From: Dominika Phillips [mailto:DOMPH@orsted.co.uk]
Sent: 08 February 2019 21:10
To: KJ Johansson; Kay Sully; Hornsea Project Three
Cc: Andrew Guyton; Stuart Livesey
Subject: Hornsea Project Three (UK) Ltd response to Deadline 6 (Part 3)

Dear Kay, K-J

Please find attached the 3rd instalment of documents.

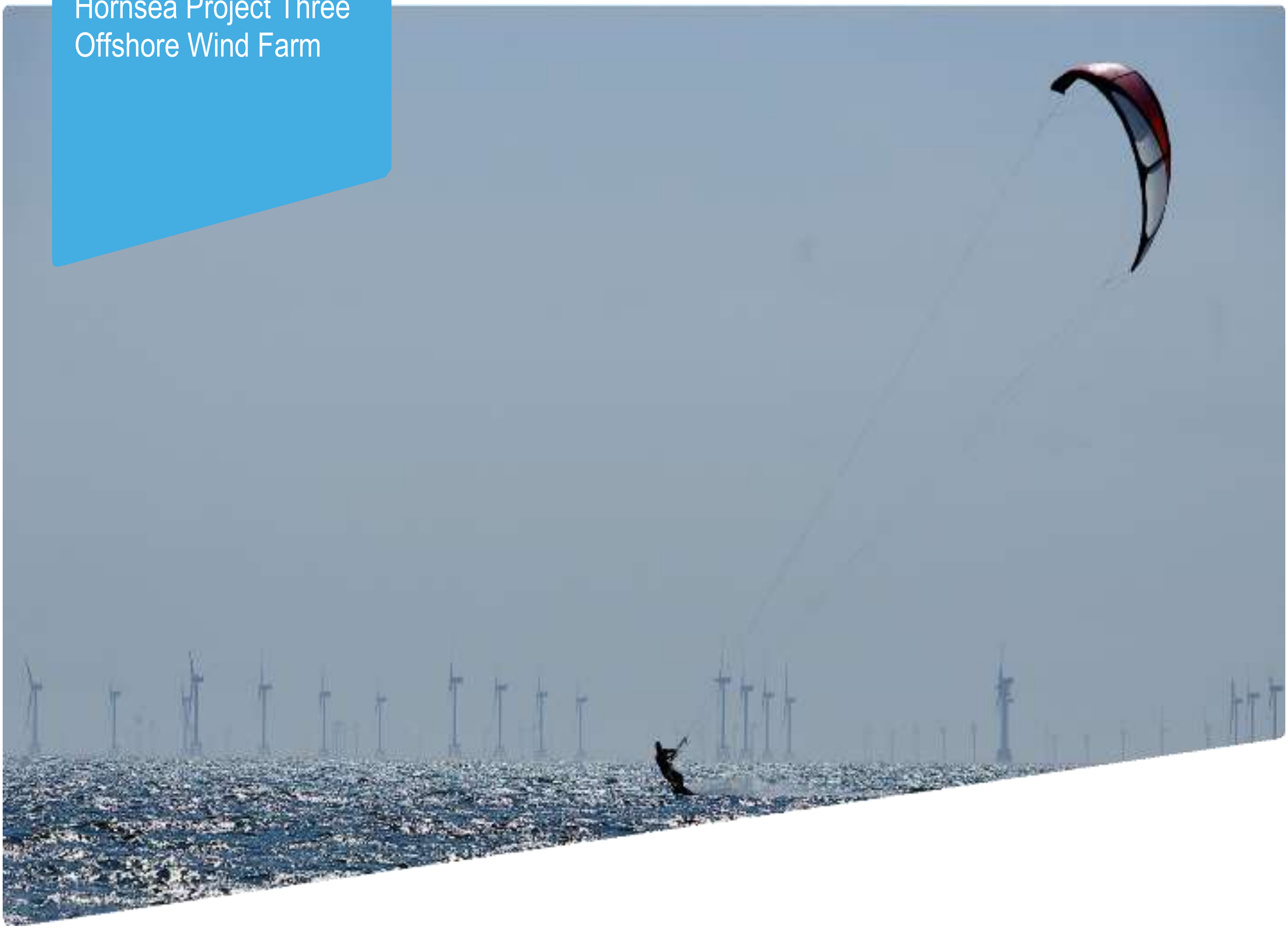
Best regards,
Dr Dominika Chalder PIEMA
Environment and Consent Manager

[redacted]

Environmental Management UK¦ Wind Power
5 Howick Place ¦ London ¦ SW1P 1WG

Ørsted

Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Appendix 4 to Deadline 6 submission - Rock Protection Decommissioning Methods

Date: 8th February 2019

Hornsea 3
Offshore Wind Farm

Orsted

Document Control			
Document Properties			
Organisation	Ørsted Hornsea Project Three		
Author	Jan de Nul		
Checked by	Felicity Browner		
Approved by	Andrew Guyton		
Title	Appendix 4 to Deadline 6 submission - Rock Protection Decommissioning Methods		
PINS Document Number			
Version History			
Date	Version	Status	Description / Changes
08/02/2019	A	Final	Submitted at Deadline 6 (08/02/2019)

Ørsted

5 Howick Place,

London, SW1P 1WG

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1. Introduction

1.1 At Deadline 4 (REP4-012) the Applicant, stated that it was prepared to make a commitment (subject to agreement with the SNCB and MMO) to decommission any remedial cable and/or scour protection within designated sites at the end of the operation and maintenance phase for the project, subject to agreement from regulatory and nature conservation bodies at that time.

1.2 At Issue Specific Hearing 5, the Applicant advised the ExA that it would provide information at Deadline 6 on the feasibility of removing rock protection based on current technology. This being acknowledged, the Applicant is therefore providing with this note, documentation written by Jan de Nul to support the Race Bank Marine Licence applications for remedial rock protection (MLA/2017/00277/4 and MLA/2018/00385) to evidence existing methods and tools for removing rock from the marine environment. The documents provided are as follows:

1.2.1 Annex 1: Rock Installation Method Statement, Jan De Nul (2018).

This document demonstrates that the rock berms can be removed on decommissioning without permanent impact by outlining the methods for decommissioning which are currently available on the market and discussing the options which are likely to be available at the time of decommissioning.

1.2.2 Annex 2: Technical Note for Decommissioning Race Bank Export Cable Rock Protection, Jan De Nul (2018).

This note provides case studies where the two proposed decommissioning methods in Annex 1 have been successfully used to remove rock of similar size to those proposed for Hornsea Three and Race Bank and lessons learnt from previous these projects.

1.3 The Applicant acknowledges that there are constraints associated with different technology types, one of the main ones being water depth. However, the Applicant can confirm that water depths within the designated sites overlapping with Hornsea Three are within the operational limits for the proposed methodologies. Given the water depths, both tools would be appropriate for the Cromer Shoal Chalk Beds MCZ, the Wash and North Norfolk Coast SAC and the majority of the North Norfolk Sandbanks and Saturn Reef SAC, with only trailing suction hopper dredging appropriate in short sections of deeper water (i.e. up to approximately 41 m depth) within of the North Norfolk Sandbanks and Saturn Reef SAC, where backhoe dredging is not possible (i.e. backhoe dredging not possible in water depths greater than 32 m). Water depths are greater within Markham's Triangle rMCZ which would render backhoe dredging unfeasible (i.e. >32 m), however in these areas trailing suction hopper dredging would be an appropriate method for removal of rock protection.

