Title document:

Outline Method Statement Submarine Export cable installation

Company:

Van Oord Offshore Wind Projects bv

Client:

Typhoon Offshore B.V.

Project Name:

Gemini

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1 Introduction

Van Oord Offshore Wind Projects bv and Typhoon Offshore B.V. have established a Framework Agreement to develop the Gemini project. The Gemini project consists of the offshore wind farms Buitengaats and ZeeEnergie. The wind turbines are capable of producing 300 MW of electricity per wind farm. The two wind farms are located approx. 60 km north of the islands of Schiermonnikoog and Ameland in the Dutch Exclusive Economic Zone (EEZ) next to the German border, see Figure 1.

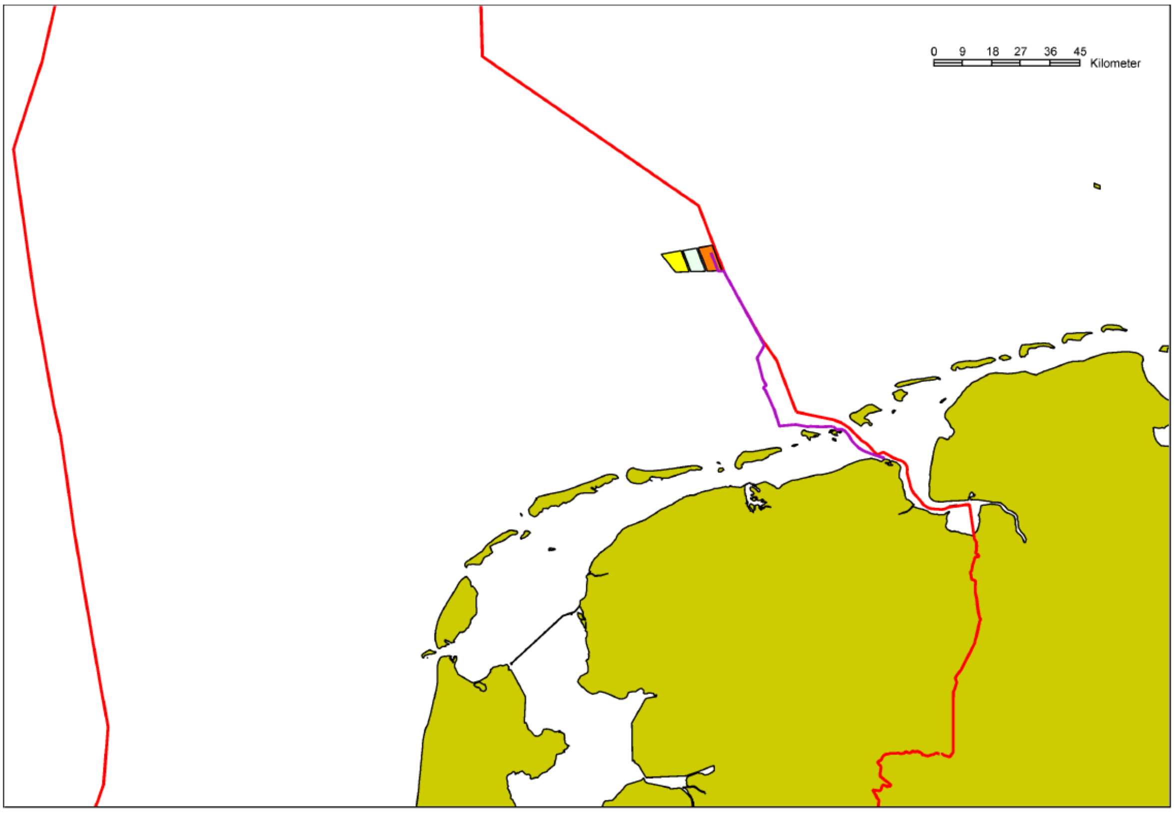


Figure 1: Overview of the German and Dutch EEZ, showing the location of Buitengaats (orange) and ZeeEnergie (yellow).

The electricity produced by the wind turbines will be transported to the two HV AC substations of both wind farms through 33 kV AC infield cables. The HV AC substations are connected to each other with a 220 kV AC Submarine connector cable. The power connection to shore consists of a 220 kV AC Submarine Export cable with an approximate length of 93 for Buitengaats and 102 km for ZeeEnergie and AC Land Export cable of approximately 5 km. At the onshore AC transformer substation in Eemshaven the power is transformed into 380 kV AC. After this the power is supplied via a 2 km long 380 kV AC grid connection cable to the grid station Oudeschip of TenneT.

The Van Oord scope in this project comprises the engineering, procurement, construction and installation activities related to scope of work except for the supply of the WTGs.

2 Scope of the Method Statement

The purple line in Figure 1 shows the cable route which has been approved by Rijkswaterstaat (RWS) in the WBR-permit. Since this route has a number of challenges (e.g. dredging and sedimentation) alternative routes have been investigated.

This method statement provides the outline for the installation method of the AC Export cable of the Gemini project for the cable route along the Ballonplate. This AC Export cable will transport the power from the offshore platforms to the onshore station in Eemshaven.

2.1 Export cable

The export cable will be an AC cable of 220 kV, 1 per windfarm. The cables will be installed next to each other with a minimal clearance of 5 m due the thermic influences and to reduce the risk of damage while installing the cables.

2.1.1 Two AC cables 220 kV

The outer diameter of the cables will be around 230-270 mm and the internal cores will be between 800 and 1200 mm^2 (values based on copper cores). An Optical Fibre cable is already incorporated inside the cable. The core diameter of the export cable will vary along the export cable route. For indicative sizes, see table below.

2.1.1.1 Typical dimensions

Figure 2: Typical HVAC cable

Section	Route length [Km]	Installation depth [m]	Conductor cross section [mm^2]	Cable weight in air [Kg/m]	Outer diameter [mm]
KP 0 - KP 15.4	15.4	3	800/1000	100-130	230-270
KP 15.4 - KP 37	21.6	Between 1.6 and 12	800-1200	100-130	230-270
KP 37 - KP 93/102	56-65	1	800/1000	100-130	230-270
Between platforms	11	1	500	80-100	210-230

Table 1: Preliminary values export cables

2.1.1.2 Transport of cables from supplier to port

The Export cable will probably be supplied in five sections, depending on the cable supplier and storage capacity on the installation vessels. The sections are, excl. overlength:

- Section 1: 2 times 15.4 km cables for the shallow water part,
- Section 2: 2 times 21.6 km for the near shore part,
- Section 3: 2 times 30 km for the offshore part,
- Section 4: 1 time 26 km and 1 time 35 km for the offshore part to connect to both windfarms and
- Section 5: 1 time an offshore part of 11 km to connect the two AC platforms in the windfarms together.

When manufactured outside Europe, the cable sections are loaded from the cable supplier's yard/quay onto turntables mounted in the hold of a cargo vessel.

Figure 3: Turntable on board of transport ship

The cargo vessel will deliver the cables to a port in the vicinity of the wind farm, where the cable is either directly loaded on to the installation barge/vessel or to an intermediate storage facility. A direct load-out is preferred, but is dependent on the delivery schedule of the supplier.

2.2 Installation Methods

The installation of the Export cable along the route is split into three main sections, each with their respective cable installation or cable protection method: These sections will be joined together offshore.
The cable will cross several 3rd party infrastructures on its route. The most critical one is the NorNed cable, which will be crossed twice.

The following chapters of this outline method statement describes the different types of operations that will be required to install and protect these cables and is split in following sections:

- Shallow water section from KP 0 – KP 15.4
- Shallow water joint around KP 9
- Near shore joint around KP 15.4
- HDD KP 15.4 – KP 16.3
- Near shore section from KP 16.3 – KP 37
- Crossing NorNed cable around KP 34
- Offshore joint around KP 37
- Crossing the WesterEms around KP 40
- Offshore section from KP 37 – KP 93/102
- Offshore joints around KP 65

See below for an overview of the sections and joints.

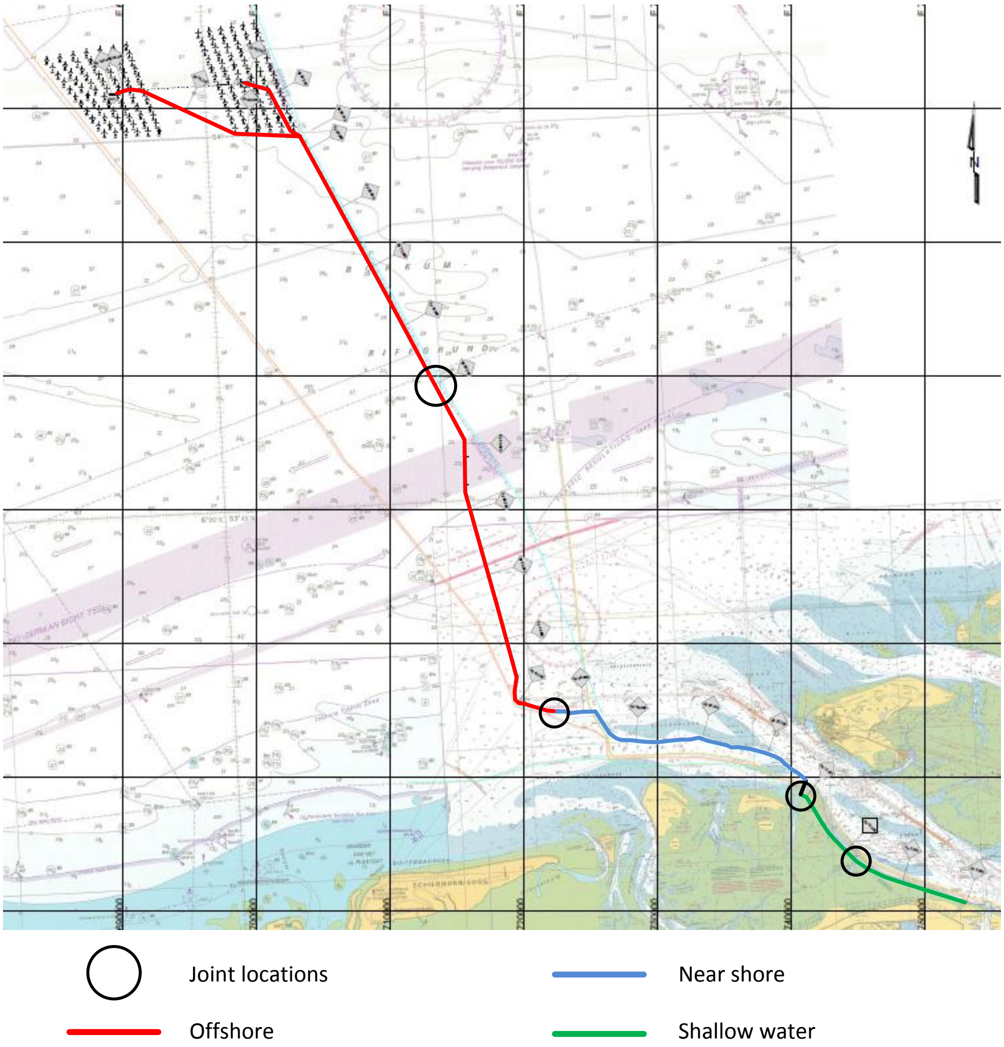


Figure 4: Overview of sections and joints along the route

2.3 Survey

Before the start of the cable installation works a pre survey shall be done. This survey shall be the reference survey for the installations works and to prove if the required burial depths have been reached in that part where dredging have to take place. Simultaneously with the execution of the works a survey will be done (e.g. with dredging and cable installation). After finishing a scope again a survey will be done, this part will be the as-laid survey.

2.4 Corridor

The route is plotted with a corridor. The corridor will give the route some space for manoeuvring to avoid unknown objects and suddenly changed seabed levels (e.g. result in lots more dredging m^3). Especially the seabed of the route above the Islands is characterized by lots of movements. The corridor will be discussed in each particular chapter.

2.5 Cable burial depth

For determining the cable burial depth along the cable route the following general rules/requirements have been taken into account (see Figure 6Figure 6 on the next page for more details):

- Inside 3 km of the LLWL the burial depth shall be 3 m (KP 0 – KP 31);
    - In morphological dynamic areas the burial depth will either be the lowest historical seabed level (25 years) or 3 m below current seabed, if this lower than the lowest historical seabed level (bury and forget strategy).

- Outside 3 km of the LLWL and inside the EDT zone (KP 31 – KP 34) the burial depth will be according the requirements of the 2 Kelvin rule. Calculations show that the burial depth should be 1.6 m to meet these requirements. Calculations are based on a 220 kV AC 3-core cable with a conductor size of 800 mm^2. This conductor size has been calculated by multiple cable suppliers to meet the electrical requirements of the cable on this part of the route.
- Outside 3 km of the LLWL and outside the EDT zone (KP 34 – HVS) the burial depth shall be 1 m;
- When crossing shipping lanes, if applicable, the burial depth shall be 3 m.

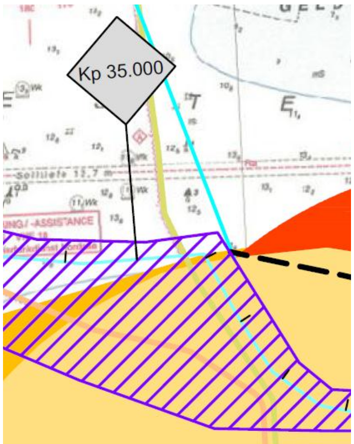
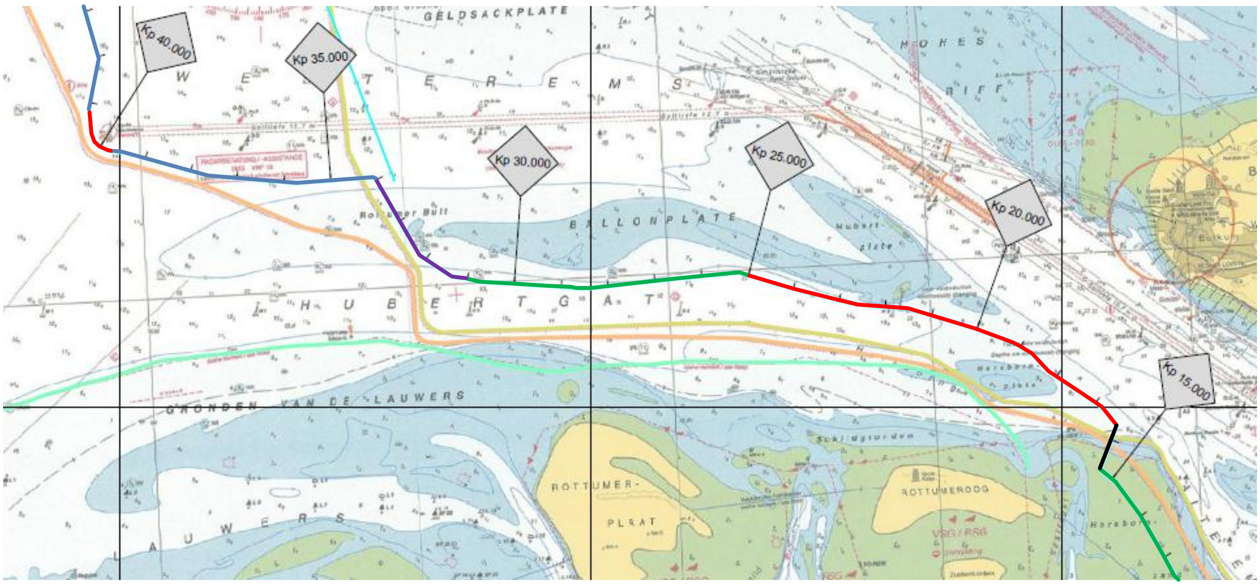


Figure 5: Border EDT zone



Burial depth 1 m below seabed
Burial depth 1.6 m below seabed
Burial depth 3 m below seabed or on historical seabed level
Burial depth 19.1 m below NAP
Cable in HDD (7 m below NAP at southwest entry point, 19.1 m below NAP at northeast exit point

Figure 6: Overview burial depths along the route

3 Cable installation Shallow water KP 0 - KP 15.4

3.1 Introduction

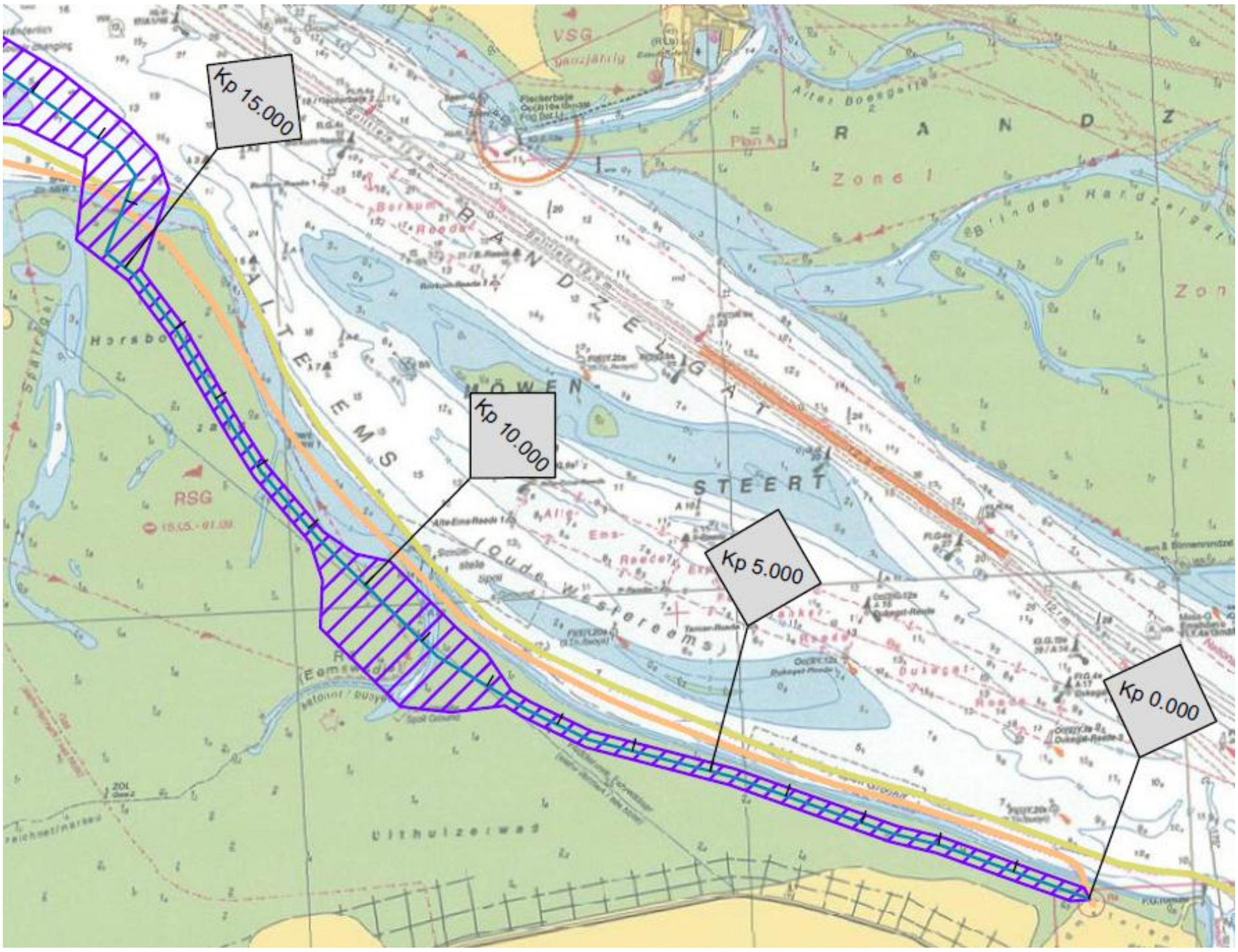


Figure 7: Cable route from KP 0 – KP 15.4

This chapter describes the type of operation that will be required to install and protect the Export cable in the shallow water section (KP 0 – KP 15.4) along the planned cable route.
The submarine cables will be jointed to the land cable in a joint pit at the landward end of the sea cable route in the Eemshaven.

In Figure 7 the route is drawn with a corridor. The corridor will give the route some space for manoeuvres to avoid unknown objects. From KP 0 – KP 15.4 the route has a corridor of 210 m, between KP 8 – KP 10 the corridor is maximum 1200 m wide. Referring to the data of 2010 – 2011 (Svasek) the depth of the Ra is LAT -9 m. The corridor will give space to move to a less deep seabed to cross the Ra with a trenching device which will prevent substantial dredging volumes, time and environmental impact.

3.2 Scope AC 2x220 kV

3.2.1 General

The near shore cable installation activities will be performed by a barge suitable for the job. This Cable Laying Barge (CLB) will need to be a shallow draught barge capable of carrying a coil of cable weighing around 2000 tonnes, suitable to carry one of the two 220 kV AC cables. It will have cable handling machinery, crew accommodation and a mooring system for manoeuvring and positioning control in the shallow water areas. It will be supported by anchor handling tugs. Read for “cable” 2 trenches with an average cable distance of 25 meter clearance. See below:

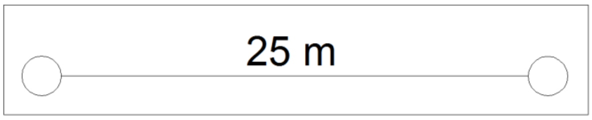


Figure 8: Average cable distance along the route

3.2.2 Mobilisation of the Cable Lay Barge

The cable lay spread will be prepared at the Port of Mobilisation. The spread will be fully equipped with all required cable lay and handling equipment, such as a dynamic turntable, tensioners, cable highways etc. in order to enable the lay of the AC Export cable. Furthermore, the CLB will be fully crewed to carry out the scope of work. All the equipment will be checked, tested and serviced. Spares on board of the spread will be checked and replenished.

Upon completion of the preparatory activities the CLB will be towed to the cable loading site/port. Here the cable will be loaded and the final mobilisation of personnel and additional equipment will be completed after which the CLB will sail to site to commence the installation of the cable. Upon completion of the installation works of the first cable, the CLB will return to the cable loading site/port for loading and subsequent installation of the second cable. Upon completion of the installation works of the second cable the barge will be towed back to port where it will be demobilised or used for the cable laying of another section.

3.2.3 Loading the cable onto the CLB

In the loading port the cable will be spooled directly from the transport vessel or from a possible intermediate storage onto the dynamic turntable mounted on the shallow water CLB.

Figure 9: Cable on board an installation barge with dynamic turntable

Figure 10: Cable on board a shallow draught installation barge

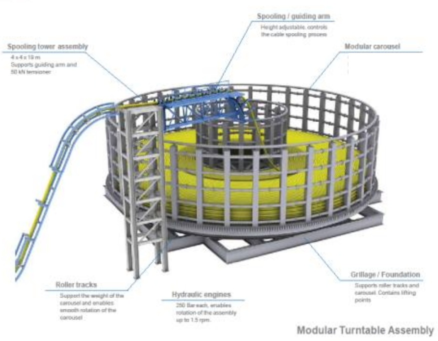


Figure 11: Dynamic turntable

3.3 Cable installation with a CLB

3.3.1 Cable Installation

3.3.1.1 Preparation works and initiation at Transition Joint pit

Prior to the arrival of the CLB the cable joint pit will be made at the landward side of the dyke near the "Borkumkade" in Eemshaven.

Planning for the work will include selection of a suitable weather and tidal window that will allow the Export cable to be installed safely into the joint pit in a continuous process.

A cable hauling winch will be placed behind the joint pit. Temporary barriers will be erected to protect all of the work areas for the duration of the works. Local vessels will be informed about the schedule for any temporary access limitations to the work area.

The CLB will position itself using its anchor handling system between 300 and 400 m offshore of the joint pit depending on the draught of the CLB. The anchors will be placed using Anchor Handling support vessels. Communication links to the shore will be established.

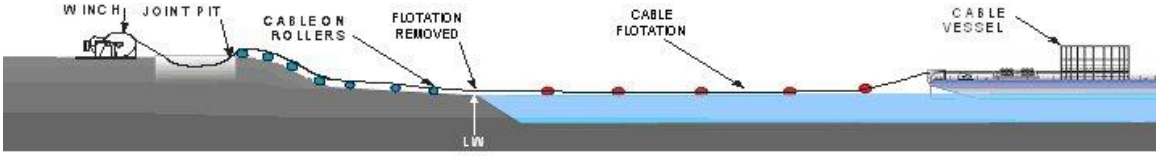


Figure 12: Cable initiation at joint pit, side view

With the CLB in position, work will commence at High Water (weather permitting). First the pull in wire will be connected to the cable end on board the CLB. The shore winch will then commence hauling the cable from the barge towards the shore. As the cable leaves the barge, floats are attached to prevent the cable to drag on the seabed. As the cable end approaches the low dyke the floats are removed and the cable is transferred onto temporary rollers, specially made to accommodate the cable, to cross the dry area in front of the jointing pit on the dyke. The pull continues until the cable is and at the winch. At this stage the cable can be lifted from the cable rollers and any remaining offshore floats will be removed.

Figure 13: Detail of temporary roller

Figure 14: Cable on rollers

According to the results of the site investigation (*Ref: MN-00397_RoutesurveyBard_Report_Rev1.pdf*) it is not expected that tracked land based equipment will have problems working on the drying areas.

3.3.1.2 Installation of the cable

Once the shore landing has been completed and the cable is secured, the installation along the remainder of the shallow water route can commence. In this case for the first 15.4 km of the route there is insufficient water depth for the CLB to transit directly over the cable route while paying out the cable. Instead the barge will transit a parallel route along the edge of the nearby channel where there is sufficient water depth to allow the barge to remain afloat. The cable will be hauled and floated to the dry area from the barge. An indication of the distance from the barge with a draught of 3 m to the drying areas and to the cable route is shown in the table below.

On the "dry" area the floats will be removed. The cable will then be supported and directed onto the correct route using tracked vehicles carrying cable guides. These vehicles will transit along parallel with the installation vessel supporting and directing the cable onto the cable route, with the use of GPS, in the drying areas during LW periods. The distance between the tracked vehicles will be approx. 50 m. Detailed calculations will be done to determine the distance more precisely and with which tension the tensioners will keep in position. Calculations can be performed, once cable specifications are available.

In the table below, due to the draft of the CLB, the different distances from the CLB to the cable route are shown.

KP	**0-8**	**8-15**
Floating distance	75 – 265 m	80 – 600 m
"Dry Area" distance	220 – 450 m	150 – 850 m
Total distance	360 – 530 m	270 – 900 m

Table 1: Approximate barge distance to cable route for CLB with 3 m draught

See Figure 17 for a typical anchor pattern for the CLB.

Figure 15: Cable with cable floats

Figure 16: Excavator with lifting bow, removal of floaters

During HW periods, if necessary, the vehicles can temporarily lay down the cable onto the seabed and take refuge on a ramped barge nearby provided specifically for this purpose.
To extend the tidal working window Van Oord intends to use specially outfitted land based equipment able to work in several meters of water depth.

3.3.1.3 Positioning of the CLB

The barge will be brought in position using two shallow draft support vessels. Both support vessels are equipped with the appropriate positioning system for precise positioning of the anchors. This will happen during HW periods. The positioning system comprises of DGPS receiver and computer screens for visualization. The individual systems installed on the CLB and the tugs are interconnected, allowing for real-time representation of the individual vessel movements on each location

Once the barge is in position the support vessels will lay out the anchors in a pre-designated anchor pattern taking into account local bathymetry and 3rd party infrastructure. Once the anchors are in position the CLB is able to position itself, using the winches, as close as possible to the position where the cable has to be laid. The CLB's forward speed will be approx. 600 m/LW period, depending on the detailed anchor lay-out of the CLB.

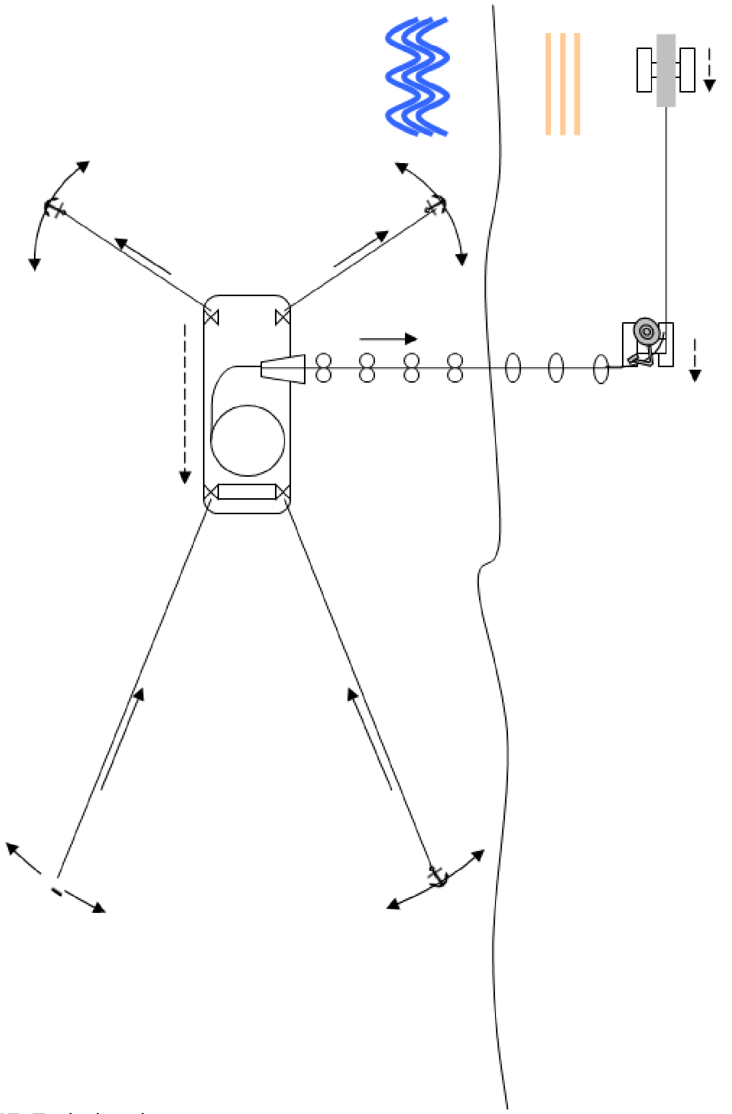


Figure 17: Typical anchor pattern

3.3.2 Cable burial

For protection from mechanical damage by external forces such as wave action, fishing gear and anchors the subsea cables will be buried 3 m below the seabed. This will be carried out using fluidisation, chain cutter or ploughing technology that minimises seabed sediment disturbance.

In the immediate cable landfall at Eemshaven (up to approx. 50 m from the dike) the cable burial work will be carried out using low ground pressure land based excavators or with a chain cutter. Care will be taken to return the seabed to its original level as soon as possible by backfilling the trench. A few tidal cycles will return the seabed to its original condition.

On the tidal flats of the cable route parallel to the channel a trenching tool mounted on a tracked excavator will be used. To increase the workable window all equipment will have elevated cabins to be able to work in several meters of water depth.

A barge with an access ramp beached on the drying area will provide refuge for the land equipment during the HW periods. The barge will be shifted by one of the Cable Lay Barge supporting vessel.

3.3.2.1 Crossing creek "de Ra"

The cable route crosses a creek called "de Ra". There are various methods to install the cable below the seabed at "de Ra". Due to the meandering of "de Ra" the burial depth of the cable will be at historical sea bed or -3 m under current level (=2011 level) in case this is deeper than historical seabed level.

Due to the meandering of the creek the corridor for this part (from KP 8 – KP 10) is 1200 m wide (see figure below). The wider corridor will provide an opportunity to install the cable at the most optimal location considering the works and impact on environment.

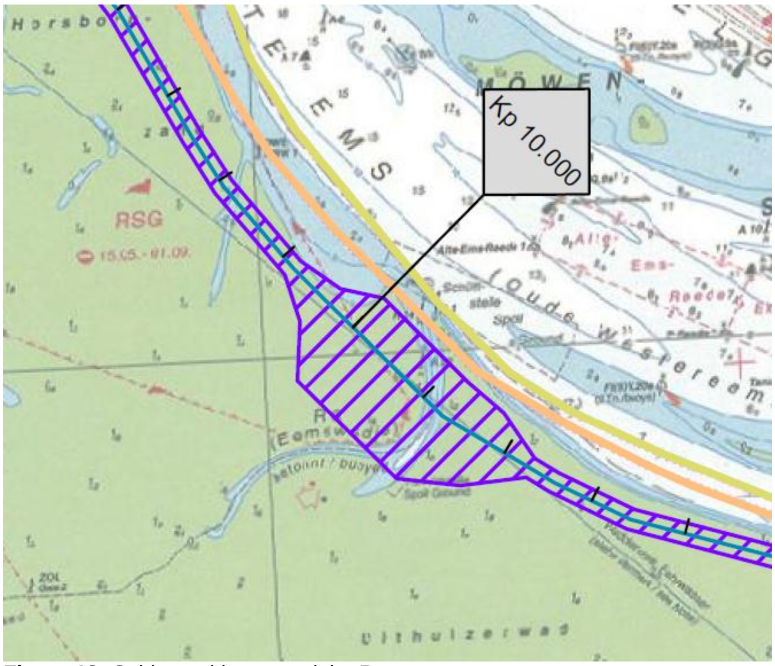


Figure 18: Cable corridor around the Ra

Based on the data of Svasek sea bottom profile (see figure below) the route can be changed to the South-West to avoid deep water depths that cannot be crossed with the trenching device mentioned in section 3.4.3.

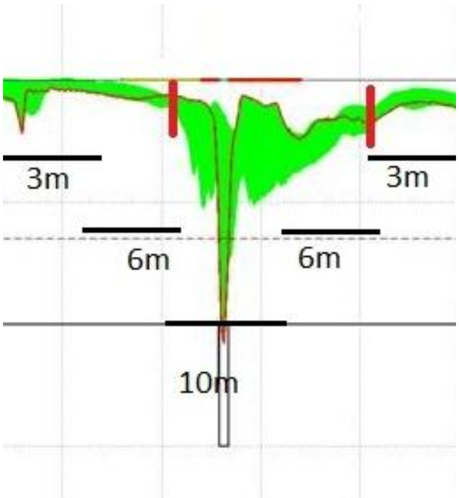


Figure 19: Sea bottom profile Ra

A burial tool will be used to trench the cable to historical depth. The challenge is to install the cable on historical known depth because of the variation in this depths. The trenching tool needs to have an adjustable variation in the trenching chute to follow the contours of the seabed.

3.4 Equipment

3.4.1 Cable Lay Barge

Van Oord intends to use a project dedicated cable lay barge for the execution of the cable laying activities. A concept layout based on 80 m x 28 m x 6 m.

This barge is fitted with following items:

- 4-8 anchor winches, the exact amount of anchor winches is to be worked out via anchor analysis/plans.
- 20 m OD turntable, this can hold the cables for the near-shore and shallow water sections.
- a loading tower, which includes control cabin, loading arm and a 10 mT loading tensioner.
- one over-boarding tensioner just before the over-boarding chute.
- one 'central' control cabin next to the over-boarding chute. This control cabin can combine the controls of the anchor winches, over-boarding tensioner and touch-down/catenary monitoring. The control cabin has displays for video footage and control systems from carousel, loading arm, tensioner, track ways for control and monitoring purposes. There is a communication interface between the turntable control cabin and the 'central' control cabin.
- Workability Hs ≤1.5 m

3.4.2 Supporting vessels

Figure 20: *Example of Anchor Handling tug*

Figure 21: *Example of Ultra shallow support vessel*

For the positioning of the barge, the anchors and cable the following typical vessels/boats can be used:

- Type Shoalbuster 2609
- Dimensions 26.21*9.1*2.6 m
- Displacement 381 mton
- Bollard pull 29 mton

- Type Ultra shallow water support vessel
- Dimensions 39*11.5*1.23 m
- winch 45 tons
- crane 240 mton

- Type Small support boats for controlling cable during cable float
- Dimensions 7*3*0.8 m

3.4.3 Cable Burial Equipment

There are different options for cable burial equipment. Below two common types of equipment have been listed. A selection has to be done yet.

Chain cutter

For the burial of the cable on the tidal flats a self-supporting cable trencher can be used which will be able to work in several meters of water depth.

Figure 22: *Typical self-supporting cable trencher*

Details of a typical self-supporting cable trencher:

- Type — Self-supporting cable trencher
- Weight — ca 82 ton
- Max water depth — ca 10 m
- Burial depth — up to 10 m
- Output — ca 485 HP
- Inner diameter — 8 m
- Dimensions / footprint — approx. 75 m^2
- Trench width — 1 m

Vibration plough

For the burial of the cable on the tidal flats an self-supported vibration plough can be used which will be able to work in several meters of water.

Figure 23: *Typical self-supporting vibration plough*

Details of a typical self-supporting vibration plough:

- Type — Self-supporting vibration plough
- Weight — ca 36 ton
- Burial depth — up to 3 m
- Dimensions / footprint — approx. 40 m^2
- Trench width — 1 m

3.4.4 Auxiliary Equipment

Land based equipment specially outfitted for working in several meters of water will be used, this to make maximum use of the tidal windows when working on the tidal flats. This type of equipment will be used at least at the landfall to excavate the trench and to guide the cable.

Figure 24: *Typical Elevated Excavator*

Able to work in to 3m of water

Details of an excavator:

- Type — Elevated excavator
- Weight — ca 60 ton
- Dimensions / footprint — approx. 72 m^2
- Trench width, if applicable — approx. 40 m

A barge with a ramp will be used if necessary for transport and shelter of land based equipment during HW.

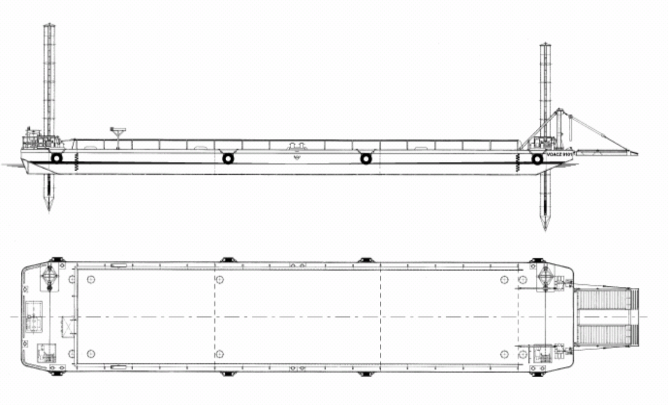


Figure 25: *Typical example of Refuge barge*

- Type — Pontoon
- Dimensions — 50,4m*8,8m*2,0m
- Cargo capacity — 474 ton (inland mark)

3.4.5 Required working space for equipment

The required working space for equipment used during cable installation is as follows:

- Cable Lay Barge — approx. 2400 m^2
- Aux tugs (2 pcs) — approx. 475 m^2 per tug
- Support boats to assist with cable float (4 pcs) — approx. 20 m^2 per boat
- Cable burial Equipment — approx. 75 m^2
- Winch + tensioner on tracks — approx. 250 m^2
- Excavators (4-18 pcs) — approx. 160 m^2 per excavator
- Rollers for cable guidance (approx. 20 pcs) — approx. 20 m^2
- Refuge Barge — approx. 450 m^2

The complete cable installation spread will move along the cable route during cable installation. The working area of the spread is depending on the distance of the CLB to the cable route. Minimum will be approx. 270 m and the maximum will be approx. 900 m distance between the CLB and the cable route. Depending on a wet or dry install method, this area will approx. be between 5000 m^2 and 35000 m^2.

