SUBSEA CABLE PROTECTION BY ROCK BERM

Presentation to demonstrate the used of rock berms as an alternative protection measure for subsea cables in offshore fields – Case study: NASR Package 2 Project

John Mackenzie – Jan De Nul Group – john.Mackenzie@jandenul.com

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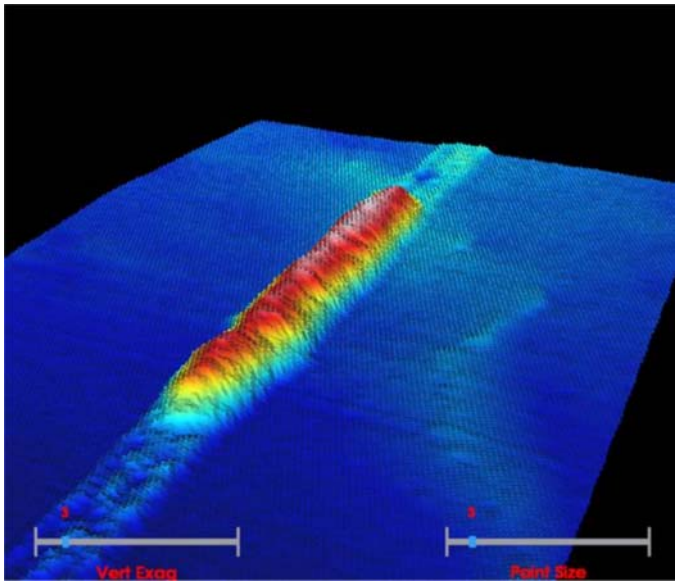

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Company Profile – Key Facts

Jan De Nul started as a civil contractor

1951 - First dredging work

1973 - First project outside Europe

1991 - First offshore project

2000-16 - Active in 107 countries

4 Main Activities

- Dredging and Maritime Works
- Offshore Services
- Civil Engineering Works
- Environmental Works and Brownfield Development

Ultramodern fleet

2018 Turnover of 1.7 billion €

Company Profile – Key Activities

DREDGING AND MARITIME WORKS

- Port infrastructure and port maintenance
- Capital and maintenance dredging
- Coastal defence and riverbank protection
- Land reclamation and beach restoration

OFFSHORE SERVICES

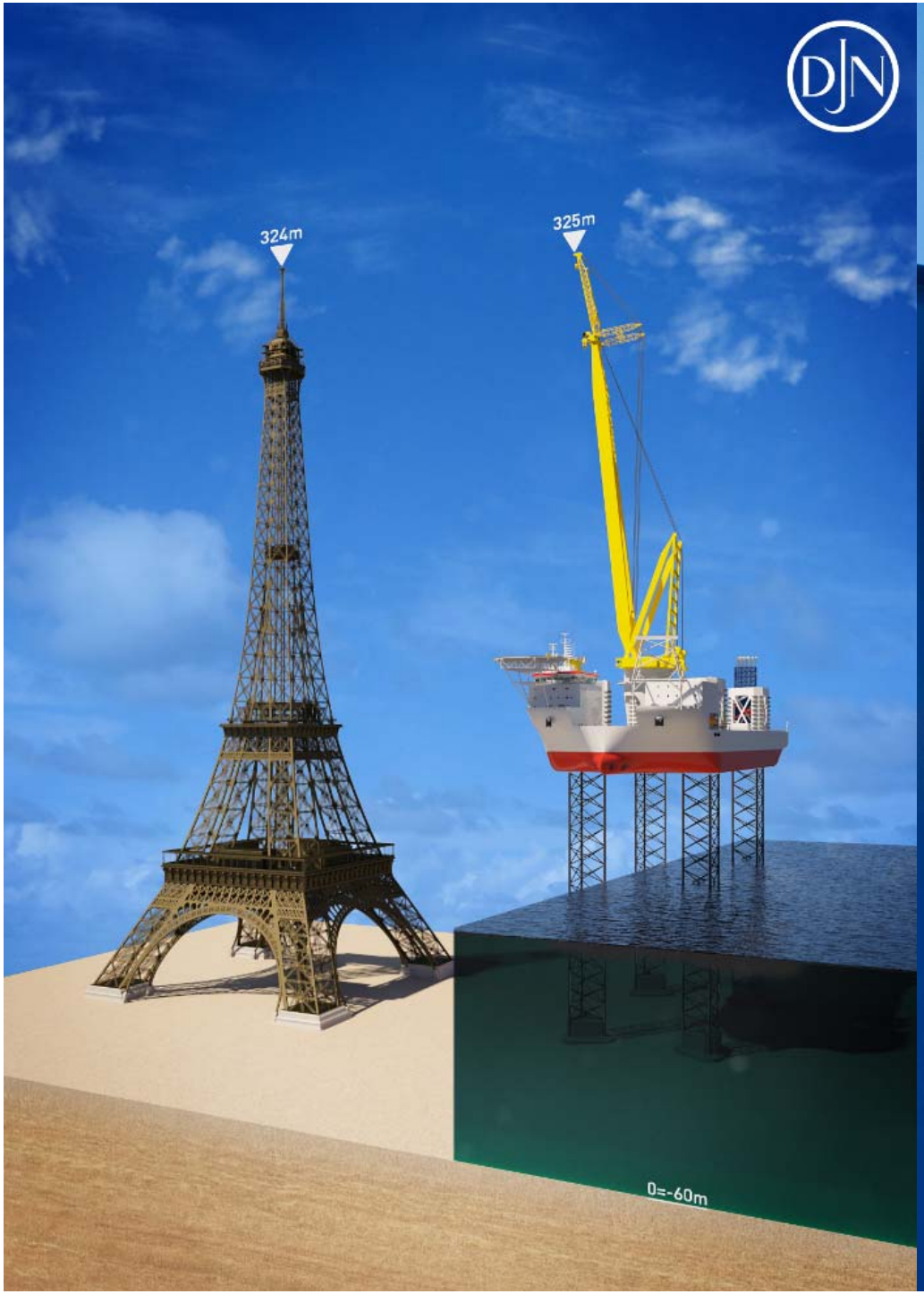
- Seabed intervention
- Rock installation and ballasting
- Subsea cable and umbilical installation
- Offshore renewables
- Heavy lifting and decommissioning

