



SEAFAN AKER BP

SeaFAN Storjo

Aker BP ASA

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1 INTRODUCTION

DNV has on behalf of Aker BP performed particle modelling and following environmental risk assessment on cold water corals for the planned exploration drilling campaign at Storjo East. Cuttings, cement, and water-based drilling chemicals from drilling sections 36"x42", 9 7/8" pilot hole and 26" for is planned discharged to sea. The discharge has been modelled from the following location (UTM zone 32N, ED 50 N62):

Storjo PWL

X: 434669.0 m Y: 7298195.0 m

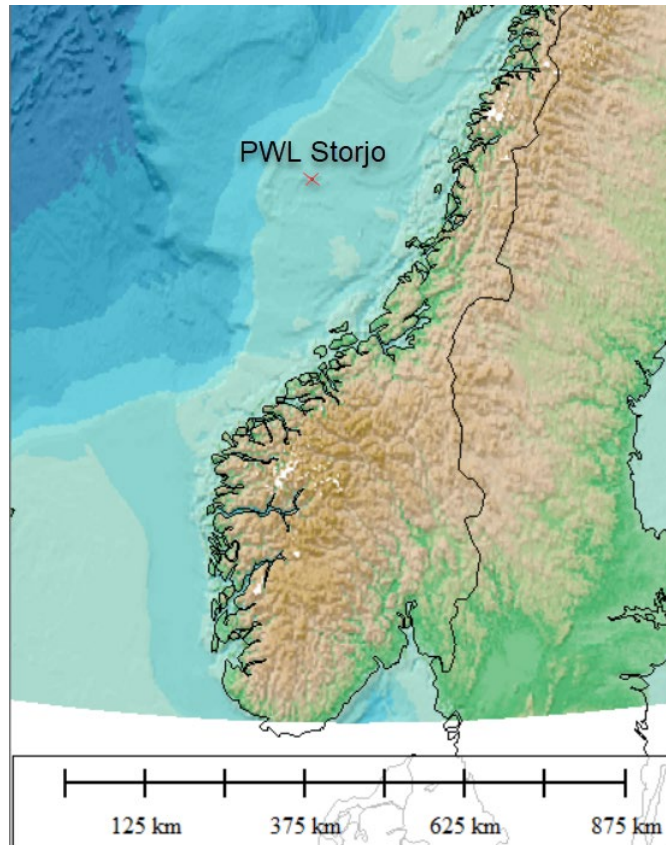


Figure 1-1 Location of the drilling location at Storjo

Potential cold water coral areas and verified coral gardens are identified in the vicinity to the PWL at Storjo East locations (Fugro 2021, DeepOcean 2021). This report presents a risk assessment based on the accumulated sediment deposition given by the discharge modelling at nearest coral structures.

The risk assessment methodology and derived thresholds for sediment deposition on corals applied are used and as outlined in the "Handbook Species and habitats of environmental concern: Mapping, Risk Assessment, Mitigation and Monitoring. - In relation to Oil and Gas activities" (NOROG, 2019).

The project used the model DREAM MEMW 13, and DNV's internal SeaFAN tool for statistical analysis and presentation of modelling results. A total of 24 parallel simulations using different high-resolution hind cast modelled current data (NORKYST800 – met.no) were applied in the modelling to create variance in the output results.

2 MODELLING METHODOLOGY AND RISK ASSESSMENT

2.1 Discharge characteristic and methodology

The project used the model DREAM MEMW 13 and DNVs internal SeaFAN tool for statistical analysis and presentation of modelling results. A total of 48 parallel simulations using different high-resolution hind cast modelled current data (NORKYST800 – met.no) were applied in the modelling to create variance in the output results. The results from the simulations have been compiled statistically in discharge footprint maps for sea floor deposition expressed as mm thickness layer. Modelling was carried out for in the period March-May – the anticipated period for the operation to be carried out. Measured high resolution bathymetry and flat seabed were used in the model simulations. Drilling discharges (barite, bentonite, cement and cuttings) and durations for the sections are modelled. All discharges were modelled with a release 1 m above sea floor. Planned discharge durations and amounts are shown in Table 2-1. Discharge specific, and area/model specific elements used in the modelling are presented in Table 2-2.

