5th PIANC YP-Com (BTV)
Friday, May 8 – Ghent – Port of Ghent Visitors' centre
11:30 – 12:00
Ir. Bart Moens

State-of-the-art

Cable Installation Projects

Presentation Overview

- Introduction
- Case study: Race Bank Project
- State-of-the-art project references

1. INTRODUCTION

Jan De Nul GROUP

2014 turnover

Euro 2.1

billion

5,725

employees

fleet

75

vessels

Company Overview

International maritime contractor operating over 75 vessels

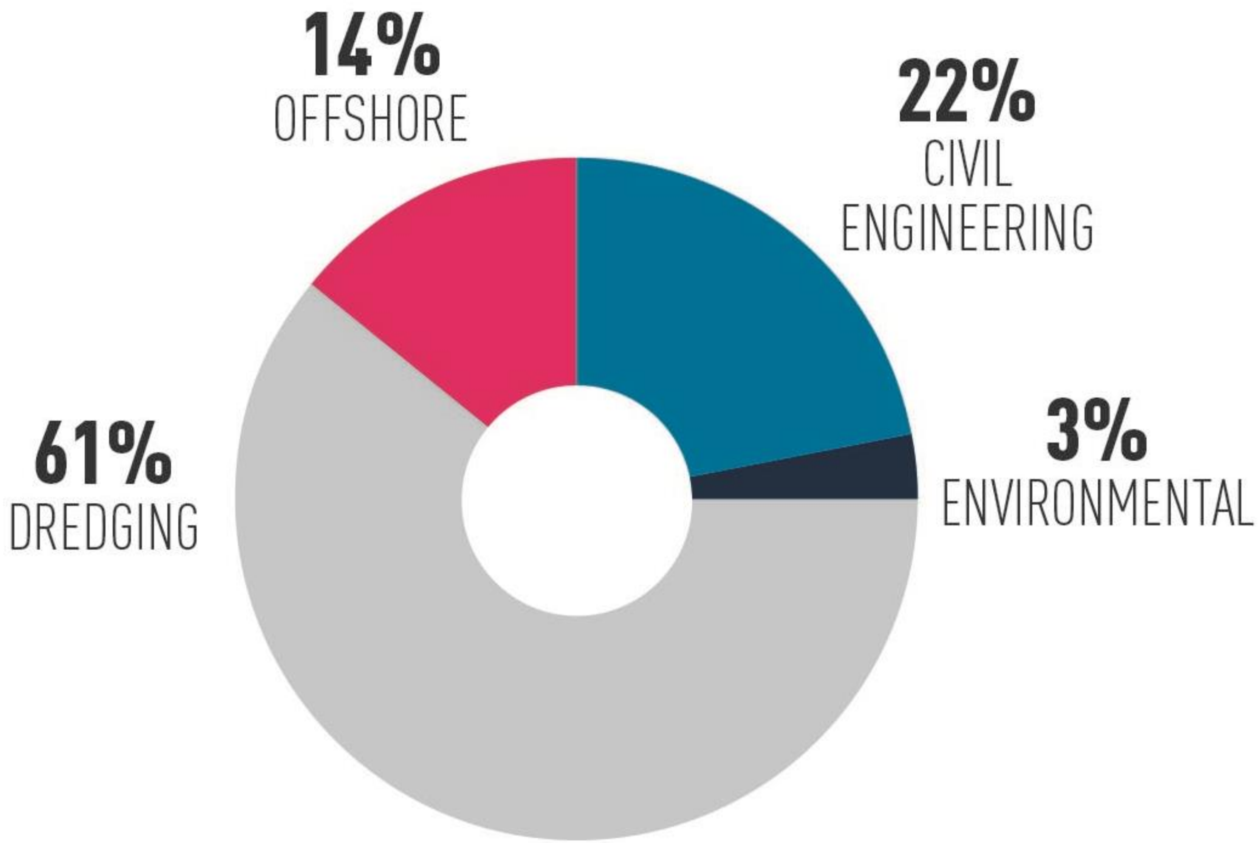
Founded as Civil Engineering Contractor in 1938

