Environmental risk analysis (ERA) and Oil spill contingency analysis (OSCA) for exploration well 25/8-20 S&A Prince/King in PL027 in the North Sea

Vår Energi AS

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CONCLUSIVE SUMMARY

Vår Energi AS (Vår Energi) is planning the drilling of exploration well 25/8-20 S&A in PL027 in the North Sea. The well is located about 142 km from the closest shoreline that is Utsira in Rogaland county. The water depth in the area is 127 meters. The drilling is planned to start in Q3 2020, and the well will be drilled with the semi-submersible rig Scarabeo 8. As part of the preparation for the upcoming drilling operation, DNV GL have prepared an environmental risk analysis and an oil spill contingency analysis for the activity.

Environmental risk

There is not identified the need for a full damage based environmental risk analysis for exploration well 25/8-20 S&A, but it is referred to the environmental risk analysis performed for Aker BPs well 25/11-29 JK (Acona, 2018). Calculated flow potential for well 25/8-20 S&A shows that potential blowout rates will be lower than the one calculated for well 25/11-29 JK.

The environmental risk analysis for the reference analysis (25/11-29 JK) is performed as a damage-based analysis in accordance to NOROG guideline for performing environmental risk analysis for petroleum activity on the NCS (OLF, 2007). The environmental risk was measured against Aker BPs operation specific acceptance criteria. These acceptance criteria are similar to the acceptance criteria defined by Vår Energi's.

Pelagic seabirds (Northern gannet) is dimensioning for the risk level with 18 % of the acceptance criteria for moderate environmental damage (1-3 years restitution time) in the winter season (December- February) (see Figure 0-1). The highest risk level for coastal seabirds is 9 % (Common scoter- Winter) for moderate environmental damage. The highest risk level for marine mammals (Grey seal) and coastal habitats is 8 % of the acceptance criteria, both in moderate environmental damage.

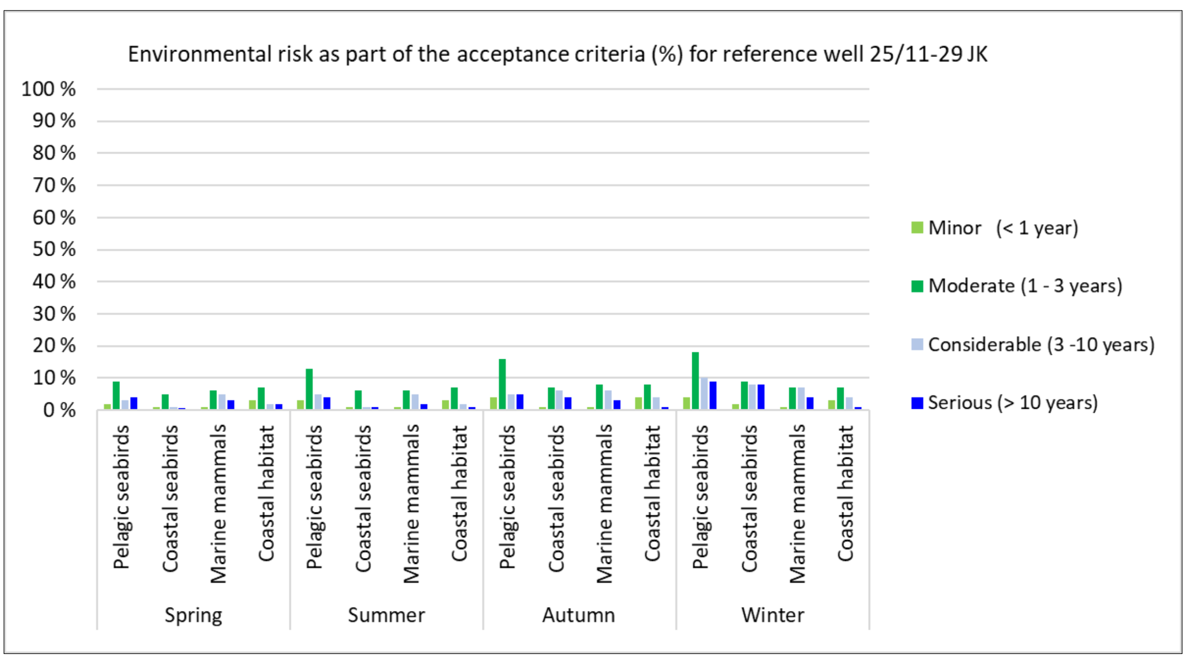

Figure 0-1 *Calculated environmental risk for all VEC groups included in the analysis for reference well 25/11-29 JK in the North Sea, shown for the different seasons.*

Exploration well 25/8-20 S&A is located about 27 km north for reference well 25/11-29 JK. In the reference-based analysis the environmental risk performed for well 25/11-29 JK is compared to input data for well 25/8-20 S&A. All input parameters that may influence the environmental risk level is evaluated, and it is concluded that the reference analysis covers the planned activity for well 25/8-20 S&A.

Well technical conditions are approximately similar, the well will be drilled with similar rigs, GOR is low in both wells and distance to shore is similar.

The longest blowout duration is two days longer for well 25/8-20 S&A than for the reference well (52 days vs 50 days) and the Forseti oil will have a little longer lifetime on the sea surface than Avaldsnes oil. But the rates are lower for well 25/8-20 S&A for both surface and seabed (surface: 5220 Sm^3/d vs 5897 Sm^3/d, seabed: 4071 Sm^3/d vs 5256 Sm^3/d) and the blowout frequency is 9.5 % lower for well 25/8-20 S&A than for the reference well (1.14×10^{-4} vs 1.26×10^{-4}). The Forseti oil is conservatively chosen as a reference oil and it is not expected that the 2 days longer duration or the oil type will give higher results than the reference well when all parameters are evaluated together.

Based on the evaluations and comparison of all input parameters for the two wells it is expected that the environmental risk level for well 25/8-20 S&A will be similar to the environmental risk for well 25/11-29 JK and within Vår Energi's operation specific acceptance criteria in all seasons.

Oil spill contingency

The OSCA is performed with calculations of response requirements on open sea and calculations of need for response in the coastal areas (barrier 1-4). All calculations are based on the industry guideline «Veiledning for miljørettede beredskapsanalyser» (NOROG, 2013) and done using the BarKal tool (www.nofo.no). BarKal is the recommended tool in the updated NOROG guideline (*in prep.).*

There is not performed any oil drift modelling for exploration well 25/8-20 S&A, and stranded amount of oil and drift time to shore from the reference well 25/11-29 JK is used in the analysis to calculate response requirements in the coastal barriers.

For well 25/8-20 S&A the system requirements is calculated for dimensioning scenario, a surface blowout (5220 Sm^3/day). The calculation gives the following need for oil spill response systems in barrier 1 and 2: 3 systems in barrier 1 and 4 systems in barrier 2, a total of 7 systems in the winter season (September-February) and 2 systems in barrier 1 and 1 system in barrier 2, a total of 3 systems in the summer season (March-August).

The response option requires 7 NOFO systems in barrier 1 and 2 in the winter season, with response time of 10 hours for the first system and fully developed and functional barrier 1 and 2 within 24 hours.

95-percentile of highest amount of stranded oil emulsion is dimensioning for the response requirements in barrier 3 and 4. If the number of affected example areas exceeds the calculated system requirements for barrier 3 and 4, this capacity should be extended to cover the number of example areas (updated NOROG guideline- *in prep*). It is required a capacity equivalent to 9 coastal systems and 8 fjord systems. Requirements for fully developed and functional barrier 3 and 4 is 4 days.

DEFINITIONS AND ABBREVIATIONS

Acceptance criteria	The criteria define the maximum allowed occurrence of accidents that can cause an environmental damage with a given recovery time. The classification is in line with the NOROG guideline for environmental risk analysis (OLF, 2007).
ALARP	As Low As Reasonably Practicable. ALARP expresses that the risk level is reduced (through a documented and systematic process) so far that no further cost-effective measure is identified.
Analysis area	Area that make the basis for environmental risk analyses and that are larger than the influence area (influence area is a result of oil drift modelling). The resource description is carried out in the analyses area to make sure the size of the area is sufficient.
BarKal	Barrier Calculator (BarKal) is an Excel-based tool for calculating oil spill response needs in different barriers from open sea close to source to beach cleaning.
Contingency system	System used in oil spill contingency operations- such as a system for application of chemical dispersants (usually one boat or aircraft) or a system for mechanical recovery (usually includes one OR-ship and a towing boat, including boom and skimmer equipment).
DSHA	Defined Situations of Hazard and Accident. DSHA is a selection of hazardous and accidental events that is used for the dimensioning of the emergency preparedness for the activity and Environmental Risk Analysis.
ERA	Environmental Risk Analysis
GOR	Gas-Oil Ratio
Hit probability	The probability that a given 10 × 10 km grid is hit by oil from a potential oil spill.
Influence area	A defined area with 5 % or more probability for pollution within a 10 × 10 km grid if an oil discharge has taken place.
MIRA	Method for environmental risk analysis (OLF, 2007).
NCS	Norwegian Continental Shelf
NOROG	The Norwegian Oil and Gas Association (Norsk Olje og Gass)
OLF	Previous name for The Norwegian Oil and Gas Association.
OR-vessel	Oil recovery vessel. The main vessel in a mechanical oil recovery system, containing storage tank and equipment such as skimmer and boom.
OSCA	Oil Spill Contingency Analysis
OSCAR	Oil Spill Contingency And Response model (SINTEF)
PL	Production License
ppb	Parts per billion
Recovery system	A system for mechanical recovery of oil, which normally includes one OR-ship and a towing boat, including boom and skimmer equipment).
System efficiency	Percent of swept area that is recovered.
Restitution/recovery time	Recovery is achieved when the original animal- and plant life in the affected environment is present on the same level as before the oil spill (natural variation considered), and the biological processes works normally. Recovery time is the time from an oil spill occurs until the recovery is achieved.
THC	Total Hydrocarbon Concentration
VEC	Valued Ecosystem Component. Recourses with high vulnerability and conservation value. VECs are chosen as dimensioning resources in the analysis due to high vulnerability to oil pollution and/or high degree of presence in the analytic area. VECs are species that are likely to be affected in the analysis.

NAMELIST FOR SPECIES

Names for species given in English, Latin and Norwegian for seabirds, marine mammals and fish.

Seabirds

Species (English name)	Latin name	Norwegian name
Razorbill	*Alca torda*	Alke
Little Auk	*Alle alle*	Alkekonge
Common Gull	*Larus canus*	Fiskemåke
European Herring Gull	*Podiceps grisegena*	Gråmåke
Northern Fulmar	*Fulmarus glacialis*	Havhest
Northern Gannet	*Morus bassanus*	Havsule
Common Loon	*Gavia immer*	Islom
Ivory Gull	*Pagophila eburnean*	Ismåke
Black-legged Kittiwake	*Rissa tridactyla*	Krykkje
Common Guillemot	*Uria aalge*	Lomvi
Atlantic Puffin	*Fratercula arctica*	Lunde
Common Tern	*Sterna hirundo*	Makrellterne
Brünnich's Guillemot	*Uria lomvia*	Polarlomvi
Glaucous Gull	*Larus hyperboreus*	Polarmåke
King Eider	*Somateria spectabilis*	Praktærfugl
Arctic Tern	*Sterna paradisaea*	Rødnebbterne
Red-breasted Merganser	*Mergus serrator*	Siland
Lesser Black-backed Gull	*Larus fuscus*	Sildemåke
Red-throated Loon	*Gavia stellata*	Smålom
Steller's Eider	*Polysticta stelleri*	Stellerand
Great Skua	*Stercorarius skua*	Storjo
Great Black Cormorant	*Phalacrocorax carbo*	Storskarv
Common scoter	*Melanitta nigra*	Svartand
Great Black-backed Gull	*Larus marinus*	Svartbak
Black Guillemot	*Cepphus grylle*	Teist
European Shag	*Phalacrocorax aristotelis*	Toppskarv
Common Eider	*Somateria molissima*	Ærfugl

Marine mammals

Species (English name)	Latin name	Norwegian name
Grey Seal	*Halichoerus grypus*	Havert
Harbour Seal	*Phoca vitulina*	Steinkobbe
Otter	*Lutra lutra*	Oter

Fish

Species (English name)	Latin name	Norwegian name
Cod	*Gadhus morhua*	Torsk
Herring	*Clupea harrengus*	Sild

1 INTRODUCTION

1.1 Activity description

Vår Energi AS (from now on Vår Energi) is planning to drill exploration well 25/8-20 S&A Prince/King in PL027 in the North Sea. The well is located about 142 km from the closest shoreline that is Utsira in Rogaland county (Figure 1-1). The water depth in the area is 127 meters. The drilling is planned to start in Q3 2020, and the well will be drilled with the semi-submersible rig Scarabeo 8.

As part of the preparation for the upcoming drilling operation, DNV GL have prepared an environmental risk analysis and an oil spill contingency analysis for the activity. Basis information for the activity is summed up in Table 1-1.

There is not identified the need for a full damage based environmental risk analysis for exploration well 25/8-20 S&A, but it is referred to the environmental risk analysis performed for Aker BPs well 25/11-29 JK (Acona, 2018), which is considered to cover for Vår Energi's planned activity. Exploration well 25/8-20 S&A is located about 27 km north for reference well 25/11-29 JK (Figure 1-1).

The oil spill contingency analysis is performed with calculations of response requirements for mechanical recovery of oil on open sea and calculations of need for response in the coastal areas (barrier 1-4). All calculations are based on the industry guideline «Veiledning for miljørettede beredskapsanalyser» (NOROG, 2013) and done using the BarKal tool (https://www.nofo.no/planverk/metoder-og-standarder/nofo/barkal/). There is not performed any oil drift modelling for exploration well 25/8-20 S&A, and stranded amount of oil and drift time to shore from the reference well 25/11-29 JK is used in the analysis to calculate response requirements in the coastal barriers.

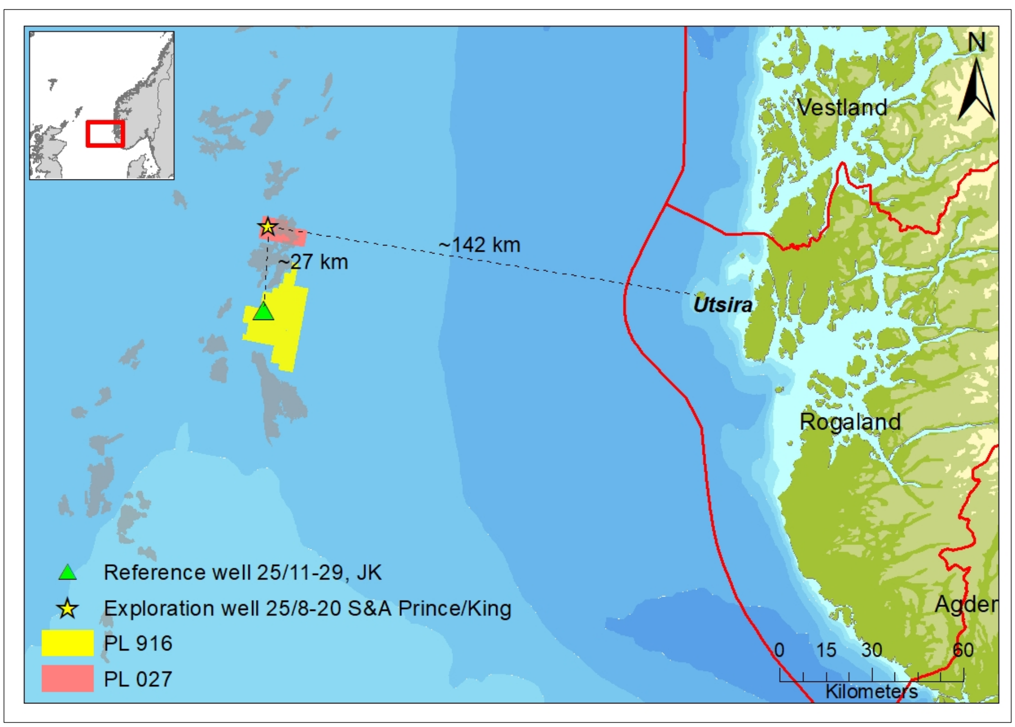

Figure 1-1 *Location for exploration well 25/8-20 S&A Prince/King, and location for reference well 25/11-29 JK in the North Sea.*

Table 1-1 *Basic information for exploration well 25/8-20 S&A Prince/King (AddEnergy, 2020; Vår Energi, 2020).*

Basic information	Drilling of exploration well 25/8-20 S&A Prince/King
Coordinates for modelled scenario	59° 17' 27.38" N, 02° 22' 27.05" Ø
Period for analysis	Whole year, 4 seasons
Water depth	127 meters
Distance to closest shoreline	Ca. 142 km (Utsira)
Oil type	Forseti (916 kg/m^3)
Rig type	Semi-submersible drilling rig
Weighted blowout rates	Weighted rate, surface: 5220 Sm^3/d Weighted rate, seabed: 4071 Sm^3/d
Weighted durations	Surface: 6 days Seabed: 19 days
GOR (Sm^3/Sm^3)	35
Time to drill a relief well (longest duration)	52 days
Activity	Exploration drilling
Scenarios	Blowout (surface/seabed)
VEC species/ populations in the analysis	Pelagic seabirds, coastal seabirds, marine mammals, fish and coastal habitats – for the North Sea
Expected spud date	Q3 2020

1.2 Purpose and objective

Environmental risk and oil spill contingency analyses for exploration of and/or production of oil and gas on the Norwegian Continental Shelf (NCS) is required by Norwegian rules and regulations (see chapter 1.4 and Appendix A).