CIVIL ENGINEERING

- Infrastructure works
- Maritime engineering & Port Construction
- Buildings
- Foundation and piling works
- Major earth works

ENVIRONMENTAL WORKS

- Environmental dredging and sediment treatment
- Soil and groundwater remediation
- Waste treatment and valorisation
- Solar farm development


DJN
324m
325m
0=-60m


DJN
ULEV
ULTRA-LOW EMISSION

Offshore Services – 1. Seabed Intervention

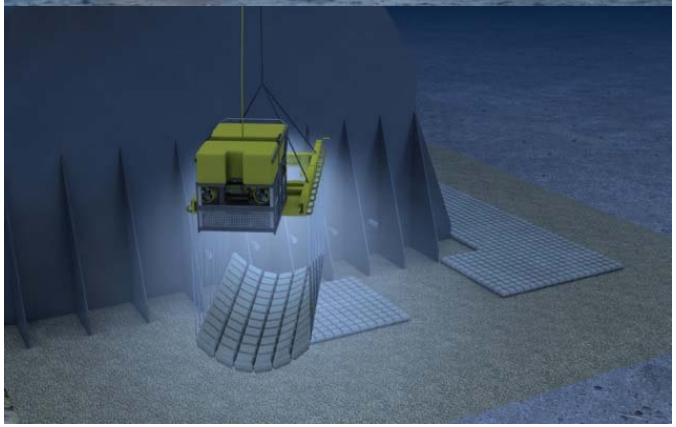
Seabed intervention with dredging fleet
-Trenching with hopper and cutter dredgers
-Pre-sweeping
-Seabed levelling for gravity based structures
-Artificial Islands

Landfalls and pipeline installation / pipe pull

Offshore Services - 2. Subsea Rock Installation

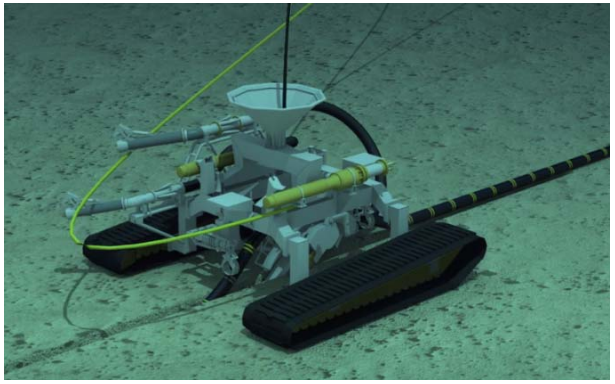
Fleet of several DP vessels ranging
between 1,500t & 32,500t capacity and working
up to 2,000m water depth
-Cable and pipeline protection and stabilisation
-Foundation layers of rock for GBS

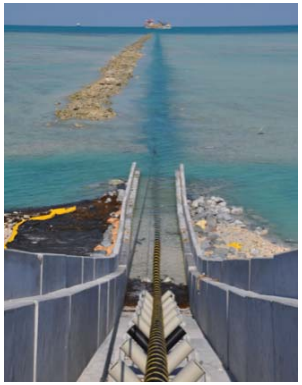
-Ballasting of GBS
-Installation of mattresses, gravity blocks ...