1.4 The Applicant acknowledges that at the time of decommissioning the decommissioning of rock protection and subsequent disposal activity would need to be duly assessed and licenced. However, with respect to effects on protected features of the relevant designated sites, as outlined in paragraph 3.3 of the Written Summary of Applicant's oral case put at Issue Specific Hearing 5, disturbance to these features during decommissioning of rock protection is within the envelope assessed within the Volume 2, Chapter 2: Benthic Ecology of the Environmental Statement (APP-062) and the Report to Inform Appropriate Assessment (APP-051).

Annex 1 - Race Bank Decommissioning Method Statement

PROJECT

Racebank Offshore Windfarm 01

Services

Rock Installation Decommissioning

Document Title

Method Statement

Submission Date	22 June 2018
Contractor	Jan De Nul Luxembourg sa
Client	Orsted
Country	Great Britain
Project Ref.	2705

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TABLE OF CONTENTS

1. INTRODUCTION

Race Bank Offshore Windfarm (ROW) will have a capacity of approximately 580 MW. The Race Bank project is located approximately 27km from the nearest landfall on the UK east coast of north Norfolk (Blakeney Point) and just over 28km from Chapel Point, Chapel St. Leonards on the Lincolnshire coast.

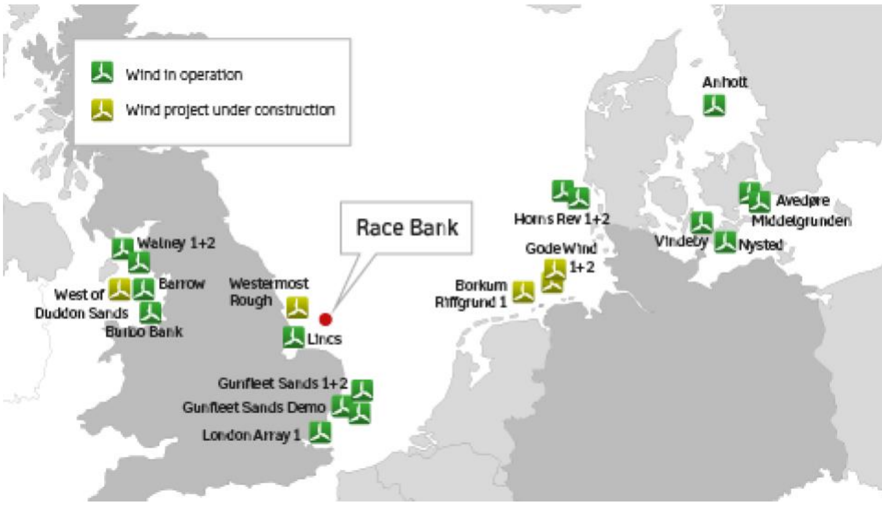


Figure 1-1: ROW01 Approximate position

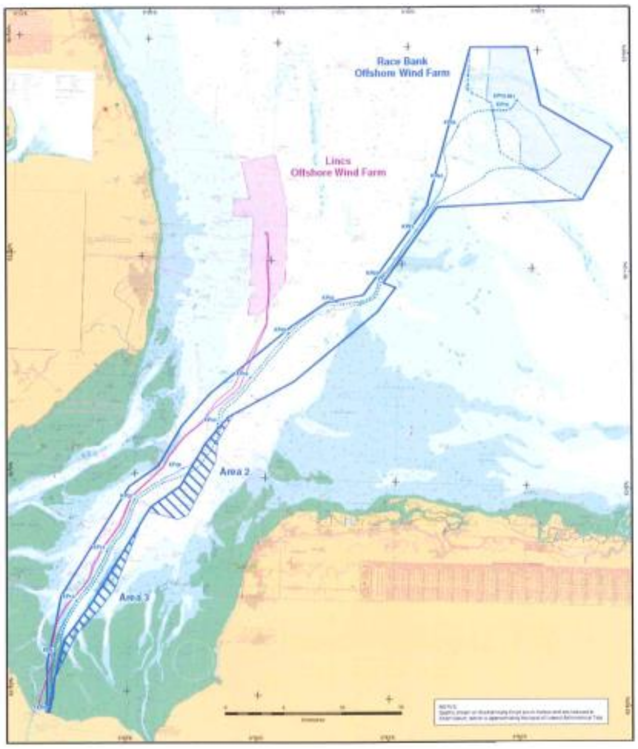


Figure 1-2: Export cable layout (2 x 71 km submarine cables + 6 km Interlink)

The wind farm consists of 91 wind turbines (WTGs) each of 6 MW – max wind farm production of 580 MW and two offshore substations (OSSs) connected with an interlink cable. The WTGs are interconnected to the two offshore substations with 34 kV internal array cable systems.

The two offshore substations are situated inside the wind farm area and are connected to the onshore Transition Joint Bay (TJB) through 2 x 220kV submarine cables of approximately 71 km each.

One part of the ROW01 project includes supply of approx. 2 x 71km 220kV submarine cable systems with integrated fibre optic cable between the offshore substations and the transition joint onshore and supply of a 220kV underground cable system.

1.1 Purpose and scope

The purpose of this document is to:

- Introduce the methods for decommissioning which are currently available on the market and discuss the options which are likely to be available at the time of decommissioning
- Provide an explanation of each of the methods, discuss any positives and negatives associated with each method
- It demonstrates that the rock berms can be removed on decommissioning without permanent impact by describing the options for rock berm decommissioning, an outline of the method statement, the physical impact from rock berm decommissioning on the immediate and surrounding seabed and the disposal of the materials.

2. DECOMMISSIONING

2.1. Method of removal

Contractor has several vessels available to decommission as much as possible of the installed rock material. A first option, to minimise the impact of the removal contractor proposes to deploy two trailing suction hopper dredgers which can remove almost all the installed material with the least impact on the original seabed. A second option to remove the rock material is the deployment of backhoe dredgers which can dredge the installed rock berm and load it in to barges. In the future it is expected that even more alternatives will become available on the market which may even further reduce the impact on the seabed and guarantee removal of the rocks without influencing the surrounding seabed.

2.2. Option1: TSHD equipment

Two Trailing Suction Hopper Dredgers are proposed to be used on the project: TSHD Bartolomeu Dias (BA) and TSHD Taccola (TL). See Table 6-1 for mains specifications of TL:

Taccola		
draft empty	3.7	m
draft fully loaded	7.3	m
max dredge depth	28.5	m
dump through bottom doors	yes	
discharge through suction pipe	yes	

Table 1: Taccola specifications

See Table 6-2 for main specifications of BA:

Bartolomeu Dias		
draft empty	5.6	m
draft fully loaded	11.2	m
max dredge depth	43.8	m
dump through bottom doors	yes	
discharge through suction pipe	no	

Table 2: Bartolomeu Dias specifications

2.3. Option 2: Backhoe dredger equipment

In view of the soil conditions, the design, the bathymetry, the metocean conditions and the project location, an alternative option to the deployment of the TSHD vessel is to deploy our Backhoe Dredgers 'Mimar Sinan' and 'Postnik Yakovlev' to remove the installed rock material.

