded oil occurring in 72% of the simulations and <1 tonne beaching in 85% of the cases during the winter season. The maximum length of coastline potentially at risk from stranded oil exceeding the minimum film or sheen thickness threshold of 1 micron (1 g/m^2) was 270 km (Table 7.1).

No shore contacts were predicted for the WO and EO capping stack scenarios during the summer seasons with maximum probabilities of 1 - 2% for the capping stack winter scenarios and the WO relief well summer scenarios.

The EO relief well, winter scenario gave rise to the second highest amount of accumulated oil on the shoreline (270 tonnes) with potentially 205 km of coastline at risk from stranded oil film or sheen thicknesses > 1 micron (1 g/m^2). Peak oiling occurred between 30 and 60 days, but with no stranded oil occurring in 86% of the simulations and <1 tonne beaching in 88% of the cases (Figure 7.44).

This scenario also produced the earliest arrival time of oil to shore (27 days) of all the scenarios modelled. The earliest arrival times for shoreline oiling ranged from 27 to 145 days for the scenarios where beaching of oil occurred (Table 7.1).

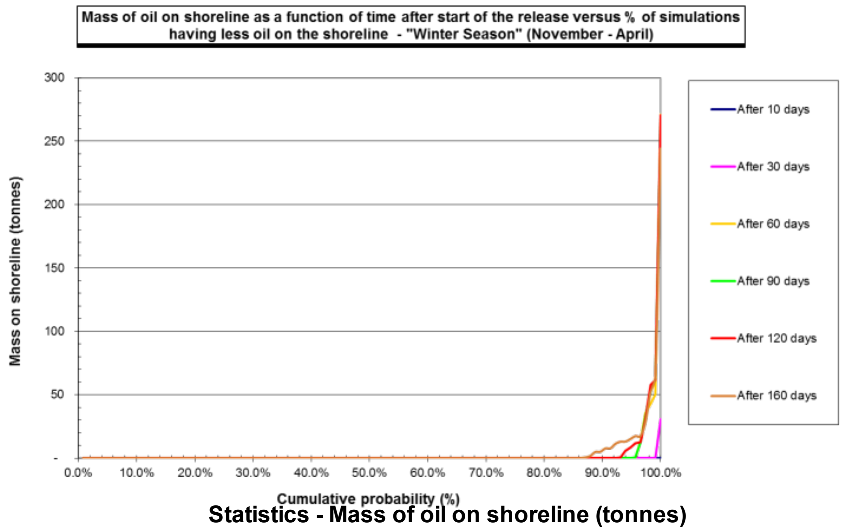
Figure 7.43 Scenario 1: West Orphan relief well scenario - Winter Season (120 day duration). Mass of oil on the shoreline as a function time after the start of the release with percentage of simulations having less oil on the shoreline.



Statistics - Mass of oil on shoreline (tonnes)

	After 10 days	After 30 days	After 60 days	After 90 days	After 120 days	After 160 days
Average	-	-	7	15	15	15
d10	-	-	-	-	-	-
Median - d50	-	-	-	-	-	-
d90	-	-	-	-	3	14
d95	-	-	-	155	145	131
Max - d100	-	-	287	402	403	366

Figure 7.44 Scenario 3: East Orphan relief well scenario - Winter Season (120 day duration). Mass of oil on the shoreline as a function time after the start of the release with percentage of simulations having less oil on the shoreline.



Statistics - Mass of oil on shoreline (tonnes)

	After 10 days	After 30 days	After 60 days	After 90 days	After 120 days	After 160 days
Average	-	0	4	4	4	4
d10	-	-	-	-	-	-
Median - d50	-	-	-	-	-	-
d90	-	-	-	-	-	6
d95	-	-	-	0	9	16
Max - d100	-	31	271	262	271	244

Shoreline statistics from the stochastic simulations are presented in the following statistical maps based on at least 220 runs completed for the summer and winter scenarios:

- Probability of Shoreline Oiling (Figures 7.45, 7.46, 7.51and 7.52)
    - Maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m^2).
- Minimum Arrival Time of Shoreline Oiling (Figures 7.47, 7.48, 7.53 and 7.54)
    - Maps showing the fastest time from the start of the release when oil appears on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m^2).
- Degree of Shoreline Oiling (Figures 7.49, 7.50, 7.55 and 7.56)
    - Maps showing the maximum accumulated amounts of emulsified oil on the shoreline exceeding the minimum film or sheen thickness threshold of 1 micron (1 g/m^2), categorised by degree of oiling according to the International Tank Owners Pollution Federation (ITPOF) guidelines for the recognition of oil on shorelines[(19)].

7.1.3.1 West Orphan release site

Figure 7.45 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m^2)

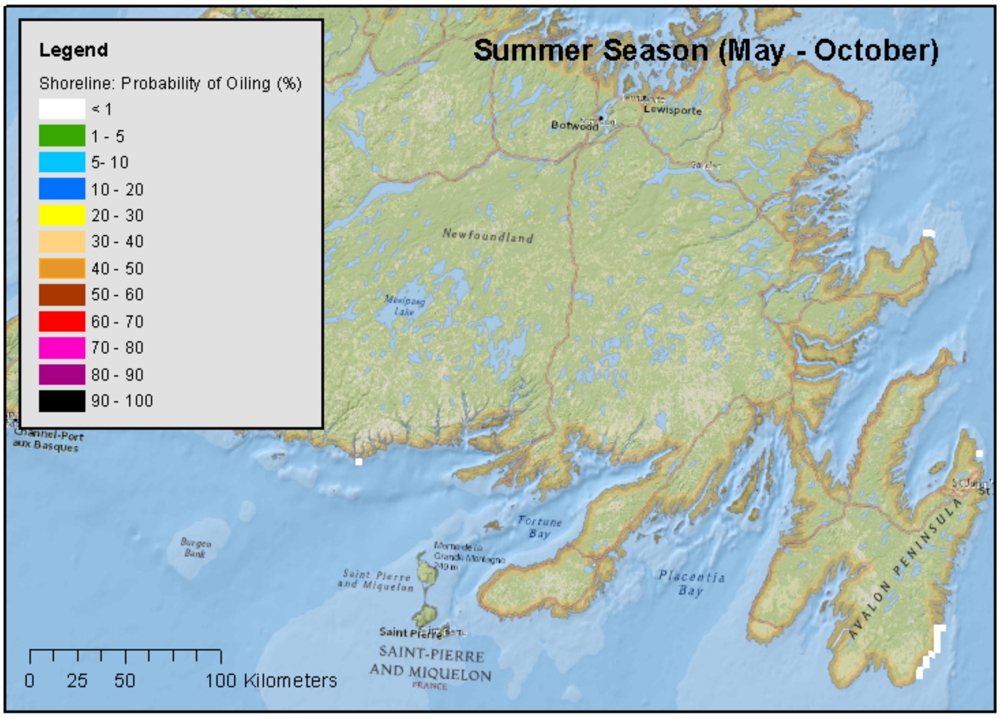
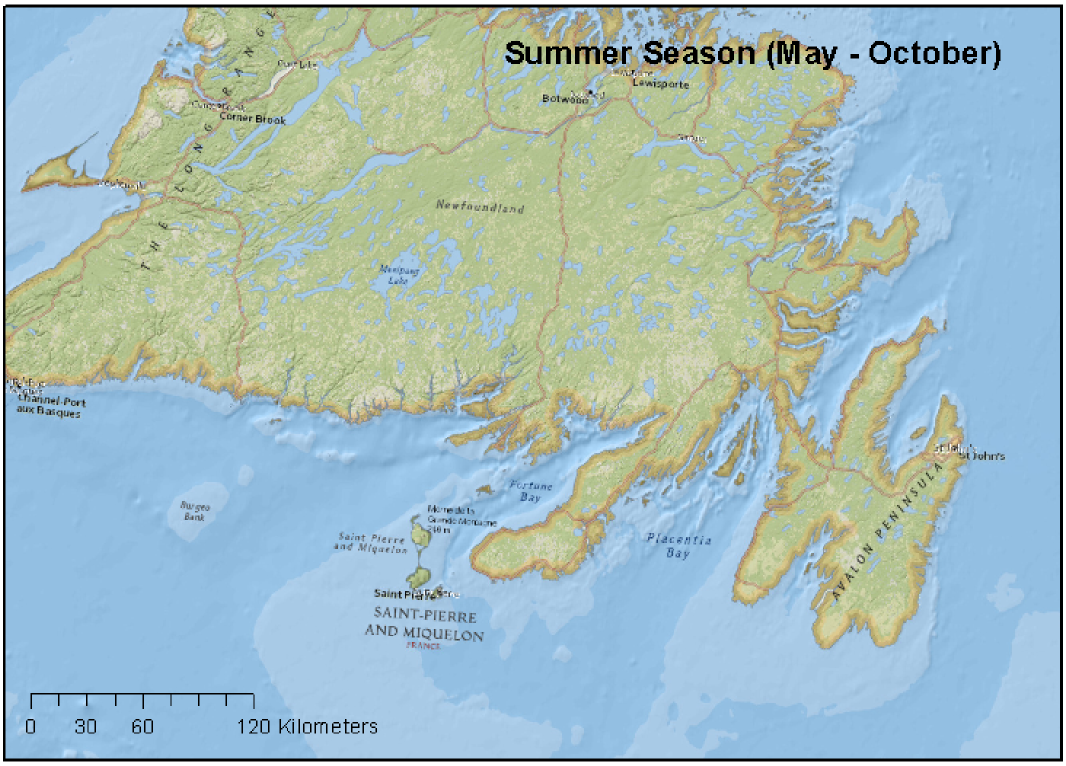


Figure 7.46 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²)



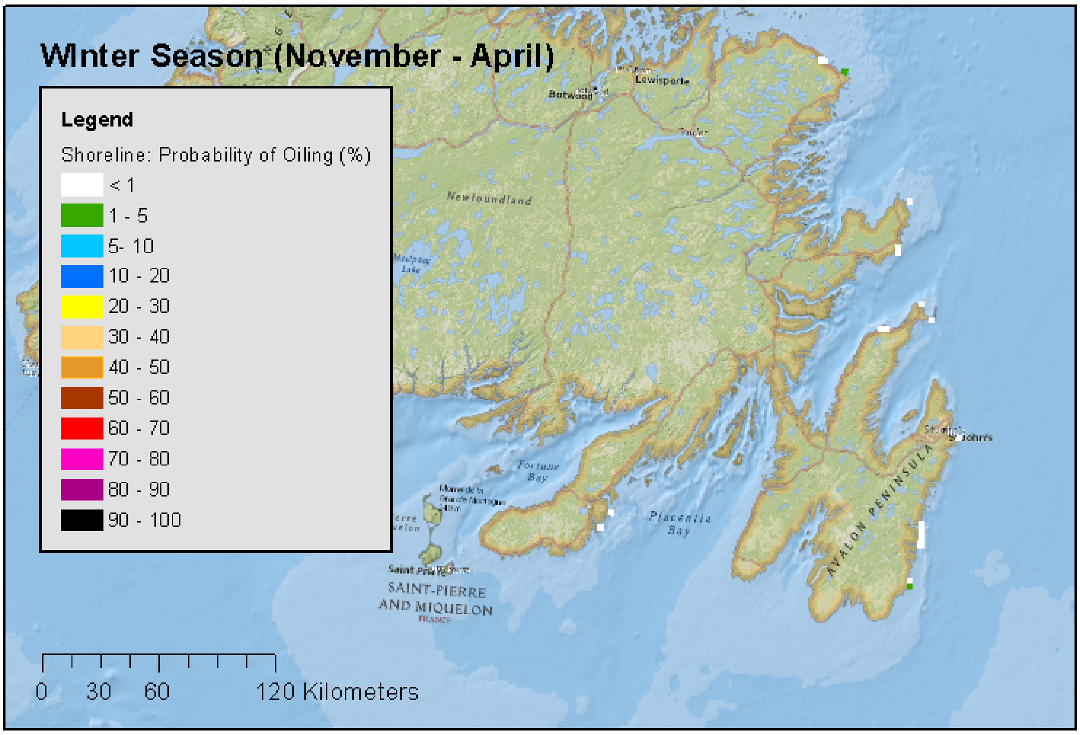


Figure 7.47 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical maps showing the minimum arrival time of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²)

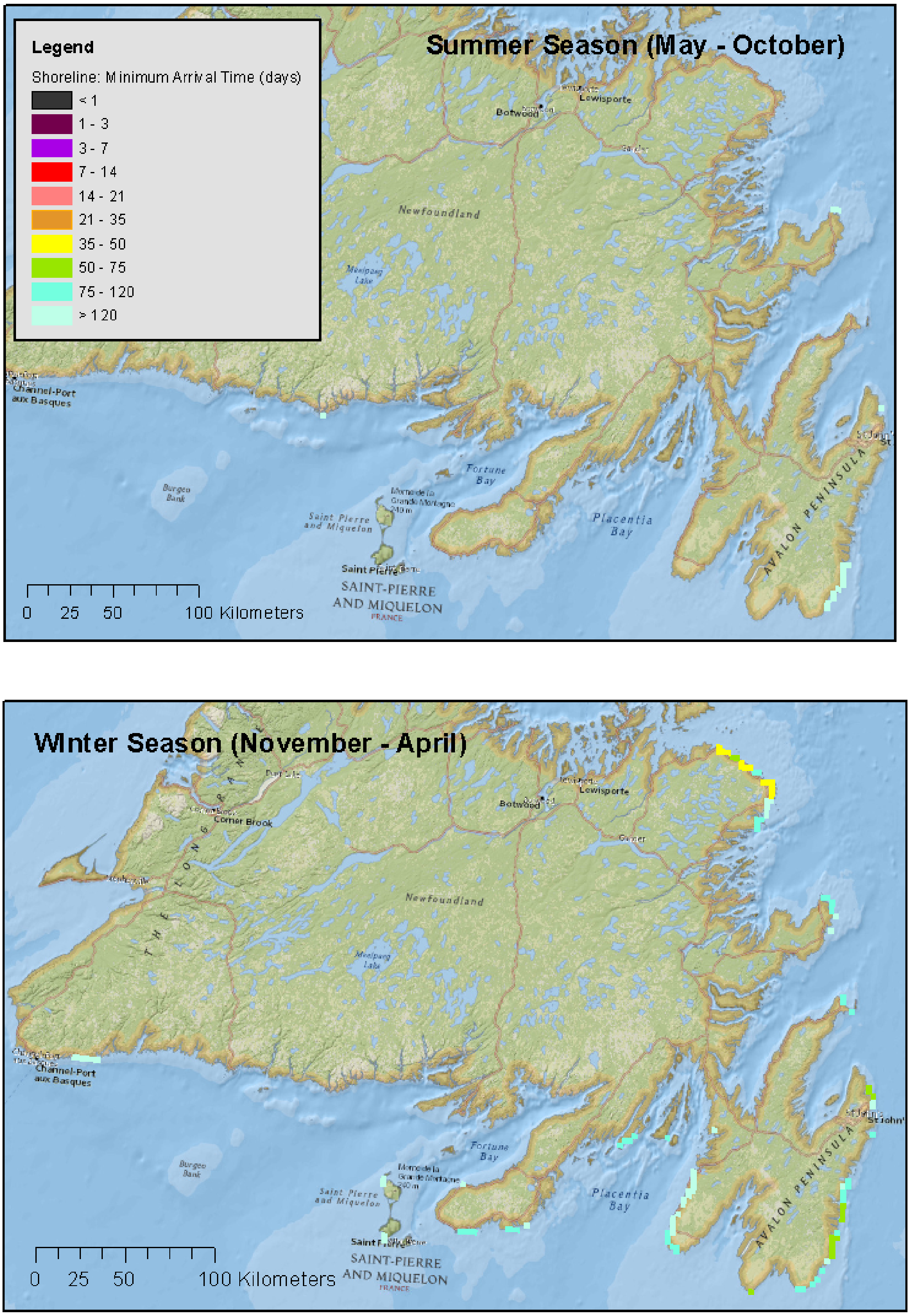
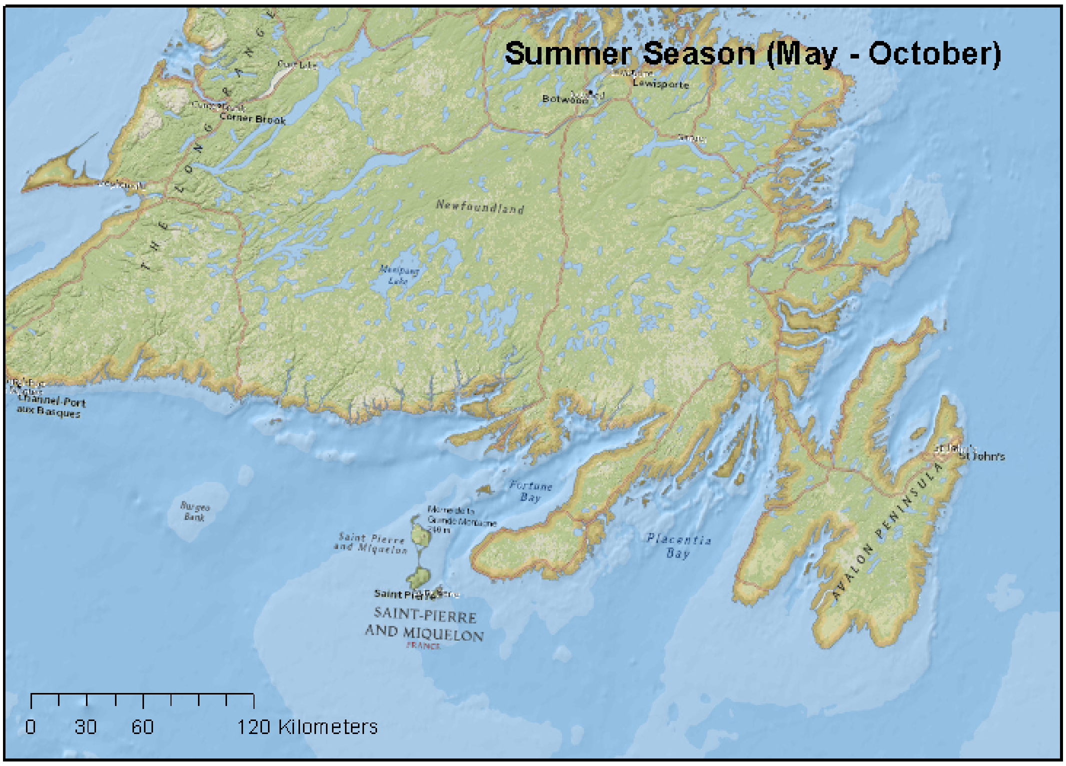


Figure 7.48 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical maps showing the minimum arrival time of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²)



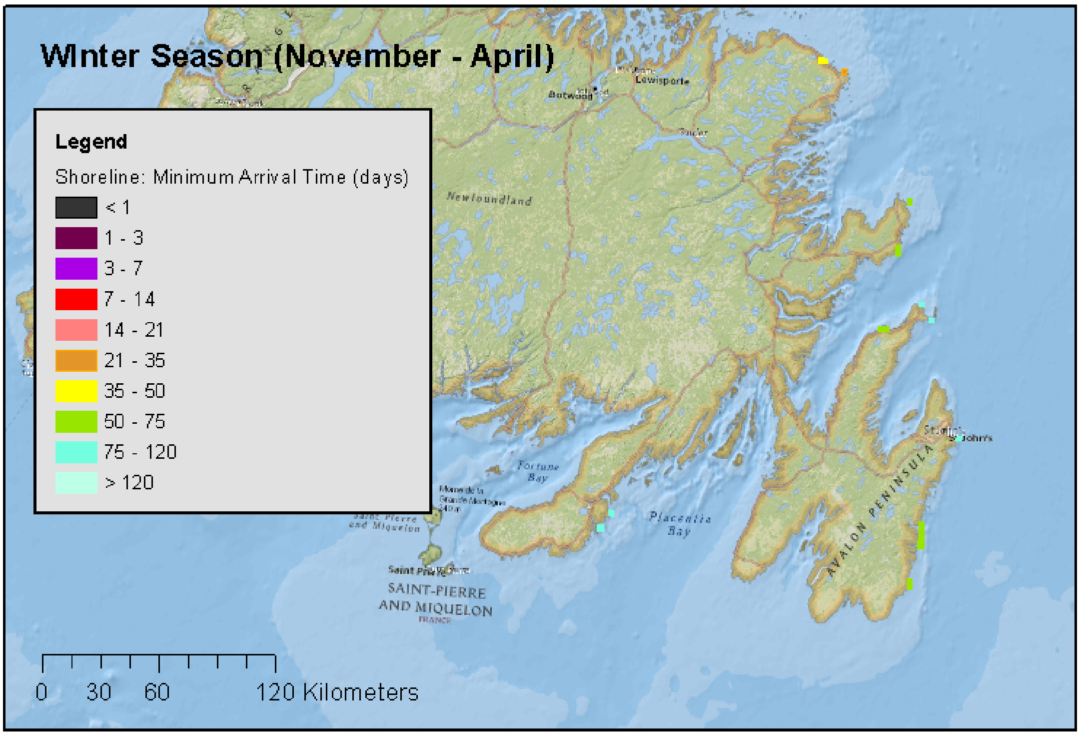


Figure 7.49 Scenario 1: West Orphan relief well scenario (120 day duration). Statistical maps showing the maximum accumulated emulsion thickness on the shoreline in accumulated amounts that exceed the minimum thickness threshold of 1 micron (1 g/m2). (Degree of oiling categorised according to the International Tank Owners Pollution Federation (ITPOF) guidelines for the recognition of oil on shorelines [(24)])

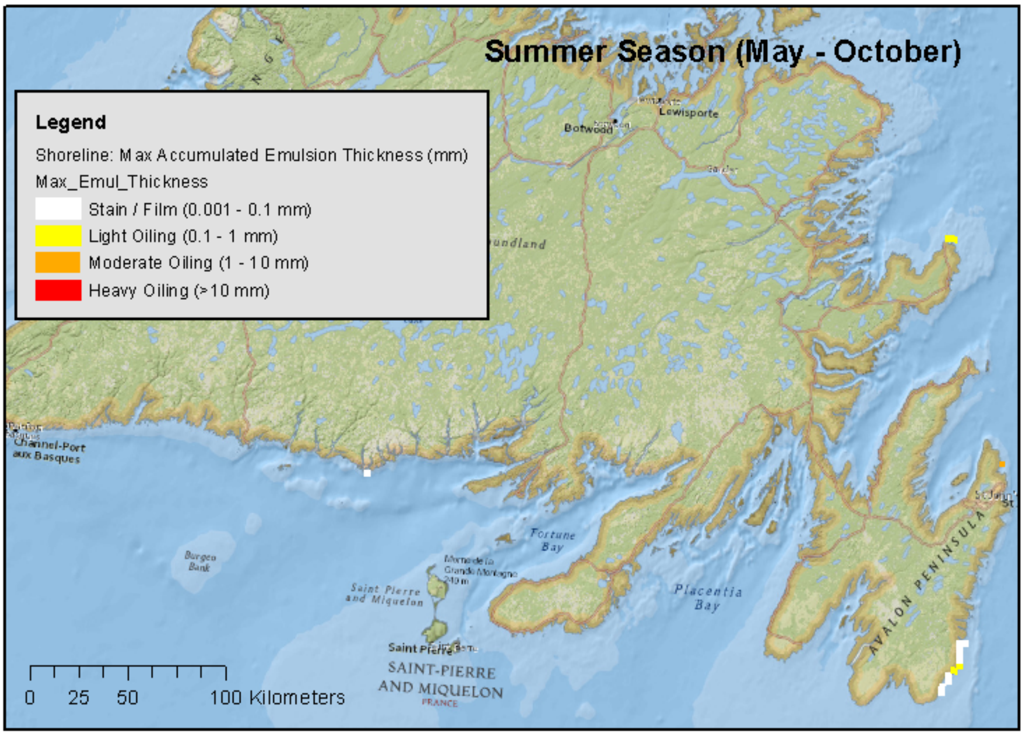
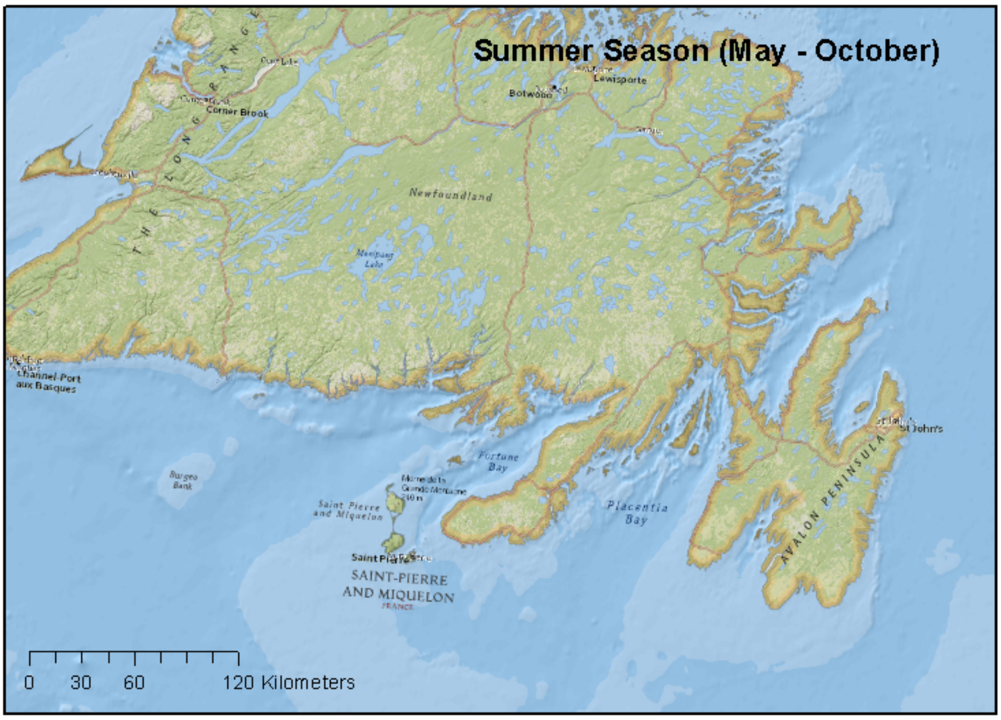
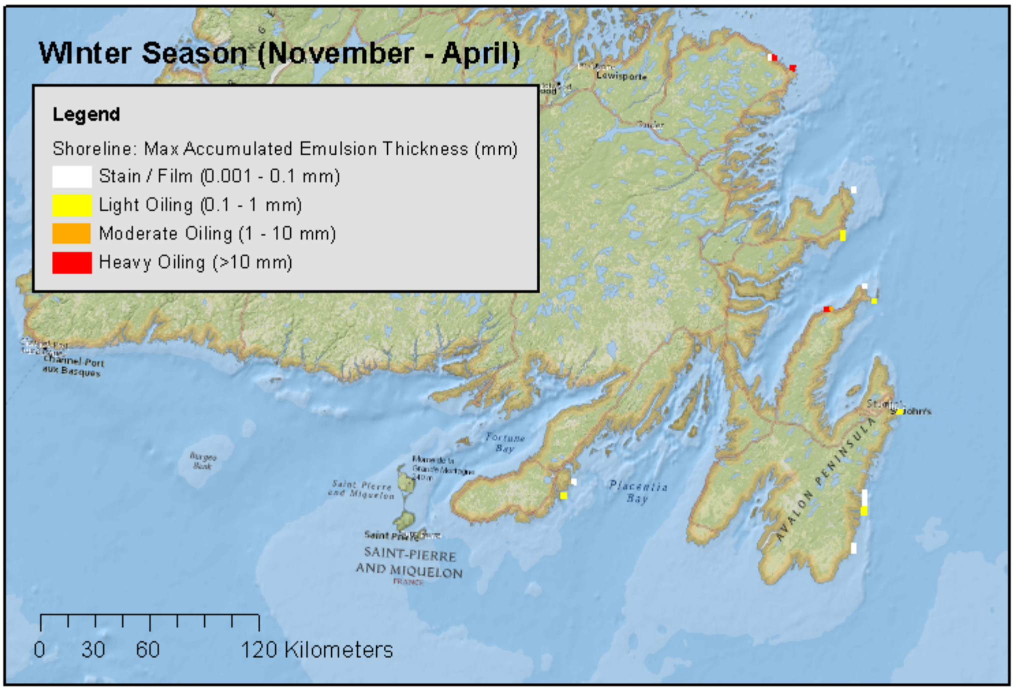


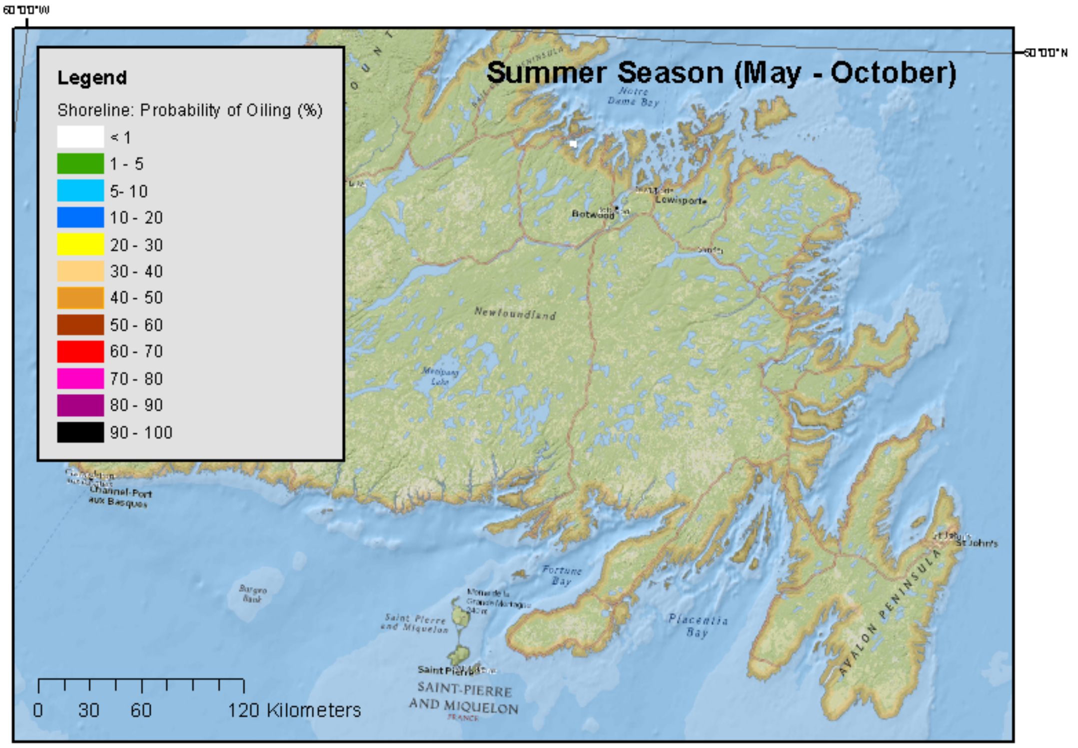
Figure 7.50 Scenario 2: West Orphan capping stack containment scenario (30 day duration). Statistical maps showing the maximum accumulated emulsion thickness on the shoreline in accumulated amounts that exceed the minimum thickness threshold of 1 micron (1 g/m^2). (Degree of oiling categorised according to the International Tank Owners Pollution Federation (ITPOF) guidelines for the recognition of oil on shorelines [24])





7.1.3.2 East Orphan release site

Figure 7.51(a) Scenario 3: East Orphan relief well scenario (120 day duration). Statistical maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²) - Newfoundland



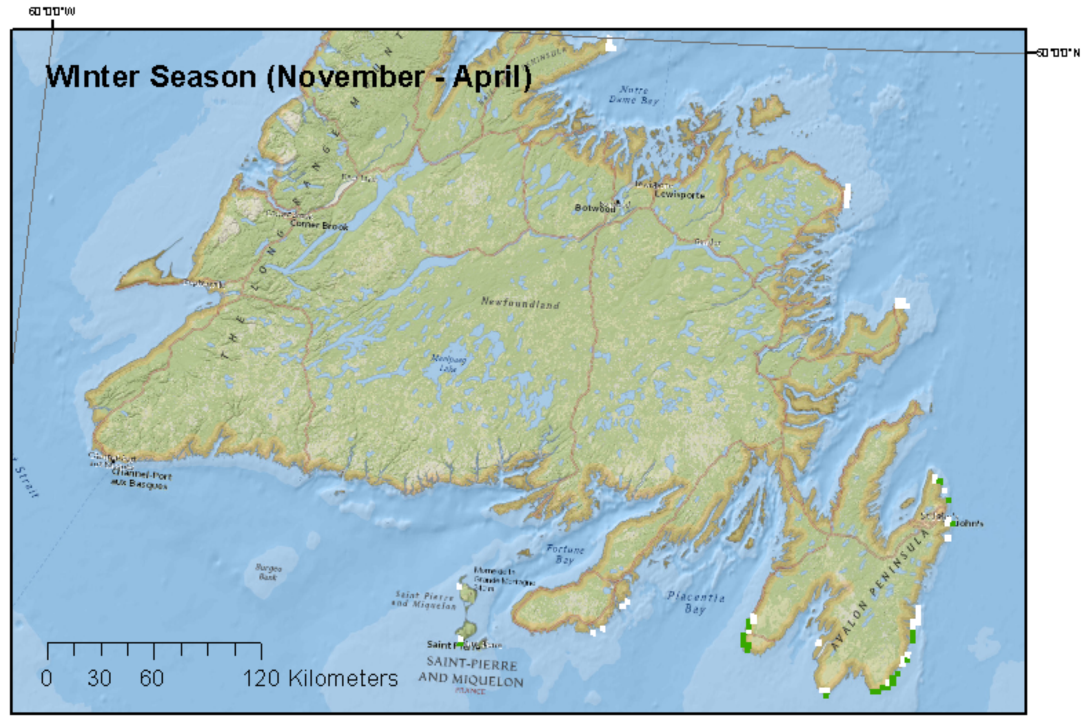
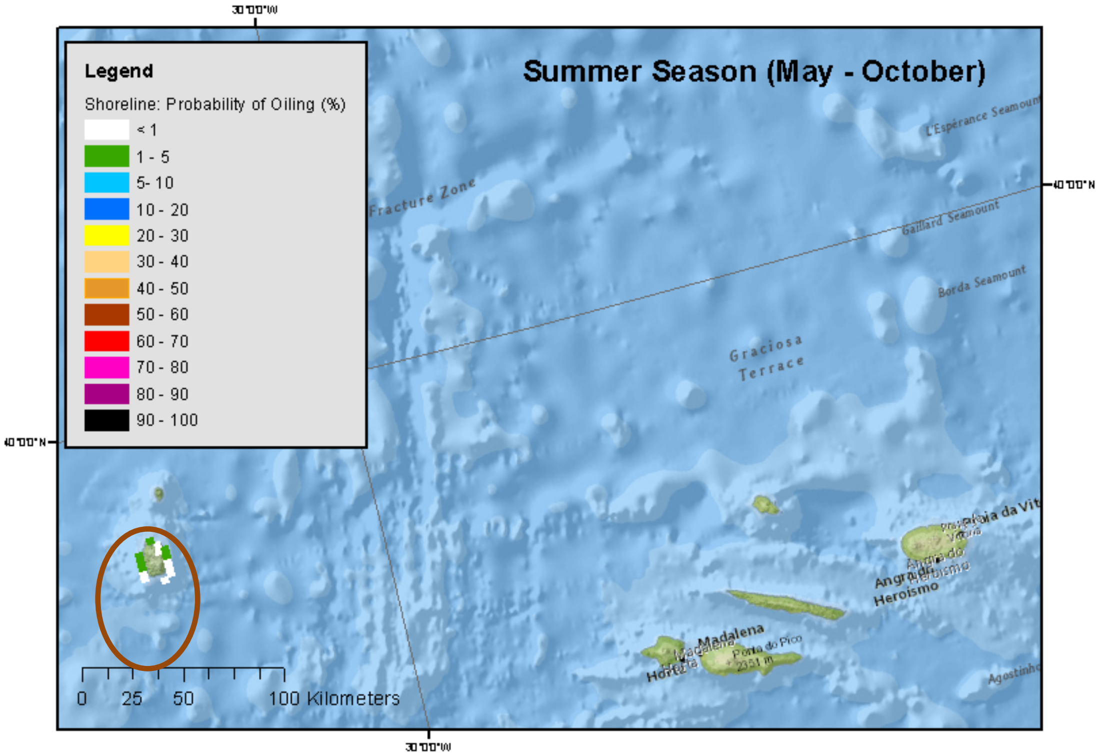


Figure 7.51(b) Scenario 3: East Orphan relief well scenario (120 day duration). Statistical maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m^2) - Azores (Santa Cruz das Flores)



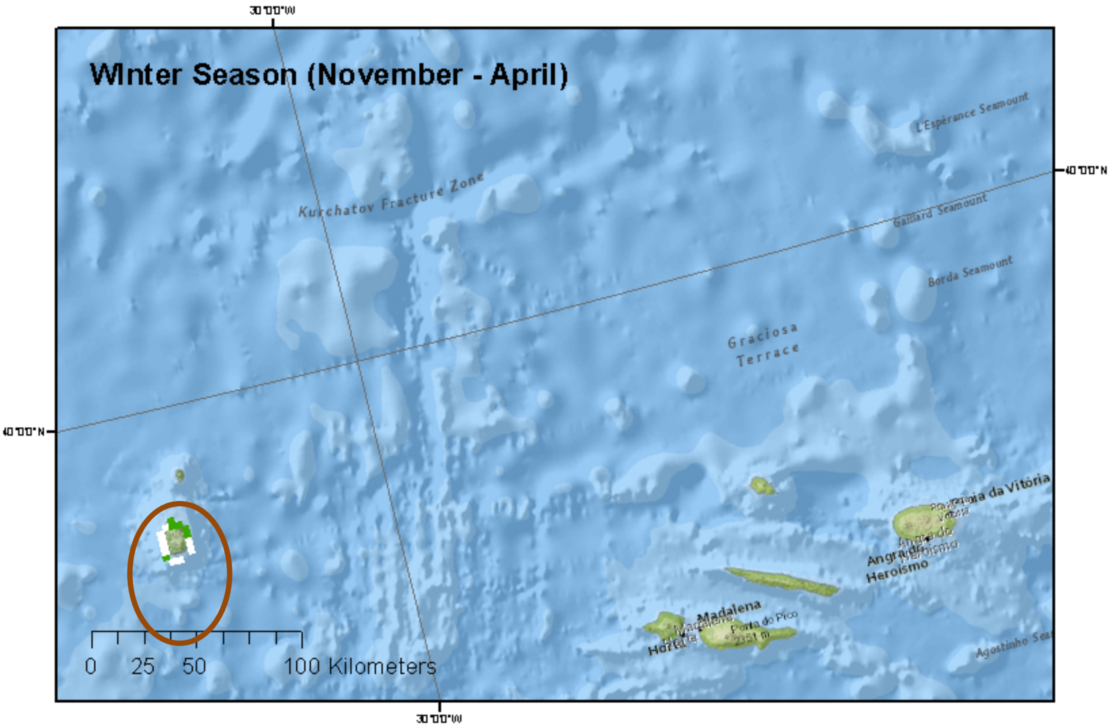
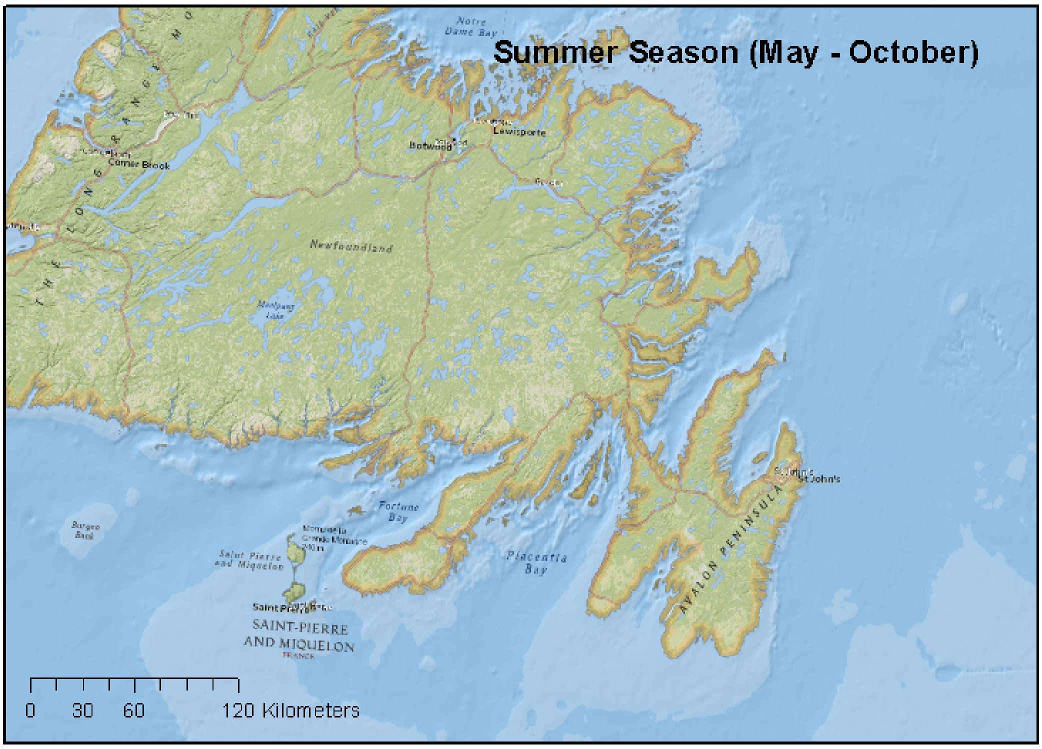


Figure 7.52 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical maps showing the probability of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²)



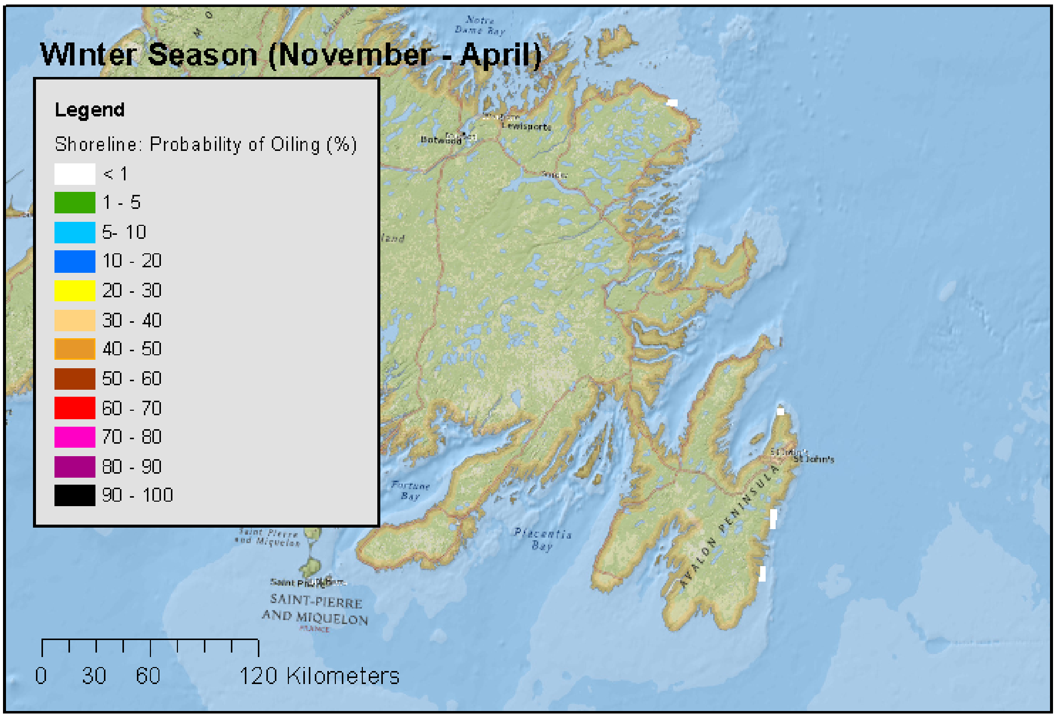
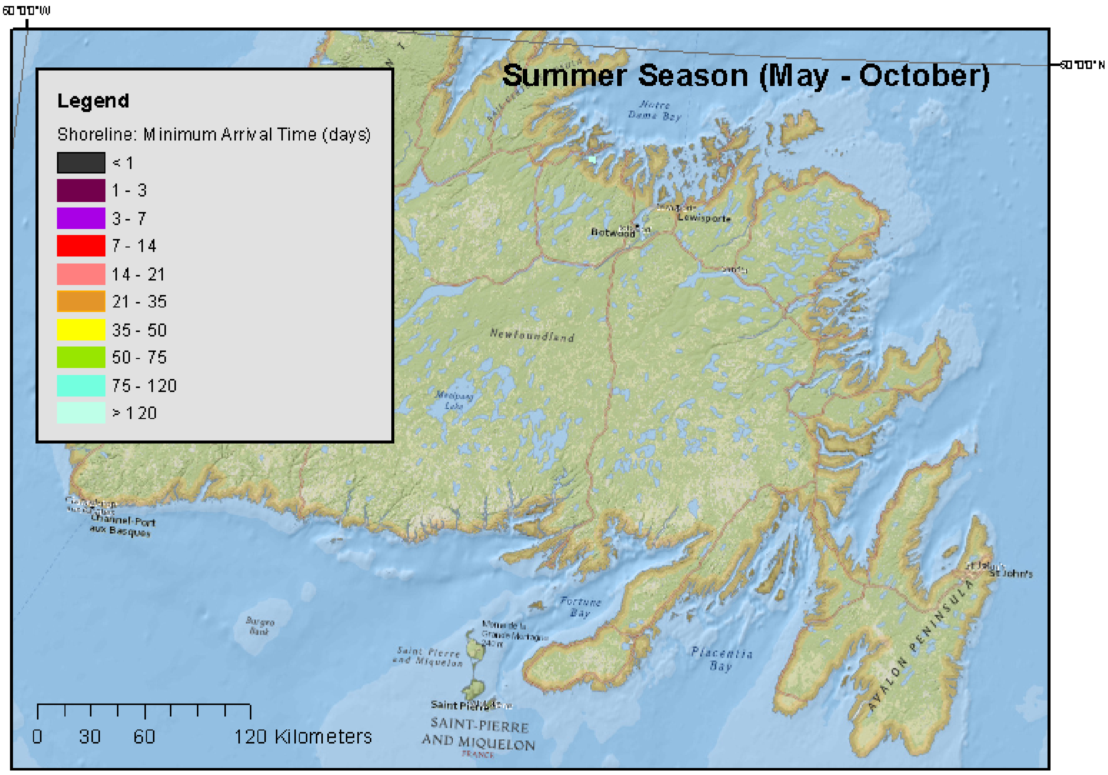


Figure 7.53 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical maps showing the minimum arrival time of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m^2).



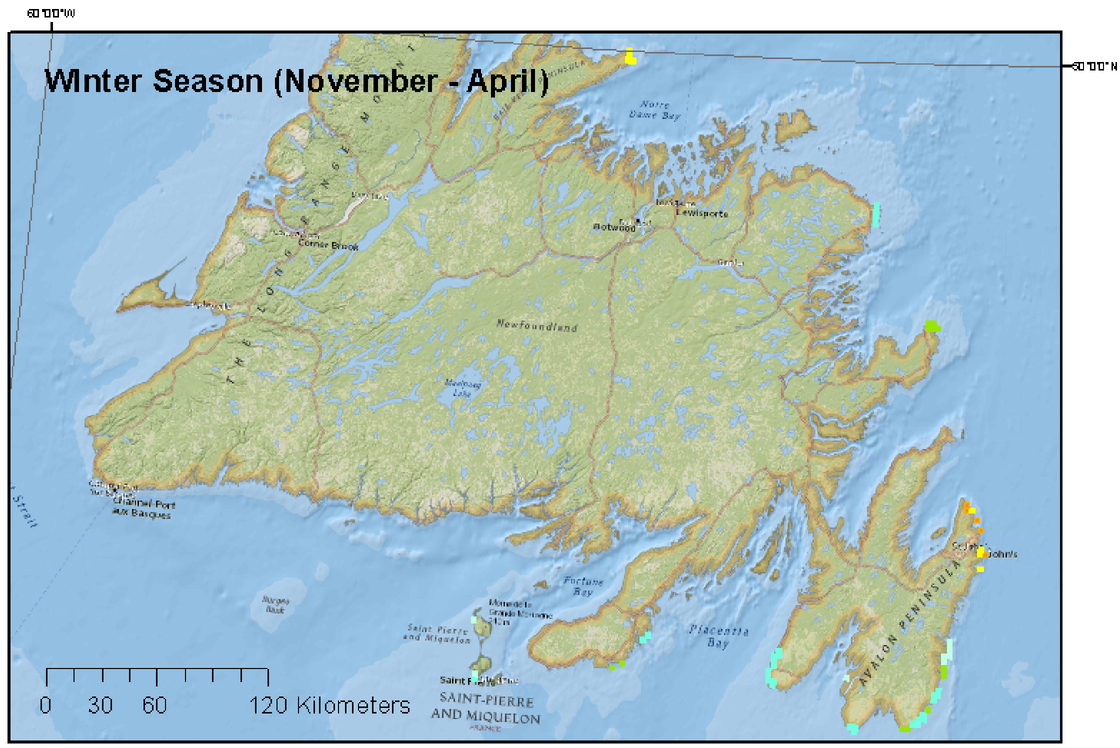


Figure 7.54 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical maps showing the minimum arrival time of oil being stranded on the shoreline in accumulated amounts that exceed the minimum film or sheen thickness threshold of 1 micron (1 g/m²)

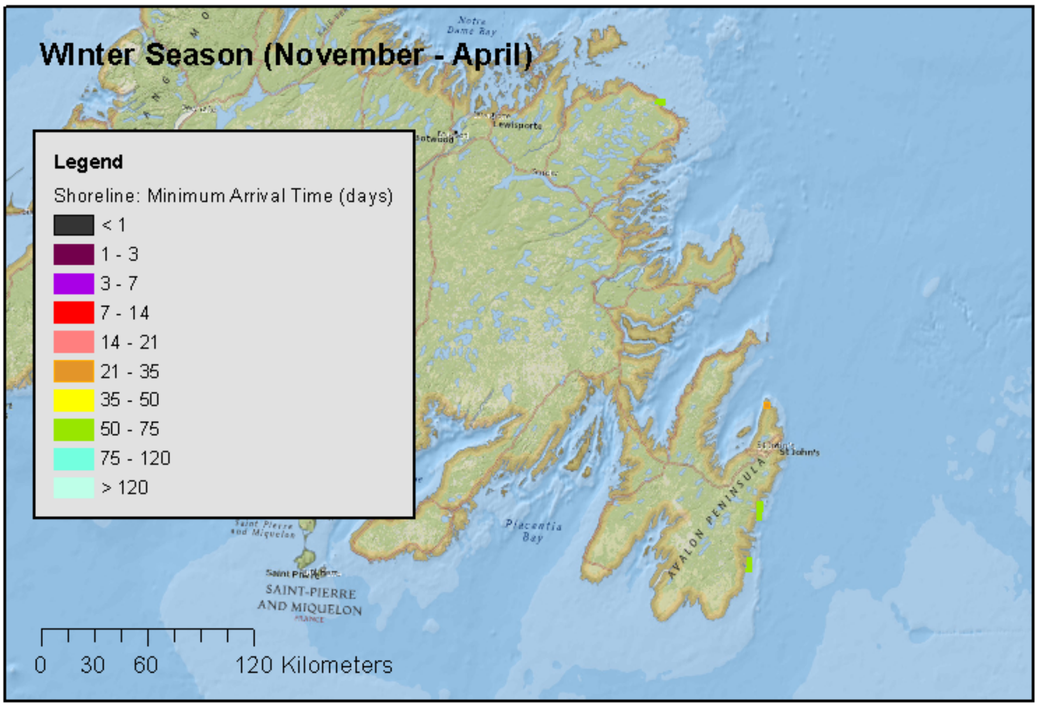
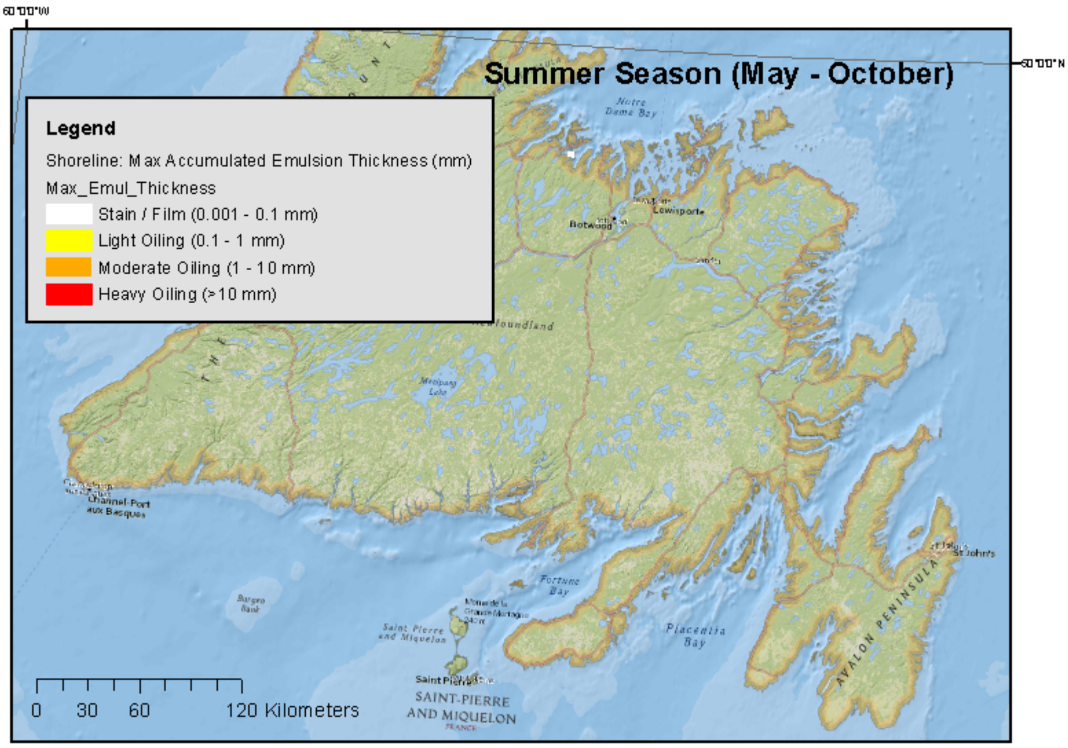


Figure 7.55 Scenario 3: East Orphan relief well scenario (120 day duration). Statistical maps showing the maximum accumulated emulsion thickness on the shoreline in accumulated amounts that exceed the minimum thickness threshold of 1 micron (1 g/m2). (Degree of oiling categorised according to the International Tank Owners Pollution Federation (ITPOF) guidelines for the recognition of oil on shorelines [24])



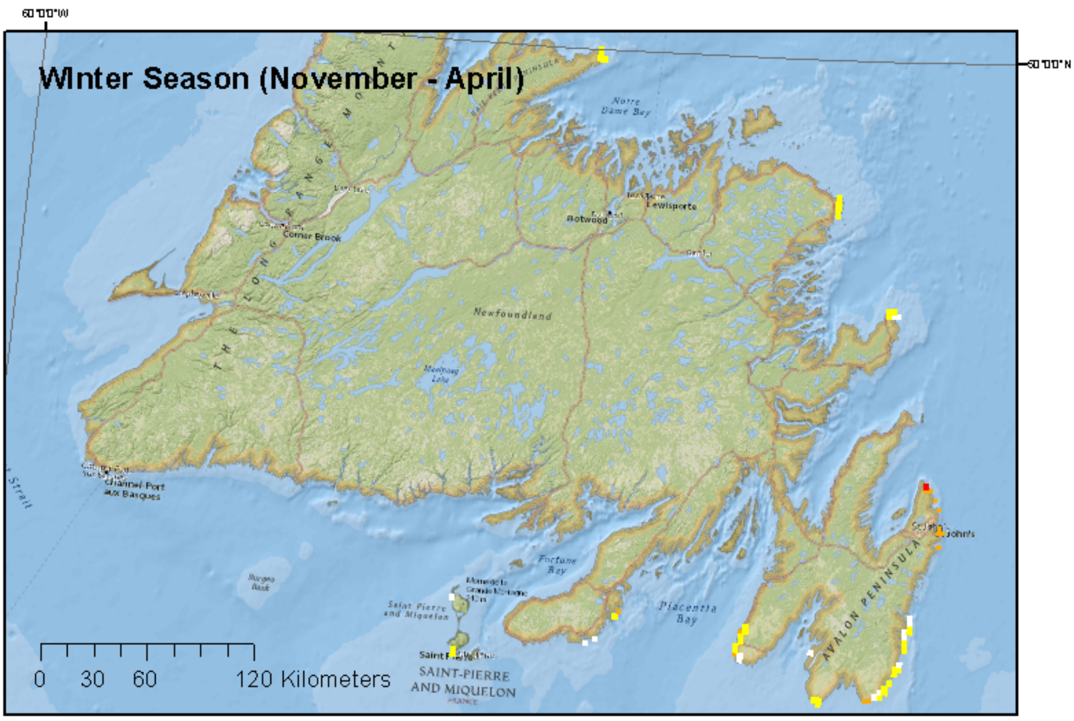
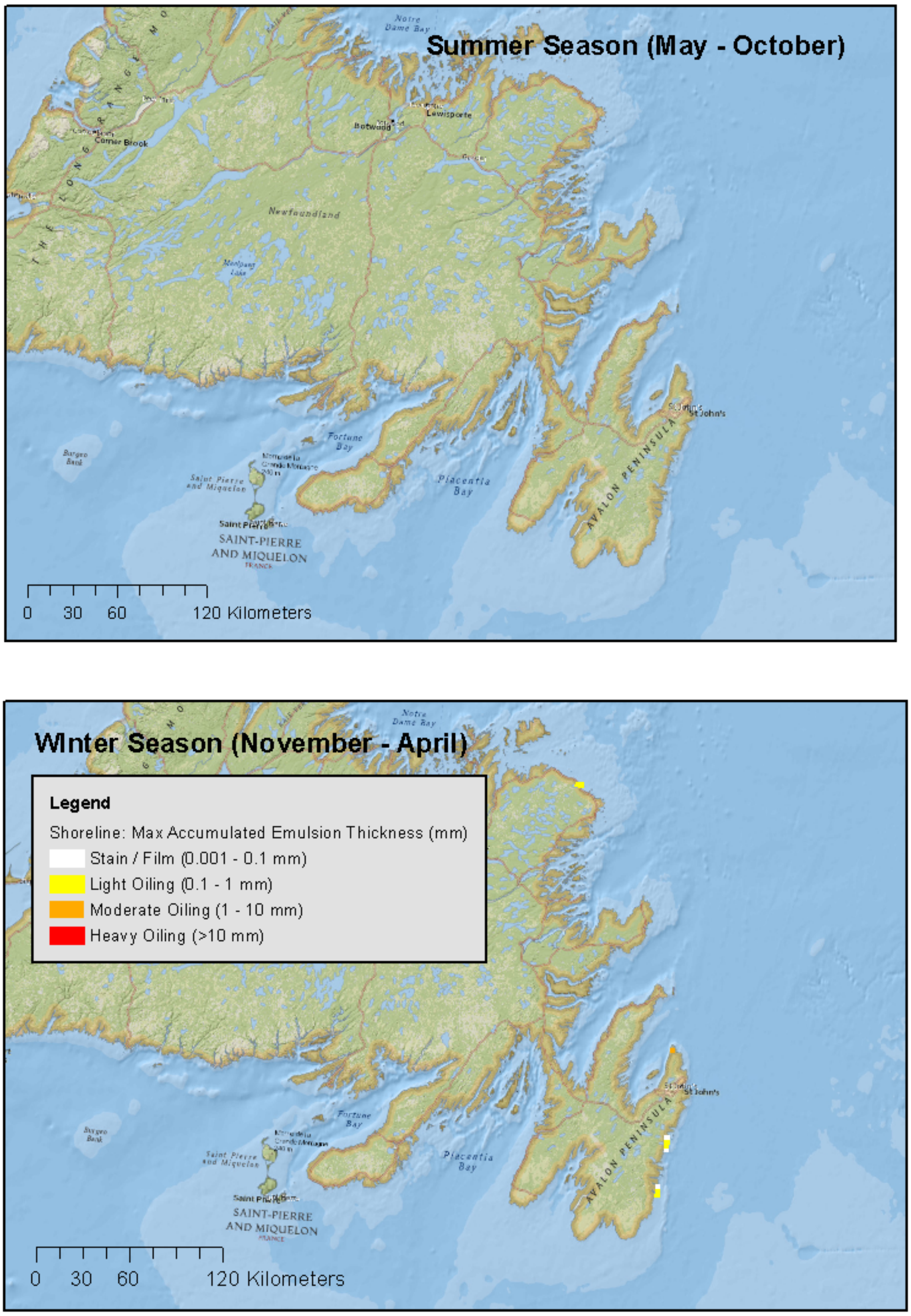


Figure 7.56 Scenario 4: East Orphan capping stack containment scenario (30 day duration). Statistical maps showing the maximum accumulated emulsion thickness on the shoreline in accumulated amounts that exceed the minimum thickness threshold of 1 micron (1 g/m²). (Degree of oiling categorised according to the International Tank Owners Pollution Federation (ITPOF) guidelines for the recognition of oil on shorelines [24])



7.1.3.3 Summary of shoreline results

If shoreline contact was predicted to occur, it would likely be localized to small portions of shoreline, but could span from the Avalon Peninsula, to the southern and eastern coasts of Newfoundland. For the WO relief well winter season scenario, there is a 2 - 4% probability of stranded oil occurrences along the Windmill Bight Provincial Park, Witless Bay, Ecological Reserve and Mistaken Point Ecological Reserve (IUCN II) with light to heavy oiling. However with arrival times ranging from 35 to 100 days at these locations the oil is likely to be heavily weathered.

For the EO relief well scenarios, the modelling results also indicated that some occasional beaching events can occur along the coastline of Santa Cruz das Flores, the most westerly island in the Azores archipelago, with probabilities 1 - 5% and arrival times 150 days. These events are associated with the light to moderate oiling..

7.2 Deterministic Simulation Results

Individual or deterministic trajectories were identified and selected from the stochastic results that represented the maximum shoreline oiling for each well site and season. These representative worst credible case scenarios were then rerun deterministically to establish near-field and far-field fate and transport. The deterministic simulations provide insight to the individual trajectories, oil weathering behaviour, the mass of oil in each environmental compartment (air, water, surface, land and sediment) and other information (area of oil slick, length of shoreline oiled etc.) related to each single spill at a given location and time which cannot be assessed using stochastic models.

The results of representative cases identified for maximum shoreline oiling, from each stochastic analysis, for both well sites and for winter and summer seasons, are provided in Table 7.2. It describes the specific details for each scenario including the time for oil to reach the shoreline, maximum mass of oil on the shoreline, length of coastline impacted, and the total amount of oil released.

The worst case stranded oil cases for each site (relief well - winter season) are analysed in more detail below.

Thresholds for surface oil thickness (0.04 µm), total hydrocarbon concentration in the water column (58 ppb) were applied to the cumulative footprint deterministic simulation outputs.

Figures 7.57 to 7.76 provide outputs for these, unmitigated relief well blowout scenarios depicting surface oiling, in-water oiling, and shoreline oiling.

Descriptions of these figures are provided below to assist with the interpretation.

Surface Oil Figures: Figure 7.66 and 7.73 show the footprint of floating emulsified surface oil and the predicted maximum thicknesses (µm) which exceeds the 0.04 µm thickness threshold at each surface location over the 160-day spill simulation period.

Table 7.2 WO and EO subsea well blowout scenarios. Summary of the release conditions and deterministic modelling results for the oil spill trajectories selected from the stochastic scenarios that produced the maximum amount of accumulated oil on shoreline

	Deterministic simulations	Scenario 1 - WO Well Blowout - Relief Well	Scenario 2 - WO Well Blowout - Capping Stack	Scenario 3 - EO Well Blowout - Relief Well	Scenario 4 - EO Well Blowout - Capping Stack
		128,000 bpd (Initial oil release rate) / 120 days duration	128,000 bpd (Initial oil release rate) /30 days duration	39,000 bpd (Initial oil release rate) / 120 days duration	39,000 bpd (Initial oil release rate) /30 days duration
	Season	"Winter Season" (November - April)	"Winter Season" (November - April)	"Winter Season" (November - April)	"Winter Season" (November - April)
	Simulation number	100	103	104	104
	Start time	31 December 2009 02:00	22 January 2010 17:00	30 January 2010 06:00	30 January 2010 06:00
	Simulation duration	160 days	90 days	160 days	90 days
	Release duration	120 days	30 days	120 days	30 days
	Initial Release rate	128,282 bbls/day	128,282 bbls/day	39,195 bbls/day	128,282 bbls/day
	Total oil release	1,350,011 tonnes	471,008 tonnes	460,148 tonnes	160,590 tonnes
Stranded oil	First shore hit	104 days	43 days	78.0 days	79.0 days
Stranded oil	Maximum mass on shoreline	403 tonnes	54 tonnes	271 tonnes	9 tonnes
Stranded oil	Maximum mass of emulsified oil on the shoreline	2,338 tonnes	314 tonnes	271 tonnes	9 tonnes
Stranded oil	Ashore time (maximum mass)	107 days	45 days	98 days	80 days
Stranded oil	Length of coastline impacted (at maximum mass ashore)	16 km	8 km	20 km	4 km
Stranded oil	Maximum length of coastline impacted	20 km	8 km	27 km	4 km
Stranded oil	Ashore time (maximum length)	119 days	44 days	132.0 days	80.0 days
Surface Oil	Maximum mass of oil on sea surface	99,660 tonnes	78,740 tonnes	127,400 tonnes	40,610 tonnes
Surface Oil	Time of occurance (maximum surface mass)	60 days	29 days	30 days	20 days
Surface Oil	Average mass of oil on sea surface	31,524 tonnes	17,401 tonnes	20,549 tonnes	12,929 tonnes
Surface Oil	Maximum area coverage of emulsified oil (> 0.04 microns) on the sea surface	181,000 km2	59,710 km2	195,400 km2	91,300 km2
Surface Oil	Time of occurance for maximum area coverage of emulsified oil (>0.04 microns thickness) on the sea surface)	149 days	50 days	42 days	83 days
Surface Oil	Average area coverage of emulsified oil (> 0.04 microns) on the sea surface	26,711 km2	17,792 km2	58,435 km2	34,307 km2
Surface Oil	Maximum area coverage of thick	388 km2	354 km2	386.7 km2	179.9 km2
Surface Oil	Time of occurance for maximum area coverage of thick emulsified oil (> 100 microns thickness) on the sea surface)	46 days	23 days	31 days	20 days
Surface Oil	Average area coverage of thick emulsified oil (> 100 microns) on the sea surface	139 km2	109 km2	96 km2	59 km2
Surface Oil	Max water content of surface oil	80 %	80 %	0.0 %	0.0 %
Surface Oil	Average Mean Viscosity of Surface Oil	306,479 cP	300,018 cP	903,800.6 cP	897,711.1 cP
Surface Oil	Maximum Max Viscosity of Surface Oil	668,600 cP	527,200 cP	1,050,000.0 cP	958,300.0 cP
	Cumulative Impacted Area Exceeding Thresholds: ***Surface Oiling:***				
	0.04 microns	1,551,332 km^2	n/d km^2	1,554,575 km^2	n/d km^2
	10 microns	96,290 km^2	n/d km^2	32,941 km^2	n/d km^2
	100 microns	21,271 km^3	n/d km^3	868 km^3	n/d km^3
	Water Column:				
	58 ppb THC	247,524 km^2	n/d km^2	112,547 km^2	n/d km^2
	10 ppb total dissolved hydrocarbons	3,060 km^2	n/d km^2	231 km^2	n/d km^2

Water Column Figures: Figure 7.64 and 7.74 show the footprint of THCs (dispersed and dissolved oil in the water column and the predicted maximum concentrations of THCs which exceed the 58 ppb THC threshold at any grid cell within the upper 100 m of water column over during the 160-day spill simulation period. Figures 7.65 and 7.75 show the footprint of dissolved oil in the water column and the predicted maximum concentrations of dissolved oil which exceed a 1 ppb threshold at any grid cell within the upper 100 m of water column over during the 160-day spill simulation period.

Mass Balance Figures: Figures 7.59, 7.60, 7.69 and 7.70 provide an estimate of the oil's weathering and fate for a specific run for the entire model duration as a fraction of the oil released up to that point. Components of the oil tracked over time include the proportion of oil on the sea surface, entrained into the water column, stranded on shore, evaporated into the atmosphere, and that which has been degraded through biodegradation.

Shoreline Impact Figures: Figures 7.66 and 7.76 show the stranded oil thickness deposited onto shoreline and length of shoreline impacted.

Surface Oil Area Coverage Figures: Figures 7.62 and 7.72 show the areal coverage of emulsified surface oil exceeding a 0.04 µm sheen thickness threshold and a 100 µm minimum threshold for thick oil.

7.2.1 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season)

7.2.1.1 Near-field plume dynamics

Figure 7.57 shows the results of a near-field deterministic simulation over the first 12 days of the WO relief well blowout event (worst case shoreline oiling scenario, winter season).

Vertical cross sections through the water column show the extent of the subsea plume, and rise of oil droplets and dissolved oil. As the oil rises to the surface within a few hours, the radial extent that the plume and oil droplets move away from the release location is relatively small compared to the lateral transport of oil once it arrives at the surface.

Due to the high turbulence at the release point, oil and gas released from the seabed rise as droplets and bubbles along with a substantial quantity of entrained water as a multiphase plume. Oil droplet size does not significantly affect the transport of the mixture of plume fluid. Hence, the phases are initially clustered together and then move as an integral mixture governed by plume buoyancy forces. The Terminal Level for Plume Dynamics (TLPD), is the level where the plume dynamics is not important any more. Above the TLPD the oil droplet size distribution become important, as smaller droplets move more slowly towards the surface when compared to larger droplets. Cross currents move droplets laterally, thus the droplets can spread in all directions. The 3-D plume model OSCAR simulation results suggest that the high exit velocity cause the plume to rise rapidly. The TLPD occurs at about 535 m below sea-level and is reached within 10 minutes of oil being released at the seabed.

The oil droplet size model in OSCAR predicts an initial d95 droplet size of 4.3 mm and d50 (median) droplet size of 2.0 mm for the WO release. The model predicts it will take the largest oil droplets (4.1 mm) another 2 hours to rise to the surface, with 50% having arrived after 4 hours (see Figure 7.58).

Figure 7.57 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Snapshot map showing the trajectory of dispersed oil droplets and dissolved oil model particles the water column 12 days after start of release.