Offshore Services – 3. Cables and Umbilicals

Cable installation fleet of several DP vessels with up to 10,500t capacity
-MVAC Inter-Array Cables
-HVAC Export Cables
-HVDC Interconnector Cables
-Umbilicals for O&G offshore





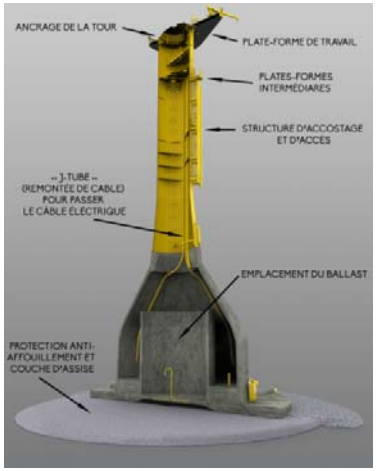
Multiple burial tools available for pre-lay and post-lay trenching; and for onshore, nearshore as well as offshore operations

Offshore Services - 4. Offshore Wind Farm Installation

EPCI of WTG foundations
- Monopiles (MP)
- Transition Pieces (TP)
- Jackets (JKT)
- Gravity Based Foundations (GBF)

Transport and Installation
- Wind Turbine Generators (WTG)
- Offshore High Voltage Stations (OHVS)

Cable laying and scour protection
(see previous slides)



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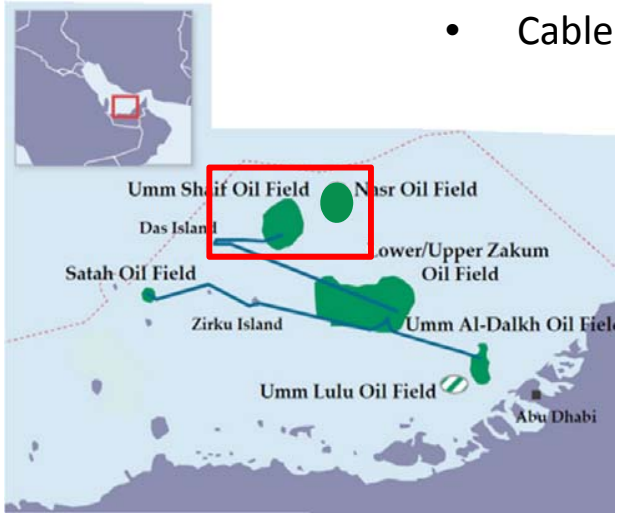
PROJECT OVERVIEW – PROJECT LOCATION



- Cable installation in/near Adma Opco Oil Fields:
  - in between Das Island – Umm Shaif Field and Nasr Field.
  - 3 x 132kV submarine cables (total Length 147km)
    - 132kV cable from Das Island to USSC PDP
    - 132kV cable from Das Island to NSGTP
    - 132kV cable from USSC PDP to NSGTP
  - 11kV infield cables – NASR field (total length 57km)

A total of 204km of cable was loaded in Norway, and transported and installed at the project site in two separate trips. The longest and heaviest of all thirteen cables, being the 71km long and almost 6,000 tons heavy 132kV cable between Das Island and the NASR field, was installed in a single length