Table 2-1 Overview of activity and discharge amounts (tons) for the planned drilling campaign at Storjo.

Drilling section	36"x42"	Other act.	9 7/8" pilot hole	Other act.	26"
Modelled discharge period	March-May				
Section length, m:	82		848		848
Drilling rate, m/h	5		35		25
Duration of Discharge, hrs	16.40		24.23		33.92
Discharge depth, (m above seabed)	1		1		1
Cuttings (MT sg2,6)	190.4		108.0		646.0
Bentonite (MT sg2,5)	7		6		33
Barite (MT sg 4,1)	38		19		170
Water (MT)	141		132		655
sum mud (bentonite, barite, water)	186		157		858

Table 2-2 Area and model specific elements.

Element	Item	Specification
Site specific	Current	Norkyst800 (Hourly, 800*800m) (met.no)
	Bathymetry	High resolution measured data (24sim) and flat seabed (24sim)
	PSU	35 no halocline
	Temp	8 °C no thermocline
Model specific	Number of particles	3000
	Output interval	30 min
	Time step	10s
	Concentration z cell	10m (200-300m)
	Model grid	25*25m cells, 4*2km
	Output files	NETCDF4 (water column conc and sediment thickness)

2.2 Environmental risk assessment methodology

The risk assessment methodology and derived thresholds for effects from sediment deposition on corals applied are described in the “Handbook Species and habitats of environmental concern: Mapping, Risk Assessment, Mitigation and Monitoring. - In relation to Oil and Gas activities” (NOROG, 2019).

2.2.1 Environmental Resources provided by Fugro and Deep Ocean

Potential Coral areas were initially interpreted from collected MBES and SSS-mosaic (Fugro, 2021). An initial ROV survey was further performed along transects and a selection of potential coral areas. Based on a preliminary risk assessment along with planning of the drilling operation, a more specific and detailed ROV survey was acquired (Deep Ocean 2021). Based on the assessment of potential coral areas and video from the ROV surveys, the corals are classed in the categories excellent, good, fair and poor in accordance with NOROG 2019 classification criteria. When a potential coral area has not been visually surveyed, in the risk assessment the classification Excellent – DD (data deficit) has been used. In the overlap analysis between the discharge deposition map and the coral map a total of 10 coral features are included in the risk assessment (Table 2-3).

Table 2-3 Classification of corals within the influence area from drilling discharges at Storjo (>1mm). The classifications are based on two independently carried out ROV surveys (Fugro 2021, DeepOcean 2021)

Coral ID	Feature description	Classification	Survey reference	Area (m2)
6	Coral area	Fair	Fugro (2021)	131
20	Coral area	Fair	DO/DNV (2021)	1296
91	Coral spotheight	Fair	DO/DNV (2021)	36
103	Coral spotheight	Fair	DO/DNV (2021)	26
287	Coral area	Poor	DO/DNV (2021)	28

2.2.2 Threshold values for deposition of particles

The applied threshold values for consequences of particle deposition arising from drilling discharges on cold-water corals are presented in Table 2-4 (same intervals as in the footprint maps).

Table 2-4 Threshold values for consequences of deposition thicknesses of particle discharges (NOROG, 2019).

Deposition thickness	Degree of impact	Consequences
0.1-1 mm	Negligible	No detectable influence
1-3 mm	Low	Minor smothering. Good ability to shed sediments, but might start to aggregate
3-10 mm	Significant	Moderate smothering. Reduced ability to shed sediments. Some polyp mortality of sponge necrosis can occur
>10 mm	Considerable	Considerable smothering. Potential suffocation. Polyp mortality or sponge necrosis expected. Potential for depletion of energy reserves

2.2.3 Risk Matrix

A generic approach is applied combining anticipated influence areas and environmental resource map in an overlap analysis terminating in an expression for risk (Table 2-5) (NOROG 2019).

Table 2-5 Generic Risk matrix based on condition of SHEC and expected impact (Norog, 2019).