4 Joints vicinity KP 9

4.1 Introduction

If the future seabed level conditions are such that it is necessary to lay the cable on the southwest side of the corridor to be able to use the previously mentioned cable trencher, it might be necessary to lay the cable between KP 0 and KP 15.4 in two parts and make a joint around KP 9 (circle below). This because it might become impossible to float the cable from the barge laying in the deeper part over 2 km to the cable route in a controlled way. In that case the cable float-in operation can be supported by the use of a modular transport vehicle with a cable drum on it and approx. 1000 m of cable (see Figure 27). That vehicle can lay the cable to the most distant part of the corridor.

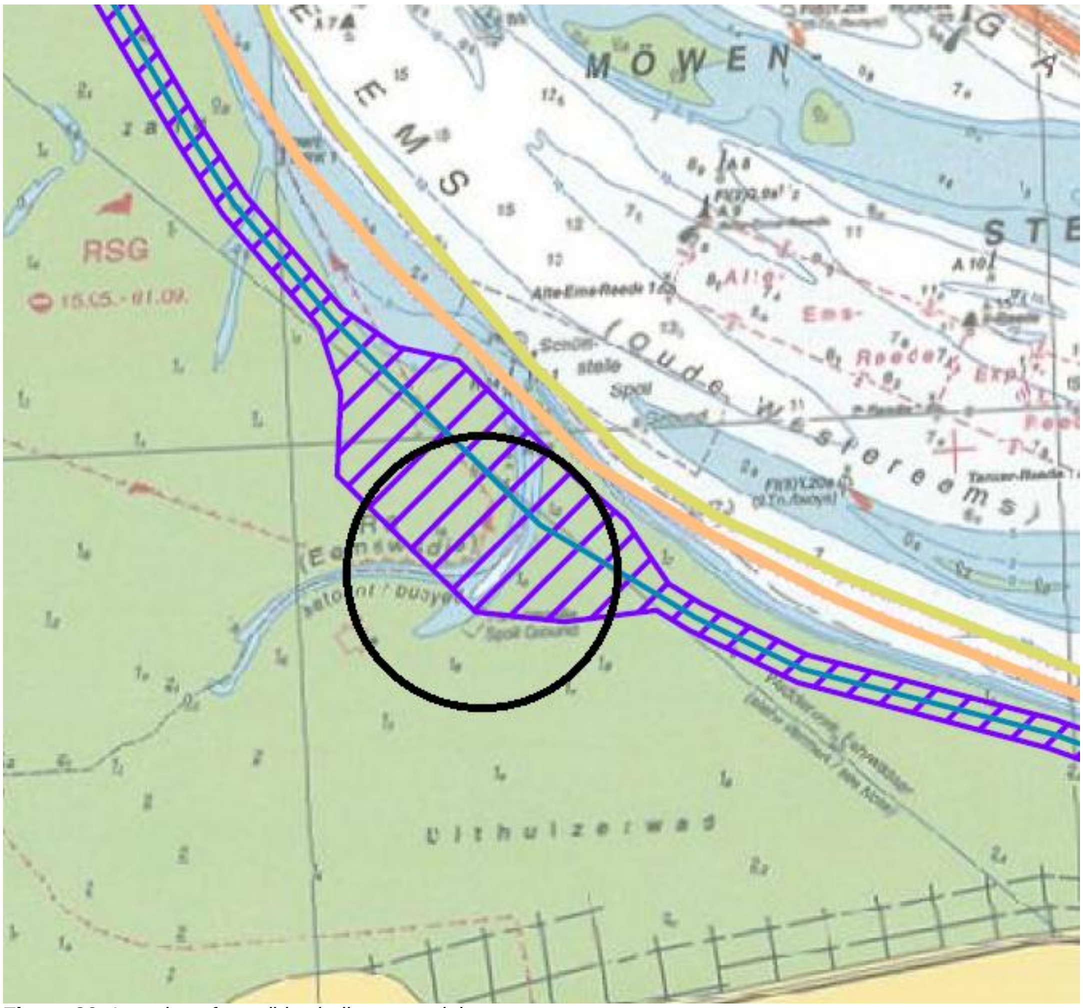


Figure 26: *Location of possible shallow water joint*

Figure 27: *Modular transport vehicle with cable drum*

Details of a modular transport vehicle:

- Type — Self-supporting transport vehicle
- Weight (empty) — ca 90 ton
- Max water depth — ca 10 m
- Dimensions / footprint — approx. 58 m^2

4.2 Jointing

Around the Ra a joint will connect both cables. Typical example of an AC joint is shown below.

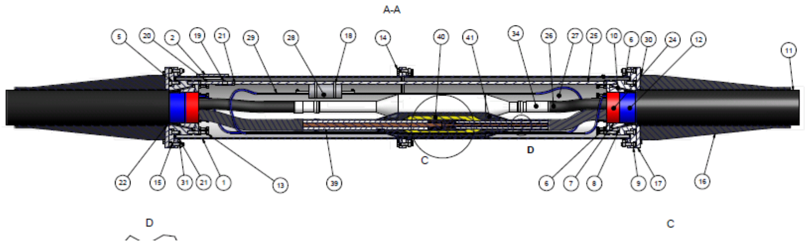


Figure 28: *Typical Example AC offshore Joint*

4.2.1 Offshore scaffold platform

The joints will be made on a scaffolding platform (see typical example below).

Figure 29: *Typical example Shallow water Jointing platform*

Such a scaffolding construction (approx. 50 x 10 x 8 m) will be made onshore and shipped to the cable jointing location. The scaffold platform will be installed with a crane at the location and fixed with ground anchors.

The cable ends of both installed cable sections will be retrieved on the platform for jointing.

4.3 Burial

After the jointing process, the joints will be laid down in the joint pit. The joints will be buried on a depth of 3 metres below seabed level to protect the joint against damage due to fishing gear, anchors and future seabed movements.

5 Crossing of Tycom and NorNed cables around KP 15.4 – KP 16.3

5.1 Introduction

The cables of Tycom (±KP 15.9) and NorNed (±KP 16.1) which have to be crossed by the export cable are located in a highly geomorphologic dynamic area, see below the crossing location. The owners of the cables are Tata for the Tycom cable and TenneT for the NorNed cable.

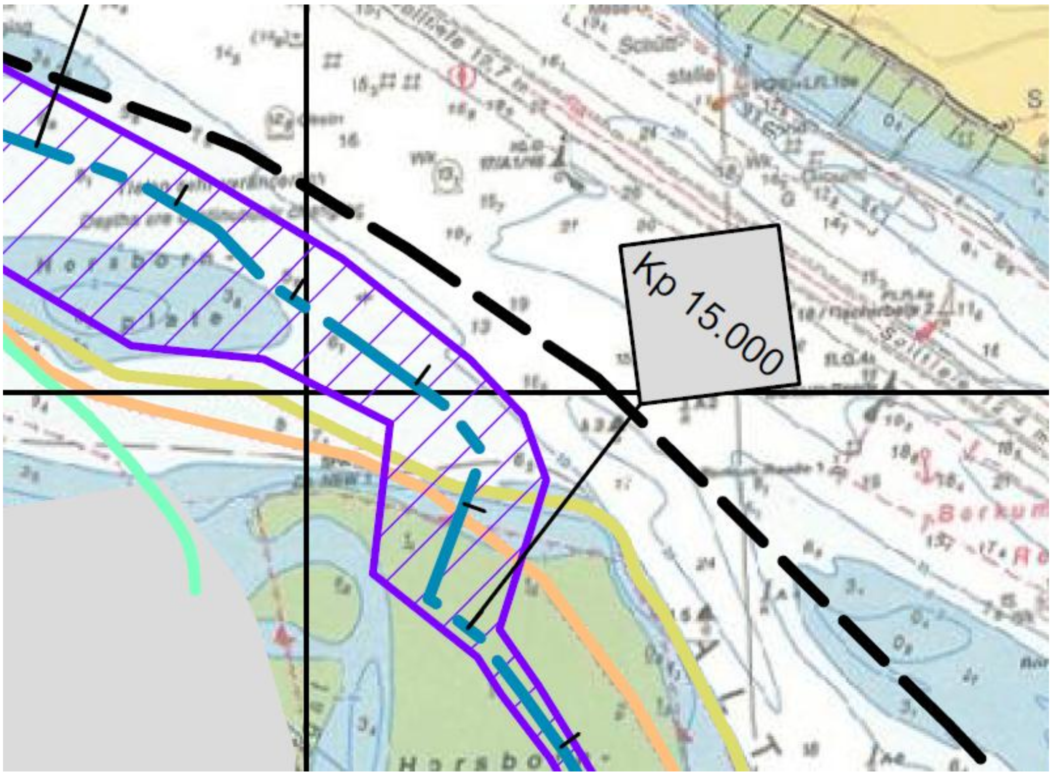


Figure 30: *Cable crossing location with Horizontal Directional Drilling*

5.2 Approach

To cross the NorNed and TyCom cables a crossing underneath those cables is necessary due to the morphological dynamic area. Gemini has learnt cables in this area have been exposed in the recent past and therefore a regular crossing on top of those cables is not a sustainable option and also not allowed by the cable owners.

To make a crossing possible in this area without disturbing the existing cables Horizontal Directional Drilling is necessary. For each of the Gemini cables a HDD will be drilled. Drilling will be preferably done from the tidal flats into the deep part, especially since directly after the HDD the cable should be installed at 19.1 meter below NAP. The drill process itself will not hamper any shipping traffic entering or leaving Emden or Eemshaven. At the end of the HDD a receiving pit will be made which might result in a minor restriction in navigational aspects in the close vicinity of the HDD exit.

During the pull-in of the lining in the drilled hole an approx. 1000 m long HDPE pipe will be brought in from north to south. This HDPE pipe, with a diameter of approx. 600 mm, has been prefabricated on shore and will be transported by a tugboat from Eemshaven to site. The use of prefabricated pipe will shorten the duration of the works and minimize the amount of equipment and personnel on site considerably. During this stage of the process navigation from and to the Huibertgat will be limited, but not blocked. The red dotted line in the next picture shows the area in which traffic will be blocked during the short period of the pull-in. Shipping traffic in the Randzelgat will not be hindered during this operation. Shipping traffic from and to the Huibertgat has enough space to manoeuvre around the working area.

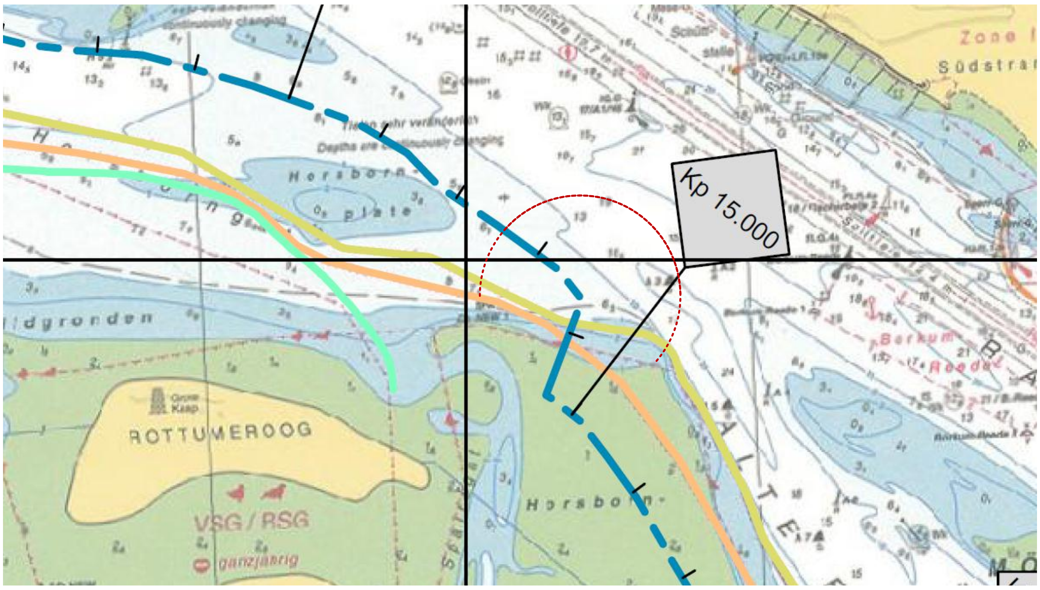


Figure 31: *Working space around HDD during pipe pull-in*

Guard vessels in the area will make sure shipping traffic is informed about the ongoing works and that both the pipe and the vessels will be protected from any accidents.

Once the pipe is in place, cable pull-in can start. The cable laying vessel will be positioned at the north side of the HDD and the cable will be pulled in to the south side. At the south side a joint to connect the cable on the tidal flats will be made.

5.3 Horizontal Direct Drilling (HDD)

The 2 separated drills will be approx. 25 m separated from each other to avoid influences of the cables on each other. The HDPE pipes will be installed at least 5 m below the cables to be crossed (Tycom and NorNed). Through these pipes the export cables will be individually pulled. The HDD process is explained in more detail in the following paragraphs.

Corridor

The corridor of the HDD area is between 900 and 1100m. The corridor of this size is used because of the known seabed changes in the past 25 years in which it should be possible to find the right locations for the HDD to make.

5.3.1 Cofferdam

A cofferdam needs to be made to prevent bentonite being spilled into the environment during drilling and providing a pit in which the joint can be installed at the required burial depth of approx. NAP - 7m.

Creating the cofferdam

The dam needs to build with sheet piles, these sheet piles will be drilled into the seabed with a vibro tool. For the work a pontoon will be installed onto the seabed on the high side of the sea to protect the work area from swell. The equipment needed for the execution of the cofferdam can work protected and with high tide the equipment can easily been moved to the pontoon/barge for safety.

When the sheet piles are installed, excavators will dig out the soil of the cofferdam and store this next to the pit.

Dimensions of the cofferdam

The sizes of the cofferdam are depending on the joint sizes and the required drilling workspace.

The dam will have the following dimensions:

Length:	approx. 30 m
Width:	approx. 70 m

Depth: approx. NAP -9 m
Length of ramps: approx. 15 m

The create stiffness to the cofferdam the structure will be executed with stabilisation structures.

Figure 32: *Typical example of a cofferdam in the shallow area*

At the end of the cable trench (KP 16.3) a pit shall be dredged. This pit is necessary to connect the reamer and HDPE pipe onto the drilling equipment during pull in. When the cable will be installed, the pit will be dredged out and, if necessary to avoid damage to the installed HDPE pipes, jetting tools shall be used instead of dredging heads.

5.3.2 Pilot-Drill

When the cofferdam is installed the HDD rig and necessary equipment (e.g. drilling fluid handling device and store facilities) will be installed on a pontoon. The pontoon will be installed to the seabed next to the site of the Cofferdam.

Once the drill rig is in position drilling will commence. The drill head direction can be adjusted to follow the predefined route (see Figure 33) of approx.1000 m.

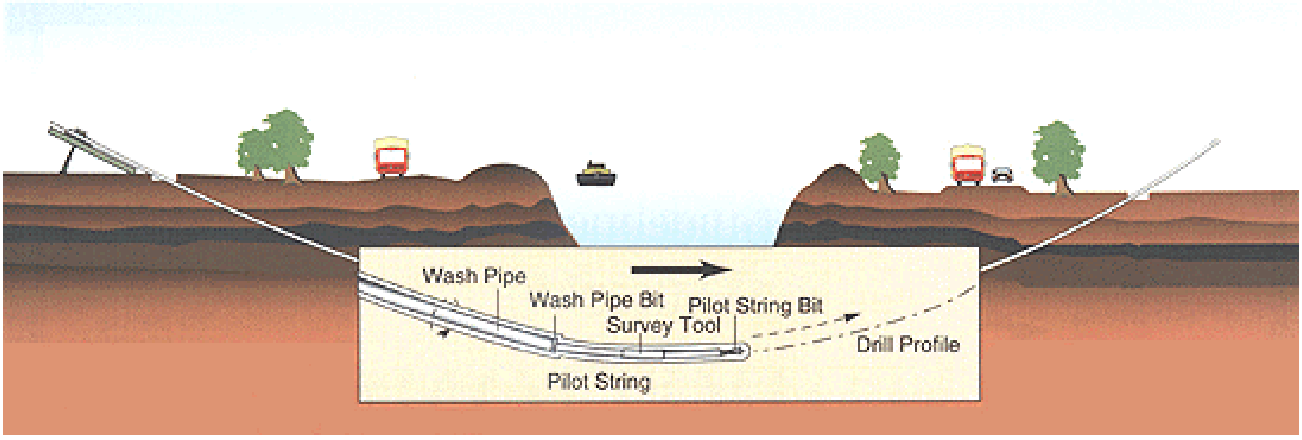


Figure 33: *Pilot-drill*

5.3.3 Reaming

After the pilot drill the bore head is exchanged for a reamer. The reamer is pulled back increasing the borehole diameter to approx. 700 mm, depending on the type of HDPE pipe and cable to be installed. This reaming process is continued with increasing reamer-size till the required borehole diameter is reached.

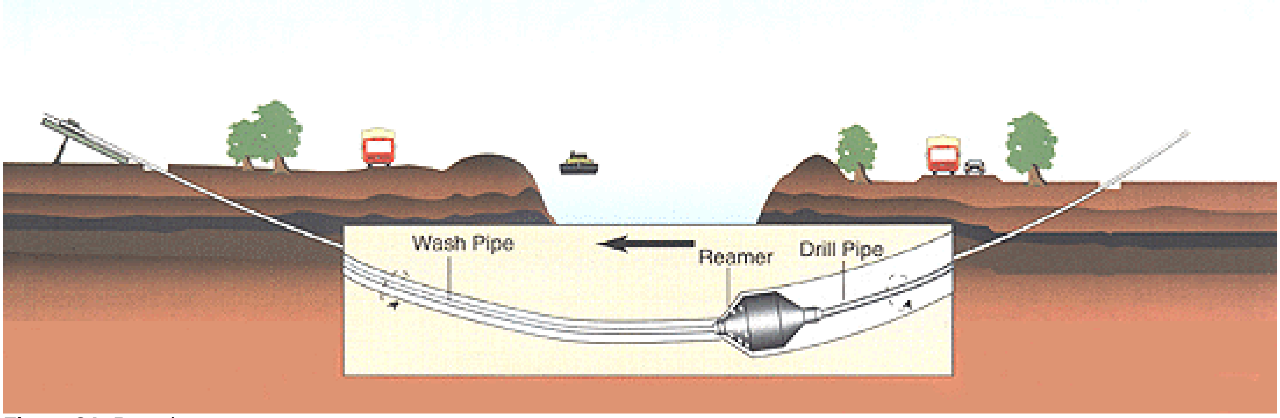


Figure 34: *Reaming process*

5.3.4 Pull-in HDPE Pipe

Now the HDPE pipes including pull wire can be installed in the borehole. The HDPE pipes will be connected with a swivel to the reamer. The reamer is pulled back for the last time pulling the HDPE pipes into the borehole. After the pull-in of the HDPE pipes, the pipes will be sealed and the HDD process is completed.

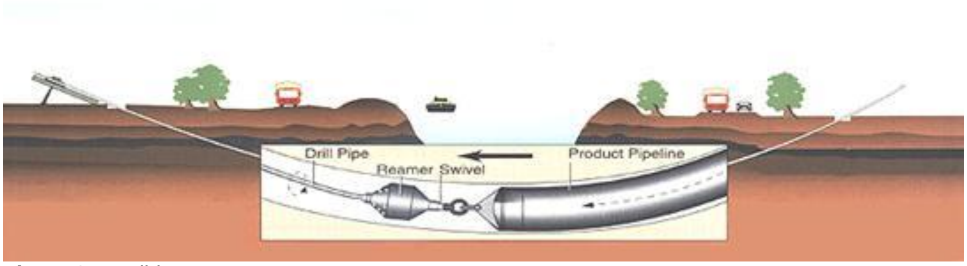


Figure 35: *Pull-in process*

5.3.5 Pull-in Export cable

To pull the export cables through the HDPE pipes the seals are removed and an individual export cable is connected by Chinese finger or pulling head to the pull-in wire. The pull wire is pulled through the HDPE pipe by a winch.

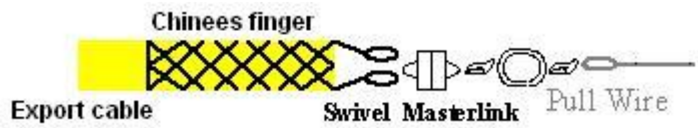


Figure 36: *Chinese finger + swivel + pull wire*

5.3.6 Equipment and Materials

Drill rig

Figure 37: *Typical example 250 ton drillrig*

- Details typical drill rig:
- Maxi-rig — 250 tractive power
- Drilling rods — 5" 4.5 IF tooljoint, length per section 6 metres
- Jet bit stainless steel — 0 280 mm (drill head)
- Drilling orientation: — Gyro measurement system.
- Fly cutter — 0 700 mm,
- Barrelreamer — 0 600 mm
- Swivel — 250 ton capacity X-overs
- Mud pump — 2.500 ltr/minute, 5" plungers
- Electric generators — 250 Kva and 150 Kva
- Mixing unit — 2.500 ltr/minute

Drilling fluid handling devices

The device makes and retrieves the drilling fluid from the extracted sand mixture. The drilling fluid is used to reduce friction on the reamer and to support the borehole for the duration of the drilling process.
The device further has a supply tank and a pump. The pump is operated from the control cabin and is fully adjustable in yield and pressure.

Figure 38: *Bentonite Mix installation*

Aux Equipment

- Several waste water pumps
- Hydraulic crane for drilling rig assistance
- Pontoon with a working space of approx. 1200 m^2

Hopper Barge

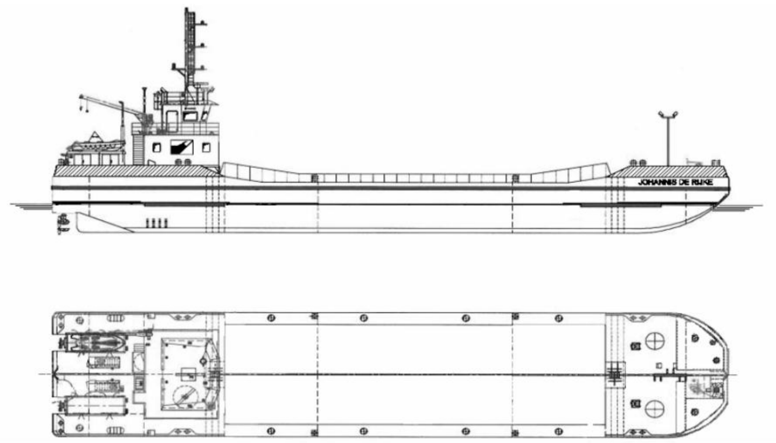


Figure 39: *Typical example of a split hopper barge*

The hopper barge will be used for the transport and removal of drilling fluid from the drilling site to the shore.

- Type: Split hopper barge
- Dimensions: 54.8*11.18*4 m
- Hopper Volume: 942 m^3
- Sailing speed: 6.5 knots
- Depth moulded: 4.15 m
- Displacement: 2,353 tons
- Workability: Hs ≤1.5 m

6 Cable trench near shore KP 16.3 – KP 31

6.1 Introduction

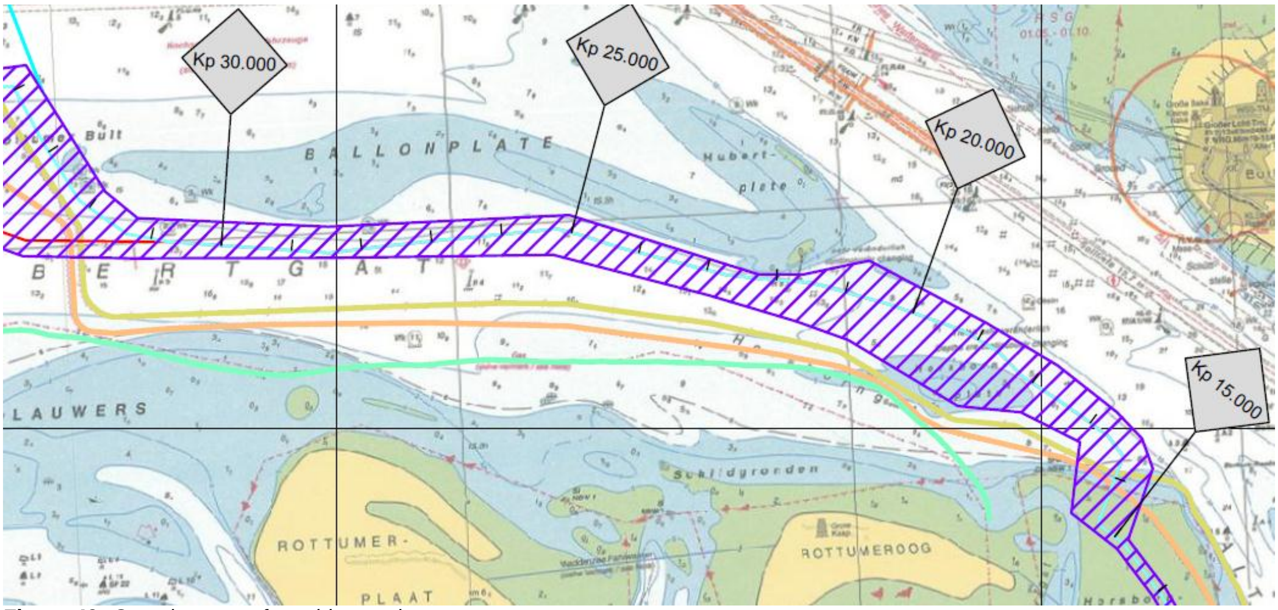


Figure 40: *Overview route for cable trench*

This chapter describes the type of operation that will be required to dredge the trench for the Export cable in the near shore section (KP 16.3 – KP 31) of the planned cable route.
The cable will be jointed at KP 15.4 to the "shallow water" cable.

Corridor
For the Near-shore part different corridors shall be used, see listed below:

- KP17 – KP21: 600 – 1200m: Required space to dredge on the slopes of the Horsbornplate. Distance from NorNed cable will be at least 200m.
- KP21 – KP23: 1200 – 300m
- KP23 – KP31: 500 – 600m: Required to avoid ship wrecks
-

6.2 Scope

The cable route between KP 16.3 and KP 31 is located in a highly geomorphologic dynamic area.
To avoid cable exposure in this area the cable has to be buried below historic seabed level (lowest level of the seabed in 25 years) or 3 metres below current seabed level if that is lower. This mitigates the need for reburial and/or subsequent maintenance work once the cable is exposed.

To be able to reach the required burial depth in this geomorphologic dynamic area it is necessary to dredge a trench. The dredging method will depend on local bathymetry and workability conditions (waves, currents etc.)

Between KP 16.3 and KP 31 (Horsbornplate and Ballonplate) has to be dredged to install the cable on the required burial depth. The slopes of the trench will be 1:5 to assure stable slopes.

As sedimentation of the trenches is expected, maintenance dredging on the trenches shall take place before the cable will be installed. The trenches will be separated 25 meters from each other (centre-to-centre), such that one trench can be maintained at the required depth while in the other trench a cable already has been installed.
See next picture for the design of the trench.

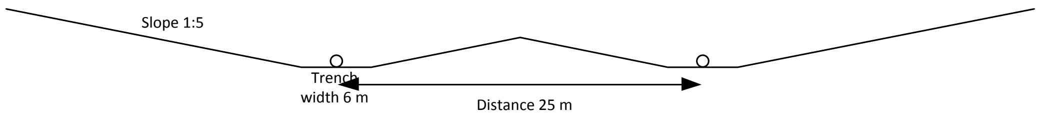


Figure 41: *Profile trench (W-trench)*

The dredged material will be dispersed in the vicinity of the trench. For the works with the hoppers it is assumed that the material can be dispersed within a distance of 1 nm.

For the cable route an indicative calculation points out a total dredging volume of approx. 6.4 million m^3 (excluding sedimentation dredging works) with the showed W-trench above.
Sedimentation on this route is to be estimated 25%, which is approx. 1.6 million m^3.

During the execution of the dredging works the trench will be continuously surveyed to verify whether the required depth of the trench has been reached.
Just before starting the cable laying process the trench will be surveyed again (re-verification).

During the installation of the first cable, the trench depth for the second cable will be maintained by TSHDs.

Based on the current seabed levels the Horsbornplate has to be crossed on the east side. However since the plate is moving along the years seabed contours might be totally different once the execution of the works start. A survey will be done at that stage to investigate the seabed contours and to determine what the best approach is to go along the Horsbornplate. That might be either crossing it at the east side or crossing at the west side if the seabed conditions allow TSHDs to work there. In order to keep both options open a larger corridor is required at this part of the route.

6.3 Crossing the Huibertgat

In case the Huibertgat is becoming the primary shipping lane instead of the WesterEms the cable has to be installed in such a way shipping traffic will experience minimum hindrance from cable installation activities. Furthermore the cable should be installed to a depth required for the shipping lane able to serve the requirements of the ports in this area.

The historical development (last 25 years) of the seabed has been investigated to ensure that the burial depth will be met along the Huibergat crossing, taking into account the uncertainty where the shipping lane in the Huibertgat will be located then.

The next picture shows the greatest depths in that area for the last 25 years. By assessing this picture the cable has to be installed 19.1 m below NAP from KP 16.3 (that is directly after the HDD) up to KP 25.

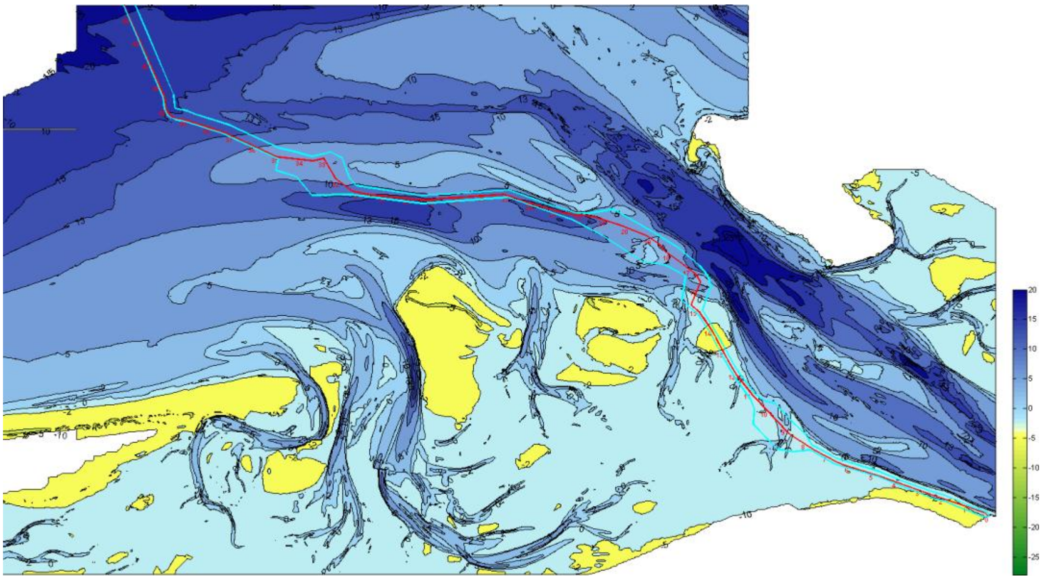


Figure 42: *Overview greatest depths in the last 25 years*

The Huibertgat will be crossed with the shortest length possible, keeping optimal dredging works in mind. With the use of TSHDs dredging can be executed in such a way that the works can be done in minimal time and the safest way. If the situation requires so, the TSHDs can easily manoeuvre away from the working site.

The corridor around the Huibertgat has been chosen in such a way that crossing the Huibertgat can be done with minimal impact on the shipping traffic, if it is the primary shipping lane at that time.

The crossing will be performed by choosing the most optimal solution with respect to the navigational, environmental and economic aspects during installation and operation.

6.4 Equipment

The type of equipment that can be used for the dredging of the trench depends on the local bathymetry, dredging volumes and local workability conditions. Different types of Trailer Suction Hopper Dredgers will be deployed (very small to medium size).

6.4.1 Trailer Suction Hopper Dredger (TSHD)

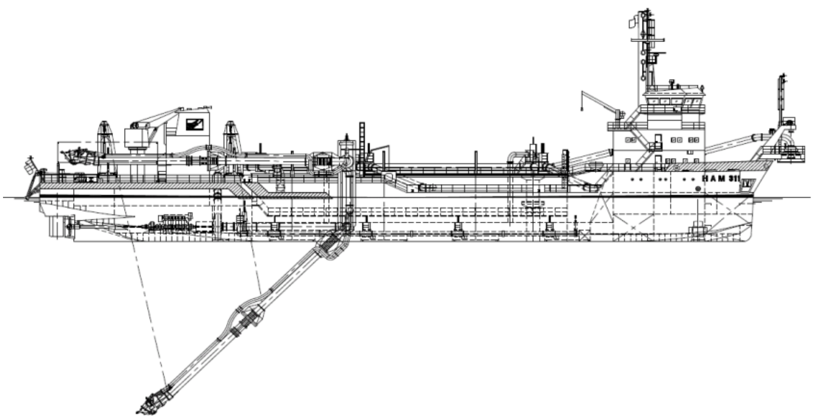


Figure 43: *Typical example Trailing Suction Hopper Dredger*

Typical dimensions (TSHD)

- Dimensions 94m x 16m x 5.68
- Hopper Volume 3700 m^3

• Sailing speed	11.5 knots
• Dredging depth	27.5 m
• Displacement	7407 tons
• Workability	Hs ≤1.5 m

7 Cable installation near shore KP 15.4 – KP 37

Various installation methods will be used for this stretch with a total of 21.6 km. These will be explained in the following paragraphs.

7.1 KP 15.4 to KP 31

If the required depth has been achieved the cable installation process will start. During the installation of the cable, touch-down monitoring will be used to guarantee the cable is at the required depth and in the right position.

After the installation process of the cable(part) a post-lay survey will be done to register the exact location and depth (x, y and z coordinates) of the cable.

Around KP 16.3 the cables shall be connected to the winglines which are installed into the HDPE pipes. The winch in the Cofferdam shall winch the cables through the HDPE pipes. Once the cable has been pulled through the HDD cable laying will start. The CLV will continue to KP 37 and will install the cables separate into the pre dredged W-Trench until KP 31. From that point on the cables will be laid onto the seabed and trenched afterwards to the required burial depth.

7.1.1 Backfilling

The trench will be backfilled again to protect the cables for external influences. This will be done partly by dispersing sand in the trench again by a hopper (approx. 1 m sand coverage) and partly by natural sedimentation.

7.2 KP 31 to KP 37

The cables will be installed onto the seabed with a Cable Lay Vessel.
Before the cable installation starts a pre-lay grapnel run will be executed to avoid hitting unknown objects during installation. The cables will be controlled spooled of the turntable with a horizontal clearance of approx. 25 m between the both cables. After the cables are laid onto the seabed a ship with a ROV/jetting sledge, with jetting swords of approx. 2 m, will install the cables to -1.6m below seabed between KP 31 and KP 34. This is due to the 2 Kelvin rule set by the German Authorities and consequently the cable is also directly protected against anchors, fishing net, etc. From KP 34 tot KP 37 the cables will be installed to -1 m below seabed.
The cable installation equipment will be controlled, supported and dragged with a ship.

For more details on the cable installation see chapter 11.

7.2.1 Corridor

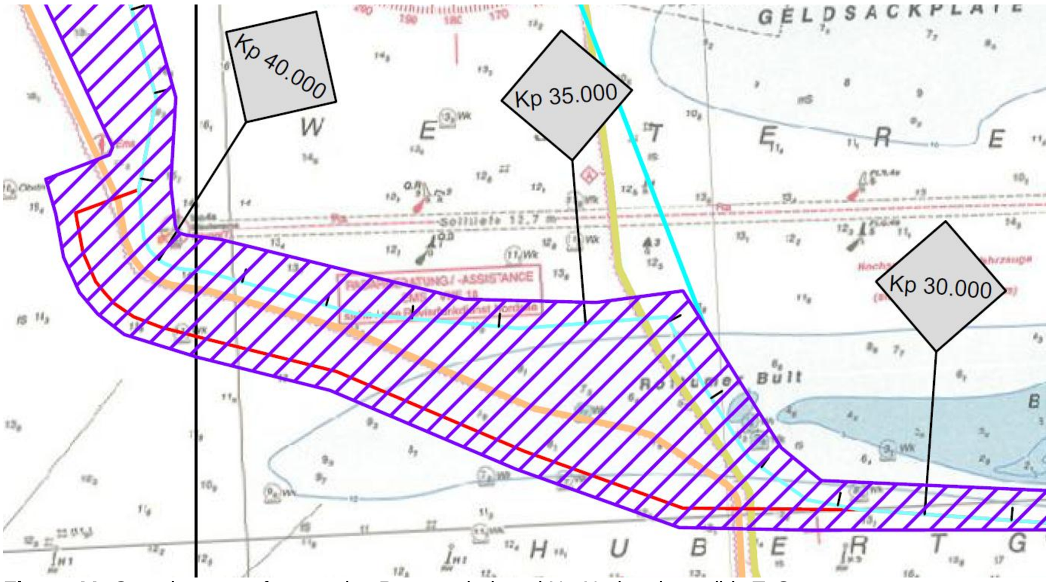


Figure 44: *Overview route for crossing Rottumerbult and NorNed and possibly TyCom*

In the 6 km between KP 31 – KP 37 various are being applied for due to the uncertainty in the exact locations of known and unknown wrecks, the crossing of 3rd party cables and minimal parallel distance to these cables.

- KP 31 – KP 37: 500 – 2700 m: Required to avoid ship wrecks, the shallows of Rottumerbult, to cross the NorNed and possibly TyCom cable and to keep distance from the TyCom and NorNed cable.

The light blue line indicates the preferred route. The red line shows an alternative if the route between KP 32 and KP 34 turns out to be impossible.

8 Joints vicinity KP 15.4

8.1 Introduction

In the cofferdam around KP 15.4, used for the HDD, a joint has to be made to connect the near shore and the shallow water cable ends.