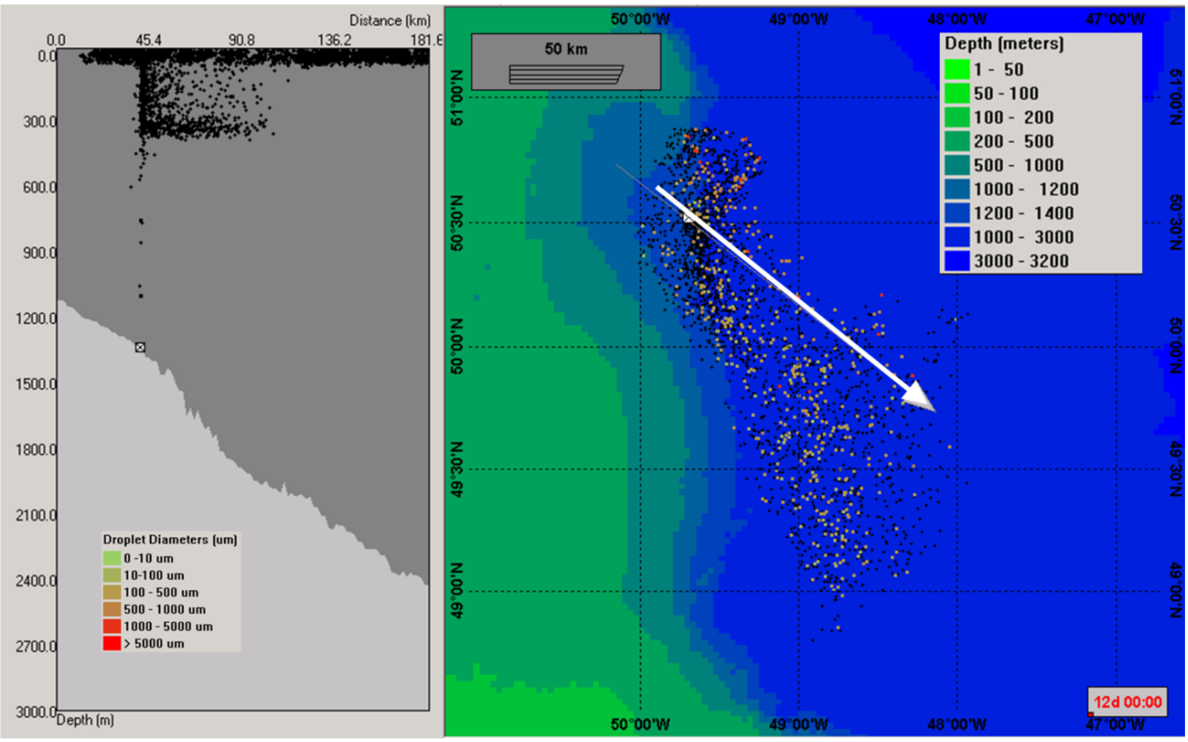
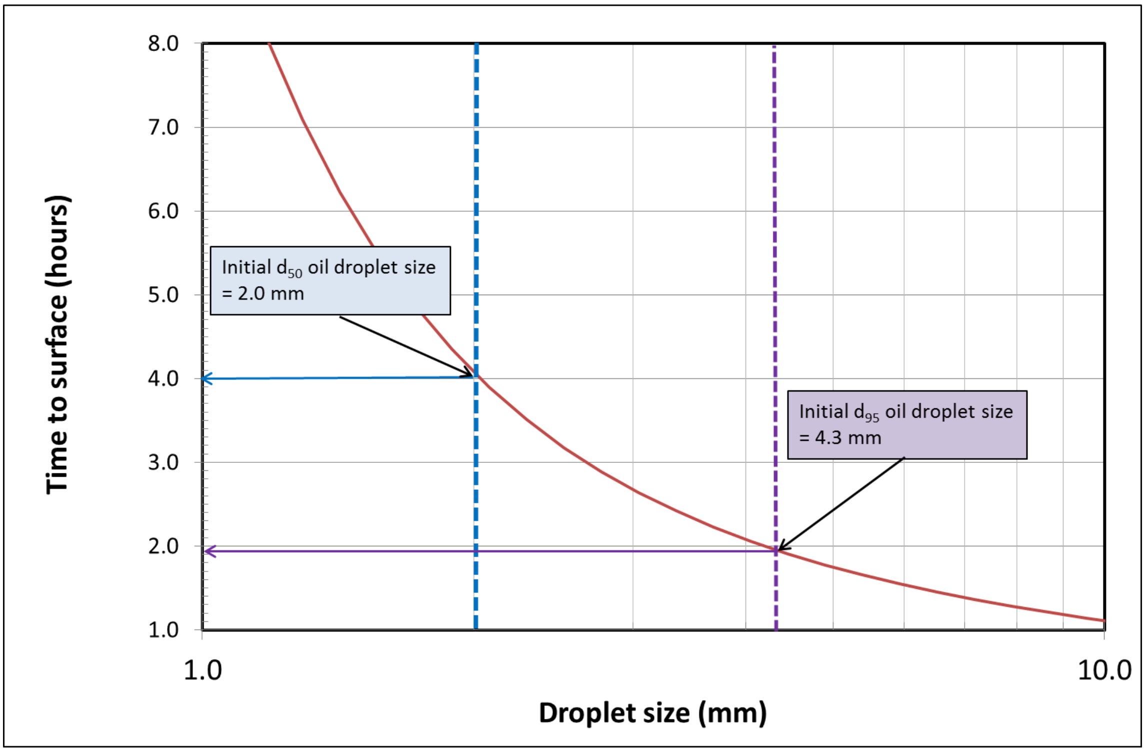


Figure 7.58 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Graph showing the predicted droplet rise-time to surface from the plume trapping height (535 m below sea-level) vs droplet size



7.2.1.2 Oil mass balance

Figures 7.59 and 7.60 show the mass balance time development and distribution of oil for the WO relief well, maximum shoreline oiling, winter scenario. The simulation chosen started on 31st December 2009 at 02:00 GMT and resulted in a maximum oil mass on the shore of 403 tonnes, with the first oil beaching after 65 days.

The model results predicted that the water content of the oil emulsion arriving on the shoreline would be 80%, so the stranded oil tonnages need to be increased by a factor of 5 to derive the tonnage of oil emulsion beached on the shoreline.

At the end of the worst shoreline oiling simulation for the winter season, 484,500 tonnes of oil would be biodegraded (decayed) and 365,600 tonnes evaporated (Figure 7.59). This accounts for 36% and 27% of the total oil released respectively. The maximum amount of oil in the water column (dispersed) is reported as 523,700 tonnes after 120 days, the maximum amount of oil on the surface is 99,660 tonnes after 60 days and the maximum amount of weathered oil that sinks and becomes incorporated into the sediment is 32,670 tonnes after 160 days. After 160 days, 0.19% of the release is reported on the surface and 34% in the water column; with that remaining in the water column dispersed to negligible concentrations (<58 ppb THC dispersed oil).

The modelling results for Site 1 (Figures 7.64 – 7.66) predict that the majority of oil would remain offshore. In the event that surface oil was to enter the near shore area of Newfoundland (Avalon Peninsula), it is predicted to have a BAOAC metallic thickness. Exceedances of the in-water oil threshold is predicted to also be limited to offshore waters; however, the area impacted is smaller than that of surface oiling. Shoreline oiling exceeding the threshold level is expected to be limited to the Avalon Peninsula with occurrences of moderate, light and stain oiling (Figure 7.66). The maximum length of shoreline impacted would occur after 119 days with 20 km of coastline being affected (Figure 7.61 and 7.66). The maximum mass of oil on the shoreline occurs slightly earlier (after 107 days) and is associated with 403 tonnes of oil accumulated on the shoreline.

Figure 7.59 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Graph showing time development of oil mass balance.

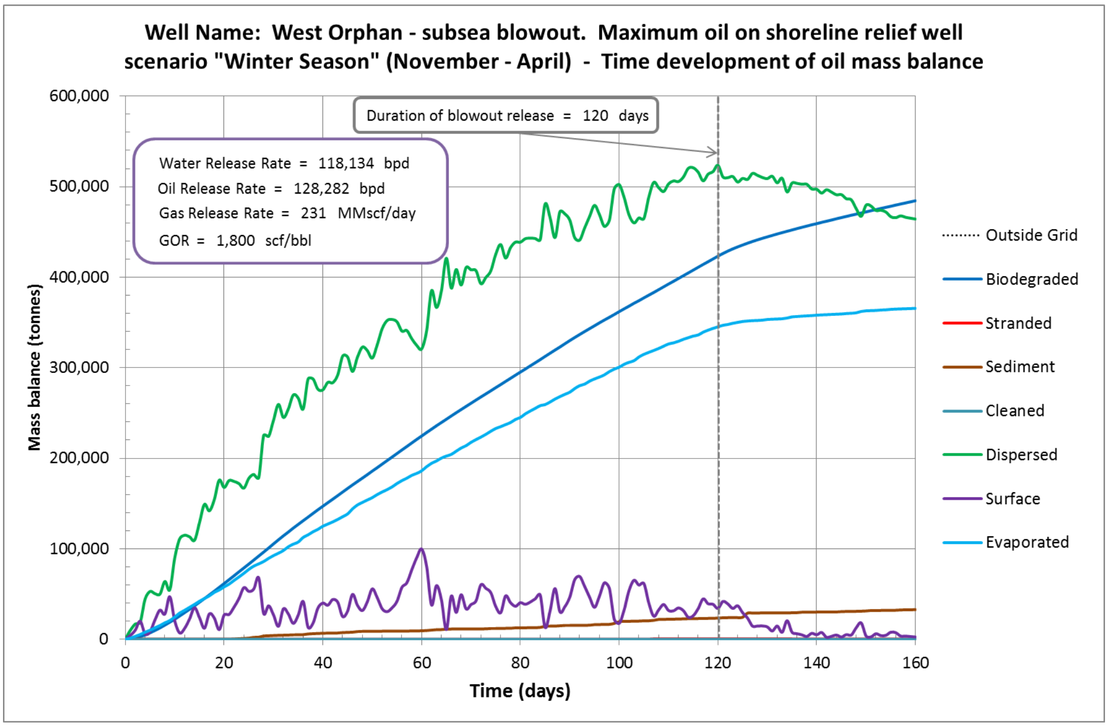


Figure 7.60 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Graph showing mass balance distribution of oil over the duration of the simulation.

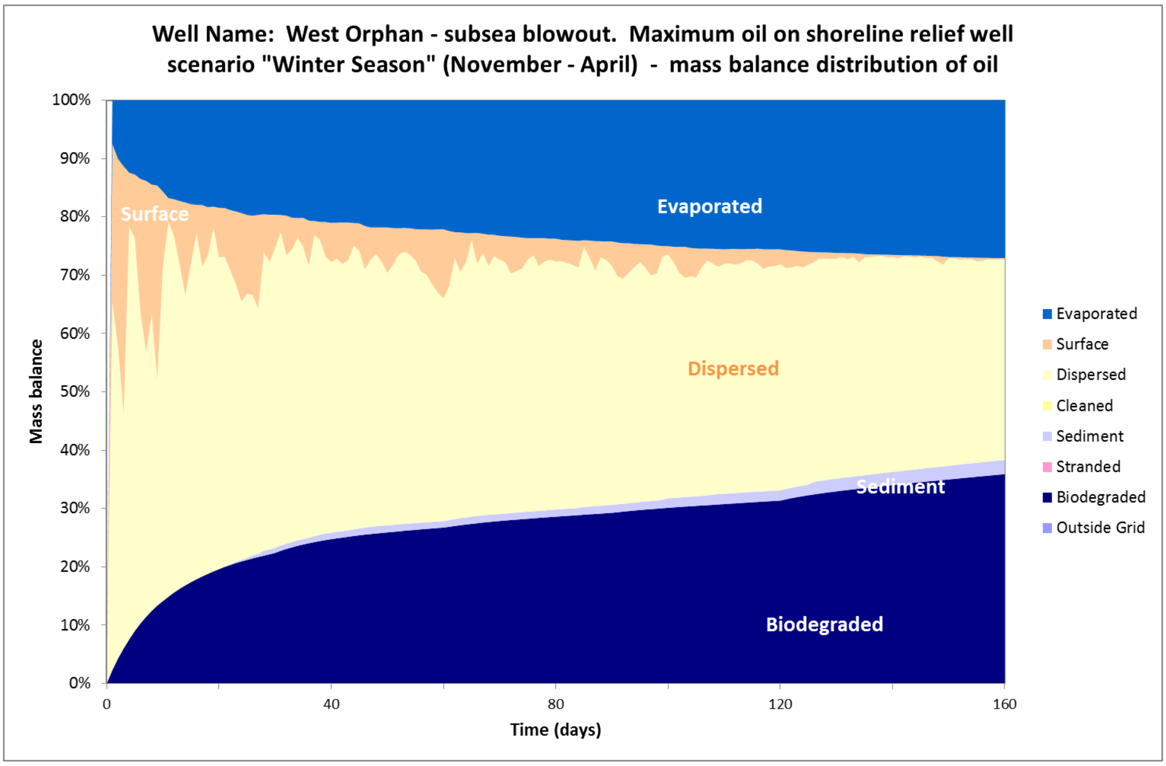


Figure 7.61 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Graph showing mass of oil stranded on the shoreline and length of shoreline oiled.

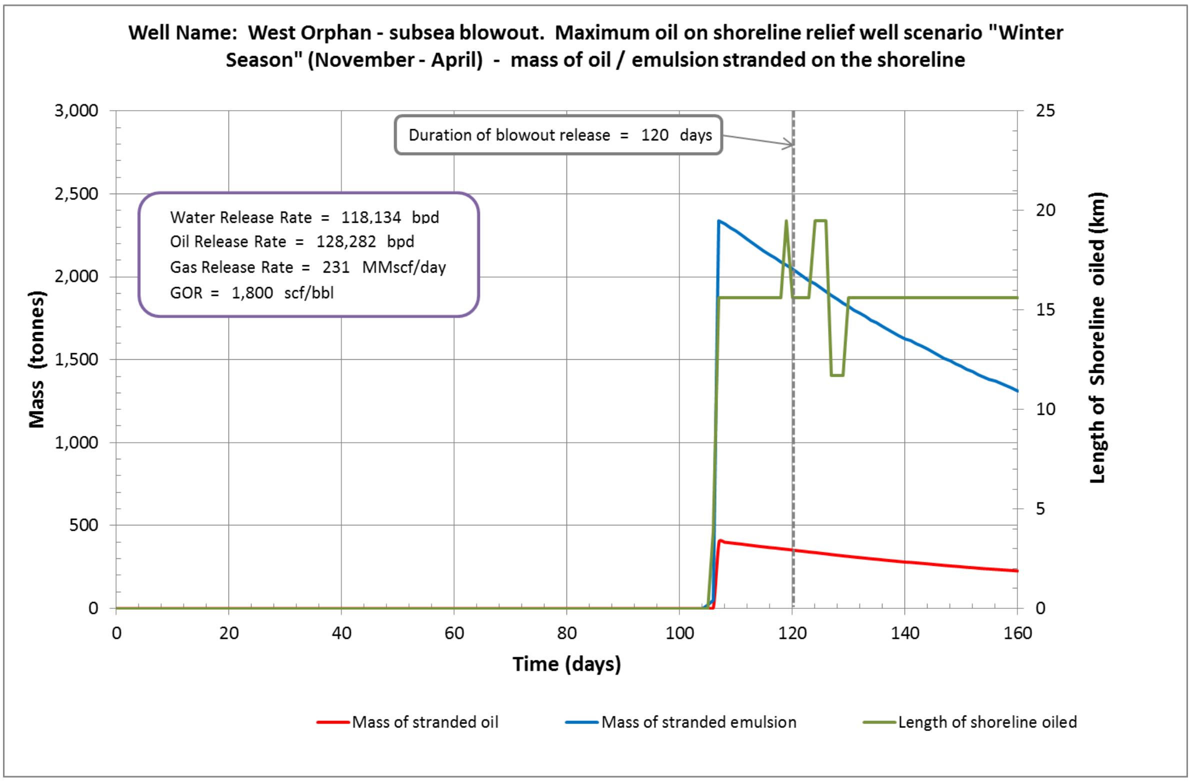


Figure 7.62 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Graph showing area coverage of surface oil.

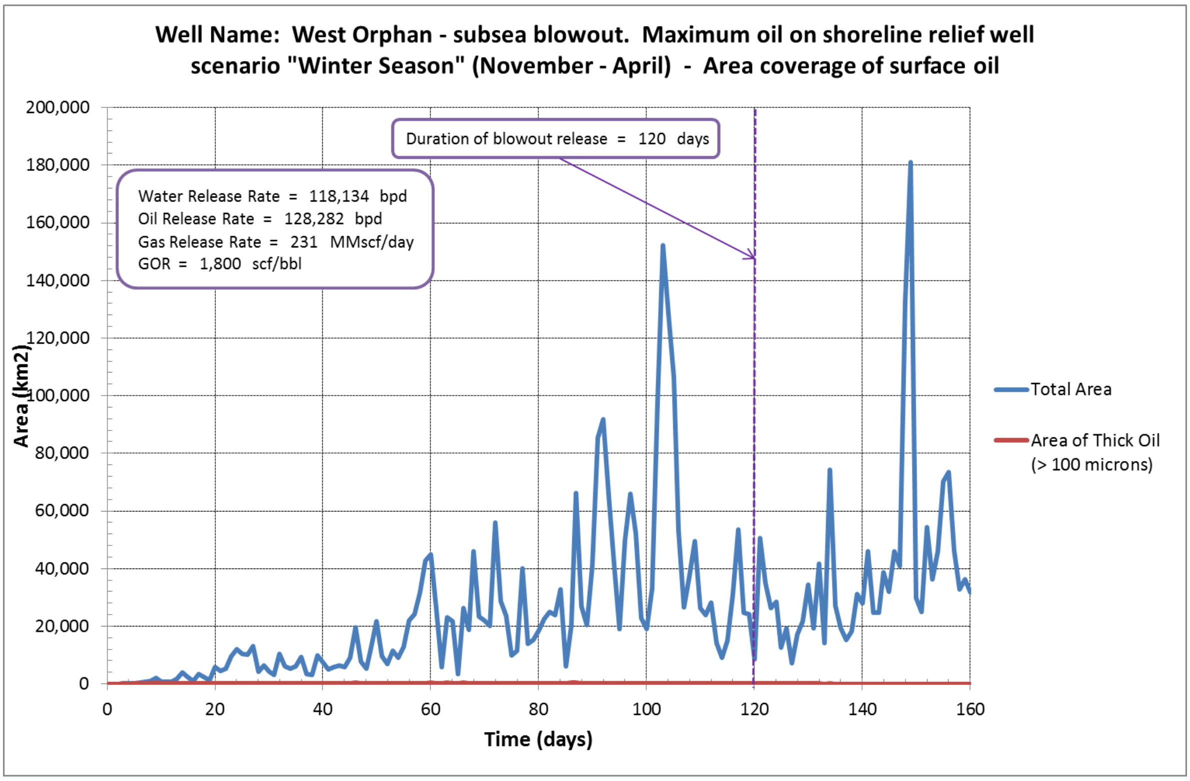


Figure 7.63 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Contour map showing the maximum surface oil thickness at each location over the simulation period (0.04µm BAOAC "Sheen" thickness threshold applied).

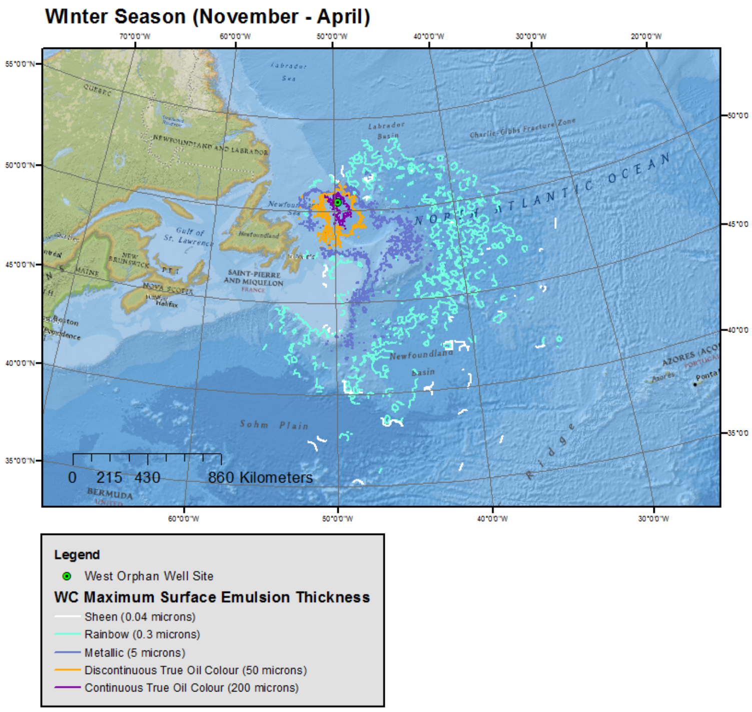


Figure 7.64 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Contour map showing the maximum concentration of total hydrocarbons (dispersed and dissolved) within any grid cell in the top 100 m of water column over the entire simulation (58 ppb THC threshold applied).

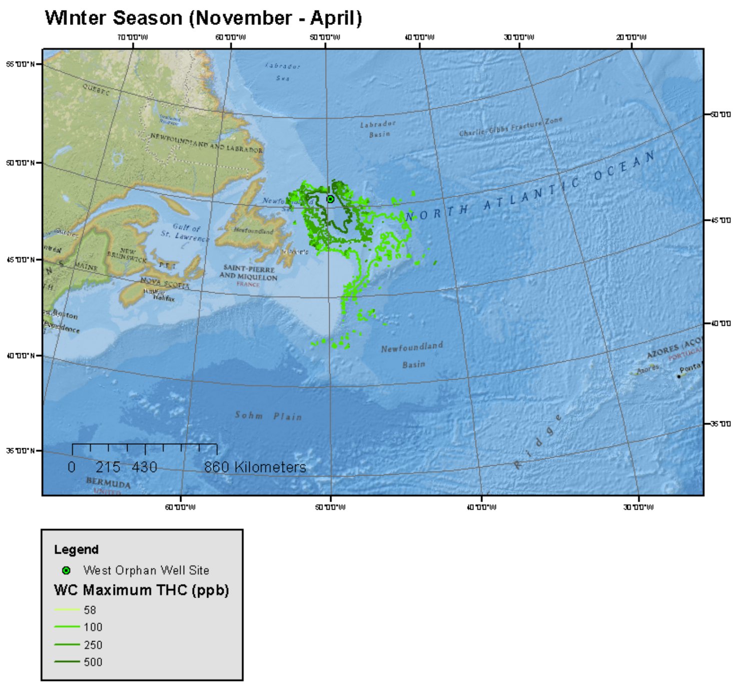


Figure 7.65 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Contour map showing the maximum concentration of dissolved oil within any grid cell in the top 100 m of water column over the entire simulation (1 ppb threshold applied).

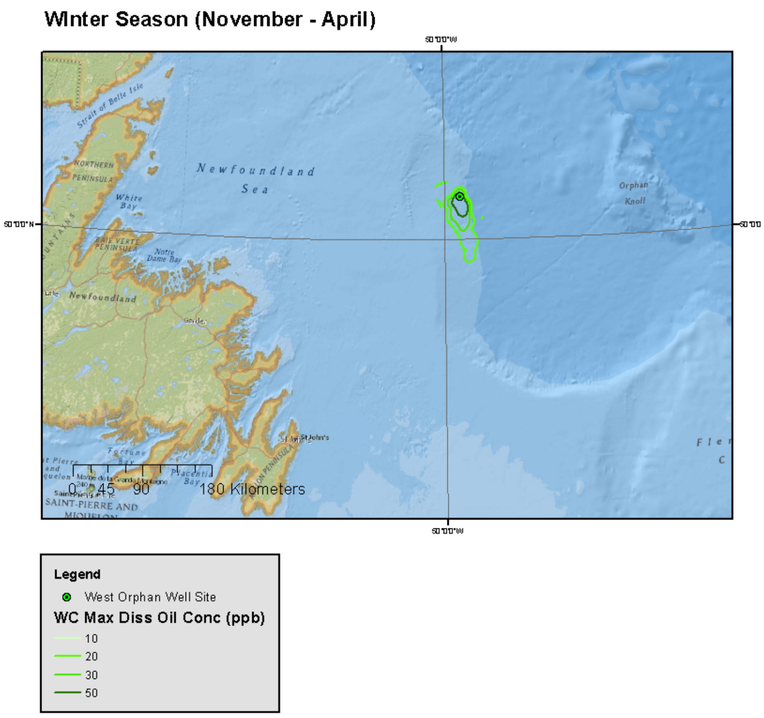
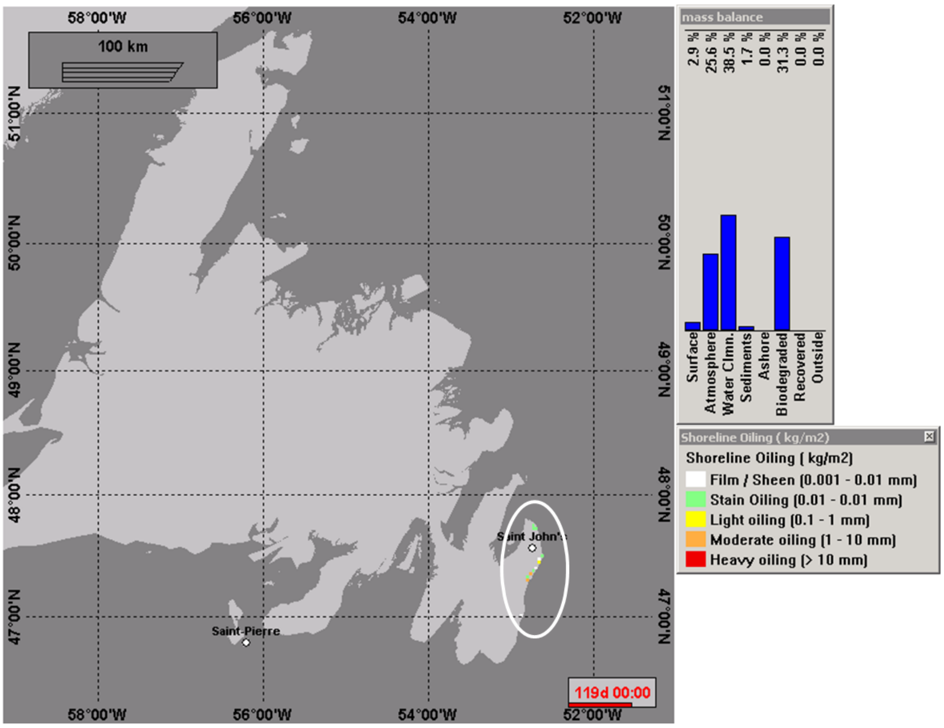


Figure 7.66 Scenario 1: West Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 31st Dec 2009 02:00 GMT). Snapshot map showing the stranded oil thickness at the time of maximum length of shoreline impacted (Day 119).



7.2.2 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season)

7.2.2.1 Near-field plume dynamics

Figure 7.67 shows the results of a near-field deterministic simulation over the first 12 days of the EO relief well blowout event (worst case shoreline oiling scenario, winter season).

Vertical cross sections through the water column show the extent of the subsea plume, and rise of oil droplets and dissolved oil. The outlet velocity of the EO release is 3 times less than that of the release at WO. Although the oil droplet sizes are larger in the EO release, due to the lower release rate, the decrease in outlet velocity means that plume does not rise as rapidly at EO and terminates at a much deeper water depth. The TLPD is predicted to occur at about 2,435 m below sea-level, only 300 m above the release water depth. Consequently the oil droplets on leaving the plume take far longer to reach the sea surface, are dispersed more by cross currents as they rise, resulting in much thinner oil slick at the sea surface than was the case for the WO blowout scenarios.

The oil droplet size model in OSCAR predicts an initial d95 droplet size of 9.8 mm and d50 (median) droplet size of 4.6 mm for the EO release. The model predicts it will take the largest oil droplets (9.8 mm) 8 hours to rise to the surface, with 50% having arrived after 23 hours (see Figure 7.68).

Figure 7.67 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Snapshot map showing the trajectory of dispersed oil droplets and dissolved oil model particles the water column 12 days after start of release.

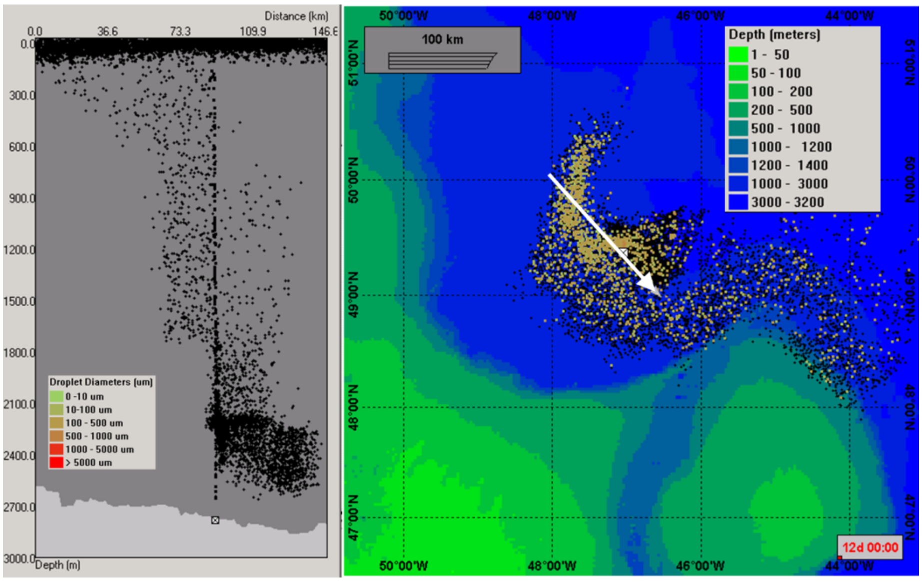
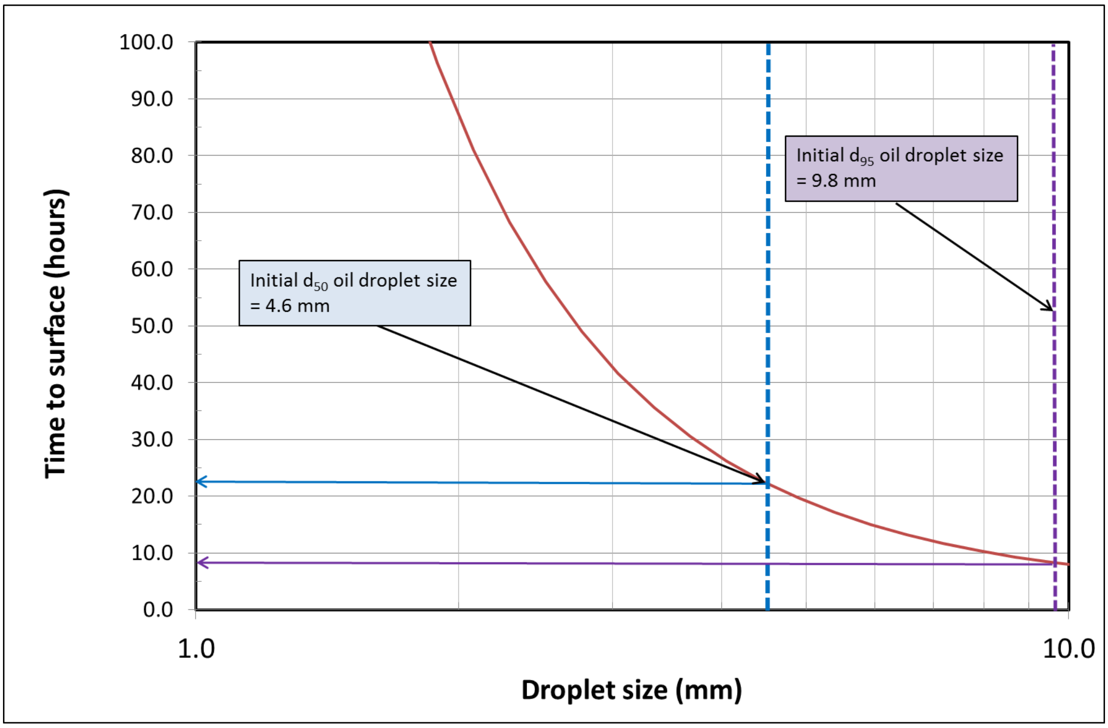


Figure 7.68 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Graph showing the predicted droplet rise-time to surface from the plume trapping height (2,435 m below sea-level) vs droplet size.



7.2.2.2 Oil mass balance

Figures 7.69 and 7.70 show the mass balance time development and distribution of oil for the EO relief well, maximum shoreline oiling, winter scenario. The simulation chosen started on 30th January 2010 06:00 GMT and resulted in a maximum oil mass on the shore of 271 tonnes, with the first oil beaching after 78 days.

The model results predicted that the water content of the oil arriving on the shoreline would be 0%, indicating that stranded oil is arriving as very thin oil sheens with no water uptake.

At the end of the worst shoreline oiling simulation for the winter season, 162,600 tonnes of oil would be biodegraded (decayed) and 122,900 tonnes evaporated (Figure 7.69). This accounts for 46% and 37% of the total oil released respectively. The maximum amount of oil in the water column ("dispersed") is reported as 174,400 tonnes after 55 days, the maximum amount of oil on the surface is 127,400 tonnes after 30 days and the maximum amount of weathered oil that sinks and becomes incorporated into the sediment is 9,665 tonnes after 160 days. After 160 days, 0.65% of the release is reported on the surface and 25% in the water column; with that remaining in the water column dispersed to negligible concentrations (<58 ppb THC dispersed oil).

The modelling results for EO (Figure 7.74 – 7.76) predict that the majority of oil would remain offshore. In the event that surface oil was to enter the near shore area of Newfoundland (Avalon Peninsula), it is predicted to have a BAOAC sheen thickness . Exceedances of the in-water oil threshold is predicted to also be limited to offshore waters; however, the area impacted is smaller than that of surface oiling. Shoreline oiling exceeding the threshold level is expected to be limited to the Avalon Peninsula with occurrences of light and stain oiling (Figure 7.76). The maximum length of shoreline impacted would occur after 132 days with 27 km of coastline being affected (Figures 7.71 and 7.76). The maximum mass of oil on the shoreline occurs slightly earlier (after 98 days) and is associated with 271 tonnes of oil accumulated on the shoreline.

Figure 7.69 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Graph showing time development of oil mass balance.

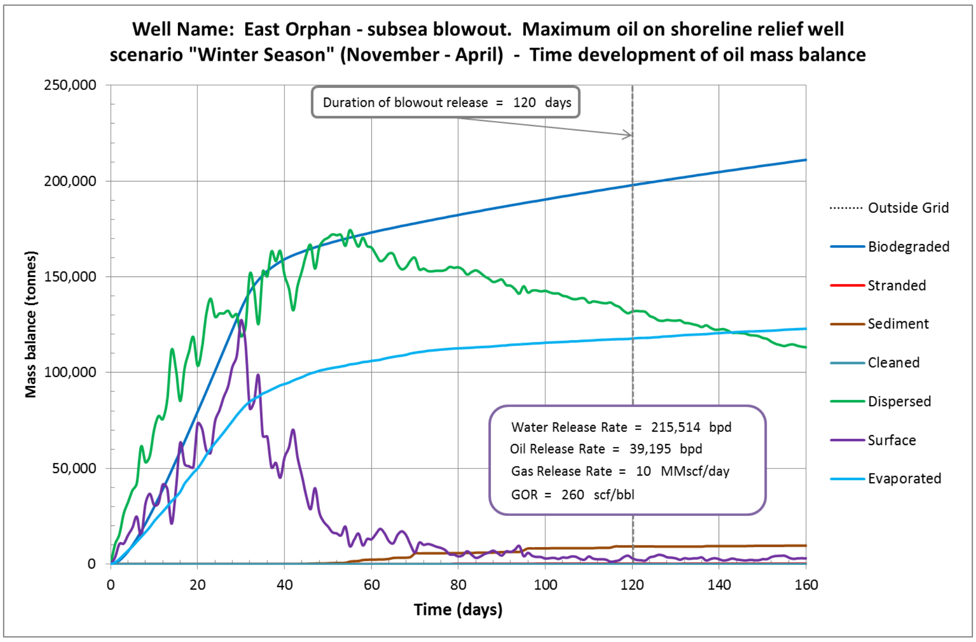


Figure 7.70 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Graph showing mass balance distribution of oil over the duration of the simulation.

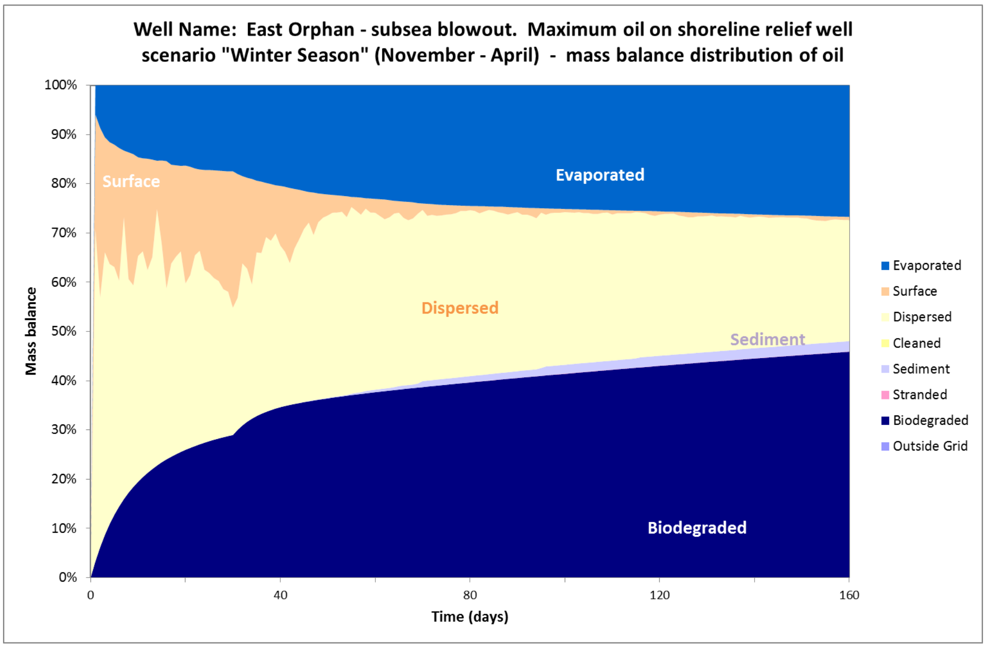


Figure 7.71 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Graph showing mass of oil stranded on the shoreline and length of shoreline oiled.

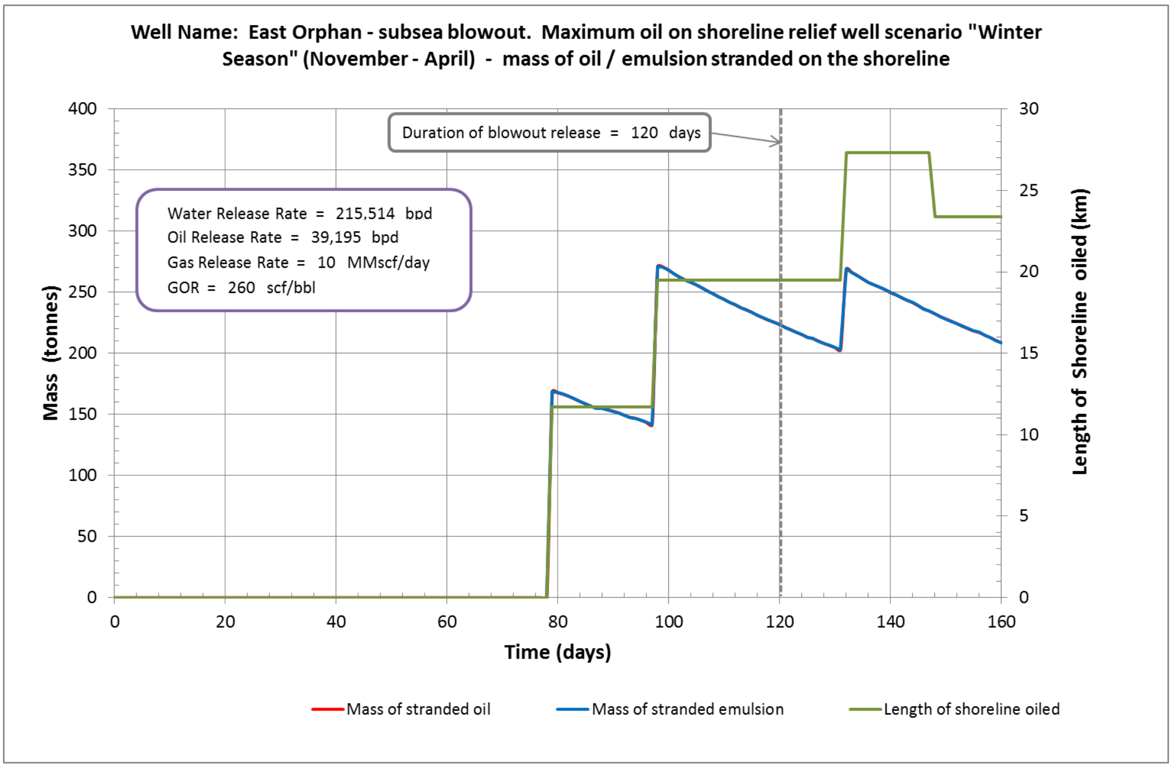


Figure 7.72 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Graph showing area coverage of surface oil.

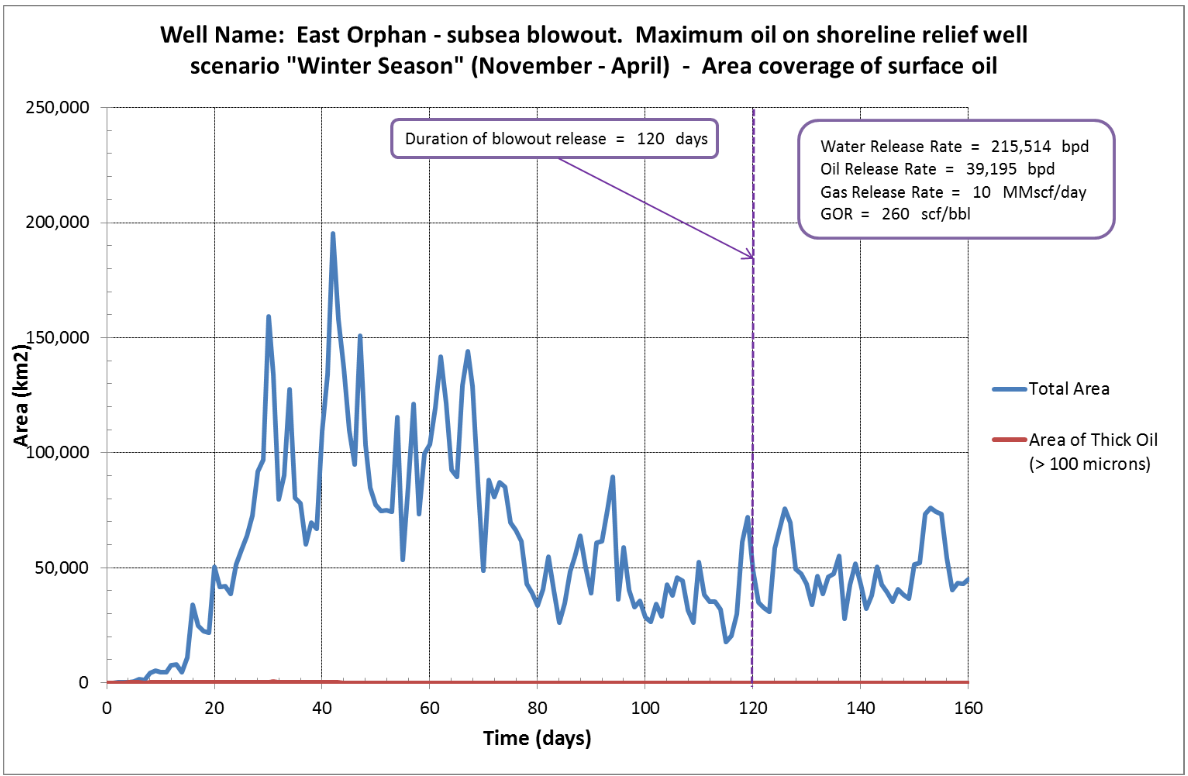


Figure 7.73 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Contour map showing the maximum surface oil thickness at each location over the simulation period (0.04µm BAOAC "Sheen" thickness threshold applied).

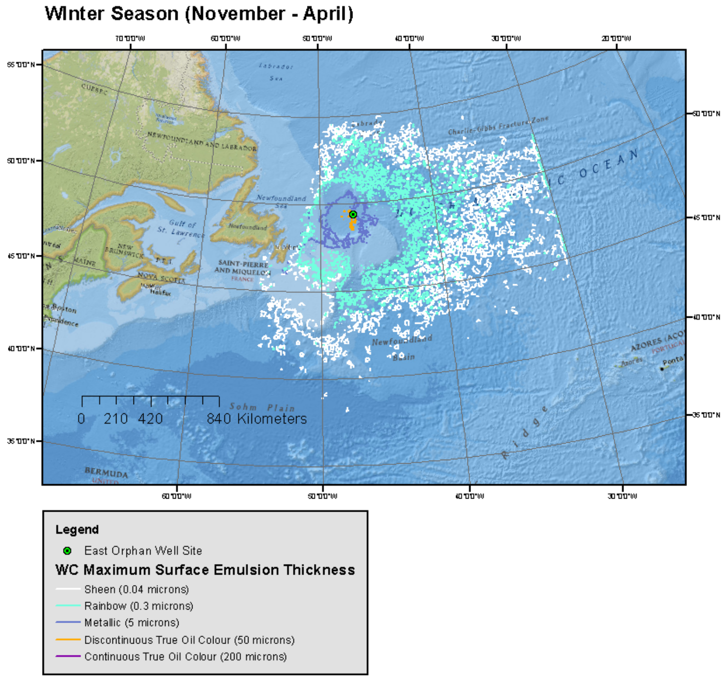


Figure 7.74 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Contour map showing the maximum concentration of total hydrocarbons (dispersed and dissolved) within any grid cell in the top 100 m of water column over the entire simulation (58 ppb THC threshold applied).

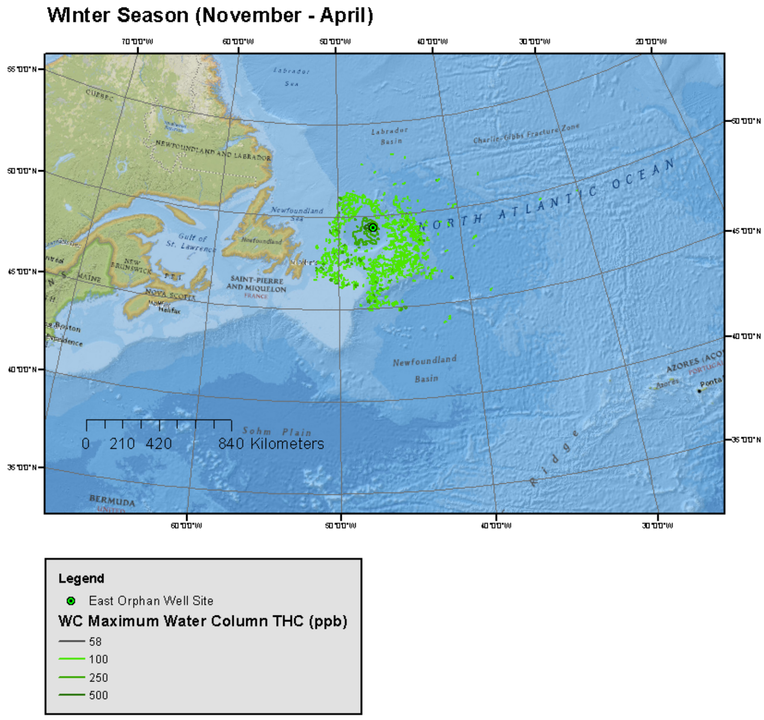


Figure 7.75 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Contour map showing the maximum concentration of dissolved oil within any grid cell in the top 100 m of water column over the entire simulation (1 ppb threshold applied).

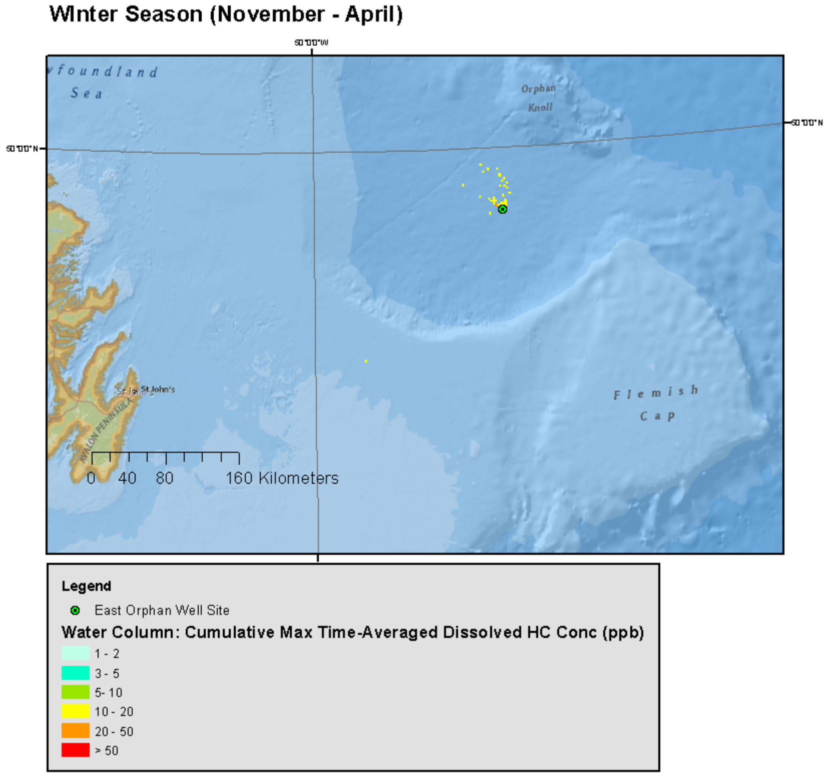
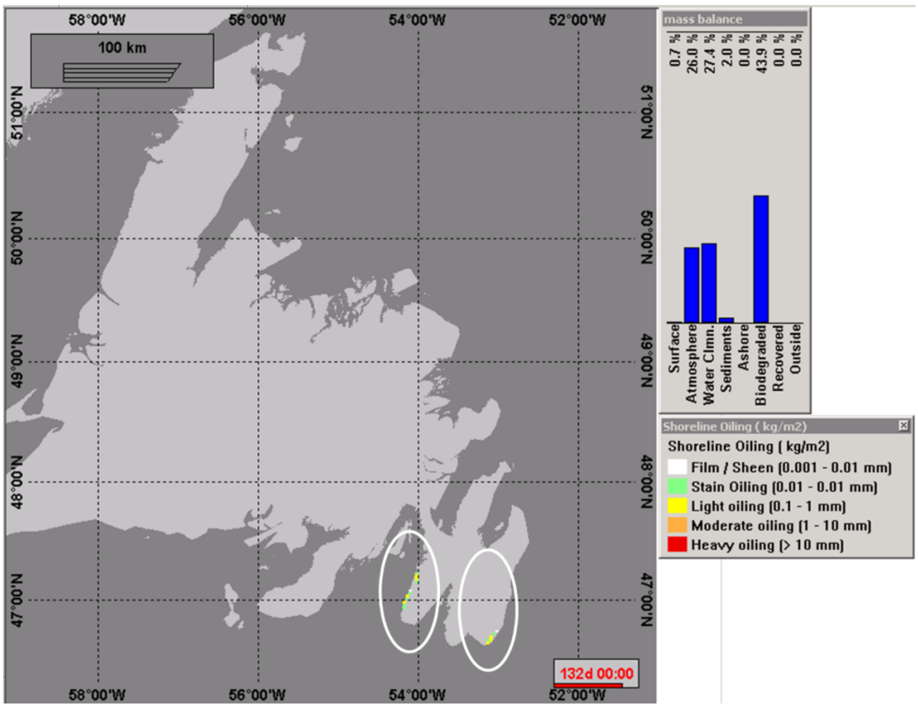


Figure 7.76 Scenario 3: East Orphan relief well scenario (120 day duration) – maximum oil on shoreline scenario (Winter Season), start date 30th January 2010 06:00 GMT). Snapshot map showing the stranded oil thickness at the time of maximum length of shoreline impacted (Day 132).



7.3 Oil Spill Intersections with Protected Areas, Environmentally Sensitive Areas and World Maritime Boundaries

The results of the geospatial analysis to assess the potential exposure risk from an oil release from the WO and EO well locations with Protected Areas, Environmentally Sensitive Areas and World Maritime Boundaries based on the stochastic modelling outputs is presented in Annex D.

The following diagrams provide a ranking of the Special Areas most likely at risk from either stranded oil, oil on the sea surface, or oil in the upper water column. As mentioned earlier in Section 6.3, the intersection approach is conservative. Some of the marine protected/sensitive areas may be designated for seabed features (such as pockmarks, trenches, corals etc.) and will therefore not be directly impacted by surface oil or oil entrained in the upper water column. However, the intersection routines used in the GIS analysis show all locations where surface oil and oil in the water outputs from oil spill modelling spatially overlap with protected/sensitive areas (designated by latitude and longitude), even when the oil spill outputs are vertically separated from the Marine protected / sensitive area.

7.3.1 Scenario 1: West Orphan well blowout relief well scenario (Summer Season)

Figure 7.77 West Orphan well blowout relief well scenario (Summer Season)

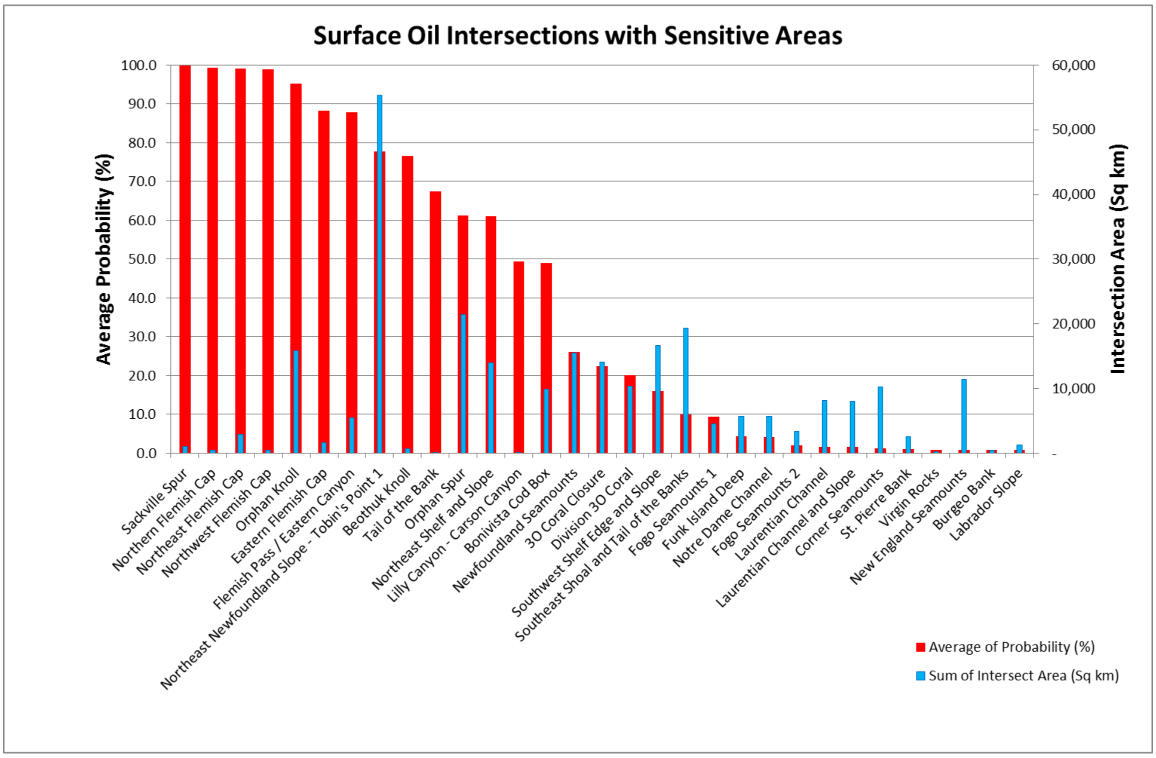


Figure 7.78 West Orphan well blowout relief well scenario (Summer Season)

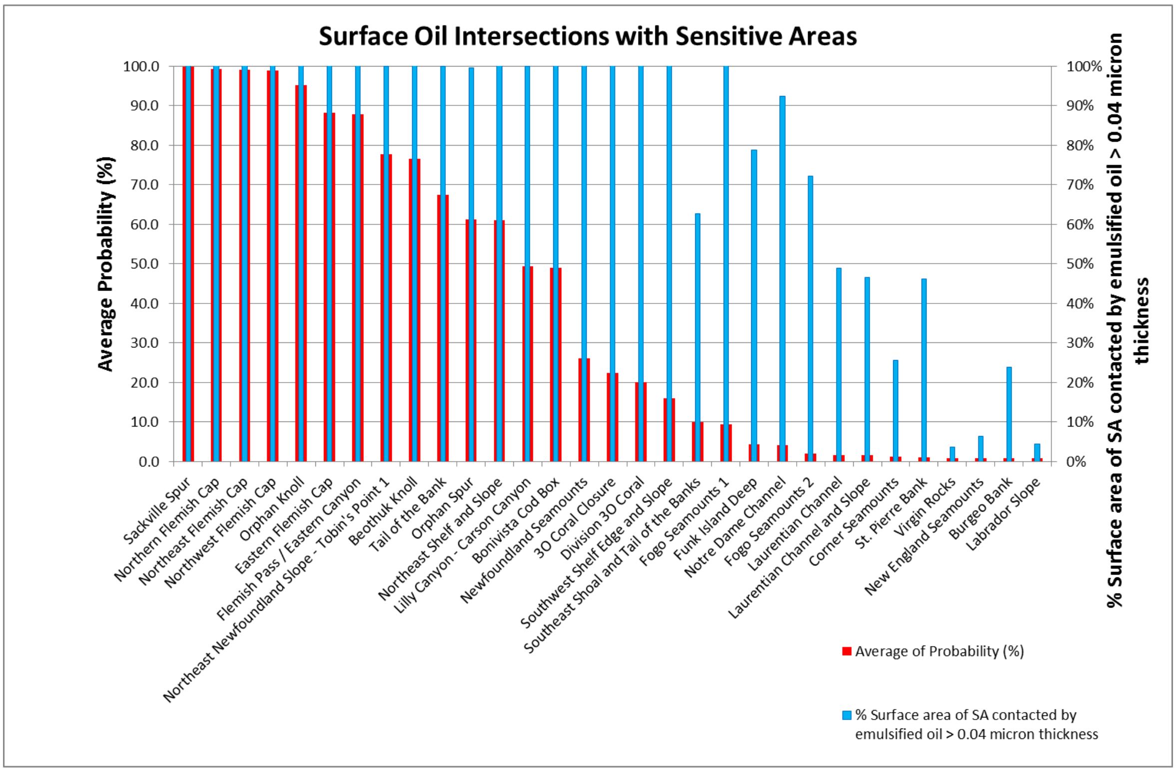


Figure 7.79 West Orphan well blowout relief well scenario (Summer Season)

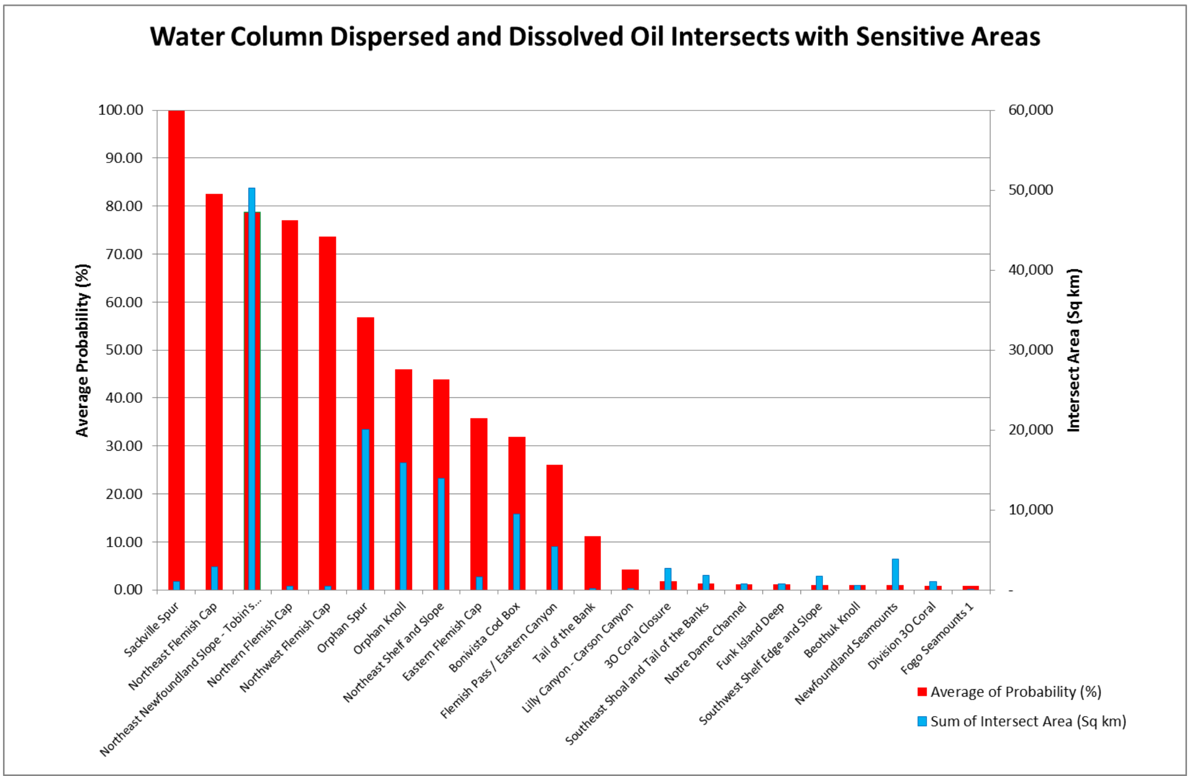
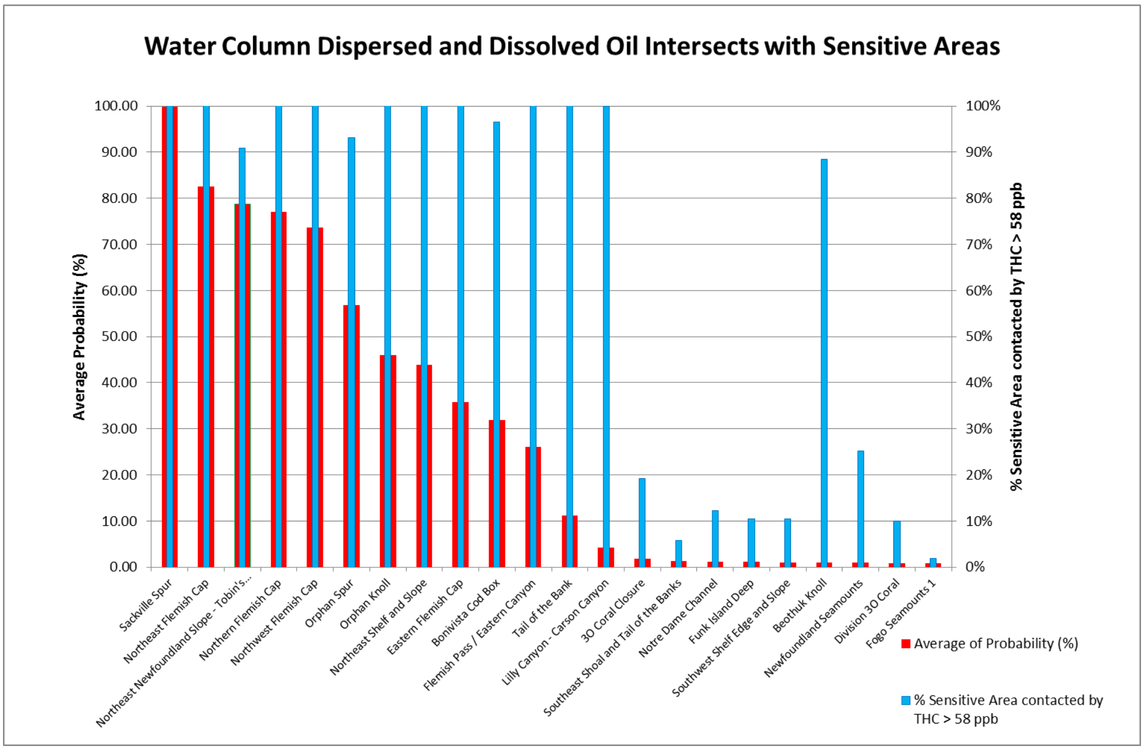


Figure 7.80 West Orphan well blowout relief well scenario (Summer Season)



7.3.2 Scenario 1: West Orphan well blowout relief well scenario (Winter Season)

Figure 7.81 West Orphan well blowout relief well scenario (Winter Season)

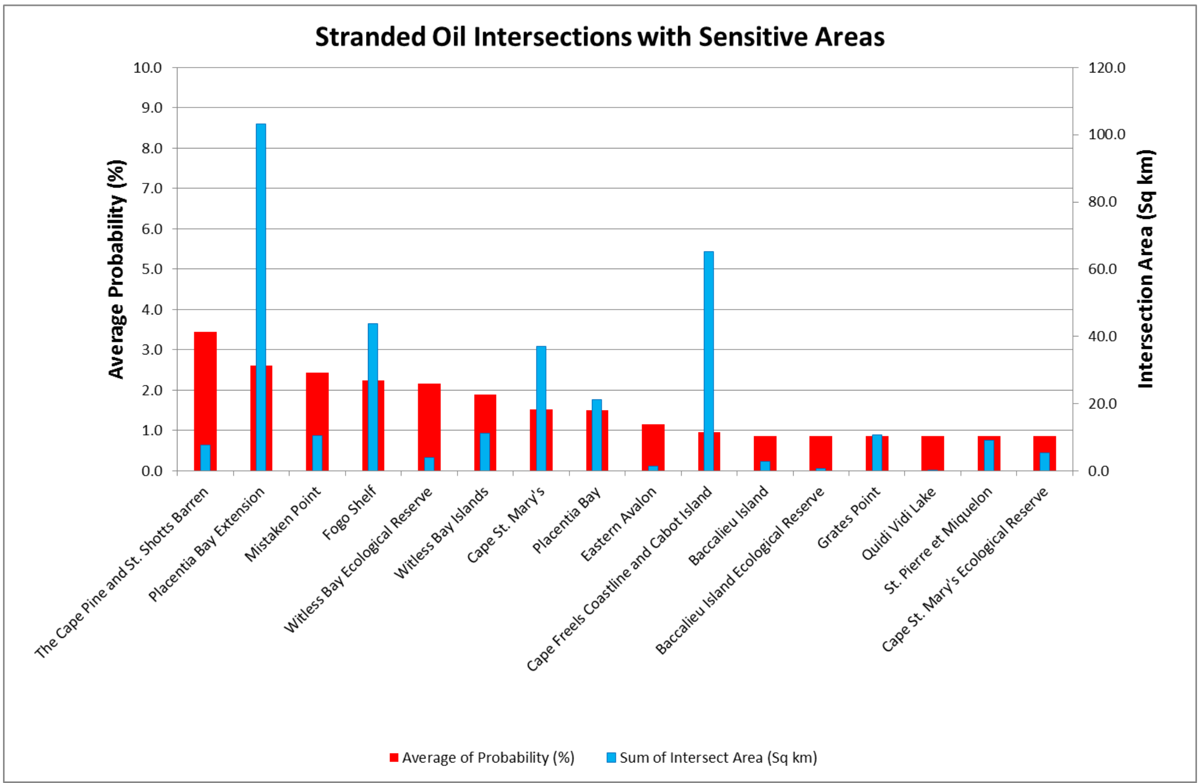


Figure 7.82 West Orphan well blowout relief well scenario (Winter Season)

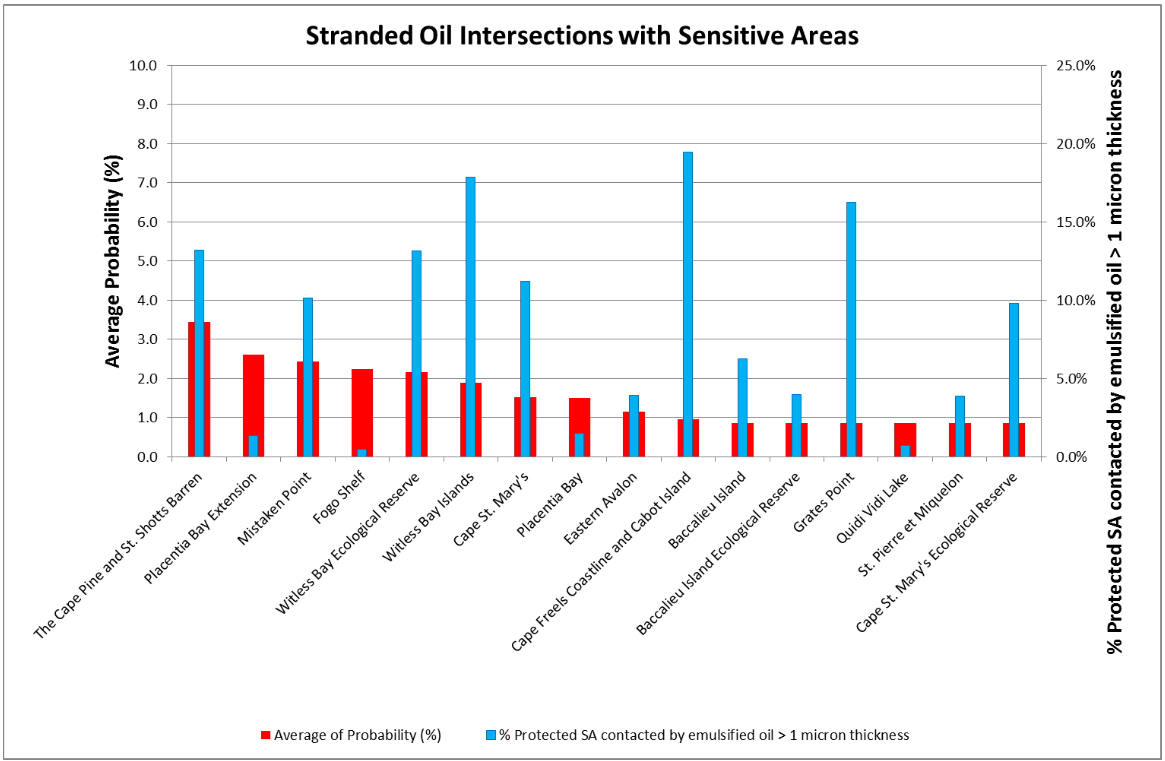


Figure 7.83 West Orphan well blowout relief well scenario (Winter Season)

