Memorandum

To (SodM), (RWS), (Kustwacht), (Min EZK)

Copy

From ONE-Dyas

Date 23 september 2020

Subject Verslag overleg vergunningsaanvraag pijpleiding, kabel N05-A

ONE-Dyas is bezig met de vergunningsaanvragen voor een ontwikkeling van het N05-A veld in blok N05. Hiervoor zal ook een pijpleiding naar de NGT en een kabel naar het Duitse windpark Riffgat aangelegd worden.
Ter voorbereiding van de vergunningsaanvraag houdt ONE-dyas een presentatie om het tracé en de wijze van installatie van de leiding en de kabel te verduidelijken.

Introductie
ONE-Dyas presenteert een overzicht van de ontwikkeling van N05-A. Slide 2 en 3.
Hij gaat in op de pijpleidingroute en de route voor de kabel naar het Windpark Riffgat, slide 4 en 5.
Het jacket en platform ontwerp van N05-A worden getoond, slide 6-8

> Opmerking SodM:
> Omdat die niet tussen mijnbouwinstallaties loopt, wordt de kabel niet automatisch aangewezen als pijpleiding onder het Mbb. Het dient bevestigd te worden of de minister de kabel aanwijst als pijpleiding onder de Mbb, waarbij mogelijk meespeelt dat het verbonden is met een buitenlands windpark.
> Indien de kabel niet aangewezen wordt als pijpleiding onder het Mbb, is mogelijk een Watervergunning nodig voor de kabel.
>
> ONE-Dyas overlegt met EZK over soort vergunning voor de kabel.
> RWS zal dit ook overleggen met EZK.
> *Reactie ONE-Dyas: art 92 Mbb: met een pijpleiding wordt bedoeld een andere leiding dan bedoeld onder 1°, aan te wijzen door Onze Minister, die een mijnbouwwerk verbindt met een ander werk ten behoeve van het vervoer van stoffen te rekenen vanaf de eerste isolatieafsluiter van het mijnbouwwerk; (Mijnbouwwet art 1, sub ag onder 2). De kabel kan dus aangewezen worden als pijpleiding, omdat:*
> 1. *Een windpark een 'ander werk' is.*
> 2. *De locatie van dit 'andere werk' is geen criteria voor de aanwijzing als pijpleiding.*

Presentatie onderzoeken
ONE-Dyas presenteert de onderzoeken die gedaan zijn om een tracé voor de pijpleiding en de kabel vast te stellen. Slide 9-13. Opmerking over Environmental Survey Results: Geen habitat H1170 gevonden, Borkumse Stenen wordt mogelijk beschermd obv KRM.

Vraag RWS
Worden UXO's vermeden?
Reactie ONE-Dyas: Dit is het uitgangspunt voor de pijplijn route, Magnetische contacten worden met een vaste afstand gemeden. In Duitsland zal nog extra UXO onderzoek nodig zijn, hierbij wordt de kabel in Nederland meegenomen.
Opmerking Kustwacht
UXO campagnes graag melden aan de Kustwacht, zodat Defensie zich kan voorbereiden op eventuele ontmanteling.

Presentatie pijpleiding en kabel
Frits toont de fysische eigenschappen van de pijpleiding, slide 14
Vraag van SodM:
welke operationele druk heeft de leiding, aangezien de leiding aansluit op de NGT
Reactie ONE-Dyas: de leiding is ontworpen voor een druk van 85 en 90 bar, omdat NGT overweegt de druk te verlagen. Voorlopig zal de operationele druk 90 bar zijn.
Vraag van SodM:
Is het mogelijk de leiding te piggen? Het is een harde eis, ook voor spur leiding, dat de integriteit van de leiding op ieder moment kan worden aangetoond.
Reactie ONE-Dyas: het wordt mogelijk om de pijpleiding te piggen via een tijdelijke sidetap vanaf de NGT naar N05-A. Deze tijdelijke pig launcher wordt verwijderd na aanleg. ONE-Dyas komt met een alternatieve methode om de integriteit van de leiding te kunnen aantonen.

ONE-Dyas toont de fysische eigenschappen van de kabel, slide 15. De kabel moet nog ontworpen worden; inclusief fiber optic voor data communicatie.
Opmerking SodM:
In het verleden zijn er bepaalde stakeholders die de wenselijkheid van het gebruik van duurzaam opgewekte energie voor fossiele energie ter discussie hebben gesteld. Het is goed hier rekening mee te houden.

Slide 16: installatie methode pijpleiding, kabel. Door waterdiepte is een DP schip niet mogelijk voor de aanleg van de pijpleiding: mogelijk zullen mass excavation pumps gebruikt worden. Eerst pijpleiding leggen dan met mass excavation in de bodem laten zakken.
Opmerking RWS:
Er zijn veel stenen in dat gebied. De pijpleiding door het eigen gewicht in de bodem laten zakken kan een probleem zijn bij een stenige ondergrond.
Reactie ONE-Dyas: Route is op 25 m van grotere stenen gekozen. Er zijn met name stenen bij eerste km vanaf het platform.
Opmerking SodM:
Minimale begraafdiepte opnemen in aanvraag en ook de onderzochte aspecten die hebben geleid tot de minimale begraafdiepte beschrijven.
Reactie ONE-Dyas: voor leidingen groter dan 20" geldt in principe geen begraafdiepte, dit was alleen nodig voor de stabiliteit. Er wordt nog gekeken of de leiding (top op pipe) gelijk met het zeebed kan worden gelegd. Minimale begraafdieptes incl. onderbouwing zullen in de vergunningsaanvraag worden meegenomen.
Opmerking SodM, RWS
Voor een kabel geldt een minimale diepte van 1 m beneden zeebed op open zee, gerelateerd aan ligging van het zeebed.

Memorandum

Reactie ONE-Dyas: begraafdiepte is inderdaad 1 m. de streefdiepte is dieper.
Vraag Kustwacht:
Hoe zit het met de overvisbaarheid van de pijpleiding?
Reactie ONE-Dyas: Bij een 20" leiding is dit geen probleem: vistuig blijft er niet achter hangen, leiding wordt niet beschadigd door vistuig.

ONE-Dyas presenteert de voorgestelde methode voor de tie-in op de NGT. Slide 17 en 18 locatie van de tie-in NGT: aansluiting op bestaande tie-in scheelt kosten, maar ligt net buiten de gesurveyde corridor. Ontbrekende informatie is opgevraagd bij NGT en getracht te intrapoleren met bestaande onderzoeken.

Slide 19- 25 Bestaande tie-in aanpassing

Vraag SodM:
Welke waterdiepte moet gehanteerd worden bij de NGT?
Reactie Kustwacht: In principe 10 meter
Reactie ONE-Dyas: Waterdiepte bij NGT is nu 6 m, dome steekt 2 m boven NGT uit. Voor de installatie zal eerst de bestaande rockdump verwijderd worden.
Reactie SodM: belangrijk om dit goed op te nemen in vergunningsaanvraag. Ook moet de subsea dome overvisbaar zijn.

Opmerking SodM:
Het eigendom van de pijpleiding moet helder zijn: waar begint de eigendom, aansprakelijkheid van de NGT, waar begint eigendom.
Reactie ONE-Dyas: het meest logisch lijkt de eerste klep op de sidetap. Voor vergunningsaanvraag dient duidelijk te zijn welke afspraken er gemaakt zijn met de NGT, alternatief is dat dit als mogelijk voorwaarde opgenomen wordt in de vergunning.

Opmerking SodM:
Goede oplossing voor gebruik van bestaande sidetap. Goed om piglauncer aan te kunnen sluiten: extra aansluiting.
Reactie ONE-Dyas: aansluiting via een hottap is de fall back optie.

Vragen Jaap van den Hoed:

1. Is er overleg met TenneT over de kabel van de windparken 'Boven de eilanden' Reactie ONE-Dyas: Er is overleg, de kabels van het windpark liggen westelijker dan de N05-A leiding, er zijn geen kruisingen met onze leiding.
2. Coordinaten in lat lon: ETRS89
3. Westereems: leiding loopt door Westereems: moet betrokken worden bij de aanvraag. VTS loopt tot ongeveer boorlokatie. Kusteacht geeft naw . (*deze zijn ontvangen*): Reactie ONE-Dyas: de pijpleiding ligt buiten de eigenlijk vaarroute en passeert de boei aan de westkant.
4. Oesterherstelproject ten noorden van N05-A: bekend? Reactie ONE-Dyas: Ja, er is overleg met WNF.
5. Verdachte bewegingen van Greenpeace etc. doorgeven aan Kustwacht.
6. Wanneer gaat ONE-Dyas het jacket installeren? Reactie ONE-Dyas: over 2 a 3 jaar
7. UXO campagne: melden aan kustwacht/defensie.

Memorandum

Vragen RWS
Grens NL-Dtl: Westereemsverdrag: check grensoverschrijdende situatie

Vragen aan EZK:
Kan de kabel als pijpleiding aangewezen worden. EZK gaat het onderzoeken. Als het niet het geval is dan is een Waterwetvergunning nodig en co-ordinatie tussen Waterwet en Wabo.
Voorbeelden worden genoemd van Q13 en Ameland-Westgat van de NAM. Hier is de kabel vergund onder het mijnbouwbesluit.
SodM checkt het voorbeeld van Q13.

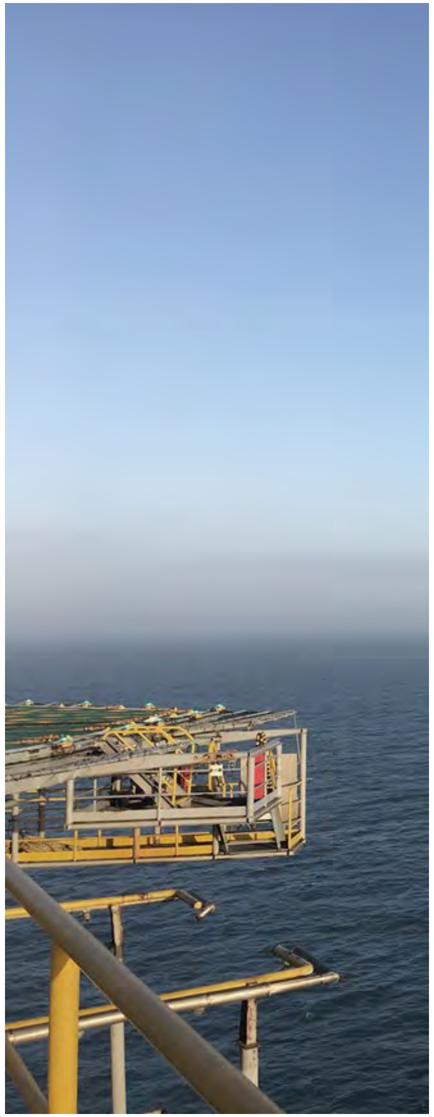
N05A Development

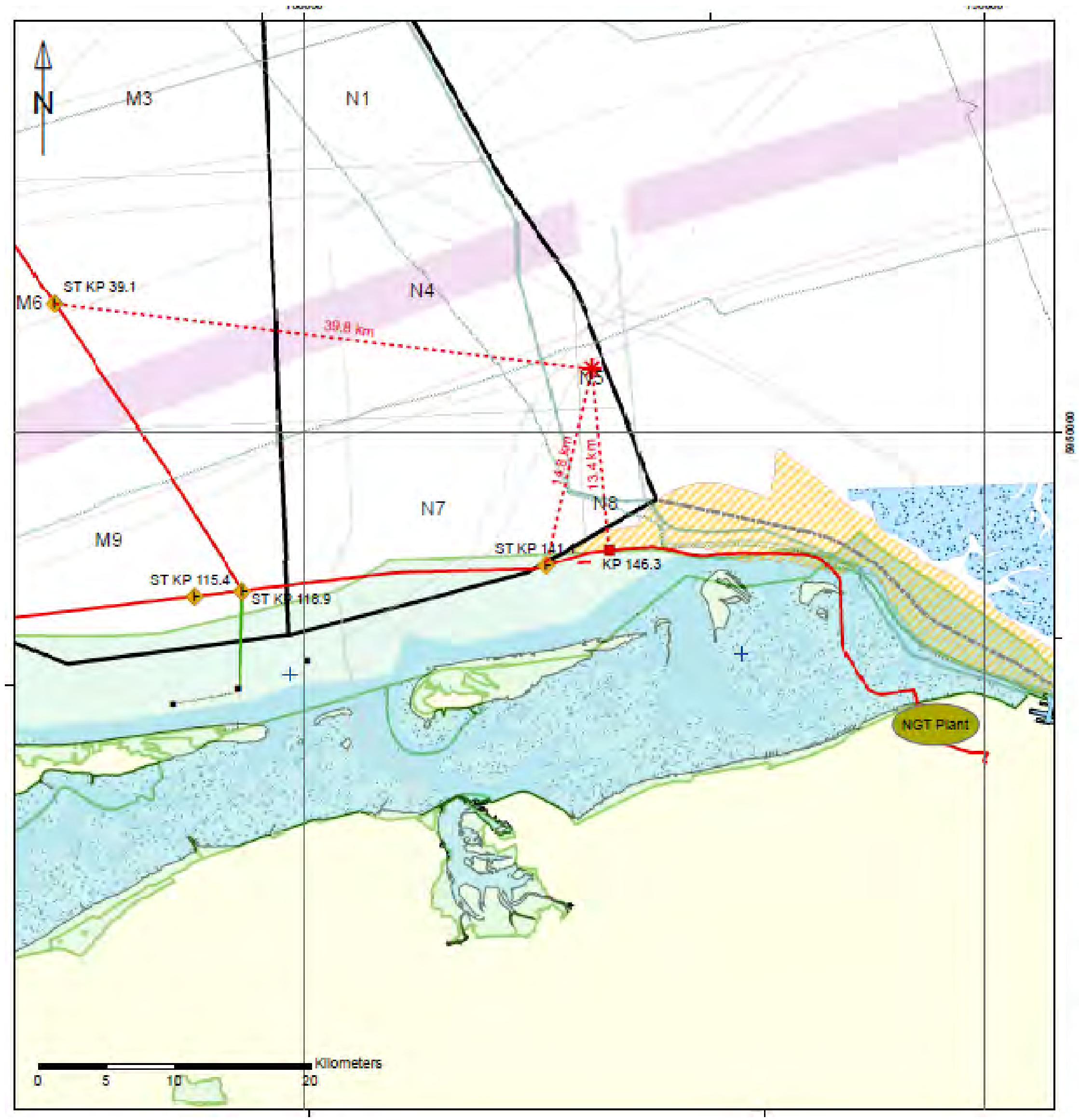
SODM September 2020

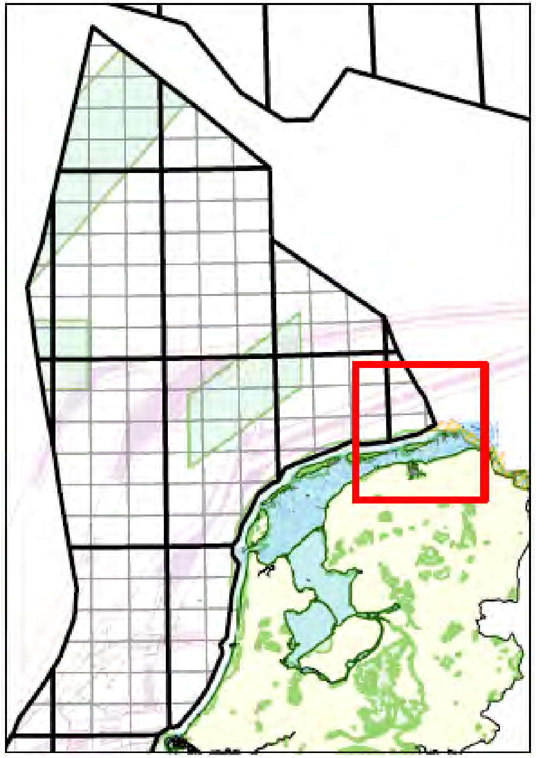
N5A Development Project Overview

- Drilling and completion of gas wells in the N05A block.
- Installation of a gas processing platform.
- Installation of a gas export pipeline from the N05A platform to a tie-in point at the NGT pipeline.
- Tie-in of the pipeline to the platform and NGT pipeline.
- Installation of a power cable from the Riffgat windfarm to the N05A platform.
- Tie-in of the power cable to the platform and windfarm transformer station.
- Burial of the pipeline and power cable.

N05A Field Location







Route Option	Route Description	Crossings	Length [km]
1	N5 - STKP 141.1 - 12"	?	14.845
2	N5 - STKP 39.1 - 12"	?	39.774
3	N5 - NP-001 KP 146.260 - 24"	?	13.391

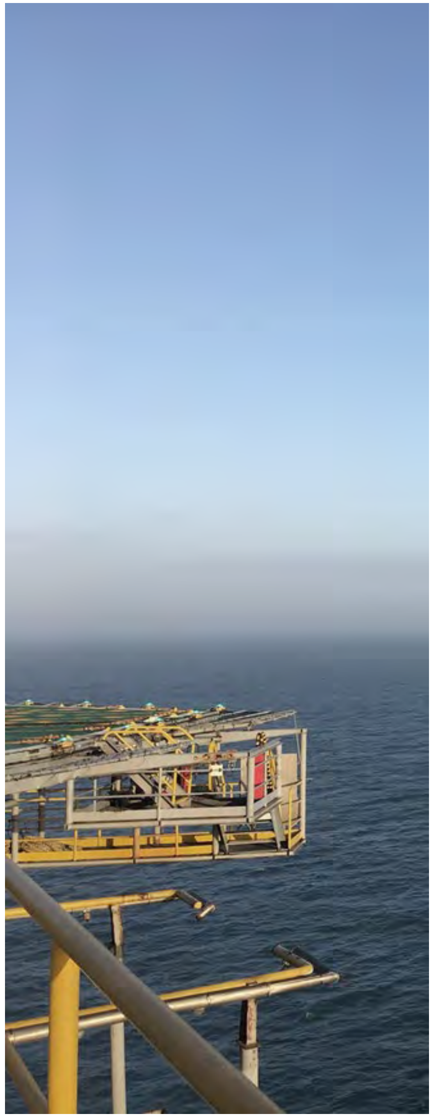
N5 - NGT

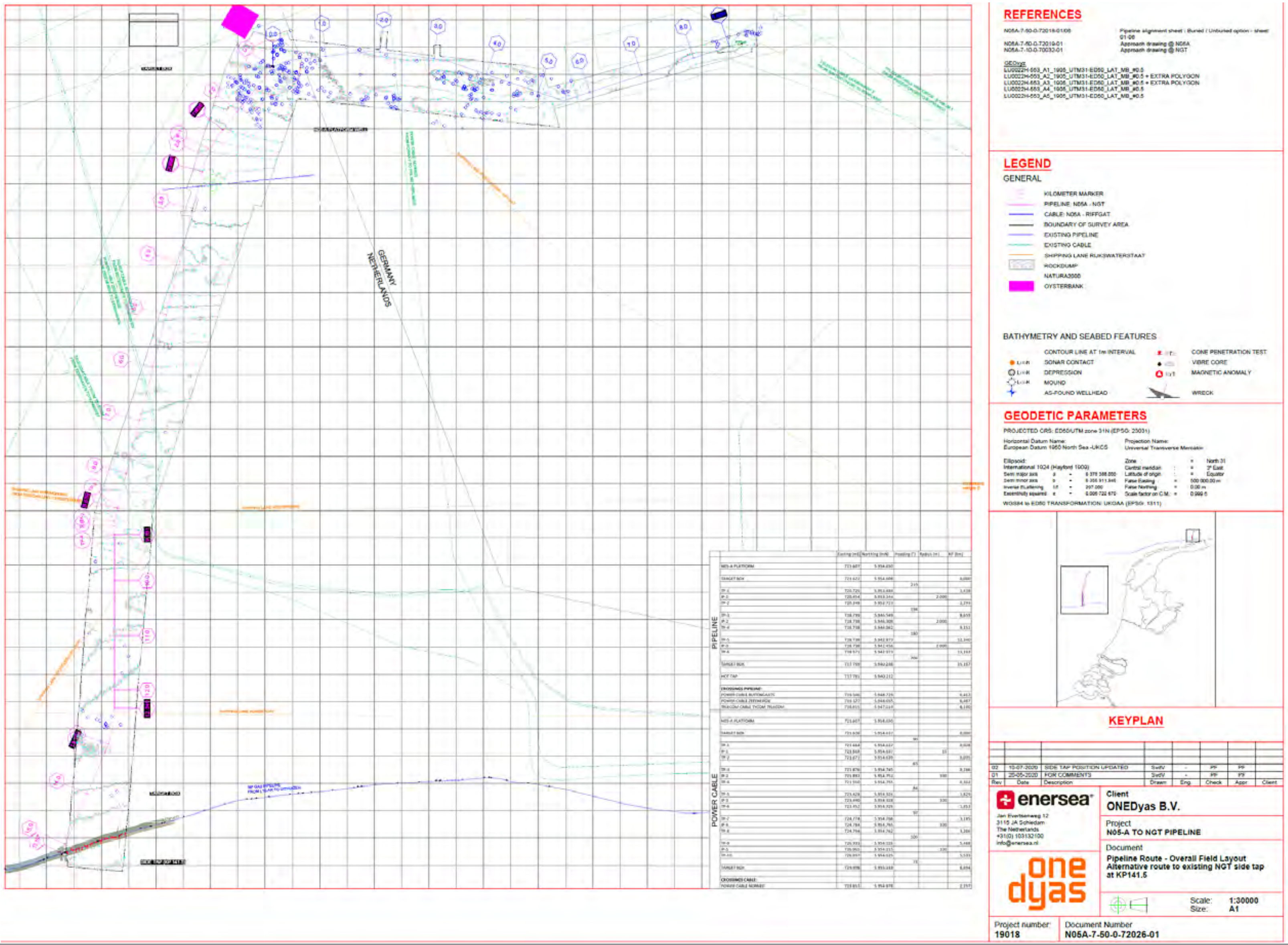
Date: 29 March 2018
Author: F.J. Westdijk
Geodesy: Datum: ED50, Projection: UTM Zone 31, CM: 3° East

Proposed route
Border
Eems-Dollard treaty area
Natura 2000

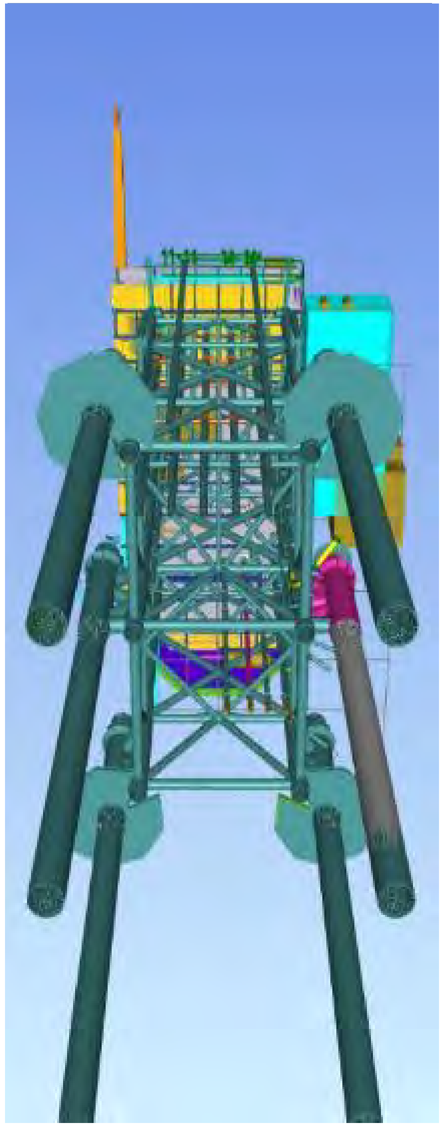
NGT NOORDGASTRANSPORT

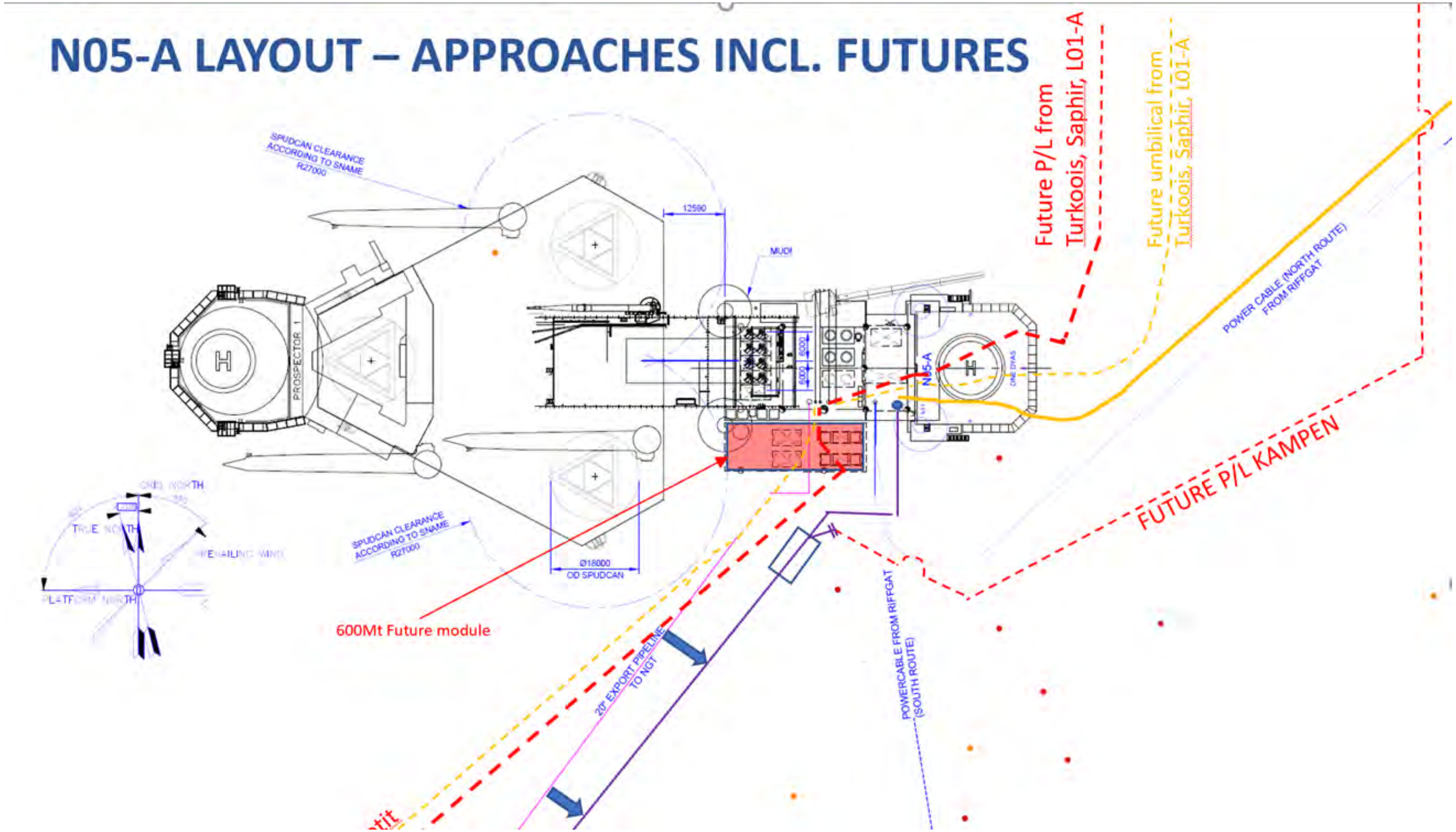
N05A Field Layout



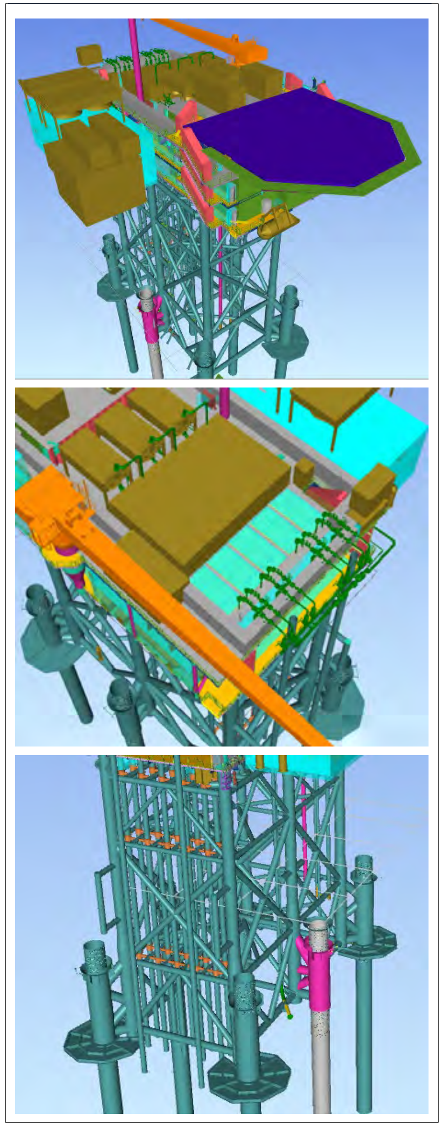


N05A Platform Approaches



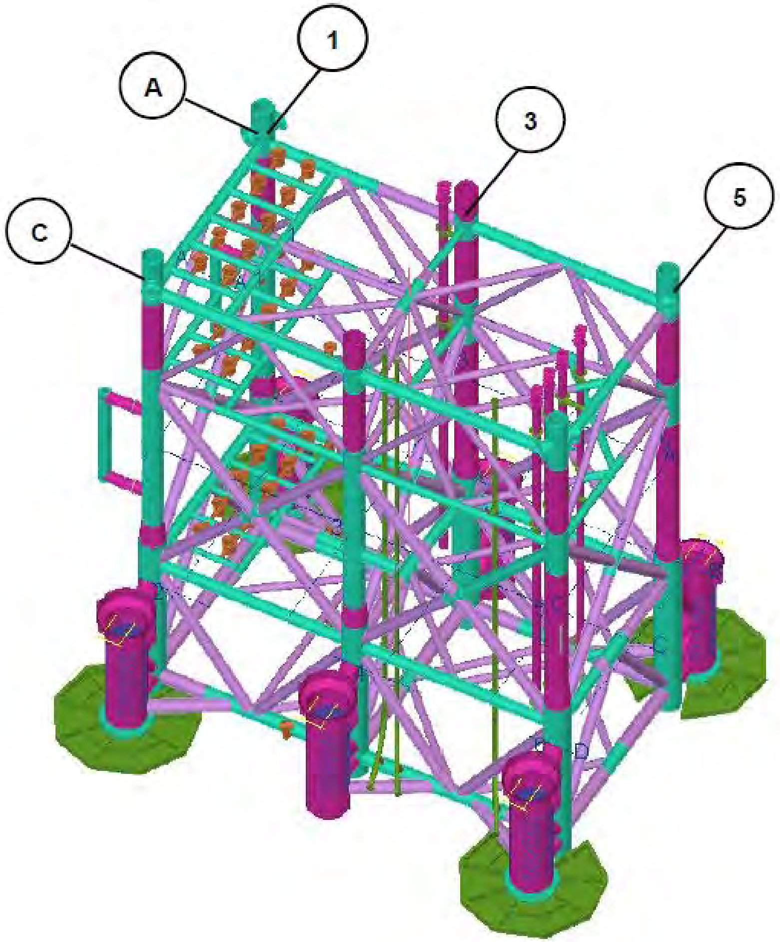


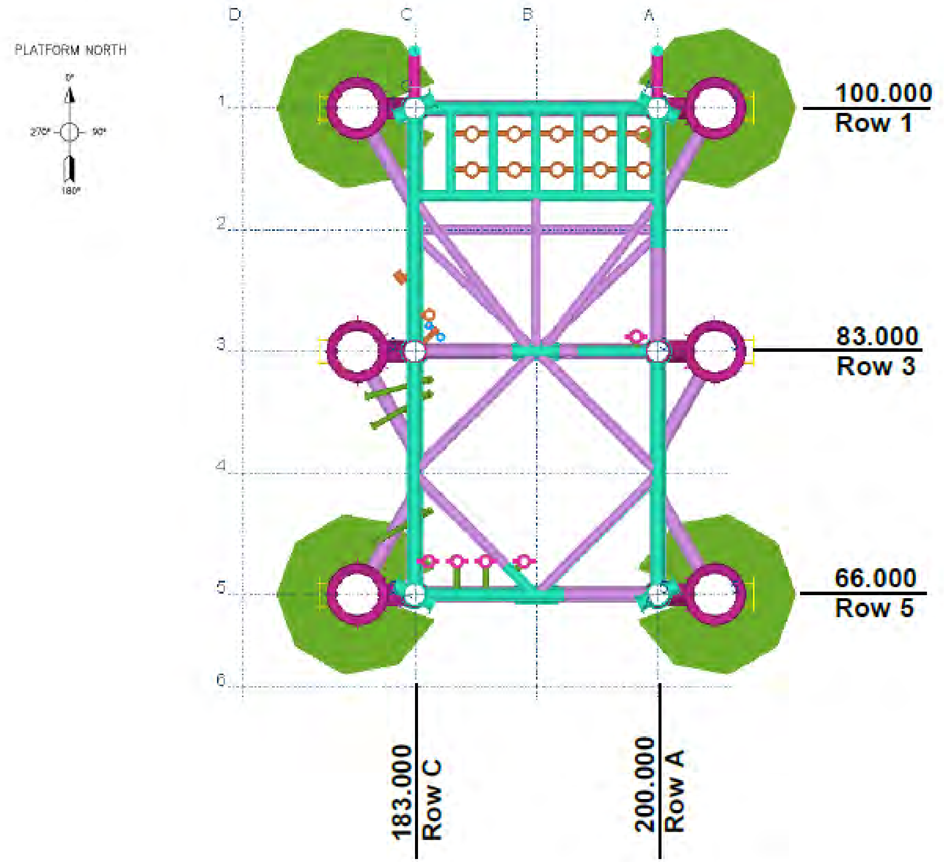
N05-A field Development – Jacket



- The substructure is a 6 legged skirt pile jacket.
- Legs are straight with a leg spacing of 17x34m.
- Each leg is connected to a pile sleeve for a 108” pile.

Weight condition	Nett. Weight (mT)	Gross Weight (mT)
Operational excl.	2.356	2.593

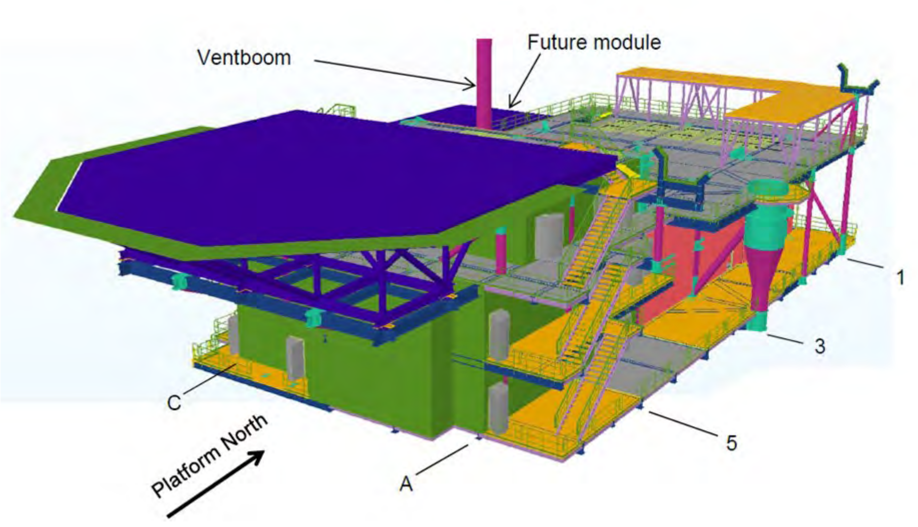




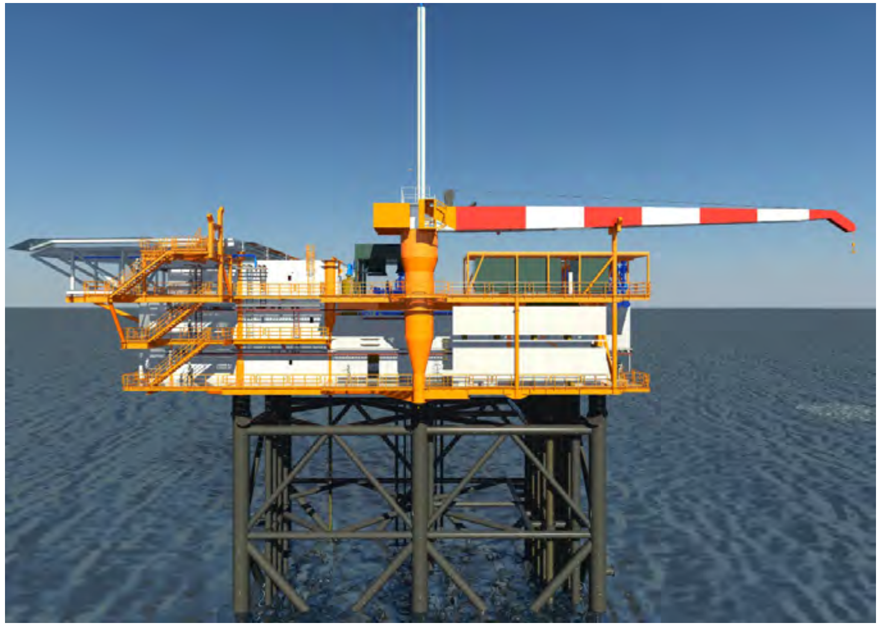
N05-A field Development – Topside

- Topside structure consists of 2 main levels and an aluminium helicopter structure.
- On the topside there is space for equipment, living quarters and walkways, three staircases enable personnel to reach the different levels.
- Ventboom 33m.

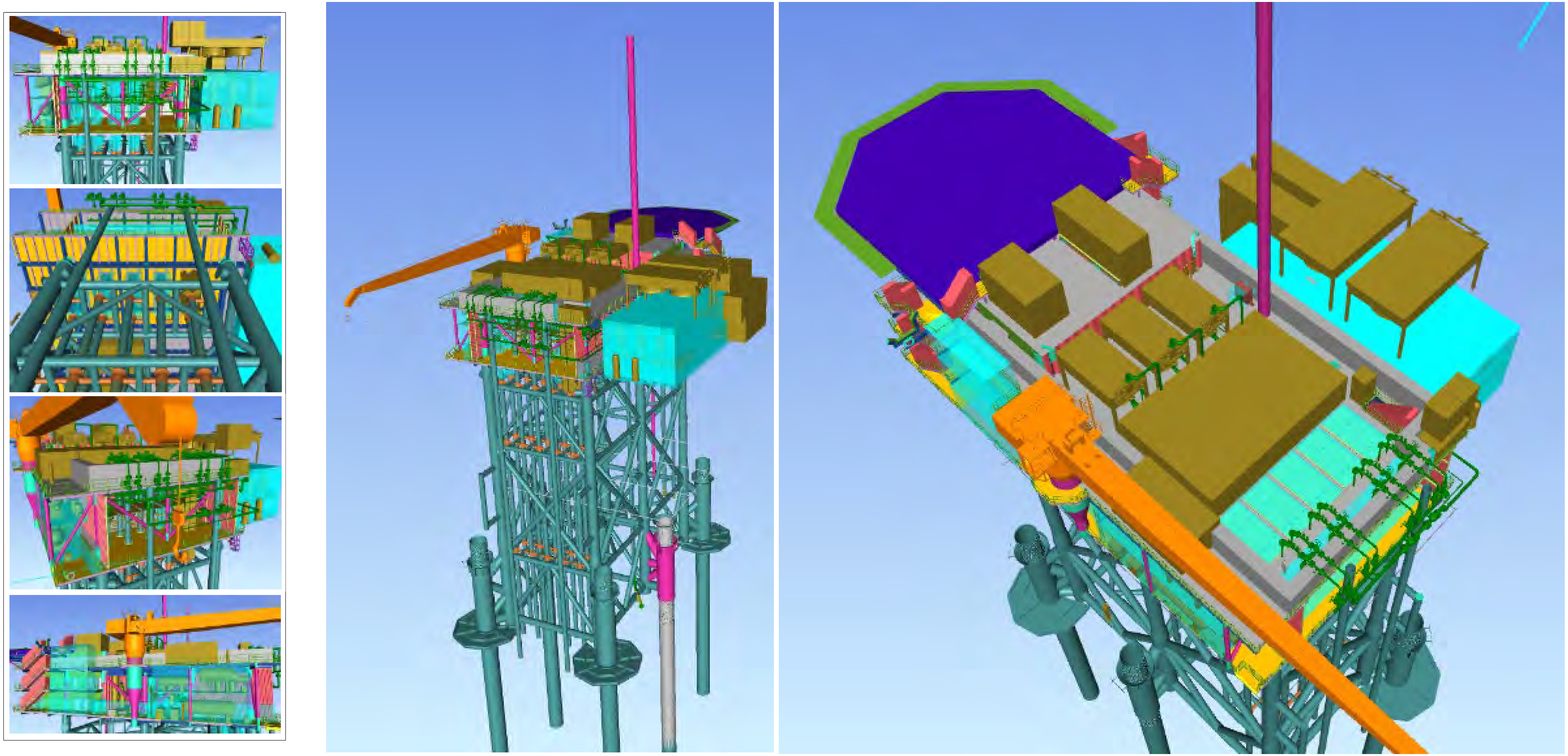
Weight condition	Nett Weight (mT)	Gross Weight (mT)
Operational	2.265	2.640
Operational incl. future module	2.887	3.265



Weight categories	Gross Weight (mT)
Architectural	57,0
Electrical	148,2
Instrumentation	52,6
Mechanical	571,0
Piping	409,3
Structural	1.426,3
Future	600,0



Results Basic Engineering – 3D Model including future module



Performed Surveys and Studies

- The following surveys have been performed for the N05A platform location and pipeline and cable routes:

  - Geophysical survey
  - Geotechnical survey
  - Environmental survey

- The selected survey corridor is 1000m wide,

- Using the survey data the following studies have been done:

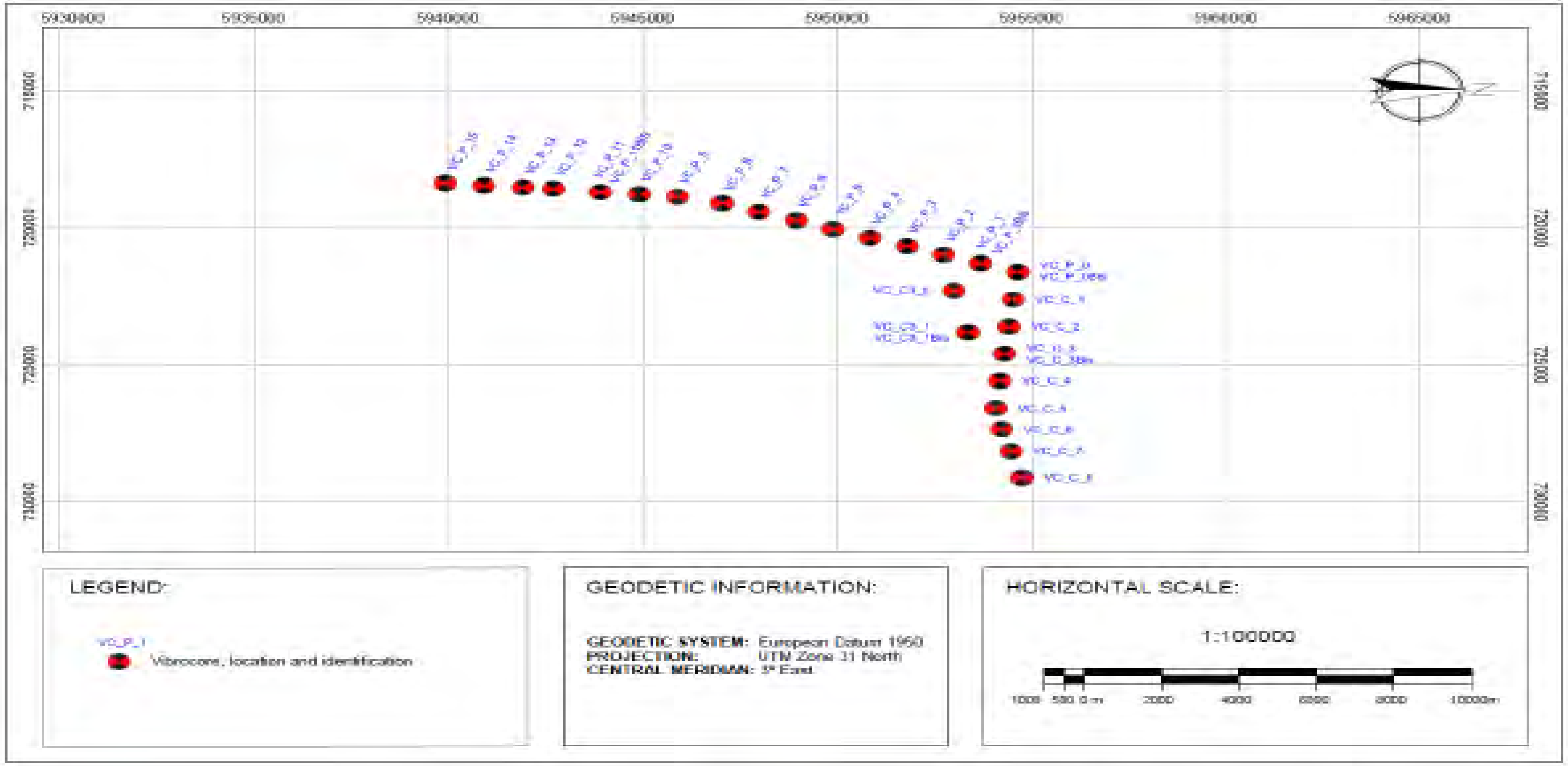
  - Archaeological study
  - Concrete weight coated pipeline or buried pipeline
  - Plume modelling for pipeline and cable installation
  - Environmental temperature influencing by power cable.

Geophysical Survey Results

Water depths within route corridor	Maximum: 26.7m LAT; Minimum: 9.4m LAT. The seabed shoals gently towards the south of the survey area, the end of the proposed route.
Seabed sediments within corridor	Seabed sediments along the proposed pipeline route corridor are expected to comprise fine to coarse SAND, with occasional areas of coarse SAND and CLAY with gravel and shell fragments.
Debris/obstructions within corridor	Numerous objects interpreted as boulders and items of debris are observed within the proposed pipeline route corridor. Most of the objects interpreted as boulders occur towards the north of the survey corridor area and coincide with areas of clay exposure. The most significant objects identified on the sonar records are interpreted as shipwrecks. The largest occurs at approximately KP2.462, the other at KP 2.373, both lay East of the selected pipeline route. Numerous magnetic contacts have been detected within the corridor survey area.

Geotechnical Survey Results

- The soils in the study area of the pipeline and cable routes mostly consist of fine to medium SAND. Along the VC_C locations the percentage of clayey SILT (which can include a variable percentage of clay) increase. It should be noted that gravelly Sand was found in VC_C_5, VC_C_6, VC_C_8 VC_P, VC_P_3 between -22 and -25 m LAT approximately.

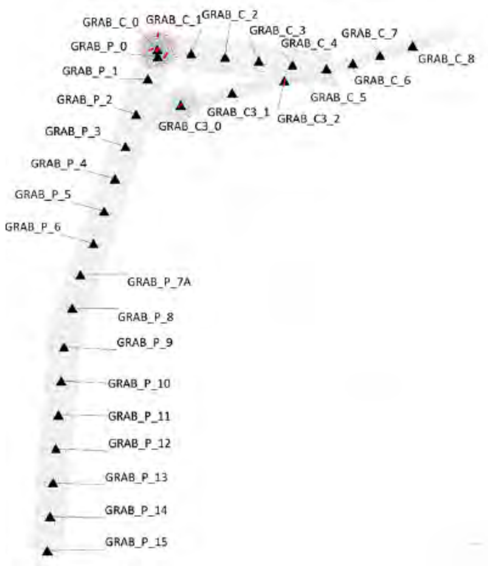


Although a single patch of cobbles was observed within the survey area, there was deemed to be insufficient cover or elevation of cobbles to warrant consideration as a potential EC Habitats Directive Annex I stony reef habitat (after Irving, 2009).

The seabed sediments within the survey area were characterised by sand-dominated and supported several species listed by Jak et al., (2009) as being characteristic of the EC Habitats Directive Annex I permanently submerged sandbank habitat (subtype H1110_C). At present there is insufficient publicly available information to confirm classification of the survey area as the H1110_C habitat subtype, but it is possible that the survey area will be classified as such.

While *Lanice conchilega* beds are not currently listed as protected habitats, they are known to act as 'ecosystem engineers' (Rabaut et al., 2007) and have been suggested for inclusion as EC Habitats Directive Annex I habitats (Rabaut et al, 2009).

No other protected habitats or species were observed within the survey area, based on review of the acquired geophysical data and environmental ground-truthing by grab sampling and seabed photography.



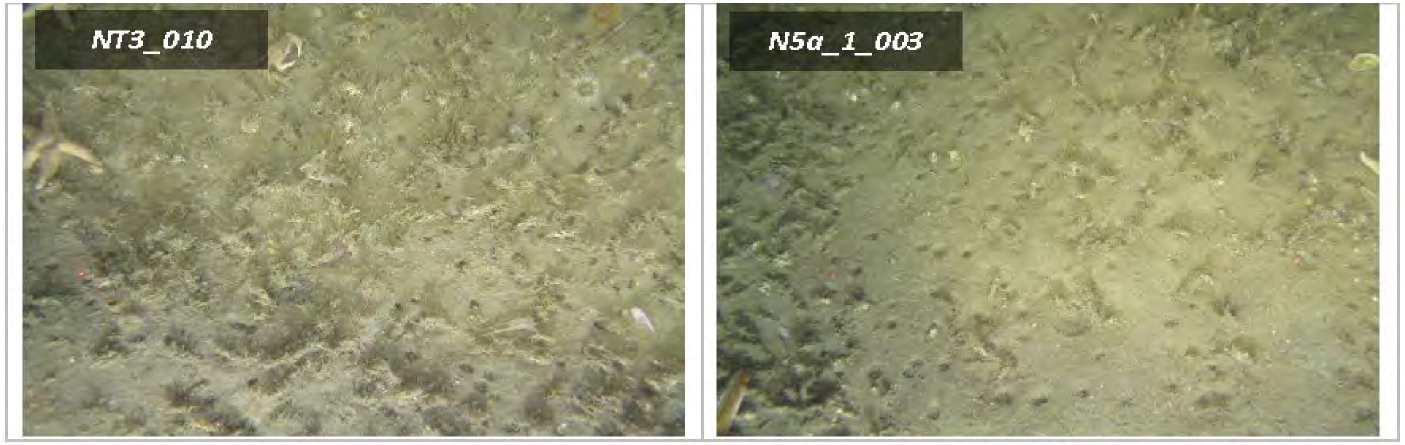


Figure 8: Example images of Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137)

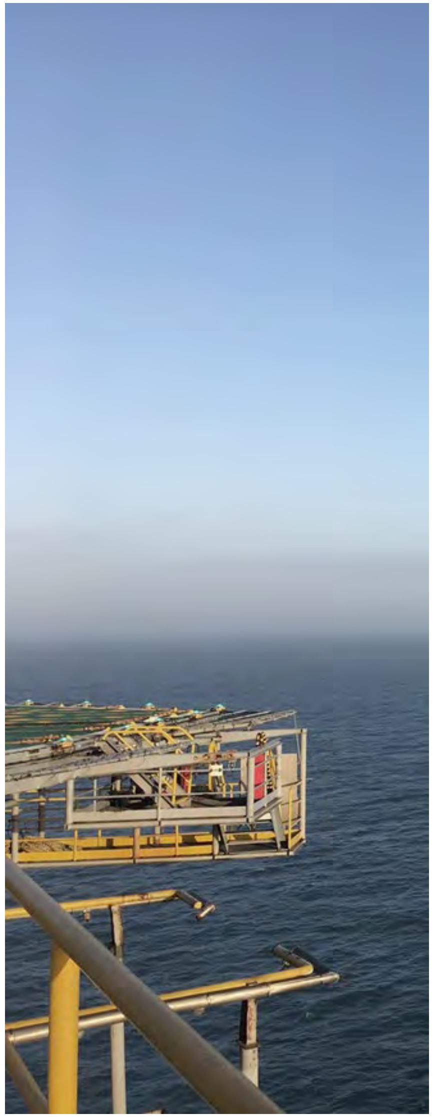
Archaeological Study Results

Het gecombineerde bureauonderzoek en de analyse van de meetgegevens van *geofysisch onderzoek* heeft uitgewezen dat in het onderzoeksgebied op twee locaties resten van mogelijk archeologische waarde voorkomen. Het gaat om de wraklocatie van de Iris/Sperrbrecher (NCN1404), die in 1942 gezonken is, en een locatie (NCN661) waar (vermoedelijk) resten van een onbekend wrak voorkomen.

De beoogde pijpleidingroute ligt op 133 tot 168 meter afstand van de twee locaties met wrakresten met mogelijke archeologische waarde. Als deze route wordt aangehouden zal de aanleg van de pijpleiding de wrakresten op deze locaties niet aantasten.

Op basis van de gegevens van dit bureauonderzoek wordt de kans dat archeologische resten worden aangetast door de geplande installatie van het platform en de aanleg van de pijpleiding en de kabel klein geacht. Dit geldt zowel voor het Nederlandse als het Duitse deel van het onderzochte gebied. Daarom wordt geadviseerd om het gebied vrij te geven voor de geplande ontwikkeling, op voorwaarde dat de routes en platformlocaties niet worden gewijzigd.

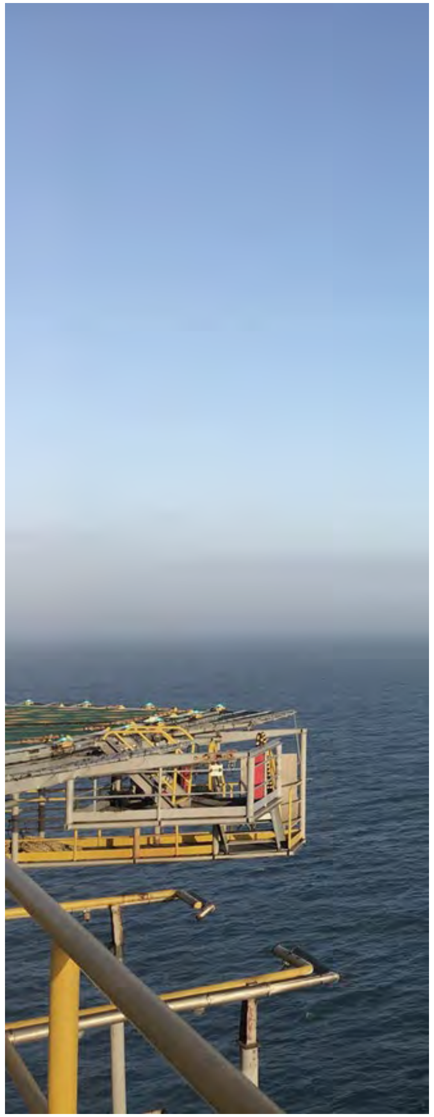
Gas Export Pipeline Data



Property	
Product transported	Natural gas (dry)
Design life (years)	25
Approx. length (km)	14.7
Material grade	L360 NB
Manufacturing process	HFIW
Pipe outside diameter (")	20"
Pipe outside diameter (mm)	508
Pipe internal diameter	466.76
Wall thickness (mm)	20.62 (Sch60)
Wall thickness tolerance (%)	7.3
Wall thickness tolerance (mm)	+/- 1.5mm
Internal corrosion allowance (mm)	3
Anti-corrosion coating	3LPP
Anti-corrosion coating thickness (mm)	3
Anti-corrosion coating density (kg/m³)	930
(Concrete) weight coating thickness (mm)	t.b.d
concrete weight coating density (kg/m³)	3300
Minimum hot bend radius (mm)	2540 (5D)

Target burial depth minimum 1m measured from top of pipeline to mean natural seabed

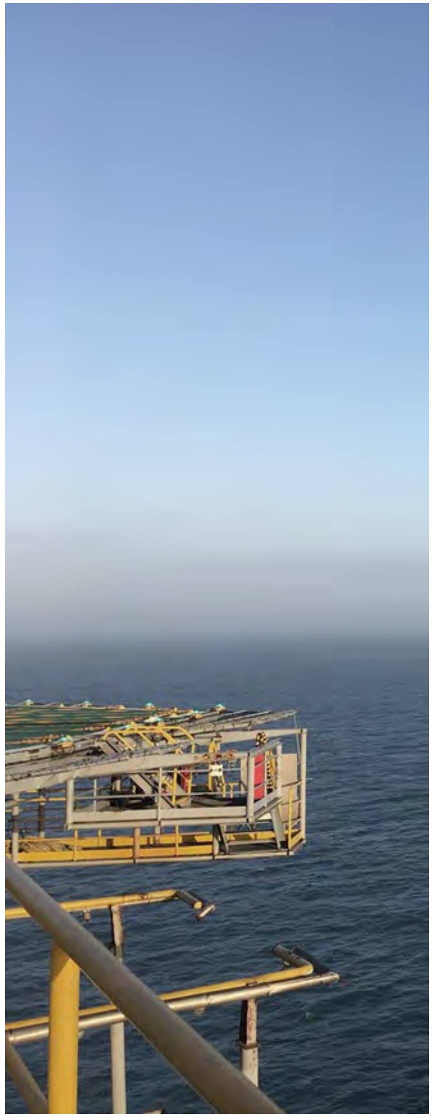
Power Cable Data



- The power cable is currently being designed.
- Design input data:
  - 33kV rated 20MW
  - cable dimension 3x1x300 sqmm
  - length approx. 9km
  - From OWF Riffgat transformer station to N05A platform

- Target burial depth minimum 1m measured from top of cable to mean natural seabed

Pipeline and Power Cable Installation



- The power cable will be installed by a dedicated cable installation vessel, by S-lay reeling.
- The power cable shall be buried by jetting using a specific cable trencher.
- Power cable tie-ins executed from the installation vessel by pulling through J-tubes.

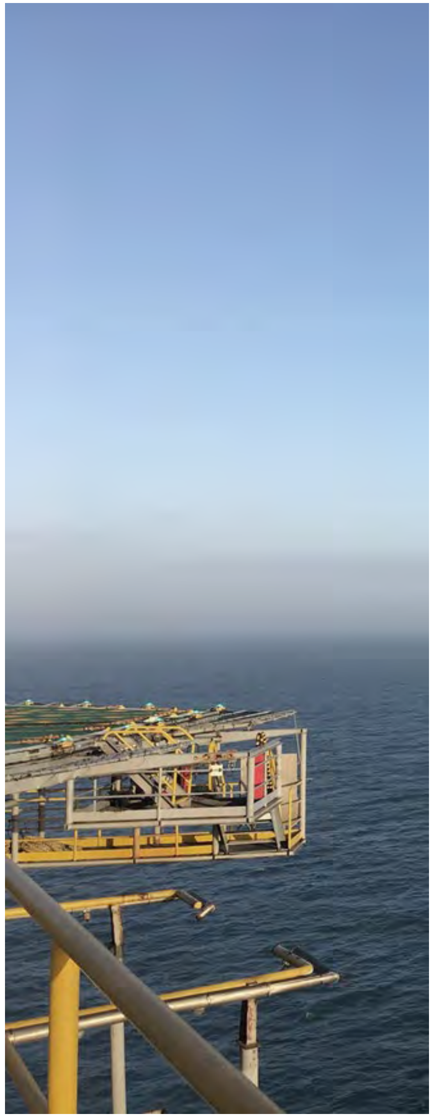
- Pipeline installation options:
  - S-lay from an anchored shallow water pipelay barge.
  - Pull-in by S-lay from a static DP vessel at sufficient waterdepth towards NGT, followed by normal S-lay.
- Pipeline burial may be executed by mechanical trenching or jetting.
- Pipeline tie-in at the N05A platform performed by air-diving from a DP DSV.
- Pipeline tie-in to the NGT pipeline executed by air diving from a static jack-up platform.

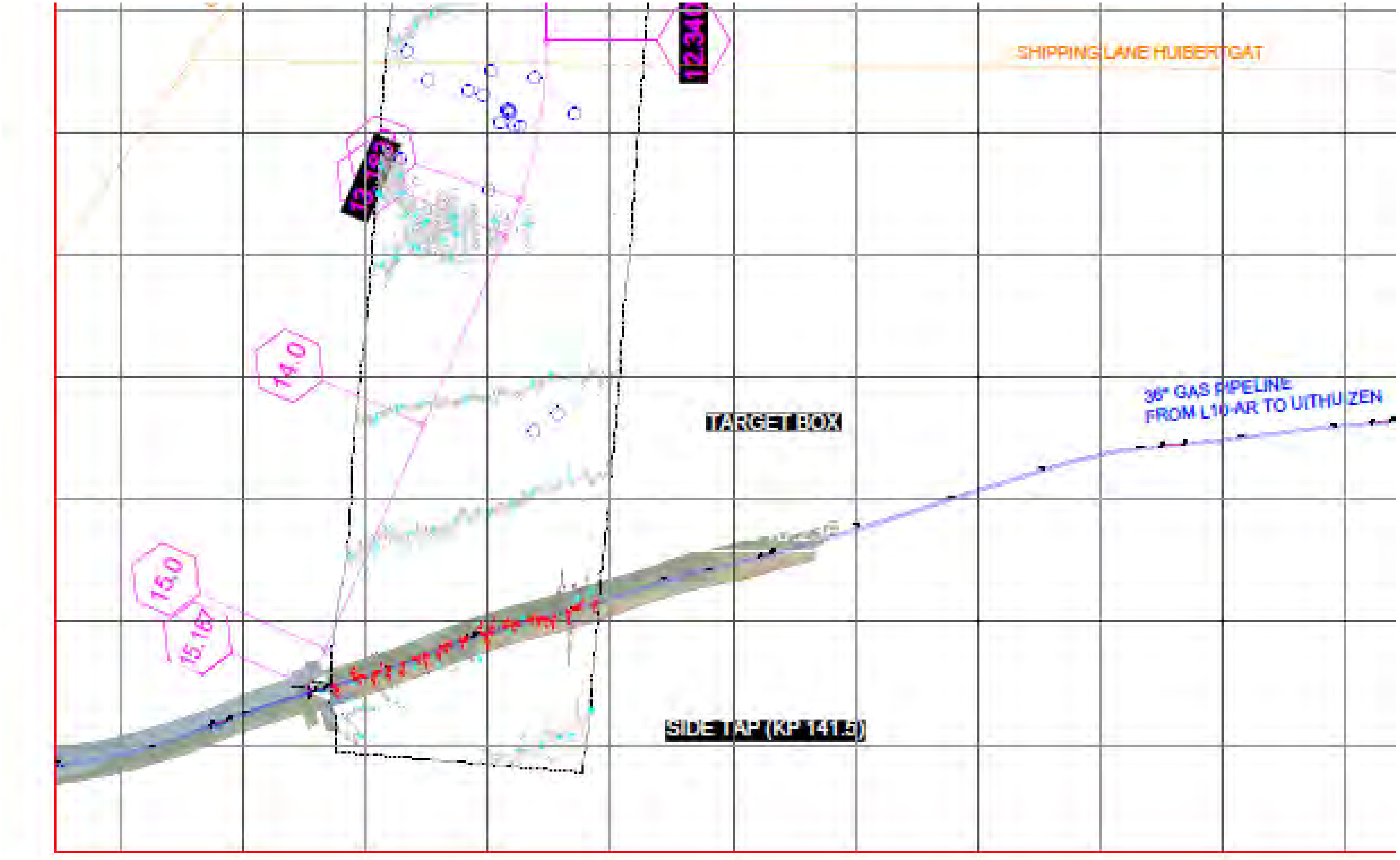
- Pipeline and cable crossings with existing cables will be made by separation mattresses on either side of existing cables. Thereafter crossings will be rock-dumped.

- Pipeline and cable tie-ins will also be rock-dumped.

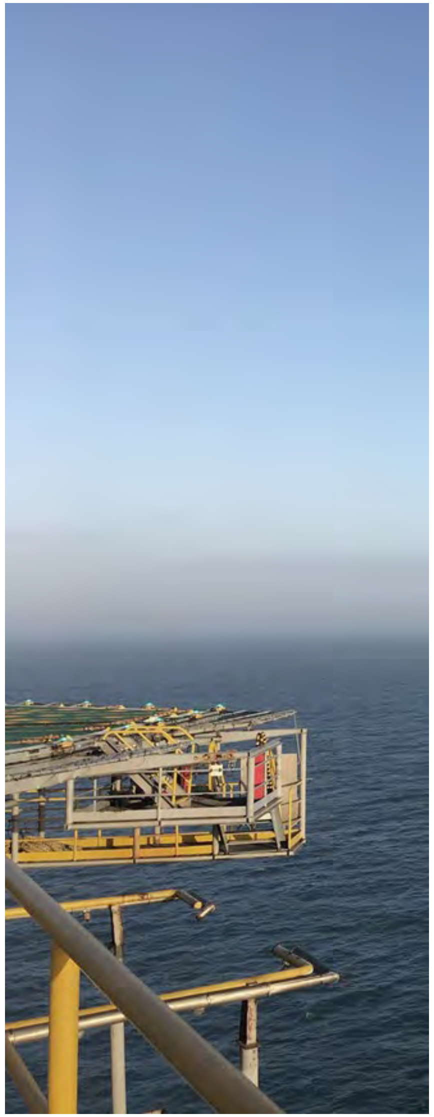
- Estimated durations:
  - Pipeline installation and trenching 30 days
  - Power cable installation and trenching 10 days
  - Pipeline tie-ins 20 days
  - Rock-dumping 7 days

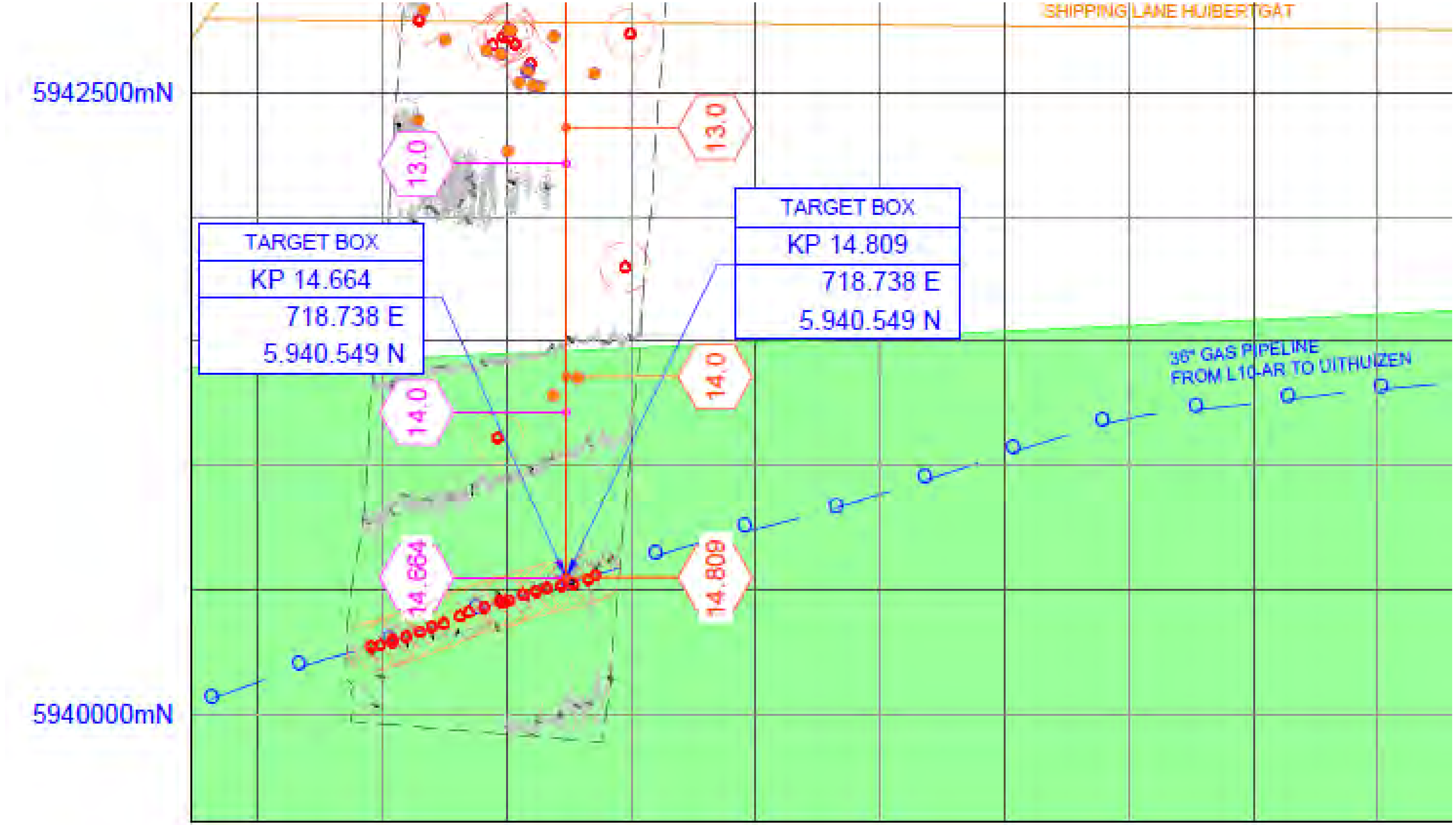
Pipeline tie-in at existing NGT sidetap



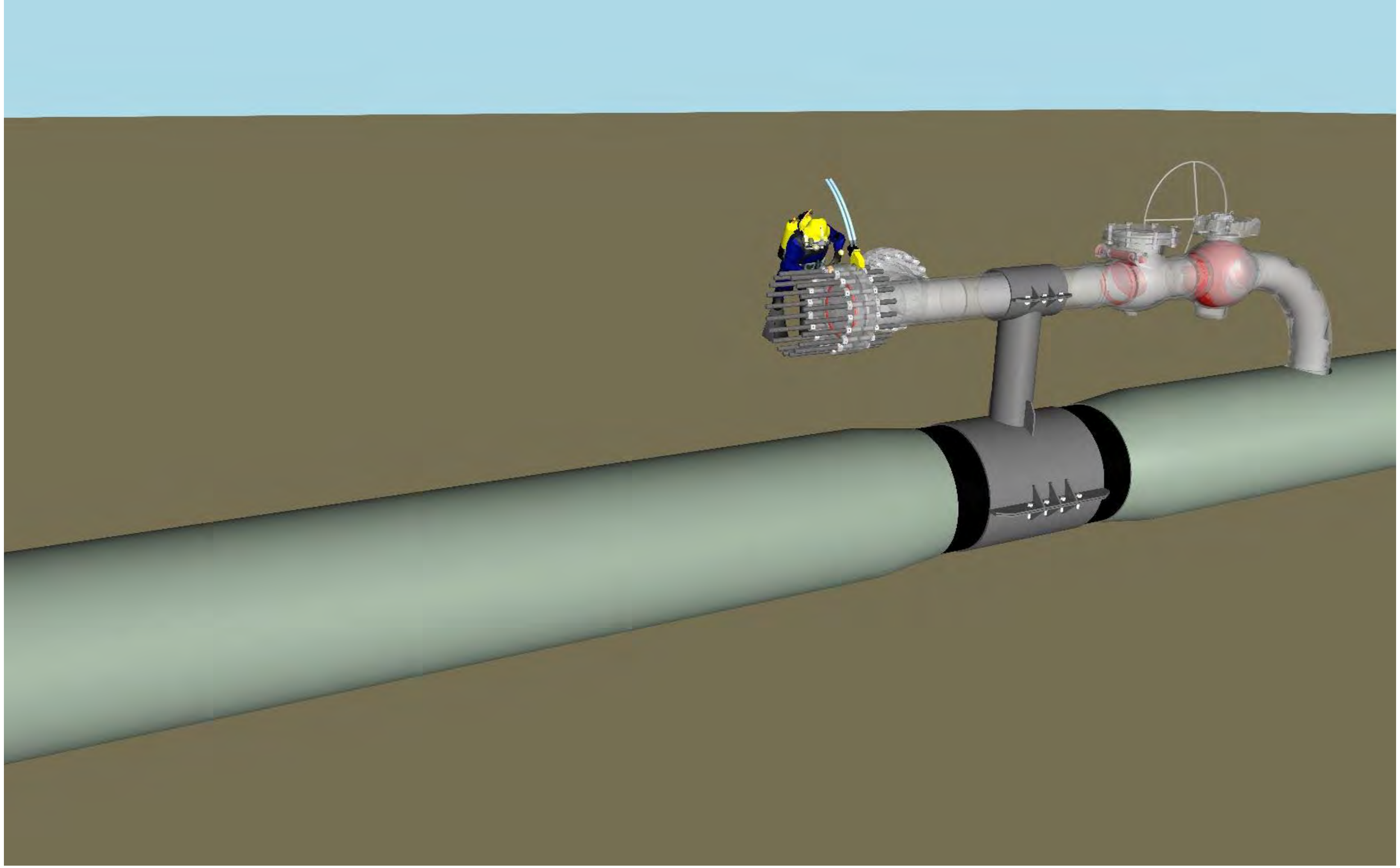


Alternative tie-in by hot-tapping into NGT pipeline

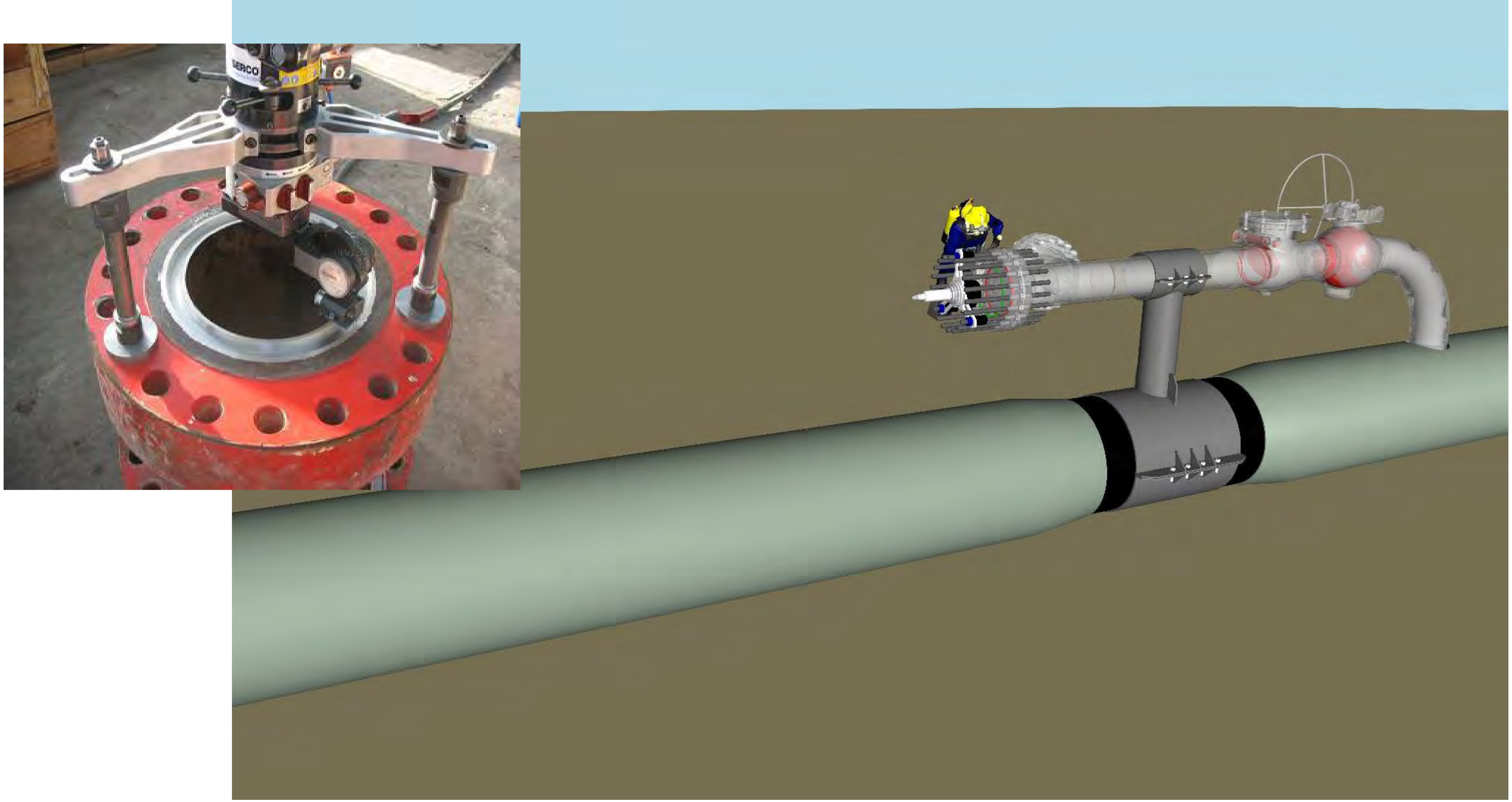




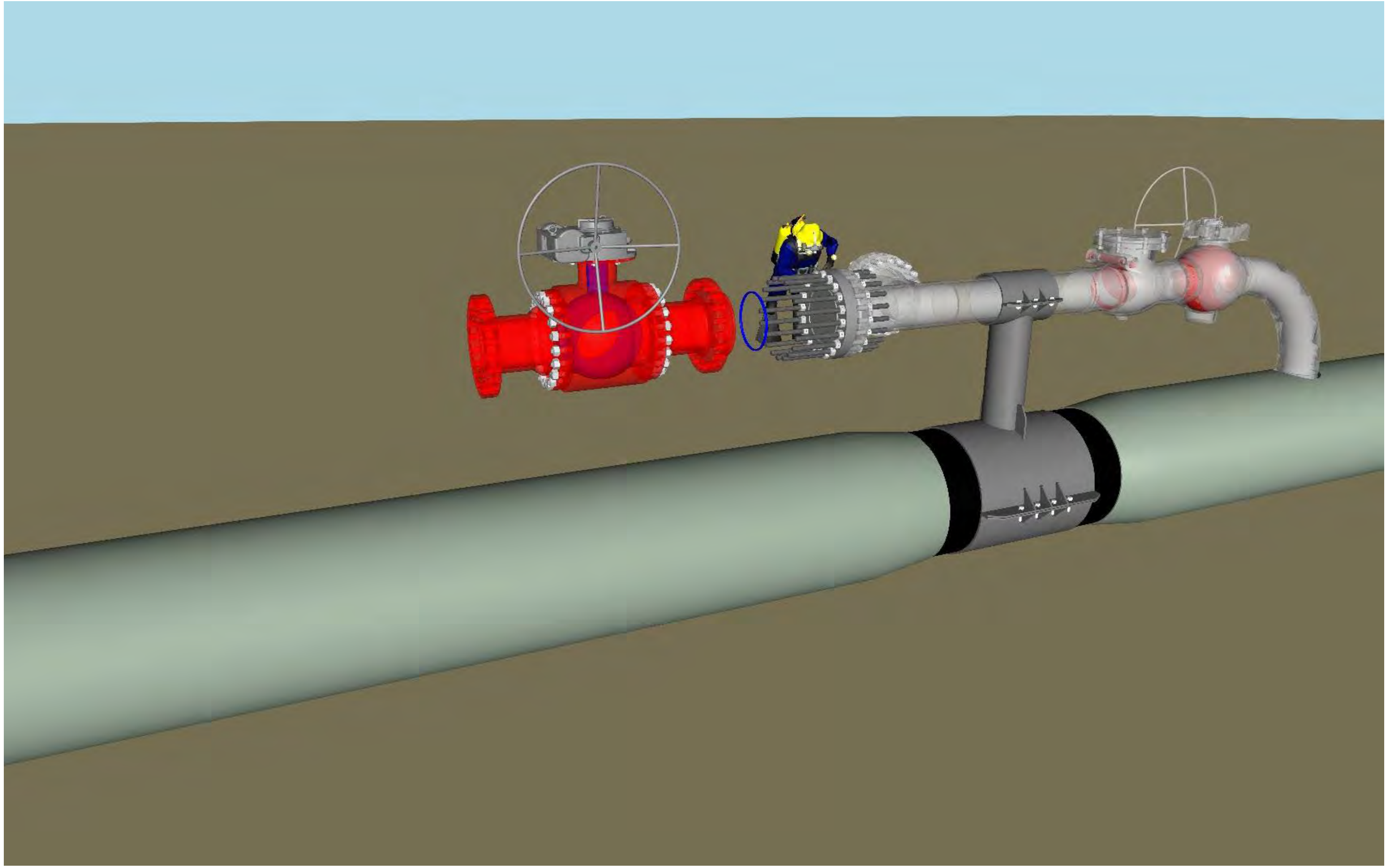
Side Tap Tie-in – Exchange bolts for Long bolts



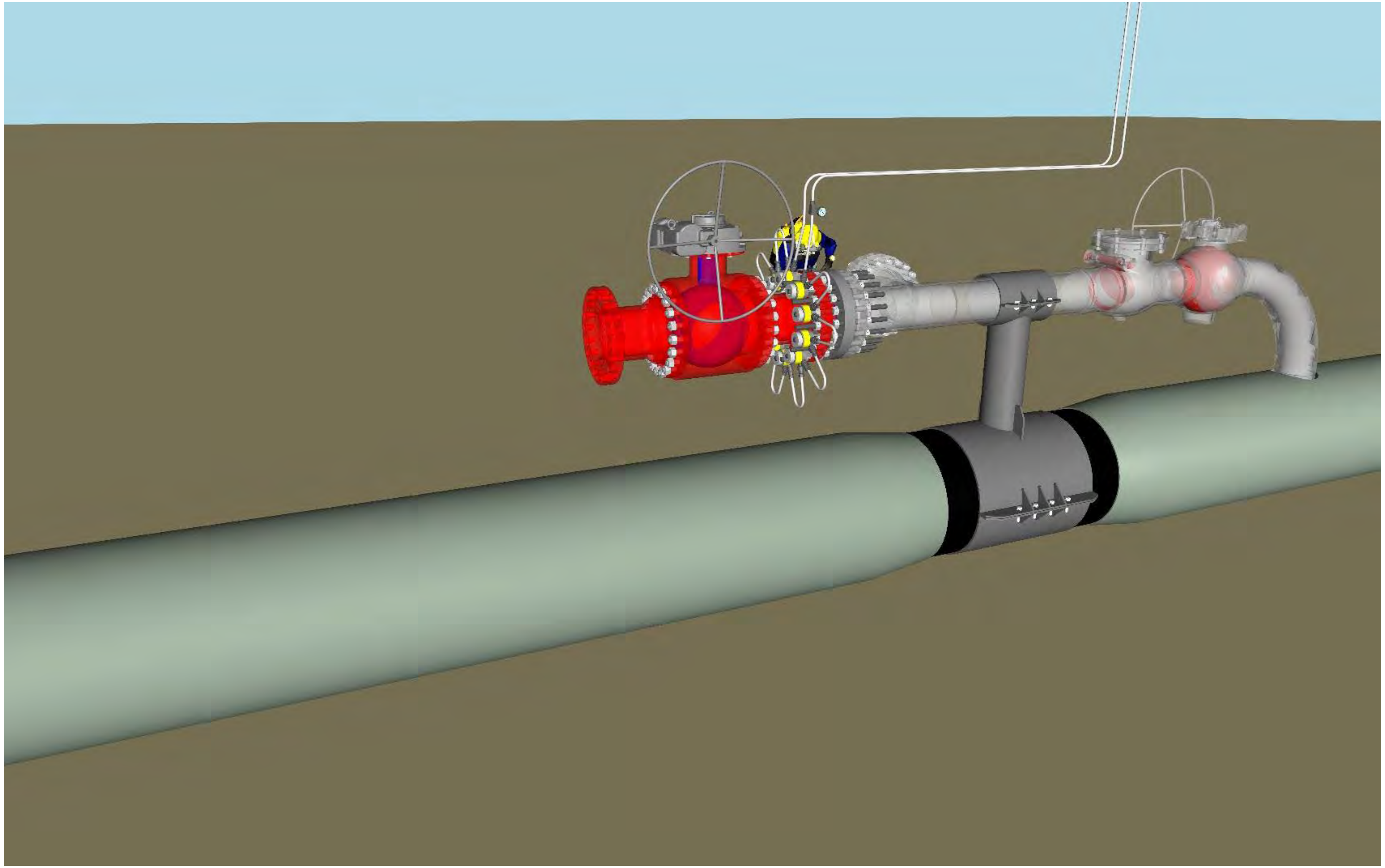
Side Tap Tie-in – Milling RTJ groove



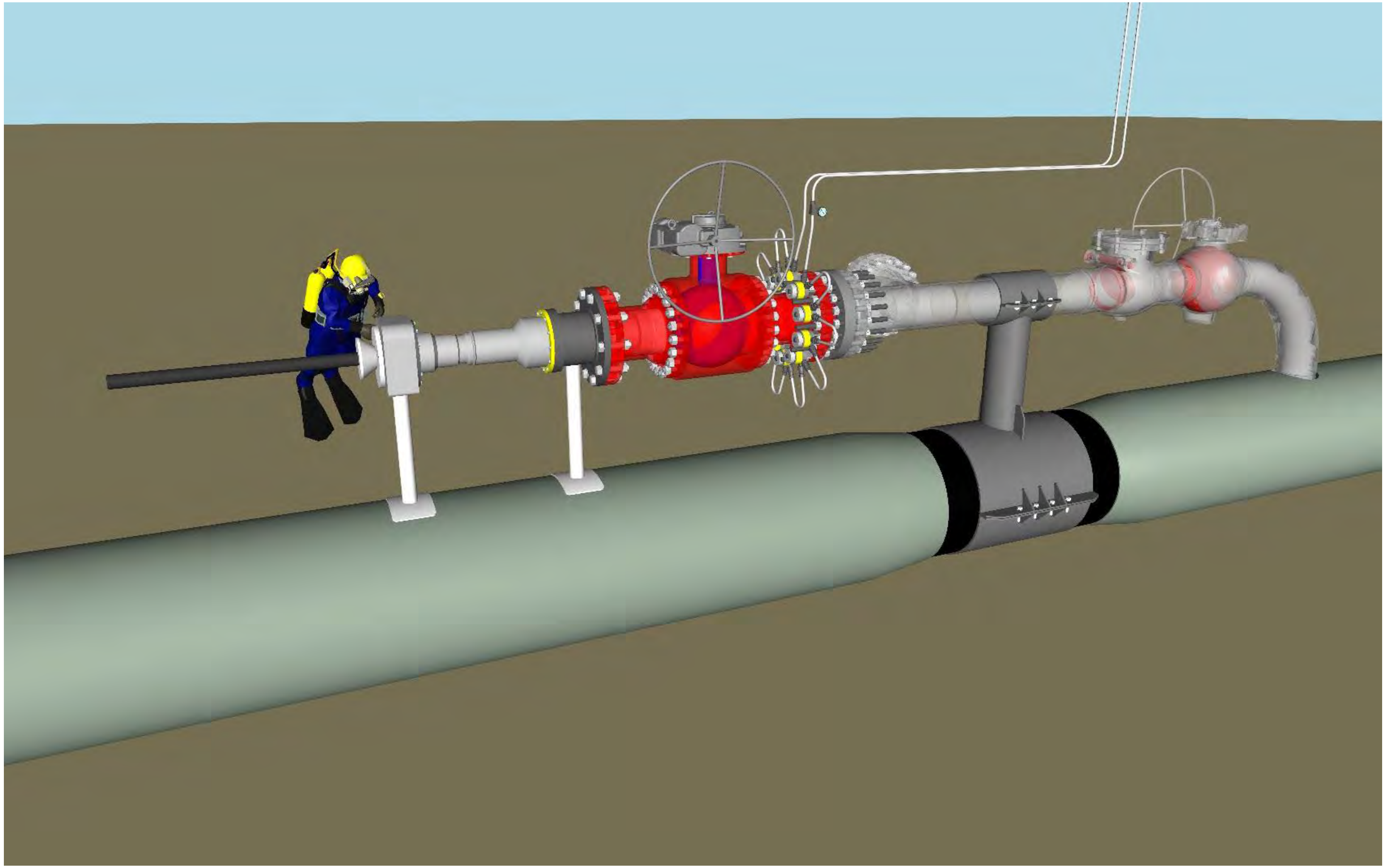
Side Tap Tie-in – Install DBB Ball Valve



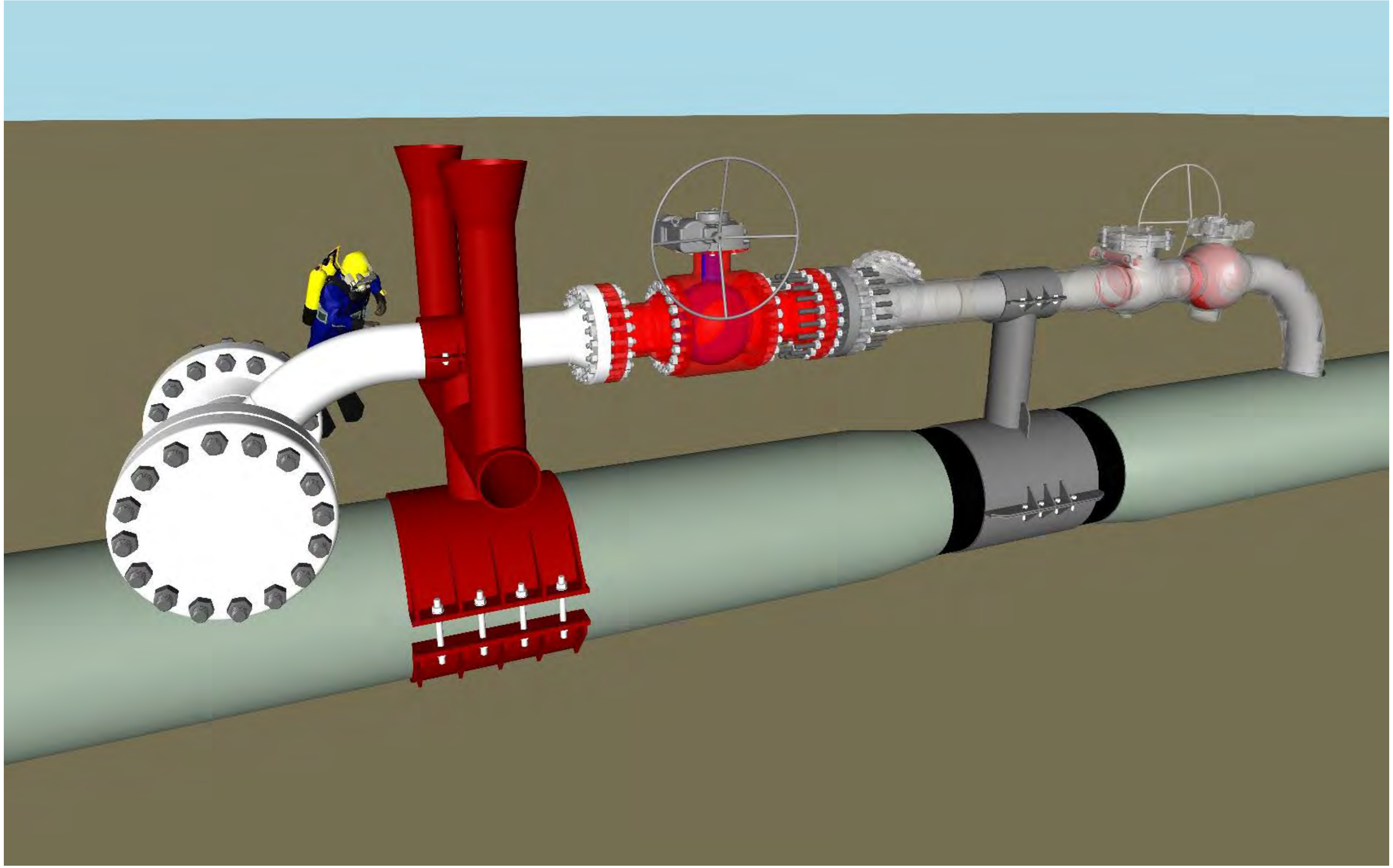
Side Tap Tie-in – Hydratight Bolts



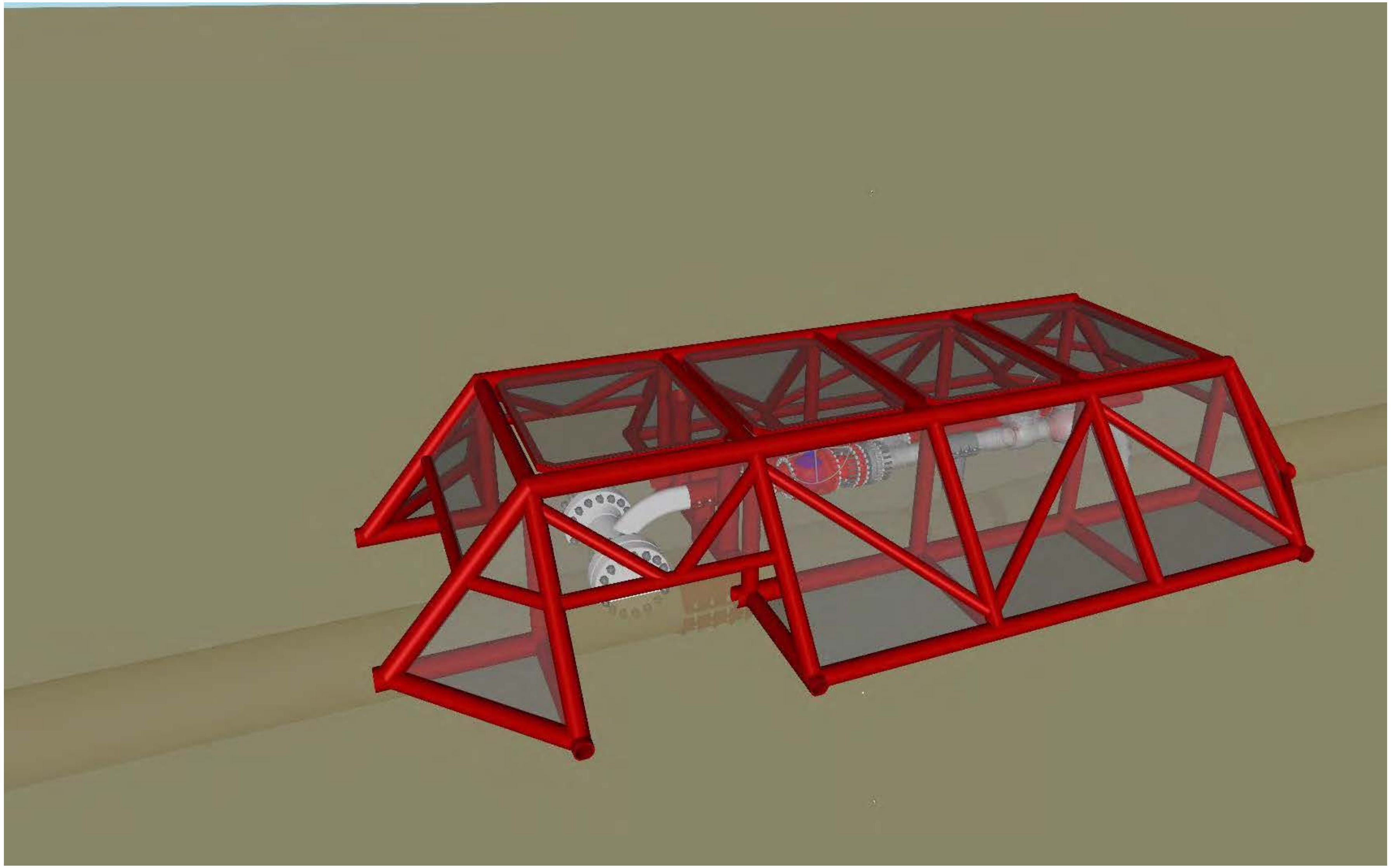
Side Tap Tie-in – Hottap Through Valve and Blind flange



Side Tap Tie-in – Mount TEE Piece



Side Tap Tie-in – Install Protection Dome



N05-A Pipeline design

Route Selection Report

DOCUMENT NUMBER:

N05A-7-10-0-70031-01

Rev.	Date	Description	Originator	Checker	Approver
01	15-01-2020	For Comments			
02	17-03-2020	For Approval			

Client

ONE-Dyas B.V.

Project

N05-A Pipeline Design

Document

Route Selection Report

Project number	19018
Document number	N05A-7-10-0-70031-01
Revision	02
Date	17-03-2020

Revision History

Revision	Description
01	For Client Comments
02	Client comments incorporated

Revision Status

Revision	Description	Issue date	Prepared	Checked	Enersea approval	Client approval
01	For Client Comments	15-01-2020				
02	For Approval	17-03-2020				

Table of content

1. Introduction

1.1. Project Introduction

One-Dyas plans to develop a successfully drilled well in block N05-A of the North Sea Dutch Continental Shelf. More wells will be drilled at this location through the same jacket. It is planned to develop the wells by installing a platform and a gas export pipeline with a connection to the NGT pipeline @KP142.1. The approximate length of the pipeline is 14.7 km.

In addition, a power cable will be installed from the Riffgat Windpark to the N05-A platform.

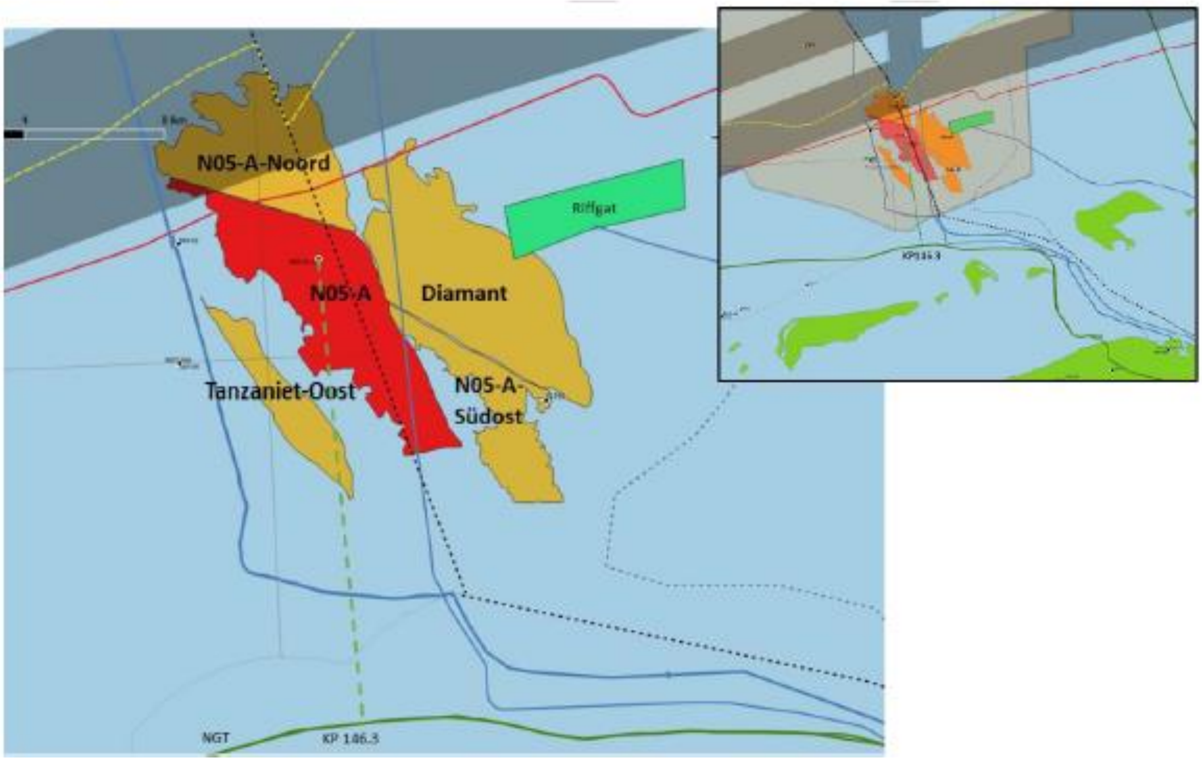


Figure 1, N05A Field layout

1.2. Purpose and Scope Document

The objective of this route selection study is to present the optimum pipeline route from the N05-A platform to the NGT tie-in and the power cable route from the N05-A platform to the Riffgat Offshore Substation.

The major aspects that are involved in the selection of pipeline route are orientation, seabed features, future developments and constructability of the pipeline.

The following aspects have been considered in the pipeline route selection study:

- Identification of seabed features such as sand dunes, mega ripples, anomalies, magnetic contacts and risk of their impact towards the selected pipeline & cable route,
- Avoid possible archaeological values
- Avoid possible environmentally sensitive areas
- Selection of the shortest pipeline & cable route,
- Minimizing pipeline and cable crossings,
- Optimizing the extent of pre-sweeping, if required,
- Constructability aspects such as platform approach, start-up and lay down, spool installation, tie-ins, pre-sweep and trenching limitations such as lateral slopes,
- Fulfilling pipeline & cable route requirements in accordance with COMPANY Specifications, codes and standards,
- Minimum radius of curvature calculations for pipeline & cable route bends, based on installation conditions.

Note1: the installation contractor will perform a route survey immediately prior to pipelay. Subject to actual findings (sand waves, ripples, mega ripples, anomalies, magnetic contacts) a rerouting may be required

1.3. System of Units

All dimensions and calculations applied are based on the International System of Units (SI) unless noted otherwise.

1.4. Abbreviations

LAT = Lowest Astronomical Tide

MSL = Mean Sea Water Level

KP= Kilometer Post

N = North

OSS = Offshore Substation

TP = Tangent Point

IP = Intersection Point

NGT= Noord Gas Transport

1.5. References

1.5.1. Regulations, Codes, Standards and Guidelines

[i] NEN3656. “Eisen voor stalen buisleidingsystemen op zee.” December 2015.