The environmental risk analysis for the reference analysis (25/11-29 JK) is performed as a damage-based analysis in accordance to NOROG guideline for performing environmental risk analysis for petroleum activity on the NCS (OLF, 2007). For more detailed information it is referred to the report (Acona, 2018) and the NOROG guideline. The environmental risk was measured against Aker BPs operation specific acceptance criteria. In a damage-based analysis the consequences given a spill is linked with the probability (frequency) for the spill to happen, to be able to quantify the environmental risk this spill may have on vulnerable resources in the area. The vulnerable resources are referred to as Valuable Ecosystem Components (VEC) and is a mix of different populations (seabirds, marine mammals and fish) and habitats (coastal areas).

The OSCA is performed with calculations of response requirements for mechanical recovery of oil on open sea and calculations of need for response in the coastal areas. All calculations are based on the industry guideline «Veiledning for miljørettede beredskapsanalyser» (NOROG, 2013) and done using the BarKal tool.

1.3 Vår Energi's acceptance criteria for acute pollution

Vår Energi has defined acceptance criteria for environmental risk as part of their management system. For exploration well 25/5-20 S&A, Vår Energi's operation specific acceptance criteria for environmental risk are used (Table 1-2). These acceptance criteria are similar to the one used by Aker BP in the reference well 25/11-29 JK. The acceptance criteria state the limit for what Vår Energi has defined as acceptable risk for the company's activities (probability for a given consequence). These criteria are formulated as a measure of environmental damage to natural resources, expressed by duration and degree of seriousness.

Vår Energi uses the same acceptance criteria in all regions across the NCS. Environmental risk analysis captures differences in environmental vulnerability on a regional level based on the presence and vulnerability of environmental resources in each area and through calculation of restitution time for potentially affected resources. This means that the calculated environmental risk is higher for areas where a larger share of a vulnerable population or habitat is affected.

The acceptance criteria express Vår Energi's attitude to keep nature as far as possible untouched by the company's activities. The criteria state maximum tolerated incident frequency which can cause harm to the environment.

Table 1-2 *Vår Energi's operation specific acceptance criteria for acute pollution.*

Environmental damage	Duration of damage (Recovery/ restitution time)	Operation specific acceptance criteria (per operation)
Minor	< 1 year	$< 1 \times 10^{-3}$
Moderate	1-3 years	$< 2.5 \times 10^{-4}$
Considerable	3-10 years	$< 1 \times 10^{-4}$
Serious	> 10 years	$< 2.5 \times 10^{-5}$

1.4 Regulatory framework

The requirements from the Norwegian authorities include the Pollution Act, the Framework regulation, the Management regulation and the Activities regulation. A brief description of the requirements is given in Appendix A.

2 ENVIRONMENTAL RISK ANALYSIS FOR EXPLORATION WELL 25/8-20 S&A

The present chapter presents the method for reference-based environmental risk analysis, expected oil type for the activity and results from the oil drift modelling and environmental risk for reference well 25/11-29 JK.

2.1 Method reference-based environmental risk analysis

It is performed a reference-based environmental risk analysis in accordance with the MIRA method (OLF, 2007). A reference-based analysis can be performed if there exist an environmental risk analysis with input data comparable to input data for the planned activity. A former analysis is then used as a reference analysis. Important parameters for the planned drilling activity and the sensitivity for the environment is reviewed and compared to the reference analysis. The results from the comparison is then evaluated, and it is concluded if the reference analysis is covering the planned activity. The reference analysis is considered adequate if it is similar or more conservative for the parameters compared, so a further full analysis for the planned activity would conclude with similar or lower environmental risk than the reference analysis.

The following parameters are included in the evaluation:

- Geographic location
- Oil type
- Probability for blowout
- Rates and durations
- Release location (surface or seabed)
- Type of activity
- Acceptance criteria for environmental risk
- Special vulneranle season
- Climatic conditions
- Influence areas from the reference well
- Well technical aspects

It is referred to the guideline for more information (OLF, 2007).

2.2 Important parameters for evaluation of environmental risk

The environmental risk is performed as a reference-based analysis in accordance with the MIRA-method (OLF, 2007). Important parameters for the planned drilling activity of exploration well 25/8-20 S&A is compared to corresponding parameters in the environmental risk analysis for reference well 25/11-29 JK (Acona, 2018). Comparison of parameters for the two activities is shown in Table 2-1. Input data and potential differences in the input data is discussed in the following chapters.

Table 2-1 *Comparison of parameters for exploration well 25/8-20 S&A and reference well 25/11-29 JK (AddEnergy, 2020; Vår Energi, 2020; Acona, 2018).*

Parameters	25/8-20 S&A	25/11-29 JK (2018)	Criteria for comparison	Result of comparison
Operator	Vår Energi	Aker BP	--	--
Position (geographical coordinates)	59° 17' 27.38" N 02° 22' 27.05" Ø	59° 02' 48.441" N 02° 26' 21.804" Ø	--	--
Distance to 25/11-29 JK (km)	27	--	Less than 50 km	Ok
PL	027	916	--	--
Type of well	Exploration well	Exploration well	--	--
Reference oil	Forseti (SINTEF, 2002)	Avaldsnes (SINTEF, 2012)	--	Ok, see chapt. 2.6
Oil density	916	891	Similar	Ok, see chapt. 2.6
Water depht (m)	127	120	Similar	Ok
GOR (Sm3/Sm3)	35	39.2	Similar	Ok, see chapt. 2.6.1
Distance to shore (km)	Ca. 142 km to Spannholmane outside Utsira	Ca. 142 km to Spannholmane outside Utsira	Similar or longer distance to shore	Ok
Rates surface (Sm3/d)	1421-22425	2748-24202	--	--
Weighted rate surface (Sm3/d)	5220	5897	Similar or lower rate	Ok, see chapt. 2.5
Rates seabed (Sm3/d)	1325-16003	2152-20095	--	--
Weighted rate seabed (Sm3/d)	4071	5256	Similar or lower rate	Ok, see chapt. 2.5
Longest duration (d)	52	50	Similar or shorter duration	Ok, see chapt. 2.5
Weighted duration top/sub	6 / 19	6.0 / 18.6	Similar or shorter duration	Ok, see chapt. 2.5
Frequency for blowout	1.14 x 10-4	1.26 x 10-4	Similar	Ok, see chapt. 2.4
Topside/subsea distribution	20/80 %	20/80 %	Similar	Ok
Type of rig	semi sub floating rig	semi sub floating rig	--	--
Period for analysis	Whole year	Whole year	Must cover planned drilling period	Ok
Seapop dataset	2013 (open sea)/2017 (coastal)	2013 (open sea)/2017 (coastal)	--	--
Acceptance criteria	Vår Energi's operation specific acceptance criteria	Aker BPs operation specific acceptance criteria	Similar	Ok, see chapt. 1.3
Highest environmental risk		18 % of acceptance criteria for moderate environmental damage in winter season.	--	Ok, see chapt. 2.9

2.3 Location

Exploration well 25/8-20 S&A is located about 142 km from closest shore that is Spannholmane outside Utsira, and 42 km north for reference well 25/11-29 JK (Figure 1-1 and Figure 2-1).

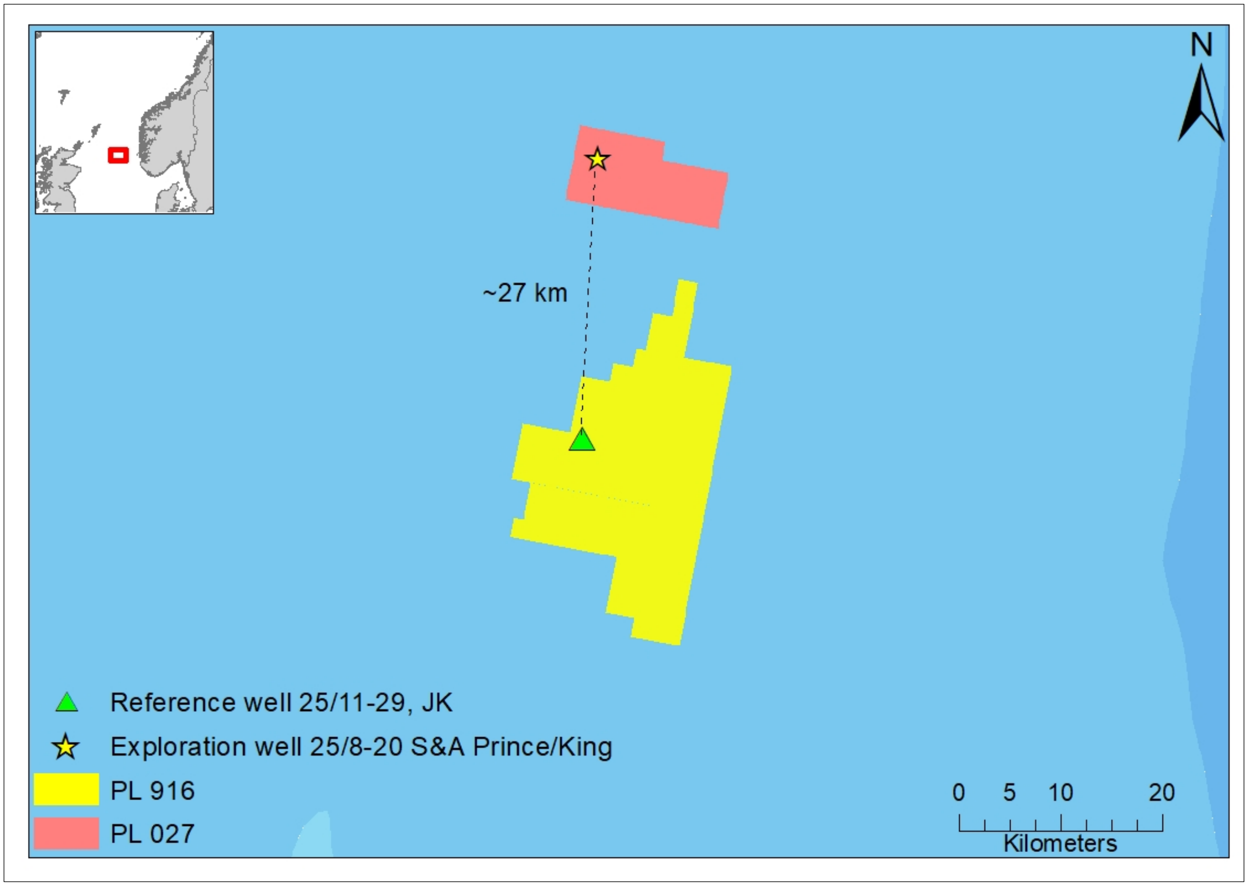

Figure 2-1 *Location for exploration well 25/8-20 in PL027 and location to well 25/11-29 JK in PL916.*

2.4 Blowout probability

Well 25/8-20 S&A is an exploration well where it is expected to find oil. Based on SINTEF offshore blowout database 2018, the total blowout frequency is set to 1.14 x 10-4 for an exploration well (Lloyd's, 2019). For drilling of reference well 25/11-29 JK the total blowout frequency was set to 1.26 x 10-4 (based on Lloyd's 2017).

Exploration well 25/8-20 S&A is planned drilled with a semi-submersible drilling rig. The rig has BOP placed on the seabed, so a blowout is most likely to happen on the seabed. The probability distribution between blowout on surface contra seabed during drilling for a semi-submersible rig is set to 20 % / 80 % (Lloyd's, 2019). The reference well 25/11-29 JK was also drilled with a semi-submersible rig with similar probability distribution (based on Lloyd's 2017).

2.5 Blowout rates and durations

Most unintentional discharges related to exploration drillings are limited with small amounts of light compounds with no or low potential for damage. Incidents with the greatest potential to harm the surrounding environment are uncontrolled releases from the wells during drilling (blowout). A blowout is considered dimensioning for the environmental risk analysis and is further described in the following sections.

The longest blowout duration is set to the time it takes to drill a relief well. For exploration well 25/8-20 S&A this is set to 52 days, divided on mobilizing the rig, drilling into the reservoir and killing the blowout (Add Energy, 2020). Add Energy has in the blowout study used three durations, and that gives weighted duration for a surface blowout to 6 days and for a seabed blowout 19 days.

For the reference well 25/11-29 JK the longest blowout duration was set to 50 days (Acona, 2018), and with a weighted duration for a surface blowout to 6,0 days and for a seabed blowout to 18,6 days.

The rate- and duration matrix used in the oil drift modelling and environmental risk analysis for well 25/11-29 JK was based on a blowout study from Add Energy (Acona, 2018). Weighted rate for a surface blowout was 5897 Sm^3/day, and 5256 Sm^3/day for a seabed blowout in this study. The rate- and duration matrix is given in Table 2-2.

Table 2-2 *Rate- and duration matrix for exploration well 25/11-29 JK (from Acona, 2018).*

Utslippspunkt		Rater		Sannsynlighet for varighet		
Dybde	Sanns. (%)	Sm^3/døgn	Sanns. (%)	2 dager	15 dager	50 dager
Overflate	20	2 748	58	84	10	6
Overflate	20	7 707	26	84	10	6
Overflate	20	10 368	4	84	10	6
Overflate	20	14 667	11	84	10	6
Overflate	20	24 202	2	84	10	6
Sjøbunn	80	2 570	18	47	25	28
Sjøbunn	80	12 352	11	47	25	28
Sjøbunn	80	20 095	2	47	25	28
Sjøbunn*	80	2 152	42	47	25	28
Sjøbunn*	80	8 161	28	47	25	28

Expected blowout rates for exploration well 25/8-20 S&A is based on the blowout study from Add Energy (2020) and calculated with the same methodology as for the reference well. The exploration well consists of King mainbore (25/8-20 S) and Prince sidetrack (25/8-20 A). The potential flow rates are higher for the sidetrack, and the sidetrack is conservatively selected for performing the reference-based analysis.

Weighted rate for a surface blowout is 5220 Sm^3/day and 4071 Sm^3/day for a seabed blowout (Table 2-3).