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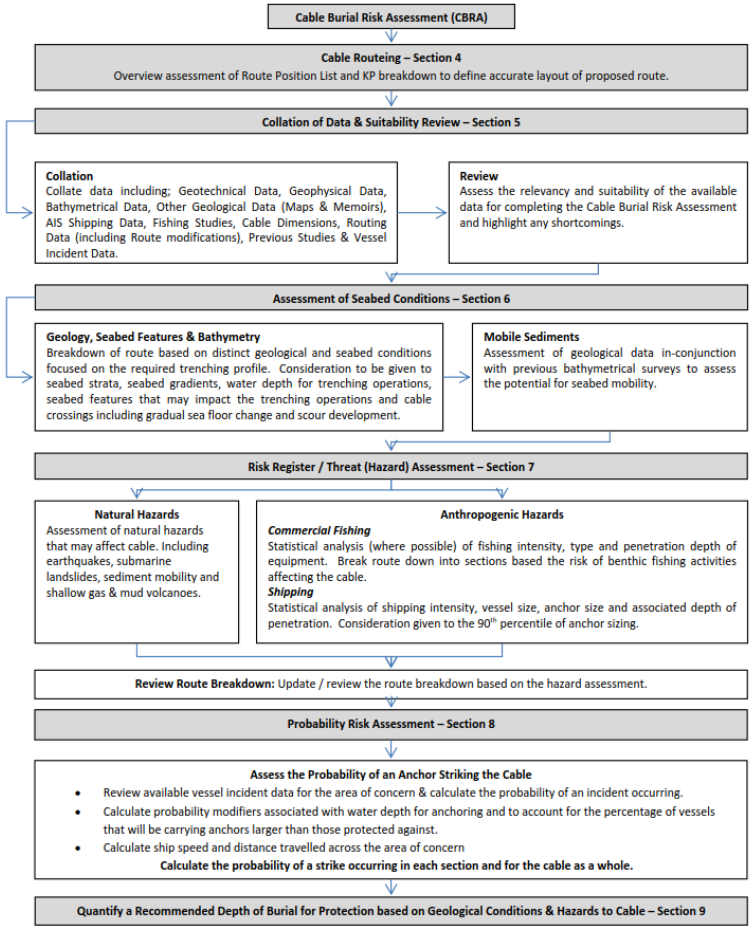
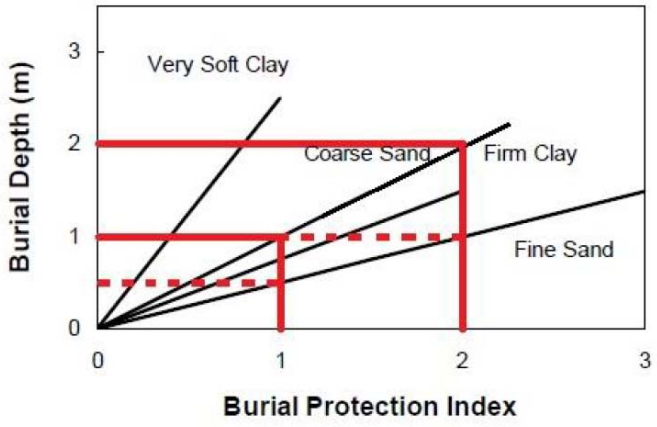
CABLE PROTECTION



Cable Burial Risk Assessment
- Seabed conditions
- Risk / threat to cable



The preferred external hazard mitigation method would be the burial of the cable to an appropriate depth. However, if burying the cable is not viable due to seabed geology, then other means of protection with equivalent safety should be applied.

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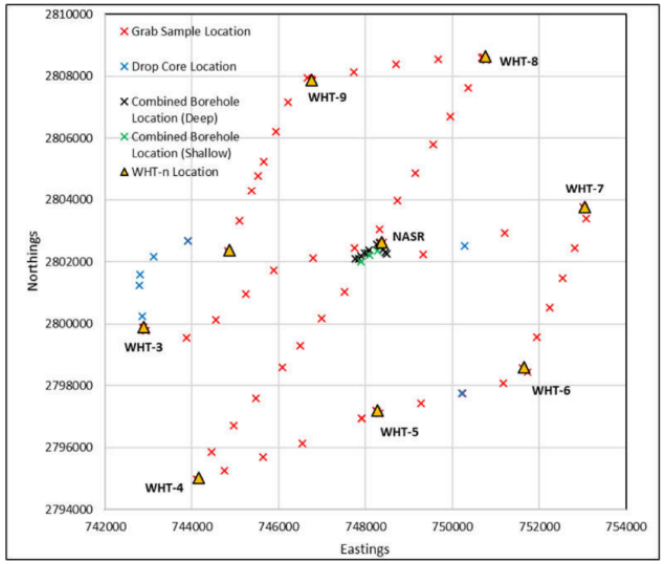
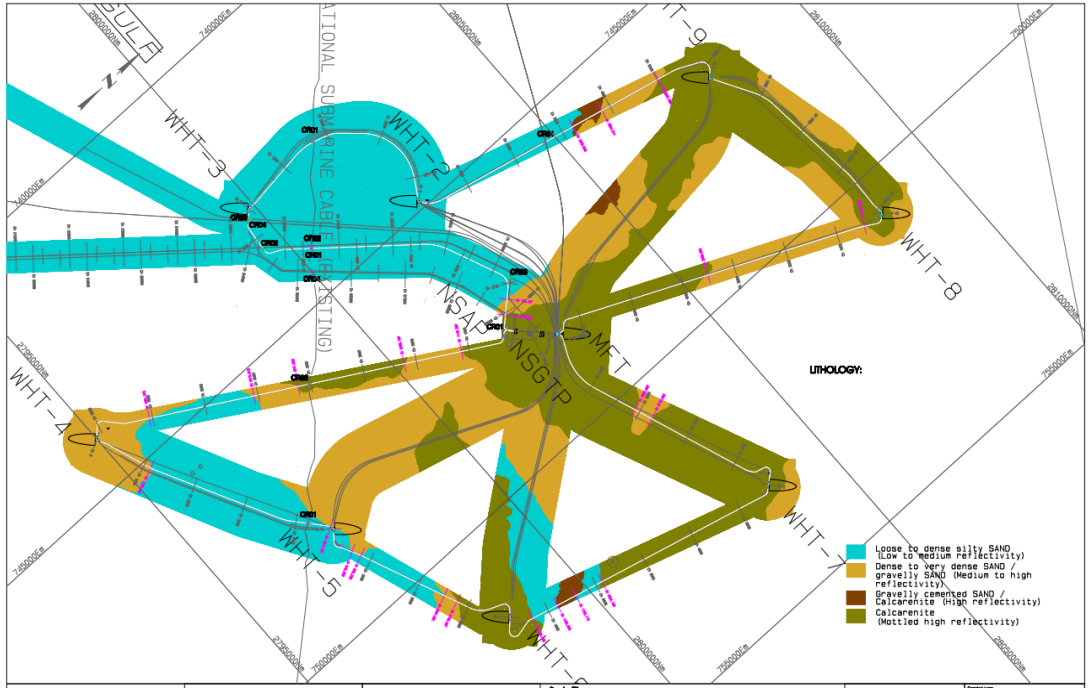
SITE GEOLOGY