1.5.2. Company Engineering Standards and Specifications

[A] Hold [1]

1.5.3. Project Reference Documents

[1] LU0022H-553-RR-02 “5A to NGT hot tap Pipeline Route Report”

[2] LU0022H-553-RR-03-2.0 “N5a Lab Test Results Report”

[3] LU0022H-553-RR-04-2.1 N5a “Habitat Assessment Survey Report”

[4] LU0022H-553-RR-05-1.1 N5a “Environmental Baseline Survey Report”

[5] 181892-1-R2 “Metocean Criteria for the N05A Platform”

[6] 191146-1-R2 “Metocean Criteria for the N05A Platform – Side Tap”

[7] P904921/02 “N5A Development Site – Engineering Advice – Geotechnics”

[8] N05A-7-10-0-70026-01 “Basis of Design Pipeline & Tie-in Spools”

[9] N05A-7-10-0-70030-01 “Risk assessment & dropped object analysis”

[10] N05A-7-51-0-72510-01-04 “Overall field layout drawing”

[11] Geo XYZ, Surveys, 2019 LU0022H-553-RR-04-2.1, LU0022H-553-RR-05-1.1, LU0022H-553-RR-02

1.6. Holds

[1] -

2. Summary

The 14.7 km pipeline originates at the N05-A Platform and terminates at the NGT tie-in location (NGT KP 142.1). The 8.7 km power cable is located between the N05-A platform and the Riffgat Offshore Substation.

The pipeline and power cable route is selected on the basis of the following criteria:

1. Shortest route possible within the given constraints;
2. Immunizing seabed intervention requirements;
3. Avoidance of restricted areas;
4. Adept a route radius curvature greater or equal to the radius requirements (2000 m resp. 100m for pipeline and cable)
5. Minimum clearance distance of 25m from sonar contacts, 100m from magnetic contacts points and 150m at wrecks,
6. Minimizing pipeline and cable crossings
7. Location of Start-up and lay-down target boxes such that pipeline expansion can be absorbed and installability is feasible.

The route layout for both the pipeline and cable is shown in Figure 2-1. Reference is made to route drawing “N05A-7-51-0-72510-01-04 Overall field layout drawing”.

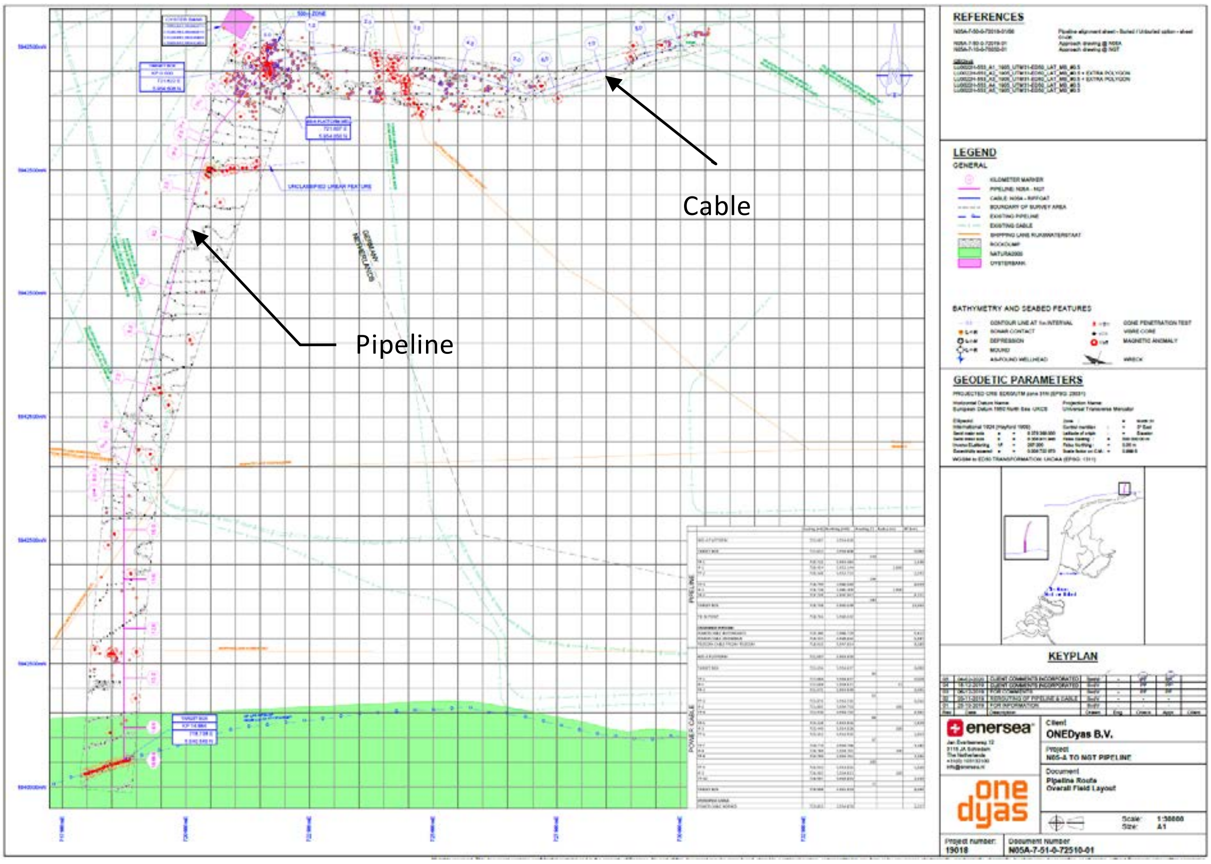


Figure 2-1 – Pipeline Route (see also appendix A)

3. Pipeline & Power Cable Route Data Options

3.1. General

As per the requirements of ref. [i], the pipeline is to be buried along its entire length with a minimum burial depth TOP of 0.2m outside shipping lanes and 0.6m TOP inside shipping lanes. However, a target burial depth of 1.0m TOP is chosen covering the results of the risk assessment study and bottom roughness analysis.

ITEM	VALUE
Original location	N05-A Platform
Tie-in location	NGT tie-in
Approx. pipeline length	14.7 KM
Water depth	-10.0 to -25.9m LAT
Route bend radius pipeline	2000m

Table 3-1 General Pipeline Overview

ITEM	VALUE
Original location	N05-A Platform
Tie-in location	Riffgat OSS
Approx. cable length	8.7 KM
Water depth	-19.5 to -25.9m LAT
Route bend radius cable	100m

Table 3-2 General Cable Overview

3.2. Coordinate System

The parameters of the geodetic system to be used for horizontal positions are taken from ref. [4] and listed in Table 4-2.

ITEM	VALUE
Datum	European Datum 1950 (ED50)
Projection	ED50 / UTM zone 31 N
Ellipsoid name	International 1924
Semi major axis	6 378 388 m
Inverse flattening	297.000
Central Meridian	03º00”00’ E
Latitude of Origin	00º00”00’ N
False Northing	0 mN
False Easting	500 000 mE
Scale Factor	0.9996

Table 3-3 Geodetic parameters

The vertical position is given relative to the Lowest Astronomical Tide (LAT).

3.3. Routing Options

For both the pipeline and the power cable several routing options have been reviewed bearing in mind the selection criteria as mentioned in section 1.2 and 2.

For the pipeline as well as for the power cable 3 different routes have been determined:

- Pipeline:
  The pipeline starts at the south side of the platform and leaves the platform in a south-westly direction. In the first area there are a lot of boulders which make it more difficult to route the pipeline without having any removals. The pipeline is running along most of the boulders with respect to the minimum clearance of 25m accept for two. The minimum distance at these locations is 14m. From this point there are three different pipeline routes determined.
  - Magenta route

    The pipeline is routed with a minimum bending radius of 2000m, where the first bend starts at least 1.0 km from the target box. The pipeline is routed at the west side of the ship wreck found, where the distance is at least 150m. From here the pipeline is routed between the magnetic contacts with respect to the distances as given in chapter 2.
  - Blue route

    The pipeline is routed with a minimum bending radius of 1500m, where the first bend starts at least 1.0 km from the target box. The pipeline is routed at the east side of the ship wreck found, where the distance is at least 150m. From here the pipeline is routed between the magnetic contacts with respect to the distances as given in chapter 2.
  - Green route

    The pipeline is routed with a minimum bending radius of 2000m, where the first bend starts at 0.8 km from the target box. The pipeline is routed at the east side of the ship wreck found, where the distance is at least 150m. From here the pipeline is routed at the east side of the first magnetic contact because the bending radius of 2000m is not allowing it to pas the magnetic contact at the west side. The next section of the pipeline is routed between the magnetic contacts with respect to the distances as given in chapter 2.

- Power cable:
  The power cable starts at the east side of the platform and has three different cable routes.
  - Option 1a

    The cable is routed to the north side of the corridor with minimum distances as given in chapter 2. At KP 0.8 the cable is routed to the centre of the corridor and goes through the magnetic contacts. At KP 2.5 the cable is routed between two magnetic contacts where the minimum distance to the closed magnetic contact is 60m. From here the cable is going North to avoid the SSS-contacts in this area.
  - Option 1b

    The cable is routed at the north side of the corridor with minimum distances as given in chapter 2. At KP 2.5 the cable is routed close to the North edge of the corridor with a minimum distance of 150m with the upper North magnetic contact.
  - Option 2

    The cable is routed at the south side of the corridor with minimum distances as given in chapter 2. At KP 3.0 the cable is routed between two magnetic contacts where the minimum distance to the closest magnetic contact is 38m. From here the cable is going North to avoid the SSS-contacts in this area.

Reference is made to figure 3-1 indicating the different pipeline and cable route options.

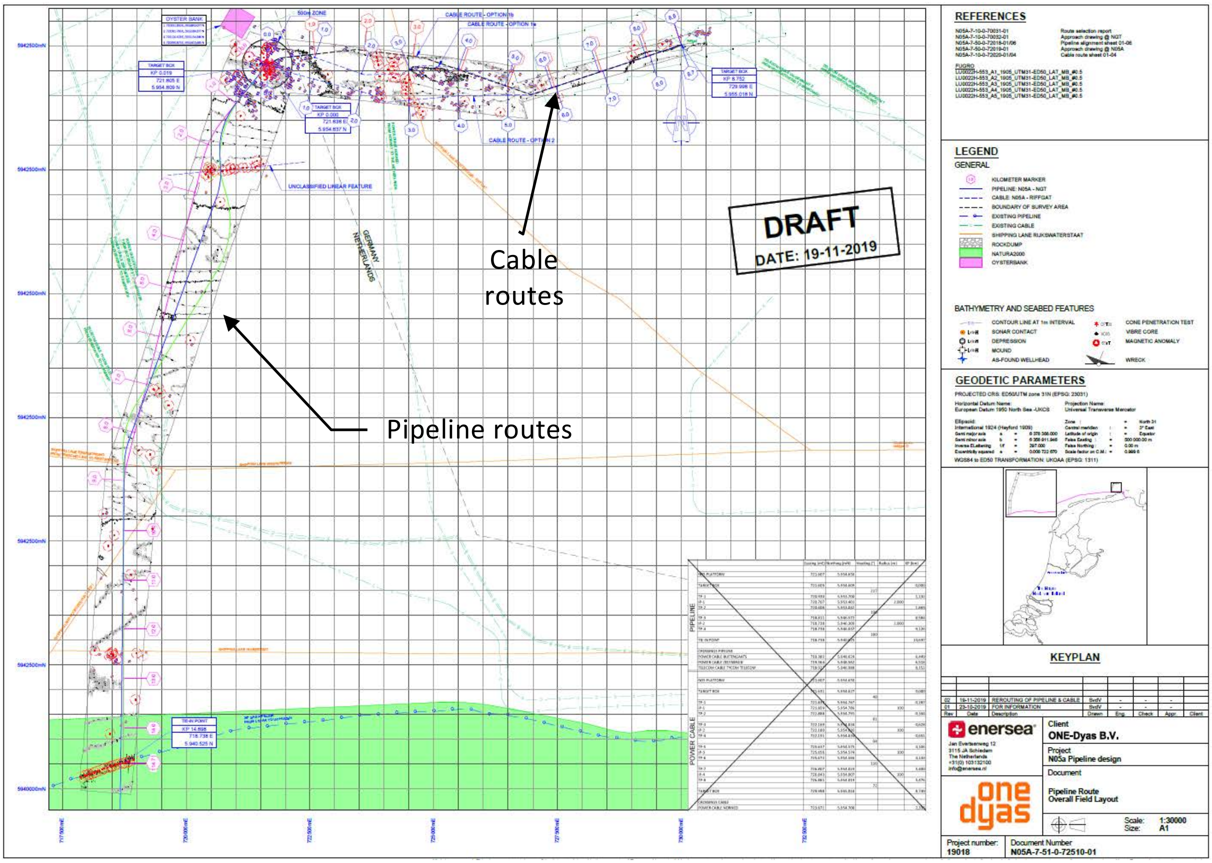


Figure 3-1 – Pipeline Route Options (see also appendix B)

3.4. Crossings

Along the route options several in/out of use cable crossings/features are anticipated based on the surveys [1], [3] and [4]:

Pipeline:

- Unclassified linear feature @KP 2.6
- Power cable crossing Gemini OWP (2x) @KP 6.4
- Telecom cable Tycom Telecom @KP 8.2

Cable:

- Power cable NorNed @KP 2.3

3.5. Selected Routes

Pipeline:

The selected pipeline is the magenta route option. By passing the wreck at the west side the magnetic contacts of the unknown linear feature are avoided. This pipeline route has also the minimum amount of bends, only 2 and has the longest straight part between the first bend and the platform.

Cable:

The selected cable route is cable route option 01b. By routing the cable at the north side of the corridor all the magnetic contacts are avoided with a minimum clearance of 100m.

3.6. Coordinates of Pipeline & Cable Routes and Key Facilities

For the selected routes, table 3-4 provides an overview of the positions of the pipeline, cable, tie-in locations and crossings.

	Location Point	Easting (mE)	Northing (mN)	Bearing (°)	Radius (m)	KP (km)
PIPELINE						
	N05-A PLATFORM	721.607	5.954.650			
	N05-A PLATFORM TARGET BOX	721.622	5.954.608			0,000
				219		
	TP-1	720.725	5.953.484			1,428
	IP-1	720.454	5.953.144		2000	
	TP-2	720.348	5.952.723			2,293
				194		
	TP-3	718.799	5.946.549			8,659
	IP-2	718.738	5.946.309		2000	
	TP-4	718.738	5.946.062			9,151
				180		
	NGT TARGET BOX	718.738	5.940.549			14,664
	NGT TIE-IN POINT	718.766	5.940.532			
	CROSSINGS PIPELINE					
	POWER CABLE BUITENGAATS	719.346	5.948.729			6,412
	POWER CABLE ZEEENERGIE	719.327	5.948.655			6,487
	TELECOM CABLE TYCOM TELECOMS	718.915	5.947.014			8,180
POWER CABLE						
	N05-A PLATFORM	721.607	5.954.650			
	N05-A PLATFORM TARGET BOX	721.636	5.954.637			0,000
				90		
	TP-1C	721.664	5.954.637			0,028
	IP-1C (platform pull in)	721.668	5.954.637		15*	
	TP-2C	721.671	5.954.639			0,035
				63		
	TP-3C	721.876	5.954.745			0,266
	IP-2C	721.892	5.954.753		100	
	TP-4C	721.910	5.954.755			0,302
				84		
	TP-5C	723.428	5.954.926			1,829
	IP-3C	723.440	5.954.628		100	
	TP-6C	723.452	5.954.626			1,853
				97		

* The pull-in radius is smaller than the normal bending radius of the cable.

	Location Point	Easting (mE)	Northing (mN)	Bearing (°)	Radius (m)	KP (km)
	TP-7C	724.774	5.954.766			3,185
	IP-4C	724.784	5.954.765		100	
	TP-8C	724.794	5.954.762			3,206
				109		
	TP-9C	726.933	5.954.026			5,468
	IP-5C	726.965	5.955.015		100	
	TP-10C	726.997	5.954.025			5,533
				72		
	OSS RIFFGAT TARGET BOX	729.998	5.955.018			8,694
	CROSSINGS CABLE					
	POWER CABLE NORNED	723.853	5.954.878			2,257

Table 3-4 Coordinates of Selected Pipeline & Cable Route and Key Facilities

3.7. Bathymetry

The water depth ranges between -10.0m and -25.9m LAT along the pipeline route, whereas the water depth variation along the cable route is between -19.5m and -25.9m LAT, with the seabed gently dipping to the north.

3.7.1. Pipeline Route

The water depths along the pipeline route at the platform, tie-in and at crossing locations are listed in the Table below; data has been taken from Reference [10].

Location	Water Depth (m) [LAT]
N05-A Platform – target box	-25.9
NGT tie-in – target box	-10.0
Power cable Buitengaats	-19.2
Power cable Zeeenergie	-19.0
Telecom cable Tycom Telecom	-17.6

Table 3-5 Pipeline Water Depths at Platform, tie -in and Crossings

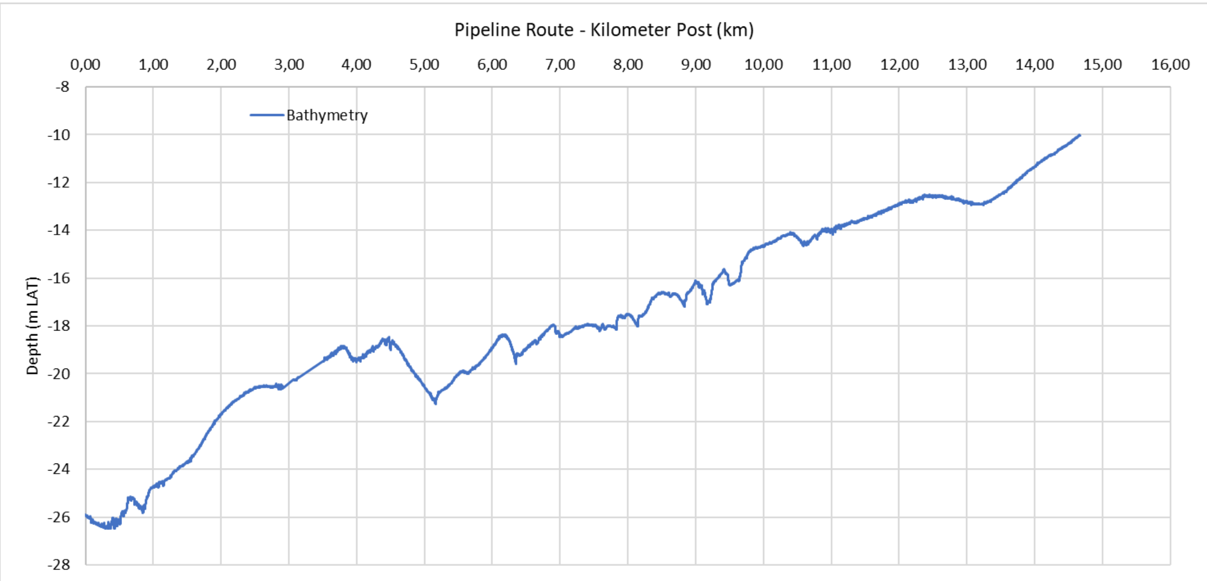


Figure 3-2 – Seabed Profile along Proposed Pipeline Route

3.7.2. Power Cable Route

The water depths along the cable route at the platforms and at crossing locations are listed in the Table below; data has been taken from Reference [10].

Location	Water Depth (m) [LAT]
N05-A Platform – target box	-25.9
Riffgat OSS – target box	-20.0
Power cable NorNed	-23.6

Table 3-6 Power Cable Water Depths at Platforms and Crossings

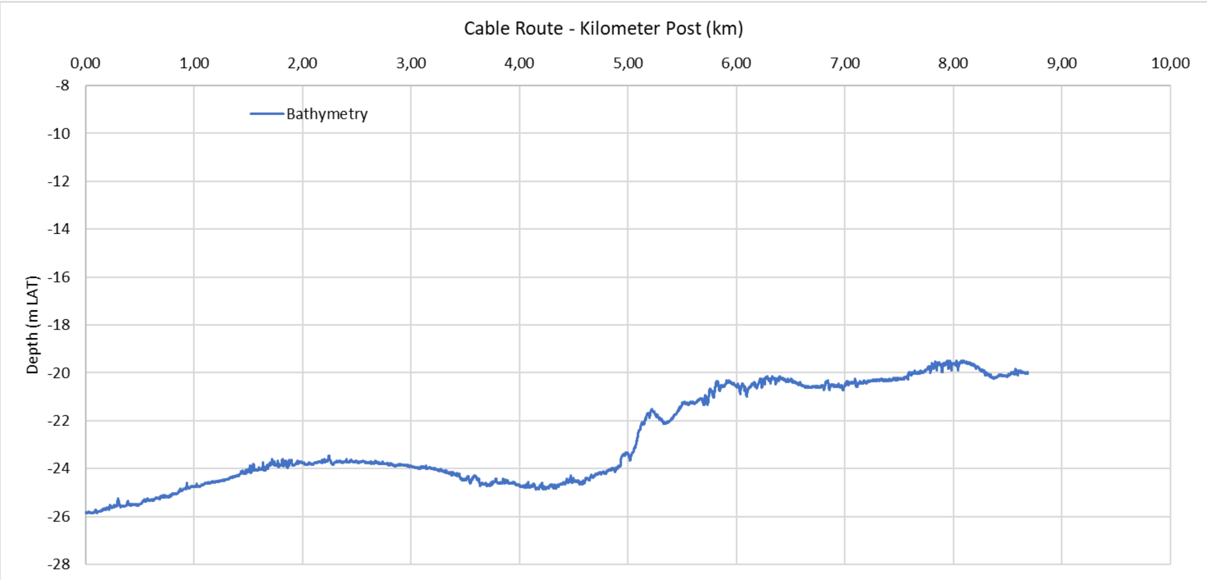


Figure 3-3 – Seabed Profile along Proposed Power Cable Route

3.8. Survey Route

3.8.1. Magnetometer Contacts

A total of 241 magnetic anomalies (appendix C) were picked within the surveyed N05-A platform to the 36" NGT Tie-in and N05-A platform to Riffgat Tie-in route corridor. Most of these anomalies can be attributed to unknown identified seabed features. The following seabed infrastructures are known, one (1) pipeline and four (4) cables. However, there is one (1) unknown linear feature.

The following existing pipelines and cable are detected:

- 36" Pipeline from L10-AR to Uithuizen
- Tycom Telecom cable
- Buitengaats Power cable
- Zeeenergie Power cable
- Norned Power cable

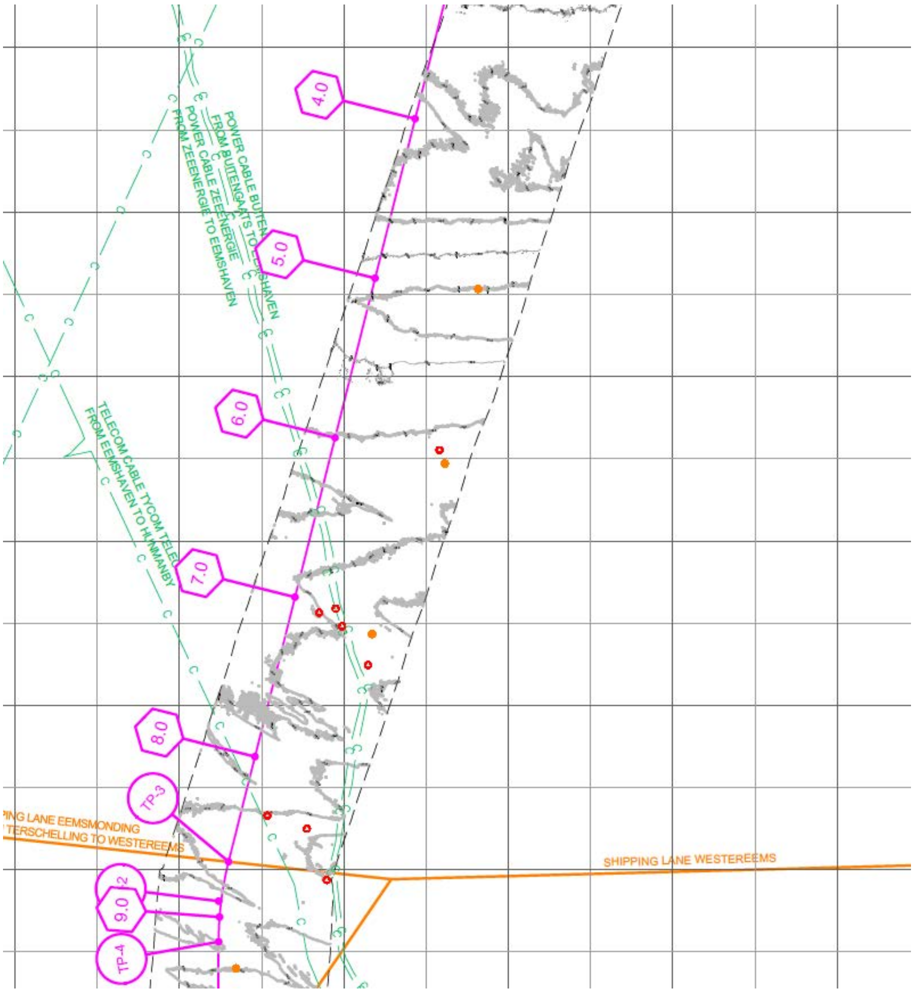


Figure 3-4 – Magnetometer Contacts showing route crossing with cables

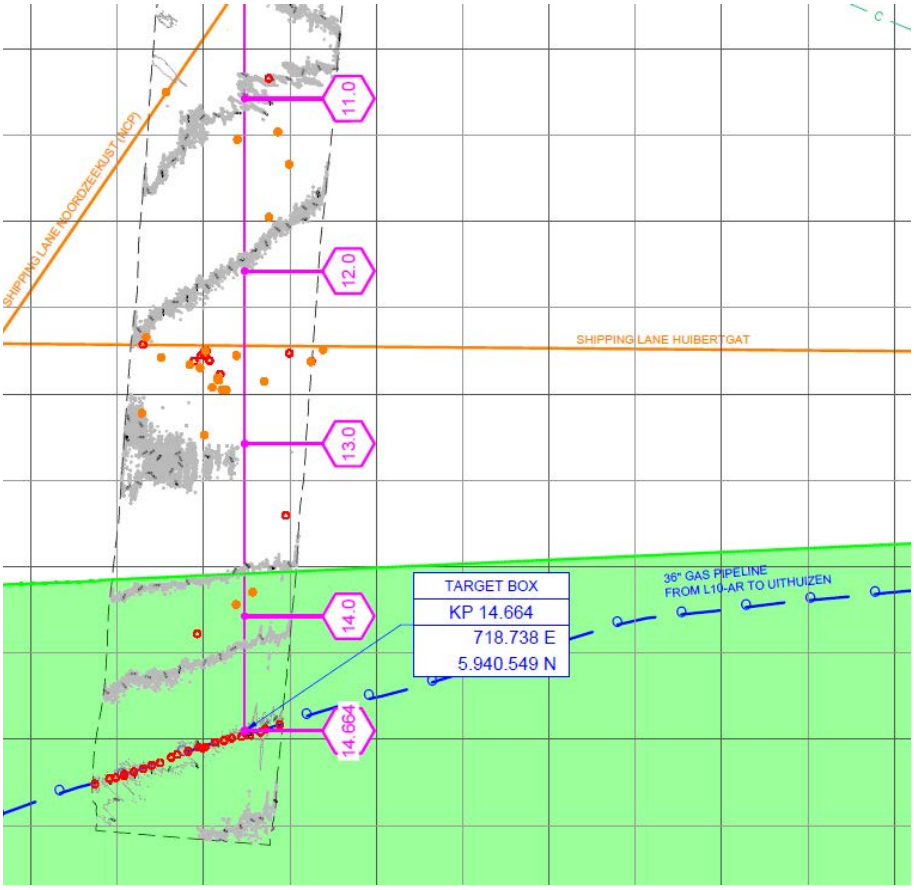


Figure 3-5 – Magnetometer Contacts showing route crossing with 36" NGT Pipeline

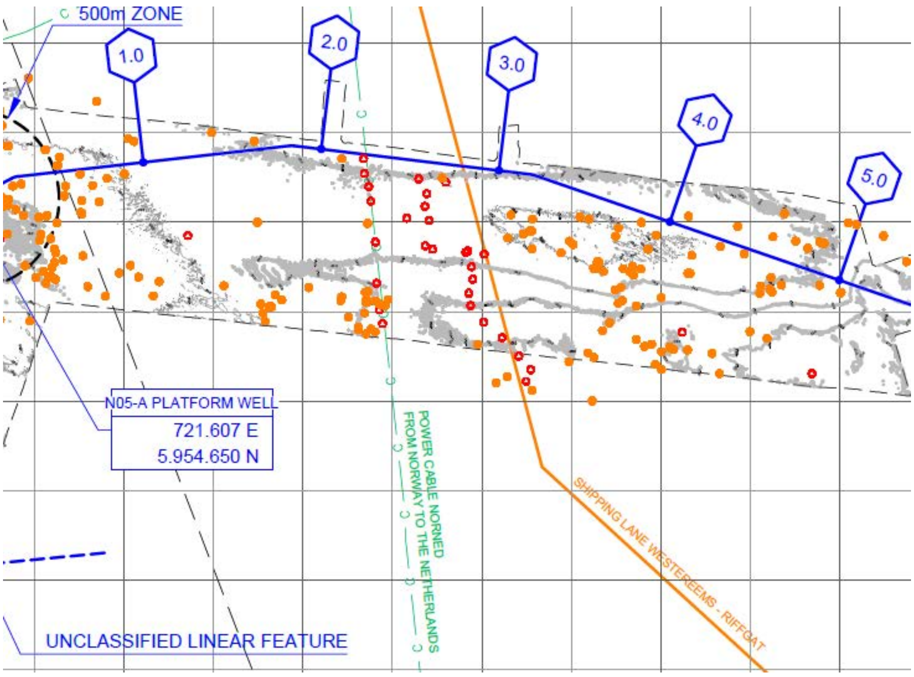


Figure 3-6 – Magnetometer Contacts showing route crossing with Norned Cable

3.8.2. Geophysical Data

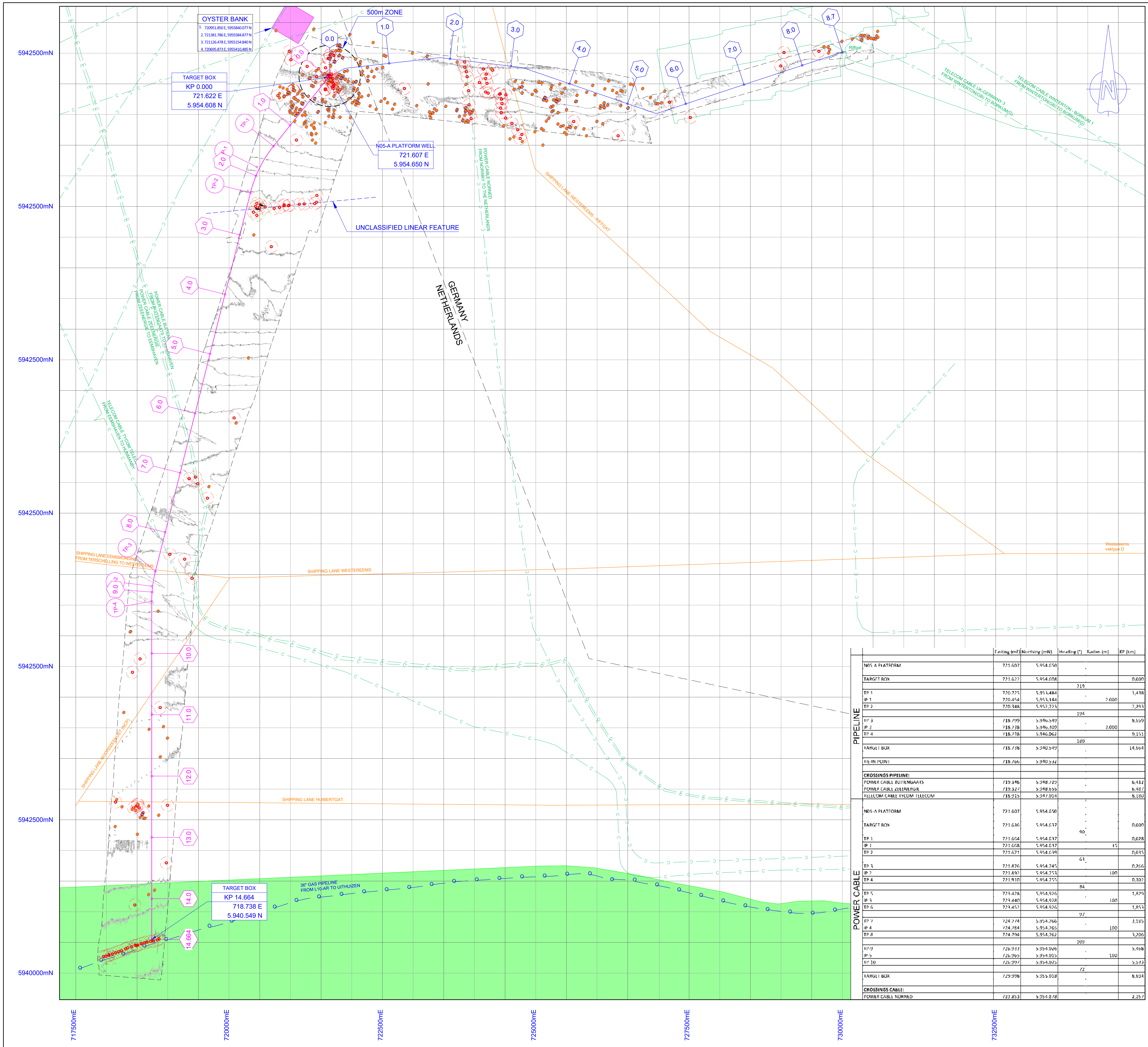
Eight-Hundred-Thirty (830) side scan sonar contacts were observed within the route survey. Most of the contacts are boulders located around the N05-A platform and stretching to the east side to Riffgat. Besides the boulders the following contacts are found: twenty-six (26) debris items, two (2) wrecks. Side scan sonar data can be found in Appendix C

3.8.3. Geotechnical Data

The majority of the surface sediments is interpreted as fine to medium grained sand and generally thickening to the south. Sand was absent (or less than 0.5m thick) from KP 0.430 to KP 0.450, KP 0.757 to KP 1.045 and near KP 5.0 (channel), where the subsoil consists of sand with layers of clay. The soil properties are based on assumptions with reference to the geo-surveys reports, ref [11]. The 0.5 m top layer consists of mobile and loose sand properties. The clay outcrops are regarded as hard soil and to the South the subsoil sands are assumed to be medium.

A. Selected Pipeline & Power Cable Route

(1 page: ref. N05A-7-51-0-72510-01-05 Overall field layout drawing)



		Easting (mE)	Northing (mN)	Heading (°)	Radius (m)	KP (km)
PIPELINE	N05 A PLATFORM	721.607	5.954.650			
	TARGET BOX	721.622	5.954.608			0,000
				219		
	TP 1	720.725	5.953,484			1,438
	IP 1	720.454	5.953,144		2.000	
	TP 2	720.348	5.952,723			2,293
				194		
	TP 3	718.799	5.946.549			8,659
	IP 2	718.738	5.946.309		2.000	
	TP 4	718.738	5.946.062			9,151
				180		
	TARGET BOX	718.738	5.940.549			14,664
	TIE-IN POINT	718.766	5.940.532			
	CROSSINGS PIPELINE:					
	POWER CABLE BUITENGAATS	719.346	5.948.729			6,412
	POWER CABLE ZEEENERGIE	719.327	5.948.655			6,487
	TELECOM CABLE TYCOM TELECOM	718.915	5.947.014			8,180
POWER CABLE	N05-A PLATFORM	721.607	5.954.650			
	TARGET BOX	721.636	5.954.637			0,000
				90		
	TP 1	721.664	5.954.637			0,028
	IP 1	721.668	5.954.637		15	
	TP 2	721.671	5.954.639			0,035
				63		
	TP 3	721.876	5.954.745			0,266
	IP 2	721.892	5.954.753		100	
	TP 4	721.910	5.954.755			0,302
				84		
	TP 5	723.428	5,954,926			1,829
	IP 3	723.440	5.954,928		100	
	TP 6	723.452	5.954.926			1,853
				97		
	TP 7	724.774	5,954,766			3,185
	IP 4	724,784	5,954,765		100	
	TP 8	724.794	5,954,762			3,206
				109		
	TP 9	726.933	5.954.026			5,468
	IP 5	726.965	5.954.015		100	
	TP 10	726.997	5,954.025			5,533
				72		
	TARGET BOX	729.998	5.955.018			8,694
	CROSSINGS CABLE:					
	POWER CABLE NORNED	723.853	5.954.878			2,257

REFERENCES

N05A-7-50-0-72018-01/06 — Pipeline alignment sheet - Buried / Unburied option - sheet 01-06
N05A-7-50-0-72019-01 — Approach drawing @ N05A
N05A-7-10-0-70032-01 — Approach drawing @ NGT

GEOxyz
LU0022H-553_A1_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A2_1905_UTM31-ED50_LAT_MB_#0.5 + EXTRA POLYGON
LU0022H-553_A3_1905_UTM31-ED50_LAT_MB_#0.5 + EXTRA POLYGON
LU0022H-553_A4_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A5_1905_UTM31-ED50_LAT_MB_#0.5

LEGEND

GENERAL

- KILOMETER MARKER
- PIPELINE: N05A - NGT
- CABLE: N05A - RIFFGAT
- BOUNDARY OF SURVEY AREA
- EXISTING PIPELINE
- EXISTING CABLE
- SHIPPING LANE RIJKSWATERSTAAT
- ROCKDUMP
- NATURA2000
- OYSTERBANK

BATHYMETRY AND SEABED FEATURES

- CONTOUR LINE AT 1m INTERVAL
- SONAR CONTACT
- DEPRESSION
- MOUND
- AS-FOUND WELLHEAD
- CONE PENETRATION TEST
- VIBRE CORE
- MAGNETIC ANOMALY
- WRECK

GEODETIC PARAMETERS

PROJECTED CRS: ED50/UTM zone 31N (EPSG: 23031)

Horizontal Datum Name: European Datum 1950 North Sea -UKCS
Projection Name: Universal Transverse Mercator

Ellipsoid: International 1924 (Hayford 1909)

Semi major axis	a	=	6 378 388.000
Semi minor axis	b	=	6 356 911.946
Inverse ELattening	1/f	=	297.000
Excentricity squared	e	=	0.006 722 670

Zone :	= North 31
Central meridian :	= 3° East
Latitude of origin :	= Equator
False Easting :	= 500 000.00 m
False Northing :	= 0.00 m
Scale factor on C.M.:	= 0.999 6

WGS84 to ED50 TRANSFORMATION: UKOAA (EPSG: 1311)

KEYPLAN

Rev	Date	Description	Drawn	Eng.	Check	Appr.	Client
05	04-02-2020	CLIENT COMMENTS INCORPORATED	SvdV	-	PF	PF	
04	18-12-2019	CLIENT COMMENTS INCORPORATED	SvdV	-	PF	PF	
03	06-12-2019	FOR COMMENTS	SvdV	-	PF	PF	
02	20-11-2019	REROUTING OF PIPELINE & CABLE	SvdV	-	-	-	
01	23-10-2019	FOR INFORMATION	SvdV	-	-	-	

enersea
Jan Evertsenweg 12
3115 JA Schiedam
The Netherlands
+31(0) 103132100
info@enersea.nl

Client: ONEDyas B.V.

Project: N05-A TO NGT PIPELINE

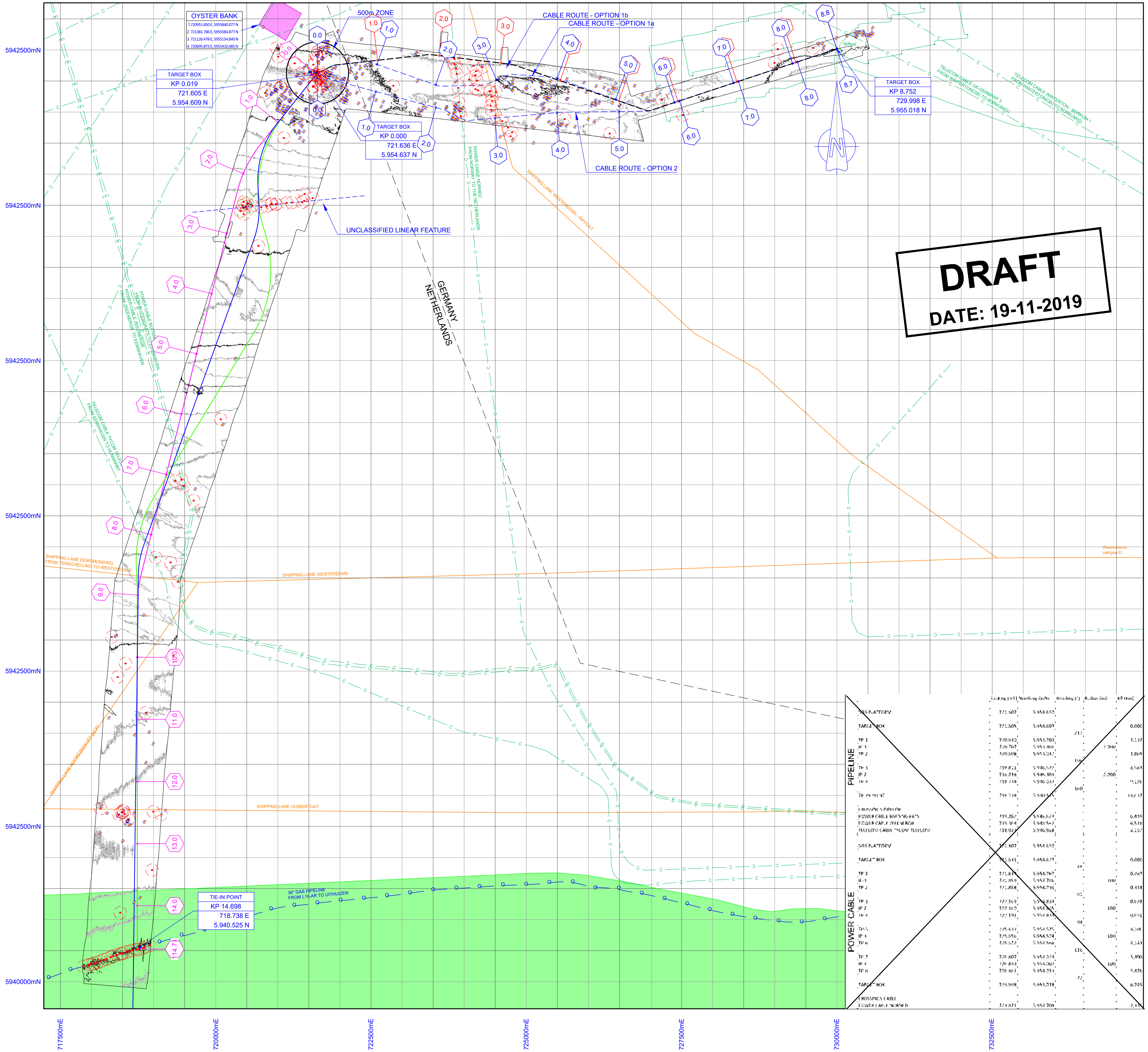
Document: Pipeline Route Overall Field Layout

Scale: 1:30000
Size: A1

Project number: 19018
Document Number: N05A-7-51-0-72510-01

B. Pipeline & Power Cable Route Options

(1 page: ref. N05A-7-51-0-72510-01-02b Overall field layout drawing)



REFERENCES

N05A-7-10-0-70031-01	Route selection report
N05A-7-10-0-70032-01	Approach drawing @ NGT
N05A-7-50-0-72018-01/06	Pipeline alignment sheet 01-06
N05A-7-50-0-72019-01	Approach drawing @ N05A
N05A-7-10-0-72020-01/04	Cable route sheet 01-04

FUGRO
LU0022H-553_A1_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A2_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A3_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A4_1905_UTM31-ED50_LAT_MB_#0.5
LU0022H-553_A5_1905_UTM31-ED50_LAT_MB_#0.5

LEGEND

GENERAL

- KILOMETER MARKER
- PIPELINE: N05A - NGT
- CABLE: N05A - RIFFGAT
- BOUNDARY OF SURVEY AREA
- EXISTING PIPELINE
- EXISTING CABLE
- SHIPPING LANE RIJKSWATERSTAAT
- ROCKDUMP
- NATURA2000
- OYSTERBANK

BATHYMETRY AND SEABED FEATURES

- CONTOUR LINE AT 1m INTERVAL
- SONAR CONTACT
- DEPRESSION
- MOUND
- AS-FOUND WELLHEAD
- CONE PENETRATION TEST
- VIBRE CORE
- MAGNETIC ANOMALY
- WRECK

GEODETIC PARAMETERS

PROJECTED CRS: ED50/UTM zone 31N (EPSG: 23031)

Horizontal Datum Name: European Datum 1950 North Sea -UKCS

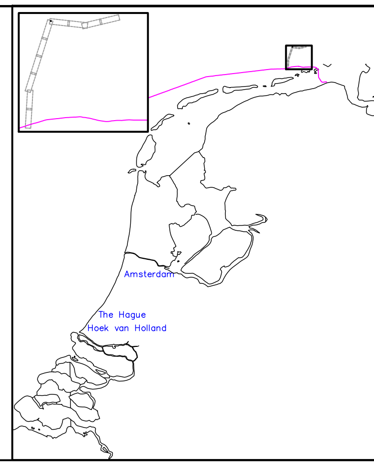
Projection Name: Universal Transverse Mercator

Ellipsoid: International 1924 (Hayford 1909)

Semi major axis	a	=	6 378 388.000
Semi minor axis	b	=	6 356 911.946
Inverse ELattening	1/f	=	297.000
Excentricity squared	e	=	0.006 722 670

Zone	North 31
Central meridian	3° East
Latitude of origin	Equator
False Easting	500 000.00 m
False Northing	0.00 m
Scale factor on C.M.	0.999 6

WGS84 to ED50 TRANSFORMATION: UKOAA (EPSG: 1311)



KEYPLAN

Rev	Date	Description	Drawn	Eng.	Check	Appr.	Client
02	19-11-2019	REROUTING OF PIPELINE & CABLE	SvdV	-	-	-	
01	23-10-2019	FOR INFORMATION	SvdV	-	-	-	

enersea
Jan Evertsenweg 12
3115 JA Schiedam
The Netherlands
+31(0) 103132100
info@enersea.nl

Client: ONE-Dyas B.V.

Project: N05a Pipeline design

Document: Pipeline Route Overall Field Layout

Scale: 1:30000
Size: A1

Project number: 19018

Document Number: N05A-7-51-0-72510-01

C. Environmental Data GEOxyz

Magnetic Contacts

MAG ID	Easting	Northing	Size nT
MAG_001	717953,7	5940271,5	1846
MAG_002	717991,0	5940276,5	2449
MAG_003	718039,9	5940290,0	1412
MAG_004	718041,2	5940299,0	88
MAG_005	718096,4	5940310,5	5750
MAG_006	718148,3	5942788,5	35
MAG_007	718149,5	5940331,0	2207
MAG_008	718198,9	5940350,5	4606
MAG_009	718247,8	5940365,0	878
MAG_010	718312,4	5940395,0	4218
MAG_011	718346,7	5940412,0	1847
MAG_012	718409,7	5940429,5	1254
MAG_013	718424,0	5944905,0	44
MAG_014	718444,3	5942692,5	828
MAG_015	718462,9	5941110,5	163
MAG_016	718472,4	5940453,5	1966
MAG_017	718484,8	5942724,5	4590
MAG_018	718491,8	5940449,0	962
MAG_019	718506,9	5942723,0	1900
MAG_020	718508,2	5942754,0	9330
MAG_021	718509,3	5940455,5	558
MAG_022	718516,3	5942748,5	5361
MAG_023	718534,0	5942694,0	1157
MAG_024	718548,1	5945123,5	32
MAG_025	718565,1	5940481,0	3279
MAG_026	718595,9	5942616,0	52
MAG_027	718617,5	5940493,0	5243
MAG_028	718662,3	5940506,0	613
MAG_029	718720,1	5940516,0	2386
MAG_030	718766,9	5940523,0	2963
MAG_031	718829,4	5940541,0	706
MAG_032	718856,6	5940558,0	9291
MAG_033	718875,8	5944329,5	23
MAG_034	718975,9	5941798,0	86
MAG_035	718995,8	5942736,5	67
MAG_036	719033,8	5946829,5	22
MAG_037	719274,9	5946749,5	136
MAG_038	719349,1	5948063,0	51
MAG_039	719395,2	5946438,0	14
MAG_040	719449,5	5948089,0	11
MAG_041	719489,0	5947981,0	40
MAG_042	719645,7	5947744,5	73
MAG_043	720080,7	5949053,0	11
MAG_044	720398,8	5952407,0	22
MAG_045	720432,3	5952500,5	428
MAG_046	720451,3	5952357,0	15
MAG_047	720452,1	5952553,0	197
MAG_048	720492,5	5952478,5	6757
MAG_049	720507,6	5952530,5	846
MAG_050	720589,2	5952492,5	539
MAG_051	720687,5	5951846,0	11
MAG_052	720733,6	5952469,5	17
MAG_053	720796,44	5954306,50	11

MAG_054	720823,9	5952486,5	38
MAG_055	720895,0	5952512,5	195
MAG_056	720896,6	5952528,5	258
MAG_057	720966,9	5952512,5	155
MAG_058	720972,6	5952521,0	30
MAG_059	720981,25	5955029,50	15
MAG_060	721006,69	5954892,50	18
MAG_061	721006,69	5954892,5	18
MAG_062	721043,6	5954396,5	50
MAG_063	721043,63	5954396,50	50
MAG_064	721043,6	5954396,5	50
MAG_065	721050,88	5954393,50	66
MAG_066	721050,9	5954393,5	66
MAG_067	721050,9	5954393,5	66
MAG_068	721097,9	5953584,0	8
MAG_069	721144,6	5952537,5	59
MAG_070	721224,2	5952542,0	88
MAG_071	721272	5954784,5	23
MAG_072	721272,00	5954784,50	23
MAG_073	721272,0	5954784,5	23
MAG_074	721395,3	5952547,0	97
MAG_075	721424,3	5952569,5	110
MAG_076	721424,88	5954616,50	285
MAG_077	721424,9	5954616,5	285
MAG_078	721424,88	5954616,5	285
MAG_079	721424,9	5954616,5	285
MAG_080	721430,5	5952680,5	22
MAG_081	721567,25	5954416,50	12
MAG_082	721567,3	5954416,5	12
MAG_083	721567,25	5954416,5	12
MAG_084	721567,3	5954416,5	12
MAG_085	721568,5	5954404,5	22
MAG_086	721568,50	5954404,50	22
MAG_087	721571,7	5954762,5	18
MAG_088	721571,69	5954762,50	18
MAG_089	721571,69	5954762,5	18
MAG_090	721571,7	5954762,5	18
MAG_091	721615,3	5954915,0	27
MAG_092	721615,25	5954915,00	27
MAG_093	721615,25	5954915	27
MAG_094	721615,3	5954915	27
MAG_095	721625,25	5954596,50	53
MAG_096	721625,3	5954596,5	53
MAG_097	721625,25	5954596,5	53
MAG_098	721625,3	5954596,5	53
MAG_099	721625,4	5954919,0	28
MAG_100	721625,38	5954919,00	28
MAG_101	721625,38	5954919	28
MAG_102	721625,4	5954919	28
MAG_103	721645,7	5954971,5	66
MAG_104	721645,69	5954971,50	66
MAG_105	721645,69	5954971,5	66
MAG_106	721645,7	5954971,5	66
MAG_107	721650,5	5954550	376
MAG_108	721650,50	5954550,00	376
MAG_109	721650,5	5954550,0	376
MAG_110	721657,8	5954589	358
MAG_111	721657,8	5954589,0	358

MAG_112	721657,81	5954589,00	358
MAG_113	721657,81	5954589	358
MAG_114	721658,0	5954624,0	45
MAG_115	721658,00	5954624,00	45
MAG_116	721658	5954624	45
MAG_117	721666,7	5954576,0	1100
MAG_118	721666,69	5954576,00	1100
MAG_119	721666,69	5954576	1100
MAG_120	721666,7	5954576	1100
MAG_121	721670,5	5954647,5	27
MAG_122	721670,50	5954647,50	27
MAG_123	721672,2	5954562,0	2733
MAG_124	721672,19	5954562,00	2733
MAG_125	721672,19	5954562	2733
MAG_126	721672,2	5954562	2733
MAG_127	721683,56	5954529,00	252
MAG_128	721683,6	5954529,0	252
MAG_129	721683,56	5954529	252
MAG_130	721683,6	5954529	252
MAG_131	721685,69	5954453,00	110
MAG_132	721685,7	5954453,0	110
MAG_133	721685,69	5954453	110
MAG_134	721685,7	5954453	110
MAG_135	721691,2	5954590,0	360
MAG_136	721691,19	5954590,00	360
MAG_137	721691,19	5954590	360
MAG_138	721691,2	5954590	360
MAG_139	721695,69	5954426,00	35
MAG_140	721695,7	5954426,0	35
MAG_141	721695,69	5954426	35
MAG_142	721695,7	5954426	35
MAG_143	721702,2	5954504,0	58
MAG_144	721702,19	5954504,00	58
MAG_145	721702,19	5954504	58
MAG_146	721702,2	5954504	58
MAG_147	721708,19	5954468,00	119
MAG_148	721708,2	5954468,0	119
MAG_149	721708,19	5954468	119
MAG_150	721708,2	5954468	119
MAG_151	721709,3	5954964,0	21
MAG_152	721709,25	5954964,00	21
MAG_153	721709,25	5954964	21
MAG_154	721709,3	5954964	21
MAG_155	721806,3	5954401,5	10
MAG_156	721806,3	5954401,5	10
MAG_157	721806,31	5954401,50	10
MAG_158	721806,31	5954401,5	10
MAG_159	722858,06	5954425,00	43
MAG_160	722858,1	5954425,0	43
MAG_161	722858,1	5954425	43
MAG_162	723840,1	5954855,5	31
MAG_163	723840,13	5954855,50	31
MAG_164	723843,06	5954772,50	17
MAG_165	723843,1	5954772,5	17
MAG_166	723868,19	5954698,50	23
MAG_167	723868,2	5954698,5	23
MAG_168	723879,8	5954617	25
MAG_169	723879,81	5954617,00	25

MAG_170	723905,06	5954389,00	15
MAG_171	723905,1	5954389,0	15
MAG_172	723905,1	5954389	15
MAG_173	723911,8	5954159	16
MAG_174	723911,81	5954159,00	16
MAG_175	723927,25	5954010,00	14
MAG_176	723927,3	5954010	14
MAG_177	723945,06	5953933,50	16
MAG_178	723945,1	5953933,5	16
MAG_179	724080,88	5954522,00	40
MAG_180	724080,9	5954522,0	40
MAG_181	724080,9	5954522	40
MAG_182	724147,19	5954742,00	61
MAG_183	724147,2	5954742	61
MAG_184	724181,8	5954587,5	57
MAG_185	724181,81	5954587,50	57
MAG_186	724182,56	5954368,00	43
MAG_187	724182,6	5954368,0	43
MAG_188	724182,6	5954368	43
MAG_189	724191,56	5954659,00	54
MAG_190	724191,6	5954659	54
MAG_191	724205	5954508,5	31
MAG_192	724205,00	5954508,50	31
MAG_193	724205,0	5954508,5	31
MAG_194	724223,6	5954348,5	27
MAG_195	724223,63	5954348,50	27
MAG_196	724223,6	5954348,5	27
MAG_197	724298,25	5954723,50	41
MAG_198	724298,3	5954723,5	41
MAG_199	724410,1	5954332	36
MAG_200	724410,13	5954332,00	36
MAG_201	724410,1	5954332,0	36
MAG_202	724420,9	5954339	38
MAG_203	724420,94	5954339,00	38
MAG_204	724420,9	5954339,0	38
MAG_205	724426,56	5954103,00	27
MAG_206	724426,6	5954103	27
MAG_207	724436,6	5954034	31
MAG_208	724436,63	5954034,00	31
MAG_209	724442,19	5954251,00	18
MAG_210	724442,2	5954251,0	18
MAG_211	724442,2	5954251	18
MAG_212	724449,06	5954180,50	16
MAG_213	724449,1	5954180,5	16
MAG_214	724449,1	5954180,5	16
MAG_215	724509,3	5953941,5	48
MAG_216	724509,31	5953941,50	48
MAG_217	724512,88	5954320,50	12
MAG_218	724512,9	5954320,5	12
MAG_219	724512,9	5954320,5	12
MAG_220	724611,8	5953854,5	26
MAG_221	724611,81	5953854,50	26
MAG_222	724706,25	5953751,50	26
MAG_223	724747,06	5953610,50	37
MAG_224	724772,75	5953676,00	29
MAG_225	725618,75	5953886,50	38
MAG_226	725618,8	5953886,5	38
MAG_227	726342,9	5953654	25

MAG_228	726342,94	5953654,00	25
MAG_229	727182,38	5954201,00	25
MAG_230	727182,4	5954201,0	25
MAG_231	727182,4	5954201	25
MAG_232	727518,9	5953952	5
MAG_233	727518,94	5953952,00	5
MAG_234	728994,88	5954791,50	14
MAG_235	728994,9	5954791,5	14
MAG_236	728994,9	5954791,5	14
MAG_237	729047,19	5955011,50	14
MAG_238	729047,2	5955011,5	14
MAG_239	729615,69	5955031,50	26
MAG_240	729615,7	5955031,5	26
MAG_241	729615,7	5955031,5	26

Side Sonar Scan Contacts

Contact ID	Easting	Northing	Height	Contact Type
DEB_001	718843,3	5945900,7	5.9x1.5x0.1	Debris
DEB_002	718696,2	5943976,4	3.0x0.3x0.1	Debris
DEB_003	718510,6	5942751,2	1.5x1.7xnmh	Debris
DEB_004	718689,5	5942724,0	3.0x0.5x0.3	Debris
DEB_005	718419,5	5942669,9	0.8x0.3x0.1	Debris
DEB_006	718479,3	5942653,2	2.5x1.2x0.1	Debris
DEB_007	718581,4	5942595,0	5.0x1.3x0.3	Debris
DEB_008	718582,9	5942591,3	4.1x1.0x0.6	Debris
DEB_009	718580,4	5942585,2	1.8x0.5x0.2	Debris
DEB_010	718589,2	5942584,2	5.1x2.4x0.3	Debris
DEB_011	718584,4	5942581,4	4.1x3.3x0.5	Debris
DEB_012	718550,1	5942539,3	1.4x0.8x0.2	Debris
DEB_013	718606,0	5942526,9	2.9x1.0x0.6	Debris
DEB_014	718630,6	5942524,1	2.0x0.5x0.1	Debris
DEB_015	720403,1	5952036,9	1.9x0.7x0.2	Wreck
DEB_016	718395,4	5945567,7	1.0x0.7x0.1	Wreck
DEB_017	718387,7	5945566,4	3.9x0.5x0.1	Debris
DEB_018	718282,9	5944250,1	1.6x0.7x0.3	Debris
DEB_019	718930,1	5944019,3	6.2x1.8x0.4	Debris
DEB_020	718995,4	5943832,0	2.0x0.6x0.2	Debris
DEB_021	718878,1	5943526,3	2.1x0.7x0.2	Debris
DEB_022	718167,1	5942830,6	2.2x0.8x0.2	Debris
DEB_023	718254,5	5942712,2	2.9x1.1x0.1	Debris
DEB_024	718142,1	5942390,0	3.4x1.6x0.8	Debris
DEB_025	718784,2	5941352,3	3.3x1.5xnmh	Debris
DEB_026	718687,6	5941281,5	1.4x0.6x0.1	Debris
SSS_001	720764,04	5955368,29	0,9	Debris
SSS_002	720829,13	5954453,20	0,6	Debris
SSS_003	720820,73	5954342,72	0,6	Object
SSS_004	720821,77	5954270,88	0,5	Object
SSS_005	720880,99	5954431,59	0,6	Object
SSS_006	720892,17	5954300,94	0,8	Object
SSS_007	720893,26	5954290,00	0,7	Object
SSS_008	720905,80	5954298,46	0,9	Object
SSS_009	720945,81	5954410,62	0,6	Object
SSS_010	720952,19	5954327,47	0,6	Object
SSS_011	720959,37	5954364,43	0,6	Object
SSS_012	720960,29	5954352,58	0,7	Object
SSS_013	720968,48	5954364,83	0,6	Object

SSS_014	720988,35	5954348,47	1	Object
SSS_015	720987,94	5954062,19	0,9	Object
SSS_016	721039,97	5954486,91	0,6	Object
SSS_017	720995,11	5954033,91	0,8	Object
SSS_018	721014,90	5954205,53	0,5	Object
SSS_019	721048,07	5954440,97	0,5	Object
SSS_020	721014,60	5954144,86	0,6	Object
SSS_021	721047,79	5954403,65	0,8	Object
SSS_022	721023,57	5954124,07	0,8	Object
SSS_023	721031,84	5954112,67	0,6	Object
SSS_024	721055,06	5954273,47	0,5	Object
SSS_025	721070,04	5954387,96	0,5	Object
SSS_026	721047,65	5954157,24	0,8	Object
SSS_027	721039,23	5954011,52	0,5	Object
SSS_028	721083,56	5954252,55	0,6	Object
SSS_029	721077,94	5954055,23	0,5	Object
SSS_030	721120,45	5954342,55	0,6	Object
SSS_031	721082,86	5953986,73	0,5	Object
SSS_032	721096,70	5954103,85	0,6	Object
SSS_033	721124,20	5954225,46	0,6	Object
SSS_034	721108,47	5954016,11	1	Object
SSS_035	721111,52	5954015,55	0,6	Object
SSS_036	721154,23	5954387,61	0,5	Object
SSS_037	721200,49	5954647,37	0,6	Object
SSS_038	721129,50	5954019,15	0,7	Object
SSS_039	721147,68	5954077,59	0,5	Object
SSS_040	721189,65	5954331,95	0,8	Object
SSS_041	721166,42	5954080,67	0,7	Object
SSS_042	721183,36	5954184,19	0,5	Object
SSS_043	721204,09	5954287,89	0,7	Object
SSS_044	721200,07	5954168,32	0,5	Object
SSS_045	721202,45	5954182,88	0,6	Object
SSS_046	721195,78	5953987,53	0,5	Object
SSS_047	721381,17	5955392,95	1,1	Object
SSS_048	721235,00	5954040,36	0,6	Object
SSS_049	721304,21	5954594,42	1	Object
SSS_050	721246,88	5953990,00	0,7	Object
SSS_051	721321,53	5954595,76	0,9	Object
SSS_052	721290,57	5954297,19	0,6	Object
SSS_053	721343,86	5954472,53	0,5	Object
SSS_054	721373,40	5954458,69	0,5	Object
SSS_055	721419,15	5954712,64	0,7	Object
SSS_056	721408,52	5954529,08	1,3	Object
SSS_057	721395,63	5954262,43	0,6	Object
SSS_058	721395,15	5954252,77	0,7	Object
SSS_059	721458,06	5954747,89	0,9	Object
SSS_060	721444,60	5954037,80	0,6	Object
SSS_061	721455,66	5954048,13	0,5	Object
SSS_062	721554,96	5954666,23	0,8	Object
SSS_063	721517,58	5954248,05	0,6	Object
SSS_064	721523,03	5954218,83	0,7	Object
SSS_065	721637,89	5954907,07	0,7	Object
SSS_066	721648,13	5954914,13	0,5	Object
SSS_067	721571,49	5954203,12	0,5	Object
SSS_068	721656,39	5954932,11	1	Object
SSS_069	721616,00	5954554,46	0,6	Object
SSS_070	721674,18	5955016,59	0,5	Object
SSS_071	721655,25	5954793,46	0,7	Object

SSS_072	721625,01	5954519,17	0,7	Object
SSS_073	721680,77	5955011,05	0,7	Object
SSS_074	721652,06	5954564,38	0,6	Object
SSS_075	721604,57	5954084,46	0,7	Object
SSS_076	721626,38	5954092,91	0,5	Object
SSS_077	721625,38	5954063,72	0,7	Object
SSS_078	721717,09	5954862,86	0,6	Object
SSS_079	721718,05	5954870,34	0,7	Object
SSS_080	721738,42	5955038,28	0,7	Object
SSS_081	721723,22	5954856,19	0,6	Object
SSS_082	721624,62	5953973,00	0,7	Object
SSS_083	721767,69	5955126,00	0,6	Object
SSS_084	721775,98	5955044,12	0,7	Object
SSS_085	721796,01	5955132,17	0,8	Object
SSS_086	721801,77	5955134,43	0,7	Object
SSS_087	721710,89	5954302,92	0,5	Object
SSS_088	721800,27	5955078,78	0,5	Object
SSS_089	721746,76	5954595,75	0,6	Object
SSS_090	721788,65	5954958,66	0,6	Object
SSS_091	721808,34	5955123,30	0,6	Object
SSS_092	721684,49	5953956,43	1,6	Object
SSS_093	721798,86	5954964,39	0,6	Object
SSS_094	721766,62	5954616,90	0,8	Object
SSS_095	721819,68	5955039,44	0,8	Object
SSS_096	721759,40	5954496,67	0,6	Object
SSS_097	721704,59	5954008,27	0,5	Object
SSS_098	721712,63	5954066,90	1	Object
SSS_099	721703,78	5953951,67	0,9	Object
SSS_100	721791,38	5954654,79	0,5	Object
SSS_101	721764,51	5954382,53	0,5	Object
SSS_102	721772,48	5954430,59	0,6	Object
SSS_103	721847,33	5954926,04	0,6	Object
SSS_104	721815,38	5954641,85	0,6	Object
SSS_105	721788,50	5954369,26	0,6	Object
SSS_106	721854,68	5954924,85	0,5	Object
SSS_107	721825,40	5954588,20	0,5	Object
SSS_108	721829,40	5954595,07	0,6	Object
SSS_109	721851,99	5954594,19	0,6	Object
SSS_110	721858,18	5954627,12	0,6	Object
SSS_111	721880,66	5954700,94	0,6	Object
SSS_112	721850,61	5954434,71	0,6	Object
SSS_113	721810,07	5953955,71	0,7	Object
SSS_114	721968,21	5955303,95	0,5	Object
SSS_115	721896,80	5954569,62	0,7	Object
SSS_116	721926,97	5954712,77	0,5	Object
SSS_117	721940,17	5954537,16	0,7	Object
SSS_118	721949,13	5954256,82	0,7	Object
SSS_119	722061,99	5954903,71	0,5	Object
SSS_120	722026,14	5954527,01	0,7	Object
SSS_121	721976,86	5953947,97	0,6	Object
SSS_122	722031,16	5954397,32	0,7	Object
SSS_123	722007,93	5954191,32	0,6	Object
SSS_124	722037,39	5954431,37	0,9	Object
SSS_125	722065,60	5954532,75	0,5	Object
SSS_126	722072,28	5954539,20	0,5	Object
SSS_127	722049,53	5954224,70	0,8	Object
SSS_128	722128,63	5954814,33	0,6	Object
SSS_129	722131,17	5954814,97	0,5	Object

SSS_130	722141,98	5954862,02	0,5	Object
SSS_131	722091,64	5954408,44	0,8	Object
SSS_132	722066,30	5954157,96	0,6	Object
SSS_133	722079,71	5954193,94	0,6	Object
SSS_134	722127,92	5954494,60	0,5	Object
SSS_135	722094,41	5954197,41	0,5	Object
SSS_136	722100,07	5954244,99	0,7	Object
SSS_137	722112,91	5954349,57	1	Object
SSS_138	722112,75	5954276,00	0,7	Object
SSS_139	722119,71	5954332,11	0,6	Object
SSS_140	722168,47	5954646,15	0,5	Object
SSS_141	722175,02	5954701,14	0,7	Object
SSS_142	722117,03	5954180,65	0,5	Object
SSS_143	722162,02	5954289,85	0,6	Object
SSS_144	722256,41	5954766,99	0,8	Object
SSS_145	722258,54	5954554,99	0,6	Object
SSS_146	722266,05	5954620,89	0,5	Object
SSS_147	722266,66	5954547,24	0,6	Object
SSS_148	722348,34	5955174,34	1	Object
SSS_149	722271,90	5954311,52	0,5	Object
SSS_150	722326,41	5954704,99	1,1	Object
SSS_151	722299,30	5954139,59	1	Object
SSS_152	722362,88	5954613,53	0,6	Object
SSS_153	722407,24	5954745,37	0,6	Object
SSS_154	722397,54	5954086,30	0,6	Object
SSS_155	722524,39	5954965,64	0,7	Object
SSS_156	722504,06	5954768,70	0,5	Object
SSS_157	722557,20	5954951,23	0,6	Object
SSS_158	722475,09	5954215,99	0,6	Object
SSS_159	722536,86	5954258,29	0,7	Object
SSS_160	722583,42	5954193,39	0,5	Object
SSS_161	722664,75	5954088,19	0,5	Object
SSS_162	722698,08	5954168,32	0,7	Object
SSS_163	722990,18	5955000,42	0,6	Object
SSS_164	723059,38	5954145,40	0,6	Object
SSS_165	723228,22	5954951,32	0,8	Object
SSS_166	723230,39	5954954,08	0,6	Object
SSS_167	723246,39	5954499,21	0,8	Object
SSS_168	723264,94	5954042,88	0,6	Object
SSS_169	723277,68	5953991,55	0,8	Object
SSS_170	723288,81	5953947,23	0,5	Object
SSS_171	723312,59	5954027,25	0,5	Object
SSS_172	723325,45	5954026,92	0,6	Object
SSS_173	723346,77	5954092,76	0,5	Object
SSS_174	723383,38	5954065,30	0,7	Object
SSS_175	723532,73	5954134,02	0,6	Object
SSS_176	723718,13	5954854,97	0,5	Object
SSS_177	723711,89	5954061,63	0,8	Object
SSS_178	723715,87	5954080,48	0,7	Object
SSS_179	723716,67	5954083,25	0,9	Object
SSS_180	723754,52	5953968,95	1,1	Object
SSS_181	723862,13	5954493,02	1	Object
SSS_182	723808,64	5953913,20	0,8	Object
SSS_183	723809,10	5953901,40	0,7	Object
SSS_184	723849,19	5954109,37	0,6	Object
SSS_185	723845,06	5953991,78	0,6	Object
SSS_186	723854,66	5954067,59	0,5	Object
SSS_187	723853,79	5954050,54	0,5	Object

SSS_188	723862,24	5954111,86	0,5	Object
SSS_189	723857,63	5954050,68	0,6	Object
SSS_190	723852,05	5953876,48	0,6	Object
SSS_191	723881,22	5953902,89	0,7	Object
SSS_192	723905,57	5954059,20	0,6	Object
SSS_193	723903,64	5953887,23	0,6	Object
SSS_194	723926,72	5954041,65	0,5	Object
SSS_195	723960,42	5954035,26	0,5	Object
SSS_196	723975,07	5954068,32	0,5	Object
SSS_197	724277,58	5954747,16	0,6	Object
SSS_198	724476,72	5953817,57	0,5	Object
SSS_199	724644,94	5954411,18	0,5	Object
SSS_200	724661,78	5954539,65	0,6	Object
SSS_201	724579,57	5953602,83	0,7	Object
SSS_202	724731,05	5954433,07	0,7	Object
SSS_203	724642,24	5953636,41	0,6	Object
SSS_204	724766,83	5954450,51	0,6	Object
SSS_205	724783,12	5954517,10	0,6	Object
SSS_206	724778,58	5954449,53	0,6	Object
SSS_207	724778,70	5954349,32	0,6	Object
SSS_208	724780,26	5953558,96	0,5	Object
SSS_209	724942,39	5954328,74	0,7	Object
SSS_210	724989,45	5954393,95	0,6	Object
SSS_211	725009,84	5954374,67	0,7	Object
SSS_212	725048,36	5954528,27	0,6	Object
SSS_213	724985,69	5953718,56	1,2	Object
SSS_214	725096,72	5954515,79	0,5	Object
SSS_215	725124,32	5954241,75	0,6	Object
SSS_216	725134,42	5954237,50	0,6	Object
SSS_217	725144,69	5954278,59	0,6	Object
SSS_218	725092,50	5953770,38	0,5	Object
SSS_219	725150,03	5954266,54	0,5	Object
SSS_220	725152,17	5954277,48	0,5	Object
SSS_221	725178,56	5954225,18	0,5	Object
SSS_222	725124,87	5953745,24	0,6	Object
SSS_223	725115,87	5953501,85	0,5	Object
SSS_224	725172,54	5953894,35	0,5	Object
SSS_225	725246,91	5954420,97	0,7	Object
SSS_226	725261,74	5954467,16	0,7	Object
SSS_227	725212,52	5953937,96	0,6	Object
SSS_228	725244,46	5954123,17	0,5	Object
SSS_229	725262,43	5954046,93	0,6	Object
SSS_230	725276,31	5954136,17	0,5	Object
SSS_231	725288,51	5954240,26	0,6	Object
SSS_232	725285,49	5954061,94	0,9	Object
SSS_233	725327,30	5954221,86	0,7	Object
SSS_234	725336,55	5954215,62	0,8	Object
SSS_235	725341,32	5954252,77	0,6	Object
SSS_236	725346,39	5954204,15	0,5	Object
SSS_237	725390,80	5954497,76	0,6	Object
SSS_238	725361,58	5954030,67	0,7	Object
SSS_239	725387,33	5954238,49	0,5	Object
SSS_240	725361,50	5953844,71	0,8	Object
SSS_241	725428,26	5954348,17	0,6	Object
SSS_242	725473,83	5954428,28	0,7	Object
SSS_243	725407,58	5953805,92	0,7	Object
SSS_244	725447,98	5953818,37	0,8	Object
SSS_245	725500,73	5954077,67	0,6	Object

SSS_246	725469,00	5953705,87	0,7	Object
SSS_247	725502,53	5953777,01	0,6	Object
SSS_248	725503,43	5953676,67	0,5	Object
SSS_249	725549,47	5953801,34	0,7	Object
SSS_250	725568,76	5953790,04	1,1	Object
SSS_251	725654,15	5954532,82	0,5	Object
SSS_252	725650,48	5954214,47	0,5	Object
SSS_253	725671,55	5954313,50	0,6	Object
SSS_254	725663,15	5954214,40	0,6	Object
SSS_255	725649,37	5953785,79	0,6	Object
SSS_256	725831,42	5954364,25	0,5	Object
SSS_257	725785,29	5953766,44	0,6	Object
SSS_258	725827,13	5953653,81	0,6	Object
SSS_259	725928,37	5954476,41	0,6	Object
SSS_260	725965,90	5954322,62	0,7	Object
SSS_261	725997,41	5953887,92	0,5	Object
SSS_262	726052,22	5954102,79	0,5	Object
SSS_263	726057,41	5954141,89	0,6	Object
SSS_264	726125,63	5954417,63	0,7	Object
SSS_265	726114,48	5954190,77	0,6	Object
SSS_266	726107,63	5954125,64	0,7	Object
SSS_267	726119,61	5954110,39	0,6	Object
SSS_268	726091,62	5953851,33	0,7	Object
SSS_269	726190,19	5954548,21	0,6	Object
SSS_270	726173,34	5954150,49	0,5	Object
SSS_271	726253,07	5954394,21	0,9	Object
SSS_272	726319,83	5954354,42	0,5	Object
SSS_273	726386,30	5954389,49	0,7	Object
SSS_274	726412,12	5954380,81	0,6	Object
SSS_275	726385,89	5954146,61	0,9	Object
SSS_276	726544,54	5954494,79	0,5	Object
SSS_277	726502,03	5954104,70	0,8	Object
SSS_278	726506,85	5954107,53	0,7	Object
SSS_279	726592,04	5954486,38	0,7	Object
SSS_280	726742,62	5954423,38	0,7	Object
SSS_281	726870,97	5954279,25	0,6	Object
SSS_282	726958,22	5954177,60	0,6	Object
SSS_283	726989,51	5954175,50	0,7	Object
SSS_284	727046,94	5954189,82	0,5	Object
SSS_285	727104,19	5954382,52	1,1	Object
SSS_286	729697,53	5955104,13	0,6	Object
SSS_287	729774,83	5955004,78	0,7	Object
SSS_288	729767,36	5955100,95	0,5	Object
SSS_289	729791,72	5955056,65	0,9	Object
SSS_290	729990,54	5955191,79	0,6	Object
SSS_291	730162,26	5955230,58	0,5	Object
SSS_292	730317,76	5955207,78	0,6	Object
SSS_293	730309,61	5955222,10	1,2	Object
SSS_294	730297,63	5955291,03	0,5	Object
SSS_295	730324,81	5955286,64	0,5	Object
SSS_296	730359,44	5955287,63	0,7	Object
SSS_297	730418,89	5955242,55	0,5	Object
SSS_298	730417,60	5955276,24	0,6	Object
SSS_299	730463,81	5955245,45	0,5	Object
SSS_300	730506,71	5955235,50	0,5	Object
SSS_301	730516,10	5955237,56	0,5	Object
SSS_302	730541,92	5955229,90	0,9	Object
SSS_303	730556,17	5955284,38	0,6	Object

SSS_304	730578,58	5955257,66	0,9	Object
SSS_305	730574,39	5955355,60	0,5	Object
SSS_306	721419,2	5954712,6	0,7	Object
SSS_307	721408,5	5954529,1	1,3	Object
SSS_308	721458,1	5954747,9	0,9	Object
SSS_309	721555,0	5954666,2	0,8	Object
SSS_310	721616,0	5954554,5	0,6	Object
SSS_311	721655,2	5954793,5	0,7	Object
SSS_312	721625,0	5954519,2	0,7	Object
SSS_313	721652,1	5954564,4	0,6	Object
SSS_314	721746,8	5954595,7	0,6	Object
SSS_315	721766,6	5954616,9	0,8	Object
SSS_316	721759,4	5954496,7	0,6	Object
SSS_317	721791,4	5954654,8	0,5	Object
SSS_318	721772,5	5954430,6	0,6	Object
SSS_319	721815,4	5954641,9	0,6	Object
SSS_320	721825,4	5954588,2	0,5	Object
SSS_321	721829,4	5954595,1	0,6	Object
SSS_322	721852,0	5954594,2	0,6	Object
SSS_323	721858,2	5954627,1	0,6	Object
SSS_324	721880,7	5954700,9	0,6	Object
SSS_325	721850,6	5954434,7	0,6	Object
SSS_326	721896,8	5954569,6	0,7	Object
SSS_327	721927,0	5954712,8	0,5	Object
SSS_328	721940,2	5954537,2	0,7	Object
SSS_329	722026,1	5954527,0	0,7	Object
SSS_330	722037,4	5954431,4	0,9	Object
SSS_331	722065,6	5954532,7	0,5	Object
SSS_332	722072,3	5954539,2	0,5	Object
SSS_333	722091,6	5954408,4	0,8	Object
SSS_334	722127,9	5954494,6	0,5	Object
SSS_335	722168,5	5954646,2	0,5	Object
SSS_336	722175,0	5954701,1	0,7	Object
SSS_337	722256,4	5954767,0	0,8	Object
SSS_338	722258,5	5954555,0	0,6	Object
SSS_339	722266,1	5954620,9	0,5	Object
SSS_340	722266,7	5954547,2	0,6	Object
SSS_341	722326,4	5954705,0	1,1	Object
SSS_342	722362,9	5954613,5	0,6	Object
SSS_343	722407,2	5954745,4	0,6	Object
SSS_344	723246,4	5954499,2	0,8	Object
SSS_345	723862,1	5954493,0	1	Object
SSS_346	724644,9	5954411,2	0,5	Object
SSS_347	724731,1	5954433,1	0,7	Object
SSS_348	724766,8	5954450,5	0,6	Object
SSS_349	724778,6	5954449,5	0,6	Object
SSS_350	724778,7	5954349,3	0,6	Object
SSS_351	724942,4	5954328,7	0,7	Object
SSS_352	724989,4	5954394,0	0,6	Object
SSS_353	725009,8	5954374,7	0,7	Object
SSS_354	725124,3	5954241,8	0,6	Object
SSS_355	725134,4	5954237,5	0,6	Object
SSS_356	725144,7	5954278,6	0,6	Object
SSS_357	725150,0	5954266,5	0,5	Object
SSS_358	725152,2	5954277,5	0,5	Object
SSS_359	725178,6	5954225,2	0,5	Object
SSS_360	725246,9	5954421,0	0,7	Object
SSS_361	725244,5	5954123,2	0,5	Object

SSS_362	725262,4	5954046,9	0,6	Object
SSS_363	725276,3	5954136,2	0,5	Object
SSS_364	725288,5	5954240,3	0,6	Object
SSS_365	725285,5	5954061,9	0,9	Object
SSS_366	725327,3	5954221,9	0,7	Object
SSS_367	725336,5	5954215,6	0,8	Object
SSS_368	725341,3	5954252,8	0,6	Object
SSS_369	725346,4	5954204,1	0,5	Object
SSS_370	725361,6	5954030,7	0,7	Object
SSS_371	725387,3	5954238,5	0,5	Object
SSS_372	725428,3	5954348,2	0,6	Object
SSS_373	725500,7	5954077,7	0,6	Object
SSS_374	725650,5	5954214,5	0,5	Object
SSS_375	725671,5	5954313,5	0,6	Object
SSS_376	725663,1	5954214,4	0,6	Object
SSS_377	725831,4	5954364,2	0,5	Object
SSS_378	725965,9	5954322,6	0,7	Object
SSS_379	726052,2	5954102,8	0,5	Object
SSS_380	726057,4	5954141,9	0,6	Object
SSS_381	726114,5	5954190,8	0,6	Object
SSS_382	726107,6	5954125,6	0,7	Object
SSS_383	726119,6	5954110,4	0,6	Object
SSS_384	726173,3	5954150,5	0,5	Object
SSS_385	726385,9	5954146,6	0,9	Object
SSS_386	726502,0	5954104,7	0,8	Object
SSS_387	726506,9	5954107,5	0,7	Object
SSS_388	726871,0	5954279,2	0,6	Object
SSS_389	726958,2	5954177,6	0,6	Object
SSS_390	726989,5	5954175,5	0,7	Object
SSS_391	727046,9	5954189,8	0,5	Object
SSS_392	727104,2	5954382,5	1,1	Object
SSS_393	729697,5	5955104,1	0,6	Object
SSS_394	729774,8	5955004,8	0,7	Object
SSS_395	729767,4	5955101,0	0,5	Object
SSS_396	729791,7	5955056,7	0,9	Object
SSS_397	729990,5	5955191,8	0,6	Object
SSS_398	721343,9	5954472,5	0,5	Object
SSS_399	721373,4	5954458,7	0,5	Object
SSS_400	721517,6	5954248,1	0,6	Object
SSS_401	721290,6	5954297,2	0,6	Object
SSS_402	721395,6	5954262,4	0,6	Object
SSS_403	721571,5	5954203,1	0,5	Object
SSS_404	721523,0	5954218,8	0,7	Object
SSS_405	721395,2	5954252,8	0,7	Object
SSS_406	721626,4	5954092,9	0,5	Object
SSS_407	721604,6	5954084,5	0,7	Object
SSS_408	721455,7	5954048,1	0,5	Object
SSS_409	721444,6	5954037,8	0,6	Object
SSS_410	721235,0	5954040,4	0,6	Object
SSS_411	721246,9	5953990,0	0,7	Object
SSS_412	721195,8	5953987,5	0,5	Object
SSS_413	721388,2	5953864,3	0,6	Object
SSS_414	721246,8	5953887,4	0,6	Object
SSS_415	721227,5	5953868,5	0,7	Object
SSS_416	721343,0	5953829,2	0,5	Object
SSS_417	721224,7	5953846,8	0,6	Object
SSS_418	721379,4	5953792,7	0,6	Object
SSS_419	721392,0	5953769,8	0,7	Object

SSS_420	721261,2	5953798,9	0,8	Object
SSS_421	721418,9	5953687,4	0,6	Object
SSS_422	721338,8	5953691,8	0,8	Object
SSS_423	721339,8	5953688,0	0,8	Object
SSS_424	721351,0	5953668,2	0,8	Object
SSS_425	721357,9	5953583,8	0,5	Object
SSS_426	721410,7	5953535,3	0,6	Object
SSS_427	718503,9	5942263,9	0,8	Object
SSS_428	720988,4	5954348,5	1	Object
SSS_429	721040	5954486,9	0,6	Object
SSS_430	721048,1	5954441	0,5	Object
SSS_431	721047,8	5954403,6	0,8	Object
SSS_432	721055,1	5954273,5	0,5	Object
SSS_433	721070	5954388	0,5	Object
SSS_434	721083,6	5954252,5	0,6	Object
SSS_435	721120,5	5954342,5	0,6	Object
SSS_436	721124,2	5954225,5	0,6	Object
SSS_437	721154,2	5954387,6	0,5	Object
SSS_438	721200,5	5954647,4	0,6	Object
SSS_439	721189,7	5954332	0,8	Object
SSS_440	721204,1	5954287,9	0,7	Object
SSS_441	721304,2	5954594,4	1	Object
SSS_442	721321,5	5954595,8	0,9	Object
SSS_443	721290,6	5954297,2	0,6	Object
SSS_444	721343,9	5954472,5	0,5	Object
SSS_445	721373,4	5954458,7	0,5	Object
SSS_446	721419,2	5954712,6	0,7	Object
SSS_447	721408,5	5954529,1	1,3	Object
SSS_448	721395,6	5954262,4	0,6	Object
SSS_449	721395,2	5954252,8	0,7	Object
SSS_450	721458,1	5954747,9	0,9	Object
SSS_451	721555	5954666,2	0,8	Object
SSS_452	721517,6	5954248,1	0,6	Object
SSS_453	721523	5954218,8	0,7	Object
SSS_454	721637,9	5954907,1	0,7	Object
SSS_455	721648,1	5954914,1	0,5	Object
SSS_456	721571,5	5954203,1	0,5	Object
SSS_457	721656,4	5954932,1	1	Object
SSS_458	721616	5954554,5	0,6	Object
SSS_459	721674,2	5955016,6	0,5	Object
SSS_460	721655,2	5954793,5	0,7	Object
SSS_461	721625	5954519,2	0,7	Object
SSS_462	721680,8	5955011	0,7	Object
SSS_463	721652,1	5954564,4	0,6	Object
SSS_464	721717,1	5954862,9	0,6	Object
SSS_465	721718,1	5954870,3	0,7	Object
SSS_466	721738,4	5955038,3	0,7	Object
SSS_467	721723,2	5954856,2	0,6	Object
SSS_468	721767,7	5955126	0,6	Object
SSS_469	721776	5955044,1	0,7	Object
SSS_470	721710,9	5954302,9	0,5	Object
SSS_471	721800,3	5955078,8	0,5	Object
SSS_472	721746,8	5954595,7	0,6	Object
SSS_473	721788,7	5954958,7	0,6	Object
SSS_474	721808,3	5955123,3	0,6	Object
SSS_475	721798,9	5954964,4	0,6	Object
SSS_476	721766,6	5954616,9	0,8	Object
SSS_477	721819,7	5955039,4	0,8	Object

SSS_478	721759,4	5954496,7	0,6	Object
SSS_479	721791,4	5954654,8	0,5	Object
SSS_480	721764,5	5954382,5	0,5	Object
SSS_481	721772,5	5954430,6	0,6	Object
SSS_482	721847,3	5954926	0,6	Object
SSS_483	721815,4	5954641,9	0,6	Object
SSS_484	721788,5	5954369,3	0,6	Object
SSS_485	721854,7	5954924,8	0,5	Object
SSS_486	721825,4	5954588,2	0,5	Object
SSS_487	721829,4	5954595,1	0,6	Object
SSS_488	721852	5954594,2	0,6	Object
SSS_489	721858,2	5954627,1	0,6	Object
SSS_490	721880,7	5954700,9	0,6	Object
SSS_491	721850,6	5954434,7	0,6	Object
SSS_492	721896,8	5954569,6	0,7	Object
SSS_493	721927	5954712,8	0,5	Object
SSS_494	721940,2	5954537,2	0,7	Object
SSS_495	721949,1	5954256,8	0,7	Object
SSS_496	722062	5954903,7	0,5	Object
SSS_497	722026,1	5954527	0,7	Object
SSS_498	722031,2	5954397,3	0,7	Object
SSS_499	722007,9	5954191,3	0,6	Object
SSS_500	722037,4	5954431,4	0,9	Object
SSS_501	722065,6	5954532,7	0,5	Object
SSS_502	722072,3	5954539,2	0,5	Object
SSS_503	722049,5	5954224,7	0,8	Object
SSS_504	722128,6	5954814,3	0,6	Object
SSS_505	722131,2	5954815	0,5	Object
SSS_506	722142	5954862	0,5	Object
SSS_507	722091,6	5954408,4	0,8	Object
SSS_508	722066,3	5954158	0,6	Object
SSS_509	722079,7	5954193,9	0,6	Object
SSS_510	722127,9	5954494,6	0,5	Object
SSS_511	722094,4	5954197,4	0,5	Object
SSS_512	722100,1	5954245	0,7	Object
SSS_513	722112,9	5954349,6	1	Object
SSS_514	722112,7	5954276	0,7	Object
SSS_515	722119,7	5954332,1	0,6	Object
SSS_516	722168,5	5954646,2	0,5	Object
SSS_517	722175	5954701,1	0,7	Object
SSS_518	722117	5954180,7	0,5	Object
SSS_519	722162	5954289,9	0,6	Object
SSS_520	722256,4	5954767	0,8	Object
SSS_521	722258,5	5954555	0,6	Object
SSS_522	722266,1	5954620,9	0,5	Object
SSS_523	722266,7	5954547,2	0,6	Object
SSS_524	722271,9	5954311,5	0,5	Object
SSS_525	722326,4	5954705	1,1	Object
SSS_526	722299,3	5954139,6	1	Object
SSS_527	722362,9	5954613,5	0,6	Object
SSS_528	722407,2	5954745,4	0,6	Object
SSS_529	722397,5	5954086,3	0,6	Object
SSS_530	722524,4	5954965,6	0,7	Object
SSS_531	722504,1	5954768,7	0,5	Object
SSS_532	722557,2	5954951,2	0,6	Object
SSS_533	722475,1	5954216	0,6	Object
SSS_534	722536,9	5954258,3	0,7	Object
SSS_535	722583,4	5954193,4	0,5	Object

SSS_536	722664,8	5954088,2	0,5	Object
SSS_537	722698,1	5954168,3	0,7	Object
SSS_538	723059,4	5954145,4	0,6	Object
SSS_539	723228,2	5954951,3	0,8	Object
SSS_540	723230,4	5954954,1	0,6	Object
SSS_541	723246,4	5954499,2	0,8	Object
SSS_542	723264,9	5954042,9	0,6	Object
SSS_543	723277,7	5953991,5	0,8	Object
SSS_544	723312,6	5954027,2	0,5	Object
SSS_545	723325,5	5954026,9	0,6	Object
SSS_546	723346,8	5954092,8	0,5	Object
SSS_547	723383,4	5954065,3	0,7	Object
SSS_548	723532,7	5954134	0,6	Object
SSS_549	723718,1	5954855	0,5	Object
SSS_550	723711,9	5954061,6	0,8	Object
SSS_551	723715,9	5954080,5	0,7	Object
SSS_552	723716,7	5954083,2	0,9	Object
SSS_553	723754,5	5953969	1,1	Object
SSS_554	723862,1	5954493	1	Object
SSS_555	723808,6	5953913,2	0,8	Object
SSS_556	723809,1	5953901,4	0,7	Object
SSS_557	723849,2	5954109,4	0,6	Object
SSS_558	723845,1	5953991,8	0,6	Object
SSS_559	723854,7	5954067,6	0,5	Object
SSS_560	723853,8	5954050,5	0,5	Object
SSS_561	723862,2	5954111,9	0,5	Object
SSS_562	723857,6	5954050,7	0,6	Object
SSS_563	723881,2	5953902,9	0,7	Object
SSS_564	723905,6	5954059,2	0,6	Object
SSS_565	723903,6	5953887,2	0,6	Object
SSS_566	723926,7	5954041,6	0,5	Object
SSS_567	723960,4	5954035,3	0,5	Object
SSS_568	723975,1	5954068,3	0,5	Object
SSS_569	724277,6	5954747,2	0,6	Object
SSS_570	724644,9	5954411,2	0,5	Object
SSS_571	724661,8	5954539,6	0,6	Object
SSS_572	724731,1	5954433,1	0,7	Object
SSS_573	724766,8	5954450,5	0,6	Object
SSS_574	724783,1	5954517,1	0,6	Object
SSS_575	724778,6	5954449,5	0,6	Object
SSS_576	724778,7	5954349,3	0,6	Object
SSS_577	724942,4	5954328,7	0,7	Object
SSS_578	724989,4	5954394	0,6	Object
SSS_579	725009,8	5954374,7	0,7	Object
SSS_580	725048,4	5954528,3	0,6	Object
SSS_581	725096,7	5954515,8	0,5	Object
SSS_582	725124,3	5954241,8	0,6	Object
SSS_583	725134,4	5954237,5	0,6	Object
SSS_584	725144,7	5954278,6	0,6	Object
SSS_585	725092,5	5953770,4	0,5	Object
SSS_586	725150	5954266,5	0,5	Object
SSS_587	725152,2	5954277,5	0,5	Object
SSS_588	725178,6	5954225,2	0,5	Object
SSS_589	725172,5	5953894,4	0,5	Object
SSS_590	725246,9	5954421	0,7	Object
SSS_591	725261,7	5954467,2	0,7	Object
SSS_592	725212,5	5953938	0,6	Object
SSS_593	725244,5	5954123,2	0,5	Object

SSS_594	725262,4	5954046,9	0,6	Object
SSS_595	725276,3	5954136,2	0,5	Object
SSS_596	725288,5	5954240,3	0,6	Object
SSS_597	725285,5	5954061,9	0,9	Object
SSS_598	725327,3	5954221,9	0,7	Object
SSS_599	725336,5	5954215,6	0,8	Object
SSS_600	725341,3	5954252,8	0,6	Object
SSS_601	725346,4	5954204,1	0,5	Object
SSS_602	725390,8	5954497,8	0,6	Object
SSS_603	725361,6	5954030,7	0,7	Object
SSS_604	725387,3	5954238,5	0,5	Object
SSS_605	725361,5	5953844,7	0,8	Object
SSS_606	725428,3	5954348,2	0,6	Object
SSS_607	725473,8	5954428,3	0,7	Object
SSS_608	725407,6	5953805,9	0,7	Object
SSS_609	725448	5953818,4	0,8	Object
SSS_610	725500,7	5954077,7	0,6	Object
SSS_611	725502,5	5953777	0,6	Object
SSS_612	725549,5	5953801,3	0,7	Object
SSS_613	725568,8	5953790	1,1	Object
SSS_614	725654,1	5954532,8	0,5	Object
SSS_615	725650,5	5954214,5	0,5	Object
SSS_616	725671,5	5954313,5	0,6	Object
SSS_617	725663,1	5954214,4	0,6	Object
SSS_618	725649,4	5953785,8	0,6	Object
SSS_619	725831,4	5954364,2	0,5	Object
SSS_620	725785,3	5953766,4	0,6	Object
SSS_621	725928,4	5954476,4	0,6	Object
SSS_622	725965,9	5954322,6	0,7	Object
SSS_623	725997,4	5953887,9	0,5	Object
SSS_624	726052,2	5954102,8	0,5	Object
SSS_625	726057,4	5954141,9	0,6	Object
SSS_626	726125,6	5954417,6	0,7	Object
SSS_627	726114,5	5954190,8	0,6	Object
SSS_628	726107,6	5954125,6	0,7	Object
SSS_629	726119,6	5954110,4	0,6	Object
SSS_630	726091,6	5953851,3	0,7	Object
SSS_631	726190,2	5954548,2	0,6	Object
SSS_632	726173,3	5954150,5	0,5	Object
SSS_633	726253,1	5954394,2	0,9	Object
SSS_634	726319,8	5954354,4	0,5	Object
SSS_635	726386,3	5954389,5	0,7	Object
SSS_636	726412,1	5954380,8	0,6	Object
SSS_637	726385,9	5954146,6	0,9	Object
SSS_638	726544,5	5954494,8	0,5	Object
SSS_639	726502	5954104,7	0,8	Object
SSS_640	726506,9	5954107,5	0,7	Object
SSS_641	726592	5954486,4	0,7	Object
SSS_642	726742,6	5954423,4	0,7	Object
SSS_643	726871	5954279,2	0,6	Object
SSS_644	726958,2	5954177,6	0,6	Object
SSS_645	726989,5	5954175,5	0,7	Object
SSS_646	727046,9	5954189,8	0,5	Object
SSS_647	727104,2	5954382,5	1,1	Object
SSS_648	729697,5	5955104,1	0,6	Object
SSS_649	729774,8	5955004,8	0,7	Object
SSS_650	729767,4	5955101	0,5	Object
SSS_651	729791,7	5955056,7	0,9	Object

SSS_652	729990,5	5955191,8	0,6	Object
SSS_653	730162,3	5955230,6	0,5	Object
SSS_654	730317,8	5955207,8	0,6	Object
SSS_655	730309,6	5955222,1	1,2	Object
SSS_656	730297,6	5955291	0,5	Object
SSS_657	730324,8	5955286,6	0,5	Object
SSS_658	730359,4	5955287,6	0,7	Object
SSS_659	730418,9	5955242,5	0,5	Object
SSS_660	730417,6	5955276,2	0,6	Object
SSS_661	730463,8	5955245,5	0,5	Object
SSS_662	730506,7	5955235,5	0,5	Object
SSS_663	730516,1	5955237,6	0,5	Object
SSS_664	721968,2	5955304,0	0,5	Object
SSS_665	721381,2	5955392,9	1,1	Object
SSS_666	721801,8	5955134,4	0,7	Object
SSS_667	721796,0	5955132,2	0,8	Object
SSS_668	721808,3	5955123,3	0,6	Object
SSS_669	721767,7	5955126,0	0,6	Object
SSS_670	721800,3	5955078,8	0,5	Object
SSS_671	721819,7	5955039,4	0,8	Object
SSS_672	721776,0	5955044,1	0,7	Object
SSS_673	721738,4	5955038,3	0,7	Object
SSS_674	722062,0	5954903,7	0,5	Object
SSS_675	721674,2	5955016,6	0,5	Object
SSS_676	722142,0	5954862,0	0,5	Object
SSS_677	721680,8	5955011,0	0,7	Object
SSS_678	721798,9	5954964,4	0,6	Object
SSS_679	721788,7	5954958,7	0,6	Object
SSS_680	721854,7	5954924,8	0,5	Object
SSS_681	721847,3	5954926,0	0,6	Object
SSS_682	722131,2	5954815,0	0,5	Object
SSS_683	722128,6	5954814,3	0,6	Object
SSS_684	721656,4	5954932,1	1	Object
SSS_685	721648,1	5954914,1	0,5	Object
SSS_686	721637,9	5954907,1	0,7	Object
SSS_687	721718,1	5954870,3	0,7	Object
SSS_688	721717,1	5954862,9	0,6	Object
SSS_689	721723,2	5954856,2	0,6	Object
SSS_690	722031,2	5954397,3	0,7	Object
SSS_691	721200,5	5954647,4	0,6	Object
SSS_692	721321,5	5954595,8	0,9	Object
SSS_693	721304,2	5954594,4	1	Object
SSS_694	721764,5	5954382,5	0,5	Object
SSS_695	721788,5	5954369,3	0,6	Object
SSS_696	721949,1	5954256,8	0,7	Object
SSS_697	721710,9	5954302,9	0,5	Object
SSS_698	721040,0	5954486,9	0,6	Object
SSS_699	721048,1	5954441,0	0,5	Object
SSS_700	721154,2	5954387,6	0,5	Object
SSS_701	721047,8	5954403,6	0,8	Object
SSS_702	721070,0	5954388,0	0,5	Object
SSS_703	721189,7	5954332,0	0,8	Object
SSS_704	721120,5	5954342,5	0,6	Object
SSS_705	721204,1	5954287,9	0,7	Object
SSS_706	720988,4	5954348,5	1	Object
SSS_707	721712,6	5954066,9	1	Object
SSS_708	721055,1	5954273,5	0,5	Object
SSS_709	721083,6	5954252,5	0,6	Object

SSS_710	721625,4	5954063,7	0,7	Object
SSS_711	721124,2	5954225,5	0,6	Object
SSS_712	721202,4	5954182,9	0,6	Object
SSS_713	721183,4	5954184,2	0,5	Object
SSS_714	721704,6	5954008,3	0,5	Object
SSS_715	721200,1	5954168,3	0,5	Object
SSS_716	721810,1	5953955,7	0,7	Object
SSS_717	721014,9	5954205,5	0,5	Object
SSS_718	721703,8	5953951,7	0,9	Object
SSS_719	721684,5	5953956,4	1,6	Object
SSS_720	721624,6	5953973,0	0,7	Object
SSS_721	721047,7	5954157,2	0,8	Object
SSS_722	721014,6	5954144,9	0,6	Object
SSS_723	721096,7	5954103,8	0,6	Object
SSS_724	721166,4	5954080,7	0,7	Object
SSS_725	721023,6	5954124,1	0,8	Object
SSS_726	721147,7	5954077,6	0,5	Object
SSS_727	721031,8	5954112,7	0,6	Object
SSS_728	721077,9	5954055,2	0,5	Object
SSS_729	721129,5	5954019,2	0,7	Object
SSS_730	720987,9	5954062,2	0,9	Object
SSS_731	721567,9	5953867,9	0,6	Object
SSS_732	721111,5	5954015,6	0,6	Object
SSS_733	721108,5	5954016,1	1	Object
SSS_734	720995,1	5954033,9	0,8	Object
SSS_735	721039,2	5954011,5	0,5	Object
SSS_736	721082,9	5953986,7	0,5	Object
SSS_737	721072,1	5953895,1	0,6	Object
SSS_738	720316,0	5950031,5	0,9	Object
SSS_739	720114,5	5948971,1	0,8	Object
SSS_740	719671,1	5947933,0	0,6	Object
SSS_741	718851,9	5942574,8	0,5	Object
SSS_742	722065,602	5954532,748	0,5	Object
SSS_743	721847,333	5954926,036	0,6	Object
SSS_744	721718,052	5954870,335	0,7	Object
SSS_745	721723,219	5954856,189	0,6	Object
SSS_746	721523,033	5954218,829	0,7	Object
SSS_747	721517,576	5954248,052	0,6	Object
SSS_748	721717,093	5954862,856	0,6	Object
SSS_749	721395,154	5954252,774	0,7	Object
SSS_750	721395,633	5954262,425	0,6	Object
SSS_751	721321,532	5954595,757	0,9	Object
SSS_752	721738,417	5955038,276	0,7	Object
SSS_753	721767,685	5955125,998	0,6	Object
SSS_754	721800,267	5955078,779	0,5	Object
SSS_755	721200,485	5954647,373	0,6	Object
SSS_756	721710,894	5954302,916	0,5	Object
SSS_757	721759,398	5954496,665	0,6	Object
SSS_758	721815,378	5954641,854	0,6	Object
SSS_759	721940,171	5954537,155	0,7	Object
SSS_760	722072,284	5954539,197	0,5	Object
SSS_761	721571,489	5954203,118	0,5	Object
SSS_762	722031,163	5954397,323	0,7	Object
SSS_763	721764,507	5954382,525	0,5	Object
SSS_764	721788,498	5954369,264	0,6	Object
SSS_765	722112,914	5954349,566	1	Object
SSS_766	721656,392	5954932,107	1	Object
SSS_767	721788,653	5954958,655	0,6	Object

SSS_768	721896,799	5954569,624	0,7	Object
SSS_769	721819,678	5955039,442	0,8	Object
SSS_770	721775,982	5955044,12	0,7	Object
SSS_771	721808,335	5955123,298	0,6	Object
SSS_772	721458,055	5954747,893	0,9	Object
SSS_773	721880,655	5954700,943	0,6	Object
SSS_774	721554,962	5954666,225	0,8	Object
SSS_775	722119,708	5954332,113	0,6	Object
SSS_776	721637,887	5954907,072	0,7	Object
SSS_777	721625,005	5954519,167	0,7	Object
SSS_778	721419,153	5954712,644	0,7	Object
SSS_779	721746,755	5954595,746	0,6	Object
SSS_780	721766,615	5954616,901	0,8	Object
SSS_781	721825,401	5954588,196	0,5	Object
SSS_782	721851,994	5954594,191	0,6	Object
SSS_783	721854,677	5954924,845	0,5	Object
SSS_784	722037,385	5954431,371	0,9	Object
SSS_785	722026,142	5954527,01	0,7	Object
SSS_786	721290,573	5954297,188	0,6	Object
SSS_787	721343,864	5954472,532	0,5	Object
SSS_788	721373,402	5954458,692	0,5	Object
SSS_789	721408,521	5954529,082	1,3	Object
SSS_790	721829,398	5954595,074	0,6	Object
SSS_791	721652,063	5954564,38	0,6	Object
SSS_792	721791,384	5954654,785	0,5	Object
SSS_793	721798,859	5954964,393	0,6	Object
SSS_794	721648,134	5954914,129	0,5	Object
SSS_795	721796,007	5955132,171	0,8	Object
SSS_796	721655,249	5954793,462	0,7	Object
SSS_797	721304,212	5954594,415	1	Object
SSS_798	721674,177	5955016,59	0,5	Object
SSS_799	721949,132	5954256,82	0,7	Object
SSS_800	721850,605	5954434,709	0,6	Object
SSS_801	721680,772	5955011,048	0,7	Object
SSS_802	721858,183	5954627,117	0,6	Object
WRECK_001	720537,7	5952510,7	19.1x12.9x0.2	Wreck
WRECK_002	720467,1	5952450,6	40.1x12.8x1.1	Wreck

N5a Development

Title	Environmental Baseline Survey Report
GEOxyz Report No.	LU0022H-553-RR-05
ONE Report No.	N05A-7-10-0-70020-01
Revision	1.1

1.1	30/10/2019	Review copy	PC	PC		
1.0	11/09/2019	First draft	IE	PC		
Revision	Date	Description of Revision	Author	Checked	Approved	Approved by Client

REVISION HISTORY

The screen version of this document is always the CONTROLLED COPY. When printed it is considered a FOR INFORMATION ONLY copy, and it is the holder's responsibility that they hold the latest valid version.