Table 2-3 *Calculation of rates for drilling of exploration well 25/8-20 S&A given a surface blowout (at the top) or seabed blowout (bottom) (AddEnergy, 2020).*

Based on Sintef Offshore Blowout Database and NOROG guidelines							GOR =	35	Time to drill Relief Well:		52 days	
Surface scenario	Scenario Dist. %	Pentetration Depth Dist.%	top/entire	IBOP/TIW Opening Dist %	Opening	Total Dist. %	Oil Sm3/d	Gas MSm³/d	Distribution - Duration t<2 days	t~15 days	t~52 days	Weighted Duration
1S - Drillpipe	11	55	Top	30	Open	1.8	2 561	0.09	90	5	5	5
				70	5% open	4.2	1 421	0.05				
		45	Entire	30	Open	1.5	3 464	0.12				
				70	5% open	3.5	1 675	0.06				
2S - Annulus	78	55	Top	30	Open	12.9	6 277	0.22	85	10	5	6
				70	5% open	30.0	3 705	0.13				
		45	Entire	30	Open	10.5	8 901	0.32				
				70	5% open	24.6	5 216	0.19				
3S - Open Hole	11	55	Top	30	Open	1.8	10 847	0.39	75	15	10	9
				70	5% open	4.2	5 073	0.18				
		45	Entire	30	Open	1.5	22 425	0.80				
				70	5% open	3.5	3 464	0.12				
Totals and weighted rates:						100	5 220	0.19	Weighted duration:			6

Based on Sintef Offshore Blowout Database and NOROG guidelines							GOR =	35	Time to drill Relief Well:		52 days	
Seabed scenario	Scenario Dist. %	Pentetration Depth Dist.%	top/entire	BOP Opening Dist %	Opening	Total Dist. %	Oil Sm3/d	Gas MSm³/d	Distribution - Duration t<2 days	t~15 days	t~52 days	Weighted Duration
1 - Drillpipe	11	55	Top	30	Open	1.8	2 267	0.08	50	25	25	18
				70	5% open	4.2	1 325	0.05				
		45	Entire	30	Open	1.5	3 520	0.13				
				70	5% open	3.5	1 576	0.06				
2 - Annulus	78	55	Top	30	Open	12.9	3 281	0.12	50	25	25	18
				70	5% open	30.0	2 928	0.10				
		45	Entire	30	Open	10.5	5 861	0.21				
				70	5% open	24.6	4 673	0.17				
3 - Open Hole	11	55	Top	30	Open	1.8	4 758	0.17	25	25	50	30
				70	5% open	4.2	4 012	0.14				
		45	Entire	30	Open	1.5	16 003	0.57				
				70	5% open	3.5	8 845	0.31				
Totals and weighted rates:						100	4 071	0.14	Weighted duration:			19

2.6 Oil type

Both lifetime on the sea surface and degree of down-mixing and associated potential environmental effects will be dependent of the type of oil. The same apply to suitability and effect of different oil spill recovery techniques (mechanical and chemical recovery). If hydrocarbons are discovered in exploration well 25/8-20 S&A, it is expected to have characteristics between the one for Balder oil and Forseti oil. Forseti oil is conservative chosen as a reference oil in the analysis.

Forseti oil is categorized as an asphaltene oil with high density (916 kg/m^3) and with a relative high content of asphaltenes and a low wax content. The oil makes stable emulsions with relatively high viscosity and is expected to have a long lifetime on the sea surface (SINTEF, 2002).

In the analysis for reference well 25/11-29 JK Avaldsnes oil (Johan Sverdrup) was used as a reference oil (SINTEF, 2012). Avaldsnes oil has a high density, low wax content and a high content of asphaltenes compared to other oil in the North Sea. If spilled to sea the oil will have a high initial evaporation and this results in a rapid increase in the wax and asphaltene content. Maximum water uptake in the winter season (5°C) is 63 % and 68 % in the summer season. The oil creates stabile emulsions with high viscosity in both summer and winter conditions. The viscosity increases considerable with increased weathering of the oil. The oil will have a long lifetime if spilled at sea, even in high wind speeds.

Key characteristics for Forseti crude oil (SINTEF, 2002) and Alvaldsnes crude oil (SINTEF, 2012) are presented in Table 2-4.

Table 2-4 *Parameters for Forseti oil expected oil type in exploration well 25/8-20 S&A, and for Avaldsnes oil used in the oil spill modelling for reference well 25/11-29 JK.*

Parameters	**Forseti crude oil (SINTEF, 2002)**	**Avaldsnes crude oil (SINTEF, 2012)**
Oil density [kg/ m³]	916	891
Maximum water content at 15 °C [volume %]	78	68
Viscosity, fresh oil at 13 ºC ($10s^{-1}$) [cP]	274	61
Wax content, fresh oil [vekt %]	2.4	2.9
Asphaltene content, fresh oil [weight %]	2.7	1.8

Figure 2-2 shows expected oil on the sea surface (in %) after 1-120 hours (5 days) on sea with wind speed 2, 5, 10 and 15 m/s and temperature 5°C (winter season) for Forseti oil and Avaldsnes oil (SINTEF, 2014 and SINTEF, 2002). The mass balance indicates that both Forseti and Avaldsnes oil will disappear from the sea surface within 5 days with wind speed 15 m/s. At lower wind speeds the oils live longer on the sea surface and Figure 2-2 shows that Forseti oil will have a little higher part of oil on the surface than Avaldsnes oil at the different wind speeds. The explanation for this can be that Forseti oil have a higher initial viscosity than Avaldsnes oil and will hence have less down mixing in the water column after a short time on the surface.

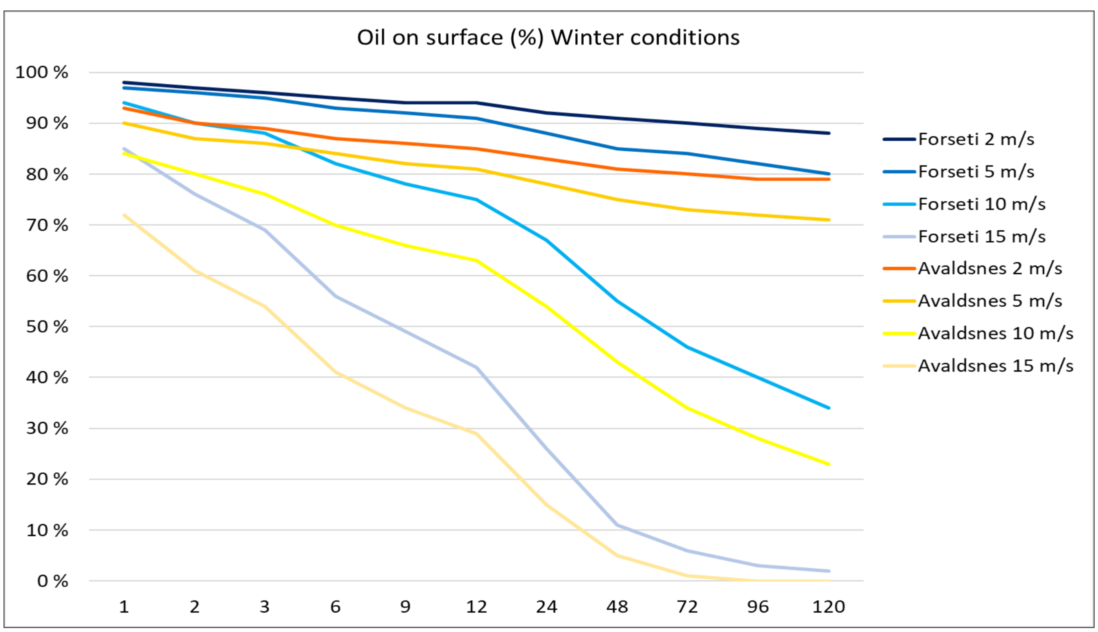

Figure 2-2 *Remaining oil on the sea surface for Forseti oil and Avaldsnes oil after 1-120 hours on the sea surface with wind speeds 2 m/s, 5 m/s, 10 m/s and 15 m/s and a temperature of 5°C (SINTEF, 2014 and SINTEF, 2012).*

2.6.1 GOR (Gas-Oil-Ratio)

GOR (gas-oil-ratio) gives an indication of how much gas the expected oil contains. For exploration well 25/8-20 S&A GOR is 35 Sm^3/Sm^3, while GOR for the reference well 25/11-29 JK was set to 39,2 Sm^3/Sm^3. Higher GOR for relative similar oil types can give thinner oil film om the sea surface and more oil in the water column because oil from a seabed blowout will get smaller droplets in the water column. GOR is low for both well, and the small difference is not expected to influence the analysis results.

2.7 Oil drift modelling – reference analysis

2.7.1 Oil on the sea surface

Oil drift statistics for surface and seabed blowouts from well 25/11-29 JK are generated on a grid level (10 x 10 km resolution) and presented seasonally for the different seasons (spring: March-May; summer: June-August; autumn: September-November and winter: December-February). The influence areas (≥ 5 % hit of oil over 1 ton in 10 x 10 km grid cells) given a surface blowout is shown in Figure 2-3 and given a seabed blowout in Figure 2-4.

It is important to keep in mind that expected amounts of oil and hit probability of oil is based on all blowout rates and durations and their individual probabilities. The influence areas do not reflect a single blowout, but the area affected in ⩾ 5 % of the single simulations in each season.

The result shows that the influence area covers part of the North Sea and the Norwegian Sea and extend into Skagerrak in the south and to Trøndelag county in the north. The influence areas have a larger extension for seabed blowouts compared to surface blowouts. Hit probability along the coast is between 5-50 %.

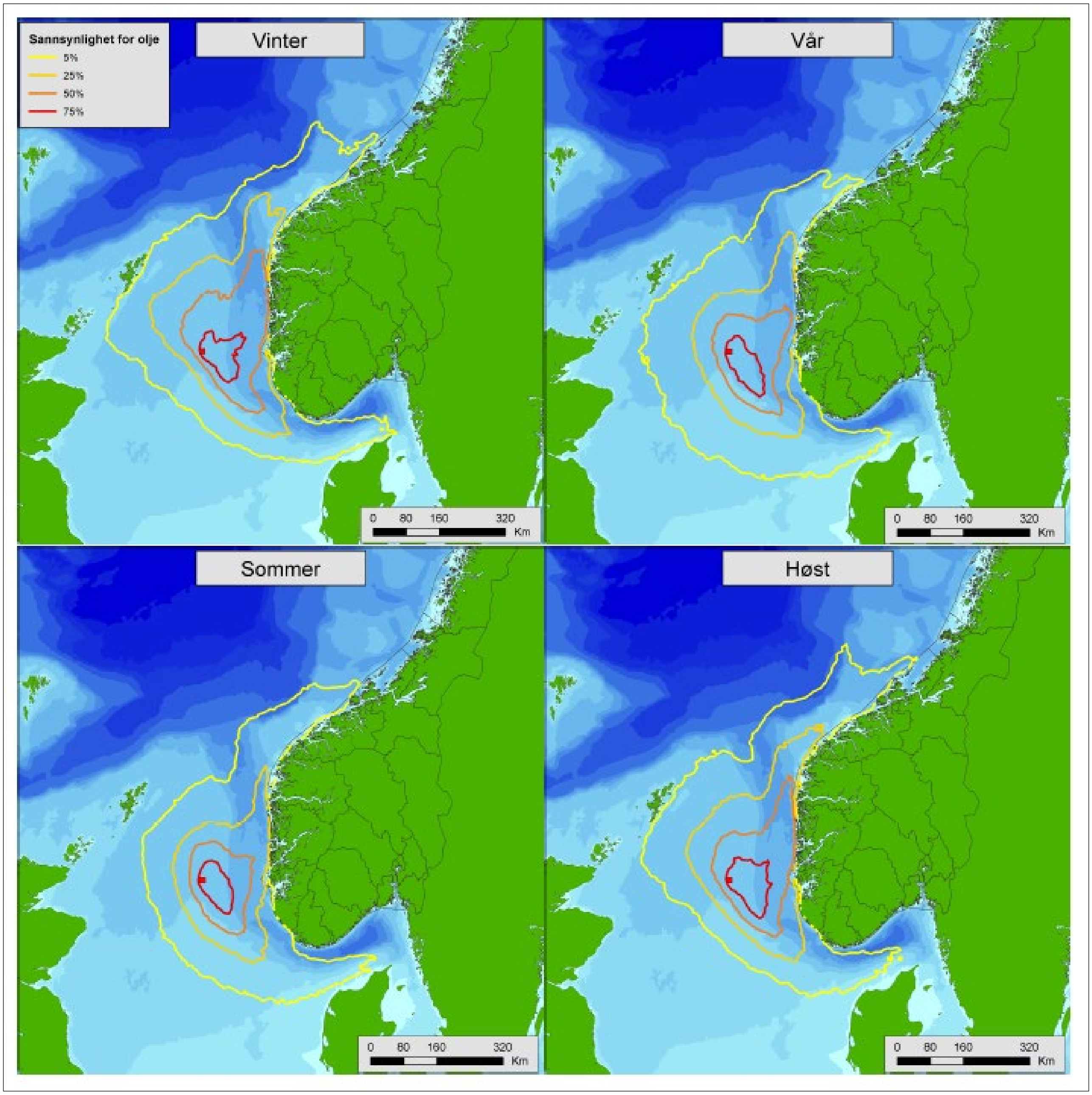

Figure 2-3 *Influence areas on the sea surface, calculated from the stochastic oil drift simulations for a* ***surface blowout*** *during drilling of reference well 25/11-29 JK. Each area consists of all 10 x 10 km grid cells with more than 0.01 ton/km2 oil in more than 5, 25, 50 or 75 % of all single simulations, shown with different color codes (Acona, 2018).*

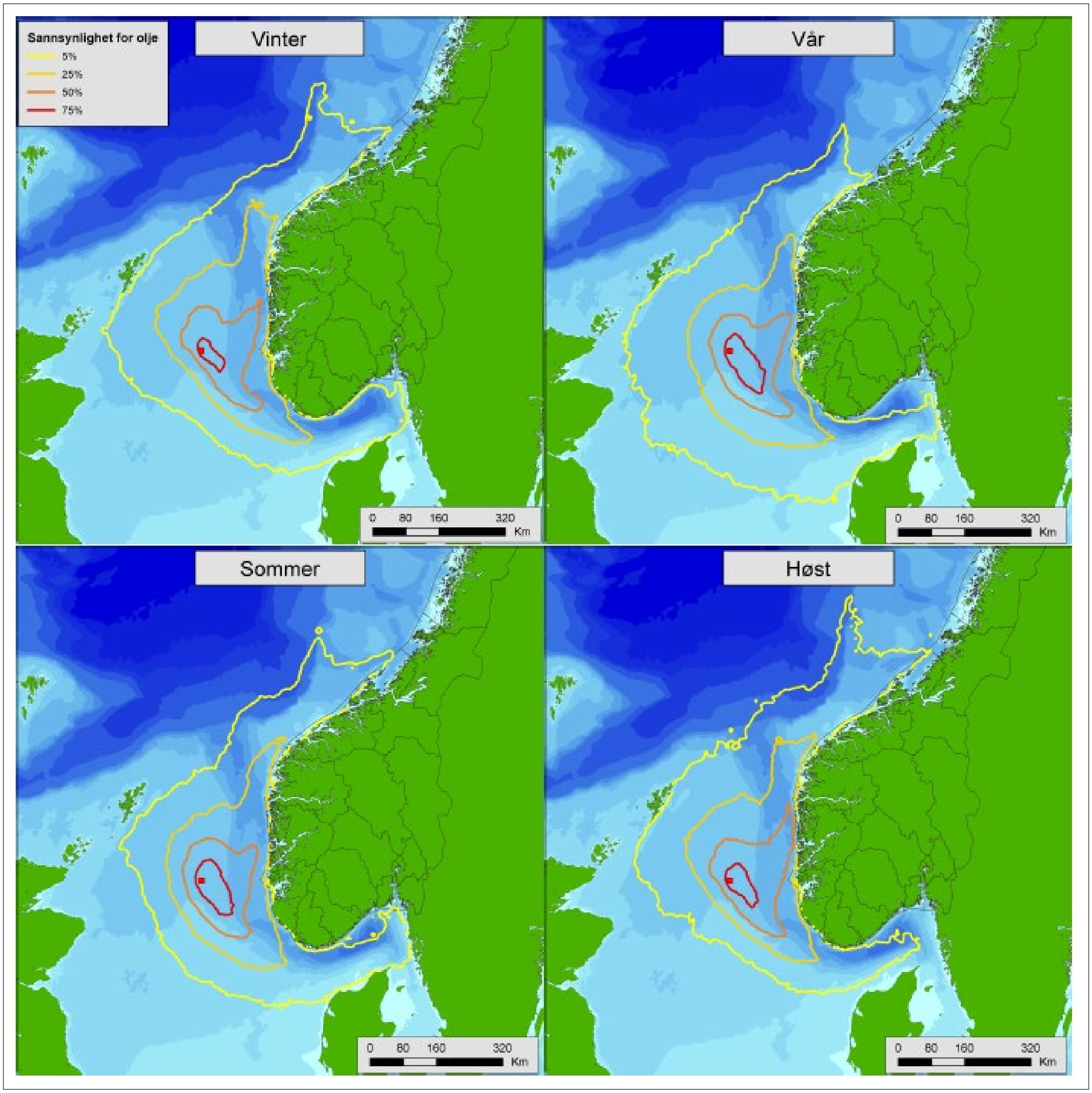

Figure 2-4 *Influence areas on the sea surface, calculated from the stochastic oil drift simulations for a **seabed blowout** during drilling of reference well 25/11-29 JK. Each area consists of all 10 x 10 km grid cells with more than 0.01 ton/km2 oil in more than 5, 25, 50 or 75 % of all single simulations, shown with different color codes (Acona, 2018).*

2.7.2 Stranding of oil in the coastal habitats

Coastal grid cells with ≥5 % hit probability for stranding of more than 1 ton of oil per cell (10 x 10 km) are presented in Figure 2-5 for a surface blowout and in Figure 2-6 for a seabed blowout. There is highest probability for stranding of oil (≥5 %) along the coast from Mandal to Ørlandet.