Figure 2-1: BHD ' Postnik Yakovlev'

The material from the rock removal operations shall be disposed offshore. Therefore, in view of this requirement, we propose to deploy the above mentioned backhoe dredger in combination with several Split Hopper Barges such as "L'Aigle".

Table 2-3: Split Hopper Barge 'L'Aigle'

2.4. Impact to the seabed

The preferred option, using a TSHD, will remove the installed material using its draghead. The width of the draghead is normally between 3-6m and thus normally one or two passes of the draghead should be sufficient. The position of the draghead can be fully controlled by using the Suction Tube Positioning Monitoring System (STPM) which is a system of angle transducers on every lid of the suction pipe. This allows determination of the draghead position relative to the ship and makes relative X, Y and Z co-ordinates of the draghead available to the positioning and dredging computers.

The draghead will be kept at a constant height just above the seabed and the rocks will be sucked into the draghead. The draghead will therefore not penetrate in the original seabed deeper than 30cm below the rock level and thus minimal seabed below the rock level will be disturbed and brought into suspension at the draghead of the TSHD. Additionally the overflow will result in process water being released though the overflow pipe underneath the vessel. This process water will contain only a small amount of fines (most areas have a sandy seabed) and thus the sediment brought into suspension via the overflow is expected to settle down relatively fast. However the temporal and spatial extent of the plume also depends on the depth of release point in the water column and the hydrodynamic conditions at the time.

After the TSHD has removed the rock berm, a shallow trench will be left in the seafloor.

The tidal current regime is considered to be an important governing factor for the sediment transport and morphological regime in offshore locations and also throughout The Wash (Royal Haskoning, 2004). The median grain size of the seabed sediments within the Wash range from 170µm (KP8-15) to 480µm (KP15-22.5) and 240 µm (KP22.5-KP35) (Burial performance assessment study, Deepocean 2016). Analysis of bed shear stress measurements within the Project ES, identified that fine sands KP08-15 and KP22.5-35) would be mobilised up to 85% of the time during a representative spring-neap tidal cycle. The larger median grain size of 480 µm (KP15-22.5), would be mobilised approximately 76% of the time during a representative spring-neap tidal cycle and would be immobile during the lowest neaps (ES, Centrica, 2009).

It is estimated that approximately 1.4×10^4 Ton of material per annum enters the Wash from marine sources through bedload transport. Approximately 500-1000 times more is transported into the Wash by suspended load (Royal Haskoning, 2004).

Taking these natural movement of the sediment into account and due to the reduced wave and current energy inside the lowered part of the seabed it is expected that this area will be filled in relatively fast and therefore the seabed is expected to return relatively fast to its original profile.

2.5. Disposal of the decommissioned materials

The material will be disposed offshore at a dedicated disposal area. Different disposal areas are available near the rock berm area but a permit will be requested and specific areas will be selected for a licensed area where the rock can be relocated. A licenced disposal site will be selected as close to the site as possible, and all consents/licences will be secured in advance of the works

3. GENERAL WORKING PRINCIPLES

3.1. Option 1: Main working components TSHD

A Trailing Suction Hopper Dredger is a common dredging vessel. It is a sea-going, self-propelled vessel that is suitable to remove, transport and dispose silty, sandy or gravely soils or soft clayey soils. Its main working components and their respective function in the dredging process are briefly explained below. A general layout of a TSHD can be seen in Figure 3-1.

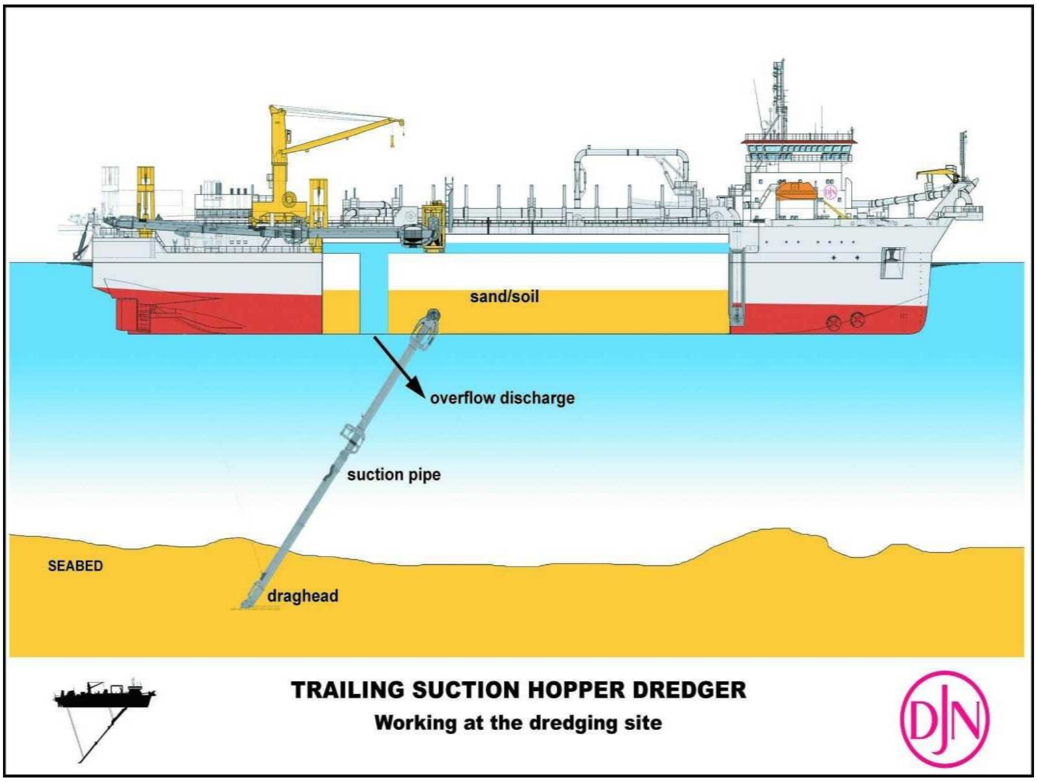


Figure 3-1: General layout of a TSHD

The draghead (Figure 3-2) is the T-shaped part mounted at the end of the suction pipe. It has several movable parts that ensure that the draghead makes good contact with the soil that needs excavating. It can also be fitted with a set of teeth that help loosen the soil. A set of jet nozzles through which water is jetted at high flow rates is also used to loosen cohesive soils. A grid can be installed inside the draghead to prevent objects larger than a certain size to enter the pumps. Such grid also prevents ordnance entering the pumps.

Figure 3-2: Draghead

The suction pipe (Figure 3-3) is the tube that transports the dredged materials to the hopper. It is made up of two sections that hinge at a flexible pipe section but the movement is limited by a metal frame (cardan) to allow a certain range of movement flexibility. On the suction pipe an underwater pump is mounted to boost the vessel's output while removing the rock material.