100% owned and managed by the De Nul family

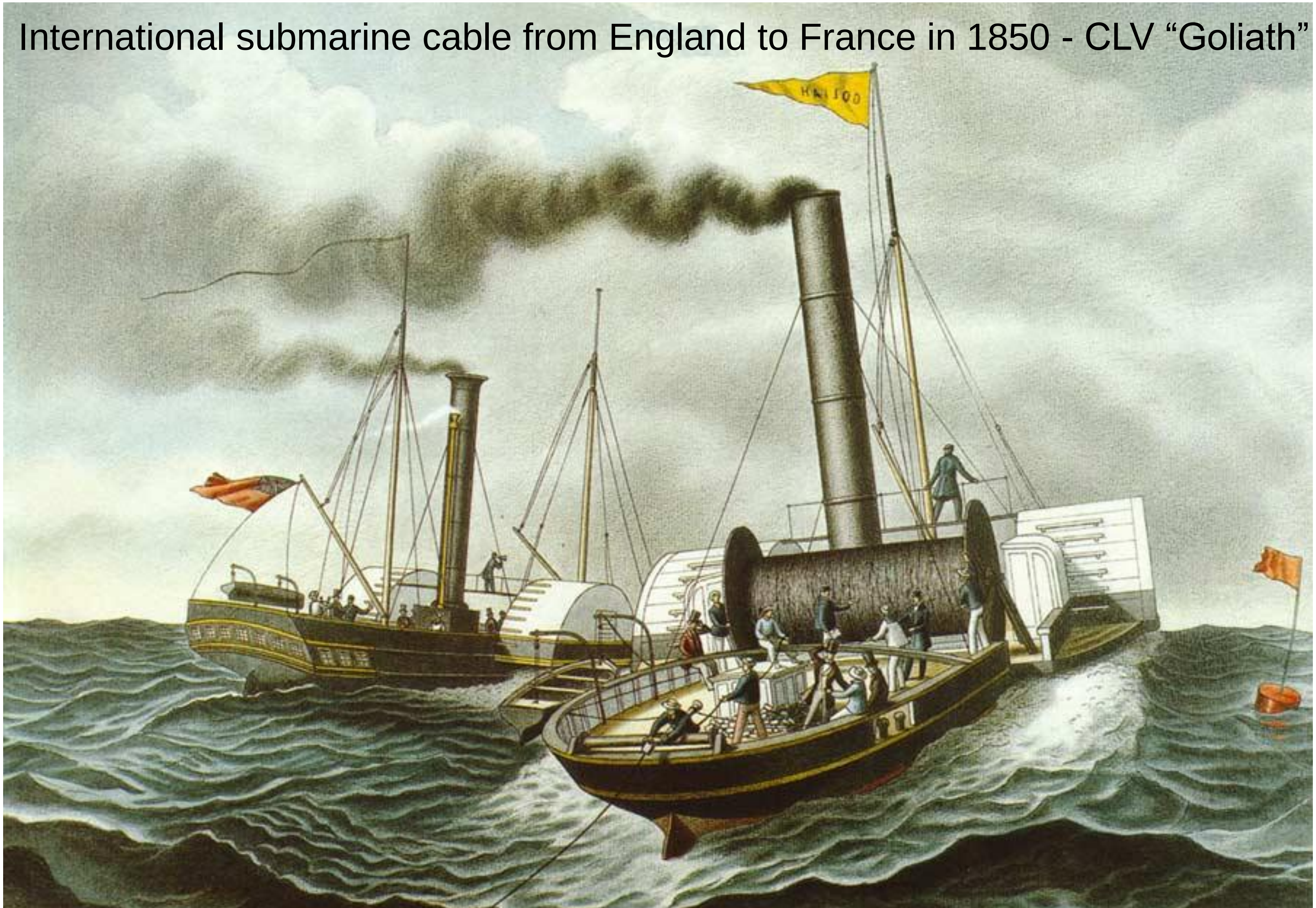
Belgium based with offices worldwide

Principal business: carry out projects with vessels owned and operated by company

What we do...


14%
OFFSHORE
22%
CIVIL
ENGINEERING
3%
ENVIRONMENTAL
61%
DREDGING

International submarine cable from England to France in 1850 - CLV “Goliath”



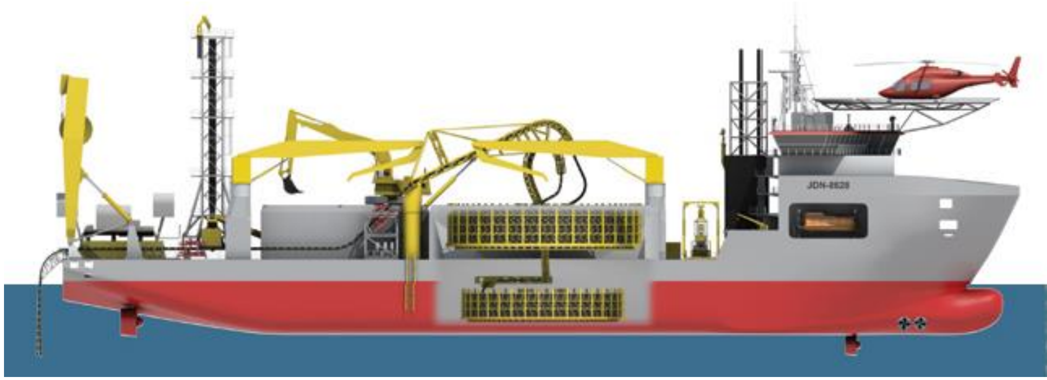
State-of-the-art

Cable installation vessels

Cable Laying Services

- **‘Willem de Vlamingh’**
  - 2011: Built as Rock Installation Vessel (FPV, SSDV)
  - 2013: Reconfigurated to Cable Laying Vessel (CLV)

- **‘Isaac Newton’**
  - March 2015: Launched at Uljanik Shipyard (Pula, Croatia)
  - August 2015: Delivery



Cable Installation Vessel – ‘Willem de Vlamingh’

Multi-purpose DP2 vessel

- Cable lay (5,400mT)
- Rock placing (6,000mT; FPV/SSDV)
- Trencher support
- Combination

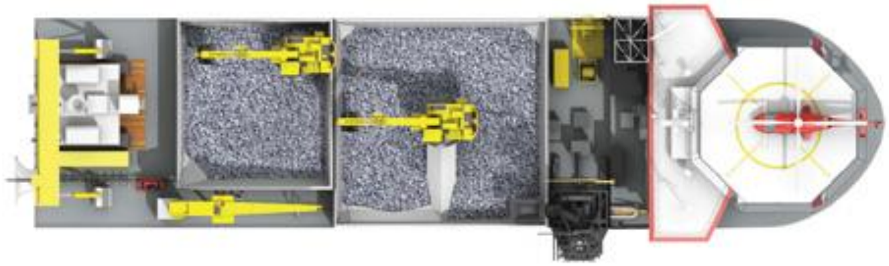
Potential layouts:

Cable Installation Vessel – 'Isaac Newton'

Multi-purpose DP2 vessel:

- **Cable lay (7,400mT + 4,500mT)**
- **Rock placing (7,000mT + 3,000mT)**
- **Trencher support**
- **Combination**

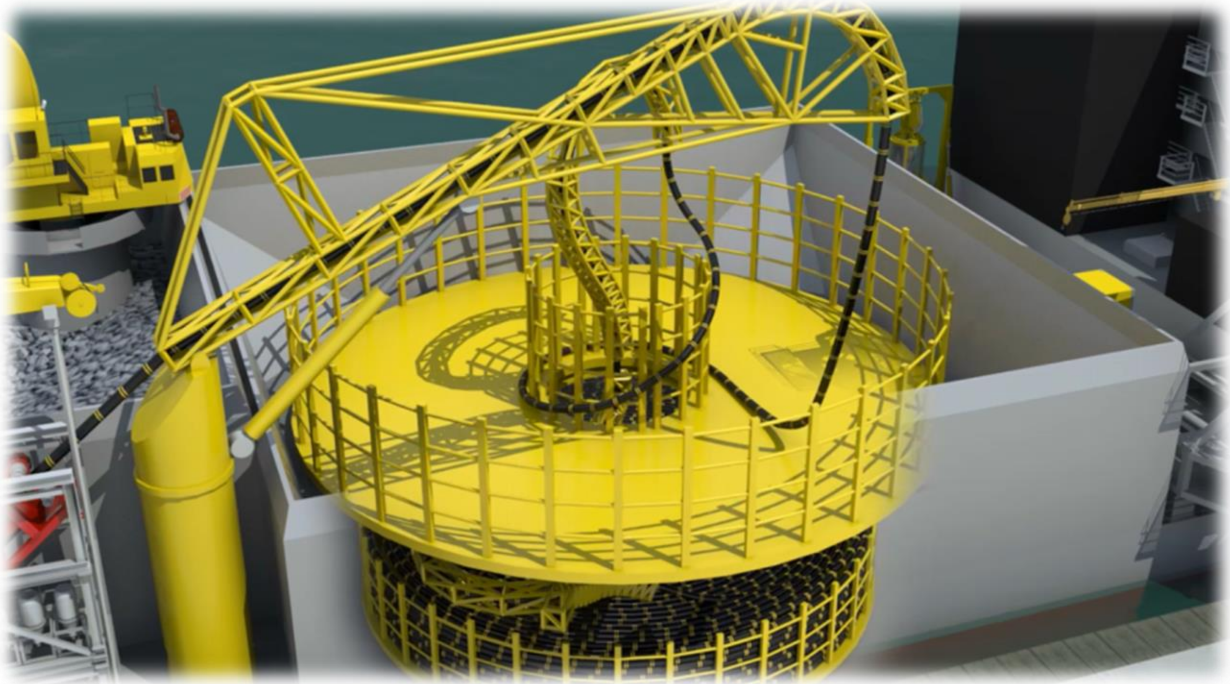
Potential layouts:



Cable Installation Vessel – 'Isaac Newton'

Deadweight	10,500 t	Propulsion	2 x 3,000 kW
Length	138.0 m	Bow thruster	2 x 1,500 kW
Breadth	32.0 m	Total power	12,000 kW
Draught loaded	7.0 m	Speed	12.0 knots
Dynamic Positioning	DP2	Accommodation	75

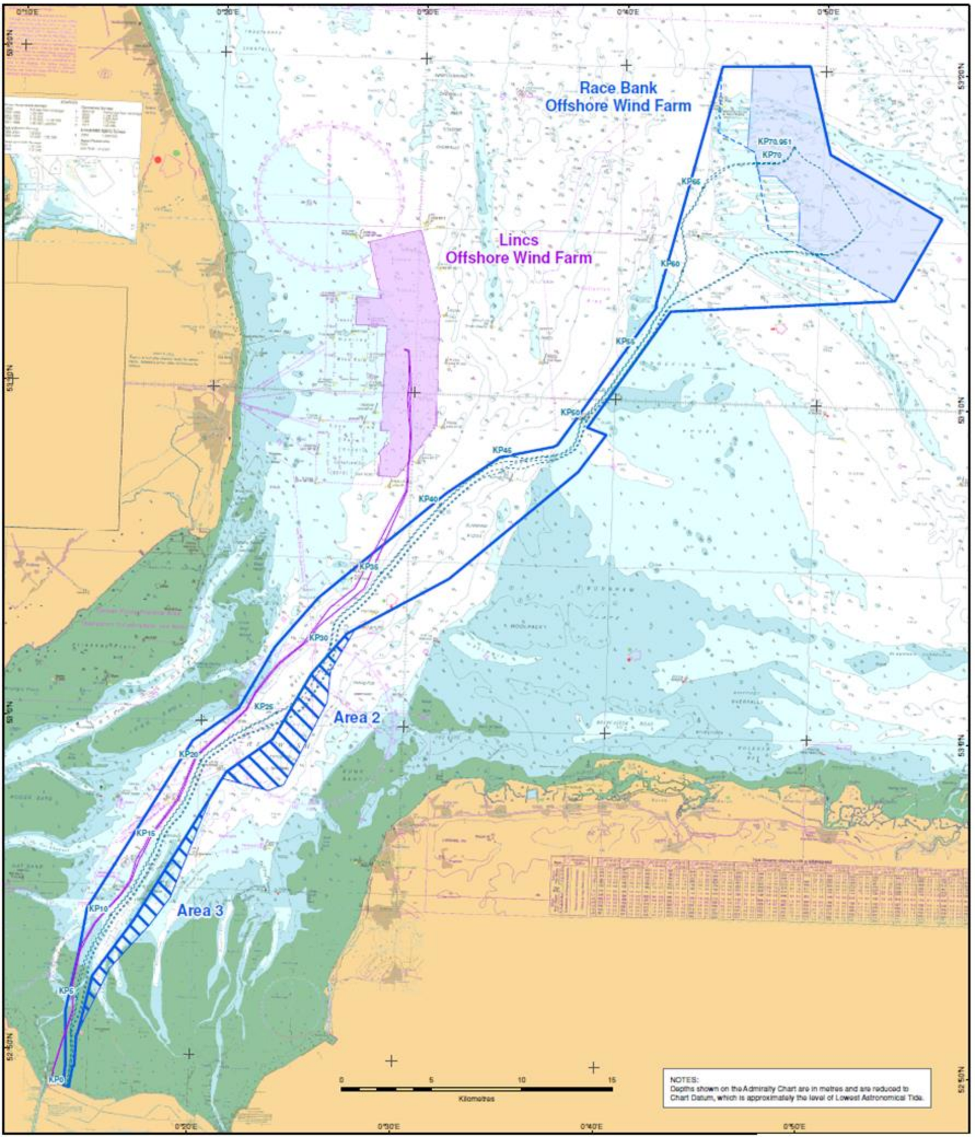
Unique patented cable loading design which allows to load, transport and install a maximum of 10,500 tonnes of cable in one single length divided over two turntables