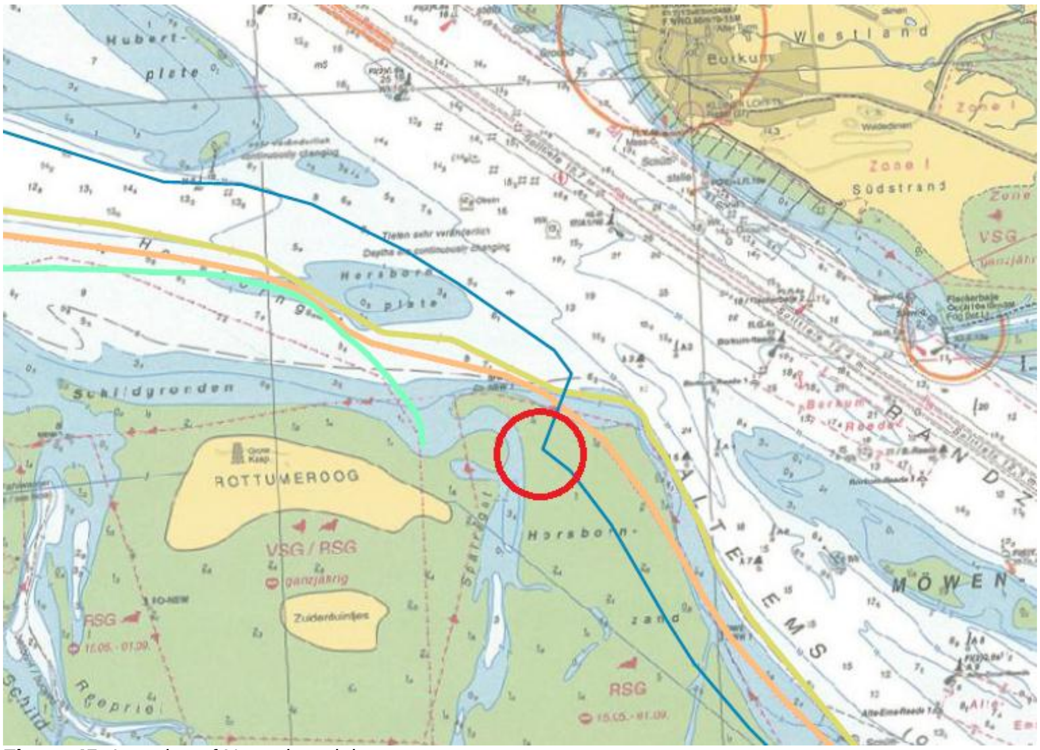


Figure 45: *Location of Near shore joint*

8.2 Jointing

At the transition of the near shore route to the shallow water route a joint will connect both cables. Typical example of an AC joint is shown below.

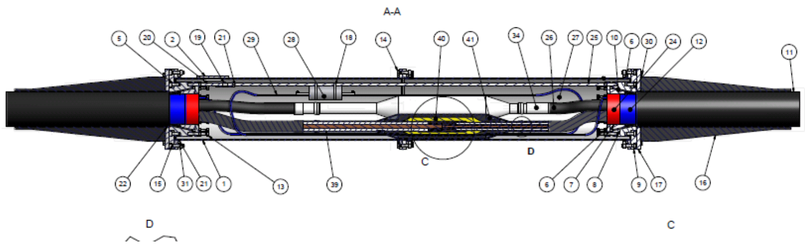


Figure 46: *Typical Example AC offshore Joint*

8.2.1 Offshore platform in or next to the Cofferdam

The joints can be made on a scaffolding platform installed into the cofferdam or on a pontoon. This depends on the seabed conditions at that time and the exact construction of the cofferdam.

8.3 Jointing

The cables of the near shore cables will be lead from the HDPE pipes to the top site of the jointing platform approx.4m above the ground level of the cofferdam. Also the cables of the shallow water route will be lead to the point of jointing onto the platform. The joint will be placed onto the platform and will be installed with the both cables.

8.4 Burial

After the jointing process, the joints will be laid down in the joint pit in the cofferdam. The joints will be buried on a depth of 7 metres below 2011 seabed level to protect the joint against damage due to fishing gear, anchors and future seabed movements.

9 Crossings of cables between KP 32 and KP41

9.1 Introduction

A regular crossing with a rock installation (over the cable) will be used to cross the NorNed cable.

The picture below shows the preferred crossing location (red circle in Figure 47). However, if crossing Rottumerbult (shallow water) between KP 32 and KP 34 in combination with avoiding the ship wrecks over there turns out not to be possible in the future an alternative in the red route has to be taken. The red route is not preferred, due to the increase in cable length and additional crossings of the TyCom cable (orange-pink line).

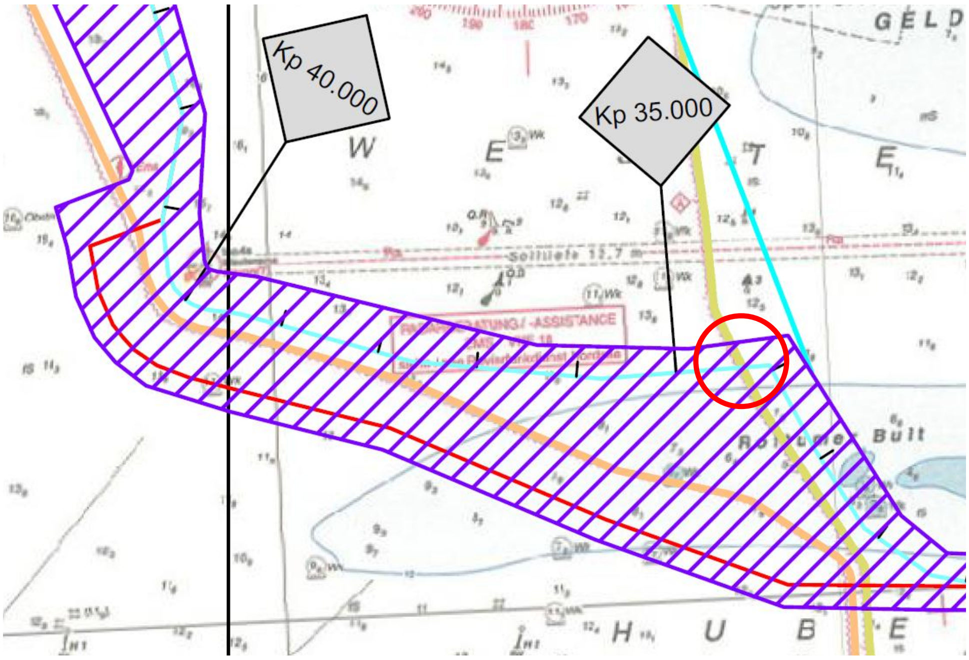


Figure 47: *Crossing NorNed cable at KP 34*

Alternative crossing locations is:

1. with additional crossings of the TyCom cable:
   a. one in combination with crossing the NorNed cable to the south of the preferred location and
   b. one for crossing the TyCom cable back between KP 37 and KP 41.

See the next picture for the alternative. The crossing locations are indicative.

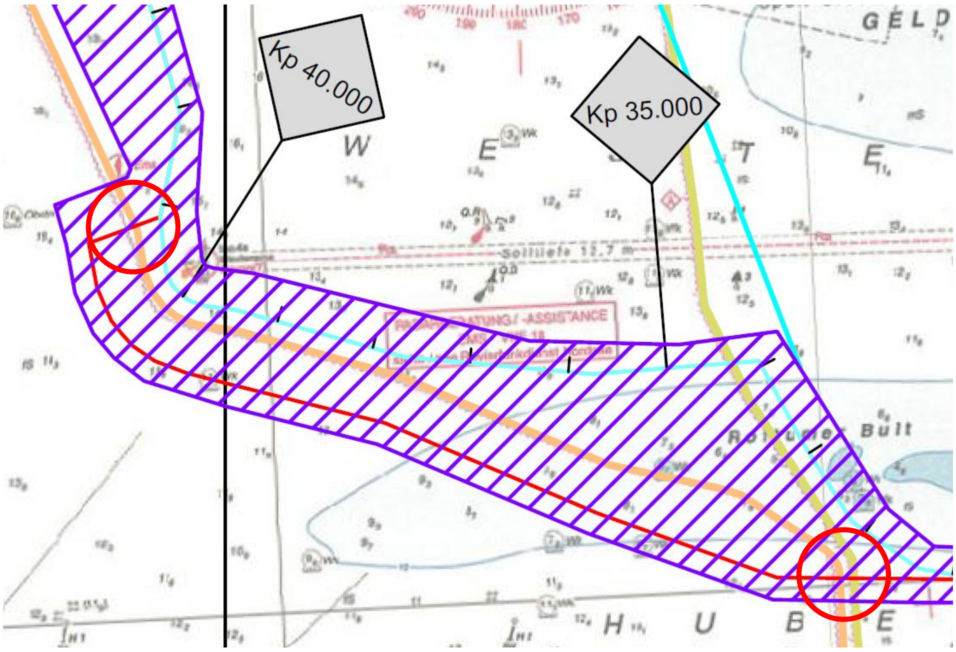


Figure 48: *Alternative crossing locations*

If the alternative route has to be used this will lead to two additional crossings (over the TyCom cable) per cable.

9.2 Rock installed crossing

A crossing method, with respect to the International Cable Protection Committee Standards, will be worked out in detail and send for approval to the owner of the cable. In order to separate both cables a layer of rocks will be used.

9.2.1 Pre-Survey

Before rock installation an in-survey will be made. The exact coordinates, depths and dimension of the crossing location will be defined.

After evaluating the pre-survey data, a cable protection installation plan will be made.

9.2.2 Rock installation

The vessel will be manoeuvred to the start position of the rock installation location and the current will be measured at 10 metre intervals along the vertical. If the existing cable is laying close to the surface a pre-lay rock layer will be installed on the seabed level. The NorNed cable is buried under seabed and will be deepened. The minimal gap between the crossed cable and the export cable should be at least 0.5 m.

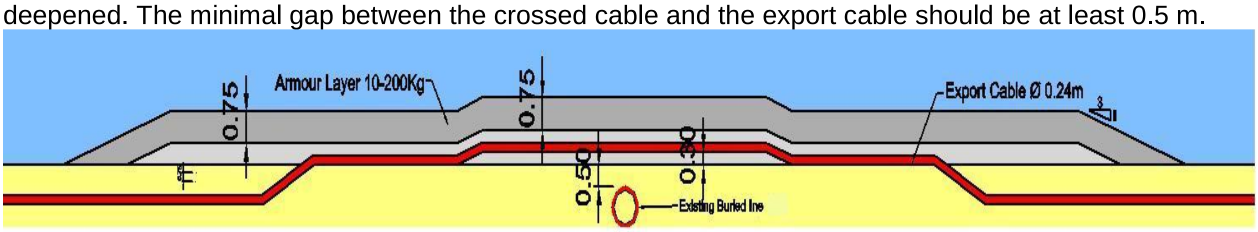


Figure 49: *Typical example cross section standard crossing of cable*

After the Export cable is laid directly onto the seabed or onto the preinstalled rock layer a cushion layer of small rocks will be installed onto the Export cable to protect the cable from the impact of the armour rocks. The rock installation crossing protection will be completed by the installation of the post-lay armour rock layer.

9.2.3 Post-Survey

After completion of the rock installation a post-survey will be performed.

9.3 Equipment

9.3.1 DP Side Stone installation Vessel

A DP Side Stone installation Dumping Vessel can be used for the installation of the subsea rock materials.

Figure 50: *Typical example of a side stone dumper*

The specifications of the DP Side Stone Dumping Vessel “HAM 601”

- Length 62.5 m
- Beam 15.8 m
- Draught 3.0 m
- Loading Capacity ~950 tonnes
- Propulsion 2 * 625 kW

10 Joints vicinity KP 37

10.1 Introduction

In the vicinity of KP 37 a joint is planned to make the connection between the near and offshore cable.

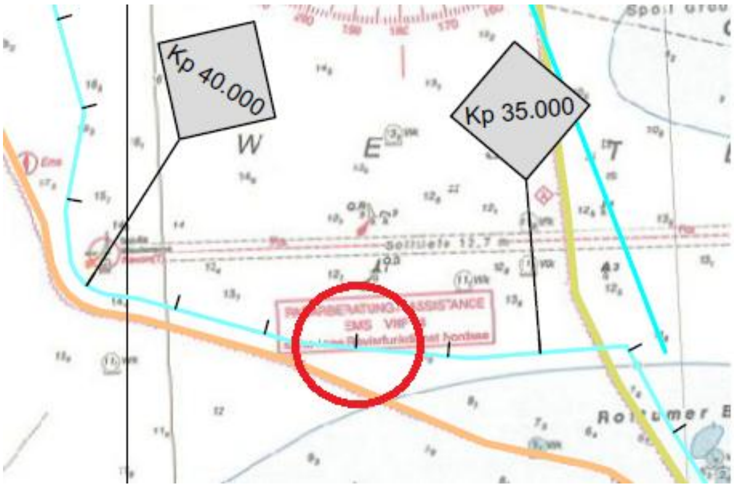


Figure 51: *Location of the Near shore – Offshore joint*

10.2 Scope

At the transition of the near shore route to the offshore route (around KP 37) a joint will connect both cables. The joint will be buried by using the earlier mentioned burial tool or in a pit with a volume of approx. 50m^3 1 metre below the seabed level, this for protection against fishing gear and anchors. The pit will be made by using a jetting tool.

The near shore joint will be made on a dedicated cable lay vessel (CLV) or jack up barge.
If a vessel is used, it will be respectively on DP or anchored on its mooring system in order to provide a stable platform during the jointing process. Upon positioning at the joint location, the end of the 'near shore' cable will be retrieved and subsequently the cable end of the 'offshore' cable will be retrieved on board of the CLV or jack up barge for jointing.

11 Cable installation offshore KP 37 – KP 93/102 and Connector cable

11.1 Introduction

This chapter describes the type of operation that will be required to install and protect the Export cable in the offshore section (KP 37 till KP 93 (Buitengaats)/KP 102 (ZeeEnergie) of the planned export cable route and the connector cable between the AC platforms within both windfarms.

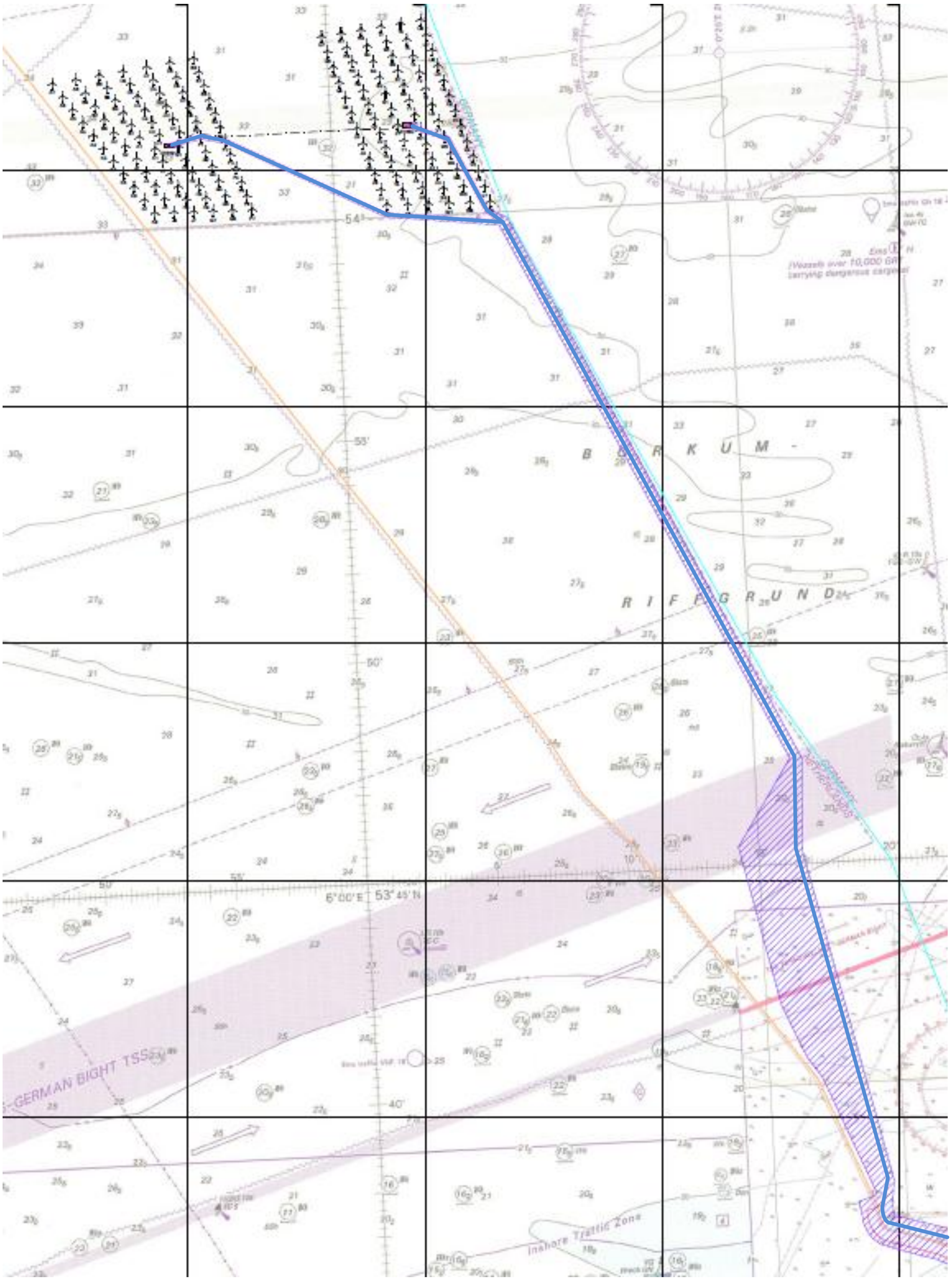


Figure 52: *Offshore export cable and connector cable route*

Note: The below described method assumes starting offshore at the Platform working towards the joint at KP 37.

Starting with the first end pull-in at the Offshore substation the cable will be laid through the Buitengaats wind farm. Further on the route to shore several live or out of service cables and pipes will be crossed. Out of service cables will be attempted to be cut and moved aside to create a corridor for the export cable, this will be done during a pre-lay-grapnel-run operation along the cable route. Live cables will be crossed by a rock berm.

While laying, special care will be taken when crossing the offshore traffic lanes and port approaches.
The end of the offshore cable will be jointed to the near shore cable end. The burial of the export cable will commence directly after the laying has started to minimise the exposure time of the cable on the seabed.

While laying the connector cable between both the AC platforms special care will be taken with other installation activities, e.g. the installation of Infield cables and WTGs.

11.2 Scope

The installation procedure will take place in the following order.

11.2.1 Survey

A bathymetric survey for the **complete** cable route will be carried out prior to start of works. The final cable lay route will be based on this survey.

11.2.2 Pre-lay grapnel run

A de-trenching grapnel will be used with a penetration of approximately 1 metre. The grapnel is a type of anchor designed for de-trenching work. Once the grapnel is on the sea bed, the forward motion of the workboat forces one of its' two narrow flukes to penetrate into the sea bed, ripping a narrow trench along the cable route. The de-trenching grapnel is connected to the tow line of the workboat at a distance of typically three times the water depth. The weight of the grapnel anchor is approximately 1250 kg. This will be done on both export cable routes (Buitengaats and ZeeEnergie) and the connector cable route, to avoid hitting unknown objects during installation.

A = 3900 mm
B = 4000 mm
C = 2350 mm

Figure 53: *Typical example of a grapnel anchor*

11.2.2.1 Deploying the grapnel train

The grapnel train consists of the grapnel, 15m steel chain, 90m towing wire, recovery line and 2 buoys. The grapnel is connected to the chain, the chain to the towing wire and the towing wire is connected to the tow winch of the workboat. The recovery line, including the buoys, is connected to the grapnel as well. The grapnel train is laid out on the deck, ready for launching.

11.2.2.2 Equipment

- Workboat
- Grapnel anchor
- 15 m 40 mm anchor chain
- 90 m (or more) 6x34 steel wire, towing wire
- 45 m 28 mm polyprop, recovery line
- 45 m 30 mm retrieving wire
- 2 Norwegian buoys, recovery buoys
- 32 ton lock-a-loy, 12 ton shackles, 6 ton shackles

Workboat
A Workboat with just over 20 tons bollard pull is enough to have a descent towing with such a grapnel.

Tow wire
A 32 mm steel tow wire with a minimum length of 3 times the maximum water depth + 50 m. The extra 50 m is for loss of length due to the distance from stern deck to the tow winch and to keep one full layer of wire on the tow winch for safety reasons.

Anchor chain
With a length of ± 3.0 meter, depending on the deck length.

Grapnel
A good quality grapnel is essential to resist the high tensions during operations.

11.2.2.3 Personnel

- Work boat crew, size depends on workboat
- Surveyor on board of work boat

11.3 Rock Berm Crossings

At crossings of live cables a pre-lay rock layer will be installed to ensure the minimal required 0.3m gap between the export cable and the crossed cable or pipe. A post-lay rock installation will be performed to protect the cable (similar to section 9.2.2).

Several in-use cables will be crossed. For all these cable crossings count a suitable crossing method will be used.

The applicable offshore cable infrastructures are:
- TAT14 cable
- SEA-MW-WE3 cable

11.4 Cable installation

11.4.1 Corridor

For the offshore route a corridor shall be used:
- KP 37 – KP 41: ±1400m (around the TyCom cable), with a distance of at least 200m from the Tycom cable.
- KP 41 – border of wind farm: 450 – 2600 m with a distance of at least 200m from the TyCom cable.
- Within the wind farms and in between the wind farms: 150 m.

11.4.2 Cable pull-in at offshore substation

Preparation
On and offshore preparations will be performed for the cable pull-in on the substation. The pull-in team will finalise the preparations on the cable deck of the offshore substation prior to the pull-in.

Pull-in
Once the messenger wire is connected the winch will pull on the export cable. Simultaneously the cable lay vessel (CLV) will pay-out the export cable while monitoring the tension on the cable.
Once sufficient cable length is pulled in the cable will be temporarily hanged-off by the pull-in team after which the cable termination team can commence. The CLV will proceed with laying the cable on the seabed.

11.4.3 Cable termination

After the pull-in the termination team will permanently hang-off the export cable and further terminate the cable including fixating the cable on the cable ladders.

11.4.4 Cable laying

The cable laying spread will be a DP vessel with a turntable, depending on installation method and type of cable. The cable will be loaded at the designated load-out facility. After testing (OTDR test) the cable the DP2 cable lay vessel will sail to the offshore AC substation for the first end cable pull-in.
After the pull-in the cable will be laid as per the predefined cable route while monitoring the tension and the catenary of the cable. For cable and pipeline crossings the cable laying speed will be reduced to ensure proper crossing of the installed rock berms. When crossing traffic sea-lanes and port approaches extra care will be taken.

11.4.5 Crossing in front of the Westerems

Crossing in front of the Westerems at KP 39.5 – KP 40.5 will be done 3m below future shipping lane level of -16.1 m NAP.
The same installation approach as for the installation between KP16.3 and KP31 will be used, which means dredging a trench and then lay the cable.

11.4.6 Cable burial

Once the CLV is laying the cable the burial spread commences. The burial spread consists of an ROV with jetting swords to bury the cable and a DP vessel which acts as the support vessel with ROV launch and recovery capabilities. The trenching philosophy is initially based on a two pass operation, with intermediate surveys to achieve the required burial depth. Sword and nozzle settings will be designed accordingly.

The Seabed level between KP 37 and KP 93/KP 102 and in between the AC platforms is morphological stable. From KP 37 to KP 92/KP 102 the required burial depth is 1 m below seabed.

11.4.7 Survey of the buried cable

After the burial, the burial spread will perform a dedicated survey run to determine the burial depth of the cable using a cable tracker. Typical survey speed is 1000 m/hr.

11.5 Equipment

Figure 54: *Typical Example Cable Lay vessel*

Details of a typical cable lay vessel:

- Type Cable Lay Vessel

- Dimensions 112.25*32.15 m
- Draft at 9483 DWT 5.4 m
- Speed approx. 10 knots
- Turn table capacity 6600 mton

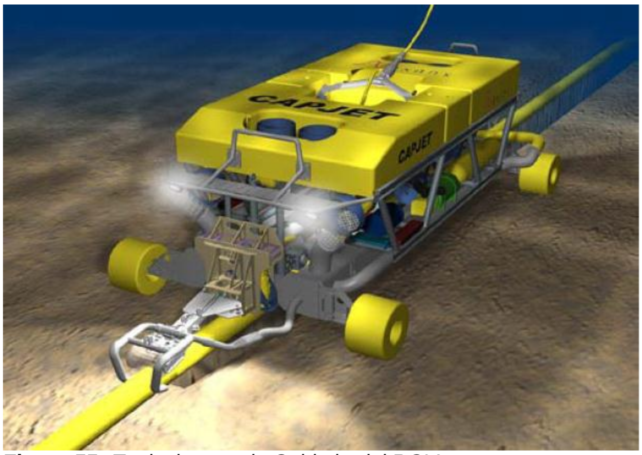


Figure 55: *Typical example Cable burial ROV*

Details of a typical cable burial ROV:

- Type Capjet 650 MW 1
- Dimensions 8 * 4 * 2.5 m
- Weight 14.5 mton
- Burial depth up to 3 m
- Fluidisation width approx. 2 m

The ROV is a device which will propel itself forward and is electrically driven. The necessary power will be provided by the assisting vessel.

Figure 56: *Typical example Survey vessel (Geo Ocean 1)*

Details of typical survey vessel

- Type Geo Ocean 1
- Dimensions 27x6 m
- Speed approx 12 knots

12 Joints vicinity KP 65

12.1 Introduction

In the vicinity of KP 65 joints are planned to make the connection between the sections of the offshore cables.

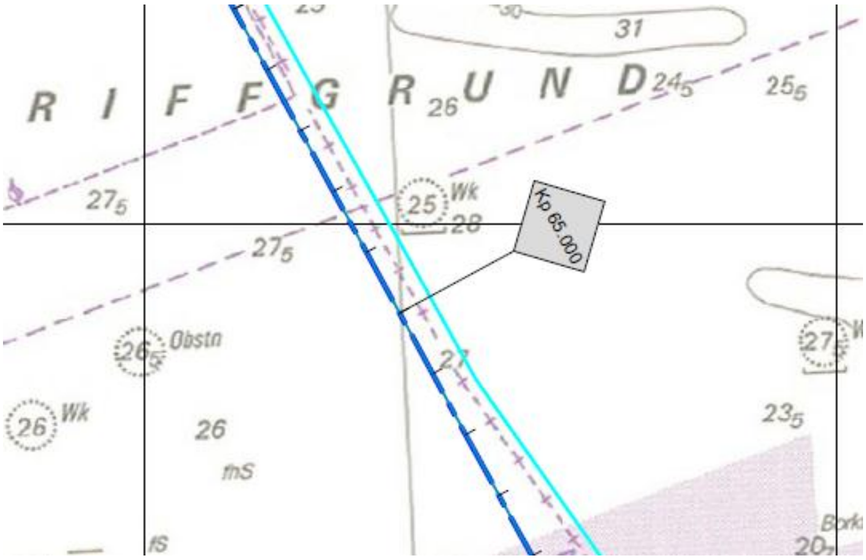


Figure 57: *Location of the offshore shore joints in the vicinity of KP 65*

12.2 Scope

After 30 km a transition will be made between two separated sections of cables. This due to the extent length of the offshore cable. In the vicinity of KP 65 joints will connect both cables. The joint will be buried by using the earlier mentioned burial tool or in a pit with a volume of approx. 50m^3 1 metre below the seabed level, this for protection against fishnets and anchors. The pit will be made by using a jetting tool.

The joint will be made on a dedicated cable lay vessel (CLV) or jack up barge.
If a vessel is used, it will be respectively on DP or anchored on its mooring system in order to provide a stable platform during the jointing process. Upon positioning at the joint location, both ends of the offshore cable will be retrieved on board of the CLV or jack up barge for jointing.

13 Health, Safety & Environment

Van Oord will execute all works in line with Contract requirements, Federal Law and International Guidelines and Standards. In view of the potential hazards for this type of work in these circumstances and in addition to the project related procedures, special attention is drawn to, but not limited to, the following:

13.1 Health and safety

13.1.1 General

In order to arrange, provide and maintain safe systems of work for all employees at all times:

- Areas of health and safety responsibility will be clearly defined;
- Adequate and proper facilities, equipment and apparatus will be provided and its correct use will be ensured;
- Adequate training, instruction and information on workplace health, safety and hazards on the workplace will be provided;
- All industrial accidents will be regarded as preventable and the follow-up of all health and safety standard will be ensured;
- A registration of all Personnel, nationality, work permits, qualifications and certifications and time is up to date.

13.1.2 Guard vessels

Before any Installation operations a notice to mariners will be issued.
During Installation of the export cable a dedicated Guard vessel will guard the unprotected cable and will actively approach any vessel coming close or entering the work restricted area's
On all installation vessels a dedicated look out on the bridge will be appointed to avoid accidents.

13.2 Personnel

All construction personnel involved in the work will observe the following basic working rules, amongst others:

- Relevant personnel protective equipment (PPE) will be issued and used prior to the commencement of the work;
- PPE shall be worn at all times on site with exception of the dedicated safe area(s) and welfare facilities;
- Proper training and induction in the various roles for the type of activity will be performed;
- Experienced and active supervision will be in place at all work times.

13.3 Reporting of incidents and near misses

Incidents and near misses will be timely reported in compliance van Oord corporate procedure.

13.4 Emergency response

Emergency Response will be in compliance with van Oord corporate procedure and the project Emergency Response Plan.

13.5 Risk assessment

Risk assessments will be carried out in order to identify and control all hazards to the activities and to associate the risk and/or reduce it to acceptable levels.

13.6 Environment

13.6.1 General

In order to minimize environmental impacts arisen from the work based on ecological knowledge and on regulatory background the following measures will be taken:

- All personnel will be appropriately trained about general and specific environmental issues prior to the start of the operation;
- All onshore construction areas will be properly fenced to provide a restricted area with entrance control;
- All equipment will be in good condition to avoid spillage or discharge of oil, smoke and excessive noise;
- All access roads, work sites, corridors and right-of-way will be marked, and there will be no vehicular movement outside the work zone/area. Existing tracks will be used to access the site to the extent possible and new tracks shall be minimized;
- Refuelling will be carried out by competent and trained people away from any environmentally sensitive areas and precautionary measures to prevent spillage;
- An appropriate number of waste containers will be placed to collect waste before the final disposal by authorized company and hazardous material storage areas will be identified, labelled, and properly marked and fitted with spill containment systems;

13.6.2 Footprint Equipment

To minimise the footprint of the land based equipment used during installation on the shallow water part of the export cable, low ground pressure equipment will be used. After a few tidal cycles will return the seabed to its original condition.

13.6.3 Restricted areas

The planned export cable route will cross the "Natura 2000" area from KP 0 to KP 19 and "Article 20" area from KP 9 – 16.
According to Article 20 it is not allowed to access the area from May 15th till September 1st.
To avoid crossing prohibited areas the borders of these areas will be shown on the navigation systems of all equipment used during installation.

13.6.4 Light

The lights on all equipment used during installation will be kept to an absolute minimum needed for safe working and safe navigation. All working lights will be pointed downwards to minimise any disturbance of the environment or passing aircrafts.

13.6.5 Noise

Reference is made to CEDA Position Paper on Underwater Sound in relation to Dredging *(www.dpcmagazine.com - December 2011 page 30 – 33)* and TNO report on noise measurement during construction of Maasvlakte 2 (*TNO-DV2010 C335)*

Underwater noise caused by Dredgers is dominated by cavitation noise from propellers and bow thrusters.
For a hopper (Ham 311 or similar) noise levels for dredging sand are as stated below:

Dredging (1.6 - 2.0 kn, depth 23-26 m at 100 m):	Low frequency (31.5 – 2000 Hz)	160 – 175 dB
	High frequency (2 kHz-63 kHz)	150 – 160 dB
Transit (10 - 12 kn, depth 17-19 m at 100 m) :	Low frequency (31.5 – 2000 Hz)	160 – 175 dB
	High frequency (2 kHz-63 kHz)	<160 dB
Dumping (0 kn, depth 13 m at 65 m) :	Low frequency (31.5 – 2000 Hz)	150 – 155 dB
	High frequency (2 kHz-63 kHz)	<140 dB

The offshore Cable laying Equipment will generate similar or less noise levels as dredging equipment in transit because the noise is mainly generated by cavitation of the propellers. For stationary equipment expected noise levels will be similar as for dumping.

14 Planning

Planning of the cable installation is subject to cable manufacturing and delivery schedule, future seabed conditions and permit restrictions.

Activities are in principle based on a 24/7 schedule, workability included.

Supply of cable

Shallow water cable KP 0 – KP 15.4	March- April 2015
Near shore cable KP 15.4 – KP 37	July - September 2015
Offshore cable KP 37 – KP 102	July - September 2015
Connector cable	June 2015

Complete Route KP 0 – KP 93/102

In-survey:	TBD
Working time required:	60 days

Shallow water Route KP 0 – KP 15.4

Non-working period:	*May 15th until September 1st (KP 9 – KP 16)*
Laying and burial:	March – June 2015
Working time required:	79 days
2 Joints at KP 9:	April – June 2015
Working time required	28 days
2 Transition joints at KP 0/Landfall:	May 2015
Working time required	20 days

Near shore Route KP 15.4 – KP 37

Cofferdam and HDD (NorNed and Tycom crossing):	March – May 2015
Working time required:	49 days
Dredging KP16.3– KP31:	May – August 2015
Working time required:	97 days
• Very small TSHD	week 1 – 3
• 1st Small TSHD	week 1 – 14
• 2nd Small TSHD	week 1 – 14
• Medium TSHD	week 4 – 14
Sedimentation dredging KP 16.3 – KP 31:	August – September 2015
Working time required:	30 days
• Small TSHD	week 14 – 18
• Medium TSHD	week 14 – 18
Pre-lay grapnel run KP 31 – KP 37:	July - August 2015
Working time required:	4 days

Laying and burial:	August - October 2015
Working time required:	39 days
Backfilling KP 16.3 – KP 31:	September – October 2015
Working time required:	14 days
2 Joints at KP 15.4:	September – October 2015
Working time required:	28 days
Crossing NorNed (+ TyCom) between KP 32 and KP 41:	September – October 2015
Working time required:	40 days

Offshore Route KP 37 – KP 93/102

(Sedimentation) Dredging KP 39.5 – KP 40.5:	August – October 2015
Working time required:	5 days
Pre-lay grapnel run:	June – July 2015
Working time required:	30 days
Laying, burial and survey cable Buitengaats:	July - September 2015
Working time required:	66 days
Joint at KP 63 Buitengaats:	August 2015
Working time required:	12 days
Joint at KP 37 Buitengaats:	September 2015
Working time required:	12 days
Laying, burial and post-lay survey cable ZeeEnergie:	September 2015 – January 2016
Working time required:	104 days
Joint at KP 67 ZeeEnergie:	October - November 2015
Working time required:	15 days
Joint at KP 37 ZeeEnergie:	November – December 2015
Working time required:	15 days
Crossings of 2 offshore cables:	July – December 2015
Working time required:	20 days

Connector cable between AC platforms

Pre-lay grapnel run:	July 2015
Working time required:	3 days
Laying, burial and survey:	July – August 2015
Working time required:	26 days

Title document:

Outline Method Statement Land Cable Installation

Company:

Van Oord Offshore Wind Projects bv

Client:

Typhoon Offshore B.V.

Project Name:

Gemini

Project Number:

14.4082

Document number:

14.4082-VOWP-INS-MS-6001-MS Land Cable Installation-C5

Reference:

C5	Update on description landfall	26-09-2012		RLS		
C4	Further update	17-09-2012		SML	RLS	
C3	Further update, optical cable to be detailed	08-06-2012		EGR/RLS		
C2	Updated for permit **Remark: Optical fibre cable to be added**	06-06-2012		EGR		
C1	Preliminary	21-03-2011		RDG / EGR		
Rev.	**Document Status**	**Date**	**Sections**	**Prepared by**	**Checked by**	**Approved by**

Table of Contents

Abbreviations and definitions

AC	Alternating Current
HDPE	High Density PolyEthylene
HVAC	High Voltage Alternating Current
kV	kilo Volt
MW	Mega Watt
WTG	Wind Turbine Generator

Related documents

Document Number	Document Name
144082-VOWP-INS-MS-4001	Method statement Submarine Export cable installation
ENSOL-RPT-2011.24	TenneT Masterplan Eemshaven rev. 2

1 Introduction

1.1 General

Van Oord Offshore Wind Projects bv (VOWP) and Typhoon Offshore B.V. have established a Framework Agreement to develop the Gemini project. The Gemini project consists of the offshore wind farms Buitengaats and ZeeEnergie. The wind turbines are capable of producing 300 MW of electricity per wind farm. The two wind farms are located approx. 60 km north of the island of Schiermonnikoog in the Dutch Exclusive Economic Zone (EEZ) next to the German border, see figure 1.