Figure 3-3: Suction pipe

The hopper well (Figure 3-6) is the large compartment in which the removed material from the seabed are pumped and stored for transport disposal area.

Figure 3-4: Hopper well

Suction is provided by the inboard pump (Figure 3-5), for during rock removal as well as for discharging.

Figure 3-5: Inboard pump

The overflow funnel(s) (Figure 3-6) are vertically mounted tubes inside the hopper well that are normally used to drain off (through the keel) excess water inside the hopper well allowing the hopper load to be maximized. The funnels are adjustable in height and can be controlled by the dredging operator from the bridge. The anti-turbidity valve or so-called "green valve" is a hydraulically controlled valve mounted inside the overflow funnel(s). This valve drastically reduces the turbidity generated by the overflow water drained through the overflow funnels.

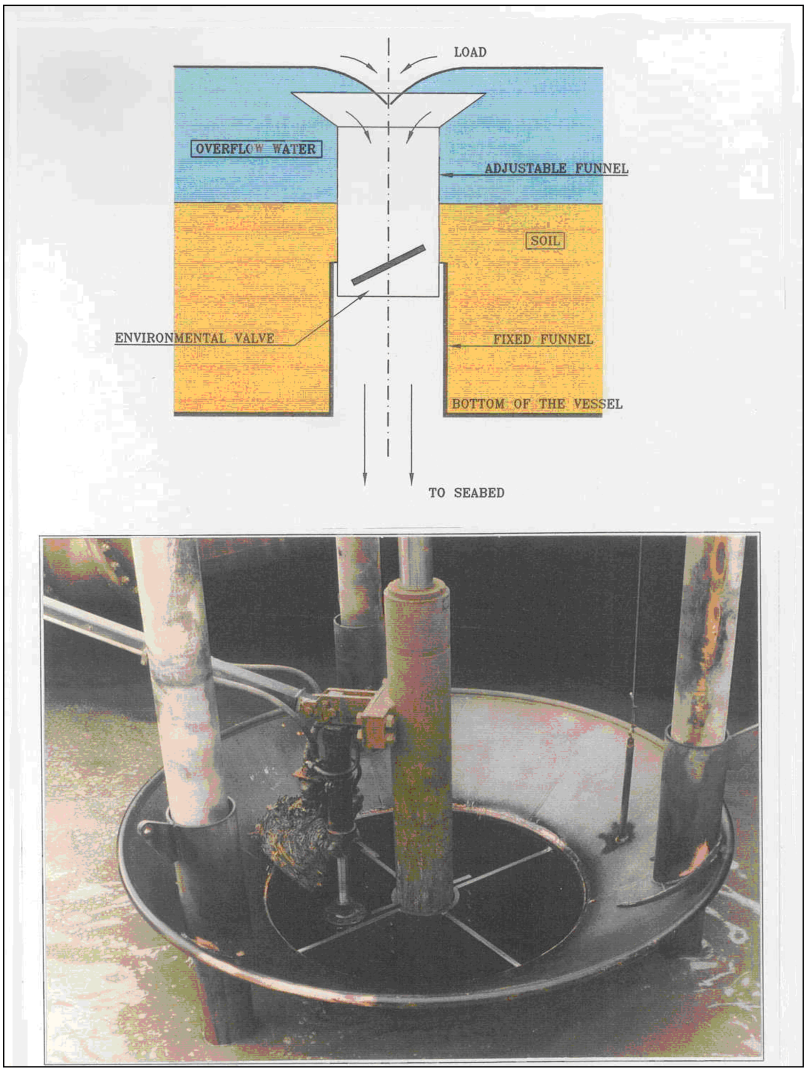
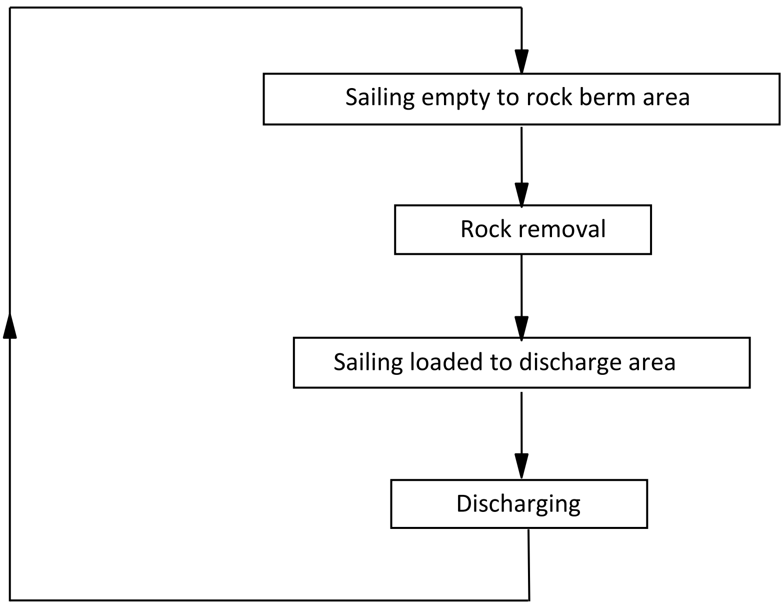


Figure 3-6: Overflow funnel

3.2. Working principle of the TSHD for decommissioning the installed rock berm

For the decommissioning works the TSHD will go through a typical set of four consecutive activities, called a dredging cycle. This conventional dredging cycle can be divided in following activities: sailing empty to the rock berm area, loading (rock removal), sailing loaded to the discharge area and discharging.



3.2.1. Sailing to the Rock berm area

The dredging cycle starts with the empty hopper dredge sailing to the rock berm area guided by its navigation systems. In this stage of the dredging cycle, the hopper dredge is regarded as a normal cargo vessel.

3.2.2. Rock removal

Once the hopper dredger approaches the rock berm area, the sailing speed is reduced, the suction tube will be hoisted over board, the dredge pump will be started and the draghead is lowered to the seabed

The draghead is attached at the lower end of the suction tube, which is designed for maximizing the removal production during the loading phase. During rock removal operations, the draghead will penetrate typically 30 cm below the rock level, depending on the size of the draghead and type of soil, into the seabed and the TSHD will maintain a low trailing speed around 2kn.

Figure 3-7: TSHD while removing rock from the seabed

The rock material thus lifted (dredged) from the seabed, will be pumped through the suction pipe and inboard pipelines into the hopper well as a soil/water mixture as schematically presented on Figure 3-8.