1. CASE STUDY

UK –Race Bank (ROW) Project

08/05/2015



ROW01 project includes installation of approx. 2 x 71km 220kV submarine cable systems with integrated fibre optic cable between the offshore substation and the transition joint onshore and installation of a 6km long link cable.

2016

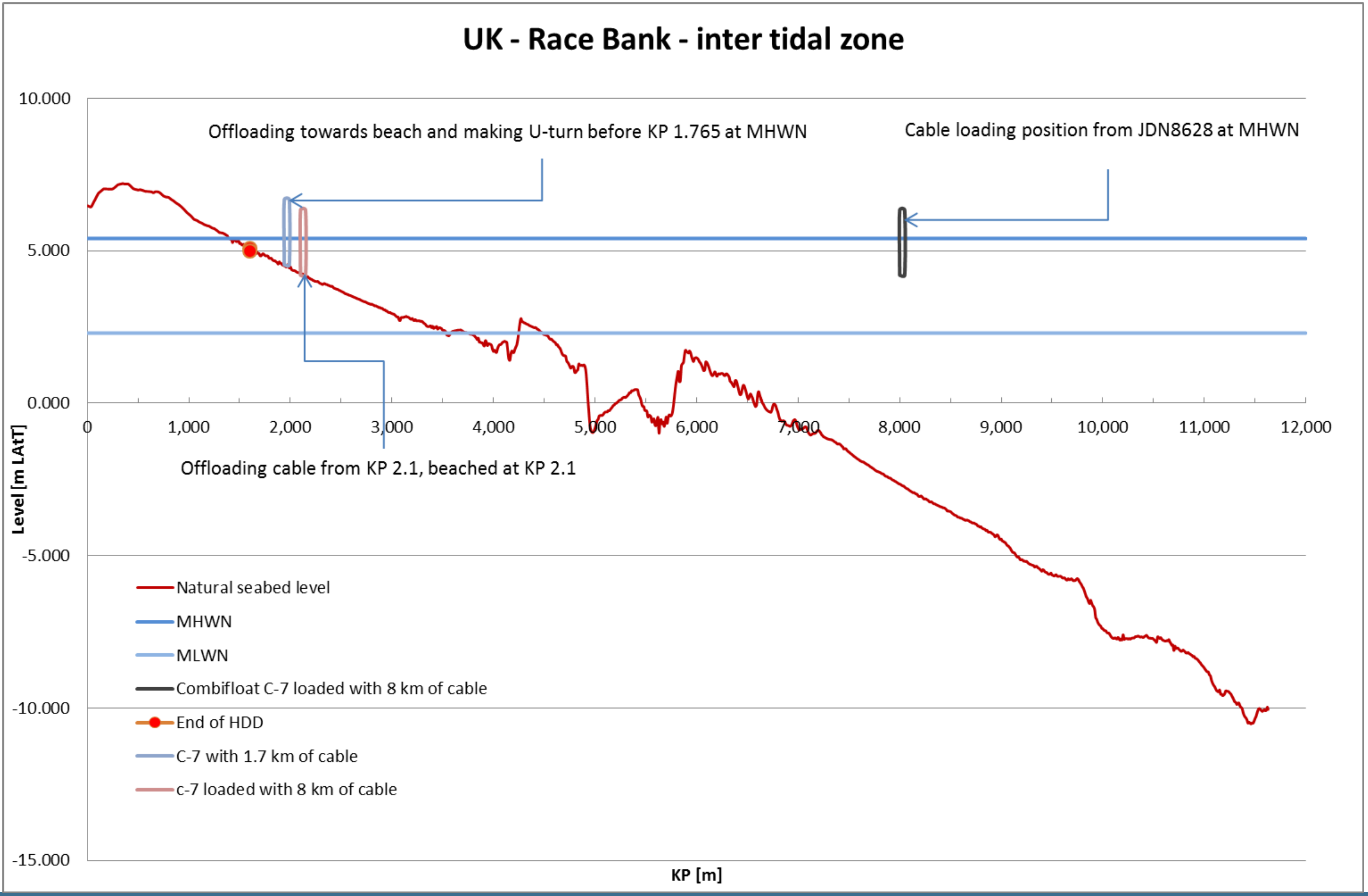
Circuit 1 and 2 – intertidal (2 x 8 km)
Circuit 1 - Offshore Section (63km)