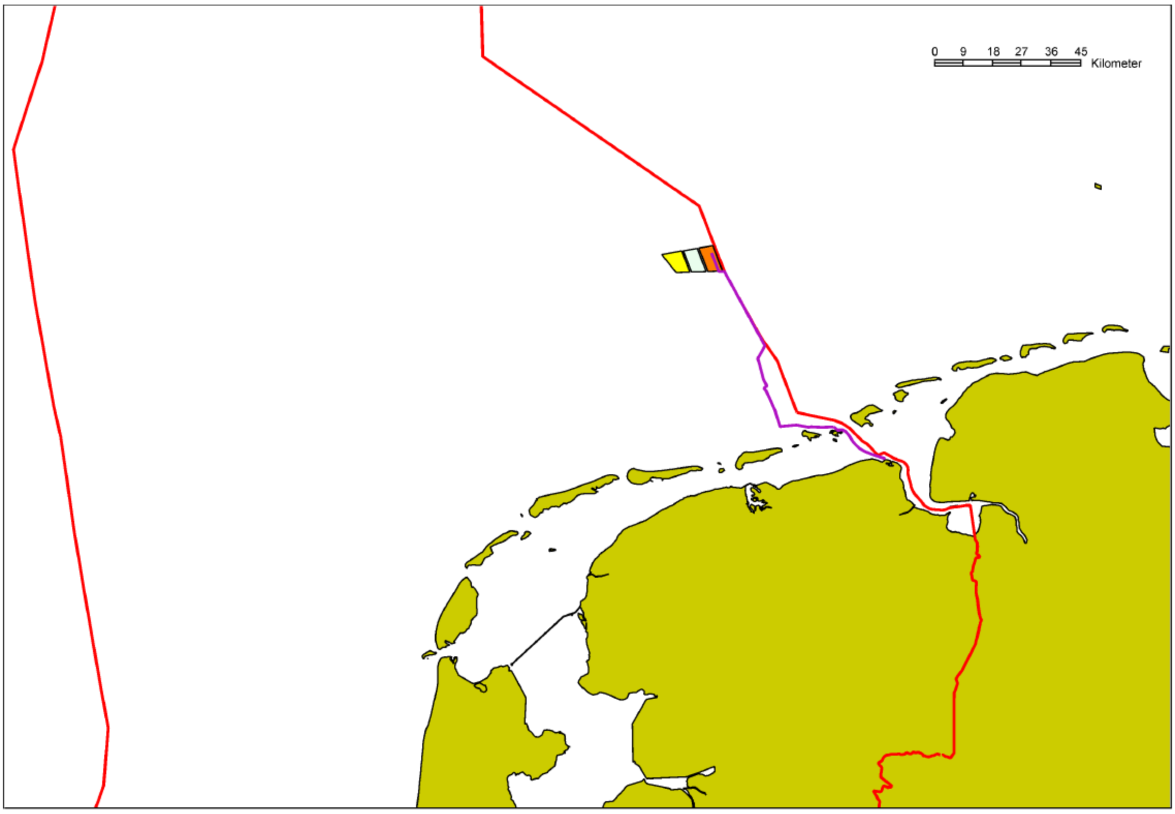


Figure 1: **Overview of the German and Dutch EEZ, showing the location of Buitengaats (orange) and ZeeEnergie (yellow).**

The electricity produced by the wind turbines will be transported to the two HVAC substations of the both wind farms through 33 kV AC infield cables. From these two HVAC substations the power is transported via 220 kV AC export cables to shore. The power connection to shore consists of two AC Submarine Export cables with an approximate length of 92 km and 101 km and two AC Land Export cables of approximately 5 km. These export cables transports the power to the onshore substation in Eemshaven. At the onshore station the 220kV will be transformed into 380 kV AC. After this last transformation the power is supplied to a main grid station of Tennet via a 1.7 km long 380 kV AC Grid Connection cable.

The Van Oord scope in this project comprises the engineering, procurement, construction and installation activities related to scope of work except for the supply of the WTGs.

This method statement focuses on the method of installation and protection of the following on land HV power cables:

- 220 kV AC cables (approx. 5 km) running from the arrival point on the beach (landfall) till the Onshore Substation in Eemshaven.
- 380 kV AC cables (approx. 2 km) running from the Onshore Substation in Eemshaven till the PCC of Tennet (Oude Schip) (see TenneT Masterplan Eemshaven rev. 2).

2 Scope of Work

2.1 Land Cable Route

The power connection to shore consists of Submarine AC power cables. The cables of the offshore route will be connected to the on land AC HV power cables in the Eemshaven as detailed in section 3.2.
The HV power cables of the onshore route have a length of approximately 5 km. These cables transport the power to the Onshore Substation in Eemshaven. At this station the power is bundled and the voltage transformed into 380 kV AC. After this last transformation the power is supplied to the PCC of Tennet via a 1.7 km long 380 kV AC Grid Connection cable.

An overview of the on land cable route is given below. The blue line represents the 220 kV AC export cable from the landfall till the Onshore Substation. The purple line represents the 380 kV AC cable from the Onshore Substation till the PCC of Tennet.

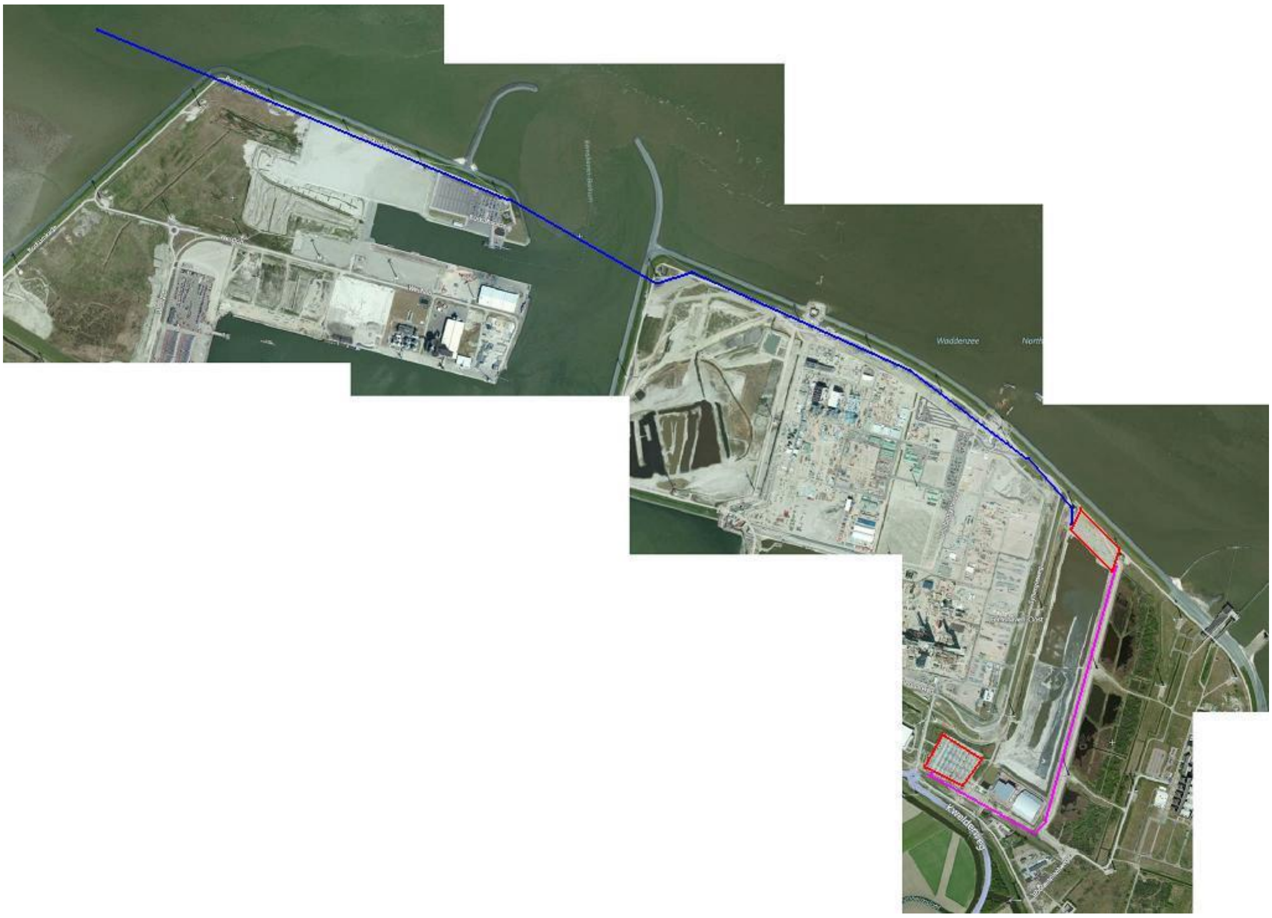


Figure 2: **Overview of land HV cable route Eemshaven**

The determination of the final route in detail for the onshore HV power cables will be co-depended on the type and location of the existing 3rd party underground infrastructures at the project location. Several cable and pipeline crossings have to be made. The most important cable crossings are the crossing of the Tycom cable and NorNed cable. Because the data obtained from the Klic-Alert and third party information is not always accurate, test trenches have been made to exactly establish the type, dimensions and number of underground infrastructure at certain, critical locations like cable crossings. The report of the test trenches is attached in Appendix A: Proefsleuven Eemshaven - Gemini project.

During the power transport trough the HV cable there will be some (electrical) transport losses (heat dispersion). The HVAC cables will be installed 1.0 m apart in order to minimize the mutual influence, given the available space on land.

The influence of the cables on their surroundings (soil + existence cables) and the type of cable isolation needed etc. is greatly dependent on the physical characteristics of the soil, such as thermal resistivity. The thermal resistivity will be measured with a special device called the Hukseflux FTN01. The working method is described in Appendix B: Ensol_PRT_2010 19 Werkinstructie grondonderzoek.

2.2 Typical cable dimensions

Stated below are the type cable dimensions for the on land power export cable. The first section of the land HV power cable (blue line in Figure 2) will be two 220 kV AC cables. The second section of the land HV power cable (purple line in Figure 2) will be a 380 kV AC cable.

2.2.1 First section: 220 kV AC cable

Start	End	Route length [Km]	Type of cable	Install depth [m]	Conductor cross section [mm^2]	Cable weight in air [Kg/m]	Outer diameter [mm]
Landfall	Onshore Substation	+ /- 5	2 x 1x3 220 kV	+/- 1,3	1600		

The HVAC cable solution for the on land route consist out of two times 3 AC cables of 220 kV. The AC cables will be installed 1.0 m apart from each other.

Figure 3: **Typical HVAC cable**

2.2.2 Second section: 380 kV AC cable

Start	End	Route length [Km]	Type of cable	Installation depth [m]	Conductor cross section [mm^2]	Cable weight in air [Kg/m]	Outer diameter [mm]
Onshore Substation	PCC Oude Schip	+ /- 1.7	1x3 380 kV	+/- 1,3	1200	33	125

2.3 Installation Methods

2.3.1 General

The onshore HV power cables will be most likely delivered in one shipment at the Eemshaven. The cable will be delivered on cable reels. On each reel a typical cable length is loaded, most likely 36 reels for the 220 kV AC cable and 6 reels for the 1.7 km 380 kV AC cable.

2.3.2 Trenching

The cable route needs to be trenched, this will be done with several cranes. Depending on the spot where the trench will be made there will be heavy cranes used or, when the trench will be made nearby other underground infrastructure, mini-cranes or ground workers will be used. This for protection of the existing infrastructure.

Figure 4: **Trenching with a crane**

The cables will be installed in different parts. For each cable reel a trench will be excavated, temporary drains with pumps/drainage (both horizontal and vertical might be possible, but determined in a later stage) will be made, the cables will be installed on the bottom of the trench, positioned and after the installation the cables will be connected to the next cable part with a joint. The trench will be closed directly after the installation of the cables, taking specific tests into account and except for the jointing location. This will be done in layers to get the required compressing of the situation before. After backfilling 0.40 m of the trench two separated casing tubes for the Optical Fibre cable will be installed. After installing the tubes a new layer of 0.10 m will be installed and the cover plates will be laid above the tubes. After a new layer of 0.20 m a warning tape will be installed through the trench. The joint locations will be closed after the jointing process is finished. After closing the trenches and joint locations, they will seed the ploughed ground with normal inhabitant seeds.

2.3.3 Working strip

For the installation of the cables a working strip is needed. The working strip will have a width of around 40 m. This is necessary for the execution of all the trenching work. The length of the Western part will be approximately 1400 m and of the Eastern part 2500 m. The strip will look like the picture below.

Figure 5: **Working strip**

The working strip is setup in this way to have some executional benefits. On the site of the trench without cables and pipes there is space for the cranes to excavate the trench and to store the excavated material. On the other site of the trench there is space to install a ramp lane for equipment. This will be installed to protect the nearby infrastructure, on and below ground level, against possible damage.
During the execution of the works two parts of the trench will be open. This will be between approximately 1400 and 2000 m (2 times the length of cable on a reel).

2.3.4 Pull-in of the cable

For the cable pull-in a lot of guiding cable rollers and some cable tensioners are required. These will support the cable where needed. The cable hauling winch (Figure 6) will be installed on the end of the trench, the wire will be guided over the cable rollers (Figure 7) and tensioners (Figure 8) to the cable reel (Figure 9). The cable will be connected to the pulling wire at the beginning of the trench, where the cable reel is positioned. After this process the cables will be winded with the cable winch through the trench. A crane with a quadrant (Figure 10) will be present as supporting equipment and to lower and position the cable in the bottom of the trench. Together with the power cables, two separate data cables will be installed 200 mm above the power cables (Figure 14).

Figure 6: **Typical cable hauling winch**

Figure 7: **Typical cable roller**

Figure 8: **Typical cable tensioners**

Figure 9: **Typical cable reel**

Figure 10: **Typical crane with a quadrant**

2.3.5 Jointing

The joints will be made by the certified personnel of the cable supplier. The dimensions of the joints are not known yet.

2.4 Crossing with 3rd party infrastructure

2.4.1 General

The HV power cable route will cross different types of existing 3rd party underground infrastructure. The most important cable crossings are the crossing of the Tycom cable and NorNed cable.

To exactly determine the type, dimensions and number of underground infrastructure test trenches have been excavated at certain critical locations. For the location of the test trenches reference is made to the drawing in Appendix C: Route Gemini - GRS with test trenches and G-values ant the report Appendix A: Proefsleuven Eemshaven - Gemini project. Just before the execution of the works new test trenches will be made to check the situation again and notice differences.

Based on the outcome of the preliminary Klic-Alert an initial inventory of stakeholders is made (See Appendix D: Stakeholders out of the preliminary Klic-Alert). With the major parties there was a contact moment to discuss the cable/pipe location. The exact crossing method will be agreed and designed when the route is permitted. When preparing and starting the actual works for a crossing the relevant 3rd party will be involved and if required they can supervise the work or assist if necessary.

For most cable crossings it is possible to construct an open trench en temporarily lay or hang the cables aside in the trench. Another possibility is to install a tubular casing under the existing infrastructure by drilling the casing into the ground. The HV power cables will then be pulled through the casing. This is a preferred solution for the crossing of pipelines because it is not possible to lay them aside.

3 Sections

3.1 General

The total route of the land HV power cables can be split up in six main parts:

1. Transition joint at the landfall
2. Western side of the Eemshaven
3. Horizontal Direction Drill (HDD) underneath the "Doekegatkanaal"
4. Eastern side of the Eemshaven
5. Crossing primary dike
6. Grid Connection Cable route

These parts will be discussed in the following sections.

3.2 Transition joint at the landfall

3.2.1 Location

The Offshore HV power cables will be connected to the on land HV power cables in Eemshaven. The transition joint at the landfall will be preferably made on top of the dyke at the Borkumkade. If not possible a location directly after crossing the "Borkumkade" road will be picked in consultation with Groningen Seaports.
The pull-in winch will be placed on the landside of the jointing location to pull-in the cable.

To make the transition joint temporarily a pit will be excavated of a size of approximately 40m^2. The exact dimensions and location of the temporary pit are yet to be determined in consultation with the parties involved (including: Groningen Seaports). On this temporary pit a tent will be installed to protect the cable and the workers against weather influences.

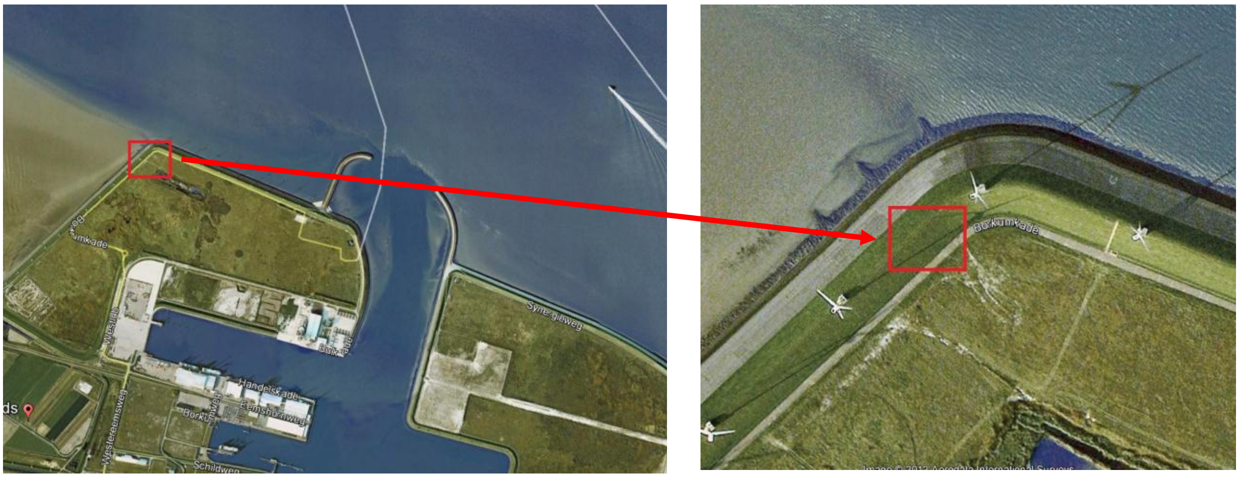


Figure 11: **Location (in red square) of the transition joint at Eemshaven**

3.2.2 Preparation works and initiation at the landfall

Prior to the arrival of the cable installation vessel the pit will be excavated.

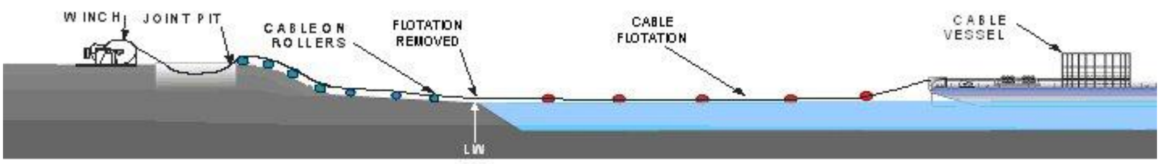


Figure 12: Cable installation process at landfall

The planning for the work is depended on the selection of a suitable weather and tidal window that will allow the HV power cables to be installed safely into the pit.

A cable hauling winch will be placed behind the jointing location. Temporary barriers will be erected to protect all of the work areas for the duration of the works. Local vessels will be informed about any temporary access limitations to the work area. The cable lay barge will position itself between 500 and 1000 m offshore of the jointing location, depending on tidal conditions. Dedicated communication links will be established between the cable-lay barge and the shore.

The Submarine HV power cables will be floated into the trench. When the cable is near the landfall, the pulling wire is connected to the cable. When the connection is made the pulling winch will winded the wire to pull the cable through the trench over the dyke. The cables, 6 power cables and 2 optical fibre cables, will be jointed to the land cables in the temporary pit. After the joints have been made the pit will be restored in its original state. Reference is made to the document "144082-VOWP-INS-MS-4001-MS Submarine Export Cable Install". For crossing the dyke there are no additional requirements by the Water Board, because the cable will be approximately 1.3 m below surface and not even close to the core of the dyke. When a storm is coming, the excavators will be nearby and will temporarily close the trench.

3.3 Western side Eemshaven

3.3.1 Location

The location of the Western side is showed in Figure 13.

Figure 13: **Overview Western side Eemshaven**

To install the HV power cables the first part of the trench will be excavated over the length corresponding with the length of cable on the reel. This will be done using typical land auxiliary equipment. An example of the dimensions of a typical trench is given in Figure 14.

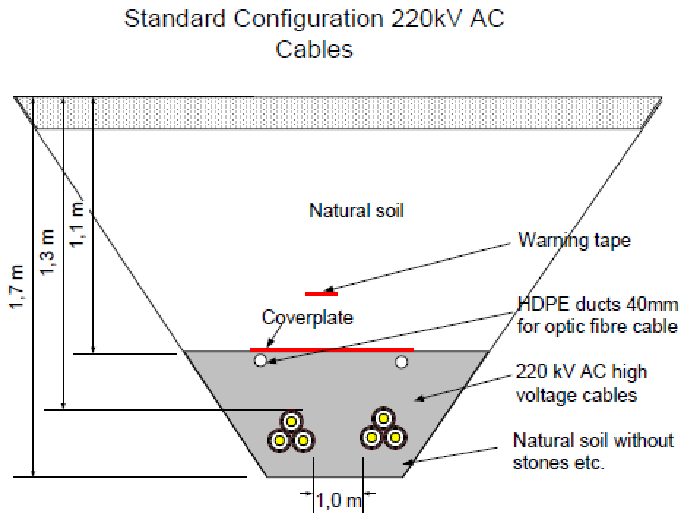


Figure 14: **Cross view typical 220 kV AC cable trench Eemshaven**

3.3.2 Crossing 3rd party infrastructure western side

The Land cable will cross several cables and pipes. References is made to the drawing "58807_ingemetensleuven(120501PW)-sleuf 1.pdf" The land cables will be installed approximately 1 m beneath the existing infrastructure (see Figure 29 for an example). The trench will be excavated with a mini-crane and workers with a shovel, to minimise the risk of damaging the existing cables and pipes.
An important data cable of Tata (formerly known as Tycom) is installed on the location marked in Figure 15 at a depth of approx. 3 m. The HV land cable will cross this data cable along the top.

Figure 15: **Location of the crossing with Tycom**

3.3.3 Installation of the cables

After a part of the trench is excavated a cable reel will be installed at the beginning of the trench and a winch will be installed at the end of the trench. The pulling wire of the winch will be laid over the cable rollers and connected to the cable. After connecting the pulling wire the winch will pull the cable into the trench. This will be repeated for the other cable reels. After the cables have been installed at the bottom of the trench the cables will be jointed with one joint per phase. The trench will be closed directly after the installation of the cables, taking required tests into account and except for the jointing location. These will beclosed after the jointing process is finished. For this section a length of 1400 metres will be needed and the cables will be loaded onto 12 cable reels.

The cable route on the western part of Eemshaven will cross a ditch. The ditch will be excavated to the required installation depth of the cable. After the cables have been installed a horizontal drain will be installed at the bottom of the ditch to restore its original function and the trench will be filled to ground level. See figure 16 below for the location of the ditch.

Figure 16: **Location of the ditch on western side of the Eemshaven**

3.3.4 Crossing 3rd party infrastructure eastern side

After the ditch there will be a crossing with several cables and pipes. References is made to the drawing "58807_ingemetensleuven(120501PW)-sleuf 45.pdf" The land cables will be installed approximately 1 m beneath the existing infrastructure. The trench will be made with a mini-crane and people with a shovel to avoid damage on the existing cables and pipes.

3.3.5 Execution time

Preparation of ramps track	5 days
Excavation of trench of 1400m	14 days
Installation of drainage	3 days
6 times jointing process (6x2 days)	12 days
2 times installation of 2x3x1 cable parts	5 days
Closing the trench	7 days
Duration (approximately)	44 days

3.4 Horizontal Direction Drill underneath "Doekegat"

3.4.1 Location

To connect the cable from the western side to the eastern side of the Eemshaven there will be a crossing with the "Doekegat" (entrance of the Eemshaven). Due to the minimal depth of 20 meters of the canal and the clearance for a deepening in the future a Horizontal Directional Drill (HDD) will be made for the crossing (see Figure 17). The HDD crossing will have a length of approx. 900 m. The exact drill length and dimensions are not yet decided. A single drill will be made. (see Figure 18) The working surface at the drill side needs to be approx. 800 m^2 to place the drill rig, bentonite mud mixing unit and other additional equipment like a crane and lorries. On the end point a tank will be used to transport the redundant bentonite back to the mixing unit.

Figure 17: **HDD drilling route (red line) Doekegat (Eemshaven)**

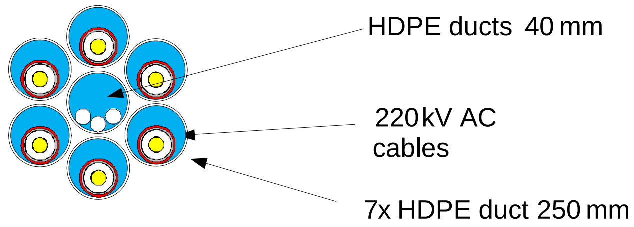


Figure 18: HDD Configuration 2* 3 – 220 kV AC Cables

3.4.2 Pilot drill

Prior to the drilling, a drill platform will be made with storage facilities and a drilling fluid handling device. This device retrieves the drill fluid from the extracted sand mixture out of the borehole. The drill fluid is used to reduce friction and to support the borehole for the duration of the drilling process.
The drill-rig used will need to be able to apply a drilling force of at least 2000 kN. The drilling rig must be properly secured to the underground in order to resist the impact of the different vertical and horizontal forces which occur during the drilling.
Once the drill rig is in position drilling will commence. The drill head direction can be adjusted to follow the predefined route (see Figure 19) of approx. 900 m.

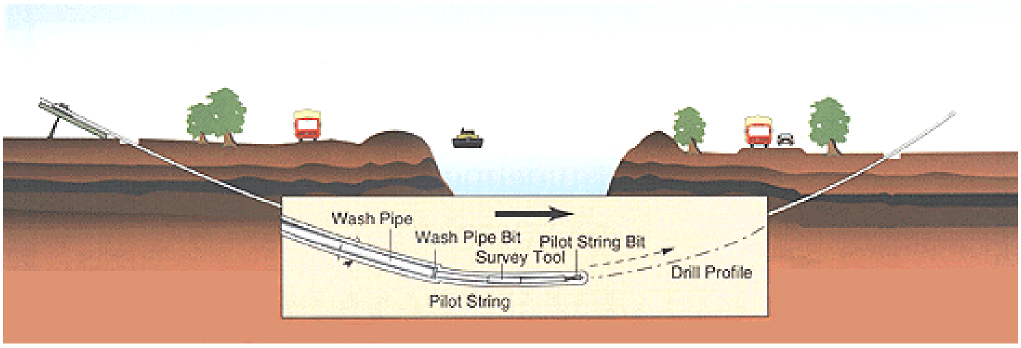


Figure 19: **Illustration pilot drill HDD**

3.4.3 Reaming

After the pilot drill the bore head is exchanged with a reamer. The reamer is pulled back and thus increasing the borehole diameter. This reaming process is continued with increasing reamer-size till the required borehole diameter is reached.

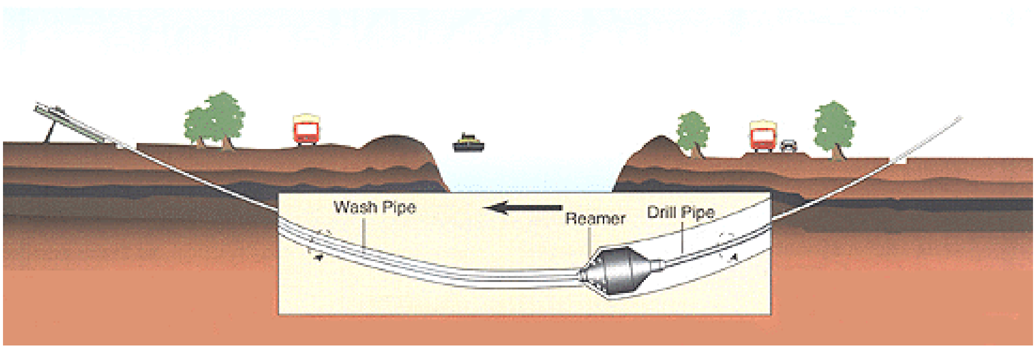


Figure 20: **Illustration reaming process HDD**

3.4.4 Pull-in HDPE Pipe

Now the HDPE pipes including pull wire can be installed in the borehole. The HDPE pipes will be connected with a swivel to the reamer. The reamer is pulled back for the last time pulling the HDPE pipes into the borehole. After the pull-in of the HDPE pipes, the pipes will be sealed and the HDD process is completed.

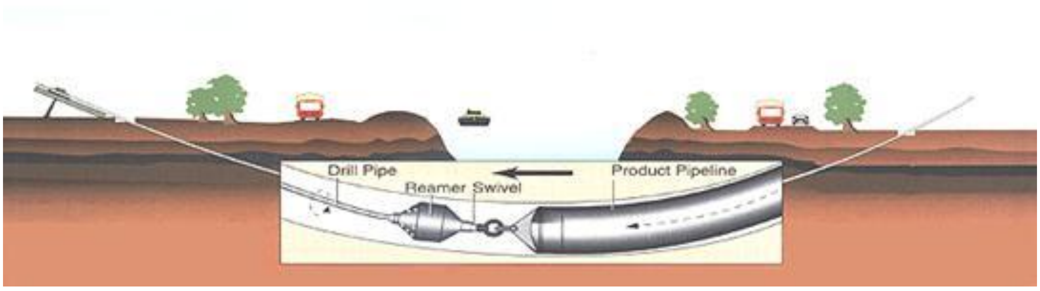


Figure 21: **Illustration Pull-in HDPE pipe process HDD**

3.4.5 Pull-in AC Export cable

In order to pull the export cables through the HDPE pipes, the seals of the HDPE pipe will be removed and an individual export cable is connected by Chinese finger to the pull-in wire. The pull wire is pulled through the HDPE pipe by a winch. For this 6 cable reels are needed. The Optical Fibre cables shall be installed by high pressure air installation. The Optical Fibres will be preferably delivered on a reel in one continuous length for the whole 220 kV AC cable route.

3.4.6 Jointing

To connect the cables through the HDD with the other two sections on the Western and Eastern side a temporary joint pit will be constructed on both sides. The cable joints on the western side can be made directly after finishing with the pull-in of the AC cables. For this jointing section in total 6 joints are needed, for each phase 1. When all 6 cables are jointed the joint pit will be closed.

3.4.7 Execution time

The execution period for the HDDs will be approx.

Mobilisation	2 days
Pilot drill	2 days
Reaming	2 days
Pull-in HDPE pipe	4 days
Pull-in AC cables	4 days
Demobilisation	2 days
Jointing Western side	12 days
Duration (approximately)	28 days

3.5 Eastern side Eemshaven

3.5.1 Location

The location of the Western side is shown in the Figure 22.

Figure 22: **Eastern side of the Eemshaven**

3.5.2 Installation of the cables

To connect the HV power cables exiting the HDD to the Onshore Substation a trench will be excavated. For the cable installation process reference is made to section 2.3.
After the trench is constructed a cable reel will be installed at the beginning of the trench and a winch will be installed at the end of the trench. The pulling wire of the winch will be laid over cable rollers and connected to the cable. After connecting the pulling wire the winch will winded the wire with the cable into the trench. On the end of the cable section joints will be made to connect the next cable section. For these 2500 metres there 18 cable reels are needed.

3.5.3 Jointing

The cables will be jointed with the HDD Doekegat in the open joint location on the Eastern side. In the joint pit there will be 6 joints installed, after installation the joint pit will be closed.

The other part of the Eastern side will have 12 other joints. The jointing process will start when 2 cable lengths have been installed and the cables have been tested. When the jointing process is started the cable trenches will be closed again, except of the joint location. Parallel to the jointing process and closing of the trench, another team will make the last part of the trench.

3.5.4 Cooling water outlet Nuon

The cooling water outlet pipes of the powerplant of Nuon are installed approximately 3.5 – 4 m below the surface. Above the pipes some cables and pipes have been/will be installed. The exact location of these are unknown yet. When there is no space available there is a possibility to cross the cables and pipes with a Auger drilling.
The exact information is not known, since Nuon is still installing the pipes and its related cables. The exact information will become available when it is known by Nuon and Groningen Seaport.

Figure 23: **Location cooling pipes Nuon**

3.5.5 Cooling water outlet RWE

The cooling water outlet pipes of the coal-power plant of RWE are installed approximately 5 m below the surface. A normal open trench method will be used here.

Figure 24: **Location cooling pipes RWE**

3.5.6 Execution time

The execution period for the eastern part of the Eemshaven will be approximately:

Preparation of ramps track	7 days
Excavation of a trench of 2500m	25 days
Installation of drainage	4 days
18 times a jointing process	36 days
3 times installation of 2x3x1 cable parts	8 days
Closing of the trench	10 days
Duration (approximately)	84 days

3.6 Crossing a primary dyke

The onshore cable route crosses a dike which is a part of the primary flood defence of the Netherlands. The crossing of the dyke with the land HV power cables has to be done by open trench according to GSP and the Water Board. The trench must be higher than the table height of the dyke incl. future raisings of table height. The table height that needs to be taken into account for the trench design will have to be approved by local department in charge of the waterways. The excavation of the trench and the installation of the cables shall be done outside the storm season – first of October till the first of April.

Figure 25: **Dyke locations in red circle**

After approval of the crossing design the trench will be excavated. To do this the road needs to be cut. After finishing the crossing with the primary dyke the road will be closed with pavement. When the project is finished the road will be asphalted again. This will be done by use of small asphalt equipment. The road will be milled to get the original layers of the road back in the asphalted spot.

Figure 26: **Typical mill equipment**

Furthermore, the on land HV power cables must be laid with an extra over length to cover possible the future risings of the dyke table heights. This over length of cable will be laid on the plot of the Onshore Substation.

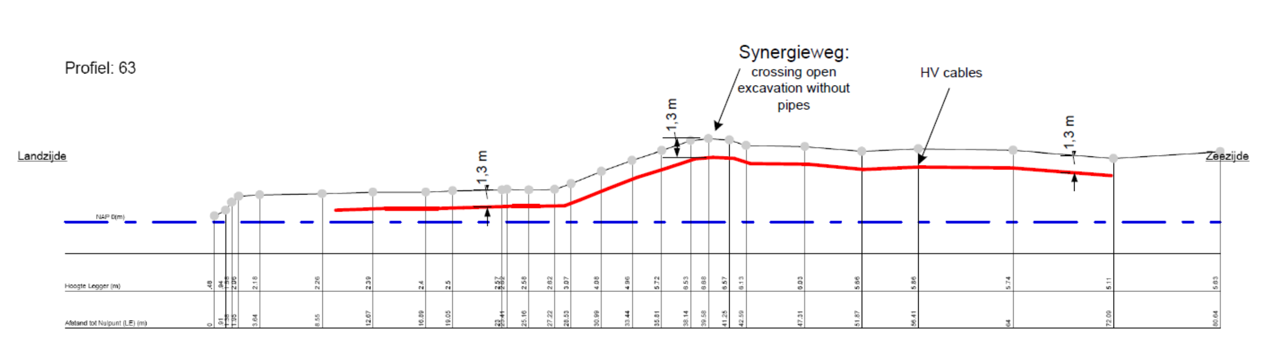


Figure 27: **Cross section with dyke**

3.6.1 Crossing of the NorNed cable

The NorNed cable is installed in the dyke zone (Figure 28) and will be crossed by the HV power cable route.

Because the NorNed cable only lies at a depth of 1 to 1.5 m, the HV power cable needs to be installed underneath the NorNed cable. The dimensions of the typical trench are presented in Figure 29. The NorNed cables will be temporarily put aside in the trench. For the AC power cable solution the trench width will be wider since the cables have to be laid deeper and the distance between the two cable bundles still is 1 m.

Figure 28: **Location NorNed cable**

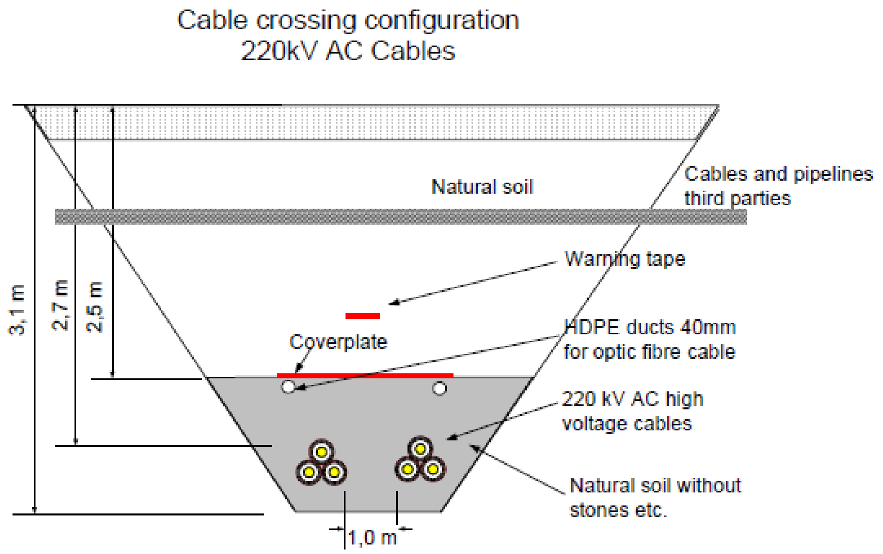


Figure 29: **Cross view NorNed cable crossing HV cable trench Eemshaven**

3.6.2 Onshore Substation

At the Eastern side of the Eemshaven the HVAC power cables will be connected to the Onshore Substation in Eemshaven. At this station the power is bundled and the voltage transformed into 380kV AC. The location of this station can be seen in Figure 31.

3.6.3 Execution time

The execution period for the dike crossing and last part of the 220kV AC cable of the Eemshaven will be approx.

Cutting the road	1 day
Excavating trench through the Dyke	2 days
Installation of the cables	2 days
Crossing with NorNed	1 day
Connection to the Onshore station	1 day
Closing of the trench	3 days
Duration (approximately)	10 days

3.7 380 kV AC Grid Connection cable route

To connect the HV power cables from the onshore substation to the main grid of Tennet, Oude schip, a trench of approximately 1.7 km needs to be excavated. This trench is different from the trench for the 220 kV AC cables, because only 1x3 cables need to be installed.

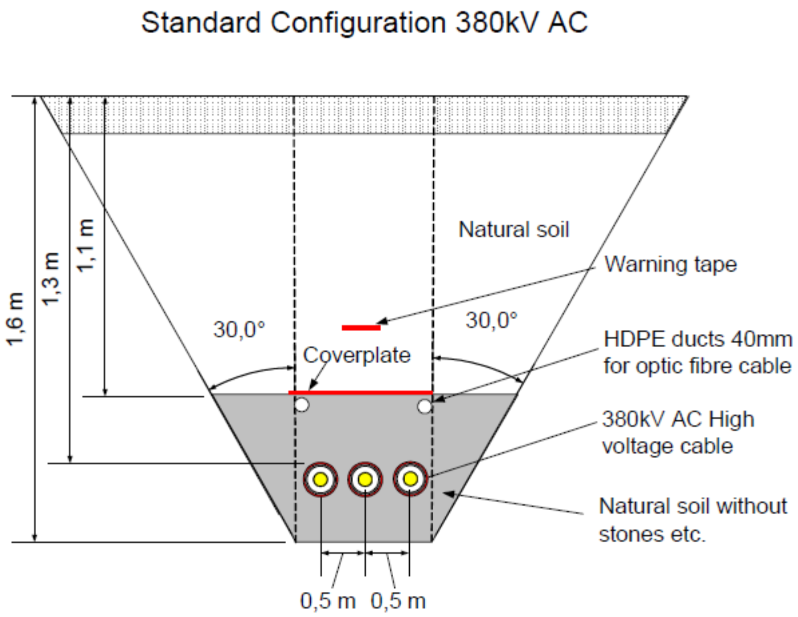


Figure 30: **Trench of the 380 kV AC cable**

3.7.1 Location

Location of the route is shown in figure 31.