On the front page the 'Description of Revision' box should always contain only one of three possible descriptions; First draft, Review copy, or approved. The table on this page can be used to explain the reason for the revision and what has changed since the previous revision. If number of changes are significant, the document ID of the comment sheet can be referenced in the 'Changes' column instead.

Rev.	Reason for revision	Changes from previous version
1.0	First Issue	N/A
1.1	Review copy	Application of client comments

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DEFINITIONS AND ABBREVIATIONS

Throughout this document the following terminology is used:

ONE-Dyas	*Oranje Nassau Energie B.V. (Client)*
GEOxyz	*GEOxyz Offshore (Contractor)*
TTS	*T.T. Surveys Ltd (Supplier)*
Igeotest	*Igeotest Geoscience Group (Supplier)*
BSL	*Benthic Solutions Ltd (Supplier)*
Peak	*Peak Processing (Supplier)*

Where abbreviations used in this document are not included in this list, it may be assumed that they are either equipment brand names or company names.

Table 1: Abbreviations used in this Document

Acronym	Description	Acronym	Description
Al	Aluminium (element)	MP	Megapixel
ANOSIM	Analysis of Similarity	NGT	Noordgastransport
AQC	Analytical Quality Control	Ni	Nickel (element)
AR	Aqua Regia	NMBAQC	National Marine Biological Association Quality Control
As	Arsenic (element)	n-MDS	Non-Metric Multidimensional Scaling
Ba	Barium (element)	NOAA	National Oceanic and Atmospheric Administration
BAC	Background Assessment Concentration	NPD	Naphthalene, Anthracene and Dibenzothiophene
BSL	Benthic Solutions Limited	N/S	No Sample
Cd	Cadmium (element)	OGUK	Oil & Gas United Kingdom
CEFAS	Centre for Environment, Fisheries and Aquaculture	OSPAR	Convention for the protection of the Marine Environment of the North East Atlantic
CEMP	Coordinated Background Monitoring Programme	OWF	Offshore Wind Farm
CPI	Carbon Preference Index	PAH	Polyaromatic Hydrocarbons
Cr	Chromium (element)	Pb	Lead (element)
Cu	Copper (element)	P/B Ratio	Petrogenic Biogenic Ratio
CV	Coefficient of Variation	PC	Physico-chemical grab sample
DBT	Dibenzothiophene	PCA	Principal Components Analysis
DCM	Dichloromethane	Ph	Phytane
DVV	Double Van Veen	Pr	Pristane
EBS	Environmental Baseline Survey	PRIMER	Plymouth Routines In Multivariate Ecological Research
ED50	European Datum 1950	PSA	Particle Size Analysis
EOL	End Of Line	PWL	Proposed Well Location
EPA	Environmental Protection Agency	SAC	Special Area of Conservation
ERL	Effective Range Low	Sb	Tin (element)
ERM	Effective Range Median	SBP	Sub-bottom profiler
EU	European Union	SCI	Sites of Community Importance
EUNIS	European Nature Information System	SD	Standard Deviation
F1,2 & 3	Fauna grab sample 1, 2 & 3	SIC	Single Ion Current
Fe	Iron (element)	SIMPROF	Similarity Profile Analysis
GC	Gas Chromatography	SNS	Southern North Sea
GC-FID	Gas Chromatography with Flame Ionisation Detection	SOL	Start Of Line

Acronym	Description	Acronym	Description
GC-MS	Gas Chromatography Mass Spectrometry	SOP	Standard Operating Procedure
HAP	Habitat Action Plan	SPA	Special Protection Area
HAS	Habitat Assessment Survey	SSS	Side-scan Sonar
HD	High Definition	THC	Total Hydrocarbon Content
HF	Hydrofluoric acid	TOC	Total Organic Carbon
Hg	Mercury (element)	TOM	Total Organic Matter
HM	Heavy and Trace Metals	TRV	Toxicity Reference Value
ICP-MS	Inductively Coupled Plasma Mass Spectrometry	UCM	Unresolved Complex Mixture
ICP-OES	Inductively Coupled Plasma - Optical Emission Spectrometry	UK	United Kingdom
IMS	Industrial Methylated Spirit	UKAS	United Kingdom Accreditation Service
IUCN	International Union for Conservation of Nature	UK BAP	United Kingdom Biodiversity Action Plan
JNCC	Joint Nature Conservation Committee	UKCS	United Kingdom Continental Shelf
LAT	Lowest Astronomical Tide	UKOOA	United Kingdom Offshore Operators Association
LED	Light-emitting Diode	UTC	Universal Time Coordinated
LOI	Loss on Ignition	UTM 31	Universal Transverse Mercator – Zone 31
MAG	Magnetometer	V	Vanadium (element)
MBES	Multi Beam Echo Sounder	VC	Vibrocore
MDL	Mean Detection Limit	WGS84	World Global Spheroid 1984
MDS	Multi-Dimensional Scaling	Zn	Zinc (element)

EXECUTIVE SUMMARY

A geophysical, geotechnical and environmental baseline survey of the proposed N5A site, Pipeline to NGT Hot Tap tie in and Cable Route to Riffgat Wind Park was conducted in block N5A of the Dutch Sector, Southern North Sea (SNS, Figure 1), on behalf of Oranje Nassau Energie (ONE). An additional 4km x 1km cable route survey and 1km x 1km rig site survey was completed for an alternative N5A platform location upon request from the client. The geotechnical and environmental surveys were carried out aboard the *Geo Ocean III* from 1st and 15th May 2019, while the geophysical survey was split between the *Geo Ocean III* and *Geo Surveyor VIII*.

Seabed imagery and grab sampling was conducted at twenty-eight locations around the proposed site and route and involved the acquisition of physico-chemical and macro-invertebrate samples. The results from this survey revealed a sandy sediment type throughout the survey site and route corridor, varying from fine to coarse sand, with infrequent patches of cobbles and some clay outcrops. Stations along the pipeline route were finer than those along the cable route, showing some geographical pattern.

TOC results revealed an organically-deprived environment with associated low moisture content, indicating consistent sediment consolidation throughout. The total hydrocarbon contents were toward the lower end of expected background concentrations for the SNS with the exception of GRAB_P_1 where levels exceeded the 95th percentile background concentrations for the SNS. Alkanes accounted for an average of 1.22% of THC and the UCM accounted for the remaining 98.78%, with results for GRAB_P_1 consistently higher than other stations. The GC traces for all stations reflected a likely input of terrigenous plant materials which typically comprise the long-chain, odd carbon-numbered n-alkanes, and to a much lesser extent, a possible combination of general contaminants from shipping activity or UCM, but not a level to cause concern. Carbon Preference Index where applicable showed mixture of dominance between biogenic and petrogenic alkanes, although should be treated with caution due to many alkanes below the limits of detection. The pristane/phytane ratio where applicable, revealed a pristane dominance, likely attributable to a planktonic contribution and/or terrestrial inputs. Total PAH concentrations were relatively low throughout survey area to levels well below the mean UKOOA background level for the SNS. Total concentrations of heavy and trace metals were analysed, and the majority were relatively consistent over the N5A survey area showing little sign of any anthropogenic contamination except for possible slight contamination at GRAB_P_1.

A total of 16550 individuals from 118 infaunal taxa were identified with a mean richness of 30.7 (±8.7SD) across the survey area. Analysis of the infaunal and epifaunal communities indicated a dominance of infauna, with only ten colonial epifaunal species identified during the seabed sampling campaign. In most instances, annelids dominated the macrofaunal community in terms of species richness and abundance. Results, analysed using multivariate techniques, showed that the faunal community recorded over the N5A survey area was rich but variable across sites, with some homogeneity attributed to the dominant sandy substrate found across the area. Broad separations between the pipeline and cable route macrofauna communities were apparent.

Four main habitats, ‘infralittoral fine sand’, ‘infralittoral coarse sediment’, ‘infralittoral mixed sediment’ and ‘dense *Lanice conchilega* and other polychaetes in tide swept infralittoral sand and mixed gravelly sand’ were identified. The seabed sediments within the survey area were sand-dominated and supported a number of species deemed to be characteristic of EC Habitats Directive Annex I permanently submerged sandbank habitat (H1110_C subtype), so it is possible that the survey area could be deemed to represent this protected habitat. In addition, *L. conchilega* beds, which were evident across large parts of the survey area, are not currently listed as a protected habitat but are known to act as ‘ecosystem engineers’ and some authors have recommended their inclusion as EC Habitats Directive Annex I habitats.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

GEOxyz was contracted by Oranje Nassau Energie (ONE) to undertake a range of geophysical, geotechnical and environmental surveys in block N5A of the Dutch Sector, comprising a site survey and two route surveys (Figure 1 and Table 2):

- Site survey (1km x 1km) over the N5A exploration well which will be developed by emplacement of the N5A Platform.
- Cable route survey (9km x 1km) from proposed N5A Platform to Riffgat Offshore Windfarm (OWF) Transformer Station.
- Pipeline route survey (15km x 1km) for proposed gas export pipeline from N5A Platform to with a proposed cable route corridor between the N5A Platform location and the Noordgastransport (NGT) Hot Tap location.

The geophysical surveys comprised acquisition of multibeam echosounder (MBES), side scan sonar (SSS), magnetometer (MAG) and sub-bottom profiler (SBP) data over the site and routes with Sparker multi-channel seismic data also acquired over the site survey area. An additional 4km x 1km cable route survey and 1km x 1km rig site survey was completed for a potential alternative location of the N5A platform upon request from the client.

The environmental survey work comprised a habitat assessment and environmental baseline survey and was carried out by GEOxyz Offshore UK Limited, supported by Benthic Solutions Ltd (BSL).

Table 2: Proposed N5A Platform, N5A to Riffgat Cable Route and N5A to NGT Hot Tap Route Locations

ED50, UTM 31N, CM 3° E					
Proposed Location	KP	Easting (m)	Northing (m)	Latitude	Longitude
N5A Platform	0.000	721 607.00	5 954 650.00	53° 41' 32.347" N	06° 21' 23.281" E
End of Route – Riffgat Wind Park Transformer Station Location	8.681	730 081.00	5 954 988.00	53° 41' 30.080" N	06° 29' 05.312" E
End of Route – NGT Hot Tap Location	14.675	718 409.00	5 940 429.00	53° 33' 57.806" N	06°17' 53.314" E

Survey operations were performed onboard the survey vessel Geo-Ocean III (Appendix A) between the 1st and 15th May 2019.

The objectives of the environmental survey were as follows:

- Identify UKCS sensitive environmental habitats and species (e.g. Annex I Habitats).
- Acquire baseline data to assess the sediment physico-chemical and biological characteristics within the survey area.

This report provides the results of the environmental baseline survey over the N5A site survey areas (original and alternative) and associated cable and pipeline route survey corridors.

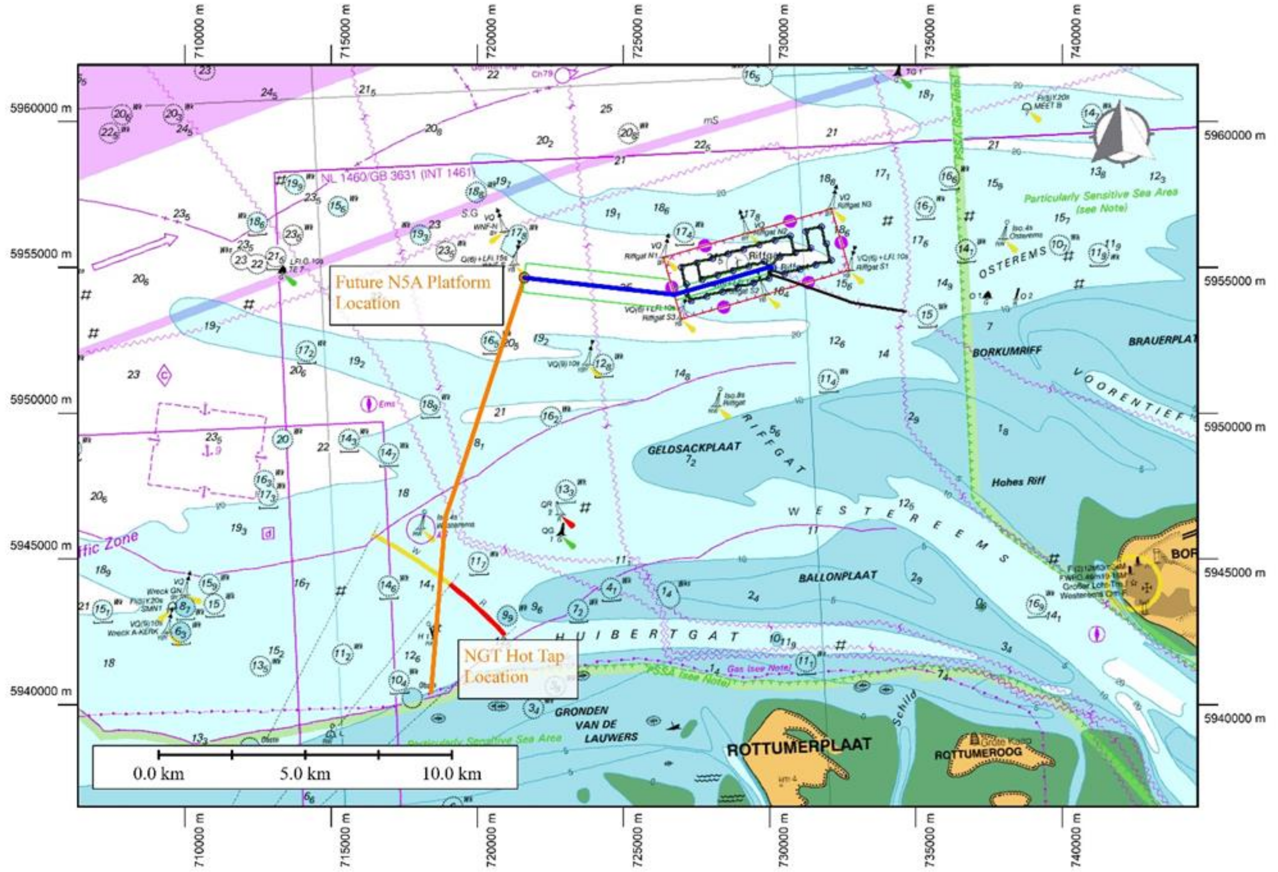


Figure 1: Project location overview

1.2 SCOPE OF WORK

There were three main work areas for geophysical, geotechnical and environmental surveys as described in N5A-7-10-0-70000-01-05 - Pipeline Route and Platform Area Survey Scope. These were:

- Platform Survey Future N5A location;
- Pipeline Route Survey from the future N5A platform location to a subsea hot-tap tie-in at the NGT pipeline near KP 142.1(orange line in Figure 1 above);
- Cable Route Survey from the future N5A platform location to the Riffgat transformer station (blue line in Figure 1 above).

The following surveys were required by ONE and are described in more detail in Table 3:

- Geophysical Pipeline and Power Cable Route Surveys;
- Geotechnical Pipeline and Power Cable Route Surveys;
- Environmental Pipeline and Power Cable Route surveys including the Platform Area;
- Geophysical Platform Area Survey.

Table 3: Detailed scope of work for each area

Scope	N5A Platform site	Hot Tap Pipeline Route	Riffgat Cable Route
Geophysical Analogue	MBES, SSS, MAG, SBP	MBES, SSS, MAG, SBP	MBES, SSS, MAG, SBP
Geophysical Digital	Multi-channel sparker 80 m depth		
Environmental	Two grab samples within the platform site survey area	Grab sampling each km	Grab sampling each km (including within Riffgat OWF)
Shallow Geotechnical		VC each km	VC each km

The geophysical pipeline route survey works was divided between two vessels, where the Geo Ocean III carried out operations in water deeper than around 10 to 15m LAT and the Geo Surveyor VIII completed operations in the shallower sections.

The survey areas were further broken down into five sections where there were natural turning points on routes and separate surveys such as the N5A Site survey.

- Area 1 – Southern part of pipeline route
- Area 2 – Northern part of pipeline route
- Area 3 – Western part of cable route
- Area 4 – Eastern part of cable route
- Area 5 – N5A site survey area
- *Alternative N5A Site (Added workscope)*
- *Alternative Cable Route C3 (Added workscope)*

1.1.1 Objectives

The survey objectives were to:

- Accurately determine water depths and seabed topography;
- Provide information on seabed and sub-seabed conditions to ensure the safe emplacement and operation of the proposed pipeline, cable route and platform;
- Assess the area for the presence of any potential sensitive habitats or species, to include EC Habitats Directive (97/62/EC) Annex I habitats and OSPAR threatened and declining habitats and/or species (OSPAR, 2008);
- Acquire environmental baseline samples across the survey area to establish a benchmark against which potential future impacts could be assessed;
- Assess the route corridor for the possible presence of anomalies and boulders/debris that may impede pipelay or cable installation;
- Identify any seabed and sub-seabed features or obstructions.

1.3 GEODETIC PARAMETERS

1.1.2 Horizontal Reference

Table 4: Geodetic parameters

Geodetic Parameters	
Spheroid	International 1924
Semi-major axis	6378388.297
Semi-minor axis	6356911.946
Datum	European Datum 1950 (ED50)
Projection	Universal Transverse Mercator (UTM)
False Easting	500000.00
False Northing	0.00
Central Meridian	3° East
Central Scale Factor	0.9996
Latitude of Origin	0°
Grid Zone	31 North
Datum Transformation WGS84 – ED50	
dx	+ 89.5m
dy	+93.8m
dz	+123.1m
Rx	0.0
Ry	0.0
Rz	-0.156
Scale	-1.2ppm

1.1.3 Vertical Reference

All water depths have been reduced to LAT using the UKHO VORF model. MSL is 1.6m above LAT within the survey area.

2 SURVEY OPERATIONS AND DATA REVIEW

2.1 SUMMARY OF SURVEY OPERATIONS

Between the 01st April and 15th May 2019, a geophysical, seismic, geotechnical and environmental survey was completed for the N5A Development Project – Pipeline Route and Platform Area Survey aboard the Geo Ocean III. An overview of the survey operations is given in Table 5.

Table 5: Overview of survey operations

Survey Operations Geo Ocean III– N5A Site, Cable Route and Pipeline Route Survey		
1	29/04/2019	Alongside Eemshaven Completed demobilisation from previous project commenced mobilisation for ONE project. Completed Survey Positioning, MRU and SVP Comparisons
2	30/04/2019	Completed mobilisation of personnel to vessel Completed all vessel crew inductions Completed kick-off meeting and mobilisation HIRA review Completed transit to work location Completed Vessel DP trials
3	01/05/2019	Completed Recce line through pipeline route and location. MBES calibration location identified Completed MBES calibration SSS verification completed Muster Drill completed Started analogue survey acquisition on northern section of pipeline route (Area 2)
4	02/05/2019	Continued analogue survey acquisition on northern section of pipeline route (Area 2) Started Vibro-coring operations on northern section of pipeline route (Area 2) Continued analogue survey acquisition cross lines only on northern section of pipeline route (Area 2) Carried out three Environmental Camera observations on environmental sample locations on northern section of pipeline route (Area 2) Continued analogue survey acquisition cross lines only on northern section of pipeline route and western section of cable route. (Area 2 and Area 3)
5	03/05/2019	Continued analogue survey acquisition cross lines only on western section of cable route. (Area 3) Stopped operations due to increasing weather affecting data. Carried out five Environmental Camera observations on environmental sample locations on northern section of pipeline route (Area 2) Stopped due to weather rising out of safe working limits for operations Standing by on weather
6	04/05/2019	Standing by on weather
7	05/05/2019	Standing by on weather
8	06/05/2019	Standing by on weather Completed Drop Camera locations on northern section of pipeline route (Area 2) Commenced Grab Sample locations on northern section of pipeline route (Area 2) Stopped Grab Sampling due to rigging issue
9	07/05/2019	Resumed analogue survey acquisition on northern section of pipeline route (Area 2) Stopped analogue survey acquisition on northern section of pipeline route (Area 2) Thruster Technician onboard to fix thruster issue and returned to shore Completed Vibro-core operations on northern section of pipeline route (Area 2)
10	08/05/2019	Completed Environmental Grab Sampling operations on northern section of pipeline route (Area 2) Completed analogue survey acquisition on northern section of pipeline route (Area 2) Commenced N5A UHR Site Survey (Area 5)
11	09/05/2019	Completed N5A UHR Site Survey (Area 5) Acquired one-line analogue survey acquisition on western section of cable route (Area 3) Completed analogue survey acquisition on eastern section of cable route (Area 4) Completed Geotechnical Vibro-cores on eastern section of cable route (Area 4) Completed Environmental Video Photography and Grab Sampling operations on eastern section of cable route (Area 4) Re-commenced analogue survey acquisition on western section of cable route (Area 3)

Survey Operations Geo Ocean III– N5A Site, Cable Route and Pipeline Route Survey		
12	10/05/2019	Completed analogue survey acquisition on western section of cable route (Area 3) Completed Geotechnical Vibro-cores on western section of cable route (Area 3) Completed N5A UHR Site Survey reshoots (Area 5)
13	11/05/2019	Completed additional environmental video and photography transects on N5A Site Survey location. Completed Environmental Video Photography and Grab Sampling operations on western section of cable route (Area 3) Commenced Geotechnical Vibro-cores on southern section of pipeline route (Area 1) Commenced Environmental Video Photography on southern section of pipeline route (Area 1)
14	12/05/2019	Completed Environmental Video Photography and Grab Sampling operations on southern section of pipeline route (Area 1) Completed Geotechnical Vibro-cores on southern section of pipeline route (Area 1) Commenced analogue survey acquisition on southern section of pipeline route (Area 1) and infill on northern pipeline route (area 2)
15	13/05/2019	Completed analogue survey acquisition on southern section of pipeline route (Area 1) and infill on northern pipeline route (area 2) Completed analogue survey acquisition on alternative cable route (C3)
16	14/05/2019	Completed Alternative N5A UHR Site Survey Completed Geotechnical Vibro-cores on alternative N5A site and cable route (C3) Completed Environmental Video Photography and Grab Sampling operations on alternative N5A site and cable route (C3)
17	15/05/2019	Arrived in Eemshaven Demobilisation Completed

2.2 GEOPHYSICAL DATA

Analogue geophysical data acquired by GEOxyz during the survey were used for site selection as no previous geophysical data were available for the survey area. This data was reviewed onboard by BSL and camera transects were selected to target any habitats and boundaries across the survey area, with particular attention paid to the investigation of potential Annex I habitats protected under the EU Habitats Directive. Where features of interest occurred in close proximity to one of the environmental sampling stations, based on the rationale outlined in the scope of work, this station was to be moved slightly to provide additional ground-truthing data for the feature of interest.

The following datasets were available for review during the preparation of this report:

- Bathymetry, reduced and processed offshore to provide a digital terrain model where major bathymetric features and minor bathymetric changes could be identified and highlighted. This included the identification of large features (e.g. linear ridges of cobbles and boulders) and seabed infrastructure (e.g. existing pipelines).
- Side scan sonar (SSS) with data run at both high (400kHz) and low (100kHz) frequencies at variable ranges for different sections of the survey; 50m/150m/200m/250m for the N5A to NGT Hot Tap Pipeline, 150m/200m on the Riffgat Cable Route and 75m/125m in the Platform Area with digital rendering onto a seabed mosaic of the area (100KHz) for review. Changes in sediment type and hardness, along with features observed through low level relief and discrete objects could also be delineated.

2.3 ENVRIONMENTAL GROUND-TRUTHING AND SAMPLING

The environmental sampling strategy was defined by the client prior to the commencement of the survey. Sampling locations along the pipeline and cable routes were positioned every kilometre from the proposed N5A well locations to the shore and to the Riffgat offshore wind farm (Figure 2). Two stations (Grab_P_0 and Grab_P_7) along the pipeline route were repositioned to cover areas of interest identified from the sidescan sonar record (Table 6). At each of these sampling locations a drop-down video assessment was conducted before grab sampling, with video footage acquired at all stations apart from Grab_P_14 where the visibility severely reduced. Additional camera transects were conducted over the proposed N5A well locations and additional areas of interest identified following review of the sidescan sonar record (Table 7).

Seabed video footage was acquired along eight camera transects using a Seabug camera system mounted within a BSL camera sled frame equipped with a separate strobe, and LED lamps. The camera unit itself is capable of acquiring images at 14.7MP resolution but was set to a resolution of 5MP (2592 x 1944 pixels) to optimise image upload times during camera operation.

A BSL Double grab (double Van Veen) was used for seabed sampling, requiring two successful deployments at each location. A maximum of three 'no sample' deployments was allowed at each station before abandoning. A 0.1m^2 Day Grab was used on the first deployment, before switching to the BSL Double grab for all remaining deployments at the client's request.

Table 6: Summary of drop-down camera and grab sampling locations for survey area

ED50, UTM 31N, CM 3° E								
Station	Rationale	Type	Easting (m)	Northing (m)	PC	F1	F2	F3
Grab_P_0	Pipeline Route - Positioned at 1km intervals	EBS/HAS	721619	5954453	Y	Y	Y	Y
Grab_P_1	Moved from KP in order to investigate area of high reflectivity sediment	EBS/HAS	721325	5953791	Y	Y	Y	Y
Grab_P_2	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720981	5952752	Y	Y	Y	Y
Grab_P_3	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720669	5951801	Y	Y	Y	Y
Grab_P_4	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720355	5950850	Y	Y	Y	Y
Grab_P_5	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720041	5949900	Y	Y	Y	Y
Grab_P_6	Pipeline Route - Positioned at 1km intervals	EBS/HAS	719729	5948950	Y	Y	Y	Y
Grab_P_7	Moved from KP to investigate mixed reflectivity sediment	EBS/HAS	719347	5948023	Y	Y	Y	Y
Grab_P_8	Pipeline Route - Positioned at 1km intervals	EBS/HAS	719105	5947052	Y	Y	Y	Y
Grab_P_9	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718861	5945912	Y	Y	Y	Y
Grab_P_10	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718779	5944917	Y	Y	Y	Y
Grab_P_11	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718695	5943920	Y	Y	Y	Y
Grab_P_12	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718614	5942923	Y	Y	Y	Y
Grab_P_13	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718532	5941927	Y	Y	Y	Y
Grab_P_14	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718450	5940930	Y	Y	Y	Y
Grab_P_15	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718366	5939933	Y	Y	Y	Y
Grab_C_0	Original Cable Route and N5A well centre location	EBS/HAS	721610	5954652	Y	Y	Y	Y
Grab_C_1	Original Cable Route – Positioned at 1km intervals	EBS/HAS	722604	5954538	Y	Y	Y	Y
Grab_C_2	Original Cable Route – Positioned at 1km intervals	EBS/HAS	723596	5954425	Y	Y	Y	Y
Grab_C_3	Original Cable Route – Positioned at 1km intervals	EBS/HAS	724588	5954315	Y	Y	Y	Y

ED50, UTM 31N, CM 3° E								
Grab_C_4	Original Cable Route – Positioned at 1km intervals	EBS/HAS	725579	5954203	Y	Y	Y	Y
Grab_C_5	Original Cable Route – Positioned at 1km intervals	EBS/HAS	726575	5954089	Y	Y	Y	Y
Grab_C_6	Original Cable Route – Positioned at 1km intervals	EBS/HAS	727355	5954245	Y	Y	Y	Y
Grab_C_7	Original Cable Route – Positioned at 1km intervals	EBS/HAS	728149	5954477	Y	Y	Y	Y
Grab_C_8	Original Cable Route – Positioned at 1km intervals	EBS/HAS	729107	5954756	Y	Y	Y	Y
Grab_C3_0	Secondary Cable Route and N5A second potential well centre location	EBS/HAS	722288	5953018	Y	Y	Y	Y
Grab_C3_1	Secondary Cable Route – Positioned to investigate mixed reflectivity sediment	EBS/HAS	723809	5953378	Y	Y	Y	Y
Grab_C3_2	Secondary Cable Route – Positioned to investigate high reflectivity sediment	EBS/HAS	725337	5953741	Y	Y	Y	Y

Table 7: Summary of camera transect locations for the survey area

ED50, UTM 31N, CM 3° E								
Transect	Rationale	SOL/ EOL	Date and time	Depth (m)	Easting (m)	Northing (m)	No. Stills	Video footage (mm:ss)
Grab P_0	Investigating area of mixed reflectivity sediment	SOL	02/05/2019 17:15:11	30	721647	595443	27	07:13
		EOL	02/05/2019 17:22:21	31	721591	595447		
North Transect 1	Investigating transition from mixed to high reflectivity sediment	SOL	11/05/2019 00:49:10	29	721486	595468	30	10:11
		EOL	11/05/2019 00:59:10	29	721363	595463		
North Transect 2	Investigating transition from low to mixed reflectivity sediment	SOL	11/05/2019 00:06:17	30	721609	595499	41	12:49
		EOL	11/05/2019 00:18:59	28	721631	595515		
North Transect 3	Investigating transition from mixed to high reflectivity sediment	SOL	11/05.2019 02:04:48	29	721902	595440	50	12:29
		EOL	11/05/2019 02:17:13	29	721802	595455		
N5A Transect 1	Transect across original N5A well location	SOL	11/05/2019 01:38:05	29	721585	595458	35	08:37
		EOL	11/05/2019 01:46:38	29	721626	595470		
N5A Transect 2	Transect across original N5A well location	SOL	11/05/2019 01:16:28	28	721668	595463	39	09:13
		EOL	11/05/2019 01:25:35	29	721544	595466		
Grab_C3_0	Transect across second proposed N5A well location	SOL	14/05/2019 21:51:02	24	722231	595298	36	09:15
		EOL	14/05/2019 22:00:14	25	722335	595304		
Grab_C3_2	Investigating area of high reflectivity sediment	SOL	14/05/2019 20:46:00	25	725366	595361	37	12:36
		EOL	14/05/2019 20:58:53	25	725326	595378		

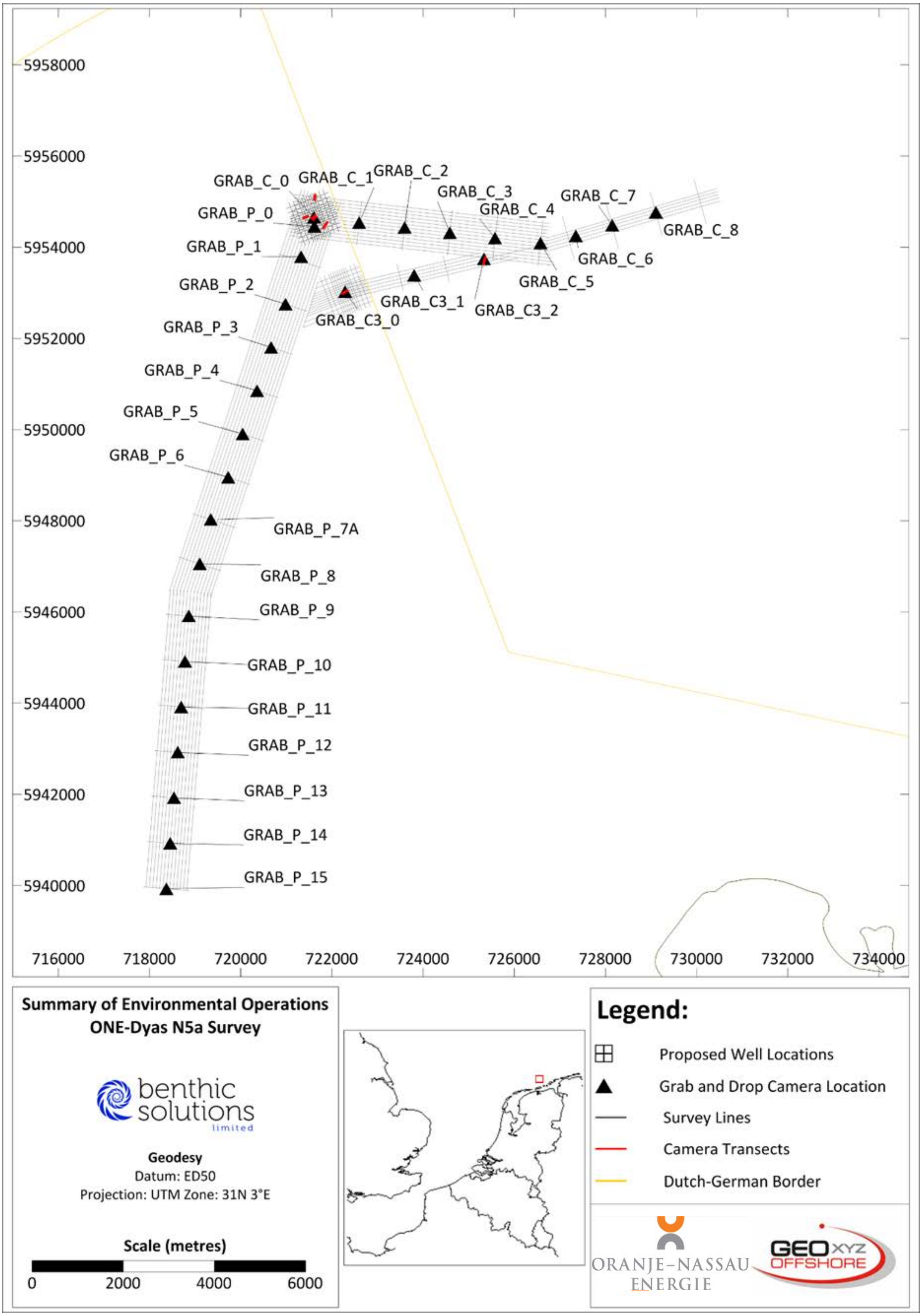


Figure 2: Survey strategy overview

2.4 HABITAT INVESTIGATION

2.4.1 Habitat Classification

A marine biotope classification system for British waters was developed by Connor *et al.* (2004) from data acquired during the JNCC Marine Nature Conservation Review (MNCR) and subsequently revised by Parry *et al.* (2015) to provide improved classification of deep-sea habitats. The resultant combined JNCC (2015) classification system is analogous with the European Nature Information Service Habitat Classification (EUNIS, 2013), which has compiled habitat information from across Europe into a single database. The two classification systems are both based around the same hierarchical analysis. Initially abiotic habitats are defined at four levels. Biological communities are then linked to these (at two lower levels) to produce a biotope classification. (Connor *et al*., 2004; EUNIS, 2013).

Habitat descriptions have been interpreted from the side scan sonar and bathymetric data acquired during the current survey, in conjunction with additional information on seabed sediment types and faunal communities from seabed photography and grab sampling. Global Mapper V20 GIS software was used to review side scan sonar mosaic (Geotiff) and multibeam bathymetry data (Geotiff and xyz) and to delineate areas of different seabed habitats.

2.4.2 Assessment of Sensitive Habitats

The Netherlands is a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979). To meet their obligations under the convention, the European Community Habitats Directive was adopted in 1992. The provisions of the Directive require Member States to introduce a range of measures including the protection of species listed in the Annexes; to undertake surveillance of habitats and species and produce a report every six years on the implementation of the Directive. The 189 habitats listed in Annex I of the Directive and the 788 species listed in Annex II, are to be protected by means of a network of sites. Each Member State is required to prepare and propose a national list of sites, which will be evaluated in order to form a European network of Sites of Community Importance (SCIs). These will eventually be designated by Member States as Special Areas of Conservation (SACs), and along with Special Protection Areas (SPAs) classified under the EC Birds Directive (2009), form a network of protected areas known as Natura 2000. The Directive was amended in 1997 by a technical adaptation Directive and latterly by the Environment Chapter of the Treaty of Accession 2003.

Based on the above, the OSPAR list of threatened and/or declining species and habitats and Annex I habitats of particular relevance to this region of Dutch waters are:

- Biogenic reefs formed by *Sabellaria spinulosa* (the Ross Worm); and,
- Sandbanks which are slightly covered by sea water all the time

Stony reefs are an Annex I habitat and are protected under the EU habitats directive. Sampling location Grab_C3_2 showed a high proportion of cobbles and boulders, and consequently a stony reef assessment was conducted. The seabed camera ground-truthing data were assessed for potential stony reefs using the criteria proposed by Irving (2009). While the Irving (2009) criteria have been approved by the UK regulators for application in UK waters, they have not been explicitly approved by the Netherlands authorities but are used here as they provide a useful basis for semi-quantitative assessment of potential Annex I stony reef habitat. The Irving (2009) method breaks down the assessment criteria into measures of reef 'quality' or 'reefiness' as outlined in Table 8. This is based on a minimum cobble size of 64mm being present and indicating relief above the natural seabed where >10% of the matrix are cobble related and a minimum surface area of around 25m^2 is recorded.

The stony reef assessment was based on HD video and stills taken during the camera transects. Stills were acquired when the camera frame landed on the seabed for one or more seconds in order to obtain the best possible image quality, while the changes in coverage and density of cobbles/boulders were estimated during the video data analysis.

Table 8: Summary of resemblance to a stony reef, as summarised in Irving (2009)

Measure of 'reefiness'	NOT a reef	Low(c)	Medium	High
Composition(a)	<10%	10-40%	40-95%	>95%
Elevation(b)	Flat seabed	<64mm	64mm-5m	>5m
Extent (m^2)	<25m²	>25m²	>25m²	>25m²
Biota	Dominated by infauna			>80% of species are epifauna

(a) Diameter of cobbles / boulders being greater than 64mm. Percentage cover relates to a minimum area of 25m². This 'composition' characteristic also includes 'patchiness'.

(b) Minimum height (64mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed.

(c) When determining if the seabed is considered as Annex I stony reef, a 'low' scored (in any category), would require a strong justification for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive.

The Irving (2009) stony reef protocol was split into separate assessments of reef 'structure' and 'overall reefiness' using a method developed by BSL staff (Table 9 and Table 10). This provided a reef structure value that could be then assessed against extent, where applicable, to provide a measure of overall 'reefiness' as illustrated in Table 10. As separate thresholds for 'Low', 'Medium' and 'High' stony reef extent were not given in Irving (2009), the overall 'reefiness' is determined by reef structure provided that the extent of the stony reef covers a minimum of 25m².

Table 9: Stony reef structure matrix (after Irving, 2009)

Reef Structure Matrix			Elevation			
			Flat	<64mm	64mm-5m	>5m
			Not a Reef	Low	Medium	High
Composition	<10%	Not a reef	NOT A REEF	NOT A REEF	NOT A REEF	NOT A REEF
	10-40%	Low	NOT A REEF	LOW	LOW	LOW
	40-95%	Medium	NOT A REEF	LOW	MEDIUM	MEDIUM
	>95%	High	NOT A REEF	LOW	MEDIUM	HIGH

Table 10: Overall stony reefiness matrix (structure vs extent)

Overall Reefiness Matrix			Reef Structure (incl. Composition and Elevation)			
			Not a Reef	Low	Medium	High
Extent (m^2)	<25	Not a Reef	NOT A REEF	NOT A REEF	NOT A REEF	NOT A REEF
	>25	Low - High	NOT A REEF	LOW	MEDIUM	HIGH

In evaluating the ground-truthing of stony patches, Irving (2009) also recommended that the associated biota was considered, indicating that areas dominated by infauna should be considered 'Not a Reef' whereas areas where greater than 80% of species were epifaunal should be considered to show 'High' reefiness, but no recommendations were given as to the proportion of infauna and epifauna warranting classification of 'Low' or 'Medium' reefiness. In practise, it is not practical to assess the proportion of infaunal and epifaunal species in a quantitative manner. This cannot be undertaken from seabed camera data (i.e. video footage or still photographs) as only the larger epifauna and emergent infauna are visible. To accurately quantify the proportion of infauna and epifauna species, it would be necessary to take large enough samples to include both the stony material (i.e. cobbles and boulders) and the surrounding sediment matrix, with sufficient replication to provide confidence in the resultant data. This would likely involve sampling with a large volume sampler such as a clam dredge and could significantly impact the integrity of the cobble/boulder patch. As such the biota associated with stony patches from the current survey has been described in a qualitatively.

2.5 SAMPLE ANALYSES

The recovered benthic samples were correctly stored prior to demobilisation and transportation of the material to the analytical laboratories. This involved the freezing of all physico-chemical samples on recovery and transporting them back to the UK to be forwarded to a laboratory, remaining frozen at all times. This material was analysed at the following laboratories:

- BSL: Particle size Analysis
- BSL: Macrofaunal Analysis
- Socotec: Sediment Chemistry

3 RESULTS AND INTERPRETATION

3.1 BATHYMETRY

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the bathymetry across the survey site and route corridors.

Bathymetry data were acquired using an R2 Sonics 2022 multi-beam echo sounder for the site and an R2Sonic 2024 multi-beam echo sounder for the two route surveys. All bathymetry data have been reduced to LAT, which was 1.6m below MSL within the survey area and are presented at a 0.5m x 0.5m bin size.

3.1.1 N5A to NGT Hot Tap Pipeline Route

Water depths along the proposed N5A to NGT Hot Tap pipeline route ranged between 9.8m LAT at KP0.000 and 26.4m LAT at KP14.675, with the seabed shoaling gently towards the southern end of the proposed pipeline route. A series of natural troughs trending west-north-west to east-south-east occurred within the survey corridor, crossing the proposed pipeline route, the largest of which was approximately 250m wide.

A variety of anthropogenic debris/wreck and areas of disturbed seabed were evident on the bathymetry data:

- Two prominent features interpreted as shipwrecks surrounded by seabed scouring; the largest (40.1m x 12.8m x 1.1m) occurred at approximately KP2.462, 369m west-north-west of the proposed route and the other (19.1m x 12.9m x 0.2m) occurred at approximately KP2.373, 339m west-north-west of the proposed route.
- Three semi-circular features with 1m of positive relief, interpreted as being related to previous drilling activity, were observed on bathymetry data. These were observed at the start of the proposed route between KP0.009 and KP0.089, offset by 90m to the east-south-east at their closest approach. These features lay within a 30m radius of each other and exhibited average dimensions of 30m x 30m.
- Three existing cables and one pipeline were expected to cross the proposed pipeline route but were not observed on the bathymetry data.

3.1.2 N5A to Riffgat Cable Route

The seabed shoaled gently towards the east-north-east end of the proposed N5A to Riffgat cable route with water depths ranging between 26.0m at KP0.280 and 19.6m KP7.941. A series of natural troughs, predominantly trending north-west to south-east, crossed the proposed cable route from approximately KP5.158 to KP8.681 and were interpreted to be related to tidal/current processes.

Three semi-circular features with 1m of positive relief, interpreted as being related to previous drilling activity, were imaged in the bathymetry data. These were positioned at the start of the proposed route between KP0.085 and KP0.168; at their minimum offset from the route they were approximately 27m south-south-west. They were positioned within a 30m radius and had average dimensions of 30m x 30m.

The Norned cable was observed crossing the proposed cable route at KP2.313 trending north-north-west to south-south-east.

3.2 SEABED FEATURES

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the seabed features across the survey area, focussing on features of particular relevance to the environmental baseline and habitat assessment of the survey area.

Side scan sonar data were acquired with an Edgetech 4200 system operating at 100kHz/400kHz with between 75m and 200m per channel range. This was supplemented by swathe bathymetry data gridded to 0.5m bin size.

3.2.1 N5A Site

Seabed sediments across the N5A survey area were expected to comprise 'fine sand with shell fragments'. An area of 'coarse sand and shell with a high density of sand mason worms and razor clams' was evident in the north of the survey area, while an area of 'coarse sand with pebbles and cobbles' was present in the south. The uppermost sand unit was merely a veneer and the boundary between the sand and the underlying clay outcrops was arbitrary with the potential for some clay to outcrop in the areas interpreted as sand.

Outcrops of clay were interpreted within the survey area, showing a positive relief of up to 0.5m above background seabed levels. Elsewhere accumulations of coarse sand and gravel were also observed on the bathymetry as having positive relief above the ambient seabed, with some accumulations likely to be caused by the stabilising effect of high densities of sand mason worms and razor clams on the seabed.

Within the survey area there was no existing infrastructure other than the previously drilled N5 Well (~140m from the proposed platform and ~1.6km from the alternative platform location). Seabed scars up to 1.1m high from the rig whilst over the N5-Ruby wellsite were observed on the bathymetry and side scan sonar data. Numerous magnetometer anomalies were observed within this area; however no wellhead or other evidence of the drilling location could be observed at seabed.

3.2.2 N5A to NGT Hot Tap Pipeline Route

Seabed sediments along the proposed pipeline route corridor were expected to comprise 'fine sand and shell fragments', with occasional areas of 'coarse sand and shell fragments'.

Bedforms were not imaged in the sonar or bathymetry records. However, photographs taken along the route as part of the environmental survey showed clear seabed rippling over much of the survey corridor.

Numerous objects interpreted as boulders and items of debris were observed within the proposed pipeline route corridor. Most of the objects interpreted as boulders occurred towards the north of the survey corridor area and coincided with areas of clay exposure.

The most significant objects identified on the sonar records were two interpreted shipwrecks, the largest (40.1m x 12.8m x 1.1m) occurring at approximately KP2.462, 369m west-north-west of the proposed route and the other (19.1m x 12.9m x 0.2m) at approximately KP2.373, 339m west-north-west of the proposed route.

Three existing cables and one pipeline were expected to cross the proposed pipeline route but were not observed on the bathymetry data.

3.2.3 N5A to Riffgat Cable Route

Seabed sediments along the proposed pipeline route corridor were expected to comprise fine to coarse SAND, with occasional areas of 'coarse sand and clay with pebbles and cobbles' and 'coarse sand with pebbles and cobbles'. Approaching the Riffgat Wind Park, the seabed sediments were dominated by 'coarse sand and shell fragments' with occasional patches of 'coarse sand with pebbles and cobbles'.

Bedforms were not imaged in the sonar or bathymetry records. However, photographs taken along the proposed route corridor as part of the environmental survey clearly showed ripples covering the majority of the seabed within the survey corridor area.

There were numerous objects interpreted as boulders within the proposed pipeline route corridor. Most of the objects, interpreted as boulders occur towards the north of the survey corridor in an area coinciding with areas of clay exposure.

3.3 SHALLOW SOILS

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the shallow soils across the survey area, focussing on the upper layers of relevance to interpretation of the seabed sediment distribution and bathymetric features.

Interpretation of shallow soils across the survey area was based upon pinger and sparker data. Additional information was gained from vibrocore logs and borehole N5-1, 90m south of the proposed Platform Location acquired by Fugro in November 2016. Vibrocore VC_P_0 is at the proposed Platform Location.

3.3.1 N5A Site

The uppermost mappable unit was confirmed as SAND in the vibrocore logs. Where mapped in the western parts of the survey area this unit was under 1.5m thick. This surficial SAND unit was only mappable when thicker than 0.5m and was likely to be present outside the mapped area but at thicknesses below 0.5m.

Three sub units within the Quaternary sequence were interpreted within the area based on the acoustic nature of the sparker data. The uppermost unit, (besides surficial sand mapped from the Pinger data), interpreted within the survey area is a chaotic unit, interpreted to comprise dense to very dense medium to coarse SAND with traces of shell fragments (as sampled within the borehole). Within the survey area, the reflector which correlates with the base of this unit undulates between 1.2m and 18.0m below seabed.

3.3.2 N5A to NGT Hot Tap Pipeline Route

This unit of fine to medium grained SAND generally thicken to the south. It was absent (or less than 0.5m thick) from KP 0.430 to KP 0.450 and KP 0.757 to KP 1.045. South of KP 5.951 the base of the mapped unit becomes indistinct to the point of being unmappable, at this point the unit was approximately 9m thick.

The mapped unit was sub-cropped by a sequence of variable composition. Vibrocore logs show that this sub-crop predominantly comprises silty fine SAND except for the area north of KP 1.246 where the sub crop was more clay prone and was interpreted to be the infill of a broad channel.

3.3.3 N5A to Riffgat Cable Route

This unit of fine to medium grained SAND generally thickened to the east. West of the route AC at KP 5.156 the unit was approximately 0.5 to 1m thick or absent/unmappably thin, east of this point the unit locally exceeds a thickness of 2m.

Vibrocore logs showed that the mapped unit was sub-cropped by clay prone deposits from KP0 to KP 3.357, interpreted to be the infill of a broad channel. From KP 3.357 to the end of the route the mapped unit was sub cropped by fine SAND.

3.3.4 N5A Site

The seabed within the N5A site survey area sloped gently to the west. The minimum water depth was 23.7m LAT in the NNE of the survey area, while the maximum depth was 26.6m LAT in the WSW. Small areas with relief of up to 0.4m were observed on the bathymetry data with measured gradients of up to 6° on their flanks, which were interpreted to be largely due to outcropping clays.

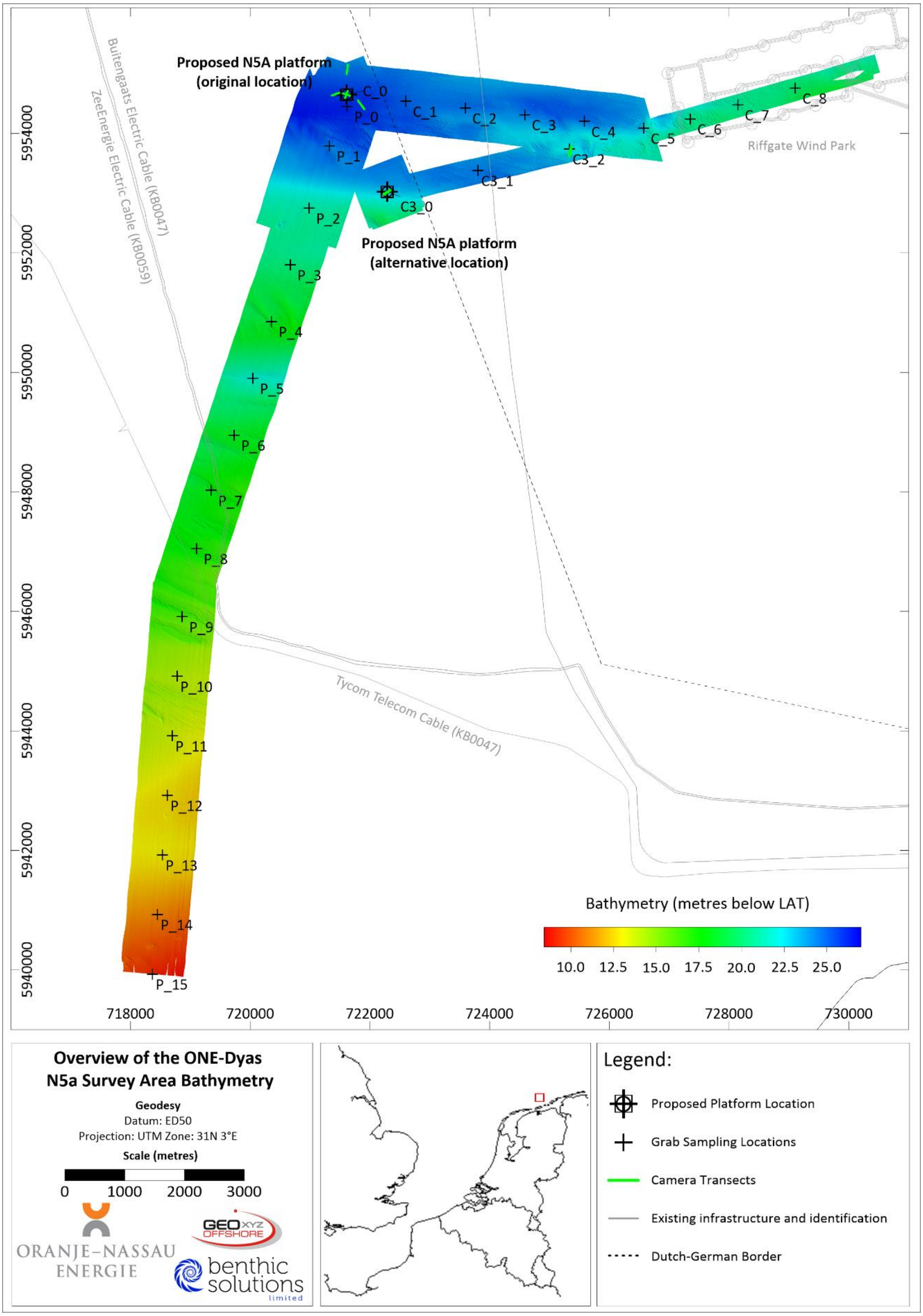


Figure 3: N5A Site and Route Survey Bathymetry

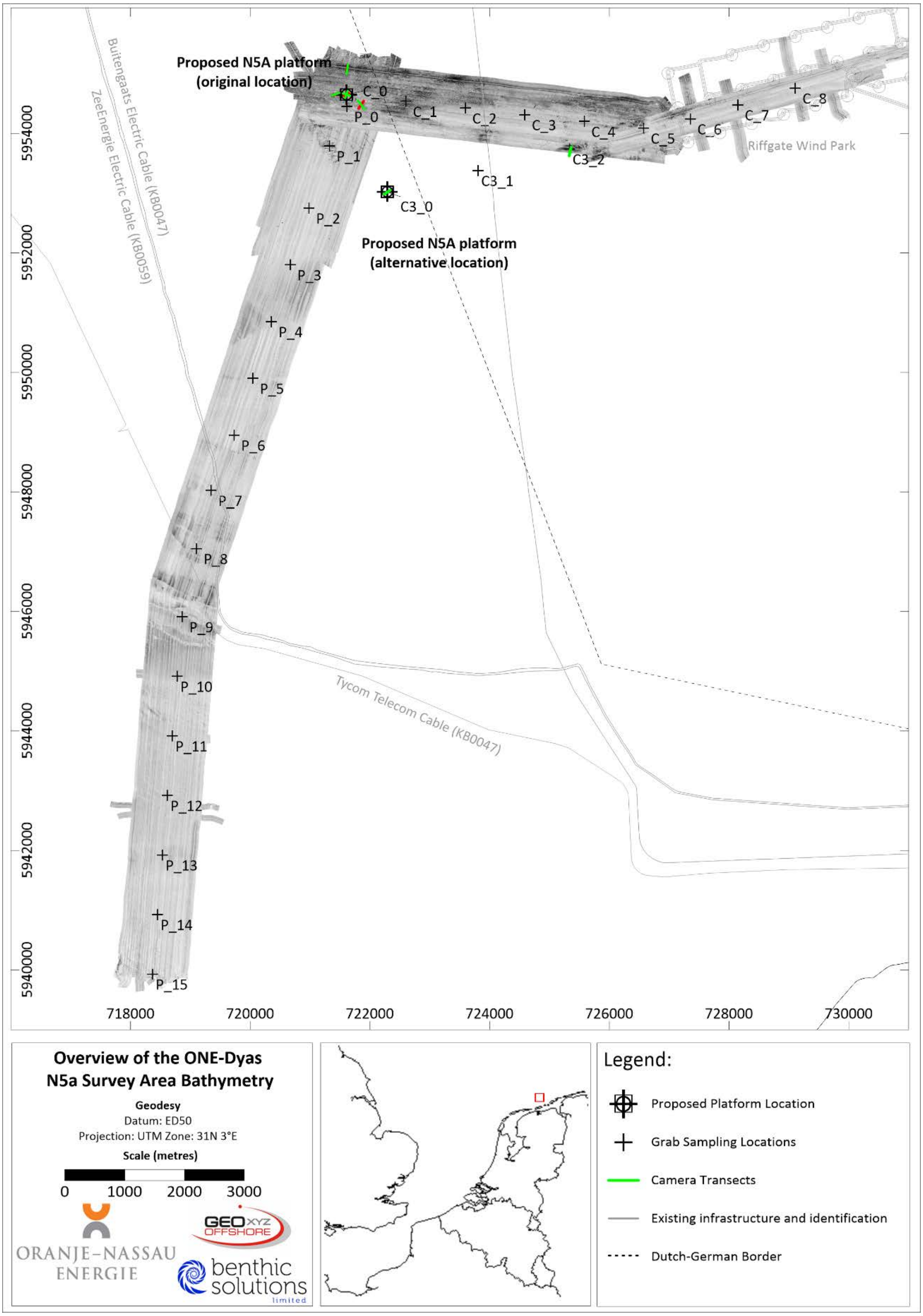


Figure 4: Interpreted N5A Site and Route Seabed Features

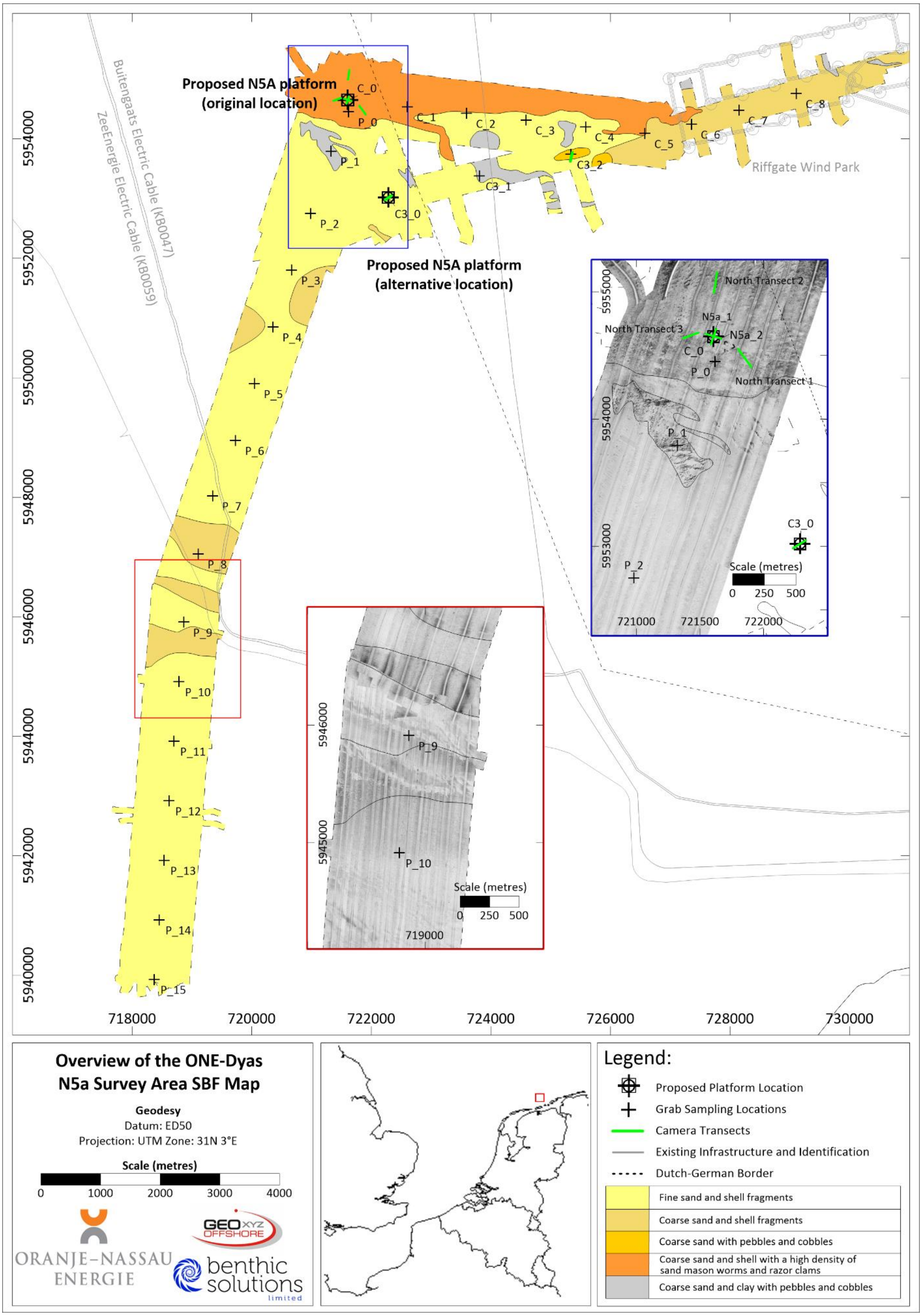


Figure 5: Interpreted N5A site and route seabed features

3.4 PARTICLE SIZE DISTRIBUTION

The particle size interpretation of sediments across the N5A survey area were based upon observations made from the acoustic data, seabed photography and the analytical results acquired from the surface sediment at all twenty-eight grab stations. Material for PSA analysis was recovered from the surface 2cm and was analysed by BSL upon return of the samples to Norfolk, UK (Please refer to Appendix F for the laboratory methods employed). Environmental stations were pre-selected to ground-truth variations in sediment and bathymetry throughout the survey area. The seabed was predominantly composed of sands with varying levels of fines and gravel.

The proportions of fines, sands and gravel sediment fractions for each sampling station are listed in Table 11. The dominant sediment type throughout the survey area was sand (63µm to 2mm), with stations falling into a range of Folk sediment classifications (Appendix G). GRAB_P_4 and GRAB_P_12 had the highest proportion of sands (99.58%) across the survey area while GRAB_C3_2 had the smallest (40.57%). A brief description of particle size characteristics for each section of the survey area (N5A to NGT Hot Tap; N5A to Riffgat; secondary cable route and alternative platform location) are given below.

The Folk and Wentworth classifications for each station are listed in Appendix G. The Folk classification differs from the Wentworth classification, as it considers a combination of the components gravel, sands, and fines, compared to the Wentworth system which assigns a single sediment classification based upon the average size class for the distribution. Where sediments are dominated by only one or two sediment groups, samples can be well represented by the Wentworth classification. Whilst the Wentworth classification can often be too generic in mixed sediment regimes, the Folk triangle can be more descriptive of the particle size distribution.

The grab stations along the platform pipeline to NGT Hot Tap route (GRAB_P_0 to GRAB_P_15) were dominated by sandy material. The mean sediment fractions for the stations along the pipeline route were as follows; 4.95% Fines (±11.30SD), 93.07% Sands (±11.55SD) and 1.98% Gravel (±2.21SD). Eight of the fifteen pipeline stations comprised 0% fines, while GRAB_P_0, GRAB_P_1 and GRAB_P_10 had the highest percentage fines of the entire survey (12.57%, 43.98% and 13.76% respectively) The sampling stations were classified by five Folk classifications; 'sand', 'muddy sand', 'gravelly sand', 'slightly gravelly sand' and 'slightly gravelly muddy sand'. All but one station along the pipeline route had sediments comprising over 85% sand and varying levels of fines (0% to 13.76%) and gravel (0.07% to 7.48%). GRAB_P_1 was the only station to show a lower proportion of sands at 52.92%. This station was positioned within an area of outcropping clay and consequently showed a substantially higher proportion of fines. The sorting coefficient ranged from moderately well sorted to poorly sorted (0.54 to 3.07), highlighting the variation in sediment composition found along the pipeline route.

Samples along the N5A to Riffgat Wind Park cable route (GRAB_C_0 to GRAB_C_8) were also dominated by sands, with all stations comprising over 80% sand. Mean sediment fractions for stations along the cable route were similar to the pipeline stations, with 2.72% fines (±1.94SD), 94.96% sand (±4.23SD) and 2.32% gravel (±3.54SD). Grab sample sediments were assigned to three Wentworth classifications ('coarse sand', 'medium sand', 'fine sand') and three Folk designations of 'sand', 'slightly gravelly sand' and 'gravelly sand'. Over 60% of these stations were identified as slightly gravelly sand, making it the dominant sediment type along the cable route. Stations within this area ranged from moderately well to poorly sorted.

Stations located within the alternative cable route corridor and platform site (GRAB_C3_0 to GRAB_C3_2) showed a similar sediment type to both the pipeline and cable routes, with both GRAB_C3_0 and GRAB_C3_1 constituting over 90% sands. These were moderately sorted and represented the Wentworth classification of 'fine sand' and the folk classification of 'sand'.

Station GRAB_C3_2 was the only station dominated by gravel (54.91%) as opposed to sand (40.57%). This station was classified as 'granule' on the Wentworth scale, 'muddy sandy gravel' on the Folk scale and was very poorly sorted. Note: four grab attempts were made at this station due to cobbles trapped in the jaws of the sampler, and video footage of this station showed an area of coarse sand and cobbles, which was explored further in the habitat assessment for its potential as an EC Habitats Directive Annex I stony reef.

Table 11: Summary of surface particle size distribution

Station	Depth (m)	Mean Sediment Size		Sorting	Skewness	Kurtosis	Fines (%)	Sands (%)	Gravel (%)
		mm	Phi(Φ)						
GRAB_P_0	29	0.301	1.73	1.80	0.49	1.29	12.47	87.13	0.40
GRAB_P_1	27	0.050	4.33	3.07	0.46	0.82	43.98	52.92	3.11
GRAB_P_2	24	0.227	2.14	0.59	0.05	1.10	3.88	95.37	0.75
GRAB_P_3	24	0.226	2.14	0.52	0.03	1.02	3.64	96.23	0.13
GRAB_P_4	22	0.278	1.85	0.54	0.02	0.99	0.00	99.58	0.42
GRAB_P_5	20	0.316	1.66	0.75	0.05	0.94	0.78	98.21	1.01
GRAB_P_6	21	0.258	1.95	0.56	-0.01	0.97	0.00	99.53	0.47
GRAB_P_7	21	0.224	2.16	0.56	-0.04	0.94	0.00	99.38	0.62
GRAB_P_8	21	0.439	1.19	0.83	0.03	1.19	0.11	96.14	3.74
GRAB_P_9	19	0.223	2.17	1.05	-0.32	1.93	0.00	94.33	5.67
GRAB_P_10	17	0.199	2.33	1.32	0.41	2.45	13.76	85.02	1.22
GRAB_P_11	17	0.285	1.81	1.14	-0.34	2.17	0.00	92.52	7.48
GRAB_P_12	16	0.223	2.16	0.56	-0.04	0.94	0.00	99.58	0.42
GRAB_P_13	16	0.200	2.32	0.54	0.02	0.99	0.52	99.42	0.07
GRAB_P_14	14	0.210	2.25	0.64	-0.07	1.02	0.00	97.52	2.49
GRAB_P_15	13	0.208	2.27	0.62	-0.10	1.11	0.00	96.29	3.71
GRAB_C_0	24	0.604	0.73	0.67	0.00	1.14	0.11	98.55	1.35
GRAB_C_1	27	0.589	0.76	1.59	-0.05	1.97	3.70	84.80	11.50
GRAB_C_2	28	0.446	1.16	0.89	0.29	1.16	2.65	96.87	0.48
GRAB_C_3	28	0.259	1.95	0.91	0.30	2.00	5.97	94.00	0.03
GRAB_C_4	25	0.223	2.16	0.70	0.06	1.05	4.36	95.10	0.54
GRAB_C_5	24	0.458	1.13	1.20	0.09	1.13	3.07	94.11	2.82
GRAB_C_6	24	0.405	1.30	0.75	0.05	0.98	1.56	97.26	1.18
GRAB_C_7	24	0.449	1.16	1.17	0.15	1.05	3.08	94.99	1.94
GRAB_C_8	28	0.361	1.47	0.64	-0.06	0.99	0.00	98.97	1.03
GRAB_C3_0	25	0.214	2.23	0.77	0.31	1.91	5.44	94.09	0.47
GRAB_C3_1	25	0.208	2.27	0.90	0.34	2.27	7.41	91.98	0.62
GRAB_C3_2	25	2.154	-1.11	2.41	0.27	0.64	4.52	40.57	54.91
Mean		0.37	1.77	0.99	0.09	1.29	4.32	91.80	3.88
SD		0.37	0.89	0.60	0.21	0.50	8.58	13.46	10.33
CV (%)		101.9	50.0	60.5	242.3	38.6	198.5%	14.7%	266.3%

A comparison of the full particle size distribution dataset by Phi classification is presented in Figure 12. The majority of samples peaked in the sand fraction (Φ-1 to Φ4), with grabs along the cable route peaking more generally in the finer fraction (Φ0.73 – Φ2.16). GRAB_C3_2 was the only station in the survey area to show a differing peak at Φ-1.11 in the granule pebbles fraction, but also showed a smaller peak similar to other stations for the medium sands fraction (Φ1.5). Some stations showed higher fines (GRAB_P_0, GRAB_P_1, GRAB_P_10), while the distribution of sediment at stations along the cable route survey area (GRAB_C stations) were generally more sandy.

The mean particle sizes for sampling stations are displayed in Figure 6 and Table 11, which ranged from 0.050mm at GRAB_P_1 to 2.154mm at GRAB_C3_2 (mean 0.37mm±0.37SD). Overall, sands proportions across the survey area were described as the major component of the sediment, which is illustrated by a negative correlation between sands and fines ($\varrho(5)=-0.723$, $p<0.001$). At 81% of the stations sampled in the N5A survey area, the sands fraction contributed >90% of the sediment type. This is likely attributed to the proximity to shore creating a strong hydrodynamic regime where the settlement of fines materials is restricted.

The proportion of gravels fraction (>63µm, <200µm) was generally very low across the N5A survey area (Figure 9) and only contributed as a major component to GRAB_C3_2 (54.91% Gravel). These results ranged from 0.00% (GRAB_P_4, P_6, P_7, P_9, P_11, P_12, P_14, P_15 and GRAB_C_8) to 54.91% (GRAB_C3_2) with a mean of 3.88% (±10.33SD).

The geographical distribution of sediment fines (i.e. silts and clays <63µm) is presented in Figure 7. Percentages of fine sediments were moderately low throughout the survey area with a mean of 4.32% (±8.58SD). There was no discernible pattern of fines across the N5A area, and as a result the proportion of fines varied from station to station. However, relatively high fines were found near the proposed platform location (GRAB_P_1, GRAB_P_0), and at GRAB_P_10 along the pipeline route. Furthermore, instances of high fines corresponded with the presence of clay materials at GRAB_P_1 and GRAB_C3_1.

It should be noted that where mixed sediment occurs (including shell debris), the sub-sampling process itself can introduce additional variation, where only a relatively small sub-sample is recovered for analysis. For example, the seabed photography at GRAB_C3_1 showed significant clay and fines materials, yet within the PSA sample this only represented 7.41% of the material recovered. As such, the results of particle size analysis should be treated with caution as grab data may not necessarily provide an accurate representation of the sediment type.

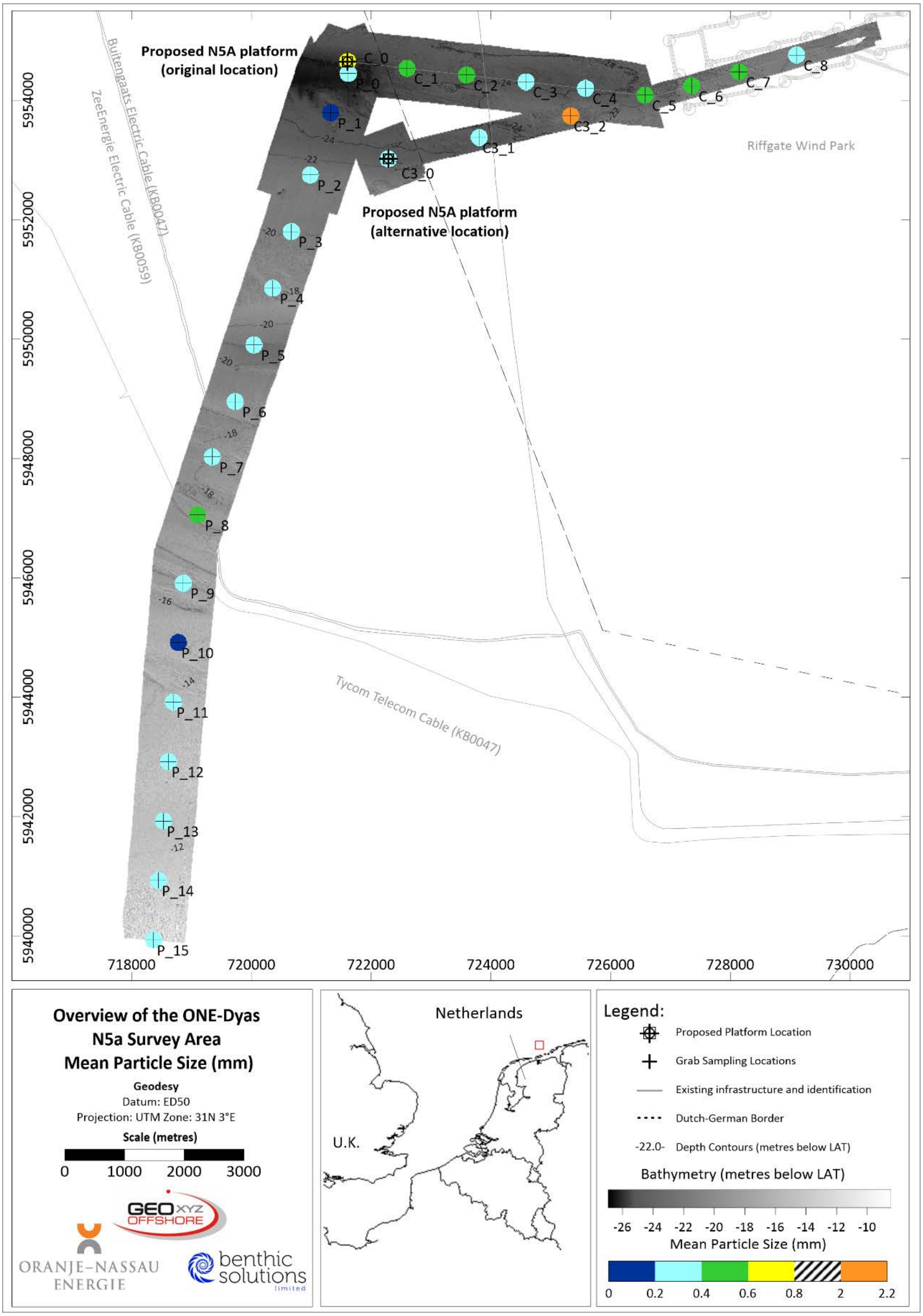


Figure 6: Mean particle size (mm)

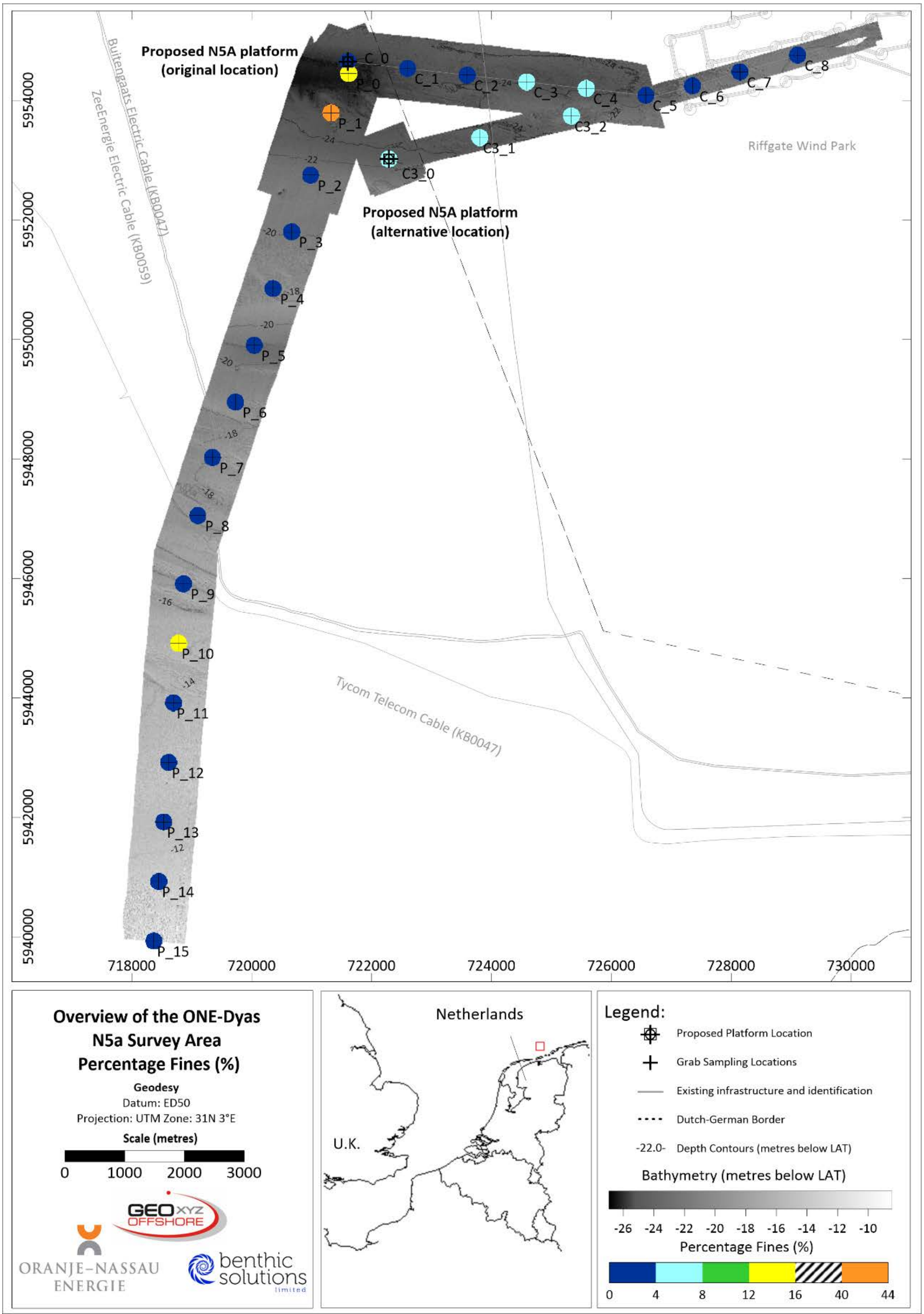


Figure 7: Proportion of fines (%)

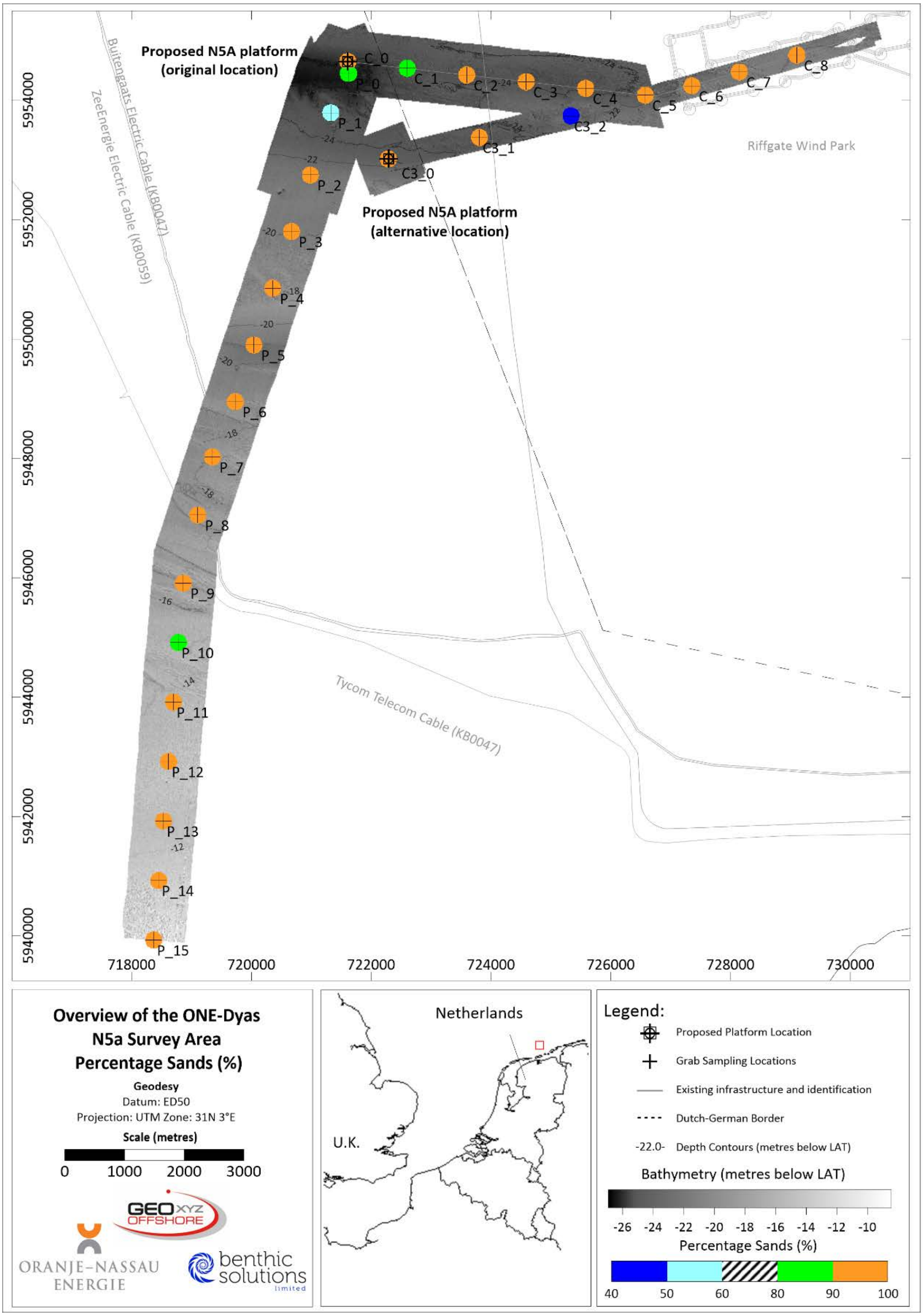


Figure 8: Proportion of sands (%)

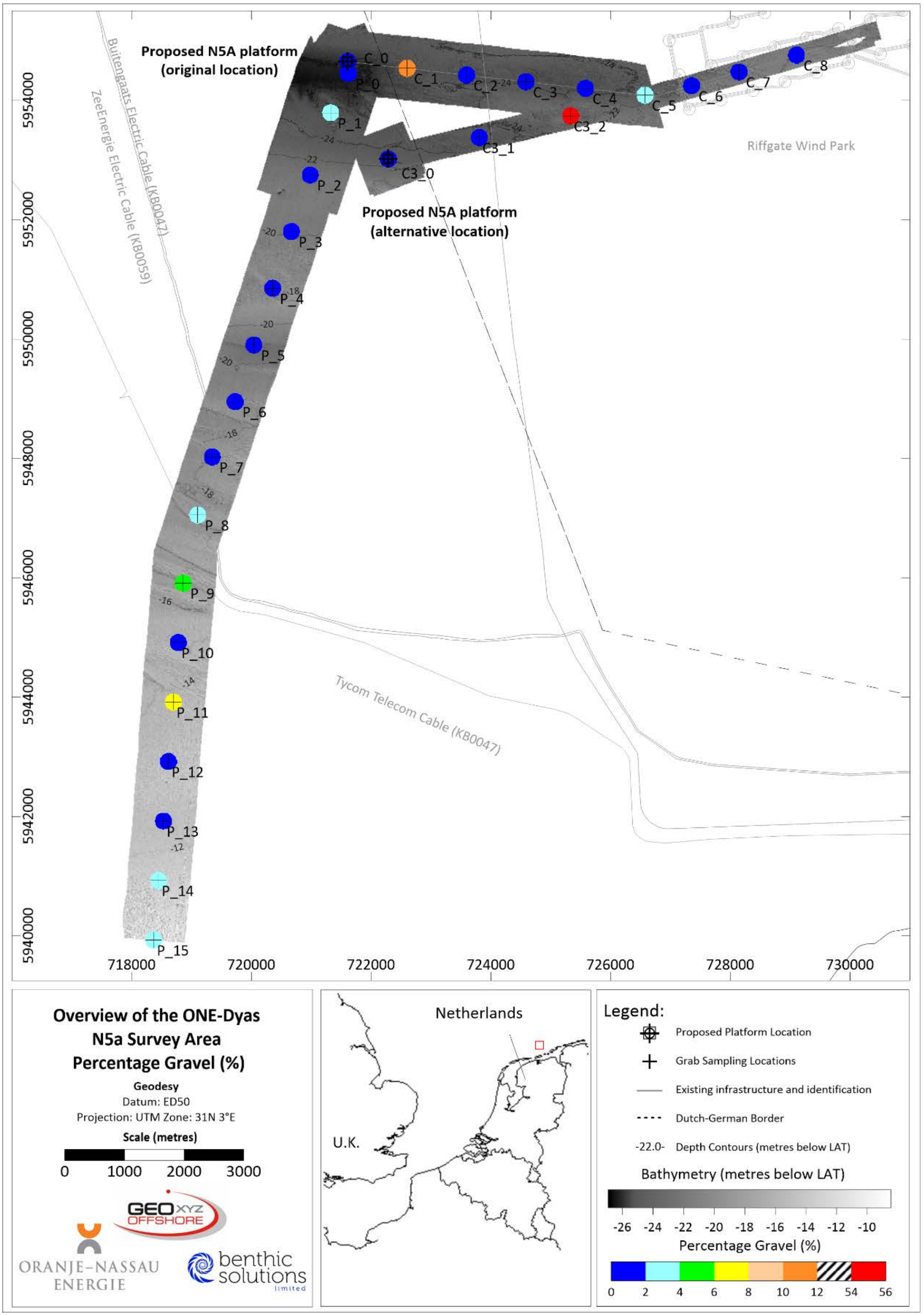


Figure 9: Proportion of gravels (%)

3.4.1 Multivariate Analysis

To provide a detailed examination of the particle size distribution within the survey area, a multivariate analysis was performed using Plymouth Routines in Multivariate Ecological Research software (PRIMER; Clarke and Warwick, 1994) to illustrate data trends.

A similarity dendrogram was generated by hierarchical agglomerative clustering (CLUSTER) with the aim to segregate stations by their similarities/dissimilarities with the results presented in Figure 10 below. A 'slice' was added at a Euclidean distance of 6.0 to reduce the number of clusters presented, for ease of interpretation.

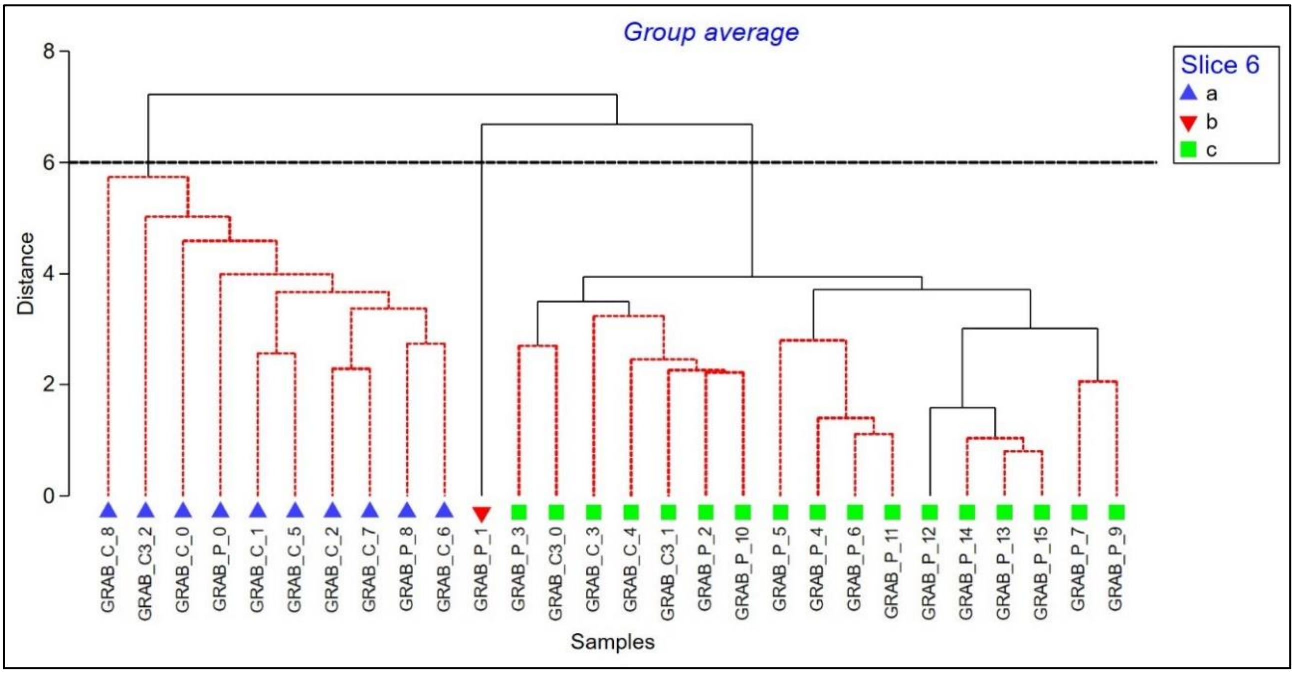


Figure 10: Particle size distribution similarity dendrogram

The results of CLUSTER analysis presented in Figure 10 indicated that the stations could be separated into three statistically distinct clusters, as follows:

- **Cluster a:** Samples in cluster *a* were dominated by coarse sand, had a mean phi value of 0.95 (±0.59SD) and were found mostly towards the northeast of the survey area. This group included a large portion of the N5A platform location to Riffgat Wind Park cable route stations (78% of GRAB_C stations) and including the particularly coarse station on the alternative cable route (GRAB_C3_2). A review of the sediment types from seabed photography and video confirmed the prevalence of coarse sand over the areas where these grabs occurred, with all stations grouped into cluster *a* having been previously categorised as either 'infralittoral coarse sediment', 'infralittoral mixed sediment' or 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' habitats (Figure 14).
- **Cluster b:** Only GRAB_P_1 was grouped into cluster *b*. This station was characterised by a dominant fines fraction (52.92%), which was significantly higher than all other stations in the N5A survey area. The habitat assessment previously identified this area as being composed of 'infralittoral mixed sediment' with clay. GRAB_P_1 had some sediment within the coarser phi fraction (small percentage

retained between Φ-3 and Φ0.5), and on one grab attempt a 'no sample' occurred due to cobbles trapped within the grab jaws. However, this station was differentiated from all other stations due to an overall mean phi of Φ4.33.

- **Cluster c:** The third cluster included almost all the N5A pipeline to hot tap stations with 80% of 'GRAB_P' stations grouped into this cluster. With an average phi value of Φ2.23 (±0.59SD), these samples consisted of finer sands than cluster *a*, and thus in the habitat assessment were mostly categorized as 'infralittoral fine sand', and one instance of 'infralittoral mixed sediment with clay' (GRAB_C3_1). This cluster was more dominant towards the southern end of the N5A survey area (found closer to coast and in shallowing waters) although some deviations in this were seen with the inclusion of two stations from the Riffgat Park Cable Route (GRAB_C_3 and GRAB_C_4) and two from the alternative cable route (GRAB_C3_0 and GRAB_C3_1).

A principal component analysis (PCA) was also carried out on each sediment fraction within the survey area Figure 11) in an attempt to elucidate the variation in particle size distribution between clusters a to c. The PCA plot shows that cluster a was principally dominated by medium to coarse sands (Φ -3 to 2). In contrast, cluster c was dominated by fine to medium sands (Φ 2-3). Cluster b was distinct from both a and c with station GRAB_P_1 characterised by much finer sediment (Φ 4 to 10).

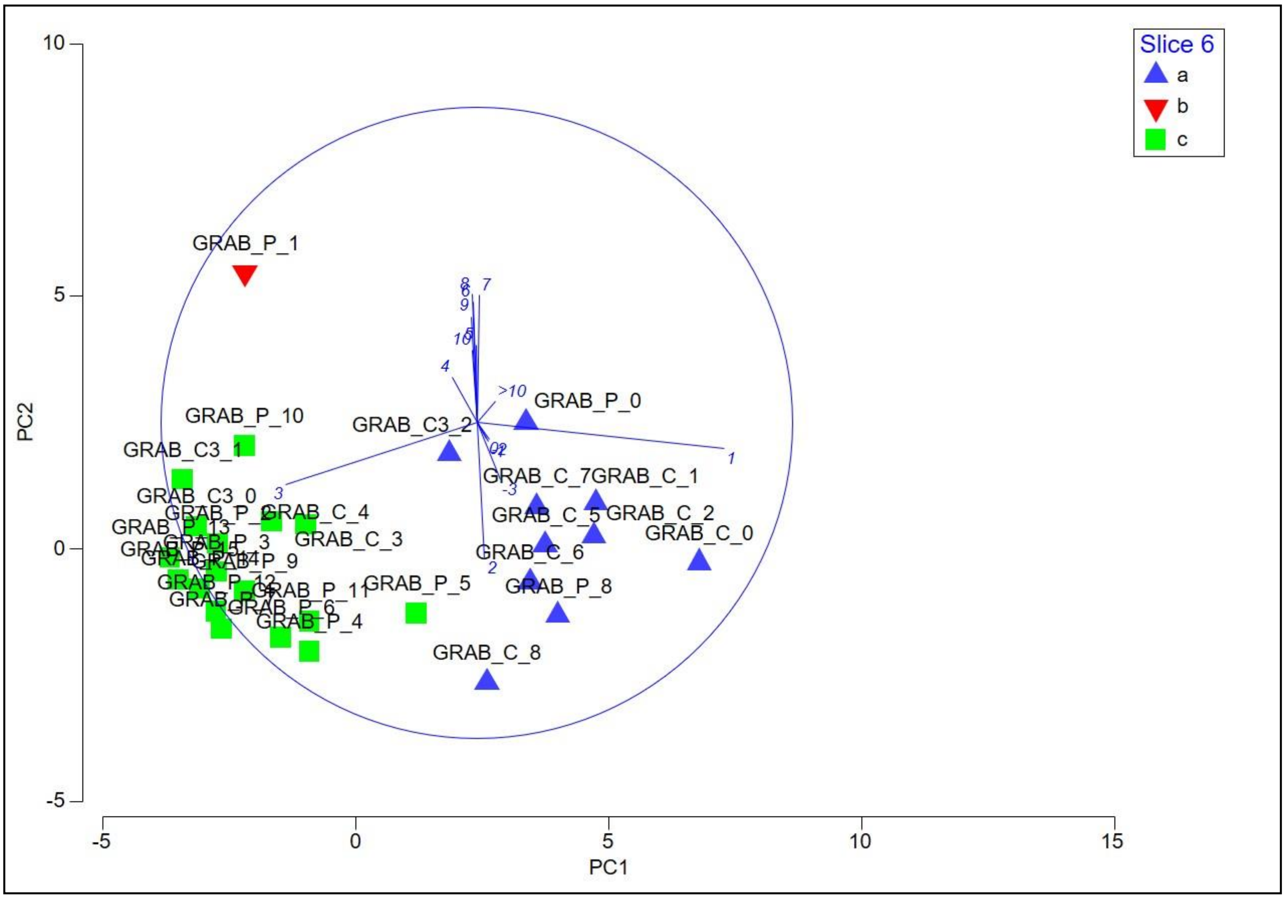


Figure 11: Principal components analysis of particle size data

A comparison of the full particle size distribution dataset for each of the clusters, is shown in Figure 12 along with example seabed and grab sample photographs for typical samples from each cluster. Cluster *a* displayed a relatively unimodal distribution for all stations within the cluster, peaking in the coarse sand fraction with the exception of GRAB_C3_2. This station shows a bimodal distribution peaking in the very coarse sands fraction. Cluster *b* displayed a slightly trimodal distribution with small peaks for the fines, sands and gravel fractions. Lastly, cluster *c* presented a unimodal distribution with sands slightly finer than cluster *a.* The geographical distribution of clusters is displayed over bathymetry data in Figure 13 and over the interpreted seabed features in Figure 14.