2017

Circuit 2 – Offshore (63 km)
Circuit 3 - Offshore interlink cable (6 km)

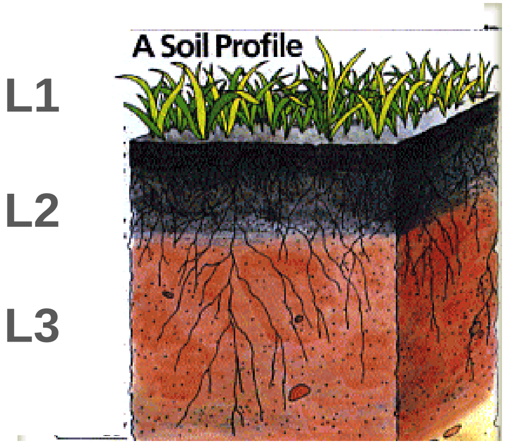
Cable loading, transport and installation

	Activity	Vessel
1	2 x 8 km (2016)	Willem De Vlamingh
2	1 x 63 km (2016)	Isaac Newton
3	1 x 63 km (2017)	Isaac Newton
4	LINK (6 km) (2017)	Isaac Newton


UK - Race Bank - inter tidal zone
Offloading towards beach and making U-turn before KP 1.765 at MHWN
Cable loading position from JDN8628 at MHWN
Offloading cable from KP 2.1, beached at KP 2.1
10.000
5.000
0.000
-5.000
-10.000
-15.000
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
Level [m LAT]
KP [m]
Natural seabed level
MHWN
MLWN
Combifloat C-7 loaded with 8 km of cable
End of HDD
C-7 with 1.7 km of cable
c-7 loaded with 8 km of cable

Site visit

- Marsh:
  - L1: Vegetation layer
  - L2: Organic layer
  - L3: Saturated soil



- Mud flats:
  - L1: missing
  - L2: missing
  - L3: Saturated soil

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Marsh | Mud flats

Effect vegetation

Effect roots in subsoil

Saturated soil

Depth	Table 4.4: Undrained Shear Strength (kPa) - Corrected for Vane Size and Rod Friction										
	KP0.2	KP0.4	KP0.6	KP0.2WS	KP0.8	KP1.0	KP1.2	KP1.4	KP1.6	KP1.8	KP2.0
0.1	4 5 7	20 26 19	16 21 11	4 5 7	3 7 8	11 21 21	10	***-4*** ***-2*** ***0***	8 7 7	***-2*** ***-2*** ***-2***	***0*** ***-1*** ***0***
0.5			15 16 16			***-1*** ***-3*** ***-1***	8 5 ***-4***	***-7*** ***-7*** ***5***		20 9 9	
1.0	4 7 5	***-7*** ***-7*** ***-8***	3 ***0*** 4	4 7 5	***-5*** ***-9*** ***-12***	***-6*** ***-4*** ***-8***	***0*** ***-7*** 9	***-4*** ***-16*** ***-14***	12 5 6	***-5*** 6 ***-5***	28 32 42
1.5			***-6*** ***-13*** ***-8***			***-13*** ***0*** ***-32***		***-11*** ***-14*** ***-14***		***-3*** ***-13*** ***-13***	
2.0	8 ***0*** 4	***-14*** ***-8*** ***-55***	***-12*** ***-1*** ***-9***	8 ***0*** 4	***-10*** ***-18*** ***-13***	***-33*** ***-29*** ***-41***	***-20*** ***-14*** ***-20***	***-36*** ***-40*** ***-32***	***-23*** ***-26*** ***-21***	***-35*** ***-34*** ***-24***	2 ***-28*** ***-28***

NB: Bold and Italic = Values deemed to be incorrect and unrepresentative of the true ground conditions.

- Conclusion: available measurement of the soil conditions
  - Very low soil strength
  - Most of the measurements are irrelevant for vegetation and organic layer
  - Other tests are required as basis for detailed design.

- What do we want to know?

  1. What is the maximal **TRACTION** possible without damaging the soil structure?
  2. What is the maximal **BEARING CAPACITY** of the soil/vegetation?
  3. What is the minimal required traction force to **DRAG** the tools (Plough / Chain cutter)?

- What is JDN-method for testing?
  - What can we measure and are the scaling laws reliable?

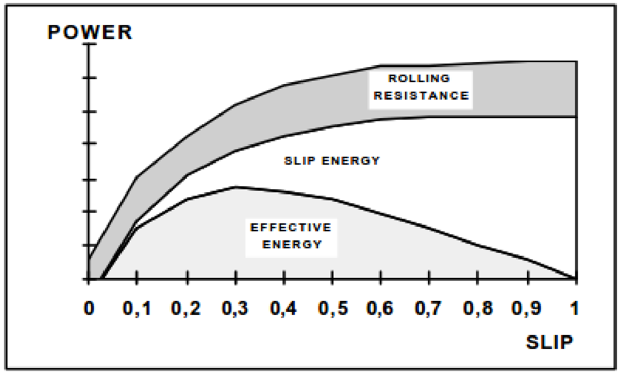
1. Traction

$$T = n.\left(c.b.L + \frac{W}{n}.\tan(\phi)\right).\left(1 - e^{\frac{-i.L}{K}}\right)$$