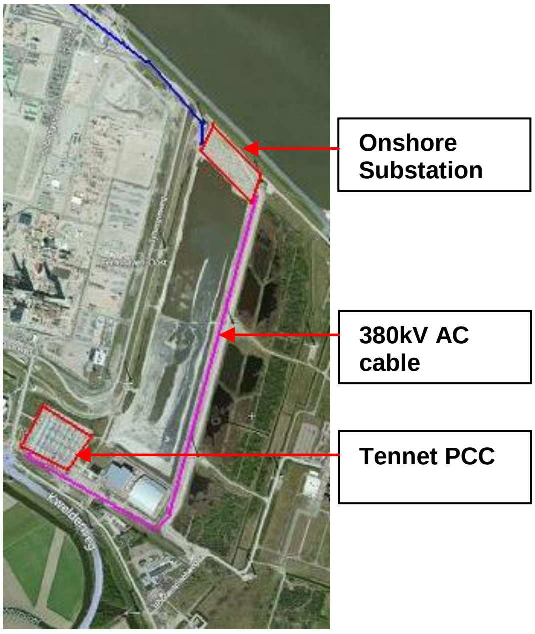


Figure 31: **380 kV AC cable route**

3.7.2 Installation of the cables

After excavation of the trench, a cable reel will be installed at the beginning of the trench and a winch will be installed at the end of the trench. The pulling wire of the winch will be laid over cable rollers and connected to the cable. After connecting the pulling wire the winch will pull the cable into the trench.
This will be repeated for the other cable reels. After the cables are installed into the trench they will be jointed with one joint per phase The trench will be closed direct after the installation of the cables, respecting tests that have to be executed and except for the jointing location. This will be done after the jointing process is finished. For this section a length of 1700 metres of cable will be needed and the cables will be loaded onto 6 cable reels.

3.7.3 Crossing cooling pipes of Eemsmond Energy

Near the onshore substation there will be in the future cooling pipes installed for a new Energy plot next to the Gemini substation. The top of the pipes will be installed on 1.25 m and the diameter of the pipes will be 0.9 m. The installation of the Grid Connection cable will be done on 2.75 m to get the minimal clearance of 0.5 m.

3.7.4 Jointing

In the route there will be 3 joints used to connect the cables to each other. After the jointing process the pit will be closed again.

3.7.5 Crossing Gasunie pipe

The live gas pipeline of Gasunie will be crossed near Tennet Oudeschip. The pipe is installed on a depth of 2.2 m. below surface. A minimal clearance of 1.5 m between the gas pipe and the Grid Connection cable will be held.

3.7.6 Execution time

The execution period for the Grid Connection cable route will be approximately:

Preparation of ramps track	5 days
Excavation of trench of 1700m	17 days
Installation of drainage	3 days
2 times installation of 1x3x1 cable parts	3 days
Crossings	4 days
3 times jointing process (3x2 days)	6 days
Closing the trench	6 days
Duration (approximately)	42 days

4 Planning

If other projects will run in parallel with the execution of this project, GSP will have to inform us in due time, so contact can be made with the other project(s) to align the works/planning.

Planning is based on a 5-day workweek.

Joint at the landfall	May 2015
Western side of the Eemshaven	March – May 2015
Horizontal Direction Drill (HDD) Doekegatkanaal	August – September 2014
Eastern side of the Eemshaven	May – July 2015
Grid Connection cable route	March – May 2015

Appendix A: Proefsleuven Eemshaven - Gemini project

Proefsleuven Eemshaven - Gemini project

Datum: 10 mei 2012
Opgesteld door: P.Weerstand

Inhoud

Werkwijze:

Elzinga Aannemingsbedrijf heeft ten behoeve van het Gemini project een aantal proefsleuven gegraven in de Eemshaven.
GeoPlus heeft de vrijgegraven kabels en leidingen ingemeten en gefotografeerd.

De metingen zijn uitgevoerd in het RD stelsel ten opzichte van N.A.P.
De meetresultaten zijn gepresenteerd in overzichtstekeningen met dwarsprofielen.
De afstanden naar vaste objecten evenals de onderlinge afstanden zijn in de dwarsprofielen weergegeven.

In de volgende paragrafen zijn de bijzonderheden per sleuf aangegeven.
Voor het overzicht van de locaties van de profielen zie blad 1 en blad 6.

Proefsleuf 1 - blad 2

Alle kabels en leidingen aan de oostzijde van de weg zijn opgezocht. Aan de westzijde van de weg zijn geen kabels en leidingen gevonden. Toch moet hier een laagspanningkabel van Hav., wellicht stopt deze kabel eerder dan ter plaatse van de proefsleuf. Volgens de aanwezige kabel- en leidingen informatie vanuit de KliC tekeningen liggen er geen kabels en leidingen in de dijk. Sleuf oostzijde van de weg moet de kabel van Tata liggen. Deze word niet op de Klic tekeningen vermeld. Er is wel een proefsleuf gegraven, maar niks gevonden. Waarschijnlijk ligt de kabel dieper. Wel adviseren wij hierover contact op te nemen met Tata gezien het belang van de kabel.

Proefsleuf 2 - blad 3

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden.

Proefsleuf 3 - blad 4

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden.

Proefsleuf 4 - blad 5

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden. Er liggen erg veel kabels en leidingen in diverse richtingen, dus wellicht is het verstandig dit verder op te zoeken.

Proefsleuf 5 - blad 5

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden. Er liggen erg veel kabels en leidingen in diverse richtingen, dus wellicht is het verstandig dit verder op te zoeken.

Proefsleuf 6 - blad 7

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn gevonden, behalve de Data kabel van KPN. Wellicht ligt deze onder het asfalt van de weg.

Proefsleuf 7 - blad 8

Er moet een kabel van Hav. Liggen. Deze is tot op een diepte van 1,80- mv. echter niet gevonden. Het terrein is kortgelden opgehoogd, dus wellicht ligt de kabel veel dieper.

Proefsleuf 8 - blad 9

Er moet een Data kabel van KPN liggen en een middenspanningskabel van Enexis. Deze zijn tot op een diepte van 1,55- mv. echter niet gevonden. Het terrein is kortgelden opgehoogd, dus wellicht liggen de kabels veel dieper.

Proefsleuf 9 - blad 9

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden.

Proefsleuf 10 - blad 10

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden, behalve de Data Hav. Kabel. Het terrein is kortgeleden opgehoogd, dus wellicht ligt de kabel veel dieper.

Proefsleuf 11 - blad 11

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden, behalve de Data Hav. Kabel. Het terrein is kortgeleden opgehoogd, dus wellicht ligt de kabel veel dieper.

Proefsleuf 12 - geen blad

Geen proefsleuf gemaakt i.v.m. asfaltverharding.

Proefsleuf 13 - blad 12

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden.

Proefsleuf 14 - blad 13

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden. Er liggen erg veel kabels en leidingen in diverse richtingen, dus wellicht is het verstandig dit verder op te zoeken.

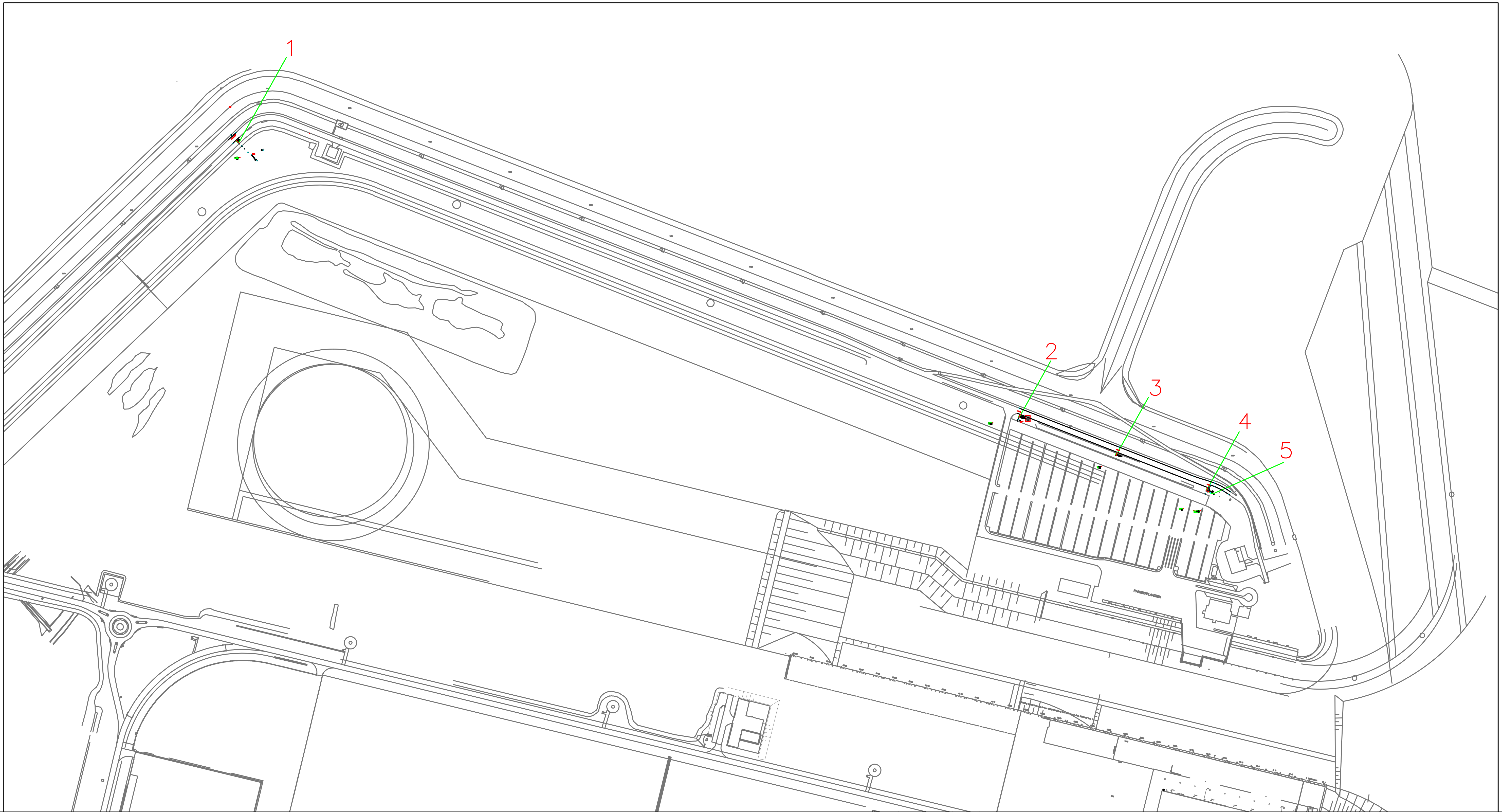
Proefsleuf 15 - blad 14

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden.

Proefsleuf 16 - blad 15

Alle kabels en leidingen die volgens de KliC-tekeningen zijn aangegeven zijn ook in de proefsleuf gevonden. Hier ligt de NorNed kabel. Deze is opgezocht tot aan de rode slab. De kabel ligt hieronder in backfillzand. Hier is niet in gegraven i.v.m. het magnetisch veld.

Op sommige plaatsen is een asbestcementwaterleiding aanwezig. Deze leiding is zeer breukgevoelig als er dicht in de buurt gewerkt word.



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OPMERKINGEN

PROJECT

Proefsleuven Eemshaven

OPDRACHTGEVER

Elzinga

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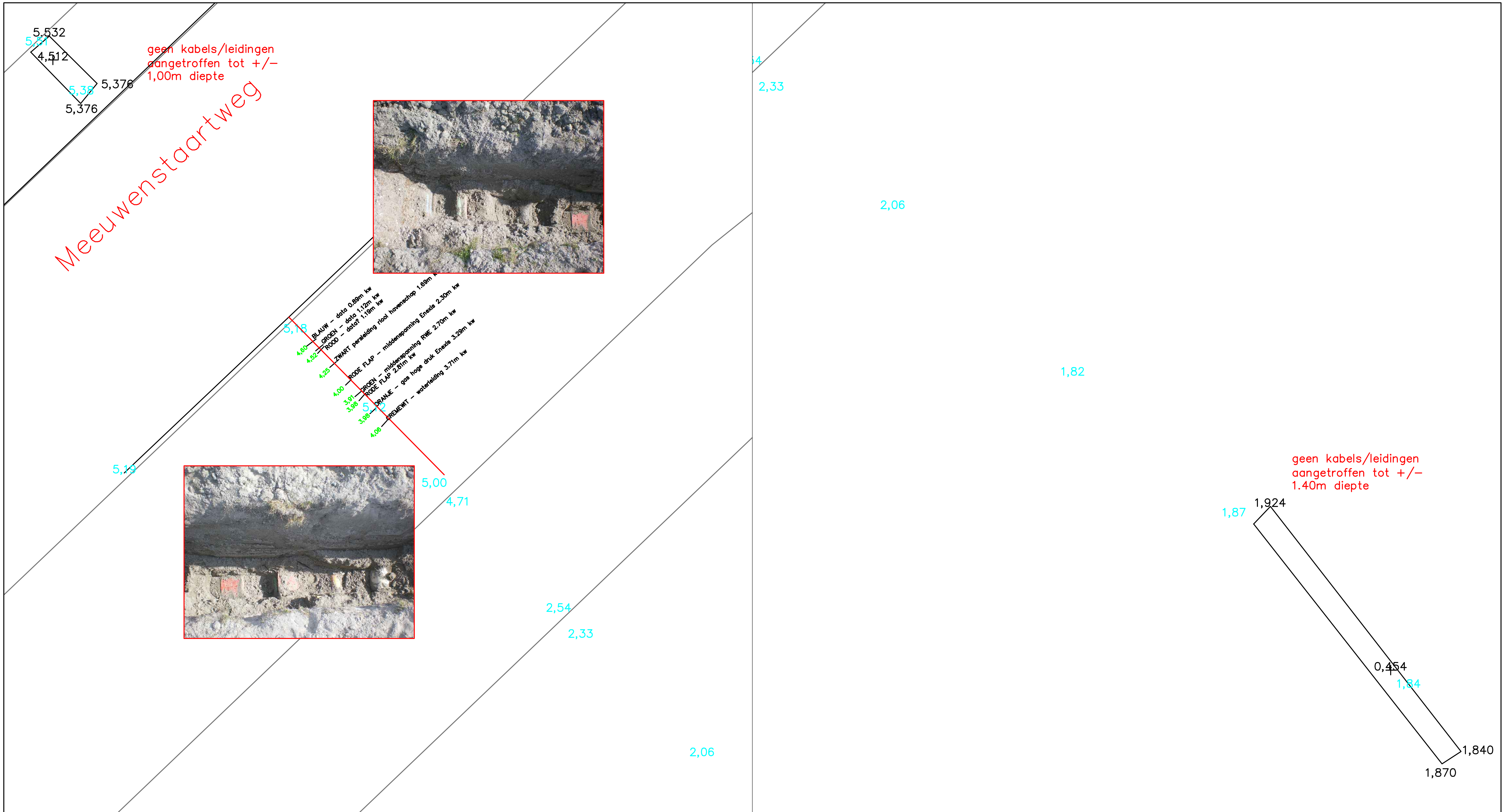
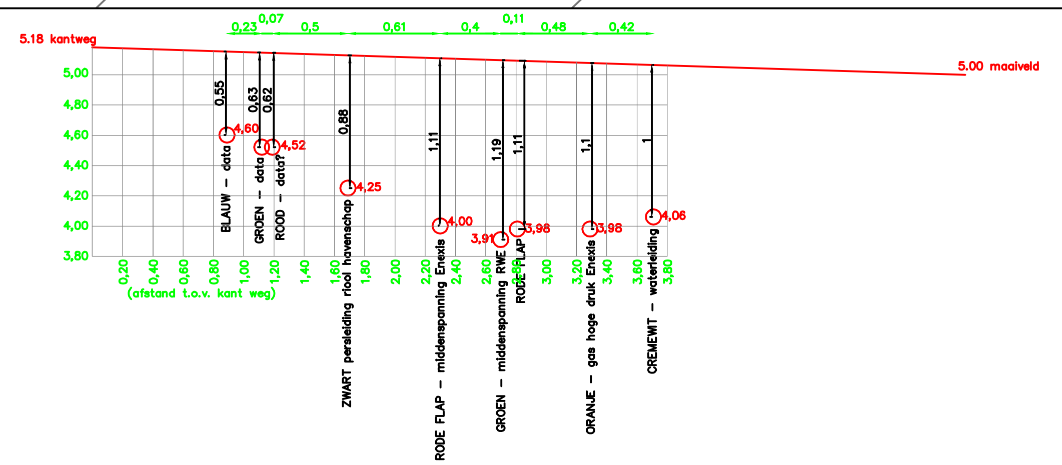
Tel.: 0597 595500 Fax: 0597 594340 E–mail: mail@geoplus.nl Internet: www.geoplus.nl





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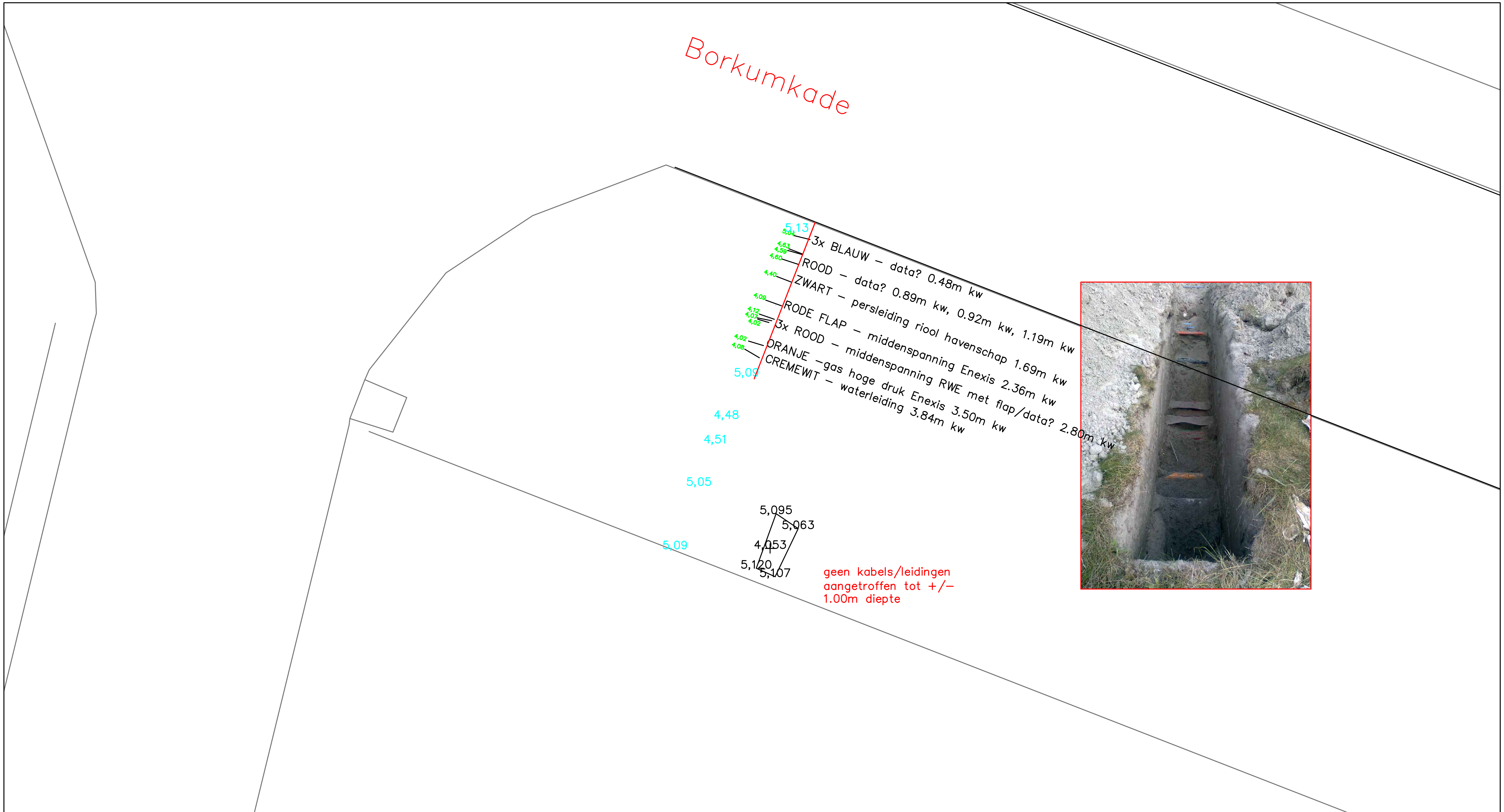

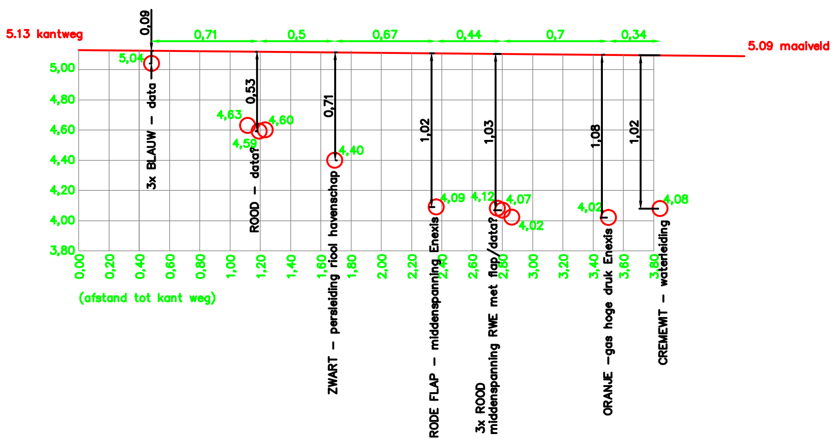

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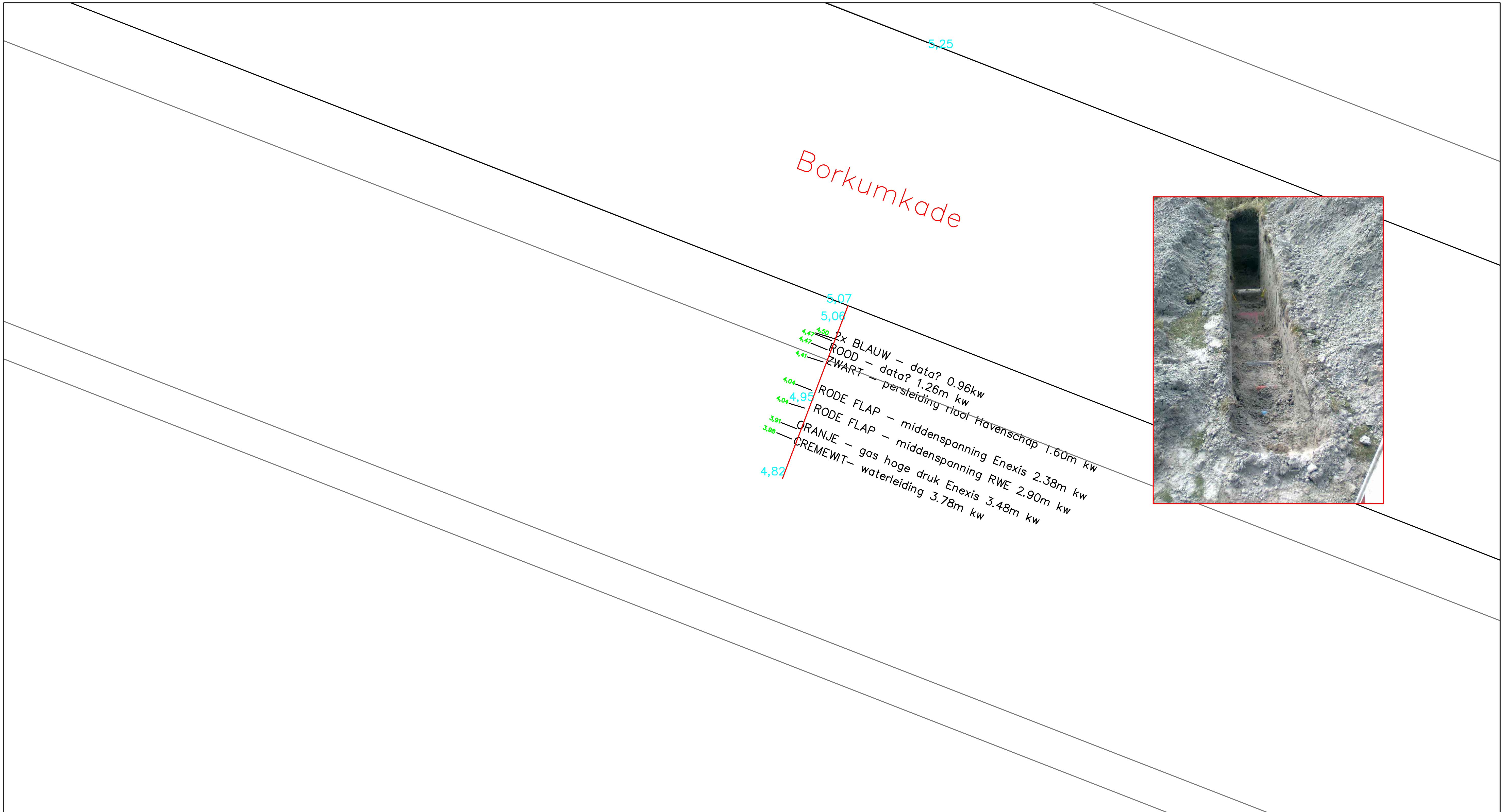

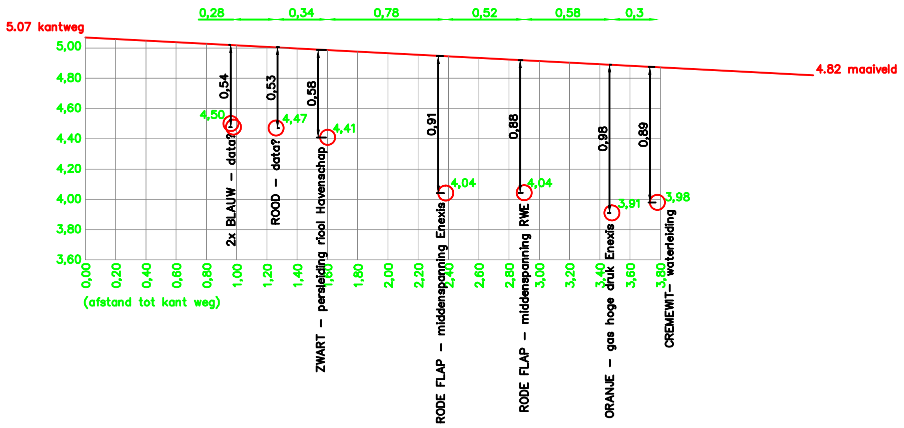

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Proefsleuven Eemshaven

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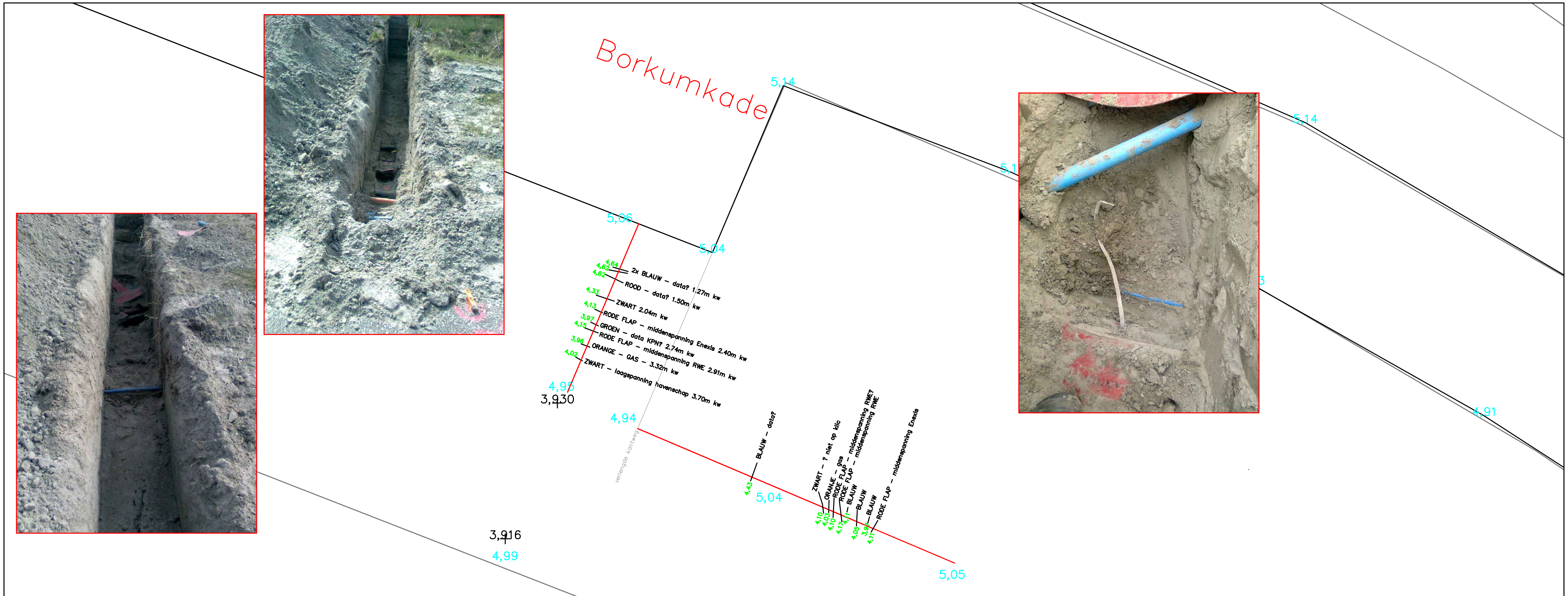

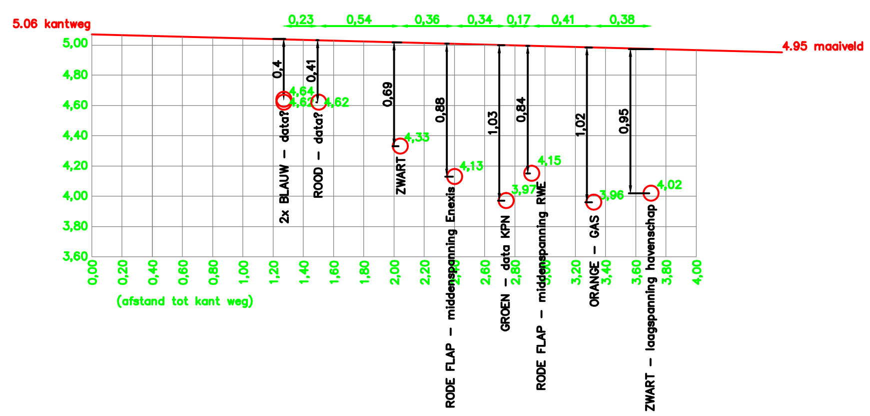

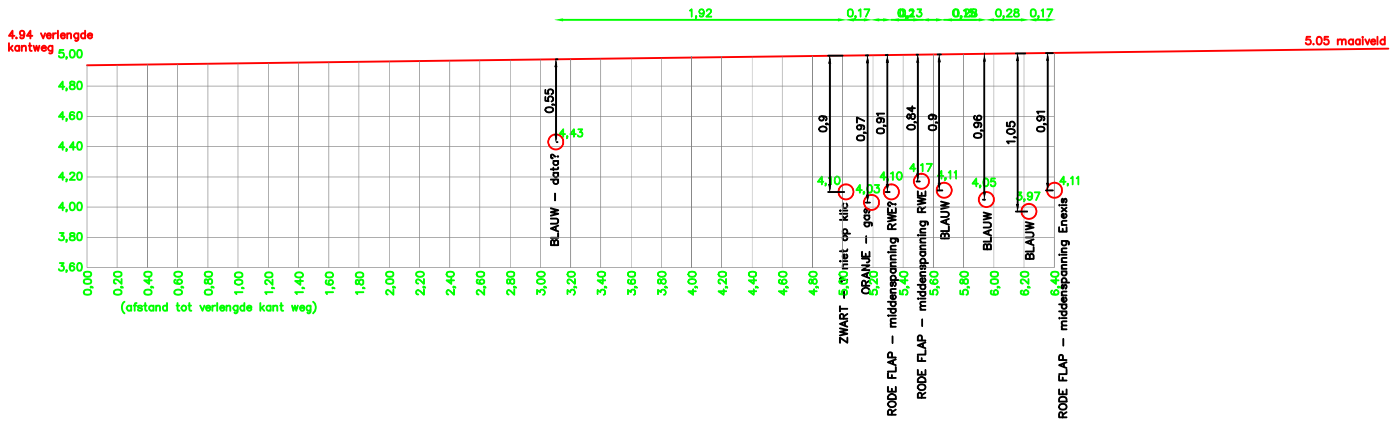

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PROJECT
Proefsleuven Eemshaven

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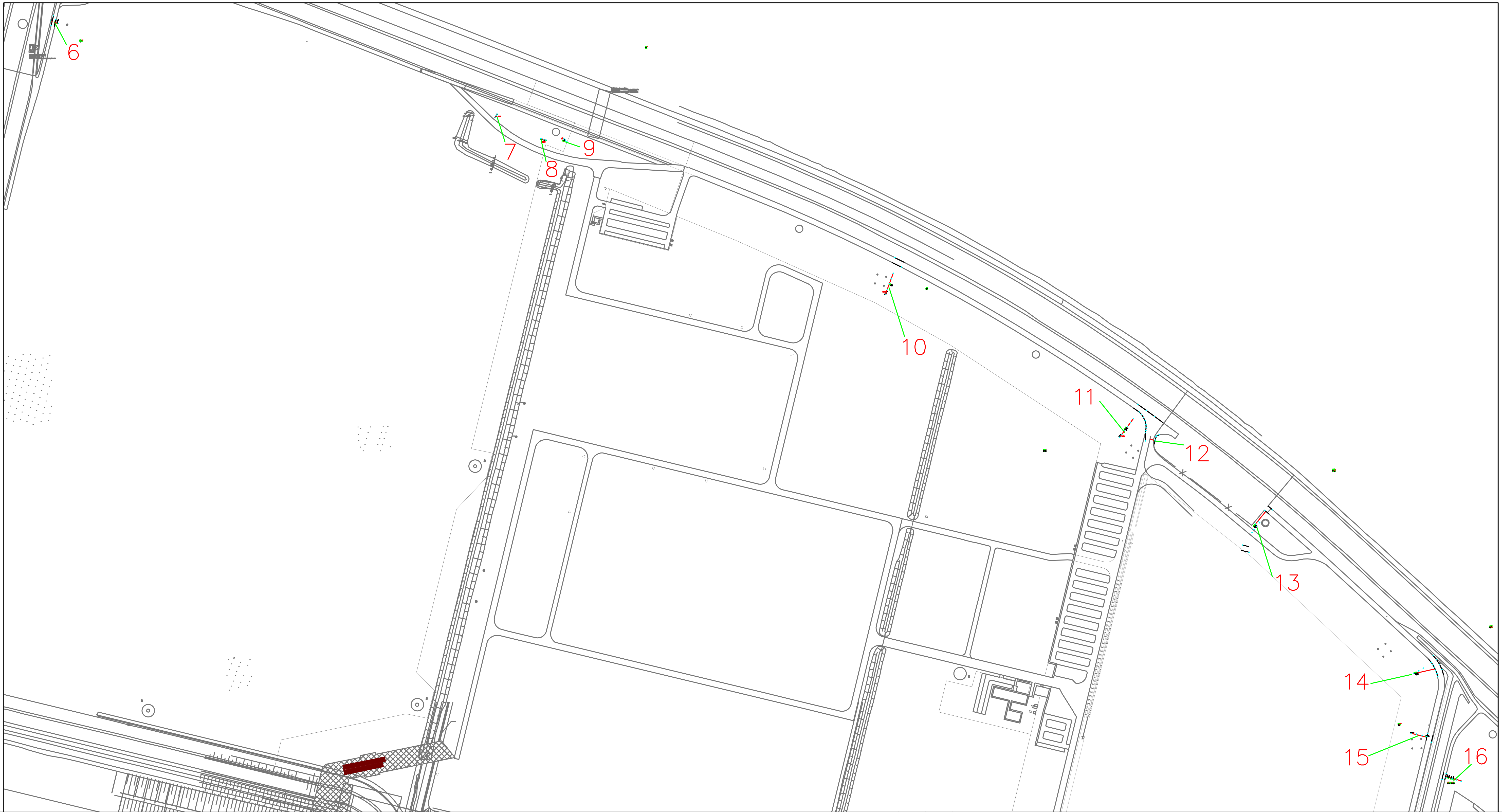

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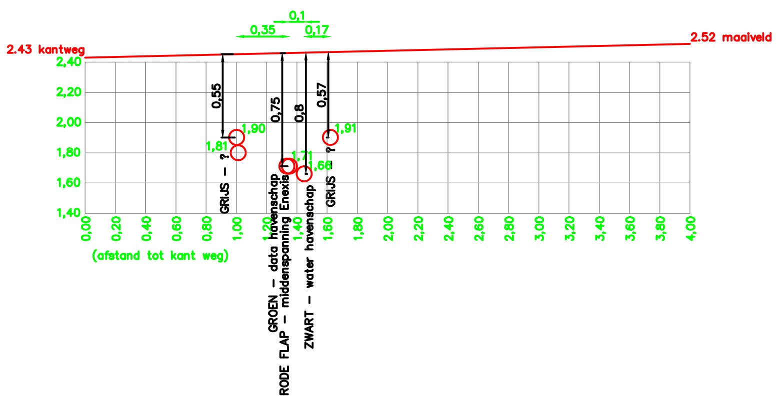