Shortest drift time to shore and amount of stranded emulsion is presented for the different seasons in Table 2-5 (95-percentile). The amount of emulsion and drift time to shore do not necessarily originate from the same simulation. 95-percentile of the scenarios gives 16079 ton of emulsion along the coastline (autumn season) and 95-percentile of the shortest drift time is 4.3 days (winter season).

Table 2-5 *Stranding statistics for blowout during drilling of reference well 25/11-29 JK (Acona, 2018).*

Utslipp		Sanns. (%)	Tid (dager)			Mengde (tonn)		
Periode	Dyp		P_{100}	P_{95}	P_{50}	P_{50}	P_{95}	P_{100}
Vinter	Overflate	69.3	2.7	4.3	16.2	41	9 872	235 722
...	Sjøbunn	54.3	2.6	6.4	42.0	13	14 413	197 678
Vår	Overflate	50.3	3.5	6.5	42.8	4	12 574	346 024
...	Sjøbunn	53.2	3.6	8.1	48.9	12	14 232	289 584
Sommer	Overflate	47.5	6.0	9.2	Inf	0	10 095	406 795
...	Sjøbunn	53.8	5.6	11.8	45.9	10	12 668	338 920
Høst	Overflate	69.7	3.0	5.5	15.0	72	11 226	206 608
...	Sjøbunn	59.8	3.4	7.0	26.5	25	16 079	157 215

Table 2-6 gives the 95-percentile of the shortest drift time and largest amount of emulsion into the pre-defined example areas along the Norwegian shoreline.

95-percentile of the scenarios gives the highest amount of stranded oil emulsion at the example area Ytre Sula with 1896 tons of emulsion in the autumn season and 95-percentile of the shortest drift time is 5.5 days (Austevoll in the winter season).

Location of the predefined example areas is shown in Figure 2-7.

Table 2-6 *Stranding statistics for NOFO example areas with stranding probability >5 % given a blowout during drilling of reference well 25/11-29 JK. The different columns show probability for stranding, 95 percentile of shortest drift time to shore and 95 percentiles of amount of stranded emulsion for the seasons winter (P1), spring (P2), summer (P3) and autumn (P4) (Acona, 2018).*

Utslipp		Sanns. (%)				Tid (d)				Mengde (t)			
Område	Dyp	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
Ytre Sula	Overflate	45	33	29	50	8.4	9.9	14.2	8.1	931	1 002	1 835	1 328
	Sjøbunn	36	31	36	40	11.8	11.9	15.8	10.8	1 296	1 057	1 896	1 622
Austevoll	Overflate	45	41	29	46	5.5	8.3	11.5	6.7	1 242	1 538	597	1 030
	Sjøbunn	35	36	34	37	8.9	9.5	15.9	10.3	1 213	1 638	903	1 138
Onøy (Øygarden)	Overflate	45	35	28	52	7.0	9.1	14.1	7.4	961	1 195	827	1 155
	Sjøbunn	36	35	33	39	11.3	10.5	16.8	10.3	1 277	1 190	1 120	1 482
Utsira	Overflate	39	31	27	44	6.2	8.7	11.8	7.3	842	680	575	674
	Sjøbunn	35	32	32	38	11.0	12.2	16.3	10.8	952	733	742	890
Nord-Jæren	Overflate	25	19	17	26	11.9	12.4	17.5	11.1	520	261	286	379
	Sjøbunn	29	23	25	29	17.8	15.9	22.3	15.8	666	294	409	410
Bømlo	Overflate	25	20	16	30	7.3	11.2	15.1	8	244	257	163	222
	Sjøbunn	22	23	21	20	15.0	13.1	21.0	14	296	340	261	267
Sverslingsosen - Skorpa	Overflate	13	13	12	17	17.9	17.1	20.6	18	43	46	74	56
	Sjøbunn	14	9	13	12	30.6	33.8	28.9	27	53	34	120	88
Frøya og Froan	Overflate	6	3	6	9	46.4	inf	65.9	31	16	0	17	57
	Sjøbunn	11	4	13	13	46.0	inf	40.3	30	40	0	119	76
Smøla	Overflate	6	3	6	9	47.7	inf	58.8	27	11	0	15	19
	Sjøbunn	9	5	13	11	47.6	inf	39.7	33	20	0	87	32
Ognabukta	Overflate	16	8	8	13	18.6	32.3	38.8	20	55	18	46	50
	Sjøbunn	18	14	16	21	25.6	33.0	37.4	28	68	33	80	58
Lista-Loshavn	Overflate	12	5	5	9	21.5	64.2	64.1	35	29	4	7	26
	Sjøbunn	18	14	11	15	29.4	30.4	52.9	37	62	52	32	65
Runde	Overflate	5	4	6	7	59.6	inf	60.3	44	6	0	16	9
	Sjøbunn	8	5	10	9	52.0	68.6	42.1	39	26	3	37	15
Vigra - Godøya	Overflate	4	1	5	4	inf	inf	66.3	inf	0	0	9	0
	Sjøbunn	6	3	8	5	62.3	inf	58.4	inf	9	0	20	0
Sandøy	Overflate	4	2	4	3	inf	inf	inf	inf	0	0	0	0
	Sjøbunn	6	3	7	5	66.1	inf	53.5	inf	6	0	12	0

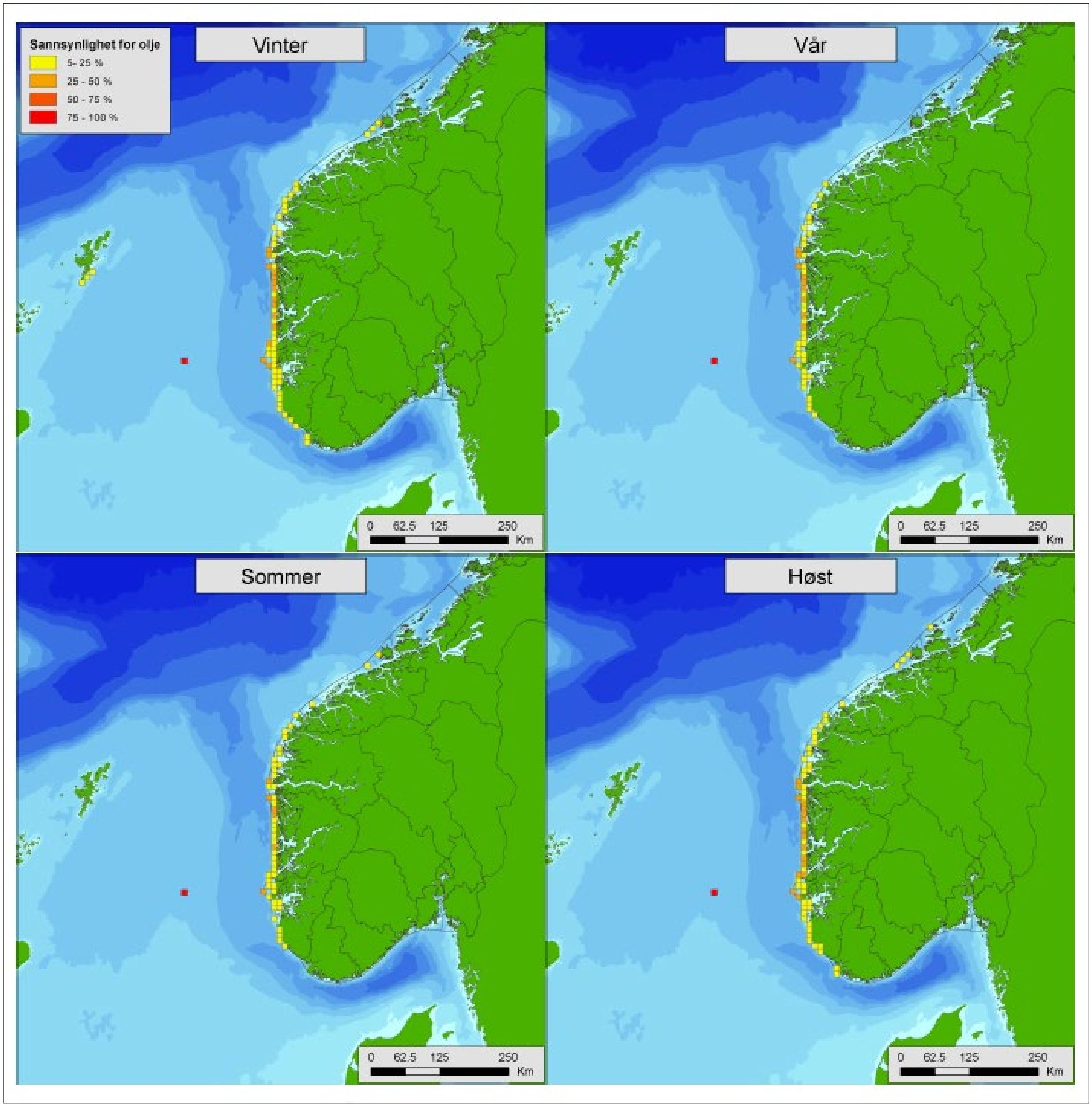

Figure 2-5 *Influence areas for oil accumulated on the coastline, calculated from the stochastic oil drift simulations for a* ***surface blowout*** *during drilling of reference well 25/11-29 JK. Each area consists of all 10 x 10 km grid cells with accumulated oil >1 ton in more than 5, 25, 50 or 75 % of all single simulations, shown with different color codes (Acona, 2018).*

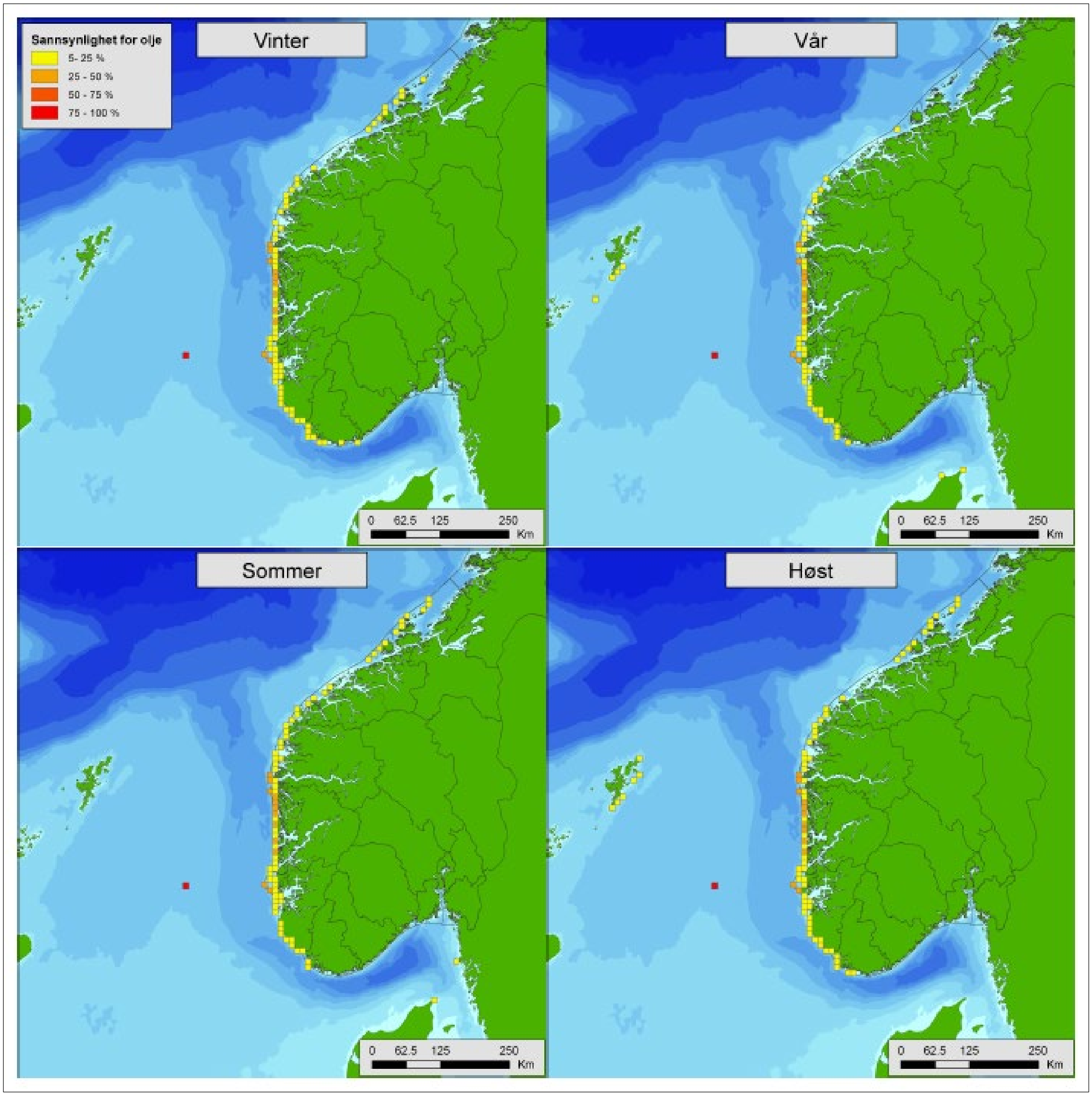

Figure 2-6 *Influence areas for oil accumulated on the coastline, calculated from the stochastic oil drift simulations for a* ***seabed blowout*** *during drilling of reference well 25/11-29 JK. Each area consists of all 10 x 10 km grid cells with accumulated oil >1 ton in more than 5, 25, 50 or 75 % of all single simulations, shown with different color codes (Acona, 2018).*