Cohesion | Friction

- Cohesion: dependent on contact area
- Friction: independent on contact area

- Highest traction efficiency @ 15-25% slippage

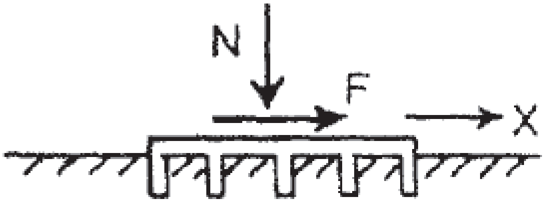


1. Traction

- Conclusion theory traction:
  - Marsh
    - ***Vegetation*** => cohesion will help us to increase traction
    - Limits in vegetation: what is the maximal force which can be applied before the vegetation is damaged?
    - **The larger the tracks, the better the cohesion factor**
    - We want to avoid friction to increase traction as this enhances RUTTING
    - **The lower the weight, the lower the risk for rutting**
  - Mud flats
    - Cohesion is probably none existing
    - Friction based on ***weight*** will help us to increase traction
    - Limits in weight: bearing capacity => using pulling wire from beached pontoon to pull the machine over the mud flats, only using the tracks for bearing the weight of the machine
    - **The larger the tracks, the better the bearing capacity**
- **Artic track design helps to maximise the available contact surface, while ridgid tracks cause load peaks damaging the soil.**

1. Traction

- Validation Traction :
  - Field test to determine c & ϕ : Grouser plate test



  - Prototype: JDN swamp excavator

2. Bearing capacity

TECHNICAL

- Working principle test Bearing capacity
  - **Marsh:** minimum ground pressure in order not to damage the vegetation layer

  - **Mud flat:** first indication gives a good bearing capacity

3. Drag tool

TECHNICAL

- Working principle test Drag tool
  - **Static situation: YIELD force**

$$F = (\rho.h^2.N_\rho + c.h.N_c + p.h.N_p + c\alpha.h.N_{c\alpha}).b$$

Soil density	Cohesion	Ground pressure	Adhesion soil - tool

    - N: dimensionless factors depending on tool geometry => a priori unknown
    - Most dominant factor in this equation is soil density
    - Yield force ~ width tool b
    - Yield force ~ (depth tool h)²
  - **Dynamic situation: DRAG force**

$$F = C_D.\frac{\rho.v^2}{2}.A$$

    - C_D: dimensionless drag coefficient depending on tool geometry => a priori unknown
    - Drag force ~ (velocity tool v)²
    - Drag force ~ projected area A = > Drag force ~ depth tool
- **General remark:** JDN estimates the plough generates a higher drag force than the chain cutter

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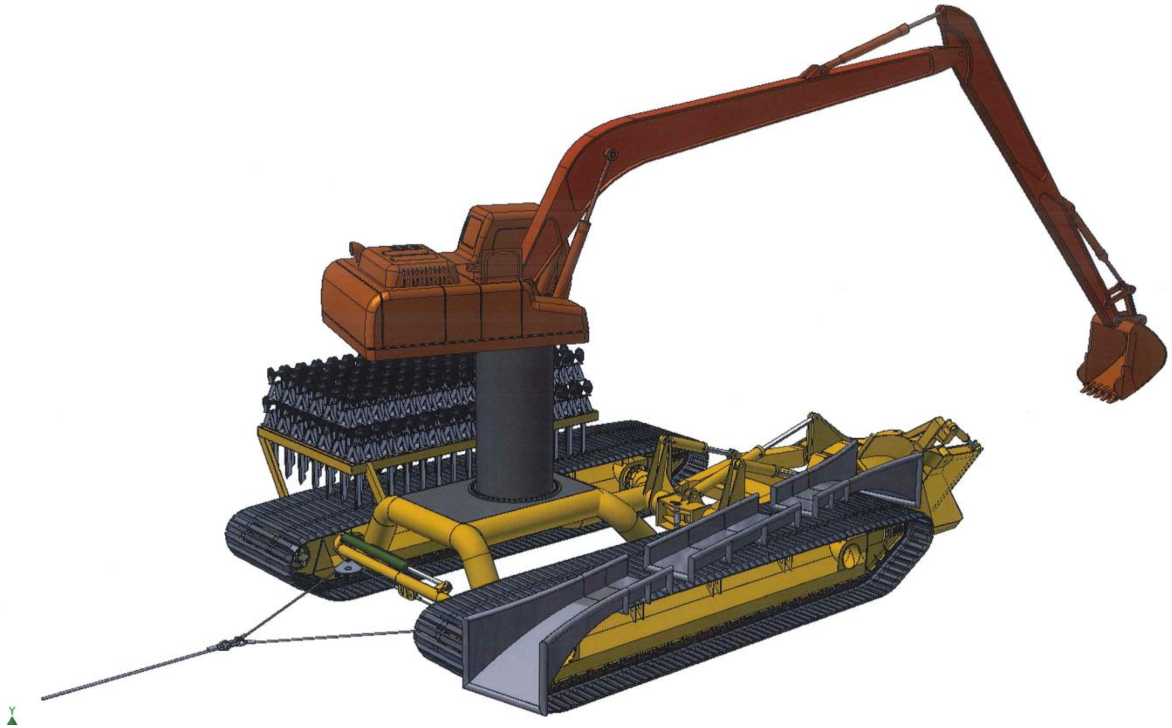
3. Drag tool