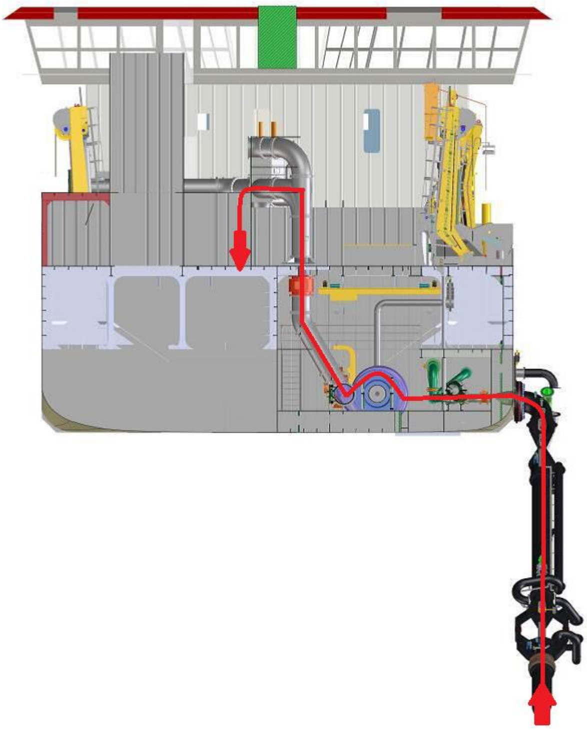


Figure 3-8: Mixture flow while dredging

To minimize the caused turbidity and optimize the load of the vessel, use will be made of the overflow funnel in the hopper – however this will be limited as the material. Material enters the hopper well in a soil/water mixture and at a certain point the water level in the hopper reaches the top of the overflow funnel; mixture of water and soil will thus be present in the hopper (Figure 3-9).

Once the hopper level reaches the overflow, water will flow back into sea through the overflow, while the soil in the soil/water mixture will settle in the hopper. More and more soil will settle in the hopper, increasing the load of the vessel. This process will continue until the vessel reaches its dredging draught with a minimal possible water layer on top of the settled soil by adjusting the funnel height. At this moment the hopper is fully loaded.

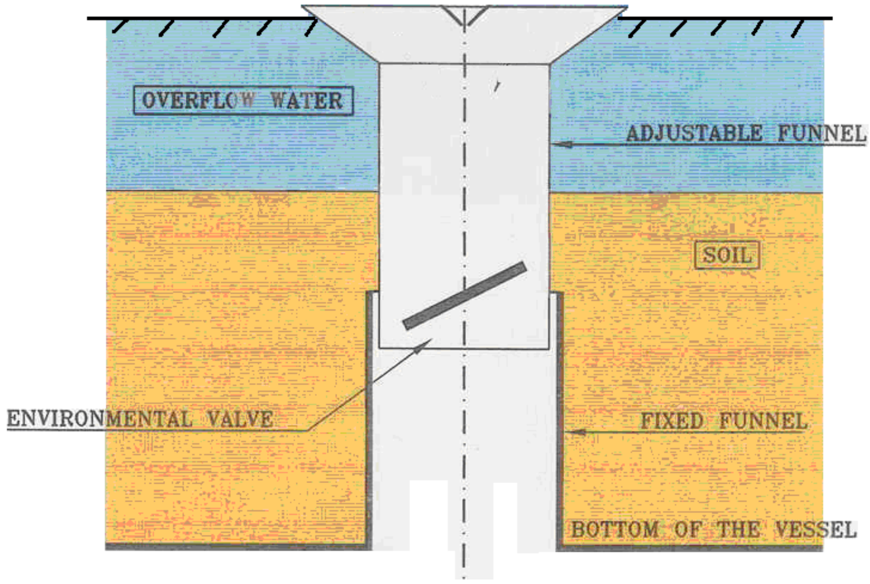


Figure 3-9: Hopper content when reaching the overflow

Anti-turbidity valve

To minimize the turbidity that is being created while overflowing, the overflow of the hopper is provided with an anti-turbidity valve (also known as “green valve”). The purpose of the valve is to throttle the flow through the overflow. This results in a raising water level inside the overflow and consequently the water flowing into the overflow falls over a lower height (difference between maximum level of the hopper and the waterline).

The valve is used to minimise the sediment plume and decrease the environmental impact. Without such a valve, the water would fall over a large height, especially at start of loading with a small vessel’s draught. The result of this “waterfall” is that large amounts of air are entrained. This air is led under the vessel, and returns to the surface at the sides and aft of the vessel. The raising air bubbles entrain the small sand or silt particles in the overflow water, and so cause a large turbid plume around and aft of the dredger.

The plume for this work scope will however be limited as the material that needs to be removed is rock material and only a small part of the original seabed will be removed as well and may cause a plume during the operations.

Reference is made to Figure 3-10 for a picture of the anti-turbidity valve.

Figure 3-10: Anti-turbidity valve

3.2.3. Sailing to the discharge location

With the TSHD fully loaded, the draghead is lifted from the seabed and the dredge pump is stopped. As discharge will be done though the suction pipe, it will depend on the discretion of the vessel master if the suction pipe is hoisted back on board; this will mainly be influenced by the distance to the discharge area. The TSHD sails from the rock berm area to the predefined discharge location by its navigation systems.

3.2.4. Discharging

Discharging with the TSHD can be done in different ways, depending on the specific TSHD.

On the project 2 different ways of discharging methods are used:

<u>Option 1: Dumping dredged material through bottom doors:</u>

Both TSHD TL and BA are able to open their bottom doors and discharge the dredged material through the bottom doors.

<u>Option 2: Discharge dredged material through suction pipe:</u>

To be able to pump the material, the soil in the hopper will be fluidized by jetting water into the hopper prior to discharging. The fluidized mixture is then transported to the dredge pump via “direct suction”. The inlet of the dredge pump is connected to a central self-emptying line installed in the hopper buoyancy space. Five branches are provided on this line acting as suction lines in the hopper. By means of valves the material is redirected through the inboard pipelines from the hopper to the dredge pump and back through the suction pipe.

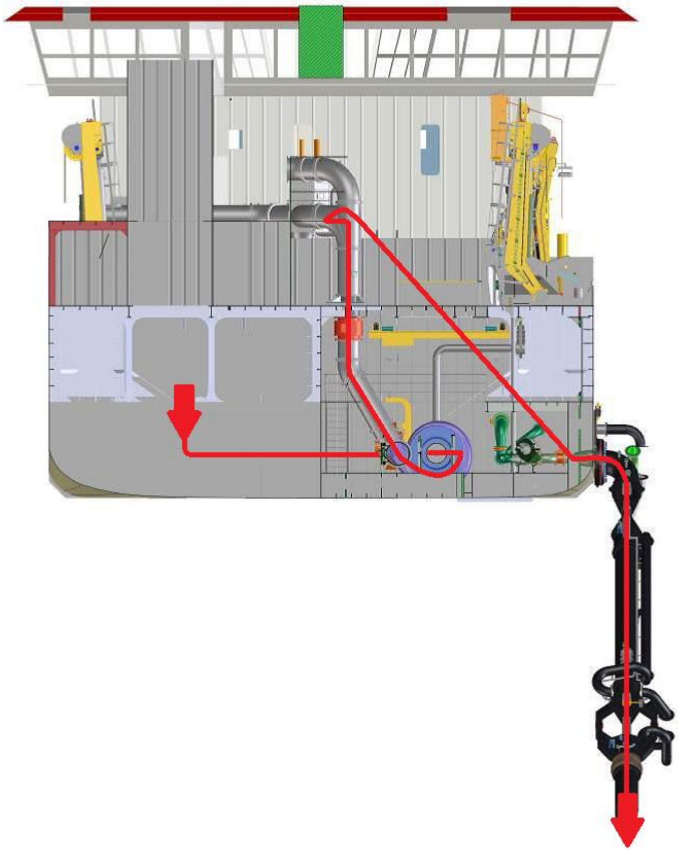


Figure 3-11: Mixture flow while discharging

BA can only discharge through the bottom doors. TL can discharge through bottom doors and through the suction pipe.