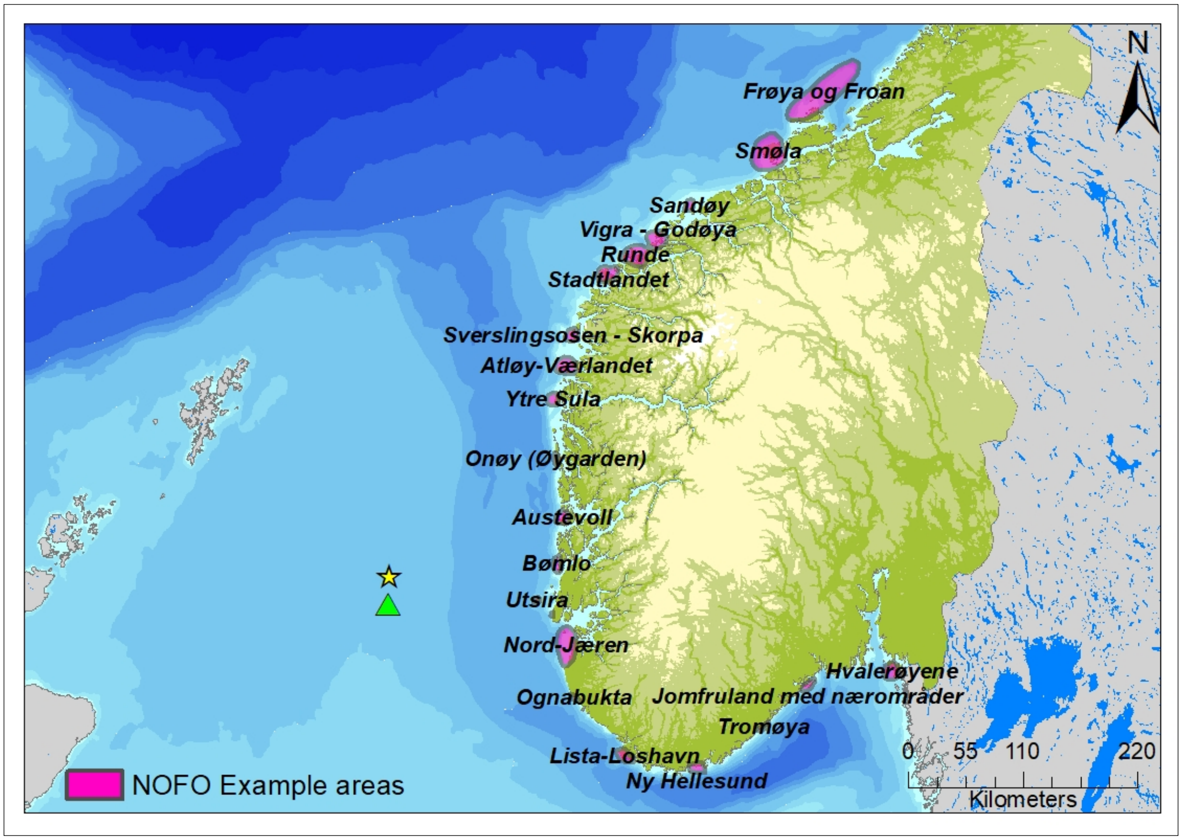

Figure 2-7 *Location of NOFO example areas along the Norwegian coast.*

2.7.3 THC in the water column

Total Hydrocarbon Concentrations (THC) represents the sum of dispersed and dissolved oil in the water column. THC concentrations in the water column >100 ppb given a surface blowout from well 25/11-29 JK is shown in Figure 2-8, and a seabed blowout shown in Figure 2-9.

The results for a surface blowout show small influence areas in the water column with only 5 % probability for THC concentrations >100 ppb. For a seabed blowout there is a probability up to 50 % for THC concentrations >100 ppb. 58 ppb is set as the lower limit for effect for damage on fish eggs and fish larvae (Nilsen et.al., 2006).

Figure 2-8 *Influence areas for oil in the water column, calculated from the stochastic oil drift simulations for a* ***surface blowout*** *during drilling of reference well 25/11-29 JK (Acona, 2018).*

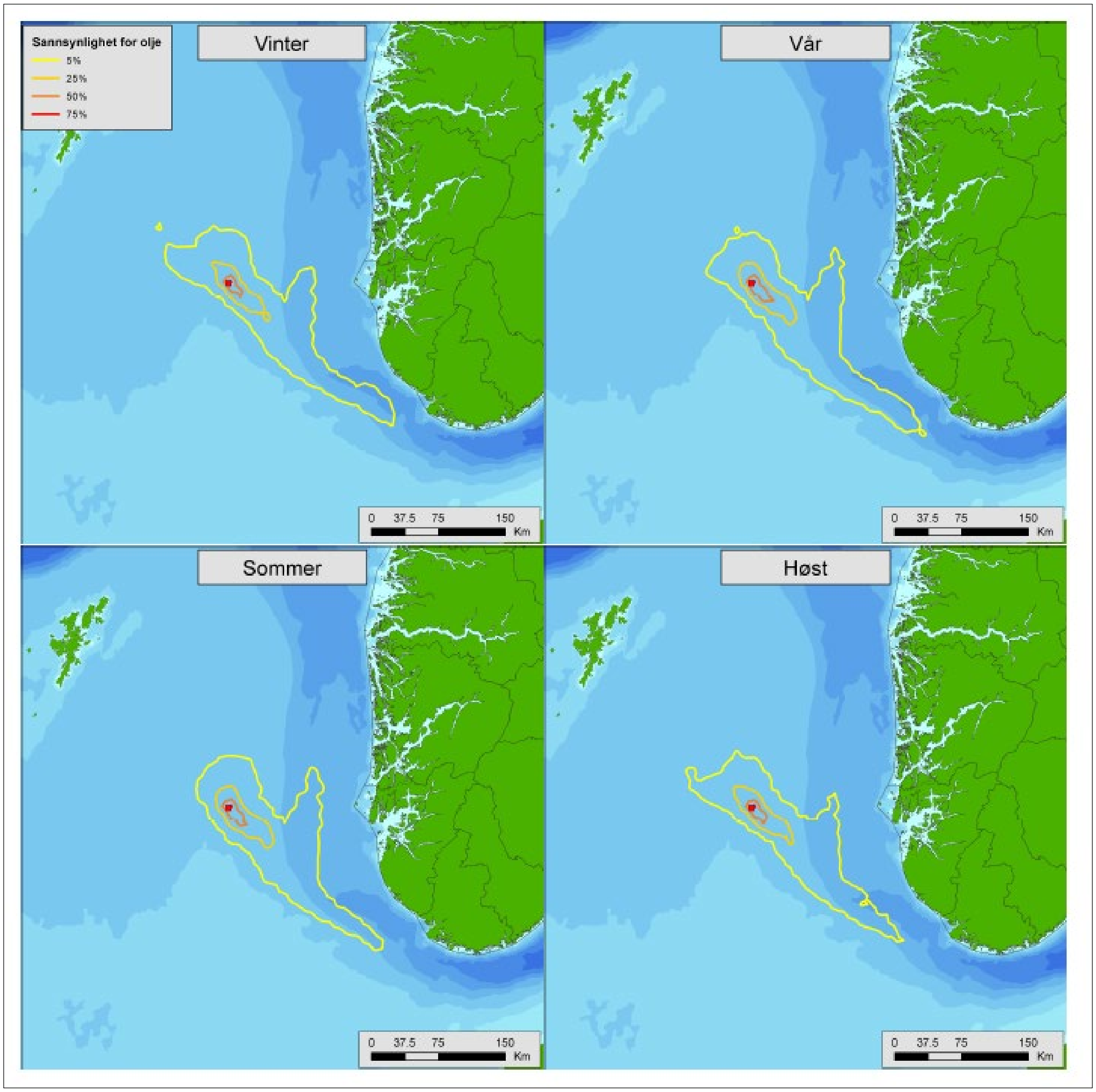

Figure 2-9 *Influence areas for oil in the water column, calculated from the stochastic oil drift simulations for a* ***seabed blowout*** *during drilling of reference well 25/11-29 JK (Acona, 2018).*

2.8 Selected Valuable Ecosystem Components (VEC)

Resource data used in the analysis for well 25/11-29 JK includes seabirds (pelagic and coastal), marine mammals, fish and coastal habitats (Table 2-7) (Acona, 2018). Plankton organisms, except fish egg and fish larvae, is not included in the analysis because of their low sensitivity for oil. This is due to great geographical distribution and short restitution time for each species.

The following dataset is used for the different VEC groups:

- Pelagic seabirds: SEAPOP, 2013
- Coastal seabirds: SEAPOP, 2017 (Systad et.al. 2018)

- Spawning areas: HI, downloaded 2018
- Fish egg and larvae: HI, 2005
- Marine mammals (seal): MRDB, 2010
- Coastal habitats: MRDB, 2010

Several of the pelagic seabird species is also included in the dataset for coastal seabirds, because there are different datasets for the bird's whereabouts in the different parts of the year. Breeding populations of these species stays around the breeding colonies along the coast in the spring and summer season before they return to the open ocean after breeding.

Table 2-7 *Valuable Ecosystem Components (VEC) in the different resource groups pelagic seabirds, coastal seabirds, marine mammals, fish and coastal habitat selected for the ERA for well 25/11-29 JK (Acona, 2018). * indicates red list status for the species in Svalbard.*

Gruppe	Art	Rødlistestatus
Sjøfugl	Alkekonge	LC*
	Alke	EN
	Fiskemåke	NT
	Grågås	LC
	Gråmåke	LC
	Gråstrupedykker	NA
	Gulnebblom	NT
	Havelle	NT
	Havhest (N og S)	EN
	Havsule	LC
	Islom	NA*
	Ismåke	VU*
	Krykkje	EN
	Laksand	LC
	Lappfiskand	VU
	Lomvi	CR
	Lunde	VU
	Makrellterne	EN
	Polarlomvi	EN
	Polarmåke	NA
	Praktærfugl	NA
	Rødnebbterne	LC
	Siland	LC
	Sildemåke	LC
	Sjøorre	VU
	Smålom	LC
	Stellerand	VU
	Storjo	LC
	Storlom	LC
	Storskarv	LC
	Svartand	NT
	Svartbak	LC
	Teist	VU
	Toppskarv	LC
	Tyvjo	NT
	Ærfugl	NT
Sjøpattedyr	Havert	LC
	Steinkobbe	LC
Fisk	Norsk vårgytende sild	LC
	Nordøstarktisk sei	LC
	Nordøstarktisk torsk (skrei)	LC
	Nordøstarktisk hyse	LC
	Nordsjømakrell	LC
	Nordsjøtorsk	LC
	Nordsjøsild	LC
	Nordsjøsei	LC
	Nordsjøhyse	LC
	Havsil (tobis)	LC
	Snabeluer	LC
	Lodde	LC
	Blåkveite	LC
	Øyepål	LC
Strandhabitat	-	-

NT – Nær Truet, EN – Sterkt Truet, CR – Kritisk Truet, VU – Sårbar, LC – Livskraftig

2.9 Environmental risk level for reference well 25/11-29 JK

Figure 2-10 shows the seasonal environmental risk for each of the VEC groups; pelagic and coastal seabirds, marine mammals and coastal habitats given a blowout from reference well 25/11-29 JK. The environmental risk is presented as part of Aker BPs operation specific acceptance criteria, which is equivalent to Vår Energi's operation specific acceptance criteria.

It is important to keep in mind that species in pelagic and coastal seabird data set may belong to the same population, but the analysis is performed with two different datasets based on the bird's location in different parts of the year. In the spring and summer season the breeding population of pelagic seabirds will migrate towards the coast (breeding colonies) and in these seasons be a part of the dataset for coastal seabirds.

Pelagic seabirds (Northern gannet) is dimensioning for the risk level with 18 % of the acceptance criteria for moderate environmental damage (1-3 years restitution time) in the winter season (December- February). The highest risk level for coastal seabird is 9 % (Common scoter- Winter) for moderate environmental damage. The highest risk level for marine mammals (Grey seal) and coastal habitats is 8 % of the acceptance criteria, both in moderate environmental damage (Acona, 2018).

There is not any measurable damage on spawning products for herring and cod, and the environmental risk is not quantifiable (zero). The influence area in the water column overlap with spawning areas for cod, pollack, haddock and Norway pout in the North Sea. The populations spawn over large areas and the risk for loss of eggs and larvae and hence the recruitment for the populations in the North Sea is considered as low and acceptable (Acona, 2018).

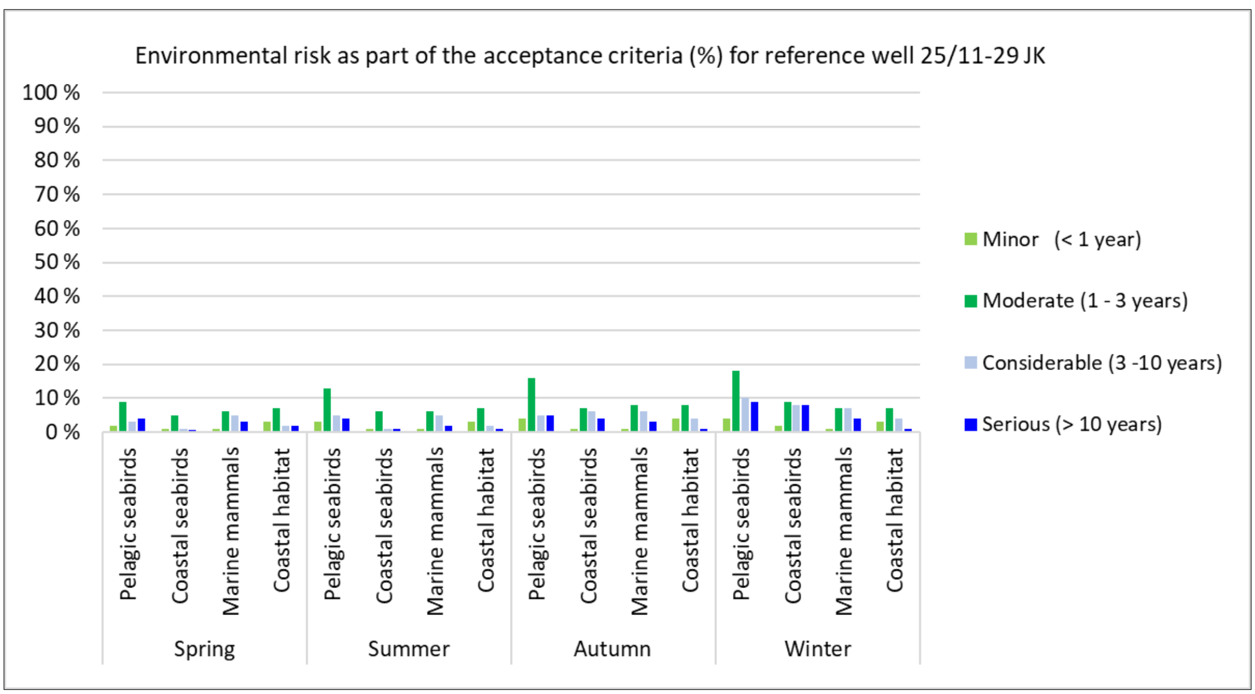

Figure 2-10 *Calculated environmental risk for all VEC groups included in the analysis for reference well 25/11-29 JK in the North Sea, shown for the different seasons.*

2.10 Environmental risk for exploration well 25/5-20 S&A

In the reference-based analysis the environmental risk performed for well 25/11-29 JK is compared to input data for well 25/8-20 S&A. All input parameters that may influence the environmental risk level is evaluated, and it is concluded that the reference analysis covers the planned activity for well 25/8-20 S&A.

Well technical conditions are approximately similar, the well will be drilled with similar rigs, GOR is low in both wells and distance to shore is similar.

The longest blowout duration set to drill a relief well is two days longer for well 25/8-20 S&A than for the reference well (52 days vs 50 days) and the Forseti oil will have a little longer lifetime on the sea surface than Avaldsnes oil. But the blowout rates are lower for well 25/8-20 S&A for both surface and seabed (surface: 5220 Sm^3/d vs 5897 Sm^3/d, seabed: 4071 Sm^3/d vs 5256 Sm^3/d) and the blowout frequency is 9.5 % lower for well 25/8-20 S&A than for the reference well (1.14×10^{-4} vs 1.26×10^{-4}). The Forseti oil is conservatively chosen as a reference oil and it is not expected that the 2 days longer duration or the oil type will give higher results than the reference well when all parameters are evaluated together.

Based on the evaluations and comparison of all input parameters for the two wells it is expected that the environmental risk level for well 25/8-20 S&A will be similar to the environmental risk for well 25/11-29 JK and within Vår Energi’s operation specific acceptance criteria in all seasons.

3 OIL SPILL CONTINGENCY ANALYSIS FOR EXPLORATION WELL 25/5-20 S&A

The oil spill contingency analysis for well 25/8-20 S&A is operation specific and the analysis is seasonally based, covering the summer season (spring and summer) and the winter season (autumn and winter). Planned drilling for exploration well 25/8-20 S&A is in Q3 2020, but since there are uncertainties around the drilling start the analysis covers the whole year.