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Proefsleuven Eemshaven

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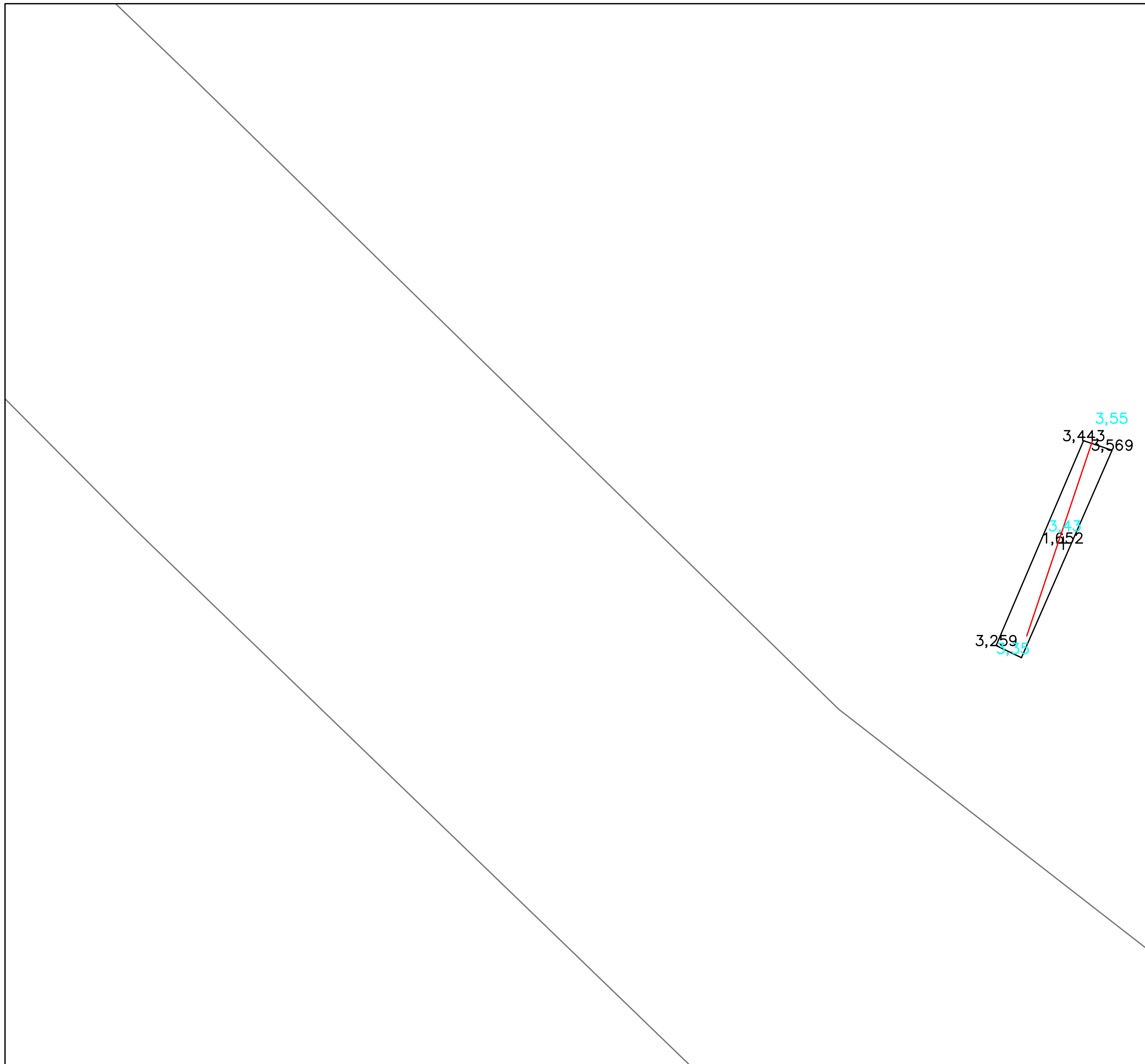

geen kabels/leidingen aangetroffen tot +/- 1.80m diepte

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Elzinga

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Formaat A3	Datum 03-05-'12	Tek.nr.	Besteknr.	Filenaam

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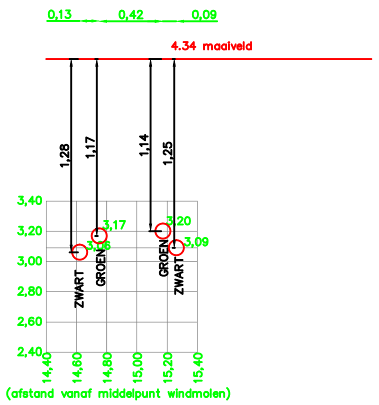

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Elzinga

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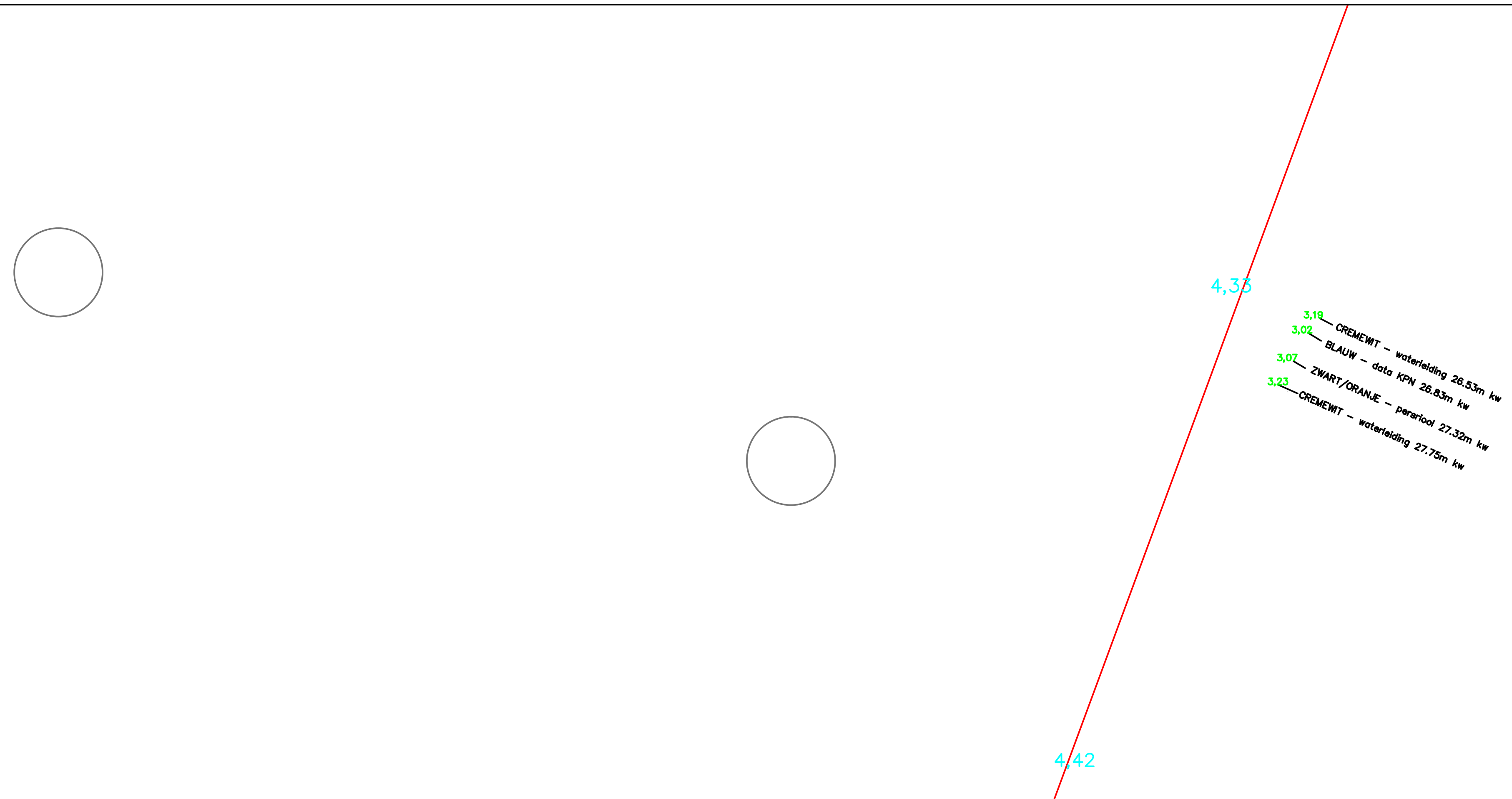

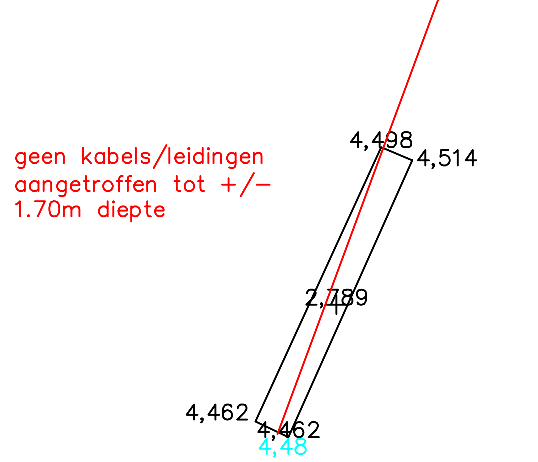

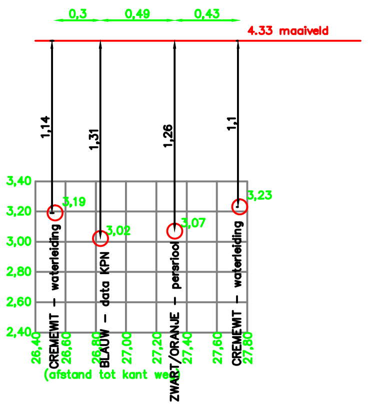

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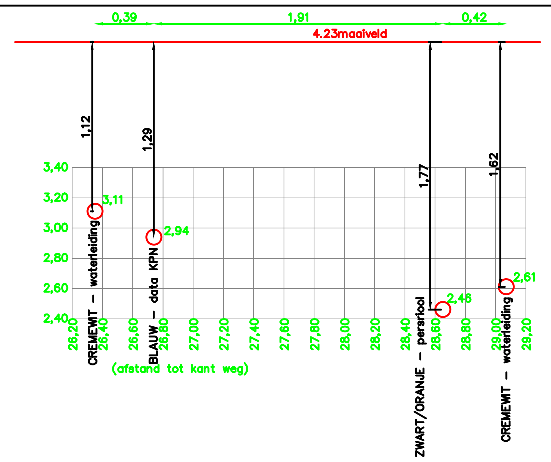

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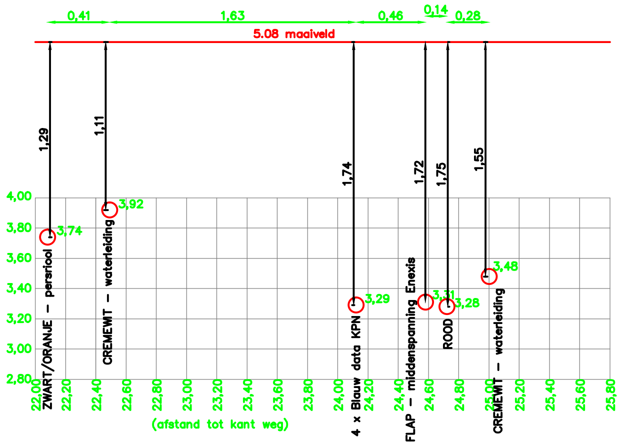

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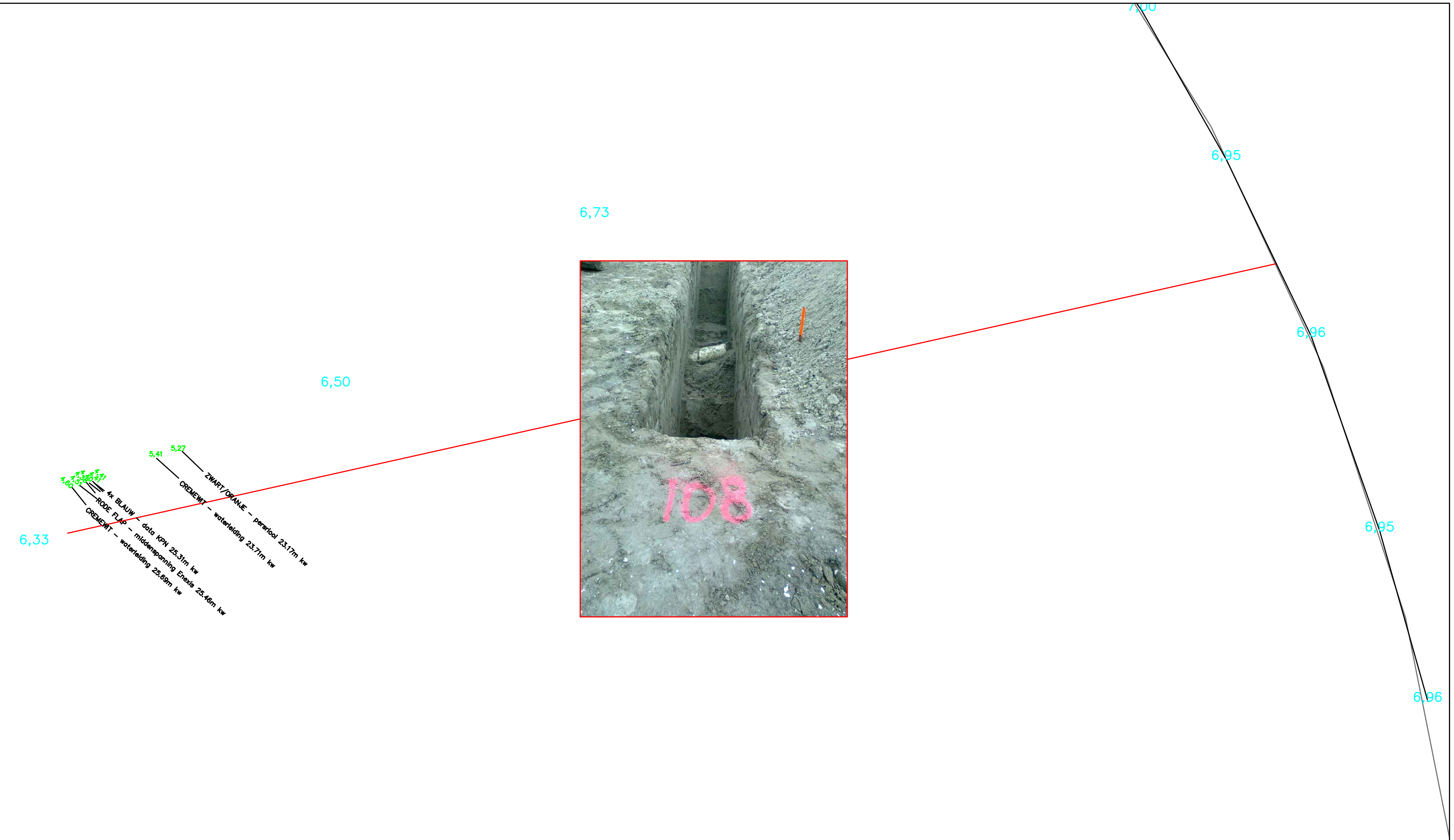

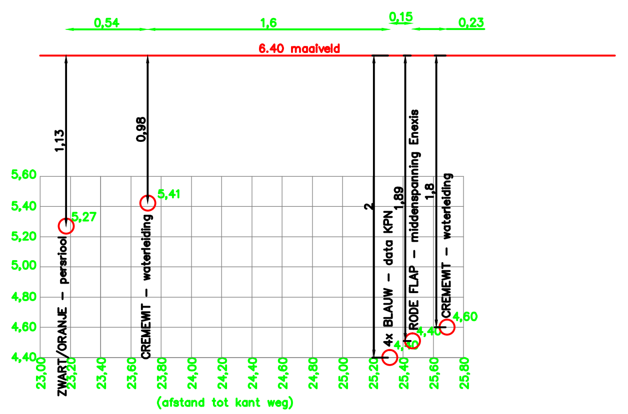

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Blad 13 van 15

Schaal 1 : 100

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Projectnr. 58807

Blad onderwerp detail sleuf 14

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Datum 10–05–'12

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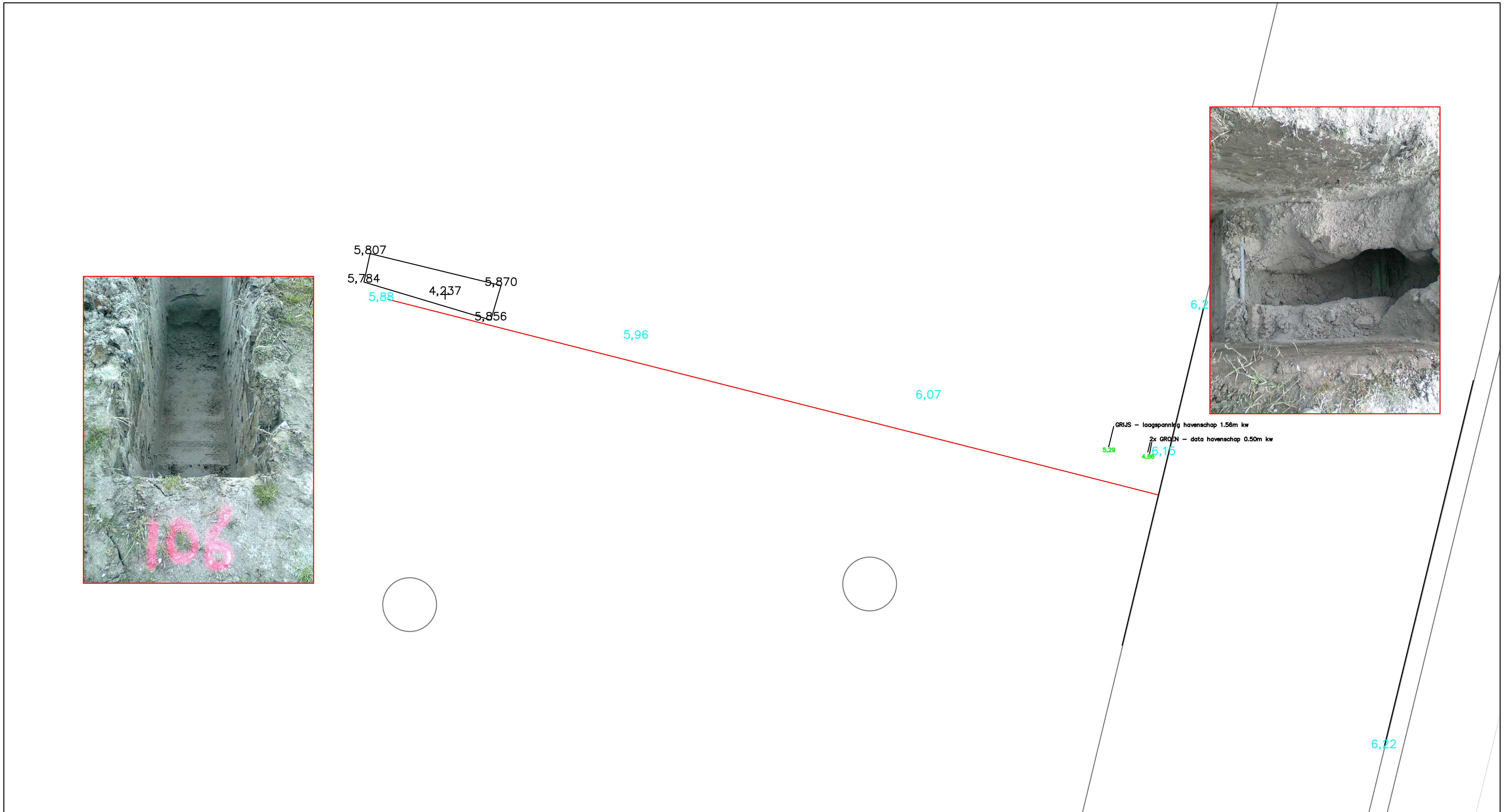

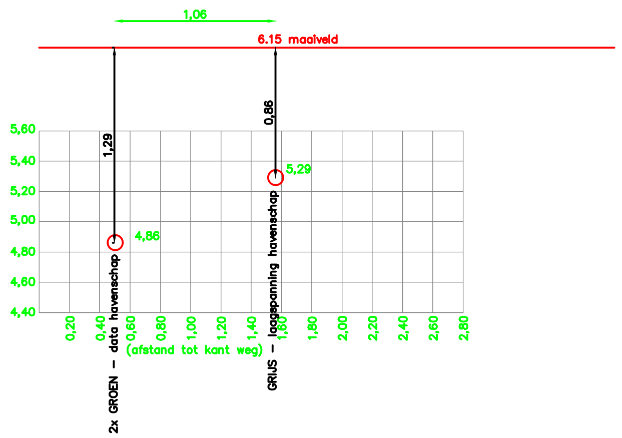

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Formaat A3	Datum 10–05–'12	Tek.nr.	Besteknr.	Filenaam

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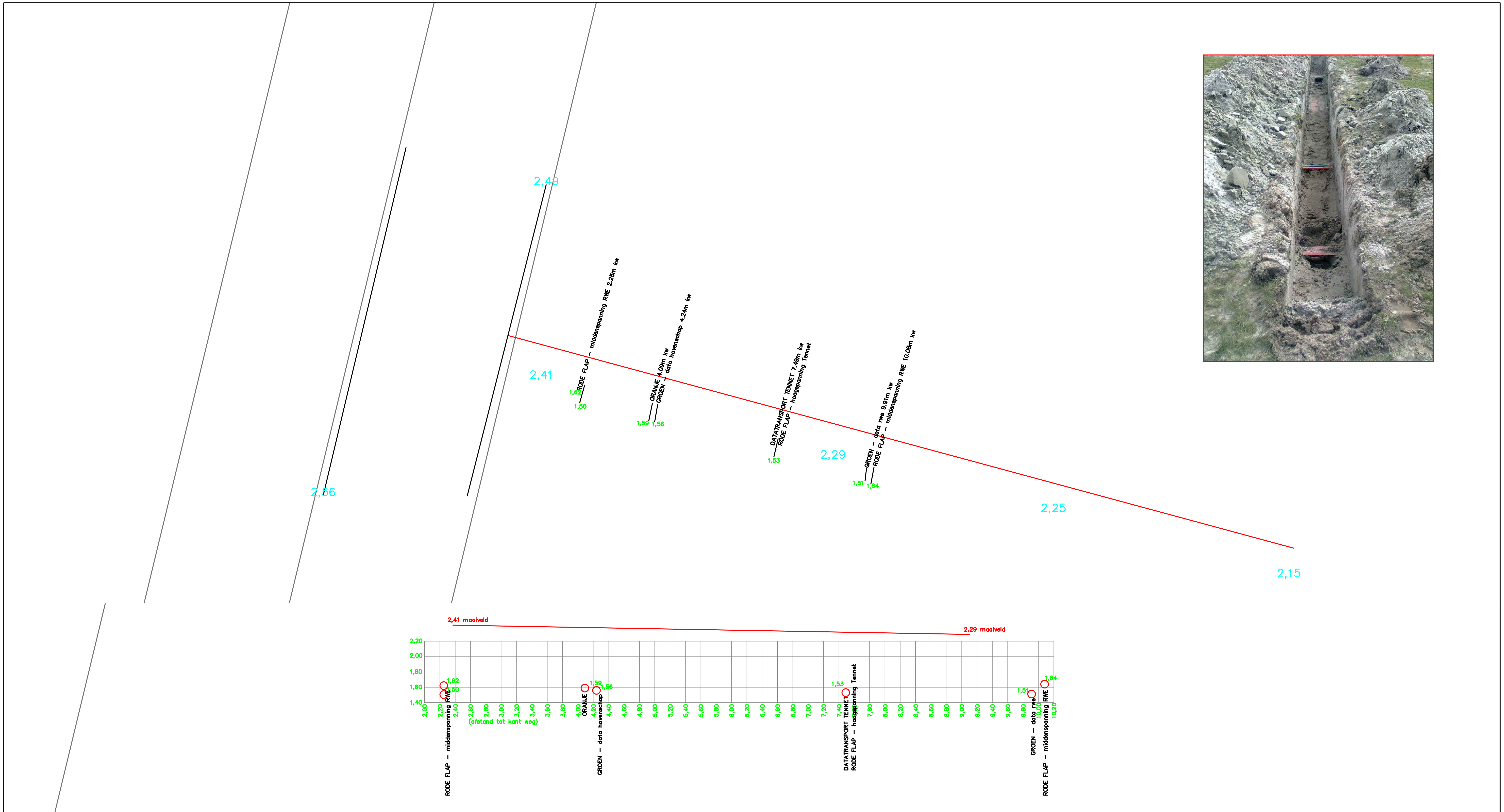

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PROJECT
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van 15	1 : 100	PAW	58807	detail sleuf 16
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Appendix B: Ensol_PRT_2010 19 Werkinstructie grondonderzoek

Werkinstructie grondonderzoek

Grondonderzoeken

(project)

Documentnummer:	ENSOL-RPT-2010.00
Auteur:	C. Schoop
Revisie:	0.1
Datum:	19 mei 2010
Gecontroleerd:	J.W. van Doeland

INHOUDSOPGAVE

Voorwoord

Voor het ondergronds aanleggen van hoogspanningverbindingen wordt alvorens de verschillende aspecten in kaart gebracht. Een belangrijk aspect is de grondgesteldheid van het aangewezen tracé, waar mogelijk de hoogspanningskabels aangelegd zullen worden.

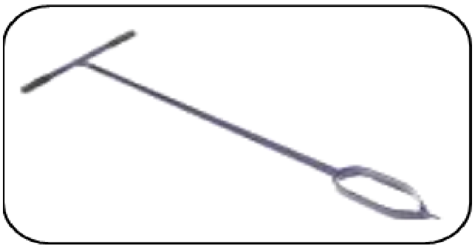
Door op meerdere locaties over een deel of geheel het tracé grondmetingen uit te voeren, worden de grondomstandigheden bepaald. De resultaten geven een nauwkeurige indicatie van de structuur en de thermische kwaliteit van de grond. Deze zijn als volgt ook bepalend voor de belastbaarheid van de verbinding.

Deze werkinstructie geeft een beschrijving van de wijze van uitvoering van een grondonderzoek.

1 Het grondonderzoek

Het grondonderzoek wordt door één of twee High-Voltage Engineers van Energy Solutions uitgevoerd. Op vooraf bepaalde locatie binnen het tracé wordt door middel van een meting de omstandigheden van de omliggende grond bepaald. Gedurende het meten wordt het tracé lopend afgelegd.

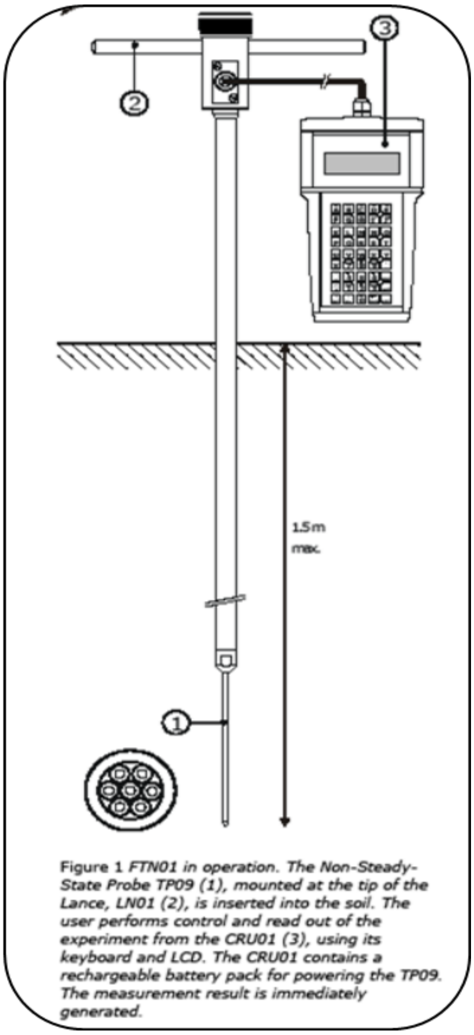
Om de metingen uit te kunnen voeren wordt eerst met behulp van een palenboor handmatig 2 gaten gemaakt in de grond. De gaten liggen naast elkaar. Dezen hebben een diameter van circa 5cm en bereiken een diepte van 60cm en maximaal 150cm. Na afloop worden alle gaten weer dicht gemaakt met dezelfde grond die hieruit gehaald is.



Figuur 1: *Palenboor*

Op de aangegeven diepten worden de metingen uitgevoerd met de Hukseflux FTN01 (Field Thermal Needle System). Dit apparaat meet de thermische weerstand/geleidbaarheid van de grond door met een verwarmingselement warmte af te geven, en te meten hoe snel de ze warmte wordt afgevoerd. Ook wel aangegeven als de g-waarde. Eén meting duurt ong. 5 min.

In figuur 2 is te zien hoe dit meetinstrument in de grond geplaatst wordt. De gemeten waarden worden met een control unit afgelezen.



Figuur 1: *Hukseflux FTN01*

2 Organisatie en Risico inventarisatie

2.1 Doorlooptijd

Energy Solutions tracht binnen de aangegeven periode de werkzaamheden uit te voeren. Indien de periode gewijzigd of verlengd moet worden door onvoorziene redenen, worden de nodige partijen hiervan op de hoogte gebracht.

2.2 Communicatie

Er wordt van te voren een afspraak gemaakt voor het uitvoeren van de werkzaamheden. Energy Solutions zal zorg dragen om de benodigde doorlooptijd bij alle betrokken partijen bekend worden gemaakt. Vóór de werkzaamheden van start gaan wordt(en) de grondbeheerder(s) op de hoogte gesteld, en bij einde werkzaamheden wordt tevens afgemeld.

2.3 Risico`s

Op basis van de wijze van uitvoering van dit grondonderzoek in combinatie met de instrumenten die gebruikt worden, zijn er geen directe risico`s en/of verstoringen vast te stellen voor het (natuur)gebied. Deze wijze sluit tevens het raken en/of beschadigen van overige leidingen die mogelijk hier ondergronds lopen uit.

2.4 Wijzigen van meetlocaties

Het kan zich voordoen dat een meetlocatie ter plekke gewijzigd moet worden. De grondstructuur van de meetlocatie kan hier de voornaamste reden voor zijn. De locatie wordt dan afhankelijk van de omliggende grond (alle kanten mogelijk) maximaal 3m opgeschoven.

Appendix C: Route Gemini - GRS with test trenches and G-values

Wind farm Gemini
Onshore Cable Route Soil Survey

Gemini wind farm

Cable Route Soil Survey

Onshore 220 kV / 380 kV

Revision history

Revision	Date	Author	Remarks
1.0	21 august 2012	J.A. van Oosterom	Final

Document number:	ENSOL-RPT-2012.064
Author:	J. A. van Oosterom
Revision:	1.0
Date:	21 augustus 2012
Checked:	A. Blanken

Summary

For the prospective Gemini wind farm, a 220 kV connection has been planned between the offshore wind farm and the Gemini onshore substation. This substation will be connected to the grid by a 380kV connection at the TenneT substation “Oudeschip” at the “Eemshaven”. For the onshore part of this connection, a soil survey has been performed to determine the thermal resistivity of the soil.

The 220 kV onshore route contains one HDD (horizontal directional drilling) to cross the water of the Eemshaven harbor. At both ends of this HDD, soil samples have been taken to a depth of 38 m. The rest of the 220 kV and 380 kV cable route is installed in open excavation. At this part, measurements have been done with a thermal needle sensor.

The advised values of the thermal resistivity based on the soil survey are listed in the table below:

Table 1: Summary thermal resistivity soil at different locations

Location	Thermal resistivity
220 kV open excavation	0,68 K.m/W
220 kV HDD	0,60 K.m/W
380 kV open excavation	0,87 K.m/W
380 kV crossing NorKop	0,47 K.m/W
380 kV crossing Eemsmond cooling water pipe	0,55 K.m/W

The results of the soil survey has been summarized in this document.

Contents

1 Introduction

For the onshore cable route of the wind farm Gemini, a soil survey has been performed to determine the thermal resistivity of the soil. In this chapter, a global view of the 380 kV and 220 kV cable route is shown, and a brief description of the measurement method for determining the thermal resisitivity of the soil is given.

In chapter two, the results of the soil survey are summarized.

1.1 380 kV AC connection

The route of the 380kV connection between the Gemini wind farm substation and the TenneT substation is in the eastern and southern piping strip, in the eastern part of “Eemshaven”. This route was suggested by “Groningen Seaports”. Figure 1 presents a general view of the 380kV connection route.

Figure 1: General view of the 380 kV AC connection

1.2 220 kV AC onshore connection

The route of the 220kV onshore connection between the wind farm and the Gemini substation is in the northern part of the “Eemshaven.” On this route the canal “Doekegatkanaal” will be crossed by horizontal directional drilling(HDD). A standard burial configuration will be used for the intersection of the dyke. Figure 2 presents a general view of the 220kV connection route.

Figure 2: General view of the onshore 220 kV AC connection.

1.3 Thermal needle system

The thermal resistivity at the part of the cable route that is installed in open excavation has been measured with a Hukseflux FTN01 Field Thermal needle System. With this device, the thermal conductivity of the soil is measured. The thermal resistivity of the soil (G-value) is then determined by taken the inverse of the measured value. The measurement device uses a probe with a heating element and a temperature sensor. When the probe is placed in the ground, the device measures the temperature rise of the soil due to the heat of the heating element. In the figure below, a view of the measurement device is given.

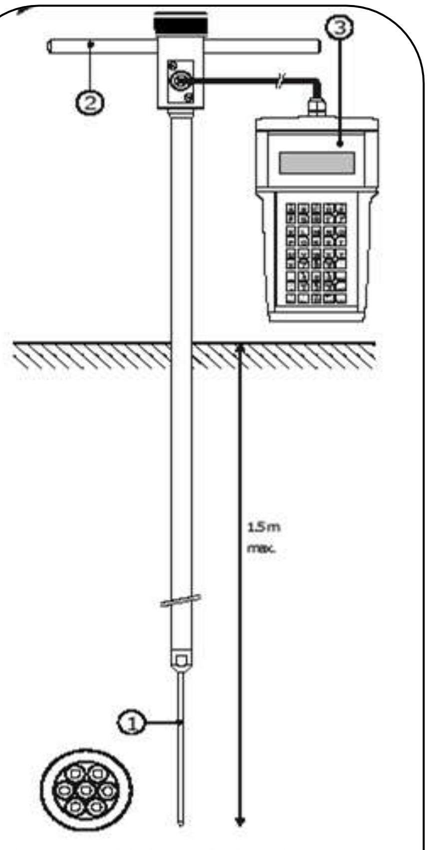


Figure 1 *FTN01 in operation. The Non-Steady-State Probe TP09 (1), mounted at the tip of the Lance, LN01 (2), is inserted into the soil. The user performs control and read out of the experiment from the CRU01 (3), using its keyboard and LCD. The CRU01 contains a rechargeable battery pack for powering the TP09. The measurement result is immediately generated.*

Figure 3: Hukseflux FTN01

The device uses the following standard to determine the thermal conductivity of the soil:

- IEEE Standard 442-1981 “Guide for soil Thermal Resistivity Measurements”.
- ASTM D5334 “Standard Test Method for determination of Thermal Conductivity of Soil and Soft Rock”.

2 Soil survey

2.1 380 kV AC connection

In 2011, a soil survey has been conducted at the 380 kV AC route for the"masterplan kabels en leidingen (ENSOL-RPT-2011.24)". In this survey the thermal resistivity of the soil (G-value) has been determined.

At 14 locations along the cable route, measurements were performed to determine the thermal resistivity of the soil.Figure 4 presents the exact locations of these measurements.

Figure 4: Locations of g-value measurements 380kV route

For the Gemini 380 kV AC cable route, measurement 1 to 6 are relevant. Measurement 1 is at the location where the 380 kV cable crosses the 380 kV NorKop cable. At the location of measurement 6, the 380 kV cable crosses a cooling water pipeline from the Eemsmond Energie power plant.

Table 2 shows the results of the relevant locations on this route.

Table 2: Results of soil investigation380kV route

Measuring Point	G-value 60 cm Km/W	G-value 150 cm Km/W	G-value conf. Map Km/W
Meting 1	0,42	0,48	0,47
Meting 2	0,46	0,47	0,47
Meting 3	0,54	0,93	0,87
Meting 4	0,37	0,69	0,64
Meting 5	0,45	0,70	0,66
Meting 6	0,75	0,51	0,55

The soil survey shows that the highest value in a standard burial configuration is 0,87 K·m/W . Near the intersection of the 380 kV AC NorKop cable, the G-value is more favorable. At this intersection, a G-value of 0,47 K·m/W can be used. For the crossing of the cooling water pipeline, a G-value of 0,55 K.m/W can be used.

2.2 220 kV AC onshore connection

2.2.1 Open excavation

The thermal resistivity of the soil for the 220kV onshore connection has been determined at 20 locations along the route. The first measuring point is at the location of the transition joint of the offshore connection (Measurement M1). Measurement M20 is at the future onshore Gemini substation. The figures below show the measurement points in the cable route.

Figure 5: Measurement M1 – M12

Figure 6: Measurement M12- M20

In the table below, the results of the measurements are shown.

Table 3: results of soil survey at the 220kV route

Measuring point	G-value		G-value conf. Map
	60 cm	150 cm	
M1	0,60	0,57	0,57
M2	0,35	0,33	0,33
M3	0,42	0,27	0,29
M4	0,39	0,36	0,36
M5	0,25	0,22	0,22
M6	0,43	0,47	0,45
M7	0,34	0,46	0,45
M8	0,35	0,60	0,57
M9	0,64	0,28	0,32
M10	0,38	0,39	0,39
M11	0,23	0,28	0,28
M12	0,32	0,56	0,54
M13	0,33	0,59	0,56
M14	0,91	0,64	0,67
M15	0,65	0,56	0,57
M16	0,65	0,68	0,68
M17	0,89	0,43	0,46
M18	0,49	0,38	0,39
M19	1,25	0,20	0,29
M20	0,61	0,34	0,37

The highest value in the soil survey of the 220 kV rout is found at measurement M16. At this location a G-value of 0,68 K·m/W is determined. This value can be used for the cable ampacity calculation in a standard burial configuration.

2.2.2 Horizontal directional drilling

At both ends of the HDD, soil samples have been taken at a depth upto 38 m. This process has been done twice, because the first time, an insufficient number of samples had been taken. The results of these soil survey drillings are found in Appendix A. In Appendix B, the drawing of the HDD is shown. In this drawing, the locations of the soil survey drillings are included (marker B-01a and B02a).

From the soil samples, the dry and wet volume weight and the moisture content has been determined. From the volume weight and moisture content, the thermal resistivity of the soil is calculated. The calculations for the thermal resistivity are done for every soil sample taken. The results of this calculation is found in the table below.