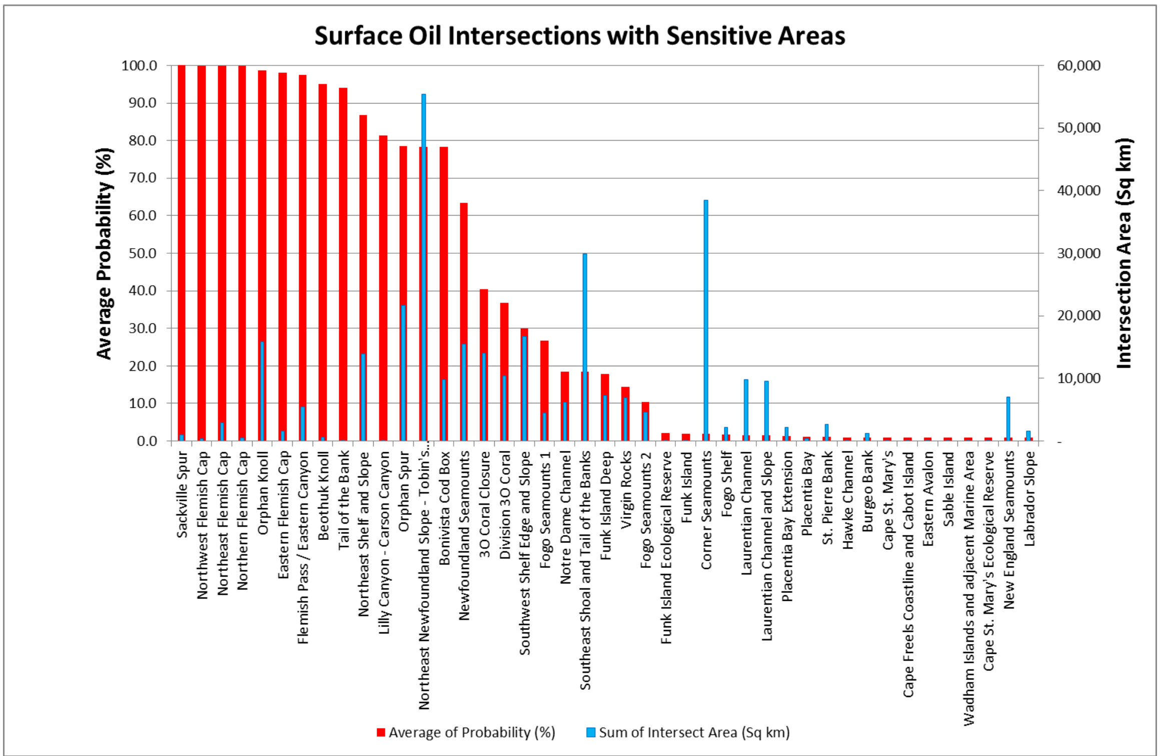


Figure 7.84 West Orphan well blowout relief well scenario (Winter Season)

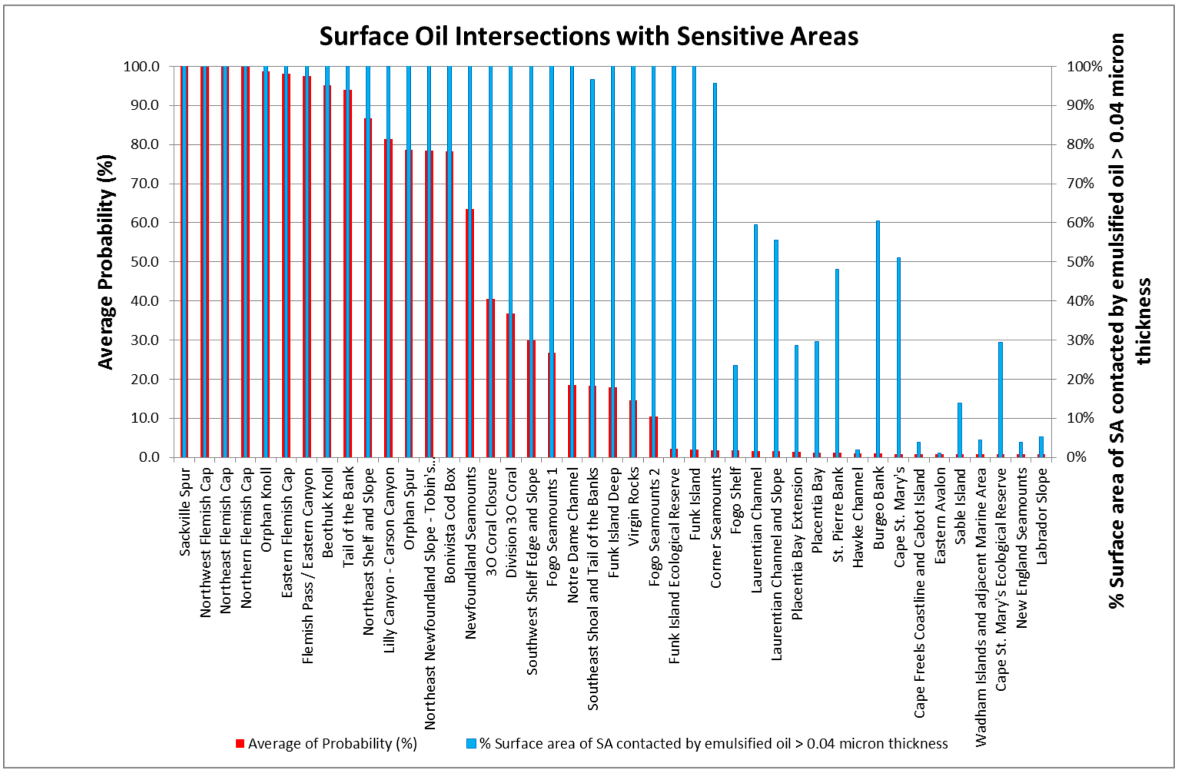


Figure 7.85 West Orphan well blowout relief well scenario (Winter Season)

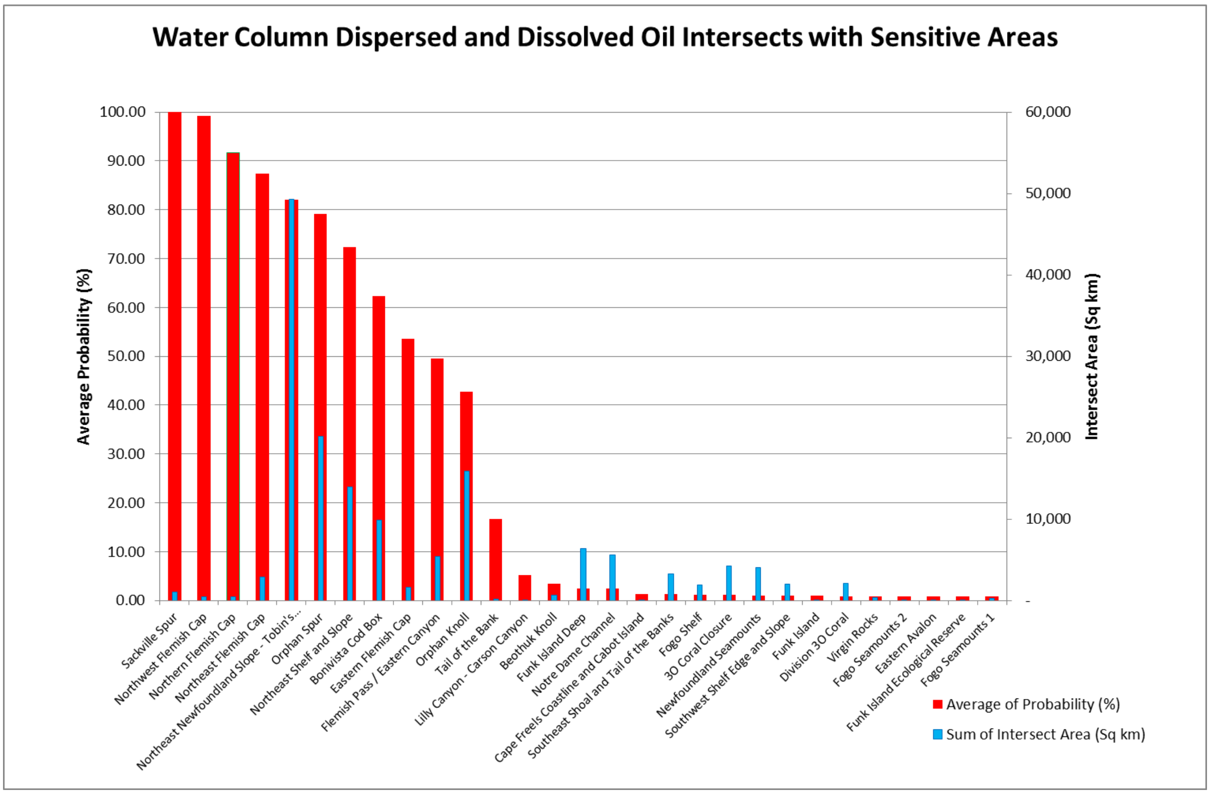
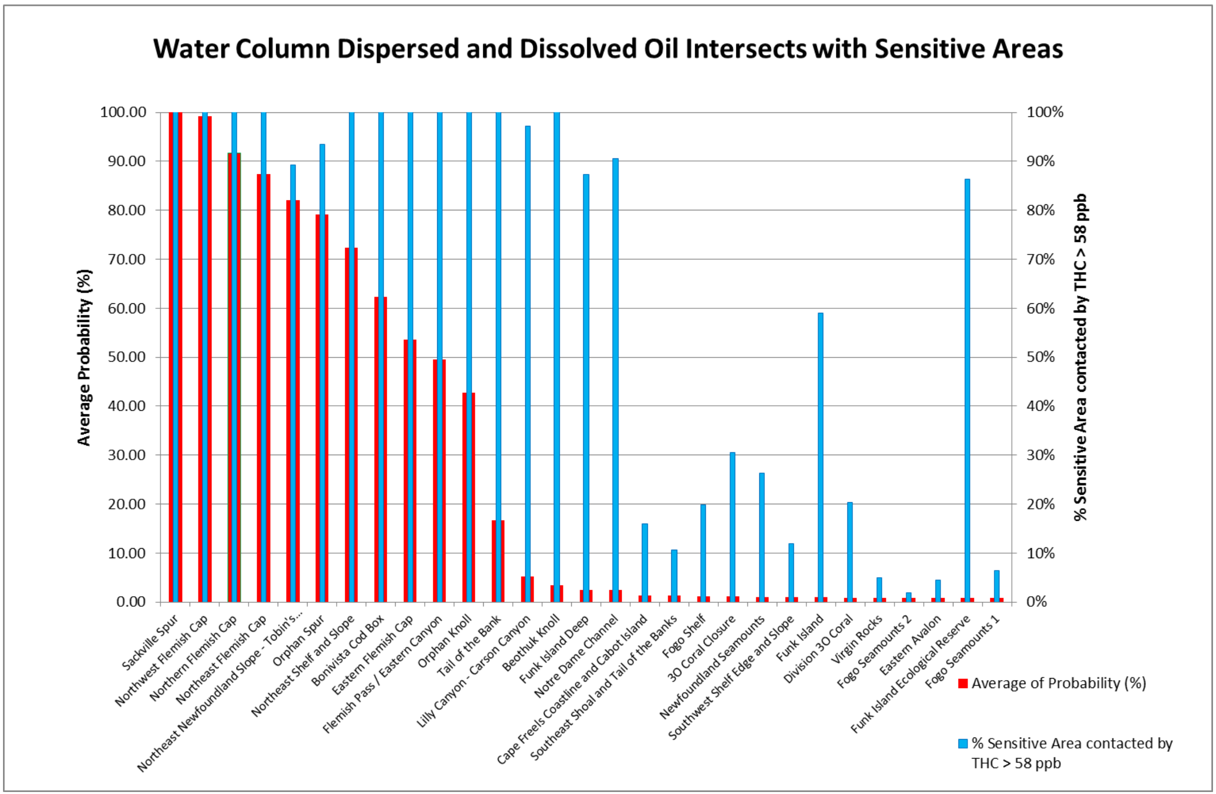


Figure 7.86 West Orphan well blowout relief well scenario (Winter Season)



7.3.3 Scenario 2: West Orphan well blowout capping stack scenario (Summer Season)

Figure 7.87 West Orphan well blowout capping stack scenario (Summer Season)

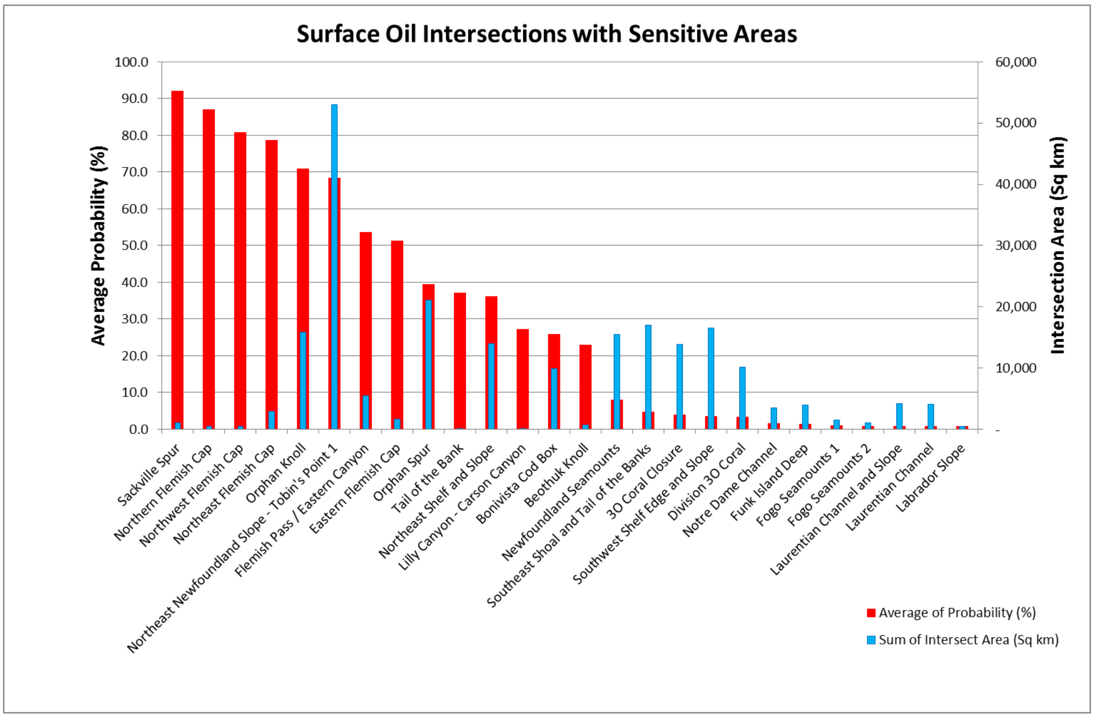


Figure 7.88 West Orphan well blowout capping stack scenario (Summer Season)

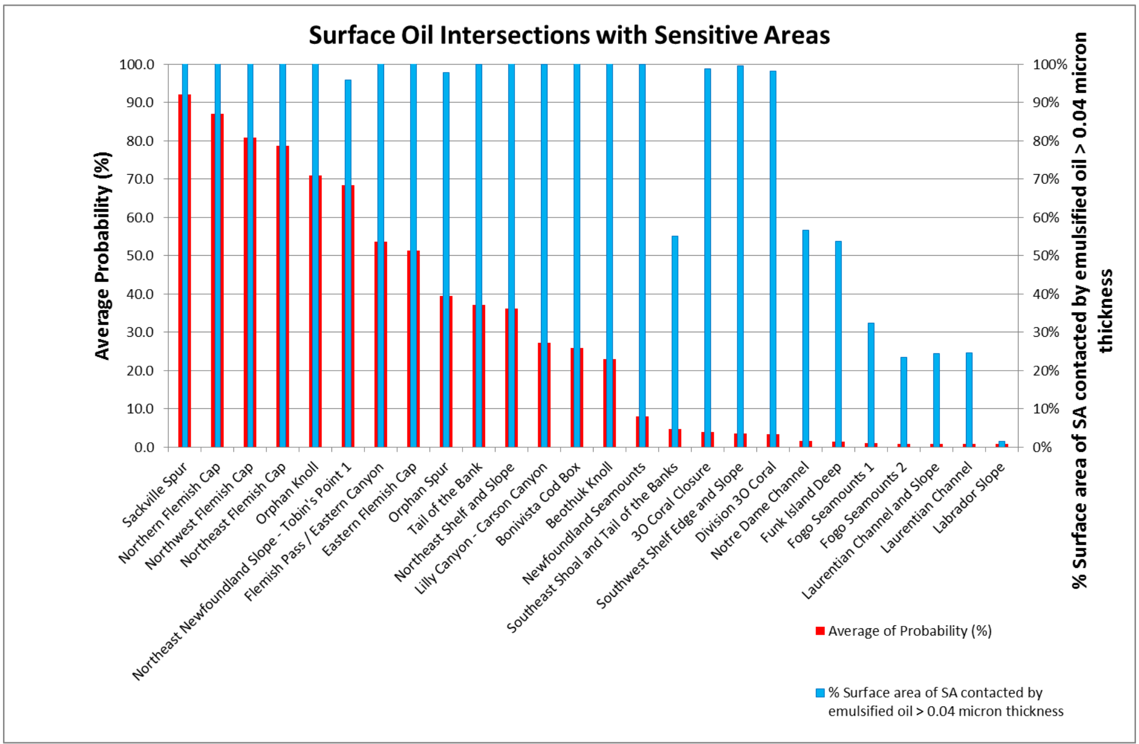


Figure 7.89 West Orphan well blowout capping stack scenario (Summer Season)

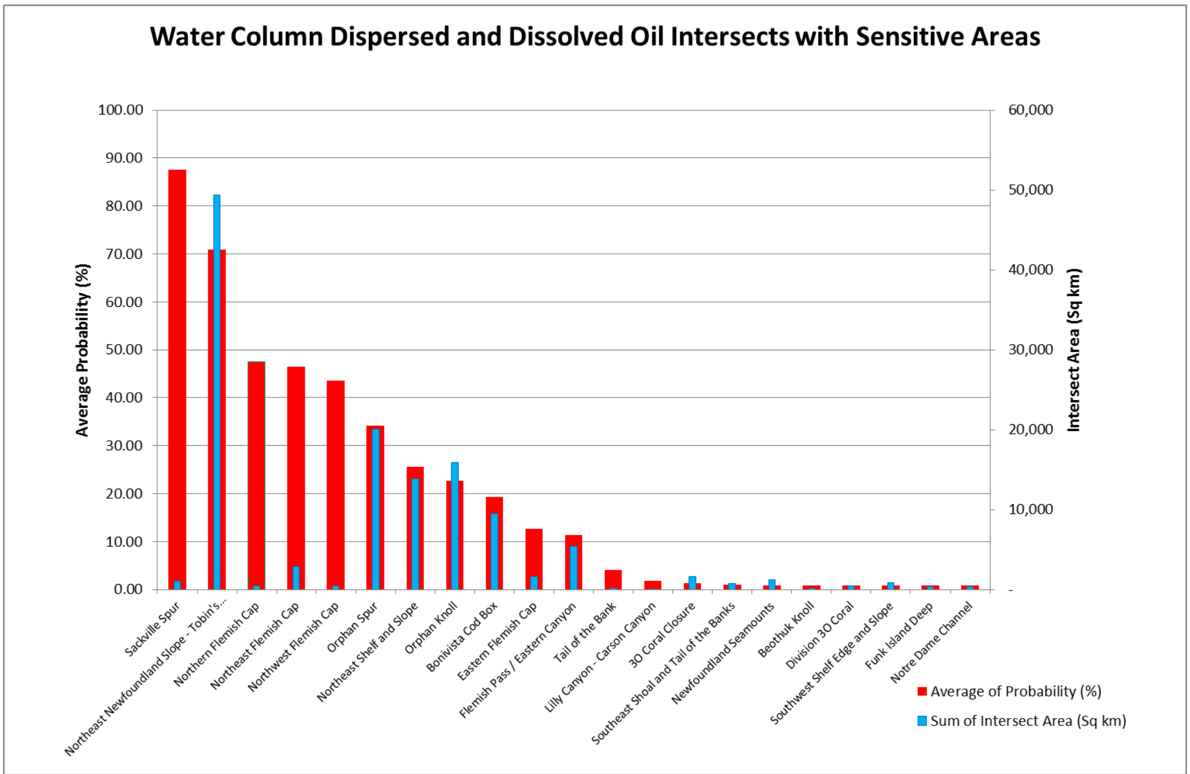
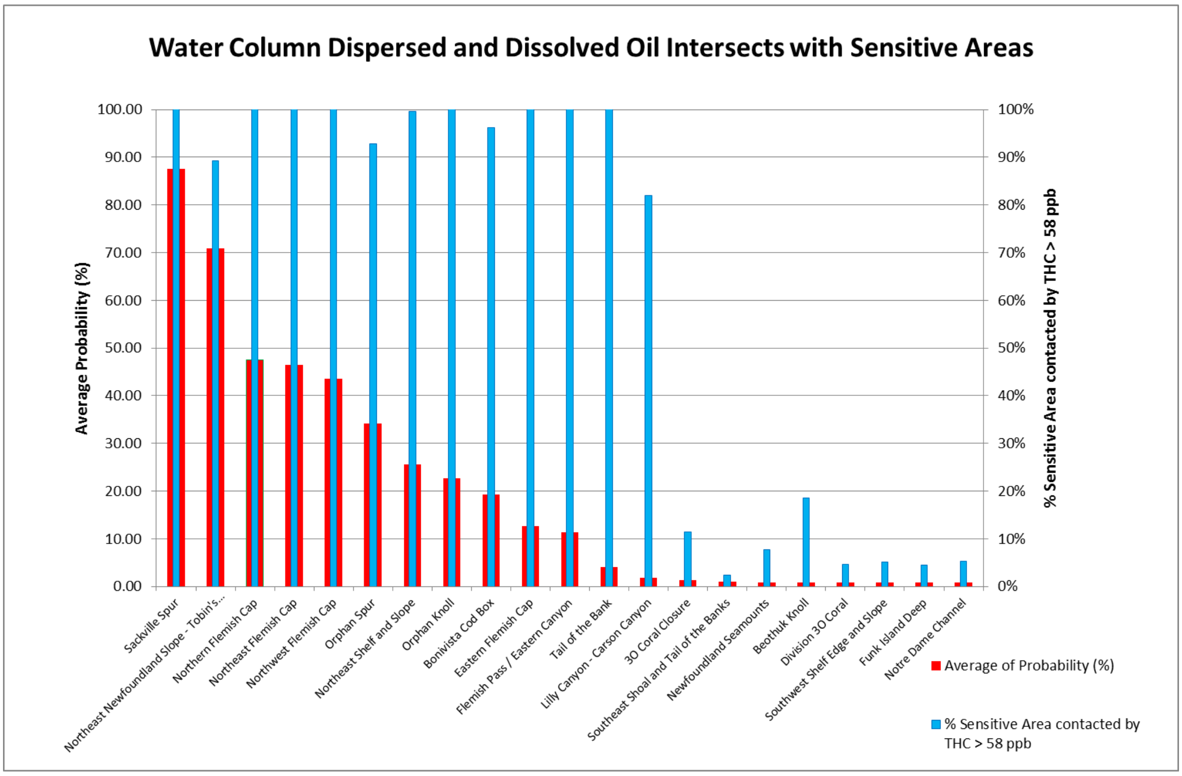


Figure 7.90 West Orphan well blowout capping stack scenario (Summer Season)



7.3.4 Scenario 2: West Orphan well blowout capping stack scenario (Winter Season)

Figure 7.91 West Orphan well blowout capping stack scenario (Winter Season)

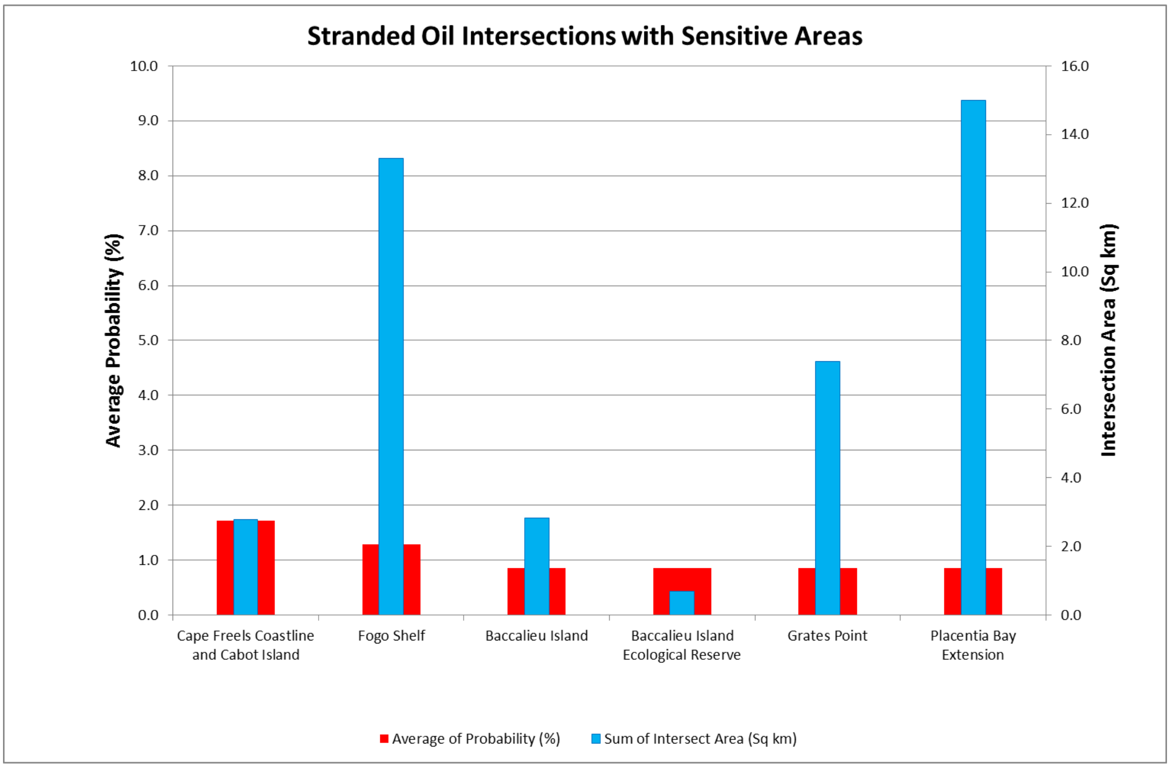


Figure 7.92 West Orphan well blowout capping stack scenario (Winter Season)

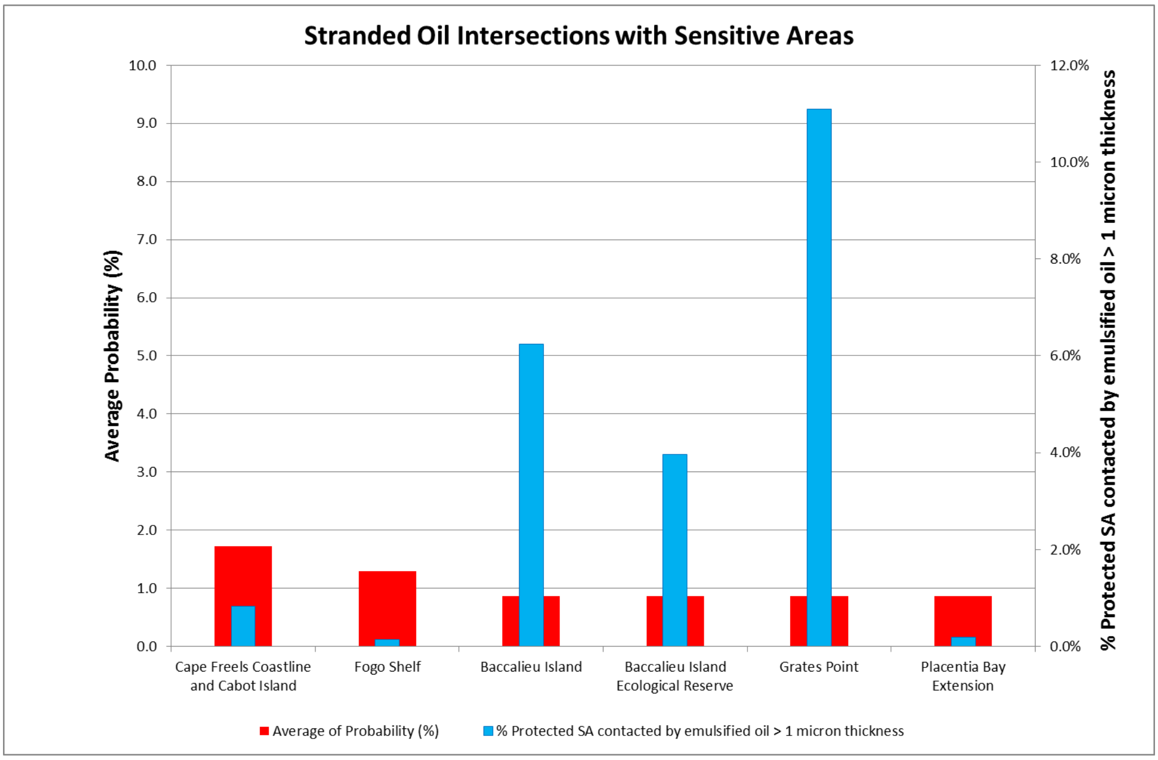


Figure 7.93 West Orphan well blowout capping stack scenario (Winter Season)

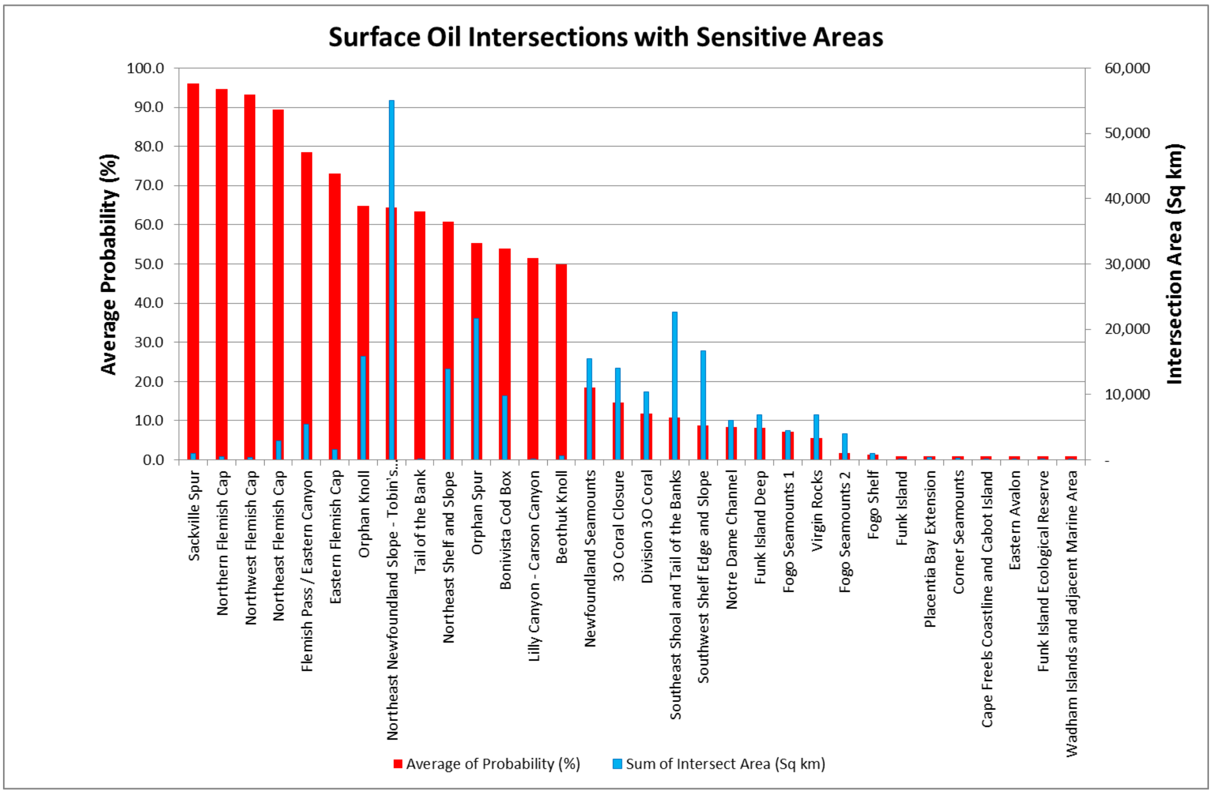


Figure 7.94 West Orphan well blowout capping stack scenario (Winter Season)

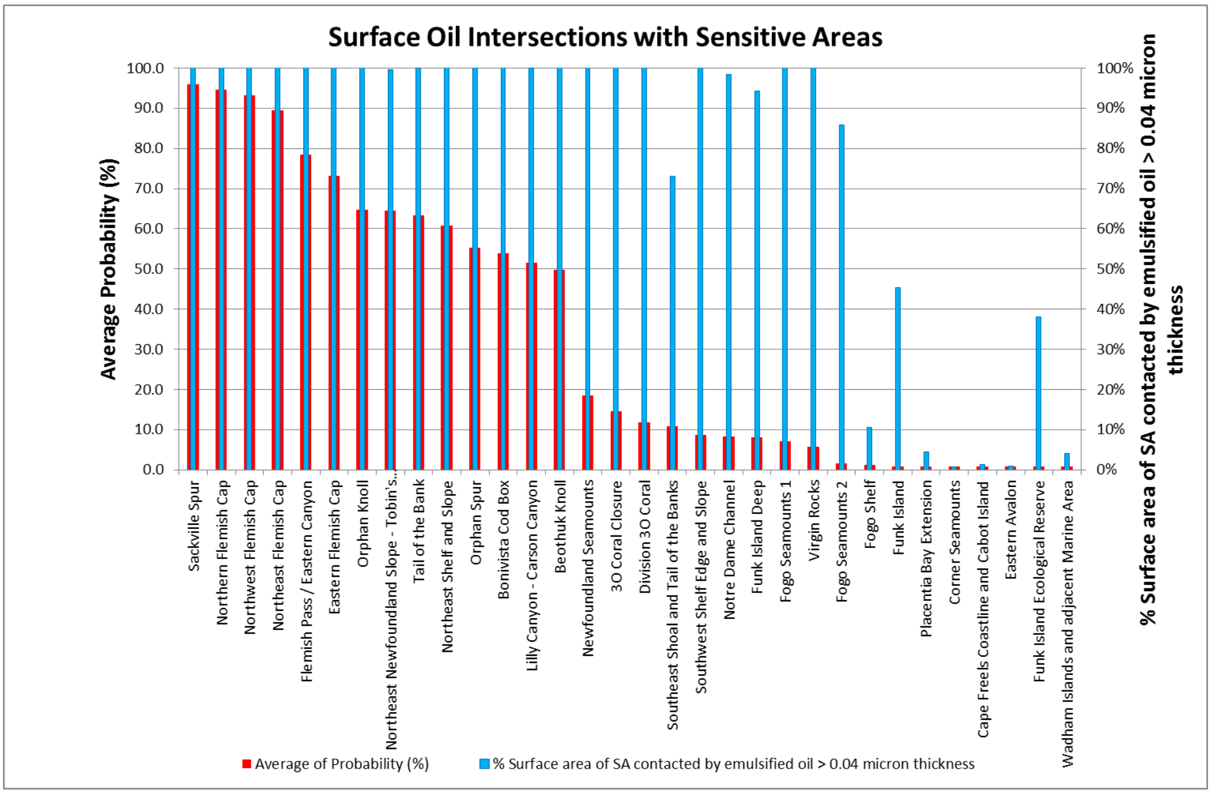


Figure 7.95 West Orphan well blowout capping stack scenario (Winter Season)

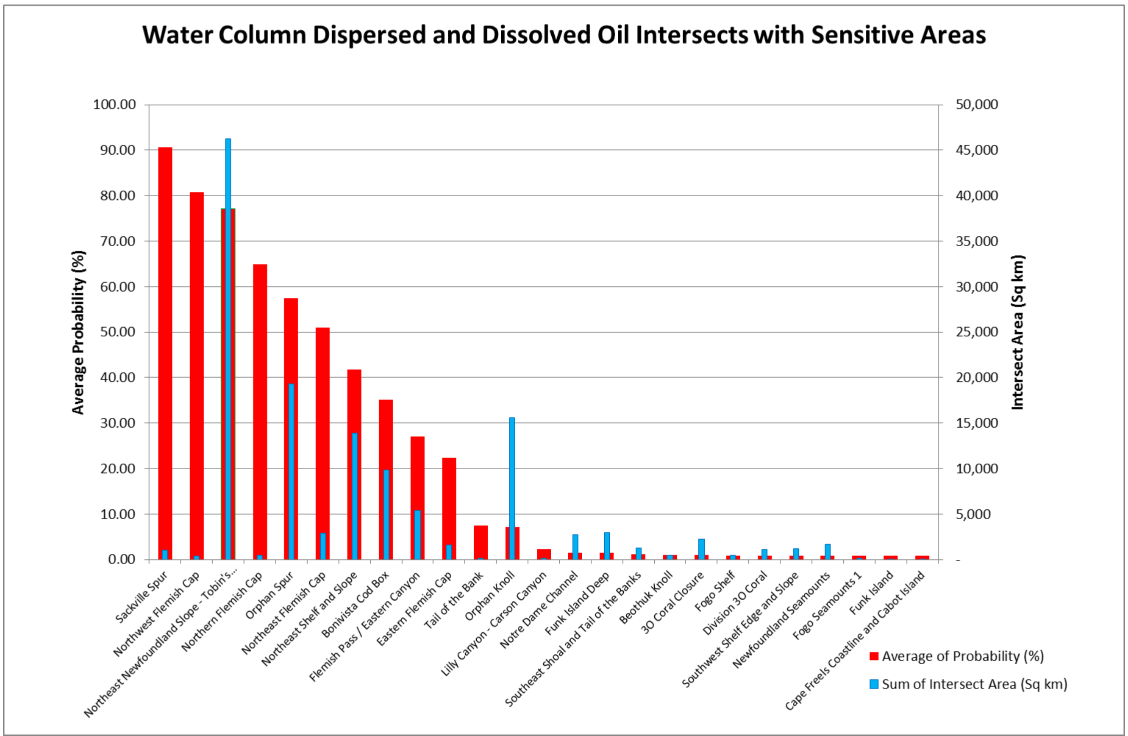
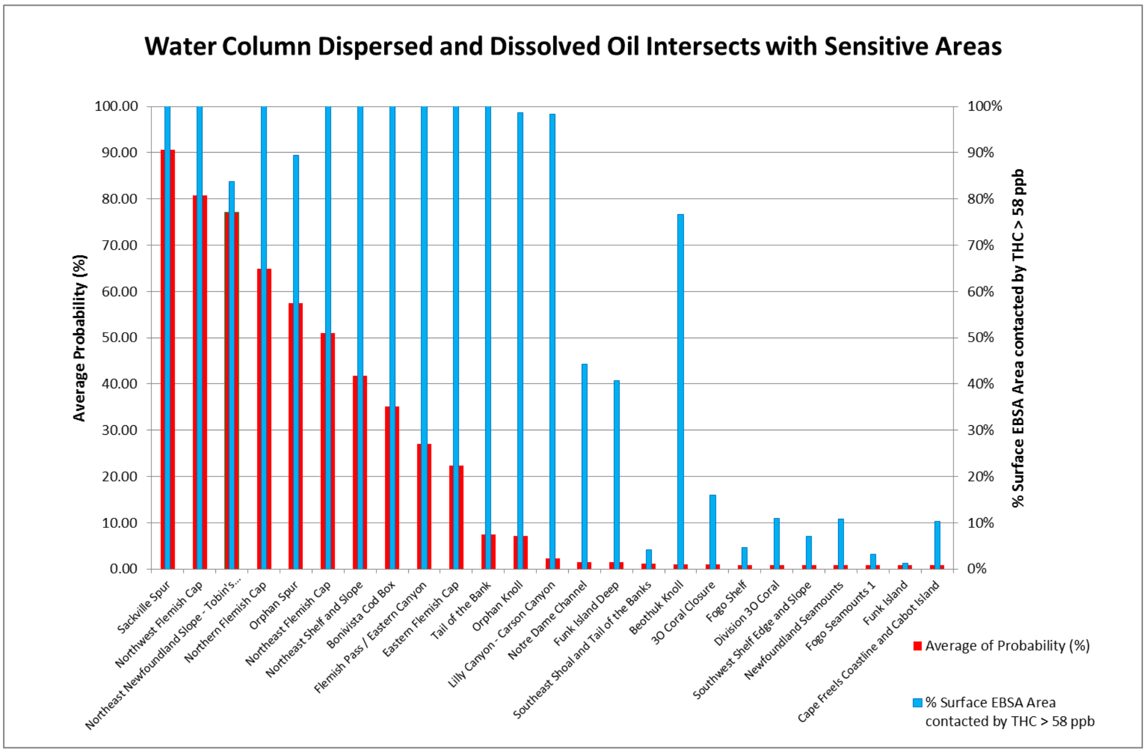


Figure 7.96 West Orphan well blowout capping stack scenario (Winter Season)



7.3.5 Scenario 3: East Orphan well blowout relief well scenario (Summer Season)

Figure 7.97 East Orphan well blowout relief well scenario (Summer Season)

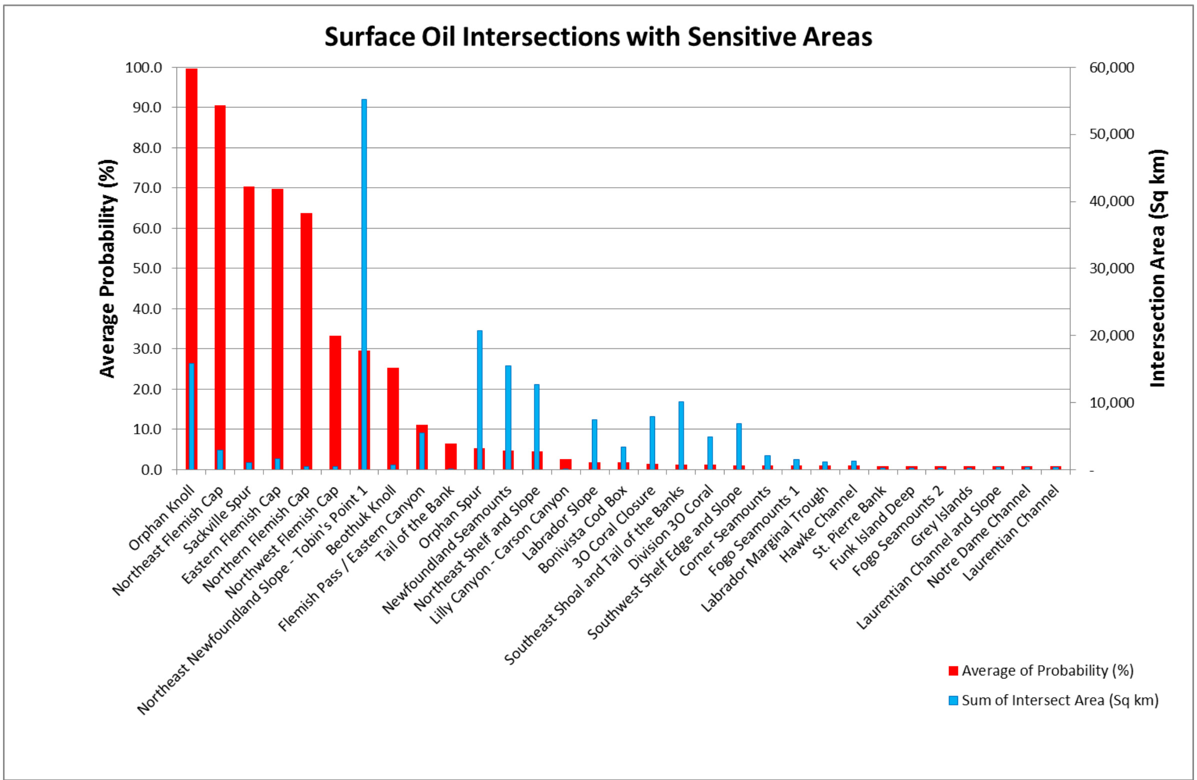


Figure 7.98 East Orphan well blowout relief well scenario (Summer Season)

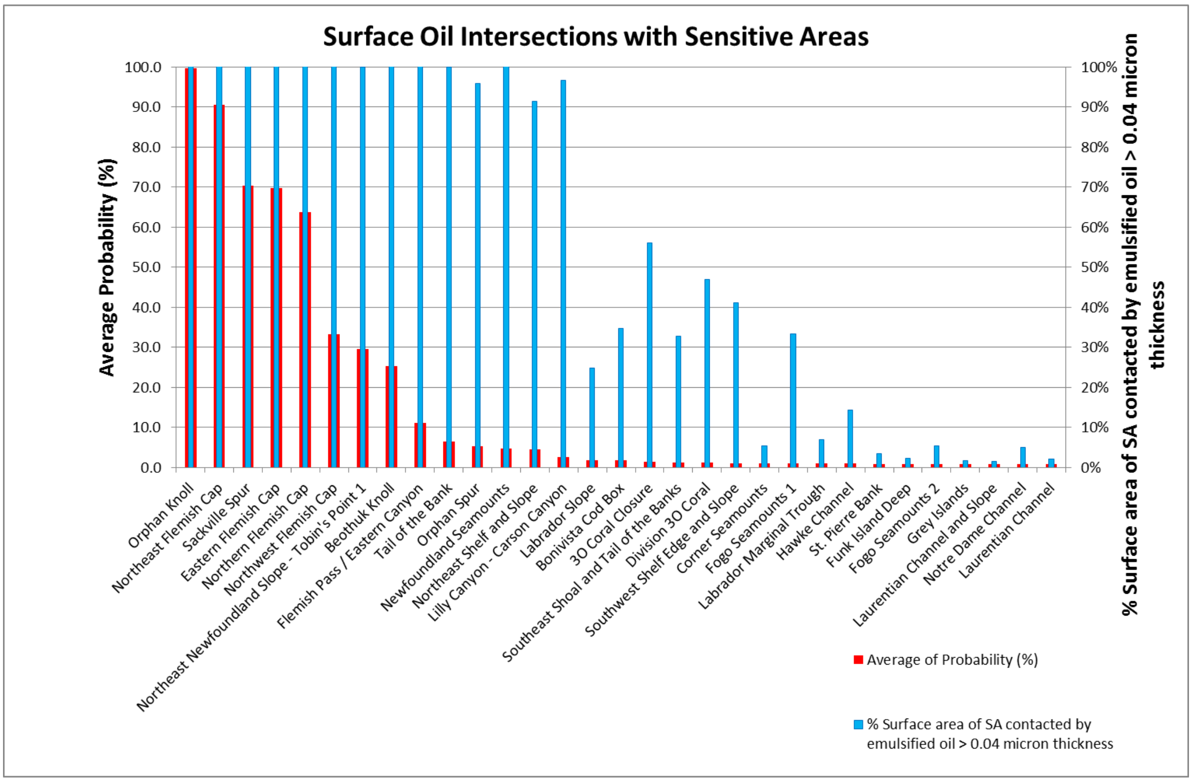


Figure 7.99 East Orphan well blowout relief well scenario (Summer Season)

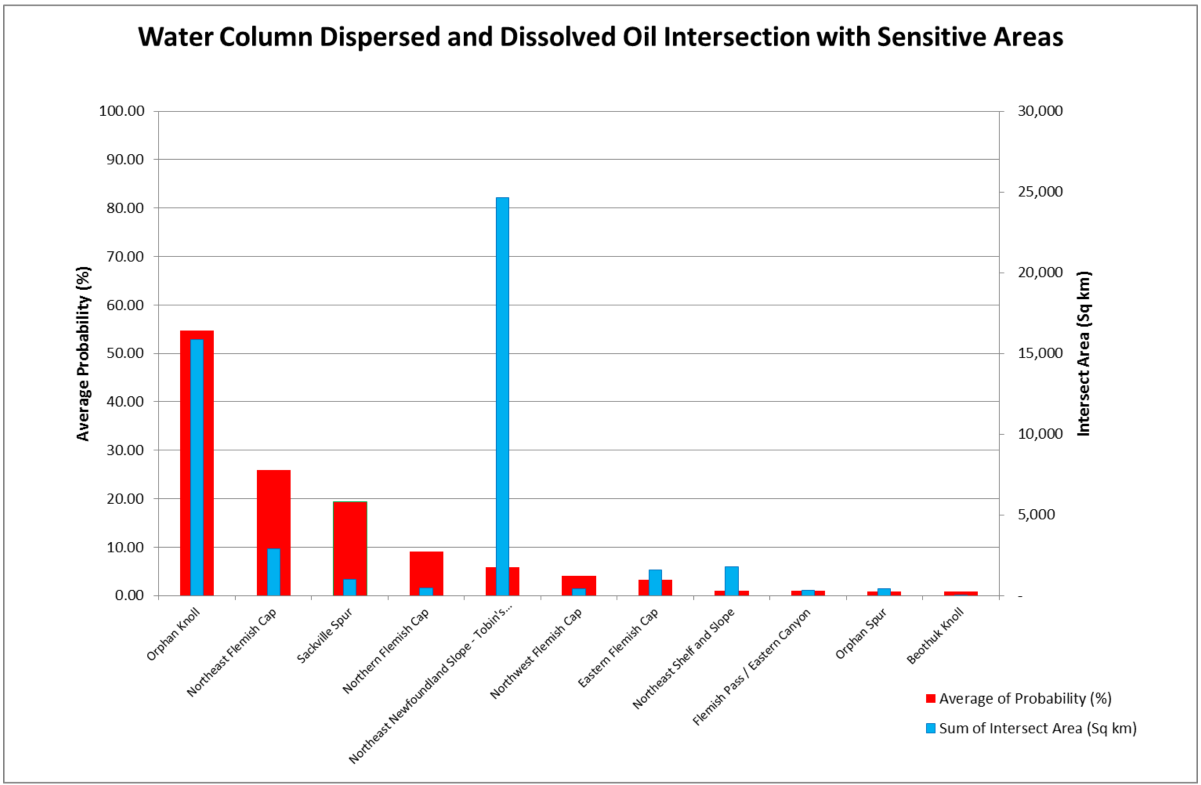
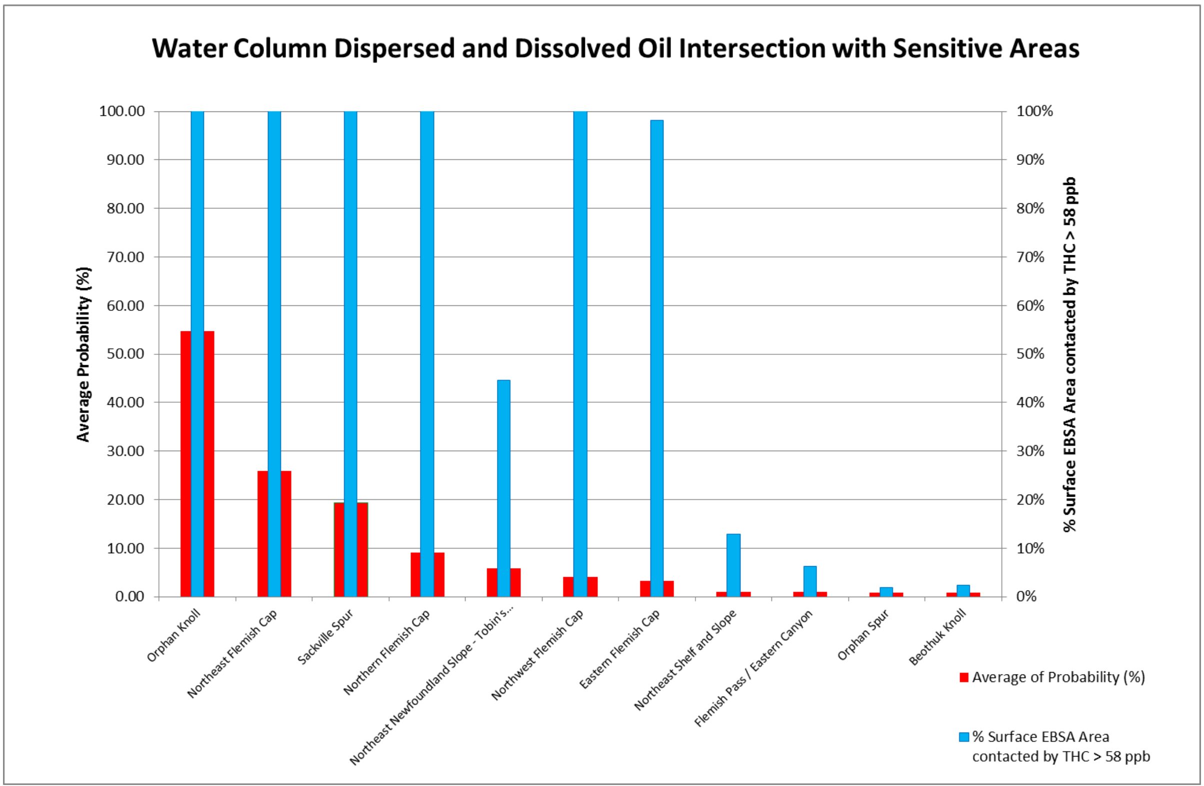


Figure 7.100 East Orphan well blowout relief well scenario (Summer Season)



7.3.6 Scenario 3: East Orphan well blowout relief well scenario (Winter Season)

Figure 7.101 East Orphan well blowout relief well scenario (Winter Season)

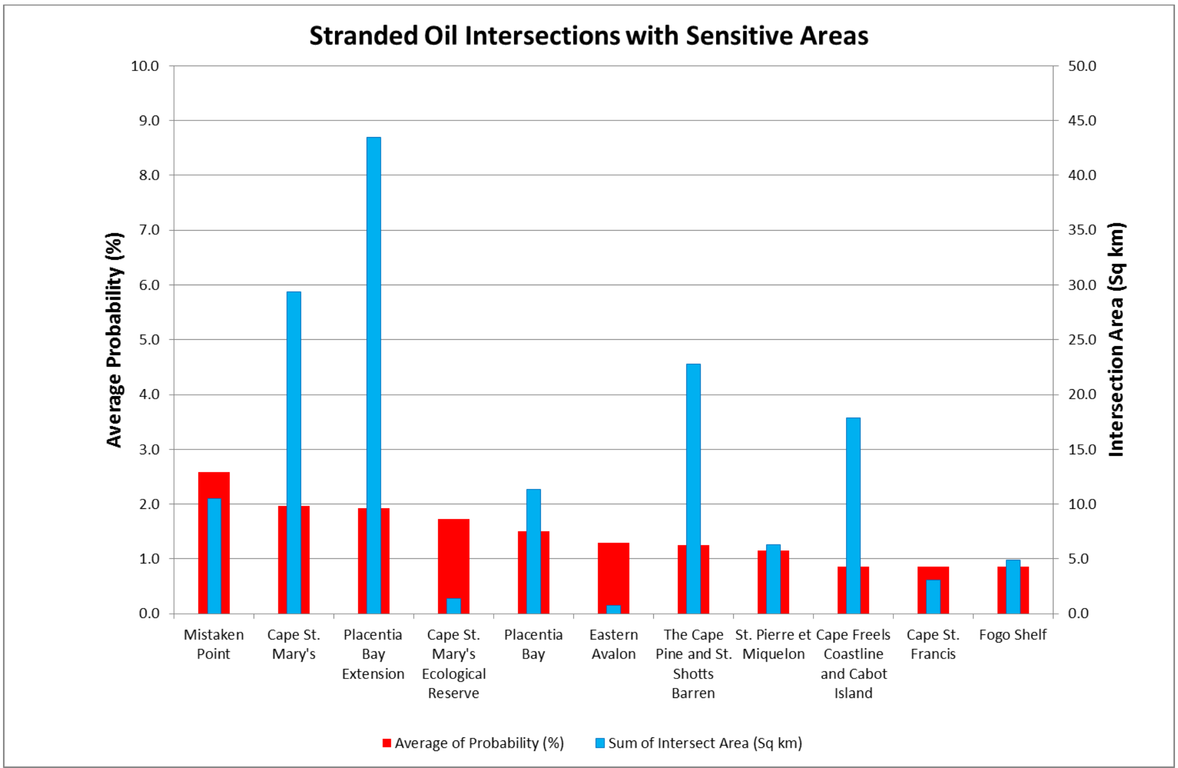


Figure 7.102 East Orphan well blowout relief well scenario (Winter Season)

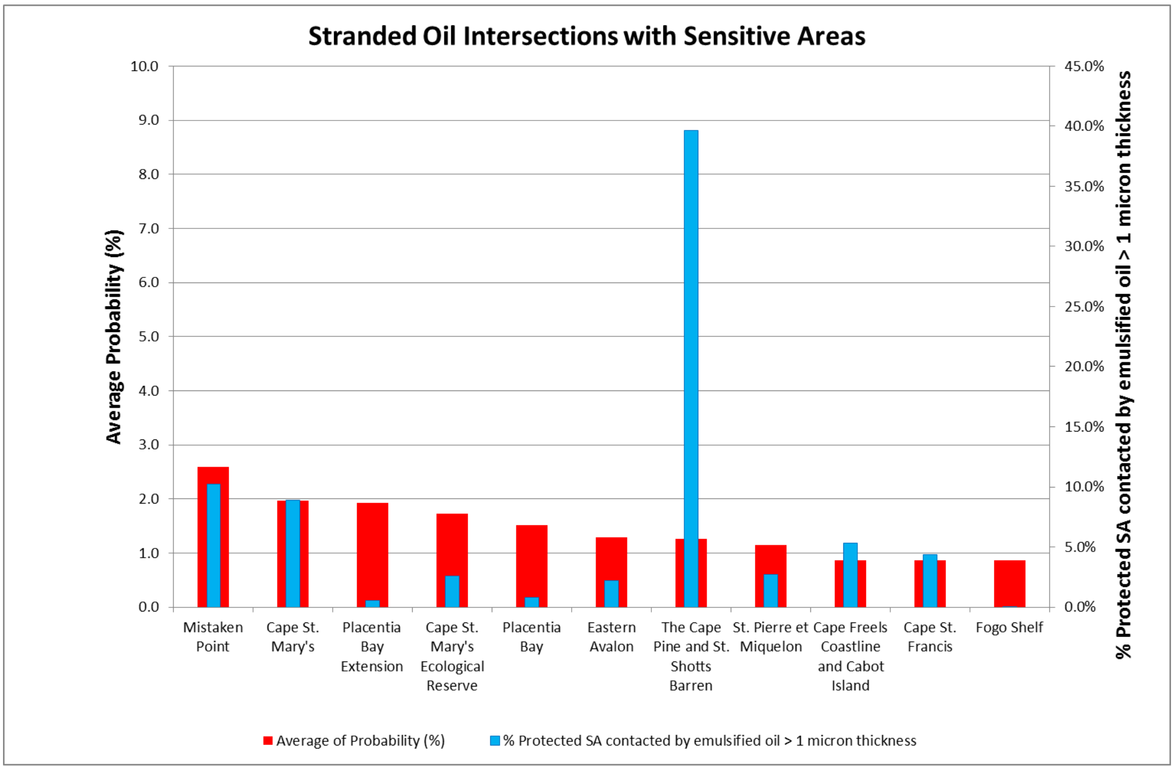


Figure 7.103 East Orphan well blowout relief well scenario (Winter Season)

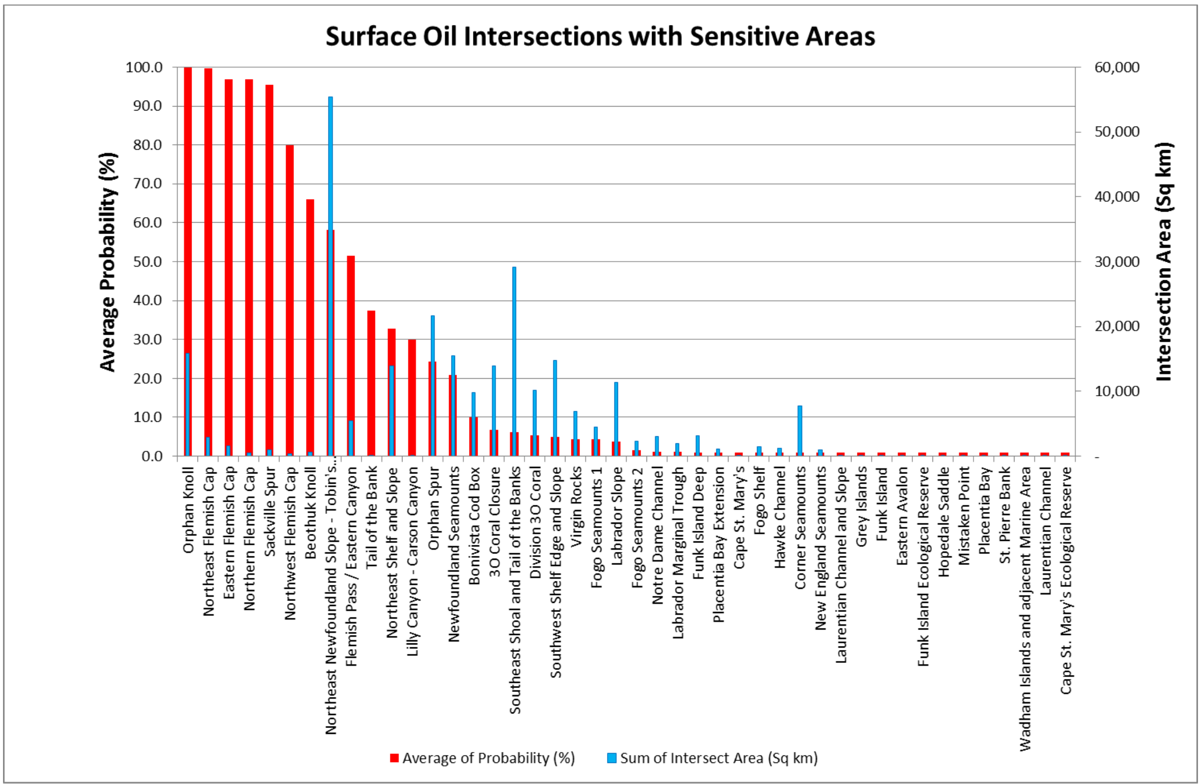


Figure 7.104 East Orphan well blowout relief well scenario (Winter Season)

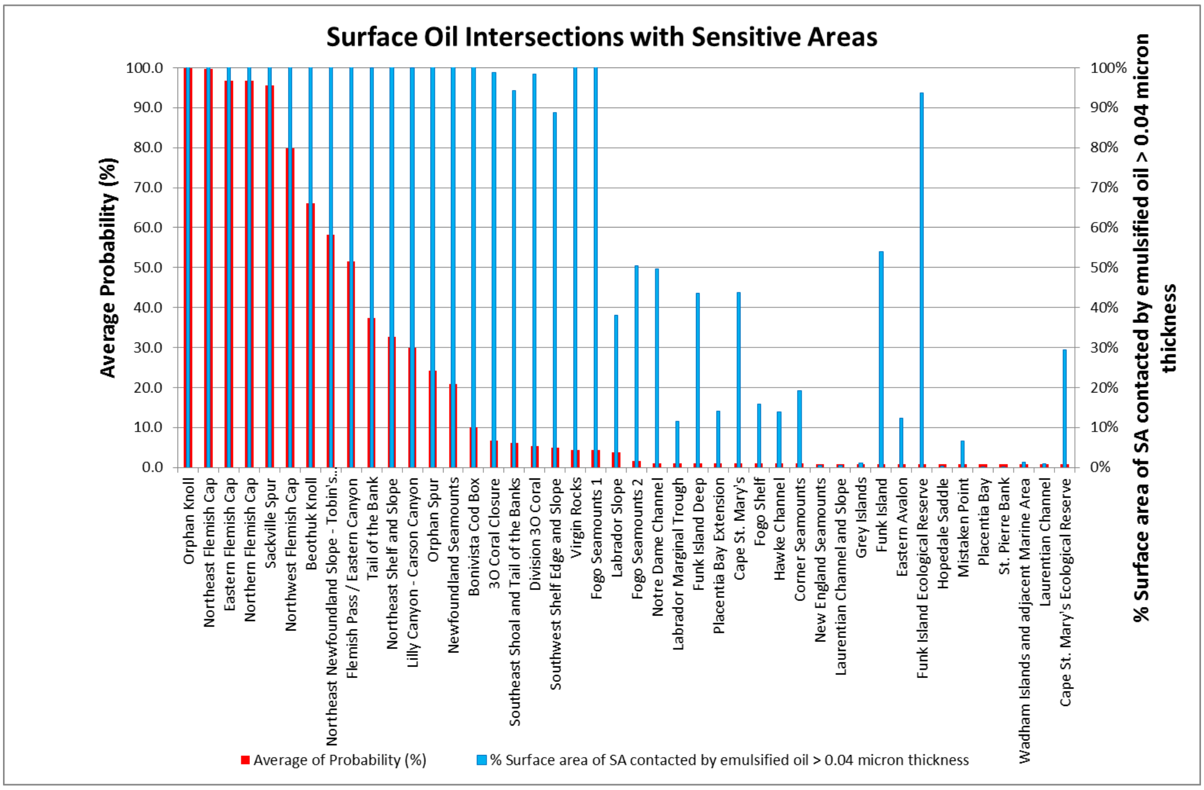


Figure 7.105 East Orphan well blowout relief well scenario (Winter Season)

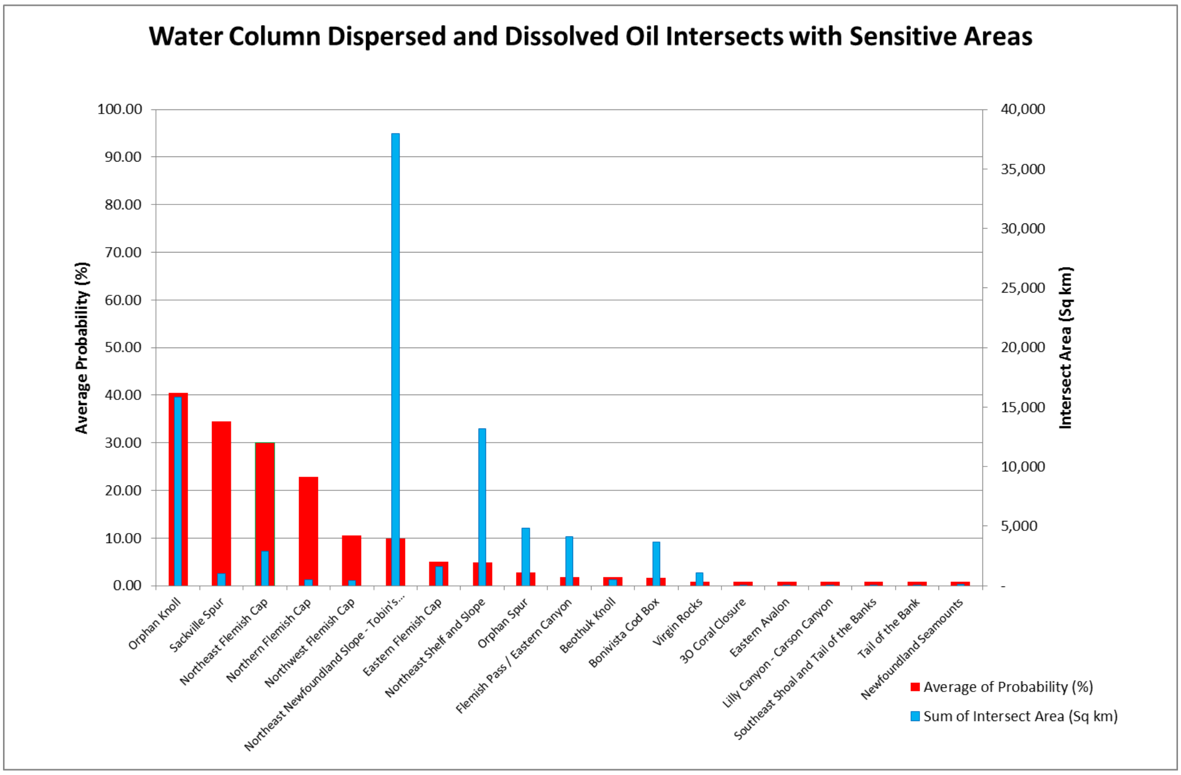
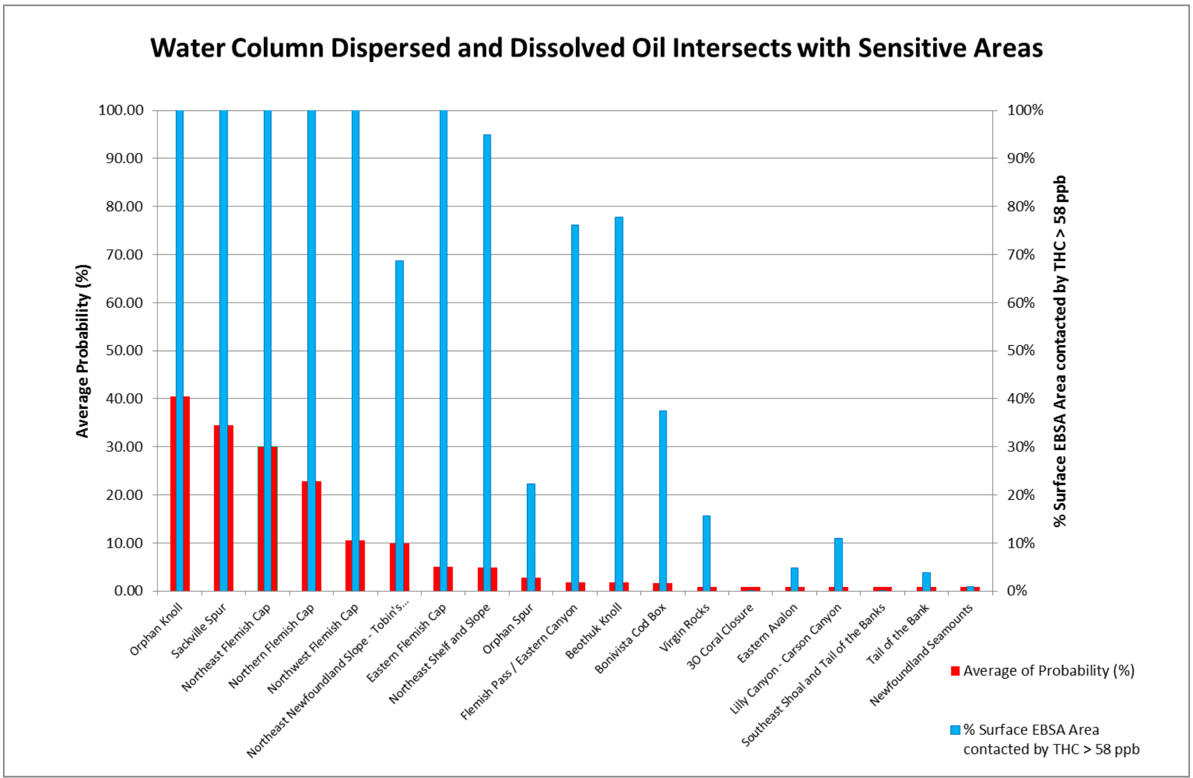


Figure 7.106 East Orphan well blowout relief well scenario (Winter Season)



7.3.7 Scenario 4: East Orphan well blowout capping stack scenario (Summer Season)

Figure 7.107 East Orphan well blowout capping stack scenario (Summer Season)