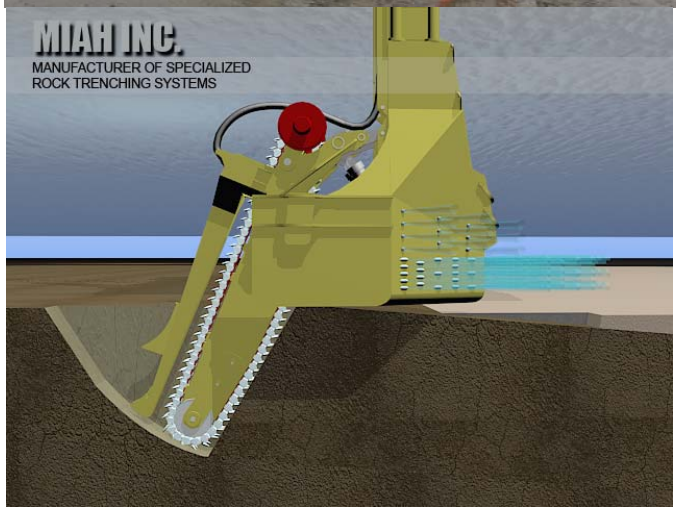




Soil investigation information was limited;

- Boreholes only in central complex location
- Grab samples on the route

TRENCHING – BURIAL METHODS



Depending on soil types:

- Ploughing
- Jetting
- Cutting

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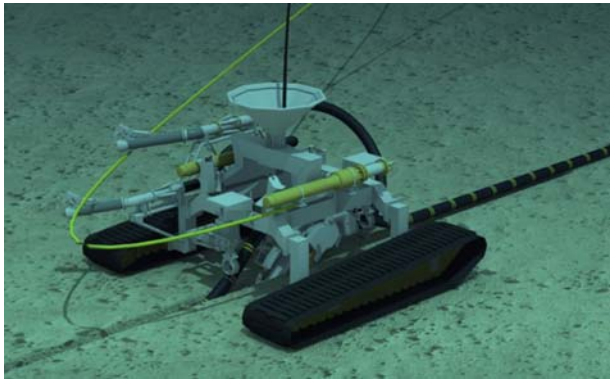
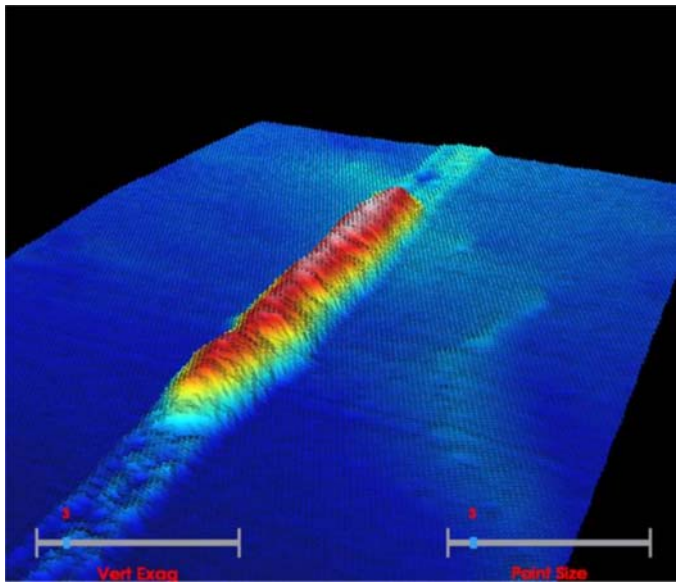
Cutting wheel trencher for post lay burial of the cable.
Suitable for both soft soils and weak rock.
20 tonnes weight
Cutting depth 1.3m