The objective of the contingency analysis is to map and analyze the need for oil spill response given a blowout from the well during drilling. This shall form the basis for selection and design of oil spill contingency in connection with acute spills. Aktivitetsforskriftens § 73 and Styringsforskriftens § 17 states that the operator has to analyze the environmental risk and oil spill contingency for activities with potential for acute spill and use this as a base for establishing oil spill contingency for the activity.

Contingency as a consequence reducing measure is an important contribution to risk reduction. Effective oil spill contingency will reduce the amount of oil on the sea surface and hence lead to a reduction of the influence area for a potential oil spill.

Vår Energi will be responsible for a potential oil spill response operation. NOFO has equipment and is in charge of the operative part of the contingency on open sea, on coastal areas and for a potential beach cleaning. Dispersion should be evaluated as a response option during an operation, and NOFO has dispersions available.

3.1 Method for oil spill contingency analysis

Calculations for response requirements given a blowout from exploration well 25/8-20 S&A Prince/King are performed. The calculations are performed in accordance with the guideline «Veiledning for miljørettede beredskapsanalyser» (NOROG, 2013), and is based on the dimensioning DSHA – a surface blowout (see chapter 2.5).

The calculations are done with the use of BarKal. BarKal is an Excel based model for calculation of response requirements in the different barriers, and is based on assumptions for barriers, systems and capacity given in NOFOs planverk (NOFO, 2020; https://www.nofo.no/planverk).

If oil is discovered in the reservoir it is expected to be an oil with similar properties as the Forseti crude oil, therefore Forseti is used as a reference oil in this analysis. Weathering data for Forseti oil (SINTEF, 2002) is used when calculating volumes of emulsion and in evaluation of relevant response properties of the oil. Both amounts of emulsion and barrier efficiency is calculated seasonally using a monthly average of the parameters (wind, light and temperature) within the seasons.

The oil spill contingency analysis uses the concept of barriers to be able to calculate the response requirements in a way that describes the operational conditions (Figure 3-1). The concept of barriers is in accordance with international standards (e.g. IPIECA) and corresponds to the different zones where oil recovery will happen:

- Barrier 1 is as close to the source as possible
- Barrier 2 is between the source and the coast

- Barrier 3 is coastal araeas
- Barrier 4 is remobilised stranded oil
- Barrier 5 is stranded oil

No measure is 100% effective on its own but combining them can achieve a high level of performance in optimal conditions. The calculations take into consideration the performance requirements for the systems, and hence also the barriers. In each barrier (except from the first) the effect from the previous barrier is included.

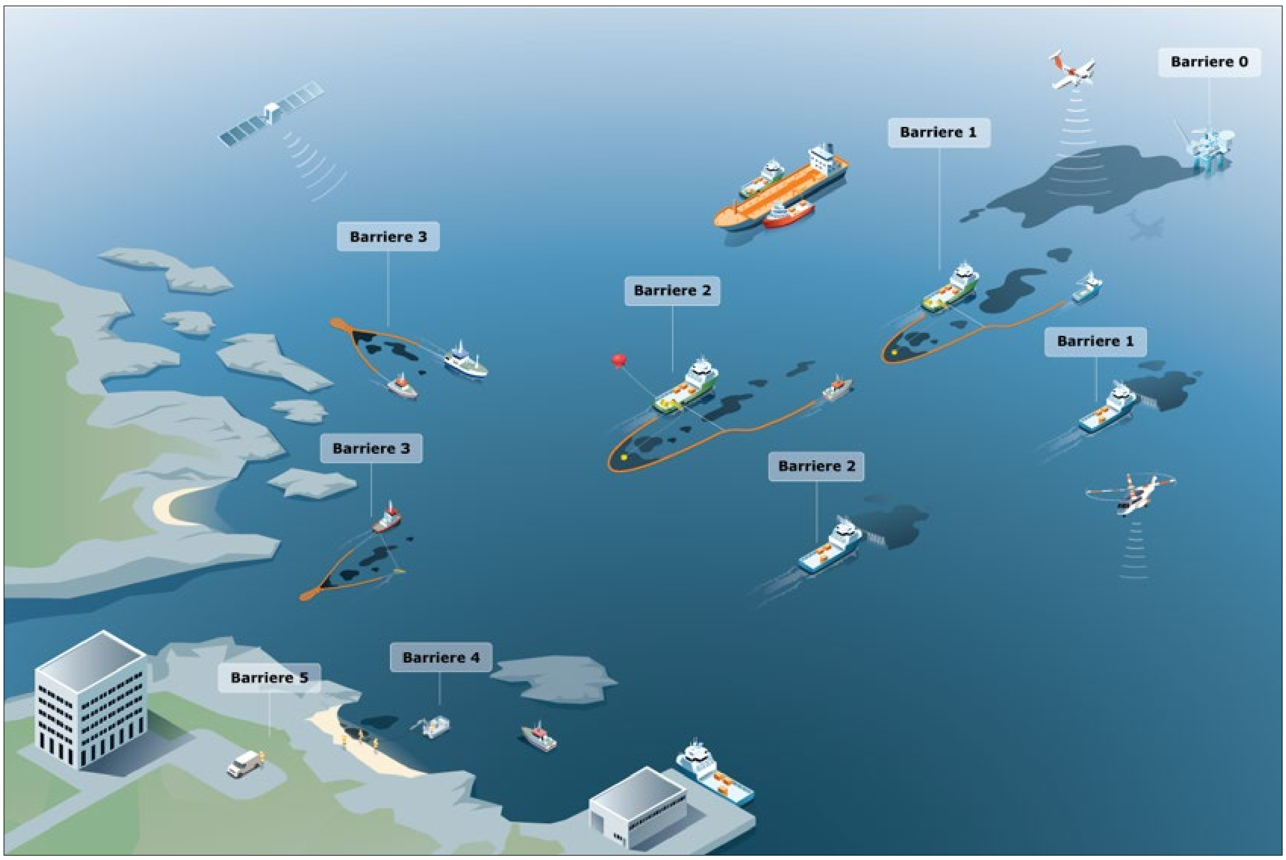

Figure 3-1 *Barriers in the oil spill response analysis (Source: NOFO planverk)*

3.1.1 Performance requirements for the different barriers

In accordance to the guideline "veiledningen for miljørettede beredskapsanalyser» (NOROG, 2013) common minimum performance requirements are basis for the calculation of the need for oil spill responses. These are:

- Each of **barrier 1 and 2** shall have sufficient capacity to handle the amount of emulsion available based on dimensioning spill rate. Response time for fully developed and functional barrier should minimum equal 95-percentile of the shortest drift time to shore or to especially sensitive environmental areas identified in the environmental risk analysis.

- **Barrier 3** shall have sufficient capacity to handle the 95-percentile amount of emulsion (calculated from full matrix in the oil drift statistics) entering the barrier after effect of previous barriers is taken into consideration. The daily volume is the amount of emulsion divided on the assumed stranding period. Plans with description of suitable tactics and response methods in identified areas should be available. The response time should be less than 95-percentile of shortest drift time to shore.
- **Barrier 4** shall have sufficient capacity to combat arriving amount of emulsion after effect of previous barriers is taken into consideration. The systems should be mobilized within the 95-percentile of shortest drift time to shore.
- **Barrier 5** shall in addition have capacity to handle stranded amount of oil (95-percentile) into the different IUAs within the influence area. Plans with description of suitable tactics and response methods shall be available. The response time should be less than 95-percentile of shortest drift time to shore. It is possible to differentiate response time to pre-defined areas in cases where the influence area expands over considerable parts of the coastline or other reasons makes it appropriate to calculate the response time to specific areas.

3.1.2 Dimensioning of barrier 1 and 2 – close to the source and on open sea

The oil spill contingency analysis for barrier 1 and 2, close to the source and on open sea, is based on weighted blowout rate and expected oil type. Calculations are performed for winter season and summer season.

For dimensioning of barrier 1 it is used parameters (evaporation, natural down missing, water uptake and viscosity of emulsion) for 2-hour old surface oil. The basic requirement is that capacity in the different barriers shall be sufficient to handle the amount of emulsion at the given conditions.

For dimensioning of barrier 2 it is performed calculation of the number of response systems required to combat the amount of emulsion that has passed barrier 1. The system efficiency is dependent of wave height and light conditions and varies between the different regions on the NCS. In the calculations of system requirements for barrier 2, oil parameters for 12-hour old surface oil is used.

The response time requirements is set to best available response time for NOFO vessels for the well, and is based on distance to oil recovery resources, moving speed for OR-vessels, tug vessel capacity and moving speed for tug vessels, mobilization of recovery equipment aboard the OR-vessels and access to personnel on the base stations. In addition, the requirement of establishing of barrier 1 and 2 within the shortest drift time to shore (95-percentile) must be evaluated.

3.1.3 Dimensioning of barrier 3 and 4 – Coast and shoreline area

For barrier 3 and 4, combat of oil in the coastal areas, the requirement is set based on the largest need by using two alternative approaches:

- 95-percentile of maximum stranded amount of emulsion. Contingency in barrier 4 shall have capacity to combat emulsion that passes barrier 3. The need for response in barrier 3 and 4 is calculated based on results from the oil drift simulations performed for the activity.

- Example areas affected by stranding with drift time <20 days (from the oil drift modelling) shall have access to 1 coastal system and 1 fjord system. The response resources shall be used where it is most appropriate and is not limited to the prioritized areas.

This approach results in the use of both volumes and area of stranded emulsion in the dimensioning and the largest need is the base when requirements for barrier 3 and 4 is set.

It is set requirements that the response in barrier 3 and 4 shall be established within the 95-percentile of shortest drift time to shore. If the drift time to shore is longer than 20 days, no specific requirements to response in barrier 3 and 4 is set. Barrier 5 will be addressed in the oil spill contingency plan for the well.

3.2 Basis for the analysis

3.2.1 Dimensioning scenario for the analysis

In accordance with existing Industry standard (NOROG, 2013), weighted blowout rate shall be used when calculating oil spill response requirements. Weighted blowout rate for exploration well 25/8-20 S&A is calculated to 5220 Sm^3/d for a surface blowout and to 4071 Sm^3/d for a seabed blowout (Add Energy, 2020).

The system requirements are based on a surface blowout (5220 Sm^3/d).

3.2.2 Oil properties

3.2.2.1 Forseti crude oil

If hydrocarbons are discovered in well 25/8-20 S&A, Vår Energi expects the hydrocarbon to have similar characteristics as Forseti crude oil (SINTEF, 2002). A short summary of the properties for Forseti oil is given in chapter 2.6.

Weathering data for Forseti oil at different wind and temperature conditions is given in Table 3-1. The oil drift simulations for the reference well 25/11-29 JK was performed with Avaldsnes oil (SINTEF, 2012), but Forseti oil is used to calculate the response requirements for well 25/8-20 S&A.

Weathering data for Forseti oil at winter conditions (5 ºC, 10 m/s wind) and summer conditions (15 ºC, 5 m/s wind) is used as input for calculating the need for response for well 25/8-20 S&A in the two seasons. Winter is defined as September to February, and summer from March to August.

Table 3-1 *Forseti crude oil, weathering properties after 2 hours and 12 hours at sea for defined winter and summer conditions.*

Time	Parameters – Forseti oil	Winter 5°C – 10 m/s	Summer 15°C – 5 m/s
2 hours	Evaporation (%)	6	5
	Down-mixing (%)	4	0
	Water content (%)	27	9
	Viscosity of emulsion (cP)	1900	630
	Remaining oil on the surface (%)	4698	4959

12 hours	Evaporation (%)	11	10
	Down-mixing (%)	14	1
	Water content (%)	68	42
	Viscosity of emulsion (cP)	17000	2200
	Remaining oil on the surface (%)	2188	1067

3.2.2.2 Oil properties regarding mechanical recovery and chemical dispersion

Properties for Forseti crude oil is used in the calculations. Information is retrieved from the weathering study for Forseti oil performed by SINTEF in 2002. It is expected that Forseti oil will have a long lifetime at the sea surface with high wind speeds.

Figure 3-2 shows that Forseti oil make emulsions with low viscosity (<1000 cP) at summer conditions and wind speed 2 m/s up to 9 hours on sea, and this may lead to boom leakage initially in a response scenario. After 9 hours and with higher wind speeds the viscosity is >1000 cP at both summer and winter conditions (SINTEF, 2002). At winter conditions and wind speeds ≥10 m/s the oil will make emulsions with viscosity above 20 000 cP after 9-12 hours on sea. Conventional weir (Transrec) skimmers can be used in an oil spill response situation, but at winter conditions with higher wind speeds there may be more efficient to use a Hi-wax/Hi-Visc skimmer.

Forseti oil have a good potential for chemical dispersion (Figure 3-2), and is dispersible up to 12 hours at sea with summer and winter conditions and wind speed 5 m/s. With higher wind speeds the oil has low potential for chemical dispersion after 3-9 hours at sea (SINTEF, 2002).

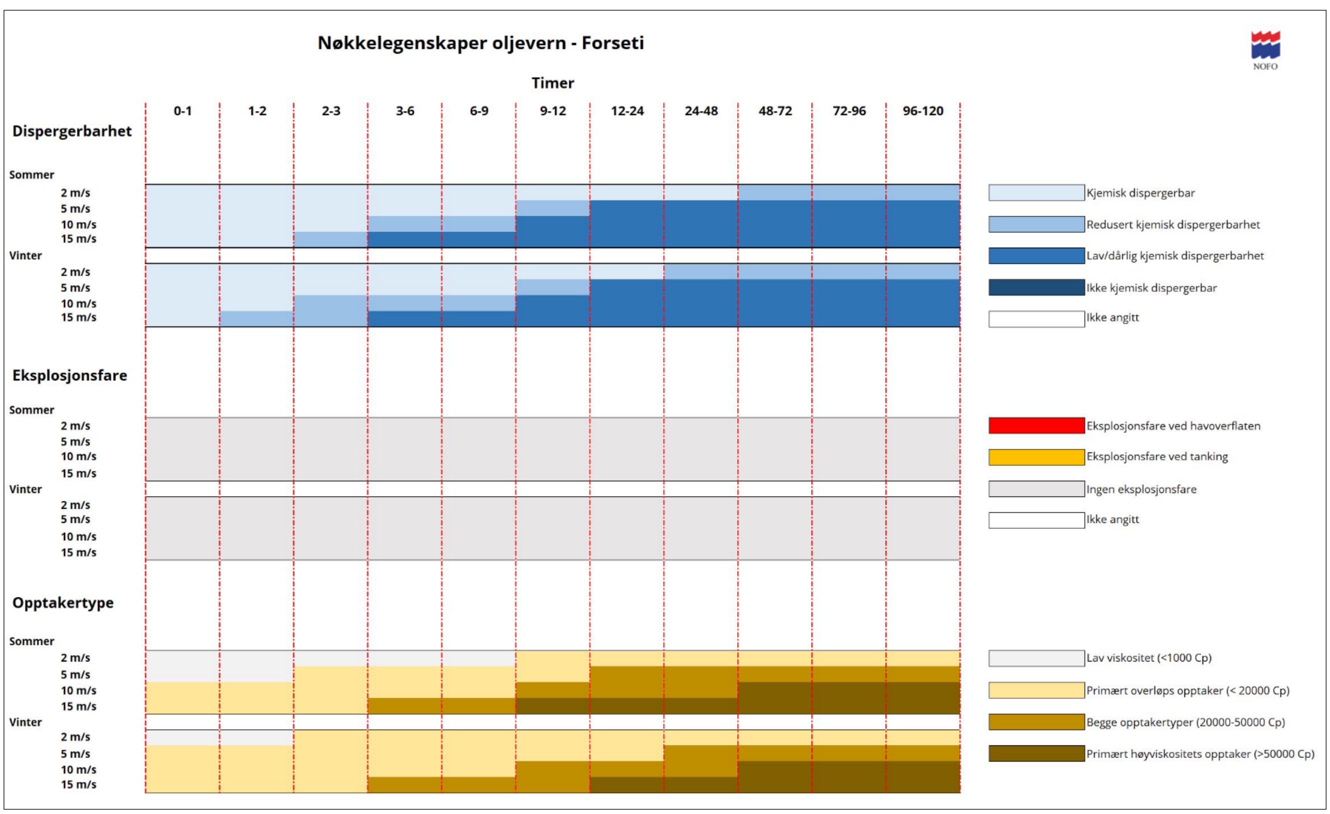

Figure 3-2 *Potential for mechanical recovery and chemical dispersion based on the viscosity of Forseti oil (SINTEF, 2002) https://www.nofo.no/planverk/datasett/oljetyper-og-egenskaper/nokkelegenskaper/).*

3.2.3 Elements that affects performance and efficiency of combat systems

The capacity for the systems included in an acute spill operation measured in recovered amount of oil emulsion per day, is a function of the following conditions:

- The time window the unit can operate (darkness, reduced sight and wave conditions)
- Efficiency within the operational window (related to different wave conditions, or expected constant)
- Recovery/ combat capacity during the operation
- Storage capacity for recovered oil (only relevant for recovery systems)
- Frequency and duration of shutdown (transfer of collected oil, minor challenges)
- Part of the time where access/new arrival of oil to the boom is less than the system capacity (for mechanical recovery) or where emulsion is distributed in a way that dispersions cannot be applied with optimal efficiency.