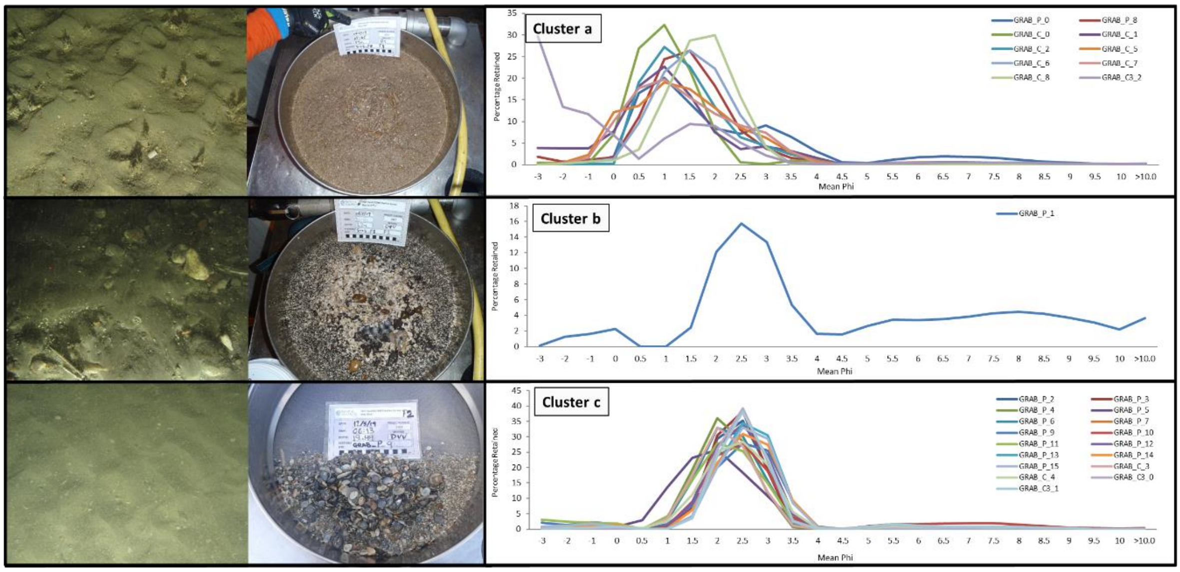


Figure 12: Particle size distribution for all stations in clusters a, b & c

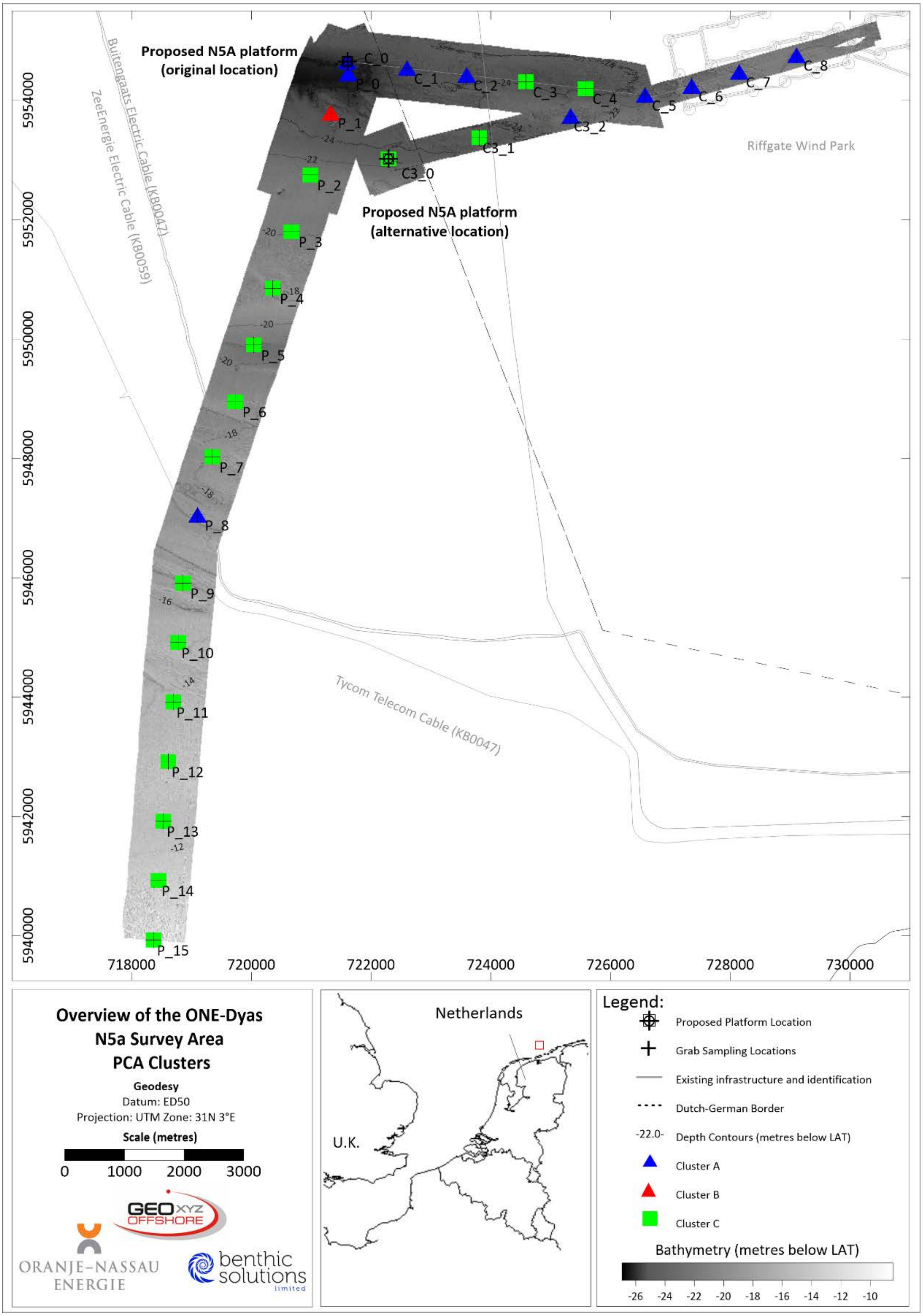


Figure 13: Multivariate cluster distribution over bathymetry

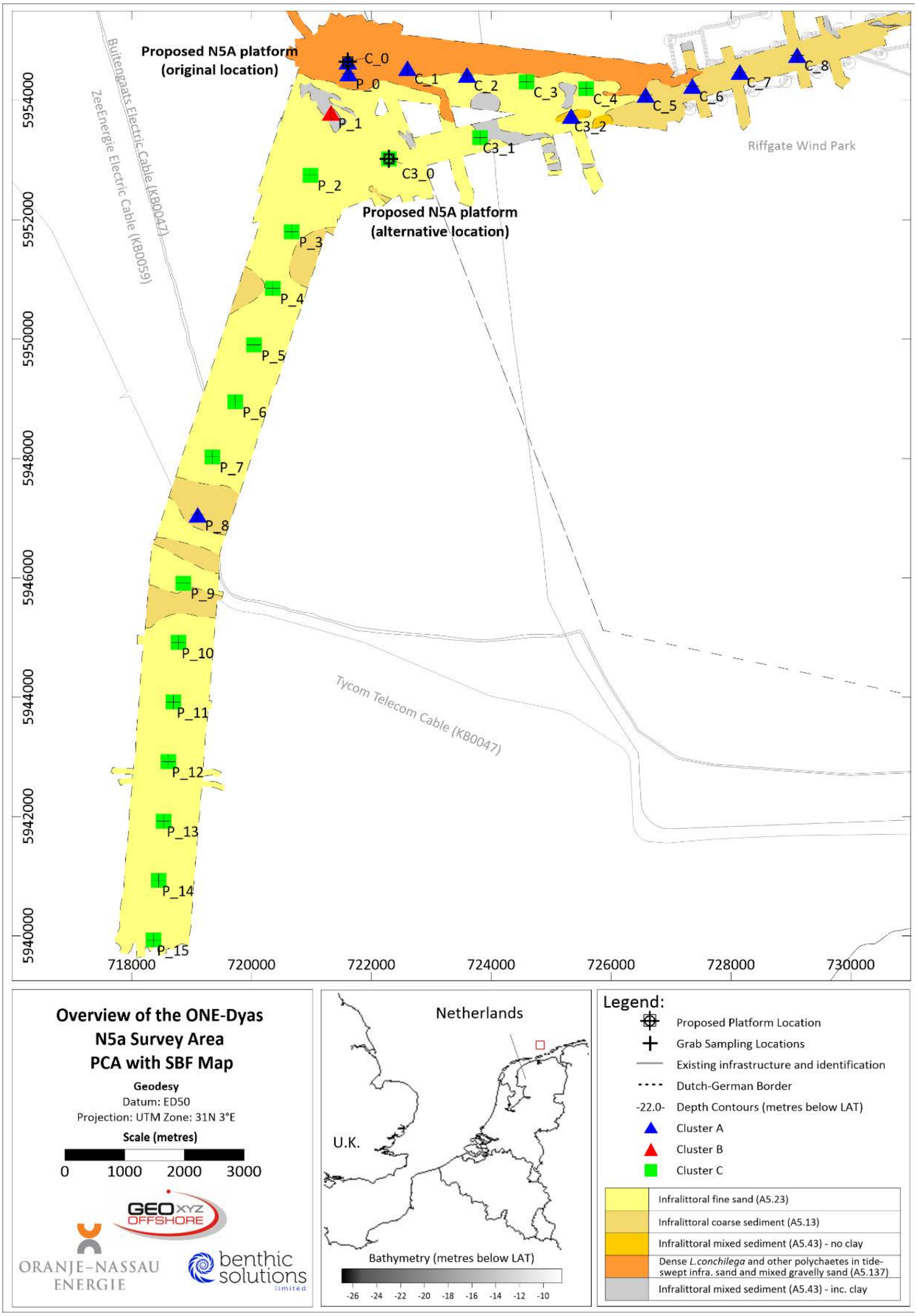


Figure 14: Multivariate cluster distribution over interpreted seabed features

3.5 TOTAL ORGANIC MATTER, TOTAL ORGANIC CARBON, AND MOISTURE CONTENT

Sediment samples were analysed for total organic matter (TOM), total organic carbon (TOC) and moisture content; the results of which are presented in Table 12, with spatial variation in TOC levels illustrated in Figure 15. TOC represents the proportion of biological material and organic detritus within the substrate. This method is less susceptible to the interference sometimes seen using crude combustion techniques, such as analysing TOM by LOI.

TOM results were low throughout the survey area with all but two stations showing less than 1% TOM. Although UKOOA (United Kingdom Offshore Operations Association) threshold levels are based on contamination and natural background levels within the UK Sector of the North Sea, they provide a useful reference for areas of similar sediment types and are used in this report to establish any areas of interest. All stations excluding GRAB_P_1 had values below the mean UKOOA (2001) background levels for the Southern North Sea of 2.3%. TOM was highest at GRAB_P_1 (5.1%), followed by 1.2% at GRAB_C3_1. These were stations where fines were higher and consequently retention of TOM is more likely to occur.

While measuring TOM is useful, it can be biased and TOC is often used as a more accurate measure of carbon. TOC represents the proportion of biological material and organic detritus within the substrate. This method is less susceptible to the interference sometimes seen using more crude combustion techniques, such as analysing TOM by loss on ignition (LOI). TOC results were consistently low throughout the N5A survey area (mean 0.40% w/w±0.08SD), ranging from 0.04% (GRAB_P_4, P_5,P_6 and P_9) to 1.03% (GRAB_P_1). These low results highlight an organically deprived environment of the N5A area with an absence of anthropogenic influences. TOC presence in surface sediments are an important source of food for benthic fauna (Snelgrove and Butman, 1994), although an overabundance may lead to reductions in species richness and number of individuals due to oxygen depletion. Increases in TOC may also reflect increases in both, physical factors (i.e. fines) and common co-varying environmental factors through elevated adsorption on increased sediment surface areas (Thompson and Lowe, 2004). This was apparent at GRAB_P_1 and is backed up by a positive statistical correlation between TOC and fines ($\rho(28)=0.583$, $p = 0.01$), and a negative correlation between sands and TOC ($\rho(28)=-0.581$, $p = 0.01$).

Terrestrially derived carbon from runoff and fluvial systems, combined with primary production from sources such as phytoplankton blooms, contribute to the TOC levels recorded in sediments. While both allochthonous and autochthonous sources will be present throughout the N5A survey area, a general lack of fine material at most stations and, therefore, reduced surface area for adsorption means that overall, TOC levels within the sediment are low. This may in turn affect the richness and abundance of deposit-feeding organisms within the sediment.

Moisture content was similar throughout the N5A survey area (mean 20.07%±2.9), results ranging from 15.4% at GRAB_C_7 to 26.2% at GRAB_P_1. The only statistical trends with moisture content (other than with TOC and TOM) were a negative correlation between moisture and mean size ($\rho(28)=-0.510$, $p = 0.01$), and a positive correlation with THC ($\rho(28)=0.445$, $p = 0.05$).

Table 12: Summary of total organic carbon and moisture content

Station	Total Organic Matter (% w/w)	Total Organic Carbon (% w/w)	Moisture Content (%)
GRAB_P_0	0.7	0.11	22.8
GRAB_P_1	5.1	1.03	26.2
GRAB_P_2	0.9	0.12	18.2
GRAB_P_3	0.6	0.06	20.0
GRAB_P_4	0.4	0.04	17.8
GRAB_P_5	0.6	0.04	20.2
GRAB_P_6	0.4	0.04	23.8
GRAB_P_7	0.5	0.05	16.4
GRAB_P_8	0.5	0.04	17.6
GRAB_P_9	0.7	0.09	24.5
GRAB_P_10	0.7	0.07	21.6
GRAB_P_11	0.5	0.06	22.1
GRAB_P_12	0.6	0.05	24.0
GRAB_P_13	0.6	0.07	20.5
GRAB_P_14	0.8	0.08	20.6
GRAB_P_15	0.6	0.05	18.7
GRAB_C_0	0.5	0.06	20.4
GRAB_C_1	0.6	0.05	19.6
GRAB_C_2	0.5	0.05	23.4
GRAB_C_3	0.6	0.06	20.0
GRAB_C_4	0.7	0.09	24.2
GRAB_C_5	0.4	0.05	17.2
GRAB_C_6	0.5	0.06	18.4
GRAB_C_7	0.5	0.06	15.4
GRAB_C_8	0.4	0.05	20.8
GRAB_C3_0	0.9	0.12	25.9
GRAB_C3_1	1.2	0.19	23.2
GRAB_C3_2	0.9	0.11	17.4
Mean	0.8	0.11	20.7
SD	0.9	0.18	2.9
CV (%)	110.8	174.9	14.1

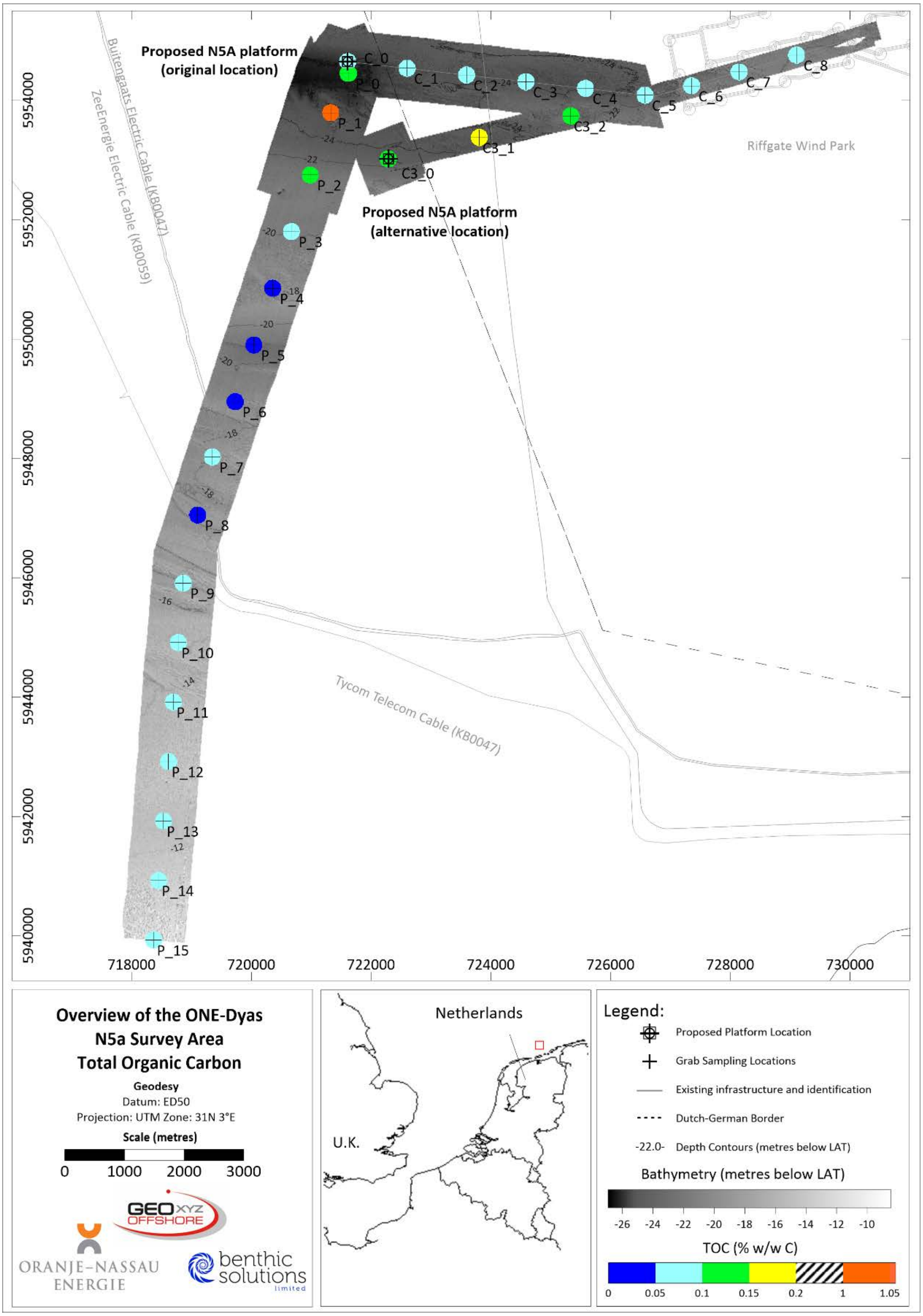


Figure 15:Total organic carbon (TOC; % w/w C)

3.6 SEDIMENT HYDROCARBONS

Results from hydrocarbon analyses are summarised and tabulated as THC, total PAH, total n-alkanes and homologue ratios in Table 13 with individual alkanes (nC_{10}-nC_{37}) listed in Appendix H. Example gas chromatography (GC) traces can be seen in Section 3.6.2 (with the remainder in Appendix I), showing the aliphatic HC traces for the N5A grab locations labelled with every fourth n-alkane, the isoprenoid HC pristane (Pr) and phytane (Ph), and the internal standards hepta-methylnonane (A), deuterated hexadecane (B) and 1-chlorooctadecane (C).

3.6.1 Total Hydrocarbon Content

The total hydrocarbon content within the sediments, measured by integration of all non-polarised components within the GC trace, showed variable concentrations, ranging from 13.65 $mg.kg^{-1}$ at GRAB_P_1 to 0.87$mg.kg^{-1}$ at GRAB_C_6 (Table 13; Figure 16; mean 3.15$mg.kg^{-1}$± 2.69SD). Finer sediments are generally expected to show higher retention of water and contaminants, particularly due to the lower levels of hydrodynamic reworking of the substrate. Where fines are dominant, contaminants such as THC are more likely to be retained in the substrate (i.e. a sink) than in areas where coarser sediments are dominant due to the increased potential for sorption onto the grains (Thompson and Lowe, 2004). Thus, there was a correlation between fines and THC ($\rho(28)=0.557$, p=<0.01) with GRAB_P_1 having the highest fines and hence the highest THC. GRAB_C3_1 had the second highest concentration of THC; this station was also characterised as an area with fines (and situated in an outcrop of clay) materials which could have resulted in the higher than normal concentrations.

The United Kingdom Offshore Operators Association (UKOOA) conducted an analysis from UK Oil & Gas Environmental Surveys From 1975-95, separating the results into regions of the North Sea (southern, central and northern). The results included the mean and 95th percentile of a range of potential contaminants found near and far from installations, providing a reference for marine environmental studies. Although the N5A survey area is not located in the UK sector, the percentiles for the Southern North Sea have been applied on the assumption that they present a similar sediment type to the N5A survey area.

The mean background THC levels for surface sediments recorded for stations located over 5km from oil and gas platforms from the SNS were estimated by UKOOA (2001) to be 4.34$mg.kg^{-1}$, with an upper 95th percentile concentration of 11.39$mg.kg^{-1}$. The mean THC level for eight of the sampling locations fell above the mean percentile value (highlighted in Table 13), while only GRAB_P_1 exceeded the 95th Percentile. All other stations fell below this threshold indicated little to no external hydrocarbon enrichment. Geographically, in general stations surrounding the proposed platform location were characterized by slightly higher THC values, perhaps an indication of the oil deposits known to be below this vicinity.

The mean proportion of unresolved complex mixtures (UCM) of hydrocarbons was 98.78% (±1.22SD) with no discernible spatial pattern of distribution evident across the survey area. UCM is composed of a complex mixture of hydrocarbons which remain after substantial weathering and biodegradation (McDougall, 2000).

Table 13: Summary of hydrocarbon concentrations

Station	Water Depth (m)	THC (mg.kg^{-1})	Total n-alkanes (µg.kg^{-1})	Carbon Preference Index (CPI)	Pristane/ Phytane Ratio	Proportion of Alkanes (%)	P/B Ratio	Total PAHs (µg.kg^{-1})	NPD (µg.kg^{-1})	NPD (%)	UCM (mg.kg^{-1})	UCM (%)
GRAB_P_0	29	4.69	46.8	2.00	-	1.00	0.42	6.82	6.82	100.00	4.65	99.00
GRAB_P_1	27	13.65	931	3.37	5.01	6.82	0.07	66.8	13.78	20.64	12.72	93.18
GRAB_P_2	24	5.17	73.5	1.44	-	1.42	0.05	1.67	1.67	100.00	5.09	98.58
GRAB_P_3	24	4.05	48.4	1.21	-	1.20	0.07	2.76	1.32	47.81	4.00	98.80
GRAB_P_4	22	1.62	1.30	-	-	0.08	-	0.00	0.00	-	1.62	99.92
GRAB_P_5	20	1.93	13.7	0.88	-	0.71	0.14	0.00	0.00	-	1.92	99.29
GRAB_P_6	21	1.96	3.49	0.76	-	0.18	0.00	0.00	0.00	-	1.96	99.82
GRAB_P_7	21	1.64	14.2	2.33	-	0.87	0.17	0.00	0.00	-	1.63	99.13
GRAB_P_8	21	0.72	4.44	-	-	0.62	-	1.35	1.35	100.00	0.71	99.38
GRAB_P_9	19	1.19	8.3	-	-	0.70	0.52	0.00	0.00	-	1.18	99.30
GRAB_P_10	17	2.54	17.5	1.77	-	0.69	0.17	3.53	3.53	100.00	2.52	99.31
GRAB_P_11	17	2.01	14.9	2.07	-	0.74	0.12	4.34	4.34	100.00	1.99	99.26
GRAB_P_12	16	2.01	12.4	2.92	-	0.62	0.13	1.92	1.92	100.00	2.00	99.38
GRAB_P_13	16	5.17	56.2	2.38	-	1.09	0.00	4.19	4.19	100.00	5.11	98.91
GRAB_P_14	14	3.34	33.3	1.69	-	1.00	0.00	1.94	1.94	100.00	3.30	99.00
GRAB_P_15	13	1.26	12.8	7.01	-	1.02	0.83	8.13	8.13	100.00	1.24	98.98
GRAB_C_0	24	1.28	22.7	0.88		1.78	0.07	0.00	0.00	-	1.25	98.22
GRAB_C_1	27	1.91	23.9	1.57	-	1.25	0.06	0.00	0.00	-	1.89	98.75
GRAB_C_2	28	5.17	22.4	2.05	-	0.43	0.00	0.00	0.00	-	5.14	99.57
GRAB_C_3	28	2.47	19.8	2.61	-	0.80	0.00	1.46	1.46	100.00	2.45	99.20
GRAB_C_4	25	2.66	27.3	1.66		1.03	0.46	0.00	0.00	-	2.64	98.97
GRAB_C_5	24	1.21	12.8	0.97		1.06	1.11	0.00	0.00	-	1.20	98.94
GRAB_C_6	24	0.87	9.78	1.86		1.12	0.00	0.00	0.00	-	0.86	98.88
GRAB_C_7	24	1.23	13.2	2.46		1.07	0.31	0.00	0.00	-	1.22	98.93
GRAB_C_8	28	0.97	7.4	3.23		0.75	0.00	0.00	0.00	-	0.97	99.25
GRAB_C3_0	25	5.85	72.1	2.18		1.23	0.07	2.09	2.09	100.00	5.78	98.77
GRAB_C3_1	25	6.09	152	1.60	0.83	2.49	0.10	19.9	0.00	-	5.94	97.51
GRAB_C3_2	25	5.63	131	1.23		2.33	0.01	6.41	0.00	-	5.50	97.67
Mean		3.15	64.5	2.08	2.92	1.22	0.19	4.76	1.88	41.7	3.09	98.78
SD		2.69	173.7	1.25	2.95	1.22	0.27	12.84	3.18	48.7	2.54	1.22
CV (%)		85.2	269.1	59.8	101.3	100.1	146.8	269.7	169.47	116.6	82.1	1.2
UKOOA 95th Percentile SNS, 2001		11.39	780	NA	-	6.85	-	366	-	-	-	-
UKOOA Mean SNS, 2001		4.34	330	1.32	-	5.94	-	66	-	-	-	-

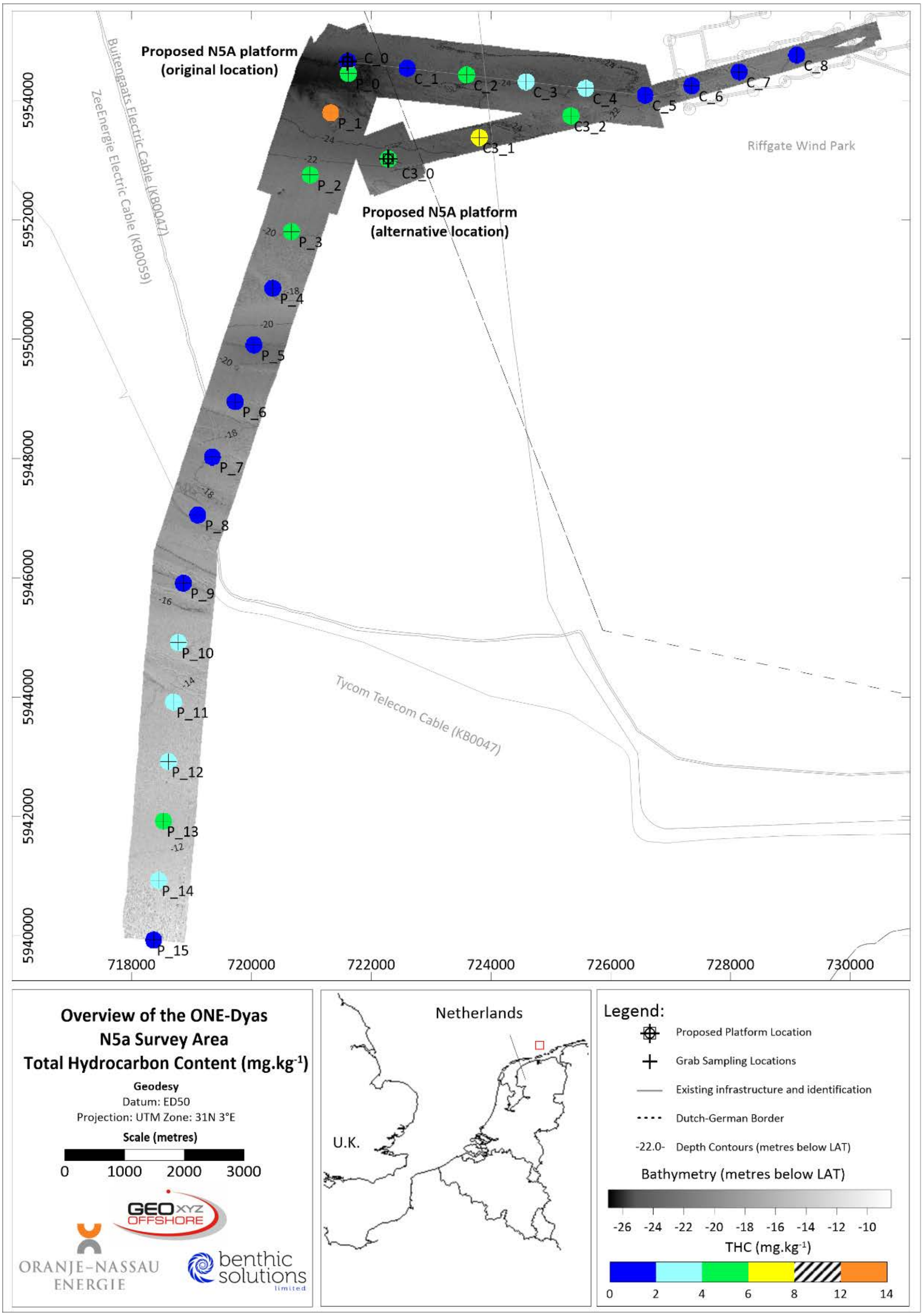


Figure 16: Total hydrocarbon concentrations (mg.kg⁻¹)

3.6.2 Saturate/Aliphatic Hydrocarbons

All samples were analysed for n-alkanes using gas chromatography flame ionisation detection (GC-FID). The results are summarised in Table 13 and individually listed in Appendix H, which gives a breakdown of consecutive n-alkane content from nC_{10} through to nC_{37}, together with the isoprenoid hydrocarbons pristane (Pr) and phytane (Ph).

Example gas chromatograms are given in Figure 18 and Figure 19. Total n alkane concentrations were variable but relatively low, with results ranging from 3.49µg.kg^{-1} to 931 µg.kg^{-1} (mean 64.53µg.kg^{-1}±174SD, Figure 17). N-alkanes are widely distributed in the environment and can be naturally sourced from a range of materials including phytoplankton and bacteria (Yu, 2016).

The mean background n-alkanes levels for surface sediments recorded for stations located over 5km from oil and gas platforms from the SNS were estimated by UKOOA (2001) to be 330µg.kg-^{1}, with an upper 95th percentile concentration of 780 µg.kg^{-1}. Most stations within the N5A survey area fell significantly below the mean background level for n-alkanes, where the second closest station to the mean was GRAB_C3_1, which had a concentration of 152µg.kg^{-1}. On the other hand, GRAB_P_1 exceeded both the mean and 95th percentile ranges with a value of 931µg.kg^{-1}.

Alkanes contributed on average 1.22% (±1.22SD) to the THC levels recovered, which is comparatively low and would be expected for uncontaminated marine sediments where background hydrocarbons are continuously replenished by a low but consistent source of alkanes. In this case, it likely reflects the sandy nature of the seabed sediments, and the local hydrodynamic regime resulting in a continual replenishment and loss of alkanes to the environment. At station GRAB_P_1, n-alkanes comprised 6.82% of THC, more than five times the mean for the survey area. This was most likely a function of the higher fines at this station and is supported by the statistically positive correlation between fines and proportion of n-alkanes ($\rho(28)=0.559$, p=<0.01).

Inspection of the individual gas chromatograms revealed a UCM envelope of between nC_{20} and nC_{37} at some stations (Figure 19 and Appendix H). This may reflect a combination of general contaminants from shipping activity (e.g. heavy greases and fuel oils, lubricants or waxes). The alkanes associated with this heavier UCM may also correspond to an input of terrigenous plant materials which typically comprise the long-chain, odd carbon-numbered n-alkanes (nC_{25}-nC_{33}; Eglinton *et al.*, 1962; McDougall, 2000; Bouloubassi *et al.,* 2001).

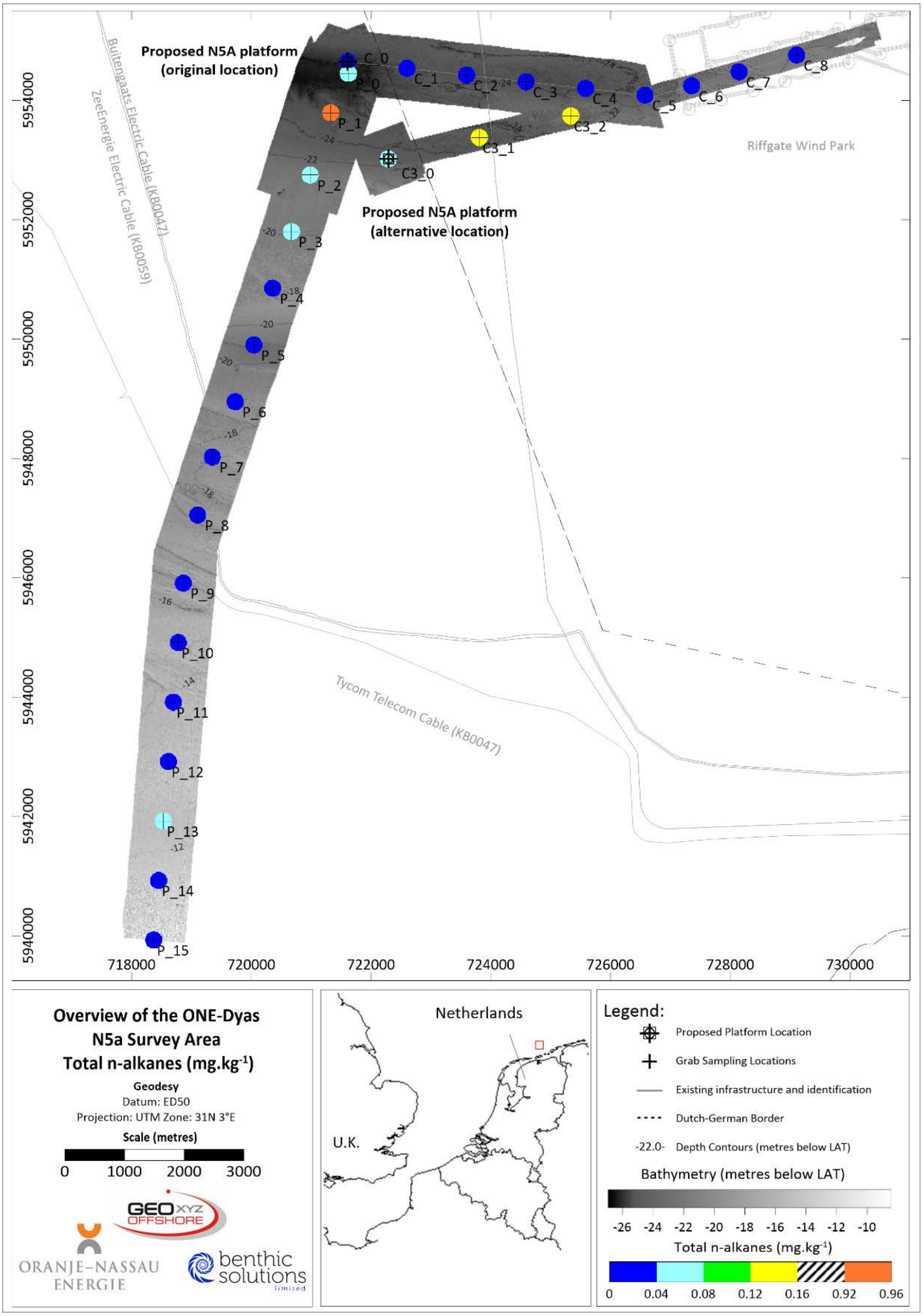


Figure 17: Total saturate alkanes (mg.kg⁻¹

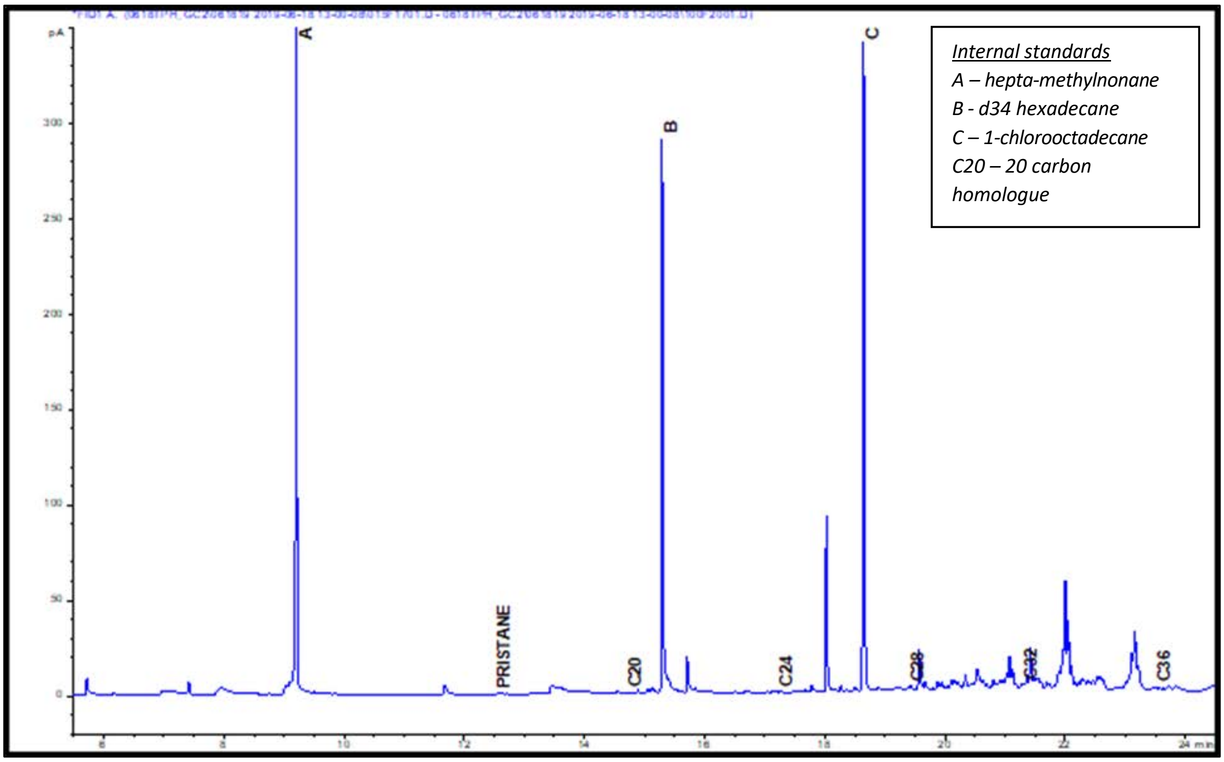


Figure 18: Example gas chromatogram for saturate hydrocarbon analysis (GRAB_C_2)

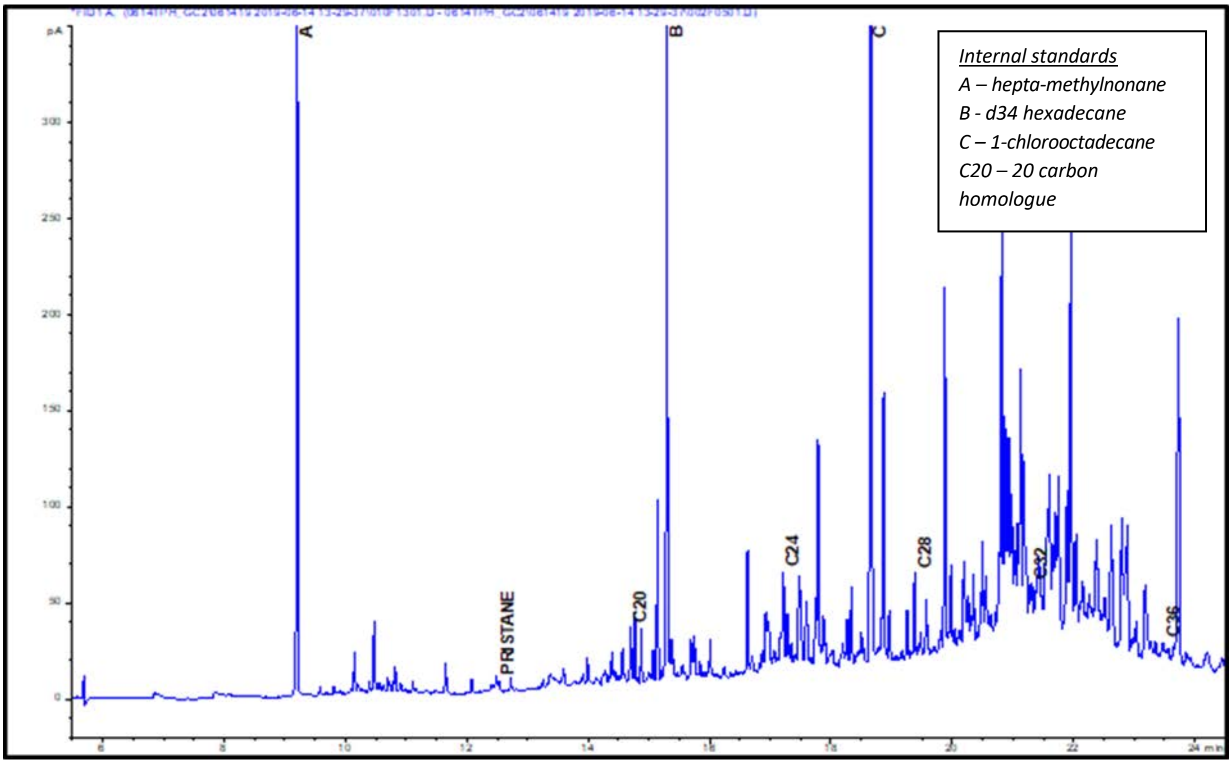


Figure 19: Example gas chromatogram for saturate hydrocarbon analysis (GRAB_P_1)

A closer review of the different proportions of n-alkanes recorded can sometimes identify trends within the data or the source from which the different organic components derive. Whilst this is particularly useful for stations that contain a moderate to high level of saturates, low concentrations can often skew such indices so they appear unrepresentative. The following ratios were further reviewed in the sections below.

Carbon Preference Index (CPI)

The CPI is associated with the preference of biogenic n-alkanes (i.e. that of a preference for odd-carbon numbered homologues, particularly around nC_{27-33}; Sleeter *et al.*, 1980), derived from fatty acids, alcohols, esters and land plant waxes. The CPI was calculated for all stations and the results were relatively consistent, ranging from 0.76 to 7.01 (Figure 20, mean 2.08± 1.25SD) for the full saturate range (nC_{10}-nC_{37}; Table 13). CPI could not be calculated for stations where alkane levels were consistently below the detectable limits (GRAB_P_4, GRAB_P_8 and GRAB_P_9).

The highest value was recorded at GRAB_P_15 (7.01), the shallowest station at 13m (and the closest to shore) which likely receives more terrestrial plant wax input than deeper stations, although there was no statistical correlation to corroborate this hypothesis. Previous studies have shown that a CPI between 5-10 is attributed to the influence of these plant materials and therefore it can be assumed that plant materials dominate GRAB_P_15 (Emerson and Hedges, 2008). CPI was also relatively high at GRAB_P_1 (3.37) suggesting a dominance of the more biogenic odd-carbon numbered alkanes. Conversely, 46.43% of stations had CPI values below 2.0; these were split between the pipeline to NGT Hot Tap and the cable route stations with no apparent geographical pattern of distribution, with no obvious correlation related to the sediment type. Stations with the lowest CPI included GRAB_P_6 (0.88), GRAB_P_7 (0.76) and GRAB_C_0 (0.88) and suggest a dominance of petrogenic compounds.

Review of individual n-alkane concentrations indicated that variation in CPI values at N5A was primarily due to many n-alkanes falling below the limits of detection, with minor variations in concentrations of n-alkanes at low levels resulting in a disproportionately large effect on the CPI. Furthermore, the opposite trend of CPI should therefore be interpreted with caution for the N5A survey area.

P/B Ratio

The P/B ratio compares the lighter, more petrogenic aliphatics with the heavier, and more biogenic aliphatics (Figure 21). For two stations (GRAB_P_4 and GRAB_P_8) this ratio was not calculated due to the majority of alkanes being recorded below the limits of detection. Where applicable, the results showed consistently low ratios, with values of 0.00 at several stations to 1.11 at GRAB_C_5 (mean 0.19±0.27) and no apparent pattern of distribution, although a significant correlation with fines was observed ($\varrho(28)=0.387$, p=<0.05), as well as a negative trend with mean size ($\varrho(28)=-0.396$, p=<0.05). All stations, excluding GRAB_C_5, had a P/B ratio of less than one. These low levels highlight the dominant biogenic influence within the survey area, indicative of aliphatics from natural biogenic origins and limited influence from petrogenic aliphatics.

The Pr/Ph Ratio

Pristane (Pr) and phytane (Ph) are both isoprenoidal alkanes commonly found as constituents within crude oils (Berthou and Friocourt, 1981). However, in biogenic environments, only Pr is commonly found in the marine environment as it is naturally biosynthesised as a product of the phytol moiety of chlorophyll. Ph is generally absent or only present at low levels in uncontaminated natural systems (Blumer and Snyder, 1965). A presence of both isoprenoids at similar levels is typically taken as an indication of petroleum contamination. It should be noted that the Pr/Ph ratio can often be difficult to interpret due to its erratic nature and should be used mainly to corroborate other results. Use of the ratio in interpretative discourse is open to criticism, mainly owing to the natural occurrence of Ph in some older sediments and the confusing variation of sedimentary Pr, induced by the variability of phytoplankton numbers (Blumer and Snyder, 1965).

Phytane was below limits of detection (<1) for all but three of the stations sampled, with one of these having undetectable levels of pristane. As a result, only two Pr/Ph ratios could be calculated for the survey area at the two stations with the highest concentrations of THC and total n-alkanes (GRAB_P_1 and GRAB_C3_1). GRAB_P_1 had a value of 5.01 suggesting pristane dominance and biogenic origin of isoprenoids while GRAB_C3_1 had a value of 0.83 indicating the dominance of phytane in this area. However, concentrations for both phytane and pristane were low at both stations which often produces inconsistent Pr/Ph ratios.

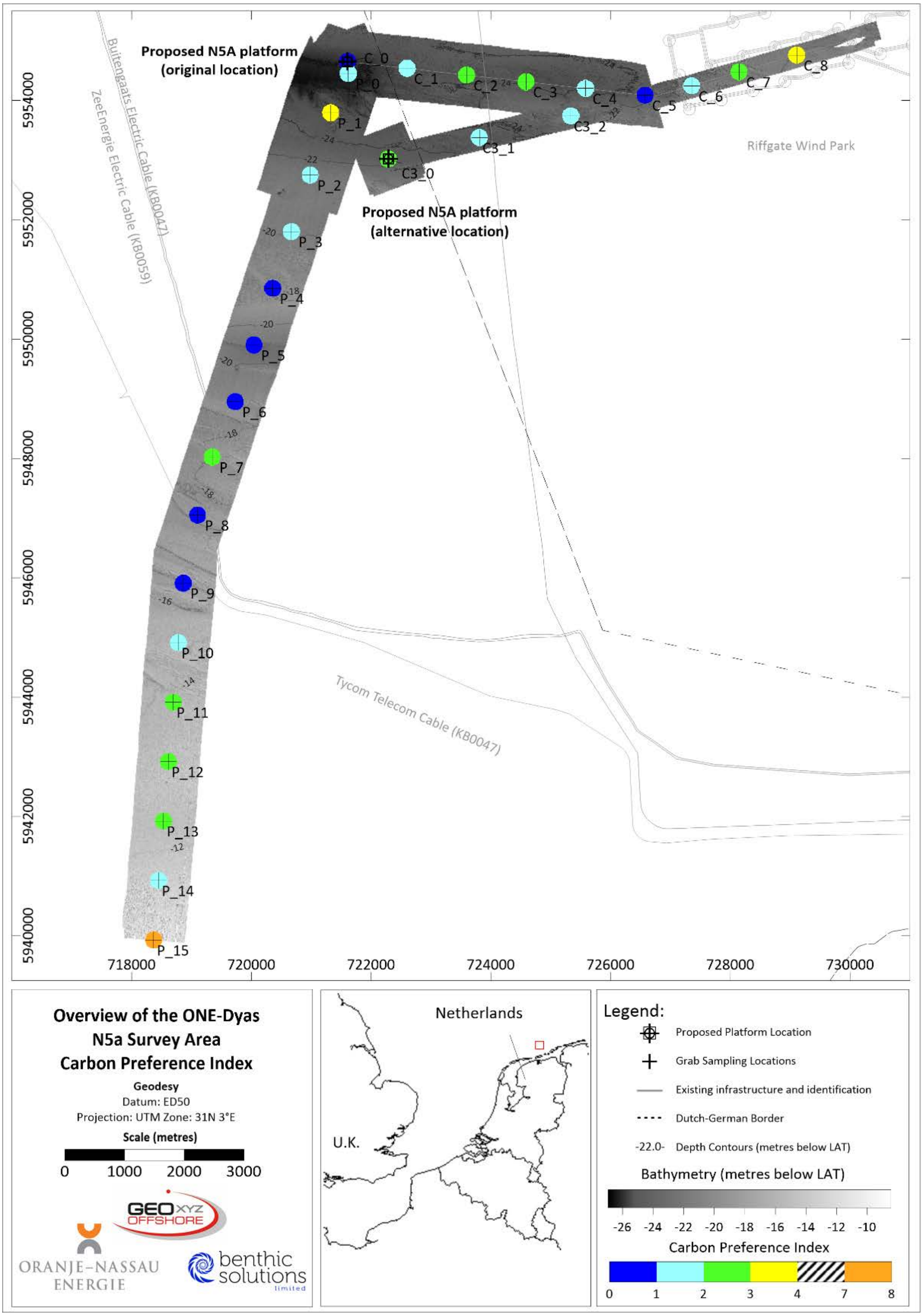


Figure 20: Carbon preference index

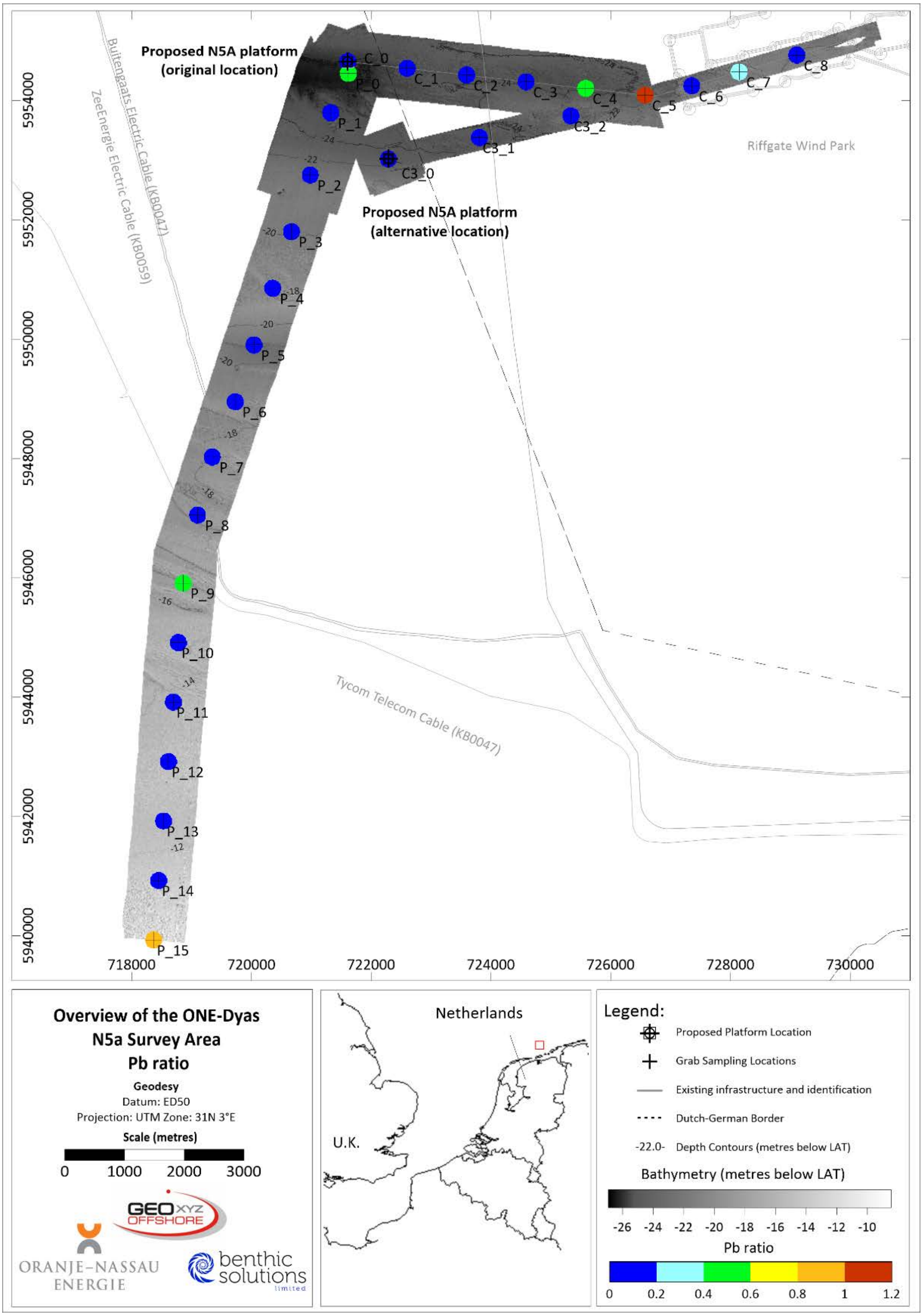


Figure 21: Petrogenic/biogenic ratio

3.6.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons were analysed at each station using gas chromatography mass spectrometry (GC-MS). Results of the single ion current (SIC) analyses are summarised in Table 13, and detailed in Appendix J, showing concentrations for both parent compounds and their alkyl derivatives. The concentrations of 18 PAH priority pollutants listed by US Environmental Protection Agency (EPA) are listed in Appendix K. The EPA list of PAHs is used globally in assessment of contamination relating to both environmental and human health studies.

Polycyclic aromatic hydrocarbons and their alkyl derivatives have been recorded in a wide range of marine sediments (Laflamme and Hites, 1978) with the majority of compounds produced from what is thought to be pyrolytic sources. These include the combustion of organic material such as forest fires (Youngblood and Blumer, 1975), the burning of fossil fuels and, in the case of offshore oil fields, flare stacks. The resulting PAHs, rich in the heavier weight 4-6 ring aromatics, are normally transported to the sediments via atmospheric fallout or river runoff. Another PAH source is petroleum hydrocarbon, often associated with localised drilling activities. These are rich in the lighter, more volatile 2 and 3 ring PAHs (NPD; naphthalene (128), phenanthrene, anthracene (178) and dibenzothiophene (DBT)) with their alkyl derivatives.

Total PAH concentrations (2-6 compounds) over the N5A survey area were relatively low and highly variable, with concentrations ranging from 0µg.kg^{-1}to 66.8µg.kg^{-1} (mean 4.76µg.kg^{-1}±12.84.72SD; Table 13). Many stations had levels of PAH that were below the limit of detection, including all stations along the N5A platform to Riffgat Wind Park cable route (Figure 22), reflecting the presence of mobile sandy sediments. The highest total PAH concentration of 66.8µg.kg^{-1} was recorded at station GRAB_P_1. As mentioned previously, this station also recorded the highest concentrations for THC and total n-alkanes (13,647µg.kg^{-1} and 931µg.kg^{-1}, respectively).

Total PAH concentrations correlated with total n-alkanes ($\rho(28)=0.596$, $p<0.01$), but both parameters were low throughout the majority of the survey area and were deemed to be consistent with uncontaminated marine sediments. All stations showed 2-6 ring PAH concentrations below the mean level for background sediments in the SNS (292µg.kg^{-1}, UKOOA, 2001).Only station GRAB_P_1 showed total PAH and total n-alkane concentrations above the UKOOA (2001) 95th percentile for background sediments in the southern North Sea.

All total PAH concentrations recorded during the survey fell significantly below the US EPA toxicity reference value (TRV) of 870µg.kg^{-1} (US EPA, 1999; Macdonald *et al.*, 1996). All stations were also found to sit at the lower end of the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) PAH concentrations for sediments surrounding North Sea oil and gas installations which ranged from 20µg.kg^{-1} to 74700µg.kg^{-1} (Sheahan *et al.*, 2001).

The lighter, more volatile NPD fraction (2 and 3 ring aromatics) was consistently low with almost negligible concentrations observed, ranging from 0.00 µg.kg^{-1} to 13.78 µg.kg^{-1} (mean 1.90µg.kg^{-1}±3.2SD). This follows a similar pattern to the total PAHs. NPD concentrations were again highest for station GRAB_P_1 (13.78µg.kg^{-1}), followed by GRAB_P_15 (8.13 µg.kg^{-1}) The NPD PAH accounted for a varying proportion of the total PAH at stations, ranging from 0% to 100%, with some percentages unable to be calculated as PAH levels were below the limit of detection. At some stations the NPD PAH accounted for 100% of the total PAHs but this reflected the overall low levels of total PAH and not elevated levels of NPD PAH. At stations where higher PAH concentrations occurred (e.g. GRAB_P_1 and GRAB_C3_1), the percentage NPD was low (20.64% and 0% respectively), indicating a dominance of pyrolytic-derived PAH at these stations. Consequently, the ratio of NPD to 4-6 ring PAHs was considered to be low (0-0.92) at every station.

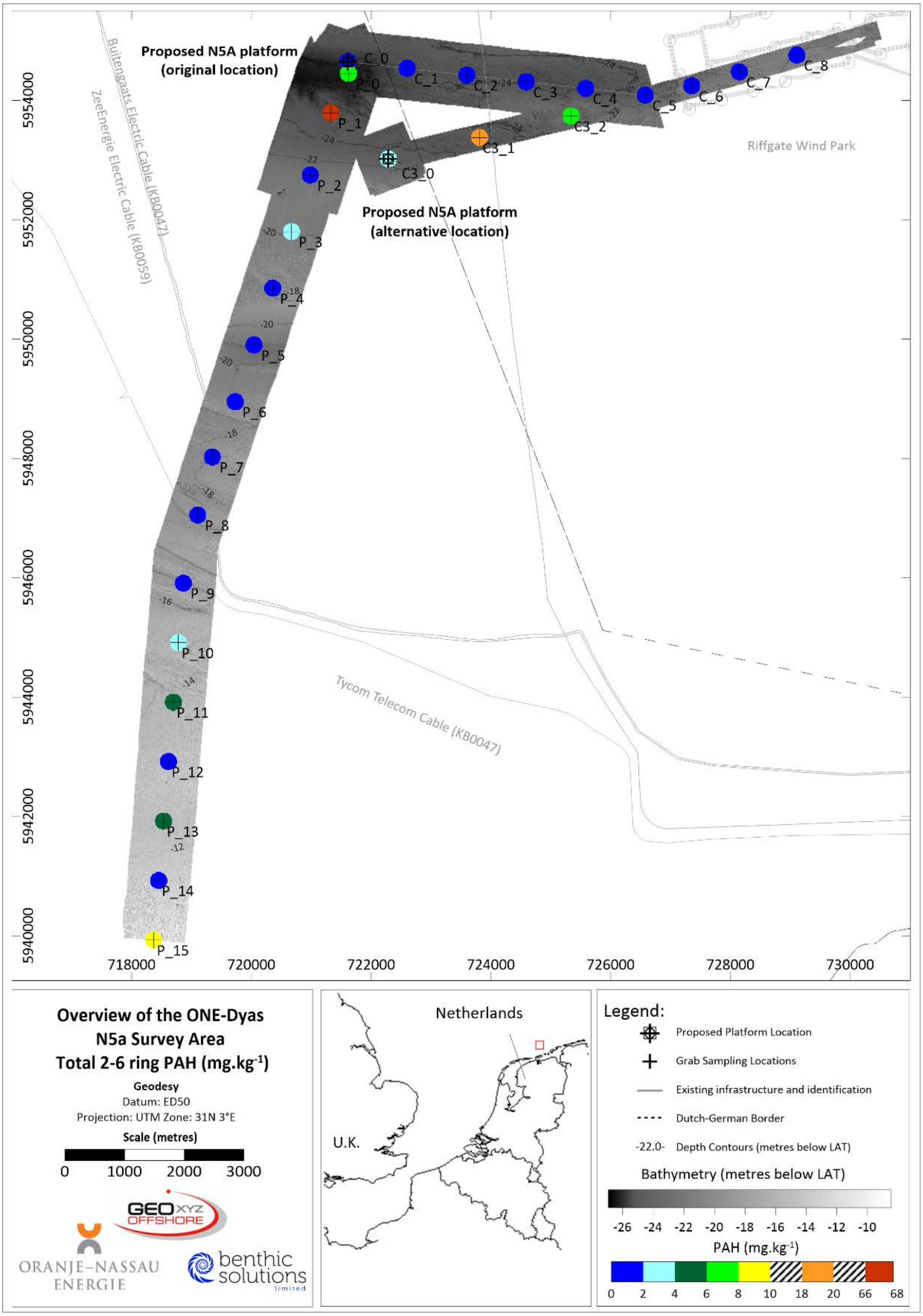


Figure 22: Polycyclic aromatic hydrocarbons (2-6 Ring)

Further information on the source(s) of PAH in the sediment may be obtained from a study of their alkyl homologue distributions (i.e. the degree of methyl, ethyl, substitution of the parent compounds). Pyrolytically derived PAHs are predominantly unalkylated compounds, whereas petrogenically derived PAHs are formed at relatively low temperatures (<150°C) and contain mainly alkylated species. The distribution of parent 2-6 ring PAH compounds also reflects whether the source is petrogenic or pyrolytic. This trend is represented graphically in Appendix L, and four example plots in Figure 23, which show three-dimensional plots of the parent compound distribution and the alkyl homologue distribution of the aromatic material in each of the sediments analysed.

Stations across the N5A survey area presented a mixed range of alkyl distributions, with some stations having little or no PAH content, as seen in Figure 23c and d (GRAB_P_9, GRAB_C_3). GRAB_P_1 and GRAB_C3_1 showed more obvious pyrolytic PAH content, dominated by 4-6 ring compounds, however the PAH concentrations at all stations were low (<12µg.kg^{-1}) and considered to represent natural variations across the N5A development survey area.

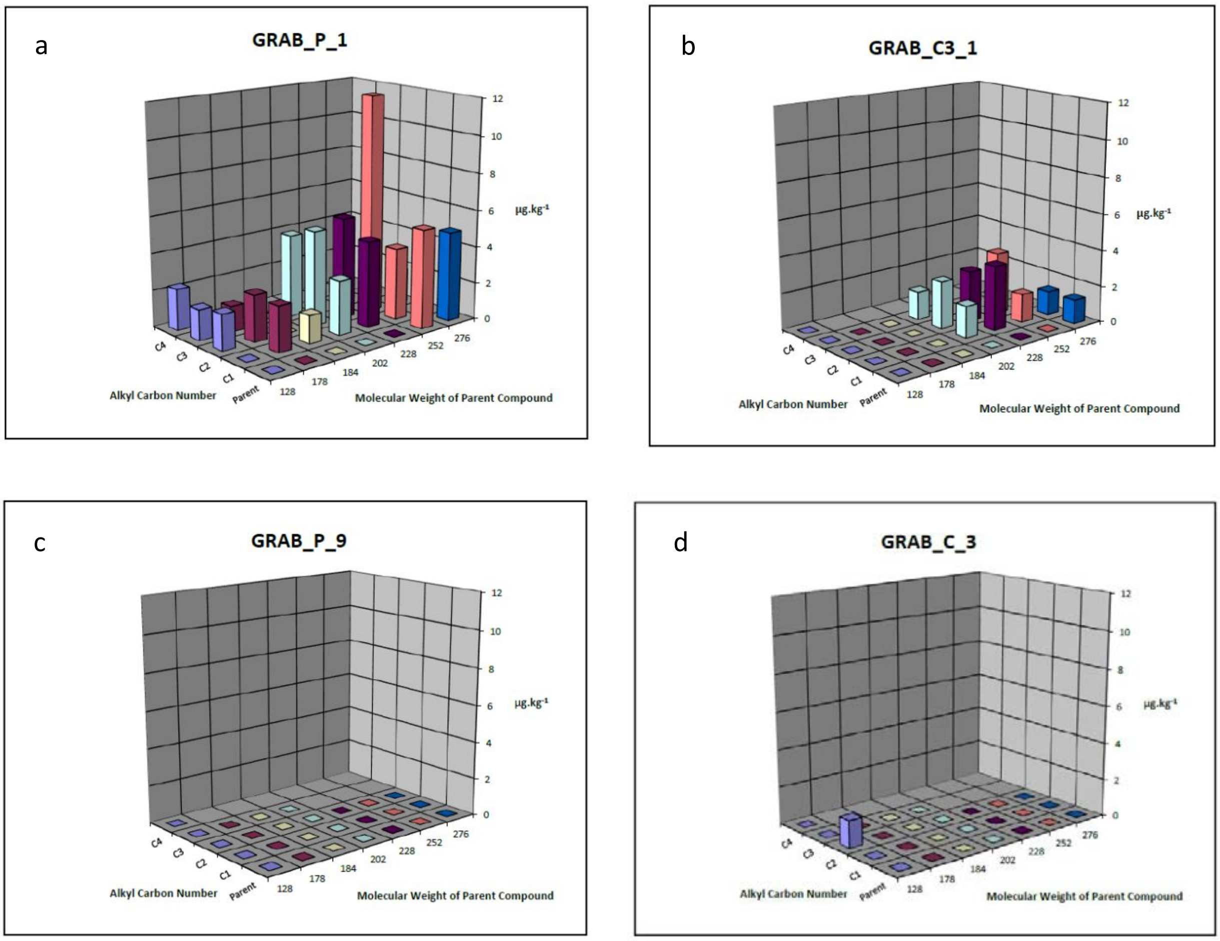


Figure 23: Example parent/alkyl PAH plots

The results indicate that PAHs could be classified as having derived from mixed sources consistent with ambient seabed conditions in the southern North Sea.

3.6.4 Normalisation of Total PAH

Normalised total PAH data were calculated to allow comparison to OSPAR background assessment concentrations (BACs; OSPAR, 2014). BACs are threshold concentrations below which contaminants can be considered at background levels (OSPAR, 2008b). Natural and anthropogenic contaminants tend to show a higher affinity to fine particulate matter compared to coarse (OSPAR, 2009) due to the increased adsorption capacity of organic matter and clay minerals. For sites where there is variability in grain size between stations, impact footprints from point sources of contamination may at least partly be obscured by differences in sediment granulometry. Normalisation was undertaken using a simple ratio approximation, where PAH concentrations (based on the 11 PAH components outlined in OSPAR, 2014) were normalised to 2.5% TOC content at each station (Table 14).

All normalised PAHs were below their respective BACs (OSPAR, 2014), indicating little or no anthropogenic impact on the PAH composition of the sediments within the survey area. This is supported by many of the PAH measurements falling below the limit of detection (Appendix K). Furthermore, PAH concentrations at station GRAB_P_1, where the highest levels of PAH occurred, levels were substantially below the various BC, BAC, ERL and ERM levels.

Table 14: Normalised PAH concentrations (µg.kg⁻¹)

Blue cell = above BC   Green cell = above BAC   Orange cell = above ERL   Yellow cell = above ERM

Station	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Dibenzothiophene	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Chrysene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[e]pyrene	Benzo[a]pyrene	Perylene	Indeno[123,cd]pyrene	Dibenzo[a,h]anthracene	Benzo[ghi]perylene
GRAB_P_0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	40	<0.5	<0.5	<0.5
GRAB_P_1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	4.93	<0.5	4.30	3.79	118.93	4.22	0.00	7.60
GRAB_P_2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_13	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_14	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_P_15	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C_8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C3_0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GRAB_C3_1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	810.53	<0.5	<0.5	17.50
GRAB_C3_2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	479.55	<0.5	<0.5	<0.5
Mean	0	0	0	0	0	0	0	0	0	0	0	0.18	0.00	0.15	0.14	51.75	0.15	0.00	0.90
SD	0	0	0	0	0	0	0	0	0	0	0	0.93	0.00	0.81	0.72	175.08	0.80	0.00	3.56
CV (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	338.3	-	-	396.8
BC (OSPAR 2014)	5	-	-	-	17	-	3	20	13	9	11	-	-	-	15	-	50	-	45
BAC (OSPAR 2014)	8	-	-	-	32	-	5	39	24	16	20	-	-	-	30	-	103	-	80
NOAA ERL*	160	44	16	19	240	-	85	600	665	261	384	-	240	-	430	-	2000	63	170
NOAA ERM**	210	640	500	540	1500	-	1100	5100	2600	1600	2800	1800	1340000	-	1600	-	320000	260	320000

Note: where levels were below the detection limit, a value of half the detection limit was applied in the calculations.
**Concentration of that produces a harmful affect 10% of the time (Long et.al., 1995)*
***Concentration of that produces a harmful affect 50% of the time (Long et.al., 1995*

3.7 HEAVY AND TRACE METAL CONCENTRATIONS

Results for Heavy and trace metal analysis are given in Table 15. All of the metals analysed (aluminium (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), nickel (Ni), lead (Pb), tin (Sn), vanadium (V) and zinc (Zn)), underwent an Aqua Regia (AR) acid extraction followed by ICP analysis.

The question of bioavailability of metals to marine organisms is a complex one, as sediment granulometry and the interface between water and sediment all affect the bioavailability and subsequent toxicity. Therefore, even if a metal is found in higher concentrations it does not necessarily follow that this will have a detrimental effect on the environment, if present in an insoluble state. Historically, several extraction techniques have been applied to metal analysis, with the most common applying to an HF/perchloric extraction for total metals, and a weaker nitric or aqua regia extraction. The latter techniques have shown close correlation to metal burdens in the tissues of benthic organisms (Luoma and Davies, 1983; Bryan and Langston, 1992). However, the way bioavailability is reflected by the extent to which a particular metal digests is not well understood, and research is ongoing. A fusion analysis for Ba is preferred due to the likely presence of insoluble Ba, which is typically recorded in areas where previous drilling activities have occurred. No barium by fusion was conducted in these analyses but is recommended for any post-drilling analyses.

Metals occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others may be toxic to numerous organisms (Paez-Osuna and Ruiz-Fernandez, 1995). Rivers, coastal discharges, and the atmosphere are the principal modes of entry for most metals into the marine environment (Schaule and Patterson, 1983), with anthropogenic inputs occurring primarily as components of industrial and municipal wastes. Historically, several HM are found in elevated concentrations where drilling fluids or produced waters have been discharged by oil and gas installations. These include intentional additives (such as metal based salts and organo-metallic compounds in the fluids) as well as impurities within the drilling mud systems such as clays (e.g. bentonites; a gelling and viscosifying agent) and metal lignosulphates (a viscosity controller; McCourt *et al.,* 1991). The metals most characteristic for offshore contamination of marine sediments from oil and gas activities are Ba, Cr, Pb and Zn (Neff, 2005), although these may vary greatly depending on the constituents used.

Trace metal contaminants in the marine environment tend to form associations with the non-residual phases of mineral matter, such as Fe and Mn oxides and hydroxides, metal sulphides, organics, and carbonates. Metals associated with these non-residual phases are prone to various environmental interactions and transformations (physical, chemical and biological), potentially increasing their biological availability (Tessier *et al*., 1979). Residual trace metals are defined as those which are part of the silicate matrix of the sediment and that are located mainly in the lattice structures of the component minerals. Non-residual trace metals are not part of the silicate matrix and have been incorporated into the sediment from aqueous solution by processes such as adsorption and organic complexes and may include trace metals originating from sources of pollution. Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish these more mobile metals from the residual metals held tightly in the sediment lattice (Chester and Voutsinou, 1981), which are of comparatively little environmental significance.

Metals are generally not harmful to organisms at concentrations normally found in marine sediments and some, like zinc, may be essential for normal metabolism although can become toxic above a critical threshold. In order to assign a level of context for toxicity, an approach used by Long *et al.* (1995) to characterize contamination in sediments will be used here. These researchers reviewed field and laboratory studies and identified nine metals that were observed to have ecological or biological effects on organisms. They defined "effect range low" (ERL) values as the lowest concentration of a metal that produced adverse effects in 10% of the data reviewed, whilst "effect range median" (ERM) values designate the level at which half of the studies reported harmful effects. Consequently, metal concentrations recorded below the ERL value are not expected to elicit adverse effects, while levels above the ERM value are likely to be toxic to some marine life.

Of particular relevance to the offshore oil and gas industry are metals associated with drilling related discharges. These can contain substantial amounts of barium sulphate (barites) as a weighting agent (National Research Council, 1983) and barium is frequently used to detect the deposition of drilling fluids around offshore installations (Chow and Snyder, 1981; Gettleson and Laird, 1980; Tricine and Trefry, 1983; Muniz *et al.*, 2004). Solid barites are often discharged during the drilling process and often contain measurable concentrations of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury, and zinc (National Research Council, 1983; McLeese *et al.*, 1987). Heavy metals, either as impurities or additives are also present in other mud components. For this survey, natural barium (Ba) levels were consistent and ranged from 8.1mg.kg-^{1} to 48.3mg.kg^{-1} (mean 13.01mg.kg^{-1}±8.38SD) when analysed by aqua regia-extraction (Figure 24), falling well below the UKOOA 95th percentile for the SNS (272mg.kg^{-1}). Barium levels were highest at station GRAB_P_1 (48.3mg.kg^{-1}) and were considered to be low and consistent with uncontaminated sediments, with contaminated stations frequently showing concentrations in thousands or tens of thousands of mg.kg^{-1} (ppm).

Mean levels of metals for the entire survey area fell below their respective UKOOA (2001) and Long *et al*. (1995) reference thresholds for anthropogenic contamination and potential toxicological impacts. In addition, concentrations of cadmium, mercury and tin were all often found to be under the limit of detection for the majority of stations. Tin (Sn) concentrations were below the limit of detection (0.5mg.kg^{-1}) at 92% of stations, with only station GRAB_P_1 recording detectable concentrations.

Heavy and trace metal concentrations showed minimal variation across the survey area. Station GRAB_P_1 recorded the highest concentrations of all analysed metals with the exception of mercury. Metals concentrations at station GRAB_P_1 were consistently more than double the mean for the N5A development survey area (excluding mercury). These included all metals associated with drilling related barite discharges (arsenic, chromium, nickel, vanadium, zinc and iron). Although highest at this station, only levels of zinc (40.4mg.kg^{-1}) and copper (14.7mg.kg^{-1}) exceeded the UKOOA 95th percentile limits for the SNS, and both fell below their respective ERL and ERM thresholds. The high concentrations at station GRAB_P_1 were considered to reflect natural variation within the survey area with the high percentage fines at this station acting to retain metals more easily.

Cadmium, mercury and zinc were consistently low across all stations with respective mean values of 0.03 mg.kg^{-1}±0.03SD, 0.02 mg.kg^{-1}±0.02SD and 0.27 mg.kg^{-1}±0.09SD. Nickel and copper levels across the N5A area were also consistently low with respective means of 3.19mg.kg^{-1}±3.46SD (Figure 25) and 6.17mg.kg^{-1}±1.82SD (Figure 26). Only copper at GRAB_P_1 exceeded the UKOOA 95th percentile (Ni, 21.45mg.kg^{-1}, UKOOA 2001; Cu, 13.86mg.kg^{-1}, UKOOA 2001). The concentrations of nickel and copper also did not surpass the effect range low values of 20.9mg.kg^{-1}and 34.0mg.kg^{-1}.

Iron (Fe) is an important metal as it is often associated with other elements, such as arsenic (As). Iron concentrations ranged from 2440mg.kg^{-1} at GRAB_P_11 to 16800mg.kg^{-1} at GRAB_P_1 (Figure 27) and was significantly correlated to 61.53% of the metals (Appendix N), including arsenic $\rho(28)=0.826$, $p<0.001$. Arsenic levels were relatively consistent at most stations (mean 3.37.kg^{-1}±1.84SD; Figure 28), however, there were slightly elevated concentrations nearer at stations to the N5A platform, and at GRAB_P_1 the value recorded (10.5mg.kg^{-1}) exceeded the effect range low (8.2mg.kg^{-1}).

Similarly, aluminium levels were also higher at GRAB_P_1 at 12700mg.kg^{-1}, well above the survey area mean of 1359mg.kg^{-1} (±2267SD). Aluminium is often associated with higher levels of silicates which also frequently correlate with higher concentrations of other metals (Figure 29). This is corroborated by the findings of the Spearman's correlation table which resulted in significant Spearman's correlations between aluminium and 69.2% of the other heavy and trace metals (Appendix N).

The physical nature of the sediment had a clear effect on the concentrations of some heavy and trace metals found in N5A. This was supported by significant correlations between the proportions of fines, sand and gravel and the heavy and trace metals (Appendix N). Significant positive Spearman's rank correlations were seen between fines and aluminium, arsenic, barium, iron, lead, nickel and vanadium in addition to negative correlations between sand and aluminium, arsenic, iron, nickel and vanadium. As such, it is unsurprising to that the sand-dominated stations grouped within PSA multivariate cluster *a* also exhibited some of the lowest metals concentrations. In particular stations GRAB_P_8 and GRAB_C_6, which showed the lowest concentrations of several metals (five and eight metals respectively) as well as the lowest THC and UMC.

There was a positive correlation between distance to shore and arsenic, vanadium, barium and iron concentrations, with higher levels recorded at stations farthest from shore. This is interesting as it would be expected that terrestrial influences would provide more metals effluents to stations closest to shore. However, the positive correlation between fines and distance to shore may account for this variation with higher fines generally found further offshore and associated with higher metals concentrations.

Table 15: Total heavy and trace metal concentrations (mg.kg^{-1})

Station	Arsenic (AR-ICP)	Cadmium (AR-ICP)	Chromium (AR-ICP)	Copper (AR-ICP)	Lead (AR-ICP)	Mercury (AR-ICP)	Nickel (AR-ICP)	Tin (AR-ICP)	Vanadium (AR-ICP)	Zinc (AR-ICP)	Aluminium (AR-ICP)	Barium (AR-ICP)	Iron (AR-ICP)
GRAB_P_0	5.3	<0.04*	4.1	6.2	3.6	0.02	2.8	<0.5	8.0	13.6	1060	16.5	4030
GRAB_P_1	10.5	0.17	23.3	14.7	9.5	0.03	20.5	1	31.5	40.4	12700	48.3	16800
GRAB_P_2	3.7	<0.04*	5.7	6.0	3.2	<0.015*	3.4	<0.5*	8.3	15.0	1760	12.5	4280
GRAB_P_3	2.8	<0.04*	3.7	4.7	2.4	<0.015*	2.1	<0.5*	5.2	11.8	832	10.0	3510
GRAB_P_4	3.0	<0.04*	3.2	5.8	1.8	<0.015*	1.8	<0.5*	4.4	19.8	633	9.1	3200
GRAB_P_5	2.7	<0.04*	3.3	5.3	1.8	<0.015*	2.0	<0.5*	4.2	10.8	647	9.5	3120
GRAB_P_6	2.8	<0.04*	4.3	5.4	2.4	0.07	2.3	<0.5*	4.1	15.8	709	9.1	3000
GRAB_P_7	2.7	0.04	4.4	5.5	2.2	0.03	2.4	<0.5*	4.4	14.8	899	10.4	3090
GRAB_P_8	2.2	<0.04*	2.5	6.1	1.6	0.02	1.9	<0.5*	3.0	8.8	467	8.4	2640
GRAB_P_9	2.5	<0.04*	3.5	4.5	1.7	<0.015*	2.1	<0.5*	3.8	14.0	873	9.9	2610
GRAB_P_10	2.9	<0.04*	4.5	5.5	2.3	<0.015*	2.4	<0.5*	5.8	10.4	797	9.1	2920
GRAB_P_11	2.3	0.05	3.4	4.6	1.7	<0.015*	1.8	<0.5*	3.7	12.3	732	8.1	2440
GRAB_P_12	2.5	0.04	4.4	5.4	2.0	<0.015*	2.3	<0.5*	4.3	16.2	960	9.9	3060
GRAB_P_13	2.6	<0.04*	4.8	5.4	2.6	0.06	2.5	<0.5*	4.9	15.7	1210	11.6	3510
GRAB_P_14	2.7	0.05	4.9	5.9	2.7	0.02	2.8	<0.5*	5.0	19.7	997	9.7	2860
GRAB_P_15	2.5	0.04	5.5	6.8	1.9	<0.015*	2.5	<0.5*	14.3	17.2	967	10.1	2860
GRAB_C_0	4.7	<0.04*	2.9	6.2	2.1	<0.015*	2.4	<0.5*	6.3	7.7	600	9.5	3420
GRAB_C_1	7.3	<0.04*	2.8	5.5	2.1	<0.015*	2.5	<0.5*	8.9	11.6	847	10.8	4370
GRAB_C_2	4.3	<0.04*	2.9	6.0	2.0	<0.015*	2.2	<0.5*	6.4	9.9	542	9.0	3440
GRAB_C_3	2.8	<0.04*	3.8	6.0	2.1	<0.015*	2.4	<0.5*	5.5	14.6	748	11.3	3450
GRAB_C_4	3.1	<0.04*	5.3	7.7	2.9	0.02	3.4	<0.5*	6.7	14.4	1140	22.9	3870
GRAB_C_5	2.5	<0.04*	2.9	5.8	1.8	<0.015*	2.3	<0.5*	4.1	7.4	721	11.1	3180
GRAB_C_6	1.3	<0.04*	2.6	6.4	1.5	<0.015*	1.9	<0.5*	2.6	7.2	508	9.3	2520
GRAB_C_7	2.2	<0.04*	3.5	7.3	1.8	<0.015*	2.8	<0.5*	4.1	9.5	733	10.2	3120
GRAB_C_8	1.8	0.04	2.6	6.2	1.5	0.02	1.9	<0.5*	3.1	6.5	448	9.3	2630
GRAB_C3_0	3.4	<0.04*	6.2	5.8	3.8	0.1	3.2	<0.5*	8.2	17.4	1270	11.6	4400
GRAB_C3_1	2.9	<0.04*	5.6	6.7	3.0	0.04	3.9	<0.5*	7.7	12.6	1740	29.8	4040
GRAB_C3_2	4.7	0.05	5.5	5.3	3.6	0.03	4.7	<0.5*	11.4	14.3	2520	17.5	6590
Mean	3.38	0.03	4.7	6.2	2.6	0.02	3.2	0.27	6.8	13.9	1359	13.0	3891
SD	1.84	0.03	3.8	1.8	1.5	0.02	3.5	0.09	5.5	6.3	2267	8.4	2664
CV (%)	54.5	95.4	80.6	29.6	59.0	108.7	108.6	32.0	81.3	45.6	166.8	64.4	68.5
UKOOA 95th Percentile SNS, 2001	-	0.72	44.8	13.9	21.0	0.05	21.5	-	35.8	35.8	-	-	18555
NOAA ERL**	8.20	1.20	81.0	34.0	46.7	0.15	20.9		-	150	-		-
NOAA ERM	70.0	9.60	370	270	218	0.71	51.6		-	410	-		-

Orange cell = *above ERL* Yellow cell = *above ERM**

Note: where levels were below the detection limit, a value of half the detection limit was applied in the calculations.

***Lowest concentration of metal that can produce a harmful affect (Long et.al., 1995)*

3.7.1 Normalisation of Heavy Metals

Normalised heavy and trace metal data are calculated to allow comparison to OSPAR background concentrations (BCs) and background assessment concentrations (BACs; OSPAR, 2014). BCs have been derived from analysis of sub-surface core samples to quantify pristine, pre-industrial metal concentrations, while BACs provide threshold concentrations below which contaminants can be considered to be at background levels (OSPAR, 2008b). Normalisation for metals are undertaken using the current Coordinated Environmental Monitoring Programme (CEMP) normalisation procedure, involving the use of pivot values (OSPAR, 2008b).

Normalisation to aluminium attempts to standardise metals data by filtering out the effect that variable clay content will have on metal concentrations, as well as the effect of aluminosilicates on other heavy and trace metals which can form part of the silicate matrix. However, aluminium had no significant correlations with any of the sediment parameters, and as such, the normalisation of heavy and trace metals to aluminium was not included. Further, when normalisation was attempted it removed all trends seen within the data at N5A.

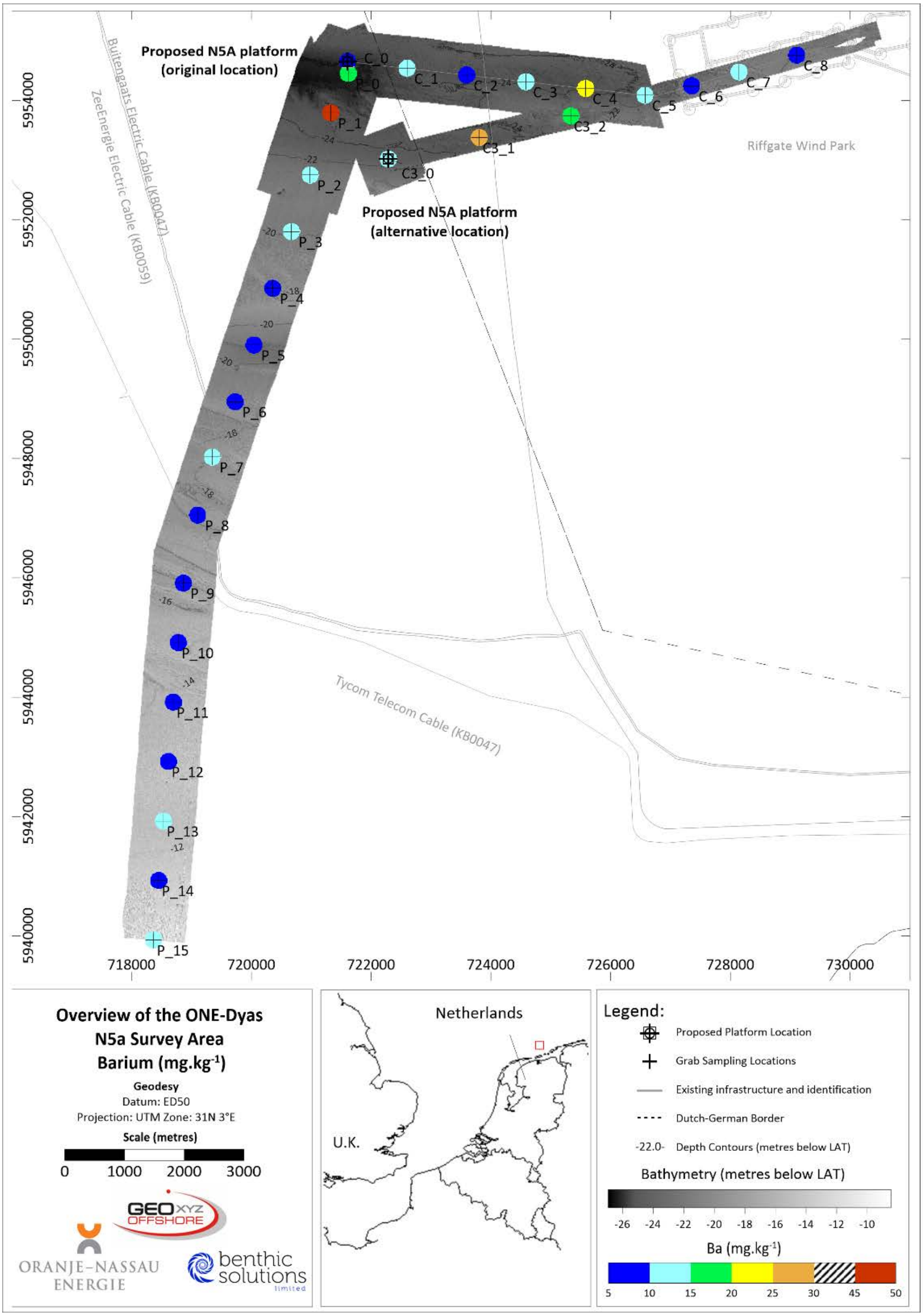


Figure 24: Heavy metal concentration for barium (Ba; mg.kg^{-1})

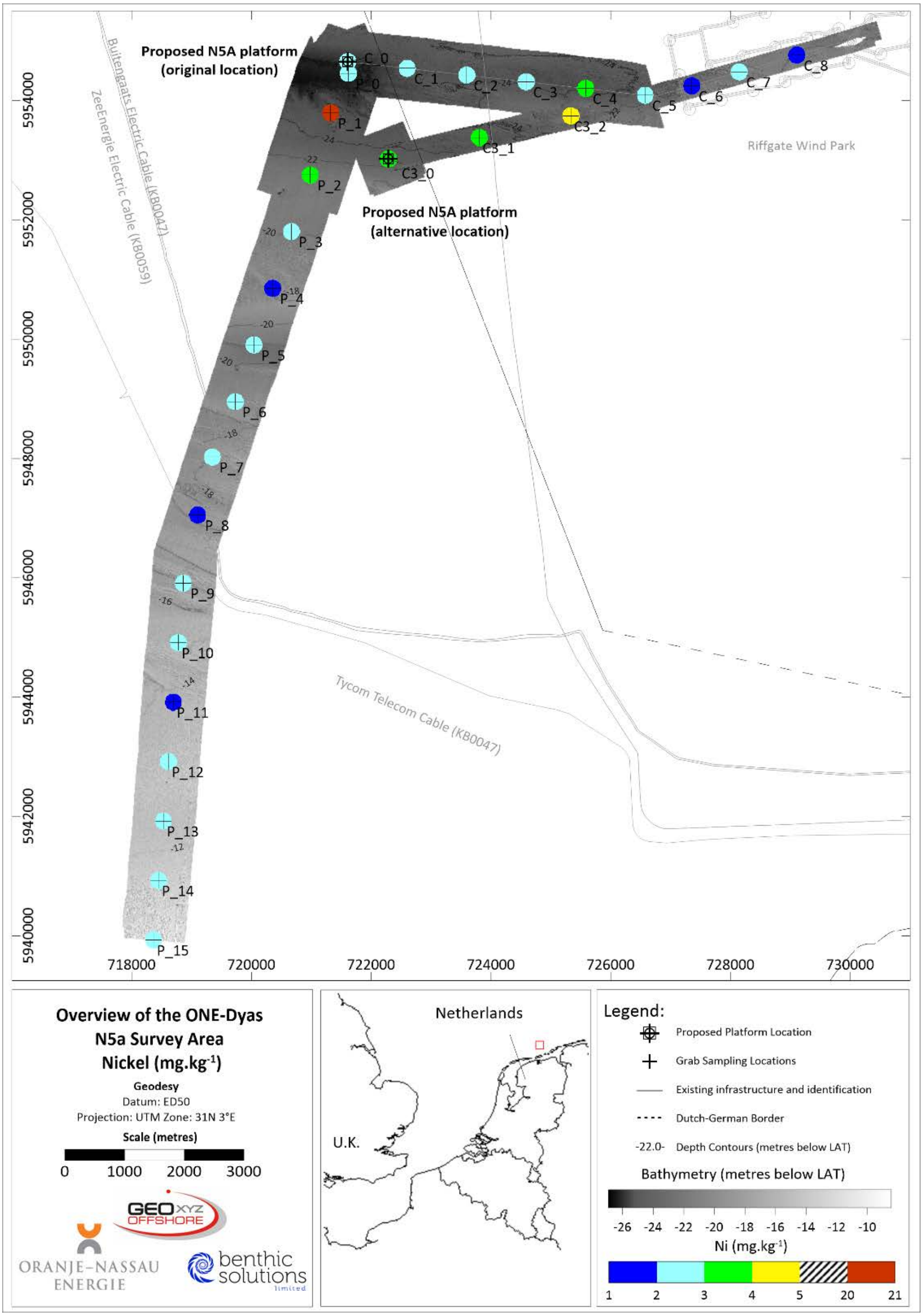


Figure 25: Heavy metal concentration for nickel (Ni; mg.kg^{-1})

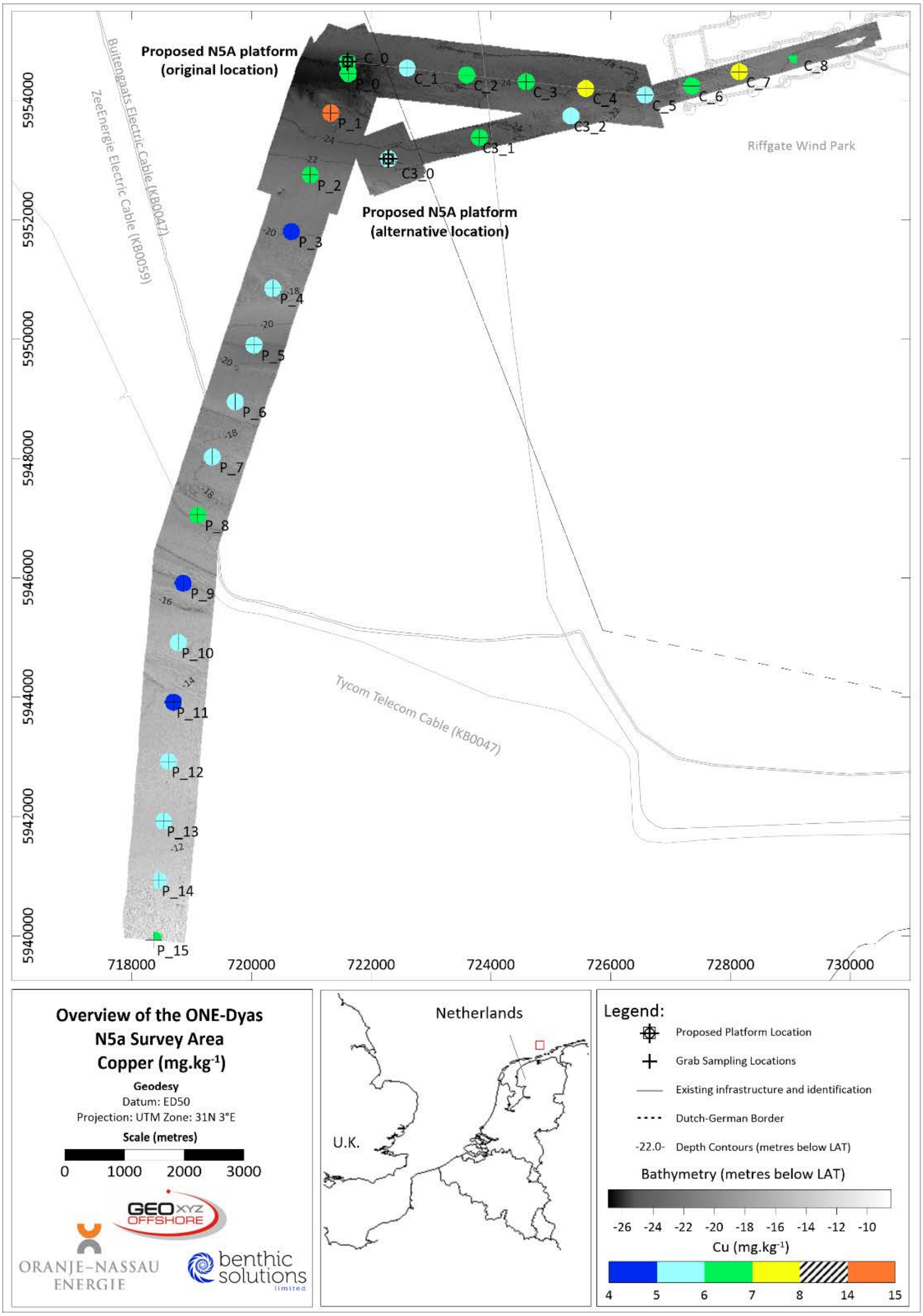


Figure 26: Heavy metal concentration for copper (Cu; mg.kg^{-1})

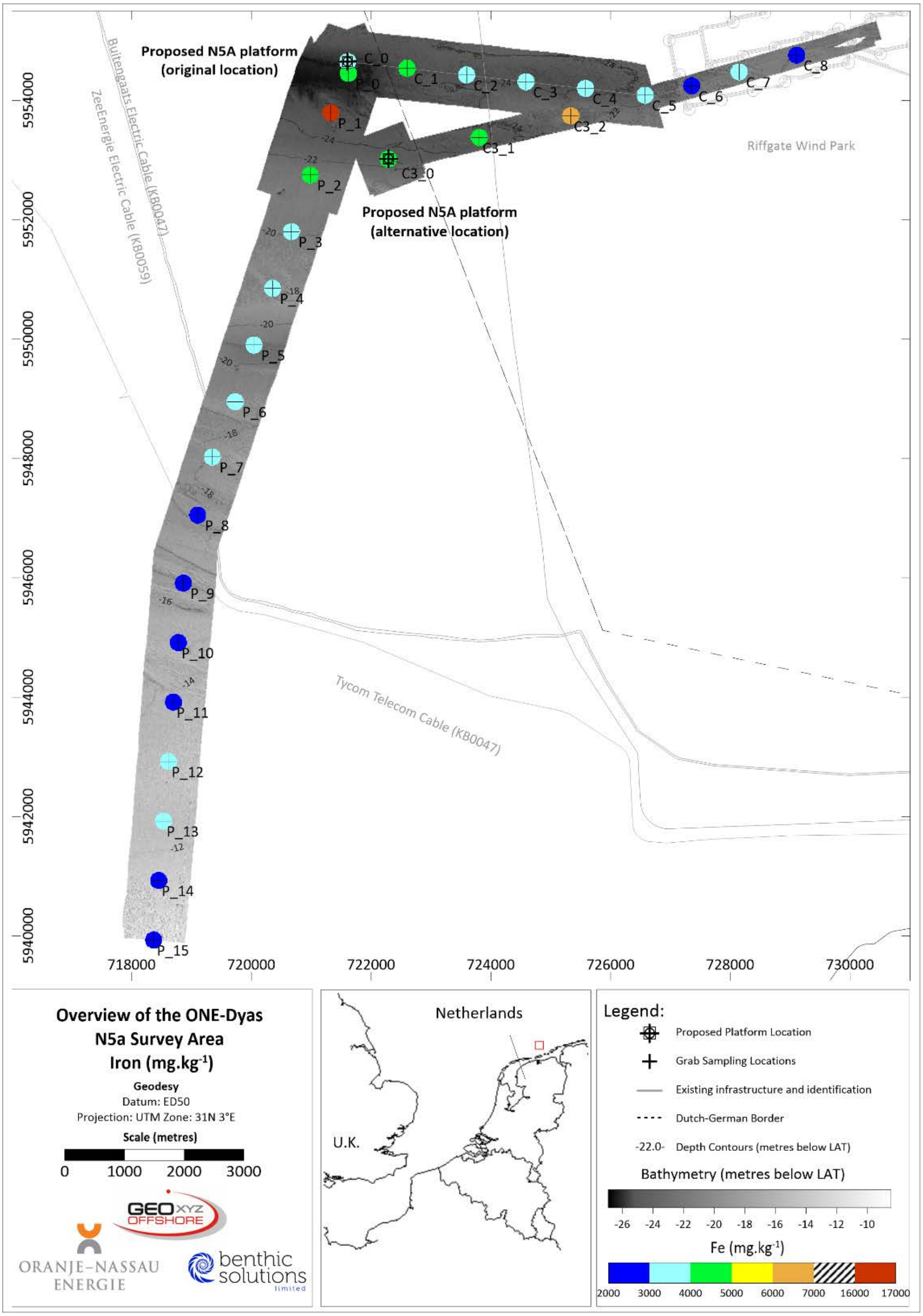


Figure 27: Heavy metal concentration for iron (Fe; mg.kg^{-1})

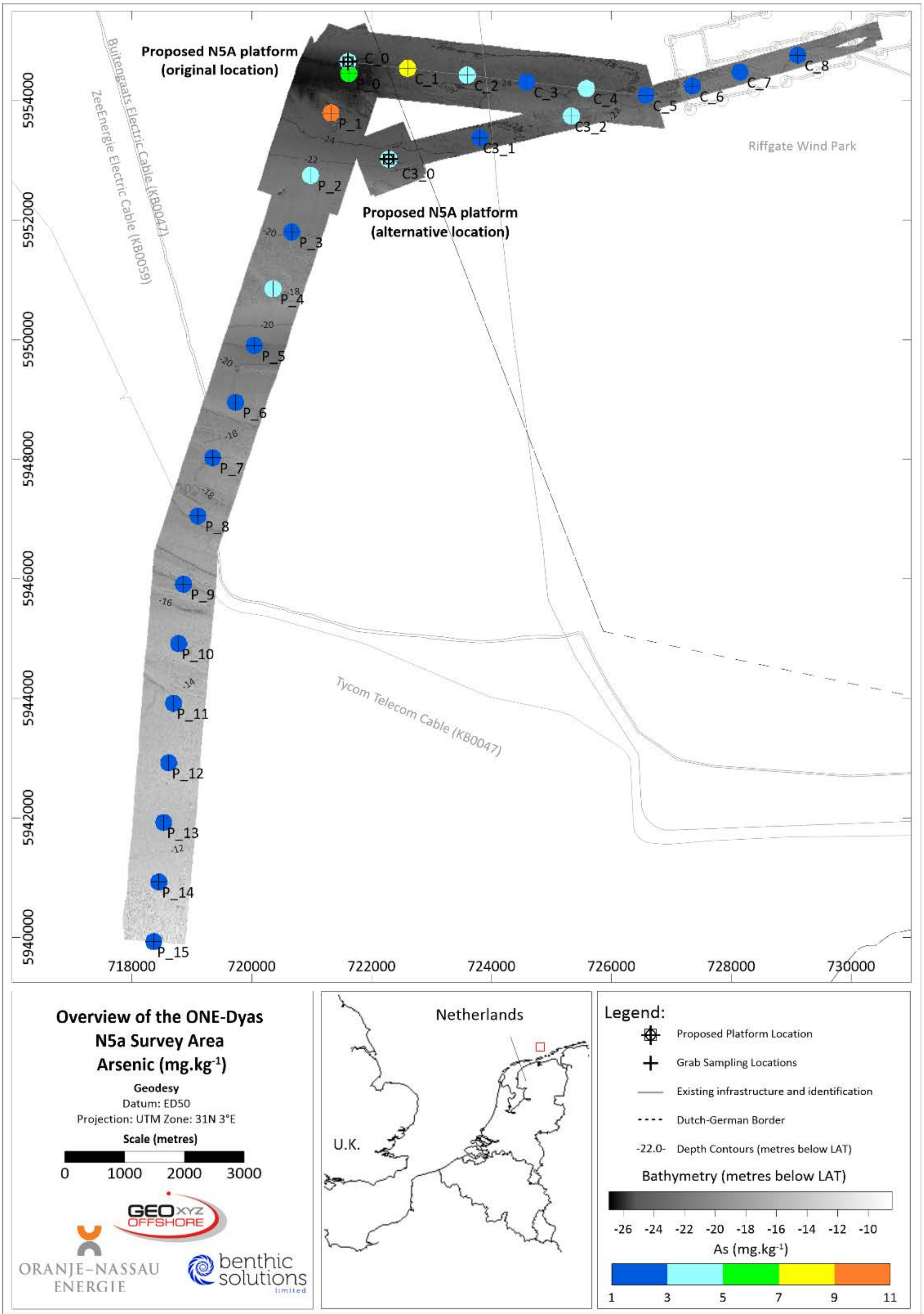


Figure 28: Heavy metal concentration for arsenic (As; mg.kg^{-1})

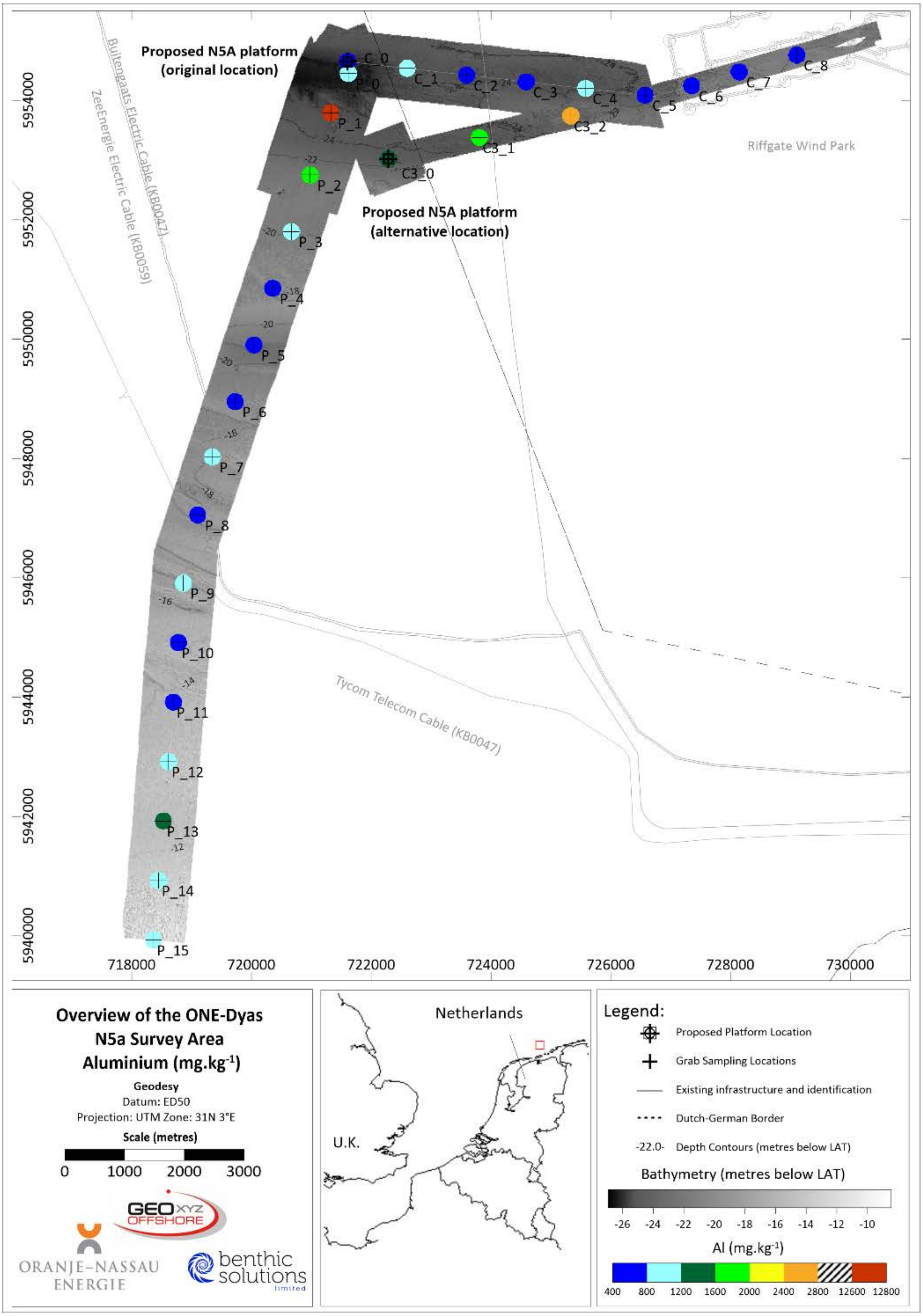


Figure 29: Heavy metal concentration for aluminium (Al; mg.kg-1)

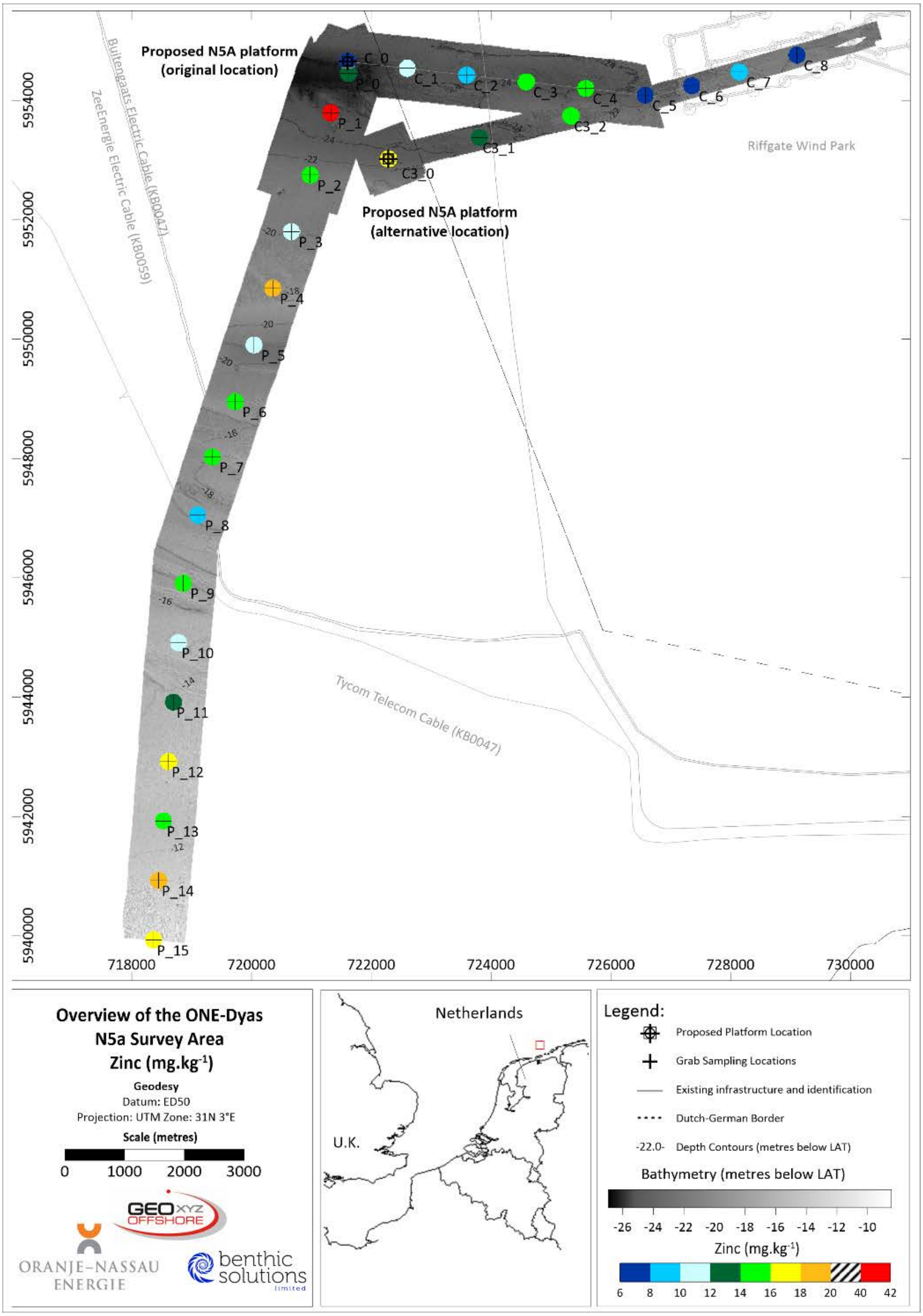


Figure 30: Heavy metal concentration for zinc (Zn; mg.kg^{-1})

3.8 MACROFAUNAL ANALYSES

Macrofaunal analysis was carried out on 56 grab sample replicates from 28 stations sampled within the N5A survey area. Macrofaunal samples were processed in the field over a 500µm mesh sieve. The sediment over the N5A survey area was found to consist of fine and coarse sand with varying densities of cobbles and some areas of exposed clay.