TECHNICAL

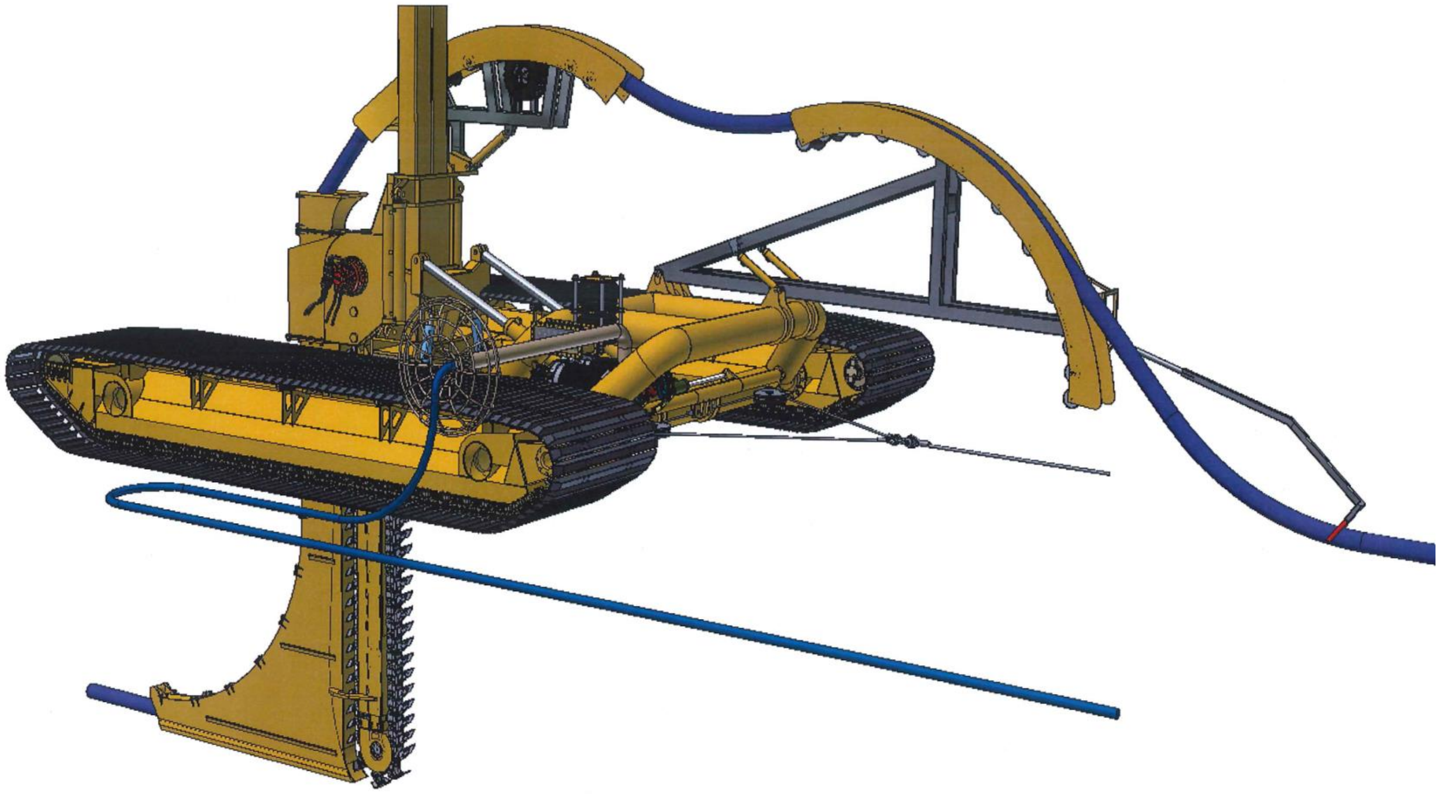
- Validation: Drag force: prototype V-shaped plough
  - Standard
  - Width legs adapted to with export cable
  - V-shaped plough with one leg, cfr. design Mastenbroek
  - Adhesion between soil and plough: anti-stick layer or greasing with water
  - Vibrating V-plough
  - Location tests?
    2 potential locations:
    Belgium & The Netherlands
  - Timing tests?
    Q4 2014