The functions are used in BarKal for response requirements in all barriers.

The capacity for seagoing NOFO systems (NOFO J with traditional Transrec skimmer) under optimal conditions and with access to sufficient emulsion with regards to sweep area and pump rate is 2865 m^3/d (NOFO planverk, 2020).

Area specific factors for well 25/8-20 S&A is discussed in the following sections.

3.2.3.1 Wave conditions

Wave conditions on open sea is included in the calculation of efficiency and performance for the systems in a response activity in barrier 1 and 2. BarKal has wave data for 27 stations, as shown in Figure 3-3. Station 5 (NOFO systems) (Table 3-2) is assumed to best represent wave conditions at the location for exploration well 25/8-20 S&A.

System group A has a window for operation in weather conditions with up to 4 m significant wave heights. Figure 3-4 shows part of time for this operational window on the Norwegian Continental Shelf in November. The basis for the data is NORA10 hindcast archive for the time period 1958 to 2016.

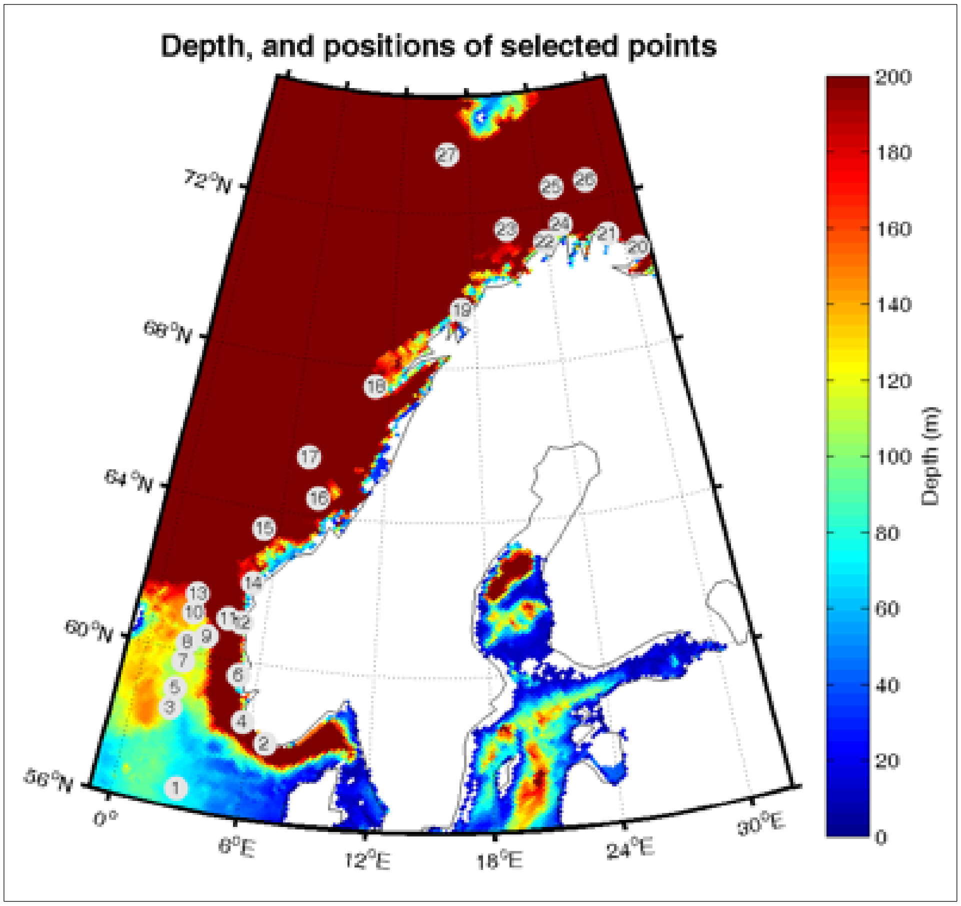

Figure 3-3 *Stations used in calculation of wave conditions on open sea.*

Table 3-2 *Average effectiveness for recovery given wave conditions at location for well 25/8-20 S&A (station 5).*

	Winter	Summer	Year
NOFO-system	45.9 %	77.5 %	62.3 %

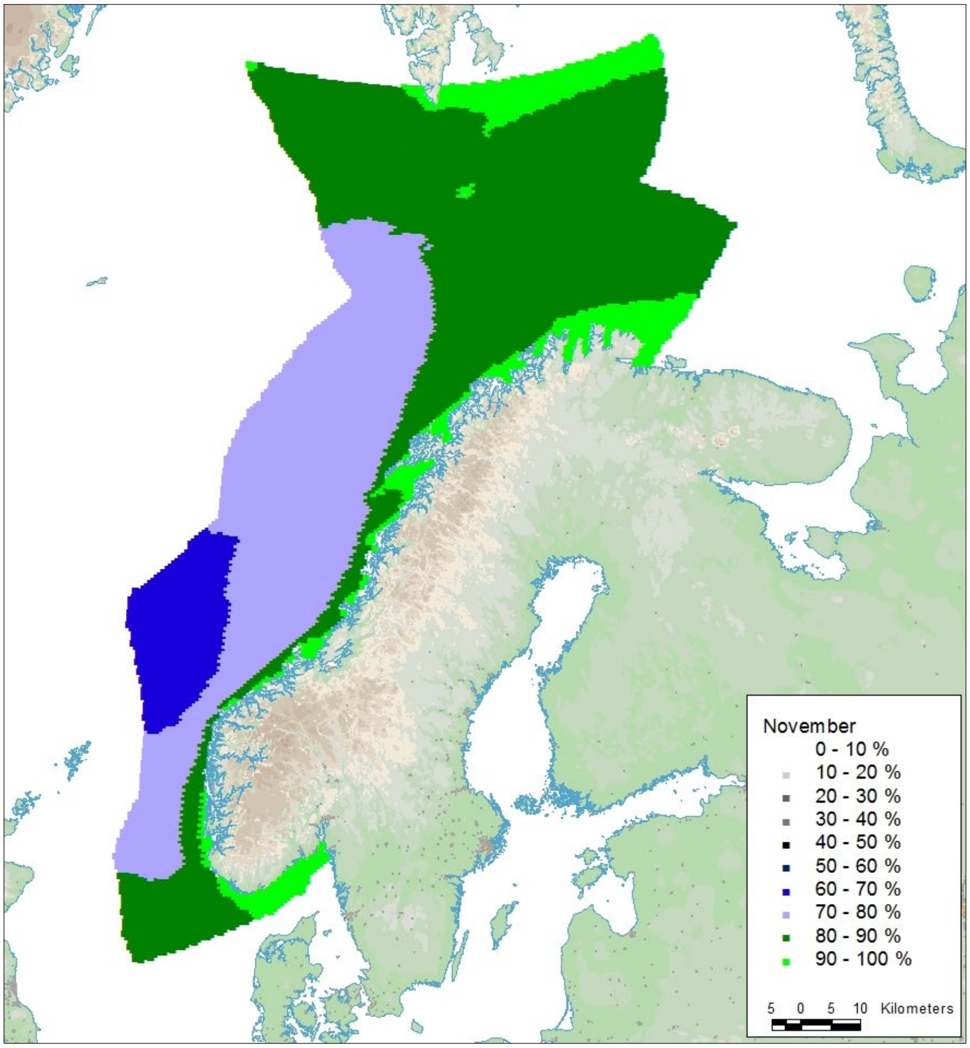

Figure 3-4 *Operational window (time in %) in weather conditions with up to 4 m significant wave height in November for system group A (https://www.nofo.no/planverk/datasett/klimatiske-forhold/bolgeklima/bolgedata4/).*

3.2.3.2 Waves in the coastal areas

Wave conditions in the coastal area is also included in the calculation of efficiency and performance for the systems in a response activity in barrier 3 and 4. BarKal has wave data for 5 coastal stations as shown in Figure 3-5. Station 4 is considered most conservative to represent wave conditions for coastal systems. Assumed average recovery efficiency for coastal systems is shown in Table 3-3.

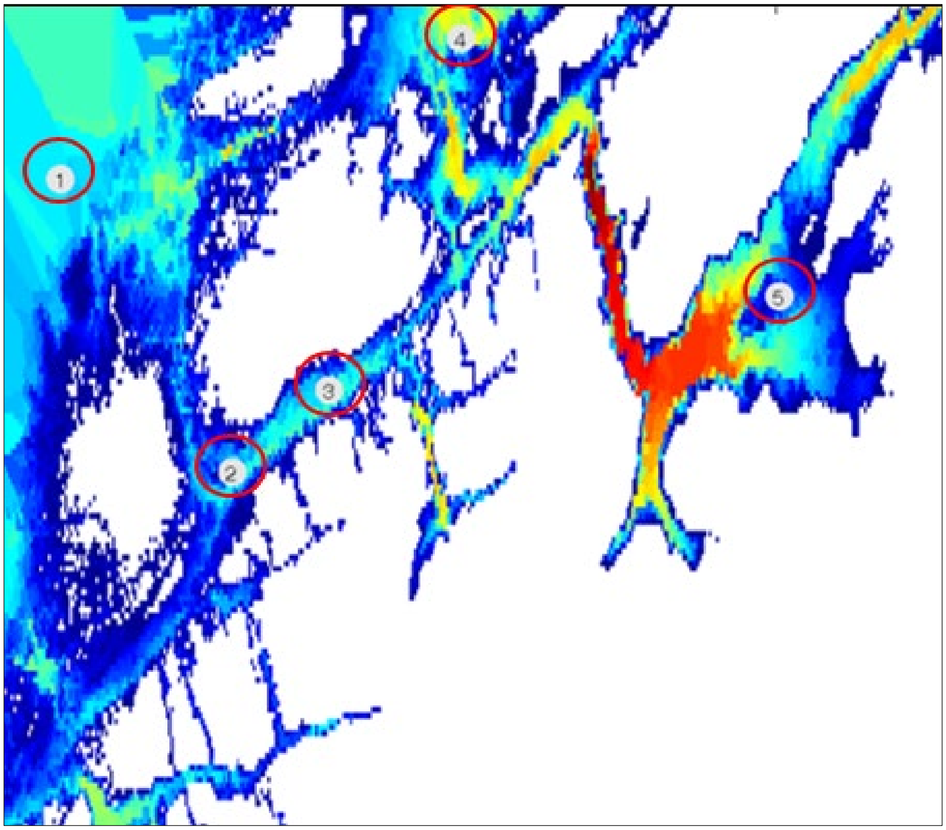

Figure 3-5 *Stations used in calculation of wave conditions in the coastal zone. The stations 1-5 is selected as representative for the Norwegian coastline.*

Table 3-3 *Average effectiveness for recovery given wave conditions at station 4 (coastal systems).*

	Winter	Summer	Year
Coastal system	47.9 %	80.9 %	63.8 %

3.2.4 Resources for oil spill response – placement of equipment and assumptions

Figure 3-6 shows location of the NOFO equipment per March 2020 (NOFO, 2020). The distance from the drilling location to potential recovery systems used as basis for the response calculations is shown in Table 3-4.

Table 3-5 shows further assumptions like transport speed, release time for response vessels and tug vessels and time for mobilising of equipment from base stations. One NOFO system includes oil booms, skimmer, tank capacity for recovered emulsion and monitoring equipment.

In total NOFO manage about 765 m^3 dispersion agents distributed on vessels and base stations.

Figure 3-6 *NOFOs overview of equipment/vessels per February 2020.*

Table 3-4 *Distances from well 25/8-20 S&A to response vessels used in the analysis.*

Response vessels	Distance from 25/8-20 S&A (nm)
Sleipner/Utsira Nord	4
Sleipner/Utsira Sør	55
Troll/Oseberg	92
Gjøa	124
Tampen	117
Ula/Gyda/Tambar	136
Stavanger S1	105
Ekofisk	177

Table 3-5 *Assumptions used in the analysis for calculation of response time in barrier 1 and 2 (NOFO, 2020).*

Transport speed, OR-vessel	14 knots
Mobilization, preparation, loading and unloading on Base – system 1 from NOFO-base	10 hours
Mobilization of system 2 from NOFO-base	30 hours
Mobilization of system 3 from NOFO-base	48 hours
Hand over time for response vessels	Sleipner/Utsira Sør: 6 hours Sleipner/Utsira Nord: 6 hours Ula/Gyda/Tambar: 6 hours Troll/Oseberg: 6 hours Gjøa: 4 hours Ekofisk: 6 hours Tampen: 6 hours
Response time for tug vessel	Slepefartøy fra NOFO-pool: 24 hours
Rescue vessel	Transport speed: 20 knots, hand over time: 2 hours Egersund, Haugesund, Florø/Måløy
Time to set out booms on sea/ preparation of dispersion on board	1 hours

3.2.5 Influence areas and stranding

Oil drift modelling for well 25/11-29 JK shows probability of stranding of oil (≥5 %) along the coast.

Planned spud for exploration well 25/8-20 S&A is in Q3 2020, but the time for drilling may change so both summer season (March-August) and winter season (September- February) is included in the calculation of oil spill contingency requirements for coastal areas. Shortest drift time to shore (95-percentile, whole coast) is 6.0 days in the summer season and 4.0 days in the winter season as shown in Table 3-6. Stranded amount of emulsion in the summer season (95-percentile) is 14232 ton and 16079 ton in the winter season (Acona, 2018). Drift time is conservatively rounded down and shown in Table 3-6.

The influence area covers 7 NOFO example areas with <20 days drift time to shore in the summer season and 8 areas in the winter season (see Table 2-6).

Table 3-6 *Stranded amount of emulsion and shortest drift time to shore for exploration well 25/11-29 JK given a surface- and seabed blowout (95-percentile) (Acona, 2018).*

Percentile	Stranded amount of emulsion (ton)		Shortest drift time to shore (days)	
	Winter 5°C – 10 m/s	Summer 15°C – 5 m/s	Winter 5°C – 10 m/s	Summer 15°C – 5 m/s
95	16079	14232	4.0	6.0

3.3 Oil spill contingency requirements and response time in open sea (Barrier 1 and 2)

For well 25/8-20 S&A the system requirements is calculated for dimensioning scenario, a surface blowout. The calculation gives the following need for systems in barrier 1 and 2 (Table 3-7):

Winter season: 3 systems in barrier 1 and 4 systems in barrier 2, a total of 7 systems.

Summer season: 2 systems in barrier 1 and 1 system in barrier 2, a total of 3 systems.

The fastest possible response time to the first NOFO system is set to 10 hours after the spill is detected. The fastest possible response time for fully operative barrier 1 and 2 is set to 24 hours.