		Identified SHEC value			
		Poor	Fair	Good	Excellent
Degree of impact	Negligible	Minor	Minor	Minor	Minor
	Low	Minor	Moderate	Moderate	Serious
	Significant	Minor	Moderate	Serious	Severe
	Considerable	Minor	Serious	Severe	Severe

Modelling results are extracted at the coral locations and presented in box whisker plot and further compared with threshold in mm (NOROG, 2019). Explanation of the box whisker plot is presented in Figure 2-1.

- 10% probability: The upper whisker (90 percentile) crosses a given deposition value (y-axis), which more than 10 % of the simulations are above this value.

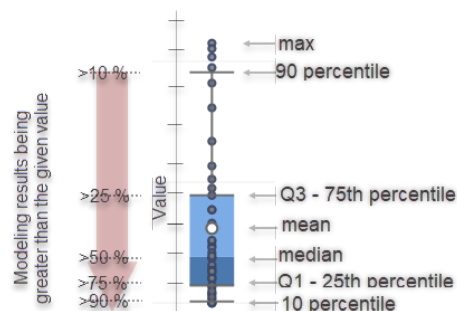


Figure 2-1 Explanation of the box whiskers presented and further relation the probability (%) of the simulations that are equal to or greater than the given value

3 MODELLING RESULTS AND RISK ASSESSMENT

Drilling discharge footprint maps have been generated based on the modelling results using a semi-stochastic approach (48 simulations) and presented as sedimentation in mm for the intervals 1-3mm, 3-10mm and >10mm based on current data for the period 2019-2020, (Figure 3-2). The footprint map is compiled from “hit probability maps” for different thickness intervals, where 90% of the modelling results are within the respective interval (meaning that <10 % are outside).

Box whisker plot for deposition of discharges at the coral locations from 48 modelling simulations is presented in Figure 3-1

Based on all the simulations, the overall degree of impact has been assessed is in the “negligible” category (<1 mm), low (1-3mm) and significant (3-10mm). The risk has been assessed as “moderate” for id6, id20, id103 and id91. The remaining corals within the potential influence area are at “minor” risk (Table 3-1).

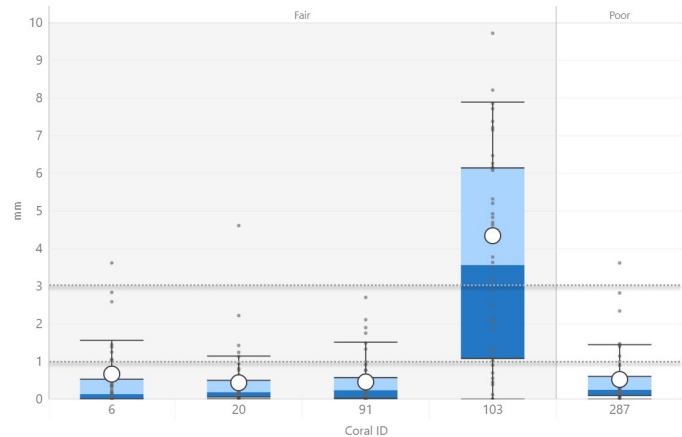


Figure 3-1 Box whisker plot for deposition of discharges at the coral locations from 48 modelling simulations.

Table 3-1 Risk assessment for the corals and discharge deposition in mm from planned drilling at Storjo. The risk categories are minor (●), moderate (●), serious (●) and severe (●).

		Coral value/class			
>10% probability		Poor	Fair	Good	Excellent
Degree of impact	Negligible (<1mm)	Multiple			
	Low (1-3mm)	id287	id6, id20, id91		
	Significant (3-10mm)		id103		
	Considerable (>10mm)				