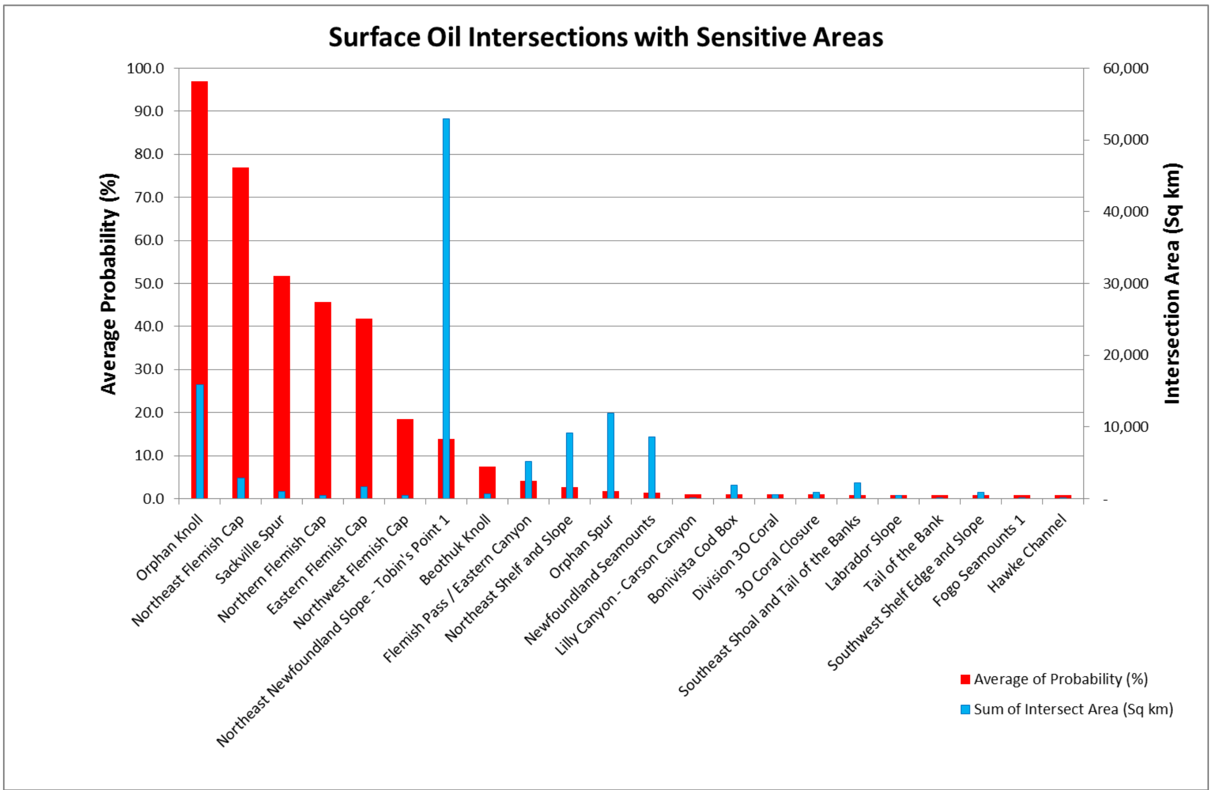


Figure 7.108 East Orphan well blowout capping stack scenario (Summer Season)

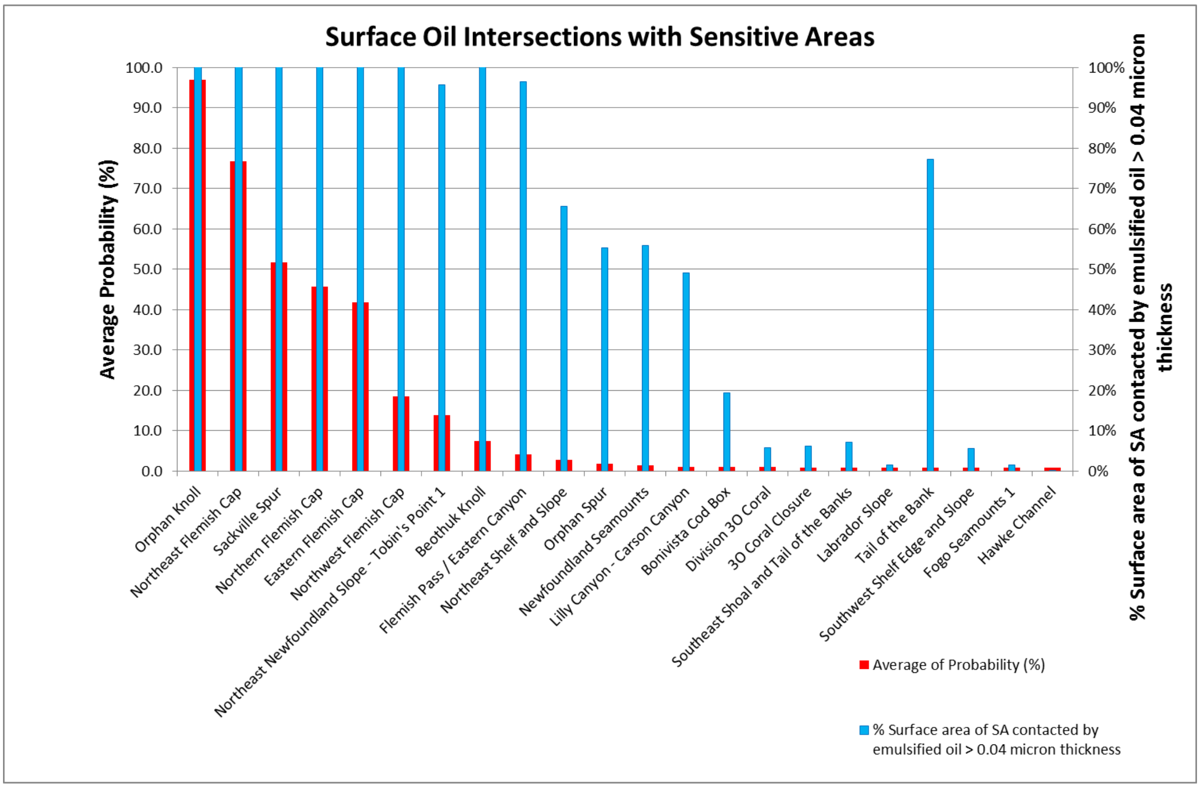


Figure 7.109 East Orphan well blowout capping stack scenario (Summer Season)

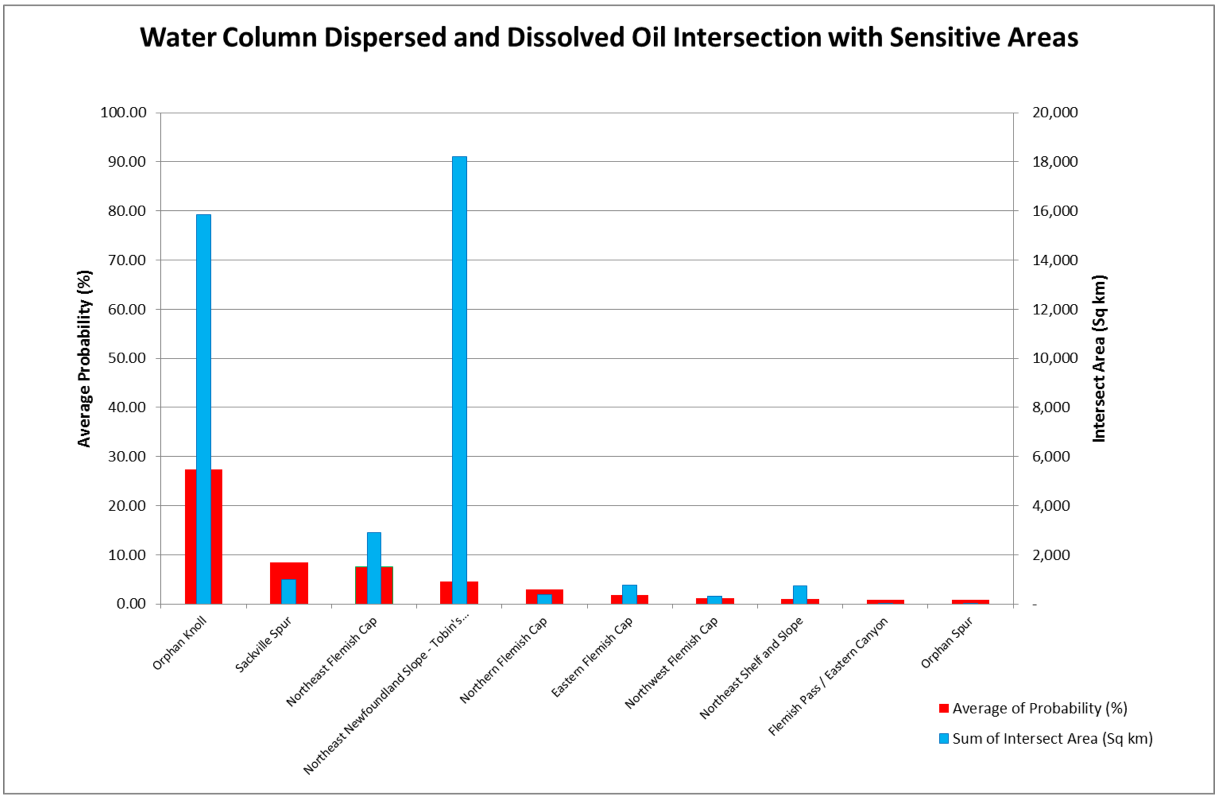
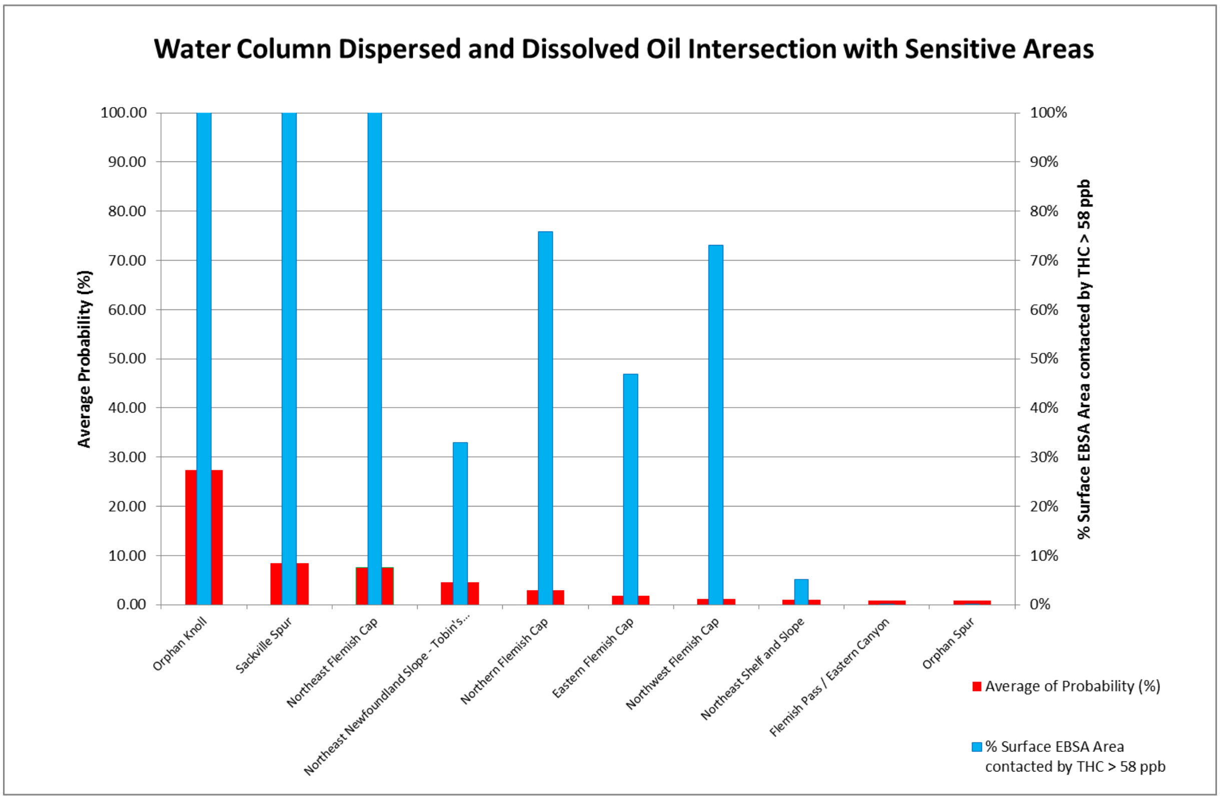


Figure 7.110 East Orphan well blowout capping stack scenario (Summer Season)



7.3.8 Scenario 4: East Orphan well blowout capping stack scenario (Winter Season)

Figure 7.111 East Orphan well blowout capping stack scenario (Winter Season)

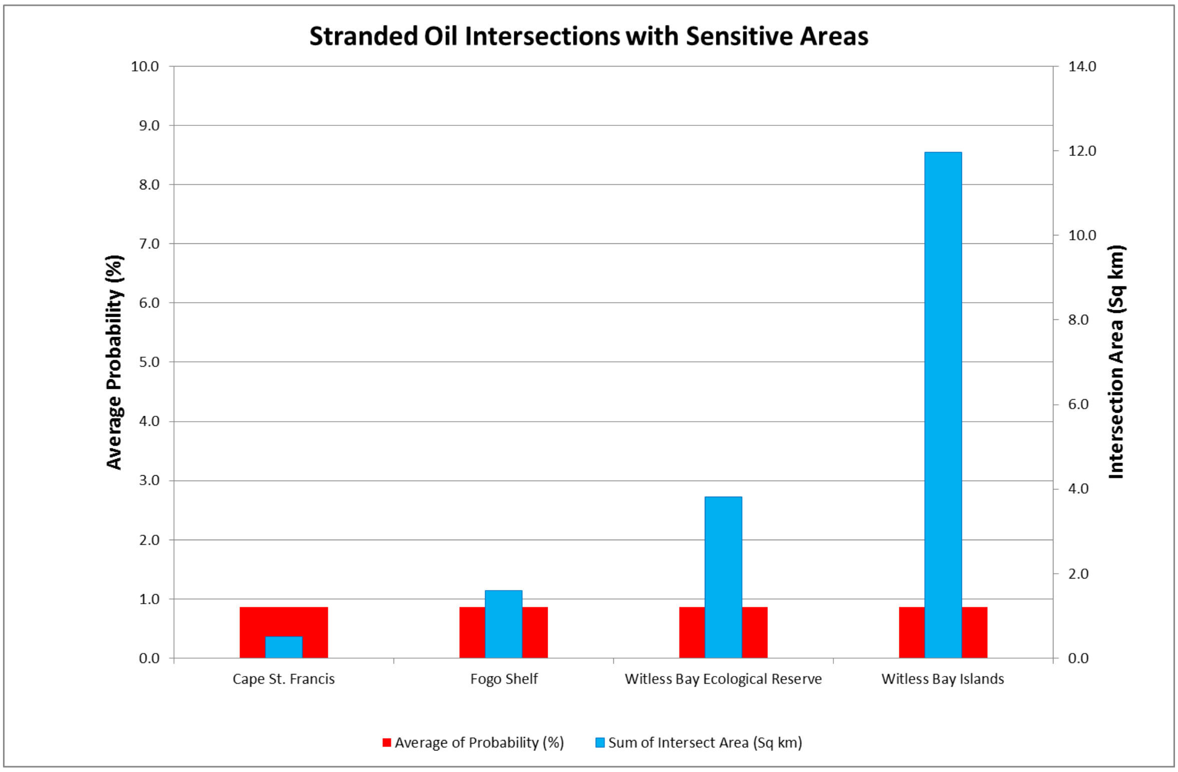


Figure 7.112 East Orphan well blowout capping stack scenario (Winter Season)

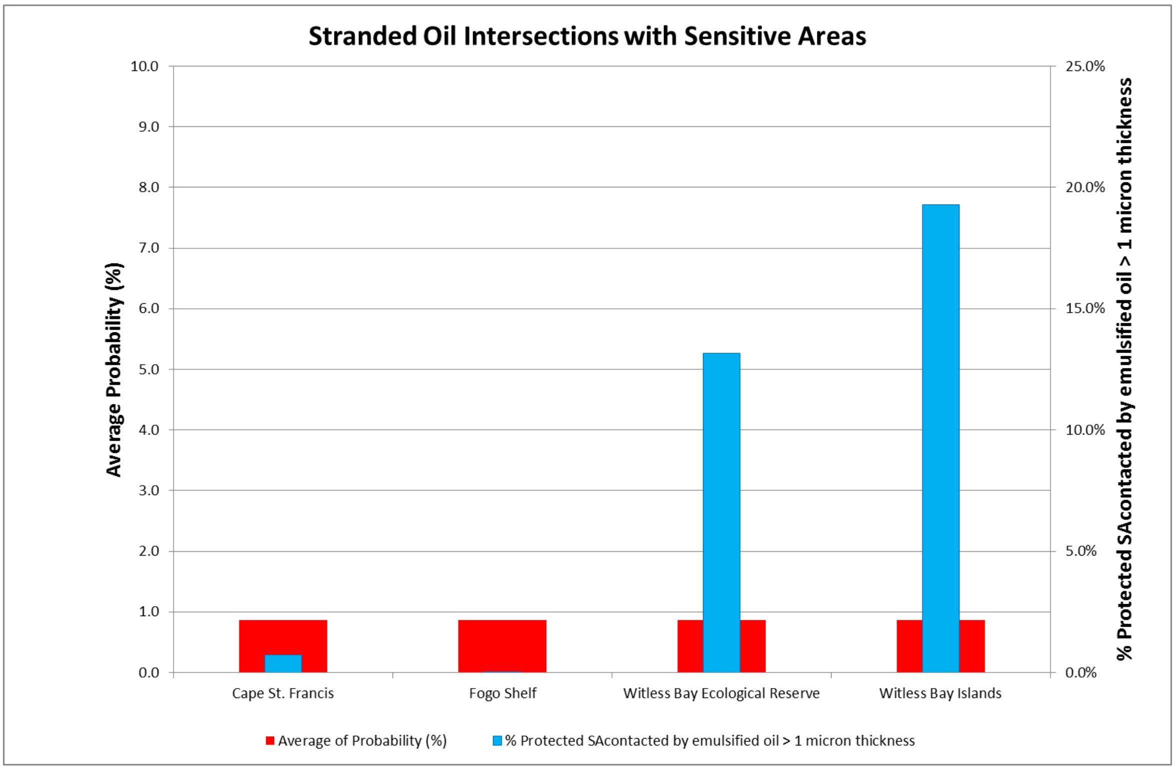


Figure 7.113 East Orphan well blowout capping stack scenario (Winter Season)

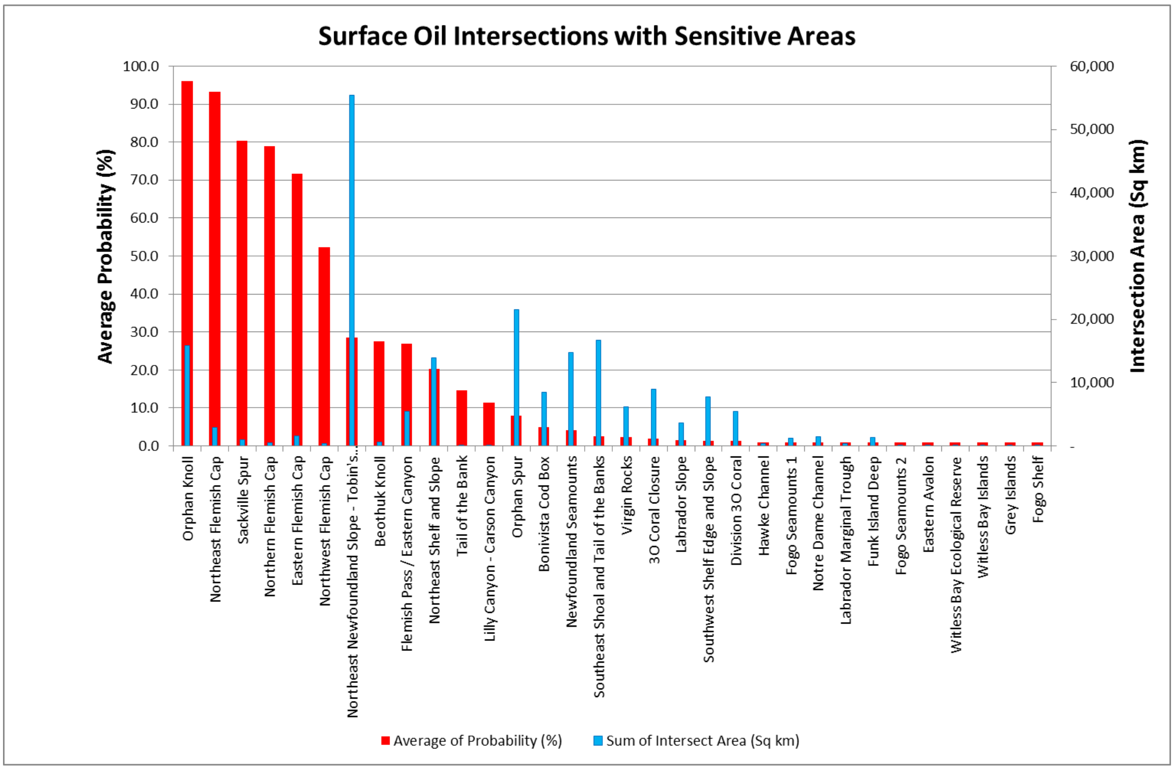


Figure 7.114 East Orphan well blowout capping stack scenario (Winter Season)

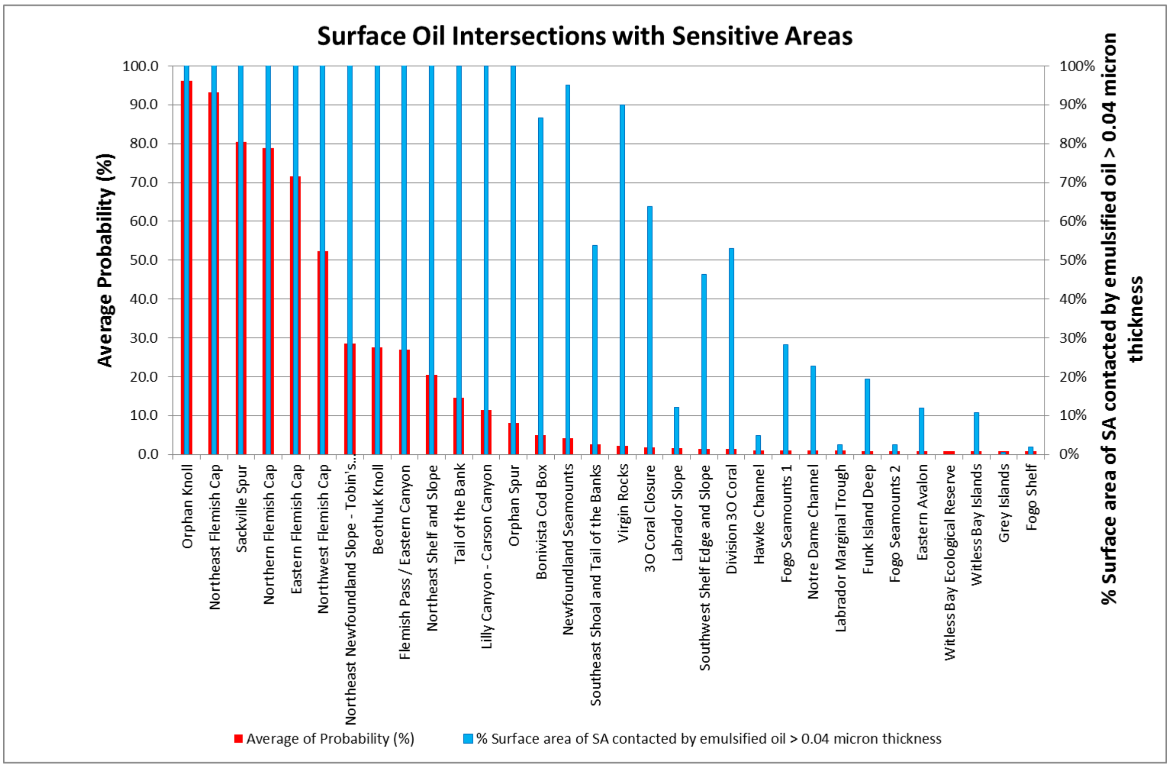


Figure 7.115 East Orphan well blowout capping stack scenario (Winter Season)

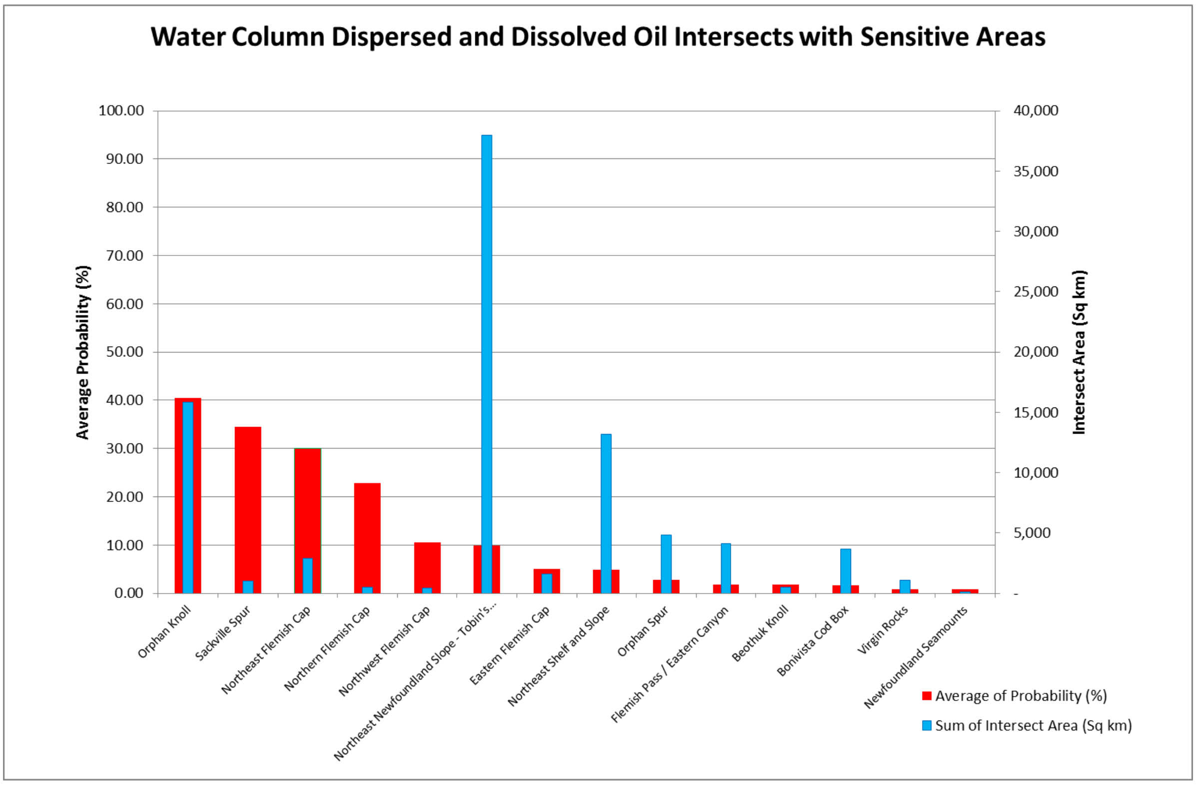
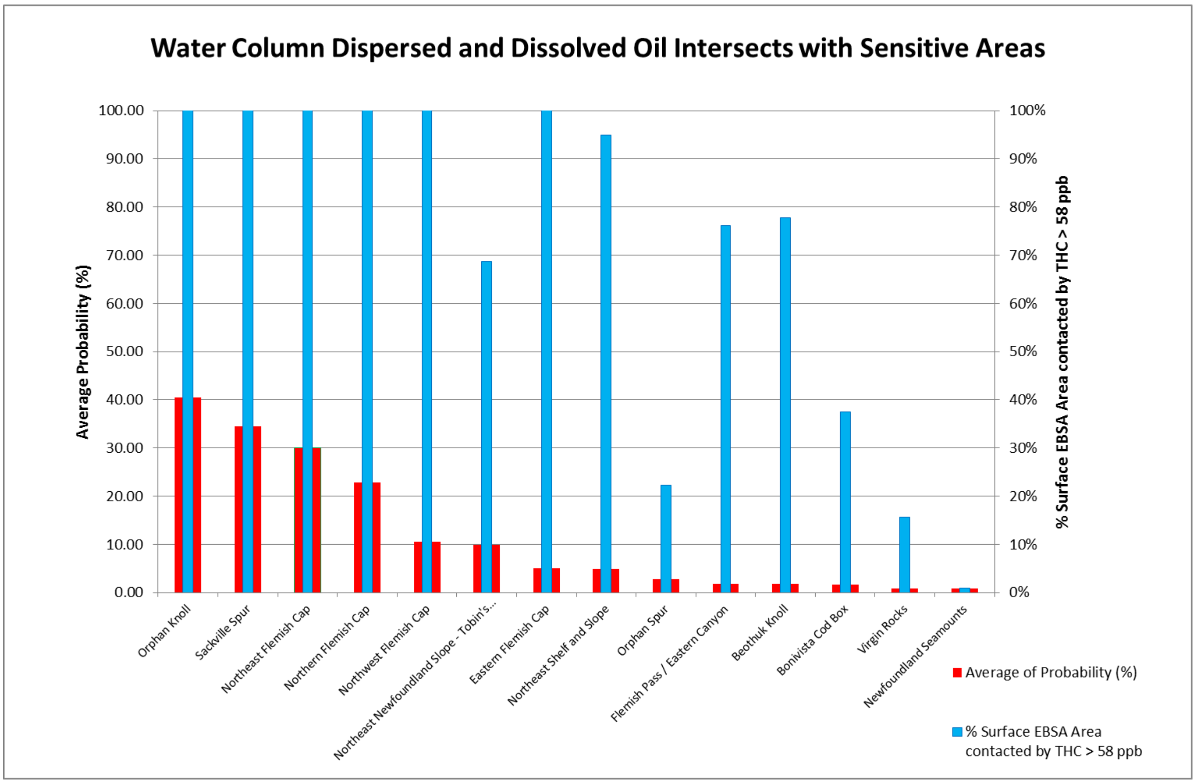


Figure 7.116 East Orphan well blowout capping stack scenario (Winter Season)



8 Accidental hydrocarbon (diesel) discharge modelling results

To simulate an accidental discharge from Project vessels, two batch spills of diesel were modelled as a surface release using stochastic and deterministic methods. Modelling for the batch release of diesel was undertaken for unmitigated incidents involving a hose failure (a 10 bbl surface release over 1 hour) and a tank failure (a 100 bbl surface batch release over 6 hours). Simulations were run over 15 day and 50 day periods for the 10 bbl and 100 bbl spills respectively, for both summer (May to October) and winter (November to April) seasons for both wellsite locations. The model settings and assumptions used in simulations were described earlier in Section 5.4.1 (Table 5.8). Stochastic simulations involved between 118 - 125 individual modelling runs for each 10 bbl and 100 bbl scenarios.

8.1 Stochastic results

Table 8.1 summarises the predicted areas exceeding the thresholds for surface oil thickness and water column THC concentration for each of the accidental discharge scenario.

Figures 8.1 - 8.4 depict the probability of sea surface emulsified oil thickness exceeding the 0.04 µm sheen thickness threshold. The results show that the location of threshold exceedances for surface effects are expected to occur over a greater area if a spill occurs during the summer season compared to the winter months.

For a 100 bbl spill, there is a less than 1% probability of surface oiling in excess of the BAOAC sheen (0.04 µm thickness) threshold extending > 25 km from either release location in the summer season and > 15 km in the winter months. The cumulative footprint of locations where there is a >1% probability of exceeding this threshold ranged between 209 and 238 km^2 for the summer season compared to 121 - 133 km^2 for the winter season (Table 8.1).

The maximum time-averaged emulsified oil thickness on the sea surface exceeding the 0.04 µm threshold for both spill scenarios are shown in Figures 8.5 - 8.8 and ranged from BAOAC sheen to metallic (0.04 µm to 50 µm oil thickness).

The predicted THC concentrations and dissolved oil concentrations were within tens of meters of the surface, as they are the result of entrained oil from wind-induced surface breaking waves within the surface mixed layer.

The duration of exposure to either surface oil or oil in the water column that exceeded thickness or oil in water concentration threshold levels was < 6 hours for the 10 bbl releases and for the 100 bbl releases ranged from 12 - 18 hours in the immediate vicinity of the release location to < 6 hours at the majority of locations further away.

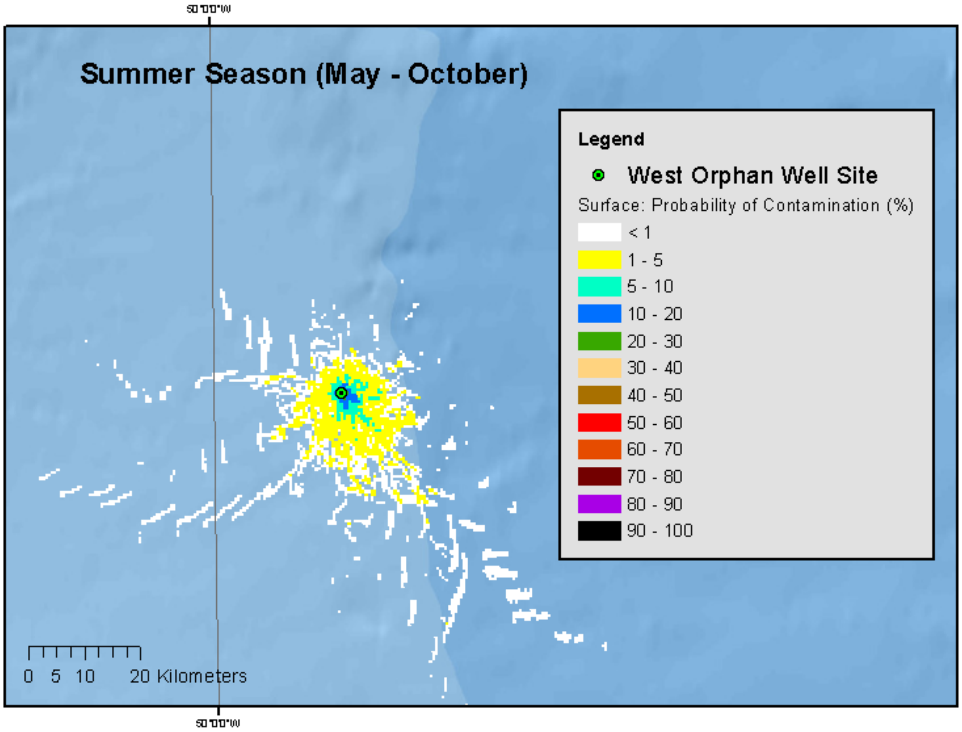
Table 8.1 Predicted areas exceeding the thresholds for surface oil thickness and water column THC concentration for each of the accidental surface discharge scenarios. Areas are reported for each season and for different probability contours.

Stochastic Scenario Parameters		Scenario 5 - WO Surface Batch 100 bbls diesel release		Scenario 6 - WO Surface Batch 10 bbls diesel release		Scenario 7 - EO Surface Batch 100 bbls diesel release		Scenario 8 - EO Surface Batch 10 bbls diesel release	
Compartment and Threshold	**Probability Contour or Bin**	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)	Summer Season (May - October)	Winter Season (November - April)
Surface Compartment: sea surface area (km^2) where emulsified oil thicknesses exceed 0.04 microns	1%	238 km^2	133 km^2	40 km^2	22 km^2	209 km^2	121 km^2	35 km^2	24 km^2
	5%	36 km^2	31 km^2	2 km^2	- km^2	36 km^2	25 km^2	- km^2	0.3 km^2
	10%	10 km^2	9 km^2	- km^2	- km^2	9 km^2	9 km^2	- km^2	- km^2
Water Column Compartment: sea surface area (km^2) where total hydrocarbon concentrations (dispersed and dissolved oil) exceed 58 ppb threshold at some depth within the top 100 m of water column	1%	70 km^2	95 km^2	3 km^2	2 km^2	81 km^2	81 km^2	4 km^2	4 km^2
	5%	3 km^2	17 km^2	- km^2	- km^2	7 km^2	18 km^2	- km^2	- km^2
	10%	- km^2	2 km^2	- km^2	- km^2	- km^2	4 km^2	- km^2	- km^2

8.2 Surface oil exposure results

8.2.1 West Orphan release site

Figure 8.1 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold.



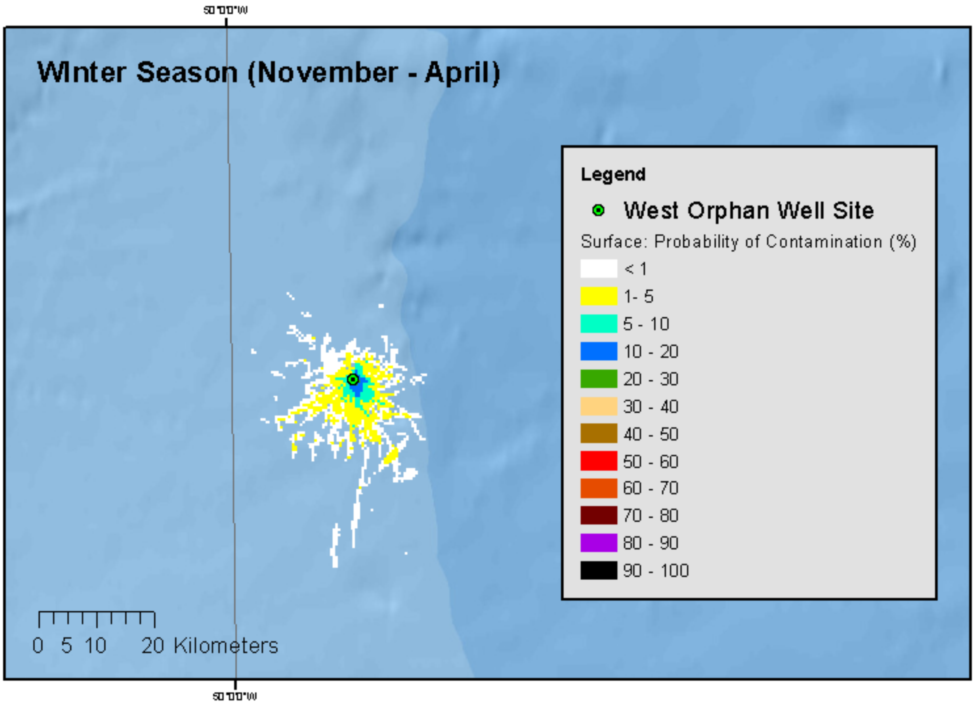
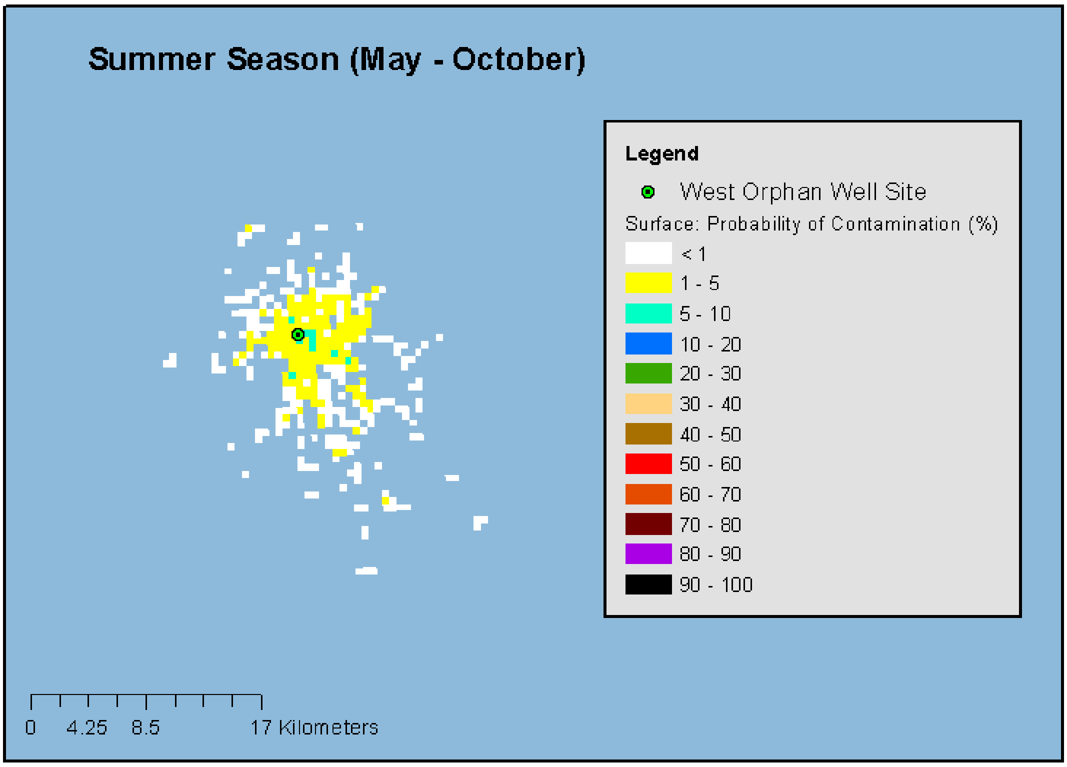


Figure 8.2 Scenario 6: West Orphan 10 bbl surface batch release of diesel. Statistical maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold.



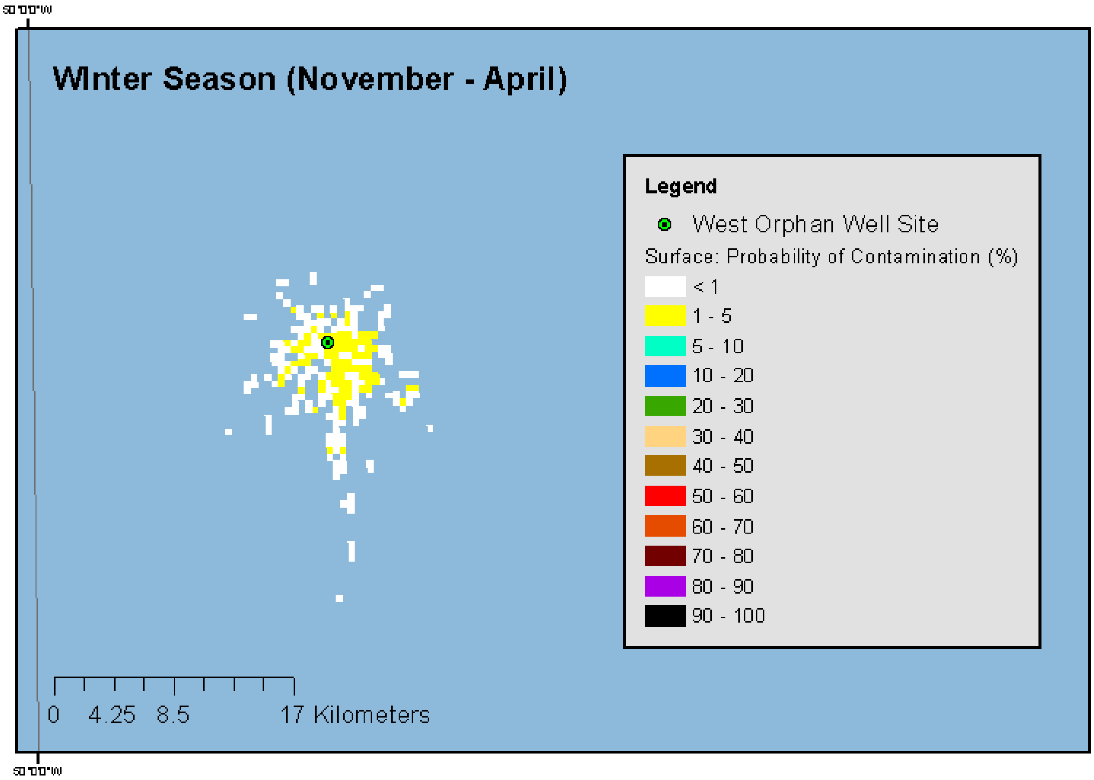


Figure 8.3 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold.

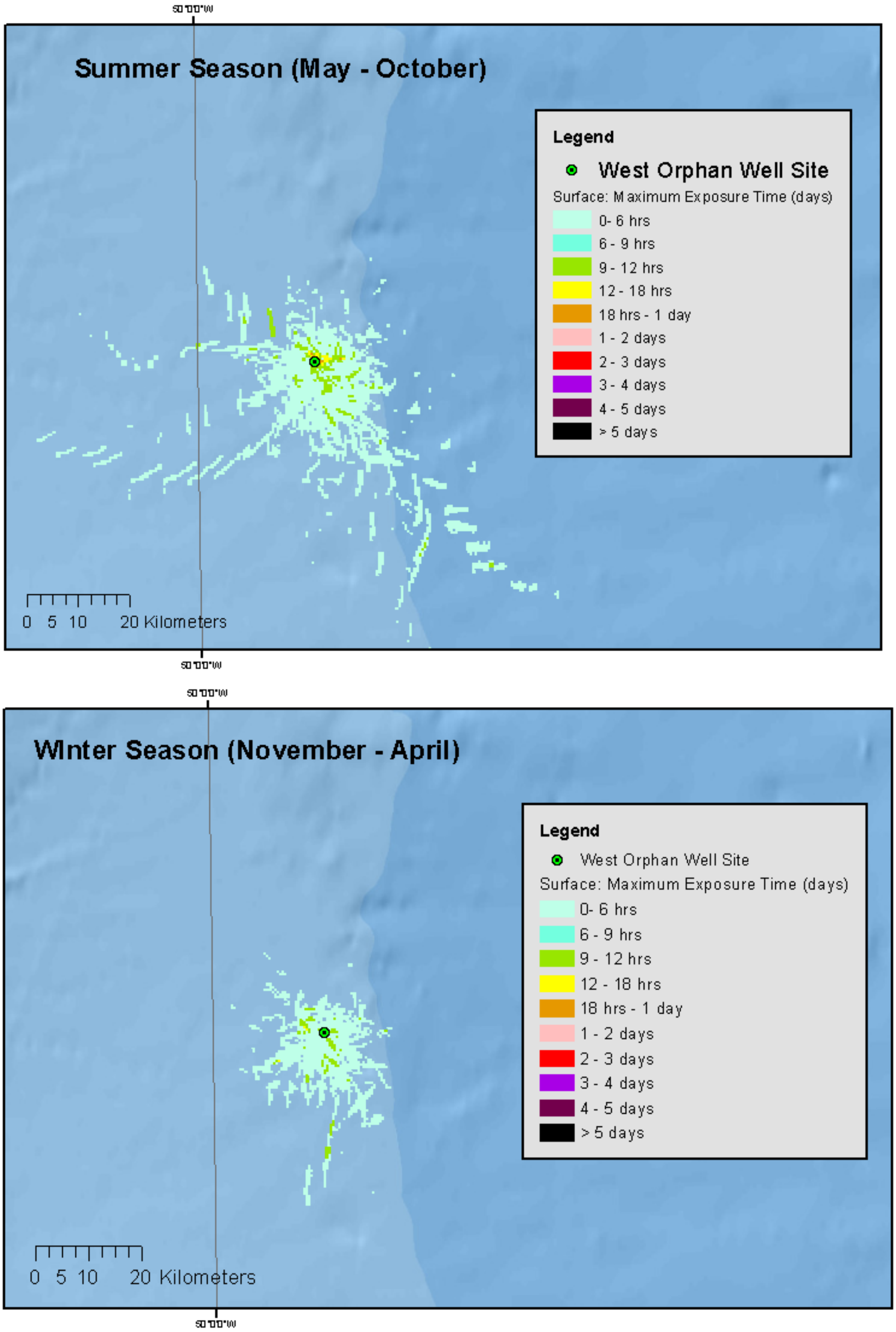
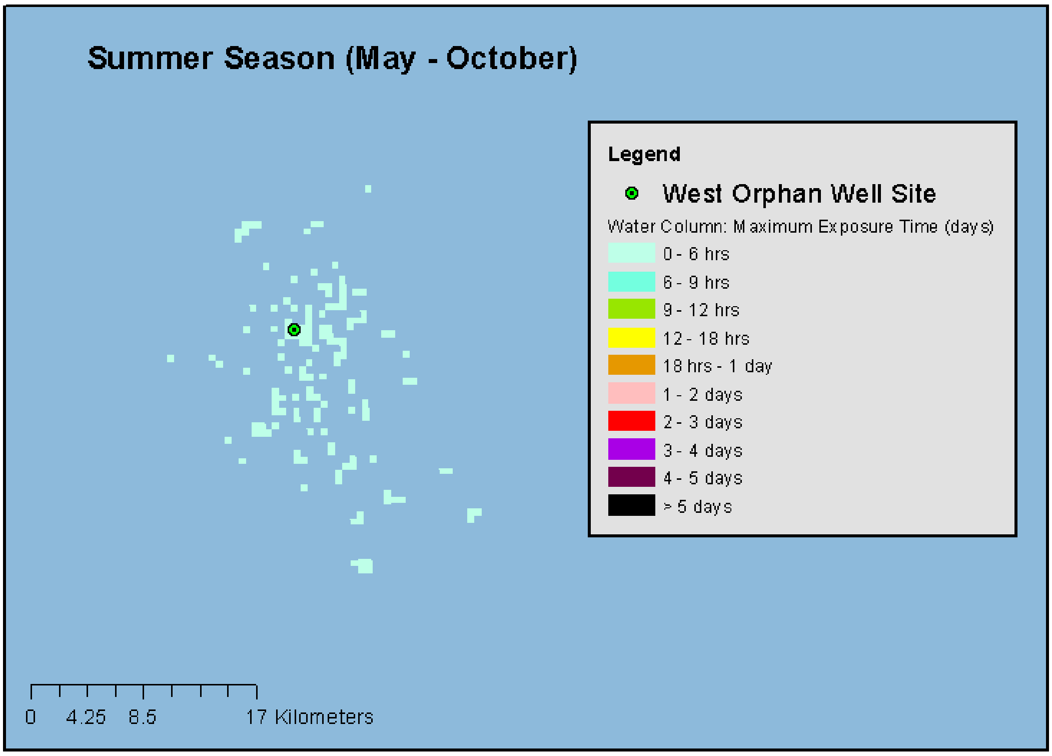


Figure 8.4 Scenario 6: West Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold.



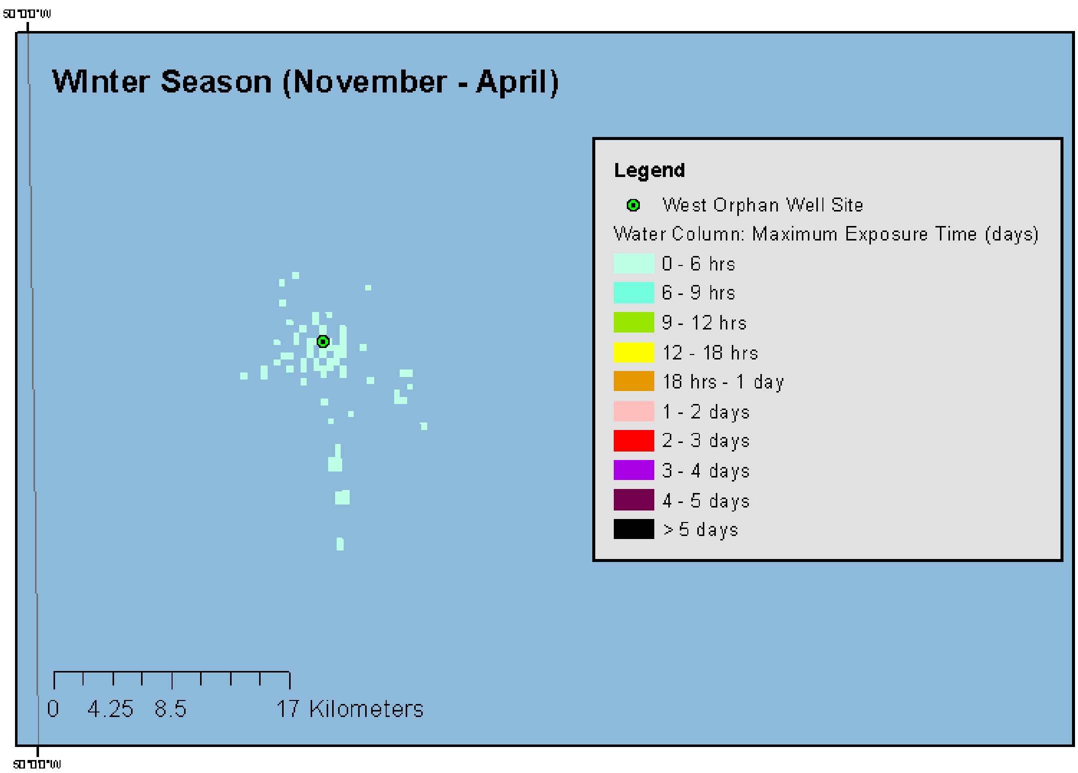


Figure 8.5 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied).

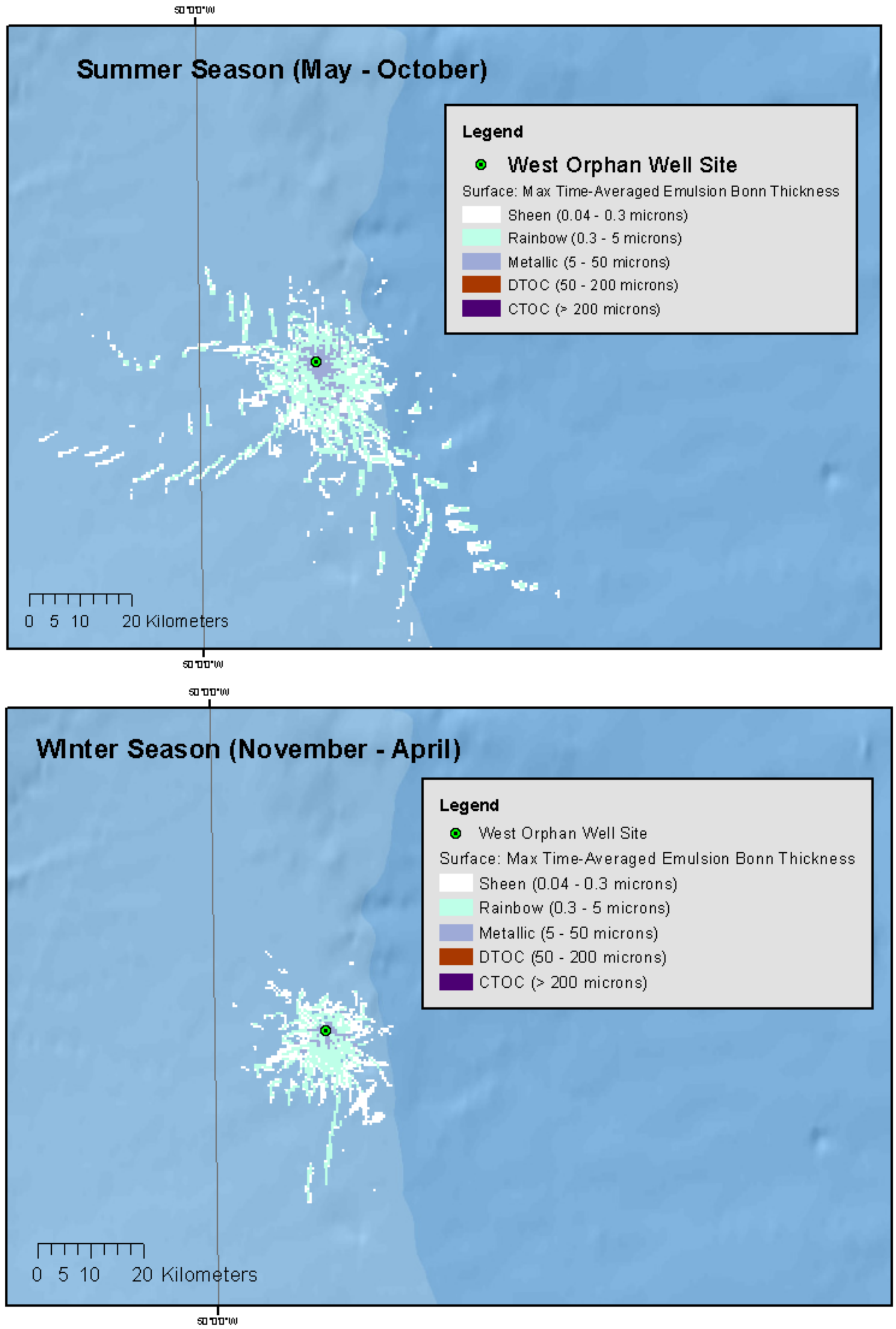
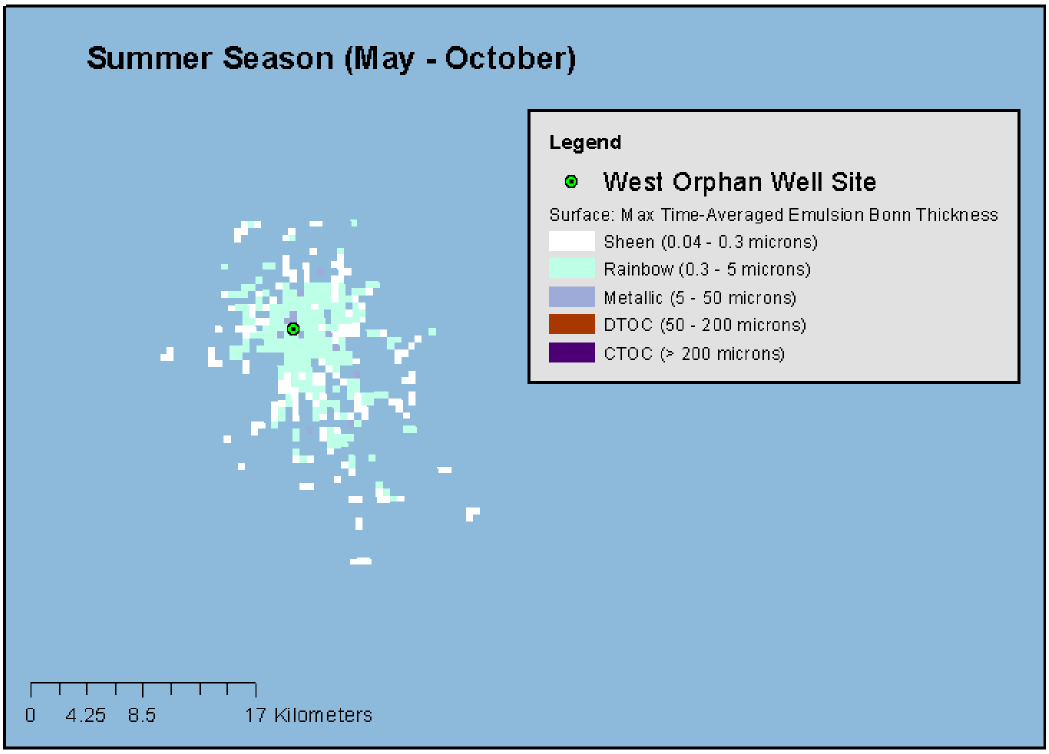
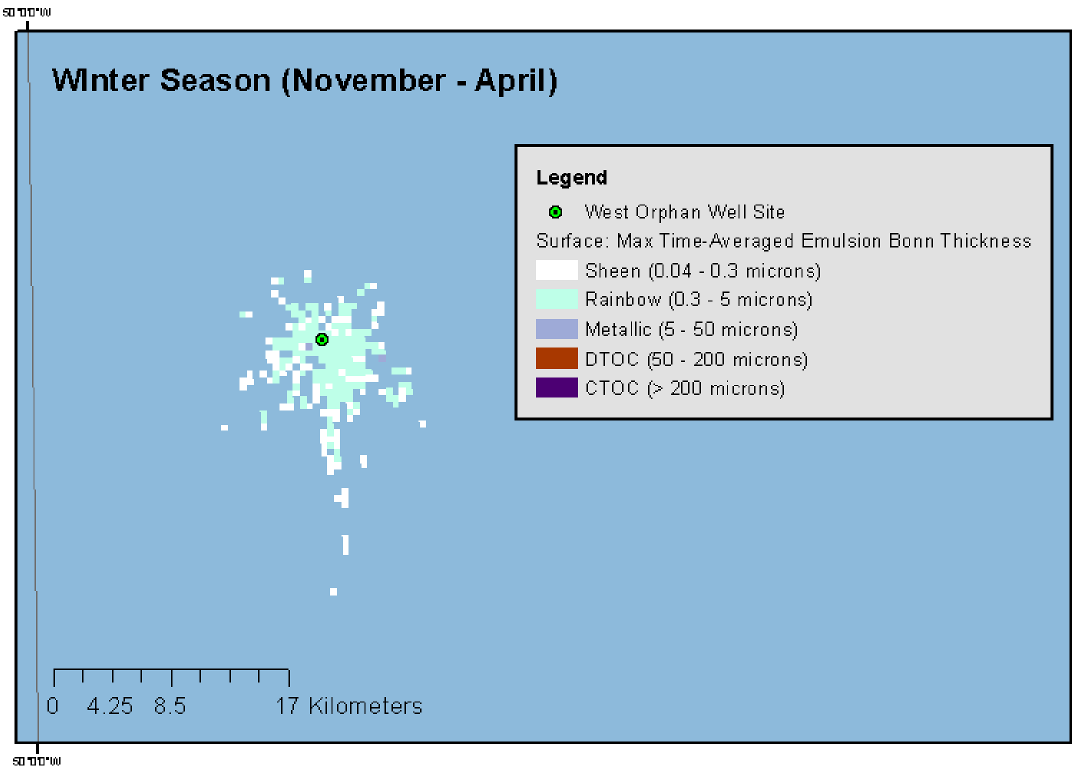


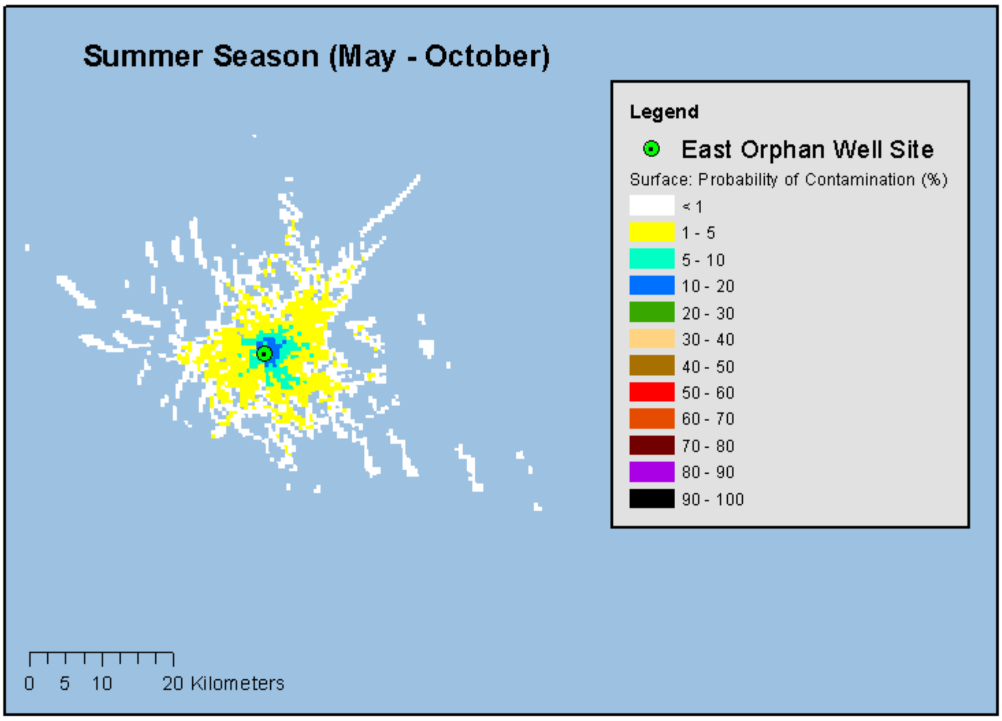
Figure 8.6 Scenario 6: West Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied).





8.2.2 East Orphan release site

Figure 8.7 Scenario7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold.



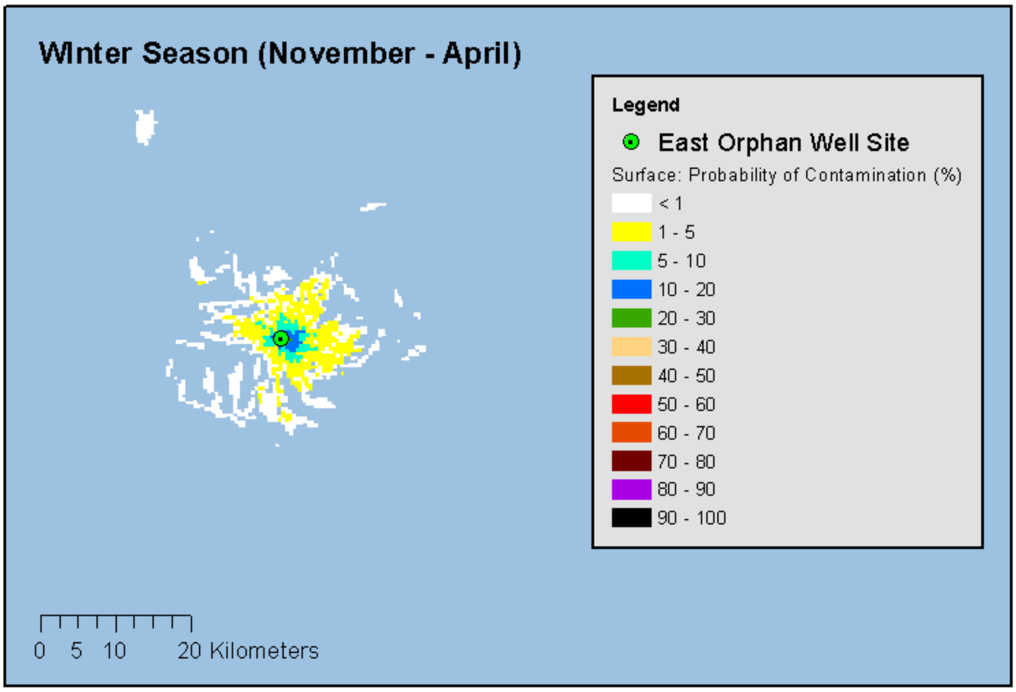
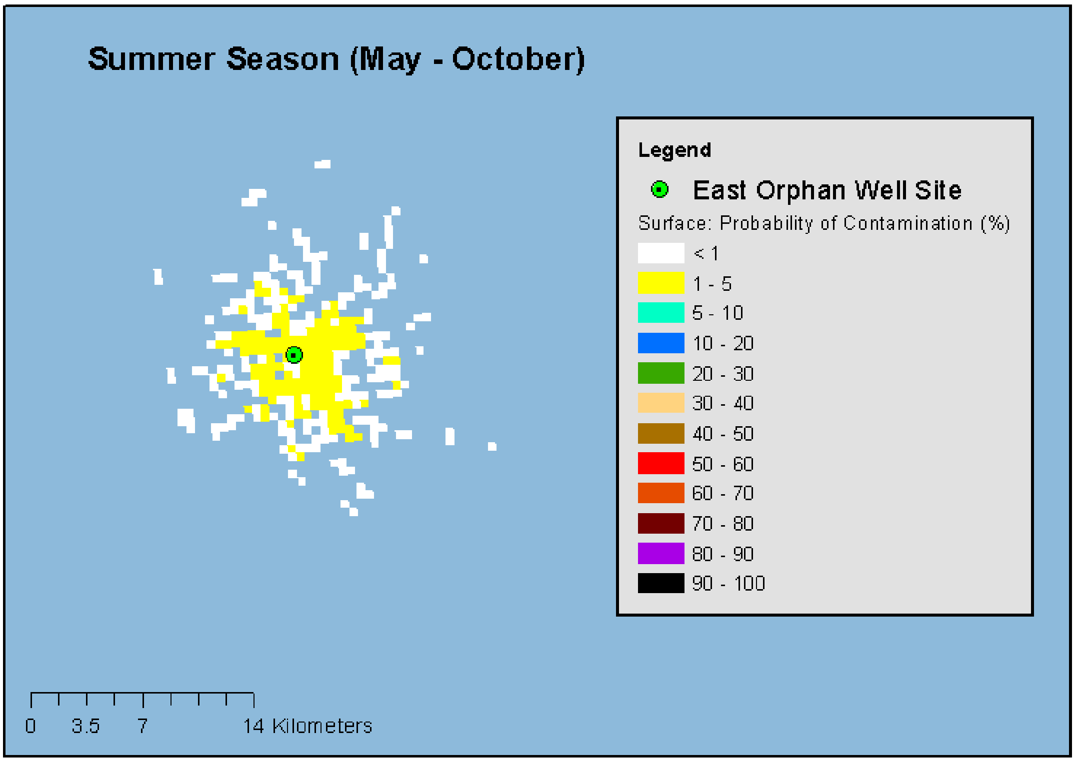


Figure 8.8 Scenario 8: East Orphan 10 bbl surface batch release of diesel. Statistical maps showing the probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC Sheen) thickness threshold.



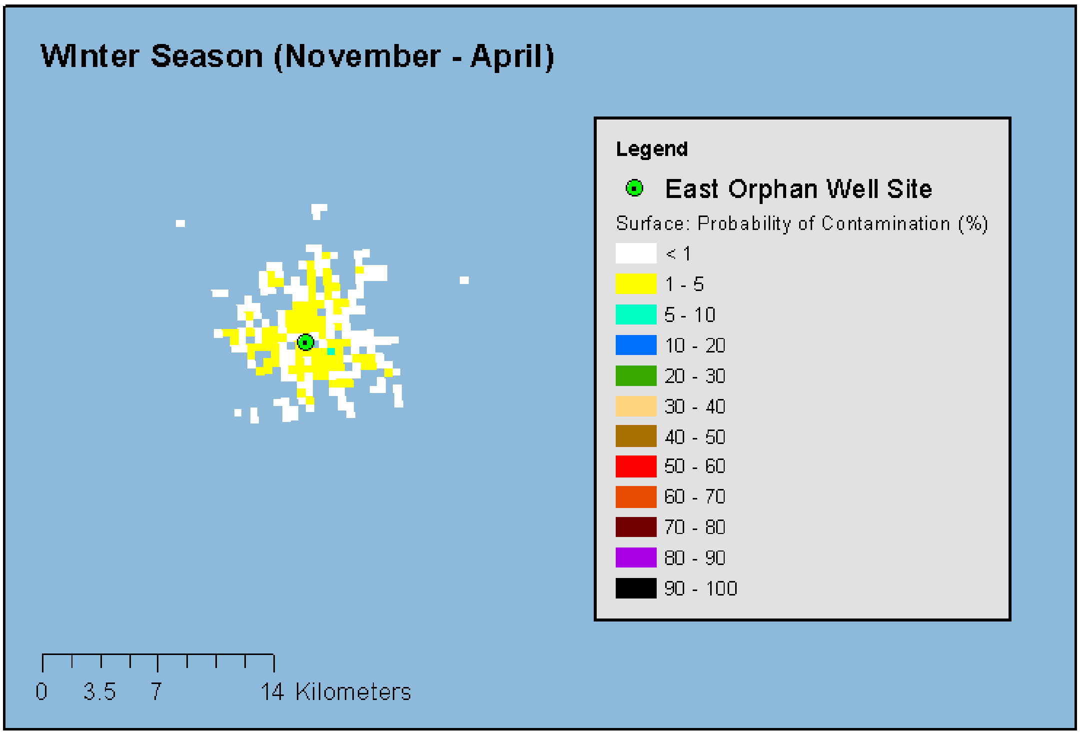
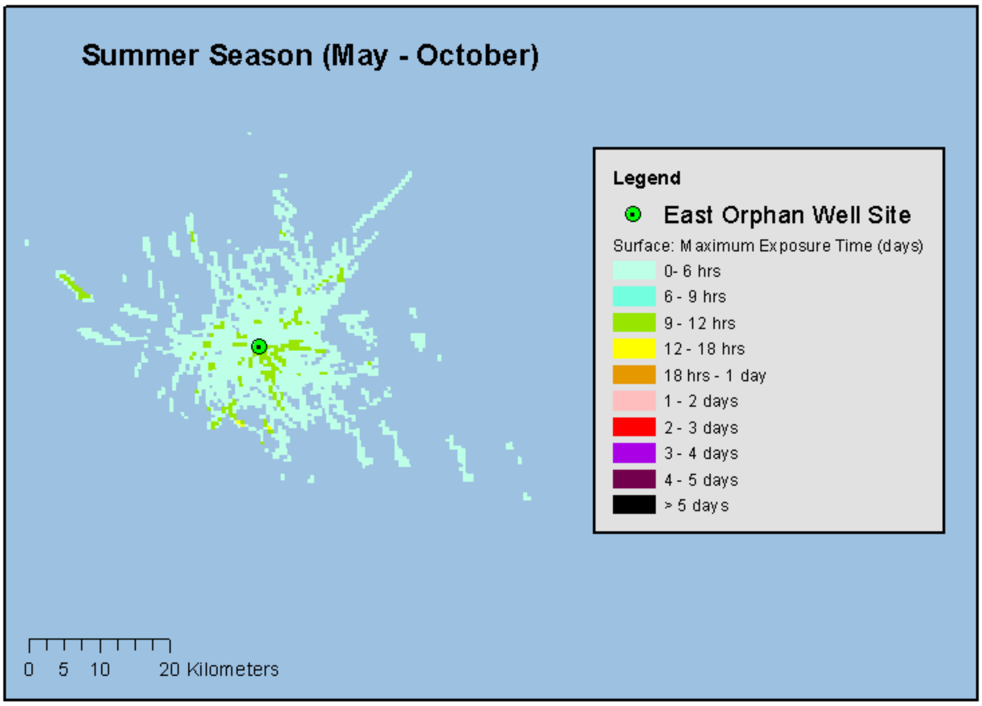


Figure 8.9 Scenario7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold.