LESSONS LEARNED – TRENCHING

Trenching operations

- Trenching operations are undertaken on a reasonable endeavours basis
- Mechanical trenching feasible in soils up to 10-15MPa UCS
- Target depth of lowering of 1.0m not met over about 50% of the route due to presence of significantly harder soils
- About 10% of the route considered untrenchable
- Alternative protection in the form of a gravel berm installed on top of exposed cable



Recommendation:
All stakeholders should be aware and in agreement of the fundamental principle of subsea trenching to be carried out on a 'Reasonable Endeavours' basis. i.e. achieving the Depth of Lowering is not guaranteed.

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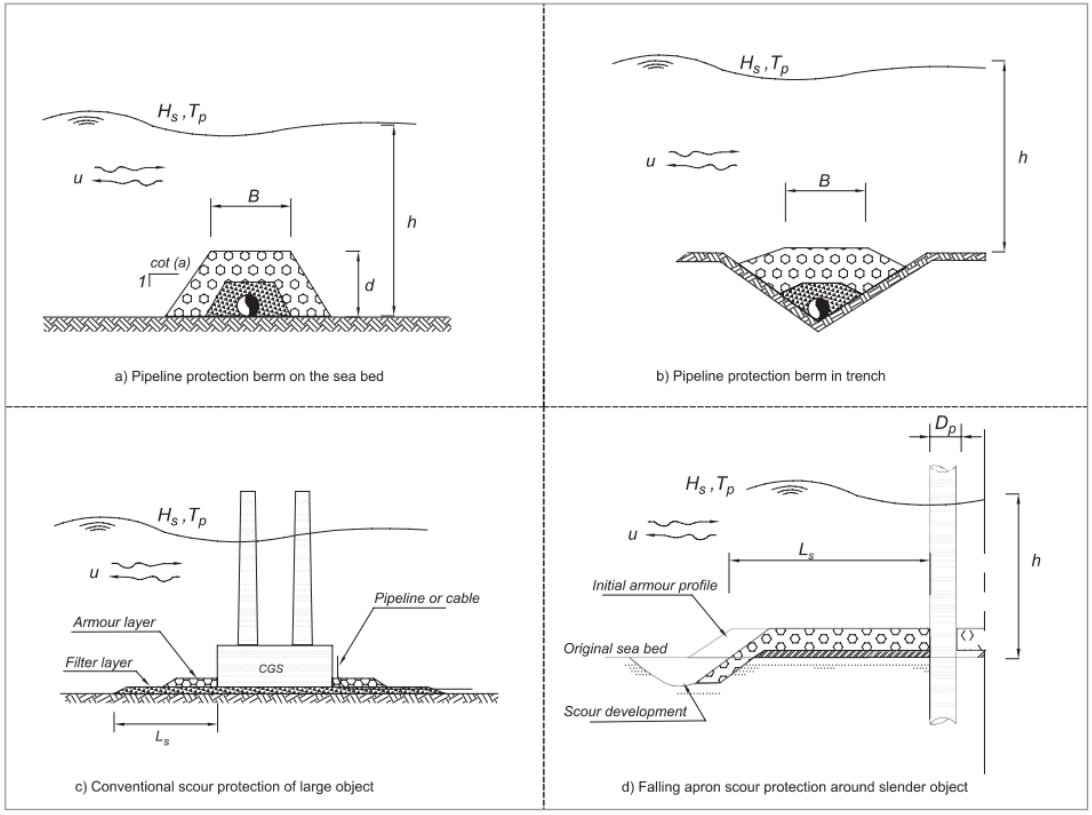
ROCKFILL IN OFFSHORE ENGINEERING



- **Rock protection to pipelines and cables**
- **Scour protection of slender structures**
- **Scour protection and bed preparation**