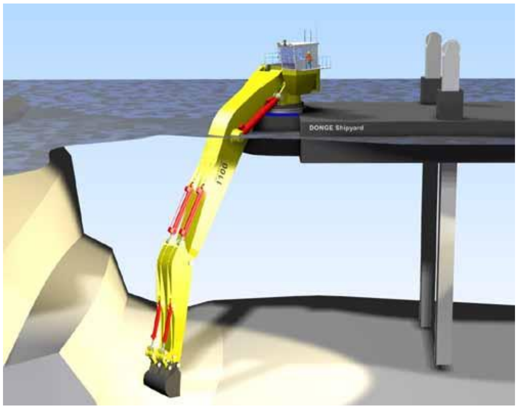
3.3. Option 2: General Working Principles of a Backhoe Dredger

Figure 3-12: Backhoe Dredger

3.3.1. Method

The backhoe dredger is a common type of dredger, which dredges mechanically. The main component is a hydraulic excavator, performing the rock removal operation, mounted on a pontoon.

The BHD is equipped with the latest technology in computer systems, used for on-line positioning and dredging monitoring. The BD also complies with the latest requirements of International Safety and Environmental standards.



The Backhoe Dredger is equipped with three spuds: one spud is located in the centre of the pontoon at the stern in a spud carriage system; this spud can be lifted and moved along the centre line of the pontoon (or the pontoon can be moved with respect to the spud fixed onto the sea bottom); the two other spuds can only be lifted/lowered.

The working method of the backhoe dredger is as such that the dredger is towed into location by the assisting tug and is then fixed into position by its three spuds. Before lowering the spuds, the exact position as shown on the DGPS positioning system is checked in order to ensure that the spuds are lowered in the trench alignment. The dredger will then move into the exact starting position by using the spud carrier and the bucket. The dredger will excavate in steps of approximately 5 to 7.5 m length. When one step has been completed, the dredger will release the front spuds from the sea bottom and raise them approximately 2 m above the seabed. The spud carrier then shifts the dredger 5 to 7.5 m backwards along the rock berm and then a new rock berm removal cycle starts.

Repositioning of the Backhoe Dredger using the spuds is done as follows:

Action	Description
1	The spud in the spud carriage is lifted and moved to the front of the carriage.
2	On arrival of the spud at the end of the carriage the spud is lowered
3	The two fixed spuds are lifted from the sea bottom while the crane bucket is lowered onto the sea bottom.
4	The pontoon is then pushed against the spud in the carriage system approx. 7.5 m backwards.
5	On confirmation of the correct alignment of the Backhoe Dredger the two fixed spuds are lowered to the sea bottom and the excavation operations can start.

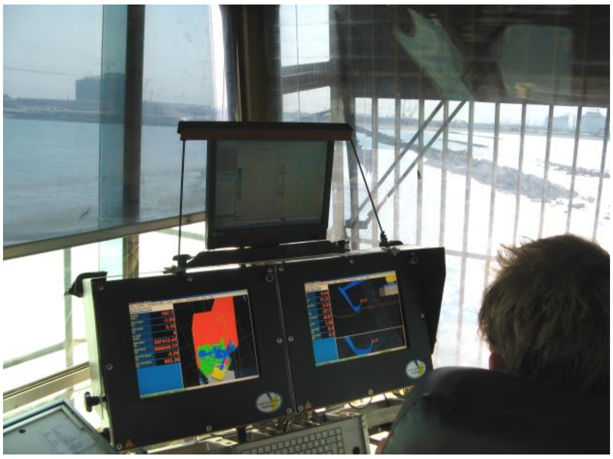
Table 3-1: repositioning of BHD

The dredger will step forwards, dredging its own flotation channel were needed. The extra volume to be dredged in order to create this flotation channel was estimated at only 4,000m³.

3.3.2. Rock removal control

For horizontal positioning the dredger will use Differential GPS systems in combination with gyrocompasses, which will give satisfactory accuracy.

For controlling the bucket position, the dredger is fitted with IHC digviewer / Seatools Digmate systems or similar. These systems will measure:



- the angles for the boom, stick & bucket
- the pontoon draught
- the pontoon tilt
- bearing

The operator can follow the excavation operation on two video screens, one for horizontal bucket position and the other for vertical bucket position. The system will enable the dredge operator to follow the exact movements and the depth of the bucket, and facilitates digging in a controlled manner to the designed limits.

In this system the required rock removal levels and slope angles can be pre-set in the computer so the operator can see the digging lines as well as the bucket position, in relation to the pre-set limits, on his video screens.

Water level information will be provided by a radio-linked tide gauge. The tide gauge will be placed in the water close to the rock berm area. The dredger will be equipped with a radio-linked receiver to monitor the tide level during the rock removal operation. The "digviewer system" will receive the actual tide level several times per minute and the rock removal depth is automatically updated.

The supervisor or the main operator on each shift will keep a log for noting events of significance for the rock removal operation, such as operation hours, breakdowns, repairs, production rates, weather conditions, rock berm area, rock removal depth etc. The area, which has been dredged during the last shift, will be marked on the specially designed rock removal lay out drawings.

Annex 2 - Race Bank Technical Note for Decommissioning

Document No.:	JDN.2705.OR.TN.83.04.e.1.0	**Rev.:** 2.0	
Supplier Doc. No.:	N/A		**Total nr. of pages:** 10

Document Title:

TECHNICAL NOTE FOR DECOMMISSIONING RACE BANK EXPORT CABLE ROCK PROTECTION

Client:

Ørsted

Contractor:

Jan De Nul Luxembourg SA

2.0	11/12/18	Issued as Final				
1.0	04/12/2018	Issued for Review	POE	FOB	WOV	
0.0	05/11/2018	Issued for Review	POE	FOB	WOV	
Rev.	**Issue Date**	**Reason for Issue**	**Made by**	**Chk'd by**	**Disc. Appr.**	**Proj. Appr.**

Project No.: 2705 **Contract No.: 0027**

REVISION CHANGE DETAILS

Revision	Location	Brief description of change
0.0		New document
1.0	Throughout	General update after receiving Orsted Comments
2.0	Sections 5.1 & 6	Additional information and clarifications added

TABLE OF CONTENTS

1. INTRODUCTION

Race Bank Offshore Wind Farm was commissioned in 2017 and is now fully operational. The wind Farm consists of 91 Siemens 6MW turbines and two offshore substations. The wind farm has a generating capacity of 571 MW. The electricity is fed to the UK national grid via two export cables which reach landfall at Sutton Bridge and connect to the grid at a new substation in Walpole.

The post construction survey of the export cable identified sections on C1 and C2 that require remedial cable protection. Two Marine Licence applications were submitted to the MMO in July and August 2018; MLA/2017/00277/4 and MLA/2018/00385 for these works.