Laag	Omschrijving lagen conform NEN5104	Klasse Tabel	NAP start	NAP eind	Laagdikte	Volume gewicht [kg/m3]		Vochtgehalte	Berekende g-waarde nat
			[m]	[m]	[m]	Wet	Dry	(droog)	[K.m/W]
1	Zand, zeer fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, lichtbruin		4	0,9	3,1				
	Monster S1	Zand				1810	1530	18,00%	0,45
2	Zand, zeer fijn, matig siltig, zwak schelphoudend, geen olie-water reactie, grijs		0,9	-0,4	1,3				
	Monster S2	Zand				1890	1530	23,50%	0,45
3	Zand, zeer fijn, zwak siltig, zwak schelphoudend, geen olie-water		-0,4	-4,5	4,1				
	Monster S3	Zand				1920	1550	23,80%	0,42
4	Zand, zeer fijn, zwak siltig, zwak humeus, laagjes klei, geen olie-water reactie, donkergrijs		-4,5	-15,4	10,9				
	Monster S4	Zand				1750	1290	35,60%	0,58
	Monster S5	Zand				1870	1470	27,60%	0,65
	Monster S6	Zand				1920	1530	25,30%	0,45
5	Klei, matig zandig, zwak humeus, laagjes klei, laagjes zand, geen olie-water reactie, donkergrijs		-15,4	-17,4	2				
	Monster S7	Klei				1650	1100	49,40%	0,89
	Monster S8	Klei				1750	1260	39,20%	0,78
6	Zand, zeer fijn, uiterst siltig, geen olie-water reactie, grijs		-17,4	-18,4	1				
7	Klei, sterk zandig, geen olie-water reactie, grijs, Matig-stijf gelaagd klei + zand		-18,4	-21,4	3				
	Monster OM1	Klei				1680	1140	47,40%	0,85
8	Zand, matig grof, zwak siltig, geen olie-water reactie, grijs		-21,4	-23,4	2				
	Monster S9	Zand				2000	1730	15,80%	0,28
9	Zand, matig grof, zwak siltig, zwak grindig, geen olie-water reactie, lichtbruin, Compacte laag met fijn grind		-23,4	-25,4	2				
	Monster S10	Zand				2110	1870	12,50%	0,22
10	Zand, matig fijn, zwak siltig, matig grindig, geen olie-water reactie, lichtbruin		-25,4	-26,4	1				
11	Zand, zeer grof, zwak siltig, zwak grindig, geen olie-water reactie, lichtbruin, grof grind, >10cm <20cm		-26,4	-27,4	1				
	Monster S11	Zand				1990	1700	17,30%	0,30
12	Zand, matig fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, lichtbruin		-27,4	-33,4	6				
	Monster S12	Zand				1920	1610	19,50%	0,37

Figure 7: Results drilling 1

Laag	Omschrijving lagen conform NEN5104	Klasse Tabel	NAP start	NAP eind	Laagdikte	Volume gewicht [kg/m3]		Vochtgehalte	Berekende g-waarde nat
			[m]	[m]	[m]	Wet	Dry	(droog)	[K.m/W]
1	Zand, matig fijn, zwak siltig		2,25	0,25	2				
2	Zand, zeer fijn, matig siltig, zwak schelphoudend		0,25	-4,75	5				
	Monster S1	Zand				1840	1520	20,60%	0,46
	Monster S2	Zand				1930	1550	24,10%	0,42
3	Zand, zeer fijn, matig siltig, laagjes klei, Veel klei lenzen		-4,75	-11,75	7				
	Monster S3	Zand				1950	1570	24,00%	0,40
	Monster S4	Zand				1870	1440	30,10%	0,51
4	Zand, zeer fijn, matig siltig, laagjes klei, Enkel lensje		-11,75	-14,75	3				
	Monster S5	Zand				1930	1570	22,80%	0,40
5	Zand, zeer fijn, zwak siltig, zwak houthoudend, zwak schelphoudend, laagjes klei, Enkel lensje		-14,75	-15,75	1				
6	Zand, zeer fijn, sterk siltig, zwak humeus		-15,75	-17,75	2				
	Monster S6	Zand				1970	1600	23,00%	0,37
7	Zand, zeer fijn, uiterst siltig, laagjes klei, lenzen klei		-17,75	-18,75	1				
8	Klei, matig zandig, Matig slap gelaagd met zand		-18,75	-23,75	5				
	Monster OM1	Klei				1800	1330	35,00%	0,80
	Monster OM2	Klei				1640	1100	49,70%	0,89
	Monster OM3	Klei				1630	1130	44,10%	0,83
9	Zand, matig grof, zwak siltig, matig grindig, Grof grind		-23,75	-24,75	1				
10	Zand, zeer fijn, matig siltig		-24,75	-26,75	2				
	Monster S7	Zand				1970	1610	22,30%	0,37
11	Zand, zeer fijn, matig siltig, Zeer hard + compact		-26,75	-31,75	5				
	Monster S8	Zand				2000	1660	20,90%	0,33
12	Zand, zeer fijn, matig siltig		-31,75	-35,75	4				
	Monster S9	Zand				1990	1640	21,60%	0,34
	Monster S10	Zand				1970	1600	22,70%	0,37

Figure 8: Results drilling 2

From these results, the thermal resistivity of three different depths are calculated using conformal mapping. The thermal resistivity of the following locations have been calculated:

- On the west side of the HDD at the descending part with the highest distance between the HDD and the surface.
- Below the Doekegatkanaal. At this point, the HDD is at a constant depth of 10 m below the surface of the canalbed.
- On the east side of the HDD at the descending part with the highest distance between the HDD and the surface.

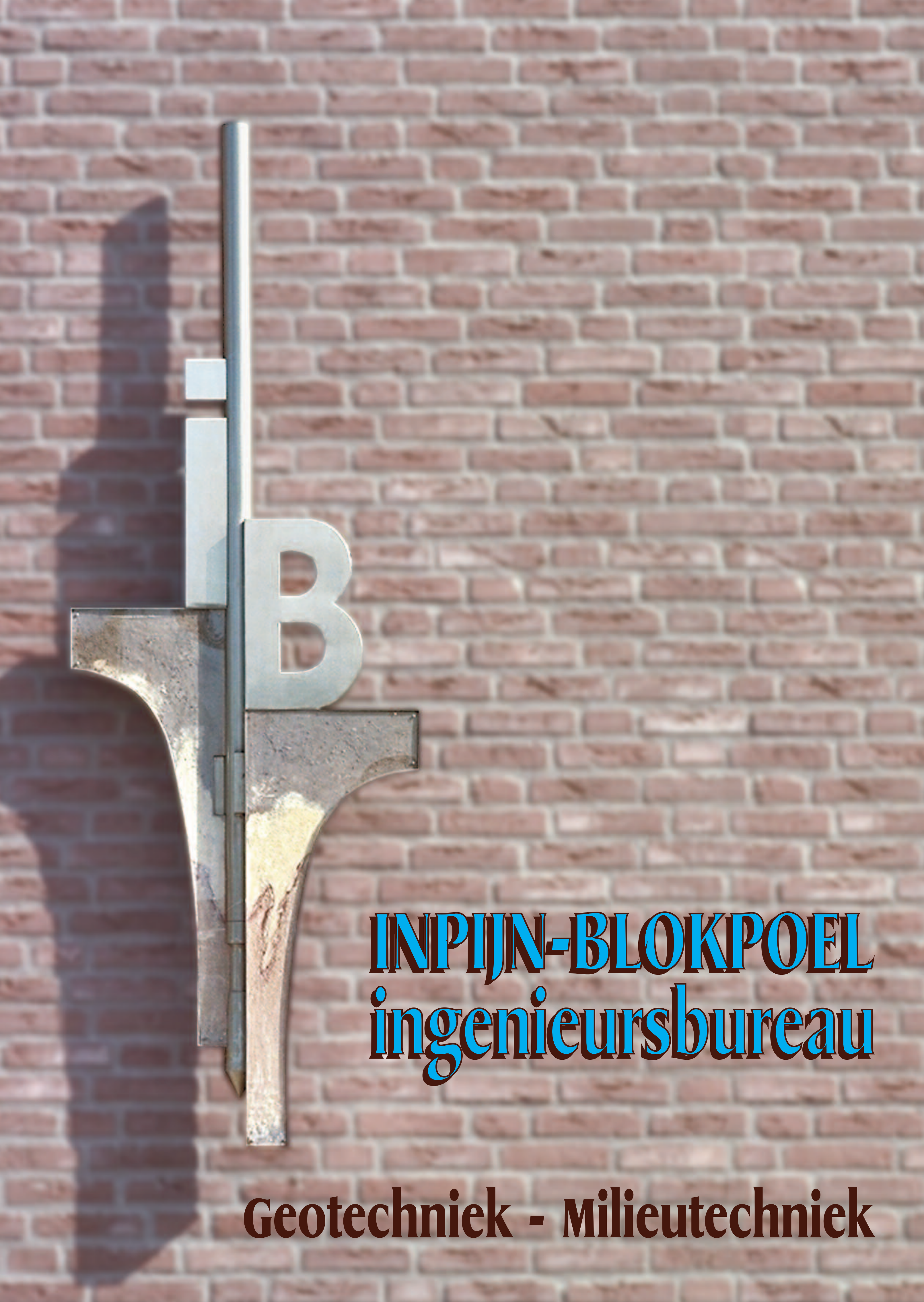
The results of the conformal mapping calculations are shown in the table below.

Table 4: Results conformal mapping calculations HDD

Location	Thermal resistivity	Depth below surface
Left side HDD	0,60 K.m/W	23 m
Under Doekegatkanaal	0,41 K.m/W	10 m
Right side HDD	0,52 K.m/W	27 m

From the calculations can be concluded that the thermal bottleneck of the HDD is at the west side of the drilling where the HDD is covered with about 23 m meters of soil. At this location, a thermal resistivity of 0,6 K.m/W has been calculated. This value can be used for the ampacity calculations.

APPENDIX A: Soil survey HDD Doekegatkanaal


INPIJN-BLOKPOEL
ingenieursbureau
Geotechniek - Milieutechniek

Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg te Eemshaven

Betreft	Resultaten geotechnisch onderzoek
Opdrachtnummer	03P000943
Documentnummer	03P000943-RG-01
Opdrachtgever	Van Vulpen B.V. Postbus 231 4200 AE GORINCHEM

Opgesteld door : H. Eenhoorn — Paraaf :
Gezien : F.J. Brouwer — Paraaf :
Status : Definitief
Codering : RG

Datum rapport : 21 maart 2012

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INHOUDSOPGAVE

BIJLAGEN:
A) Situatietekeningen
B) Boorstaten
C) Laboratoriumresultaten
D) Verklaring codering

VERZENDLIJST
1 x Van Vulpen B.V. te Gorinchem t.a.v. de heer E.J. Offers

1. INLEIDING

Ten behoeve van het project ”Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg te Eemshaven“ is door ons bureau op verzoek van Van Vulpen B.V. uit Gorinchem een geotechnisch onderzoek verricht. Voorliggend rapport bevat een beschrijving en de resultaten van het onderzoek.

2. ONDERZOEK

2.1 Boringen

Er zijn 2 boringen uitgevoerd. In de boorgaten is naar de grondwaterstand gepeild. Voor de boorprofielen wordt verwezen naar bijlage B; de locatie van de boorpunten is aangegeven op de situatietekening SIT-01, toegevoegd onder bijlage A. Voor een verklaring van de op de tekening en de boorprofielen gebruikte tekens wordt verwezen naar de “Verklaring Codering” die onder bijlage D aan dit rapport is toegevoegd. Gedurende het boorwerk zijn ongeroerde monsters genomen voor nader onderzoek in het laboratorium.

2.2 Geotechnisch laboratoriumonderzoek

2.2.1 Volumegewichten en watergehalten

Van 4 ongeroerde monsters is het nat en droog volumegewicht, het poriëngehalte en de verzadigingsgraad bepaald.

De resultaten van het laboratoriumonderzoek zijn verzameld onder bijlage C.

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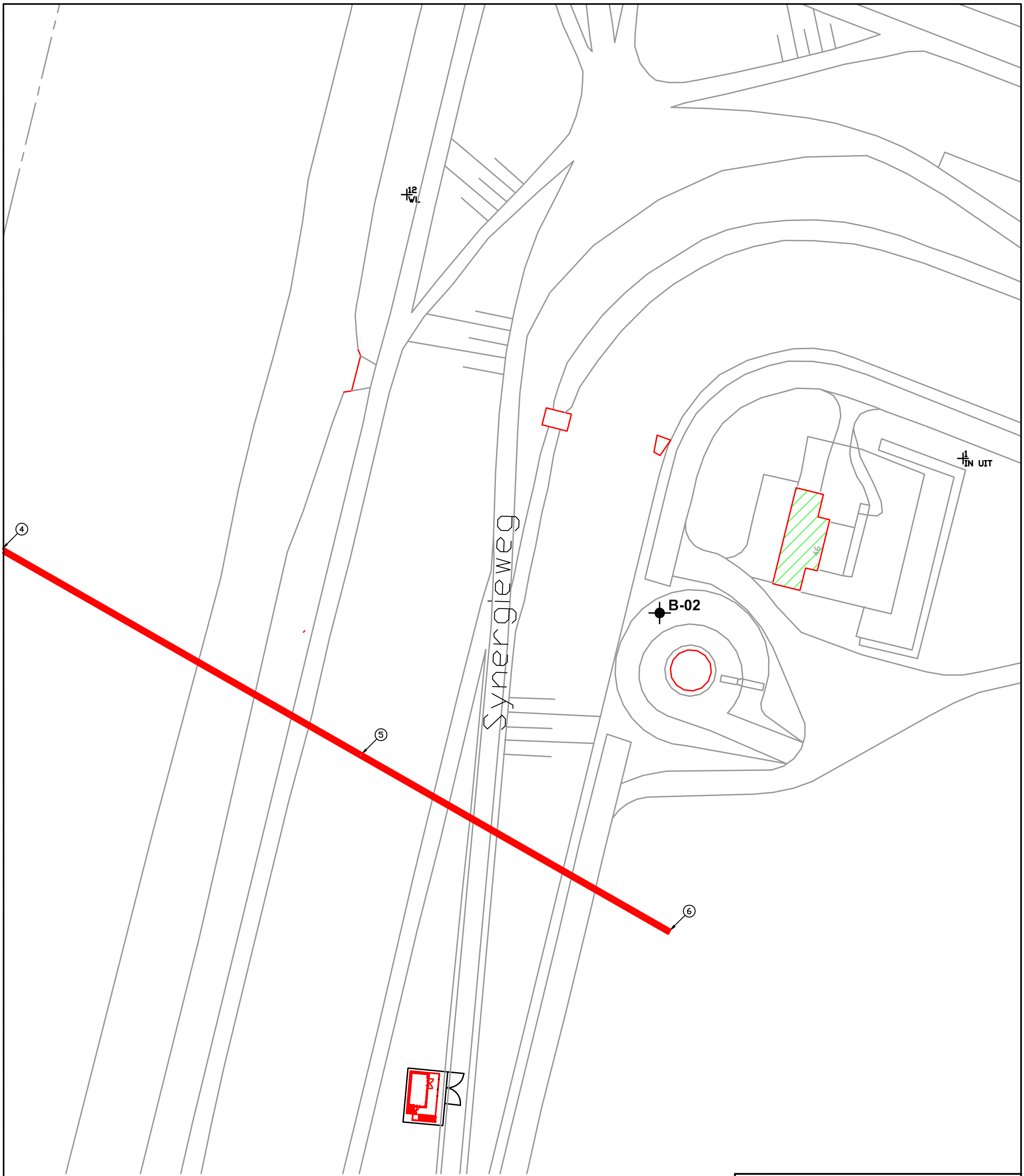
Bijlage A



0 5 10 15 20 25m

N

Bestaande bebouwing

Bron:	E-mail digitale tekening
Bureau + vestigingsplaats:	Van Vulpen B.V.
Tekening- / bladnummer:	212024614
Datum laatste bewerking:	

INPIJN-BLOKPOEL
Ingenieursbureau

Opdrachtomschrijving / locatie:

Locatie Eemshaven-Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven

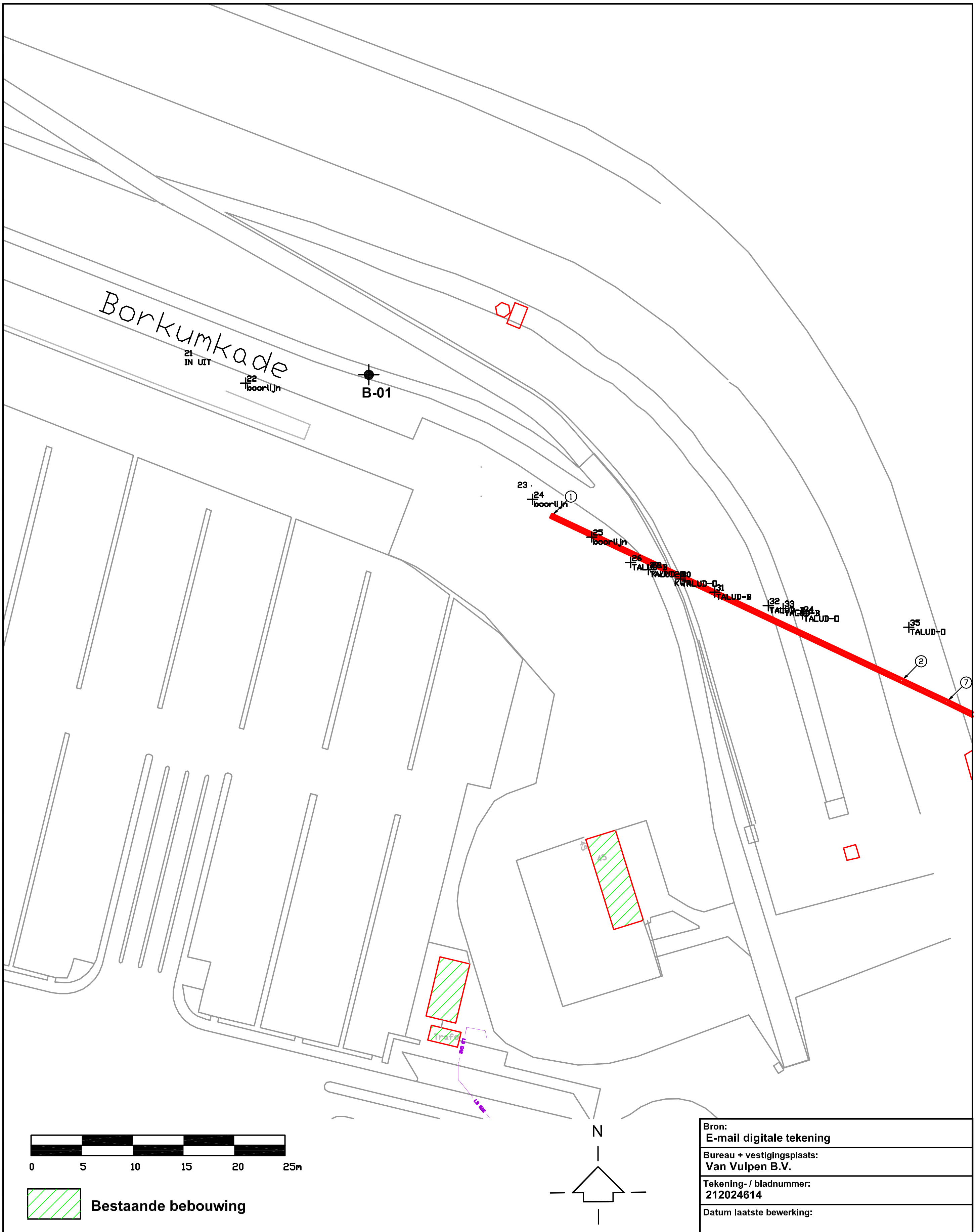
Omschrijving tekening:

Situatietekening

Opdrachtnummer: 03P000943	Bijlage: SIT-02
Bewerkt: AMA	Datum: 21-03-2012
Gezien:	Schaal: 1 : 500 / Formaat: A4

Disclaimer: Deze tekening dient om inzicht te geven in de locatie van de meet- en onderzoekspunten.
De tekening dient niet voor andere doeleinden te worden gebruikt.

M:\Opdrachten\03\03P\Teken\01-T-03P000943-AMA



Bron:	E-mail digitale tekening
Bureau + vestigingsplaats:	Van Vulpen B.V.
Tekening- / bladnummer:	212024614
Datum laatste bewerking:	

INPIJN-BLOKPOEL
Ingenieursbureau

Opdrachtomschrijving / locatie: **Locatie Eemshaven-Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven**	Opdrachtnummer: **03P000943**	Bijlage: **SIT-01**	
	Bewerkt: **AMA**	Datum: **21-03-2012**	
Omschrijving tekening: **Situatietekening**	Gezien:	Schaal: **1 : 500**	Formaat: **A4**

M:\Opdrachten\03\03P\Teken\01-T-03P000943-AMA

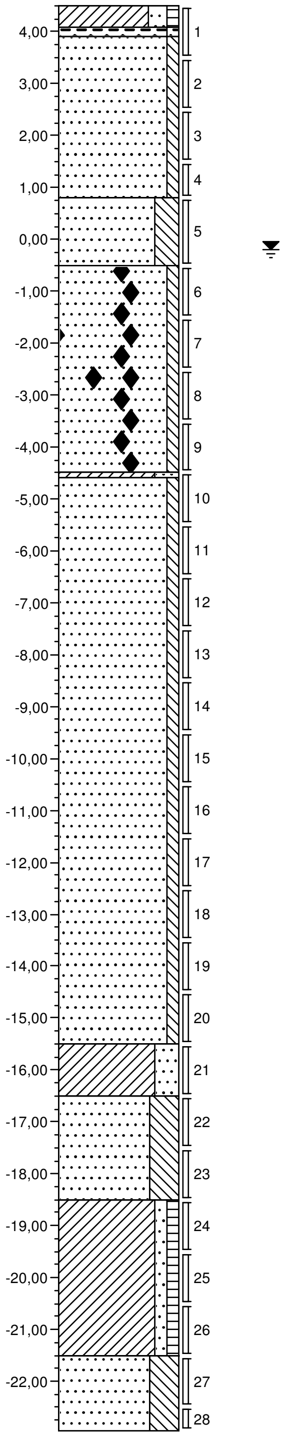
Bijlage B

Opdracht: 03P000943
Project: Locatie Eemshaven-Doekegatkanaal
Plaats: Eemshaven

Boring: **B-01 - 1** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op: 08-03-2012
Boring nabij:
Uitvoering door: R. de Vries

Maaiveldhoogte: 4,5 m t.o.v. N.A.P.
Grondwaterstand: 470 cm - maaiveld



0,00
0,40 Klei, matig zandig, zwak humeus, geen olie-water reactie, bruingrijs
0,60 Grind, fijn, zwak zandig, puin, geen olie-water reactie, bruin, Stabilisatie
Zand, zeer fijn, zwak siltig, geen olie-water reactie, lichtbruin

3,70
Zand, zeer fijn, sterk siltig, zwak schelphoudend, geen olie-water reactie, grijs

5,00
Zand, zeer fijn, zwak siltig, laagjes klei, zwak houthoudend, lenzen klei, geen olie-water reactie, donkergrijs

9,00
9,10 Klei, sterk zandig, geen olie-water reactie, donkergrijs, Zeer slap
Zand, zeer fijn, zwak siltig, laagjes klei, geen olie-water reactie, donkergrijs

20,00
Klei, sterk zandig, geen olie-water reactie, donkergrijs

21,00
Zand, zeer fijn, uiterst siltig, geen olie-water reactie, grijs

23,00
Klei, zwak zandig, zwak humeus, geen olie-water reactie, grijs, Matig-stijf gelaagd klei + zand

OM 1

26,00
Zand, zeer fijn, uiterst siltig, geen olie-water reactie, grijs

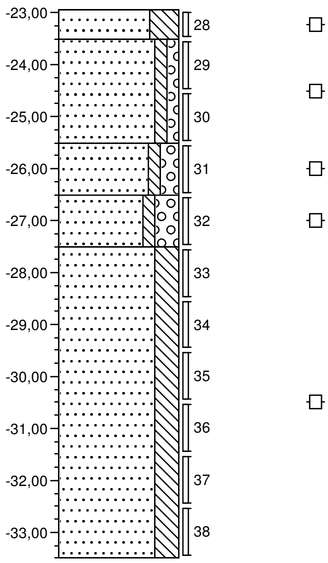
27,44

Opdracht: 03P000943
Project: Locatie Eemshaven-Doekegatkanaal
Plaats: Eemshaven

Boring: **B-01 - 2**
Uitvoering op: 08-03-2012
Boring nabij:
Uitvoering door: R. de Vries

Boring volgens NEN 5119
Maaiveldhoogte: 4,5 m t.o.v. N.A.P.
Grondwaterstand: 470 cm - maaiveld

Classificatie volgen NEN 5104



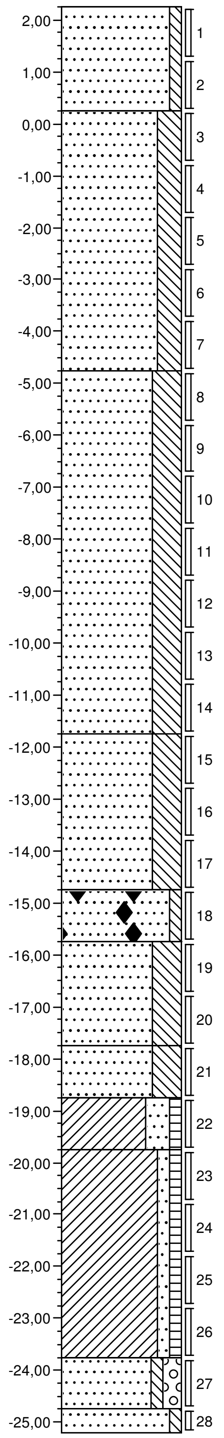
27,44
Zand, zeer fijn, uiterst siltig, geen olie-water reactie, grijs
28,00
Zand, zeer fijn, zwak siltig, zwak grindig, geen olie-water reactie, lichtbruin, Compacte laag met fijn grind
30,00
Zand, matig fijn, zwak siltig, matig grindig, geen olie-water reactie, lichtbruin
31,00
Zand, matig fijn, zwak siltig, sterk grindig, geen olie-water reactie, lichtbruin, grof grind, >10cm < 20cm
32,00
Zand, zeer fijn, sterk siltig, geen olie-water reactie, lichtbruin
38,00

Opdracht: 03P000943
Project: Locatie Eemshaven-Doekegatkanaal
Plaats: Eemshaven

Boring: **B-02 - 1**
Uitvoering op: 09-03-2012
Boring nabij:
Uitvoering door: R. de Vries

Boring volgens NEN 5119
Maaiveldhoogte: 2,25 m t.o.v. N.A.P.
Grondwaterstand: 200 cm - maaiveld

Classificatie volgen NEN 5104

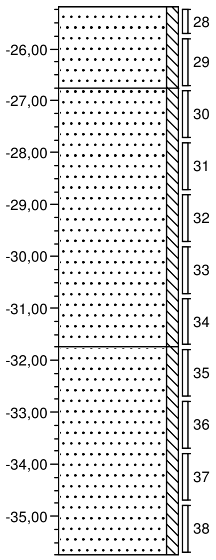


0,00	Zand, matig fijn, zwak siltig
2,00	Zand, zeer fijn, sterk siltig, zwak schelphoudend
7,00	Zand, zeer fijn, uiterst siltig, laagjes klei, Veel klei lenzen
14,00	Zand, zeer fijn, uiterst siltig, laagjes klei, Enkel lensje
17,00	Zand, zeer fijn, zwak siltig, zwak houthoudend, zwak schelphoudend, laagjes klei, Enkel lensje
18,00	Zand, zeer fijn, uiterst siltig
20,00	Zand, zeer fijn, uiterst siltig, laagjes klei, lenzen klei
21,00	Klei, sterk zandig, zwak humeus, laagjes zand OM I
22,00	Klei, zwak zandig, zwak humeus, laagjes zand, Matig slap gelaagd met zand OM II OM III
26,00	Zand, matig grof, zwak siltig, matig grindig, Grof grind
27,00	Zand, zeer fijn, zwak siltig
27,44	

Opdracht: 03P000943
Project: Locatie Eemshaven-Doekegatkanaal
Plaats: Eemshaven

Boring: **B-02 - 2** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op:	09-03-2012	Maaiveldhoogte:	2,25	m t.o.v. N.A.P.
Boring nabij:		Grondwaterstand:	200	cm - maaiveld
Uitvoering door:	R. de Vries			



27,44
Zand, zeer fijn, zwak siltig

29,00
Zand, zeer fijn, zwak siltig, Zeer hard + compact

34,00
Zand, zeer fijn, zwak siltig, laagjes klei, lenzen klei

38,00

Bijlage C

Certificaat geotechnisch laboratoriumonderzoek

Opdrachtgever	:	Van Vulpen B.V.
Projectleider	:	H. eenhoorn
Datum ontvangst	:	19 maart 2012
Aantal bladen	:	1
Aantal bijlagen	:	1

Uitgevoerde werkzaamheden:			Certificaat bijlage:
4x	Volumegewicht incl. watergehalte	NEN-5110 en NEN-5112	VGW-01

De in deze rapportage vermelde resultaten zijn alleen van toepassing op de onderzochte monsters, tenzij anders is vermeld. Certificaat met bijlagen vormen een onlosmakelijk deel van de gehele rapportage betreffende het in hoofde genoemde project.

Onderzoeksleider	:	S. 't Hart	Paraaf : StHart
Hoofd laboratorium	:	M.G. Jansen	Paraaf :
Status	:	Definitief	
Codering	:	LO	
Datum rapport	:	21 maart 2012	

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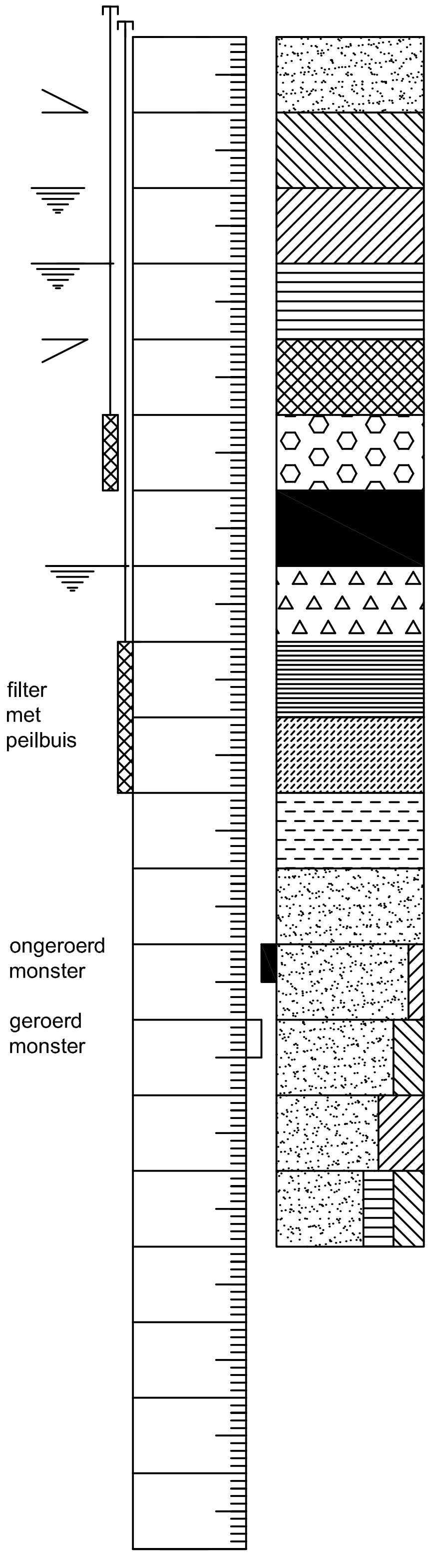
Boring	B-01	B-02	B-02
Monster	OM-1	OM-1	OM-2
Diepte monster	24,00 - 24,40 m - mv	21,50 - 21,90 m - mv	23,00 - 23,40 m - mv
Klassificatie	Klei, zwak zandig, zwak humeus, met zandlaagjes	Klei, sterk zandig, zwak humeus, met zandlaagjes	Klei, zwak zandig, zwak humeus, met zandlaagjes
Nat volumegewicht (kN/m³)	16,8	18,0	16,4
Droog volumegewicht (kN/m³)	11,4	13,3	11,0
Watergehalte in gewichts %	47,4	35,0	49,7
Watergehalte in volume %	54,1	46,7	54,6

Boring	B-02
Monster	OM-3
Diepte monster	24,50 - 24,90 m - mv
Klassificatie	Klei, zwak zandig, zwak humeus, met zandlaagjes
Nat volumegewicht (kN/m³)	16,3
Droog volumegewicht (kN/m³)	11,3
Watergehalte in gewichts %	44,1
Watergehalte in volume %	50,2

Bijlage D

VERKLARING CODERING



BESTANDDEEL

- Zand
- Leem/Löss
- Klei
- Veen
- Humus
- Grind
- Verharding
- Puin
- Gravel/Sintel
- Slib
- Water
- Zonder bijbestanddelen
- Zeer weinig bijbestanddeel
- Met bijbestanddeel
- Zeer veel bijbestanddeel
- Twee bijbestanddelen

hM-	Handsondering
M-	Middelzware sondering
MKM-	Middelzware sondering met plaatselijke kleef
D-	Diepsondering
DZ-	Zware Diepsondering
DKM-	Diepsondering met plaatselijke kleef
SD-	Slagsondering
D-	Minifilter
	Niet uitgevoerde sonderingen
B-	Boring
B-	Peilbuis
	Niet uitgevoerde boring
	Meetpunt
	Gemiddelde hoogste grondwaterstand
	Aktuele grondwaterstand
	Gemiddelde laagste grondwaterstand
Foto	Fotopijl
X, Y	Centrum coördinaten van de projectlocatie

24-11-2008

ADVISERING GEOTECHNIEK

Paalfundering
Fundering op staal

Bouwputontwerp
Bemaling
Grondkerende constructie
Taludstabiliteit

Bouwrijp maken terrein
Grondbalans
Drainage
Afkoppelen en infiltreren
Geo-hydrologische studie

Toezicht heiwerk

Funderingsrenovatie
Schade expertise

Pijpleidingen
Gestuurde boringen

Trillingsanalyse
Geluidsanalyse

VELDWERK

Sonderen
Boren
Pompproeven
Peilbuizen

Landmeetkundig werk
Nauwkeurigheidswaterpassing
DGPS-metingen
Inmeten palenplan

Trillingsmeting
Geluidsmeting
Akoestische paalcontrole
Geo-monitoring

Heibegeleiding
Toezicht bouwputten

LABORATORIUM

Classificatie proeven
Mechanische eigenschappen
Chemische analyse

MILIEU-ONDERZOEK

Verkennend-, nader- en saneringsonderzoek
Advisering
Projectbegeleiding
Akoestisch onderzoek
Partijkeuringen besluit bodemkwaliteit (Bbk)

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ingenieursbureau

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tevens vestigingen:
postbus 94 - 5690 AB Son
postbus 752 - 2130 AT Hoofddorp

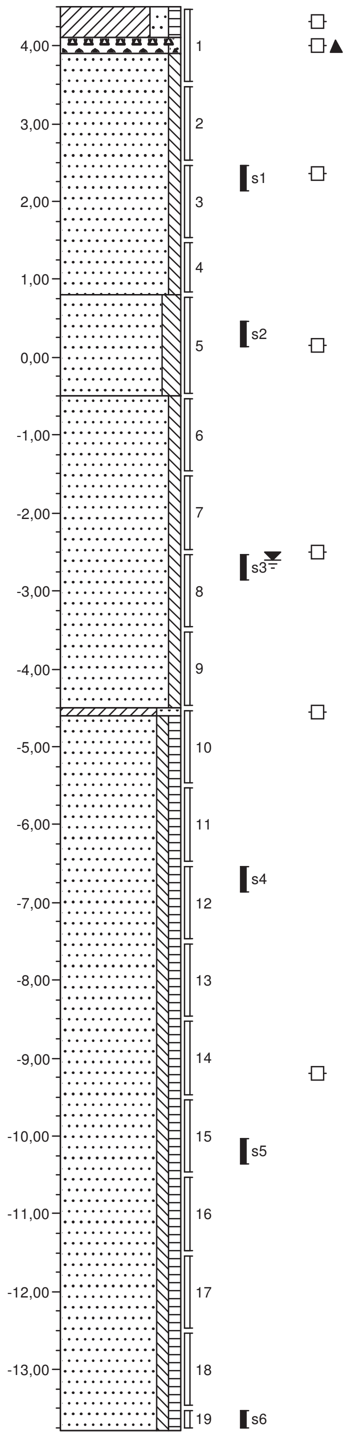
www.inpijn-blokpoel.com

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring: **B-01a - 1**
Uitvoering op: 19-06-2012
Boring nabij:
Uitvoering door: J. Hakkert

Boring volgens NEN 5119
Maaiveldhoogte: 4,5 m t.o.v. N.A.P.
Grondwaterstand: 710 cm - maaiveld

Classificatie volgen NEN 5104



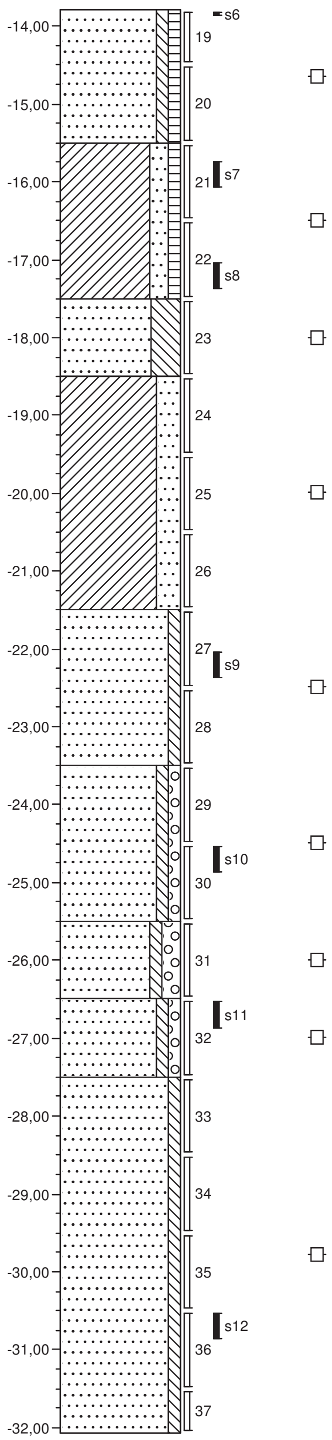
0,00
Klei, matig zandig, zwak humeus, geen olie-water reactie, bruingrijs
0,40
Grind, fijn, zwak zandig, puin, geen olie-water reactie, bruin, Stabilisatie
0,60
Zand, zeer fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, lichtbruin
3,70
Zand, zeer fijn, matig siltig, zwak schelphoudend, geen olie-water reactie, grijs
5,00
Zand, zeer fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, donkergrijs
9,00
Klei, sterk zandig, geen olie-water reactie, donkergrijs, Zeer slap
9,10
Zand, zeer fijn, zwak siltig, zwak humeus, laagjes klei, geen olie-water reactie, donkergrijs
18,29

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring: **B-01a - 2** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op: 19-06-2012
Boring nabij:
Uitvoering door: J. Hakkert

Maaiveldhoogte: 4,5 m t.o.v. N.A.P.
Grondwaterstand: 710 cm - maaiveld



18,29
Zand, zeer fijn, zwak siltig, zwak humeus, laagjes klei, geen olie-water reactie, donkergrijs

20,00
Klei, matig zandig, zwak humeus, laagjes klei, laagjes zand, geen olie-water reactie, donkergrijs