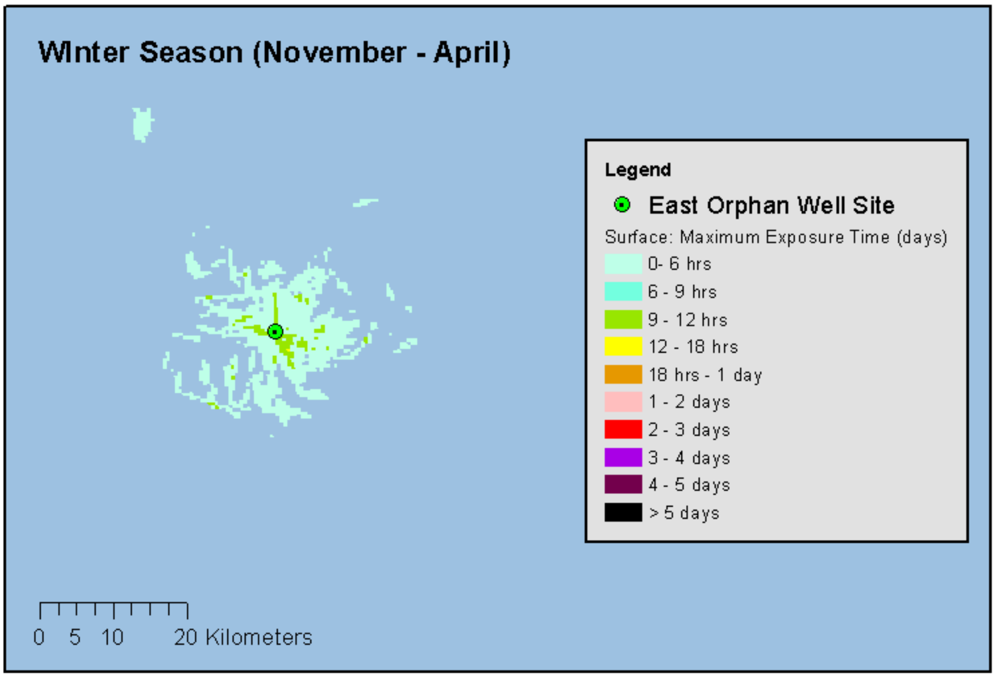
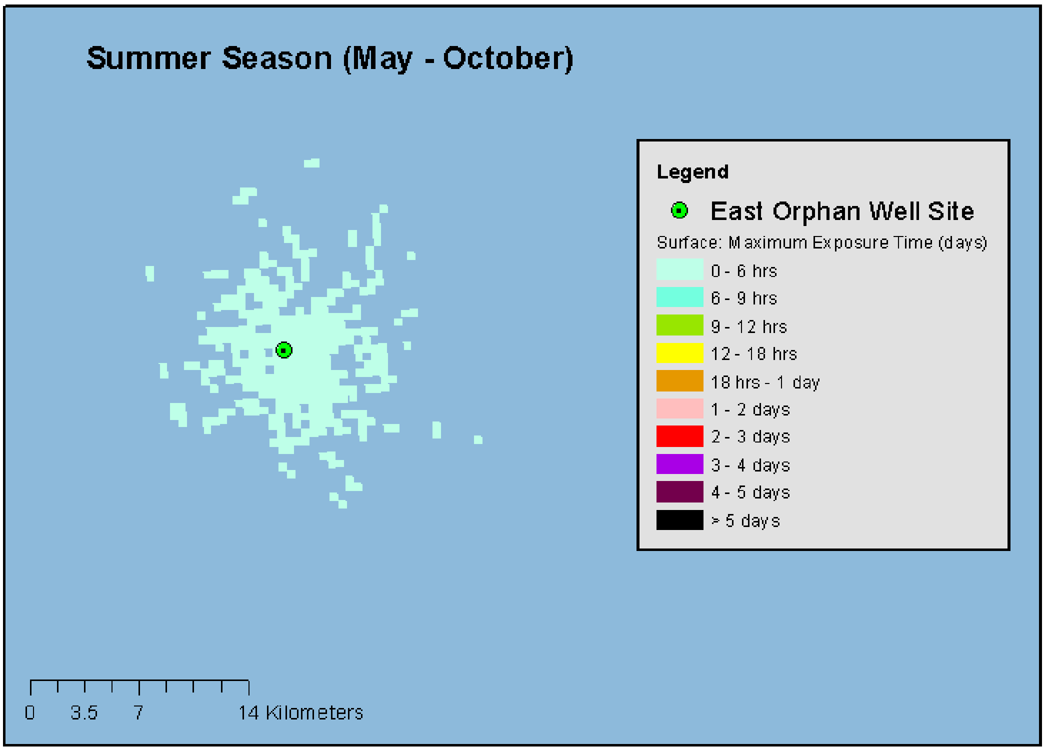


Figure 8.10 Scenario 8: East Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time for emulsified oil thicknesses on the sea surface which exceed the 0.04µm (BAOAC Sheen) thickness threshold.



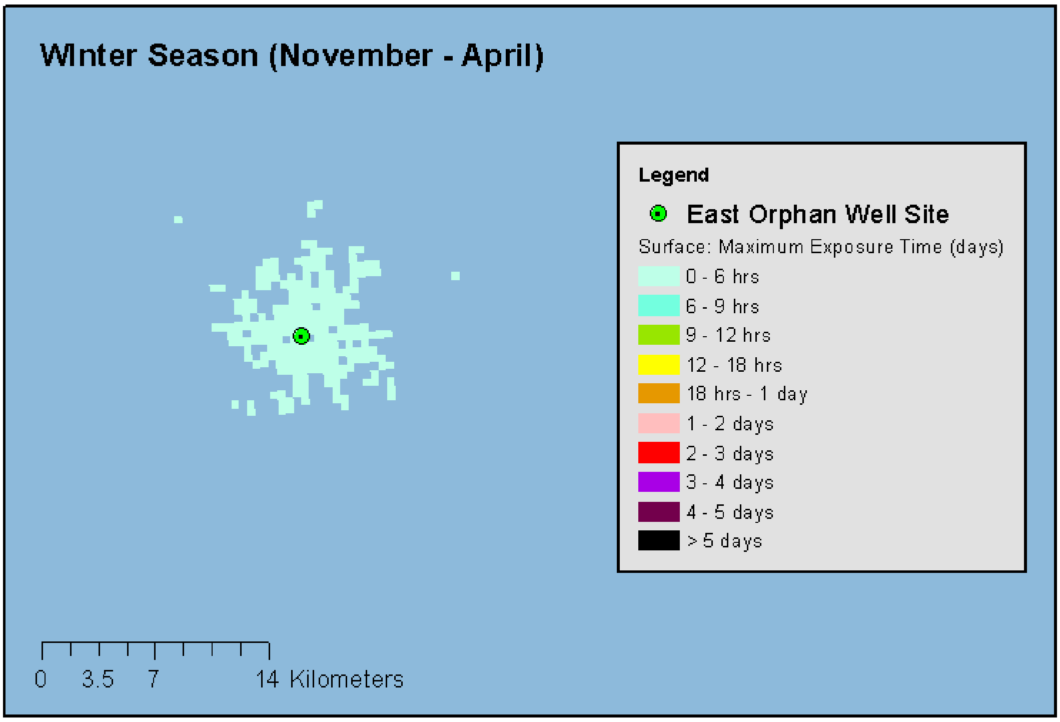
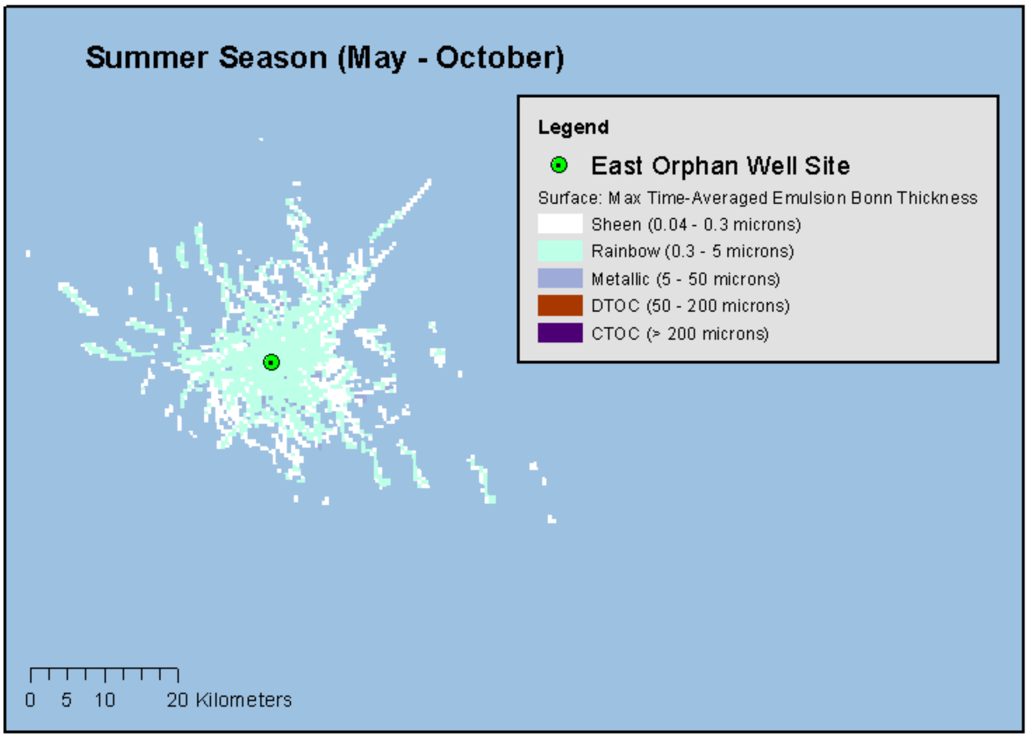


Figure 8.11 Scenario7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied).



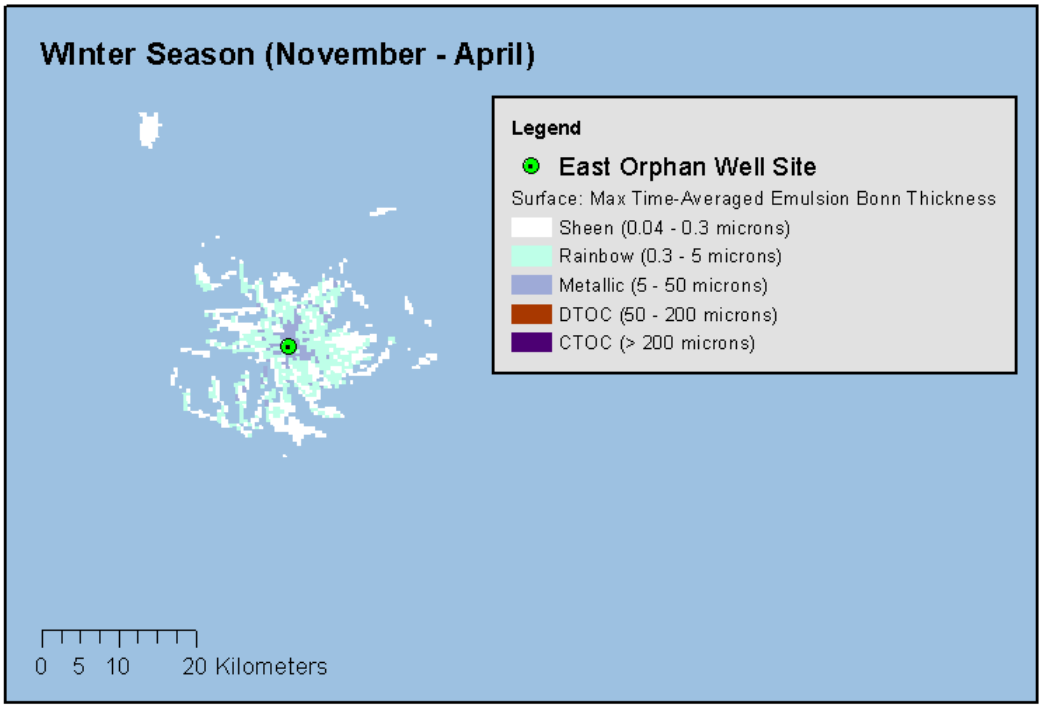
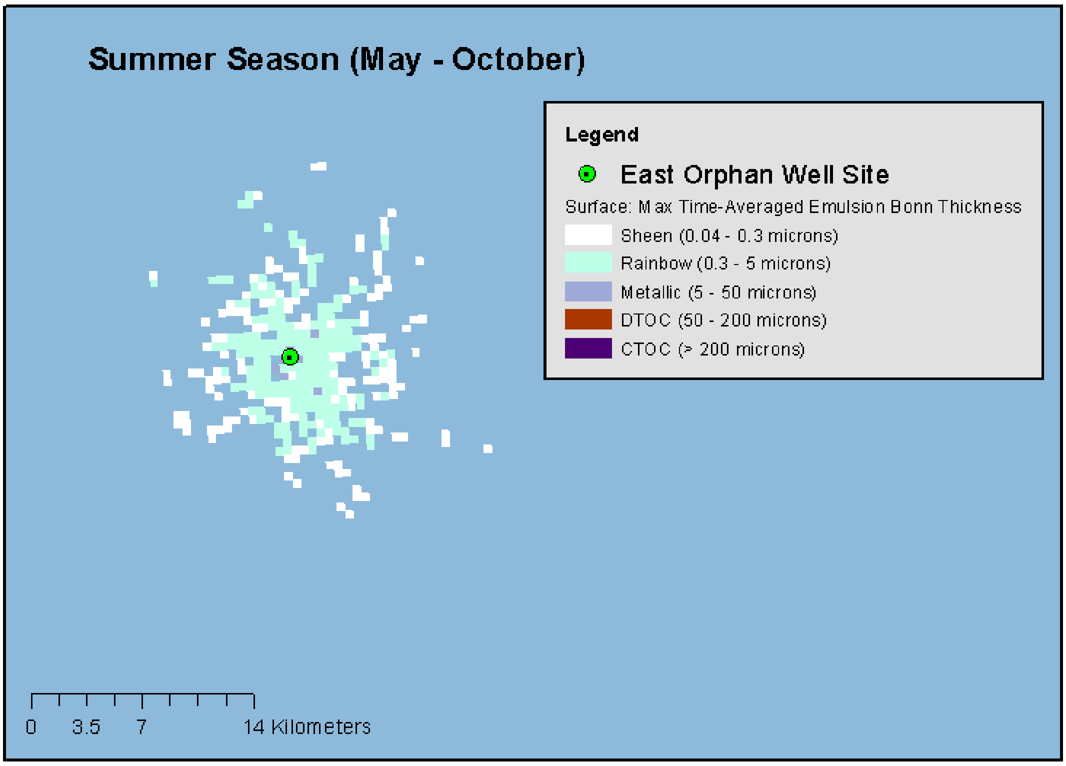
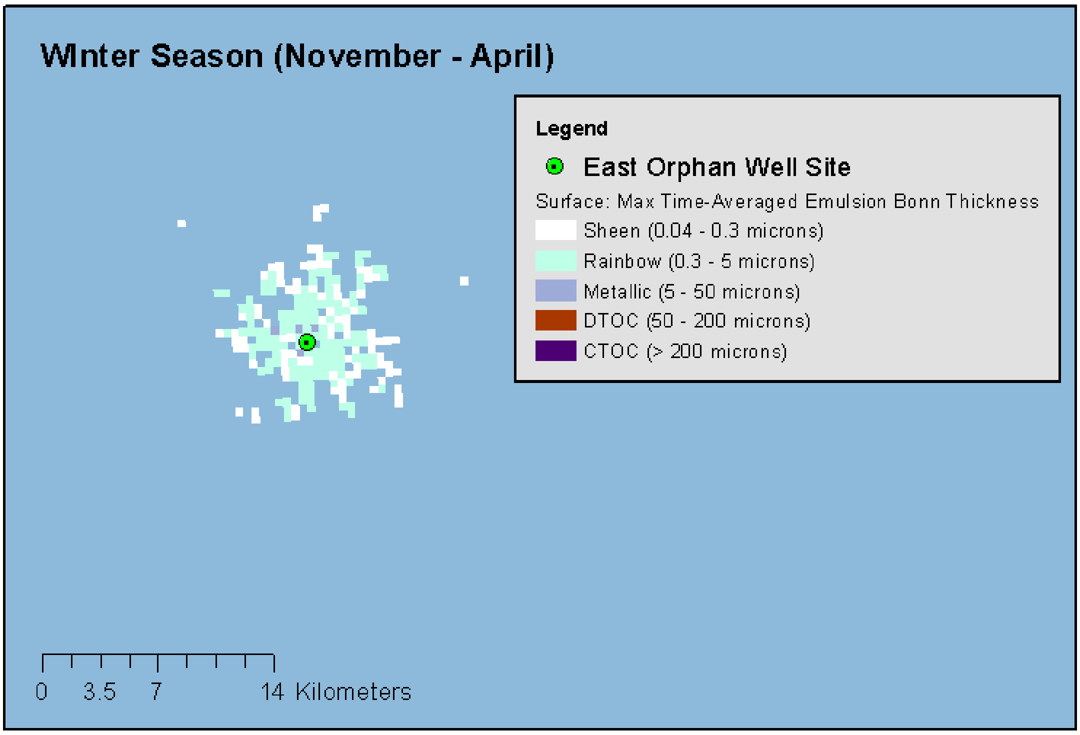


Figure 8.12 Scenario 8: East Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged emulsified oil thickness on the sea surface (0.04µm BAOAC Sheen thickness threshold applied).





8.3 Water column results

8.3.1 West Orphan release site

Figure 8.13 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column.

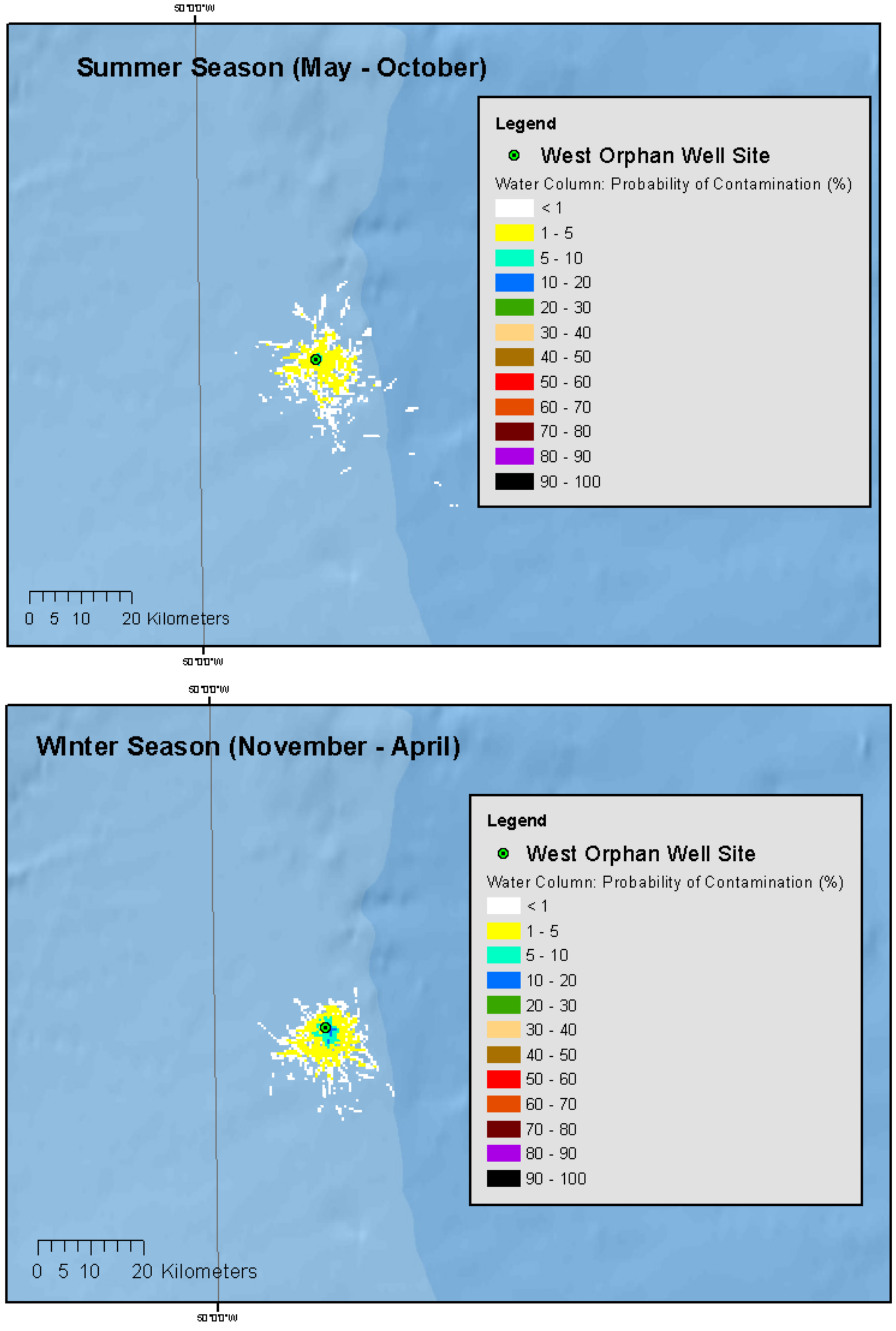
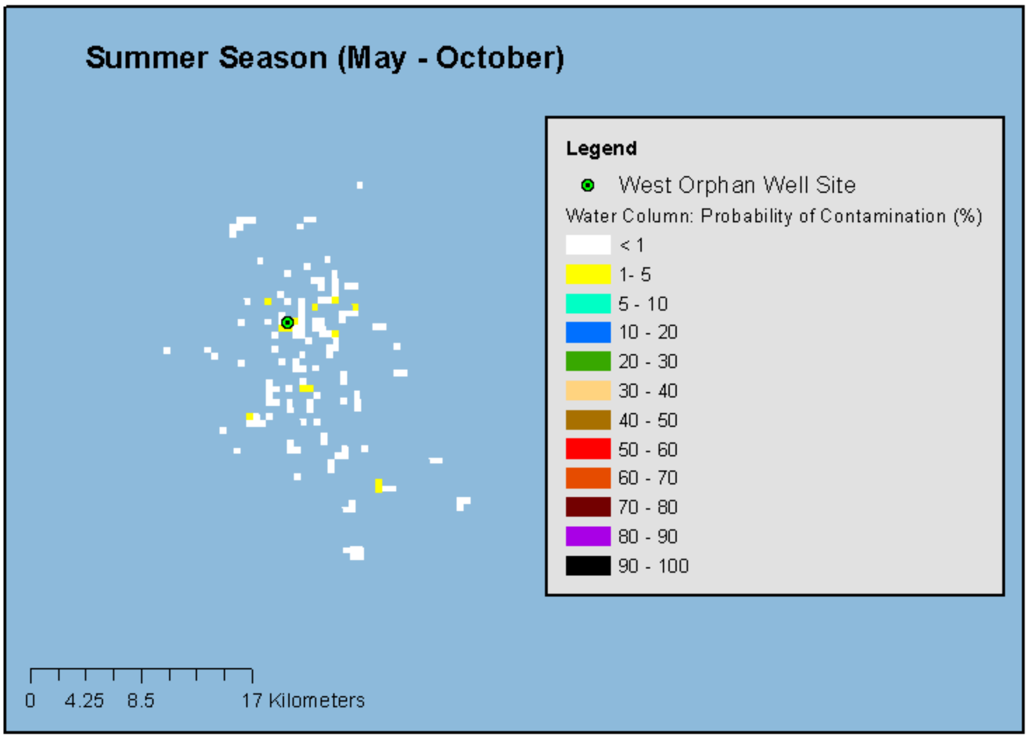


Figure 8.14 Scenario 6: West Orphan 10 bbl surface batch release of diesel. Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column.



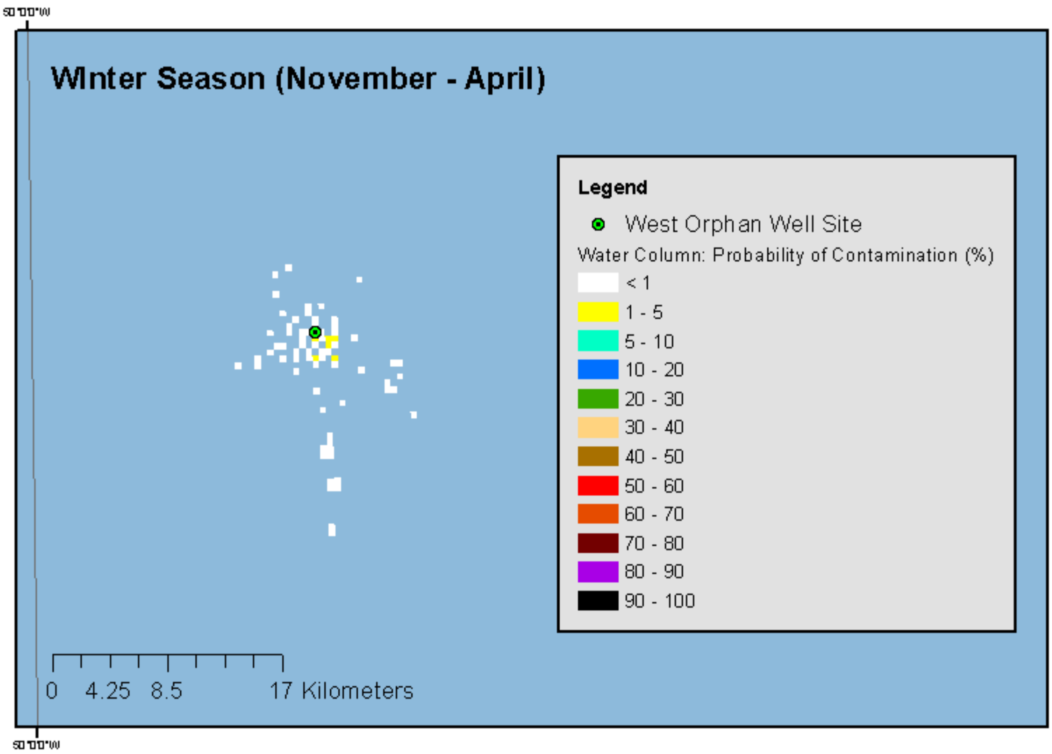
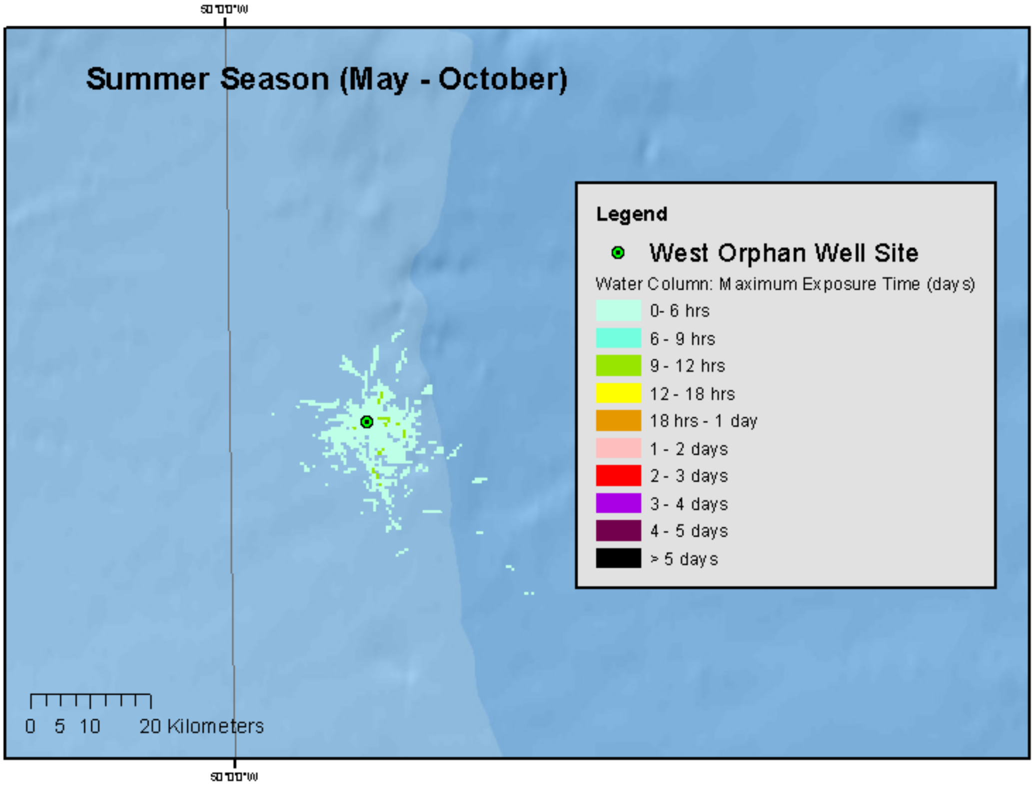


Figure 8.15 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).



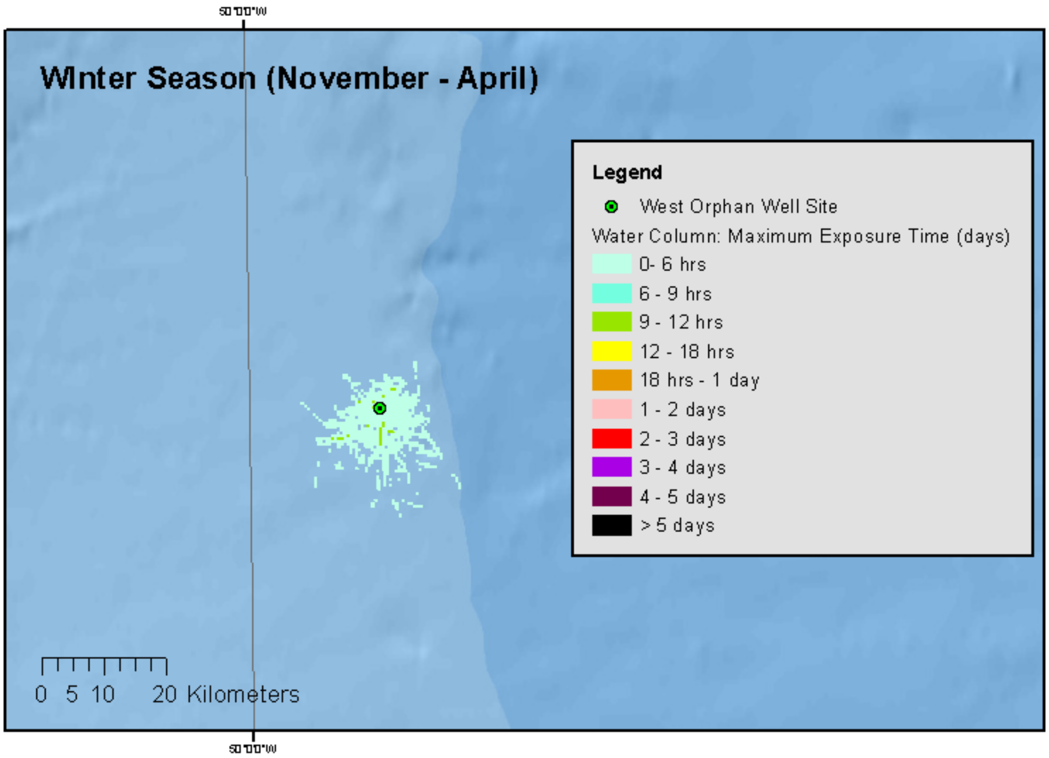
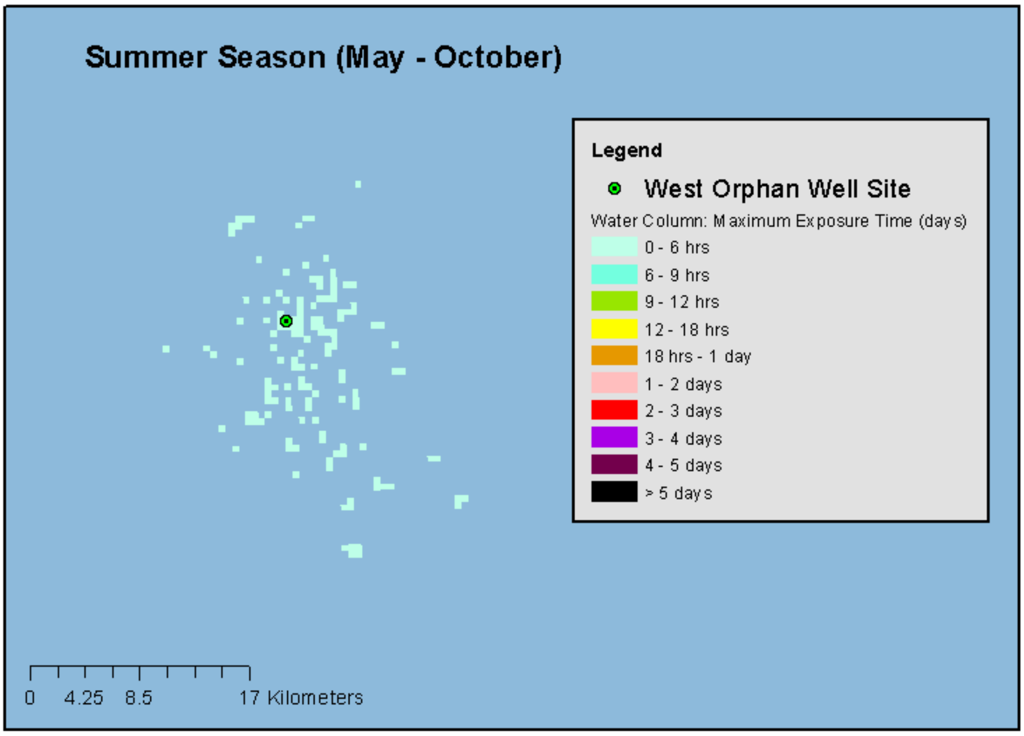


Figure 8.16 Scenario 6: West Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).



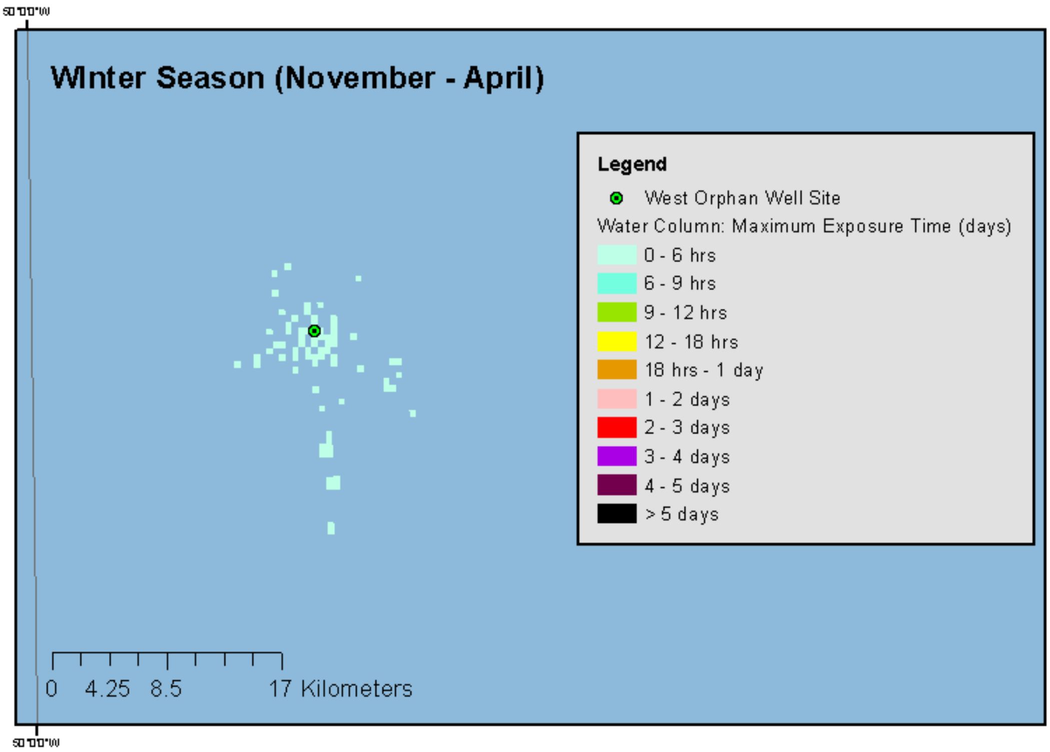
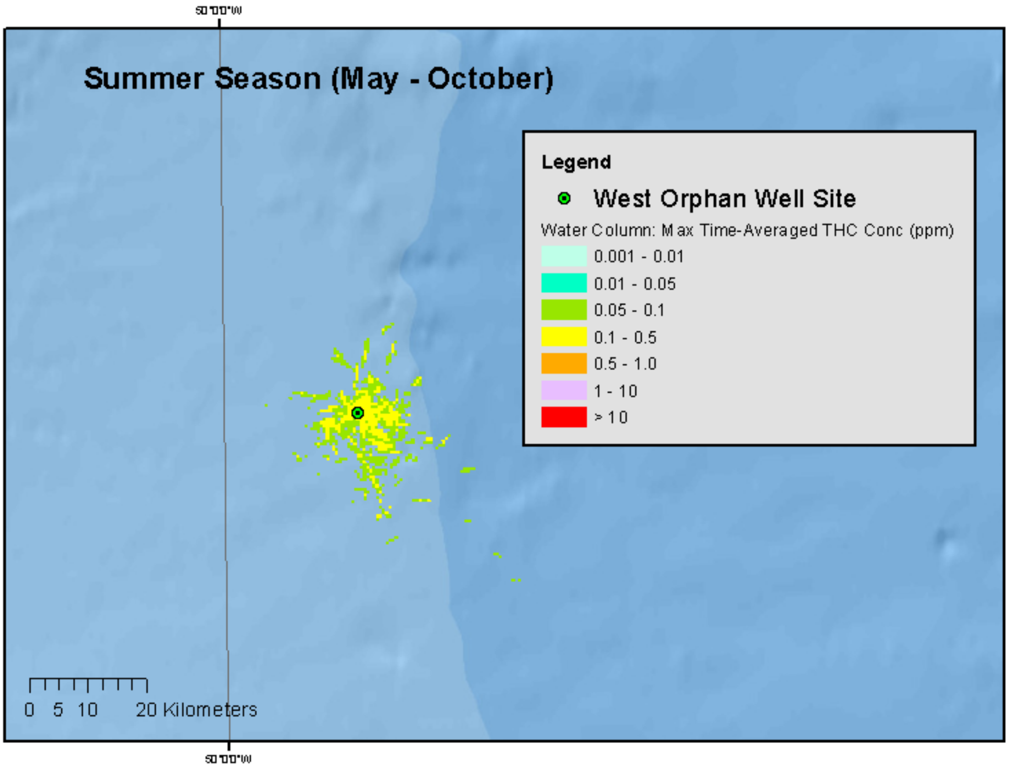


Figure 8.17 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied).



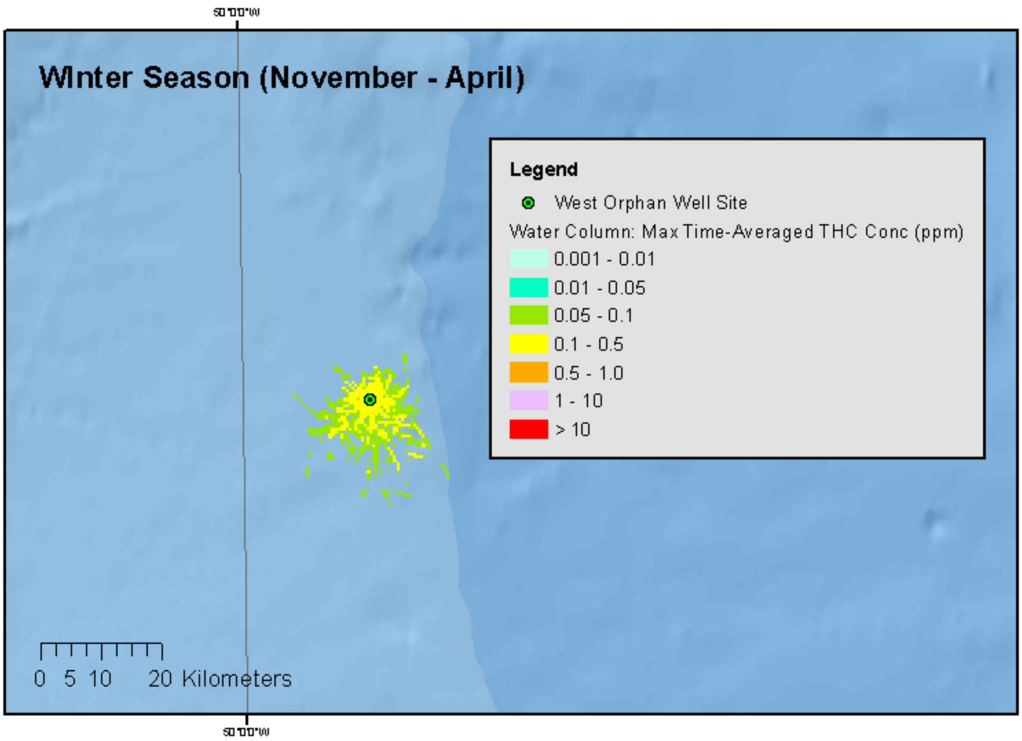
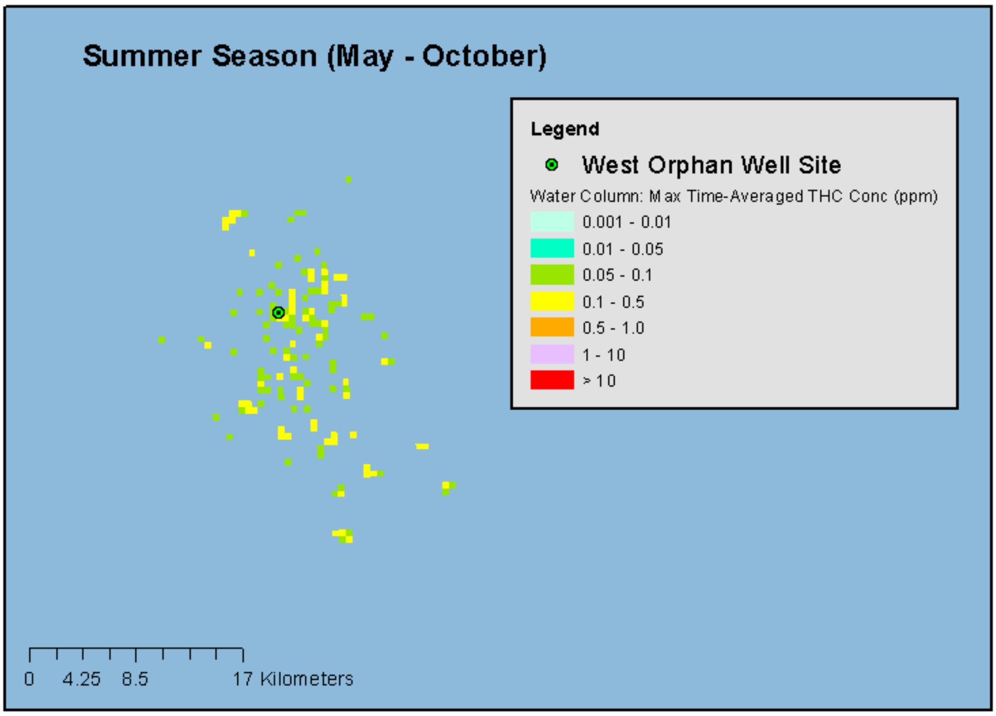
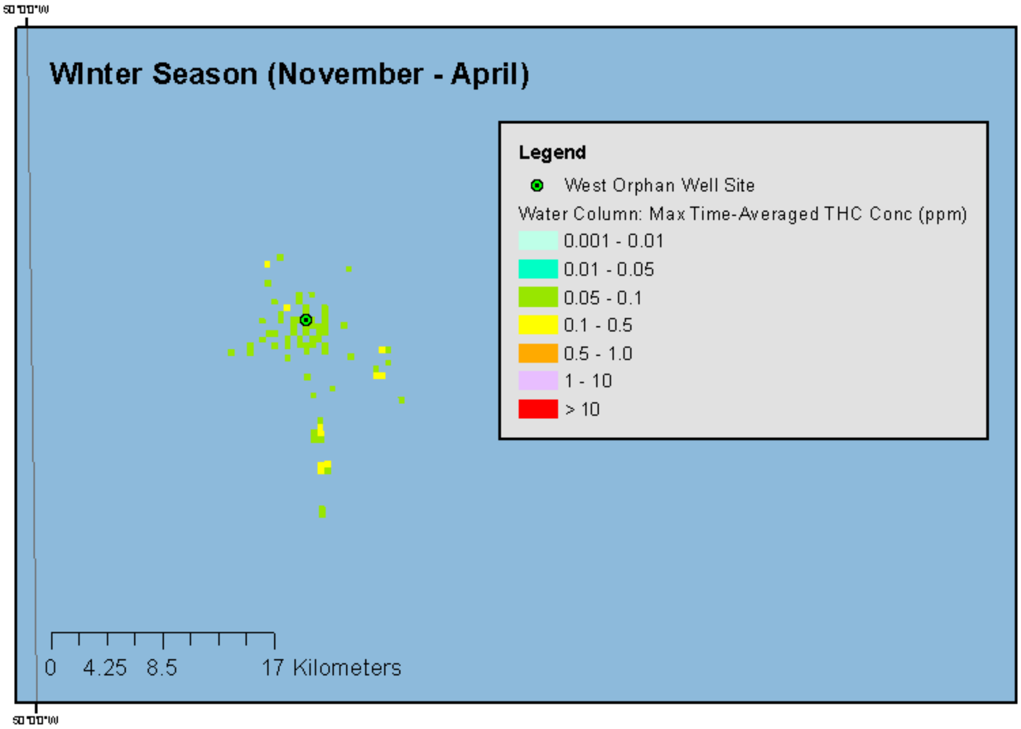


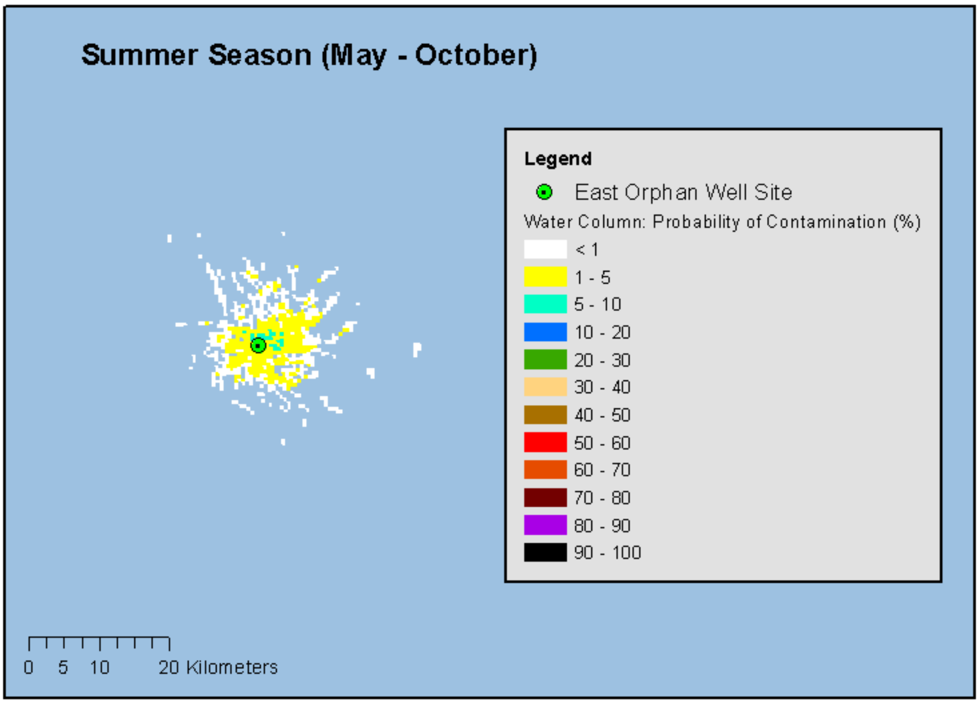
Figure 8.18 Scenario 6: West Orphan 10 bbl surface batch release of diesel. hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied).





8.3.2 East Orphan release site

Figure 8.19 Scenario 7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column.



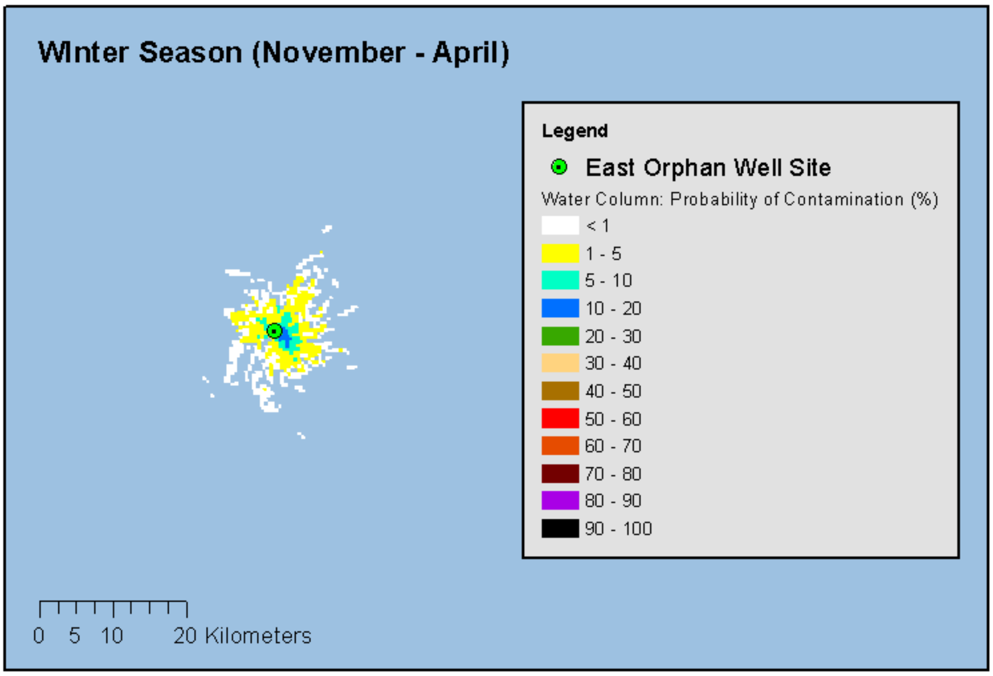
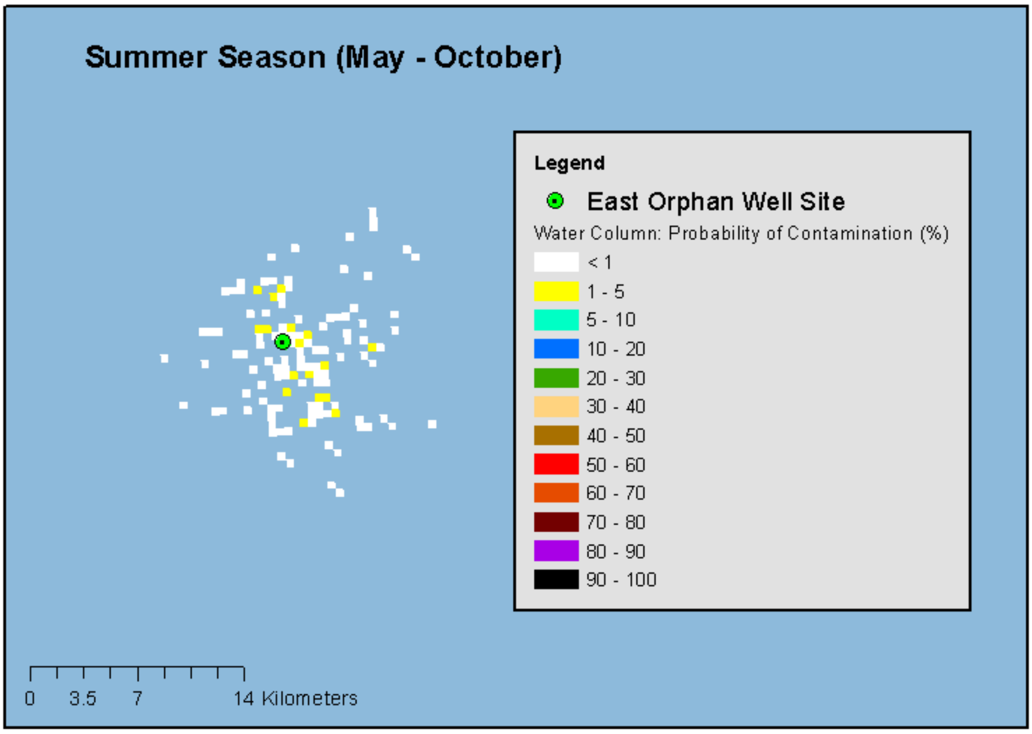


Figure 8.20 Scenario 8: East Orphan 10 bbl surface batch release of diesel. Statistical maps showing the probability of the total hydrocarbon concentration (dispersed and dissolved oil) in the water column exceeding the 58 ppb threshold concentration level for any grid cell in the top 100 m of water column.



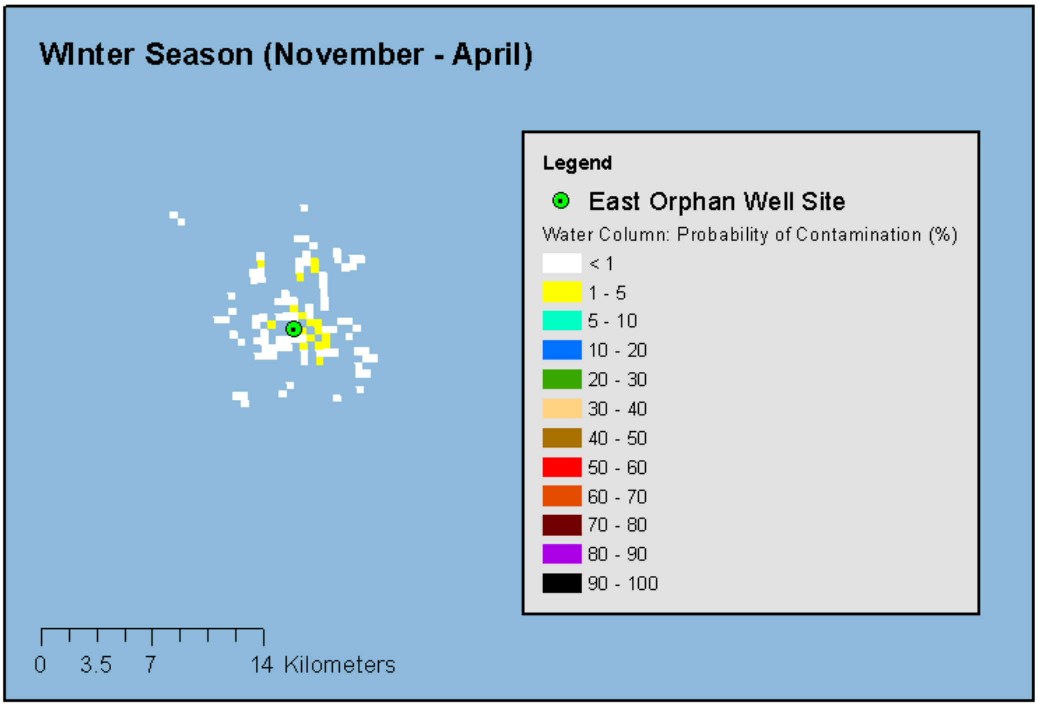
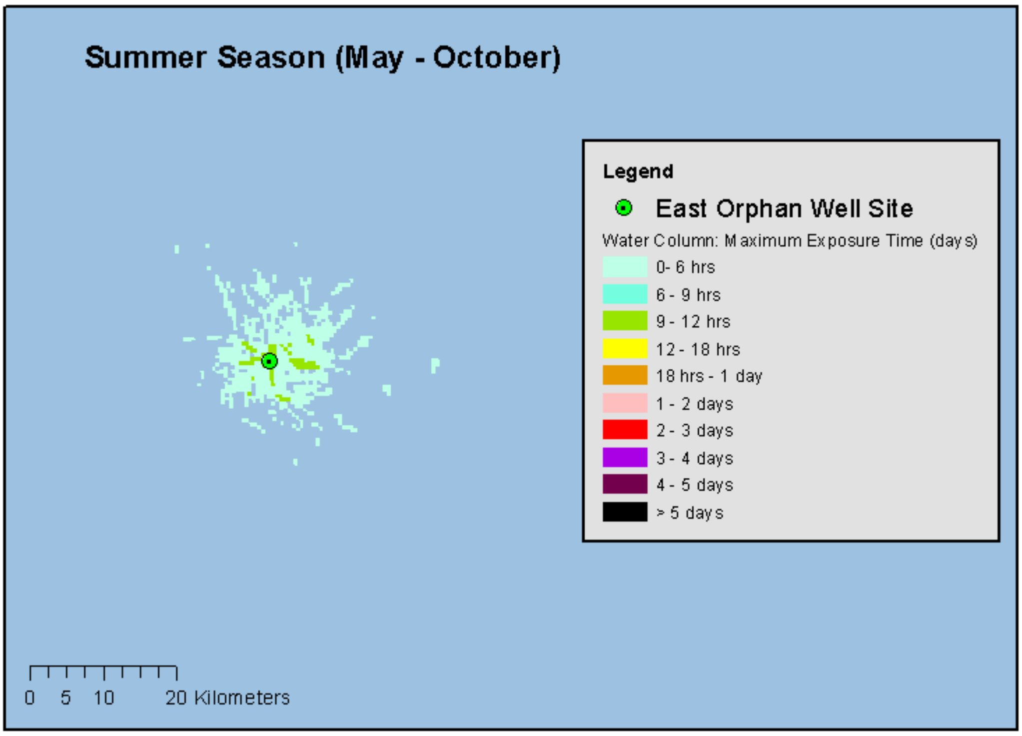


Figure 8.21 Scenario 7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).



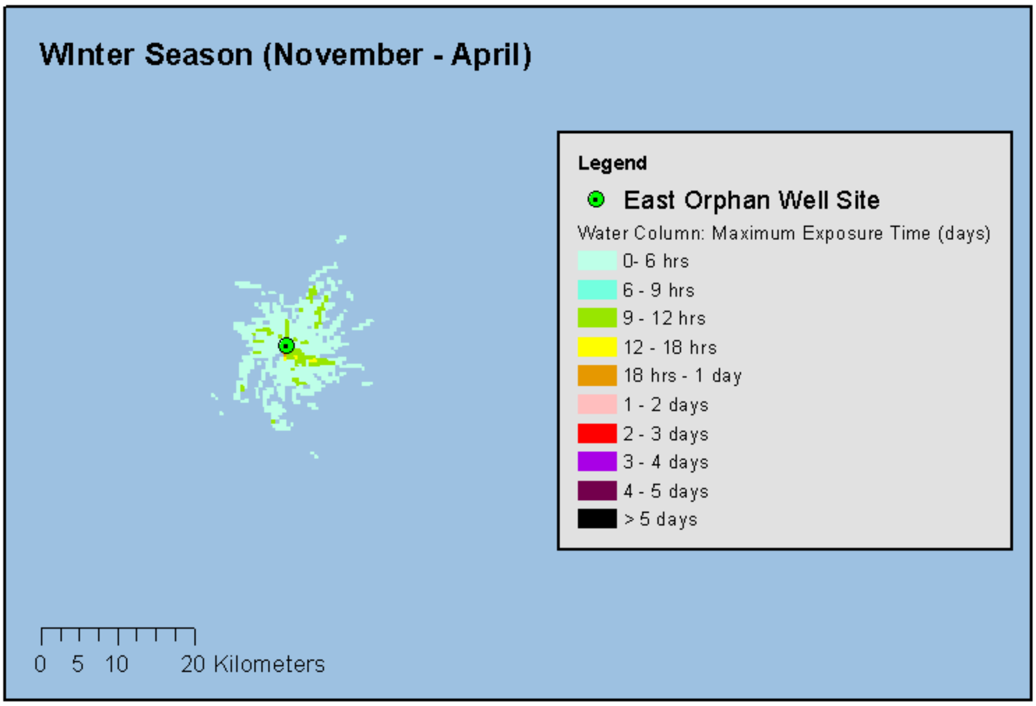
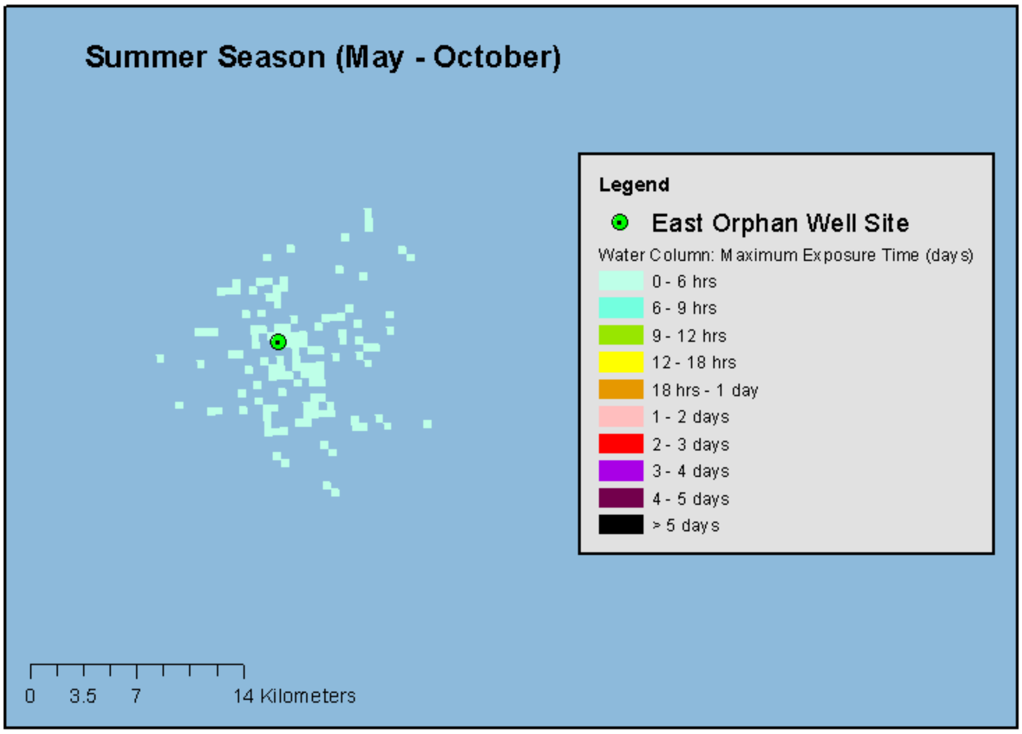


Figure 8.22 Scenario 8: East Orphan 10 bbl surface batch release of diesel. Statistical maps showing the maximum exposure time that the total hydrocarbon concentration (dispersed and dissolved oil) within any grid cell in the top 100 m of water column exceeds the 58 ppb THC concentration threshold (based on all stochastic trajectories, no probability limit applied).



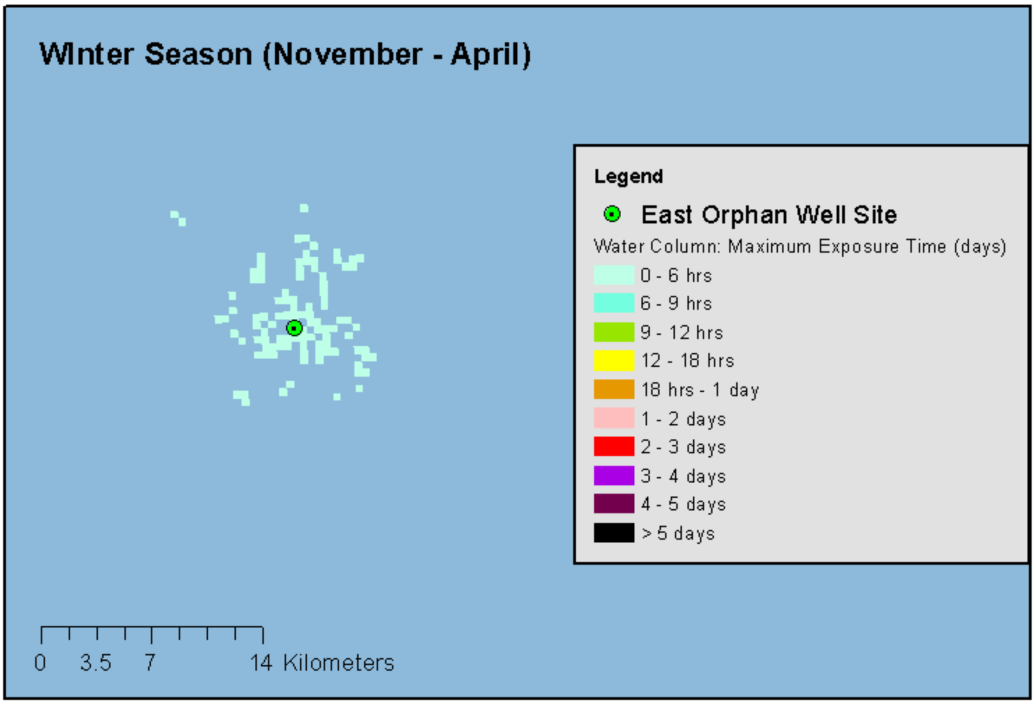
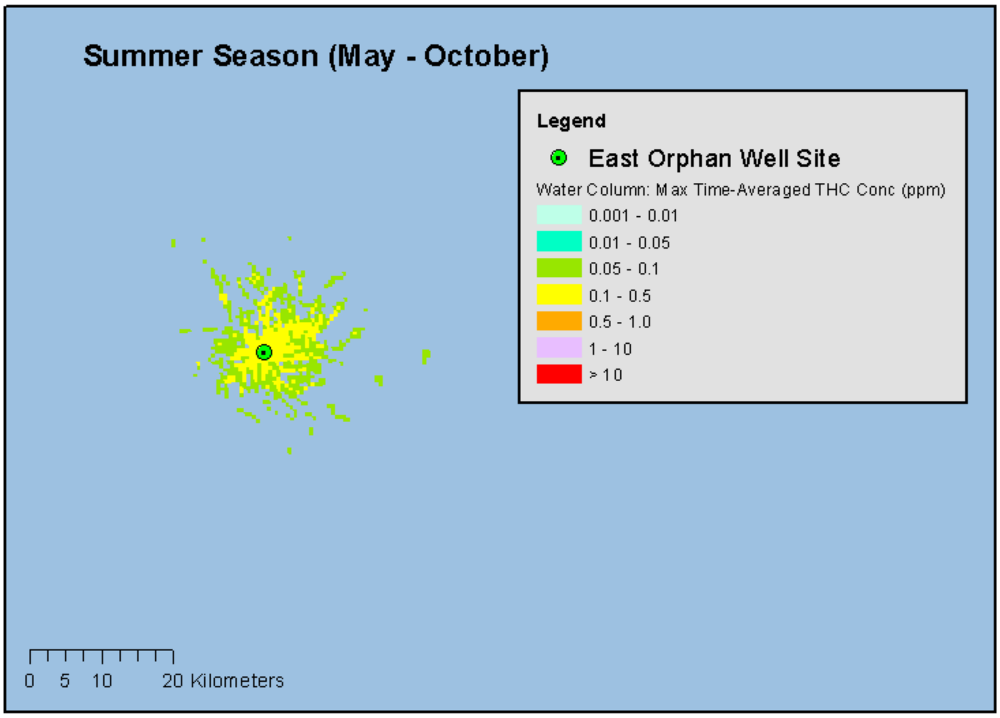


Figure 8.23 Scenario 7: East Orphan 100 bbl surface batch release of diesel. Statistical maps showing the maximum time-averaged concentration of total hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied).