- Prototype: JDN swamp excavator in combination with V-shaped plough

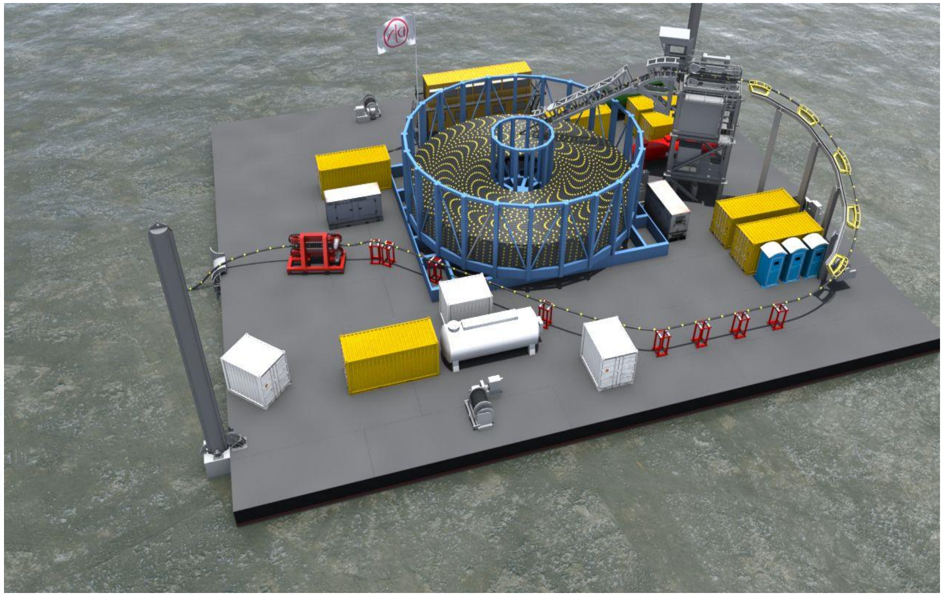
SALT MARSH TRENCHER



INTER TIDAL FLAT TRENCHER



Shallow pontoon for installation of intertidal cable



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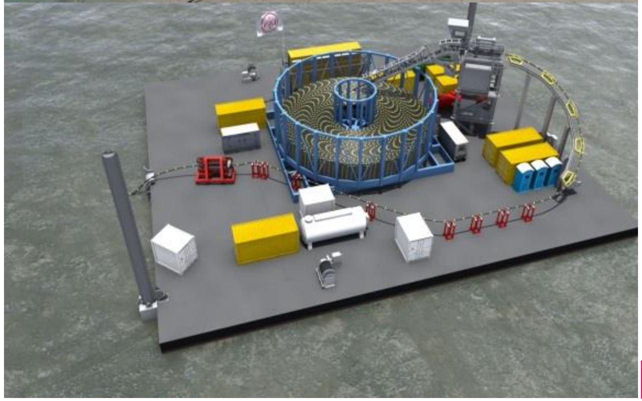
CABLE LAYING VESSELS:

WILLEM DE VLAMINGH (2 x 8 km)
DP-2, 5,400 T

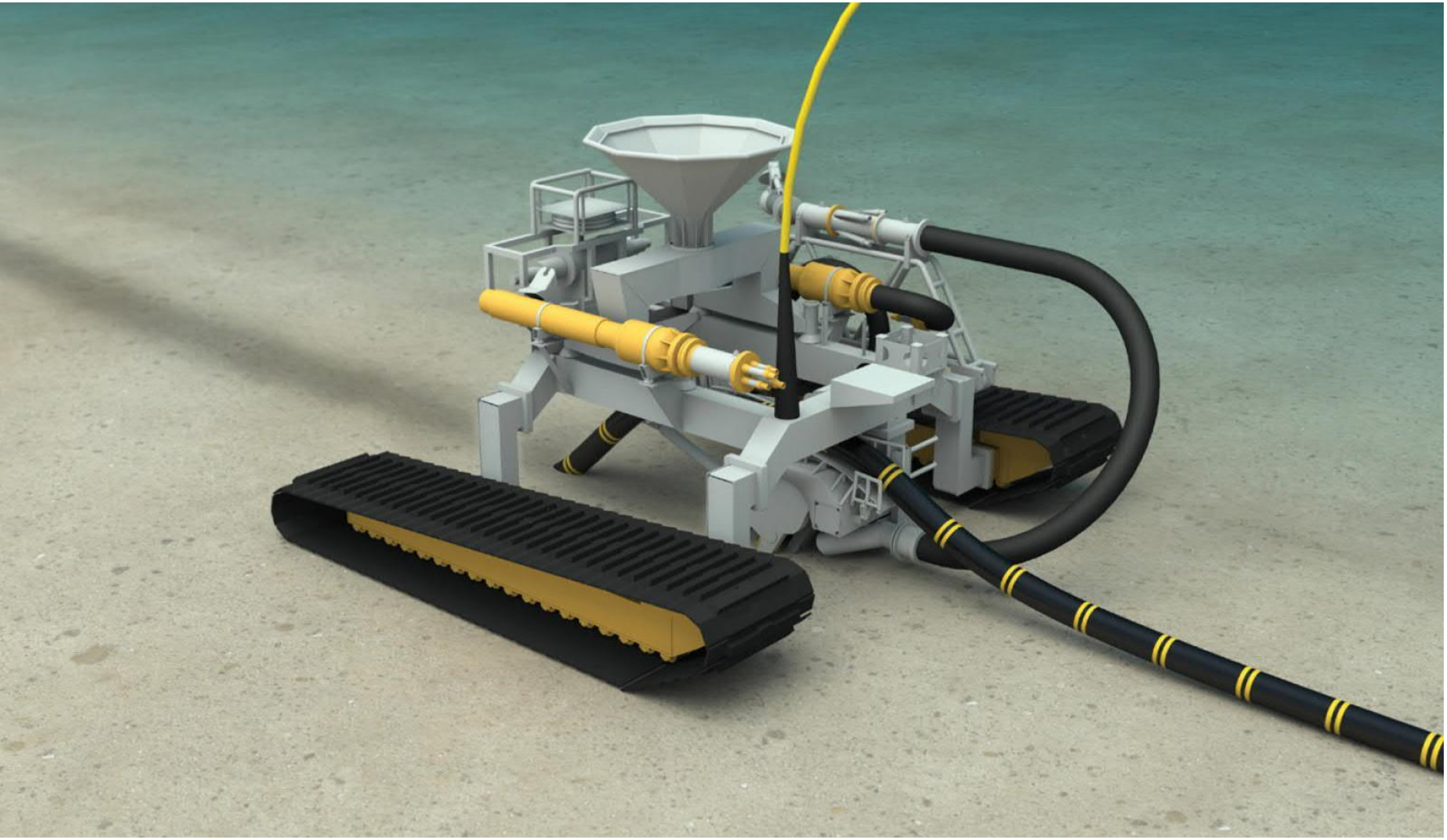
ISAAC NEWTON (2 x 63 + 6 km)
DP-2, beaching, 7,400 T & 4,500 T

PONTOON (2 x 8 km)
6p mooring + spuds



POST-LAY TRENCHING WITH UTV1200 and TSV VESSEL POMPEÏ

POST-LAY TRENCHING WITH UTV1200 and TSV VESSEL POMPEÏ



3. PROJECT REFERENCES

Thank you for your attention

- **JAN DE NUL Group**
- E-mail: info@jandenul.com
- Website: www.jandenul.com