22,00
Zand, zeer fijn, uiterst siltig, geen olie-water reactie, grijs

23,00
Klei, sterk zandig, geen olie-water reactie, grijs, Matig-stijf gelaagd klei + zand

26,00
Zand, matig grof, zwak siltig, geen olie-water reactie, grijs

28,00
Zand, matig grof, zwak siltig, zwak grindig, geen olie-water reactie, lichtbruin, Compacte laag met fijn grind

30,00
Zand, matig fijn, zwak siltig, matig grindig, geen olie-water reactie, lichtbruin

31,00
Zand, zeer grof, zwak siltig, zwak grindig, geen olie-water reactie, lichtbruin, grof grind, >10cm < 20cm

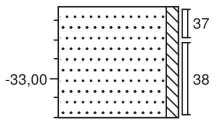
32,00
Zand, matig fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, lichtbruin

36,58

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring: **B-01a - 3** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op:	19-06-2012	Maaiveldhoogte:	4,5	m t.o.v. N.A.P.
Boring nabij:		Grondwaterstand:	710	cm - maaiveld
Uitvoering door:	J. Hakkert			

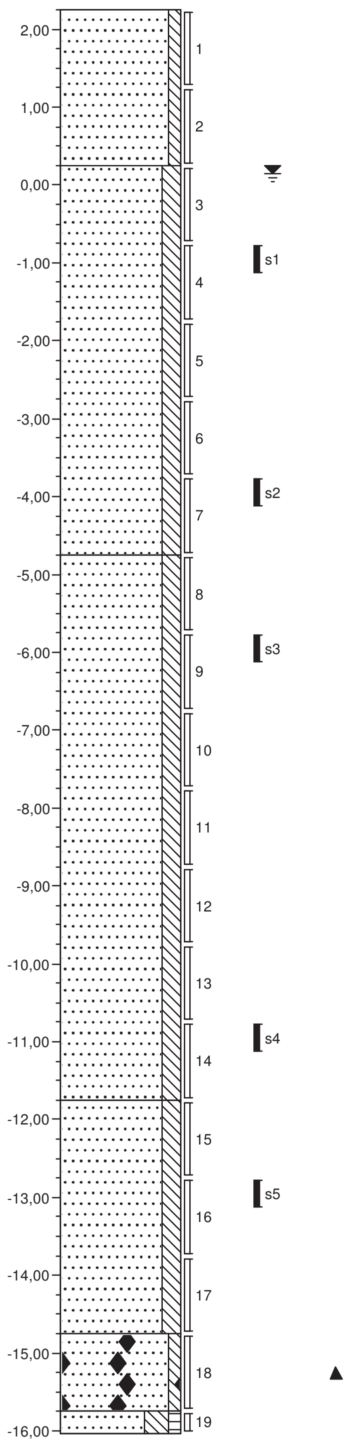


36,58
Zand, matig fijn, zwak siltig, zwak schelphoudend, geen olie-water reactie, lichtbruin
38,00

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring: **B-02a - 1** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op:	20-06-2012	Maaiveldhoogte:	2,25	m t.o.v. N.A.P.
Boring nabij:		Grondwaterstand:	210	cm - maaiveld
Uitvoering door:	J. Hakkert			



0,00
Zand, matig fijn, zwak siltig

2,00
Zand, zeer fijn, matig siltig, zwak schelphoudend

7,00
Zand, zeer fijn, matig siltig, laagjes klei, Veel klei lenzen

14,00
Zand, zeer fijn, matig siltig, laagjes klei, Enkel lensje

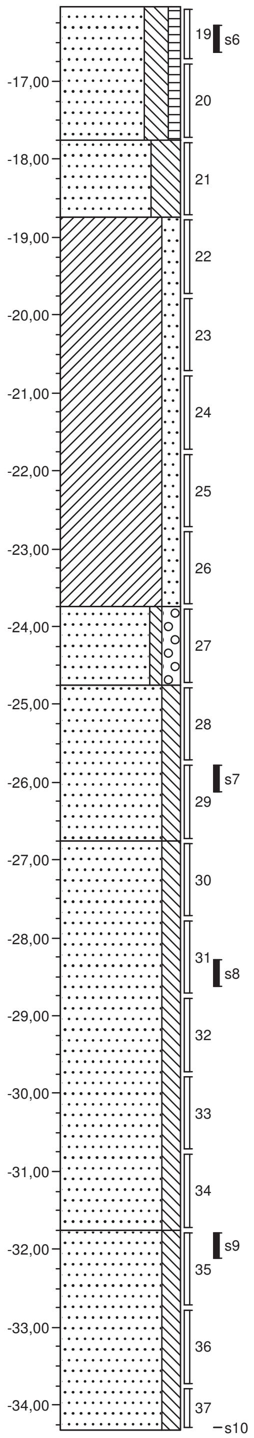
17,00
Zand, zeer fijn, zwak siltig, zwak houthoudend, zwak schelphoudend, laagjes klei, Enkel lensje

18,00
Zand, zeer fijn, sterk siltig, zwak humeus
18,29

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring: **B-02a - 2** **Boring volgens NEN 5119** **Classificatie volgen NEN 5104**

Uitvoering op:	20-06-2012	Maaiveldhoogte:	2,25	m t.o.v. N.A.P.
Boring nabij:		Grondwaterstand:	210	cm - maaiveld
Uitvoering door:	J. Hakkert			



18,29
Zand, zeer fijn, sterk siltig, zwak humeus

20,00
Zand, zeer fijn, uiterst siltig, laagjes klei, lenzen klei

21,00
Klei, matig zandig, Matig slap gelaagd met zand

26,00
Zand, matig grof, zwak siltig, matig grindig, Grof grind

27,00
Zand, zeer fijn, matig siltig

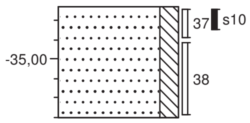
29,00
Zand, zeer fijn, matig siltig, Zeer hard + compact

34,00
Zand, zeer fijn, matig siltig

36,58

Opdracht: 03P000943-01
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring:	**B-02a - 3**	**Boring volgens NEN 5119**			**Classificatie volgen NEN 5104**
Uitvoering op:	20-06-2012	Maaiveldhoogte:	2,25	m t.o.v. N.A.P.	
Boring nabij:		Grondwaterstand:	210	cm - maaiveld	
Uitvoering door:	J. Hakkert				



36,58
Zand, zeer fijn, matig siltig
38,00

03P0000943-01

Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg

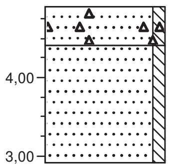
Eemshaven

Boring	Monster	van	tot	Klassificatie	Y_{nat}	Y_{droog}	W
		[m-mv]	[m-mv]	[NEN-5104]	[kN/m^3]	[kN/m^3]	[m%]
B-01a	s1	2,00	2,40	Zand, zeer fijn, zwak siltig, zwak schelphoudend	18,1	15,3	18,0
B-01a	s2	4,00	4,40	Zand, zeer fijn, matig siltig, zwak schelphoudend	18,9	15,3	23,5
B-01a	s3	7,00	7,40	Zand, zeer fijn, zwak siltig, zwak schelphoudend	19,2	15,5	23,8
B-01a	s4	11,00	11,40	Zand, zeer fijn, zwak siltig, zwak humeus, met kleilaagjes	17,5	12,9	35,6
B-01a	s5	14,50	14,90	Zand, zeer fijn, zwak siltig, zwak humeus, met kleilaagjes	18,7	14,7	27,6
B-01a	s6	18,00	18,40	Zand, zeer fijn, zwak siltig, zwak humeus, met kleilaagjes	19,2	15,3	25,3
B-01a	s7	20,20	20,60	Klei, matig zandig, zwak humeus, klei- en zandgelaagd	16,5	11,0	49,4
B-01a	s8	21,50	21,90	Klei, matig zandig, zwak humeus, klei- en zandgelaagd	17,5	12,6	39,2
B-01a	s9	26,50	26,90	Zand, matig grof, zwak siltig	20,0	17,3	15,8
B-01a	s10	29,00	29,40	Zand, matig grof, zwak siltig, zwak grindig	21,1	18,7	12,5
B-01a	s11	31,00	31,40	Zand, zeer grof, zwak siltig, zwak grindig	19,9	17,0	17,3
B-01a	s12	35,00	35,40	Zand, matig fijn, zwak siltig, zwak schelphoudend	19,2	16,1	19,5
B-02a	s1	3,00	3,40	Zand, zeer fijn, matig siltig, zwak schelphoudend	18,4	15,2	20,6
B-02a	s2	6,00	6,40	Zand, zeer fijn, matig siltig, zwak schelphoudend	19,3	15,5	24,1
B-02a	s3	8,00	8,40	Zand, zeer fijn, matig siltig, met kleilaagjes	19,5	15,7	24,0
B-02a	s4	13,00	13,40	Zand, zeer fijn, matig siltig, met kleilaagjes	18,7	14,4	30,1
B-02a	s5	15,00	15,40	Zand, zeer fijn, matig siltig, met kleilaagjes	19,3	15,7	22,8
B-02a	s6	18,50	18,90	Zand, zeer fijn, sterk siltig, zwak humeus	19,7	16,0	23,0
B-02a	s7	28,00	28,40	Zand, zeer fijn, matig siltig	19,7	16,1	22,3
B-02a	s8	30,50	30,90	Zand, zeer fijn, matig siltig	20,0	16,6	20,9
B-02a	s9	34,00	34,40	Zand, zeer fijn, matig siltig	19,9	16,4	21,6
B-02a	s10	36,50	36,90	Zand, zeer fijn, matig siltig	19,7	16,0	22,7

Boring: **vBDKP-01**
Uitvoering op: 28-06-2012
Uitvoering door: E. Németh
Boring nabij: voorboring sondering DKP-01

Boring volgens NEN 5119
Maaiveldhoogte: 4,91 m t.o.v. N.A.P.
Grondwaterstand: niet aangetroffen

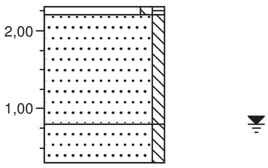
Classificatie volgen NEN 5104
x-coordinaat: 251012,1 m (in RD)
y-coordinaat: 608951,7 m (in RD)



0,00
Zand, matig grof, zwak siltig, matig puinhoudend, beigebruin
0,50
Zand, matig fijn, zwak siltig, sporen schelpen, neutraalgrijs
2,00

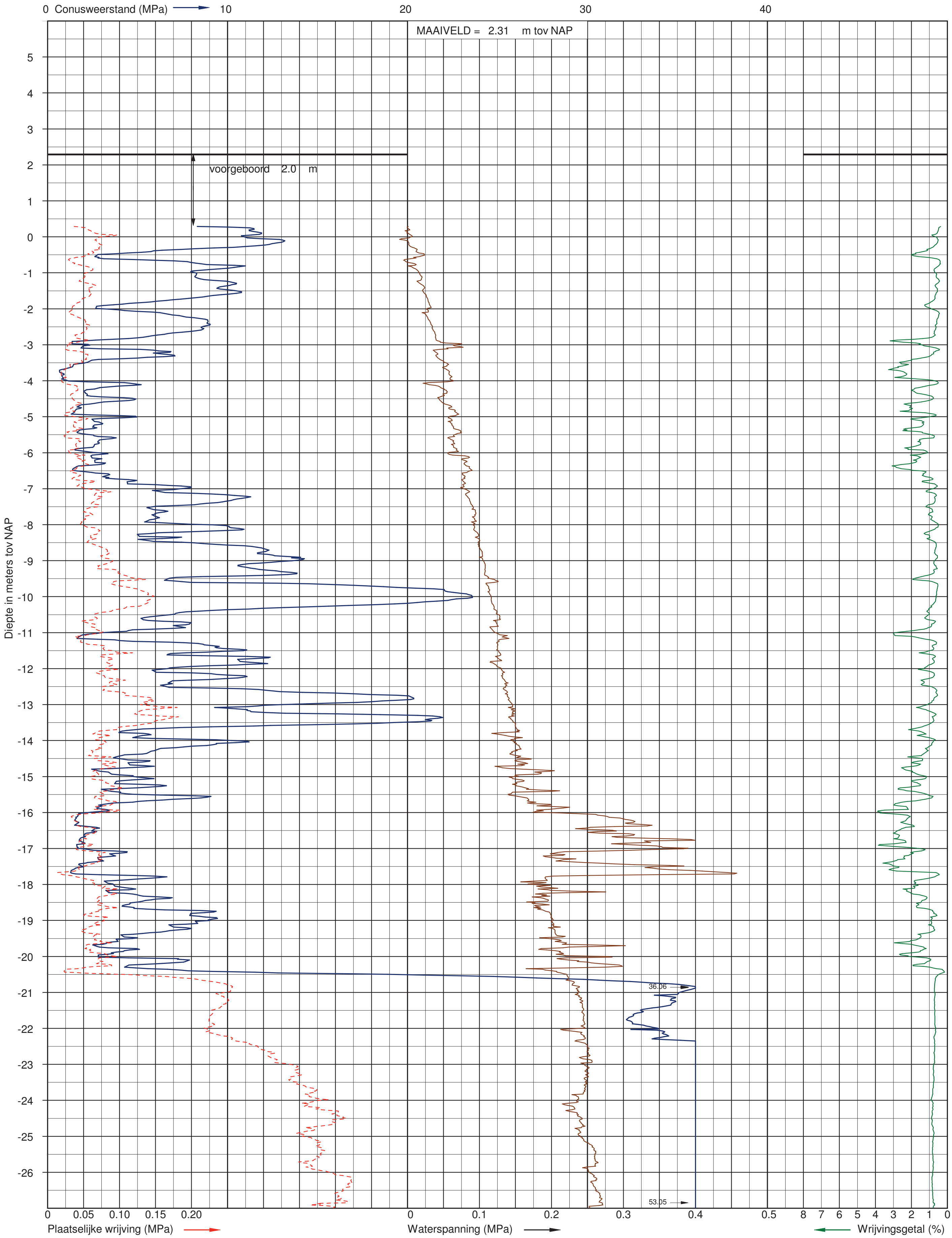
Opdracht: 03P000943-02
Project: Locatie Eemshaven-Doekegatkanaal aan de Borkumkade en Synergieweg
Plaats: Eemshaven

Boring:	**vBDKP-02**	**Boring volgens NEN 5119**			**Classificatie volgen NEN 5104**		
Uitvoering op:	28-06-2012	Maaiveldhoogte:	2,31	m t.o.v. N.A.P.	x-coordinaat:	251670,6	m (in RD)
Uitvoering door:	E. Németh	Grondwaterstand:	150	cm - maaiveld	y-coordinaat:	608550	m (in RD)
Boring nabij:	voorboring sondering DKP-02						



0,00
0,10
Zand, matig grof, zwak siltig, zwak humeus, beigebruin
Zand, matig fijn, zwak siltig, sporen schelpen, lichtgrijs
1,50
Zand, matig fijn, zwak siltig, neutraalgrijs
2,00

Opdracht: 03P000943-02
Project: Locatie Eemshaven - Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven



Sondering volgens NEN 5140 Klasse 2
Conusoppervlak 10 cm^2

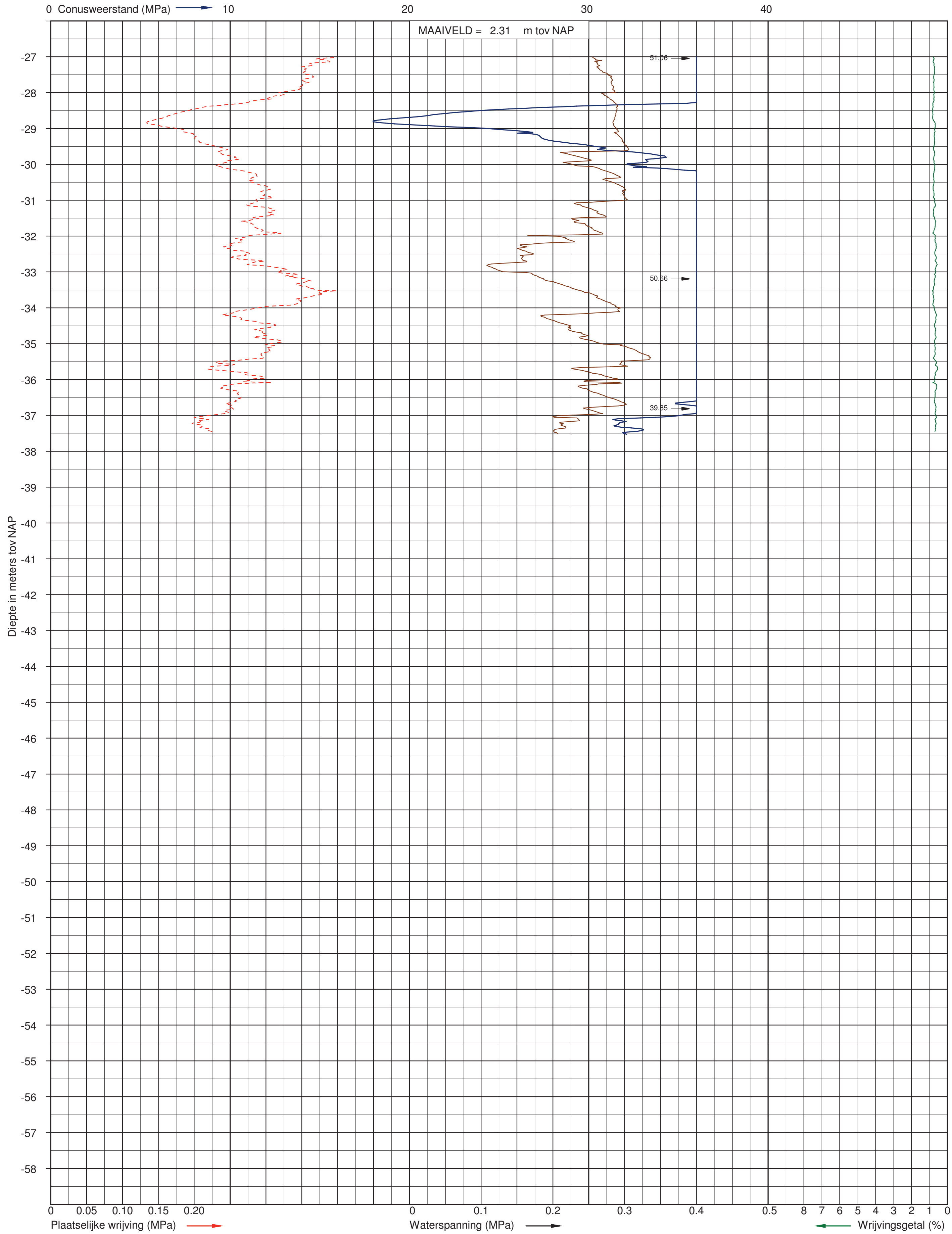
Uitvoerder: S10
Datum: 28-6-2012

X: 251671
Y: 608550

Pagina: 1/2

Sondering DKP-2

Opdracht: 03P000943-02
Project: Locatie Eemshaven - Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven



Sondering volgens NEN 5140 Klasse 2
Conusoppervlak 10 cm²

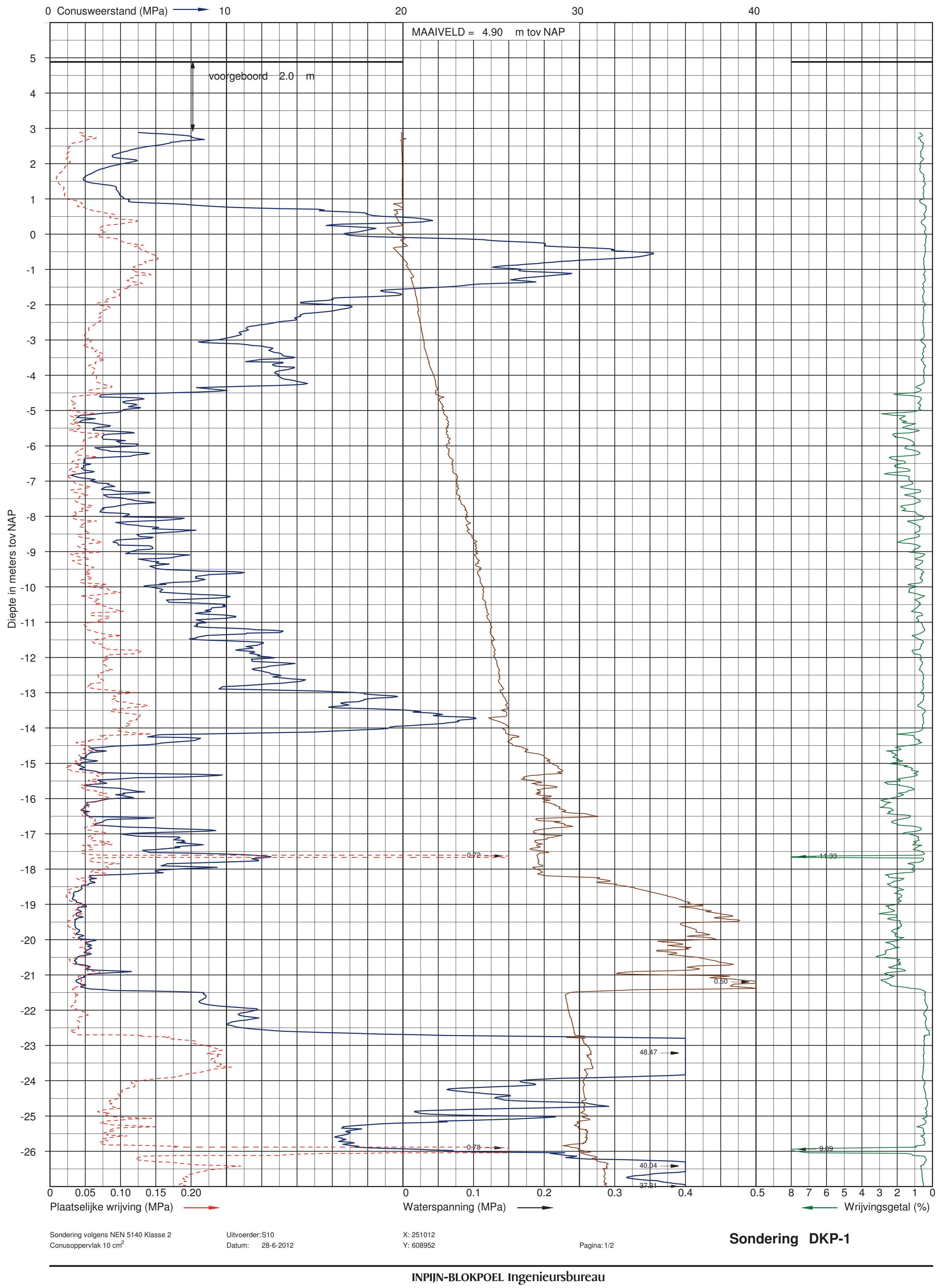
Uitvoerder: S10
Datum: 28-6-2012

X: 251671
Y: 608550

Pagina: 2/2

Sondering DKP-2

Opdracht: 03P000943-02
Project: Locatie Eemshaven - Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven



Sondering volgens NEN 5140 Klasse 2
Conusoppervlak 10 cm^2

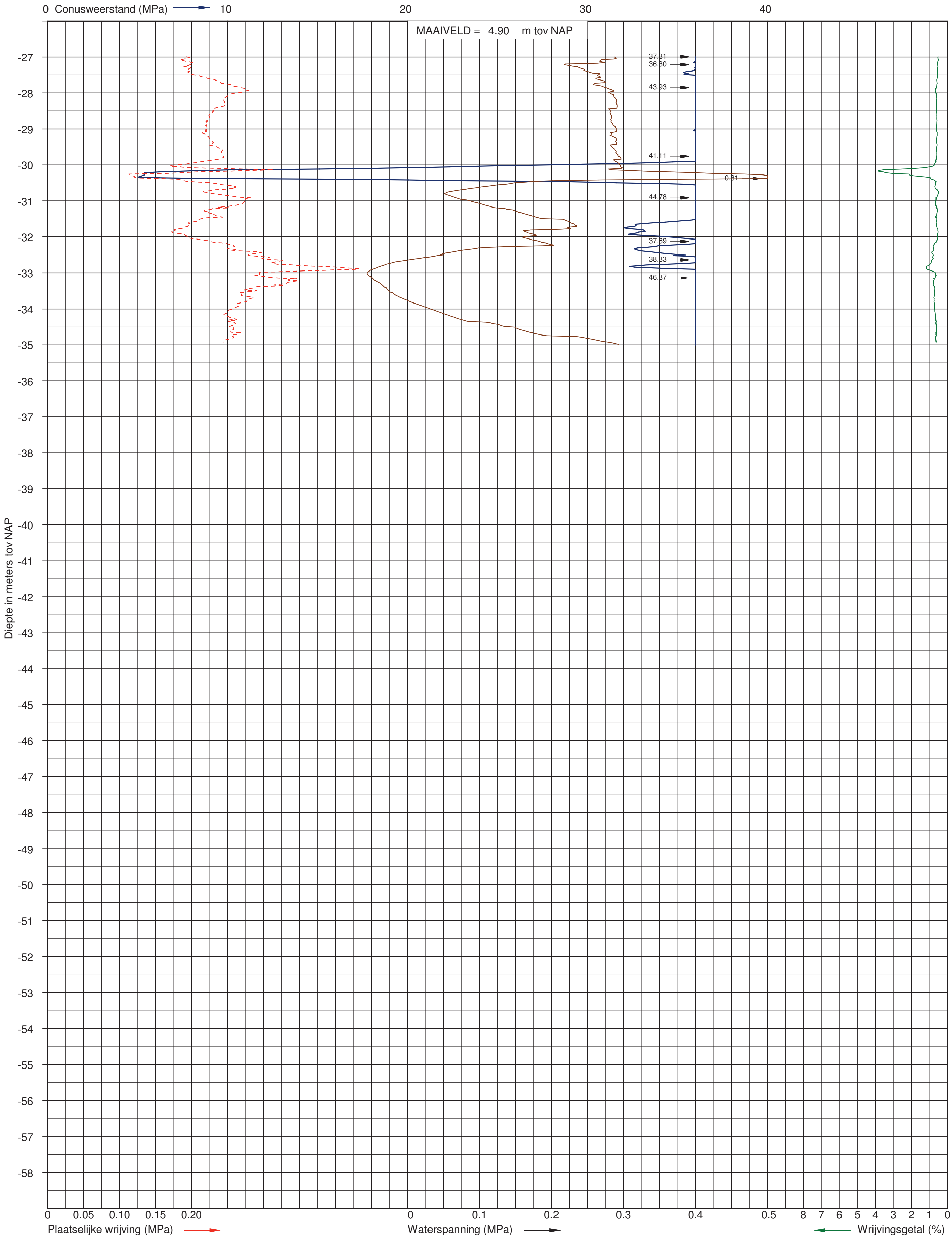
Uitvoerder: S10
Datum: 28-6-2012

X: 251012
Y: 608952

Pagina: 1/2

Sondering DKP-1

Opdracht: 03P000943-02
Project: Locatie Eemshaven - Doekegatkanaal, Borkumkade en Synergieweg te Eemshaven



Sondering volgens NEN 5140 Klasse 2
Conusoppervlak 10 cm^2

Uitvoerder: S10
Datum: 28-6-2012

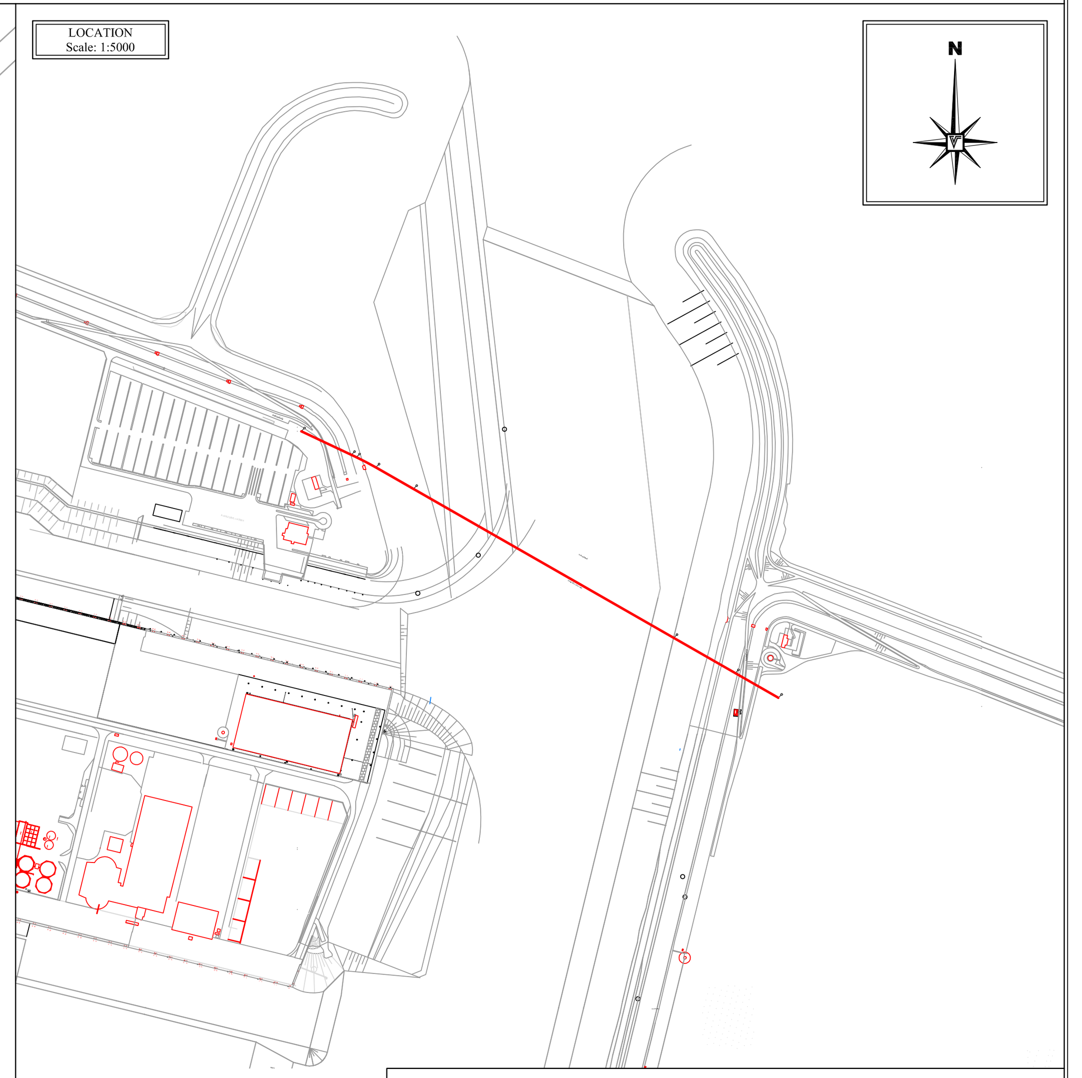
X: 251012
Y: 608952

Pagina: 2/2

Sondering DKP-1

INPIJN-BLOKPOEL Ingenieursbureau

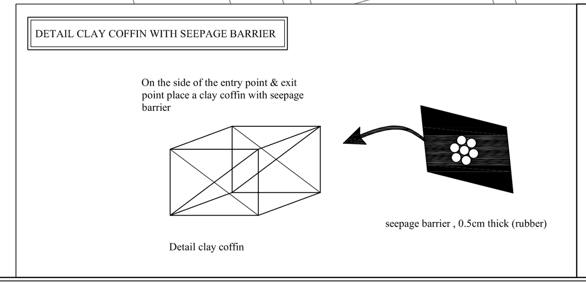
APPENDIX B: HDD drawing Doekegatkanaal



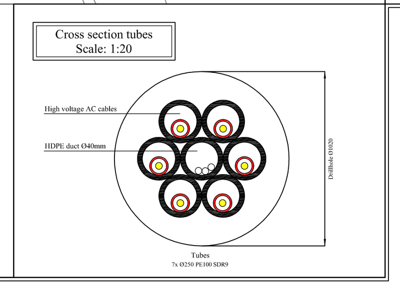
Coordinate list

NR.	DEFINITION	X-COÖR	Y-COÖR	Z-COÖR
8	End Rh	251114,68	608889,67	-25,95
7	Begin Rh	251086,28	608904,44	-19,47
6	EXIT POINT	251702,88	608553,18	2,09
5	End Rv(Ascend)	251639,83	608589,24	-17,37
4	Begin Rv(Ascend)	251549,96	608640,65	-31
3	End Rv(Descend)	251169,66	608858,22	-31
2	Begin Rv(Descend)	251078,89	608907,91	-17,37
1	ENTRY POINT	251005,74	608942,31	4,29

DETAIL CLAY COFFIN WITH SEEPAGE BARRIER



Cross section tubes
Scale: 1:20



Legend horizontal directional drilling:

- Existing drilling
- New drilling
- B-NR Mechanical drilling
- DKM-NR Plumbing

Definition:

Horizontal directional drilling
7xØ250 PE100 SDR9

Rev.	Description	Draw	Date
D	for implementation	bve	10-7-2012
B	for license	CS	28-3-2012

Location: Eemshaven-Doekegatkanaal

Place: EEMSHAVEN

Drawingnumber: 212024614BT

Version: D

Sheet: 1/1

Client:
Energy Solutions B.V.
Ampereweg 27
2627 BG DELFT

Draw:	bve
Check:	EOF
Date:	10-7-2012
Scale:	Several
Format:	2029×841
Projectnumber:	212024614

Ampereweg 27
2627 BG Delft
T: +31 (0)15-2682663
F: +31 (0)15-2682673
E: info@ensol.nl
I: www.ensol.nl

\\vulpen-fs1\data\Tekeningen\2012-07\212024614BT_D.dwg

Appendix D: Stakeholders out of the preliminary Klic-Alert

GEO

KLIC-ONLINE

Datum
14-04-2011

Onderwerp
Klic-melding 11O012342 - 1

Klantreferentie

Geachte heer, mevrouw,

Hierbij ontvangt u een overzicht van de levering per netbeheerder per thema in het door u aangevraagde gebied. Hierin kunt u zien of de informatie over ondergrondse netten van deze netbeheerders al dan niet is opgenomen.

- Het is mogelijk dat u van een bepaalde netbeheerder uit de ontvangstbevestiging geen informatie (melding geen belang) of slechts een algemene bijlage heeft ontvangen. In deze gevallen is dan gebleken dat de netbeheerder geen belang heeft in het door u opgegeven gebied.

- Ook kan het voorkomen dat een netbeheerder een leeg PNG-bestand heeft geleverd. Dit kan betekenen dat er geen netten in het door u opgegeven gebied zijn, maar dat wel een huisaansluitschets en/of Eisvoorzorgsmaatregel voor dat betreffende thema is geleverd.

- In geval netbeheerders hebben aangegeven meerdere thema's in het door u opgegeven gebied te beheren, kan het voorkomen dat u niet van al deze thema's informatie heeft ontvangen. Ook hierbij geldt dat enkel informatie is verstrekt van de netten die daadwerkelijk in het door u opgegeven gebied gelegen zijn.

In onderstaande tabel vindt u de netbeheerders die belang hebben in het door u aangevraagde gebied.

Netbeheerder	**Thema**	**Opgenomen in deze levering?**
NV Nederlandse Gasunie Oost	buisleiding gevaarlijke inhoud	Ja
Electrabel Nederland N.V.	gas hoge druk	Ja
Electrabel Nederland N.V.	hoogspanning	Ja
Electrabel Nederland N.V.	datatransport	Ja
Electrabel Nederland N.V.	laagspanning	Ja
Electrabel Nederland N.V.	riool vrijverval	Ja
Electrabel Nederland N.V.	water	Ja
Electrabel Nederland N.V.	overig	Ja
Enexis B.V.	gas hoge druk	Ja
Enexis B.V.	middenspanning	Ja
Enexis B.V.	gas lage druk	Ja
Enexis B.V.	laagspanning	Ja
TenneT TSO	landelijk hoogspanningsnet	Ja
TenneT TSO	hoogspanning	Ja

Bezoekadres
Hofstraat 110,
7311 KZ Apeldoorn

TenneT TSO	datatransport	Ja
TenneT TSO	laagspanning	Ja
TenneT TSO	overig	Ja
Havenschap Delfzijl Eemshaven	middenspanning	Ja
Havenschap Delfzijl Eemshaven	datatransport	Ja
Havenschap Delfzijl Eemshaven	laagspanning	Ja
Havenschap Delfzijl Eemshaven	riool vrijverval	Ja
Havenschap Delfzijl Eemshaven	water	Ja
RWE Innogy Windpower Netherlands B.V.	middenspanning	Ja
RWE Innogy Windpower Netherlands B.V.	datatransport	Ja
Gemeente Eemsmond	riool onder druk	Alleen bijlage(n)
Gemeente Eemsmond	datatransport	Alleen bijlage(n)
Gemeente Eemsmond	laagspanning	Alleen bijlage(n)
Gemeente Eemsmond	riool vrijverval	Alleen bijlage(n)
Gemeente Eemsmond	wees	Alleen bijlage(n)
Gemeente Eemsmond	overig	Alleen bijlage(n)
Delta Eemshaven Koning en Hartman Network services	datatransport	Ja
KPN B.V.	datatransport	Ja
RWS wegendistr Groningen Drenthe	datatransport	Alleen bijlage(n)
RWS wegendistr Groningen Drenthe	laagspanning	Alleen bijlage(n)
RWS wegendistr Groningen Drenthe	overig	Alleen bijlage(n)
Relined P/A v.d.Berg infrastructuren BV	datatransport	Ja
Waterbedrijf Groningen	datatransport	Ja
Waterbedrijf Groningen	water	Ja
Ziggo BV	datatransport	Ja

Let op: Deze Klic-melding bevat een Eisvoorzorgsmaatregel. Zie de gelijknamige bijlage in onderstaand overzicht.

Hieronder vindt u een lijst met alle bestanden die u in deze levering aan dient te treffen.

LI_11O012342_1.pdf

LI_11O012342_1.xml
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ET_mugingburo_0000588946_11O012342.png
LG_datatransport_KPN_0000546663_11O012342.png
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GB_11O012342.png
LP_11O012342_1.pdf

Toelichting:

LI: leveringsinformatie (dit bestand)	LI: leveringsinformatie (xml-document)
LG: kaartlaag met de ligging van het net	MV: kaartlaag met de maatvoering bij het net
AN: kaartlaag met de annotatie bij het net	TB: themabijlage
EV: bijlage met Eisvoorzorgsmaatregel	DK: detailkaart
HA: huisaansluitschets	BL: algemene bijlage
ET: eigen topografie	PT: plantopografie
GB: GBKN ondergrondkaart	LP: Liggings PDF (gebundelde pdf met alle kaarten)