Table 3-7 *Calculated system requirements for barrier 1 and 2 given a blowout from exploration well 25/8-20 S&A.*

Parameters	Winter 5°C – 10 m/s	Summer 15°C – 5 m/s
Weighted blowout rate (Sm^3/d)	5220	5220
Density of oil (kg/Sm^3)	916	916
Evaporation after 2 hours on sea (%)	6	5
Down-mixing after 2 hours on sea (%)	4	0
Amount of oil available to form emulsion (Sm^3/d)	4698	4959
Water uptake after 2 hours on sea (%)	27	9
Amount of emulsion available for recovery in barrier 1 (Sm^3/d)	6436	5449
Viscosity of emulsion into barrier 1 (cP)	1900	630
Increased need for systems because of high viscosity?	No	No
NOFO-system requirements in barrier 1	**3**	**2**
Amount of emulsion into barrier 2 (Sm^3/d)	3526	1248
Amount of oil into barrier 2 (Sm^3/d)	2574	1136
Evaporation after 12 hours on sea (%)	11	10
Down-mixing after 12 hours on sea (%)	14	1
Amount of oil available to form emulsion (Sm^3/d)	2188	1067
Water uptake after 12 hours on sea (%)	68	42
Amount of emulsion available for recovery in barrier 2 (Sm^3/d)	6837	1840
Viscosity of emulsion into barrier 2 (cP)	17000	2200
Increased need for systems because of high viscosity?	No	No
NOFO-system requirements in barrier 2	**4**	**1**
Total system requirements in barrier 1 and 2	**7**	**3**

Table 3-8 gives a summary of response times applied for the drilling operation.

7 NOFO systems are available within 24 hours. Fully developed and functional barrier 1 and 2 shall, in accordance with performance requirements and the guideline, be ready by the latest within the shortest drift time to shore (95-percentile). For exploration well 25/8-20 S&A the 95-percentile drift time is 4 days. The seven systems will be operative within 24 hours in all seasons. This is the fastest solution for systems considering all presumptions in the NOFO "planverk". To make the response system more robust, three additional systems are listed. All ten system are available within the requirement of full functional barriers within 4 days. Other vessels present in the area during the drilling activity will be available for use in a potential oil spill response operation.

Table 3-8 *Calculation of response time for complete response systems given a blowout from exploration well 25/8-20 S&A in PL027 for OR and tug vessels.*

System	Sailing time (h)	Mobilization/ release time (h)	Total response time NOFO-vessel (h)	Tug vessel	Total response time tug vessel (h)	Total response time for complete response system (h)
Sleipner/Utsira Nord	0.3	6	8	Egersund	10	**10**
Sleipner/Utsira Sør	3.9	6	11	Haugesund	12	**12**
Troll/Oseberg	6.6	6	14	Florø/Måløy	13	**14**
Gjøa	8.9	4	14	NOFO pool	24	**24**
Tampen	8.4	6	16	NOFO pool	24	**24**
Ula/Gyda/Tambar	9.7	6	17*	NOFO pool	24	**24**
Stavanger S1	7.5	10	19	NOFO pool	24	**24**
Ekofisk	12.6	6	20	NOFO pool	24	**24**
Mongstad S1	9.2	10	21	NOFO pool	24	**24**
Kristiansund S1	20.1	10	32	NOFO pool	24	**32**

* The system located on Ula/Gyda/Tambar will soon be moved to Hod. This cause at least 4 hours longer response time than given in the table above. The system will still have a total response time of less than 24 hours.

3.4 Oil spill contingency requirements and response time in the coastal areas (Barrier 3 and 4)

95-percentile of largest amount of stranded emulsion given a blowout is 16079 ton in the winter season and 14232 ton in the summer season. Shortest drift time to shore is 4 days in the winter season and 6 days in the summer season. It is assumed that the highest amount of stranding happens during a period of 10 days. By taking the effect of barrier 1 and 2 into consideration, this will give an entry rate into barrier 3 of 670 ton/day for the winter season and 197 ton/day in the summer season. The capacity to combat the entry rate into barrier 3 and 4 is calculated to be 9 costal systems (NOFO Kyst HH CB4) and 5 fjord systems at winter conditions, and 3 costal systems (NOFO Kyst HH CB4) and 1 fjord system at summer conditions, as shown in Table 3-9. The calculations are based on Forseti oil.

It is 8 example areas with shorter drift time than 20 days in the winter season and 7 example areas in the summer season (see Table 2-6). If the number of example areas exceeds the calculated system requirements in barrier 3 and 4, the capacity have to be extended to cover the number of affected example areas (revised NOROG guideline, *in-prep*).

The system requirements for barrier 3 and 4 including affected example areas gives a need for 9 coastal systems and 8 fjord systems in the winter season and 7 coastal systems and 7 fjord systems in the summer season. Requirements for fully developed and functional barrier 3 and 4 is shortest drift time to shore (95 percentile). The need for further resources and equipment will be a continuous evaluation during an oil spill operation. Further resources and equipment can be mobilized through existing agreements between NOFO, the coastal administration and the affected IUA's. Correct and sufficient dimensioned contingency is an important measure to reduce the amount of oil/emulsion into the coastal areas and to prevent re-mobilization of the oil. This will be covered in the oil spill response plan for the well.

Table 3-9 *Calculated system requirements for barrier 3 and 4 given a blowout from exploration well 25/8-20 S&A.*

Parameters	Winter 5°C – 10 m/s	Summer 15°C – 5 m/s
95-percentile of stranded emulsion (ton)	16079	14232
Total barrier efficiency in barrier 1 (%)	45.9	77.1
Stranded amount after effect of barrier 1 (ton)	8695.4	3258.9
Total barrier efficiency in barrier 2 (%)	23.0	38.6
Stranded amount after effect of barrier 2 (ton)	6698.9	2002.6
Number of days with stranding (d)	10	10
Amount of emulsion available for recovery in barrier 3 (ton/d)	670	201
Calculated system requirements for coastal systems in barrier 3	9	3
Amount of emulsion available for recovery in barrier 4 (Sm^3/d)	349.4	38.3
Calculated system requirements for fjord systems in barrier 4	5	1
Number of example areas with shorter drift time than 20 days	8	7
System requirements for coastal systems in barrier 3	**9**	**7**
System requirements for coastal systems in barrier 4	**8**	**7**

3.5 Use of chemical dispersion

Use of chemical dispersion as a combat strategy should be evaluated in accordance to the NEBA process and SIMA method. Forseti crude oil has a good potential for chemical dispersion, both in the summer and winter season (SINTEF, 2002). The oil/emulsions dispersibility will always be tested *in situ* with the SINTEF sample suitcase, to evaluate if chemical dispersion is a potential recovery option.

Use of chemical dispersion in an operation will always be evaluated with regards to observations or possible presence of nature resources in the area and with regards to the weather conditions. Use of dispersions is particularly relevant near high densities of seabirds, to prevent stranding and/or to reduce amount of oil into coastal areas.

Table 3-10 shows some relevant response vessels with dispersion agents on board, and their response time to well 25/8-20 S&A. The dispersion on board is Dasic Slickgone NS. If needed the vessels can refill dispersion agents on base stations.

Table 3-10 *Response time for selected response vessels with capacity for dispersion.*

Response vessel	Location	Response time*
Esvagt Stavanger	Sleipner/Utsira Nord	8
Stril Merkur	Troll/Oseberg	14
Ocean Alden	Gjøa	14
Stril Herkules	Tampen	16
Stril Mariner	Ula/Gyda	17

*including mobilisation time for dispersion on board vessels (1 hour).

3.6 Conclusion – oil spill contingency analysis

Vår Energi's requirements for oil spill response during drilling of exploration well 25/8-20 S&A is shown in Table 3-11. The need for response systems in the winter season is dimensioning for the result of the oil spill contingency analysis.

The response option requires 7 NOFO systems in barrier 1 and 2 in the winter season, with response time of 10 hours for the first system and fully developed and functional barrier 1 and 2 within 24 hours.

95-percentile of highest amount of stranded oil emulsion is dimensioning for the response requirements in barrier 3 and 4. If the number of affected example areas exceeds the calculated system requirements for barrier 3 and 4, this capacity must be extended to cover the number of example areas. It is required a capacity equivalent to 9 coastal systems and 8 fjord system. Requirements for fully developed and functional barrier 3 and 4 is 4 days.

Dimensioning blowout scenario can be handled with mechanical recovery in combination with chemical dispersion. Application from vessels, planes and possibly subsea dispersion is possible in an operation and is available through Vår Energi's agreements (NOFO).

Table 3-11 *Capacity, performance and efficiency of calculated oil spill response for exploration well 25/8-20 S&A.*

Barrier 1 and 2	Winter (5°C - 10 m/s wind)	Summer (15°C - 5 m/s wind)
Amount of emulsion into barrier 1	6436 Sm3/d	5450 Sm3/d
Viscosity of emulsion into barrier 1	1900 cP	630 cP
Number of and type of systems selected in the response option for barrier 1 and 2	7 NOFO J w/weir (pri.config.)	3 NOFO J w/weir (pri.config.)
Creation of emulsion between barrier 1 and 2	3269 Sm3/d	584 Sm3/d

Performance of selected response option in barrier 1 and 2	4505 Sm3/d	4923 Sm3/d
Emulsjonsmengde **ut** av barriere 2	5200 Sm3/d	1110 Sm3/d
Effect of barrier 1 and 2	34.2 %	67.8 %

Barrier 3 and 4	Winter (5°C - 10 m/s wind)	Summer (15°C - 5 m/s wind)
Amount of emulsion into barrier 3	670 ton/d	197 ton/d
Number of and type of systems selected in the response option for barrier 3 and 4	9+8 NOFO Kyst HH CB4 (pri.config.)	7+7 NOFO Kyst HH CB4 (pri.config.)
Performance of selected response option in barrier 3 and 4	488 Sm3/d	190 Sm3/d
Amount of emulsion out of barrier 4	183 Sm3/d	8 Sm3/d
Effect of barrier 3 and 4	47.9 %	80.9 %

4 REFERENCES

Acona AS, 2018. Stokastisk oljedriftsimulering, miljørisikoanalyse og beredskapsanalyse for letebrønn 25/11-29 JK (PL916). En analyse for Aker BP ASA. Versjonsdato: 28.06.2018. Aconas prosjektnummer: 820171.

AddEnergy, 2020. Blowout and Kill Simulation Study and Relief Well Plan, King&Prince (25/8-20 S and 25/8-20 A) Vår Energi AS. Datert 31.01.2020.

Artsdatabanken, 2015. http://www.artsdatabanken.no. Nasjonal kunnskapskilde for biologisk mangfold. Norske Rødliste for arter 2015.

Lloyd's, 2017. Blowout and well release frequencies based on SINTEF offshore blowout database 2016. Report no: 19101001-8/2017/R3. Rev: Final. Dated 28 April 2017.

Lloyd's, 2019. Blowout and well release frequencies based on SINTEF offshore blowout database 2018. Report no: 19101001-8/2019/R3. Rev: Final. Date 08 April 2019.

Nilsen H., Greiff Johnsen H., Nordtug T., Johansen Ø., 2006. Threshold values and exposure to risk functions for oil components in the water column to be used for risk assessment of acute discharges (EIF Acute). Statoil contract no.: C.FOU.DE.B02.

NOFO, 2020. Planverket, https://www.nofo.no/planverk

NOROG, 2013. Veiledning for miljørettede beredskapsanalyser, datert 16.08.2013.

OLF, 2007. Metode for miljørettet risikoanalyse (MIRA) – revisjon 2007. OLF rapport, 2007.

SINTEF, 2002. Ringhorne, Forseti og Balder- Egenskaper og forvitring på sjøen relatert til beredskap. SINTEF rapport nr. STF66 A01137.

SINTEF, 2012. Avaldsnes crude oil – Weathering properties related to oil spill response. SINTEF report no. SINTEF A22484.

Vår Energi, 2020. Input data for well 25/8-20 S&A. E-mail and PowerPoint presentation from Vår Energi.

APPENDIX A
Regulatory framework

Regulatory framework

The requirements from the Norwegian authorities include the Pollution Act, the Framework regulation, the Management regulation and the Activities regulation. A brief description of the requirements are given below.

A summary of the ERA and OSCA, together with a description of how the oil spill preparedness against acute pollution is ensured, must be sent to the government in adequate time before the activity can start, normally along with the application for consent (in accordance with the Management regulations (§ 25 and §26)).

The Management Regulation

In accordance with the Management regulations (§ 25-26), all operating companies planning activities related to exploration and/ or production of oil and gas in the Norwegian sector are required to apply for consent from the Norwegian government. In accordance with the Management regulations (§ 16-17) an environmental risk assessment and an oil spill contingency assessment for the activity shall be prepared.

The Management Regulation § 4 describes how to reduce the probability for mistakes and accidents to happen. To reduce risk the responsible body shall adopt technical, operational or organizational solutions that reduce the probability for mistakes, hazards and accidents to develop, as well as limit potential damages and inconveniences. To do so barriers shall be established. In situations where different barriers are implemented adequate independency between barriers are required.

The solutions and barriers identified to have highest potential for reducing risk shall be selected based on an individual or overall evaluation. The barrier requirements are described in §5.

The operator or others responsible for managing the installation, are to establish the strategies and principles used for shaping, using and maintaining the barriers, to ensure that the function of the barriers are in place throughout the installation's lifetime. Knowledge about established barriers as well as their functionality in combination with performance requirements measured against technical, operational and organizational criteria is required to ensure effectiveness of each individual barrier.

Any type of malfunctions shall be reported. The responsible body shall initiate required measures either by repairing the barriers or compensating for the lack of or reduced barrier capacity/effectiveness. The Management Regulation can be found here:

http://www.ptil.no/management/category401.html

The Pollution Act

The objective with The Pollution Act (§ 1) is to protect the environment against pollution and reduce existing pollution, reduce the amount of waste and promote better waste treatment. § 7 states that in case of a polluting danger, conflicting with the law or with resolutions according to the law, the responsible body for the potential pollution shall incorporate measures to ensure that no polluting takes place. In case of a discharge the responsible body shall ensure that preventive measures are taken to stop, remove or limit the impact of the spill. The responsible body is also required to implement mitigation measures to avert damages and inconveniences caused by the pollution itself or the actions taken to counteract the pollution. The duty under the article covers measures which reflect fairly the damages and inconveniences which should be avoided. The Pollution Act can be read in detail here:

http://lovdata.no/dokument/NL/lov/1981-03-13-6

The Framework Regulation

The Framework Regulation is a primary regulation providing high-level recommendations/ guidelines for health, environmental and safety issues in the petroleum industry. Principles for risk reduction are presented in § 11. The Framework regulations (§ 11) state that principles such as the ALARP (As Low As Reasonably Practicable) principle are required in order to reduce risk. The regulations also state that risk reduction shall follow the cost- benefit principle.

In addition to fulfil the minimal law requirements identified in the regulation, the risk should be reduced as much as possible. To reduce risk the responsible body shall adopt technical, operational or organizational solutions that either separately or together provides the best net benefit with regards to damage potential, if it is not a severe mismatch between cost and the achieved risk reduction. In § 26 and § 27 it refers to when consent is required and what type of information is required for the application (including environmental risk- and oil spill contingency analyses). § 20 addresses the operator's responsible to ensure a coordinated oil spill contingency strategy when several installations or vessels are operated at the same time. The operator's oil spill contingency measures shall also be aligned with public oil spill contingency resources. The operator is in charge and coordinates the resources during defined situations of hazards and accidents. Oil spill contingency collaboration is covered by § 21. The operators shall cooperate with regards to oil spill contingency given a hazard or accident. Joint regional oil spill contingency plans and resources shall be established. The Framework regulation can be read in detail here:

http://www.ptil.no/framework-hse/category403.html

The Activities Regulation

The Activities Regulation § 73 describes a requirement for establishing an oil spill response plan including a preparedness strategy. The response plan shall be based on the environmental risk- and oil spill contingency analysis, and ensure that open water, coast and shoreline are covered. The article states a relationship between environmental risk and oil spill contingency response; higher environmental risk means extended contingency measures compared to a situation with lower environmental risk. The Activity Regulation can be found here:

http://www.ptil.no/activities/category399.html

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