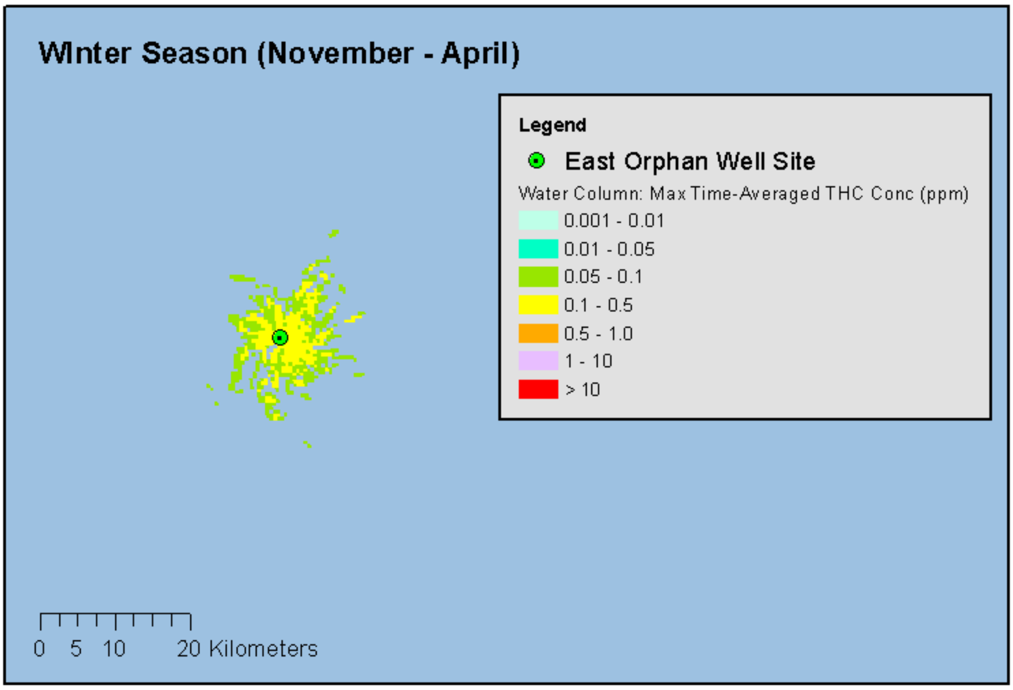
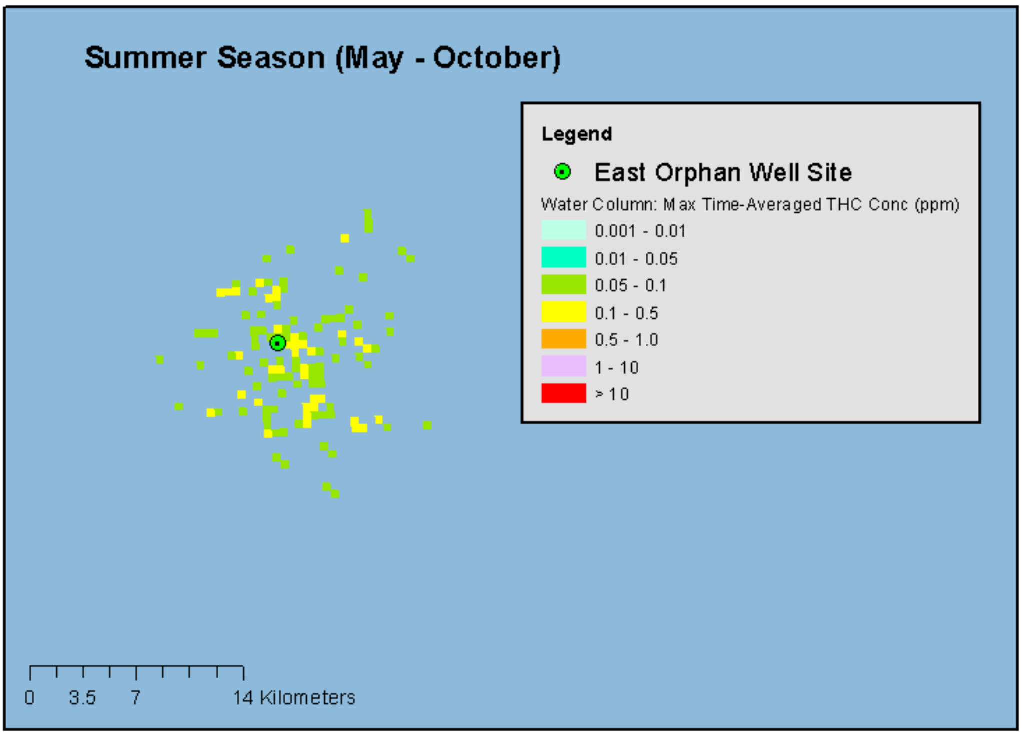
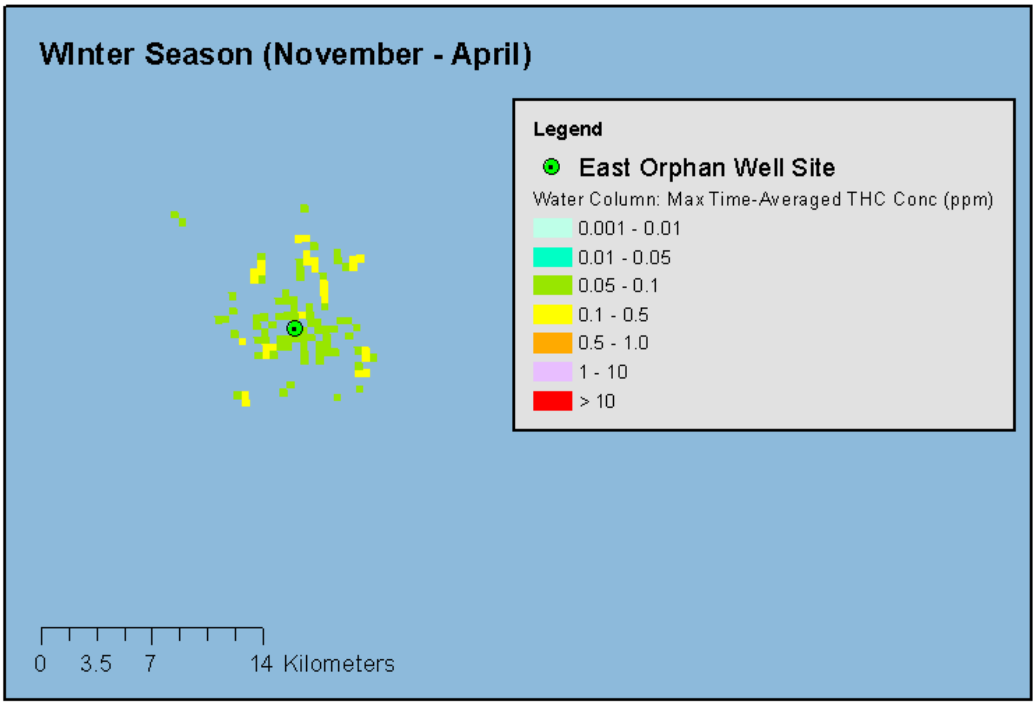


Figure 8.24 Scenario 8: East Orphan 10 bbl surface batch release of diesel. hydrocarbons (dispersed and dissolved oil) within any grid cell in the top 100 m of water column (only concentration values exceeding the 58 ppb THC threshold are included in the time-average calculations. No probability limit applied).





8.4 Deterministic results

Deterministic runs were carried out during the summer season at the time of lowest ambient surface currents to maximum surface oiling. The mass balance distribution shown in Figure 8.25 is representative of both scenarios and indicates that surface oil would rapidly evaporate and disperse into the water column following a release. In the 100 bbl batch spill scenario, approximately 60% of the spill evaporates from the surface within 3 days following the release, with remaining proportions dispersing or biodegrading within the same period.

The surface oil area coverage graphs shown in Figure 8.26 for the 100 bbl and 10 bbl spill release scenarios at WO indicates an initial transient surface oil coverage of 27 km^2 and 1. 5 km^2 which thereafter decreases rapidly as the diesel evaporates and biodegrades. Similar trends were observed for the EO scenarios.

Figure 8.25 Scenario 5: West Orphan 100 bbl surface batch release of diesel. Lowest surface ambient current conditions. Graph showing mass balance distribution of oil over the duration of the simulation.

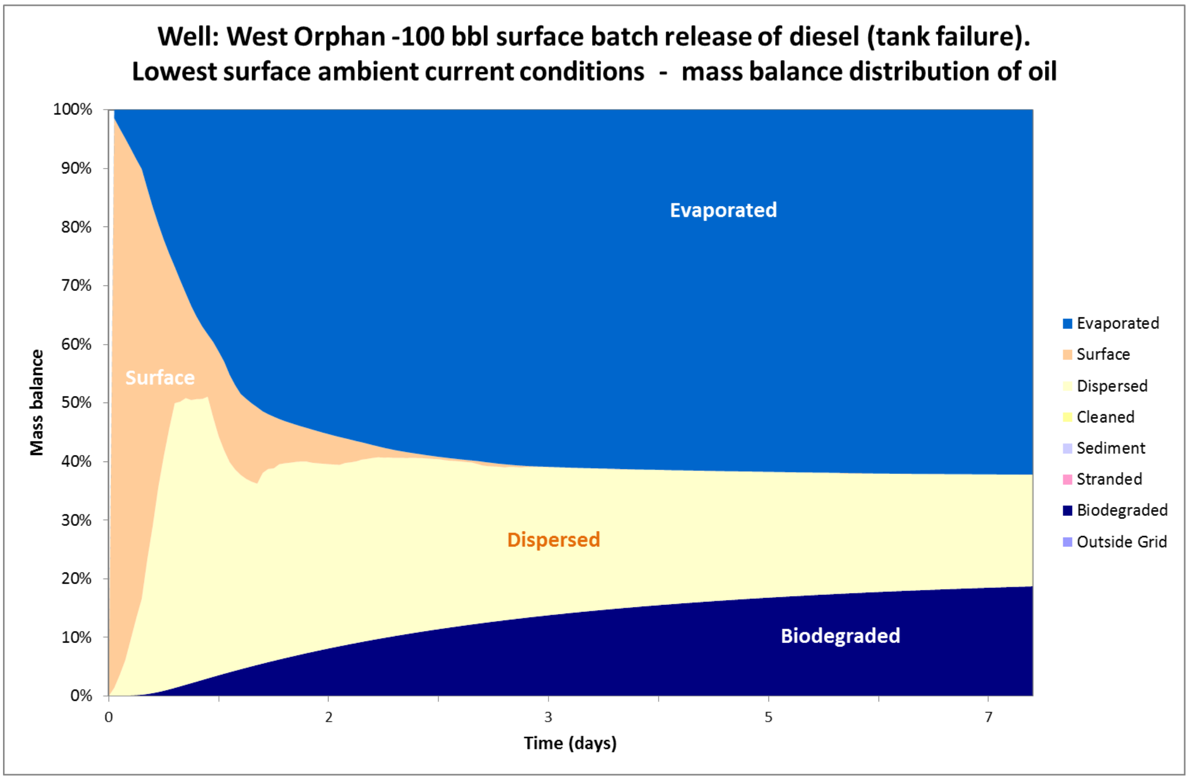
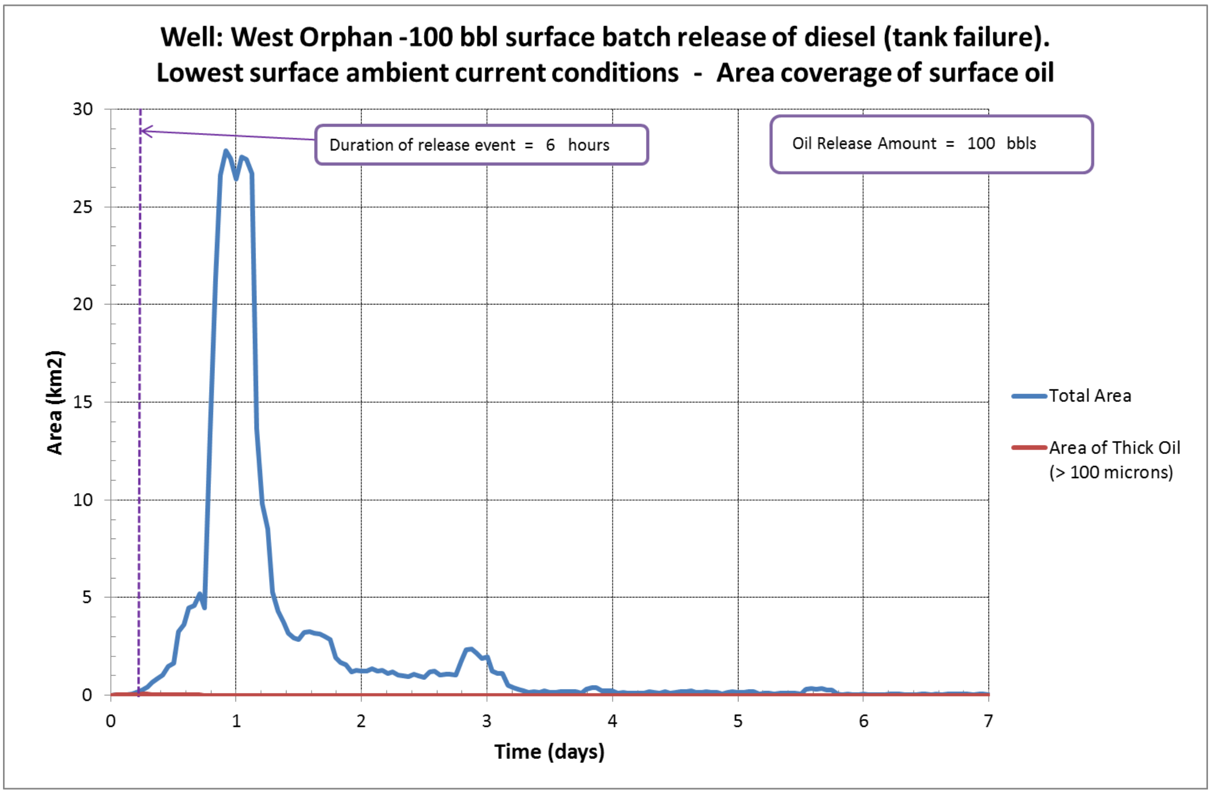
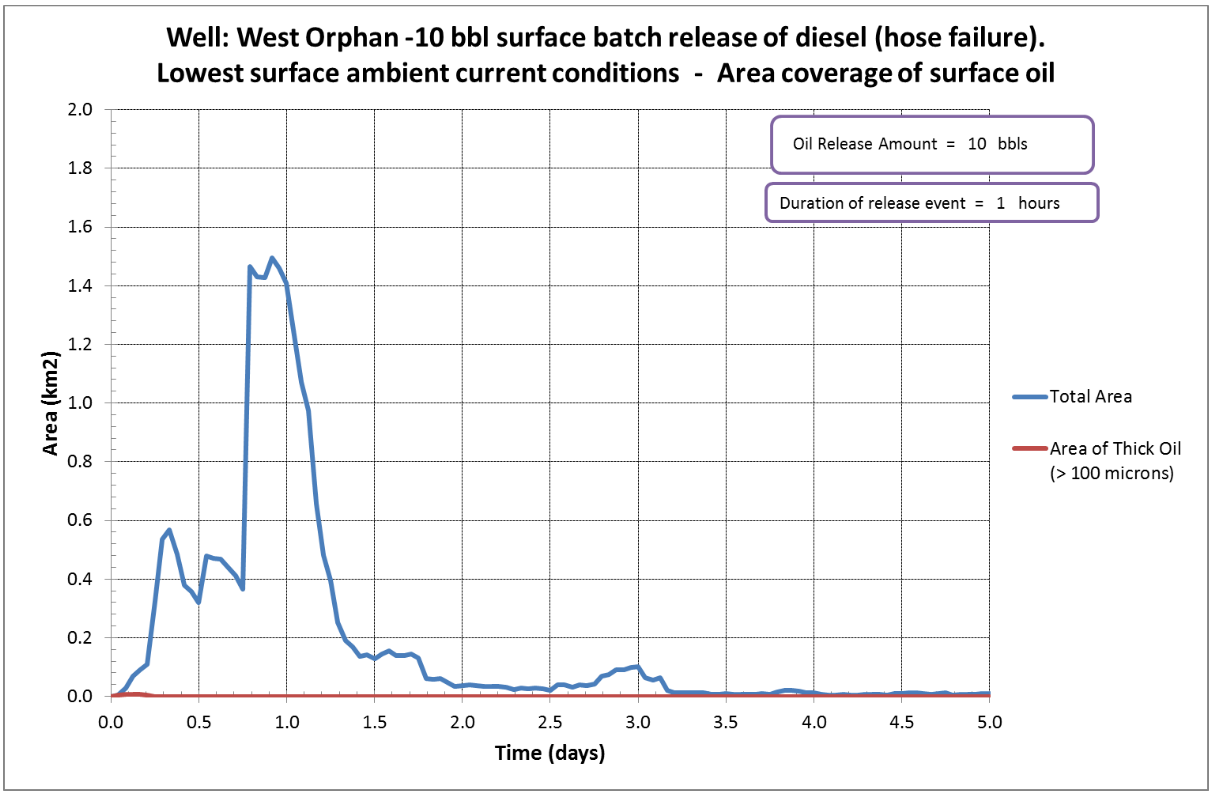


**Figure 8.26 Scenario 5: West Orphan 100 bbl surface batch release of diesel (top).
Scenario 6: West Orphan 10 bbl surface batch release of diesel (bottom).
Graph showing the area coverage of surface oil over the simulation period.**





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Annex A - Predictions of the surface oil weathering behaviour of analogue oils

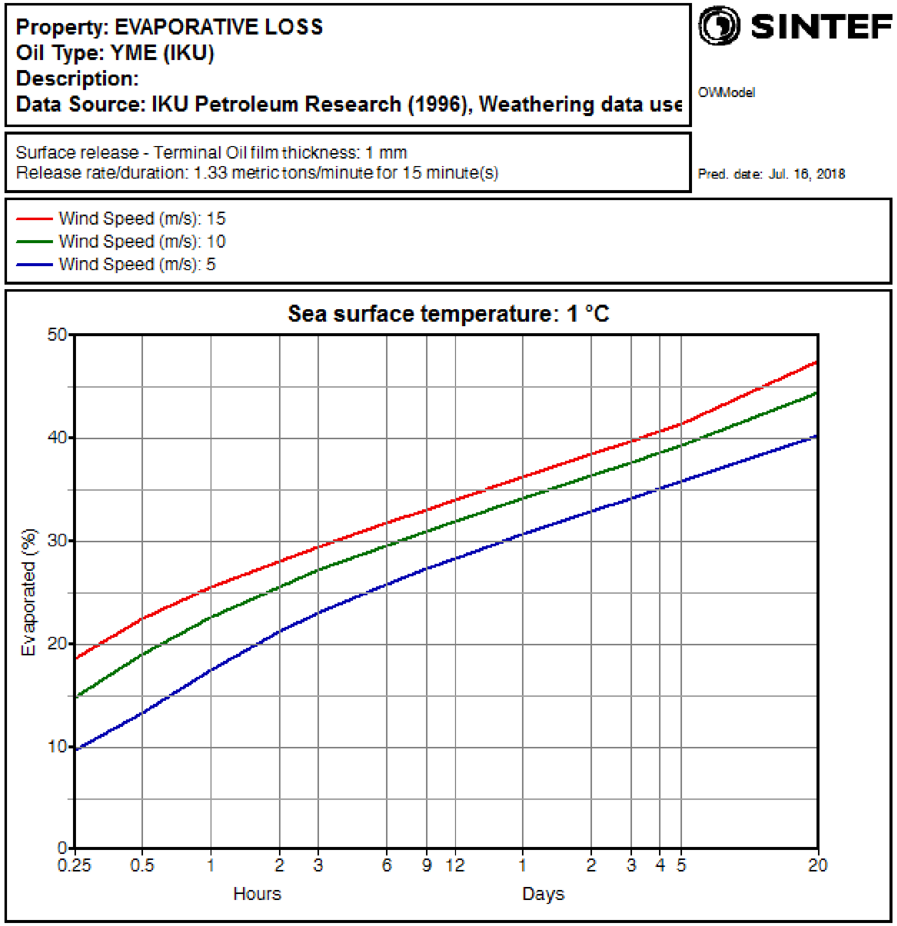
The oil characterisation data and weathering properties of the analogue oils used in the OSCAR modelling were also used in simulations carried out using the SINTEF Oil Weathering Model (OWM). Model runs were performed to predict how each oil might weather on the sea surface in terms of its evaporative loss, water uptake and emulsion viscosity under different wind speed and sea temperature conditions. The relationship between wind speed and significant wave heights used in the prediction charts obtained from the SINTEF OWM are shown in Table A1.1. The surface sea temperatures chosen (WO: 1 - 11 °C, EO: 2 - 12 °C), represent the annual temperature fluctuations in the respective wellsite areas.

Table A 1 - Relationship between wind speed and significant wave heights used in the SINTEF OWM.

Wind speed (m/s) (knots)	Beaufort wind	Wind type	Wave height (m)
2 – 4	2	Light breeze	0.1 - 0.3
5 – 10	3	Gentle to moderate breeze	0.5 - 0.8
10 – 20	5	Fresh breeze	1.5 - 2.5
15 – 30	6 - 7	Strong breeze	3 - 4

A.1 West Orphan well blowout scenarios - YME (IKU) crude oil.

Table A.1.1 Predicted evaporative loss of YME (IKU) oil predicted at sea temperatures of 1 ºC and 11 ºC.



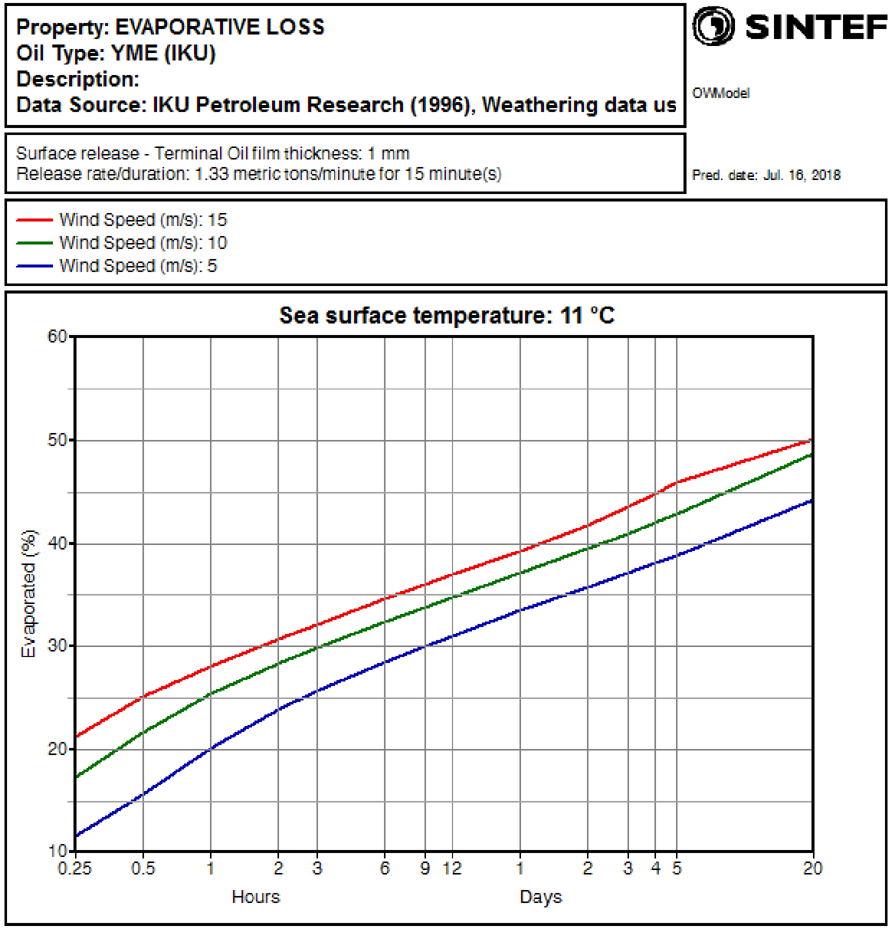
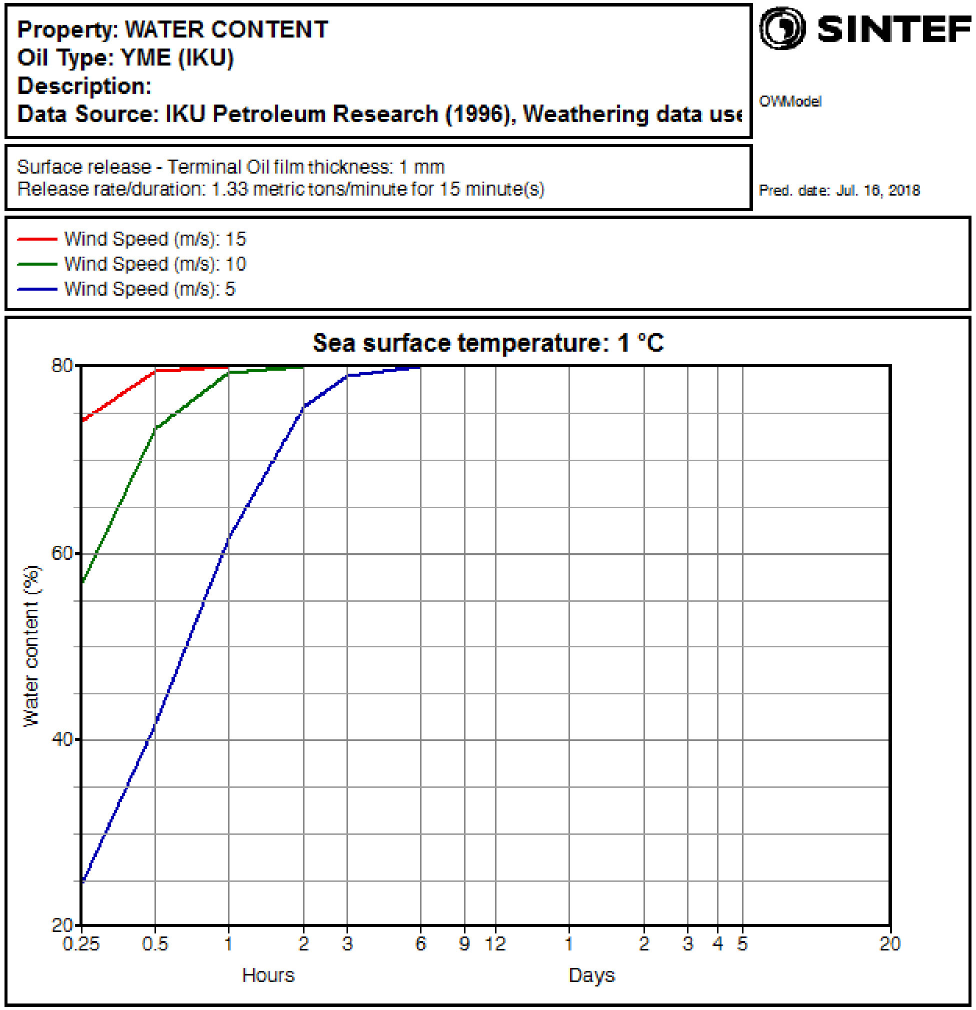


Table A.1.2 Predicted water content of YME (IKU) oil predicted at sea temperatures of 1 °C and 11 °C.



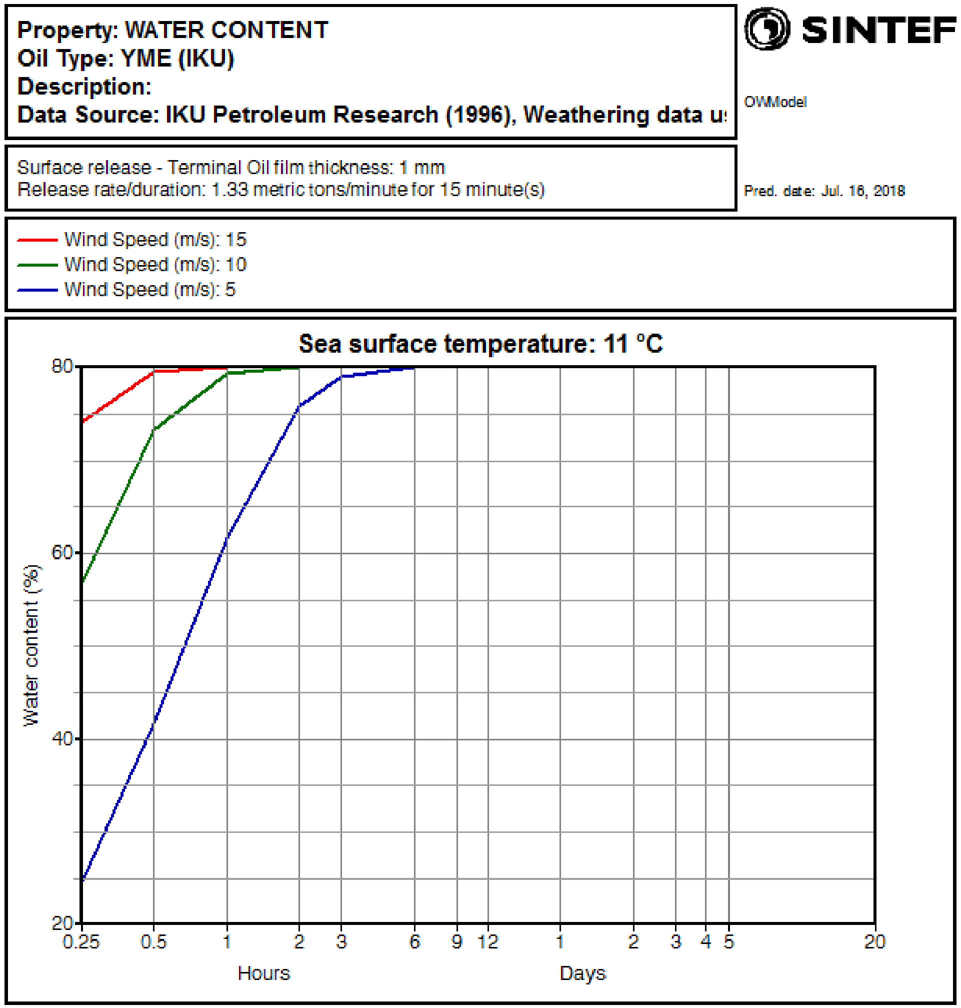
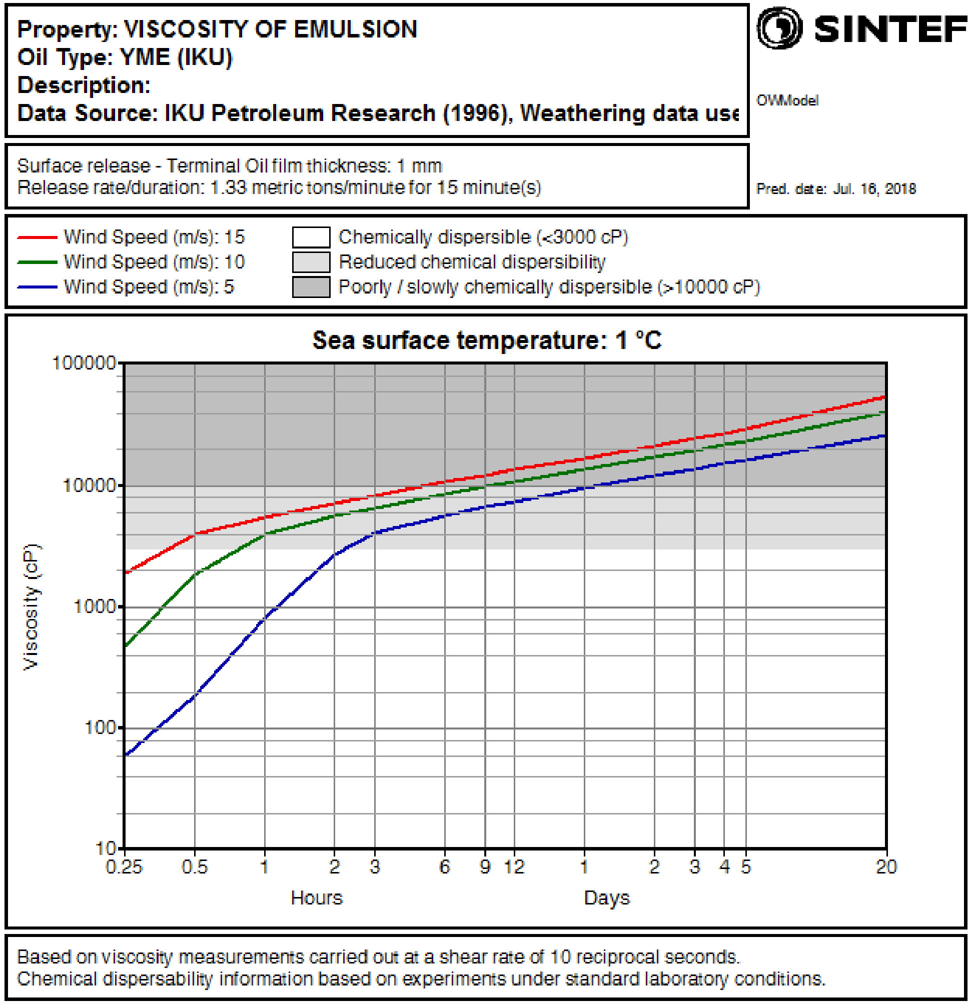
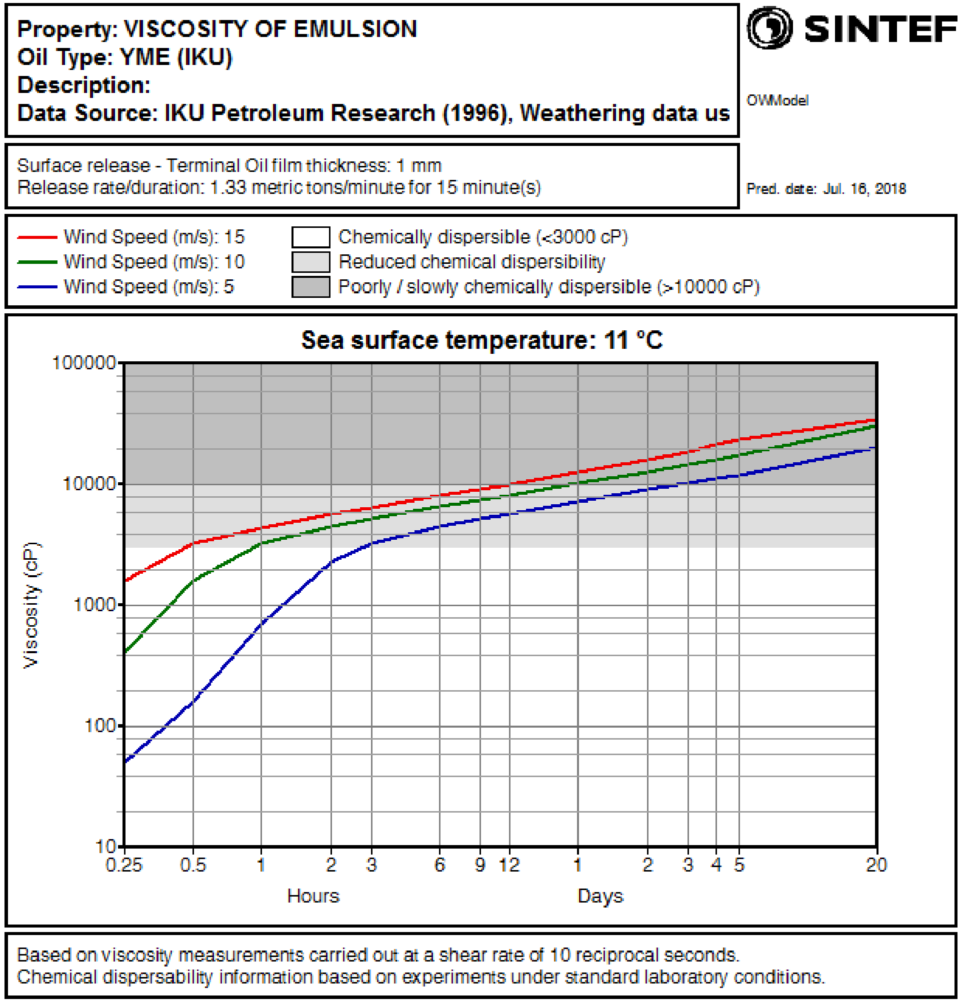


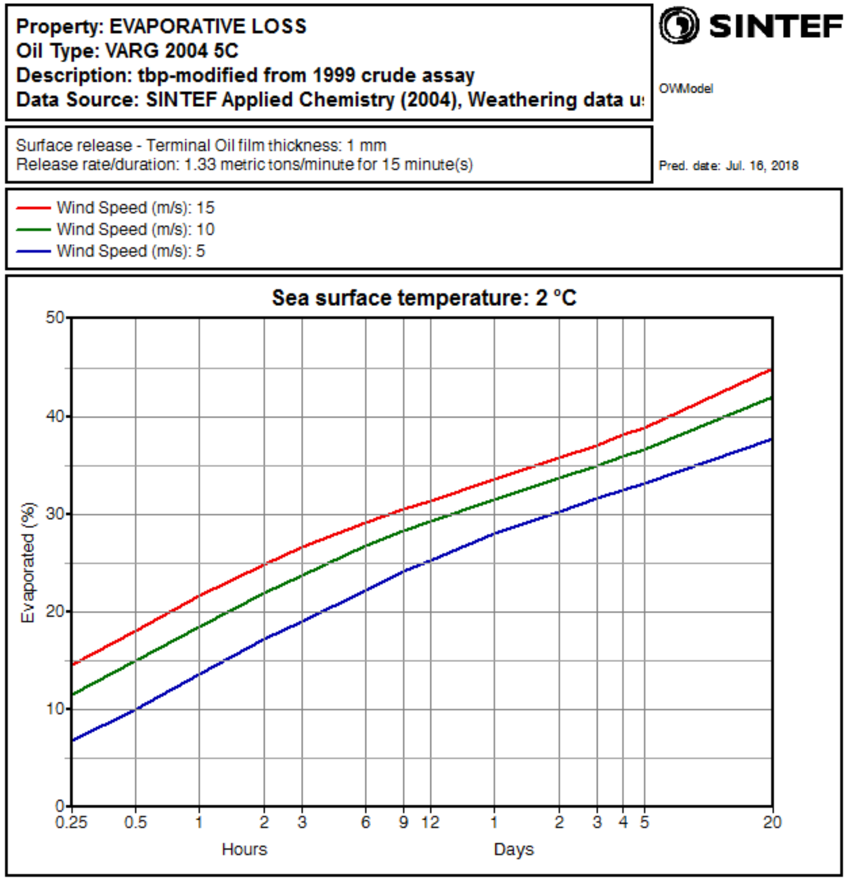
Table A.1.3 Predicted viscosity of YME (IKU) oil predicted at sea temperatures of 1 ºC and 11 ºC.





A.2 East Orphan well blowout scenarios - VARG 2004 crude oil.

Table A.2.1 Predicted evaporative loss of VARG 2004 oil predicted at sea temperatures of 2 ºC and 12 ºC.



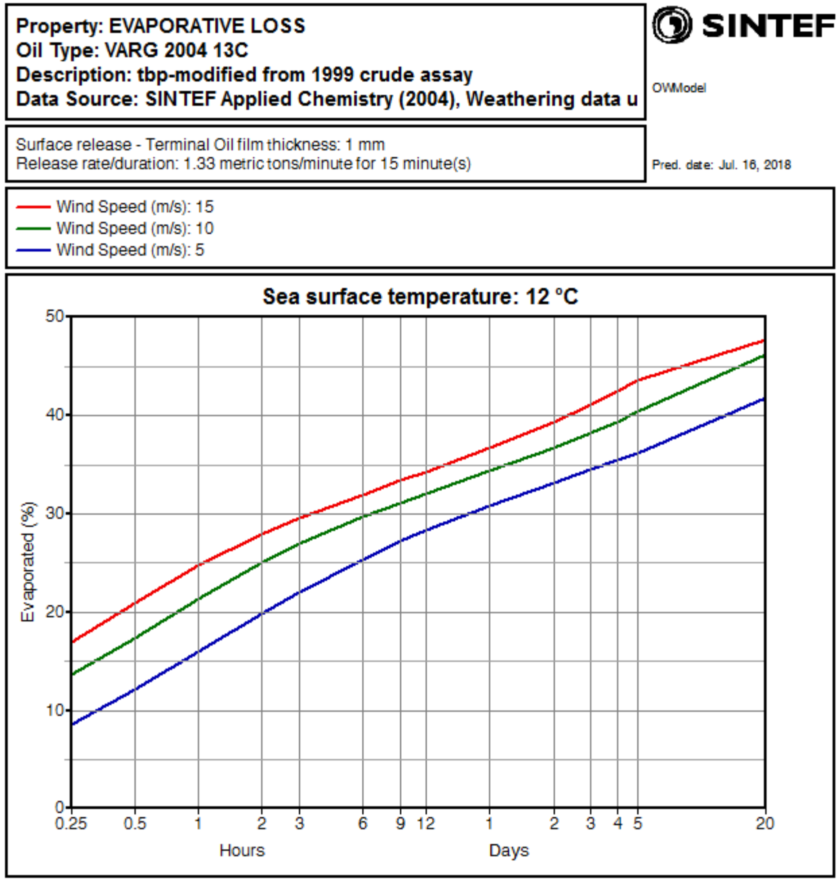
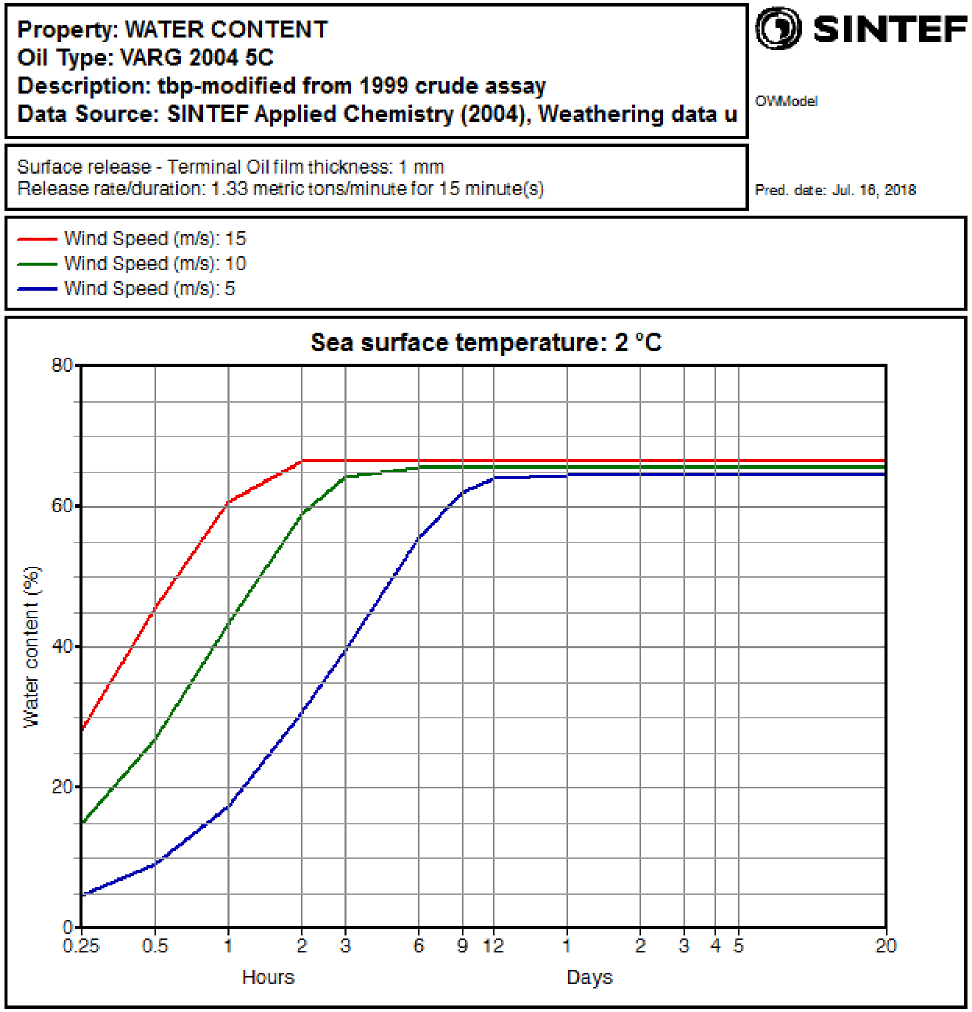


Table A.2.2 Predicted water content of VARG 2004 oil predicted at sea temperatures of 2 ºC and 12 ºC.



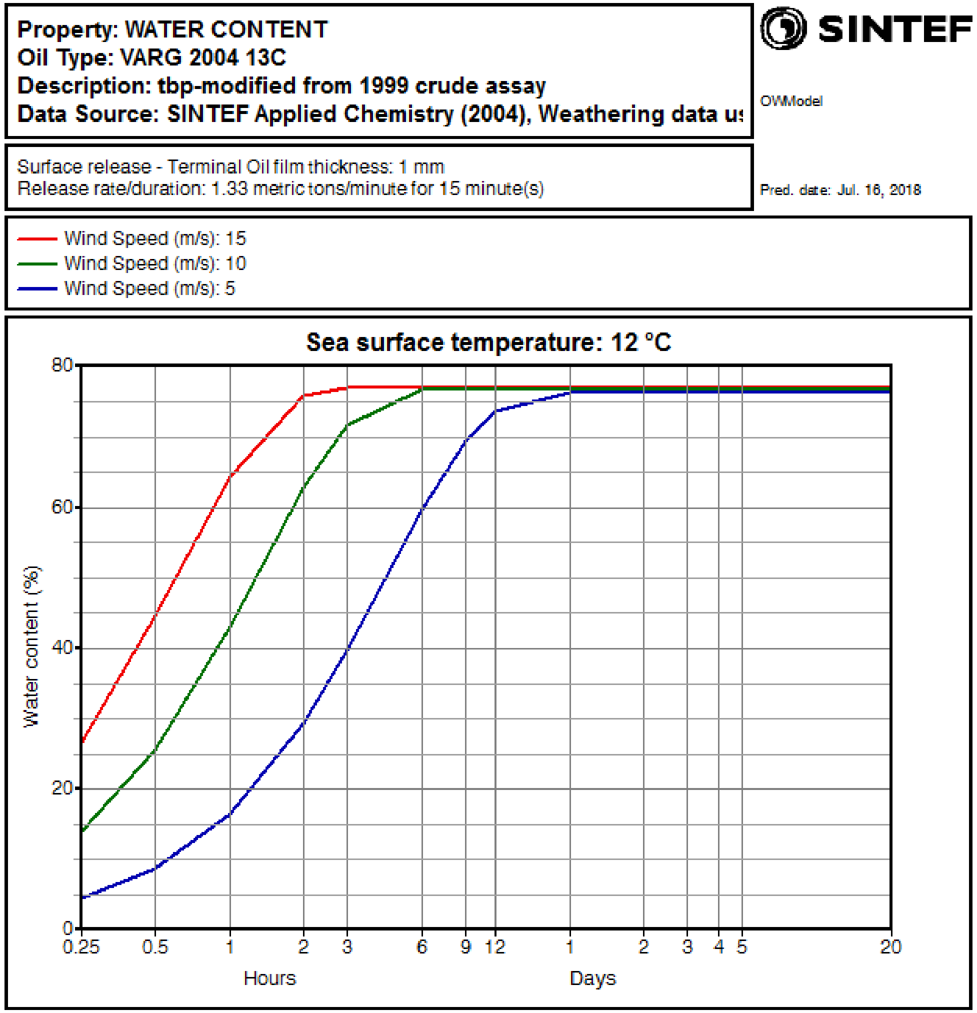
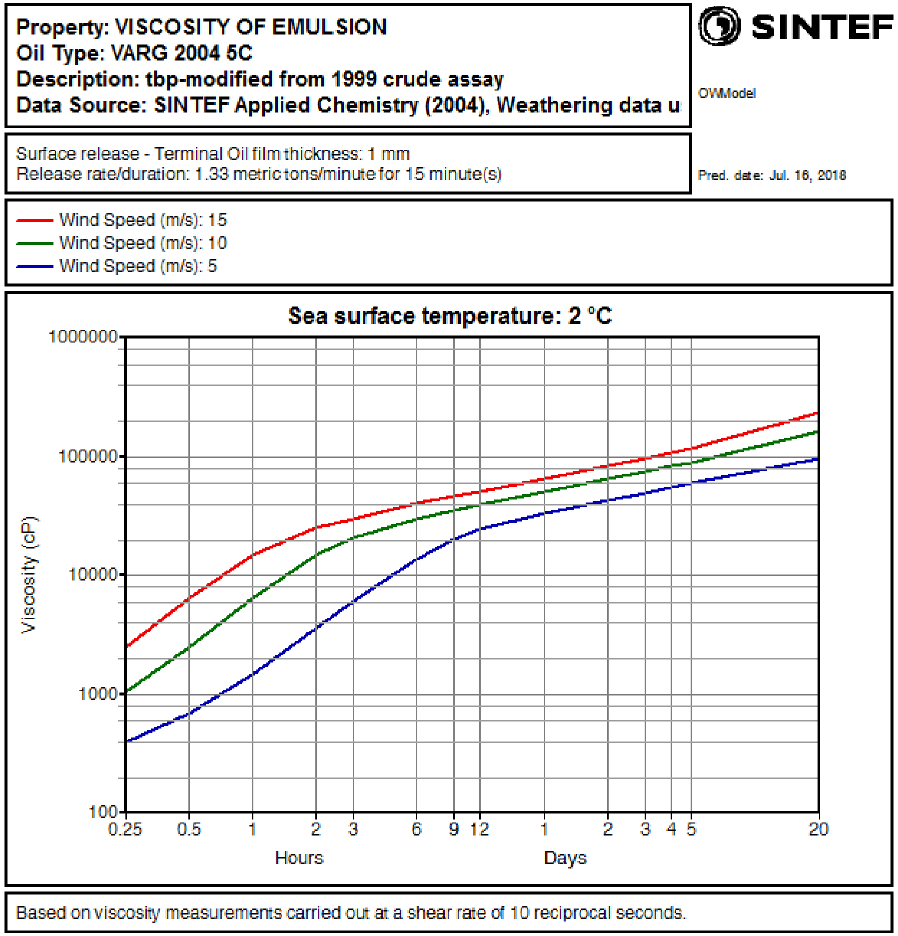
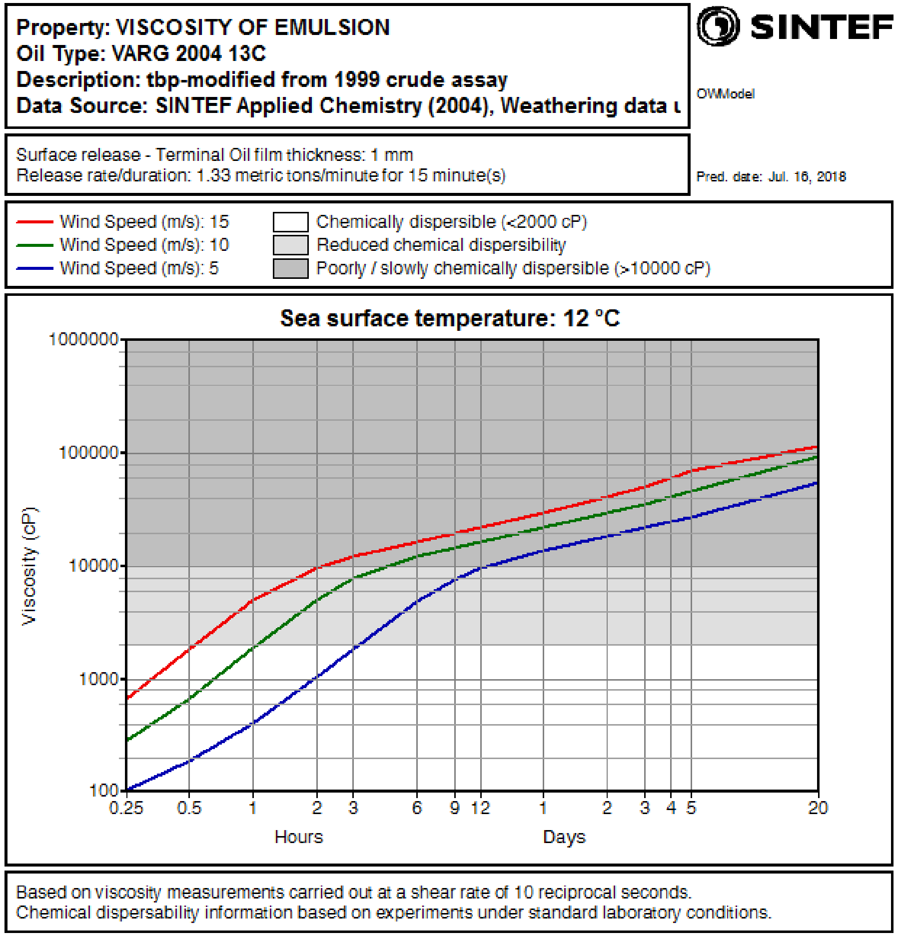


Table A.2.3 Predicted viscosity of VARG 2004 oil predicted at sea temperatures of 2 ºC and 12 ºC.





Annex B - Hindcast wind and hydrodynamic data for the West Orphan and East Orphan well locations

At each of the modelled sites 3 hourly surface HYCOM currents and NCEP (CFSR) winds were obtained by interpolating the values from the nearest model grid points. Summary statistics for both sites are presented below.

B.1 Surface Currents

Figure B.1.1 Seasonal current roses for WO and EO wellsite locations derived from HYCOM model currents between 2006 - 2010. Surface current speeds in m/s (direction of currents is going towards).

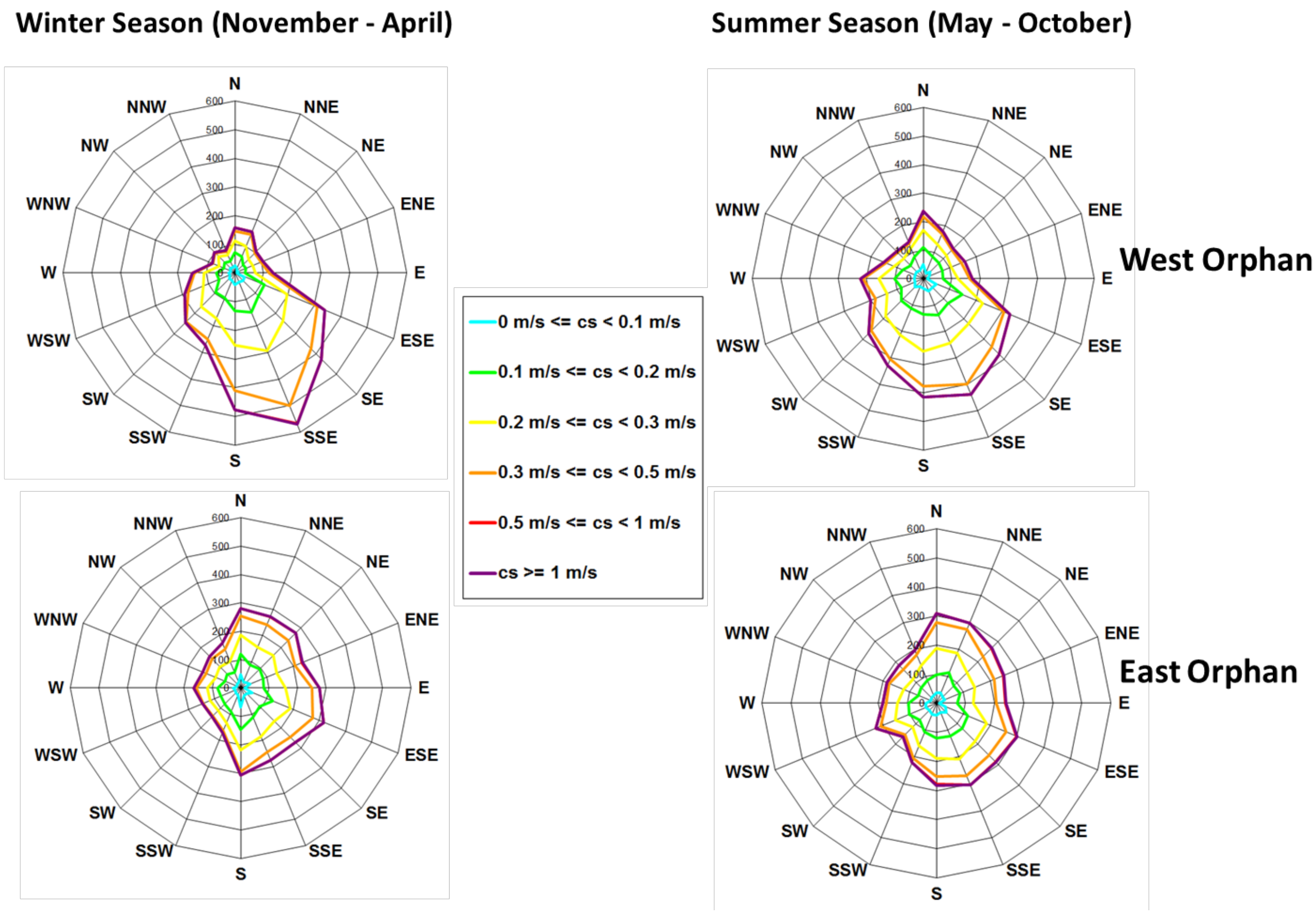


Figure B.1.2 Average surface current speeds for WO and EO wellsite locations derived from HYCOM model currents between 2006 - 2010. Surface current speeds in m/s (direction of currents is going towards).

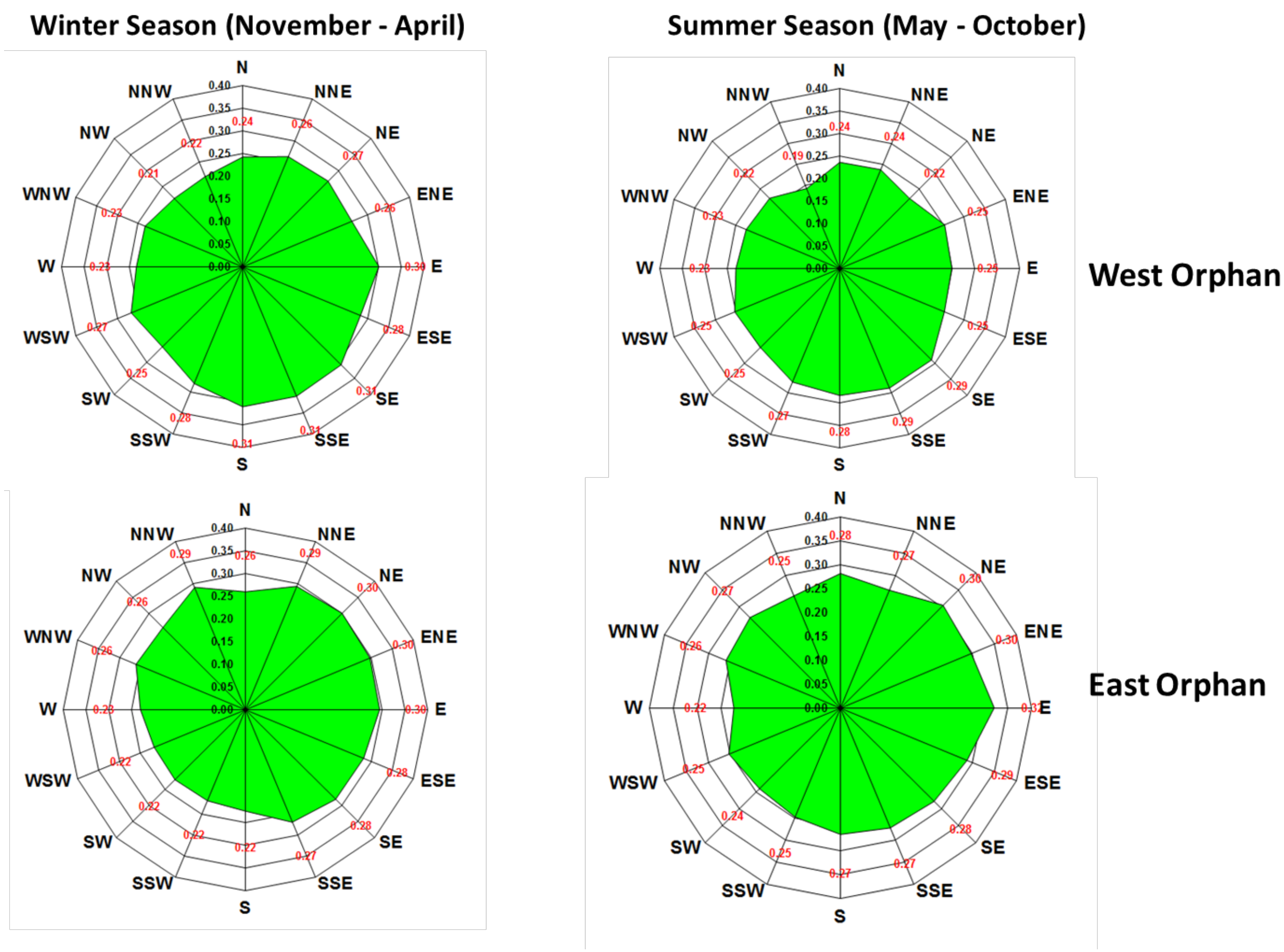


Figure B.1.3 Distribution of surface current directions for WO and EO wellsite locations derived from HYCOM model currents between 2006 - 2010. Surface current speeds in m/s (direction of currents is going towards).

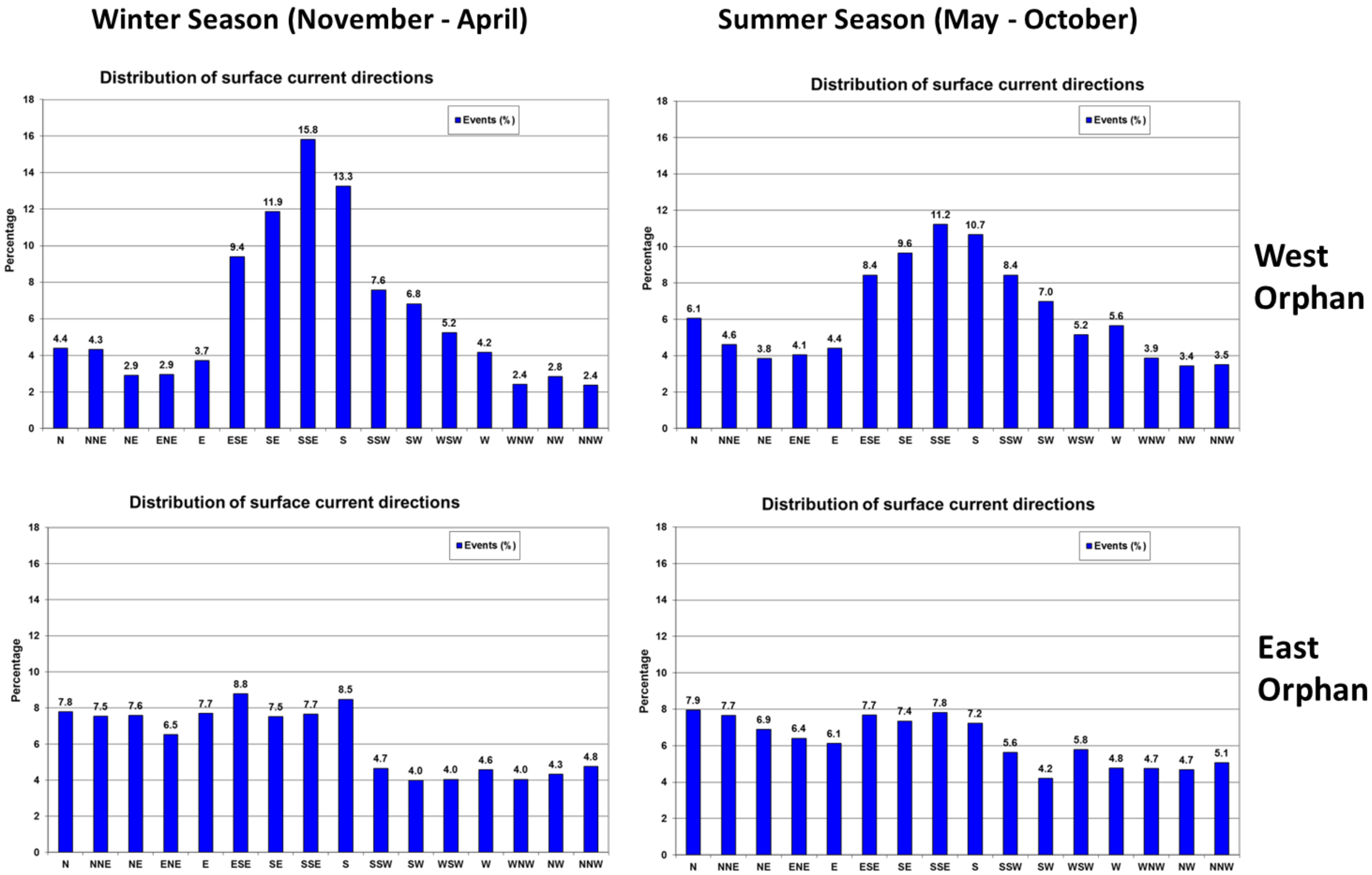


Figure B.1.4 Distribution of surface current class speeds for WO and EO wellsite locations derived from HYCOM model currents between 2006 - 2010. Surface current speeds in m/s (direction of currents is going towards).

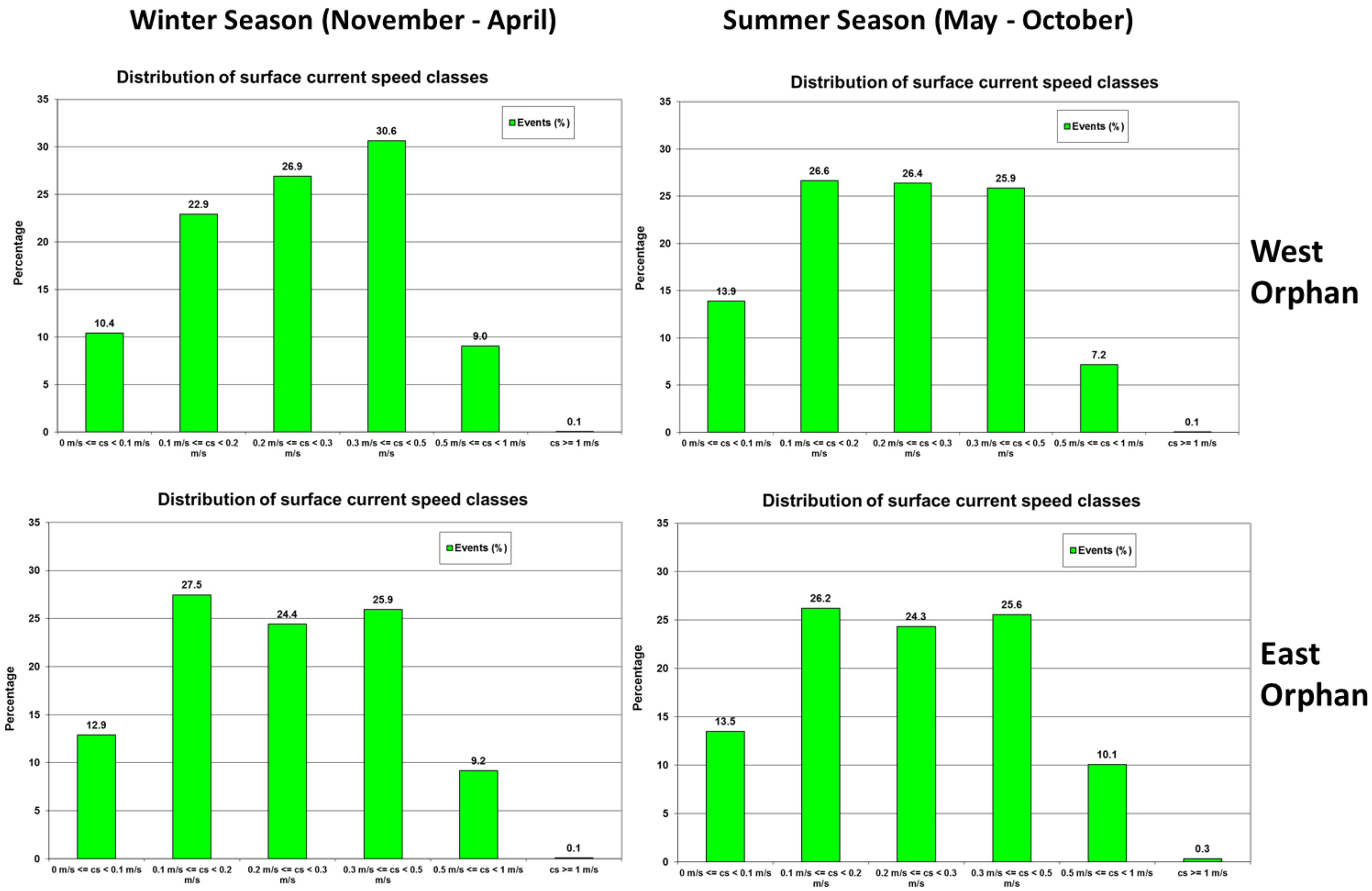
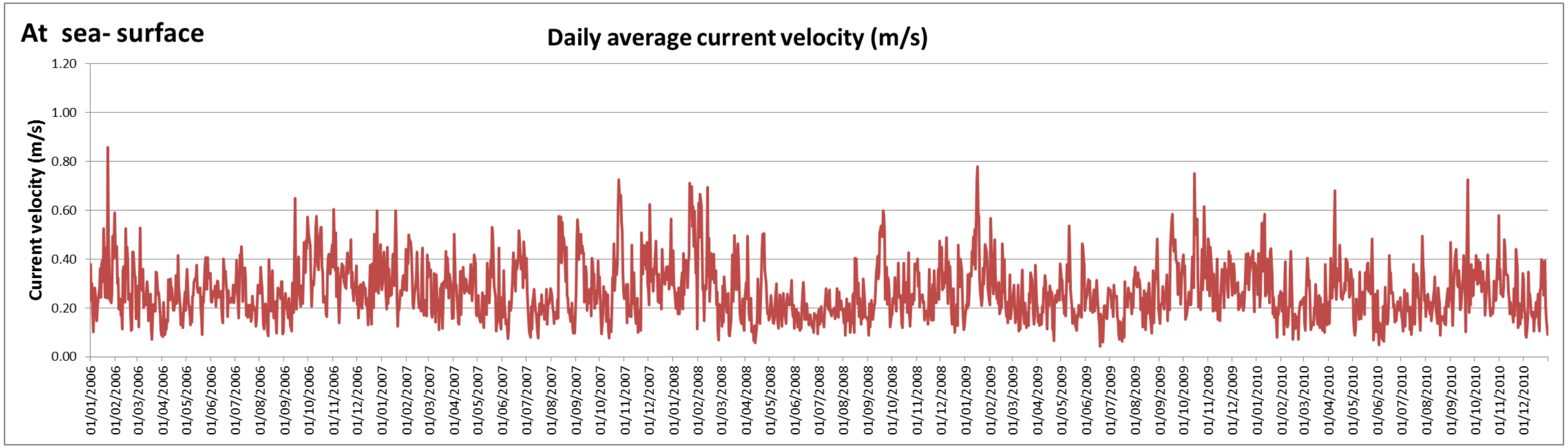


Figure B.1.5 Time series of HYCOM model currents for the WO wellsite location derived from HYCOM model currents between 2006 – 2010. Surface current speeds in m/s (direction of currents is going towards).