True solitary epifaunal species were counted while encrusting epifaunal species were recorded separately, as colonial epifauna, from the main phyla groupings (e.g. Annelida, Arthropoda, Mollusca and Echinodermata). Solitary epifauna include specimens that, although epifaunal in nature, are recorded in low counts. Colonial epifauna consist of encrusting epifauna which are generally recorded in high counts or as presence/absence. For this survey colonial epifauna included Cnidaria and Bryozoa. Colonial epifauna were omitted from statistical analyses as a true abundance cannot be determined. Within the present analyses solitary epifauna have been included with infaunal species, however, due to the importance that colonial epifauna can have at locations containing coarse sediments; the richness of these macrobenthos is presented and discussed separately in Section 3.8.5.

Subsequent macrofaunal taxonomy of all recovered fauna identified a total of 16,550 individuals (infauna) from the 56 samples analysed. Faunal data for each sample are listed in Appendix M, whilst univariate analyses are summarised by replicate in Table 17and station in Table 18. Of the 150 taxa recorded, 118 were infaunal, consisting of 52 annelids accounting for 58.9% of the total individuals. The molluscs were represented by 21 taxa (9.3% of total individuals), the crustaceans by 35 taxa (7.9% of total individuals), echinoderms by three taxa (0.2% of total individuals) and others (Nematoda, Nemertea, Platyhelminthes, Branchiostoma) were accounted by four taxa (22.6% of total individuals). Solitary epifauna consisted of four taxa and accounted for 1.2% of total abundance. Colonial epifauna were represented by ten taxa, however abundance data for these species are not available as they are recorded as presence/absence. The proportional composition of the different faunal groups is presented in Figure 31 and Figure 32 (abundance) and Figure 33 and Figure 34 (richness) by replicate, and Figure 35 (abundance) and Figure 36 (richness) by station.

With the exception of species that have been intentionally grouped at higher taxonomic levels (i.e. Nematoda and Nemertea), all adult specimens were identified to species level (~85% of samples). Five fragmented species were noted during the survey and were excluded from analyses. Juveniles (if present) are often excluded from community analyses due to their high mortality prior to reaching maturity and difficulties in distinguishing species of the same genus. Consequently, they tend to induce a recruitment spike at certain times of the year due to rapid settlement and colonisation but are essentially an ephemeral part of the population masking the underlying trends within the mature adults. A total of 1,032 juvenile individuals spanning 15 taxa were recorded during the current survey. Highest numbers of juveniles were found within the class Asteroidea, with a total number of 585 across the survey area (>300 individuals at GRAB_P_0). These numbers are considered to be low as juvenile numbers are expected to be in the thousands during recruitment periods. Nonetheless, juveniles have been excluded from further analysis as their inclusion was likely to significantly impact the results.

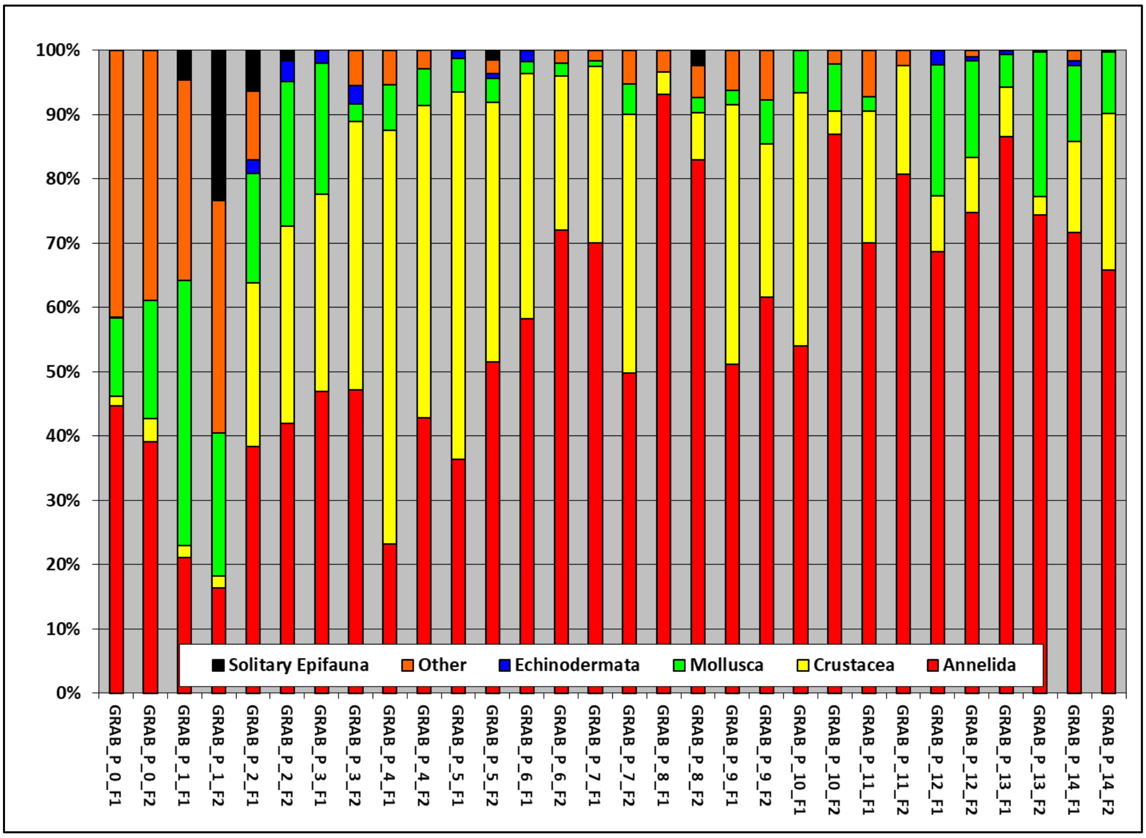


Figure 31: Proportion of individual abundance by main taxonomic group for each replicate (part 1)

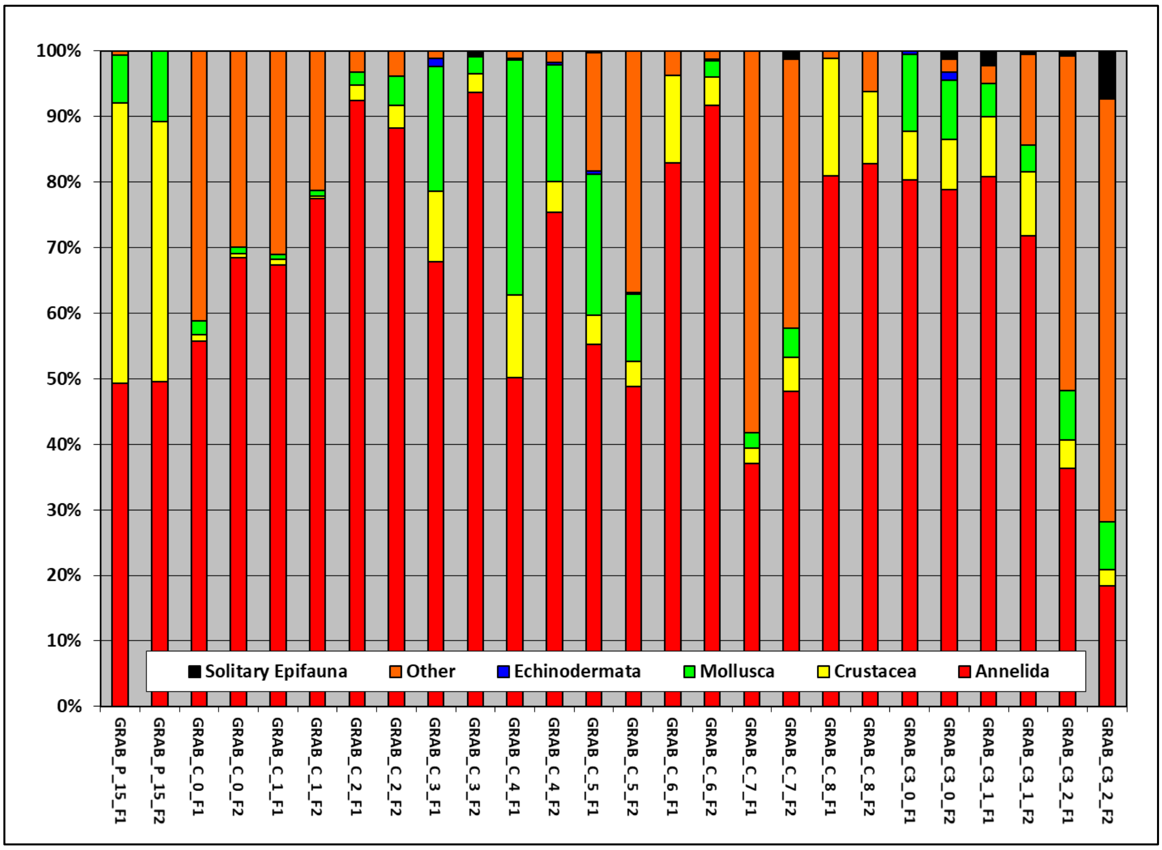


Figure 32: Proportion of individual abundance by main taxonomic group for each replicate (part 2)

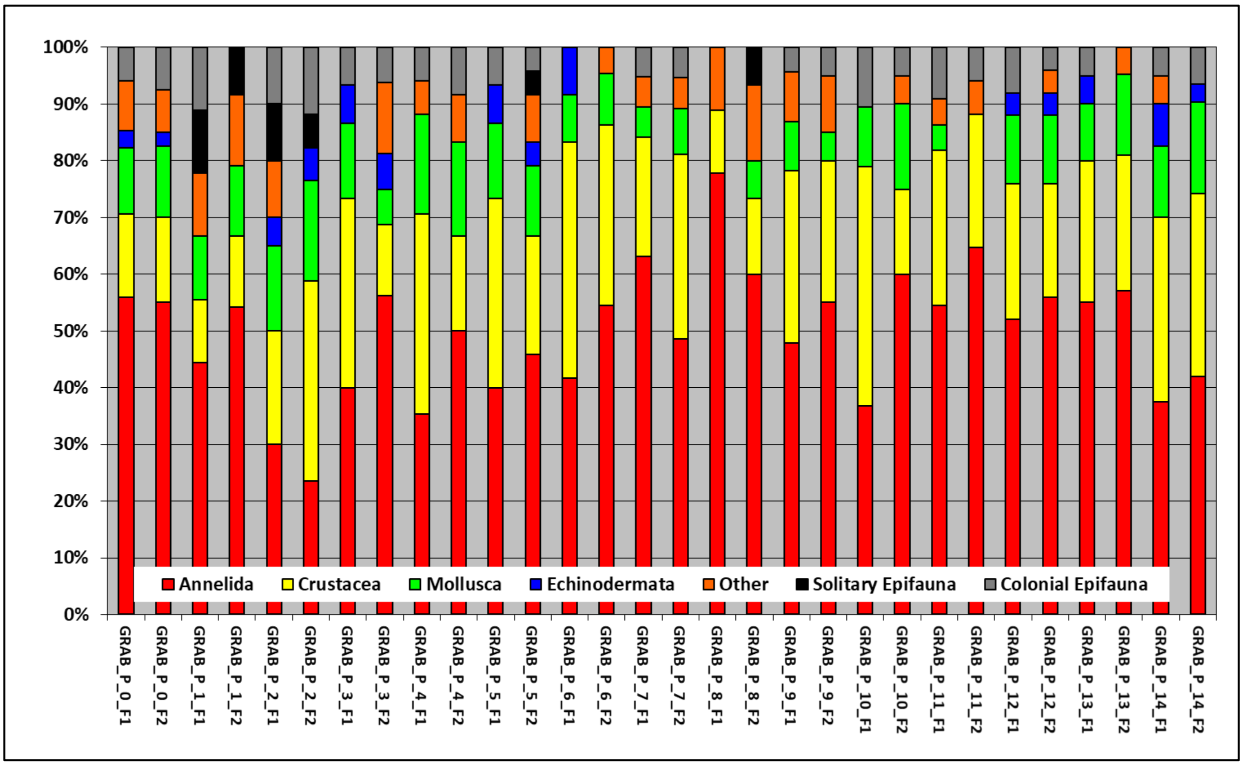


Figure 33: Proportion of individual richness by main taxonomic group for each replicate (part 3)

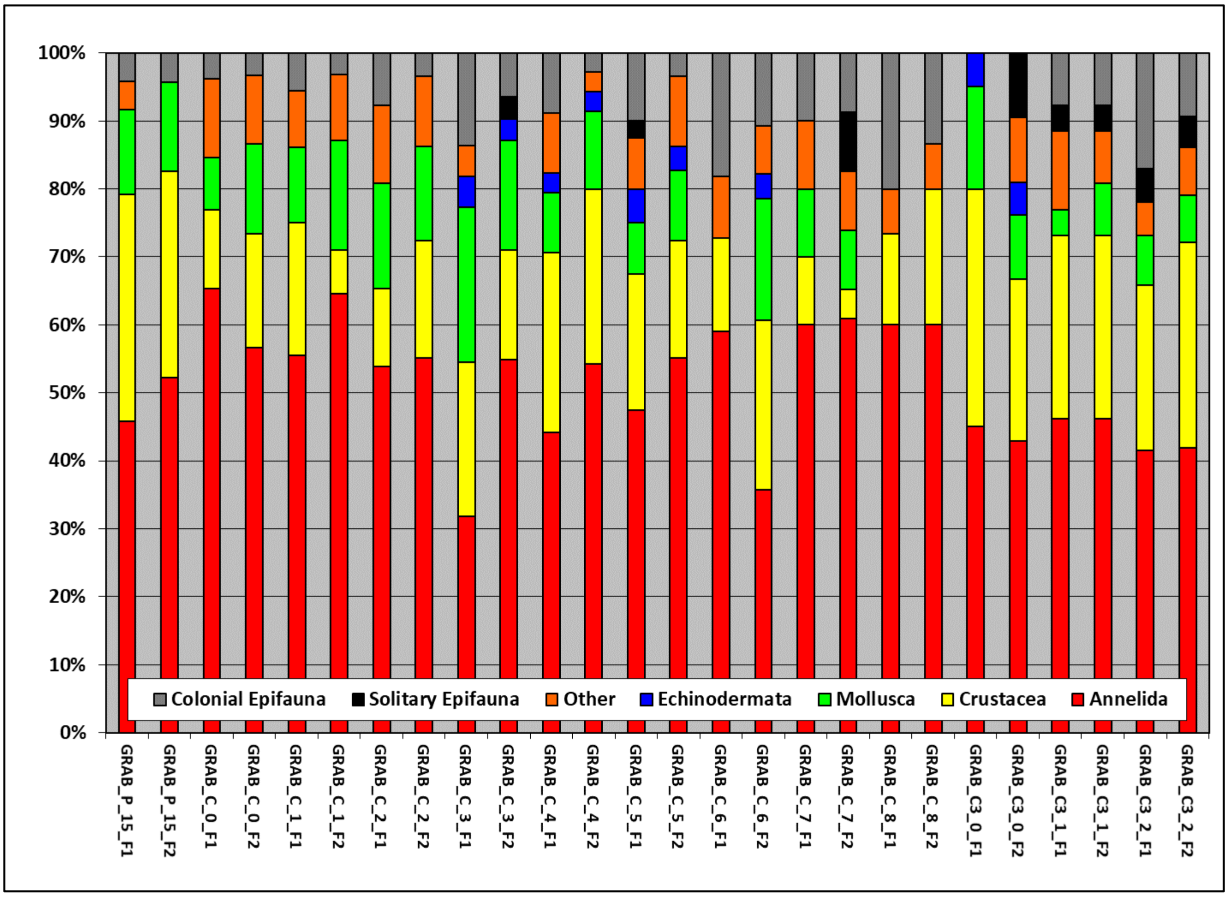


Figure 34: Proportion of individual richness by main taxonomic group for each replicate (part 4)

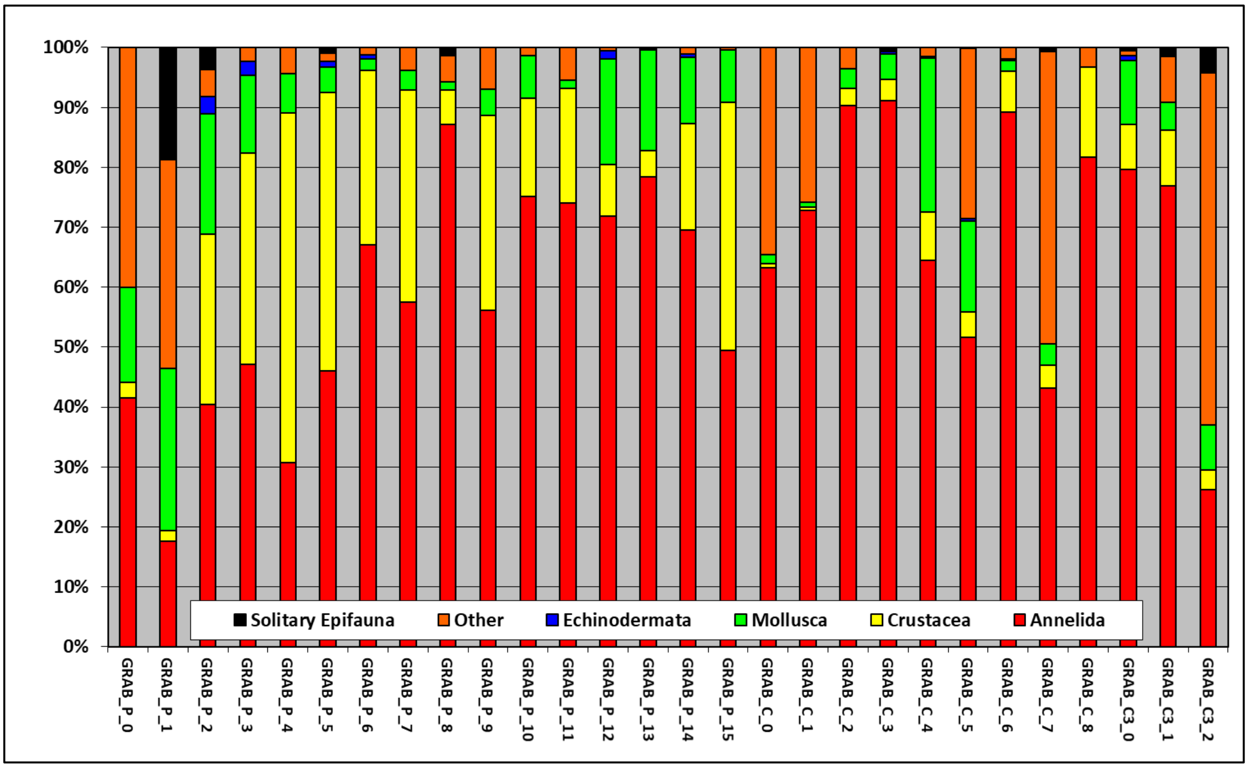


Figure 35: Proportion of individual abundance by main taxonomic group for each station

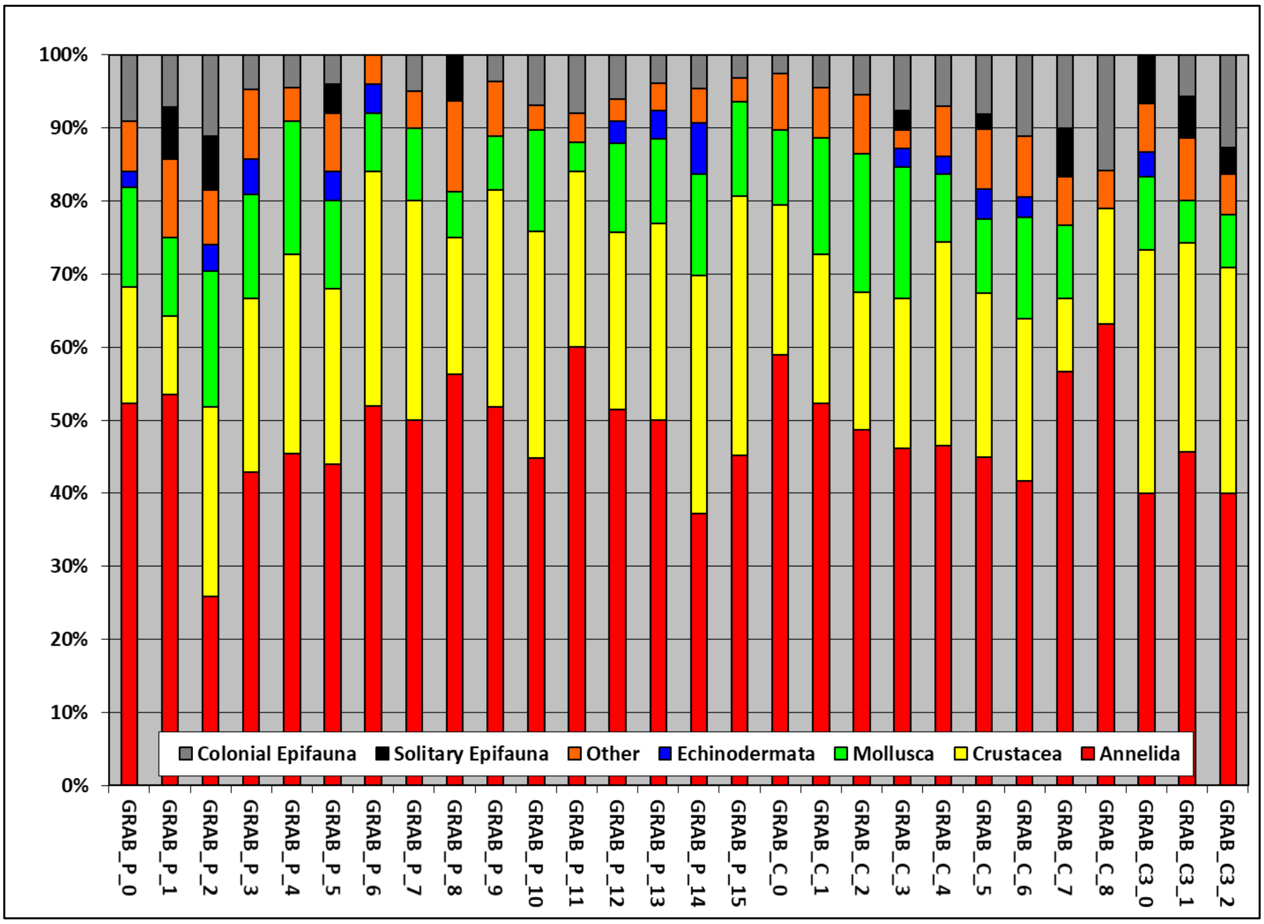


Figure 36: Proportion of individual richness by main taxonomic group for each station

3.8.1 Infaunal Trends

The macrofauna throughout the N5A survey area showed moderate species richness and high abundance, with some variation evident between stations. The infaunal community was in most instances dominated by annelids, followed by molluscs and crustaceans in terms of species richness, and in terms of abundance annelids were commonly dominant. Exceptions to this included GRAB_P_1, GRAB_P_4, GRAB_P_5, GRAB_C_7 and GRAB_C3_2, where annelids were not the most dominant phylum.

A measure of the overall dominance pattern in the sampling area was achieved by ranking the top 15 species per station according to abundance, giving a rank score of ten to the most abundant species, decreasing to one for the tenth most abundant species, and summing these scores for all 56 samples to provide an overall dominance score (Eleftheriou and Basford, 1989) for each species. The rank dominance calculation indicated a fairly homogeneous spread of macrofaunal species across the N5A survey area, resulting in seven of the highest numerically ranked species being listed in the top ten overall dominance ranks (Table 16). Notable variation in abundance and dominance rank was shown by the polychaete *Nephtys cirrosa* which was ranked 24th for abundance (103 individuals) and 13th for dominance, suggesting a patchy distribution of this species. The rank dominance was shown in both abundance and richness, with six annelids recorded in the top ten ranked species. In overall rank order, the annelid *Spiophanes bombyx* was top and relatively dominant in terms of abundance with 1993 individuals across the 56 stations (Table 16). This was followed by the two annelids, *Lanice conchilega* (2213 individuals, and commonly known as sand mason worm) and *Scoloplos armiger* (543 individuals), other Nematoda (3443 individuals) and annelid *Ophelia borealis*. Ranks six to ten were dominated by the bivalve mollusc, *Abra alba*, two crustaceans, *Tanaissus lilljeborgi* and *Bathyporeia elegans* and two annelids, *Magelona johnstoni* and *Grania*.

No single taxa was recorded in every replicate sample, however the bristle worm *Spiophanes bombyx* occurred in 52 of the 56 replicates (93% of replicates). Out of the total 16,550 individuals recorded, 38 taxa across five phyla were recorded in only one replicate across the survey area, while 17 of these taxa (3 phyla) were recorded just once. The highest number of individuals was recorded at station GRAB_P_0 and GRAB_C3_2, recording a total of 2,372 and 1,938 individuals respectively, which was a result of the high numbers of *Nematoda* counted, with over 58% of all Nematoda individuals found at these two stations alone (Table 18).

Table 16: Overall Species Ranking (Top 15 Species)

Overall Top 15 Rank	Species/Taxon	Total rank score (out of 560)	Phylum	Numerical Abundance (56 replicates)	Numerical Top 15 rank
1	*Spiophanes bombyx*	367	Annelida	1993	3
2	*Lanice conchilega*	329	Annelida	2213	2
3	*Scoloplos armiger*	263	Annelida	543	9
4	Nematoda	221	Others	3443	1
5	*Ophelia borealis*	176	Annelida	573	8
6	*Abra alba*	147	Mollusca	1087	4
7	*Tanaissus lilljeborgi*	143	Crustacea	237	11
8	*Bathyporeia elegans*	115	Crustacea	181	16
9	*Magelona johnstoni*	112	Annelida	724	7
10	*Grania*	112	Annelida	790	6
11	*Monopseudocuma gilsoni*	107	Crustacea	222	13
12	*Nephtys cirrosa*	96	Annelida	106	24
13	*Lagis koreni*	96	Annelida	353	10
14	*Eteone longa*	80	Annelida	196	14
15	*Aonides paucibranchiata*	80	Annelida	1024	5

Further comments relating to the macrobenthic infaunal population and their separate phyletic groups are presented below, with comments on epifaunal species shown in Section 3.7.5. Example photographs of some macro-invertebrate specimens recorded during the survey are shown in Figure 37.

Annelida The Annelida group encompassed 45 taxa, with 43 belonging to Polychaeta and four belonging to Oligochaeta. The most abundant polychaete by a large margin was *Lanice conchilega*, otherwise known as the sand mason worm. This species forms tubes that project from the seabed with a characteristic fringe. It was recorded in 52 out of the 56 samples, however its abundance varied across the survey area. In some stations the species was recorded with only a few individuals whereas in the sample P_00_F1 it reached 261 individuals. The species is known to display different feeding strategies depending on its densities, adopting deposit feeding in low densities and suspension feeding when the polychaete is found in higher densities as coping mechanism due to competition (several thousand individuals per m^2) (Buhr & Winter, 1977).

The Pectinariidae *Lagis koreni* was also one of the most common species recorded. These worms form a tube with a mucus extension and often co-occurs with high densities of *Abra alba* (Eagle, 1975), which was also present in high numbers in the survey area.

The errant polychaeta included a mix of omnivorous and carnivorous species. Spionidae showed the highest diversity with ten taxa recorded, including three species of the genus *Spio* sp. The Spionidae worms *Spiophanes bombyx* and *Aonides paucibranchiata* were recorded in high numbers, with *S. bombyx* occurring with upwards of 550 individuals at one station and *A. paucibranchiata* reaching 425 individuals in one sample.

Arthropoda The Arthropoda group was well represented with 38 taxa being identified, including Cirripedia, Copepoda, Amphipoda, Isopoda, Tanaidacea, Cumacea and Decapoda. Amongst the Crustacea, the tanaid *Tanaissus lilljeborgi* was the most abundant and it is the only tanaid commonly found in sublittoral sands in UK waters (Jones & Holdich, 1983).

Amphipods were varied and distributed sporadically throughout the samples, with 19 taxa identified. Two species of the amphipod genus *Bathyporeia* were recorded including *B. elegans* and *B. guilliamsoniana,* with the former being the most abundant. All species within the genus *Bathyporeia* are burrowing amphipods that are confined to sandy bottoms (d'Udekem d'Acoz, 2004). *Urothoe poseidonis* was recorded in moderate abundance and was present in 26 out of the 56 stations. Another species of Urothoe, *U. brevicornis,* was also present but in much lower abundance with only three individuals recorded.

Several species of Decapods were recorded including several brachyuran crabs, the hermit crab *Pagurus bernhardus*, the mud shrimp *Upogebia deltaura* and the caridean shrimps *Processa modica* and *Crangon crangon.* Brachyuran crabs recorded included the spider crab *Macropodia rostrata*, the thumbnail crab *Thia scutellata* and the pea crab *Pinnotheres pisum*, which is a parasitic crab that lives in bivalve shells such as *Mytilus* and *Spisula* sp. (Ingle, 1997).

Mollusca The mollusc group was well represented with 29 taxa identified including Gastropoda and Bivalvia. Bivalves were common throughout the survey with *Abra alba* occurring in 36 out of 56 samples, and in the highest abundance, with up to 243 individuals recorded at station P_00_F2. The largest bivalve observed in the samples was the non-native razor shell *Ensis leei* which occurred in moderate numbers. The species is native to the North American Atlantic coast, from Canada to South Carolina and was first reported in Europe from the Netherlands in 1984 and from the UK in 1989 and is now spreading quickly across the southeast coast of England (Oliver et al., 2016). It can burrow itself quickly into the sediment and is able to swim three to five metres at a time by flicking its foot and propelling a jet of water out of the pedal opening (Fraser *et al*., 2018).

Gastropods were represented by eight different taxa but were infrequently recorded across the survey area with the most abundant being the micromollusc *Caecum glabrum*.

Minor Phyla Minor phyla included Echinoderms, Chordates and Ascidians. The number of Echinodermata was small with only seven taxa however high numbers of juvenile Asteroidea were present in high numbers throughout the survey area. The sea potato *Echinocardium cordatum* occurred in low numbers at 21 stations. The species lives in a permanent burrow buried about 8 cm deep.

Amongst Chordata, juvenile Ascidians were recorded at 21 stations. The lancelet *Branchiostoma lanceolatum* was recorded at 14 stations. This animal is considered an invertebrate as it has a notochord but no backbone. *B. lanceolatum* is covered with fins and manages to cover small distances by swimming; however, it stays buried in coarse sediment most of the time (Degraer *et al*., 2006). Only one species of fish was found in the survey area, the sand goby *Pomatoschistus minutus*. This species is abundant in inshore waters on sandy and muddy bottoms. It is caught in abundance by shrimp fishermen using beam trawls and in push nets over sandy shores. Although it enters estuaries, it always stays in moderately deep waters (Wheeler, 1969).

As previously discussed in Section 3.4, coarse material was a minimal component of the sediment at most of the grab sample stations, where the main component was sand. As a result, there was little substrate available for colonisation by sessile epifaunal species, which was reflected in the results with a much greater abundance of infaunal species in comparison to colonial epifaunal species. Across all stations there were 118 infaunal species and only ten colonial epifaunal species.

Figure 37: Example photographs of macrofauna species within survey area

3.8.2 Univariate Parameters

The primary and univariate parameters for all stations are listed in Table 17 by replicate and in Table 18 by station. The number of species per 0.1m2 sample was considered moderately diverse, ranging from nine species for replicate GRAB_P_8 F1 to a maximum of 38 species for replicate GRAB_P_14 F1 (mean 22.8±7.5SD). The species richness throughout the N5A survey area is illustrated in Figure 38 and Figure 39.

Species abundance was considerably more variable than richness throughout the survey area, ranging from a minimum of 29 individuals for replicate GRAB_P_8 F1 to a maximum of 1,368 for replicate GRAB_P_0 F2, giving a mean of 295 ±319SD. By station, the mean number of individuals increased to 591±615SD with the highest number of 2,372 individuals recorded at station GRAB_P_0. The high variability in the mean number of individuals by replicate and station was the consequence of the patchy distribution of Nematoda and the annelids *Spiophanes bombyx* and *Lanice conchilega*, which showed particularly high abundances at some stations. For example, 915 Nematoda were recorded at GRAB_P_0 but no specimens were recorded at GRAB_C3_0. The individual abundance by station throughout the survey area is illustrated in Figure 40.

The sediment characteristics had a significant impact on the fauna observed at each station, with significant Spearman's rank correlations seen between several primary and univariate macrofauna variables and fines (Appendix N). Negative correlations were found between the percentage of fines and evenness ($\rho(28)=-0.537$, $p<0.01$), percentage fines and Shannon-Wiener Diversity ($\rho(28)=-0.534$, $p<0.01$) and percentage fines and Simpson's Diversity ($\rho(28)=-0.478$, $p<0.05$). Conversely, the percentage of sands and evenness were positively correlated ($\rho(28)=0.400$, $p<0.05$). Faunal abundance was positively correlated with water depth ($\rho(28)=0.383$, $p<0.05$) and negative correlations were seen between both Shannon-Wiener diversity and Evenness and with distance to shore and water depth. The relationship between richness and abundance is presented in Figure 40.

Table 17: Univariate faunal parameters (0.1m² replicates)

Station	Number of Species per 0.1m² (S)	Number of Individuals per 0.1m² (N)	Richness (Margalef)	Evenness (Pielou's Evenness)	Shannon-Wiener Diversity	Simpsons Diversity (1-Lambda')
GRAB_P_00_F1	32	1004	4.49	0.54	2.69	0.75
GRAB_P_00_F2	37	1368	4.99	0.57	2.96	0.79
GRAB_P_01_F1	16	109	3.20	0.66	2.63	0.75
GRAB_P_01_F2	24	324	3.98	0.60	2.76	0.78
GRAB_P_02_F1	18	47	4.42	0.89	3.72	0.92
GRAB_P_02_F2	15	62	3.39	0.83	3.25	0.86
GRAB_P_03_F1	14	49	3.34	0.90	3.43	0.91
GRAB_P_03_F2	15	36	3.91	0.87	3.39	0.90
GRAB_P_04_F1	16	56	3.73	0.76	3.04	0.81
GRAB_P_04_F2	11	35	2.81	0.76	2.64	0.78
GRAB_P_05_F1	14	77	2.99	0.81	3.07	0.85
GRAB_P_05_F2	23	136	4.48	0.80	3.61	0.88
GRAB_P_06_F1	12	55	2.75	0.76	2.74	0.80
GRAB_P_06_F2	22	100	4.56	0.80	3.57	0.89
GRAB_P_07_F1	18	120	3.55	0.70	2.90	0.80
GRAB_P_07_F2	35	191	6.47	0.81	4.16	0.91
GRAB_P_08_F1	9	29	2.38	0.92	2.90	0.88
GRAB_P_08_F2	15	41	3.77	0.87	3.39	0.89
GRAB_P_09_F1	22	129	4.32	0.84	3.75	0.90
GRAB_P_09_F2	19	117	3.78	0.85	3.61	0.89

Station	Number of Species per 0.1m² (S)	Number of Individuals per 0.1m² (N)	Richness (Margalef)	Evenness (Pielou's Evenness)	Shannon-Wiener Diversity	Simpsons Diversity (1-Lambda')
GRAB_P_10_F1	17	76	3.70	0.77	3.13	0.85
GRAB_P_10_F2	19	137	3.66	0.71	3.02	0.80
GRAB_P_11_F1	20	137	3.86	0.81	3.48	0.88
GRAB_P_11_F2	16	83	3.40	0.81	3.23	0.87
GRAB_P_12_F1	23	172	4.27	0.79	3.60	0.90
GRAB_P_12_F2	24	186	4.40	0.79	3.62	0.89
GRAB_P_13_F1	19	156	3.56	0.59	2.50	0.67
GRAB_P_13_F2	21	320	3.47	0.59	2.59	0.72
GRAB_P_14_F1	38	597	5.79	0.68	3.55	0.83
GRAB_P_14_F2	29	336	4.81	0.73	3.57	0.86
GRAB_P_15_F1	23	150	4.39	0.83	3.76	0.90
GRAB_P_15_F2	22	121	4.38	0.76	3.40	0.86
GRAB_C_00_F1	25	609	3.74	0.63	2.93	0.79
GRAB_C_00_F2	29	875	4.13	0.60	2.93	0.81
GRAB_C_01_F1	34	867	4.88	0.56	2.85	0.80
GRAB_C_01_F2	30	988	4.21	0.55	2.69	0.75
GRAB_C_02_F1	24	212	4.29	0.62	2.85	0.74
GRAB_C_02_F2	28	230	4.97	0.70	3.39	0.83
GRAB_C_03_F1	19	84	4.06	0.79	3.37	0.85
GRAB_C_03_F2	29	762	4.22	0.35	1.69	0.42
GRAB_C_04_F1	31	429	4.95	0.58	2.89	0.76
GRAB_C_04_F2	34	557	5.22	0.58	2.95	0.77
GRAB_C_05_F1	36	355	5.96	0.69	3.58	0.88
GRAB_C_05_F2	28	439	4.44	0.67	3.23	0.83
GRAB_C_06_F1	18	135	3.47	0.79	3.28	0.87
GRAB_C_06_F2	25	326	4.15	0.49	2.28	0.61
GRAB_C_07_F1	18	127	3.51	0.62	2.58	0.68
GRAB_C_07_F2	21	156	3.96	0.72	3.17	0.83
GRAB_C_08_F1	12	89	2.45	0.75	2.70	0.80
GRAB_C_08_F2	13	64	2.89	0.77	2.85	0.78
GRAB_C3_00_F1	20	203	3.58	0.63	2.71	0.75
GRAB_C3_00_F2	21	156	3.96	0.70	3.07	0.82
GRAB_C3_01_F1	24	219	4.27	0.53	2.41	0.60
GRAB_C3_01_F2	24	174	4.46	0.68	3.10	0.77
GRAB_C3_02_F1	34	842	4.90	0.55	2.77	0.72
GRAB_C3_02_F2	39	1096	5.43	0.46	2.43	0.60
Mean	22.8	296	4.09	0.70	3.08	0.80
SD	7.5	319	0.83	0.12	0.45	0.09
CV (%)	33.2	107.8	20.2	17.7	14.8	11.8

Table 18: Univariate faunal parameters (0.2m² pooled station replicates)

Station	Number of Species per 0.2m² (S)	Number of Individuals per 0.2m² (N)	Richness (Margalef)	Evenness (Pielou's Evenness)	Shannon-Wiener Diversity	Simpsons Diversity (1-Lambda')
GRAB_P_00	40	2372	5.02	0.54	2.89	0.78
GRAB_P_01	26	433	4.12	0.60	2.83	0.79
GRAB_P_02	24	109	4.90	0.85	3.90	0.91
GRAB_P_03	20	85	4.28	0.87	3.75	0.92
GRAB_P_04	21	91	4.43	0.74	3.24	0.80
GRAB_P_05	24	213	4.29	0.79	3.64	0.90
GRAB_P_06	25	155	4.76	0.76	3.55	0.88
GRAB_P_07	38	311	6.45	0.73	3.86	0.88
GRAB_P_08	16	70	3.53	0.86	3.43	0.89
GRAB_P_09	26	246	4.54	0.82	3.87	0.91
GRAB_P_10	27	213	4.85	0.71	3.38	0.85
GRAB_P_11	23	220	4.08	0.77	3.50	0.88
GRAB_P_12	31	358	5.10	0.76	3.79	0.90
GRAB_P_13	25	476	3.89	0.57	2.67	0.71
GRAB_P_14	41	933	5.85	0.69	3.67	0.84
GRAB_P_15	30	271	5.18	0.77	3.80	0.89
GRAB_C_00	38	1484	5.07	0.58	3.02	0.81
GRAB_C_01	42	1855	5.45	0.52	2.82	0.78
GRAB_C_02	35	442	5.58	0.64	3.28	0.79
GRAB_C_03	36	846	5.19	0.40	2.05	0.51
GRAB_C_04	40	986	5.66	0.60	3.18	0.82
GRAB_C_05	45	794	6.59	0.64	3.53	0.86
GRAB_C_06	32	461	5.05	0.55	2.77	0.71
GRAB_C_07	27	283	4.61	0.65	3.10	0.78
GRAB_C_08	16	153	2.98	0.74	2.94	0.80
GRAB_C3_00	30	359	4.93	0.61	3.00	0.79
GRAB_C3_01	33	393	5.36	0.57	2.87	0.68
GRAB_C3_02	49	1938	6.34	0.48	2.70	0.66
GRAB_P_00	40	2372	5.02	0.54	2.89	0.78
Mean	30.7	591	4.93	0.67	3.25	0.81
SD	8.7	614	0.84	0.12	0.46	0.09
CV (%)	28.3	104.0	17.1	18.2	14.3	11.4

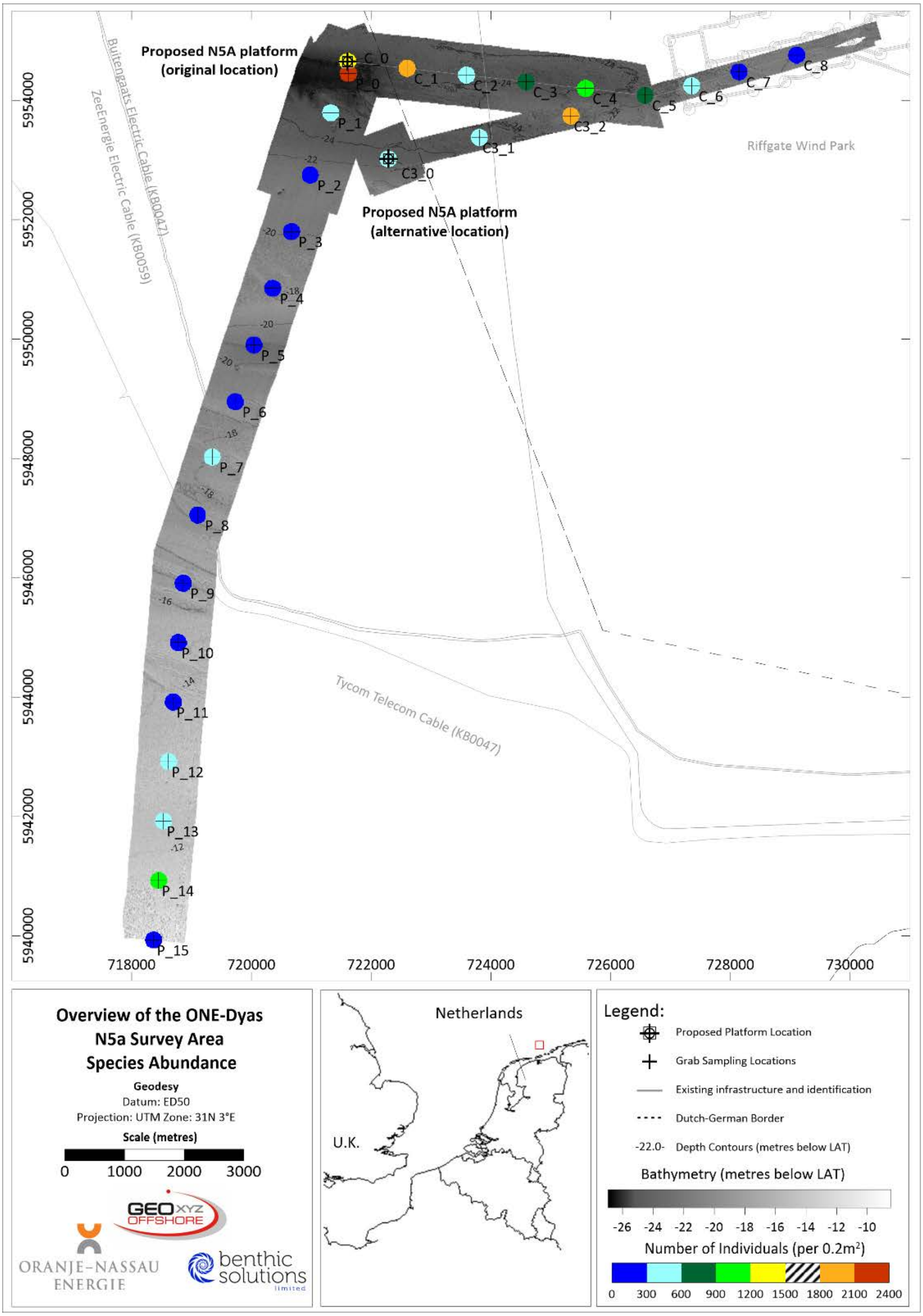


Figure 38: Macrofauna species abundance (per 0.2m²)

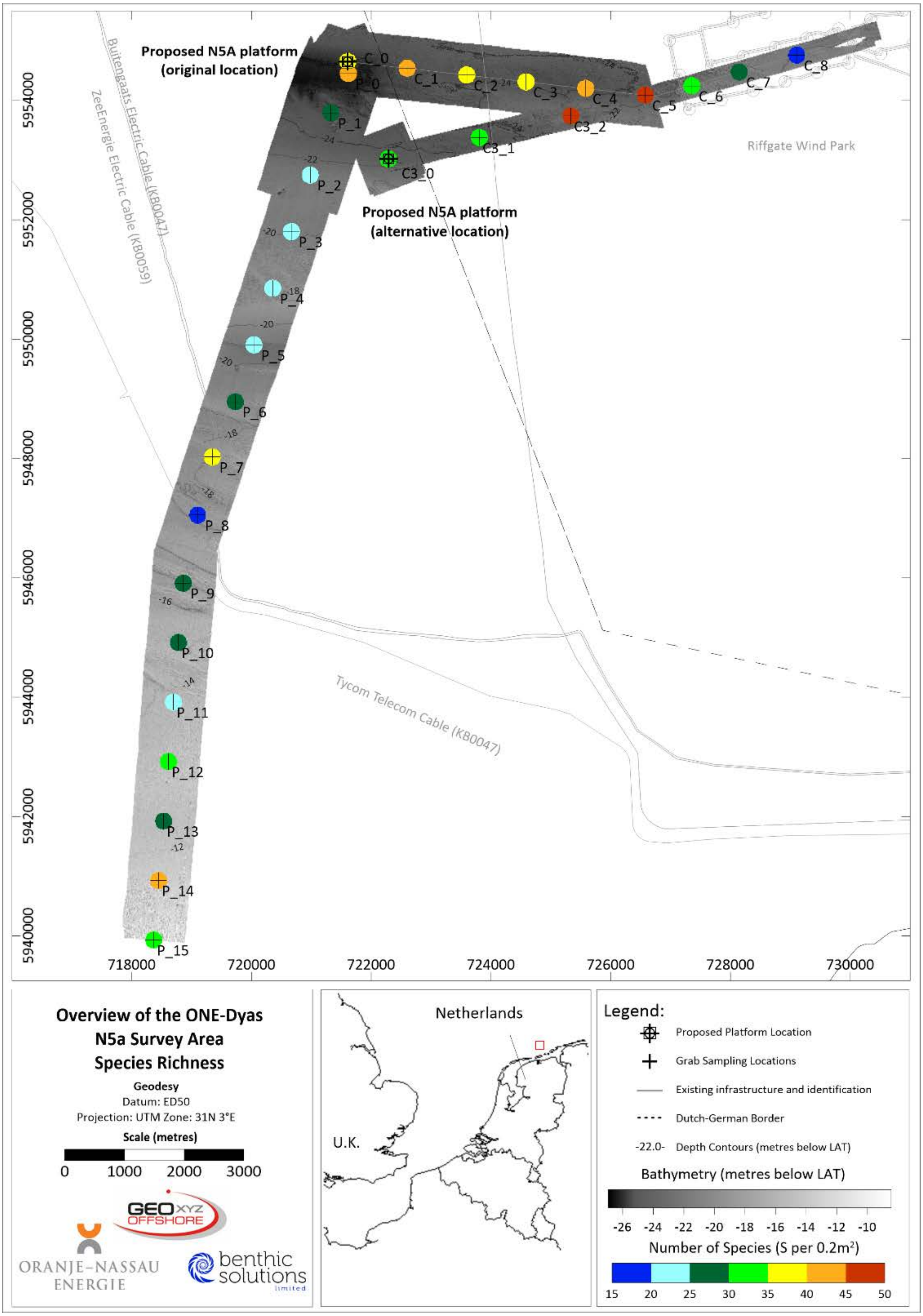


Figure 39: Macrofauna species richness (per 0.2m²)

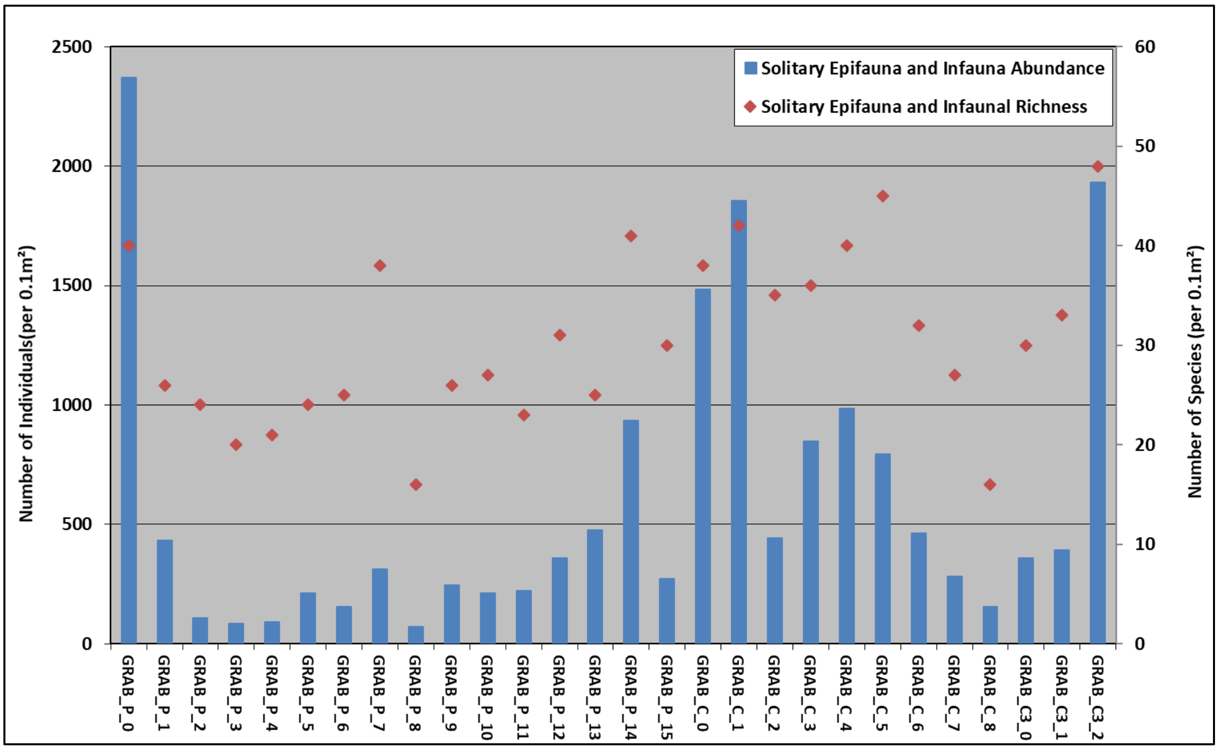


Figure 40: Species abundance and richness by station (0.2m²)

Theoretical species richness was calculated by the Chao-1 formula, which determines the number of additional species required to reach the asymptotic richness of the region based on the samples recovered (see Appendix F). The consistent accumulation of taxa with each new sample was demonstrated in a species accumulation curve as shown in Figure 41. The minimum curve in this figure demonstrated a relatively fast-incremental increase in recorded species, as additional samples were acquired. This suggests that the population was high in diversity with a relatively high species richness being recorded at most stations. This analysis estimated the maximum species accumulation for the survey area to be 136 species, compared to the actual 118 infaunal species recorded during the survey. By interpolation, this shows that between ~6 and ~45 x 0.1m^2 stations would be required to recover a representative proportion (i.e. 67% or 91 species) of the overall population. The optimum curve showed that only one new species was accumulated from replicate 27 onwards, indicating that a larger dataset (i.e. larger number of samples) would be unlikely to increase the number of species significantly.

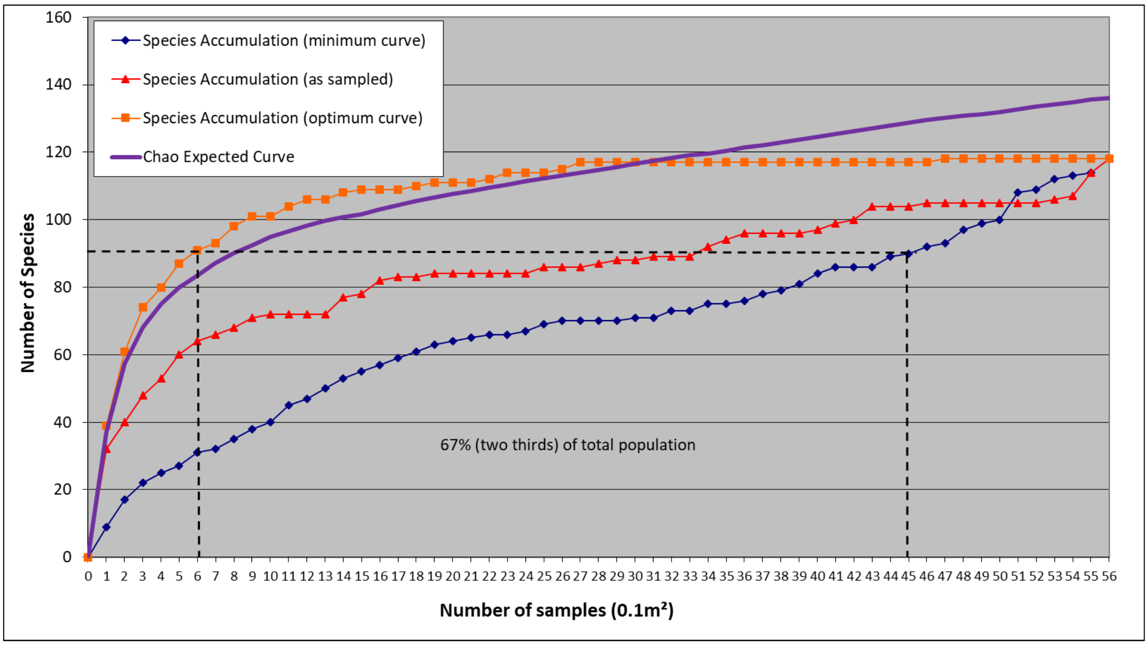


Figure 41: Species accumulation curve of the N5A survey area

The Shannon-Wiener diversity was variable throughout survey area, ranging from a minimum of 1.69 GRAB_C_3 F2 to a maximum of 4.16 at GRAB_P_7 F2 (mean 3.08±0.45SD), by replicate. The difference between the two samples is likely attributable to the high abundance of *S. bombyx* at GRAB_C3_2 F2 (576 individuals) and low abundance at GRAB_P_7 F2 (39 individuals). This trend was not repeated at station level with a minimum of 2.05 at station GRAB_C_3 to a maximum of 3.90 at station GRAB_P_2 (mean 3.25±0.46SD). The spatial variation in Shannon-Wiener diversity is presented by station in Figure 42, with stations along the pipeline route generally having a higher H' diversity value.

Pielou's equitability showed similar variation to the Shannon-Wiener index, with replicate GRAB_C_3 F2 showing the lowest evenness of 0.35, compared to a maximum equitability score of 0.92 for replicate GRAB_P_8 F1 (mean 0.70±0.12). By station, a similar pattern was observed once again as equitability was lowest for GRAB_C_3 (0.40) and highest for GRAB_P_8 (0.86) with a slightly lower mean equitability of 0.67±0.12SD. This indicates that species were relatively evenly represented within samples, although there was variation from station to station. Margalef's Index (Species Richness) showed moderate variation with maximum and minimum values recorded for GRAB_P_7 F2 and GRAB_P_8 F1 respectively by replicate (mean 4.09±0.83SD). By station, the maximum level was recorded for GRAB_C_5 (6.59) with a minimum of 2.98 for GRAB_C_8 (mean 4.93±0.84SD). Although species diversity was not highest for GRAB_C_5 (45 instead of the maximum 49 recorded elsewhere), this station showed low abundance relative to the species count. Simpson's diversity ranged from 0.51 at station GRAB_C_1 to 0.92 at station GRAB_P_3 (mean 0.81±0.09SD).

The overall picture indicated by the univariate parameters is one of a variable macrofauna diversity with no particular trend in spatial distribution.

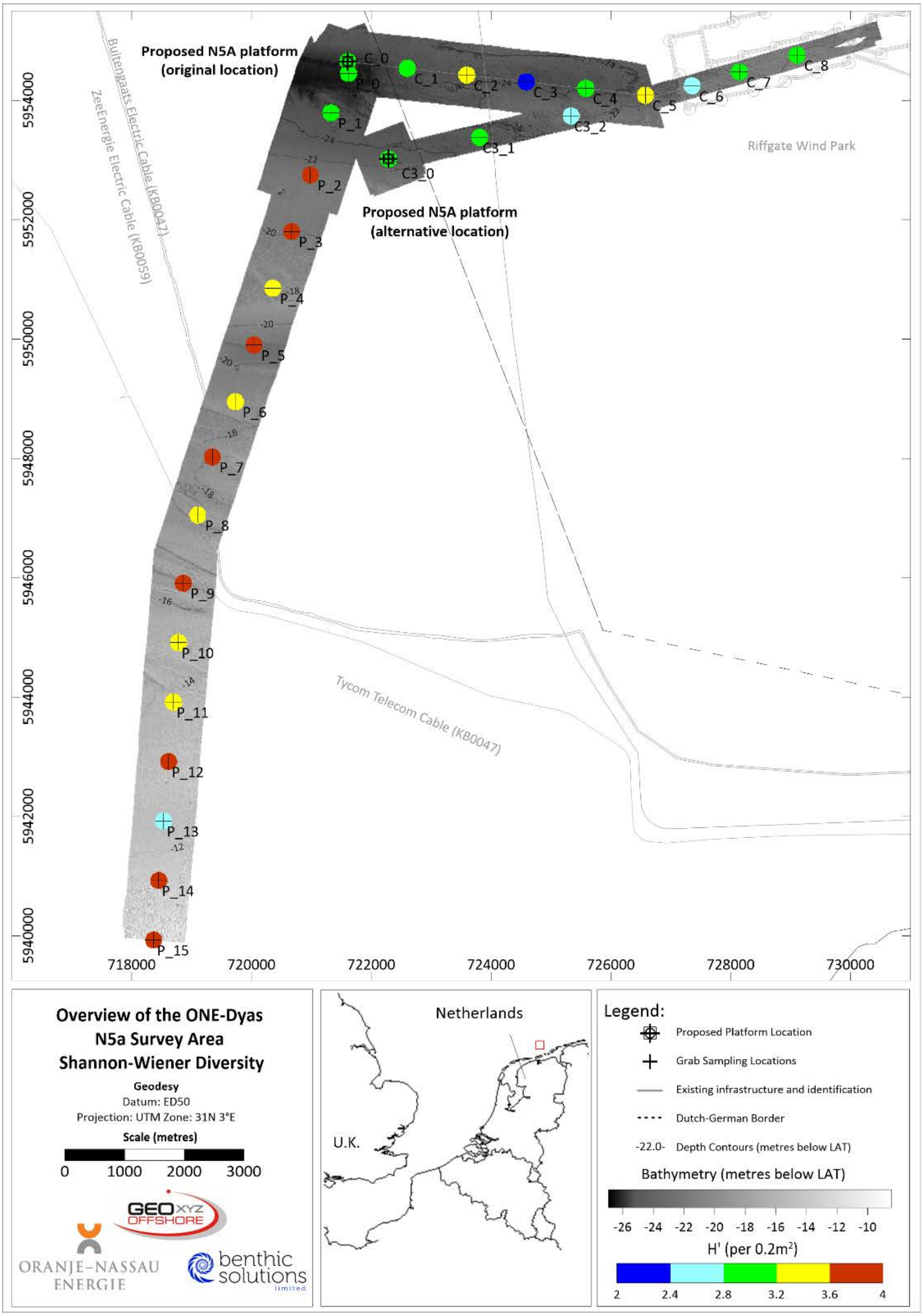


Figure 42: Macrofauna – Shannon-Wiener diversity (H per 0.1m²)

3.8.3 Multivariate Analyses

To provide a more thorough examination of the macrofaunal community, multivariate analysis was performed upon data using Plymouth Routines in Multivariate Ecological Research software (PRIMER; Clarke and Warwick, 1994) to illustrate data trends. Unlike univariate parameters, multivariate analyses preserve the identity of the different species by assigning a similarity or dissimilarity between the samples. Data were square-rooted prior to analysis to down-weight the effect of any dominant species.

Dendrogram – Group Average Method

A similarity dendrogram on a 45% slice level is presented for all replicates in Figure 43. This diagram shows that the faunal community recorded within the N5A survey area was very variable resulting in the identification of numerous SIMPROF groups (a-i). All replicates had a minimum similarity of 50.05%, with the highest similarity between GRAB_P_1 F1 & F2 at 67.68%. Samples collected along the pipeline to NGT Hot Tap route showed some separations from samples collected along the cable to Riffgat route. This was to be expected as samples acquired along the pipeline route were more southerly and closer to shore than stations along the cable route. Samples collected along the Hot Tap pipeline also showed some variability in their species composition. Intra and inter-station relationships were observed, with many replicates from the same stations clustered together. The converse was also evident, with several intra-station dissimilarities where replicates from different stations were grouped as more similar than the two samples taken for one station (e.g. cluster a, GRAB_P_3 F2 & GRAB_P_4 F2; cluster f, GRAB_P_4 F1 & GRAB_P_10 F1).

At a station level, the SIMPROF test revealed significant structural groupings (differentiated by black branches in the plot), providing further evidence for differences in the macrofauna assemblage within the survey area (Figure 44). As opposed to the 17 different SIMPROF clusters identified at replicate level, only eight significant groupings were evident. After applying a slice at 45% similarity level, four clusters were formed (a-d).

Cluster a included the highest number of stations (16 of 28 stations), comprising 81% of the pipeline route stations, two cable route stations (GRAB_C_3 & GRAB_C_4) and one alternative route station (GRAB_C3_0). These stations were also grouped together in the multivariate analysis of PSA data and were classified as 'infralittoral fine sand' habitat. Cluster b comprised stations GRAB_P_8 and GRAB_C_8, which had the lowest Margalef richness (2.98 and 3.53) for the survey area, with only 16 species recorded at low abundances (70 to 153 individuals). Being located within an area of 'infralittoral coarse sediment' habitat, resident fauna will be adapted to mobile sandy sediments, resulting in low richness and abundance. GRAB_P_1 was the only station grouped in cluster c and had high fines content (~44%), which would distinguish the faunal community from other stations. Cluster d, the second largest cluster, included ~67% of cable route stations, one pipeline station (GRAB_P_0) and two alternative route stations (GRAB_C3_1 & 2). Cluster c stations showed the highest species richness (27 to 49 species) and abundances and were also grouped together in the PSA multivariate analysis, highlighting the influence of habitat on species composition.

Table 19: Summary of SIMPROF groupings

SIMPROF Group	Similarity (%)	Stations
a	51.57	GRAB_P_2, GRAB_P_3, GRAB_P_4, GRAB_P_5, GRAB_P_6, GRAB_P_7, GRAB_P_9, GRAB_P_10, GRAB_P_11, GRAB_P_12, GRAB_P_13, GRAB_P_14,, GRAB_P_15, GRAB_C_3, GRAB_C_4, GRAB_C3_0
b	62.02	GRAB_P_8, GRAB_C_8
c	-	GRAB_P_1
d	55.09	GRAB_P_0, GRAB_C_0, GRAB_C_1, GRAB_C_2, GRAB_C_5, GRAB_C_6, GRAB_C_7

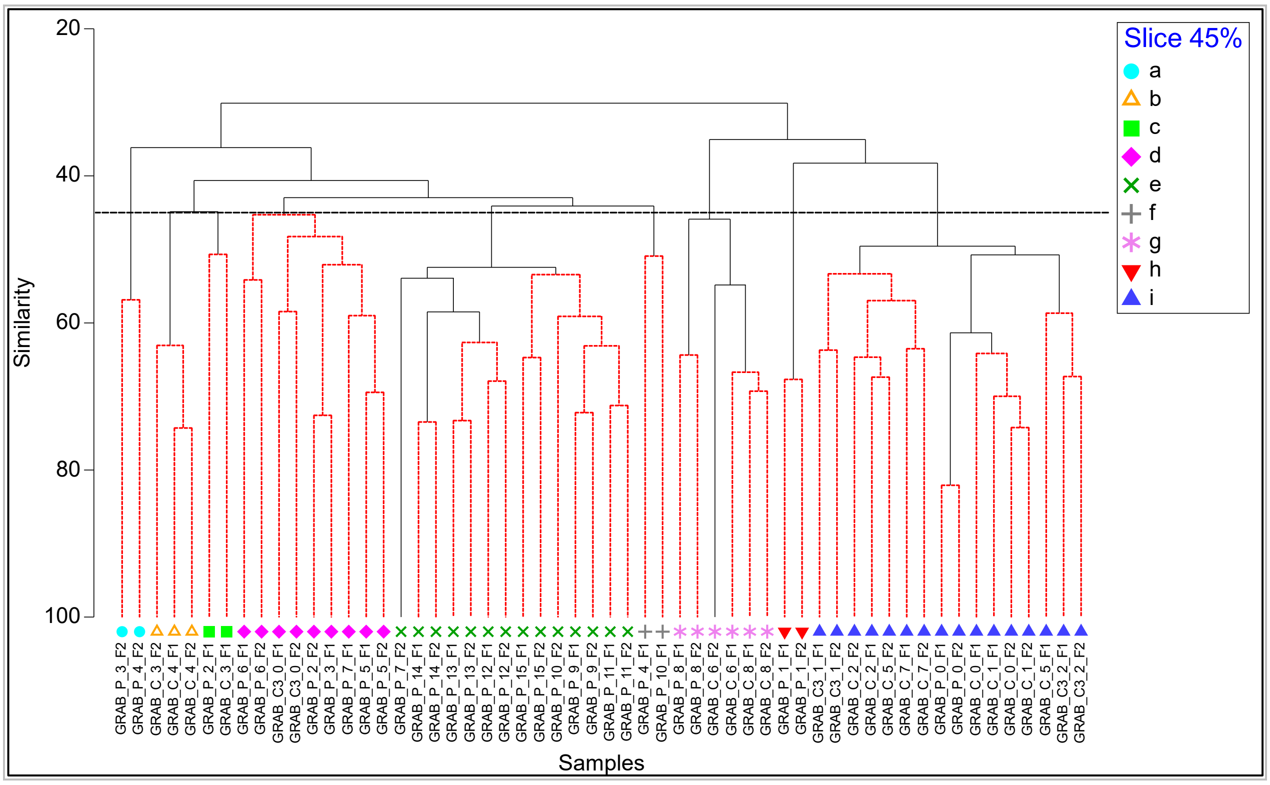


Figure 43: Dendrogram of macrofaunal replicates

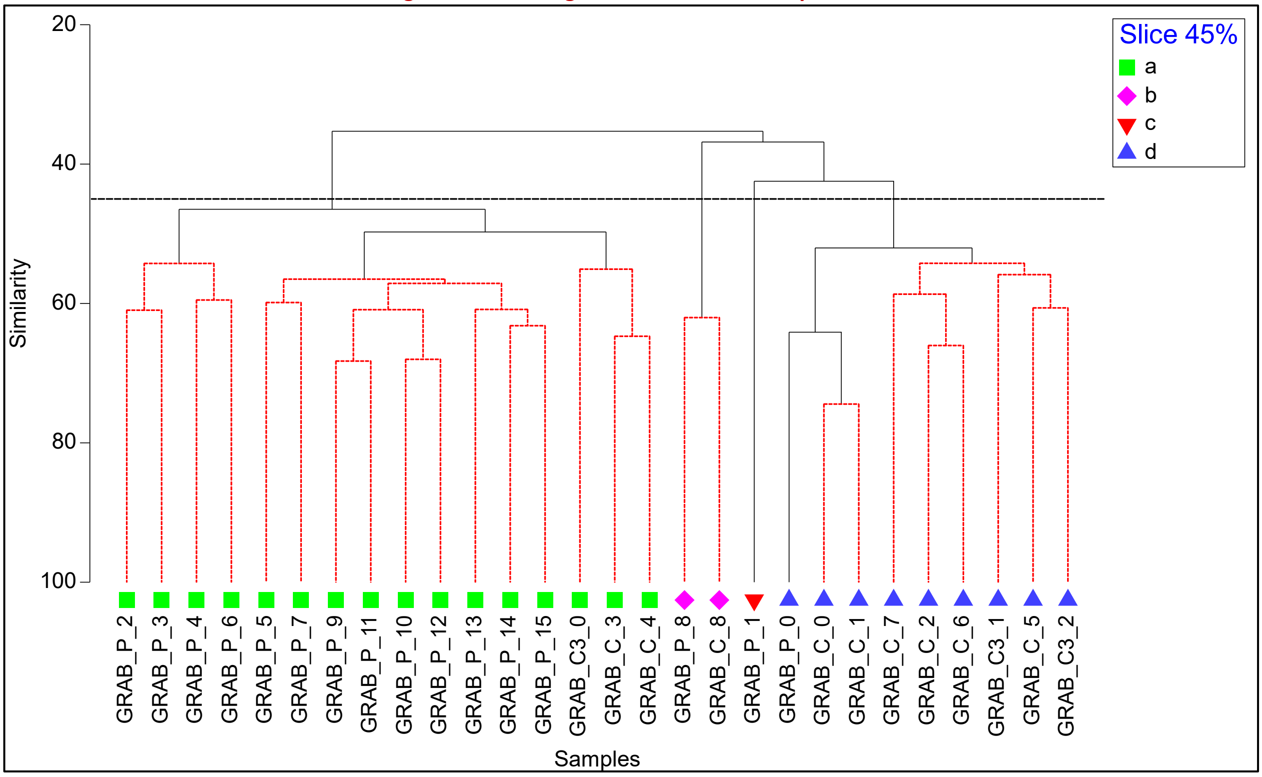


Figure 44: Dendrogram of macrofaunal stations

Multi-dimensional Scaling (MDS) Ordination Plot

Similarities in the macrofaunal communities recorded across the survey area are presented as 2-dimensional multi-dimensional scaling (MDS) ordinations in Figure 45 by replicate and in Figure 46 by station. Figure 45 shows a 2-D MDS plot that presents all 56 replicates from the survey area, revealing a potentially useful 2-D plot ordination due to a stress level of 0.175 recorded. At a replicate level, some clear separations are seen between the nine SIMPROF groups, particularly for group i and g. However, some of groups are less obvious and similarities can be seen with replicates from other groups, such as those within groups d and e. At a station level, separation of clusters is clearer and visibly show the distinct separations between the groupings, with a stress level of 0.165.

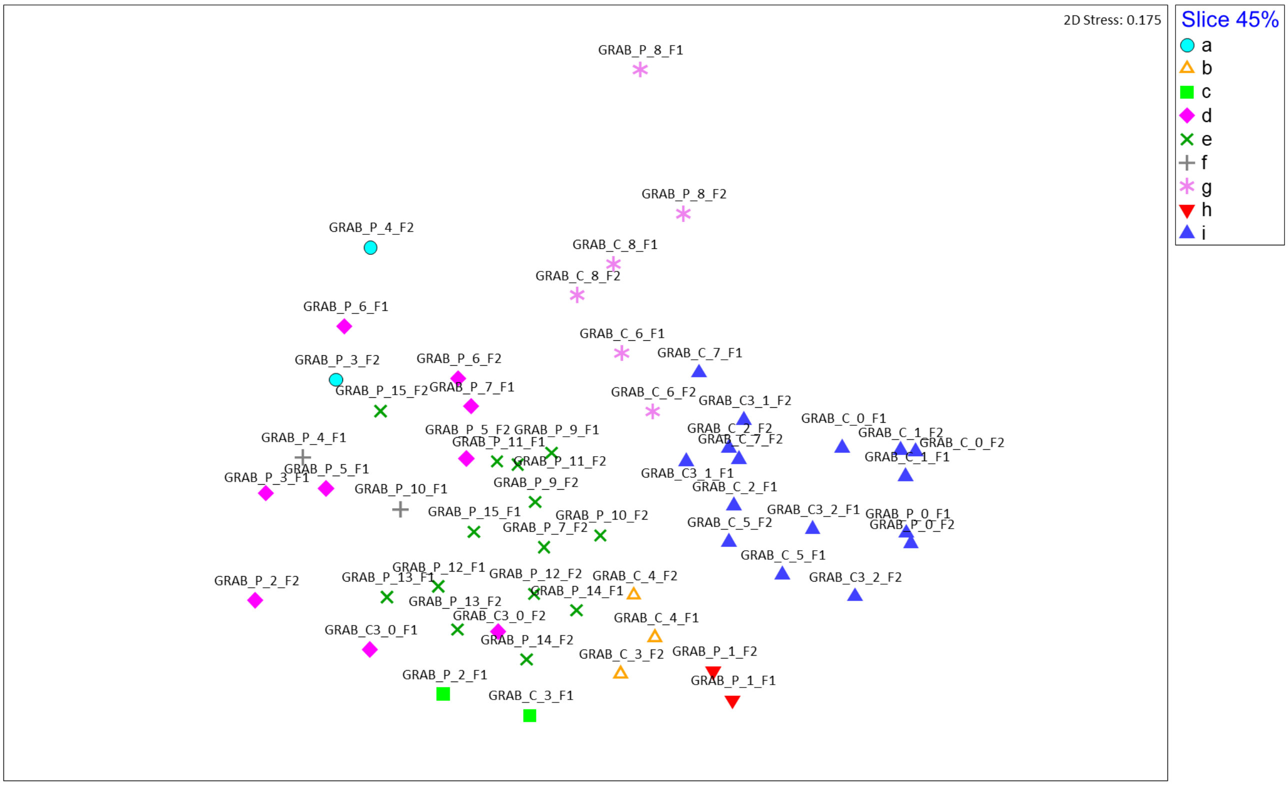


Figure 45: MDS ordination of macrofauna by replicates

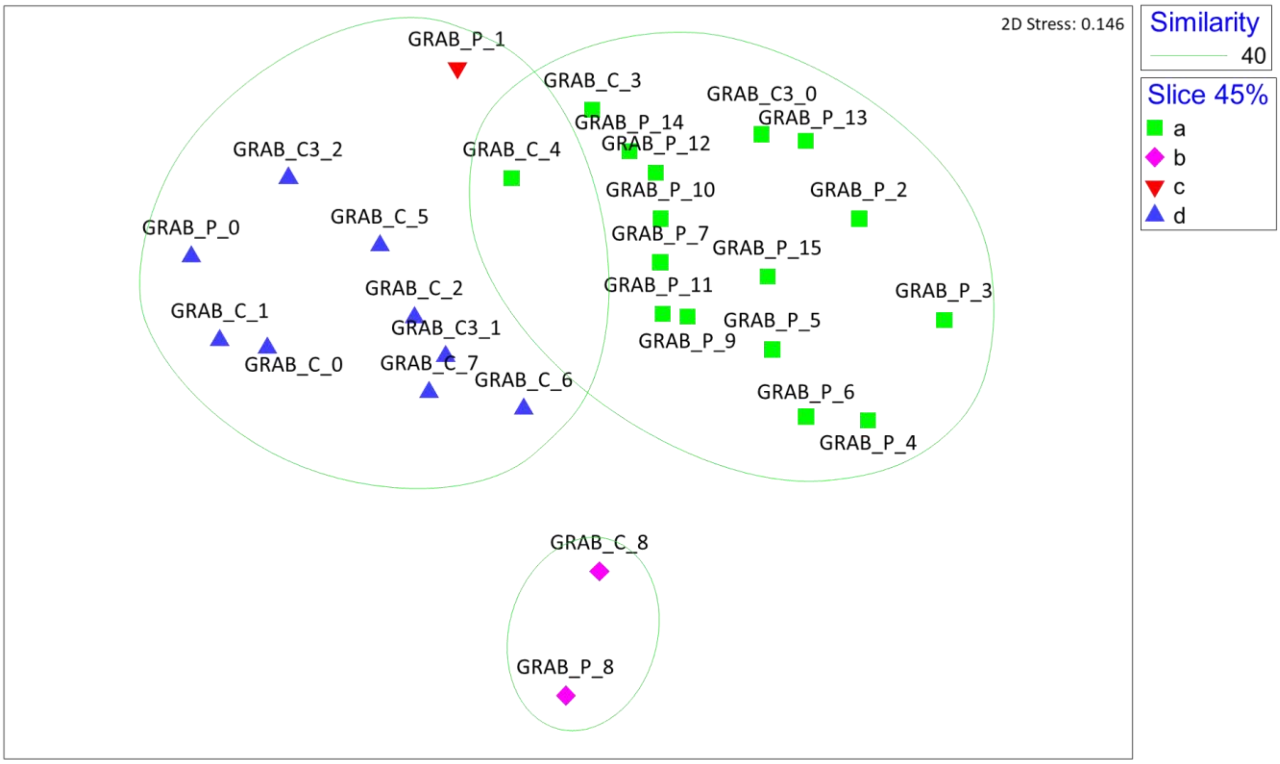


Figure 46: MDS ordination of macrofauna by station

In order to determine the magnitude of the differences between the SIMPROF groups in all dimensions, an ANOSIM (analysis of similarity) test was performed. This recorded a similarity R value of 0.813 (p=0.001) and 0.87 (p=0.001) on a replicate and station level, respectively. The combination of dendrograms, SIMPROF tests, MDSs and ANOSIM tests indicate that there is a significant difference between the macrofaunal communities recorded around the N5A survey area. A combination of factors are likely to have influenced the macrofaunal communities recorded with sediment characteristics being one of the major contributing factors.

Table 20 shows the top five species responsible for the differences between the clusters and their average contributory percentages. Differences here ranged from 57.54% to almost 69.21% dissimilarity. The results revealed variable species were responsible for changes seen within the clusters. Within cluster c, relatively high abundance of Phoronida (79) were responsible for the largest dissimilarity between this cluster and clusters a and b (5.71% and 6.87%), while the very high abundances of sand mason worm, *Lanice conchilega* and unidentified Grania in cluster d resulted in a significant dissimilarity of 5.95% and 4.51%. Differences between Cluster a and b were largely driven by the high abundances of *Spiophanes bombyx* and *Magelona johnstoni* in cluster a, while separations between a and d were driven by large numbers of Nematoda and Grania within cluster d and their absence from a. Lastly, clusters d and b differed again due to high abundances of Nematoda, *Abra alba, Spio symphyta, Spiophanes bombyx* and *Lanice conchilega* within d and their relative absence in stations within cluster b.

Table 20: Similarity percentage (SIMPER) for clusters A-D

	Cluster a		Cluster b		Cluster d	
Cluster c	Average dissimilarity 61.31%		Average dissimilarity 69.21%		Average dissimilarity 57.54%	
	Phoronida	5.71%	*Phoronida*	6.87%	*Lanice conchilega*	5.95%
	Nematoda	4.96%	*Abra alba*	6.31%	*Grania*	4.51%
	Abra alba	4.34%	*Nematoda*	4.90%	*Phoronida*	4.04%
	Lanice conchilega	3.99%	*Lagis koreni*	4.37%	*Spio symphyta*	2.86%
	Bathyporeia elegans	3.09%	*Lanice conchilega*	4.14%	*Tubificoides benedii*	2.64%
Cluster a			Average dissimilarity 67.30%		Average dissimilarity 64.52%	
			Spiophanes bombyx	4.06%	*Grania*	3.96%
			Magelona johnstoni	3.88%	*Nematoda*	3.84%
			Bathyporeia elegans	3.60%	*Aonides paucibranchiata*	3.40%
			Grania	3.58%	*Magelona johnstoni*	2.59%
			Monopseudocuma gilsoni	3.49%	*Bathyporeia elegans*	2.38%
Cluster b					Average dissimilarity 62.50%	
					Nematoda	4.11%
					Abra alba	3.29%
					Spio symphyta	3.19%
					Spiophanes bombyx	3.12%
					Lanice conchilega	3.08%

The stations grouped within cluster a showed moderate abundances with the highest contribution from the bristleworm *Spiophanes bombyx*, typically found in sandy areas. The stations within cluster b showed the lowest richness and some of the lowest abundances of all stations, and were dominated by *Ophelia borealis,* followed by an unidentified *Grania* and the annelid *Scoloplos armiger,* accounting for over 34% similarity. Amongst those stations belonging to cluster d (which included stations with the highest abundances and richness), the sand mason worm *Lanice conchilega* and unidentified Nematoda were dominant and responsible for over 16% similarity. Notably high abundances of Nematoda were found at stations GRAB_P_0 and GRAB_C3_2 within this cluster (915 and 1104 respectively).

Principal Component Analysis (PCA)

A PCA was carried out on the raw particle size and macrofaunal data for each station (Figure 47) to determine whether sediment composition can explain the differences between clusters. This PCA chart shows the distribution of each station along the axes based on their particle size distribution, overlaid with macrofauna clusters (as symbols). The plot shows a general separation between stations along the N5A platform to NGT Hot Tap pipeline dominated by a finer sands fraction (cluster a, mean ϕ2.10 ±0.20SD, 0.24mm ±0.03SD) and those along that cable route to Riffgat Wind Park with a coarser sediment (cluster d, mean ϕ1.01 ±0.93SD, 0.62mm ±0.59SD). The groupings follow a very similar pattern to those found through the particle size analysis, with only macrofauna at GRAB_C3_1 departing from this overall trend.

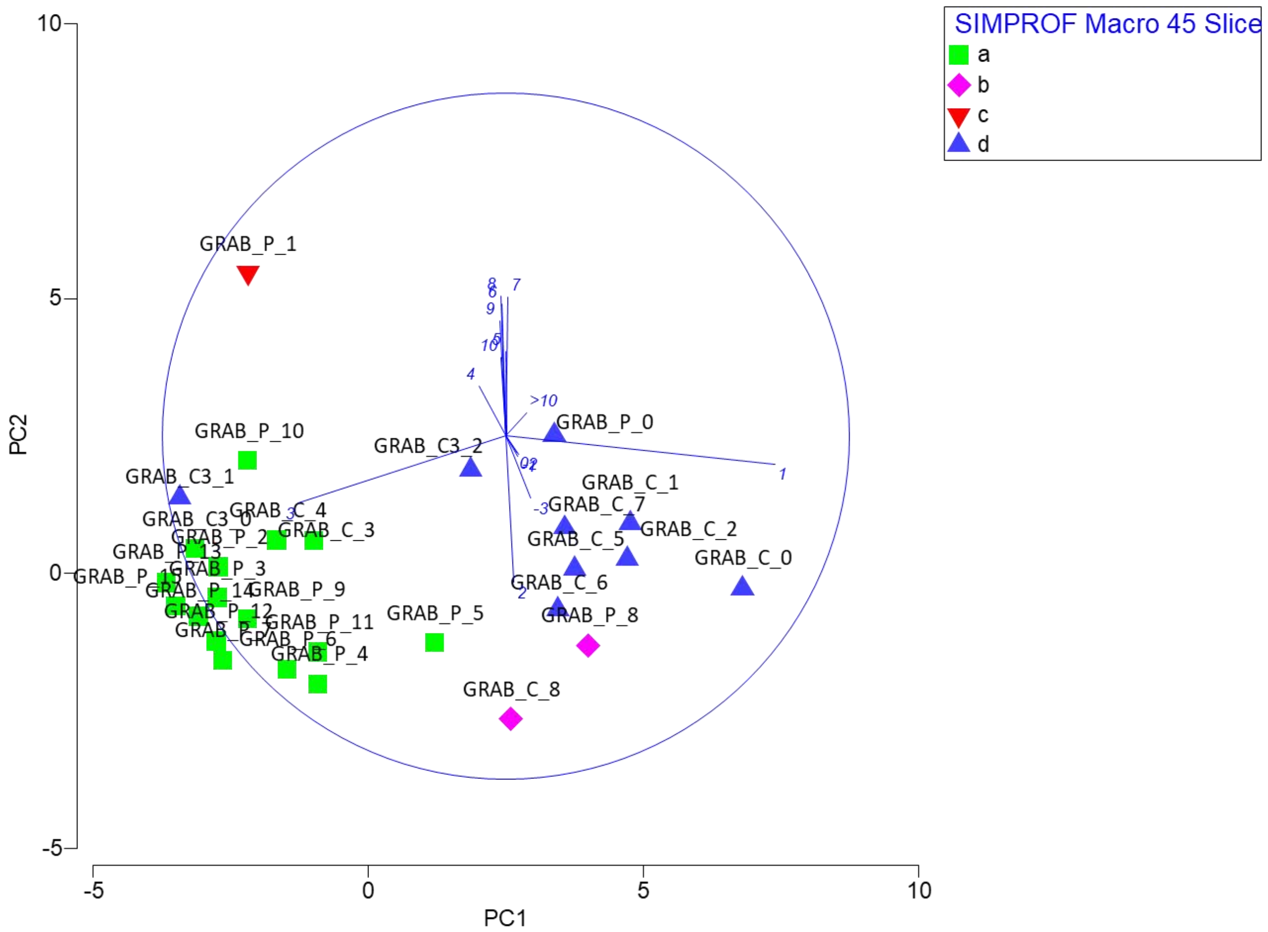


Figure 47: Principal component analysis of particle size data

3.8.4 Environmental Variables

In order to assess whether any relationships between the biological community and environmental parameters were present and whether these differences were significant, numerous RELATE tests were performed. The results revealed that few of the RELATE tests were significant, which included mean particle size, arsenic and aluminium having a significant correlation with macrofauna (MZ ρ=0.443; p<0.001, As ρ=0.371; p<0.001; Al p=0.009, ρ=0.225). Significant correlations were also evident between the macrofaunal data set and particle size data giving a Rho value of 0.483 with a confidence interval of *p<0.001*. No significant correlation between any metals strongly associated with drilling were found (e.g. barium), however a correlation between THC and macrofauna was seen (p=0.008). Nonetheless, the low Rho value of 0.175 indicates that this is of weak significance.

A Spearman's correlation matrix was calculated for biological and environmental parameters (Appendix N - Spearman's Correlation), which showed few significant correlations between individual factors. Some caution should be applied when interpreting these data, due to the potential for erroneous correlations occurring by chance (on average 1/20 correlations at *p*<0.05), as well as auto-correlations causality between variables. Both positive and negative correlations were found to exist between the sediment characteristics and some diversity indices as noted in Section 3.8.2. Relatively few correlations between the other chemical variables with macrofaunal parameters were found but are discussed below.

Correlations were observed between number of individuals and total n alkanes ($\varrho(28)=0.464$, $p<0.05$) and proportion of alkanes ($\varrho(28)=0.452$, $p<0.05$). Both richness and abundance showed significant positive correlations between Nickel (richness $\varrho(28)=0.484$, $p<0.01$; abundance $\varrho(28)=0.515$, $p<0.01$) and Barium (richness, $\varrho(28)=0.448$, $p<0.05$; abundance, $\varrho(28)=0.520$, $p<0.01$). Several similar correlations were found between metals and biological indices such as Pielou's evenness, Shannon-Wiener and Simpsons diversity. Given the generally low levels of contaminants across the survey area, the aforementioned correlations are assumed to be erroneous and do not reflect any impact of metal and hydrocarbon concentrations on macrofaunal community structure.

3.8.5 Epifaunal and other Biological Groups

A total of 48 of the 56 replicates of the N5A survey area recorded the presence of colonial epifauna which were not statistically assessed within the infauna data analysis, as they were recorded on a presence/absence basis. On a station level, colonial epifauna were seen at all stations except GRAB_P_6, GRAB_P_8 and GRAB_C_8. The distribution of epifaunal assemblages across the survey area is represented in Figure 48 highlighting the variation between infaunal and epifaunal richness.

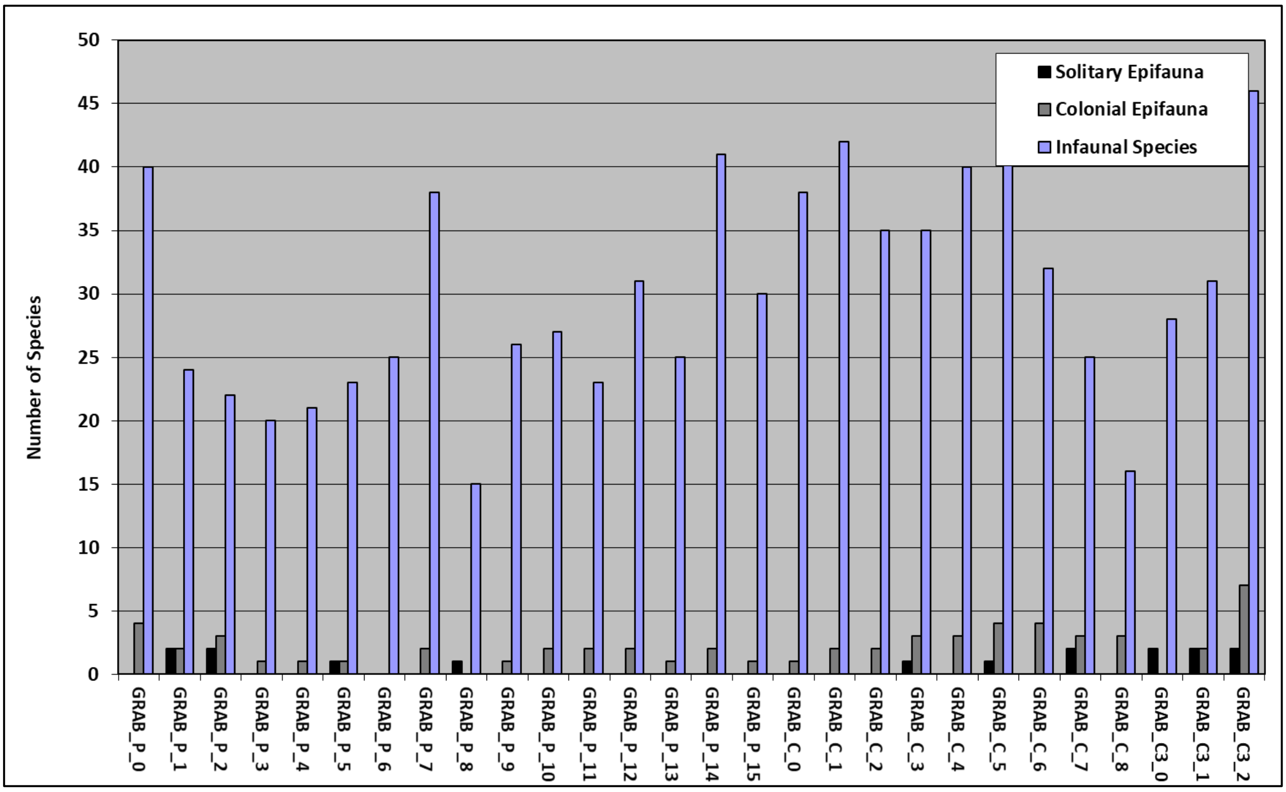


Figure 48: Epifaunal versus infaunal richness

Due to the presence/absence scale to which many epifaunal species were identified, for the purpose of this chart and to highlight the epifaunal richness; where epifaunal species were recorded as present this was given the numerical value of "1" to represent the colony. While allowing the data to be presented, the actual abundance of epifaunal species cannot be determined. Infaunal and epifaunal species are listed separately in Appendix M.

Analysis of the infaunal and epifaunal communities indicated the dominance of infauna, and varying levels of epifaunal species at each station. Ten taxa considered to be colonial epifaunal were recorded during the current survey, belonging to 2 phyla, the Cnidaria (6 taxa) and the Bryozoa (4 taxa). Some stations recorded no colonial epifauna species, while station GRAB_C3_2 recorded the highest richness of epifaunal species comprising seven different taxa; this also coincided with the highest proportion of gravels within the survey area recorded (54.91%) at this station. The general low dominance of epifauna in this survey is due to the lack of coarse sediment providing a suitable habitat in the form of hard substrate.

Grab sampling often fails to recover coarse material, especially the larger pebbles and cobbles colonised by epilithic fauna, therefore, it is important to not only assess epifauna through physical samples, but also through analysis of video and still photographs. In this case, coarse material was variable, with pebbles and cobbles present in large quantities at GRAB_C3_2 only. The higher epifaunal abundances recorded at this station may suggest a relatively true representation of macrofauna for this area, however, due to three no samples (a cause of cobbles stuck within the jaws of the grab), it should be highlighted that some macrofaunal species may have been missed due to no acquisition of the larger pebble/cobble components that epifaunal species may have colonised onto. Additionally, this station was assessed for 'stony reefiness', further justification for the possible low representation of the macrofaunal community within the grab sample.

The epifauna was not considered to be very diverse due to the low number of taxa present within the samples. However, species of interest are discussed in the following text.

The epifauna within the samples was very sparse with only four species of Bryozoa identified across the survey area. The most common was *Electra pilosa* which displays a wide variety of both encrusting and erect growing forms depending on the surfaces available (Hayward & Ryland, 1998). The only representative of the Ctenostome Bryozoa was *Alcyonidium parasiticum* which produces thick cylinders around hydroids or erect bryozoans and forming a coated surface of silt and fine sand which obscures details of the zooids and gives a distinct earthy appearance (Hayward, 1985). Hydrozoa were moderately well represented across the survey area with six distinct taxa recorded, with the Campanulariid *Clytia hemisphaerica* being the most common occurring in 15 out of 56 stations.

The solitary epifauna was represented by the occurrence of sea anemones namely Actiniaria amongst which *Sagartia troglodytes* was the most common throughout the survey area. This species displays extremely variable colouration patterns. It is a widespread species likely to be encountered in mud, sand or gravel, usually attached to stones or shell fragments (Manuel, 1988).

3.9 ENVIRONMENTAL HABITATS

Video and still photography ground-truthing from twenty-eight drop-down camera deployments and eight camera transects confirmed the presence of a predominantly sandy seabed with spatial variability in the proportions of shell fragments, coarse substrate (gravel, pebbles and cobbles) and outcropping clay. In addition, areas of coarse substrate along the northern edge of the survey area supported high densities of sand mason worms (*Lanice conchilega*) and razor clams (suspected *Ensis leei*).

Habitats were identified using a combination of field observations, detailed review of video footage and still images. Based on the ground-truthing data obtained from the N5A development site and route survey area, four EUNIS habitat classifications were assigned: 'Infralittoral fine sand' (A5.23), 'Infralittoral coarse sediment' (A5.13), 'Infralittoral Mixed Sediment' (A5.43) and 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137). The habitat classifications for the N5A development survey area are illustrated in Figure 49.

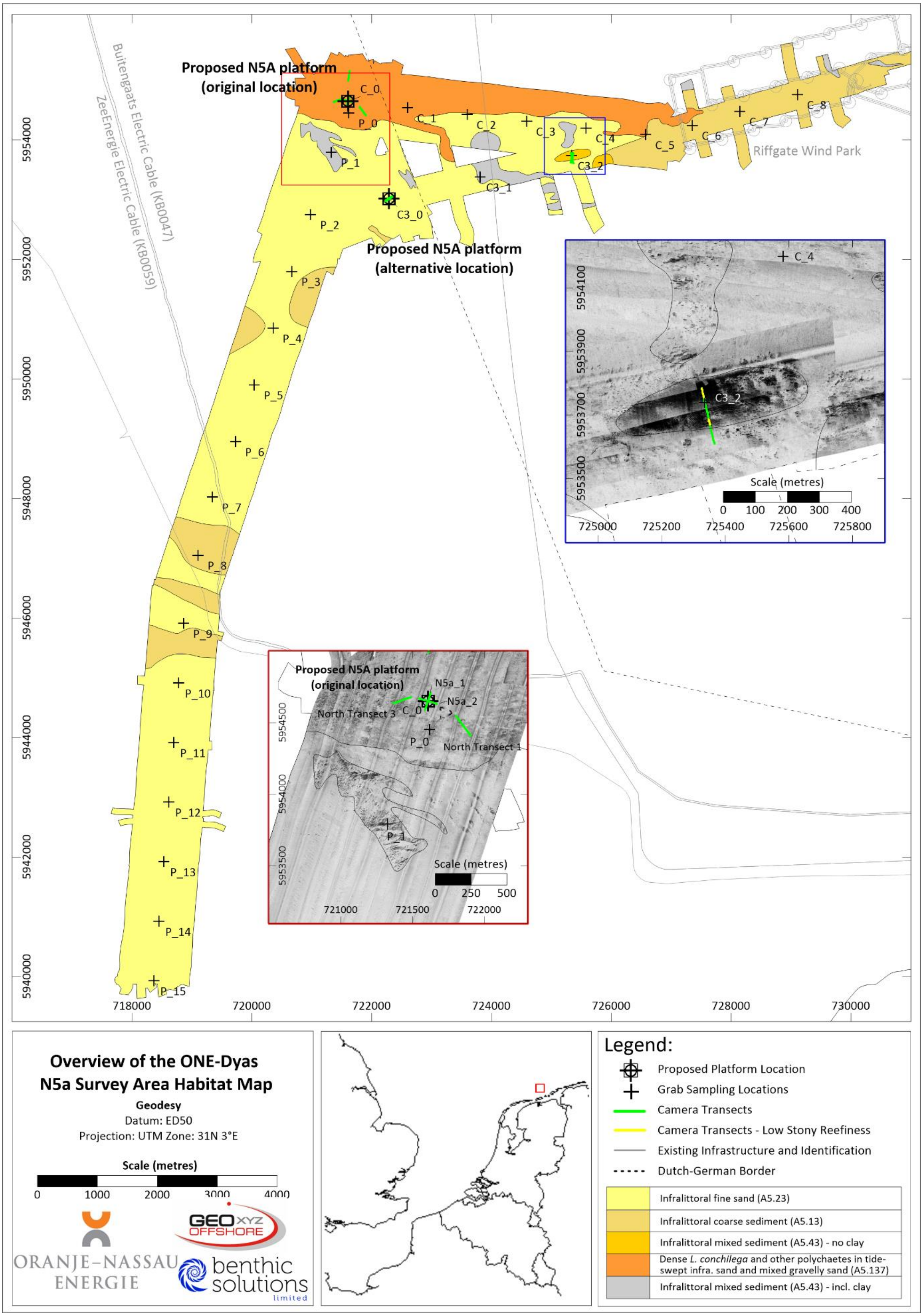


Figure 49: N5A site and route habitat distribution

3.9.1 'Infralittoral Fine Sand' (A5.23)

Habitats dominated by fine sand with variable levels of shell debris were dominant across the survey area, being observed on the majority of environmental camera drops and transects within the N5A site and route survey area. These areas were represented by relatively smooth and low reflectivity side scan sonar data and were classified as the 'fine sand and shell fragments' seabed features type (Section Seabed Features and Figure 5) and the EUNIS level four 'Infralittoral fine sand' (A5.23) habitat type (Figure 49).