As part of the Marine Licence application, Ørsted has made a proposal to decommission the cable rock protection at the end of the project life. This purpose of this document is to provide additional information in relation to the JDN Method Statement for Decommissioning which was submitted as part of the Marine Licence Applications.

1.1 Purpose and scope

The purpose of this document is to provide additional information to answer the clarifications raised by Natural England and/or MMO related to the decommissioning of cable rock protection along the Race Bank Export cables. Marine Licence Applications MLA/2017/00277/4 and MLA/2018/00385.

This technical note aims to:

1. Describe JDN's track record with using the proposed decommissioning tools: the Trailing Suction Hopper Dredger (TSHD) and Backhoe Dredger (BD).
2. Provide examples where JDN has used the BD and TSHD for similar works.
3. Describe lessons learnt from previous projects in order to ensure successful rock removal and propose measures to minimize the environmental impact during removal works.
4. Provide an estimate for the expected recovery rate / success rate for removal of rock <u>which has a footprint on the seabed</u>

2. TERMS & DEFINITIONS

2.1 Abbreviations

Table 2-1: Abbreviations

Abbr.	Written in full
LAT	Lowest Astronomical Tide
NE	Natural England
BD	Backhoe Dredger
TSHD	Trailing Suction Hopper Dredger

2.2 Definitions

Table 2-2: Definition

Term	Definition
Employer	Orsted Wind Power A/S Kraftværksvej 53, Skærbæk Fredericia 7000 Denmark
Contractor	Jan De Nul Luxembourg SA. 34-36, Parc d'Activités Capellen, 8308 Capellen Grand Duchy of Luxembourg T +352 39 89 11
Project	Contract for the Installation of Export Cable

3. REFERENCES

3.1 Contractor's documents

Table 3-1: Contractor's documents

Document Title	Document No.
/1/. Rock installation Decommissioning method statement	N/A

4. JAN DE NUL

4.1 Innovation, expertise and sustainability are the driving forces supporting the success of Jan De Nul Group. Thanks to our committed employees and tailored solutions, the Group is the current market leader in dredging and marine works as well as a specialised provider of services for the offshore market of oil, gas and renewables. The Group is also a major player in civil engineering, environmental and brownfield development projects. The professional and innovative solutions of Jan De Nul Group are trusted across the industry. Whether it concerns the construction of new locks in the Panama Canal, the installation of offshore wind turbines or the redevelopment of contaminated industrial sites, together with its clients Jan De Nul Group builds for future economic development.

4.2 The company owes its current leading position to its vision and courage. Courage of the founder, Jan De Nul, who developed the company from a small scale contractor to a genuine dredging company. Also the courage of the next generation, which has given the Group its current enviable reputation throughout the five continents. Jan De Nul started as a civil works contractor. Anticipating the market opportunities of that time, the De Nul family took on its first dredging contract in 1951. This was followed by securing the first international dredging project and the rest is history. Over the years, Jan De Nul Group grew to become a global market leader within the dredging industry. The Group would never have reached this position if it did not have had the courage and vision to continue investing in new equipment, a new dredging fleet, new employees and new activities. Over the years, Jan De Nul Group invested in expanding its expertise, always looking for new interdisciplinary synergies. Jan De Nul Group is and has always been a versatile company. As such, it is a company that is ready for the future.

4.3 Jan De Nul Group is the owner of the world's most modern and most diverse dredging fleet. This is the result of its policy to invest continuously in its own equipment. The new vessels and their state-of-the-art on-board technology have been designed by the internal design and engineering department. Also, Jan De Nul Group manufactures in its own workshops and supplies the specialist dredging equipment to the shipyard, this is unequalled within the dredging industry. Jan De Nul Group's fleet includes some of the world's most powerful dredgers and multi-purpose installation vessels: J.F.J. De Nul, the most powerful cutter suction dredger, sister vessels Cristóbal Colón and Leiv Eiriksson, the largest trailing suction hopper dredgers with a hopper capacity of 46,000 m³, sister vessels Simon Stevin and Joseph Plateau, the largest rock installation vessels, and Isaac Newton, the most high-tech cable-laying vessel that is currently available on the market.

4.4 Worldwide, Jan De Nul Group executes dredging and land reclamation projects from start to finish: design, development and maintenance of ports, deepening of channels, land reclamation and shore protection works, dredging in the most diverse conditions. Often, these dredging activities are part of a comprehensive port infrastructure project entrusted by the client to one contractor. The company already completed numerous prestigious projects across the world such as the construction of a second runway for the airport of Brisbane in Australia or the construction of the second Suez Canal in Egypt. Jan De Nul Group owes its position as global leader above all to its technical know-how and very diverse fleet. By investing in its own installations, machines and vessels, the Group has today the world's most modern dredging fleet at its disposal. Meanwhile, its employees continue to look for new opportunities...

4.5 Jan De Nul Group offers a range of offshore services for the installation of submarine structures, cables and umbilicals for the oil, gas and renewable energy market. These services included: the preparation of the seabed, dredging of trenches, installation, rock placing for stabilising and ballasting of submarine pipelines, cables, umbilicals, foundations, platforms and complete wind farms. All these services are offered according to the specific needs and requirements of our respective clients including as a comprehensive Engineer-Procure-Construct (EPC) package.

5. PREVIOUS PROJECTS

5.1 ROCK DREDGING WITH BACKHOE DREDGER

Backhoe dredgers are designed to handle hard and stiff ground soils. They have been used worldwide to deliver accurate dredge profiles in difficult reachable locations. Below are two example locations where rock was removed by use of backhoe dredgers: 'Il Principe' and 'Jerommeke'. All backhoe dredgers in the JDN fleet have similar working principles and capabilities. They can operate to capital dredge hard material or alternatively re-handle material that was pre-cut with a cutter suction dredger. In the latter case, the cutter suction dredger cuts the material to a certain design depth after which the backhoe dredger removes the loose rock to a certain dredge design. The experience gained in this second modus operandi can be used to accurately remove rocks to a certain design on the Race Bank scope.

- Backhoe dredger 'Il Principe' – Panama: Widening and Deepening of the Atlantic Entrance & North Approach channel of the Third Set of Locks of the Panama Canal. Pre-cutting and capital dredging of muck and gatun rock at the existing navigation channel and the north approach channel to the third set of locks.
- Backhoe dredger 'Jerommeke' – Qatar: Barzan Offshore project. Shore approach trenching and backfilling.

Figure 5.1-1 Rock dredged by backhoe dredgers

5.2 ROCK DREDGING WITH TRAILING SUCTION HOPPER DREDGER

Below a selective list can be found of relevant projects where rocky material was dredged using TSHD:

- Filippo Brunelleschi – Panama: Dredging works for the port of Balboa. Capital dredging, deepening specific areas of the Port's basin and berths, the dredged material includes residual soil and rock.
- Filippo Brunelleschi – Colombia: Pre-cutting and dredging works in the access channel, turning basin and the new berthing dolphin in the Buenaventura TC Buen S.A. container terminal. The activities were developed in two phases in 2013 and a third smaller phase in 2014. Soils consisted of soft sediments, clayey silts, soft and medium hard rock.
- Charles Darwin – Taiwan: Linkou Fossil plant. Dredging and reclamation works in the Linkou port, dredging cobbles + mudstone.
- Vasco Da Gama – Taiwan Linkou Fossil plant. Dredging and reclamation works in the Linkou port, dredging cobbles + mudstone.