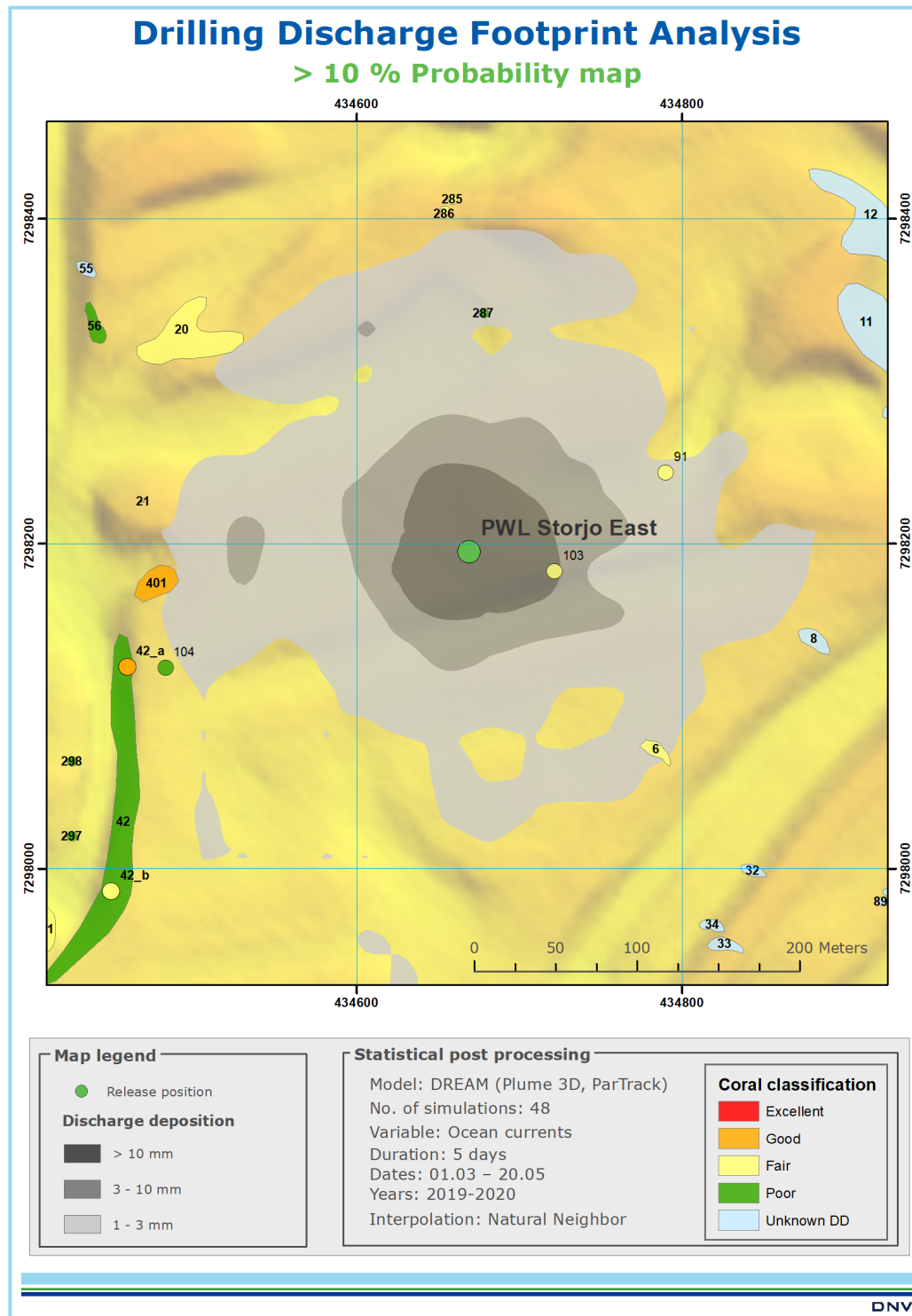


Figure 3-2 Drilling discharge footprint map for the planned drilling campaign at Storjo. Coral locations are described in table 2.3.



4 CONCLUSIONS

High resolution modelling of planned discharges to the seabed from exploration drilling at Storjo East have been performed. There are potential cold water coral areas and verified coral gardens identified in the vicinity to location (Fugro 2021, Deep Ocean 2021). The results from discharge of particulate drilling waste (drill cuttings, cement, barite, and bentonite) on depositions on the seabed are overlaid with coral structures in the proximity to well locations. The conclusions from the assessment are:

Based on all the simulations, the overall degree of impact has been assessed is in the “negligible” category (<1 mm), low (1-3mm) and significant (3-10mm). The risk has been assessed as “moderate” The risk has been assessed as “moderate” for id6, id20, id103 and id91. The remaining corals within the potential influence area are at “minor” risk.

5 REFERENCES

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