'Infralittoral fine sand' habitat is typically characterised by clean sands which occur in shallow water, either on the open coast or in tide-swept channels of marine inlets in water depths of around 0 to 20m. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly amphipods (*Bathyporeia*) and robust polychaetes including *Nephtys cirrosa* and *Lanice conchilega*. Within the N5A development survey area, this habitat comprised clean rippled sands in water depths of approximately 13 to 30m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral fine sand' included low to moderate densities the sand mason worm (*L. conchilega*) throughout, in addition to several other taxa characteristic of this EUNIS habitat, including common starfish (*Asterias rubens*), swimming crab (*Liocarcinus*) and hermit crabs (Paguridae). Other fauna observed within areas of this habitat included lugworms (*Arenicola* sp.), masked crab (*Corystes cassivellaunus*), edible crab (*Cancer pagurus*), razor clams (*Ensis* sp.), brittlestars (Ophiuridae), gobies (Gobiidae), dragonets (*Callionymus lyra*) and flatfish (Pleuronectiform). Further taxa evident from grab samples included occasional sandeel (Ammodytidae), heart urchins (*Echinocardium cordatum*), ragworms (*Nereis* spp.), unidentified sea urchins (spatangoid) and porcelain crab (Portunidae). Infaunal taxa identified from the macrofauna analysis that correspond with this habitat included the white catworm *Nephtys cirrosa* and the crustaceans *Diastylis bradyi and Bathyporeia elegans.*

Review of the seabed camera and grab sample data indicated that the mapped distribution of 'infralittoral fine sand' (A5.23) habitat was fairly accurate. Only station GRAB_P_9 showing more coarse sandy sediment than would be expected for 'infralittoral fine sand' habitat but, as this sampling station was located within an area of alternating bands of 'infralittoral fine sand' and 'infralittoral coarse sand', it is to be expected that there will be some discrepancies in this area. Some sporadic patches of higher density *L. conchilega* aggregations were evident on seabed camera data from mapped areas of 'infralittoral fine sand' but these were insufficiently widespread or dense to warrant classification as 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat.

Example images of 'Infralittoral Fine Sand (A5.23) habitat are given below in Figure 50 and the expected extent of the habitat is mapped in Figure 49.

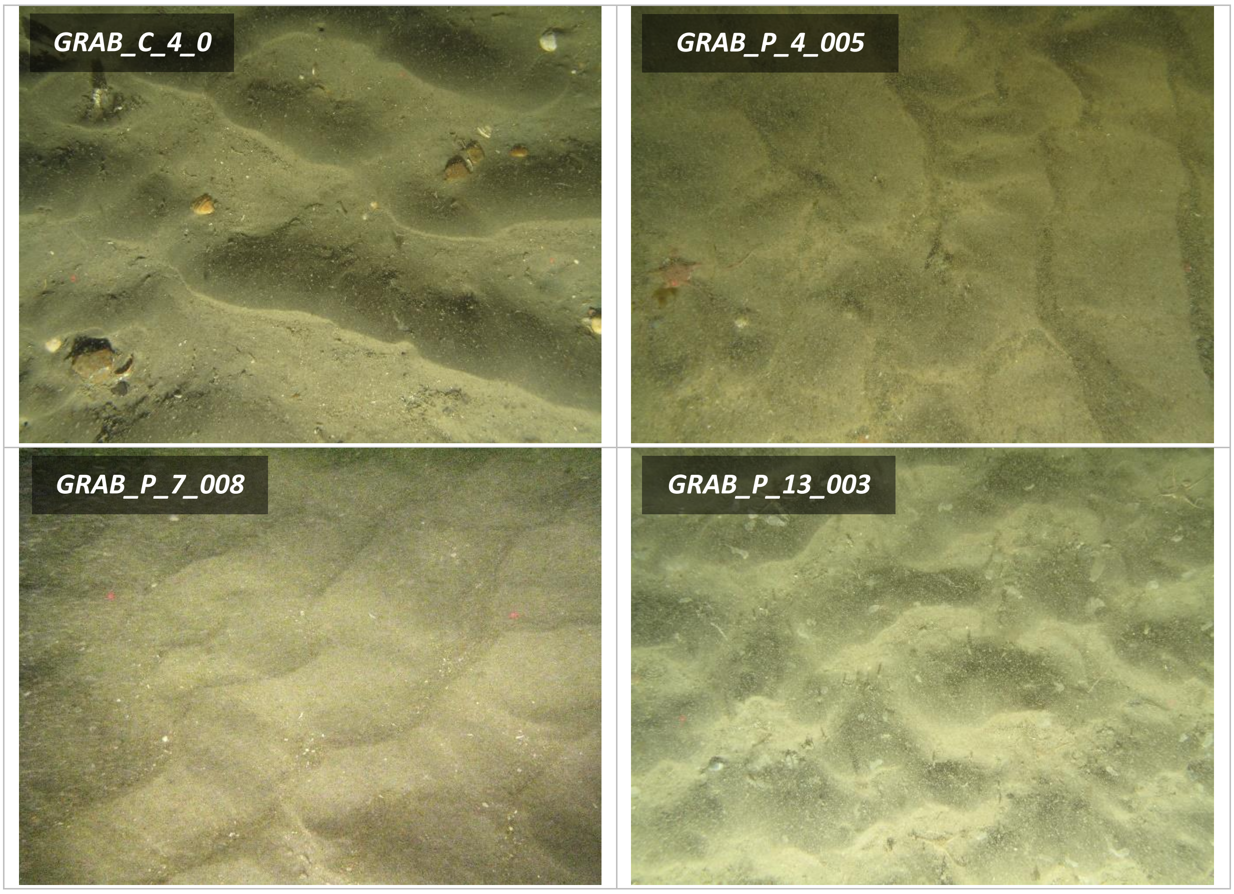


Figure 50: Example images of 'Infralittoral fine sand' (A5.23)

3.9.2 'Infralittoral Coarse Sediment' (A5.13)

Habitats dominated by coarse sand and moderate levels of shell debris and, occasionally, with gravel and pebbles were found in several patches across the combined N5A development site and route survey area, ground-truthed by stations GRAB_C_5 to GRAB_C_7, GRAB_P_8 and GRAB_P_9. These areas were represented by relatively smooth but low to moderate reflectivity side scan sonar data and were classified as the 'coarse sand and shell fragments' seabed features type (Section 3.2 and Figure 5) and the EUNIS level four 'infralittoral coarse sediment' (A5.13) habitat type (Figure 49). Seven patches of 'infralittoral coarse sediment' were mapped, including a large patch on the route survey corridor around the Riffgat Wind Park and a further six smaller patches along the N5A to NGT Hot Tap pipeline route.

'Infralittoral coarse sediment' habitat is typically characterised by coarse sand, gravelly sand, shingle or gravel which are subject to disturbance by tidal streams and wave action in water depths of around 0 to 20m. The habitat is characterised by a robust fauna of infaunal polychaetes such as *Chaetozone setosa* and *Lanice conchilega*, cumacean crustacea such as *Iphinoe trispinosa* and *Diastylis bradyi*, and venerid bivalves. Within the N5A development survey area, this habitat comprised rippled coarse shelly sands, sometimes with a discernible gravel and/or pebble content in water depths of approximately 19 to 30m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral coarse sediment' included low to moderate densities the sand mason worm (*L. conchilega*) throughout, in addition to common starfish (*Asterias rubens*), which are both characteristic species for this EUNIS habitat. Infaunal taxa from macrofauna ground-truthing for this classification included the presence of *Scoloplos armiger, Eteone longa, Lanice conchilega,* Nematoda and Nemertea.

Review of the seabed camera and grab sample data indicated that the mapped distribution of 'infralittoral coarse sediment' (A5.13) habitat was fairly accurate, but with two exceptions. Station GRAB_C_0 was classified as 'infralittoral coarse sediment' habitat but was located within an area of 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat, while station GRAB_C_8 was classified as 'infralittoral fine sand' habitat but was located within an area of 'infralittoral coarse sediment'. Both of these exceptions reflect the heterogenous nature of the seabed habitats within the survey area.

Example images of 'infralittoral coarse sediment (A5.13) habitat are given below in Figure 51, the expected extent of the habitat is mapped in Figure 49.

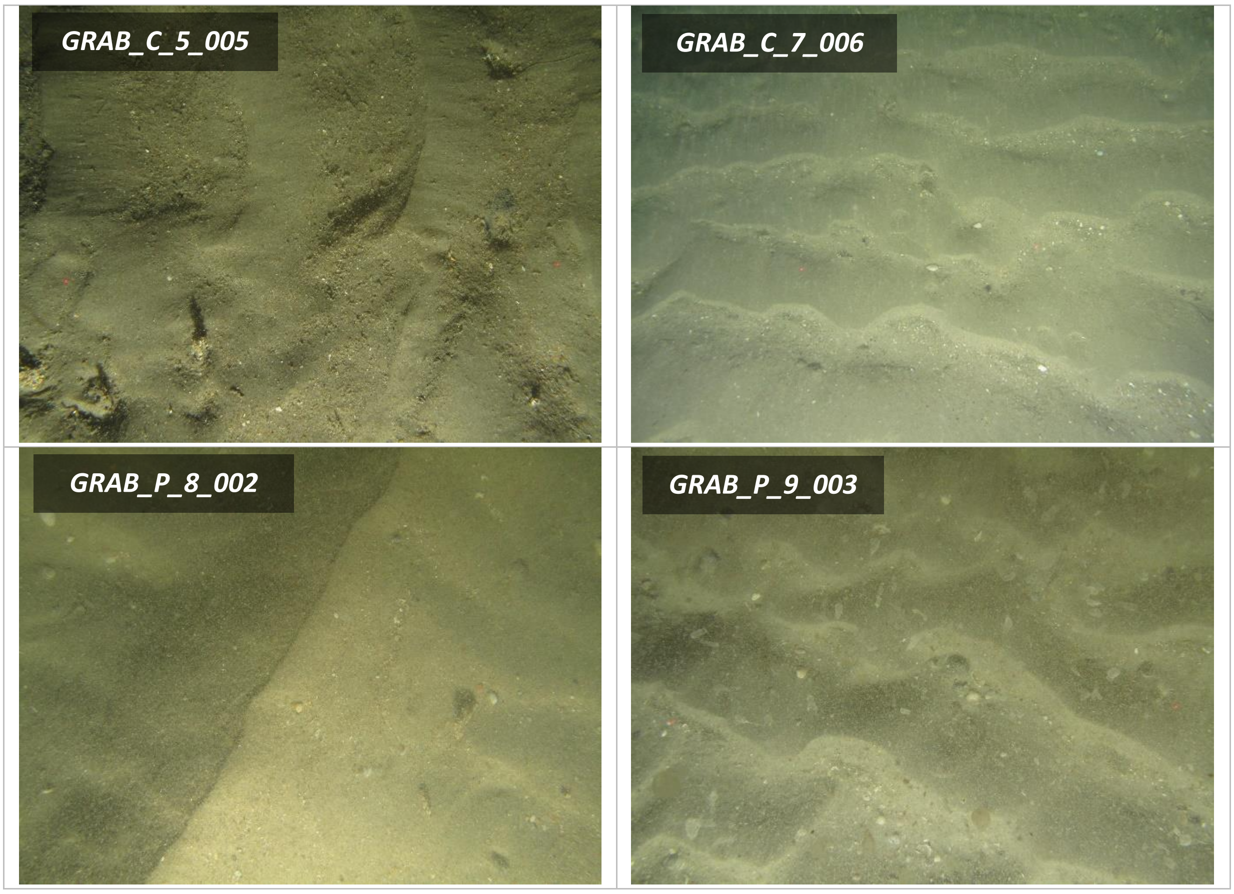


Figure 51: Example images of 'Infralittoral coarse sediment' (A5.13)

3.9.3 'Infralittoral Mixed Sediment' (A5.43)

Habitats dominated by coarse gravelly sand with pebbles, cobbles and, in some areas exposed clay clasts, were found delineated in ten patches across the combined N5A development site and N5A to Riffgat route survey area. These areas were classified as the 'coarse sand with pebbles and cobbles' seabed features type (Section 3.2 and Figure 5) and the EUNIS level four 'infralittoral mixed sediment' (A5.43) habitat type (Figure 49). Two patches located midway along the N5A to Riffgat cable route showed moderate to high reflectivity side scan sonar signatures but showed no evidence of clay on ground-truthing data from station GRAB_C3_2. A further ten patches along the N5A to Riffgat route showed similar mottled side scan sonar signatures and may include exposed clay, as evident from ground-truthing at stations GRAB_P_1 and GRAB_C3_1 over two of the patches.

'Infralittoral mixed sediment' habitat is typically characterised by mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in mud, sand or gravel in water depths of around 0 to 30m. Due to the variable nature of the sediment type, a wide array of communities are reported to be found in areas of mixed sediment, including those characterised by bivalves, polychaetes and file shells. Within the N5A development survey area, this habitat comprised coarse gravelly sand with pebbles, cobbles and sometimes with the addition of exposed clay clasts, in water depths of approximately 24 to 27m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral mixed sediment' included common starfish (*Asterias rubens*) and burrowing anemones (Cerianthidae) which are both characteristic species for this EUNIS habitat. Seabed and grab sample photographs from station GRAB_C3_1 show numerous holes within the exposed clay clasts which may indicate the presence of boring piddock bivalves (typically *Pholas dactylus* or *Barnea candida*), although no live individuals could be discerned from the seabed or grab sample photographs. While piddocks are not protected by legislation, they are not widespread in the marine environment and would therefore be worthy of note if found. However, macrofaunal analysis of these stations did not reveal the presence of piddocks at any stations within the survey area, and thus this habitat remains assigned to the 'infralittoral mixed sediment' (A5.43) classification. Macrofauna found at the stations classified as mixed sediment include high abundances of Nematoda, *Mediomastus fragilis,* and Nemertea, which are all characterizing species for this habitat.

Example images of 'infralittoral coarse sediment (A5.13) habitat are given below in Figure 52 and the expected extent of the habitat is mapped in Figure 49.

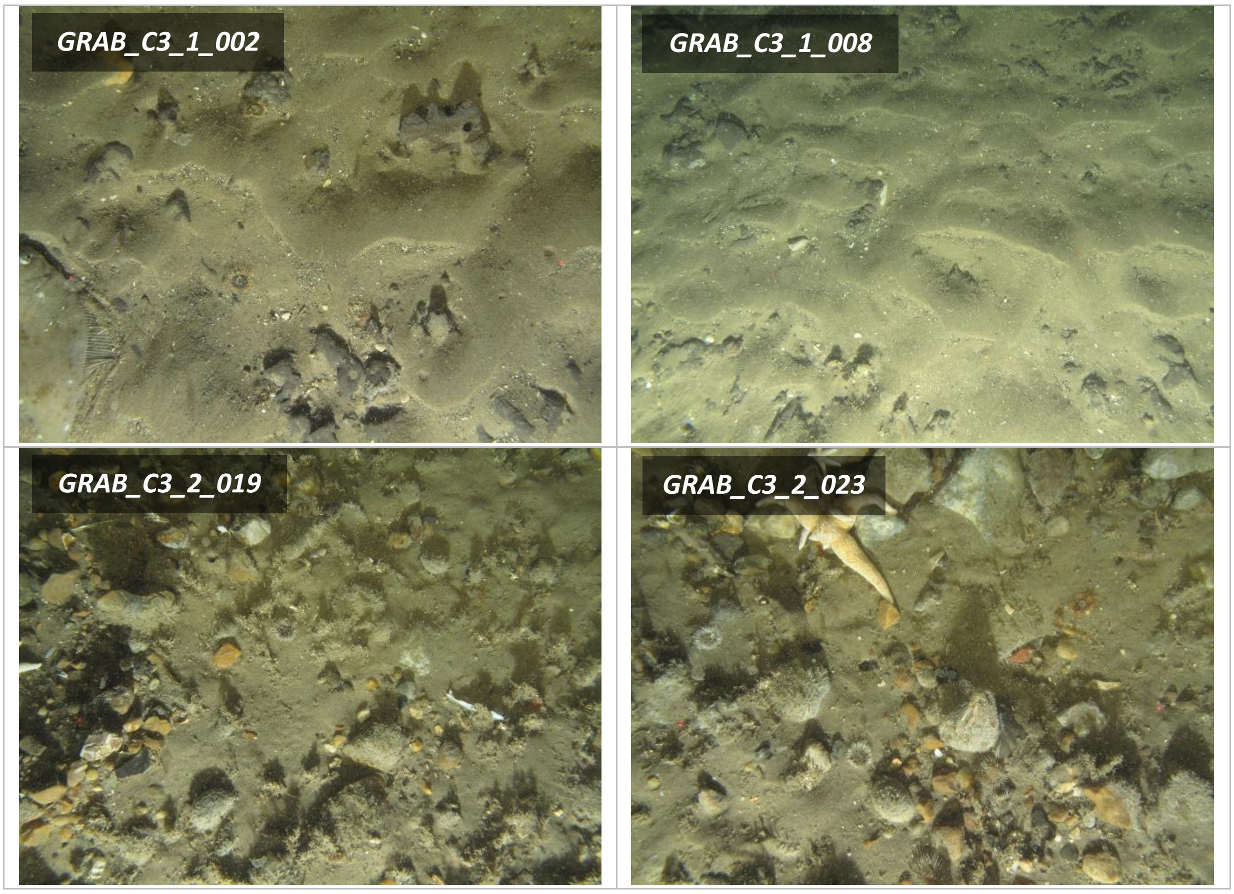


Figure 52: Example images of 'Infralittoral mixed sediment' (A5.43)

3.9.4 'Dense *Lanice conchilega* and Other Polychaetes in Tide-swept Infralittoral Sand and Mixed Gravelly Sand' (A5.137)

Habitats dominated by gravelly, shelly coarse sand with moderate to high densities of *Lanice conchilega* were evident at several ground-truthing locations (stations GRAB_C_1, GRAB_C_2 and GRAB_P_0, and transects N5A_1, N5A_2, NT_1, NT_2 and NT_3) within the N5A site and to the east along the N5A to Riffgat Wind Park route. These areas were represented by mottled low to high reflectivity side scan sonar data and were classified as the 'coarse sand and shell with a high density of sand mason worms and razor clams' seabed features type (Section 3.2 and Figure 5) and the EUNIS level four 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat type (Figure 49). This habitat was delineated in a single large area along the northern edge of the combined N5A survey area.

'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' habitat is typically characterised by coarse sand, gravelly sand, shingle or gravel which are subject to disturbance by tidal streams and wave action in water depths of around 0 to 20m. The habitat is characterised by high densities of *L. conchilega*, which are thought to stabilise the seabed and allow the development of a more diverse associated faunal community. Within the N5A development survey area, this habitat comprised gravelly, shelly coarse sands in water depths of approximately 28 to 29m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' included moderate to high densities the sand mason worm (*L. conchilega*) throughout. Razor clams (*Ensis* sp.) are also associated with this habitat and were seen in very high densities on the majority of ground-truthing data for this habitat. Review of macrofaunal data revealed that all the razor clams seen were the Atlantic jackknife clam (*Ensis leei* – synonyms include *Ensis arcuatus* and *Ensis americanus*). In addition, a number of other characterising taxa for this EUNIS habitat were observed, including common starfish (*Asterias rubens*), lugworms (*Arenicola* sp.), hermit crabs (Paguridae) and swimming crabs (*Liocarcinus*). Review of the macrofauna revealed other characterizing infaunal taxa that camera ground truthing could not assess. These included but were not limited to, the white furrow shell (*Abra alba),* the bristleworm *Spiophanes bombyx* and the white catworm (*Nephtys cirrosa*).

Review of the seabed camera and grab sample data indicated that the mapped distribution of ‘dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’ (A5.137) habitat was fairly accurate, with the exception of station GRAB_C_0 which was classified as ‘infralittoral coarse sediment’ habitat but was located within an area of ‘dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’ (A5.137) habitat. However, the mapped area of this habitat is expected to be highly heterogenous and will likely include areas of all other mapped habitats from this survey.

Example images of ‘dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’ (A5.137) habitat are given below in Figure 53 and the expected extent of the habitat is mapped in Figure 49.

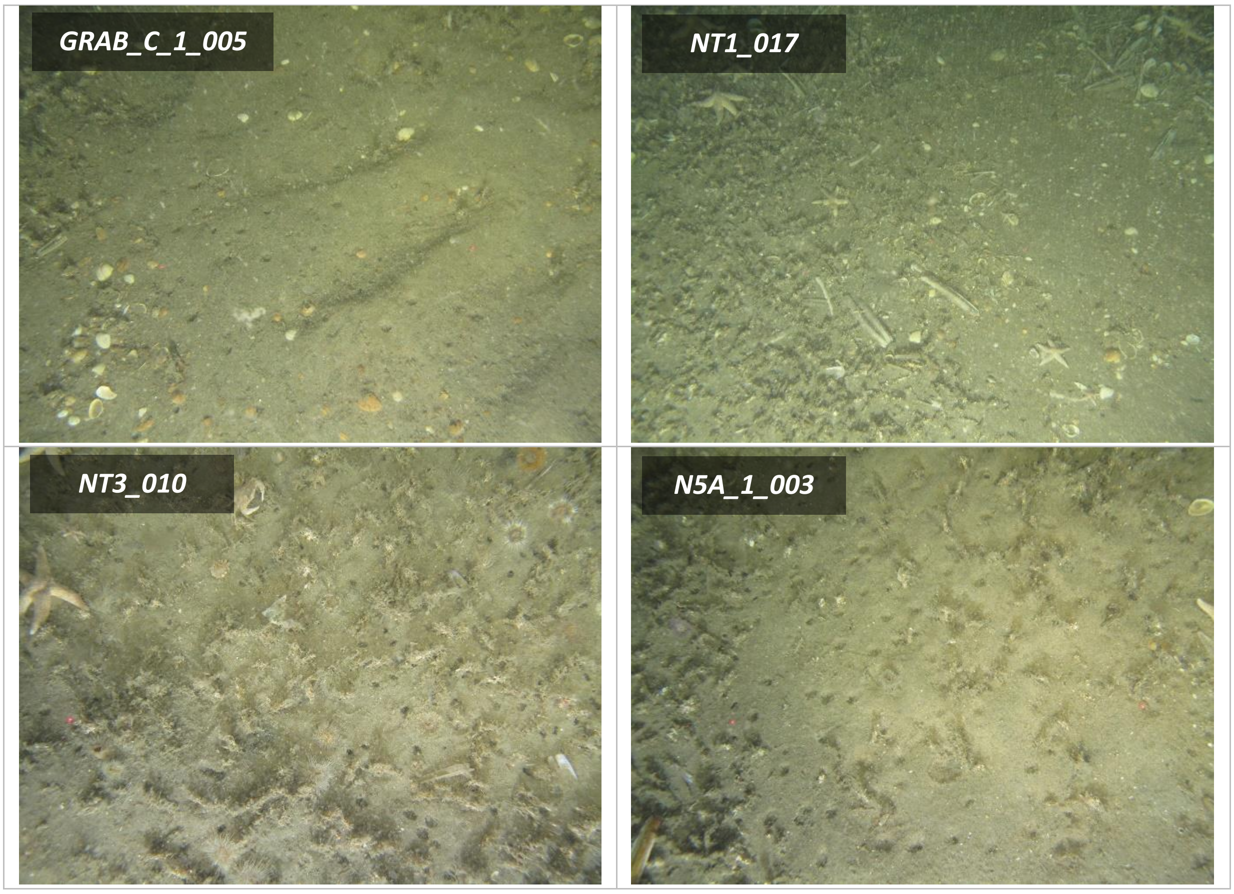


Figure 53: Example images of Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’ (A5.137)

3.9.5 Potential Sensitive Habitats and Species

There are a number of potential sensitive habitats and species which are listed by one or more International Conventions, European Directives or UK Legislation (Appendix G) and are known to occur in the wider region (southern North Sea), including:

- Biogenic reefs formed by the ross worm *Sabellaria spinulosa* (EC Habitats Directive Annex I and OSPAR threatened and declining habitat);
- Stony reefs formed by aggregations of cobbles and/or boulders (EC Habitats Directive Annex I);
- 'Sandbanks which are slightly covered by sea water all the time' (EC Habitats Directive Annex I).

Biogenic Reef Habitat

The most likely biogenic reef habitats to occur in sandy habitats in the southern North Sea are biogenic reefs formed by the polychaete worm *Sabellaria spinulosa*, also known as the ross worm. Ross worms build tubes from sand and shell fragments and where large numbers can form reefs. *Sabellaria spinulosa* form reef-like or agglomerations of sand tubes that act to stabilise cobble, pebble and gravel habitats, providing a consolidated habitat for epibenthic species. The aggregations of the tube-building polychaete worm are solid (albeit fragile), and can form large structures at least several centimetres thick, raised above the surrounding seabed, and persist for many years. A such they provide a biogenic habitat that allows many other associated species to become established (Holt et al., 1998 Foster-Smith and White, 2001, Gubbay, 2007).

These reefs are ecologically important as they provide a habitat for a wide range of other seabed dwelling organisms and as such can support a greater biodiversity than the surrounding area. Due to their conservation importance they are listed as an EC Habitats Directive Annex I habitat (Habitats Directive 1992 & 1997) and an OSPAR (2008) threatened and declining habitat. However, no evidence of *S. spinulosa* aggregations was seen on any of the video transect data from the survey area, including transects over areas of high or variable reflectivity coarse or mixed sediments. Further, no specimens of *S. spinulosa* were recorded within the macrofauna analyses.

While *Lanice conchilega* beds are not listed by either the EC Habitats Directive (EC, 2013) or OSPAR (2008) as protected habitats, Rabaut et al. (2007) highlighted the role of *L. conchilega* as 'ecosystem engineers' which act to stabilise otherwise mobile seabed substrates and facilitate the development of more diverse macrofaunal communities (Rabaut et al, 2007). Furthermore, it has been suggested that *Lanice conchilega* beds meet the qualifying criteria for inclusion as EC Habitats Directive Annex I habitats (Rabaut et al, 2009).

Stony Reef Habitat

Stony reefs are defined by the Habitats Directive as comprising 'areas of boulders (>256mm diameter) or cobbles (64mm – 256mm diameter) which arise from the seafloor and provide suitable substratum for the attachment of algae and/or animal species' (EC, 2013).

The seabed video footage was analysed to assess broad habitat changes across the survey area, and to identify any areas with potential for stony reef habitats (See Appendix E). Only one seabed camera transect (Station GRAB_C3_2) within the N5A development survey area exhibited any potential for consideration as a potential stony reef (EC, 2013). As such, the video footage from station GRAB_C3_2 was assessed further using the BSL-modified stony reef assessment method (after Irving, 2009). While the Irving (2009) criteria have been approved by the UK regulators for application in UK waters, they have not been explicitly approved by the Netherlands authorities. However, this method has been used here as a useful basis for semi-quantitative assessment of potential Annex I stony reef habitat.

As detailed in Section 2.4.2, there were three criteria that were assessed to estimate the quality of potential stony reef, including composition (%), elevation (mm) and the extent. Video footage and still photographs were first reviewed to assess the 'stony reef structure' using a combination of the composition and elevation measures (Table 21). The results of reef structure analysis are summarised in Table 21, and highlighted the limited potential for the area to be classified as a stony reef due to the low percentage cover and elevation of cobbles (>64mm diameter) in this area. As such, this area is not considered to be sufficiently noteworthy to be classified as an EC Habitats Directive Annex I stony reef.

Table 21: Summary of stony reef structure assessment

Station	Easting	Northing	Length (m)	Sediment type	Stony Reefiness (After Irving 2009)		
					Composition (% cover cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Stony Reef Structure Classification
C3_2	725 366	5 953 610	61.3	Coarse sand ripples with small shell fragments that have accumulated between ripples	Not a Reef	Not a Reef	Not a Reef
	725 352	5 953 670					
	725 352	5 953 670	17.7	Cobbles overlying coarse sand with occasional boulders	25	10	Low
	725 347	5 953 687					
	725 347	5 953 688	24.7	Coarse sand with cobbles	10	5	Not a Reef
	725 343	5 953 712					
	725 343	5 953 712	44.2	Occasional cobble overlying coarse sand and infrequent boulders	10	5	Not a Reef
	725 333	5 953 755					
	725 333	5 953 755	30.3	Cobbles overlying coarse sand with occasional boulders	30	20	Low
	725 326	5 953 785					

Shallow Sandbanks Habitat

Areas of protected shallow sandbank habitat are loosely defined by depths contours of less than 20 metres below chart datum (approximately equivalent to LAT). However, areas of seabed on the flanks of shallow sandbanks but in depths exceeding 20m LAT may also be considered to be shallow sandbank habitat as any anthropogenic impacts on these areas could potentially affect the integrity of the feature as a whole.

Sandbanks which are slightly covered by sea water all the time are sandy sediments that are permanently covered by seawater and typically at depths less than 20m (LAT) and are of conservation value as they can host maerl beds as well as being typically colonised by a range of burrowing fauna, epifauna and sand eels, which are an important food source for many birds. Although much of the survey area is shallower than 20m LAT, there were no defined sandbank features in this area (Figure 1).

Due to the variety of H1110 habitat in the Netherlands, the Dutch government decided to subdivide this into three subtypes; H1110_A Wadden Sea, H1110_B North Sea and H1110_C Offshore (Noordzeeloket, 2019). Habitat H1110_C is of most relevance to the current survey area representing permanently flooded sandbanks in water depths of up to 40m, with the Dogger Bank being the main area currently protected under this habitat subtype offshore of the Netherlands. At present, no habitat profile document has been finalised for habitat subtype H1110_C. However, some key characteristics for compiling this profile document are available in Jak et al., (2009), with requirements including the presence of sandy seabed and species characteristic of H1110_C habitat (Table 22).

With the sediments within the survey area being classified within one of three Folk designations of 'sand', 'slightly gravelly sand' and 'gravelly sand', the N5A Development survey sediments can be considered to be sufficiently sandy to meet the requirements of the H1110_C habitat subtype. Review of the macrofauna species dataset together with the grab sample and seabed video logs for the current survey, showed that several of the species characteristic of the H1110_C habitat subtype were present within the survey area. In particular, sandmason worms (*Lanice conchilega*) and bathyporeid amphipods (*Bathyporeia guilliamsoniana*, *B. elegans* and *Bathyporeia* spp.) were recorded in almost all grab samples from the survey area. Other characterising species for the permanently flooded sandbank H1110_C habitat subtype present within the survey area included the polychaete *Sigalion mathildae* and sandeels (*Ammodytes marinus*).

With both the sediment type and associated fauna present within the survey area meeting the requirements outlined by Jak et al., (2009), it is possible that the survey area will be considered to represent EC Habitats Directive Annex I habitat subtype H1110_C (permanently flooded sandbank) throughout N5A Development site and route survey areas. However, there is currently insufficient information in the public domain to pre-empt this decision.

Table 22: Species characteristic of permanently flooded sandbank – Netherlands habitat subtype H1110_C

Species Group	Common Name	Species Name	Description
Polychaete	**Sandmason**	***Lanice conchilega***	**Species occurring on sand substrate**
Polychaete	**na**	***Sigalion mathildae***	**Mainly occurring in clean sandy substrates, Dogger Bank one of the areas where the species occurs.**
Crustacea	**Sand digger shrimp**	***Bathyporeia guilliamsoniana***	**Epiphytes in clean sand and on Dogger Bank**
Crustacea	**Sand digger shrimp**	***Bathyporeia elegans***	**Occurring in coarse, clean, low-fines sediments**
Crustacea	Cumacean	*Iphinoe trispinosa*	Specific for sand from Dogger Bank
Echinodermata	Brittlestar	*Acrocnida brachiata*	Occurring in high densities in clean sand up to a depth of 40 m
Echinodermata	Pea urchin	*Echinocyamus pusillus*	Found in coarse sand and fine gravel enriched with detritus
Mollusca	Ocean quahog	*Arctica islandica*	Occurs on edges of the Dogger Bank - long-lived species
Mollusca	Common whelk	*Buccinum undatum*	Occurs on mixed substrate – long-lived species
Mollusca	Bivalve	*Mactra coralina*	Long-lived species that feeds on particles from the water column. Found in fine to coarse sand
Fish	**Lesser sandeel**	***Ammodytes marinus***	**Occurring in fine sand. An important food source for birds, fish and marine mammals**
Fish	Lesser weaver	*Trachinus vipera*	Specific to sand, where they lie buried subsurface
Ray	Thornback ray	*Raja clavata*	Residual population. Long-lived species
Fish	Plaice	*Pleuronectes platessa*	Generally found on sandy substrate. Common species

Note: species occurring within the N5a Development survey area are shown in **bold** font type.

4 CONCLUSION

In May 2019, Oranje Nassau Energie (ONE) contracted GEOxyz Offshore, supported by Benthic Solutions Ltd (BSL) to undertake a range of geophysical, geotechnical and environmental surveys in block N5A of the Dutch Sector of the Southern North Sea, comprising a site survey for the N5A proposed platform and two route surveys; one along a planned pipeline to NGT Hot Tap, and the other a cable route to Riffgat Offshore Wind Park. Environmental baseline sampling within the N5A survey area involved the acquisition of camera footage, physico-chemical and macro-invertebrate samples.

Grab sampling was carried out across 28 locations (with two replicates) within the survey area, of which both physico-chemical and fauna samples were taken for each location. To aid habitat ground-truthing, drop down video footage was taken at all grab locations (28 stations) and a further eight camera transects of approximately 100m in length were conducted within the survey area.

Review of the seabed photography, acoustic survey data, video and seabed sample analysis of the survey area revealed a uniform seabed which ranged from a minimum of approximately 9.8m LAT at KP0.000 on the N5A to NGT Hot Tap pipeline route to a maximum of 26.4m LAT at KP14.675. Both the N5A to NGT Hot Tap pipeline route and N5A to Riffgat Cable Route were crossed by a series of natural troughs trending west-north-west to east-south-east. Two potential wrecks were discovered, and scars thought to be attributed to previous exploratory drilling activity were observed near to the proposed platform location (~140m away).

Particle size analysis showed a sand-dominated environment with ~93% of samples comprising over 80% sands, largely due to the proximity to shore resulting in a strong hydrodynamic regime, restricting the settling of fine sediment. Variable proportions of gravel and fines were seen in grab sample data, reflecting the presence of areas of more mixed sediment and outcropping clay.

The results showed low levels of total hydrocarbon content (THC) within the survey area, with levels ranging from 0.72mg.kg^{-1} to 13.65mg.kg^{-1} (mean 3.15mg.kg^{-1}±2.69SD). Eight stations recorded levels above mean background levels for the southern North Sea (UKOOA, 2001) and one station (GRAB_P_1) had levels exceeding the 95th percentile for uncontaminated background sediments, reflecting the high percentage fines at this station. Alkanes contributed on average 1.22% to the THC levels recorded across the survey area indicating the seabed consisted of uncontaminated marine sediments where background hydrocarbons are continually replenished. Polyaromatic hydrocarbon levels were low but variable ranging from 0.00µg.g^{-1} to 66.8µg.g^{-1}. Once again, only GRAB_P_1 exceeded the 95th percentile value for background PAH levels in the southern North Sea. Gas chromatography traces for all stations, including station GRAB_P_1 showed signatures consistent with background uncontaminated sediments.

Concentrations of heavy metals were within the typical ranges expected for uncontaminated background sediments, with only zinc and copper at GRAB_P_1 exceeding the 95th percentile for the southern North Sea. Barium was recorded at low levels and showed no evidence of the elevated concentrations associated with drilling impact.

The macrofauna throughout the N5A survey area showed some variability in terms of abundance, richness and species composition which was shown to be influenced by the sediment composition. Overall the survey area was highly species abundant with a total of 16,550 individuals (infaunal species) identified. Of the 150 species recorded, 118 were infaunal and were dominated by annelids, accounting for 58.90% of total individuals recorded. Molluscs, followed by crustaceans, were the next major phyla represented in N5A (9.3% and 7.9% of individuals, respectively). The samples were not considered to be epifaunal rich, with a combined grouping of colonial and solitary epifauna accounting for thirteen species, of which Cnidaria was the most well represented with six taxa observed. This is due to the sand dominated area lacking suitable substrate for these species to attach to and colonise. The Shannon-Wiener Diversity was variable ranging from a minimum of 2.05 at GRAB_C_3 to a maximum of 3.90 at station GRAB_P_2. Further analysis using multivariate statistics identified four groupings, very similar to the clusters identified in the particle size analysis signifying links between particle size and the community of macrofauna, which was verified through statistical tests highlighting a correlation between macrofauna communities and particle size data.

In total, four habitats were assigned within the survey area: 'infralittoral fine sand', 'infralittoral coarse sediment', 'infralittoral mixed sediment' (split into categories 'no clay' and 'incl. clay') and 'dense *Lanice conchilega* and other polychaetes in tide swept infralittoral sand and mixed gravelly sand'. The infralittoral fine sand was the dominant sediment type and was typically assigned to the habitats along the more southerly pipeline to NGT Hot Tap route. Stations along the Riffgat cable route consisted of a combination of habitat types, with a large patch infralittoral coarse sediment further North. Clay outcrops at GRAB_P_1 and GRAB_C3_1 resulted in higher fines proportions in the PSA data for these stations, which was interpreted to be present in eight other small patches within the survey area. The last habitat type, 'dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' was seen in a single large area along the northern edge of the N5A site and the N5A to Riffgat Wind park Cable Route.

A single patch of cobbles and boulders was identified at GRAB_C3_2, and as a result a stony reef assessment was performed. Due to insufficient cover or elevation of cobbles, it was found that there was a low chance of this being a true stony reef and thus did not warrant consideration as a potential EC Habitats Directive Annex I stony reef habitat (after Irving, 2009).

The seabed sediments within the survey area were characterised by sand-dominated and supported several species listed by Jak et al., (2009) as being characteristic of the EC Habitats Directive Annex I permanently submerged sandbank habitat (subtype H1110_C). At present there is insufficient publicly available information to confirm classification of the survey area as the H1110_C habitat subtype, but it is possible that the survey area will be classified as such.

No other protected habitats or species were observed within the survey area, based on review of the acquired geophysical data and environmental ground-truthing by grab sampling and seabed photography.

5 BIBLIOGRAPHY

Berthou, F., and Friocourt, M.P. 1981. Gas Chromatographic Separation of Diastereometric Isoprenoids as Molecular Markers of Oil Pollution. J Chromatog 219: 393-402.

Blumer, M. and Snyder, W.D. 1965. Isoprenoid hydrocarbons in recent sediments: presence of pristane and probably absence of phytane, Science 150: 1588.

Bouloubassi, I., Fillaux, J. and Saliot, A. 2001. Hydrocarbons in surface sediments from the Changjiang (Yangtze river) estuary, East China Sea. Mar Pollut Bull 42: 1335-1346.

Bryan, G.W., and Langston, W.J. 1992. Bioavailability, accumulation and effects of heavy metals in sediments with special reference to United Kingdom estuaries: A review. Environ Pollut, 76: 89-131.

Buhr K.-J. & Winter J.E, 1977. Distribution and maintenance of a *Lanice conchilega* association in the Weser estuary (FRG), with special reference to the suspension-feeding behaviour of *Lanice conchilega*. In Proceedings of the Eleventh European Symposium of Marine Biology, University College, Galway, 5-11 October 1976. Biology of Benthic Organisms (ed. B.F. Keegan, P.O. Ceidigh & P.J.S. Boaden), pp. 101-113. Oxford: Pergamon Press.

Chester, R. and Voutsinou, F.G. 1981. The Initial Assessment of Trace Metal Pollution in Coastal Sediments. Mar Pol Bull 12: 84-91.

Chow, T.J. and Snyder, C.G. 1980. Barium in the Marine Environment: A Potential Indicator of Drilling Contamination. In Symposium Proceedings: Research on environmental fate and effects of drilling fluids and cuttings. Lake Buena Vista, Florida, 2: 723-736.

Clarke, K.R. and Warwick, R.M. 1994. Similarity-based testing for community pattern: the 2-way layout with no replication. Mar Biol 118: 167-17.

Connor, D. W, Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northern, K. O. and Reker, J. B. 2004. The Marine Habitat Classification for Britain and Ireland. Version 04.05. Introduction.

Degraer, S.; Wittoeck, J.; Appeltans, W.; Cooreman, K.; Deprez, T.; Hillewaert, H.; Hostens, K.; Mees, J.; Vanden Berghe, E.; Vincx, M. 2006. The macrobenthos atlas of the Belgian part of the North Sea. *Belgian Science Policy. D/2005/1191/3. ISBN 90-810081-6-1.* 164 pp.

Eagle, R.A., 1975. Natural fluctuations in a soft bottom benthic community. Journal of the Marine Biological Association of the United Kingdom, 55, 865-878.

Eglinton, G., Gonzalez, A.G., Hamilton, R.J. and Raphael, R.A. 1962. Hydrocarbon constituents of the wax coatings of plant leaves: a taxonomic survey. Phytochemistry *1*: 89-102.

Eleftheriou, A., Basford, D. J., 1989. The macrobenthic infauna of the offshore northern North Sea. J Mar Biol Assoc UK *69*: 123-143.

Emerson, S., Hedges, J., 2008. Chemical Oceanography and the Marine Carbon Cycle. Cambridge University Press. 286pp

EUNIS, 2013. The European Nature Information Service. Accessed from http://eunis.eea.europa.eu/habitats.jsp

Folk, R.L., 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. J Geol 62: 344-349.

Foster-Smith, R.L. & White, W.H. 2001. *Sabellaria spinulosa* reef in The Wash and North Norfolk Coast cSAC and its approaches: Part I, mapping techniques and ecological assessment. English Nature Research Reports, Number 545. 53pp.

Fraser, S., Shelmerdine, R.L., and Mouat, B. (2018). Razor clam biology, ecology, stock assessment, and exploitation: a review of Ensis spp. in Wales. NAFC Marine Centre report for the Welsh Government. Contract number C243/2012/2013. pp 52.

Gettleson, D.A., and Laird, C.E. 1980. Benthic Barium Levels in the Vicinity of Six Drill Sites on the Gulf of Mexico. In Symposium Proceedings: Research on Environmental Fate and Effects of Drilling Fluids and Cuttings. Lake Buena Vista, Florida, 2: 739-785.

Gubbay, S., (2007). Defining and managing *Sabellaria spinulosa* reefs: Report of an inter-agency workshop 1-2 May, JNCC Report No 405.

Hayward P.J., 1985 Ctenostome Bryozoans, Synopses of the British Fauna (New Series) No. 33, London: Brill, 169 pp.

Hayward P.J. & Ryland J.S., 1998. Cheilostomatous Bryozoa Part 1: Aeteoidea – Cribilinoidea. Synopses of the British Fauna (New Series), No. 10. (Second Edition) Published for the Linnean Society of London and The Estuarine and Coastal Sciences Association by Field Studies Council, Shrewsbury, 366pp.

Holt, T.J., Rees, E.I., Hawkins, S.J. & Seed, R. (1998). Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association of Marine Science (UK Marine SACs Project). 170pp.Habitats Directive (European Community), 1992, 1997. Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.

Ingle R. W. (1997). Crayfishes, Lobsters, and Crabs of Europe: An Illustrated Guide to Common and Traded Species. London: Chapman & Hall.

Irving, R. 2009. The identification of the main characteristics of stony reef habitats under the Habitats Directive. *JNCC Report No. 432*. pp. 42.

Jak, R.G., Bos, O.G., Witbaard, R. & Lindeboom, H.J. 2009. Conservation objectives for Natura 2000 sites (SACs and SPAs) in the Dutch sector of the North Sea. IMARES – Institute for Marine Resources & Ecosystem Studies. Report number C065/09.

JNCC. 2015. The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online]. [Date accessed]. Available from: jncc.defra.gov.uk/MarineHabitatClassification.

Jones, J., & Holdich, D. (1983). A New Species of the Tanaid Genus *Tanaissus* Norman & Scott from British Waters. Crustaceana, 45(2), 214-219.

Laflamme, R.E. and Hites, R.A. 1978. The global distribution of polycyclic aromatic hydrocarbons in recent sediments. Geochim Cosmochim Acta. 42: 289-303.

Long, E.R., MacDonald, D.D., Smith, S.L. and Calder, F.D. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuary sediments. Environ Manage 19: 81-97.

Luoma, S.N., and Davies J.A. 1983. Requirements for modelling trace metal portioning in oxidised estuarine sediments. Mar Chem, 12: 159-181.

Macdonald, D.D., Carr, R.S., Calder, F.D., Long, E.R., and Ingersoll, C.G. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. Ecotoxicology. 5: 253-278.

Manuel R.L., 1988. British Anthozoa. Keys and notes for the identification of the species. Synopses of the British Fauna (New Series), No. 18. Published for The Linnaean Society of London and The Estuarine and Brackish-Water Sciences Association by Academic Press, London, New York, Toronto, Sydney, San Francisco, 241 pp.

McCourt, C.B., Price, R.J., John, S.D., Penny, D.M. and Clarke, L.J. 1991. Environmental Applications of Plasma Spectrometries within the Oil Industry. SPE, Proceedings First International Conference on Health, Safety and Environment, The Hague, The Netherlands 10 - 14 November 1991, SPE 23349, 301-309.

McDougall, J. 2000. Section 5.1. The significance of hydrocarbons in surficial sediments from the Atlantic Margin regions. In: Hydrocarbons in environmental surveys of the seafloor of the UK Atlantic Margin. Atlantic Frontier Environmental Network [CD-Rom]. Available from Geotek Ltd, Daventry, Northants, NN11 5EA, UK.ISBN 09538399-0-7

McLeese, D.W., Sprague, J.B., and Ray, S. 1987. Effects of cadmium on marine biota. p. 171-198. In: Nriagu, J.O. and J.B. Sprague (eds.). Cadmium in the Aquatic Environment. Advances in Environmental Science and Technology, Volume 19. John Wiley & Sons, New York. pp. 272.

Muniz, P., Danulat, E., Yannicelli, B., Garcia-Alonso, J., and Bicego, M.C. 2004. Assessment of contamination by heavy metals and petroleum hydrocarbons in sediments of Montevideo harbour (Uruguay). Environmental International. 29: 1019-1028.

Neff, J.M. 2005. Bioaccumulation in marine organisms. Effects of contaminants from oil well produced water. Elsevier, Oxford, UK.

National Research Council (NRC), 1983. Drilling Discharges in the Marine Environment. National Academy Press, Washington DC. pp. 180

Noordzeeloket, 2019. Habitat type H1110C on the Dogger Bank[Online]. [Date accessed]. Available from: https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/doggersbank/dogger-bank/habitattype/.

Oliver, P. G., Holmes, A. M., Killeen, I. J. & Turner, J. A. 2016. Marine Bivalve Shells of the British Isles. Amgueddfa Cymru - National Museum Wales. Available from: http://naturalhistory.museumwales.ac.uk/britishbivalves.

OSPAR Commission, 2004. OSPAR guidelines for monitoring the environmental impact of offshore oil and gas activities. Meeting of the OSPAR Offshore Industries Committee (OIC), 15 – 19 March, 2004.

OSPAR, 2008. Descriptions of habitats on the OSPAR list of threatened and/or declining species and habitats. OSPAR Convention for the Protection of the Marine Environment of the North-east Atlantic. Reference Number: 2008-07. 8pp.

OSPAR, 2009. Agreement on CEMP Assessment Criteria for the QSR 2010. Agreement 2009-2

OSPAR 8, 2009 – Update of JAMP guidance on normalisation of contaminant concentrations in sediment.

Paez-Osuna, F., and Ruiz-Fernandez, C. 1995. Comparative Bioaccumulation of Trace Metals in *Penaneus stylirostris* in Estuarine and Coastal Environments. Estuar Coastal Shelf S 40**:** 35-44.

Parry, M.E.V., K.L. Howell, B.E. Narayanaswamy, B.J. Bett, D.O.B. Jones, D.J. Hughes, N. Piechaud, H. Ellwood, N. Askew, C. Jenkins And E. Manca. 2015. A Deep-sea Section for the Marine Habitat Classification of Britain and Ireland. JNCC report 530. In: **JNCC. 2015.** The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online].

Rabaut, M., Guilini, K., Van Hoey, G., Vincx, M., Degraer, S. 2007. A bioengineered soft-bottom environment: the impact of *Lanice conchilega* on the benthic species-species densities and community structure. Estuar. Coastal Shelf Sci. doi:10.1016/j.ecss.2007.05.041.

Rabaut, M., Vincx. M. and Degraer, S. 2009. Do Lanice conchilega (sandmason) aggregations classify as reefs? Quantifying habitat modifying effects. Helgol Mar Res (2009) 63:37–46. DOI 10.1007/s10152-008-0137-4.

Schaule, B.K. and Patterson, C.C. 1983. Perturbations of the Natural Lead Depth Profile in the Sargasso Sea by Industrial Lead. In: Trace Metals in Seawater. Plenum Press, New York.

Sheahan, D., Rycroft, R., Allen, Y., Kenny, A., Mason, C. & Irish, R. 2001. Contaminant Status of the North Sea. Technical report produced for SEA2. Report no. TR_004. Report to the Department of Trade and Industry. Centre for Environment, Fisheries and Aquaculture Science. pp. 66

Snelgrove, P.V.R., and Butman, C.A. 1994. Animal–sediment relationships revisited: cause versus effect. Oceanogr Mar Biol Annu Rev 32: 111–177.

Sleeter, T.D., Butler, J.N. and Barbash, J.E. 1980. Hydrocarbons in the Sediment of the Bermuda Region: Lagoonal to Abyssal Depths. Pp 267-288 In: Petrakis, L. and Weiss, F.T. (Eds.). Petroleum in the Marine Environment. Chem. Soc., Washington, D.C

Tessier, A., Campbell, P.G.C., and Bisson, M. 1979. Sequel Extraction Procedure for the Speciation of Particulate Trace Metals. Anal Chem 51: 844 - 851.

Thompson, B., and Lowe, S. 2004. Assessment of macrobenthos response to sediment contamination in the San Francisco estuary, California, USA. Environ Toxicol Chem 23: 2178–2187.

Tricine, R.P., and Trefry, J.H. 1983. Particulate Metal Tracers of Petroleum Drilling Mud Dispersion in the Marine Environment. Environ Sci Technol 17: 507 - 512.

UKOOA, 2001. An analysis of U.K Offshore Oil & gas Environmental Surveys 1975-95, pp. 141.

US EPA, 1999. Toxicity Reference Values – Screening Level Ecological Risk Assessment Protocol. Center for Combustion Science and Engineering. pp. 98.

Wheeler A., 1969. The fishes of the British Isles and North West Europe. MacMillan. London UK, 630pp., plates 1-16.

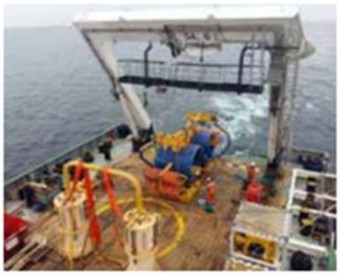
Youngblood, W.W. and Blumer, M., 1975. Polycyclic aromatic hydrocarbons in the environment: homologues series in soils and recent marine sediments. *Geochim Cosmochim Acta*, 39: 1303-1314.

APPENDIX A - *GEO OCEAN III*

GEO OCEAN III

Offshore Survey & Support Vessel

GEOxyz OFFSHORE



SUPPORT ACTIVITIES / VESSEL CAPABILITIES

The GEO OCEAN III is a multi-disciplined DP II offshore survey vessel. With her specifically selected equipment and capabilities for the North Sea survey and light construction support activities, she is the ideal candidate for our Oil & Gas and Renewables clients.

The vessel is equipped with 56 berths, Offshore crane, Survey and ROV systems. Equipment can be rapidly deployed using the large Stern A-Frame, crane or through the 6 x6 m moonpool via the dedicated A-frame and 30t AHC winch. All together making the Geo Ocean III a dynamic platform for subsea operations.

GEOxyz | T: +32 (0) 56 70 68 48 | info@geoxyz.eu | www.geoxyz.eu

GEO OCEAN III

Offshore Survey & Support Vessel

TECHNICAL SPECIFICATION

General

Name	Geo Ocean III
Flag	Luxembourg
Port Registry	Luxembourg
Call Sign	LXGP
IMO Number	9285586
Classification	LLOYDS - HULL – MACH
Vessel Type	Survey Vessel SV
Special Service:	Fire fighting ship / Fire fighting 1 Waterspray / Oil Recovery / Stand by rescue
Unrestricted navigation	AUT-UMS - ALM - DYNAPOS-AM/AT-R; SDS

Dimensions and Construction

Builder	De Hoop
Built	2004
LOA	77,30 m
Width Moulded	18 m
Depth Moulded	7,40 m
Draft min. / max.	3,80 m/6,10 m
Gross Tonnage	3,722
Moonpool	6 m x 6m

Accommodation

Total Berths	56 persons
Total Cabins	32
Single cabins	8 x 1 person
Double cabins	24 x 2 persons
Offices	1 x Dedicated Online 1 x Dedicated Offline / Conference room 1 x Client Office 1 x OCM Office 1 x 3rd Party Office
Hospital	1 x Hospital
Other Facilities	Galley, Large Mess room, 2 x day room, Gymnasium, Dirty Mess

Capacities & delivery Rates

Main Deck area:	670 m²
Hangar Deck:	290 m²
Mezzanine Deck Area:	268 m²
Max Deck Loading	Main Deck 5t/m² Mezzanine Deck 2t/m²
Max Deck Load	1,300 t @ 1m above deck
Fuel oil (capacity - transfer):	1,105m³ - 100m³/h @ 8bars
Drill or Water ballast (capacity - transfer):	1,350m³ - 40m³/h @ 4.5bars
Antiheeling (capacity - transfer):	250m³ - 2 x 500m³/h
Fresh water (capacity - transfer):	495 m3 - 40 m³/h @ 4.5bars
Oil recovery:	324 m³
Foam:	24 m³

Safety Equipment

Fi-Fi:	Class 1
Pumps:	2 x 1,200m³/h
Monitors:	2 x 1,200m³/h
Fast Rescue Craft:	1 x Seabear 23 MKII
Rescue capacity:	150 persons in tropical area

MACHINERY & PERFORMANCE

Propulsion - Machinery

Main propulsion:	2 x 1,800 kW FP Azimuth thrusters
Main Engines:	4 x 1360kW Caterpillar
Tunnel thrusters:	1 x Insert manufacturer 780 kW
Fwd Azimuth	1 x Rolls Royce 600kW retractable

SPEED & CONSUMPTION (Information only)

Service Speed	10 kts
Max Speed	12 kts

Fuel consumption

Stand-by in port:	2t/day
Survey Speed:	7t/day
DPII:	6t/day

Deck Equipment and Cranes

Main Crane:	SMST telescopic 40t @ 9m - 6t @ 23.5m
Winch Capacity:	40t / 40t - 200m
Deck Crane	4.5t @9m Man-riding
Stern A- Frame :	54t @ 8m outreach
Max launching Dims	8m clearance up / 10m wide opening
Offshore capacity:	54t @ 8m outreach
Winch Capacity	30t / 30t - 1,500m - AHC
Moonpool A-Frame	30t
Winch Capacity	30t / 30t - 1,500m - AHC
Tuggers:	1 x 10t & 1 x 30t
Capstans:	2 x 5t
Deck Service Air Supply:	66 m³/h @ 8 bars
Deck Power Supply:	3 x 265 kW - 480 VAC /60Hz

Navigation and Dynamic Positioning

DP System:	GE DP21 + IJS
Type:	DP 2
Reference 1:	DGPS 1 Fugro Seastar 9205
Reference 2:	DGPS 2 Fugro Seastar 9205
Reference 3:	G4 and XP2 corrections USBL
Reference 4:	Kongsberg Fan Beam
Primary Heading/motion/INS	POSMV 320 Ocean Master
Secondary Heading/motion/INS	POSMV 320 Ocean master
Subsea Positioning	Sonardyne Ranger 2 c/w 6G HPT 5000

Survey Suite and Offline software

Survey Suite	QINSY EIVA
Offline Software	QINSy, NaviSuite, Beamworks, Oasis Montaj (UXO marine), Visual works, Autodesk, Arc GIS,
Video Distribution	4k ultra high definition
Audio comms	Canford clear comms

Survey Sensors

MBES	Hull Mounted (Optional Dual head) R2Sonic 2024 UHR
Single Beam	XXXXXXX
Sound Velocity Sensor	Valeport Swift
Sidescan Sonar	Edgetech 2200
Sub Bottom Profiler	Silas, Depending on requirements

Subsea Equipment

WROV	1 x 150HP WROV
IROV	Mezzanine deck configured for rapid mobilisation 1 x Seaeye Cougar
Vibrocorer	3/6m electric/hydraulic systems as required
CPT	Optional 1.5 – 20t systems (Neptune or Manta type as required)

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APPENDIX B - BSL SAMPLING EQUIPMENT

BSL DOUBLE GRAB

BSL DOUBLE GRAB

- **General Specifications**
  - 2 x 0.1m^2 Sample Area
  - Total Stainless Steel Construction
  - Adjustable weight
  - Proven performance in 2000m depth
  - Flat Pack for Air Freighting

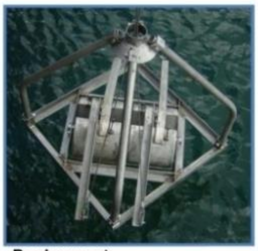
- **Services**

The BSL Double Grab was designed and built by BSL in 2007 to carry out more efficient grab sampling operations in very deep waters. It is also routinely used for projects where multiple replicates are required or where both chemical and biological analysis are needed from the same deployment. This multi-purpose sampling tool is ideal for shallow water and deep water operations alike, halving the ship-time required to acquire sample replicates in moderate water depths.

Recovery

Made of stainless steel, the grab can be ballasted with additional lead weights, for operations in deeper waters, strong currents or compacted sediments. The two pairs of extended stainless steel arms increase the leverage on closure to the buckets, but these can be fouled by coarser gravels.

Both buckets have hinged doors fully enclosing the samples on recovery but allowing the scientist access to the undisturbed sample prior to emptying the sampler. Each bucket has the capacity to collect samples of approximately 15L.



Deployment

Direct access to sample

Grab stand and sample trays

Shipping weight	200kg
Shipping dimension	0.4* to 1.2 x 1 x 0.2m
Specifications	920 x 920 x 1000mm

**if sampler is dismantled for freighting*

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Benthic Solutions, Elanco Works, Marsh Road, Hoveton, Norwich, NR12 8UH, UK

Tel : +44 (0) 1603 784726 Mail: info@benthicsolutions.com www.benthicsolutions.com

Benthic Solutions

BSL DAY GRAB

BSL MODIFIED DAY GRAB

- **General Specifications**
  - 0.1m² Sample Area
  - Total Stainless Steel Construction
  - Adjustable weight
  - Compact Design
  - Proven performance in 1000m depth
  - Modified for One Man Operation

- **Services**

Day grabs comprise of two stainless bucket sections which are mounted within a stainless steel frame. On contact with the seabed, a trigger bar is pushed upwards via pressure plates allowing the buckets to close under the gravity of the unit through a pulley system. This controlled contact and closure once on the seabed helps ensure sample disturbance is minimised. The top of the grab is covered by two catch-closed inspection doors also made of stainless steel. The doors allow direct access to the sample inside the grab when closed, and protect the sample from the grab movement through the water column during recovery.

Our Day grab sampler (offset design) was originally modified by BSL's principle scientist in the early 1990s to improve penetration and reduce sample disturbance and contamination. These grabs are fitted with additional but removable stainless steel coated lead weights which can provide better penetration in more compacted substrates, but can also be removed to prevent over-penetration of the sampler in softer sediments.

A further extended bucket lip reduces sediment washout during retrieval. The unit can be supplied with a stand allowing for easy sample access and handling. A further modification that was made provided an efficient closure system to allow arming by a single person. This modified Day grab has become the standard operating tool for the North Sea.

The grab is relatively simple to operate in almost any water depth. The (0.1m²) grabs have been constructed with stainless steel throughout making this grab ideal for accurate assessment of the chemical properties of sea floor sediments.

Shipping weight	250kg
Shipping dimension	1.5 x 1 x 1m
Specifications	800 x 800 x 850mm

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Tel : +44 (0) 1603 784726 Mail: info@benthicsolutions.com www.benthicsolutions.com
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BSL WILSON AUTO-SIEVER

WILSON AUTOSIEVER ©

*Best practice** for benthic samples

- **General Specifications**

The *Wilson* Autosiever is a semi-automated sieving table for reducing benthic sediment samples offshore in a routine and controlled manner.

- Reduces time consuming and laborious sample handling in the field
- Reduces personnel numbers required for benthic processing
- Reduces damage to biological material during processing
- Well proven field performance on benthic surveys worldwide
- Standardises sample processing
- Robust stainless steel construction that dismantles for storage or freighting

- **Services**

The *Wilson* Autosiever (WAS) was initially designed in the late 1980s by Ian Wilson (BSL Director), but was implemented from the early 1990s as the preferred benthic processing tool for all sampling operations by a major UK based environmental survey contractor. The system was subsequently commercialised and made available for purchase to other operators and users following the success of the trial at an NMBAQC workshop in 1997*.

The WAS system was designed to standardise all sieving operations between surveys and personnel, increasing the efficiency of the sample handling and processing without compromising the quality of the biology recovered.

Its simple yet unique and revolutionary design enables its employment from small vessels and large ships alike and in a variety of different sediment conditions, ranging from coarse heterogenic substrates down to soft clays and silts.

Cited as *best practice* for biological processing*, the WAS system has become the preferred tool for a large number of organisations that routinely carry out benthic surveys. Systems are currently being employed around the world (including UK, Ireland, Norway, Netherlands, Germany, France, Australia, Africa and South America) by a multitude of different users including survey companies, fish farms, government institutes and agencies, laboratories, universities and environmental consultancies.

Shipping weight	80kg
Shipping dimension	1 x 0.8 x 0.3m

* Proudfoot, R.K., Elliott, M, Dyer, M.F., Barnett, B.E. Allen, J.H., Proctor, N.L, Cutts, N.D., Nikitik, C., Turner, G. Breen, J. Hemmingway, K.L and Mackie, T., 1997. Collection and Processing of macrobenthic samples from soft sediments; a best practice review. Proceedings of the Humber Benthic Field Methods Workshop, Hull University.

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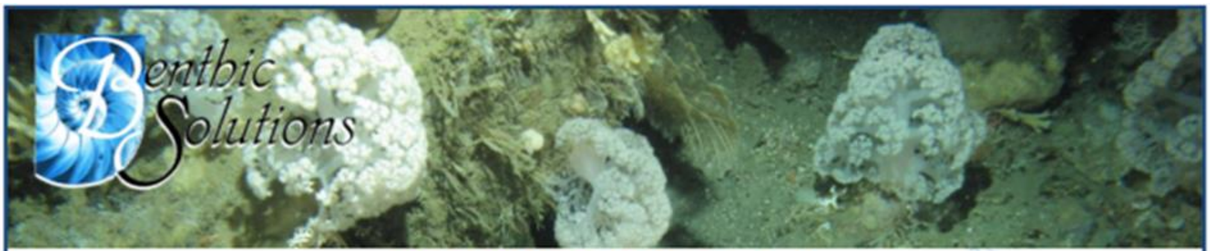
Tel : +44 (0) 1603 784726 Mail: info@benthicsolutions.com www.benthicsolutions.com

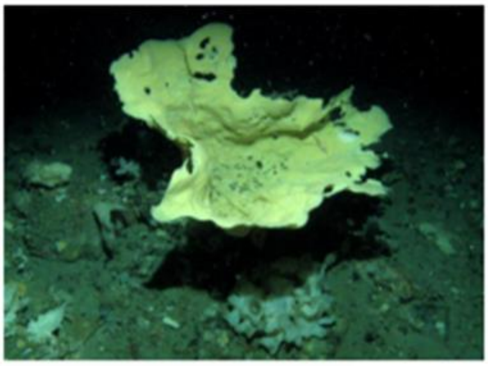
Benthic Solutions

STR SEABUG CAMERA SYSTEM



UNDERWATER CAMERA – Seabug
Seabed Monitoring & Underwater Real-time Footage

- **General Specifications**
  - Flexible deployment scenarios
  - Depth rated to 3500m
  - Digital streaming target video
  - Video overlay on video data
  - Uses vessel existing sonar cabling



- **Services**

The deep water camera system is based on a Sonar Equipment Services Seabug which was developed in conjunction with Benthic Solutions Limited in 2010. The system is based upon 14.7 megapixel digital stills camera operated from the surface via a single armoured coaxial or twisted pair cable. Typically, this utilises an existing sonar cable on the survey vessel through a multiport multiplexer carrier system to a control consol.

The system provides continuous targeting video data streamed to the surface where a computer is used to trigger the stills camera system remotely as required. These systems are fitted with inbuilt strobe units which can be deployed in a drop-down frame mounted configuration, or towed seabed sled (pictured). Seabed video is illuminated by 4 or 6 dedicated LED lamps with the camera orientated at an oblique or a downward looking aspect.

The system provides a very high quality digital image and is an ideal tool for ground truthing, habitat mapping and detailed seabed classification surveys from vessels in water depths in excess of 3km. Examples of previous projects include regional deep water surveys looking at iceberg keel scar, deep water coral and sponge communities and regional environmental habitat mapping assessments.

Shipping weight	200kg *
Shipping dimension	2 x 1 x 0.2m *
Specifications	2 x 1 x 1m *

*as multiple configurations are available, values shown indicate the maximum

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BSL MOD4 UNDERWATER CAMERA SYSTEM

UNDERWATER CAMERA – MOD4
Seabed Monitoring & Underwater Real-time Footage

- **General Specifications**
  - Flexible deployment scenarios
  - Depth rated to 4500m
  - Superior stills and streaming video quality
  - Near zero-delay shutter release
  - Unattended time lapse photography
  - Solutions for very low visibility environments

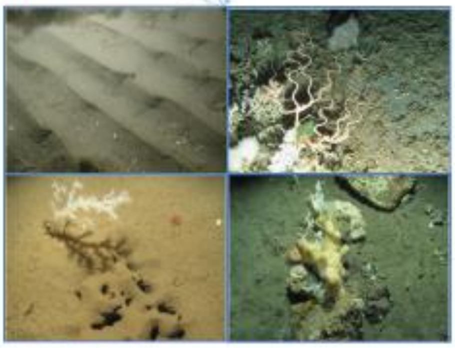
- **4 Camera Configurations**
  1. Deepwater real time
  2. Shallow water real time
  3. Ultra deepwater timelapse
  4. Remote timelapse

- **4 Deployment Configurations**
  1. Towed system (deep to shallow)
  2. Bed-hop ultra deep water
  3. Remote mooring timelapse
  4. Poor visibility freshwater lens

- **Services**

Benthic Solutions Ltd have an array of underwater cameras for various deployment scenarious. Our latest development (MOD4) is the most flexible camera to date. For water depths of less than 400m it is capable of communicating with the surface via a multicore umbilical cable, which provides a very high quality live view of the seabed. Zero-delay still images of 24 megapixels can be captured and transmitted to the surface for instant review.

For deeper waters the camera can be controlled via an armoured coax cable, of the type commonly used for towing sidescan sonar. A theoretical maximum cable length of 12km can be used. In this setup, the live feed quality is slightly reduced. To compensate for this an additional 1080p 30fps camera can be added if very high quality seabed video footage is desired.



High output lighting has been developed using the latest LED technology. 2x 2200 lumen lamps provide flood lighting ahead of the camera for video streaming, whilst a multi-head strobe system (up to three heads) can be utilised in TTL configuration to give perfectly exposed under water still images.

Benthic Solutions can also provide different camera frames suitable for seabed towing or 'drop down' use. These can be small and lightweight, or larger with increased ballast for deep water scenarios.

Shipping weight	200kg *
Shipping dimension	2 x 1 x 0.2m *
Specifications	2 x 1 x 1m *

*as multiple configurations are available, values shown indicate the maximum

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APPENDIX C - LOG SHEETS

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
1	GRAB_P_0	Day grab	29	17:43:00	06/05/2019	85%	F1	2 x 3L bucket		shells, sand	Lanice, A. rubens, Nereis
2	GRAB_P_0	DVV	29	18:20:00	06/05/2019	60% 50%	F2 PC	2 x 3L bucket Bags and jars		sand, small pieces of shells	Lanice, A. rubens, Nereis
3	GRAB_P_0	DVV	29	18:45:00	06/05/2019	60%	F3	3 x 3L bucket		sand, small pieces of shells	Lanice, A. rubens, Nereis
4	GRAB_P_1	DVV	27	20:12:00	06/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		clay	Lanice
5	GRAB_P_1	DVV	27	20:26:00	06/05/2019	N/S	N/S	N/S	cobbles		
6	GRAB_P_1	DVV	27	20:40:00	06/05/2019	70% 50%	F2 F3	1 x 3L bucket 1 x 3L bucket		sand and clay	Polychaetes, Shell debris
7	GRAB_P_2	DVV	24	21:15:00	06/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		fine sand	*Echinocardium cordatum*, Sand eel
8	GRAB_P_2	DVV	24	21:50:00	06/05/2019	60% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket	Flatfish in grab jaws, photo taken, discarded overboard. Grab seal not compromised so used for fauna	fine sand	Sand eel, polychaetes, flatfish poss. Turbot
9	GRAB_P_3	DVV	23	22:56:00	06/05/2019	N/S	N/S	N/S	Block came down, strops broken, operations stopped		
10	GRAB_P_3	DVV	24	02:05:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars	Weight added to arms	fine sand	*Echinocardium cordatum*
11	GRAB_P_3	DVV	24	02:15:00	08/05/2019	60% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		fine sand	Sand eel, *Echinocardium cordatum*
12	GRAB_P_4	DVV	22	02:45:00	08/05/2019	60% 50%	PC F1	1 x 1L bucket Bags and jars		fine sand	Lanice
13	GRAB_P_4	DVV	21	03:03:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		fine sand	*Lanice conchilega*

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
14	GRAB_P_5	DVV	20	03:31:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Sand and shell	*Echinocardium cordatum*, razor clam
15	GRAB_P_5	DVV	20	03:42:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Sand and shell	*Lanice conchilega*
16	GRAB_P_6	DVV	21	04:29:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Fine sand	*Echinocardium cordatum* (damaged)
17	GRAB_P_6	DVV	22	04:41:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell fragments	polychaetes, Nereis, *Lanice conchilega*, fish (damaged)
18	GRAB_P_7	DVV	22	05:09:00	08/05/2019	N/S	N/S	N/S	No sample, triggered but empty		
19	GRAB_P_7	DVV	22	05:22:00	08/05/2019	N/S	N/S	N/S	No sample, did not trigger		
20	GRAB_P_7	DVV	21	05:25:00	08/05/2019	N/S	N/S	N/S	No sample, did not trigger		
21	GRAB_P_7	DVV	21	05:27:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Fine sand with minor shell debris	*Lanice conchilega*, polychaetes
22	GRAB_P_7	DVV	21	05:37:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell debris, small amounts of mud/clay	Abundant *Lanice conchilega*, polychaetes
23	GRAB_P_8	DVV	21	06:01:00	08/05/2019	N/S	N/S	N/S			
24	GRAB_P_8	DVV	21	06:03:00	08/05/2019	N/S	N/S	N/S			
25	GRAB_P_8	DVV	20	06:04:00	08/05/2019	70% 70%	PC F1	1 x 5L bucket Bags and jars		Coarse sand with shell fragments	Polychaetes
26	GRAB_P_8	DVV	21	06:12:00	08/05/2019	70% 60%	F2 F3	1 x 5L bucket 1 x 5L bucket		Coarse sand with shell fragments	*Lanice conchilega*
27	GRAB_C_8	DVV	24	19:00:00	09/05/2019	80% 80%	PC F1	1 x 1L bucket Bags and jars		Coarse sand with shell fragments	*Lanice conchilega*
28	GRAB_C_8	DVV	24	19:15:00	09/05/2019	80% 80%	F2 F3	1 x 1L bucket 1 x 1L bucket		Coarse sand with shell fragments	*Lanice conchilega*

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
29	GRAB_C_7	DVV	24	19:30:00	09/05/2019	70%, 70%	PC F1	3 x 3L bucket Bags and jars		Coarse sand with shell fragments	No conspicuous Fauna
30	GRAB_C_7	DVV	24	19:45:00	09/05/2019	N/S	N/S	N/S	Deployed but no sample, not triggering		
31	GRAB_C_7	DVV	24	20:05:00	09/05/2019	70% 80%	F2 F3	2 x 5L bucket 2 x 5L bucket		Coarse sand with shell fragments	No conspicuous Fauna
32	GRAB_C_6	DVV	24	20:27:00	09/05/2019	60% 80%	PC F1	1 x 3L bucket Bags and jars		Coarse sand with shell fragments	No conspicuous Fauna
33	GRAB_C_6	DVV	24	21:05:00	09/05/2019	80%, 80%	F2 F3	1 x 3L bucket 1 x 3L bucket		Coarse sand with shell fragments	Urchin
34	GRAB_C_5	DVV	25	05:37:00	11/05/2019	40% 70%	PC F1	1 x 3L + 1x5L bucket Bags and jars		Coarse sand with shell fragments	Gobidae, Asterias, Lancelet. *Lanice conchilega*
35	GRAB_C_5	DVV	25	05:42:00	11/05/2019	70% 70%	F2 F3	2 x 5L bucket 1 x 5L + 1x 3L bucket		Coarse sand with shell fragments	*Lanice conchilega*, polychaetes, spatangoid
36	GRAB_C_4	DVV	28	06:40:00	11/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell debris	*Lanice conchilega*, polychaetes, spatangoid
37	GRAB_C_4	DVV	28	07:01:00	11/05/2019	70% 70%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	*Lanice conchilega*, polychaetes, spatangoid
38	GRAB_C_3	DVV	28	07:29:00	11/05/2019	N/S	N/S	N/S	Did not trigger		
39	GRAB_C_3	DVV	28	07:36:00	11/05/2019	70% 70%	PC F1	1 x 1L bucket Bags and jars		Very fine sand with minor shell debris	*Lanice conchilega*, polychaetes
40	GRAB_C_3	DVV	28	07:47:00	11/05/2019	N/S	N/S	N/S	Triggered but no sample		
41	GRAB_C_3	DVV	28	07:49:00	11/05/2019	70% 70%	F2 F3	1 x 1L bucket 1 x 1L bucket		Very fine sand with minor shell debris and soft clay	Anemones, *Lanice conchilega*, polychaetes, Asterias, spatangoid

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
42	GRAB_C_2	DVV	27	08:15:00	11/05/2019	70% 70%	PC F1	1 x 5L bucket Bags and jars		Coarse sand and clay	*Lanice conchilega* and polychaetes
43	GRAB_C_2	DVV	28	08:27:00	11/05/2019	70% 40%	F2 F3	1 x 5L bucket 1 x 3L bucket	Razor clams in jaws (F3)	Coarse sand	Razor clams, *Lanice conchilega*, polychaetes. Lancelet
44	GRAB_C_1	DVV	28	08:55:00	11/05/2019	60% 60%	PC F1	1 x 3L + 1x5L bucket Bags and jars		Coarse sand and abundant shell debris	Lancelet and polychaetes
45	GRAB_C_1	DVV	28	09:04:00	11/05/2019	60% 40%	F2 F3	1 x 5L bucket 1 x 5L bucket	Razor clams in jaws (F3)	Coarse sand and abundant shell debris	*Lanice conchilega*, lancelet, polychaetes, porcelain crab
46	GRAB_C_0	DVV	29	09:32:00	11/05/2019	90% 90%	PC F1	2 x 5L bucket Bags and jars	Label for F2 in F1 bucket (2 of 2)	Coarse sand	*Lanice conchilega*, razor clams and polychaetes
47	GRAB_C_0	DVV	29	09:41:00	11/05/2019	90% 90%	F2 F3	2 x 5L bucket 2 x 5L bucket	Label for F3 in F2 bucket (1 of 2)	Coarse sand	*Lanice conchilega*, razor clams and polychaetes
48	GRAB_P_15	DVV	13	02:15:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell	Polychaetes
49	GRAB_P_15	DVV	13	02:20:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell	Polychaetes, Sand eel
50	GRAB_P_14	DVV	14	03:05:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell	Asterias, Spatangoid, Ophiuroid
51	GRAB_P_14	DVV	14	03:10:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell	Spatangoid, Ophiuroid
52	GRAB_P_13	DVV	16	03:30:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with minor shell debris	Polychaetes
53	GRAB_P_13	DVV	16	03:45:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell debris	Nereis, *Lanice conchilega*, Ophiuroid, Spatangoids
54	GRAB_P_12	DVV	16	04:32:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell debris	Nereis, *Lanice conchilega*, Spatangoids

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
55	GRAB_P_12	DVV	16	04:42:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell debris	Nereis, *Lanice conchilega*, Spatangoids
56	GRAB_P_11	DVV	17	05:03:00	12/05/2019	70% 70%	PC F1	1 x 3L bucket Bags and jars		Fine sand with significant shell debris	*Lanice conchilega*
57	GRAB_P_11	DVV	17	05:13:00	12/05/2019	70% 70%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with significant shell debris	*Lanice conchilega*
58	GRAB_P_10	DVV	17	05:35:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell debris	Polychaetes, *Lanice conchilega*, Nerie's
59	GRAB_P_10	DVV	17	05:44:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	Polychaetes, *Lanice conchilega*
60	GRAB_P_9	DVV	19	06:05:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell debris	Nereis
61	GRAB_P_9	DVV	19	06:13:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell debris	Polychaetes
62	GRAB_C3_0	DVV	24	22:43:00	14/05/2019	60% 60%	PC F1	1x1L bucket		Fine sand with shell debris	*Echinocardium cordatum*
63	GRAB_C3_0	DVV	24	22:59	14/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	*Echinocardium cordatum*
64	GRAB_C3_1	DVV	25	23:36:00	14/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		Fine sand with clay beneath	Polychaetes
65	GRAB_C3_1	DVV	25	23:45:00	14/05/2019	50% 50%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with clay beneath	Polychaetes
66	GRAB_C3_2	DVV	25	00:13:00	15/05/2019	NS NS			cobbles in jaws		
67	GRAB_C3_2	DVV	25	00:20:00	15/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		sandy gravel	polychaetes hydroids
68	GRAB_C3_2	DVV	25	00:29:00	15/05/2019	50% NS	F2	1x5L bucket	cobble in jaws of one bucket	sandy gravel	polychaetes hydroids
69	GRAB_C3_2	DVV	25	00:36:00	15/05/2019	45%	F3	1x1L bucket	cobble in jaws of one bucket	sandy gravel	polychaetes hydroids

APPENDIX D - FIELD OPERATIONS AND SURVEY METHODS

SEABED PHOTOGRAPHY AND VIDEO

Seabed video footage was acquired at eight transects using a STR Seabug Underwater camera system mounted within a BSL camera sled equipped with a separate strobe, and LED lamps. The camera unit itself is capable of acquiring images at 24MP resolution but was set to a resolution of 5MP (2592 x 1944 pixels) to optimize image upload times during camera operation. Drop down video acquiring an average of five stills and one minute of video was also conducted at each grab location (28 locations).

Once at the seabed, the camera would be moved along the length of the transect at no more than 0.5 knots. Stills Photographs were captured remotely using a surface control unit via a sonar cable to the camera system. Still images were uploaded in real time and saved to the laptop via specialist software. Live video footage, overlaid with the date, time, position and site details was viewed in real-time, and recorded directly onto a media storage device and to the laptop via specialist software. The live video stream was used to assist with targeting of the stills camera. HD footage was saved internally by the video camera; data was downloaded at the end of each day of camera operations and backed-up onto a hard drive.

Full camera specifications can be found in the table below.

STR Seabug Underwater Camera Specifications

Standard Features	Comment
Image Resolution	5 to 14.7 megapixel (up to 4,416 x 3,312 pixels)
Light Sensitivity Setting	ISO 60-1600 Auto/Manual Selected
Sensor Type	1 / 1.8” format high density CCD sensor
Light source	4 x 1000 lumen controllable LED lamps Stills strobe TTL controller
Typical settings	Aperture priority at F8, Shutter speed typically 1/125th second, Auto flash mode (TTL)
Framing Video Used	320 Line / 50 Hz PAL
Control System	SES Multiport DTS
Manufacturer	STR
Other sensors	Depth sensor and compass

A MOD4 underwater camera system was also supplied as a backup. This camera was not used during operations.

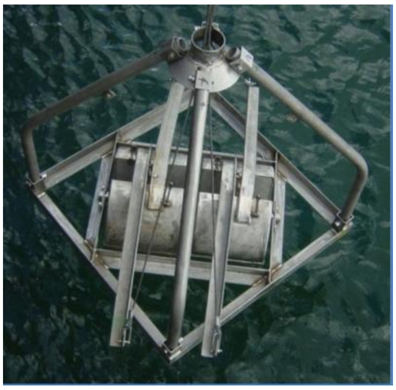
GRAB SAMPLING

The BSL double grab was designed and built by BSL for operations in soft sediments, compacted sands and shallow stiff clays. This device consists of two 0.1m^2 samplers set into a ballasted frame, reducing the time required to obtain multiple replicates at a single station.

A BSL Double grab was used for seabed sampling for the ONE Pipeline survey. Two successful deployments were required at each location. Three consecutive ‘no sample’ deployments were agreed to be the maximum number of attempts at any location before abandoning it. The inner stainless grab buckets were cleaned before deployment at any new station to avoid contamination.

Samples were subject to quality control on recovery and were retained in the following circumstances:

- Water above sample was undisturbed;
- Bucket closure complete (no sediment washout);
- Sampler was retrieved perfectly upright;
- Inspection/access doors had closed properly;
- No disruption of sample;
- Sample was taken inside the acceptable target range (<15m);
- Sample size was greater than six litres (ca. 40% of the sampler's capacity);
- No hagfish (*Myxine glutinosa*) and/or mucus coagulants.



BSL Double Grab

Key observations from samples included colour, sediment classification, layering (including redox discontinuity layers), smell (including the presence of H_2S), obvious fauna, evidence of bioturbation and anthropogenic debris.

A 0.1m^2 Day Grab was also supplied as the original primary sampler but was not used due to the clients request to use the BSL Double Grab instead.

APPENDIX E - SAMPLE AND SEABED PHOTOGRAPHS

Grab_P_0_006.JPG

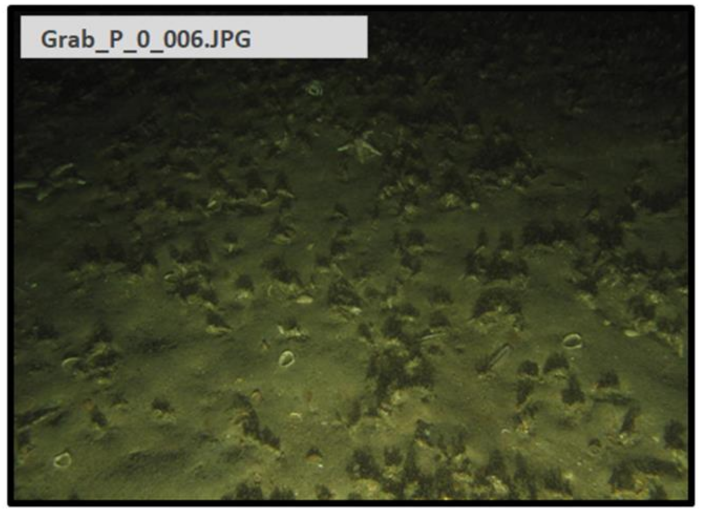


Photo Position: 721647 mE, 5954429 mN

Habitat Summary Information: Grab_P_0

Survey Area: N5a Pipeline

No. of Stills: 27 **Mins of Video: 7** **Track Length: 70m**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals. Investigating area of mixed reflectivity sediment.

Analogue Interpretation
Variable mixed reflectivity with many raised areas.

Sediment Description
Coarse sand littered with shell fragments and lanice conchilega assemblages.

Conspicuous Fauna
Cnidaria: Actiniaria sp., *Cerianthus* sp., Ceriantthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** Paguridae sp., Decapoda sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Gobiidae sp.

Grab_P_0_013.JPG

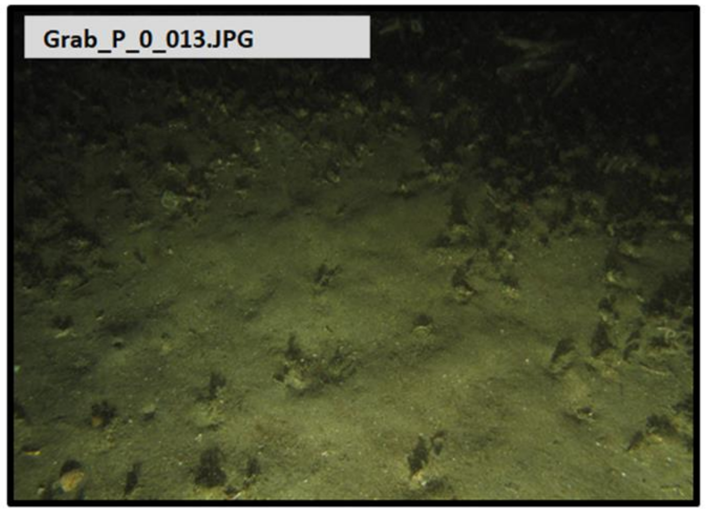


Photo Position: 721634 mE, 5954446 mN

Grab_P_0_018.JPG

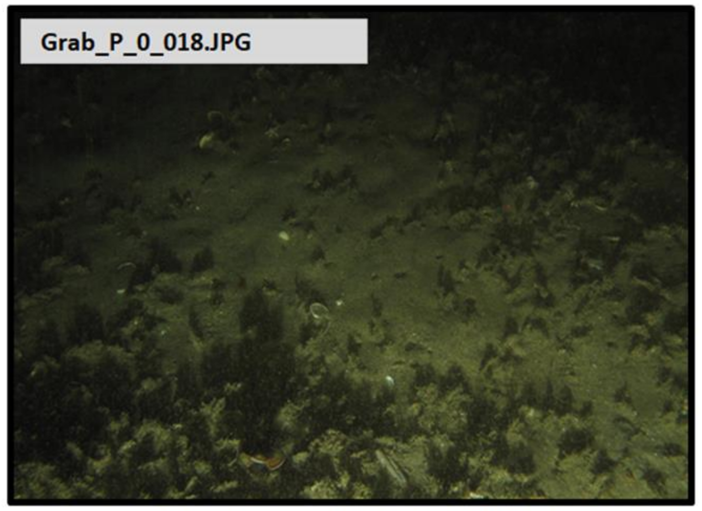
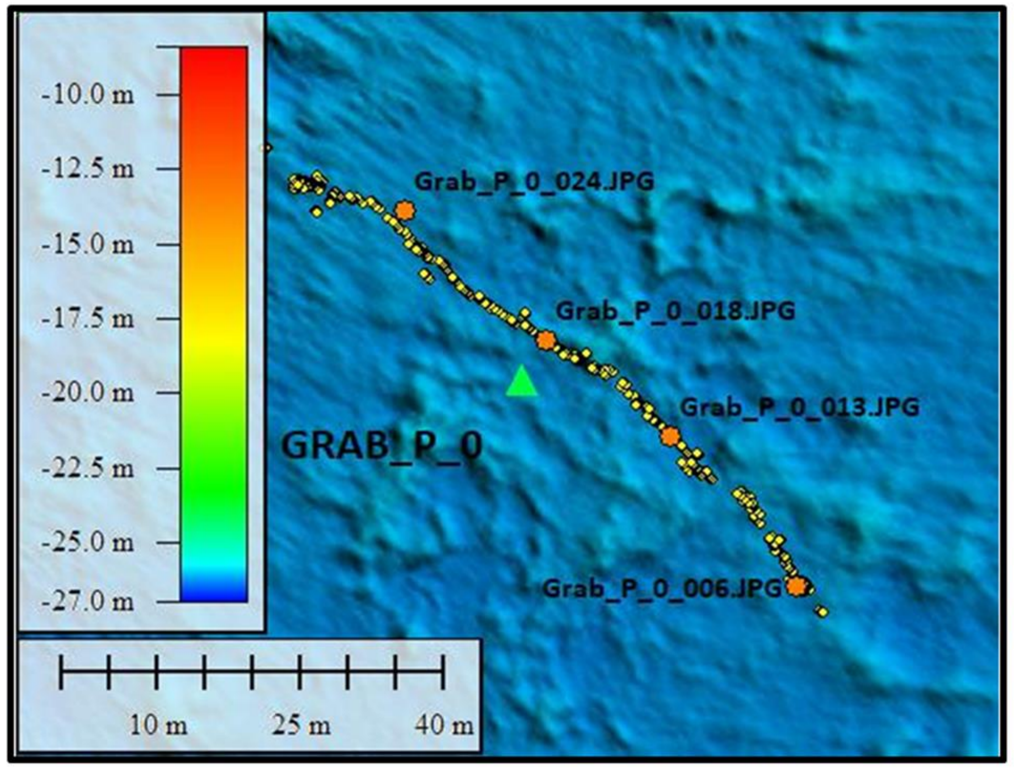


Photo Position: 721620 mE, 5954456 mN



Grab_P_0_024.JPG

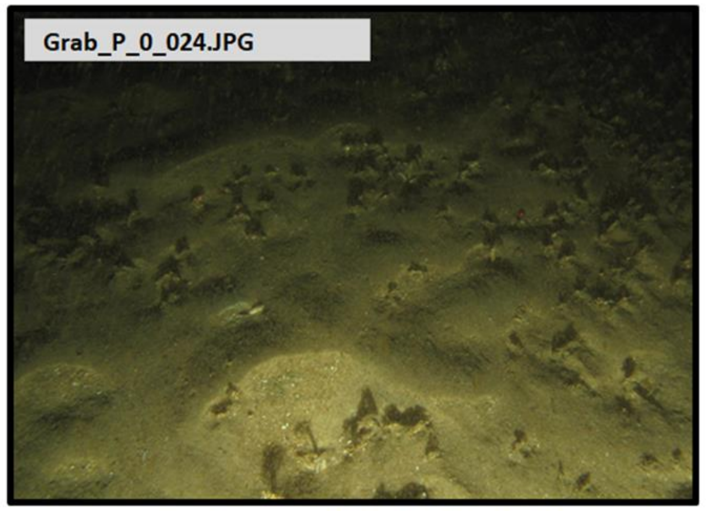


Photo Position: 721606 mE, 5954470 mN

Sediment Example Image

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Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

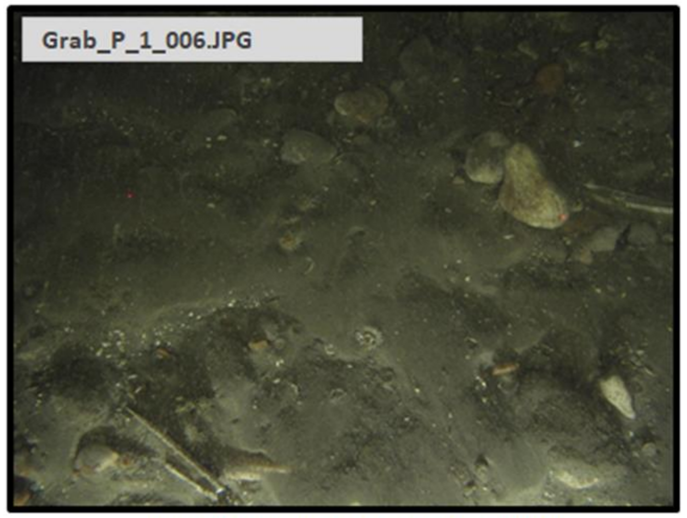


Photo Position: 721325 mE, 5953794 mN

Habitat Summary Information: Grab_P_1

Survey Area: N5a Pipeline

No. of Stills: 1 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria
Moved from KP in order to investigate area of high reflectivity sediment.

Analogue Interpretation
Area of mixed high reflectivity.

Sediment Description
Coarse sand with cobbles.

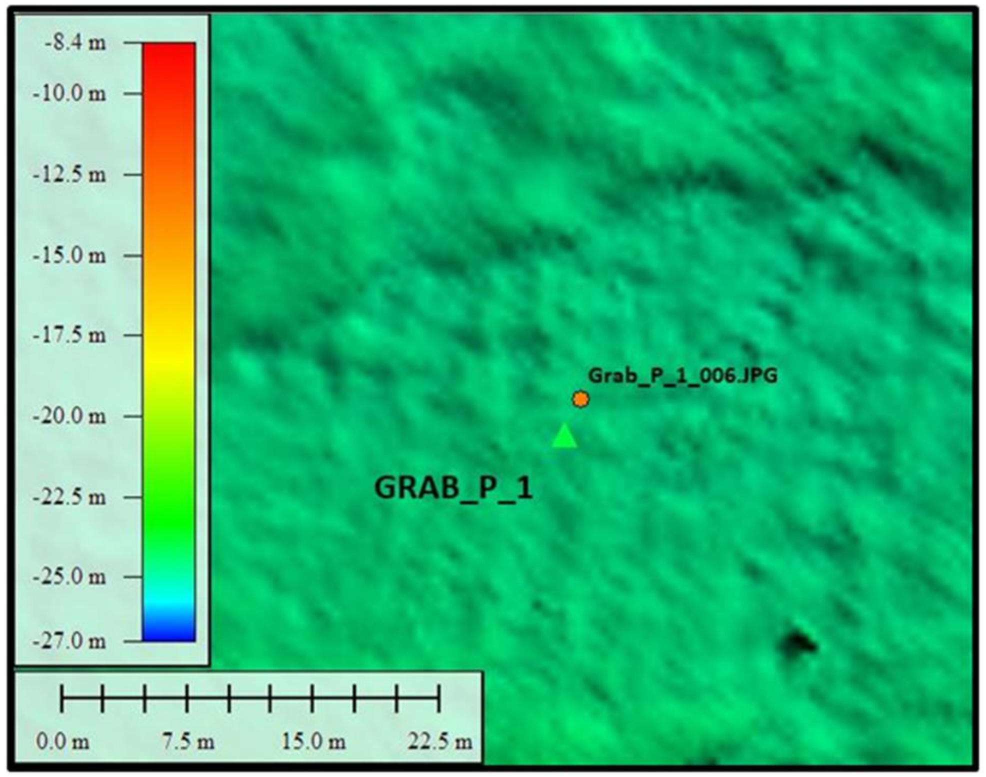
Conspicuous Fauna
Cnidaria: *Cerianthus* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Bryozoa:** Bryozoa sp.

Only one image taken

Photo Position: 0 mE, 0 mN

Only one image taken

Photo Position: 0 mE, 0 mN



Only one image taken

Photo Position: 0 mE, 0 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

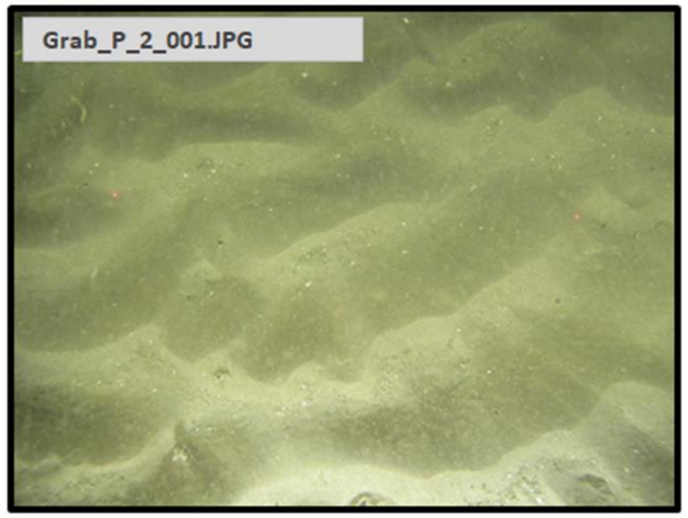


Photo Position: 720980 mE, 5952753 mN

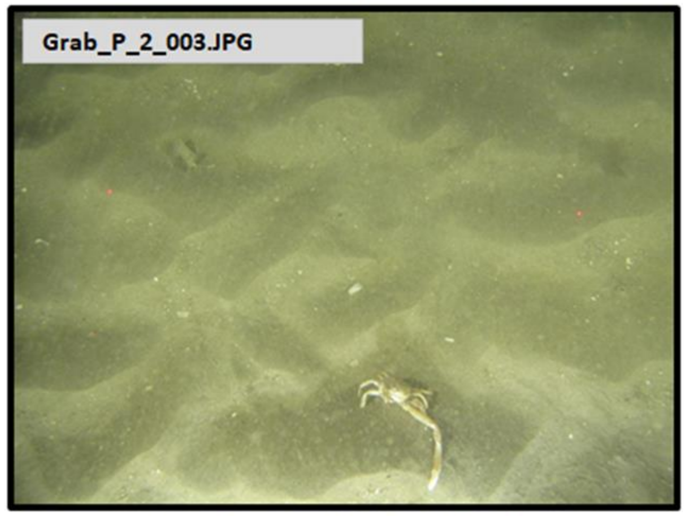


Photo Position: 720977 mE, 5952755 mN

Habitat Summary Information: Grab_P_2

Survey Area: N5a Pipeline

No. of Stills: 5 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

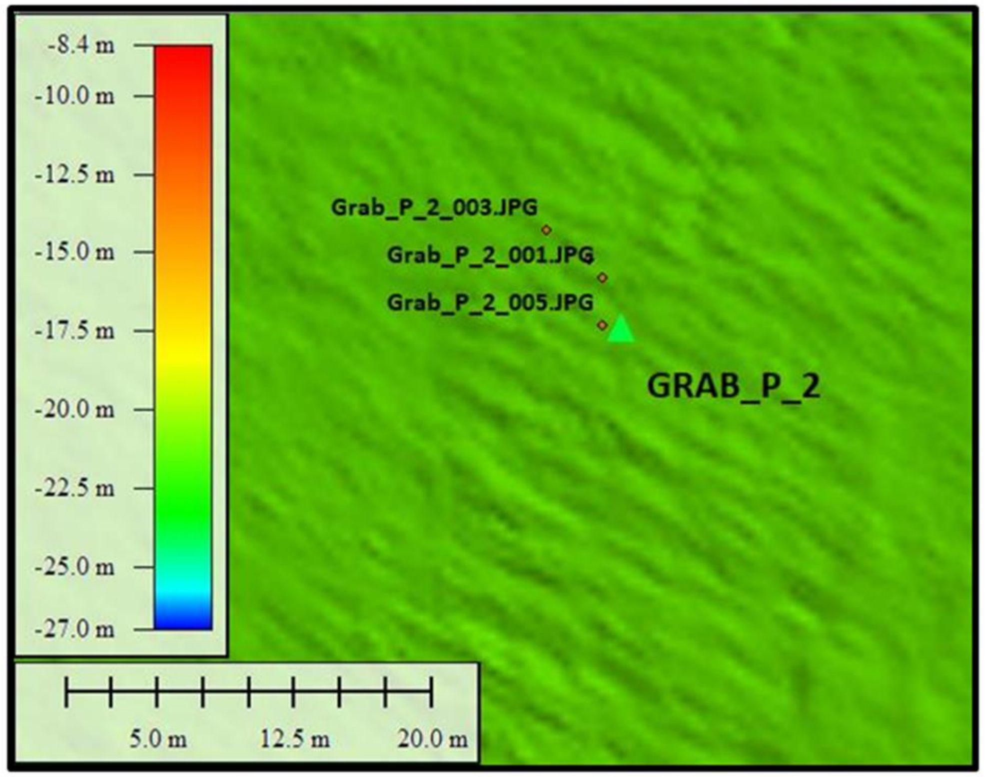
Low reflectivity.

Sediment Description

Coarse shelly sand with sand ribble bedform.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab).