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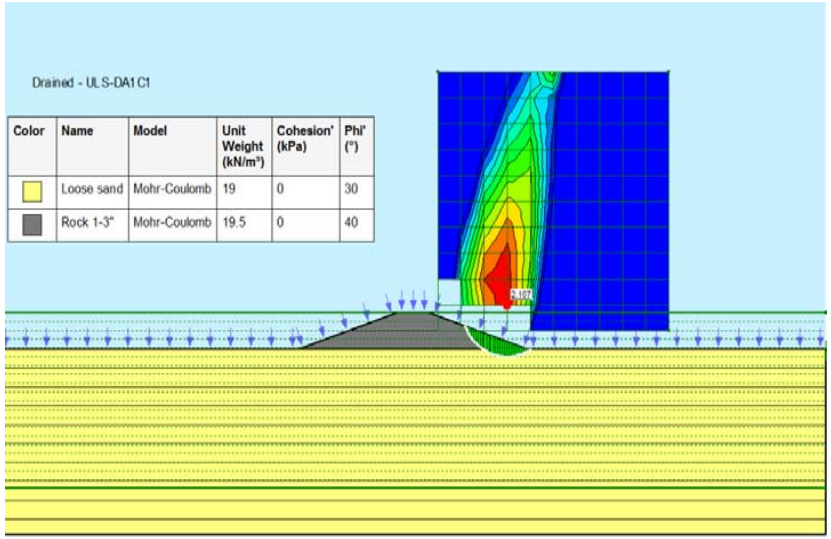
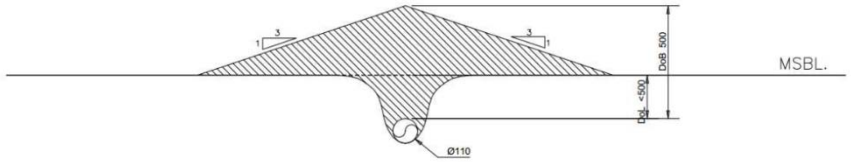
BERM ENGINEERING



- Hard Soils – DOL < 0.5m
  - **In the untrenchable sections of the cable route where the cable depth of lowering is less than 0.5m, the cable is required to be provided an alternative means of protection. The proposal is to provide this protection by the installation of a gravel berm.**

DoL <0.5m.
=> Backfill up to min 0.5m DoB.
(Berm with slope 1:3 slopes)



- As the berm protection was a new concept for ADNOC, full design verification as required
- In-house engineering
- Stability
- Gravel impact on cable
- Impact protection, dropped objects,