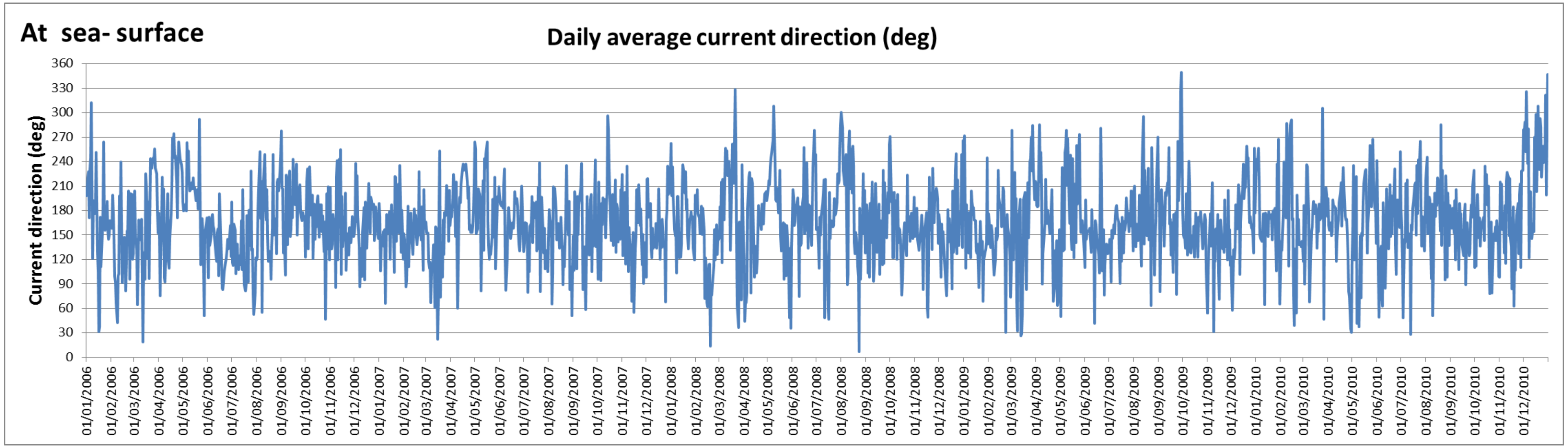
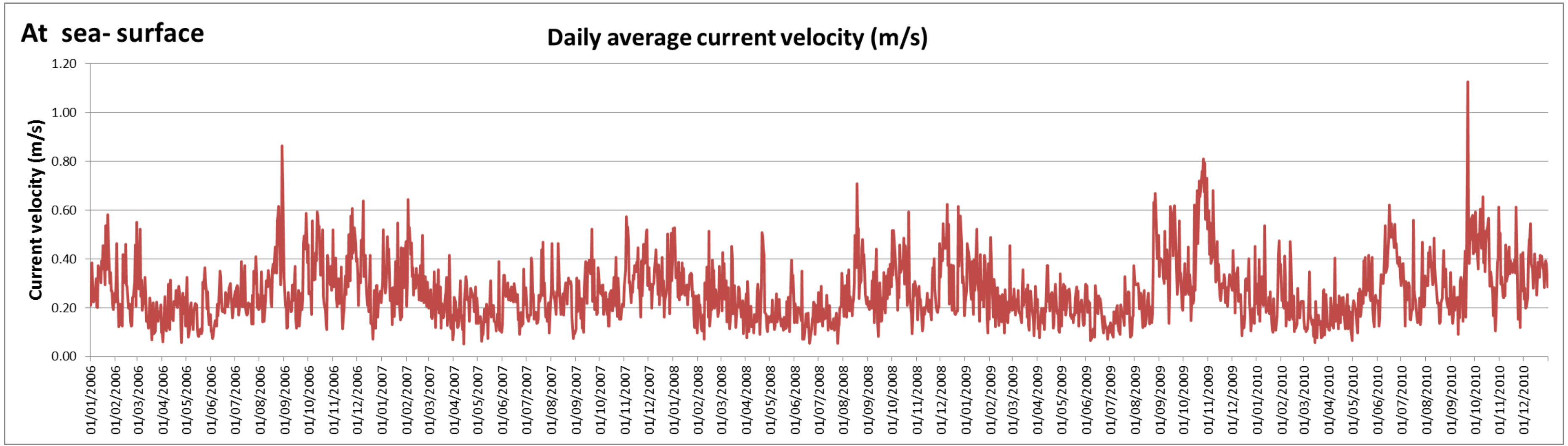


Figure B.1.6 Time series of HYCOM model currents for the EO wellsite location derived from HYCOM model currents between 2006 – 2010. Surface current speeds in m/s (direction of currents is going towards).



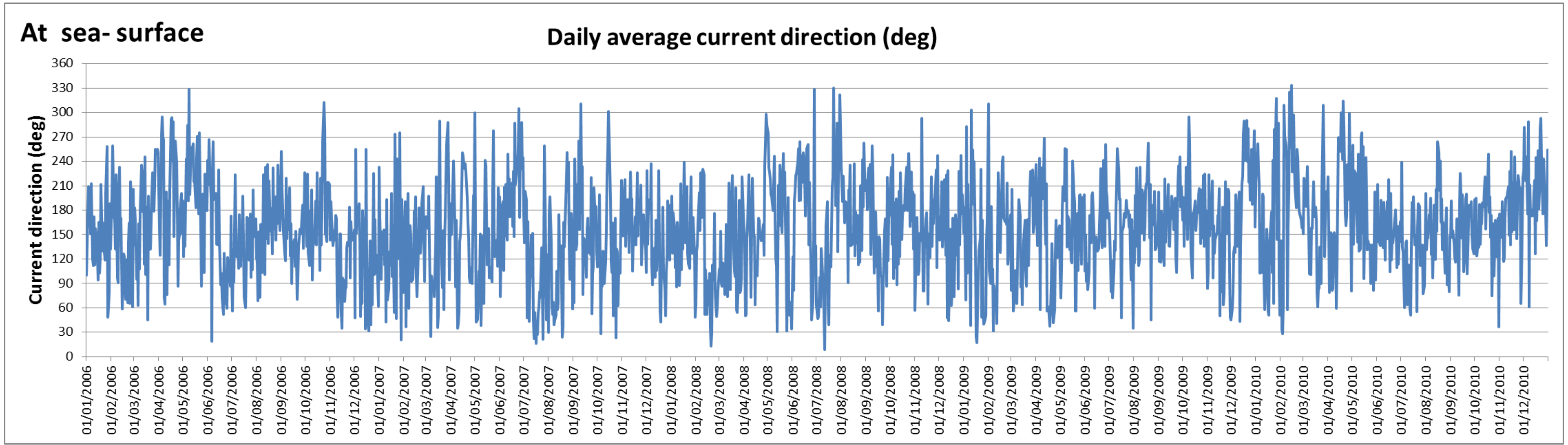
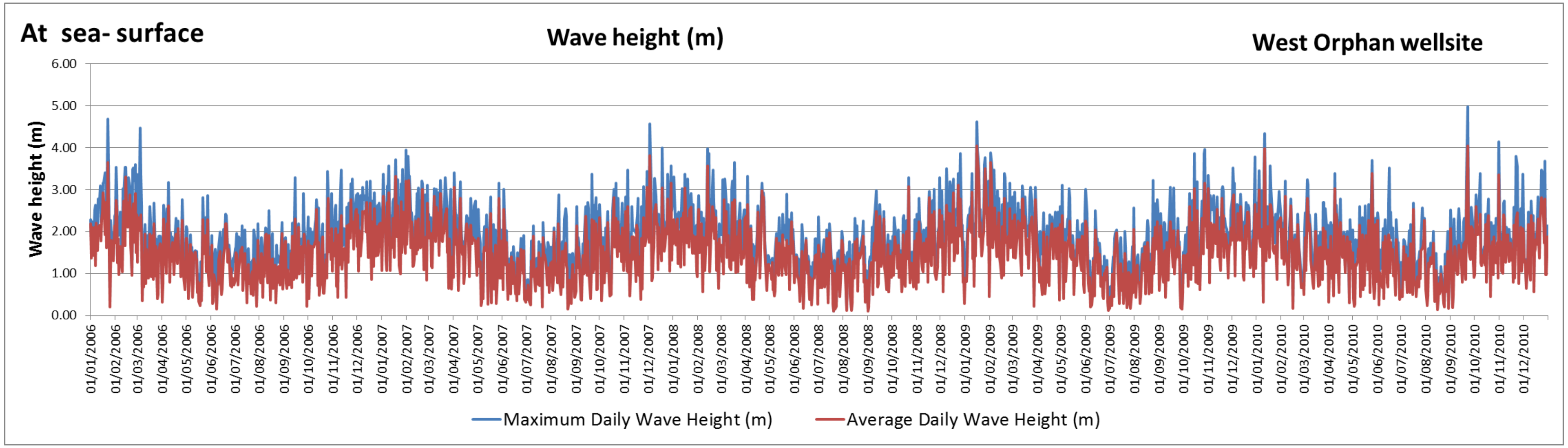
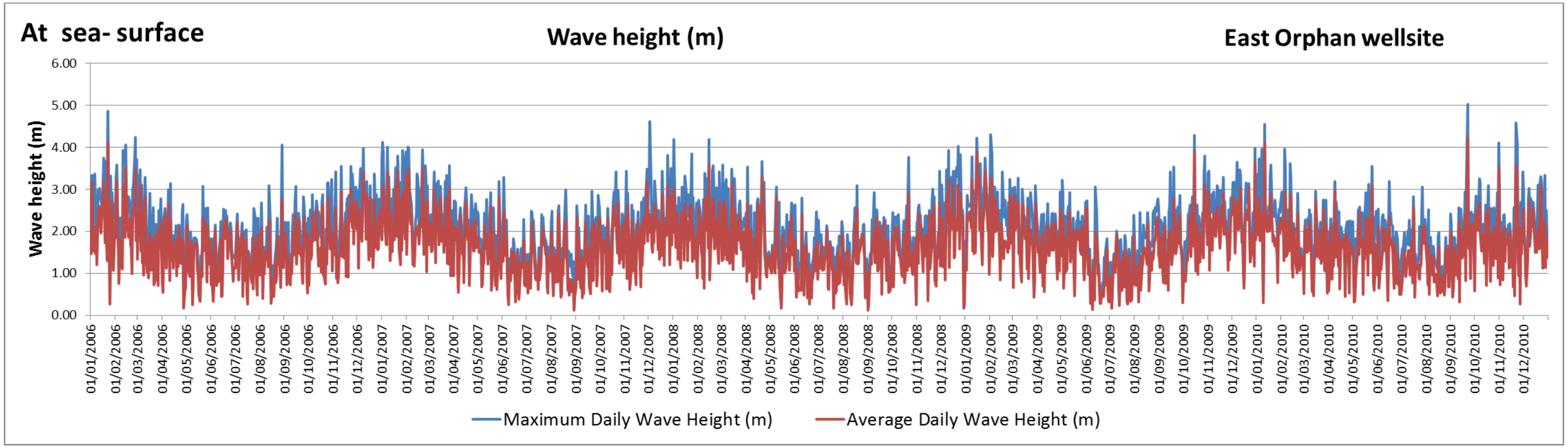


Figure B.1.7 Time series of maximum and daily average wave heights for the WO and EO wellsite locations between 2006 – 2010 calculated internally by OSCAR from wind speed, water depth and fetch.





B.2 Surface Winds

Figure B.2.1 Seasonal wind roses for WO and EO wellsite locations derived from NCAR/NCEP CFSR winds between 2006 – 2010. Surface wind speeds in m/s, using meteorological convention (direction wind is coming from).

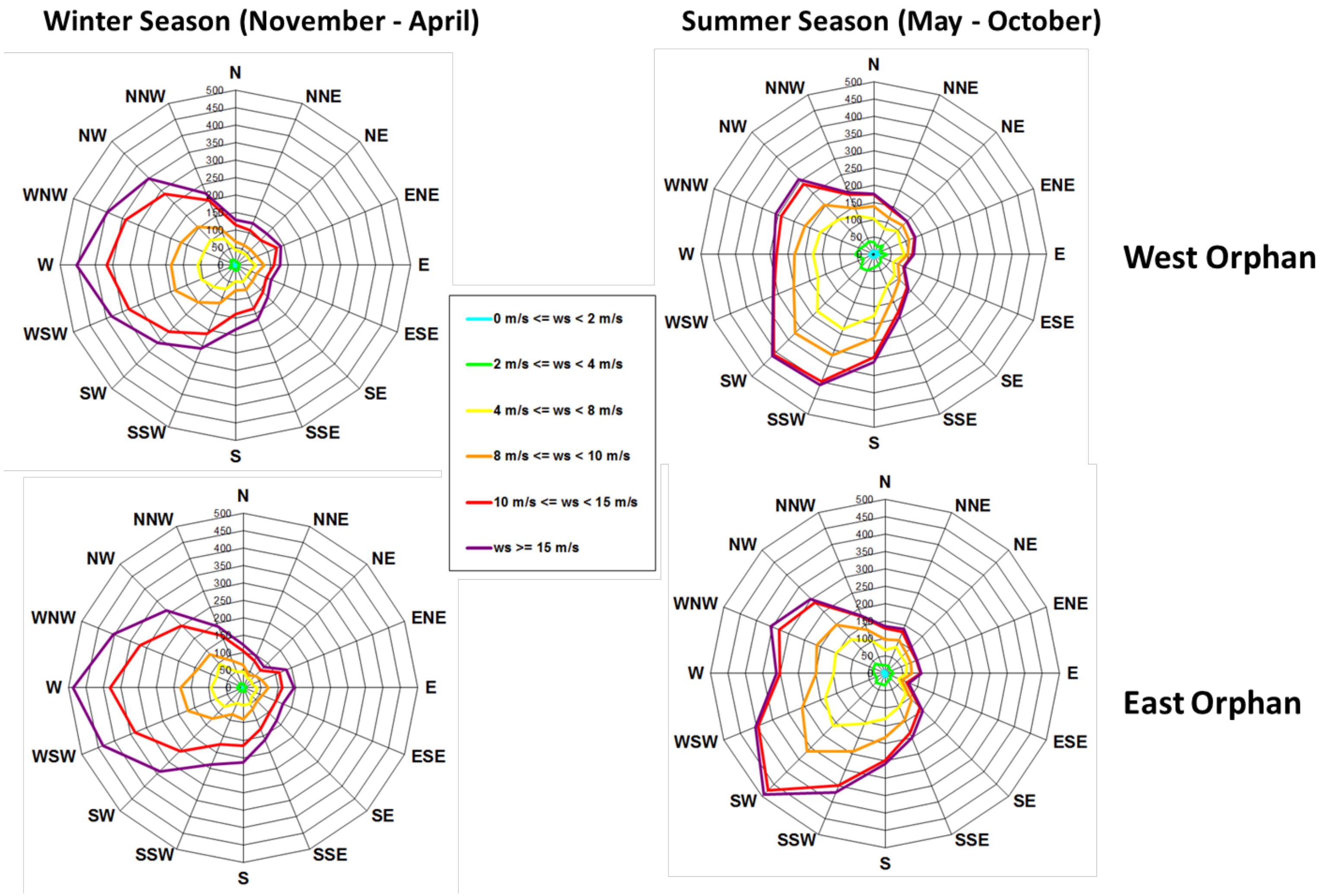


Figure B.2.2 Average wind speeds for WO and EO wellsite locations derived from NCAR/NCEP CFSR winds between 2006 – 2010. Surface wind speeds in m/s, using meteorological convention (direction wind is coming from).

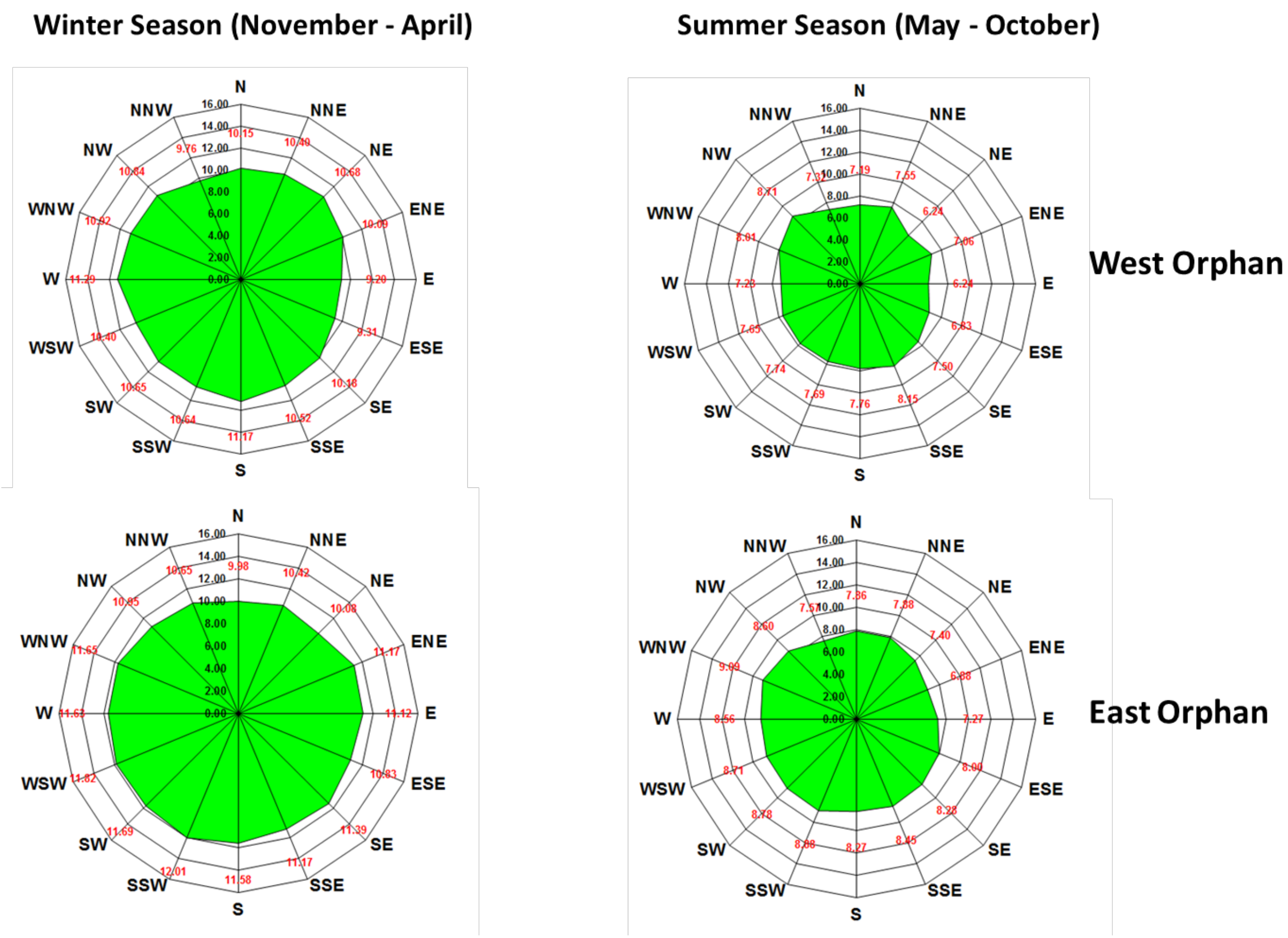


Figure B.2.3 Distribution of wind directions for WO and EO wellsite locations derived from NCAR/NCEP CFSR winds between 2006 – 2010. Surface wind speeds in m/s, using meteorological convention (direction wind is coming from).

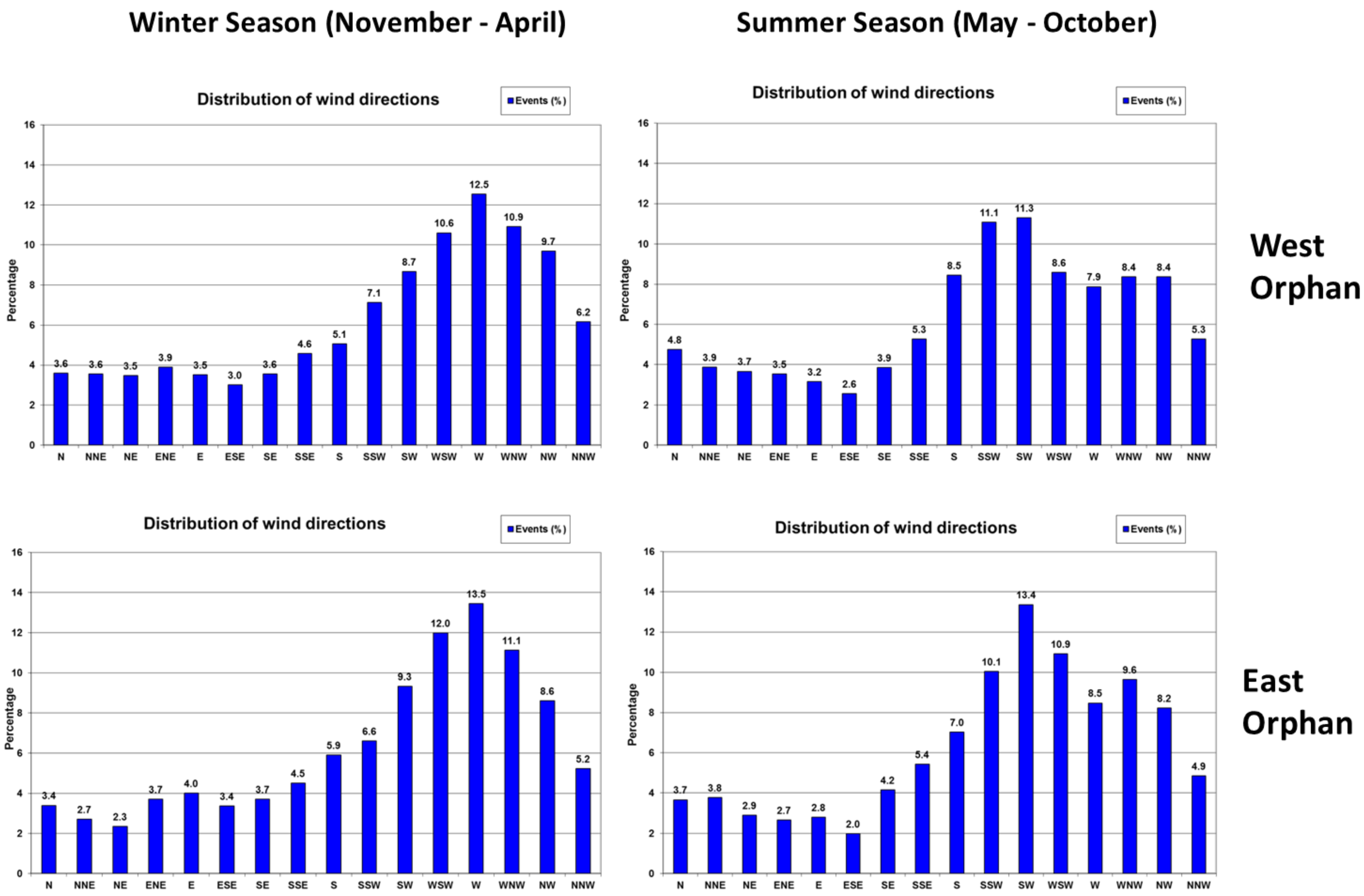


Figure B.2.4 Distribution of wind class speeds for WO and EO wellsite locations derived from NCAR/NCEP CFSR winds between 2006 – 2010. Surface wind speeds in m/s, using meteorological convention (direction wind is coming from).

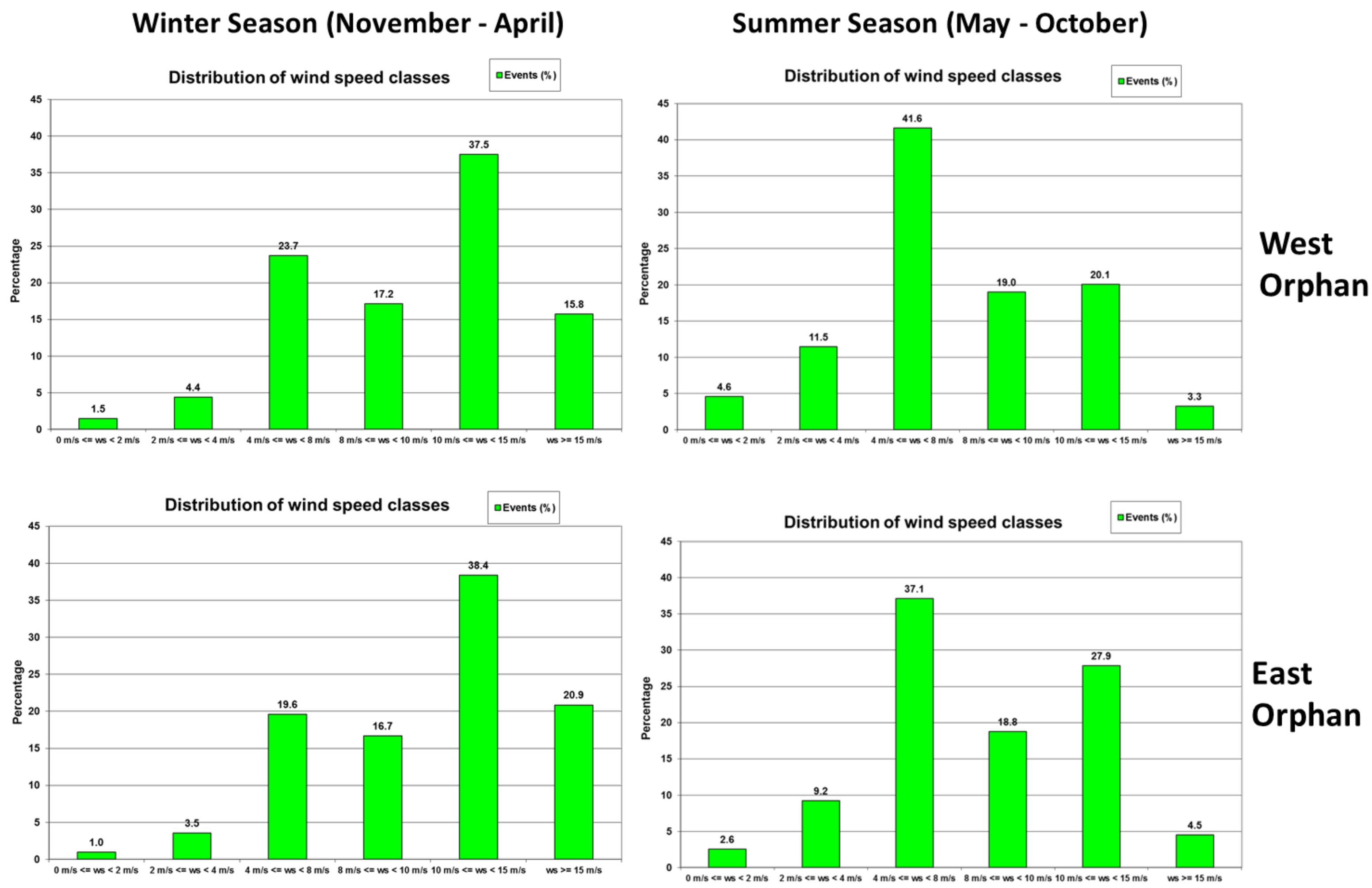
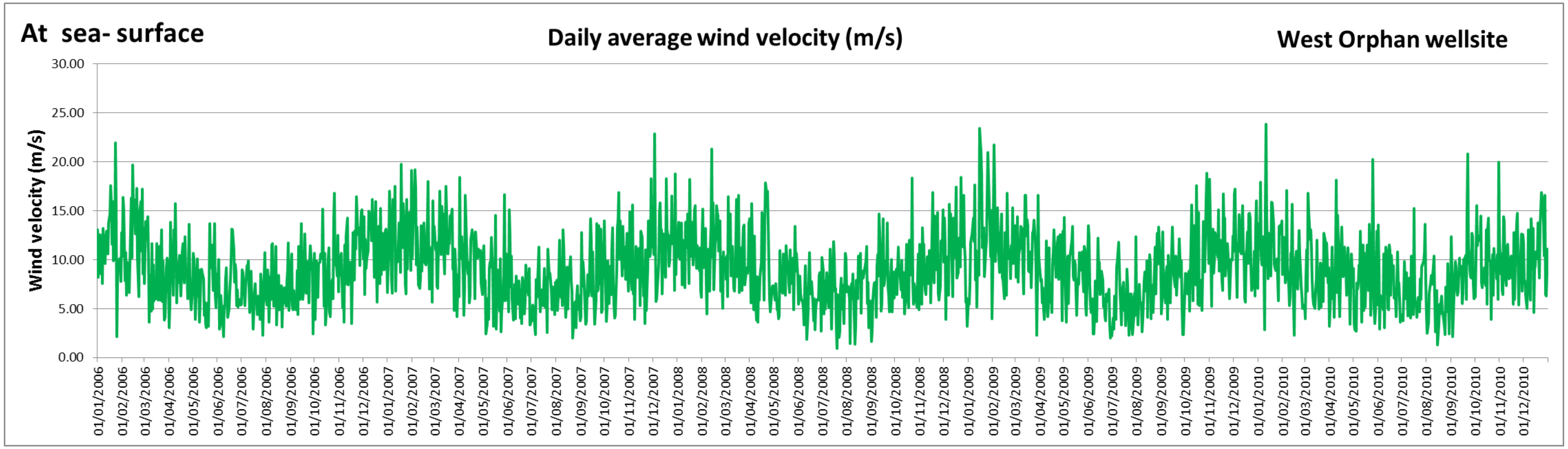
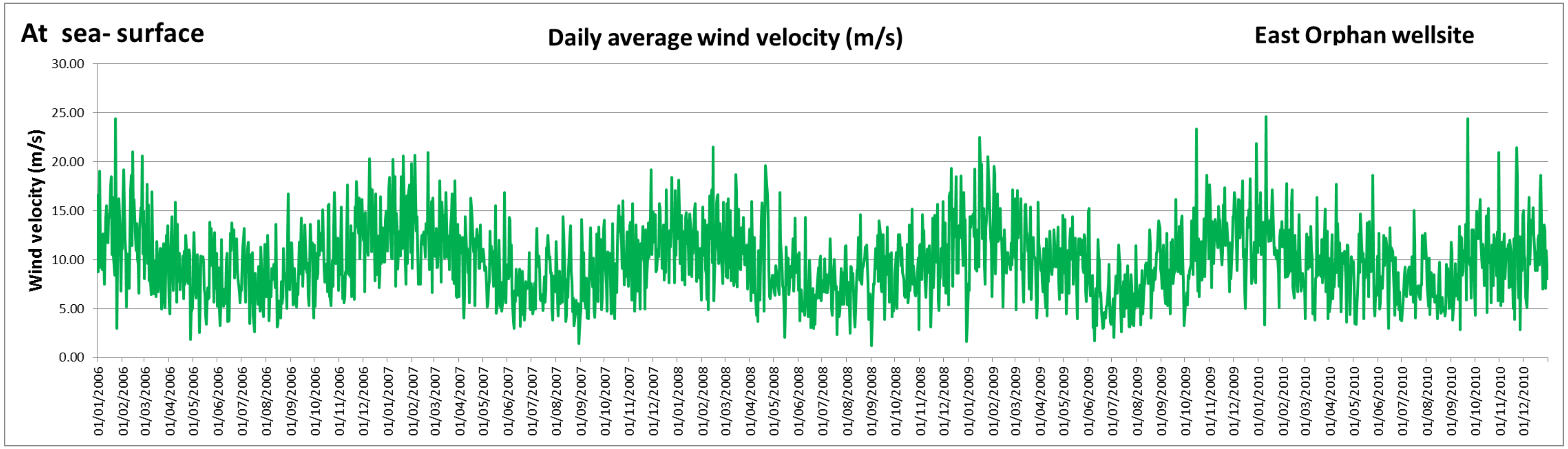


Figure B.2.5 Time series of daily average wind speeds for the WO and EO wellsite locations derived from NCAR/NCEP CFSR model winds between 2006 – 2010.





Annex C - Hydrographic profiles

Average monthly temperature and salinity vs. depth profiles (over the period 2006 to 2010) for each well location was extracted from the World Ocean Atlas 2013 version 2 (18). The data was then used to produce hydrographical profiles for each "seasonal" time period employed in the stochastic simulations.

C.1 West Orphan: Temperature and Salinity vs Depth profiles

Figure C.1.1

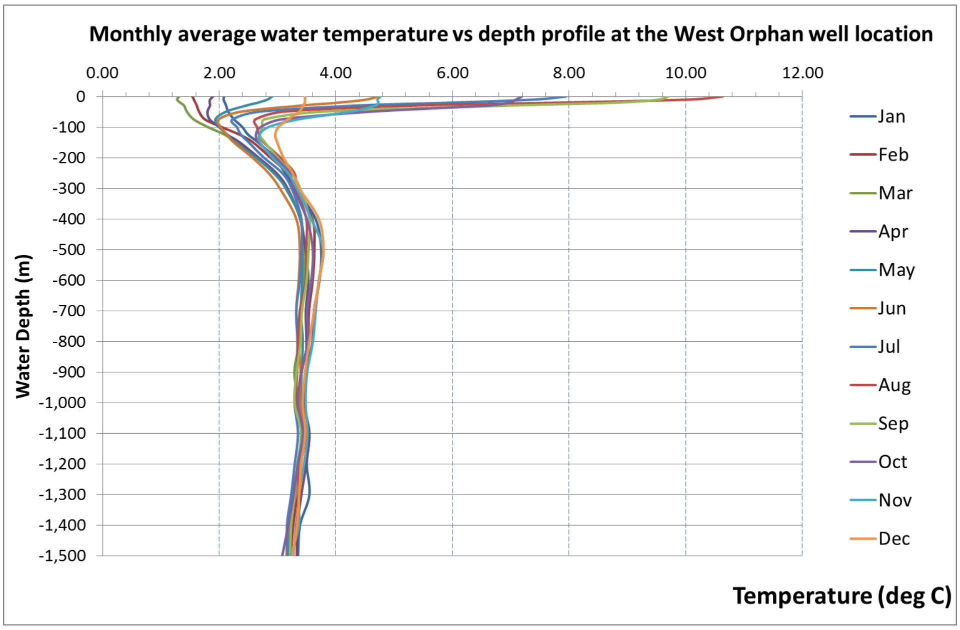


Figure C.1.2

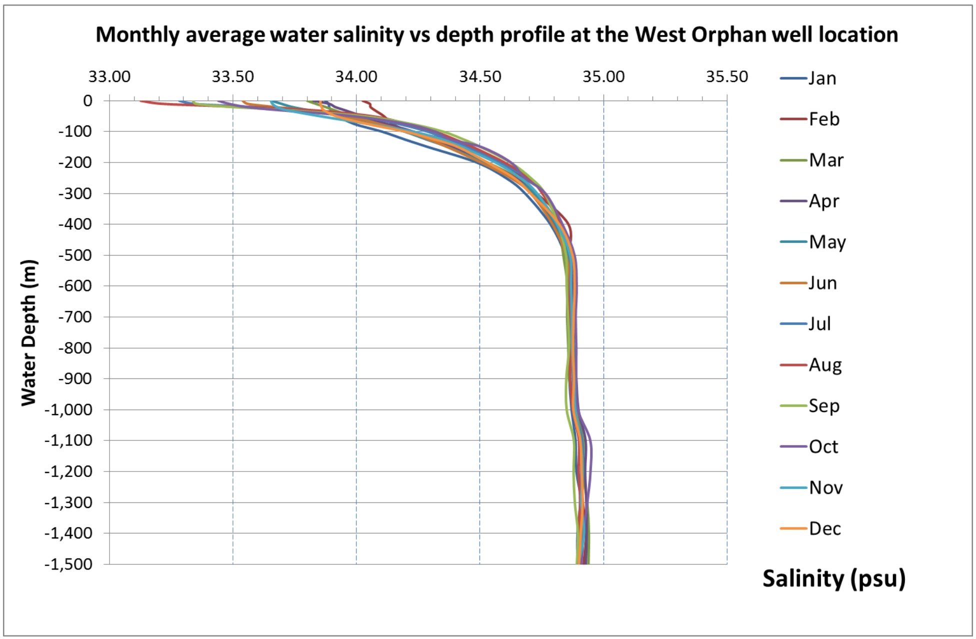


Figure C.1.3

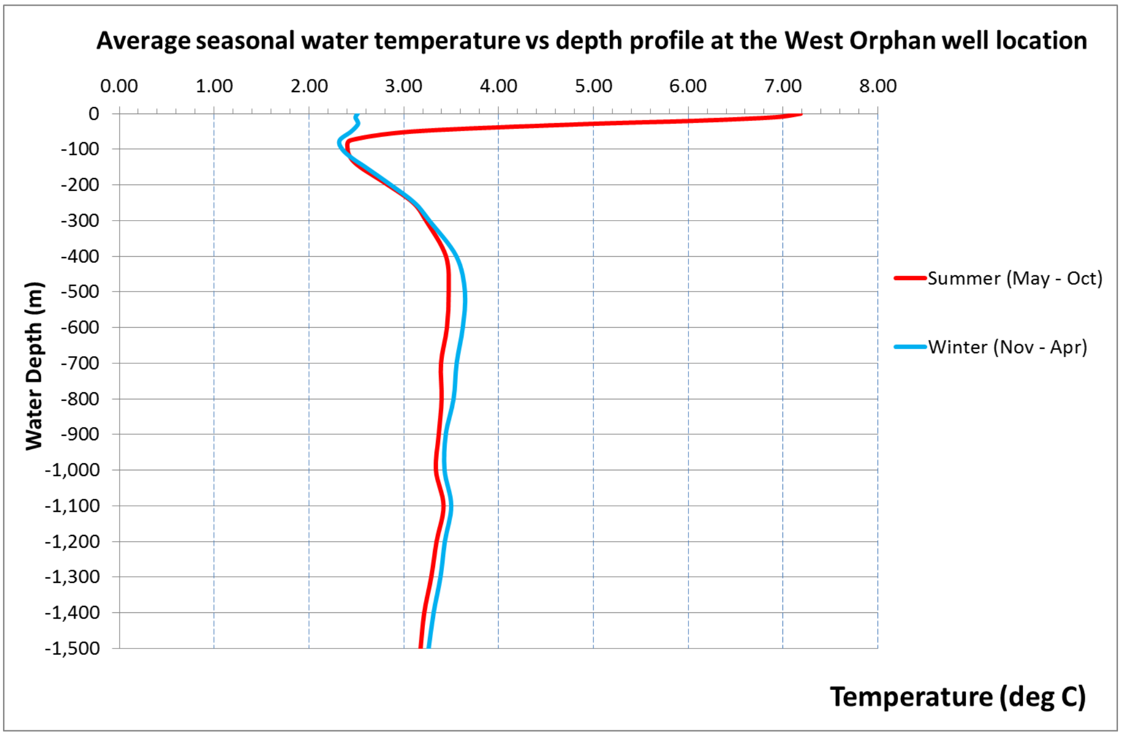
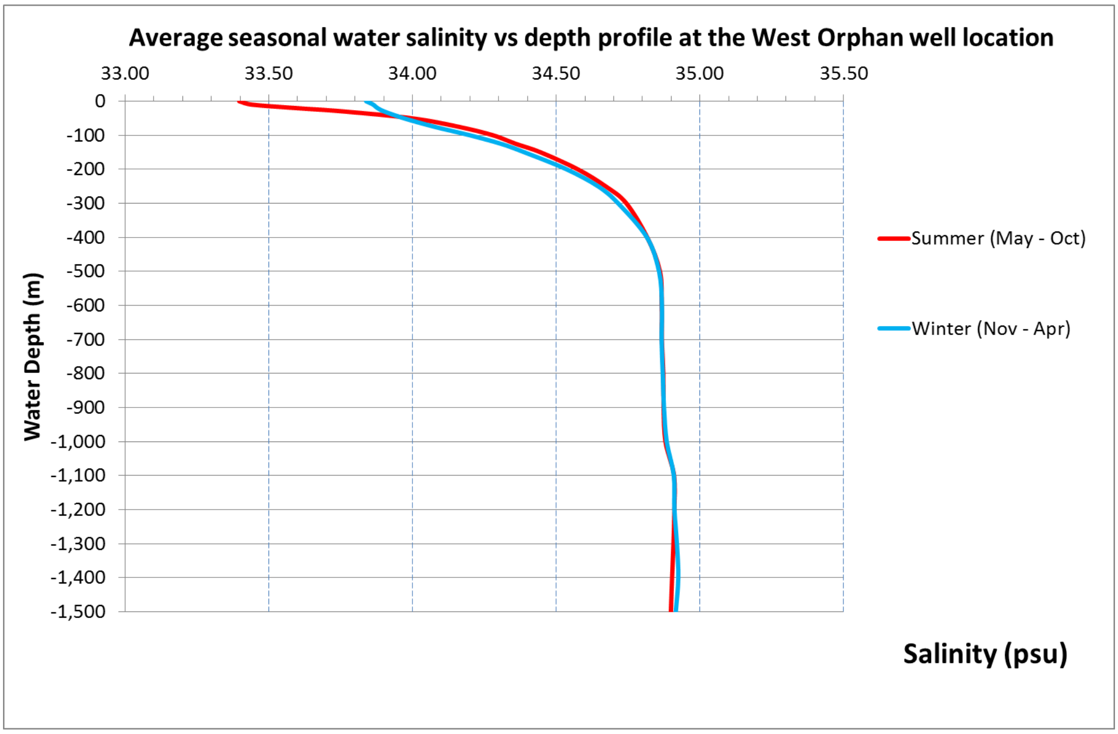


Figure C.1.4



C.2 East Orphan: Temperature and Salinity vs Depth profiles

Figure C.2.1

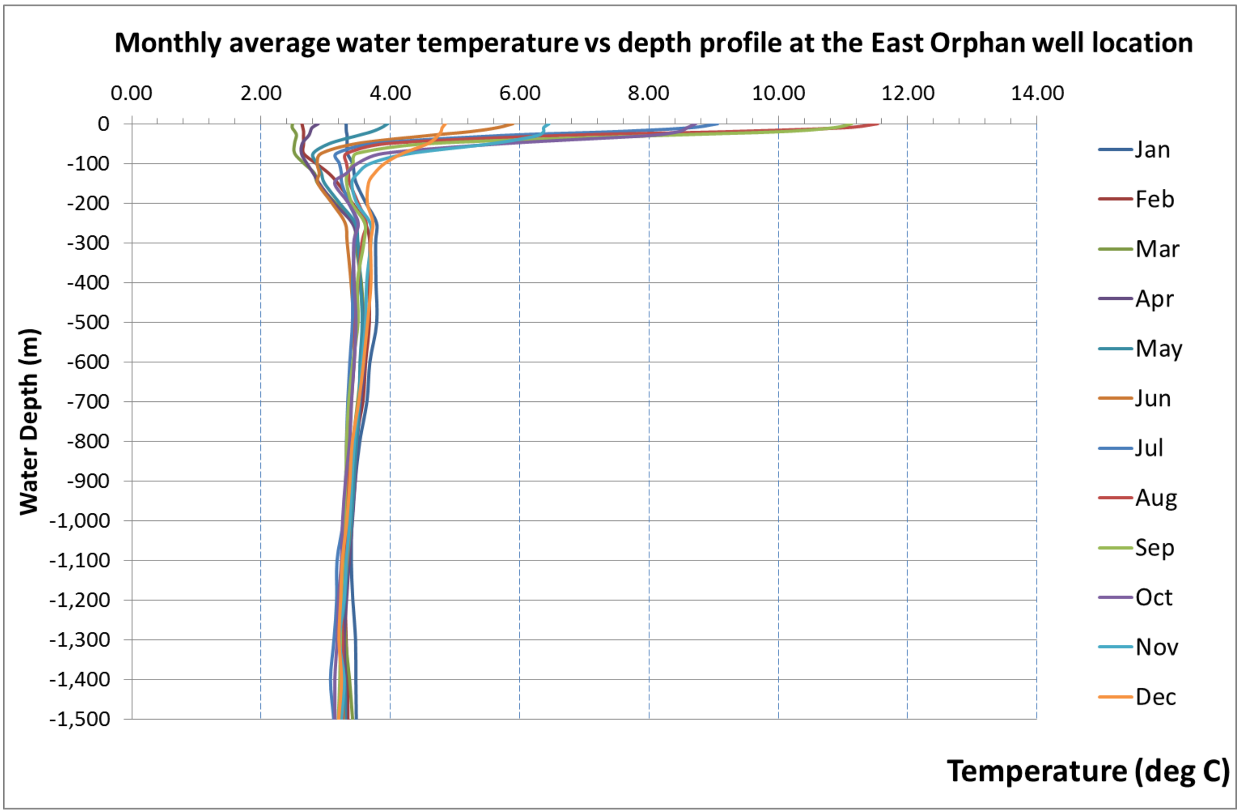


Figure C.2.2

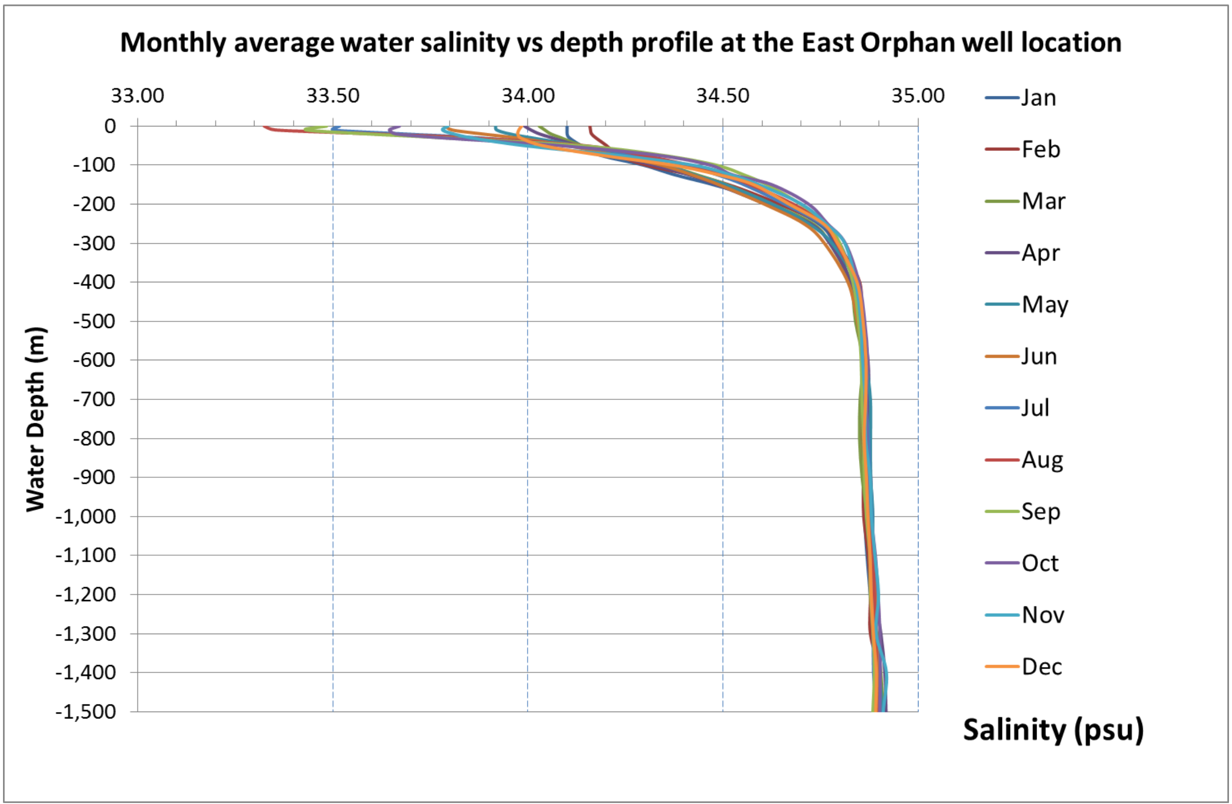


Figure C.2.3

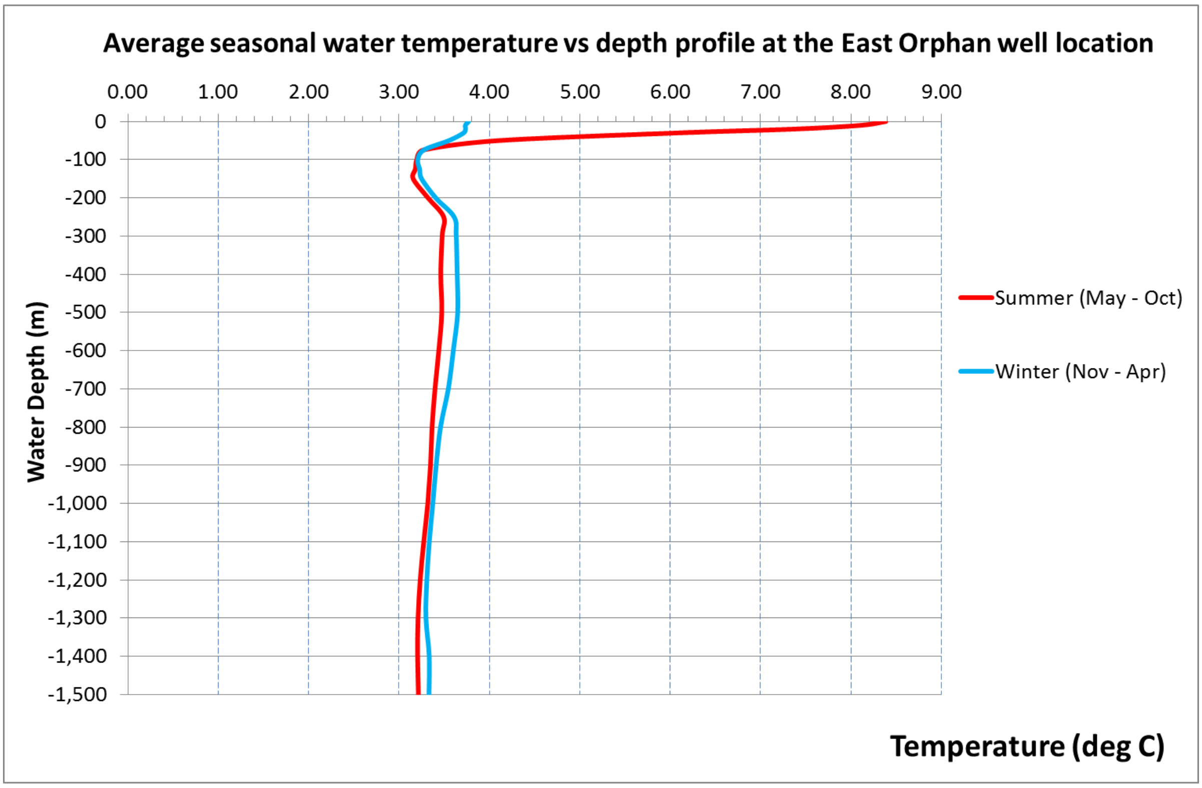
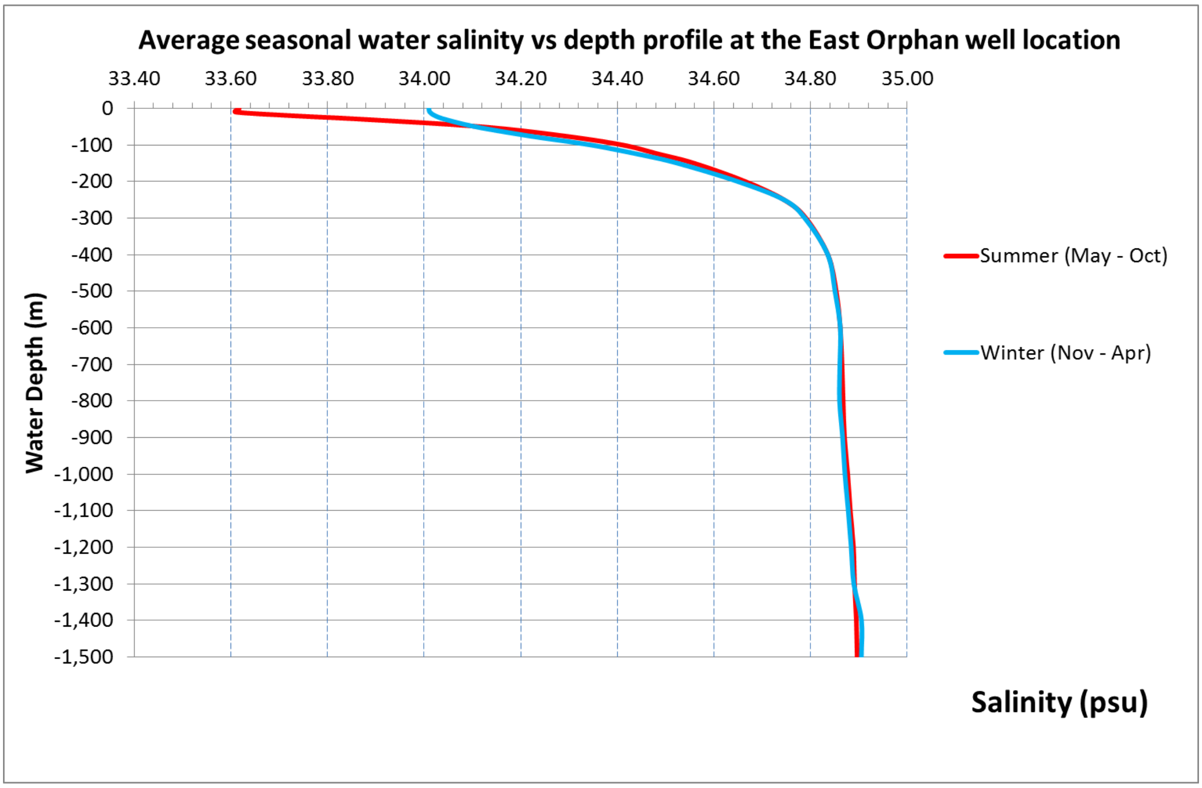


Figure C.2.4



Annex D - GIS analysis of potential subsea blowout oil spill intersections with Protected Area, Ecologically and Biologically Sensitive Areas and World Maritime Boundaries

The tables below provide a ranking of the Protected Areas, EBSAs and WMBs most likely to be impacted by either stranded oil, oil on the sea surface, or oil in the upper water column resulting from the subsea blowout release scenarios.

The tables provide a quantitative breakdown of oil intersections with PAs, EBSAs and WMBs in terms of:

- The area of intersection (km^2);
- The average, maximum and minimum probabilities of oil contact within each intersection;
- The average, maximum and minimum arrival/travel time for oil contact with each intersection;
- The average, maximum and minimum exposure time of oil contact with each intersection;
- The average, maximum and minimum degree of oiling (emulsion oil thickness / THC / dissolved oil concentration) with each intersection.

Table D.1 Environmentally Sensitive Areas considered in the oil spill exposure assessment

Name	Sensitive Area Designation	Area (Sq km)
Laurentian Channel	AOI	16,564
Burgeo Bank	EBSA	1,952
Eastern Avalon	EBSA	36
Fogo Shelf	EBSA	9,403
Gilbert Bay	EBSA	359
Grey Islands	EBSA	11,301
Hamilton Inlet	EBSA	11,038
Hopedale Saddle	EBSA	27,418
Labrador Marginal Trough	EBSA	16,952
Labrador Slope	EBSA	29,746
Lake Melville	EBSA	3,071
Laurentian Channel and Slope	EBSA	17,140
Lilly Canyon - Carson Canyon	EBSA	120
Nain Area	EBSA	6,055
Northeast Shelf and Slope	EBSA	13,885
Northern Labrador	EBSA	20,002
Notre Dame Channel	EBSA	6,222
Orphan Spur	EBSA	21,569
Outer Shelf Nain Bank	EBSA	7,477
Outer Shelf Saglek Bank	EBSA	24,729
Placentia Bay Extension	EBSA	7,693
Smith Sound	EBSA	7
Southeast Shoal and Tail of the Banks	EBSA	30,935
Southwest Shelf Edge and Slope	EBSA	16,644
St. Pierre Bank	EBSA	5,482
Virgin Rocks	EBSA	6,843
Baccalieu Island Ecological Reserve	Ecological Reserve	17
Cape St. Mary's Ecological Reserve	Ecological Reserve	54
Funk Island Ecological Reserve	Ecological Reserve	5
Gannet Islands Ecological Reserve	Ecological Reserve	22
Hare Bay Islands Ecological Reserve	Ecological Reserve	26
Lawn Bay Ecological Reserve	Ecological Reserve	4
Witless Bay Ecological Reserve	Ecological Reserve	29
Bonivista Cod Box	Experimental Closure	9,830
St. Pierre et Miquelon	France	234
Baccalieu Island	IBA	45
Bay du Nord Wilderness Reserve and Middle Ridge Wildlife Reserve	IBA	3,809
Bell Island South Coast	IBA	283
Big Barasway	IBA	10
Bird Island	IBA	7
Cape Freels Coastline and Cabot Island	IBA	334
Cape Porcupine	IBA	123
Cape St. Francis	IBA	70
Cape St. Mary's	IBA	330
Codroy Valley	IBA	36
Codroy Valley Estuary	IBA	14
Corbin Island	IBA	5
Fischot Islands	IBA	57
Funk Island	IBA	135
Galvano Island	IBA	46
Gannet Islands	IBA	246
Goose Brook	IBA	222
Grand Bay West to Cheeseman Prov. Pk.	IBA	41
Grates Point	IBA	67
Green Island	IBA	6
Gros Morne National Park	IBA	1,874
Middle Lawn Island	IBA	4

Table D.1 (cont) Environmentally Sensitive Areas considered in the oil spill exposure assessment

Name	Sensitive Area Designation	Area (Sq km)
Mistaken Point	IBA	103
Nain Coastline	IBA	1,441
Northeast Groswater Bay	IBA	174
Northern Groais Island	IBA	174
Offshore Islands Southeast of Nain	IBA	536
Placentia Bay	IBA	1,399
Point Amour, Strait of Belle Isle	IBA	108
Quaker Hat Island	IBA	33
Quidi Vidi Lake	IBA	7
Seven Islands Bay	IBA	797
South Groswater Bay Coastline	IBA	472
St. Peter Bay	IBA	171
Table Bay	IBA	306
Terra Nova National Park	IBA	656
The Backway	IBA	217
The Cape Pine and St. Shotts Barren	IBA	57
Tumbledown Dick Islands and Stag Islands	IBA	208
Wadham Islands and adjacent Marine Area	IBA	159
Witless Bay Islands	IBA	62
Gander Bay	Lobster Closure	0
Glover's Harbour	Lobster Closure	0
Gooseberry Island	Lobster Closure	0
Mouse Island	Lobster Closure	0
Penguin Island	Lobster Closure	0
Shoal Point	Lobster Closure	0
Trout River	Lobster Closure	0
Division 3O Coral	Marine Refuge	10,336
Funk Island Deep	Marine Refuge	7,272
Hawke Channel	Marine Refuge	8,839
Hopedale Saddle	Marine Refuge	15,450
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	54,097
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	1,154
Ile aux Canes	MBS	2
Shepherd Island	MBS	0
Terra Nova	MBS	9
Terra Nova	MBS	4
Eastport	MPA	0
Eastport	MPA	2
Gilbert Bay	MPA	62
3O Coral Closure	NAFO VME	14,057
Beothuk Knoll	NAFO VME	309
Beothuk Knoll	NAFO VME	340
Corner Seamounts	NAFO VME	40,251
Eastern Flemish Cap	NAFO VME	1,368
Eastern Flemish Cap	NAFO VME	241
Flemish Pass / Eastern Canyon	NAFO VME	5,418
Fogo Seamounts 1	NAFO VME	4,522
Fogo Seamounts 2	NAFO VME	4,616
New England Seamounts	NAFO VME	178,306
Newfoundland Seamounts	NAFO VME	15,491
Northeast Flemish Cap	NAFO VME	2,898
Northern Flemish Cap	NAFO VME	259
Northern Flemish Cap	NAFO VME	98
Northern Flemish Cap	NAFO VME	128
Northwest Flemish Cap	NAFO VME	317
Northwest Flemish Cap	NAFO VME	61
Northwest Flemish Cap	NAFO VME	35
Orphan Knoll	NAFO VME	15,817
Sackville Spur	NAFO VME	992
Tail of the Bank	NAFO VME	144
Sable Island	National Park reserve	33

D.1.1 Scenario 1: West Orphan well blowout relief well scenario (Summer Season)

Stranded Oil

Table D.1.1.1

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Chance Cove Provincial Park	Provincial Park	CAN	II	22.01	3.97	18%	0.9	0.9	0.9	147	147	147	Stain/Film	Stain/Film	Stain/Film

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Surface Oil

Table D.1.1.2

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,533	38%	24.7	69.6	3.6	91	137	46	5	25	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,323	100%	19.1	31.3	10.7	70	116	46	3	7	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,588	100%	12.5	21.4	5.4	106	130	79	2	3	1	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,588	100%	12.3	21.4	5.4	106	130	79	2	3	1	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	83,666	45%	6.8	30.4	0.9	113	160	62	3	13	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	26,016	26%	3.1	10.7	0.9	118	160	83	2	5	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	25,742	25%	3.1	10.7	0.9	118	160	83	2	5	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	2,390	100%	2.4	4.5	0.9	107	158	89	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.1.3

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Sackville Spur	NAFO VME	992	993	100%	99.9	100.0	98.2	20	28	16	18	26	14	Metallic	DTOC	Metallic	Rainbow	Metallic	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	99.2	100.0	96.4	23	29	18	17	28	12	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	99.2	100.0	94.6	29	35	23	15	24	10	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northwest Flemish Cap	NAFO VME	412	413	100%	98.8	100.0	94.6	20	28	17	15	20	10	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Knoll	NAFO VME	15,817	15,849	100%	95.2	100.0	85.7	21	41	8	19	34	9	Metallic	CTOC	Rainbow	Rainbow	Metallic	Rainbow
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	88.1	98.2	76.8	36	45	31	11	17	8	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	87.8	99.1	71.4	25	39	16	10	22	5	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	55,283	100%	77.8	100.0	0.9	17	135	1	19	118	1	CTOC	CTOC	Sheen	Metallic	CTOC	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	76.6	83.0	66.1	40	56	28	8	12	5	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Tail of the Bank	NAFO VME	144	144	100%	67.4	73.2	63.4	25	33	22	8	10	7	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Spur	EBSA	21,569	21,473	100%	61.2	100.0	0.9	15	135	1	13	33	1	CTOC	CTOC	Sheen	Metallic	CTOC	Sheen
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	61.0	100.0	7.1	16	96	7	8	20	2	DTOC	CTOC	Rainbow	Metallic	DTOC	Rainbow
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	49.4	67.9	32.1	31	45	24	6	8	4	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Bonivista Cod Box	Experimental Closure	9,830	9,848	100%	49.0	99.1	4.5	15	40	2	10	27	1	DTOC	CTOC	Rainbow	Metallic	DTOC	Rainbow
Newfoundland Seamounts	NAFO VME	15,491	15,522	100%	26.0	49.1	8.9	58	96	38	4	9	2	Rainbow	DTOC	Sheen	Rainbow	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	14,083	100%	22.3	41.1	6.3	68	105	38	4	8	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	10,356	100%	20.1	37.5	6.3	73	105	41	4	8	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	16,677	100%	15.9	37.5	3.6	71	105	41	3	8	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	19,369	63%	10.0	57.1	0.9	74	160	28	3	9	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Fogo Seamounts 1	NAFO VME	4,522	4,532	100%	9.4	17.0	3.6	96	120	62	3	7	2	Rainbow	Rainbow	Sheen	Rainbow	Rainbow	Sheen
Funk Island Deep	Marine Refuge	7,272	5,732	79%	4.3	15.2	0.9	83	141	31	3	9	1	Rainbow	Metallic	Sheen	Rainbow	Metallic	Sheen
Notre Dame Channel	EBSA	6,222	5,752	92%	4.1	17.0	0.9	84	141	15	3	10	1	Rainbow	DTOC	Sheen	Rainbow	Metallic	Sheen
Fogo Seamounts 2	NAFO VME	4,616	3,333	72%	2.0	6.3	0.9	134	159	95	1	2	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Laurentian Channel	AOI	16,564	8,093	49%	1.7	5.4	0.9	98	146	61	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Laurentian Channel and Slope	EBSA	17,140	7,996	47%	1.7	5.4	0.9	99	154	61	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Corner Seamounts	NAFO VME	40,251	10,278	26%	1.2	1.8	0.9	143	159	130	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
St. Pierre Bank	EBSA	5,482	2,530	46%	1.1	2.7	0.9	113	137	72	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Virgin Rocks	EBSA	6,843	252	4%	0.9	1.8	0.9	138	158	82	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
New England Seamounts	NAFO VME	178,306	11,447	6%	0.9	0.9	0.9	144	147	142	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Burgeo Bank	EBSA	1,952	467	24%	0.9	0.9	0.9	150	150	120	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	1,320	4%	0.9	0.9	0.9	132	134	111	2	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.1.4

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	2,306	33.9	100.0	0.9	66	154	4	7	43	1	Metallic	CTOC	Sheen	Rainbow	DTOC	Sheen
Canada - Saint-Pierre et Miquelon	593	5.2	13.4	0.9	91	150	58	2	6	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Azores - Atlantic Ocean	566	2.0	4.5	0.9	131	160	102	2	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Greenland - Atlantic Ocean	271	0.9	1.8	0.9	138	159	113	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.1.5

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	8	0.04%	0.89	0.89	0.89	70	70	70	1	1	1	66	66	66	0	0	0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.1.6

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Sensitive Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Sackville Spur	NAFO VME	992	993	100%	99.91	100.00	97.32	19	27	14	24	31	17	369	1253	161	0	1	0
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	82.49	99.11	58.93	32	45	22	12	19	7	304	2743	129	0	0	0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	50,247	91%	78.81	100.00	0.89	11	134	1	34	81	1	697	6466	60	20	702	0
Northern Flemish Cap	NAFO VME	486	487	100%	76.97	98.21	53.57	27	37	20	17	29	11	254	959	139	0	0	0
Northwest Flemish Cap	NAFO VME	412	413	100%	73.65	92.86	44.64	20	30	17	16	24	12	283	733	135	0	1	0
Orphan Spur	EBSA	21,569	20,080	93%	56.79	100.00	0.89	10	88	1	23	56	1	893	6732	60	9	193	0
Orphan Knoll	NAFO VME	15,817	15,849	100%	45.99	81.25	18.75	21	42	8	19	43	4	632	8116	144	0	4	0
Northeast Shelf and Slope	EBSA	13,885	13,911	100%	43.93	100.00	0.89	14	80	7	9	35	1	542	4006	69	1	27	0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	35.80	64.29	14.29	48	57	32	6	13	3	177	1130	99	0	0	0
Bonivista Cod Box	Experimental Closure	9,830	9,485	96%	31.98	100.00	0.89	15	132	3	18	46	1	691	4162	60	1	62	0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	26.10	66.96	4.46	27	48	16	9	100	2	199	1293	85	0	0	0
Tail of the Bank	NAFO VME	144	144	100%	11.27	14.29	7.14	27	35	21	5	7	3	174	220	110	0	0	0
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	4.31	11.61	0.89	35	121	21	2	6	1	128	419	59	0	0	0
3O Coral Closure	NAFO VME	14,057	2,696	19%	1.89	5.36	0.89	61	148	35	1	4	1	83	153	58	0	0	0
Southeast Shoal and Tail of the Banks	EBSA	30,935	1,808	6%	1.35	5.36	0.89	70	137	22	1	3	1	85	338	58	0	0	0
Notre Dame Channel	EBSA	6,222	764	12%	1.15	4.46	0.89	59	135	39	1	3	1	89	456	59	0	0	0
Funk Island Deep	Marine Refuge	7,272	763	10%	1.13	4.46	0.89	63	135	39	1	3	1	87	361	59	0	0	0
Southwest Shelf Edge and Slope	EBSA	16,644	1,753	11%	0.99	2.68	0.89	66	125	49	1	2	1	71	101	58	0	0	0
Beothuk Knoll	NAFO VME	648	573	88%	0.98	2.68	0.89	93	158	48	1	2	1	75	133	58	0	0	0
Newfoundland Seamounts	NAFO VME	15,491	3,902	25%	0.97	2.68	0.89	74	151	43	1	2	1	77	1051	58	0	0	0
Division 3O Coral	Marine Refuge	10,336	1,041	10%	0.92	1.79	0.89	69	124	52	1	2	1	72	101	58	0	0	0
Fogo Seamounts 1	NAFO VME	4,522	82	2%	0.89	0.89	0.89	93	94	90	1	1	1	65	68	59	0	0	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.1.7

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	949	43.39	100.00	0.89	27	143	5	16	58	1	382	2178	58	0	13	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.2 Scenario 1: West Orphan well blowout relief well scenario (Winter Season)

Stranded Oil

Table D.1.2.1

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Windmill Bight Provincial Park	Provincial Park	CAN	II	2.86	1.71	60%	3.9	4.3	3.4	40	44	36	Heavy	Heavy	Heavy
Mistaken Point Ecological Reserve	Ecological Reserve	CAN	II	5.70	2.37	42%	2.6	2.6	2.6	79	79	79	Moderate	Moderate	Moderate
Witless Bay Ecological Reserve	Ecological Reserve	CAN	II	1.46	0.29	20%	2.2	2.6	1.7	101	101	101	Light	Light	Light
Witless Bay Ecological Reserve	Ecological Reserve	CAN	VI	29.03	3.82	13%	2.2	2.6	1.7	101	101	101	Light	Light	Light
Deadman's Bay Provincial Park	Provincial Park	CAN	III	0.70	0.00	1%	1.3	1.7	0.9	61	85	36	Heavy	Heavy	Moderate
La Manche Provincial Park	Provincial Park	CAN	II	13.91	5.78	42%	1.3	1.7	0.9	122	130	115	Light	Light	Stain/Film
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	II	11.19	7.92	71%	0.9	0.9	0.9	100	100	100	Light	Light	Light
Baccalieu Island Ecological Reserve	Ecological Reserve	CAN	II	5.37	0.69	13%	0.9	0.9	0.9	107	107	107	Light	Light	Light
Gooseberry Cove Provincial Park	Provincial Park	CAN	III	0.05	0.05	100%	0.9	0.9	0.9	124	124	124	Light	Light	Light
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	VI	53.66	5.27	10%	0.9	0.9	0.9	100	100	100	Light	Light	Light

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Table D.1.2.2

Stranded Oil Intersections with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected SA contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
The Cape Pine and St. Shotts Barren	IBA	57.40	7.56	13.2%	3.4	3.4	3.4	73	73	73	Light	Light	Light
Placentia Bay Extension	EBSA	7,693.17	103.30	1.3%	2.6	5.2	0.9	104	157	96	Light	Heavy	Stain/Film
Mistaken Point	IBA	102.75	10.41	10.1%	2.4	2.6	0.9	81	103	79	Moderate	Heavy	Moderate
Fogo Shelf	EBSA	9,403.09	43.83	0.5%	2.2	4.3	0.9	50	85	36	Heavy	Heavy	Stain/Film
Witless Bay Ecological Reserve	Ecological Reserve	29.03	3.82	13.2%	2.2	2.6	1.7	101	101	101	Light	Light	Light
Witless Bay Islands	IBA	62.05	11.09	17.9%	1.9	2.6	0.9	106	130	101	Light	Light	Stain/Film
Cape St. Mary's	IBA	329.61	36.95	11.2%	1.5	5.2	0.9	100	160	96	Light	Light	Stain/Film
Placentia Bay	IBA	1,398.93	21.11	1.5%	1.5	5.2	0.9	133	160	96	Moderate	Moderate	Light
Eastern Avalon	EBSA	35.60	1.40	3.9%	1.1	1.7	0.9	110	132	68	Moderate	Moderate	Stain/Film
Cape Freels Coastline and Cabot Island	IBA	334.49	65.10	19.5%	0.9	3.4	0.9	117	151	35	Moderate	Heavy	Stain/Film
Baccalieu Island	IBA	45.21	2.82	6.2%	0.9	0.9	0.9	107	107	107	Light	Light	Light
Baccalieu Island Ecological Reserve	Ecological Reserve	17.50	0.69	4.0%	0.9	0.9	0.9	107	107	107	Light	Light	Light
Grates Point	IBA	66.53	10.80	16.2%	0.9	0.9	0.9	88	88	88	Heavy	Heavy	Heavy
Quidi Vidi Lake	IBA	7.00	0.05	0.7%	0.9	0.9	0.9	132	132	132	Stain/Film	Stain/Film	Stain/Film
St. Pierre et Miquelon	France	234.21	9.08	3.9%	0.9	0.9	0.9	124	131	122	Light	Light	Light
Cape St. Mary's Ecological Reserve	Ecological Reserve	53.66	5.26	9.8%	0.9	0.9	0.9	100	100	100	Light	Light	Light