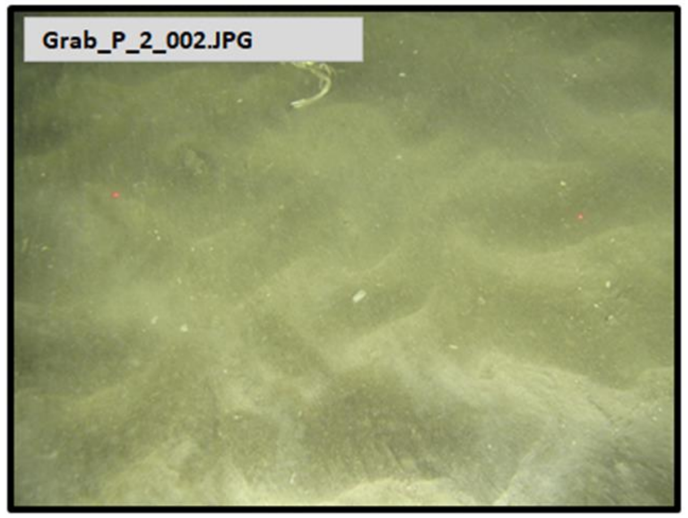


Photo Position: 720979 mE, 5952754 mN

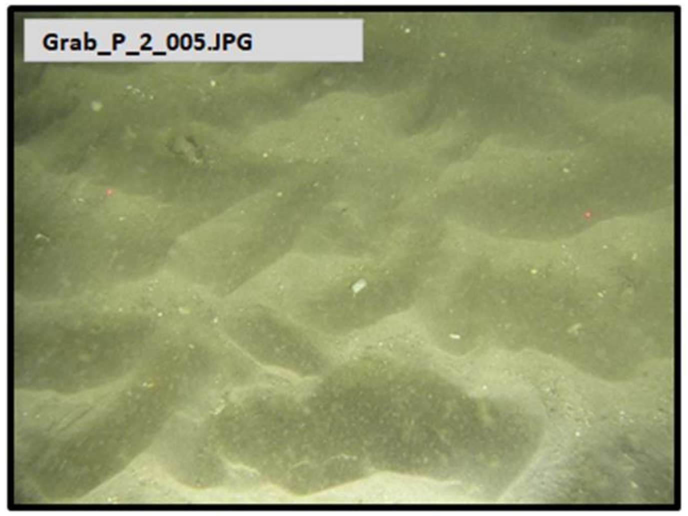
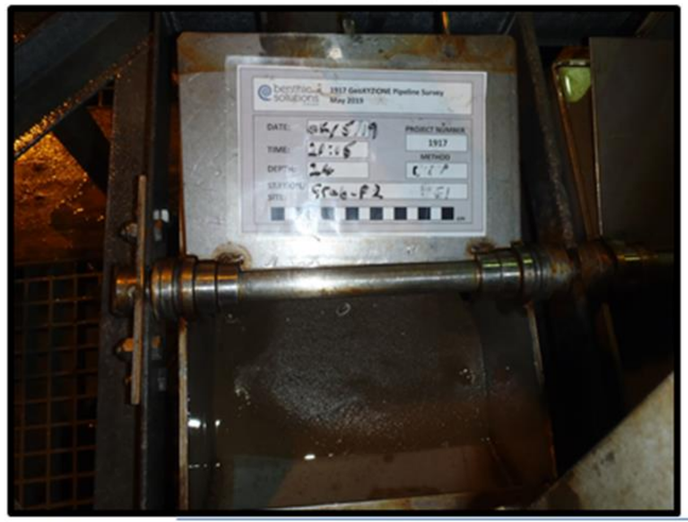


Photo Position: 720980 mE, 5952750 mN


Sediment Example Image

Grab Location | Camera Track | Selected Underwater Still


Sieved Sample Image

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

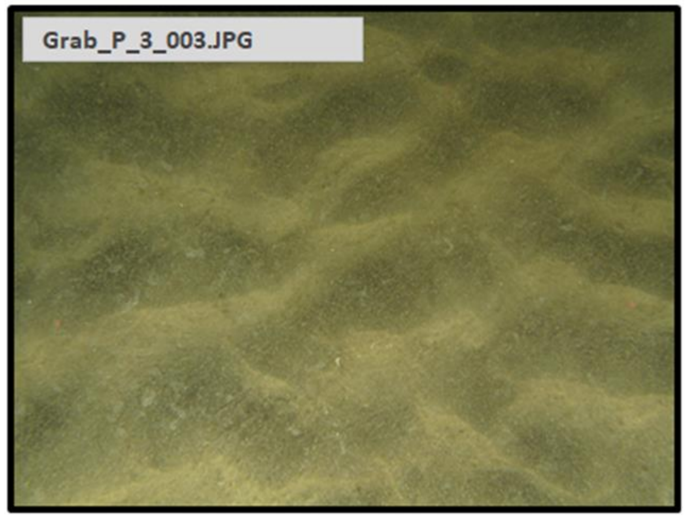


Photo Position: 720668 mE, 5951799 mN

Habitat Summary Information: Grab_P_3

Survey Area: N5a Pipeline

No. of Stills: 10 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand forming ripples.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab).
Echinodermata: *Asterias rubens* (Common starfish).

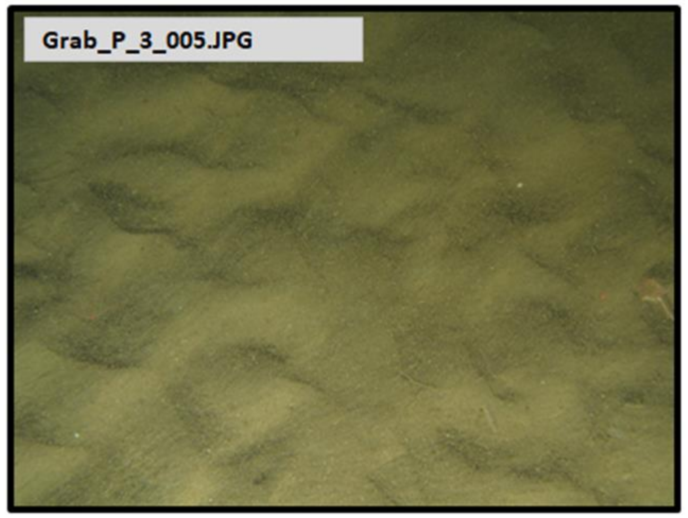


Photo Position: 720664 mE, 5951796 mN

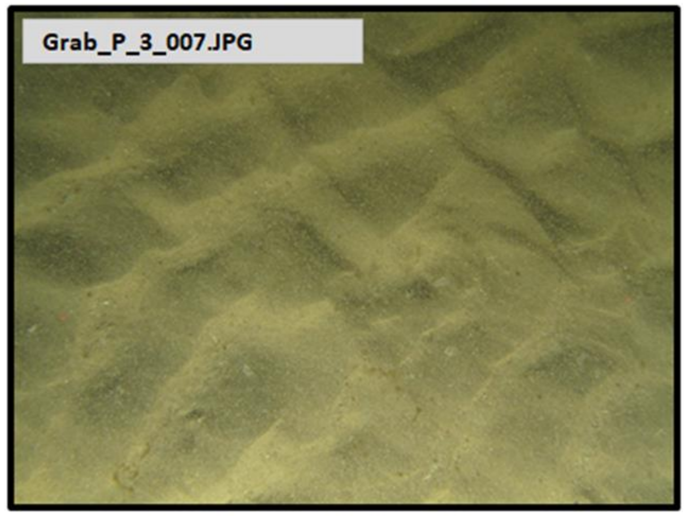
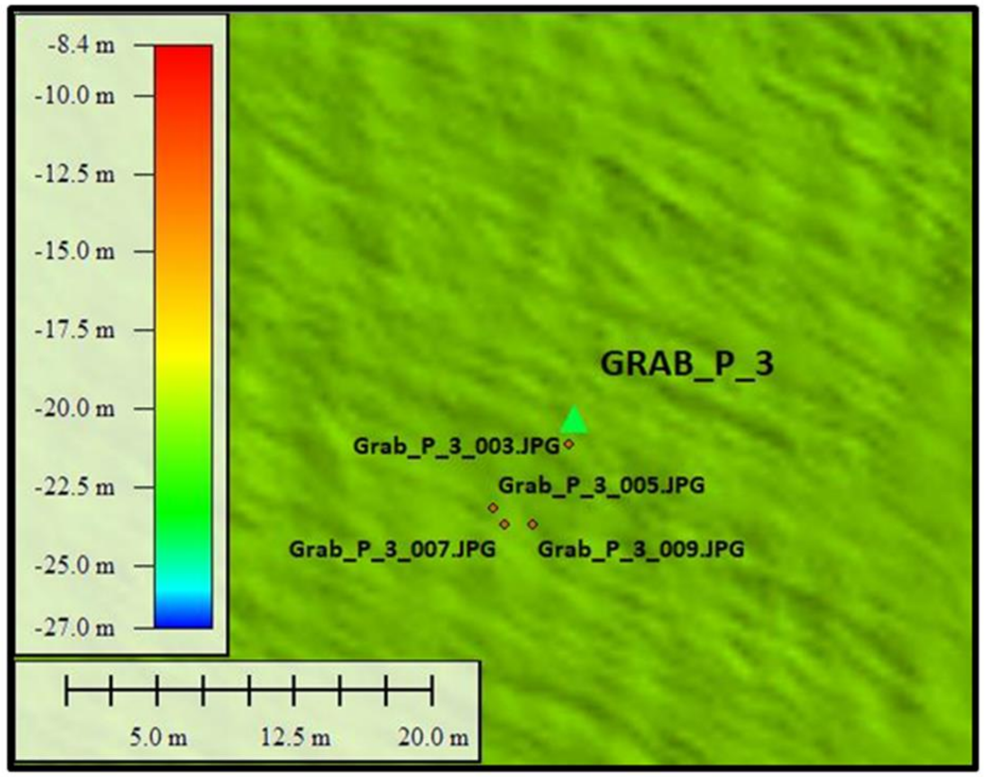


Photo Position: 720664 mE, 5951795 mN



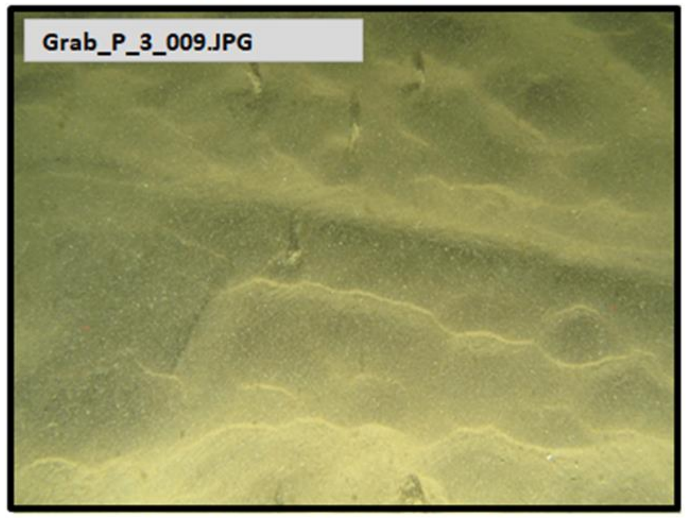


Photo Position: 720666 mE, 5951795 mN

Sediment Example Image

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Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

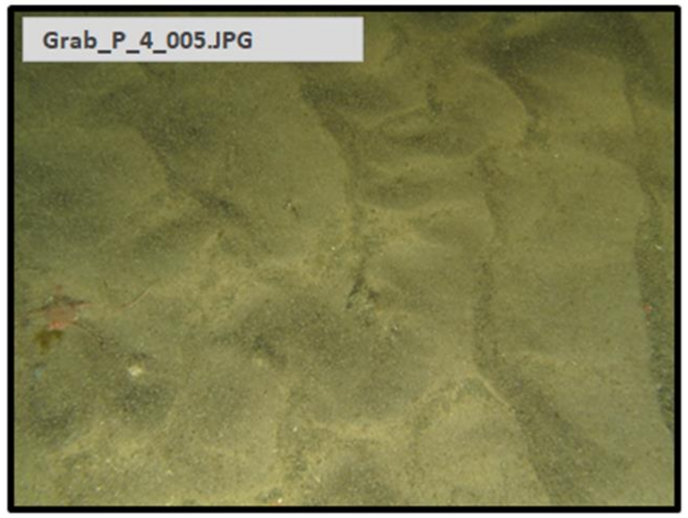


Photo Position: 720356 mE, 5950850 mN

Habitat Summary Information: Grab_P_4

Survey Area: N5a Pipeline

No. of Stills: 10 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of variable reflectivity indicating rippling.

Sediment Description

Coarse sand formed into sand ripples.

Conspicuous Fauna

Echinodermata: *Asterias rubens* (Common starfish), Ophiurida sp.

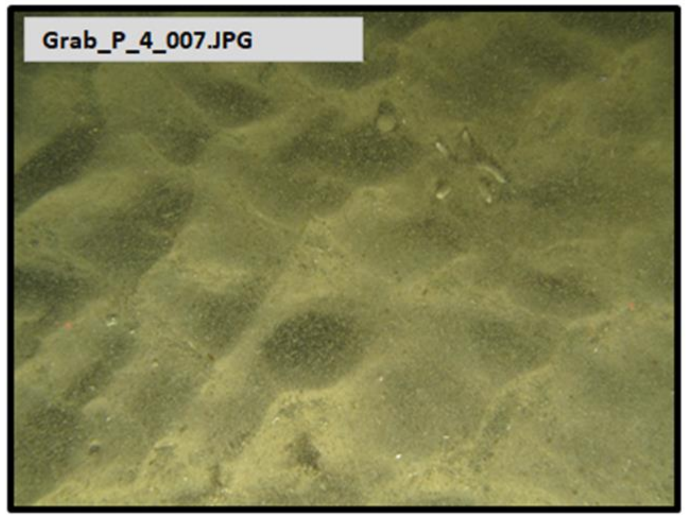


Photo Position: 720355 mE, 5950850 mN

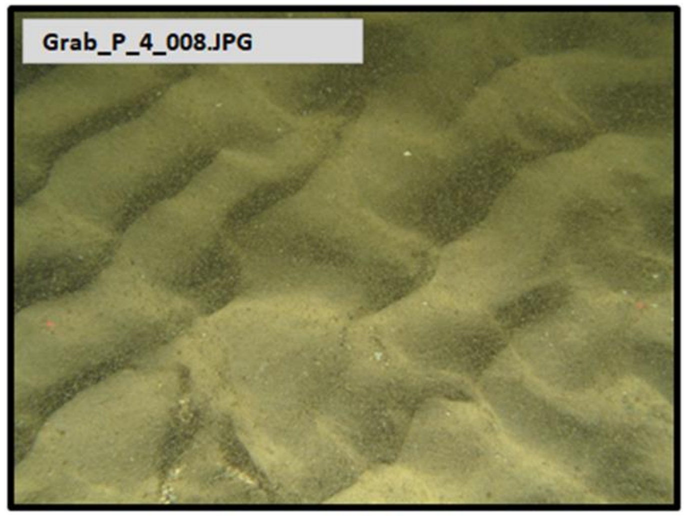
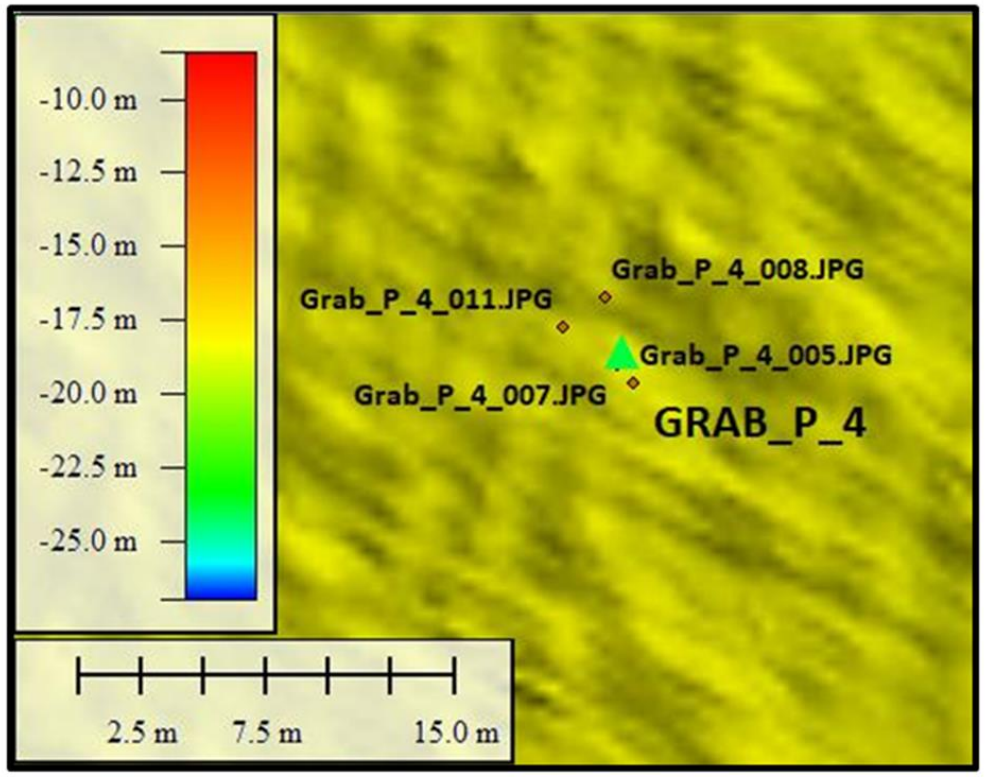


Photo Position: 720355 mE, 5950853 mN



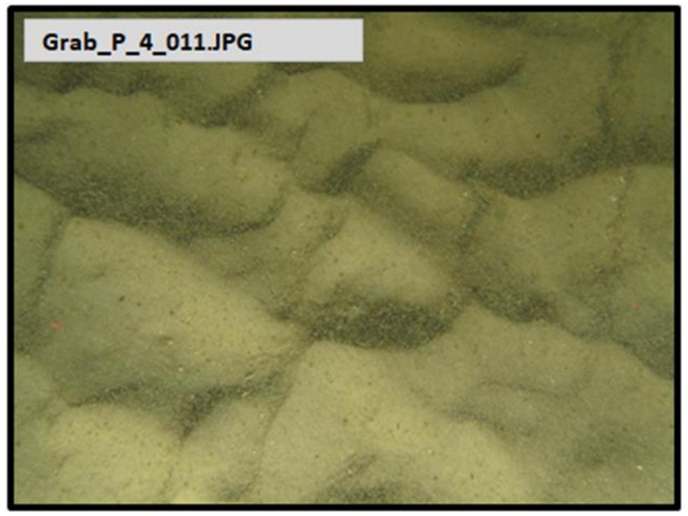


Photo Position: 720353 mE, 5950852 mN

Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

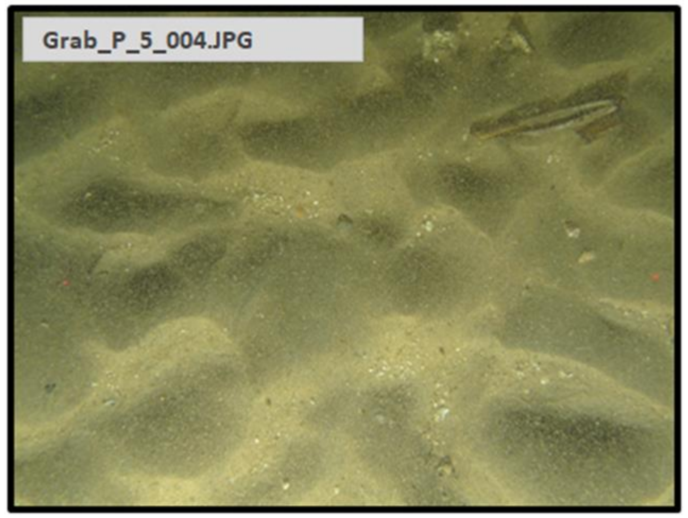


Photo Position: 720039 mE, 5949902 mN

Habitat Summary Information: Grab_P_5

Survey Area: N5a Pipeline

No. of Stills: 16 | **Mins of Video: 2** | **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of low, variable reflectivity.

Sediment Description

Coarse shelly sand with rare cobbles.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Paguridae sp. **Echinodermata:** *Asterias rubens* (Common starfish).

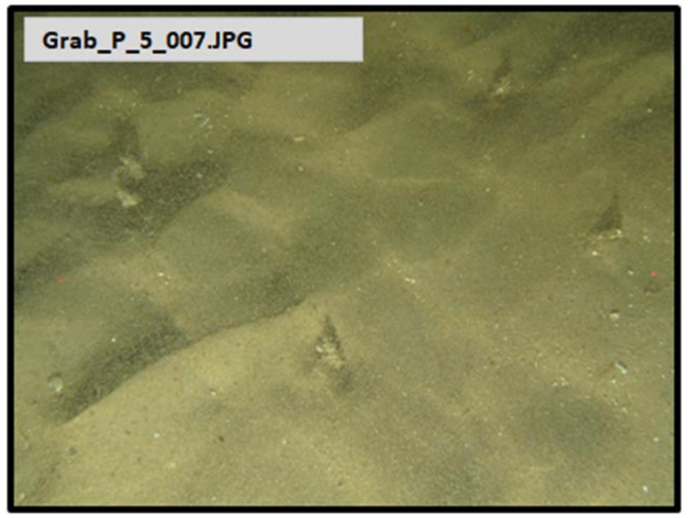


Photo Position: 720044 mE, 5949893 mN

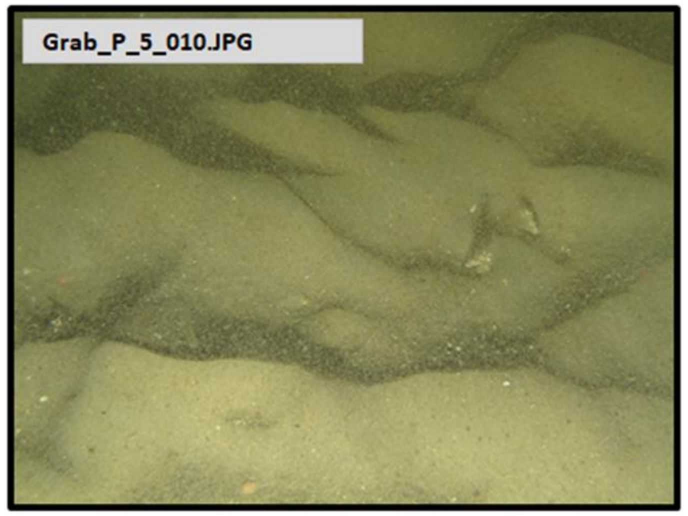
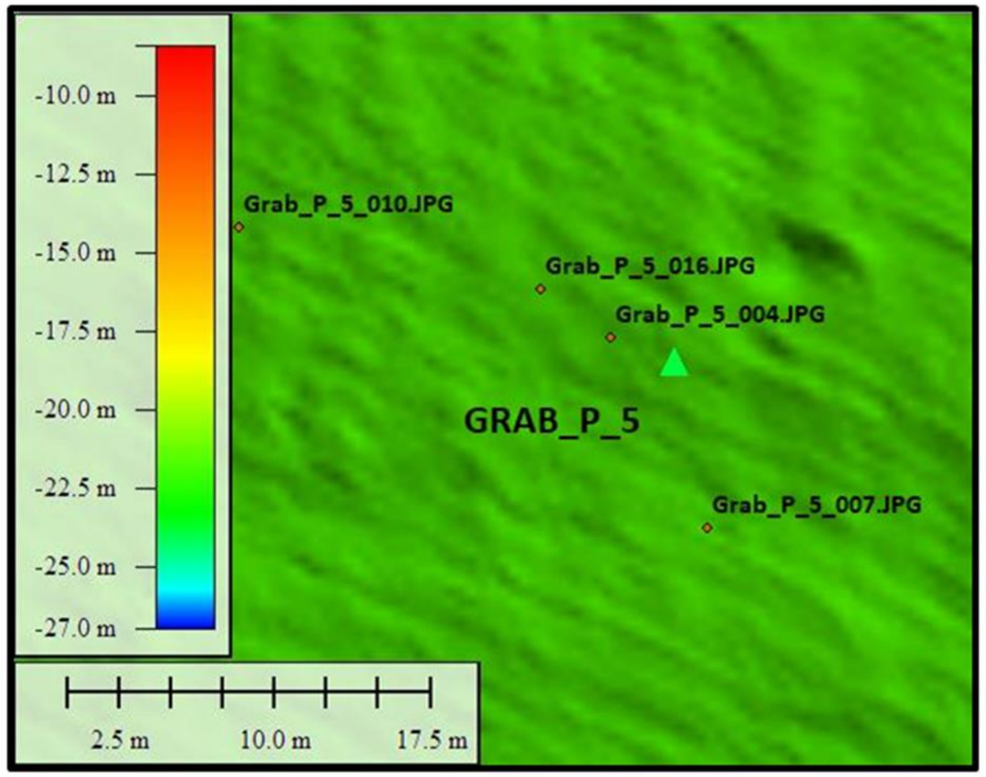


Photo Position: 720021 mE, 5949907 mN



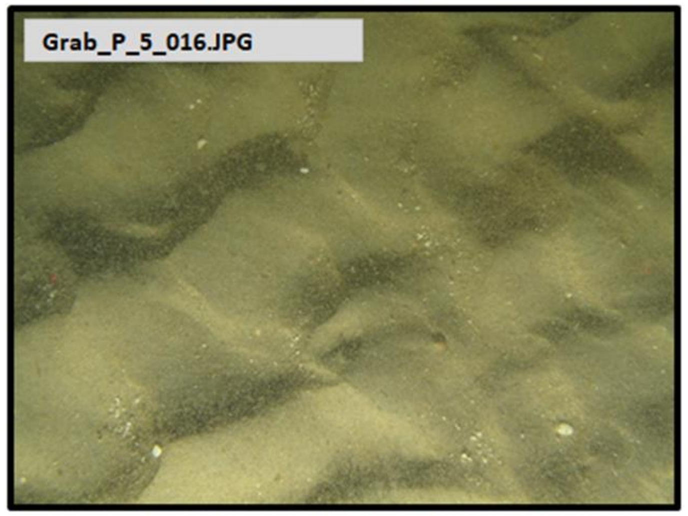


Photo Position: 720036 mE, 5949904 mN

Sediment Example Image

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Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

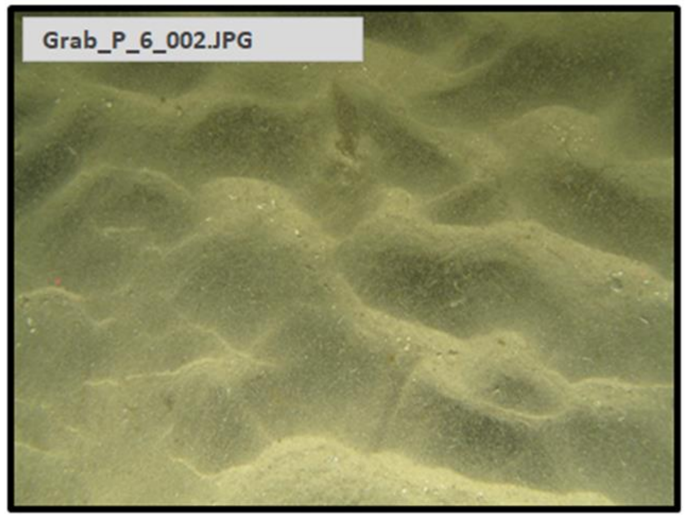


Photo Position: 719727 mE, 5948952 mN

Habitat Summary Information: Grab_P_6

Survey Area: N5a Pipeline

No. of Stills: 12 **Mins of Video:** 4 **Track Length:** DDV

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of slightly variable reflectivity.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Chordata:** Pleuronectiformes sp.

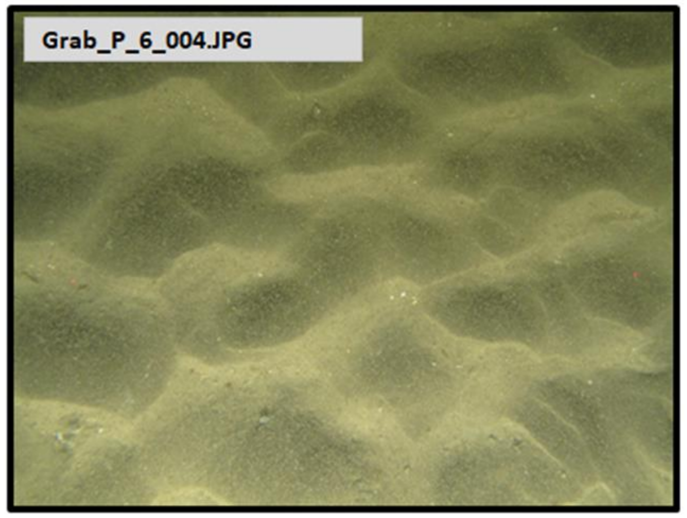


Photo Position: 719728 mE, 5948952 mN

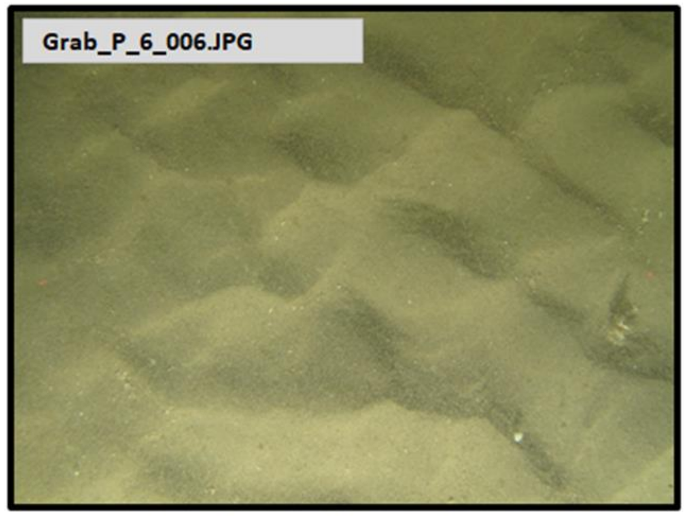
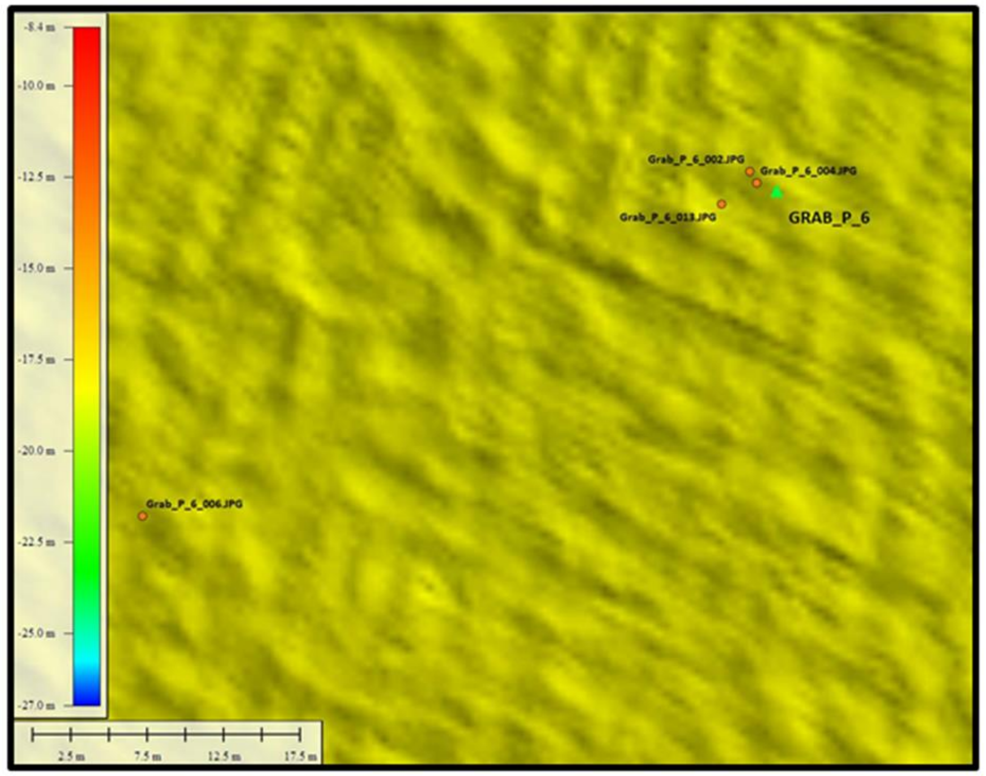


Photo Position: 719688 mE, 5948930 mN



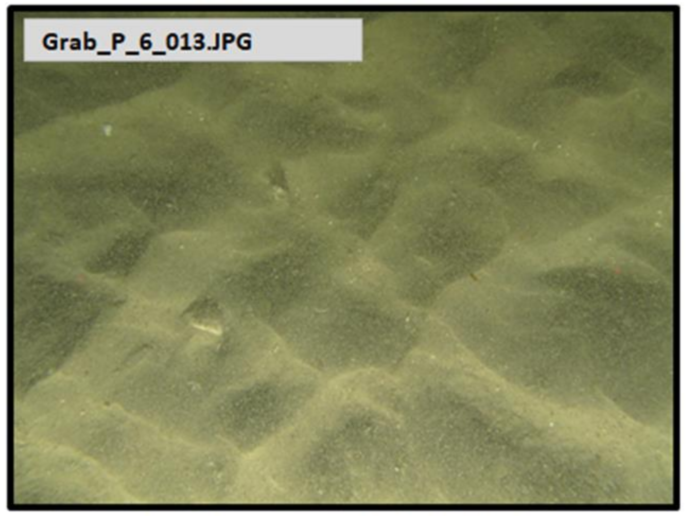


Photo Position: 719726 mE, 5948950 mN

Sediment Example Image

Grab Location   Camera Track   Selected Underwater Still

Sieved Sample Image

Geodetic Infomation: Datum: ED50   Projection: UTM   Zone: 31 North   Central Meridian: 3° East

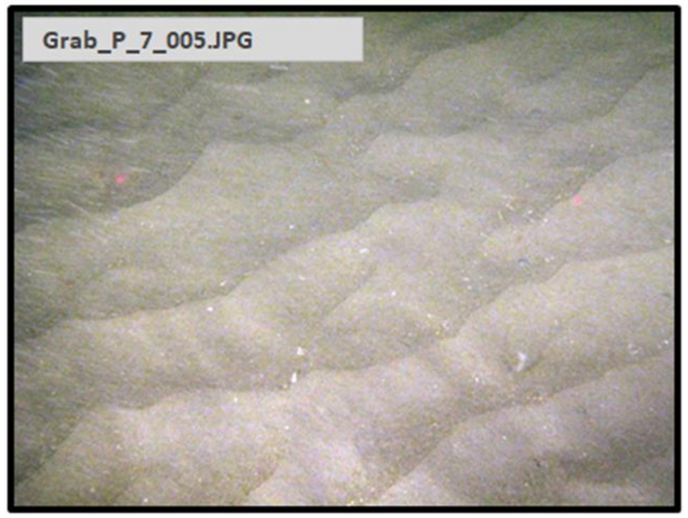


Photo Position: 719408 mE, 5948019 mN

Habitat Summary Information: Grab_P_7

Survey Area: N5a Pipeline

No. of Stills: 7 | Mins of Video: 4 | Track Length: DDV

Site Selection Criteria

Moved from KP to investigate mixed reflectivity sediment.

Analogue Interpretation

Area of variable reflectivity with scars in seabed.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** Ophiurida sp. **Chordata:** *Callionymus lyra* (Common dragonet).

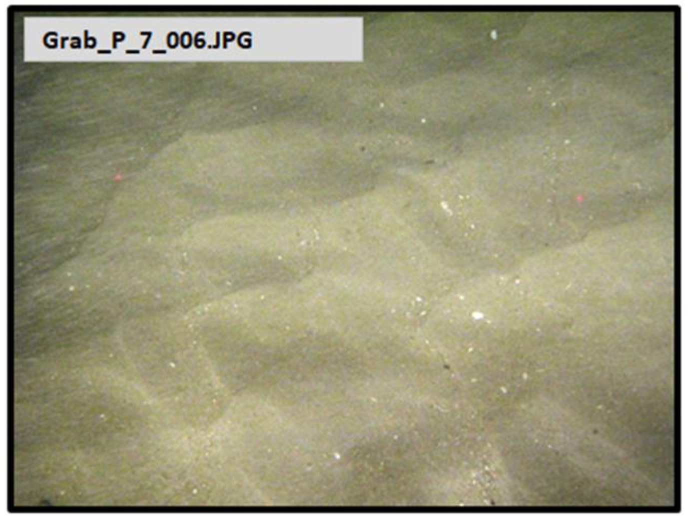


Photo Position: 719411 mE, 5948002 mN

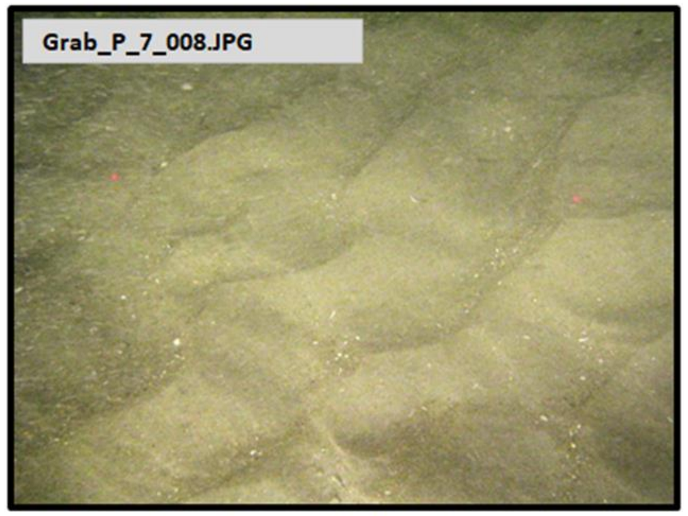
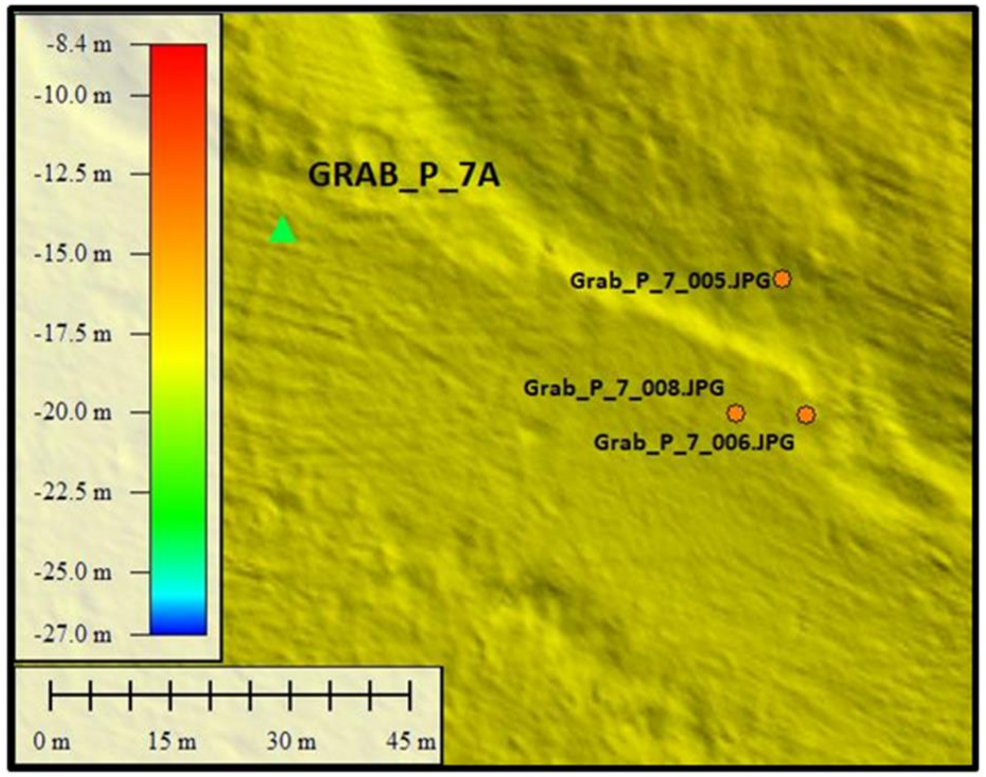
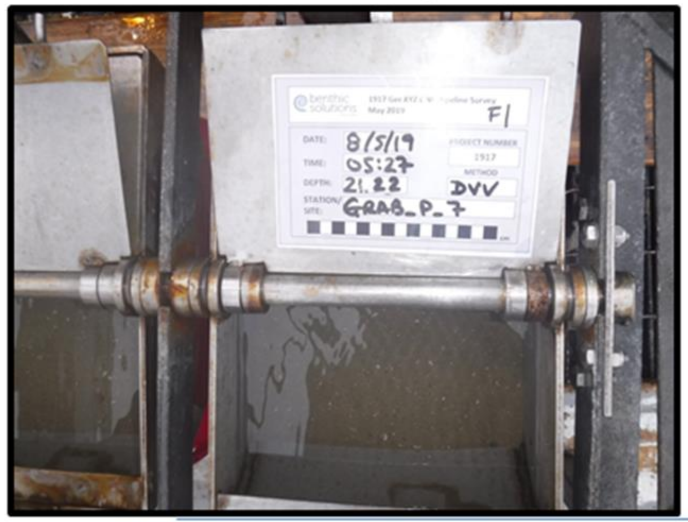


Photo Position: 719403 mE, 5948002 mN



Only 3 good quality seabed images



Sediment Example Image

Sieved Sample Image

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Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

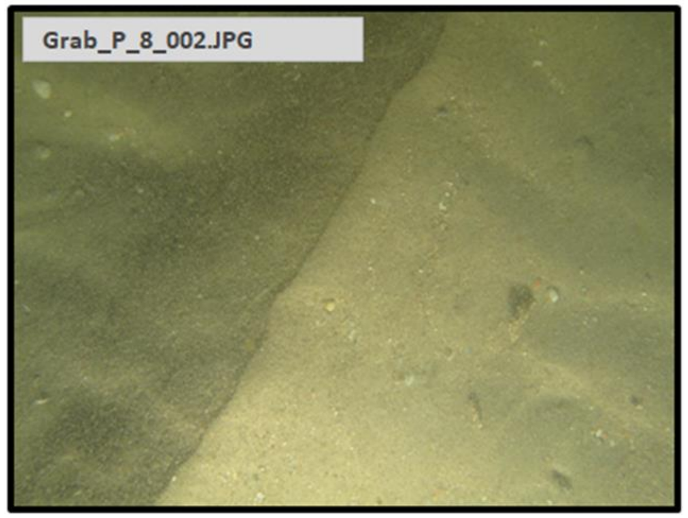


Photo Position: 719097 mE, 5947051 mN

Habitat Summary Information: Grab_P_8

Survey Area: N5a Pipeline

No. of Stills: 6 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason).

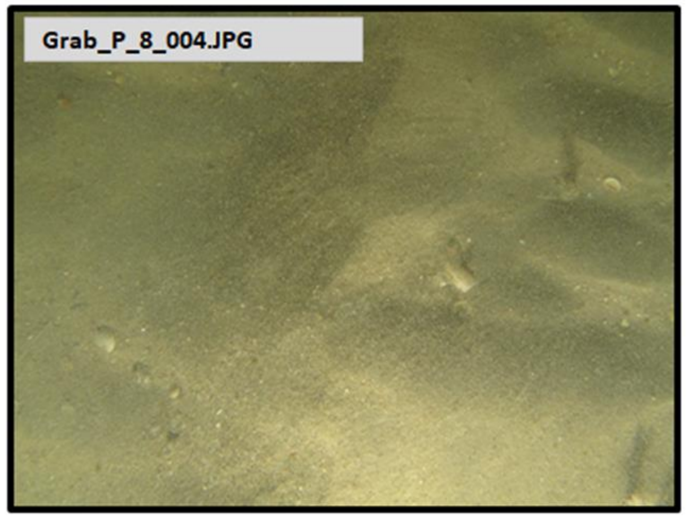


Photo Position: 719076 mE, 5947050 mN

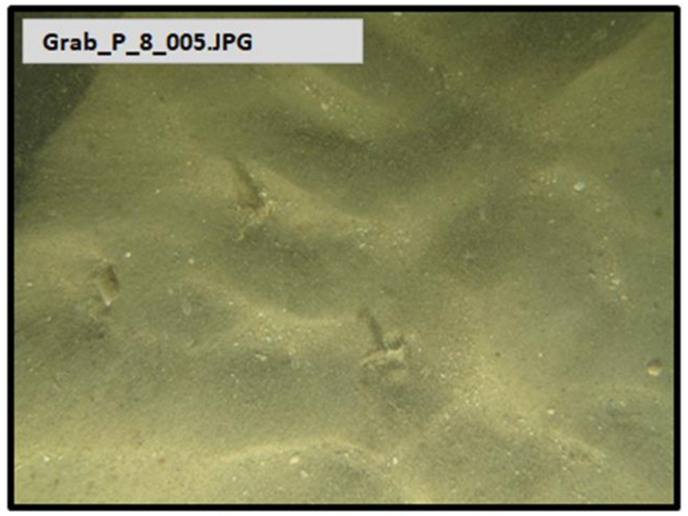
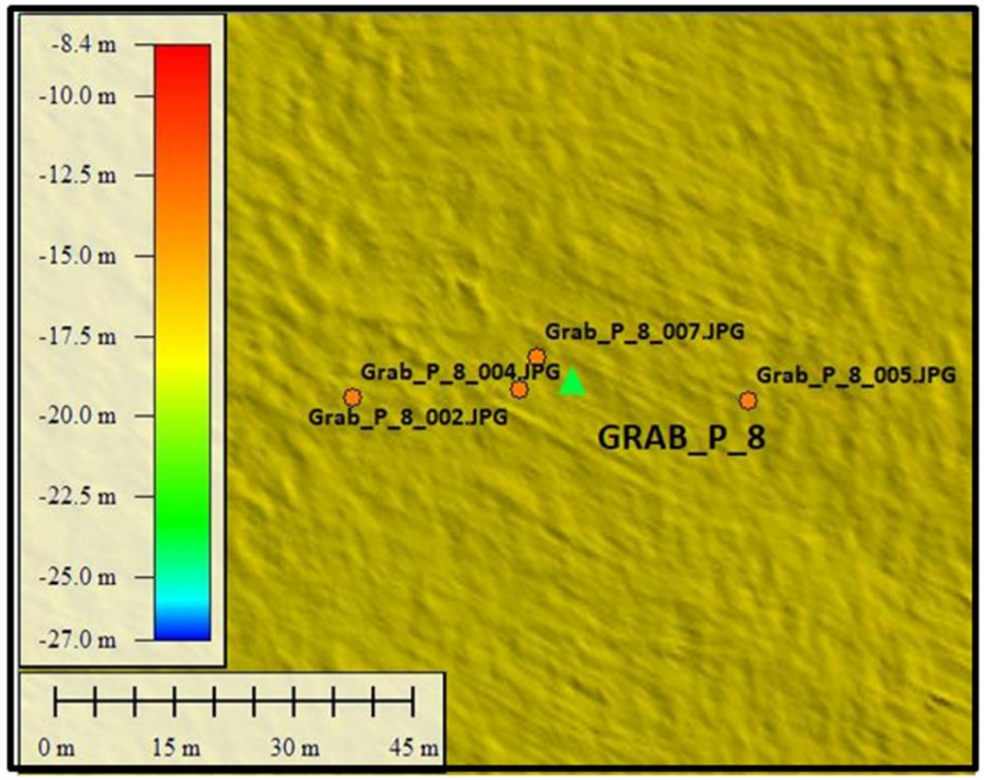


Photo Position: 719125 mE, 5947049 mN



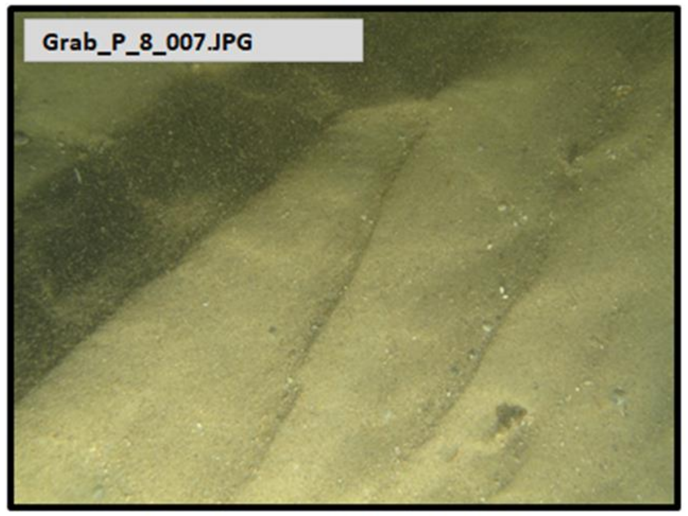


Photo Position: 719099 mE, 5947055 mN

Sediment Example Image

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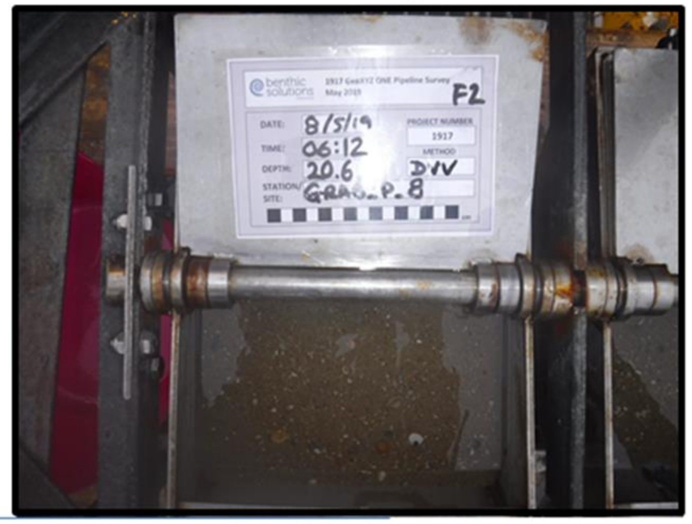


Sieved Sample Image

Grab Location   Camera Track   Selected Underwater Still

Geodetic Infomation: Datum: ED50   Projection: UTM   Zone: 31 North   Central Meridian: 3° East

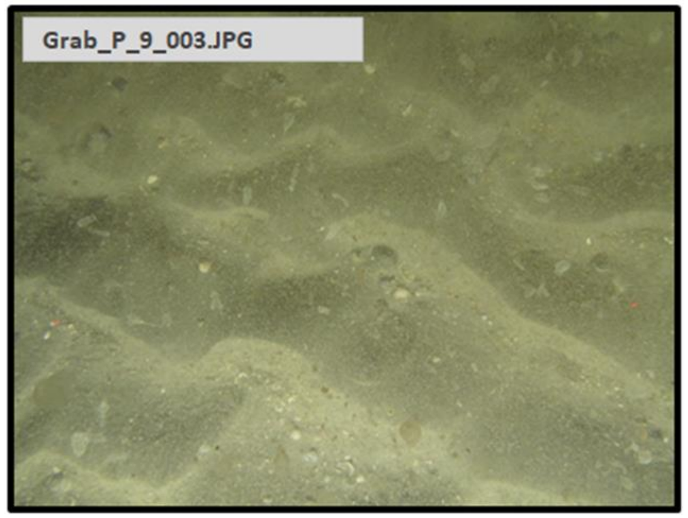


Photo Position: 718861 mE, 5945912 mN

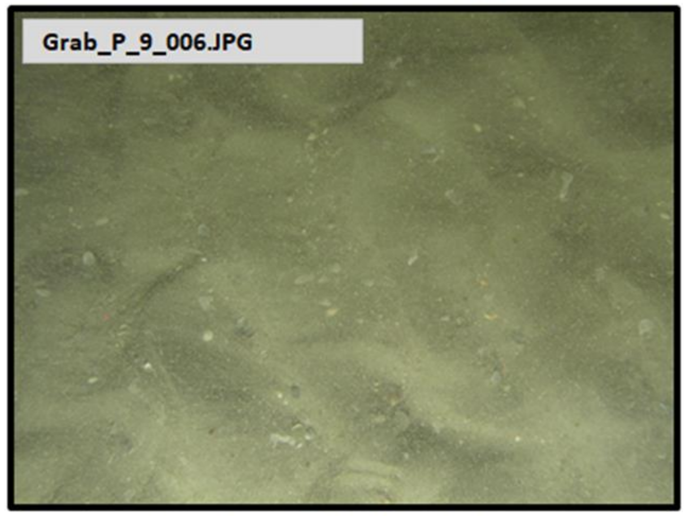


Photo Position: 718863 mE, 5945911 mN

Sediment Example Image

Habitat Summary Information: Grab_P_9

Survey Area: N5a Pipeline

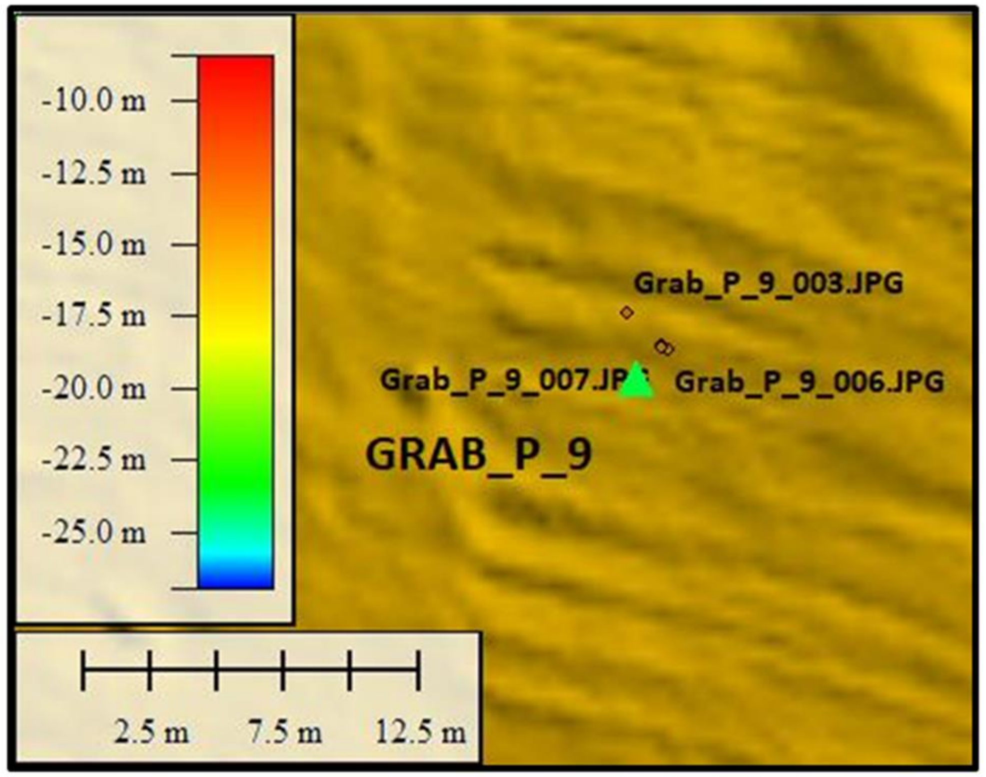
No. of Stills: 6 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Variable reflectivity with scars in seabed.

Sediment Description
Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab). **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Actinopterygii sp.



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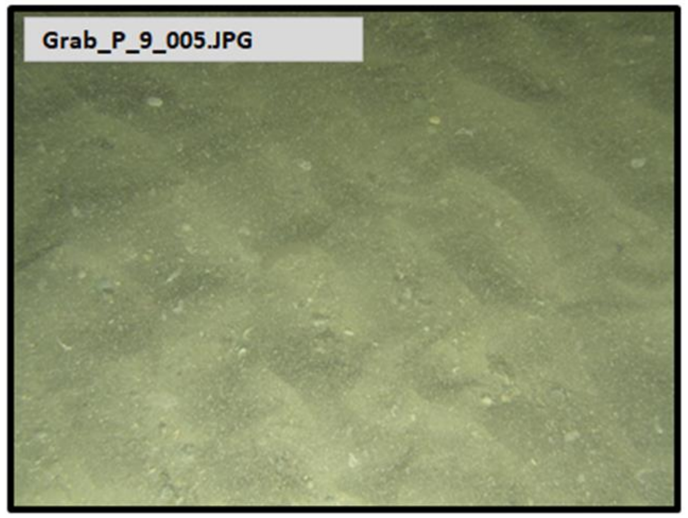


Photo Position: 718862 mE, 5945911 mN

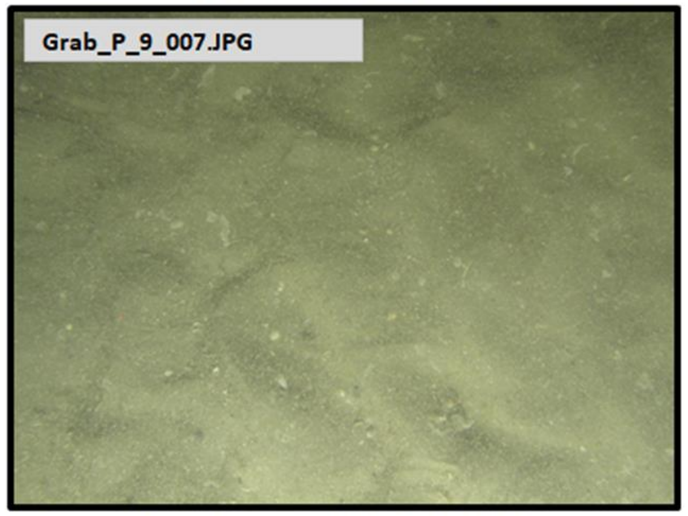


Photo Position: 718862 mE, 5945911 mN

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

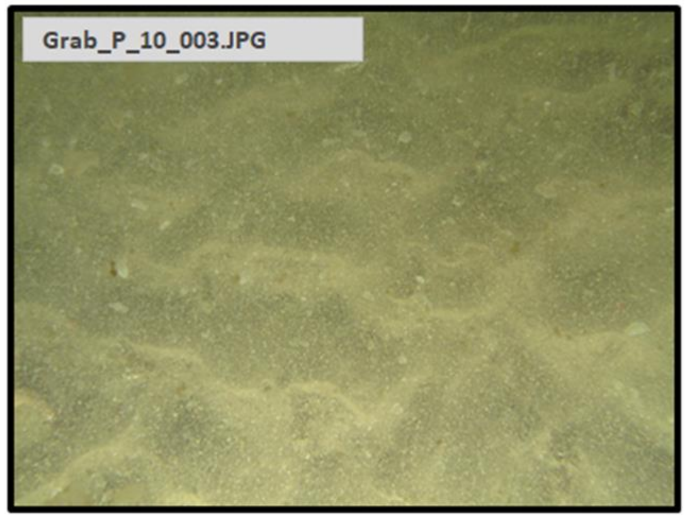


Photo Position: 718778 mE, 5944917 mN

Habitat Summary Information: Grab_P_10

Survey Area: N5a Pipeline

No. of Stills: 8 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Area of variable reflectivity.

Sediment Description
Coarse sand.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

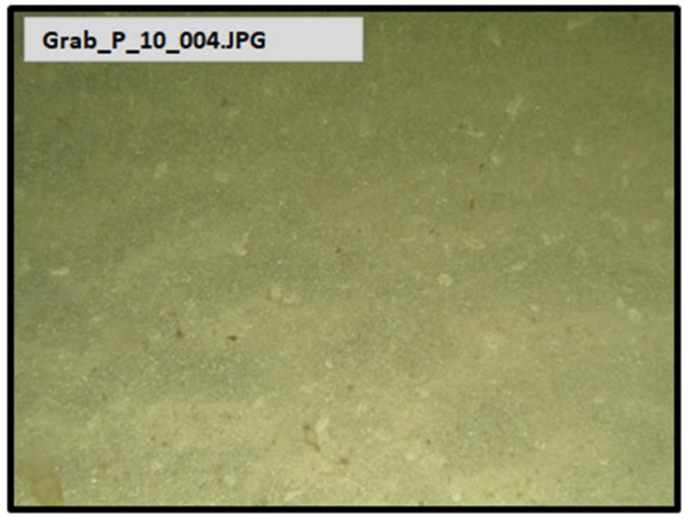


Photo Position: 718778 mE, 5944917 mN

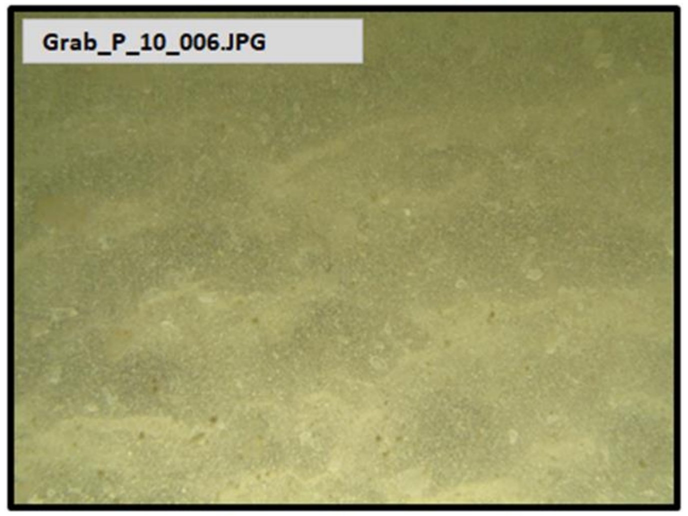
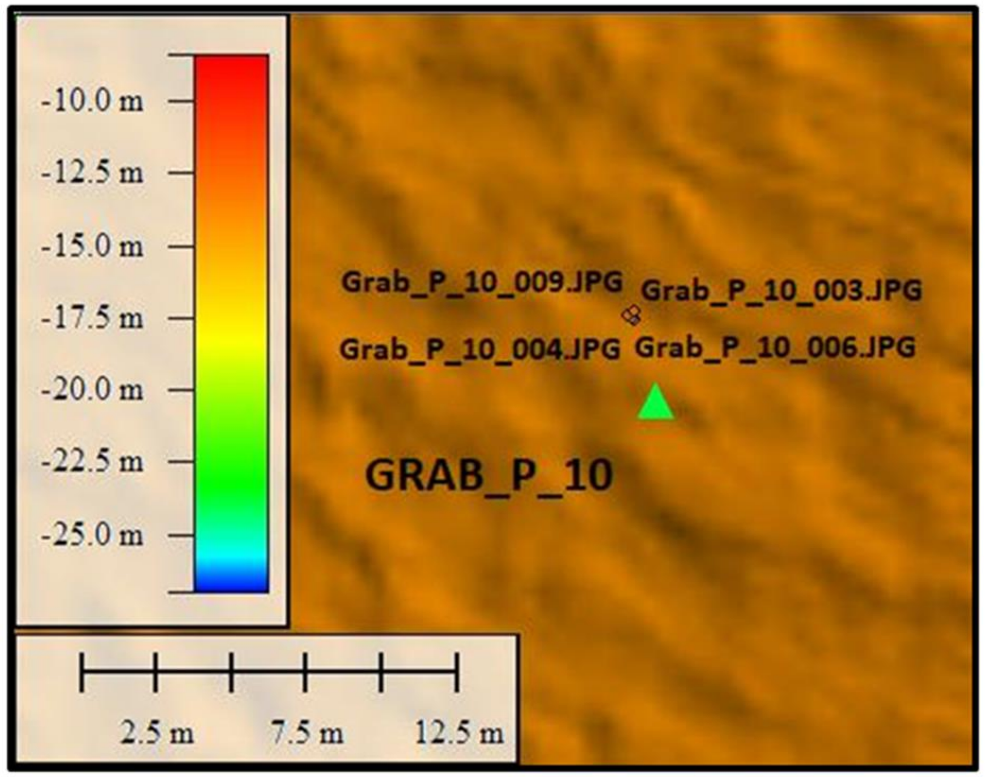


Photo Position: 718778 mE, 5944917 mN



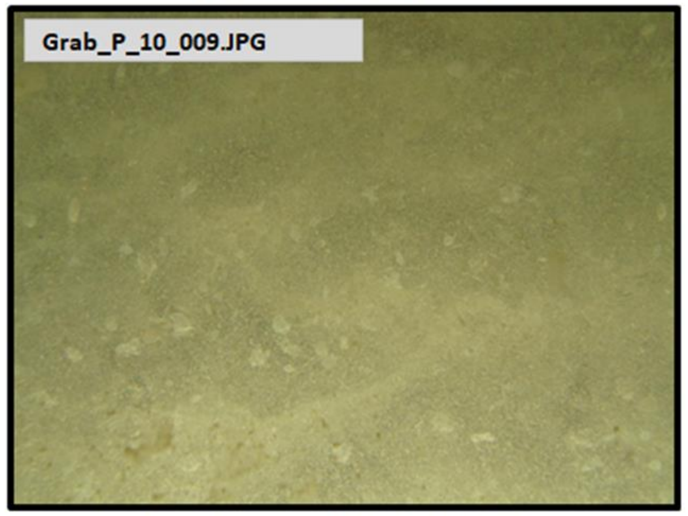


Photo Position: 718778 mE, 5944917 mN

Sediment Example Image

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Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

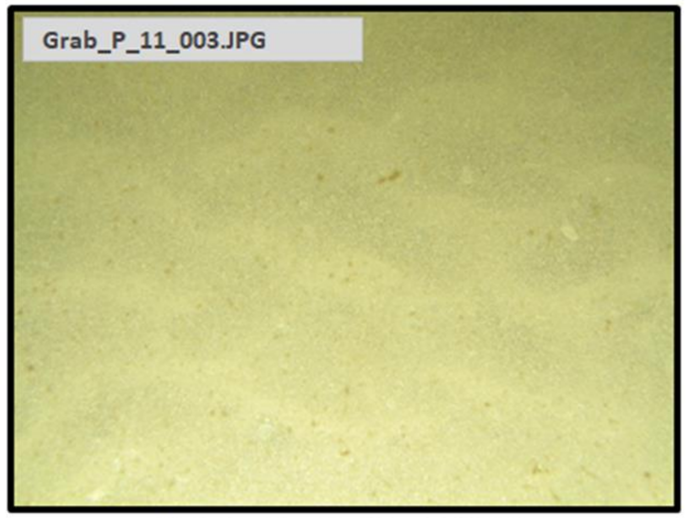


Photo Position: 718696 mE, 5943920 mN

Habitat Summary Information: Grab_P_11

Survey Area: N5a Pipeline

No. of Stills: 8 | Mins of Video: 2 | Track Length: DDVm

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Brachyura sp.

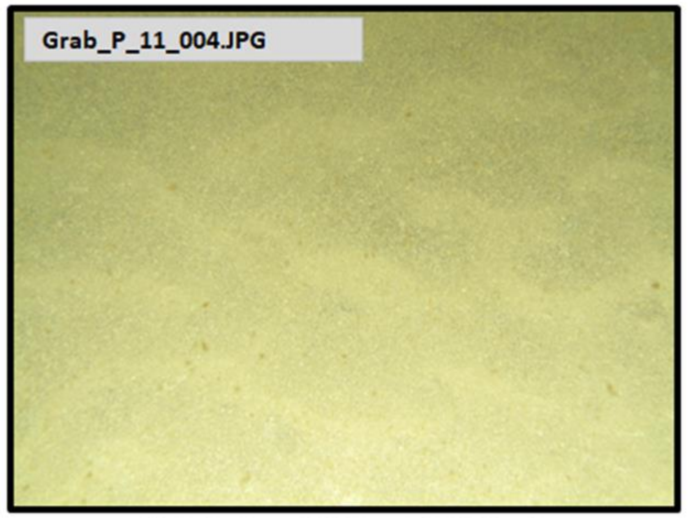


Photo Position: 718696 mE, 5943920 mN

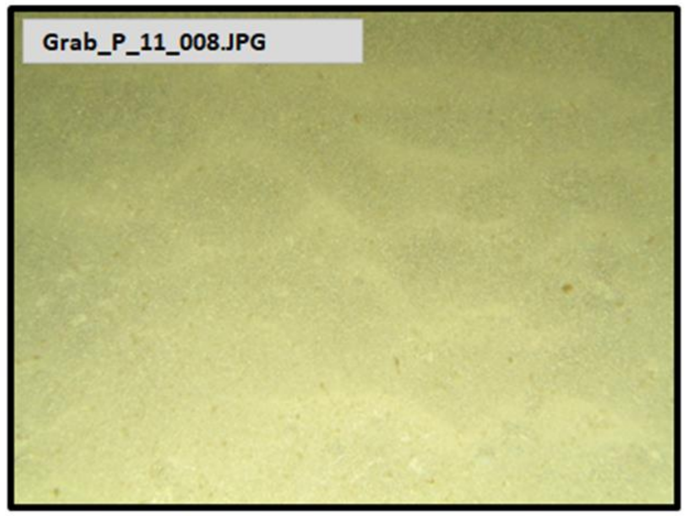
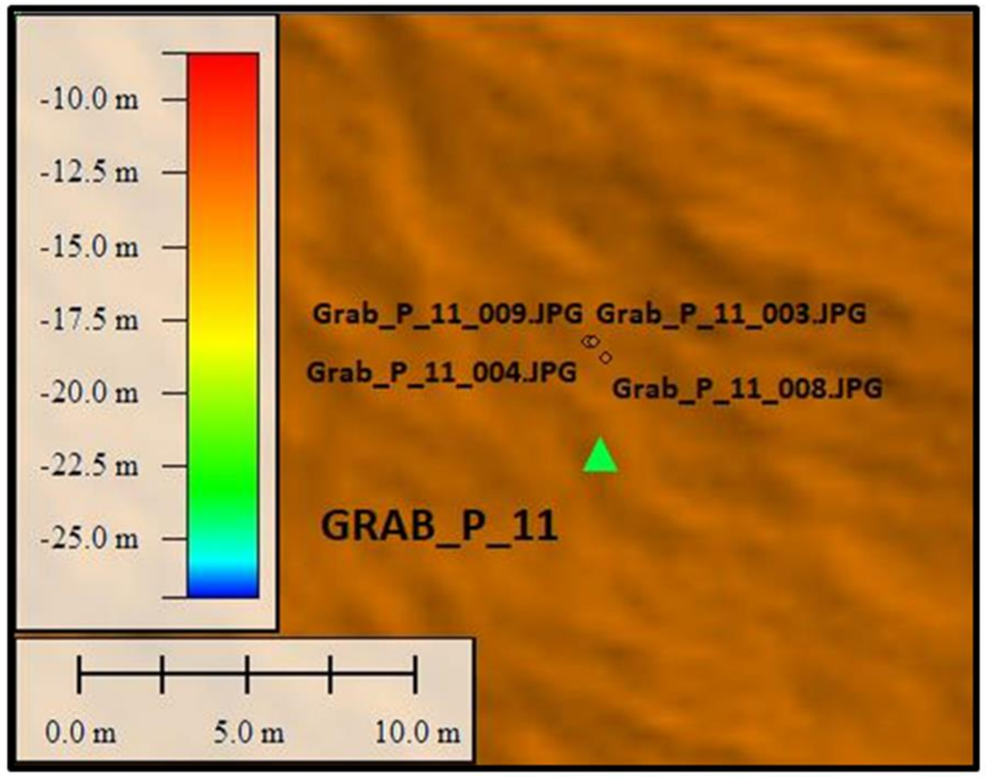


Photo Position: 718697 mE, 5943920 mN



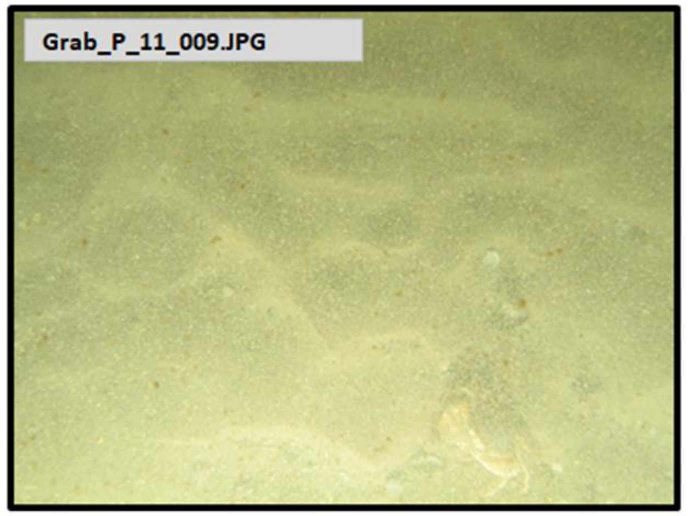


Photo Position: 718697 mE, 5943920 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

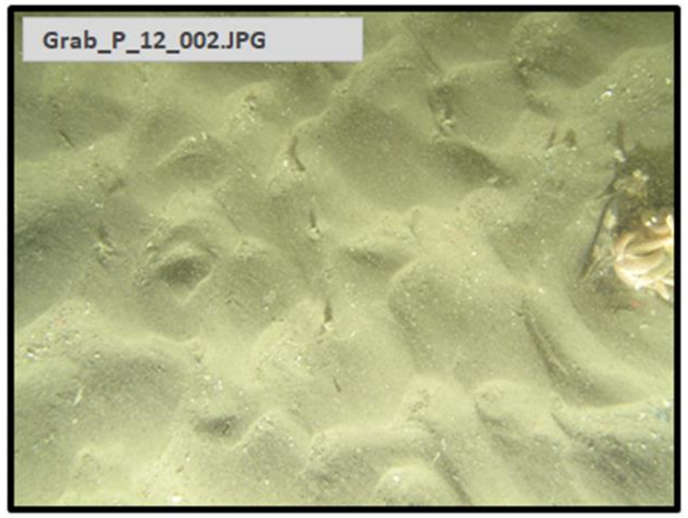
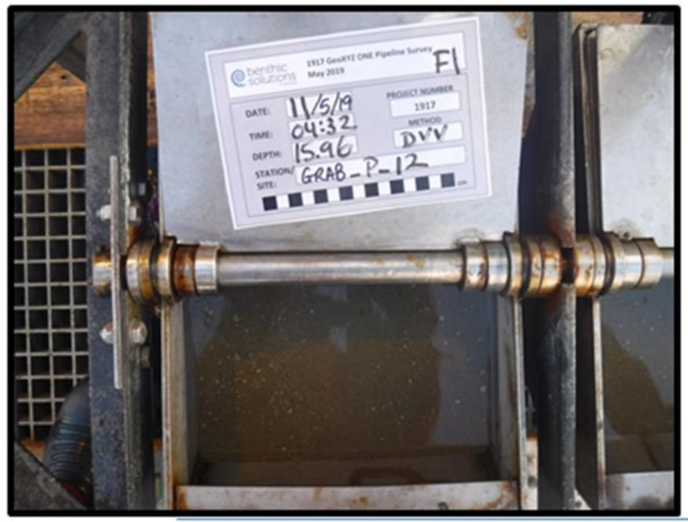


Photo Position: 718613 mE, 5942924 mN

Photo Position: 718614 mE, 5942923 mN


Sediment Example Image

Habitat Summary Information: Grab_P_12

Survey Area: N5a Pipeline

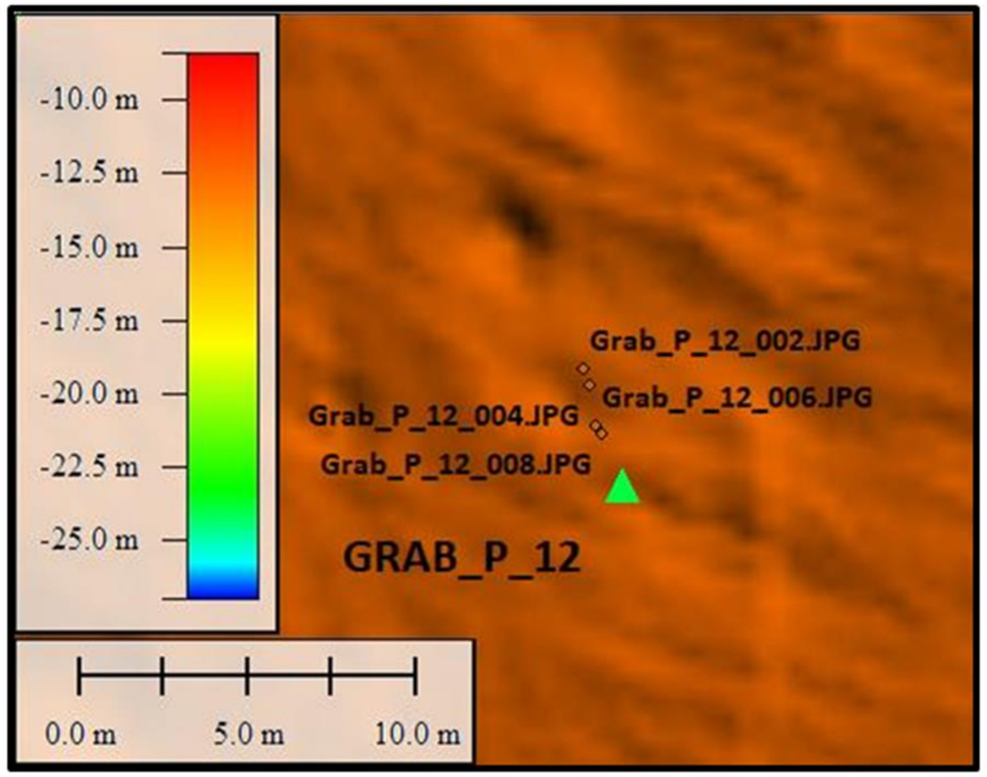
No. of Stills: 8 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Area of variable reflectivity with depressions.

Sediment Description
Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna
Cnidaria: Actiniaria sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus depurator* (Sandy swimming crab), Brachyura sp, *Cancer maenus*. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Gobiidae sp.



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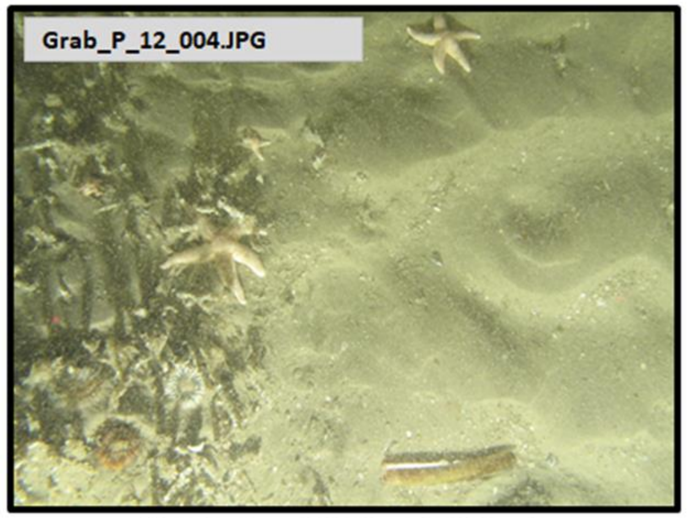


Photo Position: 718614 mE, 5942924 mN

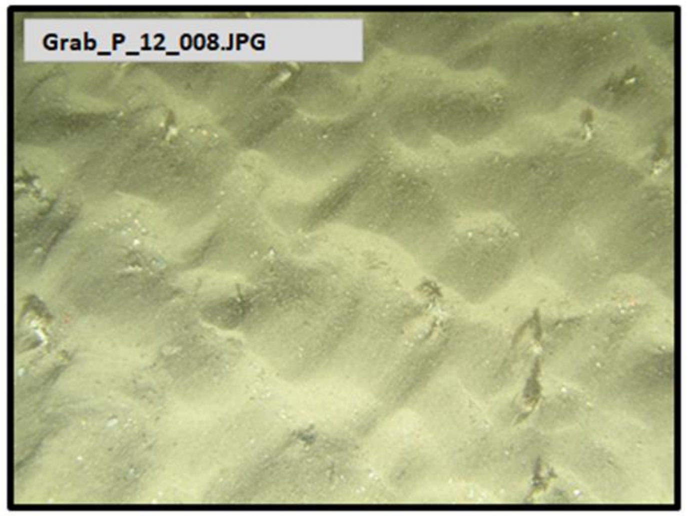


Photo Position: 718614 mE, 5942922 mN


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

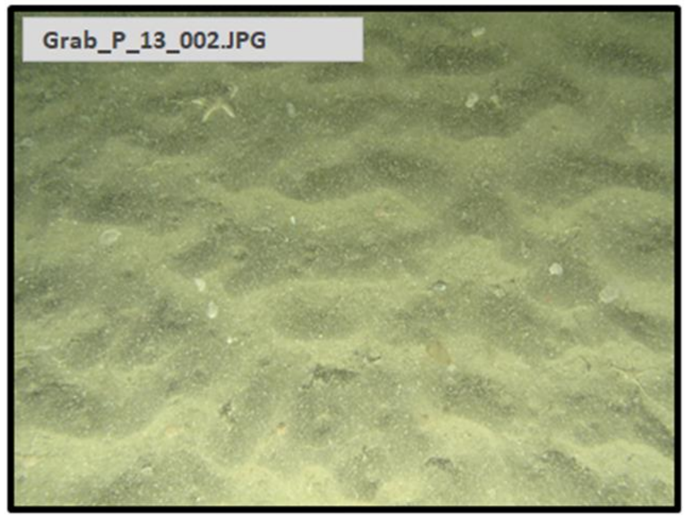


Photo Position: 718531 mE, 5941926 mN

Habitat Summary Information: Grab_P_13

Survey Area: N5a Pipeline

No. of Stills: 7 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of low reflectivity with some potential scarring.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish), Ophiurida sp.

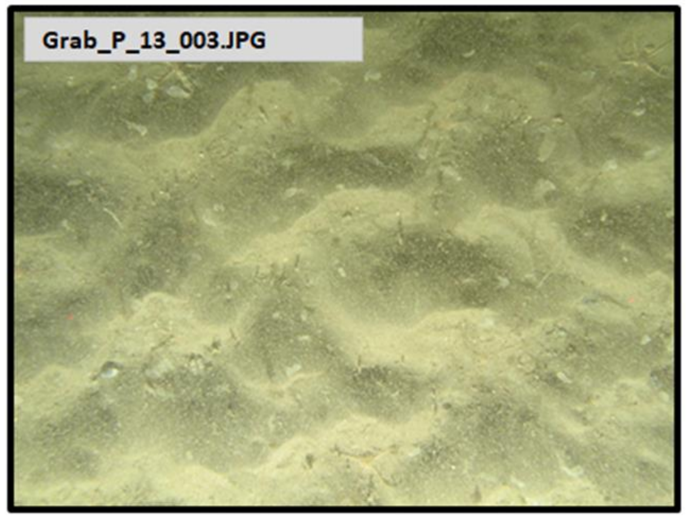


Photo Position: 718531 mE, 5941926 mN

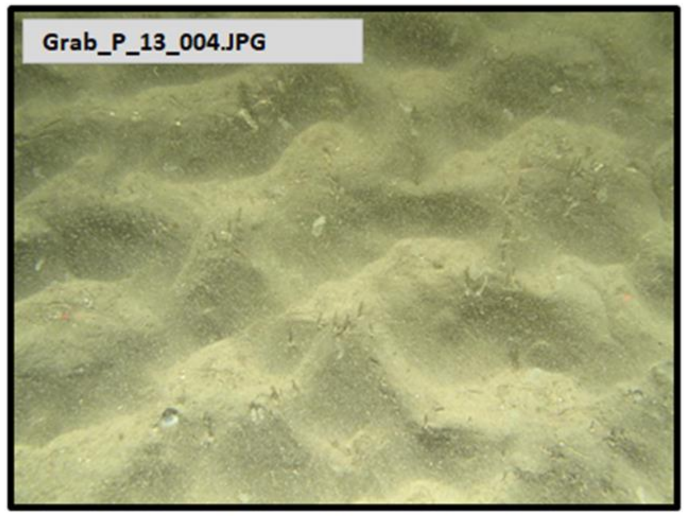
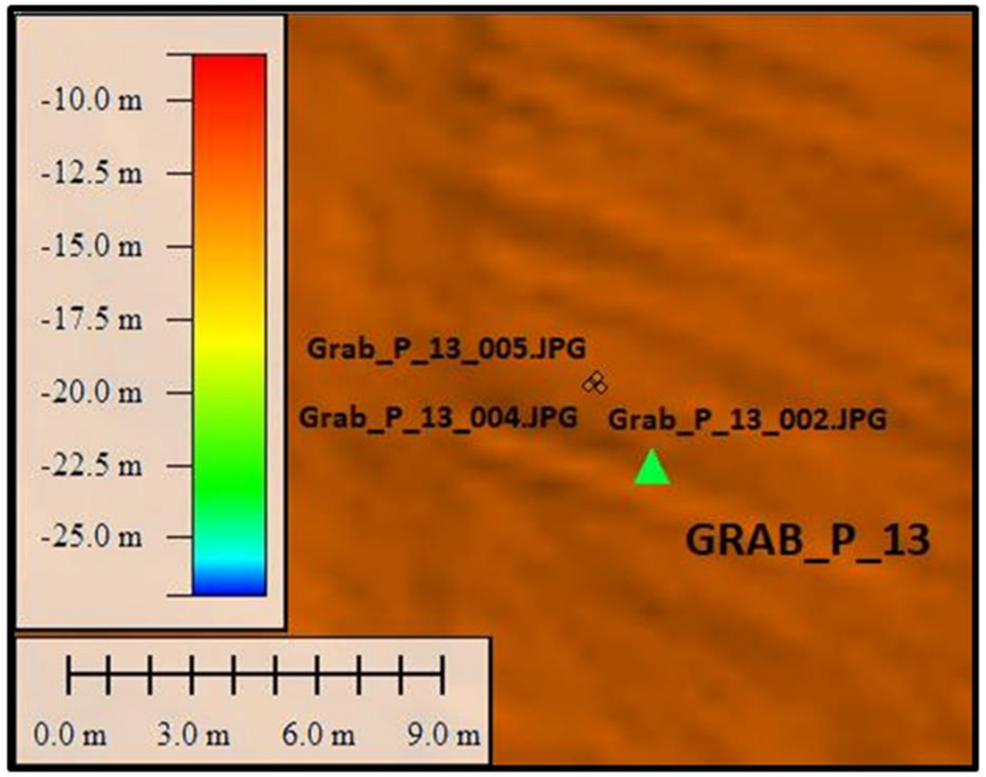


Photo Position: 718531 mE, 5941926 mN



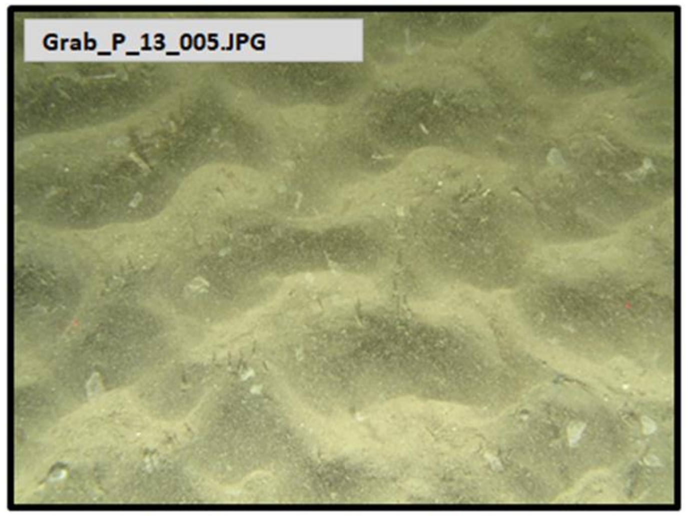
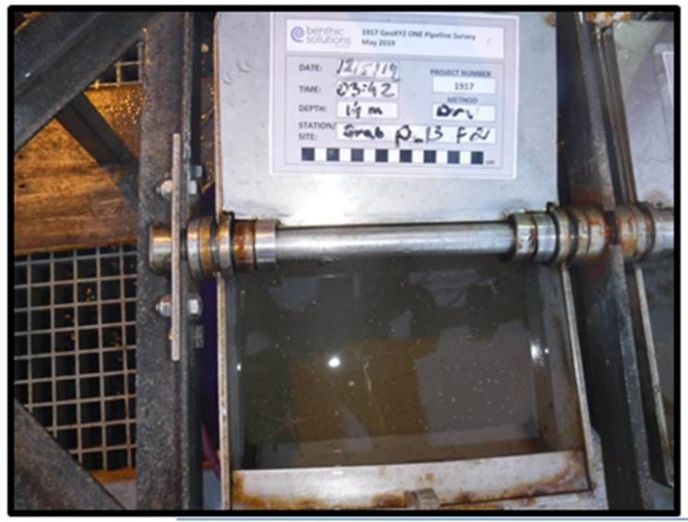


Photo Position: 718531 mE, 5941926 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

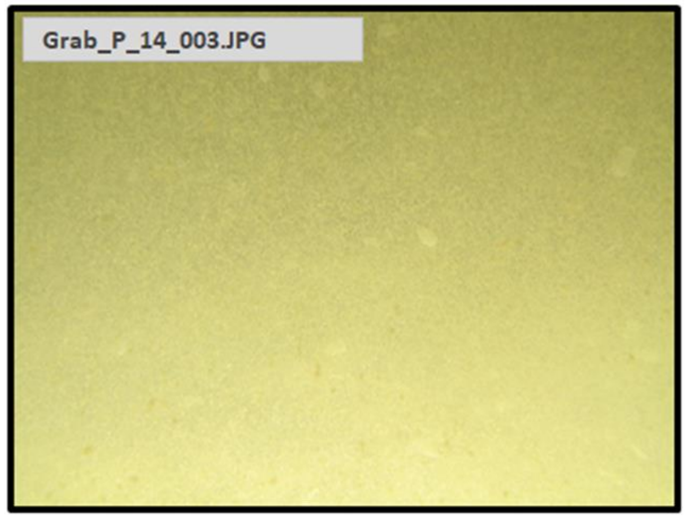


Photo Position: 718449 mE, 5940928 mN

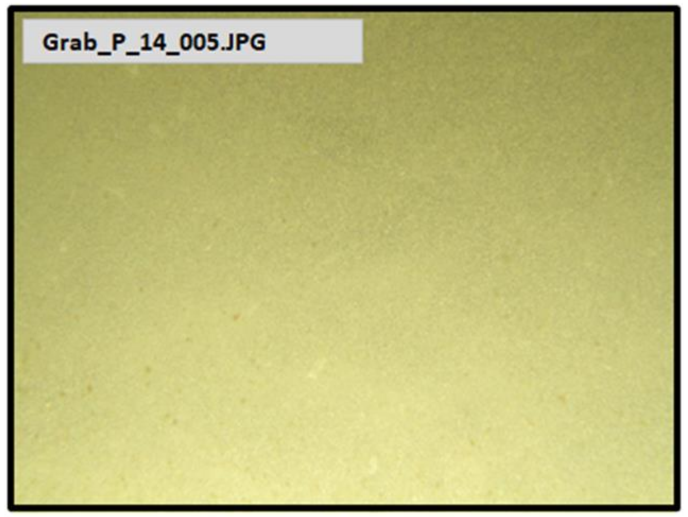


Photo Position: 718450 mE, 5940928 mN

Sediment Example Image

Habitat Summary Information: Grab_P_14

Survey Area: N5a Pipeline

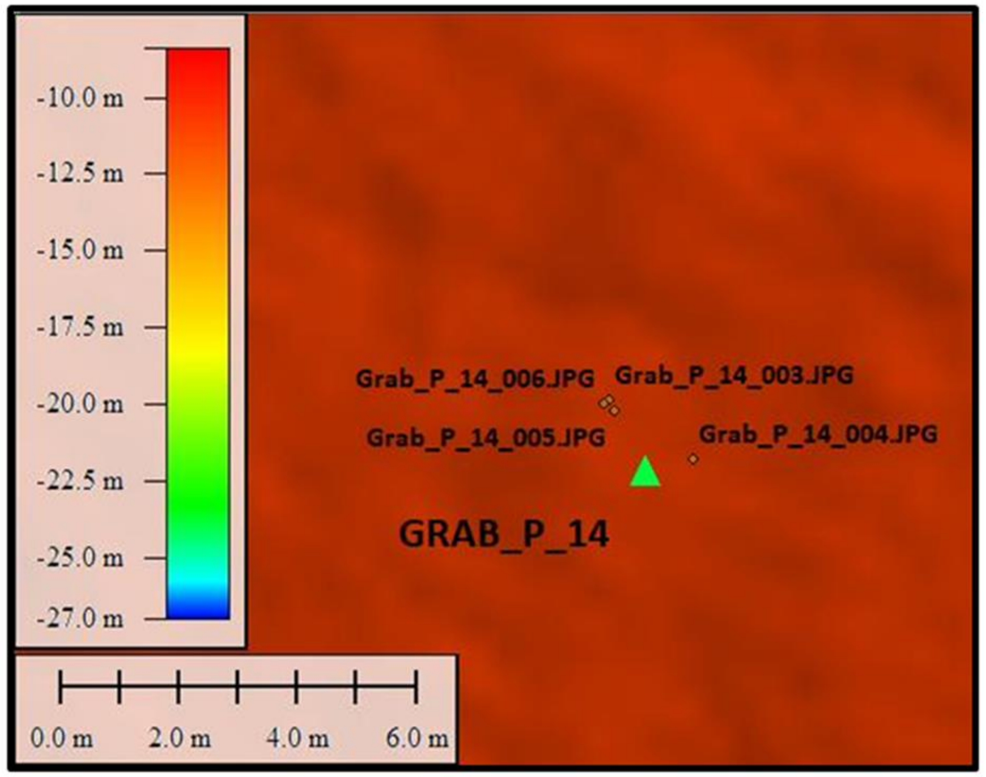
No. of Stills: 5 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity

Sediment Description
No visiblity.

Conspicuous Fauna
No visibility



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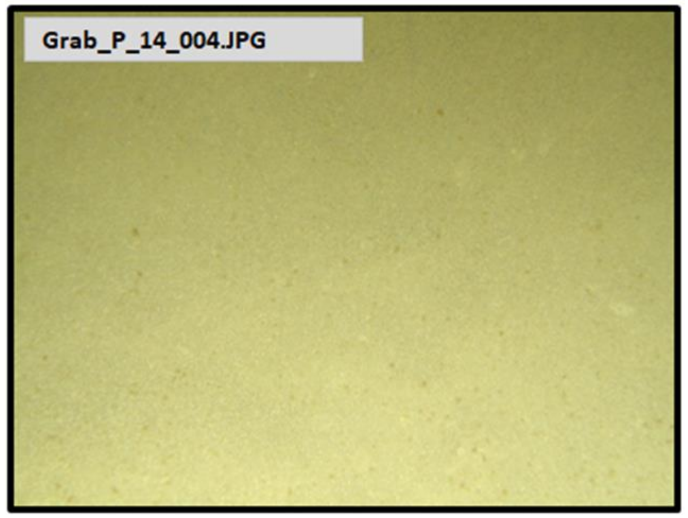


Photo Position: 718451 mE, 5940927 mN

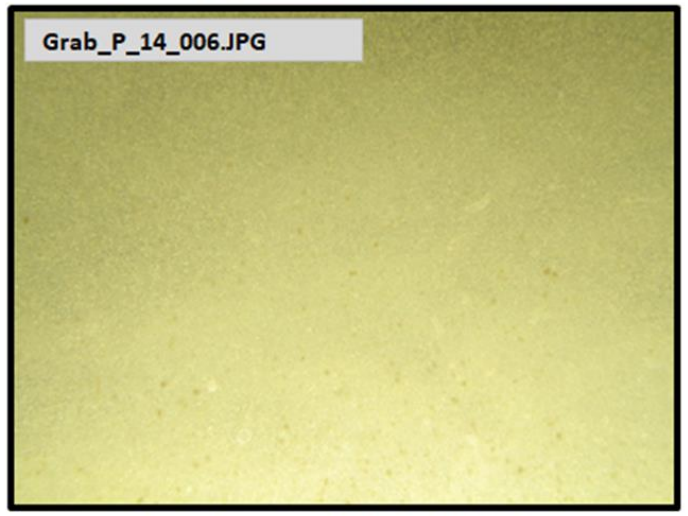


Photo Position: 718449 mE, 5940928 mN

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

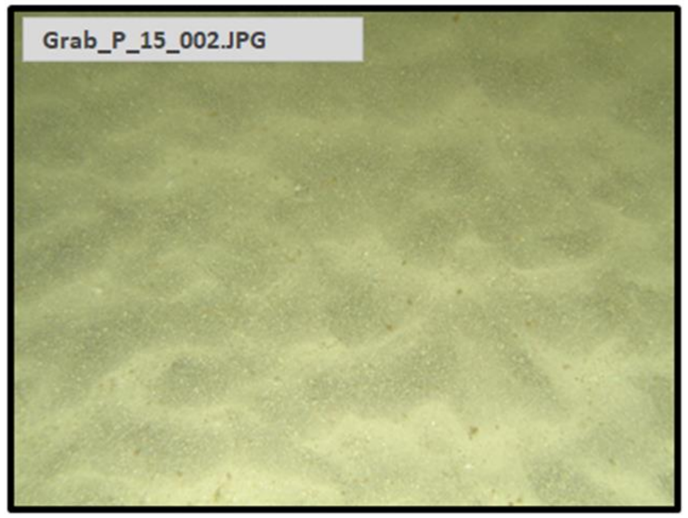


Photo Position: 718366 mE, 5939934 mN

Habitat Summary Information: Grab_P_15

Survey Area: N5a Pipeline

No. of Stills: 5 **Mins of Video:** 2 **Track Length:** DDV

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Chordata:** Actinopterygii sp.

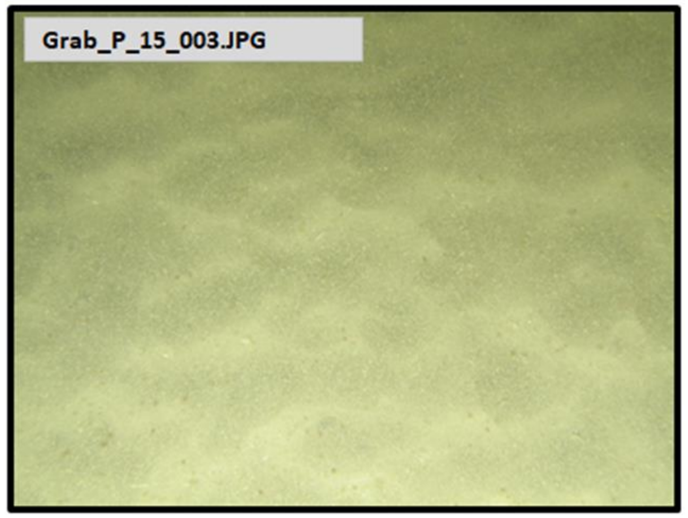


Photo Position: 718366 mE, 5939934 mN

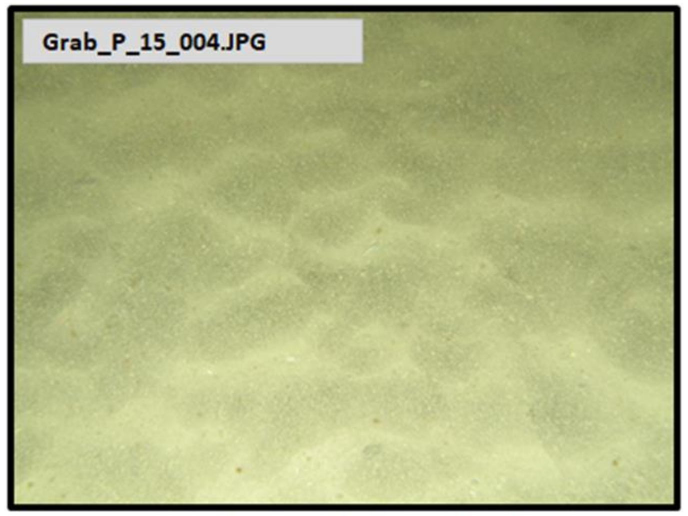
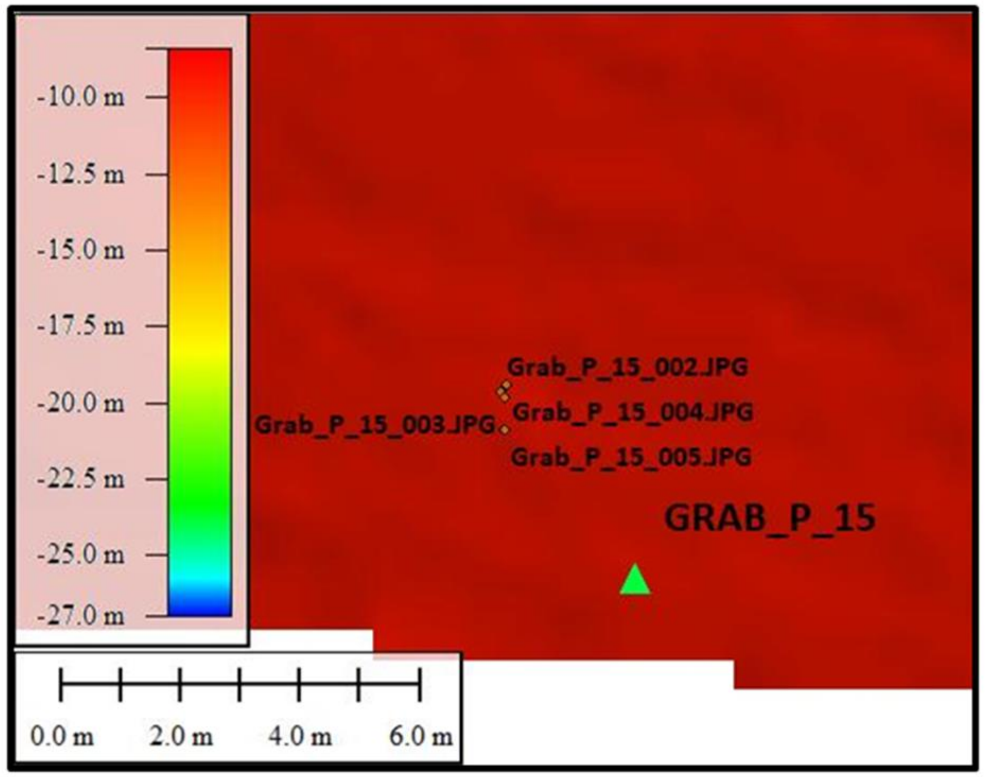


Photo Position: 718366 mE, 5939934 mN



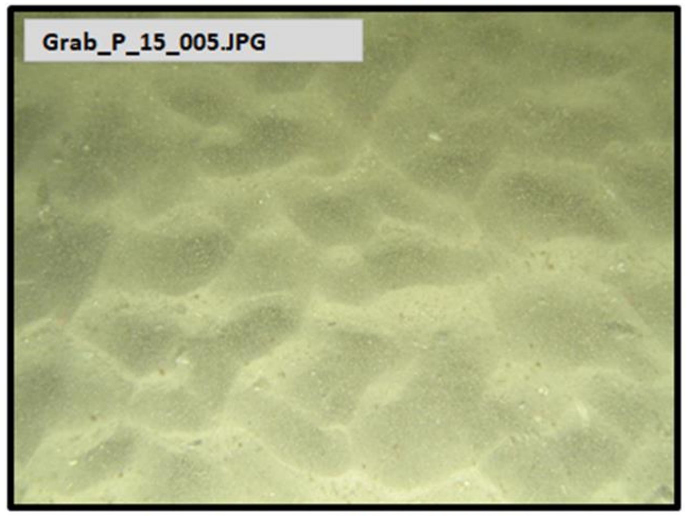


Photo Position: 718366 mE, 5939933 mN

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Sediment Example Image

Grab Location Camera Track Selected Underwater Still

Sieved Sample Image

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_0

Survey Area: N5a Cable Route

Site Selection Criteria
Original Cable Route and N5a well centre location. Covered using transect N5a_1 and N5a_2.