Below pictures show rocky material that was dredged by JDN's trailing suction hopper dredgers on various locations in the world. It shows rocky material of various sizes found in the draghead or inside the hopper.

Figure 5.2-1 Rock dredged by hopper dredger, found under draghead

Figure 5.2-2 Rock dredged by hopper dredger, found inside the hopper

5.3 CABLE ROCK PROTECTION ON RACE BANK EXPORT CABLES

Figure 5.3-1: Rock loaded on Simon Stevin

5.1 The rock material that will be installed over the Race Bank export cable has grade CP 45/125 and is identical as the rock shown on Figure 5.3-1. In fact, rock size is rather fine & smaller than what was dredged on the above-mentioned projects. This adds confidence that the installed rock can be removed without any issues by both TSHDs and BDs.

6. EXPERIENCES FROM DREDGING FOR FUTURE OFFSHORE WINDFARMS

6.1 This section explains how techniques used in dredging project could be used in offshore wind farms, and more specifically in the decommissioning of rocks.

6.2 Water depths encountered on the Race Bank export cable vary from approx. -11.2 m LAT up to approx. -31.2 m LAT, reference to Figure 6-1 for the water depths of each rock dump location. Typically a BD in deep dredge configuration can remove all rocks to a water depth of maximum 32.0m. Because of this, not all rock dump locations are within reach of the BD bucket. As Race Bank site is highly affected by tidal variations the BD can take away rock up to approx. -27.0 m LAT. Rocks installed on a depth over this limit will have to be removed by a hopper dredger. Jan De Nul, being a dredging specialist, has a fleet of hopper dredgers available that can dredge up to 155m water depths. Of the total installed volume of rock, 40% will to be removed using TSHD & 60% using BD.

6.3 The plot in figure 6-1 below identifies rock berm sections for each section of the export cables where rock protection is will be installed. It plots the average water depth for each section of rock berm and identifies which decommissioning method is suited for that section. The plot aims to give the reader an idea on the number of sections, their average water depth; and related to that, the proposed method for decommissioning.

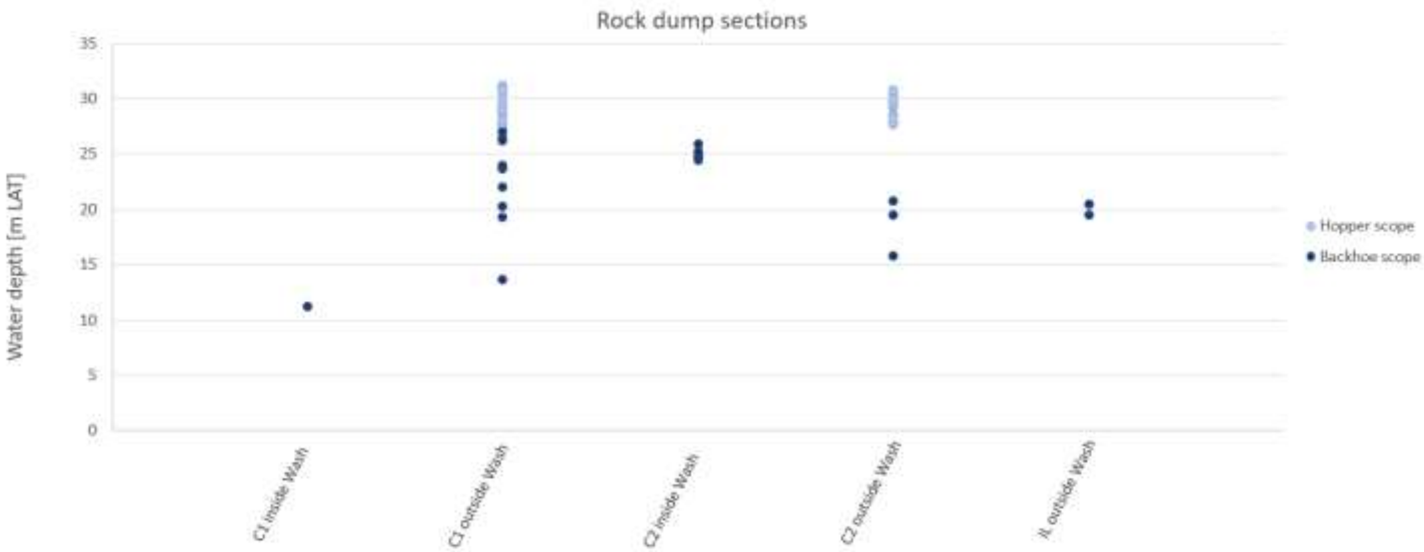


Figure 6-1 Water depths per rock dump section.

6.4 Typical accuracies that are achieved with BD and TSHD are within 30cm. A rock berm can be levelled or removed up to a vertical accuracy of 30cm. The multibeam in Figure 6-2 below shows a trench design dredged up to a vertical accuracy of 30cm.

Figure 6-2 Achieved dredging accuracies. Blue and red line show tolerances. Green is the achieved result.

6.5 **Drag Head vertical accuracy**

The high accuracy in the vertical direction can be achieved by controlling the draghead height with the draghead winch wire. By hauling or veering this winch an accurate height of the draghead can be achieved. This results in highly accurate trenching profiles in vertical direction: 30cm.

6.6 **Drag Head horizontal accuracy**

The same level of accuracy cannot be achieved in the horizontal plane, this is mainly because the draghead doesn't have active steering in the horizontal direction. Repositioning the draghead would require the vessel to reposition or adjust its course. This lower accuracy in the horizontal plane is not an issue for the rock removal scope on Race Bank as the ultimate goal will be to dredge back to original seabed.

6.7 Figure 6-2 depicts the level of accuracy that can be dredged with a TSHD. In this case, the dredge design was a pre-lay trench for a pipeline. Obviously, this design differs from Race Bank rock removal scope, but it confirms that the above mentioned accuracies can be achieved. On Race Bank Project, dredge design will be flush with seabed & all material above natural seabed level will be accurately removed.

6.8 To reduce the environmental impact of the decommissioning works JDN proposes to execute most part of the works with a BD. The sediment plumes and environmental impact with a BD are extremely limited. The TSHD scope will be limited to the locations where the BD cannot operate due to water depth restrictions.

7. CLOSING NOTE

7.1 Two important aspects to consider when assessing the feasibility to remove rock from the seabed are the ability to handle the material and the working accuracy of the tool. The accuracy of the working method relates directly to the impact on the natural environment. With the above examples of the BD and TSHD, we have shown to have extensive experience in handling rocks both larger and smaller than the rocks that will be installed on the Race Bank project.

7.2 This note also details the dredging accuracies that have been achieved. The removal of rock by applying traditional dredging methods is in essence not different from any other dredging project (e.g. dredging a shipping channel design or pipeline trench). Being a market leader in dredging industry, JDN has delivered a broad variety of dredging projects all over the world within design accuracy.