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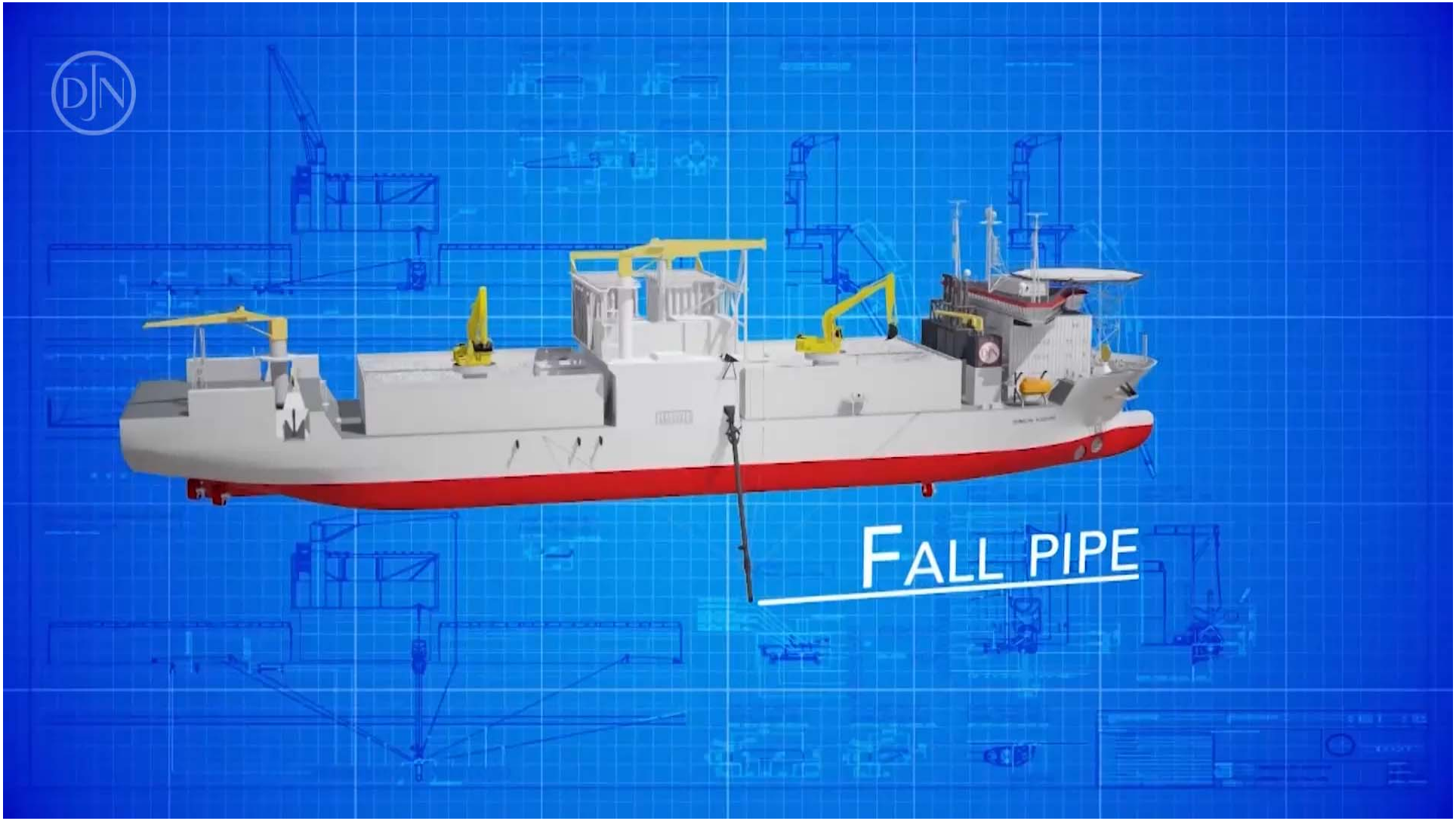
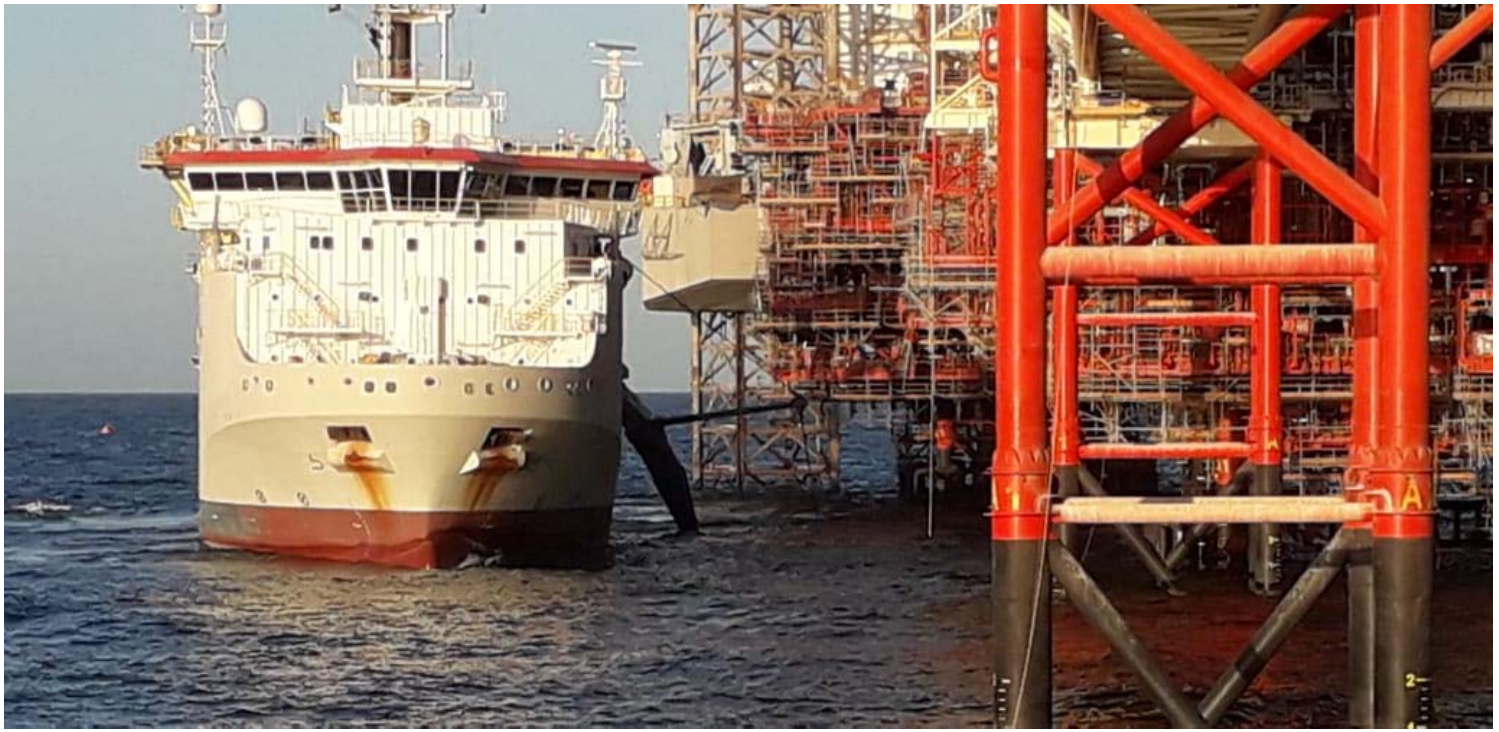


CONCLUSIONS



- **Importance of soil investigation**
- **Rock berms are a viable alternative to trenching burial in hard soils offshore Abu Dhabi**


DJN
THANK YOU