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Surface Oil

Table D.1.2.3

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,323	100%	49.0	71.6	37.1	75	102	47	6	14	3	Rainbow	Rainbow	Rainbow	Sheen	Rainbow	Sheen
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,533	38%	33.3	71.6	6.9	96	129	71	7	29	2	Rainbow	DTOC	Sheen	Sheen	Rainbow	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,588	100%	31.2	37.9	24.1	86	100	74	5	8	3	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,588	100%	31.1	37.9	24.1	86	100	74	5	8	3	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	29,513	29%	17.3	33.6	5.2	113	129	104	4	20	2	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	29,521	29%	17.3	33.6	5.2	113	129	104	4	20	2	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	88,699	48%	7.5	42.2	0.9	124	160	71	3	23	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	2,390	100%	5.1	10.3	0.9	96	139	77	3	6	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
OceÃ¢nica do Corvo	Habitats or Species Management Protected Area	PRT	IV	2,856	2,862	100%	3.3	5.2	1.7	138	158	133	3	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	CAN	VI	5.20	5.20	100%	2.2	3.4	0.9	73	125	43	1	1	1	Metallic	DTOC	Sheen	Metallic	Metallic	Sheen
Funk Island Ecological Reserve	Ecological Reserve	CAN	Ia	0.19	0.19	100%	2.2	3.4	0.9	84	125	43	1	1	1	Metallic	DTOC	Sheen	Metallic	Metallic	Sheen
Sable Island Migratory Bird Sanctuary	Migratory Bird Sanctuary	CAN	Ia	31	8	24%	0.9	0.9	0.9	139	144	137	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Sable Island National Park Reserve of Canada	National Park of Canada	CAN	II	30	8	25%	0.9	0.9	0.9	139	144	137	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	VI	54	16	29%	0.9	0.9	0.9	138	138	138	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.2.4

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Sackville Spur	NAFO VME	992	993	100%	100.0	100.0	99.1	18	25	15	22	28	18	Metallic	Metallic	Metallic	Rainbow	Rainbow	Rainbow
Northwest Flemish Cap	NAFO VME	412	413	100%	100.0	100.0	98.3	19	26	14	22	27	17	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	100.0	100.0	99.1	27	33	24	21	28	16	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	99.9	100.0	98.3	23	30	19	22	28	18	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Knoll	NAFO VME	15,817	15,849	100%	98.7	100.0	94.0	23	48	8	23	42	12	Metallic	DTOC	Rainbow	Rainbow	Metallic	Rainbow
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	98.1	100.0	94.0	35	46	32	15	27	10	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	97.6	100.0	89.7	22	30	15	15	23	10	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Beothuk Knoll	NAFO VME	648	649	100%	95.1	99.1	89.7	33	41	30	11	15	8	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Tail of the Bank	NAFO VME	144	144	100%	93.9	96.6	90.5	32	36	25	11	13	9	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	86.7	100.0	41.4	15	27	7	15	29	4	DTOC	CTOC	Metallic	Metallic	Metallic	Rainbow
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	81.4	91.4	67.2	25	35	19	11	16	7	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Spur	EBSA	21,569	21,609	100%	78.6	100.0	1.7	12	130	1	18	39	1	DTOC	CTOC	Sheen	Metallic	DTOC	Sheen
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	55,360	100%	78.4	100.0	0.9	18	149	1	20	115	1	DTOC	CTOC	Sheen	Metallic	CTOC	Sheen
Bonivista Cod Box	Experimental Closure	9,830	9,848	100%	78.3	100.0	27.6	13	42	3	17	33	3	DTOC	CTOC	Metallic	Metallic	Metallic	Rainbow
Newfoundland Seamounts	NAFO VME	15,491	15,522	100%	63.5	87.1	33.6	53	84	36	6	12	3	Rainbow	DTOC	Rainbow	Rainbow	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	14,083	100%	40.5	62.1	16.4	52	85	36	6	11	3	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	10,356	100%	36.8	53.4	16.4	56	85	42	6	10	3	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	16,677	100%	30.0	53.4	8.6	60	96	42	5	11	3	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Fogo Seamounts 1	NAFO VME	4,522	4,532	100%	26.8	43.1	17.2	56	79	43	5	8	3	Rainbow	Rainbow	Rainbow	Sheen	Rainbow	Sheen
Notre Dame Channel	EBSA	6,222	6,234	100%	18.4	50.9	0.9	40	101	11	5	12	1	Metallic	CTOC	Sheen	Rainbow	DTOC	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	29,916	97%	18.4	83.6	0.9	74	156	20	4	14	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Funk Island Deep	Marine Refuge	7,272	7,282	100%	17.8	47.4	0.9	42	125	11	5	12	1	Metallic	DTOC	Sheen	Rainbow	Metallic	Sheen
Virgin Rocks	EBSA	6,843	6,857	100%	14.5	26.7	2.6	52	73	41	5	11	2	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Seamounts 2	NAFO VME	4,616	4,626	100%	10.5	18.1	5.2	79	115	58	3	4	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Funk Island Ecological Reserve	Ecological Reserve	5	5	100%	2.2	3.4	0.9	73	125	43	1	1	1	Metallic	DTOC	Sheen	Metallic	Metallic	Sheen
Funk Island	IBA	135	135	100%	1.9	6.9	0.9	94	125	37	1	1	1	Metallic	DTOC	Sheen	Rainbow	Metallic	Sheen
Corner Seamounts	NAFO VME	40,251	38,522	96%	1.9	3.4	0.9	125	160	101	2	6	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Shelf	EBSA	9,403	2,217	24%	1.8	6.9	0.9	85	125	27	1	4	1	Metallic	DTOC	Sheen	Metallic	DTOC	Sheen
Laurentian Channel	AOI	16,564	9,848	59%	1.5	8.6	0.9	136	150	78	1	5	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Laurentian Channel and Slope	EBSA	17,140	9,514	56%	1.5	8.6	0.9	136	150	78	1	5	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Placentia Bay Extension	EBSA	7,693	2,201	29%	1.3	3.4	0.9	119	158	97	1	2	1	Rainbow	Rainbow	Sheen	Rainbow	Rainbow	Sheen
Placentia Bay	IBA	1,399	415	30%	1.1	2.6	0.9	129	151	124	1	1	1	Rainbow	Rainbow	Sheen	Rainbow	Rainbow	Sheen
St. Pierre Bank	EBSA	5,482	2,631	48%	1.1	2.6	0.9	145	153	101	2	5	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hawke Channel	Marine Refuge	8,839	159	2%	1.0	1.7	0.9	82	84	79	2	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Burgeo Bank	EBSA	1,952	1,180	60%	0.9	1.7	0.9	150	150	142	1	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape St. Mary's	IBA	330	169	51%	0.9	1.7	0.9	135	138	102	1	1	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Cape Freels Coastline and Cabot Island	IBA	334	13	4%	0.9	0.9	0.9	50	59	44	1	1	1	DTOC	DTOC	Rainbow	DTOC	DTOC	Rainbow
Eastern Avalon	EBSA	36	0	1%	0.9	0.9	0.9	91	115	67	1	1	1	Metallic	Metallic	Rainbow	Metallic	Metallic	Rainbow
Sable Island	National Park reserve	33	5	14%	0.9	0.9	0.9	140	144	137	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Wadham Islands and adjacent Marine Area	IBA	159	7	5%	0.9	0.9	0.9	51	51	51	1	1	1	DTOC	DTOC	DTOC	DTOC	DTOC	DTOC
Cape St. Mary's Ecological Reserve	Ecological Reserve	54	16	30%	0.9	0.9	0.9	138	138	138	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
New England Seamounts	NAFO VME	178,306	6,985	4%	0.9	0.9	0.9	123	160	107	2	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	1,561	5%	0.9	0.9	0.9	153	160	147	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.2.5

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	2,254	42.1	100.0	0.9	64	154	4	9	43	1	Metallic	CTOC	Sheen	Rainbow	Metallic	Sheen
Canada - Saint-Pierre et Miquelon	683	7.4	19.0	0.9	101	153	63	3	6	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Azores - Atlantic Ocean	883	5.8	14.7	0.9	127	156	106	3	5	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.2.6

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	801	3.8%	1.16	1.72	0.86	131	159	114	1	1	1	73	80	58	0	0	0
Funk Island Ecological Reserve	Ecological Reserve	CAN	VI	5.20	4.49	86%	0.86	0.86	0.86	89	89	88	1	1	1	99	121	77	0	0	0
Funk Island Ecological Reserve	Ecological Reserve	CAN	Ia	0.19	0.19	100%	0.86	0.86	0.86	89	89	88	1	1	1	99	121	77	0	0	0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.2.7

Water Column Dispersed and Dissolved Oil Intersection with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Sensitive Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Sackville Spur	NAFO VME	992	993	100%	99.98	100.00	99.14	19	23	14	30	38	22	275	1246	146	0	1	0
Northwest Flemish Cap	NAFO VME	412	413	100%	99.21	100.00	91.38	22	28	18	27	33	21	255	685	146	0	1	0
Northern Flemish Cap	NAFO VME	486	487	100%	91.70	100.00	81.03	28	35	19	23	31	16	271	1079	139	0	0	0
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	87.41	97.41	64.66	31	39	23	15	24	8	296	1566	126	0	1	0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	49,307	89%	81.98	100.00	0.86	12	147	1	37	73	1	667	5760	58	14	536	0
Orphan Spur	EBSA	21,569	20,155	93%	79.21	100.00	0.86	8	147	2	37	70	1	838	7383	59	6	161	0
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	72.29	100.00	15.52	14	28	7	17	50	2	540	4185	141	1	13	0
Bonivista Cod Box	Experimental Closure	9,830	9,848	100%	62.30	100.00	1.72	14	49	2	28	68	1	804	3890	128	1	21	0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	53.65	82.76	31.03	42	54	36	9	22	5	213	675	110	0	0	0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	49.53	88.79	14.66	25	40	18	12	113	4	227	4165	111	0	0	0
Orphan Knoll	NAFO VME	15,817	15,849	100%	42.79	78.45	12.93	28	82	8	20	47	3	492	3214	108	0	2	0
Tail of the Bank	NAFO VME	144	144	100%	16.76	18.97	12.07	31	35	24	5	7	3	195	313	109	0	0	0
Lilly Canyon - Carson Canyon	EBSA	120	117	97%	5.16	14.66	0.86	33	81	21	2	4	1	157	619	62	0	0	0
Beothuk Knoll	NAFO VME	648	649	100%	3.39	6.03	0.86	69	99	41	2	3	1	137	708	68	0	0	0
Funk Island Deep	Marine Refuge	7,272	6,352	87%	2.53	10.34	0.86	41	126	11	2	7	1	258	2082	58	0	1	0
Notre Dame Channel	EBSA	6,222	5,636	91%	2.46	12.93	0.86	40	148	11	2	7	1	253	2082	58	0	1	0
Cape Freels Coastline and Cabot Island	IBA	334	53	16%	1.25	2.59	0.86	47	68	22	1	1	1	133	211	65	0	0	0
Southeast Shoal and Tail of the Banks	EBSA	30,935	3,293	11%	1.25	6.90	0.86	72	150	24	1	3	1	94	477	59	0	0	0
Fogo Shelf	EBSA	9,403	1,868	20%	1.25	3.45	0.86	64	120	20	1	2	1	228	1330	59	0	0	0
3O Coral Closure	NAFO VME	14,057	4,281	30%	1.19	3.45	0.86	71	160	35	1	3	1	94	300	58	0	0	0
Newfoundland Seamounts	NAFO VME	15,491	4,078	26%	0.99	2.59	0.86	72	154	40	1	2	1	83	1001	58	0	0	0
Southwest Shelf Edge and Slope	EBSA	16,644	1,980	12%	0.94	1.72	0.86	78	135	40	1	2	1	95	300	58	0	0	0
Funk Island	IBA	135	80	59%	0.94	1.72	0.86	75	89	28	1	1	1	143	698	77	0	0	0
Division 3O Coral	Marine Refuge	10,336	2,100	20%	0.90	1.72	0.86	80	128	40	1	2	1	78	203	58	0	0	0
Virgin Rocks	EBSA	6,843	343	5%	0.86	0.86	0.86	73	73	73	1	1	1	92	92	91	0	0	0
Fogo Seamounts 2	NAFO VME	4,616	91	2%	0.86	0.86	0.86	72	72	72	1	1	1	134	137	134	0	0	0
Eastern Avalon	EBSA	36	2	4%	0.86	0.86	0.86	103	103	103	1	1	1	108	108	108	0	0	0
Funk Island Ecological Reserve	Ecological Reserve	5	4	86%	0.86	0.86	0.86	89	89	88	1	1	1	99	121	77	0	0	0
Fogo Seamounts 1	NAFO VME	4,522	293	6%	0.86	0.86	0.86	82	110	65	1	1	1	62	83	59	0	0	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.2.7

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	981	42.51	100.00	0.86	31	151	5	15	60	1	379	2291	59	0	12	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.3 Scenario 2: West Orphan well blowout capping stack scenario (Summer Season)

Surface Oil

Table D.1.3.1

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	48	1.1%	0.8	0.8	0.8	89	89	89	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	10,442	5.6%	1.0	4.1	0.8	75	89	62	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	36,526	24%	2.0	6.6	0.8	75	90	50	2	7	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	1,034	43%	1.0	1.7	0.8	82	89	77	1	1	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	20,099	94%	3.0	8.3	0.8	71	90	46	2	5	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	49	1.1%	0.8	0.8	0.8	89	89	89	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.3.2

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Sackville Spur	NAFO VME	992	993	100%	92.1	97.5	83.5	19	26	15	11	15	8	Metallic	DTOC	Metallic	Rainbow	Rainbow	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	87.0	92.6	78.5	22	28	18	11	16	8	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northwest Flemish Cap	NAFO VME	412	413	100%	80.8	89.3	74.4	21	28	17	10	13	7	Metallic	Metallic	Metallic	Rainbow	Rainbow	Rainbow
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	78.8	91.7	66.1	28	37	23	9	14	6	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Knoll	NAFO VME	15,817	15,849	100%	70.9	89.3	48.8	20	38	8	11	24	5	Metallic	DTOC	Rainbow	Rainbow	Metallic	Rainbow
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	52,950	96%	68.4	100.0	0.8	12	82	1	13	47	1	CTOC	CTOC	Sheen	Metallic	CTOC	Sheen
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	53.7	75.2	32.2	23	36	17	6	10	3	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	51.3	77.7	33.9	35	46	24	5	10	3	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Spur	EBSA	21,569	21,100	98%	39.5	97.5	0.8	11	74	1	12	25	1	CTOC	CTOC	Sheen	Metallic	DTOC	Sheen
Tail of the Bank	NAFO VME	144	144	100%	37.1	47.9	32.2	28	35	21	4	6	3	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	36.2	86.8	2.5	15	39	7	7	19	1	Metallic	CTOC	Rainbow	Metallic	Metallic	Rainbow
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	27.3	41.3	15.7	28	39	19	4	7	2	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Bonivista Cod Box	Experimental Closure	9,830	9,848	100%	25.9	79.3	0.8	15	63	2	9	23	1	DTOC	CTOC	Sheen	Metallic	DTOC	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	22.9	30.6	16.5	40	56	33	4	7	2	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Newfoundland Seamounts	NAFO VME	15,491	15,473	100%	7.9	20.7	0.8	51	89	35	2	7	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	17,028	55%	4.8	31.4	0.8	57	88	22	2	6	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	13,880	99%	4.0	12.4	0.8	60	90	35	2	4	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	16,577	100%	3.6	11.6	0.8	59	90	36	2	4	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	10,149	98%	3.4	9.9	0.8	64	89	36	2	4	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Notre Dame Channel	EBSA	6,222	3,522	57%	1.6	5.8	0.8	45	90	15	3	9	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Funk Island Deep	Marine Refuge	7,272	3,906	54%	1.5	5.8	0.8	45	90	15	3	9	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Fogo Seamounts 1	NAFO VME	4,522	1,465	32%	1.1	1.7	0.8	79	89	66	1	2	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Seamounts 2	NAFO VME	4,616	1,084	23%	0.9	1.7	0.8	85	85	82	1	1	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Laurentian Channel and Slope	EBSA	17,140	4,190	24%	0.9	1.7	0.8	79	89	59	1	2	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Laurentian Channel	AOI	16,564	4,070	25%	0.9	1.7	0.8	78	89	59	1	2	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	457	2%	0.8	0.8	0.8	82	83	82	2	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 μm (BAOAC " Sheen") thickness threshold

Table D.1.3.3

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Emulsion Thickness (microns)	Max of Max Time-Averaged Emulsion Thickness (microns)	Min of Max Time-Averaged Emulsion Thickness (microns)	Average of Average Time-Averaged Emulsion Thickness (microns)	Max of Average Time-Averaged Emulsion Thickness (microns)	Min of Average Time-Averaged Emulsion Thickness (microns)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	1,695	28.2	100.0	0.8	39	89	4	6	24	1	27.15	580.71	0.04	3.56	39.58	0.04	Metallic	CTOC	Sheen	Rainbow	Metallic	Sheen
Canada - Saint-Pierre et Miquelon	330	1.3	3.3	0.8	75	89	60	1	3	1	0.34	2.06	0.04	0.23	1.48	0.04	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.3.4

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	24	0.11%	0.83	0.83	0.83	81	81	81	1	1	1	60	60	60	0	0	0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.3.5

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Sensitive Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Sackville Spur	NAFO VME	992	993	100%	87.48	95.04	77.69	20	28	16	14	21	11	289	1502	169	0	2	0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	49,356	89%	70.92	100.00	0.83	9	66	1	22	48	1	546	5077	58	28	1072	0
Northern Flemish Cap	NAFO VME	486	487	100%	47.54	73.55	28.93	29	37	19	12	17	8	210	427	133	0	0	0
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	46.51	67.77	22.31	32	45	24	10	15	5	229	1454	119	0	1	0
Northwest Flemish Cap	NAFO VME	412	413	100%	43.56	58.68	20.66	20	29	17	11	17	6	247	603	140	0	1	0
Orphan Spur	EBSA	21,569	20,026	93%	34.25	99.17	0.83	8	60	1	21	44	1	495	3094	60	12	362	0
Northeast Shelf and Slope	EBSA	13,885	13,827	100%	25.64	84.30	0.83	14	50	7	7	27	1	361	1738	61	1	71	0
Orphan Knoll	NAFO VME	15,817	15,849	100%	22.74	53.72	4.13	22	55	8	11	33	2	296	2012	96	0	2	0
Bonivista Cod Box	Experimental Closure	9,830	9,452	96%	19.25	78.51	0.83	14	60	3	15	44	1	361	1867	58	1	32	0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	12.58	30.58	5.79	48	57	38	4	12	2	134	280	87	0	0	0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	11.42	33.88	1.65	30	57	18	5	59	1	157	565	68	0	1	0
Tail of the Bank	NAFO VME	144	144	100%	4.07	5.79	2.48	35	40	26	4	7	2	140	252	82	0	0	0
Lilly Canyon - Carson Canyon	EBSA	120	98	82%	1.80	4.13	0.83	36	63	24	2	6	1	102	242	61	0	0	0
3O Coral Closure	NAFO VME	14,057	1,616	11%	1.30	2.48	0.83	53	76	33	1	3	1	86	184	58	0	0	0
Southeast Shoal and Tail of the Banks	EBSA	30,935	733	2%	0.99	2.48	0.83	47	89	28	1	2	1	78	164	58	0	0	0
Newfoundland Seamounts	NAFO VME	15,491	1,205	8%	0.84	1.65	0.83	67	89	39	1	2	1	77	255	58	0	0	0
Beothuk Knoll	NAFO VME	648	120	19%	0.83	1.65	0.83	61	90	51	1	1	1	71	92	60	0	0	0
Division 3O Coral	Marine Refuge	10,336	474	5%	0.83	1.65	0.83	65	76	56	1	1	1	66	96	58	0	0	0
Southwest Shelf Edge and Slope	EBSA	16,644	868	5%	0.83	1.65	0.83	64	76	47	1	1	1	72	133	58	0	0	0
Funk Island Deep	Marine Refuge	7,272	323	4%	0.83	0.83	0.83	42	48	24	1	1	1	111	190	75	0	0	0
Notre Dame Channel	EBSA	6,222	327	5%	0.83	0.83	0.83	42	48	24	1	1	1	111	190	75	0	0	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.36

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	801	38.49	100.00	0.83	21	83	4	13	39	1	301	1386	58	1	7	0
Canada - Saint-Pierre et Miquelon	14	0.83	0.83	0.83	58	58	58	1	1	1	71	71	71	0	0	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.4 Scenario 2: West Orphan well blowout capping stack scenario (Winter Season)

Stranded Oil

Table D.1.4.1

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Baccalieu Island Ecological Reserve	Ecological Reserve	CAN	II	5.37	0.69	13%	0.9	0.9	0.9	77	77	77	Light	Light	Light
Deadman's Bay Provincial Park	Provincial Park	CAN	III	0.70	0.70	99%	0.9	0.9	0.9	44	45	43	Heavy	Heavy	Stain/Film
Windmill Bight Provincial Park	Provincial Park	CAN	II	2.86	0.06	2%	1.7	1.7	1.7	28	28	28	Heavy	Heavy	Heavy

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Table D.1.4.2

Stranded Oil Intersections with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected SA contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Cape Freels Coastline and Cabot Island	IBA	334.49	2.78	0.8%	1.7	1.7	1.7	28	28	28	Heavy	Heavy	Heavy
Fogo Shelf	EBSA	9,403.09	13.30	0.1%	1.3	1.7	0.9	36	45	28	Heavy	Heavy	Stain/Film
Baccalieu Island	IBA	45.21	2.82	6.2%	0.9	0.9	0.9	77	77	77	Light	Light	Light
Baccalieu Island Ecological Reserve	Ecological Reserve	17.50	0.69	4.0%	0.9	0.9	0.9	77	77	77	Light	Light	Light
Grates Point	IBA	66.53	7.38	11.1%	0.9	0.9	0.9	78	78	78	Stain/Film	Stain/Film	Stain/Film
Placentia Bay Extension	EBSA	7,693.17	14.99	0.2%	0.9	0.9	0.9	80	81	80	Light	Light	Stain/Film

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Surface Oil

Table D.1.4.3

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	20,309	95%	4.7	13.8	0.9	70	90	49	2	4	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	1,088	46%	1.5	2.6	0.9	75	90	70	2	4	1	Rainbow	Rainbow	Sheen	Rainbow	Rainbow	Sheen
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	25,481	17%	1.4	4.3	0.9	79	90	62	2	6	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	4,167	2%	0.9	1.7	0.9	88	90	83	2	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	1,040	1%	0.9	0.9	0.9	89	89	89	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	1,204	1%	0.9	0.9	0.9	89	89	89	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	152	3%	0.9	0.9	0.9	71	90	70	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	152	3%	0.9	0.9	0.9	70	90	70	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	CAN	VI	5.20	2.03	39%	0.9	0.9	0.9	36	36	36	1	1	1	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.4.4

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Sackville Spur	NAFO VME	992	993	100%	96.0	100.0	91.4	18	20	14	12	17	9	Metallic	Metallic	Metallic	Rainbow	Rainbow	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	94.6	98.3	87.1	22	28	19	12	19	9	Metallic	Metallic	Metallic	Rainbow	Rainbow	Rainbow
Northwest Flemish Cap	NAFO VME	412	413	100%	93.2	98.3	87.9	20	24	16	12	18	9	Metallic	Metallic	Metallic	Rainbow	Rainbow	Rainbow
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	89.4	96.6	79.3	25	31	20	11	17	7	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	78.5	94.8	59.5	21	30	16	8	14	4	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	73.1	94.0	56.0	35	39	25	7	15	5	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Orphan Knoll	NAFO VME	15,817	15,849	100%	64.7	84.5	42.2	22	45	7	11	22	3	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	54,987	100%	64.5	100.0	0.9	15	82	1	11	39	1	DTOC	CTOC	Sheen	Metallic	CTOC	Sheen
Tail of the Bank	NAFO VME	144	144	100%	63.4	69.0	54.3	28	30	25	5	9	4	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	60.8	94.8	21.6	14	23	7	9	20	3	Metallic	CTOC	Rainbow	Rainbow	Metallic	Rainbow
Orphan Spur	EBSA	21,569	21,609	100%	55.4	100.0	0.9	11	79	1	13	29	1	DTOC	CTOC	Sheen	Metallic	DTOC	Sheen
Bonivista Cod Box	Experimental Closure	9,830	9,848	100%	53.8	93.1	11.2	12	39	2	11	23	2	DTOC	CTOC	Rainbow	Metallic	Metallic	Rainbow
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	51.6	60.3	40.5	25	30	20	6	9	4	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Beothuk Knoll	NAFO VME	648	649	100%	49.9	57.8	39.7	36	45	26	5	8	3	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Newfoundland Seamounts	NAFO VME	15,491	15,522	100%	18.4	39.7	1.7	52	77	30	3	8	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	14,083	100%	14.6	37.1	1.7	49	85	33	3	7	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	10,356	100%	11.8	27.6	1.7	51	85	37	3	7	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	22,576	73%	10.8	53.4	0.9	50	90	20	3	9	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	16,660	100%	8.7	27.6	0.9	57	90	37	2	6	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Notre Dame Channel	EBSA	6,222	6,117	98%	8.3	24.1	0.9	34	86	11	3	7	1	Metallic	Metallic	Sheen	Rainbow	Metallic	Sheen
Funk Island Deep	Marine Refuge	7,272	6,861	94%	8.1	24.1	0.9	36	86	11	3	8	1	Metallic	Metallic	Sheen	Rainbow	Metallic	Sheen
Fogo Seamounts 1	NAFO VME	4,522	4,532	100%	7.1	17.2	2.6	50	72	37	3	5	1	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Virgin Rocks	EBSA	6,843	6,855	100%	5.7	12.1	0.9	52	81	35	3	6	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Seamounts 2	NAFO VME	4,616	3,964	86%	1.7	4.3	0.9	69	90	59	1	2	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Shelf	EBSA	9,403	996	11%	1.3	3.4	0.9	56	85	27	1	2	1	Rainbow	Metallic	Sheen	Rainbow	Metallic	Sheen
Funk Island	IBA	135	61	45%	0.9	1.7	0.9	37	45	36	1	1	1	Rainbow	Metallic	Rainbow	Rainbow	Metallic	Rainbow
Placentia Bay Extension	EBSA	7,693	341	4%	0.9	0.9	0.9	81	83	80	1	2	1	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow
Corner Seamounts	NAFO VME	40,251	281	1%	0.9	0.9	0.9	84	86	83	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape Freels Coastline and Cabot Island	IBA	334	4	1%	0.9	0.9	0.9	39	43	37	1	1	1	Metallic	Metallic	Sheen	Metallic	Metallic	Sheen
Eastern Avalon	EBSA	36	0	1%	0.9	0.9	0.9	75	86	70	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	5	2	38%	0.9	0.9	0.9	36	36	36	1	1	1	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow	Rainbow
Wadham Islands and adjacent Marine Area	IBA	159	6	4%	0.9	0.9	0.9	44	44	44	1	1	1	Metallic	Metallic	Metallic	Metallic	Metallic	Metallic

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.4.5

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	1,765	31.2	100.0	0.9	38	87	4	6	21	1	Metallic	CTOC	Sheen	Rainbow	Metallic	Sheen
Canada - Saint-Pierre et Miquelon	281	1.9	4.3	0.9	74	89	58	1	3	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Azores - Atlantic Ocean	59	0.9	0.9	0.9	85	87	83	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.4.6

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface EBSA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Sackville Spur	NAFO VME	992	993	100%	90.59	98.28	74.14	19	23	15	15	22	10	286	1009	153	0.5	3	0.1
Northwest Flemish Cap	NAFO VME	412	413	100%	80.77	89.66	68.97	22	29	17	17	22	12	236	909	138	0.3	1.3	0.1
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	46,284	84%	77.13	100.00	0.86	7	63	1	20	49	1	508	4114	59	16	556	0.0
Northern Flemish Cap	NAFO VME	486	487	100%	64.92	88.79	45.69	28	36	19	13	17	9	214	452	122	0	1	0.0
Orphan Spur	EBSA	21,569	19,303	89%	57.47	100.00	0.86	6	44	2	26	52	1	506	2825	60	9	191	0.0
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	51.02	68.97	23.28	32	42	25	8	15	4	224	1409	127	0.1	1	0.0
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	41.71	98.28	4.31	13	29	7	10	34	1	322	2105	103	1	21	0.0
Bonivista Cod Box	Experimental Closure	9,830	9,841	100%	35.20	96.55	0.86	13	77	2	19	52	1	411	2116	64	2	90	0.0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	27.11	72.41	5.17	26	44	17	8	61	2	202	1570	93	0.2	1	0.0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	22.39	50.00	11.21	42	52	36	6	11	3	147	493	91	0.1	0.2	0.0
Tail of the Bank	NAFO VME	144	144	100%	7.43	11.21	4.31	31	38	27	3	5	2	127	395	92	0.1	0.1	0.0
Orphan Knoll	NAFO VME	15,817	15,589	99%	7.17	23.28	0.86	34	90	7	4	14	1	156	1858	58	0.1	0.6	0.0
Lilly Canyon - Carson Canyon	EBSA	120	118	98%	2.32	7.76	0.86	31	64	21	1	4	1	109	228	58	0.1	0.4	0.0
Notre Dame Channel	EBSA	6,222	2,756	44%	1.47	5.17	0.86	43	84	12	1	4	1	127	695	58	0.0	0.1	0.0
Funk Island Deep	Marine Refuge	7,272	2,962	41%	1.46	4.31	0.86	42	84	12	1	4	1	137	1888	58	0.0	0.1	0.0
Southeast Shoal and Tail of the Banks	EBSA	30,935	1,281	4%	1.19	3.45	0.86	46	89	25	1	3	1	96	347	59	0.0	0.3	0.0
Beothuk Knoll	NAFO VME	648	497	77%	1.00	2.59	0.86	71	88	49	1	2	1	72	196	59	0.0	0.0	0.0
3O Coral Closure	NAFO VME	14,057	2,255	16%	0.98	3.45	0.86	65	84	44	1	3	1	86	321	58	0.0	0.1	0.0
Fogo Shelf	EBSA	9,403	442	5%	0.87	1.72	0.86	55	84	27	1	1	1	93	293	59	0.0	0.0	0.0
Division 3O Coral	Marine Refuge	10,336	1,135	11%	0.86	1.72	0.86	67	84	53	1	1	1	91	321	58	0.0	0.0	0.0
Southwest Shelf Edge and Slope	EBSA	16,644	1,181	7%	0.86	1.72	0.86	66	82	50	1	1	1	90	321	58	0.0	0.0	0.0
Newfoundland Seamounts	NAFO VME	15,491	1,681	11%	0.86	1.72	0.86	63	89	37	1	1	1	89	358	58	0.0	0.0	0.0
Fogo Seamounts 1	NAFO VME	4,522	145	3%	0.86	0.86	0.86	84	90	69	1	1	1	65	153	58	0.0	0.0	0.0
Funk Island	IBA	135	2	1%	0.86	0.86	0.86	42	42	42	1	1	1	124	124	124	0.0	0.0	0.0
Cape Freels Coastline and Cabot Island	IBA	334	34	10%	0.86	0.86	0.86	84	84	84	1	1	1	87	87	87	0.0	0.0	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.4.7

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	787	38.56	100.00	0.86	19	86	3	30	1	9	298	2446	58	0	4	0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.5 Scenario 3: East Orphan well blowout relief well scenario (Summer Season)

Stranded Oil

Table D.1.5.1

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Costa Nordeste (Ilha das Flores)	Habitats or Species Managemer	PRT	IV	9.48	5.45	57%	1.5	1.8	0.9	151	152	150	Light	Light	Stain/Film
Costa Norte (Ilha das Flores)	Resource Management Protecte	PRT	VI	42.64	12.26	29%	1.5	1.8	0.9	151	152	150	Light	Light	Light
Ponta da Caveira	Habitats or Species Managemer	PRT	IV	0.79	0.74	93%	1.3	1.8	0.9	150	150	150	Light	Light	Stain/Film
Morro Alto e Pico da SÃ©	Nature Reserve	PRT	Ib	17.09	2.54	15%	0.9	0.9	0.9	152	152	152	Stain/Film	Stain/Film	Stain/Film

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for “Stain / Film” oiling.

Surface Oil

Table D.1.5.3

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,533	38%	87.1	100.0	66.1	40	58	22	15	82	6	Rainbow	Metallic	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	167,121	90%	43.1	100.0	1.8	52	112	23	9	62	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,588	100%	27.4	40.2	17.9	53	73	37	4	8	2	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,588	100%	27.2	40.2	17.9	53	73	37	4	8	2	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,323	100%	25.7	45.5	11.6	44	68	25	4	8	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	29,513	29%	15.3	76.8	1.8	71	145	47	3	24	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	29,512	29%	15.3	76.8	1.8	72	145	47	3	23	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
OceÃ¢nica do Corvo	Habitats or Species Management Protected Area	PRT	IV	2,856	2,498	87%	2.1	6.3	0.9	119	158	93	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Costa do Corvo	Resource Management Protected Area	PRT	VI	276	6.8	2%	1.2	1.8	0.9	144	147	137	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Campo Hidrotermal Lucky Strike	Nature Reserve	PRT	Ib	322	111	35%	0.9	0.9	0.9	152	152	152	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	217	9%	0.9	0.9	0.9	117	118	117	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.5.4

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Orphan Knoll	NAFO VME	15,817	15,849	100%	99.8	100.0	94.6	6	13	2	38	51	28	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Sheen
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	90.7	99.1	81.3	10	17	7	24	36	19	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Sackville Spur	NAFO VME	992	993	100%	70.3	94.6	40.2	6	12	3	16	28	7	Metallic	CTOC	Rainbow	Rainbow	Metallic	Rainbow
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	69.8	84.8	56.3	18	25	8	17	31	9	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Northern Flemish Cap	NAFO VME	486	487	100%	63.7	80.4	51.8	8	16	4	16	23	11	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Northwest Flemish Cap	NAFO VME	412	413	100%	33.2	50.9	23.2	12	19	6	13	18	7	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	55,219	100%	29.6	88.4	0.9	25	153	2	9	30	1	Metallic	CTOC	Sheen	Rainbow	Metallic	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	25.2	31.3	18.8	34	36	27	7	12	4	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	11.0	23.2	2.7	31	65	14	4	11	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Tail of the Bank	NAFO VME	144	144	100%	6.5	8.9	3.6	55	76	47	2	5	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Orphan Spur	EBSA	21,569	20,694	96%	5.3	20.5	0.9	61	159	18	2	10	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
Newfoundland Seamounts	NAFO VME	15,491	15,514	100%	4.7	13.4	0.9	67	150	35	2	6	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Northeast Shelf and Slope	EBSA	13,885	12,693	91%	4.6	22.3	0.9	40	159	6	2	7	1	Metallic	DTOC	Sheen	Rainbow	Metallic	Sheen
Lilly Canyon - Carson Canyon	EBSA	120	116	97%	2.5	4.5	0.9	51	108	28	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	7,405	25%	1.7	7.1	0.9	107	160	48	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Bonivista Cod Box	Experimental Closure	9,830	3,415	35%	1.7	5.4	0.9	94	157	27	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	7,883	56%	1.4	5.4	0.9	91	160	38	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	10,168	33%	1.3	4.5	0.9	81	160	30	1	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Division 3O Coral	Marine Refuge	10,336	4,853	47%	1.1	3.6	0.9	95	160	45	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	6,857	41%	1.1	3.6	0.9	87	160	45	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Corner Seamounts	NAFO VME	40,251	2,139	5%	1.1	2.7	0.9	148	157	123	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 1	NAFO VME	4,522	1,513	33%	1.0	1.8	0.9	129	159	87	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Marginal Trough	EBSA	16,952	1,195	7%	1.0	1.8	0.9	137	145	113	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hawke Channel	Marine Refuge	8,839	1,260	14%	1.0	1.8	0.9	136	146	122	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
St. Pierre Bank	EBSA	5,482	191	3%	0.9	0.9	0.9	98	119	98	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Deep	Marine Refuge	7,272	170	2%	0.9	0.9	0.9	156	157	153	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 2	NAFO VME	4,616	248	5%	0.9	0.9	0.9	154	154	154	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Grey Islands	EBSA	11,301	198	2%	0.9	0.9	0.9	152	152	150	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Laurentian Channel and Slope	EBSA	17,140	276	2%	0.9	0.9	0.9	102	116	98	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Notre Dame Channel	EBSA	6,222	314	5%	0.9	0.9	0.9	156	157	153	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Laurentian Channel	AOI	16,564	358	2%	0.9	0.9	0.9	102	116	98	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.5.5

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	1,526	27.0	88.4	0.9	55	158	2	7	30	1	Metallic	CTOC	Sheen	Rainbow	Metallic	Sheen
Azores - Atlantic Ocean	785	5.4	36.6	0.9	99	159	54	2	13	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Greenland - Atlantic Ocean	484	1.7	9.8	0.9	105	156	56	1	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Canada - Saint-Pierre et Miquelon	19	0.9	0.9	0.9	98	98	98	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.5.6

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	22,294	12.05%	3.50	16.07	0.89	77	160	24	4	27	1	119	2551	58	0.0	0.0	0.0
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	181	0.18%	1.14	1.79	0.89	80	104	58	1	1	1	102	363	60	0.0	0.0	0.0
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Pro	PRT	IV	101,134	231	0.23%	1.11	1.79	0.89	82	104	58	1	1	1	97	363	60	0.0	0.0	0.0
Monte Submarino Altair	Habitats or Species Management Pro	PRT	IV	4,579	181	3.95%	1.06	1.79	0.89	63	95	52	1	1	1	79	348	59	0.0	0.0	0.0
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	181	3.96%	1.06	1.79	0.89	63	95	52	1	1	1	77	348	59	0.0	0.0	0.0
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	1,142	5.37%	0.90	1.79	0.89	61	94	32	1	2	1	82	933	59	0.0	0.1	0.0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.5.7

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface EBSA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Orphan Knoll	NAFO VME	15,817	15,849	100%	54.73	91.07	11.61	8	19	2	9	23	3	496	3217	179	1.4	9.0	0.2
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	25.87	46.43	8.04	13	25	7	6	12	3	368	1573	137	0.5	1.7	0.1
Sackville Spur	NAFO VME	992	993	100%	19.43	58.04	6.25	8	20	3	4	6	1	388	768	155	0.8	2.3	0.2
Northern Flemish Cap	NAFO VME	486	487	100%	9.11	24.11	2.68	11	25	5	3	7	1	290	593	137	0.2	0.8	0.0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	24,622	45%	5.90	33.93	0.89	20	106	3	3	14	1	278	1581	58	0.5	8.7	0.0
Northwest Flemish Cap	NAFO VME	412	413	100%	4.10	8.93	0.89	15	40	6	2	5	1	232	1414	59	0.2	1.0	0.0
Eastern Flemish Cap	NAFO VME	1,609	1,578	98%	3.20	11.61	0.89	32	67	9	2	10	1	163	504	59	0.0	0.4	0.0
Northeast Shelf and Slope	EBSA	13,885	1,799	13%	1.04	2.68	0.89	29	52	9	1	2	1	150	1090	58	0.0	0.9	0.0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	335	6%	1.02	3.57	0.89	30	45	15	1	1	1	83	388	59	0.0	0.1	0.0
Orphan Spur	EBSA	21,569	401	2%	0.92	1.79	0.89	43	65	33	1	1	1	85	361	59	0.0	0.0	0.0
Beothuk Knoll	NAFO VME	648	16	2%	0.89	0.89	0.89	51	74	29	1	1	1	214	430	93	0.0	0.0	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.5.8

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	426	10.69	33.93	0.89	19	62	3	4	11	1	334	1581	60	1	6	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.6 Scenario 3: East Orphan well blowout relief well scenario (Winter Season)

Stranded Oil

Table D.1.6.1.

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Mistaken Point Ecological Reserve	Ecological Reserve	CAN	II	5.70	2.37	42%	3.4	4.3	2.6	64	64	64	Moderate	Moderate	Moderate
Costa Norte (Ilha das Flores)	Resource Management Protecte	PRT	VI	42.64	13.14	31%	1.9	3.4	0.9	136	143	130	Light	Moderate	Light
Costa Nordeste (Ilha das Flores)	Habitats or Species Managemer	PRT	IV	9.48	6.86	72%	1.8	3.4	0.9	141	154	130	Light	Moderate	Light
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	II	11.19	7.31	65%	1.7	1.7	1.7	95	95	95	Stain/Film	Stain/Film	Stain/Film
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	VI	53.66	1.39	3%	1.7	1.7	1.7	95	95	95	Stain/Film	Stain/Film	Stain/Film
Morro Alto e Pico da SÃ©	Nature Reserve	PRT	Ib	17.09	0.01	0%	1.7	1.7	1.7	130	130	130	Light	Light	Light
Ponta da Caveira	Habitats or Species Managemer	PRT	IV	0.79	0.74	93%	1.3	1.7	0.9	155	156	154	Light	Light	Light
Dungeon Provincial Park	Provincial Park	CAN	III	0.02	0.02	100%	0.9	0.9	0.9	59	59	59	Light	Light	Light
IlhÃ©u de Maria Vaz	Nature Reserve	PRT	Ia	0.11	0.10	93%	0.9	0.9	0.9	141	141	141	Light	Light	Light
Windmill Bight Provincial Park	Provincial Park	CAN	II	2.86	0.06	2%	0.9	0.9	0.9	104	104	104	Light	Light	Light
Zona Central e FalÃ©sias da Costa O	Protected Landscape	PRT	V	27.52	2.30	8%	0.9	0.9	0.9	141	141	141	Light	Light	Light

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Table D.1.6.2

Stranded Oil Intersections with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected SA contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Mistaken Point	IBA	102.75	10.51	10.2%	2.6	4.3	1.7	71	78	64	Light	Moderate	Stain/Film
Cape St. Mary's	IBA	329.61	29.34	8.9%	2.0	2.6	1.7	94	97	91	Light	Moderate	Stain/Film
Placentia Bay Extension	EBSA	7,693.17	43.49	0.6%	1.9	2.6	0.9	92	97	72	Light	Moderate	Stain/Film
Cape St. Mary's Ecological Reserve	Ecological Reserve	53.66	1.39	2.6%	1.7	1.7	1.7	95	95	95	Stain/Film	Stain/Film	Stain/Film
Placentia Bay	IBA	1,398.93	11.34	0.8%	1.5	2.6	0.9	92	103	91	Light	Moderate	Light
Eastern Avalon	EBSA	35.60	0.78	2.2%	1.3	1.7	0.9	32	36	27	Moderate	Moderate	Moderate
The Cape Pine and St. Shotts Barren	IBA	57.40	22.75	39.6%	1.3	1.7	0.9	78	78	78	Light	Light	Light
St. Pierre et Miquelon	France	234.21	6.29	2.7%	1.1	1.7	0.9	121	134	110	Light	Light	Stain/Film
Cape Freels Coastline and Cabot Island	IBA	334.49	17.89	5.3%	0.9	0.9	0.9	104	104	104	Light	Light	Light
Cape St. Francis	IBA	70.18	3.06	4.4%	0.9	0.9	0.9	34	34	34	Heavy	Heavy	Heavy
Fogo Shelf	EBSA	9,403.09	4.87	0.1%	0.9	0.9	0.9	104	104	104	Light	Light	Light

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Surface Oil

Table D.1.6.3

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,533	38%	86.4	100.0	58.6	42	68	22	16	81	6	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,588	100%	46.3	56.0	37.1	48	71	35	5	10	3	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,588	100%	46.3	56.0	37.1	48	71	35	5	10	3	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,323	100%	38.3	56.0	19.0	43	79	25	5	11	2	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	163,819	89%	36.1	99.1	0.9	63	160	25	6	71	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	29,513	29%	33.6	85.3	11.2	69	106	42	5	43	2	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	29,521	29%	33.5	85.3	11.2	69	106	42	5	43	2	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
OceÃ¢nica do Corvo	Habitats or Species Management Protected Area	PRT	IV	2,856	2,835	99%	3.9	9.5	0.9	120	158	87	2	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Costa e CaldeirÃ£o do Corvo	Habitats or Species Management Protected Area	PRT	IV	8	8	100%	1.5	2.6	0.9	139	146	129	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Costa do Corvo	Resource Management Protected Area	PRT	VI	276	219	79%	1.2	2.6	0.9	135	154	127	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Gully Marine Protected Area	Marine Protected Area	CAN	Not Assigned	2,385	259	11%	1.0	1.7	0.9	148	156	117	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Campo Hidrotermal Menez Gwen	Nature Reserve	PRT	Ib	284	72	25%	0.9	0.9	0.9	135	136	135	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Campo Hidrotermal Lucky Strike	Nature Reserve	PRT	Ib	322	128	40%	0.9	0.9	0.9	139	139	139	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	CAN	VI	5.20	4.86	94%	0.9	0.9	0.9	102	102	102	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	CAN	Ia	0.187	0.187	100%	0.9	0.9	0.9	102	102	102	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape St. Mary's Ecological Reserve	Ecological Reserve	CAN	VI	54	16	29%	0.9	0.9	0.9	139	139	139	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.6.4

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Orphan Knoll	NAFO VME	15,817	15,849	100%	100.0	100.0	98.3	6	12	2	47	62	37	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	99.7	100.0	96.6	8	14	5	37	47	29	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	96.8	100.0	88.8	16	22	8	33	44	24	Rainbow	Metallic	Sheen	Sheen	Sheen	Sheen
Northern Flemish Cap	NAFO VME	486	487	100%	96.8	100.0	94.0	7	11	4	38	47	32	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Sackville Spur	NAFO VME	992	993	100%	95.5	100.0	81.9	6	9	3	30	41	24	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northwest Flemish Cap	NAFO VME	412	413	100%	79.9	93.1	62.9	10	16	7	24	35	19	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	66.1	71.6	59.5	25	32	19	21	26	15	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	55,362	100%	58.1	94.8	5.2	16	71	2	22	56	3	Metallic	DTOC	Sheen	Rainbow	Rainbow	Sheen
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	51.5	64.7	34.5	21	32	9	15	26	8	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Tail of the Bank	NAFO VME	144	144	100%	37.3	40.5	33.6	25	32	23	10	13	7	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	32.7	73.3	11.2	13	26	4	10	23	4	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Sheen
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	29.9	40.5	21.6	25	42	21	6	10	4	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Orphan Spur	EBSA	21,569	21,609	100%	24.3	50.0	1.7	29	67	6	7	20	1	Rainbow	DTOC	Sheen	Sheen	Rainbow	Sheen
Newfoundland Seamounts	NAFO VME	15,491	15,522	100%	20.9	37.9	5.2	43	92	29	4	10	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
Bonivista Cod Box	Experimental Closure	9,830	9,839	100%	10.1	34.5	0.9	31	122	7	4	16	1	Rainbow	DTOC	Sheen	Rainbow	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	13,898	99%	6.7	18.1	0.9	63	154	35	3	8	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	29,161	94%	6.1	31.0	0.9	64	160	22	2	9	1	Sheen	Metallic	Sheen	Sheen	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	10,170	98%	5.4	16.4	0.9	70	154	46	3	8	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	14,762	89%	5.0	16.4	0.9	75	160	39	2	8	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Virgin Rocks	EBSA	6,843	6,857	100%	4.4	10.3	0.9	39	124	26	7	16	1	Rainbow	Rainbow	Sheen	Sheen	Rainbow	Sheen
Fogo Seamounts 1	NAFO VME	4,522	4,532	100%	4.3	8.6	0.9	70	122	56	3	7	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	11,338	38%	3.7	12.9	0.9	64	159	26	2	11	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 2	NAFO VME	4,616	2,330	50%	1.6	3.4	0.9	100	155	79	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Notre Dame Channel	EBSA	6,222	3,090	50%	1.1	2.6	0.9	76	150	43	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Marginal Trough	EBSA	16,952	1,956	12%	1.0	2.6	0.9	117	141	97	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Deep	Marine Refuge	7,272	3,161	43%	1.0	2.6	0.9	78	157	44	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Placentia Bay Extension	EBSA	7,693	1,079	14%	1.0	1.7	0.9	97	139	74	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape St. Mary's	IBA	330	144	44%	1.0	1.7	0.9	127	139	95	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Shelf	EBSA	9,403	1,490	16%	1.0	2.6	0.9	77	137	45	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hawke Channel	Marine Refuge	8,839	1,234	14%	1.0	1.7	0.9	122	158	106	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Corner Seamounts	NAFO VME	40,251	7,709	19%	0.9	2.6	0.9	135	160	108	1	7	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
New England Seamounts	NAFO VME	178,306	1,005	1%	0.9	0.9	0.9	157	160	154	2	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Laurentian Channel and Slope	EBSA	17,140	95	1%	0.9	0.9	0.9	79	79	79	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Grey Islands	EBSA	11,301	122	1%	0.9	0.9	0.9	51	54	51	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island	IBA	135	73	54%	0.9	0.9	0.9	102	102	102	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Eastern Avalon	EBSA	36	4	12%	0.9	0.9	0.9	76	127	34	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Ecological Reserve	Ecological Reserve	5	5	94%	0.9	0.9	0.9	102	102	102	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hopedale Saddle	Marine Refuge	15,450	56	0.4%	0.9	0.9	0.9	131	131	131	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Mistaken Point	IBA	103	7	7%	0.9	0.9	0.9	156	156	156	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Placentia Bay	IBA	1,399	0.02	0.001%	0.9	0.9	0.9	90	90	90	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
St. Pierre Bank	EBSA	5,482	11	0.2%	0.9	0.9	0.9	79	79	79	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Wadham Islands and adjacent Marine Area	IBA	159	2	1%	0.9	0.9	0.9	67	67	67	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Laurentian Channel	AOI	16,564	142	1%	0.9	0.9	0.9	79	79	79	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Cape St. Mary's Ecological Reserve	Ecological Reserve	54	16	30%	0.9	0.9	0.9	139	139	139	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.6.5

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	2,216	33.8	94.8	0.9	53	159	2	12	52	1	Rainbow	DTOC	Sheen	Sheen	Rainbow	Sheen
Azores - Atlantic Ocean	892	8.6	64.7	0.9	107	159	58	2	17	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Greenland - Atlantic Ocean	545	1.7	5.2	0.9	129	160	66	1	5	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Canada - Saint-Pierre et Miquelon	195	1.2	2.6	0.9	110	160	80	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.6.6

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	207	1.0%	0.86	0.86	0.86	66	91	38	1	1	1	75	349	62	0.0	0.0	0.0
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	159.93	0.2%	0.86	0.86	0.86	136	155	69	1	1	1	94	272	60	0.0	0.0	0.0
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	140.97	0.1%	0.86	0.86	0.86	136	155	69	1	1	1	95	272	64	0.0	0.0	0.0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.6.7

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface EBSA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Orphan Knoll	NAFO VME	15,817	15,849	100%	40.45	77.59	12.93	7	16	2	9	23	3	388	2682	160	2	18	0.5
Sackville Spur	NAFO VME	992	993	100%	34.49	70.69	18.10	7	14	3	6	9	3	392	1519	224	2	8	1
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	30.01	50.00	10.34	9	21	5	6	10	3	294	1152	135	2	5	1
Northern Flemish Cap	NAFO VME	486	487	100%	22.90	39.66	14.66	8	13	5	6	11	3	337	914	222	1	5	0.4
Northwest Flemish Cap	NAFO VME	412	413	100%	10.51	18.10	1.72	13	30	7	3	8	1	290	875	96	1	2	0.0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	37,961	69%	9.98	42.24	0.86	15	90	3	4	15	1	289	2564	58	1	9	0.0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	5.05	17.24	0.86	29	58	9	3	10	1	171	521	66	1	3	0.0
Northeast Shelf and Slope	EBSA	13,885	13,185	95%	4.96	18.97	0.86	17	61	7	2	5	1	259	2481	58	0.5	4	0.0
Orphan Spur	EBSA	21,569	4,807	22%	2.80	12.07	0.86	22	90	7	1	5	1	205	833	59	0.2	5	0.0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	4,128	76%	1.83	6.90	0.86	31	86	16	1	3	1	138	1599	58	0.1	1	0.0
Beothuk Knoll	NAFO VME	648	504	78%	1.81	3.45	0.86	37	76	22	1	3	1	152	315	59	0.1	0.3	0.0
Bonivista Cod Box	Experimental Closure	9,830	3,682	37%	1.66	5.17	0.86	23	48	7	1	4	1	166	594	58	0.1	1	0.0
Virgin Rocks	EBSA	6,843	1,070	16%	0.91	1.72	0.86	43	72	28	1	2	1	108	355	59	0.0	0.2	0.0
3O Coral Closure	NAFO VME	14,057	4	0%	0.86	0.86	0.86	87	87	86	1	1	1	169	203	135	0.0	0.0	0.0
Eastern Avalon	EBSA	36	2	5%	0.86	0.86	0.86	36	36	36	1	1	1	103	103	103	0.0	0.0	0.0
Lilly Canyon - Carson Canyon	EBSA	120	13	11%	0.86	0.86	0.86	32	70	19	1	1	1	146	363	59	0.0	0.0	0.0
Southeast Shoal and Tail of the Banks	EBSA	30,935	15	0%	0.86	0.86	0.86	85	104	66	1	1	1	322	330	314	0.0	0.0	0.0
Tail of the Bank	NAFO VME	144	5	4%	0.86	0.86	0.86	53	53	53	1	1	1	73	87	58	0.0	0.0	0.0
Newfoundland Seamounts	NAFO VME	15,491	136	1%	0.86	0.86	0.86	57	74	47	1	1	1	111	348	60	0.0	0.0	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.6.8

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	618	12.55	42.24	0.86	16	62	3	4	15	1	296	1106	58	1	6	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.7 Scenario 4: East Orphan well blowout capping stack scenario (Summer Season)

Surface Oil

Table D.1.7.1

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,533	38%	23.1	86.8	2.5	44	79	22	4	35	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	148,044	80%	9.1	63.6	0.8	58	90	25	3	16	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,154	99%	4.6	13.2	0.8	53	90	28	1	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,422	97%	3.1	9.1	0.8	63	90	42	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,422	97%	3.1	9.1	0.8	63	90	42	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	14,766	15%	1.6	14.0	0.8	72	90	43	1	8	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	14,310	14%	1.6	13.2	0.8	72	90	43	1	8	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.7.2

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Orphan Knoll	NAFO VME	15,817	15,849	100%	96.9	100.0	81.0	6	14	2	19	31	12	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Sheen
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	76.8	95.0	61.2	11	17	7	14	22	9	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Sackville Spur	NAFO VME	992	993	100%	51.8	87.6	23.1	7	14	3	10	20	5	Metallic	DTOC	Rainbow	Rainbow	Rainbow	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	45.6	63.6	33.9	9	17	4	9	16	6	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	41.9	59.5	26.4	21	30	9	8	15	3	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Northwest Flemish Cap	NAFO VME	412	413	100%	18.5	32.2	9.1	14	26	6	6	8	4	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	52,892	96%	13.8	65.3	0.8	26	90	4	5	23	1	Metallic	DTOC	Sheen	Rainbow	Metallic	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	7.4	14.9	2.5	48	72	29	3	5	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,229	97%	4.1	13.2	0.8	35	89	15	2	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Northeast Shelf and Slope	EBSA	13,885	9,117	66%	2.7	11.6	0.8	35	90	6	1	6	1	Rainbow	Metallic	Sheen	Rainbow	Metallic	Sheen
Orphan Spur	EBSA	21,569	11,928	55%	1.8	6.6	0.8	53	90	17	1	5	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Newfoundland Seamounts	NAFO VME	15,491	8,647	56%	1.4	5.0	0.8	71	90	40	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Lilly Canyon - Carson Canyon	EBSA	120	59	49%	1.1	2.5	0.8	65	90	30	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Bonivista Cod Box	Experimental Closure	9,830	1,912	19%	1.1	2.5	0.8	69	90	28	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Division 3O Coral	Marine Refuge	10,336	605	6%	1.0	1.7	0.8	80	90	68	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
3O Coral Closure	NAFO VME	14,057	882	6%	0.9	1.7	0.8	79	90	67	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	2,223	7%	0.9	1.7	0.8	65	90	46	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	471	2%	0.9	1.7	0.8	84	90	78	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Tail of the Bank	NAFO VME	144	111	77%	0.9	2.5	0.8	66	75	45	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	930	6%	0.8	0.8	0.8	73	90	62	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 1	NAFO VME	4,522	67	1%	0.8	0.8	0.8	90	90	86	2	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hawke Channel	Marine Refuge	8,839	13	0%	0.8	0.8	0.8	85	85	85	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.7.3

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	999	20.2	65.3	0.8	36	90	4	5	21	1	Rainbow	DTOC	Sheen	Rainbow	Metallic	Sheen
Azores - Atlantic Ocean	88	1.0	1.7	0.8	79	90	58	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Greenland - Atlantic Ocean	19	0.8	0.8	0.8	76	90	68	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.7.4

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	803	0.43%	0.86	1.65	0.83	52	73	24	1	1	1	113	601	58	0.0	0.0	0.0
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	4	0.00%	0.83	0.83	0.83	79	79	79	1	1	1	77	77	77	0.0	0.0	0.0
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	40	0.19%	0.83	0.83	0.83	53	74	45	1	1	1	80	90	63	0.0	0.0	0.0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.7.5

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface EBSA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Orphan Knoll	NAFO VME	15,817	15,849	100%	27.42	72.73	3.31	9	24	2	4	14	1	220	1397	95	1	5	0.0
Sackville Spur	NAFO VME	992	993	100%	8.41	28.93	0.83	13	40	4	2	5	1	160	690	62	0	2	0.0
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	7.63	19.01	0.83	18	44	8	2	7	1	153	683	66	0.1	1	0.0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	18,195	33%	4.54	23.14	0.83	18	67	4	2	8	1	141	815	58	0.3	4	0.0
Northern Flemish Cap	NAFO VME	486	368	76%	2.93	8.26	0.83	16	54	5	2	5	1	113	309	58	0.1	0.3	0.0
Eastern Flemish Cap	NAFO VME	1,609	753	47%	1.79	5.79	0.83	33	66	11	1	3	1	99	635	58	0.0	0.1	0.0
Northwest Flemish Cap	NAFO VME	412	301	73%	1.15	2.48	0.83	26	53	10	1	3	1	84	437	58	0.0	0.3	0.0
Northeast Shelf and Slope	EBSA	13,885	720	5%	0.98	2.48	0.83	25	45	10	1	2	1	94	144	58	0.0	0.3	0.0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	8	0%	0.83	0.83	0.83	24	24	24	1	1	1	104	104	104	0.0	0.0	0.0
Orphan Spur	EBSA	21,569	24	0%	0.83	0.83	0.83	34	44	26	1	1	1	163	276	68	0.0	0.0	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.7.6

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	283	9.54	23.14	0.83	14	56	4	3	7	1	173	815	59	1	3	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

D.1.8 Scenario 4: East Orphan well blowout capping stack scenario (Winter Season)

Stranded Oil

Table D.1.8.1

Stranded Oil Intersections with Protected Areas

Name	Designation	Country	IUCN Category	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected Area contacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Deadman's Bay Provincial Park	Provincial Park	CAN	III	0.70	0.00	1%	0.9	0.9	0.9	58	58	58	Light	Light	Light
Marine Drive Provincial Park	Provincial Park	CAN	II	6.27	0.34	5%	0.9	0.9	0.9	34	34	34	Moderate	Moderate	Moderate
Witless Bay Ecological Reserve	Ecological Reserve	CAN	VI	29.03	3.82	13%	0.9	0.9	0.9	73	73	73	Light	Light	Stain/Film
Witless Bay Ecological Reserve	Ecological Reserve	CAN	II	1.46	0.29	20%	0.9	0.9	0.9	73	73	73	Light	Light	Stain/Film

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Table D.1.8.2

Stranded Oil Intersections with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Protected SAcontacted by emulsified oil > 1 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average Degree of oiling	Max Degree of oiling	Min Degree of oiling
Cape St. Francis	IBA	70.18	0.51	0.7%	0.9	0.9	0.9	34	34	34	Moderate	Moderate	Moderate
Fogo Shelf	EBSA	9,403.09	1.60	0.0%	0.9	0.9	0.9	58	58	58	Light	Light	Light
Witless Bay Ecological Reserve	Ecological Reserve	29.03	3.82	13.2%	0.9	0.9	0.9	73	73	73	Light	Light	Stain/Film
Witless Bay Islands	IBA	62.05	11.96	19.3%	0.9	0.9	0.9	73	73	73	Light	Light	Stain/Film

* Probability of stranded oil emulsion mass exceeding the 0.0019 tonnes/km (or 0.001 litres / m^2 = 1 micron), minimum threshold for "Stain / Film" oiling.

Surface Oil

Table D.1.8.3

Surface Oiling Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of Protected Area contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	152,732	57,528	38%	15.1	67.2	0.9	49	89	22	3	24	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	97,888	53%	5.9	40.5	0.9	60	90	23	2	14	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Milne Seamount Complex MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	21,279	21,053	99%	4.3	14.7	0.9	53	90	21	2	5	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Monte Submarino Altair	Habitats or Species Management Protected Area	PRT	IV	4,579	4,548	99%	3.8	9.5	0.9	60	88	41	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Altair Seamount High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	4,579	4,547	99%	3.8	9.5	0.9	60	88	41	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
MAR North of the Azores High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Reported	101,235	18,737	19%	1.6	12.9	0.9	74	90	47	1	10	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
MARNA (Mid-Atlantic Ridge North of the Azores)	Habitats or Species Management Protected Area	PRT	IV	101,134	19,111	19%	1.6	13.8	0.9	74	90	47	1	10	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Witless Bay Ecological Reserve	Ecological Reserve	CAN	VI	29	2	6%	0.9	0.9	0.9	73	73	73	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
OceÃ¢nica do Corvo	Habitats or Species Management Protected Area	PRT	IV	2,856	63	2%	0.9	0.9	0.9	84	86	84	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.8.4

Surface Oiling Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface area of SA contacted by emulsified oil > 0.04 micron thickness	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Orphan Knoll	NAFO VME	15,817	15,849	100%	96.1	100.0	81.0	6	13	2	20	30	14	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	93.3	100.0	79.3	9	16	5	17	25	12	Rainbow	Metallic	Rainbow	Sheen	Rainbow	Sheen
Sackville Spur	NAFO VME	992	993	100%	80.4	100.0	56.0	6	10	3	15	21	11	Metallic	Metallic	Rainbow	Rainbow	Rainbow	Rainbow
Northern Flemish Cap	NAFO VME	486	487	100%	78.8	92.2	63.8	7	12	4	19	26	14	Rainbow	Metallic	Rainbow	Rainbow	Rainbow	Sheen
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	71.6	84.5	54.3	16	25	9	14	23	9	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Northwest Flemish Cap	NAFO VME	412	413	100%	52.3	70.7	38.8	12	22	7	12	19	8	Rainbow	Metallic	Rainbow	Sheen	Rainbow	Sheen
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	55,356	100%	28.6	69.8	0.9	19	70	2	10	35	1	Rainbow	DTOC	Sheen	Rainbow	Rainbow	Sheen
Beothuk Knoll	NAFO VME	648	649	100%	27.6	38.8	17.2	28	38	21	7	14	4	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Flemish Pass / Eastern Canyon	NAFO VME	5,418	5,428	100%	27.0	40.5	12.1	23	38	12	7	15	2	Rainbow	Rainbow	Sheen	Sheen	Sheen	Sheen
Northeast Shelf and Slope	EBSA	13,885	13,912	100%	20.4	44.0	4.3	14	35	5	5	13	2	Rainbow	Metallic	Sheen	Rainbow	Rainbow	Sheen
Tail of the Bank	NAFO VME	144	144	100%	14.6	20.7	10.3	30	38	24	4	6	2	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Lilly Canyon - Carson Canyon	EBSA	120	120	100%	11.4	20.7	6.0	33	54	22	3	5	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Orphan Spur	EBSA	21,569	21,584	100%	8.0	26.7	0.9	34	72	6	3	13	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Bonivista Cod Box	Experimental Closure	9,830	8,509	87%	4.9	20.7	0.9	34	90	7	2	9	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Newfoundland Seamounts	NAFO VME	15,491	14,719	95%	4.1	14.7	0.9	53	90	30	2	4	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Southeast Shoal and Tail of the Banks	EBSA	30,935	16,640	54%	2.5	11.2	0.9	58	90	31	1	5	1	Sheen	Rainbow	Sheen	Sheen	Sheen	Sheen
Virgin Rocks	EBSA	6,843	6,158	90%	2.3	5.2	0.9	41	88	26	2	6	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
3O Coral Closure	NAFO VME	14,057	8,977	64%	1.9	7.8	0.9	66	90	36	1	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Slope	EBSA	29,746	3,627	12%	1.5	4.3	0.9	42	83	27	1	3	1	Sheen	Rainbow	Sheen	Sheen	Rainbow	Sheen
Southwest Shelf Edge and Slope	EBSA	16,644	7,723	46%	1.3	3.4	0.9	71	90	49	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Division 3O Coral	Marine Refuge	10,336	5,476	53%	1.3	3.4	0.9	70	90	46	1	4	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Hawke Channel	Marine Refuge	8,839	421	5%	1.0	1.7	0.9	62	71	54	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 1	NAFO VME	4,522	1,280	28%	1.0	2.6	0.9	65	88	52	1	3	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Notre Dame Channel	EBSA	6,222	1,414	23%	1.0	2.6	0.9	63	89	42	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Labrador Marginal Trough	EBSA	16,952	406	2%	0.9	1.7	0.9	64	71	54	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Funk Island Deep	Marine Refuge	7,272	1,405	19%	0.9	1.7	0.9	64	89	43	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Seamounts 2	NAFO VME	4,616	113	2%	0.9	0.9	0.9	88	89	69	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Eastern Avalon	EBSA	36	4	12%	0.9	0.9	0.9	73	73	73	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Witless Bay Ecological Reserve	Ecological Reserve	29	2		0.9	0.9	0.9	73	73	73	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Witless Bay Islands	IBA	62	7	11%	0.9	0.9	0.9	73	73	73	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Grey Islands	EBSA	11,301	62	1%	0.9	0.9	0.9	47	47	47	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Fogo Shelf	EBSA	9,403	182	2%	0.9	0.9	0.9	62	74	52	1	1	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Table D.1.8.5

Surface Oiling Intersects with World Maritime Boundaries

Name	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Max Time-Averaged Bonn Thickness	Max of Max Time-Averaged Bonn Thickness	Min of Max Time-Averaged Bonn Thickness	Average of Average Time-Averaged Bonn Thickness	Max of Average Time-Averaged Bonn Thickness	Min of Average Time-Averaged Bonn Thickness
Canada - Atlantic Ocean	1,507	23.9	69.0	0.9	31	88	3	7	29	1	Rainbow	Metallic	Sheen	Sheen	Rainbow	Sheen
Canada - Saint-Pierre et Miquelon	19	1.3	1.7	0.9	82	90	74	2	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen
Azores - Atlantic Ocean	172	1.2	1.7	0.9	80	90	64	1	2	1	Sheen	Sheen	Sheen	Sheen	Sheen	Sheen

* Probability of sea surface emulsified oil thicknesses exceeding the 0.04 µm (BAOAC " Sheen") thickness threshold

Oil in the Upper water column (<100 m water depth)

Table D.1.8.6

Water Column Dispersed and Dissolved Oil Intersects with Protected Areas

Name	Designation	Country	IUCN	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface WDPA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Charlie-Gibbs North High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	184,958	7	0.004%	0.86	0.86	0.86	50	50	50	1	1	1	63	63	63	0.0	0.0	0.0
Charlie-Gibbs South High Seas MPA	Marine Protected Area (OSPAR)	ABNJ	Not Applicable	152,732	29	0.019%	0.86	0.86	0.86	59	81	39	1	1	1	74	84	63	0.0	0.0	0.0

ABNJ = Areas Beyond National Jurisdiction (ABNJ) of the OSPAR Maritime Area

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.8.7

Water Column Dispersed and Dissolved Oil Intersects with Sensitive Areas

Name	Sensitive Area Type	Area (Sq km)	Sum of Intersect Area (Sq km)	% Surface EBSA Area contacted by THC > 58 ppb	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Orphan Knoll	NAFO VME	15,817	15,849	100%	40.45	77.59	12.93	7	16	2	9	23	3	388	2682	160	2	18	0.5
Sackville Spur	NAFO VME	992	993	100%	34.49	70.69	18.10	7	14	3	6	9	3	392	1519	224	2	8	1
Northeast Flemish Cap	NAFO VME	2,898	2,904	100%	30.01	50.00	10.34	9	21	5	6	10	3	294	1152	135	2	5	1
Northern Flemish Cap	NAFO VME	486	487	100%	22.90	39.66	14.66	8	13	5	6	11	3	337	914	222	1	5	0.4
Northwest Flemish Cap	NAFO VME	412	413	100%	10.51	18.10	1.72	13	30	7	3	8	1	290	875	96	1	2	0.0
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	55,251	37,961	69%	9.98	42.24	0.86	15	90	3	4	15	1	289	2564	58	1	9	0.0
Eastern Flemish Cap	NAFO VME	1,609	1,611	100%	5.05	17.24	0.86	29	58	9	3	10	1	171	521	66	1	3	0.0
Northeast Shelf and Slope	EBSA	13,885	13,185	95%	4.96	18.97	0.86	17	61	7	2	5	1	259	2481	58	0.5	4	0.0
Orphan Spur	EBSA	21,569	4,807	22%	2.80	12.07	0.86	22	90	7	1	5	1	205	833	59	0.2	5	0.0
Flemish Pass / Eastern Canyon	NAFO VME	5,418	4,128	76%	1.83	6.90	0.86	31	86	16	1	3	1	138	1599	58	0.1	1	0.0
Beothuk Knoll	NAFO VME	648	504	78%	1.81	3.45	0.86	37	76	22	1	3	1	152	315	59	0.1	0.3	0.0
Bonivista Cod Box	Experimental Closure	9,830	3,682	37%	1.66	5.17	0.86	23	48	7	1	4	1	166	594	58	0.1	1	0.0
Virgin Rocks	EBSA	6,843	1,070	16%	0.91	1.72	0.86	43	72	28	1	2	1	108	355	59	0.0	0.2	0.0
Newfoundland Seamounts	NAFO VME	15,491	136	1%	0.86	0.86	0.86	57	74	47	1	1	1	111	348	60	0.0	0.0	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold

Table D.1.8.8

Water Column Dispersed and Dissolved Oil Intersects with World Maritime Boundaries

	Sum of Boundary Intersect Length (km)	Average of Probability (%)	Max of Probability (%)	Min of Probability (%)	Average of Min Arrival Time (days)	Max of Min Arrival Time (days)	Min of Min Arrival Time (days)	Average of Maximum Exposure Time (days)	Max of Maximum Exposure Time (days)	Min of Maximum Exposure Time (days)	Average of Maximum Time-Averaged TPH Concentration (ppb)	Max of Maximum Time-Averaged TPH Concentration (ppb)	Min of Maximum Time-Averaged TPH Concentration (ppb)	Average of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Max of Maximum Time-Averaged Dissolved Oil Concentration (ppb)	Min of Maximum Time-Averaged Dissolved Oil Concentration (ppb)
Canada - Atlantic Ocean	398	9.39	26.72	0.86	12	49	3	3	11	1	165	633	58	1	4	0.0

* Probability of THC (Dispersed and dissolved oil) in the water column exceeding the 58 ppb concentration threshold