Analogue Interpretation
Low reflectivity with some scarring.

Sediment Description
Slightly gravelly/shelly coarse sand.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

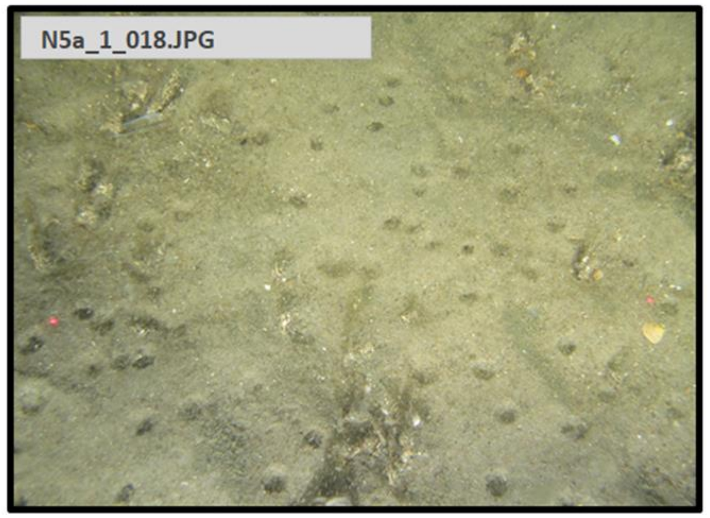


Photo Position: 721606 mE, 5954649 mN

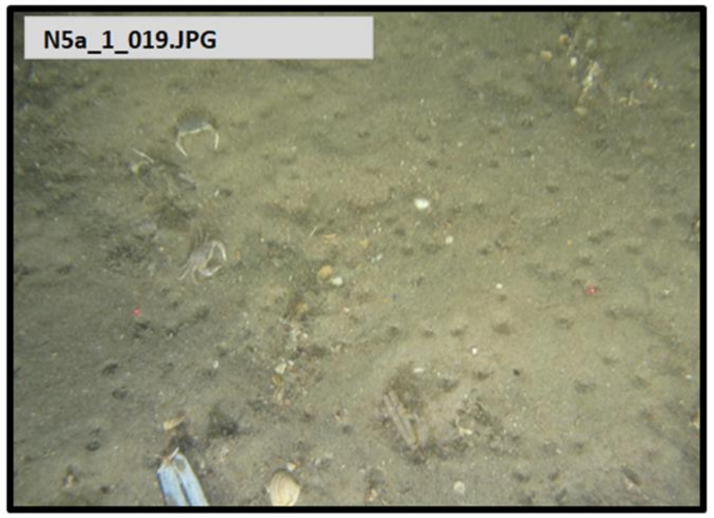


Photo Position: 721607 mE, 5954652 mN

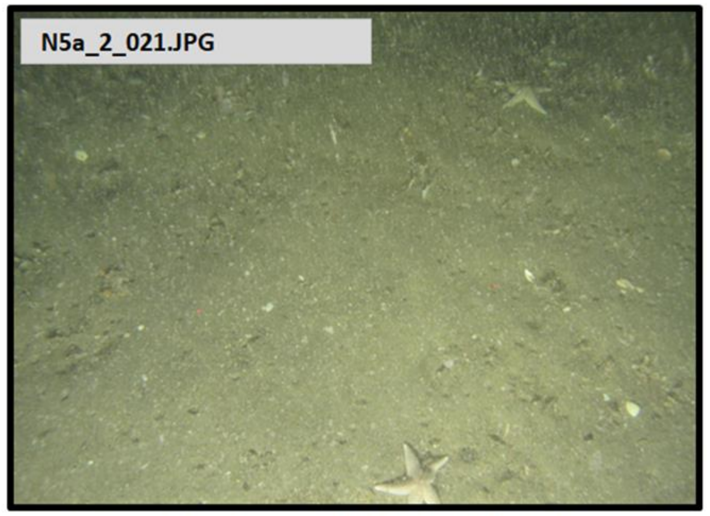
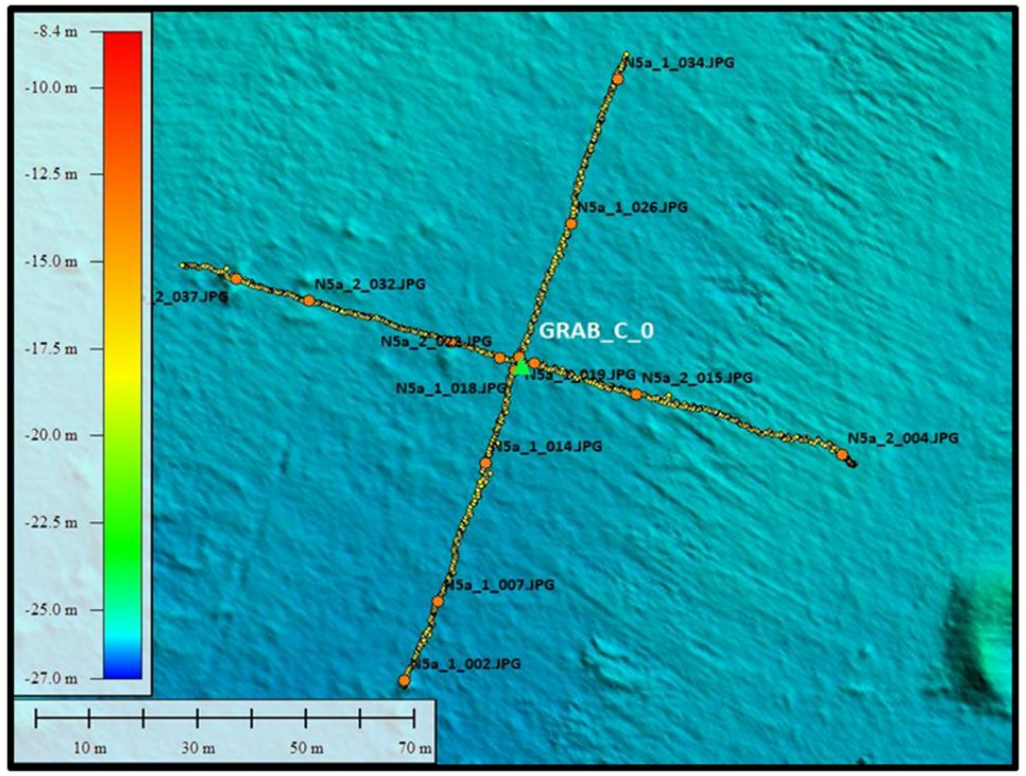


Photo Position: 721610 mE, 5954650 mN



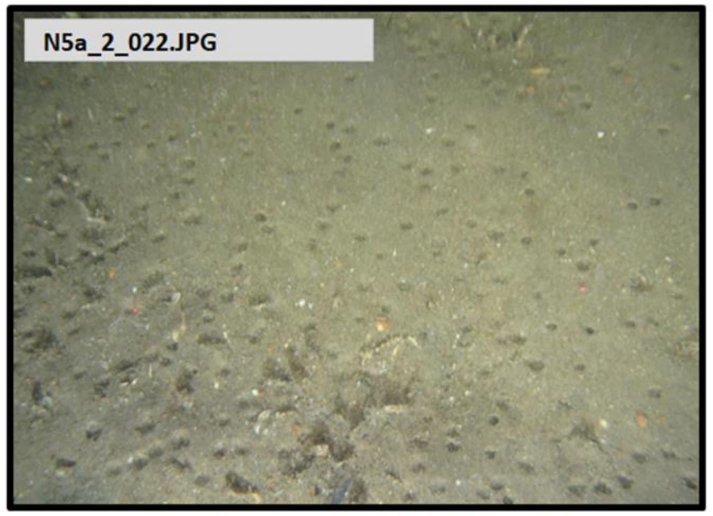


Photo Position: 721603 mE, 5954651 mN

Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

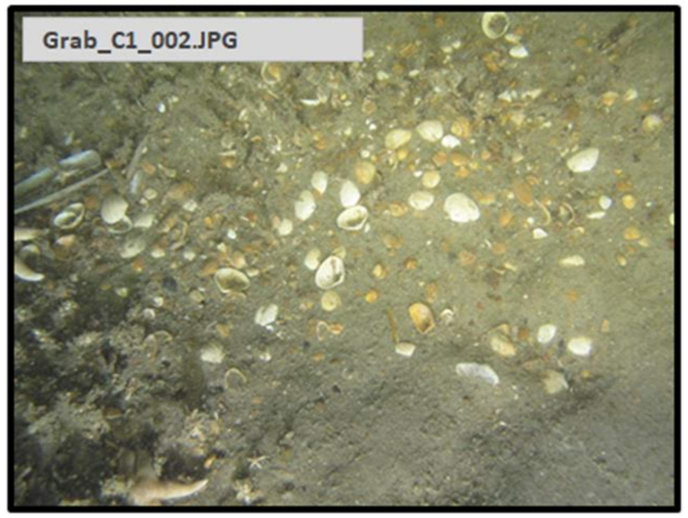


Photo Position: 722598 mE, 5954539 mN

Habitat Summary Information: Grab_C_1

Survey Area: N5a Cable Route

No. of Stills: 2 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Area of variable high reflectivity with raised area near Grab location.

Sediment Description

Coarse sand littered with shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp, *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish).

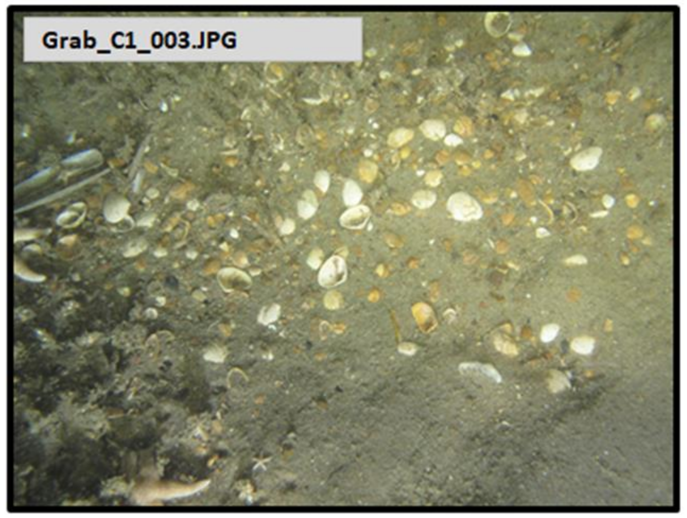


Photo Position: 722598 mE, 5954539 mN

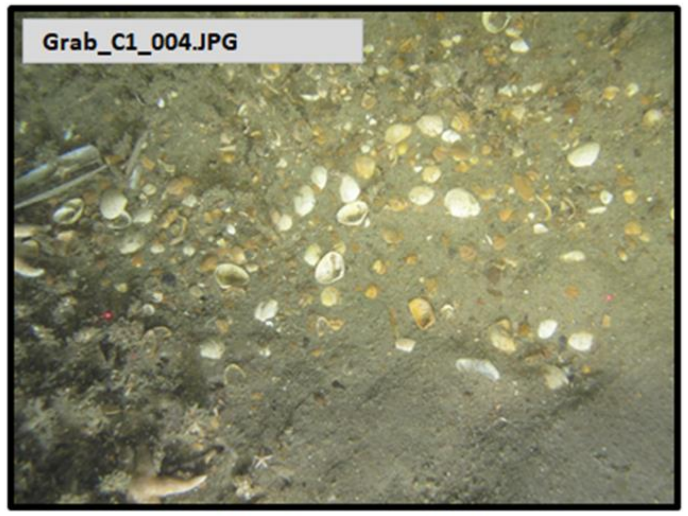
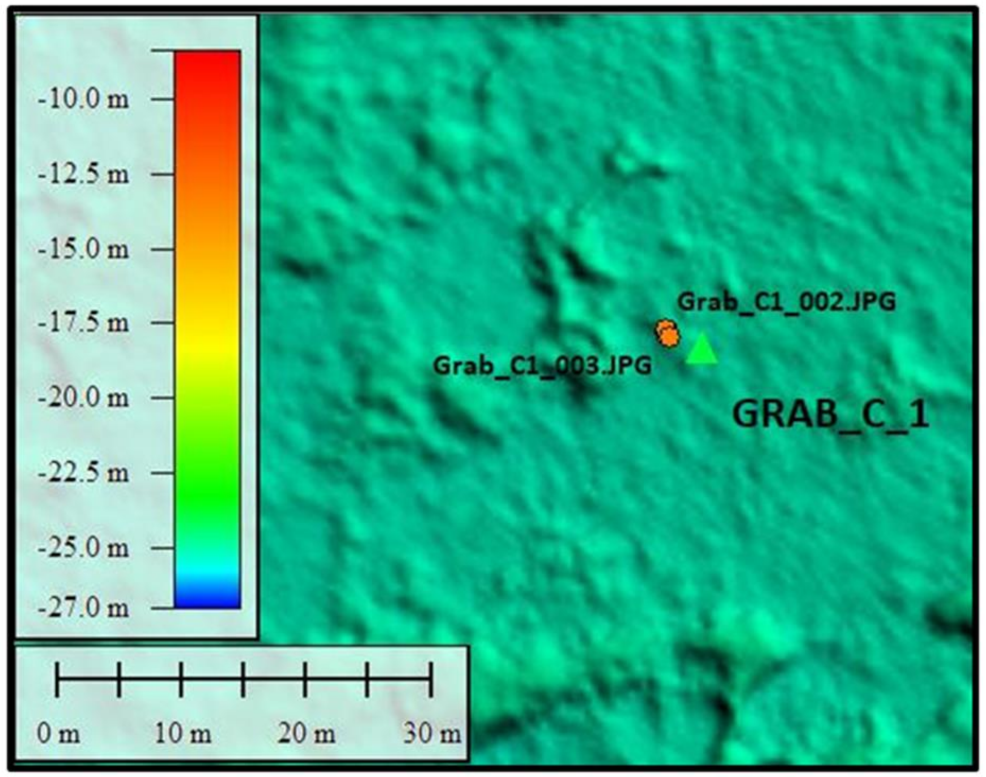


Photo Position: 0 mE, 0 mN



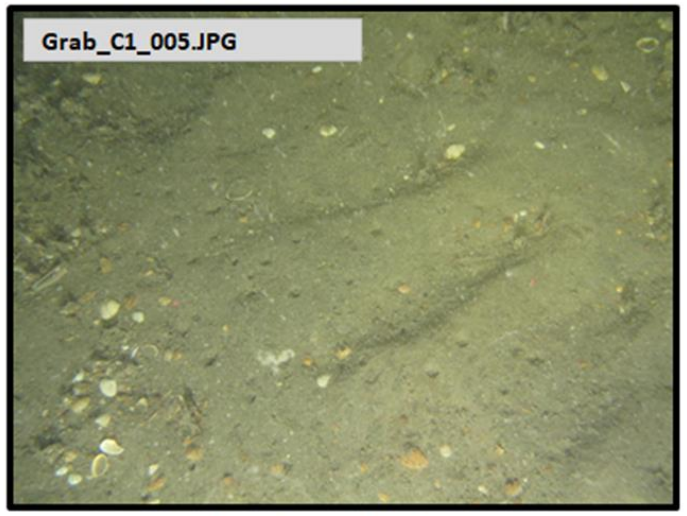


Photo Position: 0 mE, 0 mN

Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_2

Survey Area: N5a Cable Route

No. of Stills: 5 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria
Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation
Area of variable reflectivity.

Sediment Description
Coarse sand.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Mollusca:** *Loligo vulgaris*.
Echinodermata: *Asterias rubens* (Common starfish).

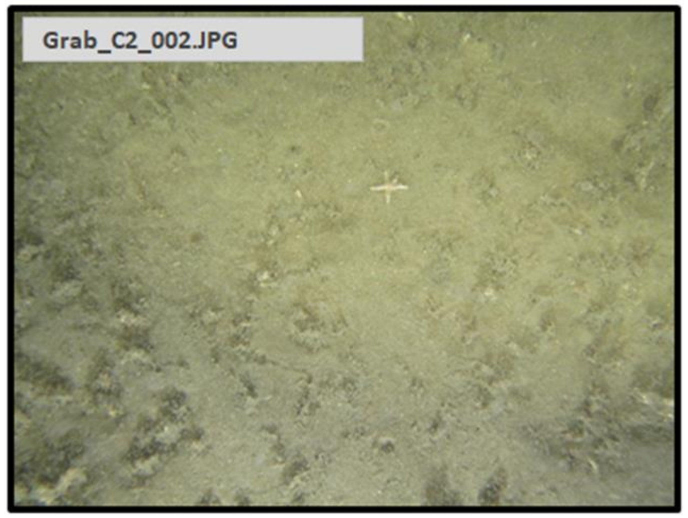


Photo Position: 723594 mE, 5954423 mN

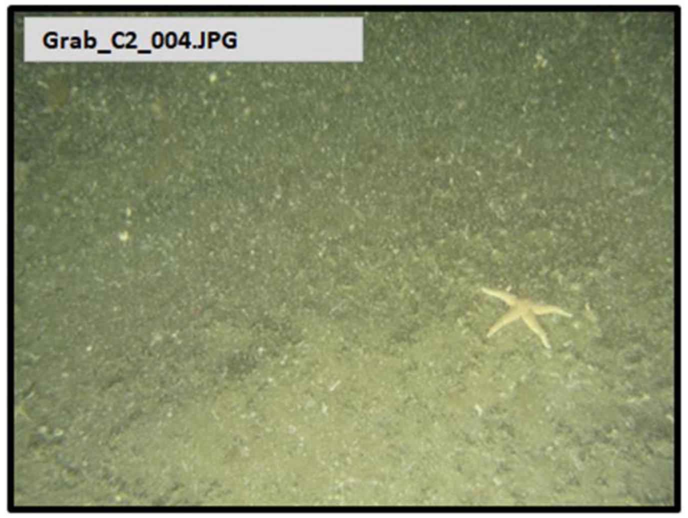


Photo Position: 723594 mE, 5954423 mN

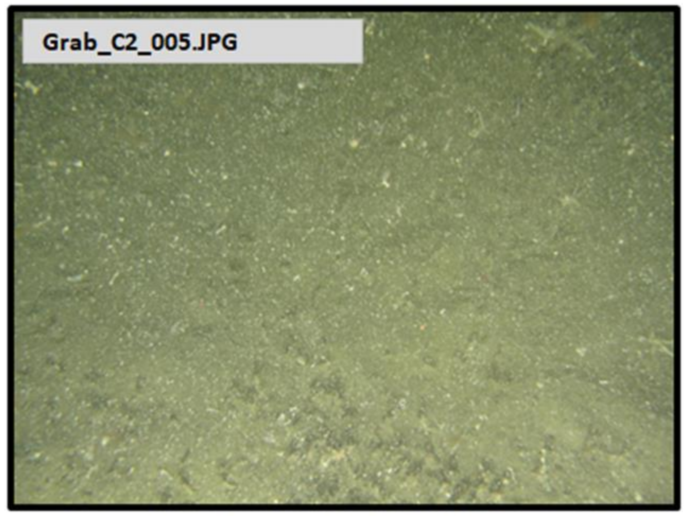


Photo Position: 723596 mE, 5954422 mN

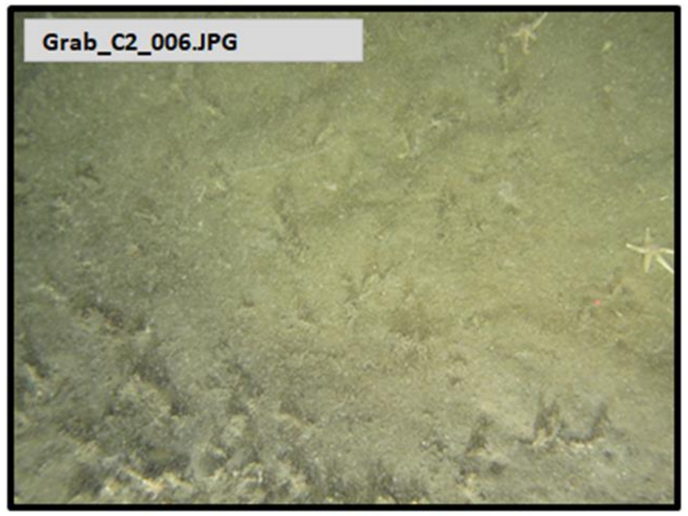
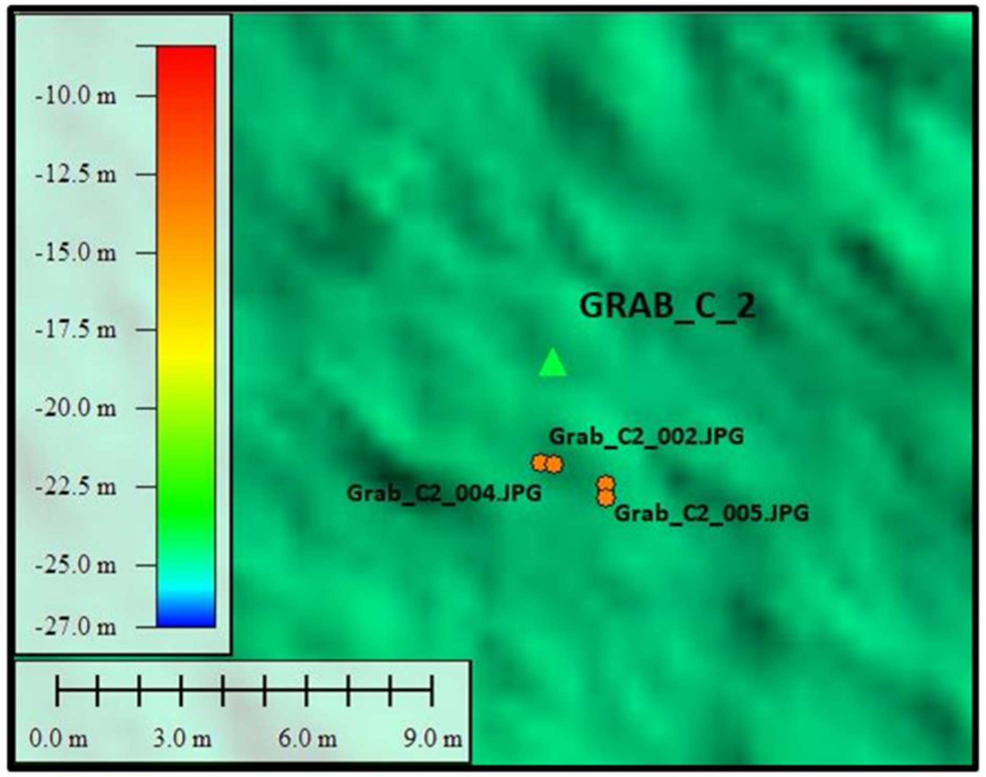


Photo Position: 723596 mE, 5954422 mN


Sediment Example Image



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Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_3

Survey Area: N5a Cable Route

No. of Stills: 8 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria
Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand ripples with small shell fragments.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish).

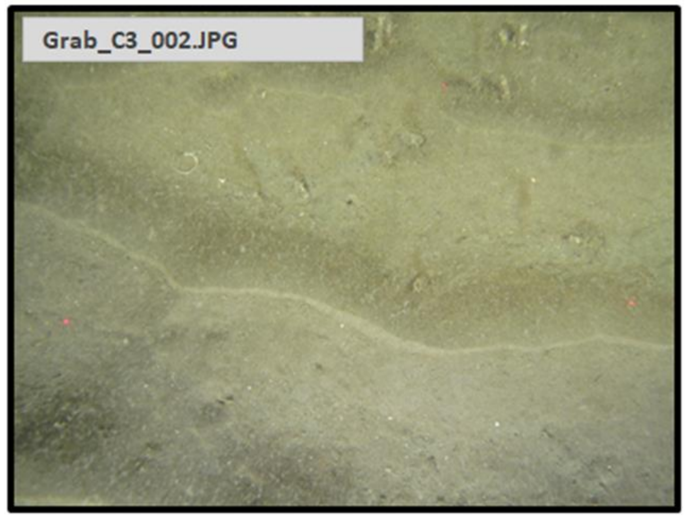


Photo Position: 724589 mE, 5954311 mN

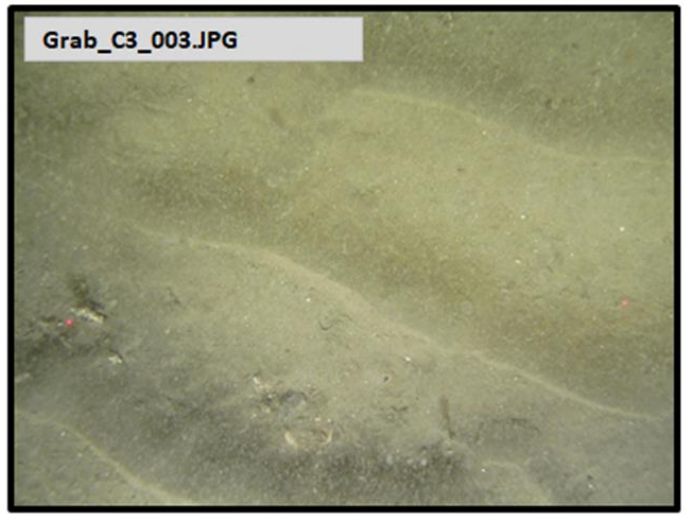
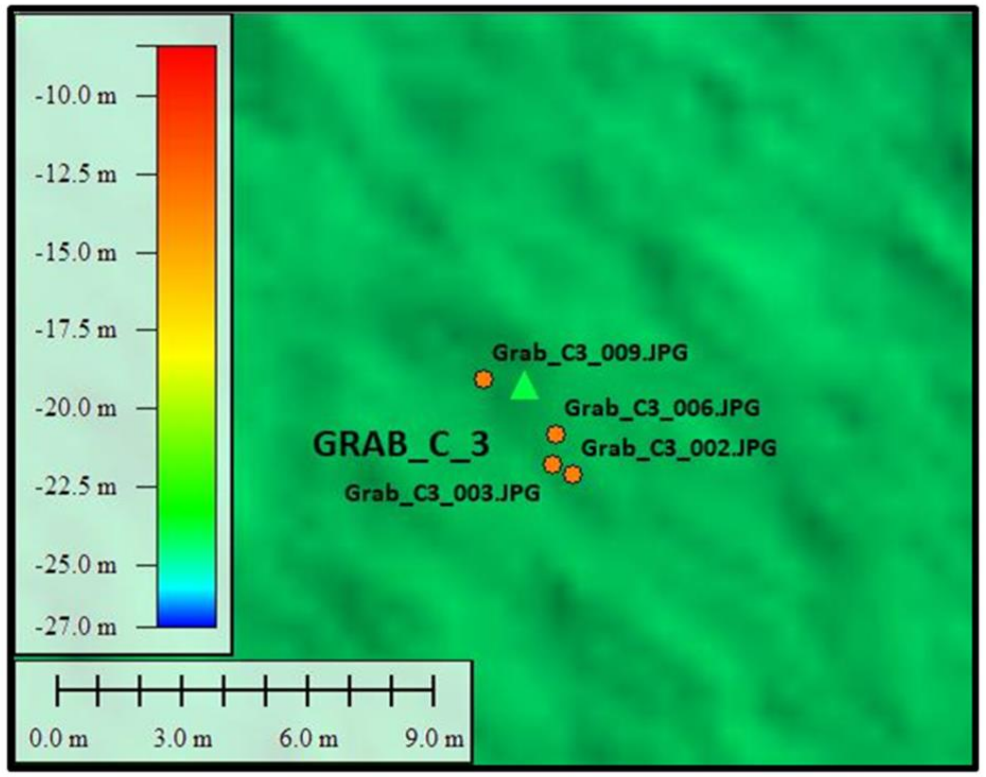


Photo Position: 724589 mE, 5954311 mN

Photo Position: 724589 mE, 5954312 mN

Photo Position: 724587 mE, 5954313 mN



Sediment Example Image

ORANJE-NASSAU ENERGIE benthic solutions limited GEOxyz OFFSHORE

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

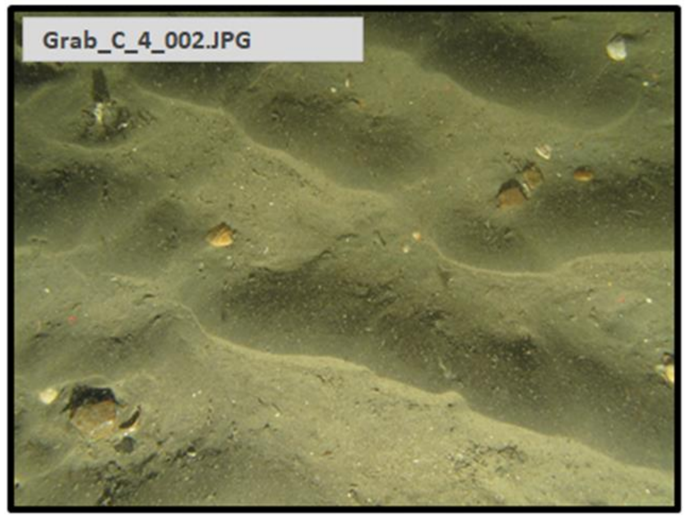


Photo Position: 725582 mE, 5954199 mN

Habitat Summary Information: Grab_C_4

Survey Area: N5a Cable Route

No. of Stills: 9 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp. **Echinodermata:** *Asterias rubens* (Common starfish).

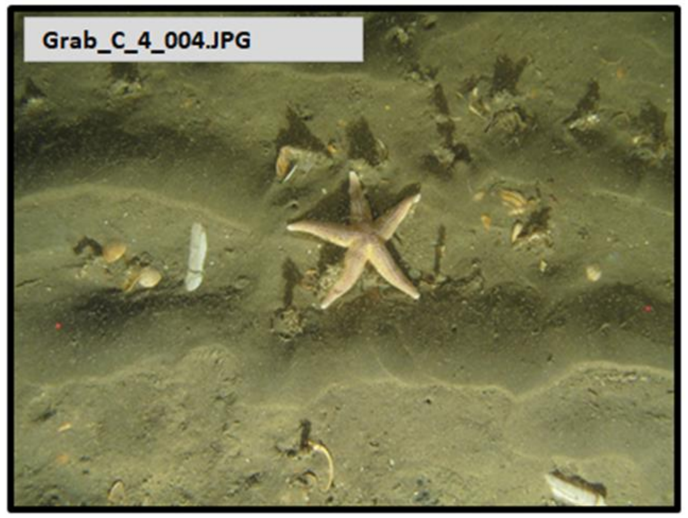


Photo Position: 725583 mE, 5954200 mN

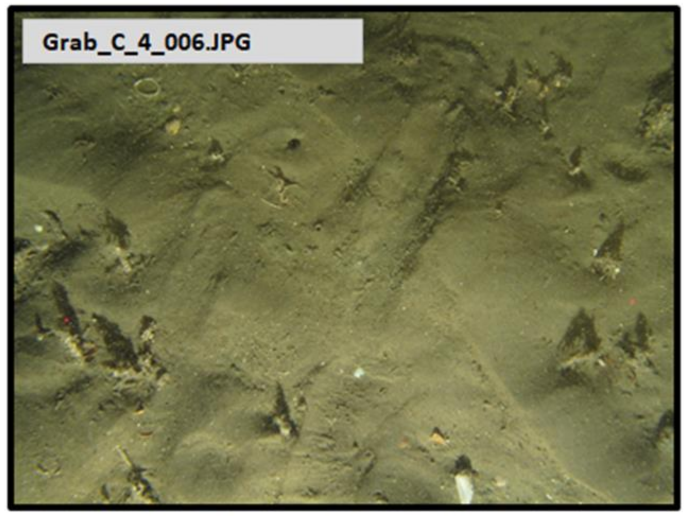
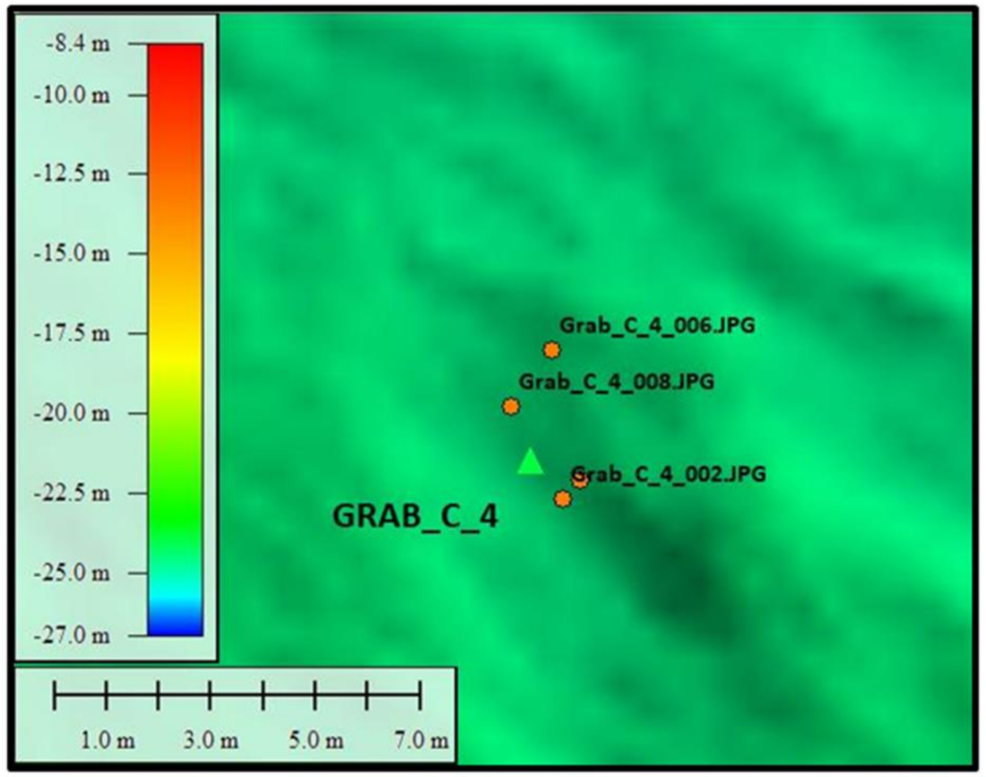


Photo Position: 725582 mE, 5954202 mN



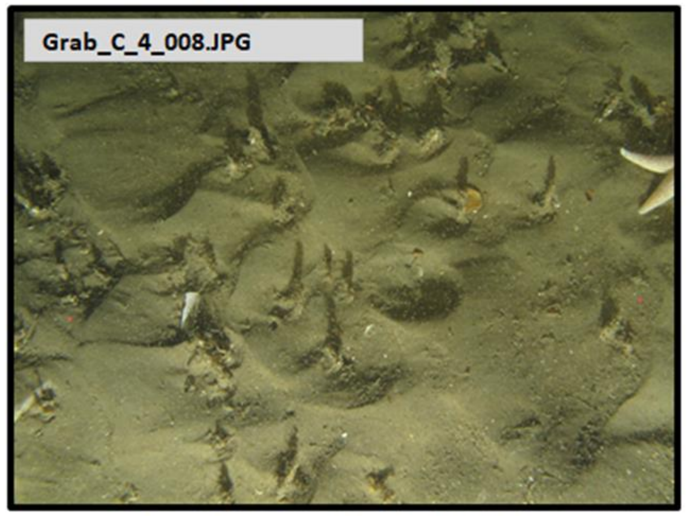


Photo Position: 725581 mE, 5954201 mN

Sediment Example Image

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Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

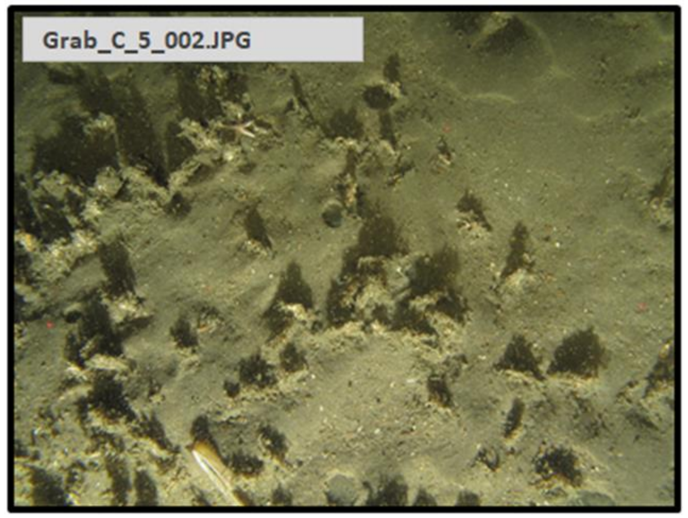


Photo Position: 726576 mE, 5954087 mN

Habitat Summary Information: Grab_C_5

Survey Area: N5a Cable Route

No. of Stills: 9 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** possibly *Callionymus lyra* (Common dragonet).

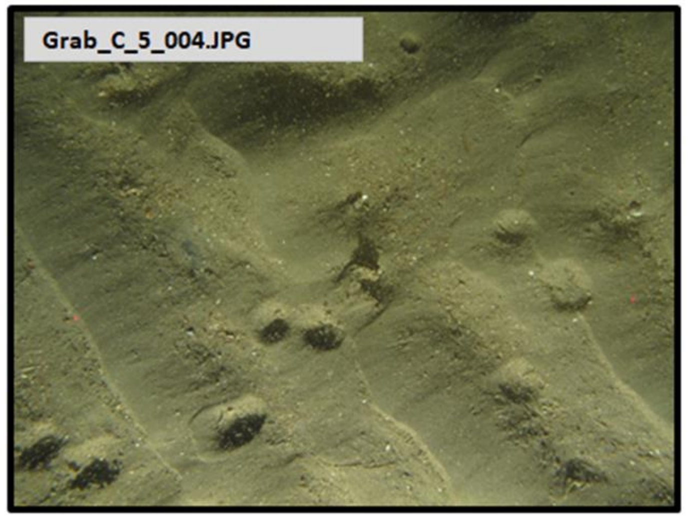


Photo Position: 726578 mE, 5954083 mN

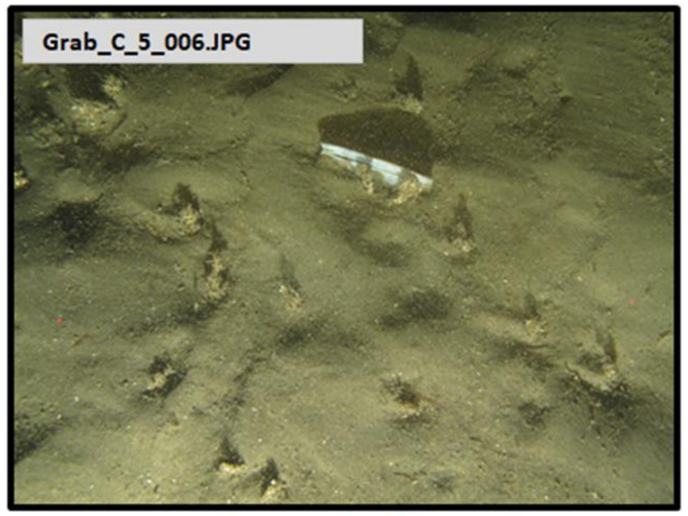
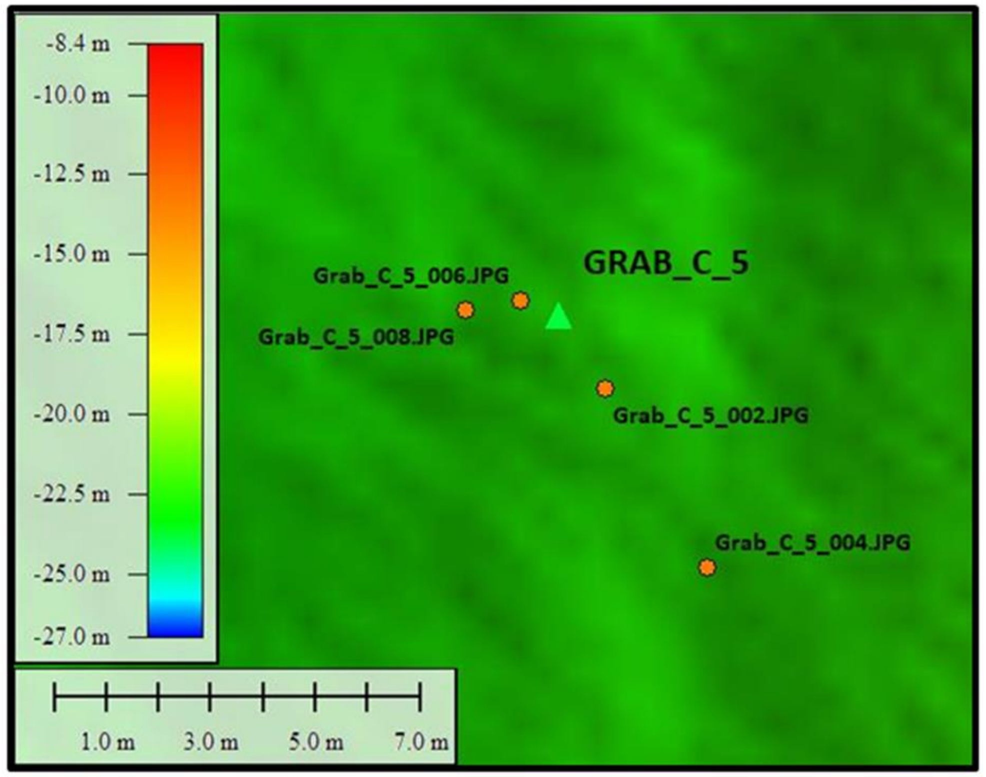


Photo Position: 726575 mE, 5954088 mN



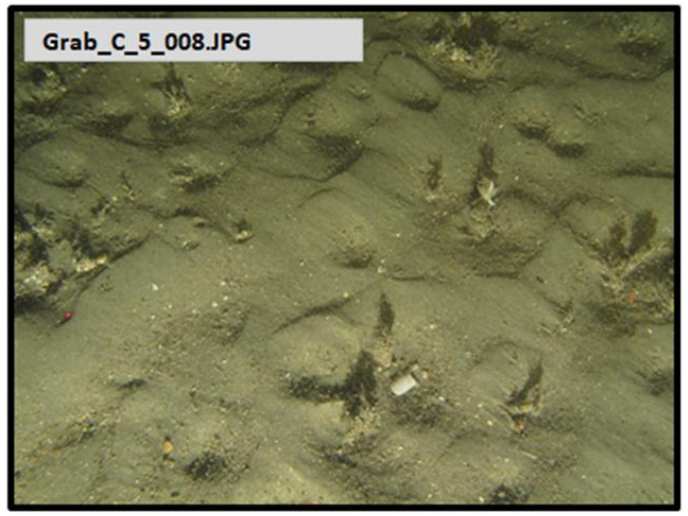


Photo Position: 726574 mE, 5954088 mN

Sediment Example Image

ORANJE-NASSAU ENERGIE | benthic solutions limited | GEOxyz OFFSHORE


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

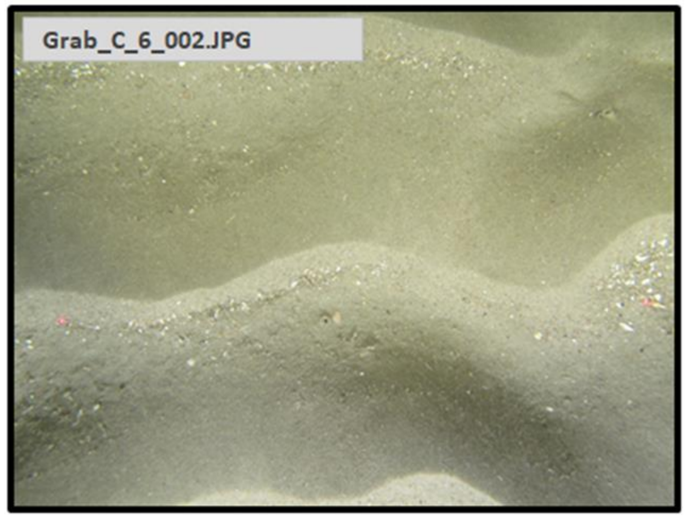


Photo Position: 727352 mE, 5954243 mN

Habitat Summary Information: Grab_C_6

Survey Area: N5a Cable Route

No. of Stills: 4 | **Mins of Video: 1** | **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason).

Photo Position: 727352 mE, 5954243 mN

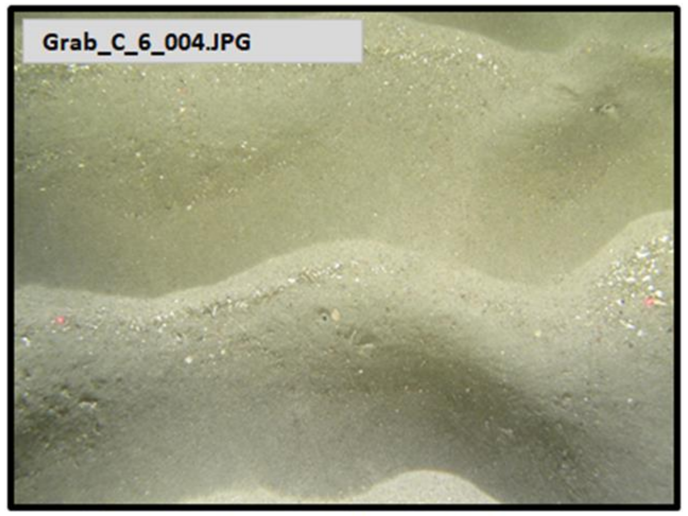
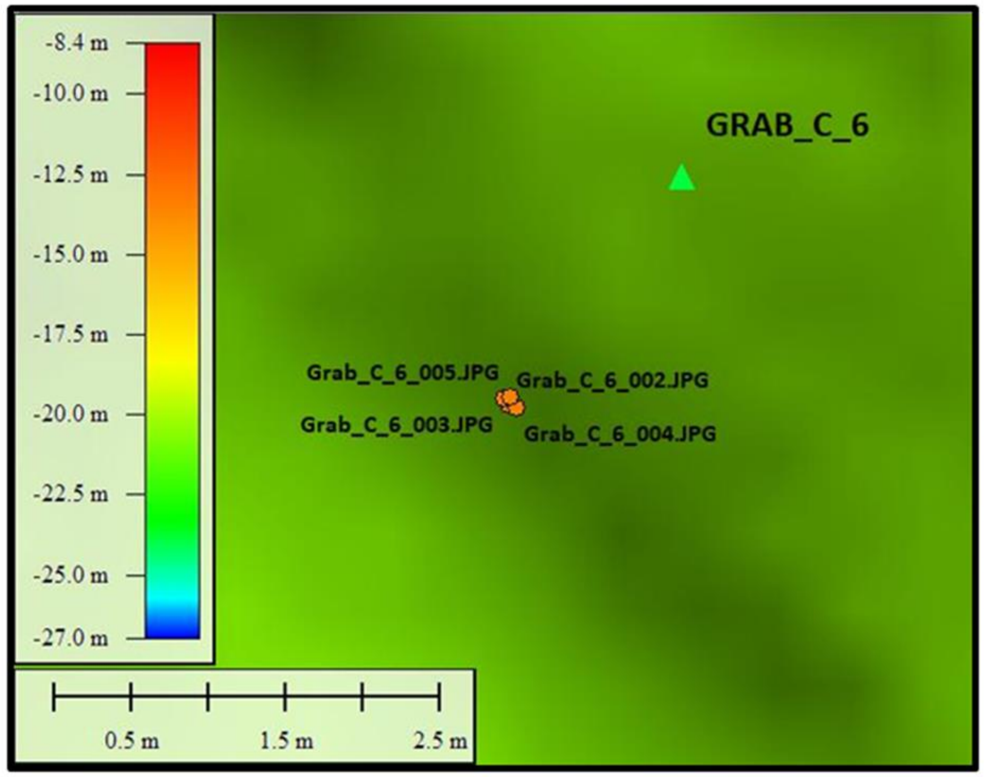


Photo Position: 727352 mE, 5954242 mN



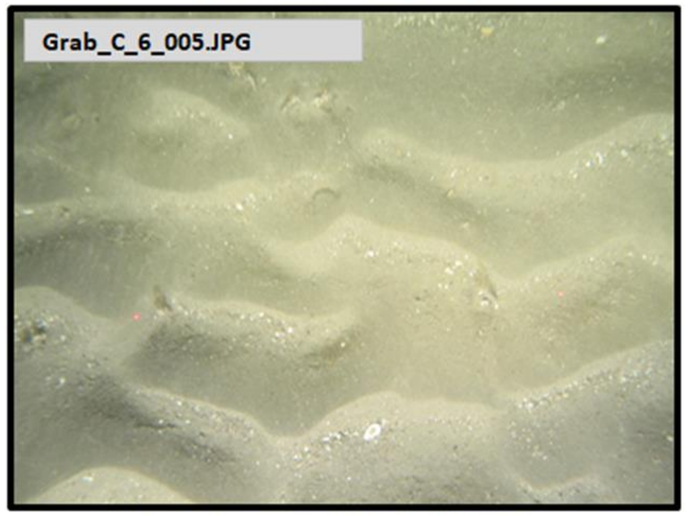


Photo Position: 727352 mE, 5954243 mN


Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

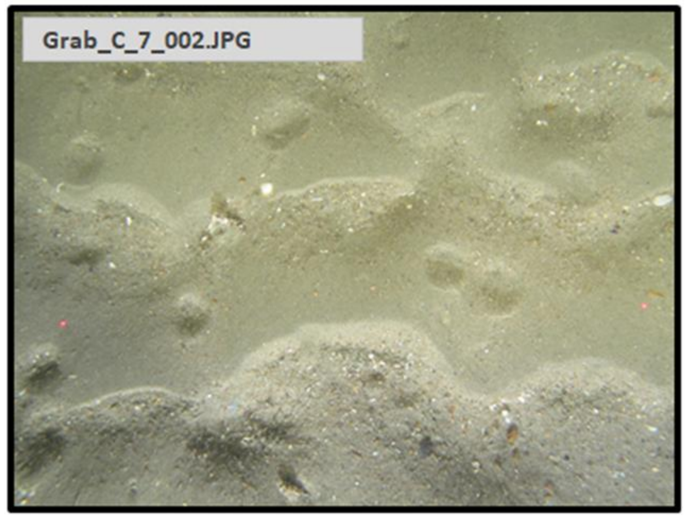


Photo Position: 728147 mE, 5954477 mN

Habitat Summary Information: Grab_C_7

Survey Area: N5a Cable Route

No. of Stills: 5 | **Mins of Video:** 1 | **Track Length:** DDV

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

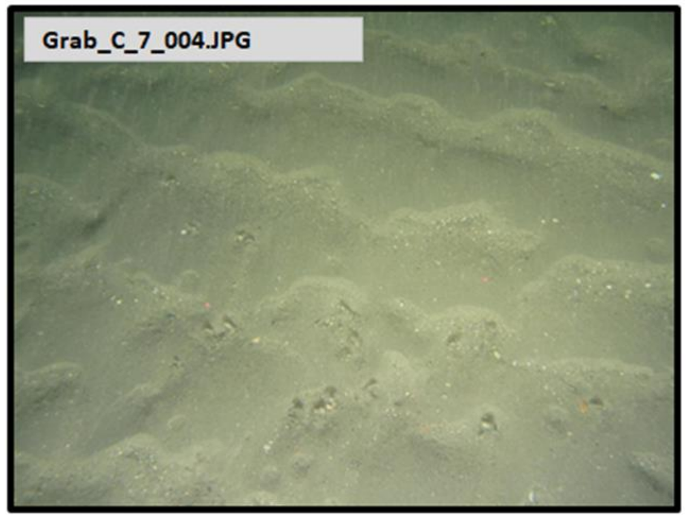


Photo Position: 728147 mE, 5954477 mN

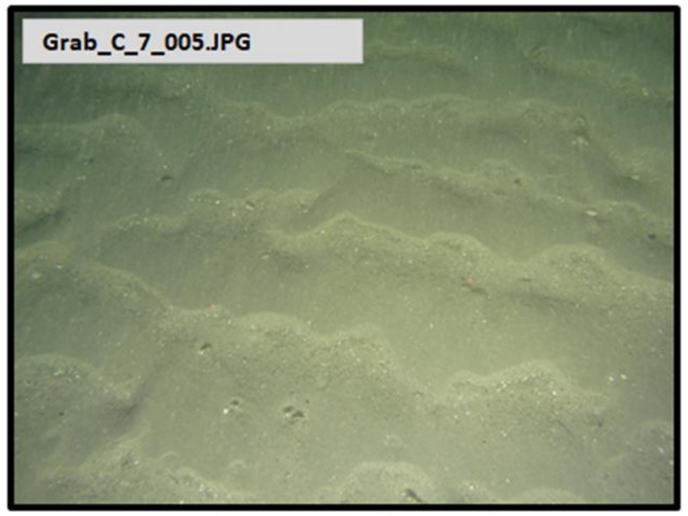
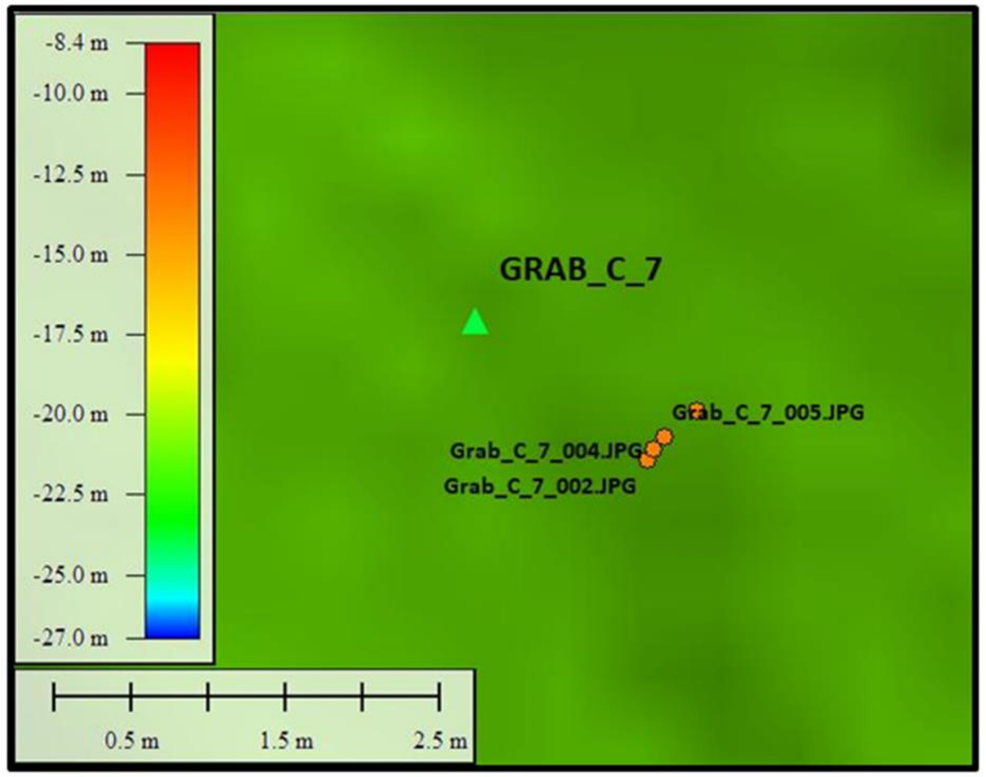


Photo Position: 728147 mE, 5954477 mN



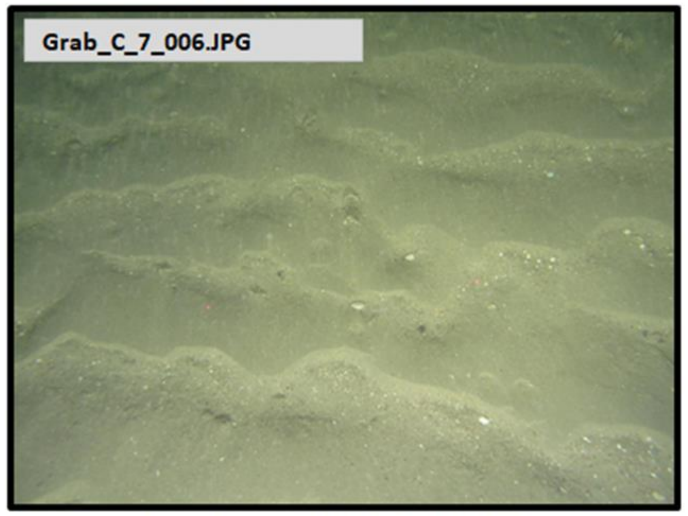
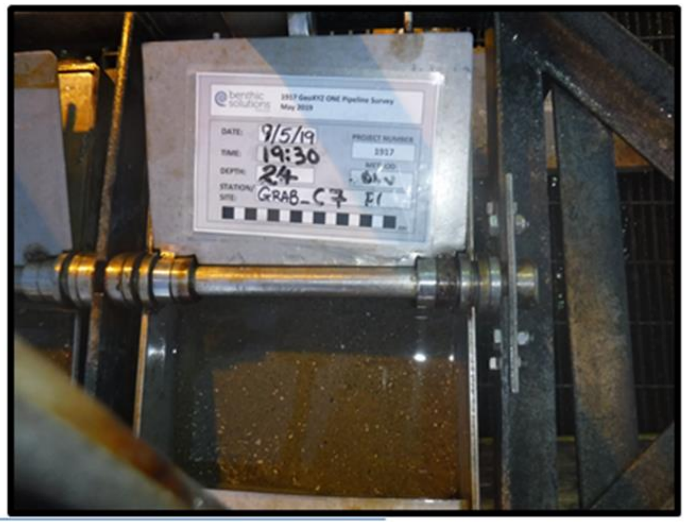


Photo Position: 728148 mE, 5954477 mN


Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

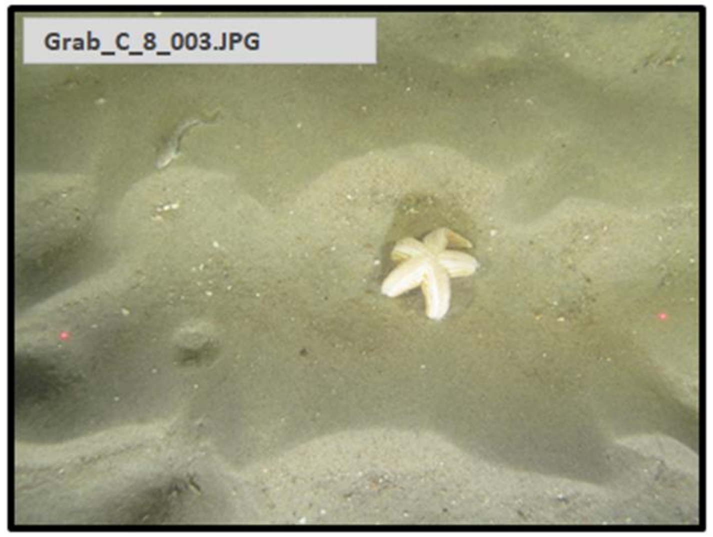


Photo Position: 729107 mE, 5954755 mN

Habitat Summary Information: Grab_C_8

Survey Area: N5a Cable Route

No. of Stills: 5 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Gobiidae sp.

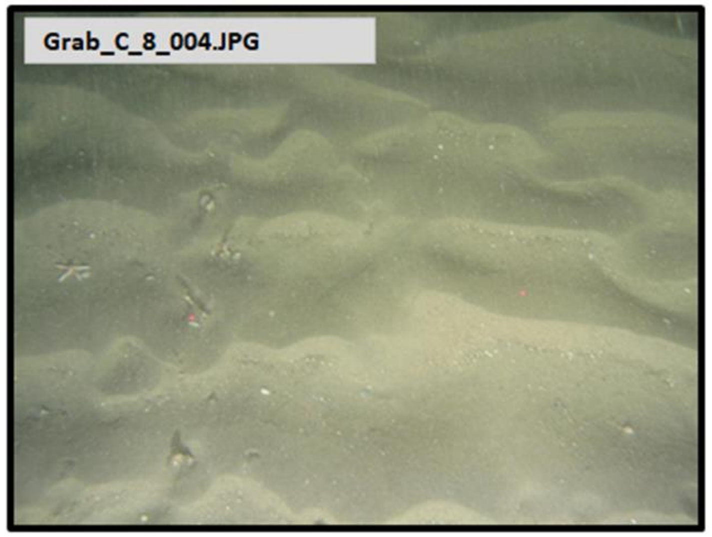


Photo Position: 729107 mE, 5954756 mN

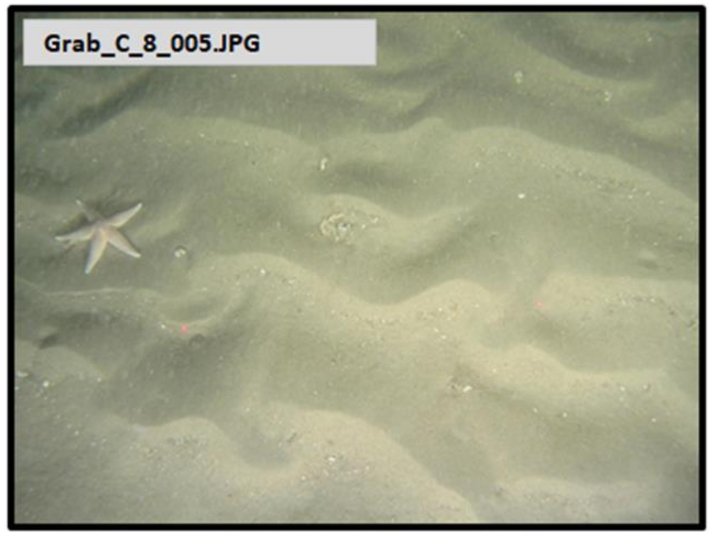
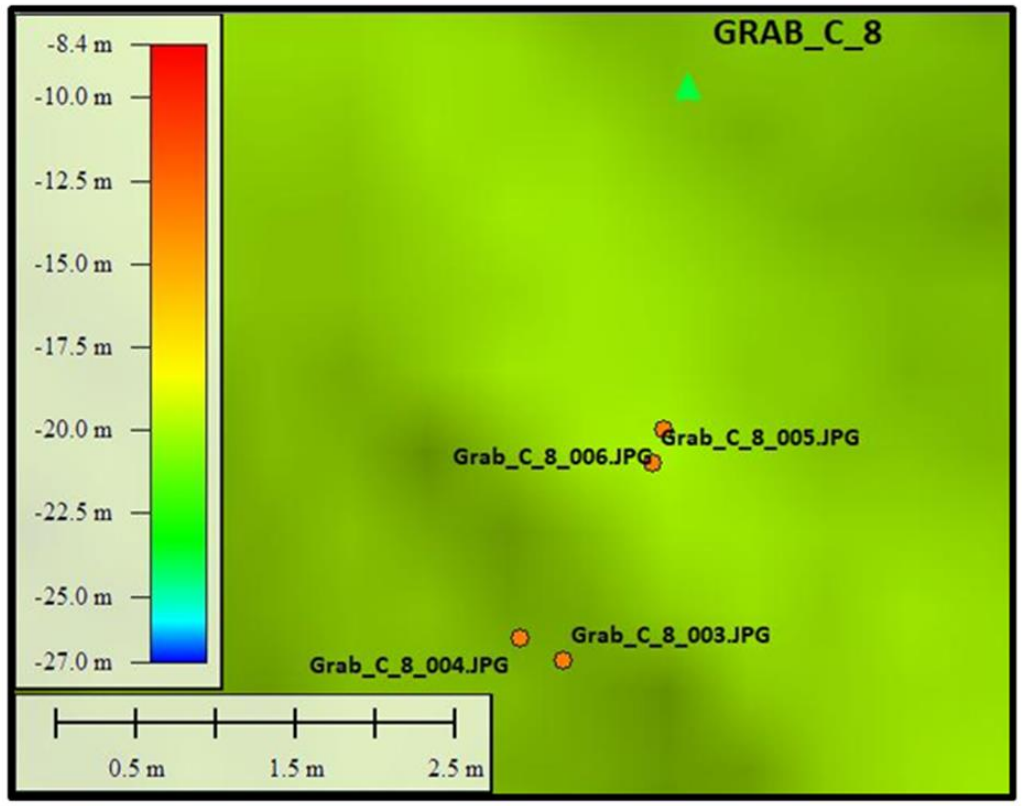


Photo Position: 729108 mE, 5954757 mN



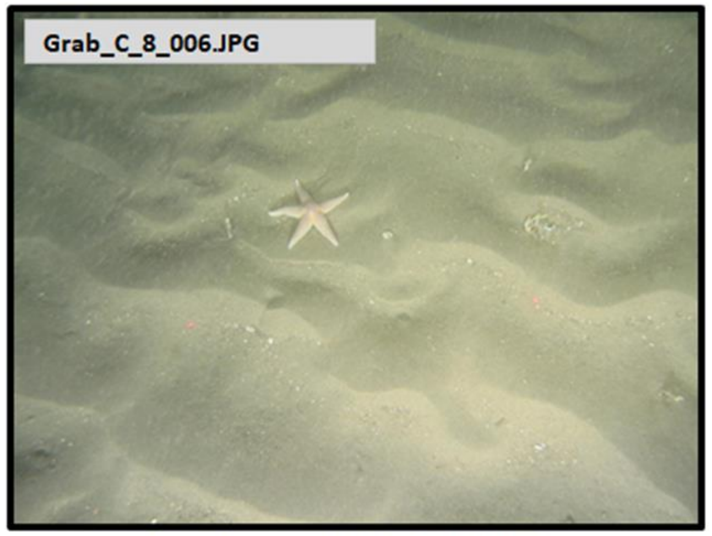


Photo Position: 729108 mE, 5954757 mN

Sediment Example Image

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Grab Location — Camera Track — Selected Underwater Still

Sieved Sample Image

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

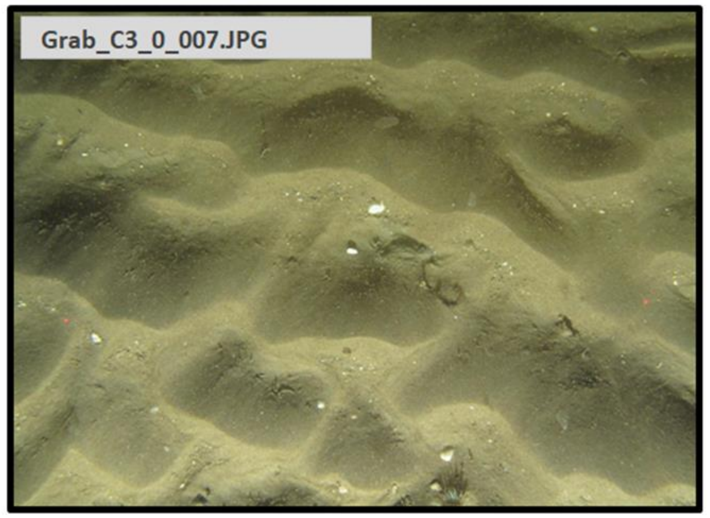


Photo Position: 722245 mE, 5952995 mN

Habitat Summary Information: Grab_C3_0

Survey Area: N5a Cable Route

No. of Stills: 36 **Mins of Video:** 9 **Track Length:** 125m

Site Selection Criteria
Secondary Cable Route and N5a second potential well centre location.

Analogue Interpretation
No analogue data.

Sediment Description
Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp., *Corystes cassivelaunus* (Masked crab). **Echinodermata:** *Asterias rubens* (Common starfish), *Ophiura* sp. **Chordata:** Gobiidae sp. , *Ammodytes* sp. (Sand eel).

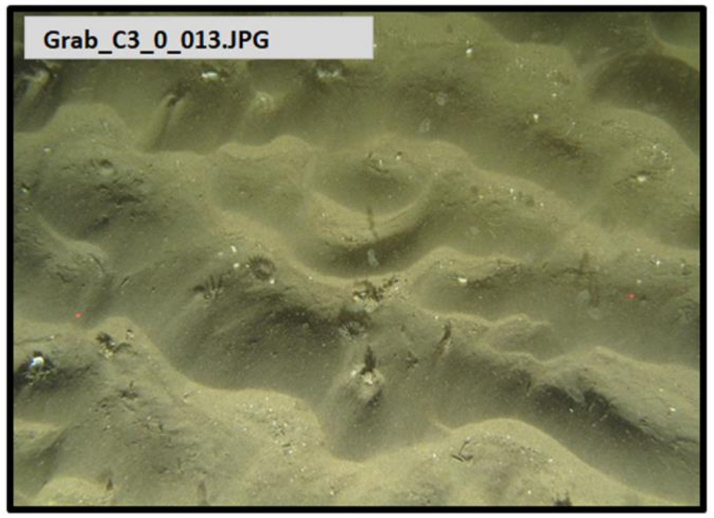


Photo Position: 722260 mE, 5953002 mN

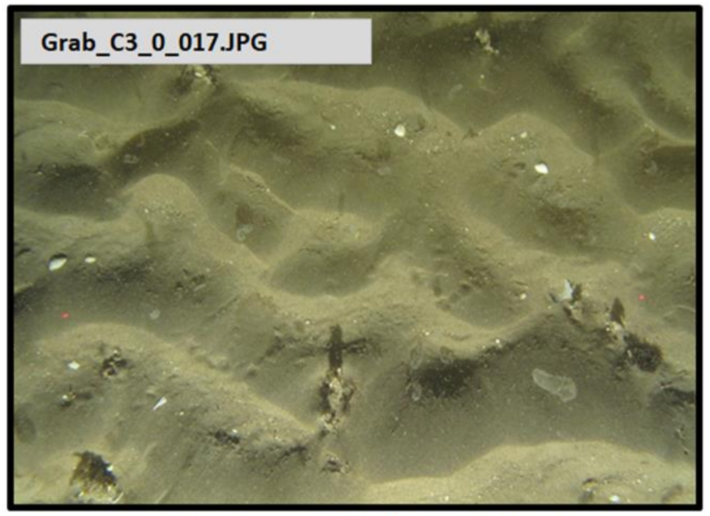
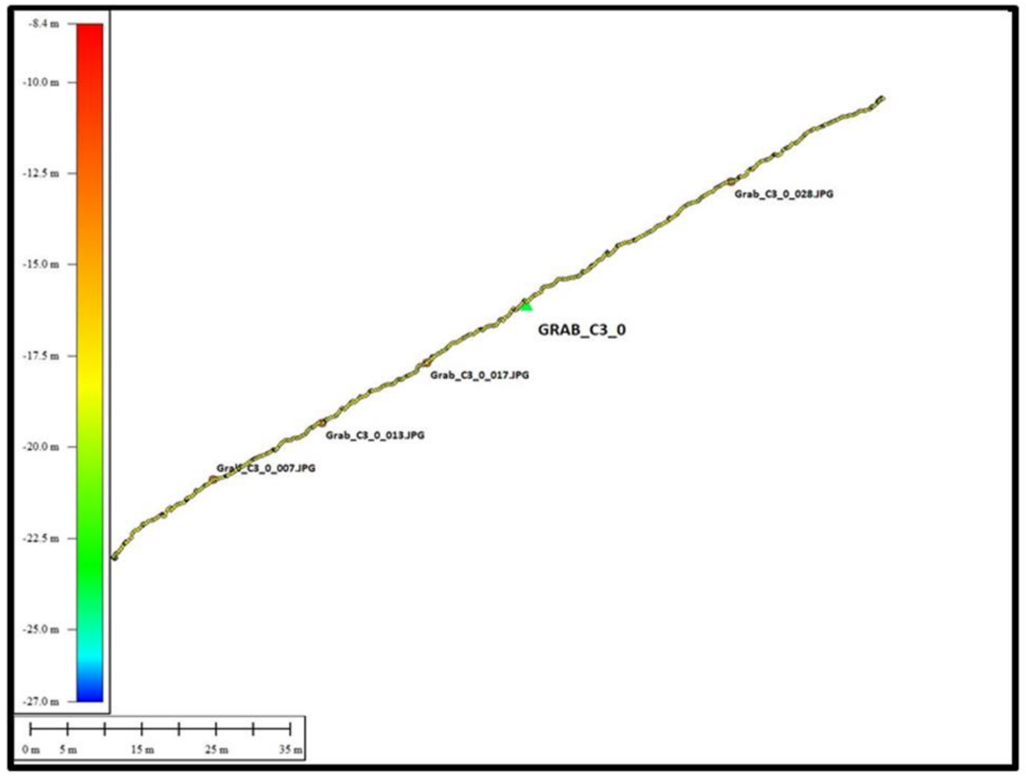


Photo Position: 722274 mE, 5953011 mN



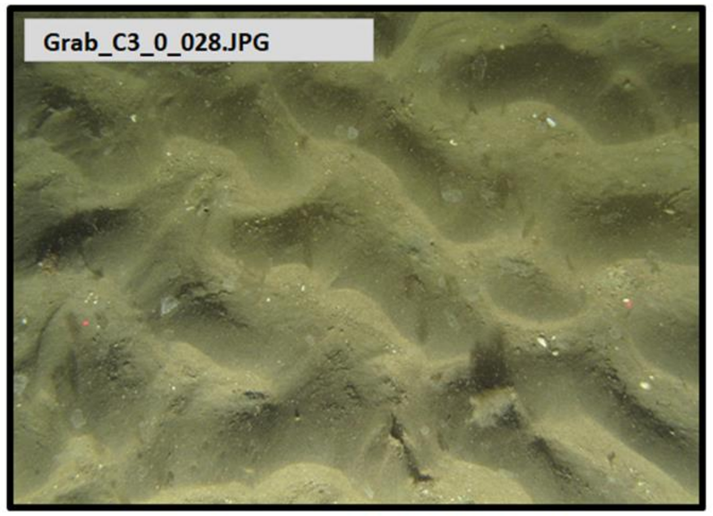


Photo Position: 722315 mE, 5953036 mN


Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

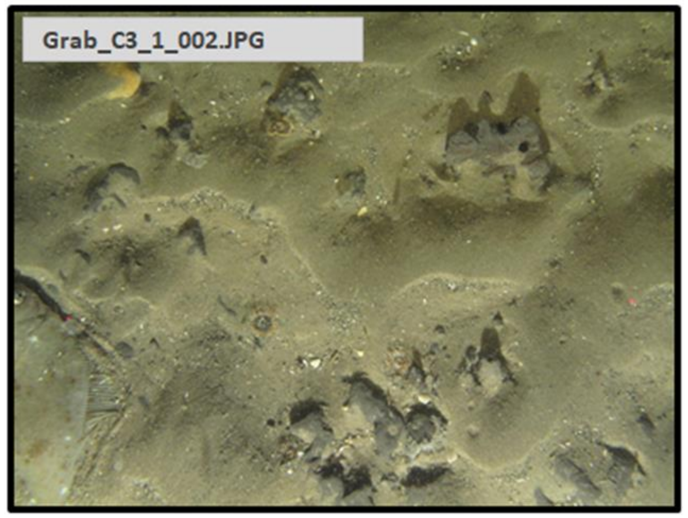


Photo Position: 723807 mE, 5953379 mN

Habitat Summary Information: Grab_C3_1

Survey Area: N5a Cable Route

No. of Stills: 7 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria
Secondary Cable Route – Positioned to investigate mixed reflectivity sediment.

Analogue Interpretation
No analogue data.

Sediment Description
Coarse shelly sand with partly buried cobbles and slight sand waves.

Conspicuous Fauna
Echinodermata: *Asterias rubens* (Common starfish). **Chordata:** Pleuronectiformes sp.

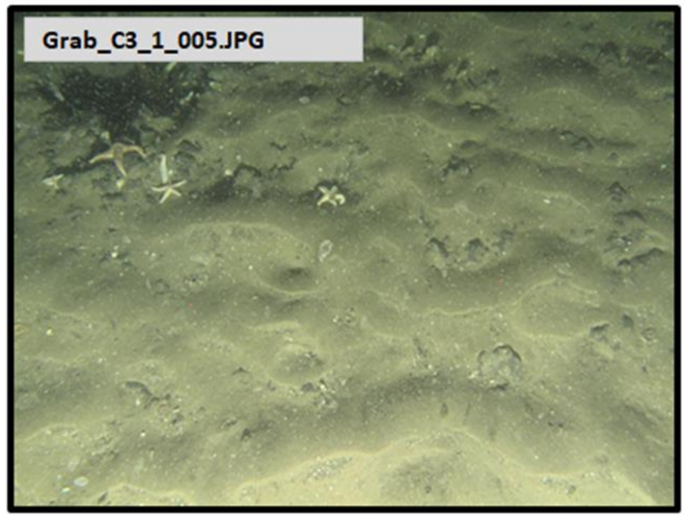


Photo Position: 723807 mE, 5953379 mN

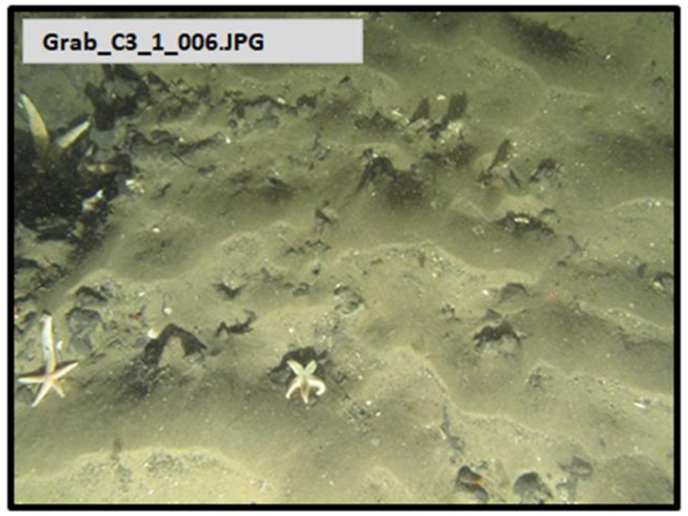
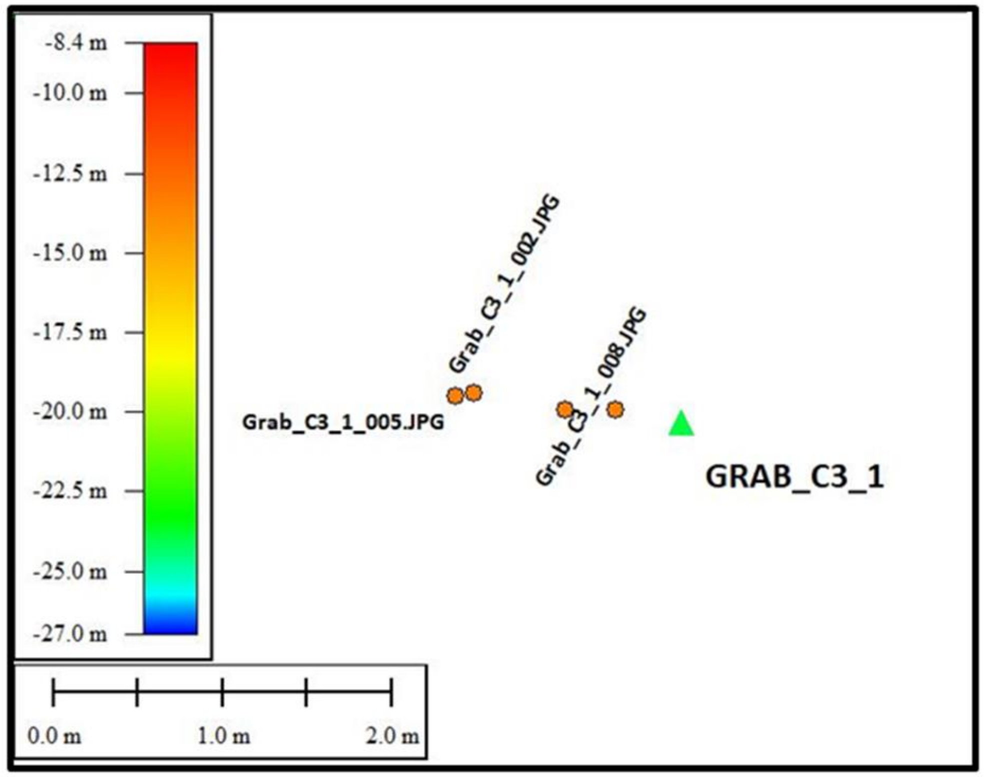


Photo Position: 723808 mE, 5953379 mN



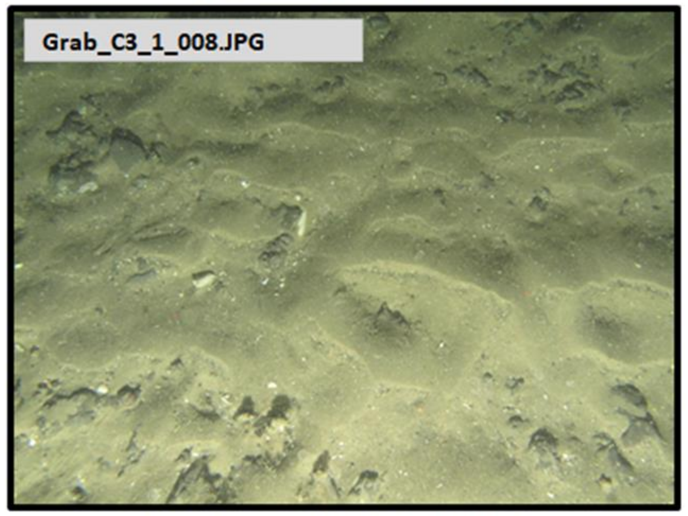


Photo Position: 723808 mE, 5953379 mN


Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

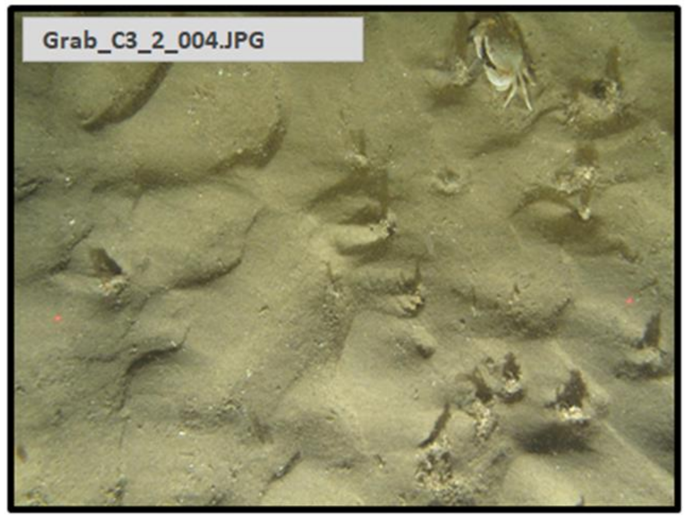


Photo Position: 725364 mE, 5953617 mN

Habitat Summary Information: Grab_C3_2

Survey Area: N5a Cable Route

No. of Stills: 37 **Mins of Video: 13** **Track Length: 180m**

Site Selection Criteria

Secondary Cable Route – Positioned to investigate high reflectivity sediment.

Analogue Interpretation

Area of variable reflectivity, scarring on seabed (analogue data only available for half of camera line).

Sediment Description

Gravelly and shelly coarse sand.

Conspicuous Fauna

Cnidaria: *Metridium senile* (Plumose Anemone), Actiniaria sp., Ceriantheidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., Decapoda sp., Liocarcinus sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** possibly *Callionymus lyra* (Common dragonet), *Ammodytes* sp. (Sand eel), Pleuronectiformes sp.

Photo Position: 725359 mE, 5953640 mN

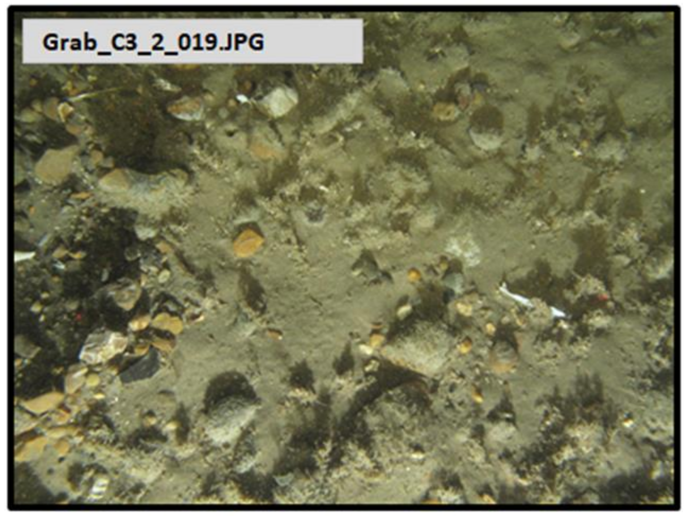
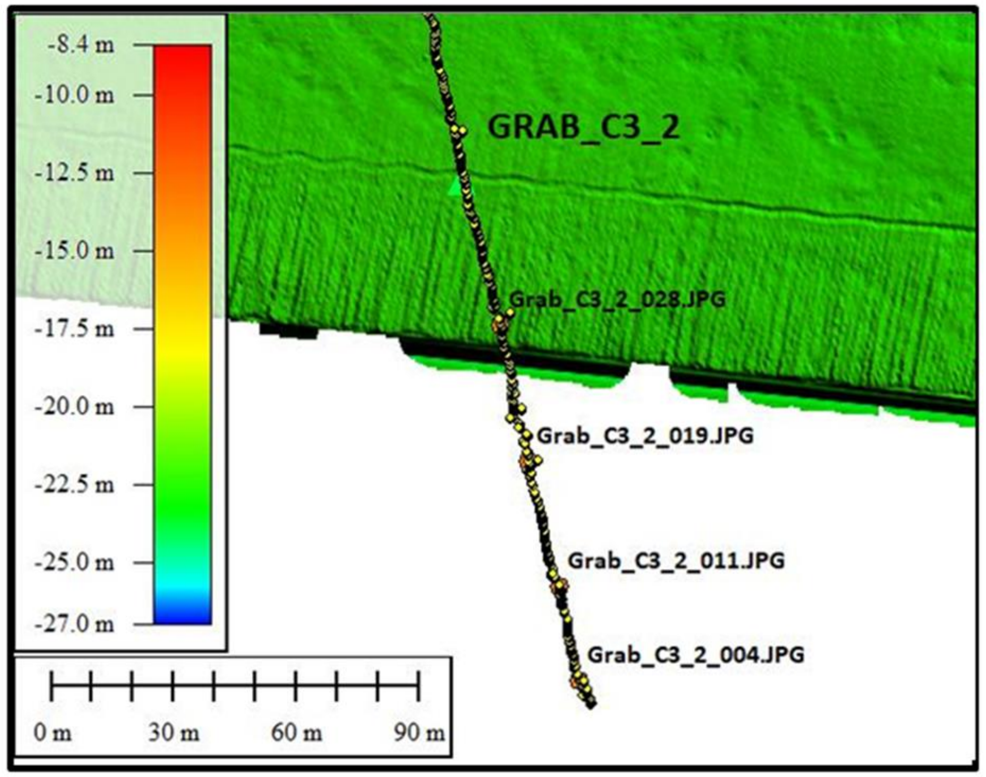


Photo Position: 725352 mE, 5953671 mN



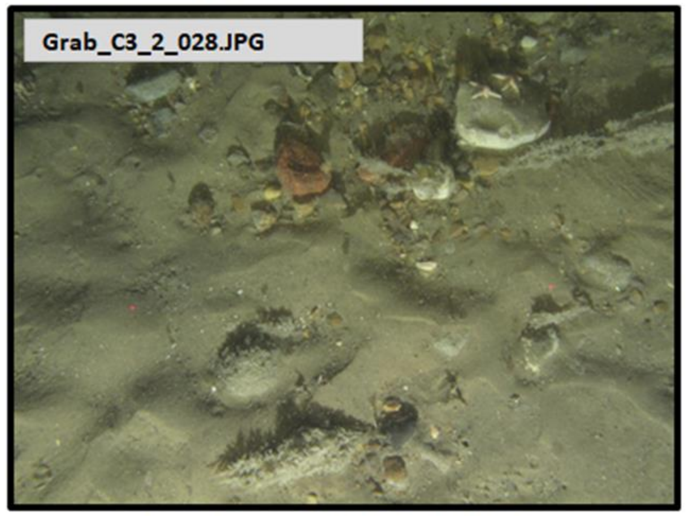


Photo Position: 725345 mE, 5953704 mN


Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: North Transect 1

Survey Area: N5a

No. of Stills: 30 **Mins of Video: 10** **Track Length: 135m**

Site Selection Criteria

Investigating transition from mixed to high reflectivity sediment.

Analogue Interpretation

Area of higher, variable reflectivity with many raised areas.

Sediment Description

Slightly gravelly/shelly coarse sand forming irregular ripples or *Lanice conchilega* aggregations.

Conspicuous Fauna

Cnidaria: Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), *Pagurus bernhardus* (Common hermit crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus*. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Limanda limanda* (Dab), Pleuronectiformes sp., Actinopterygii sp.

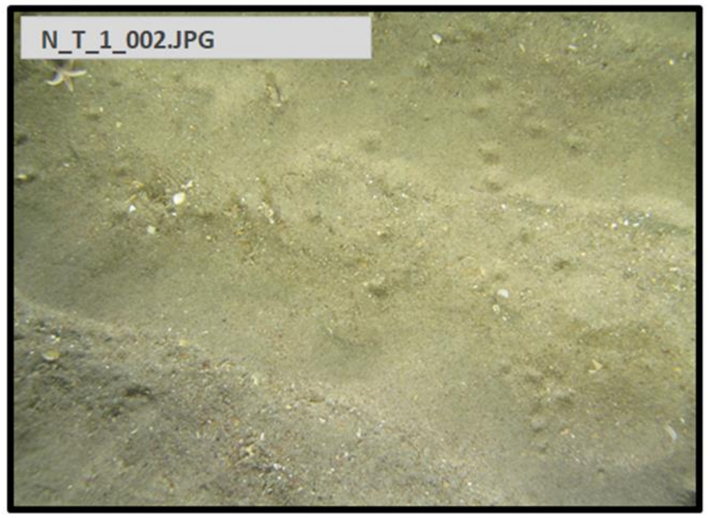


Photo Position: 721487 mE, 5954680 mN

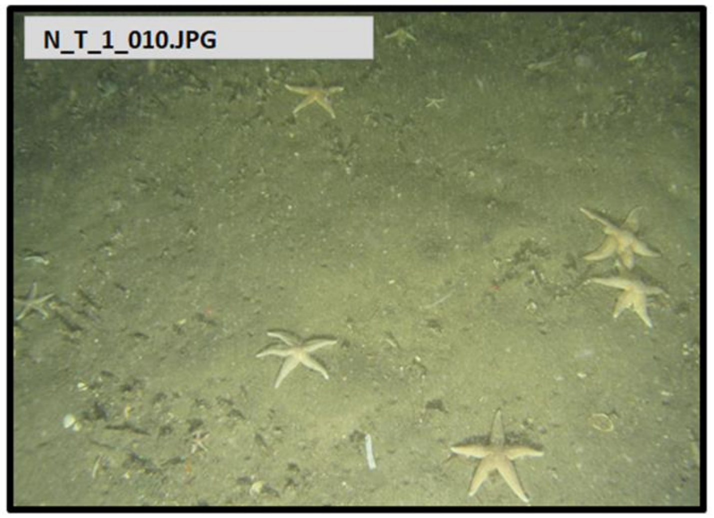


Photo Position: 721453 mE, 5954668 mN

Photo Position: 721432 mE, 5954659 mN

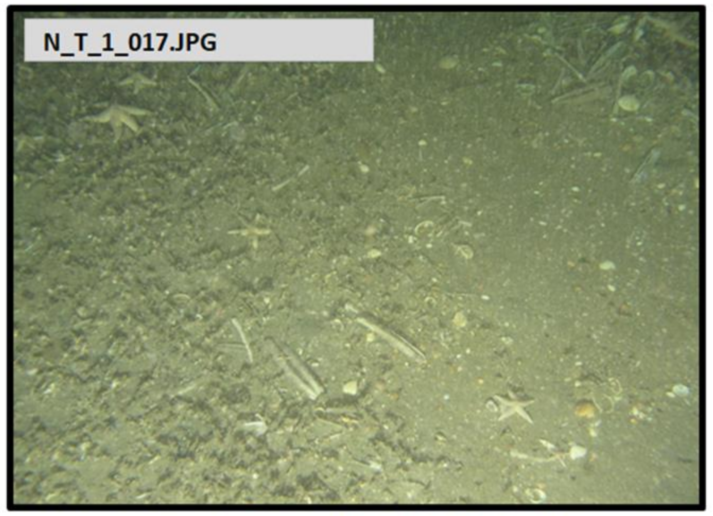
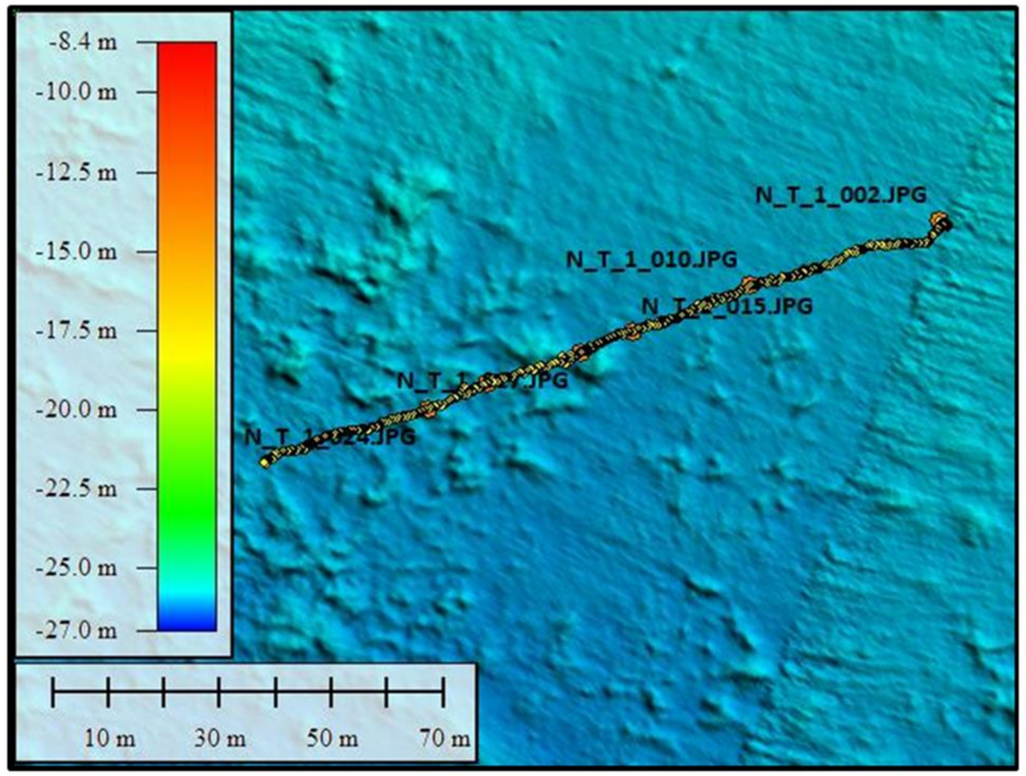


Photo Position: 721423 mE, 5954655 mN



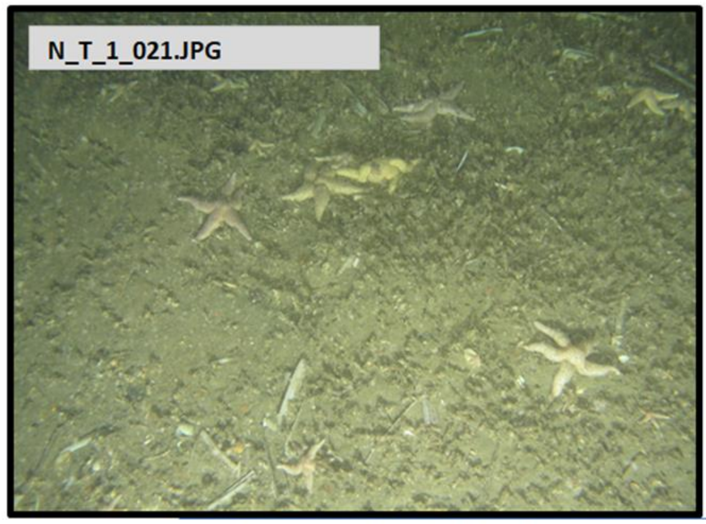


Photo Position: 721406 mE, 5954650 mN

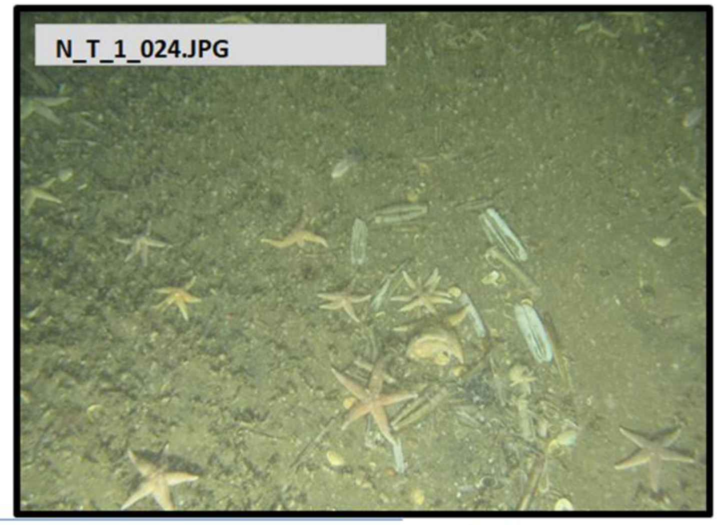


Photo Position: 721395 mE, 5954645 mN

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Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: North Transect 2

Survey Area: N5a

No. of Stills: 41 | Mins of Video: 13 | Track Length: 165m

Site Selection Criteria

Investigating transition from low to mixed reflectivity sediment.

Analogue Interpretation

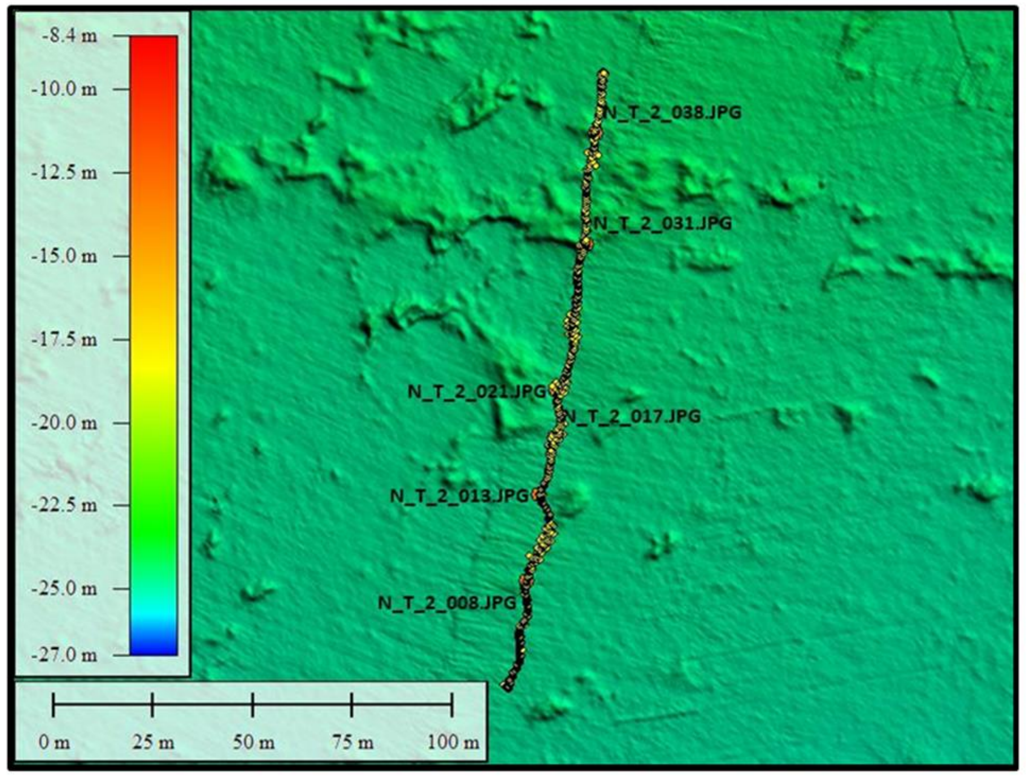
Area of higher, variable reflectivity with raised areas.

Sediment Description

Slightly gravelly/shelly coarse sand forming irregular ripples or *Lanice conchilega* aggregations.

Conspicuous Fauna

Cnidaria: Cerianthidae sp, Cerianthidae sp. **Annelida:** *Lanice conchilega*. **Arthropoda:** *Cancer pagurus*, *Pagurus bernhardus*, Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus*. **Echinodermata:** *Asterias rubens*. **Chordata:** *Callionymus lyra*, Pleuronectiformes sp., Actinopterygii sp.



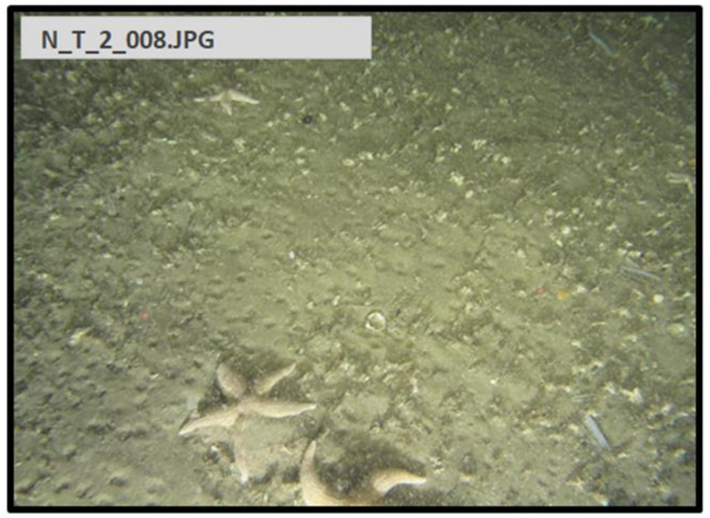
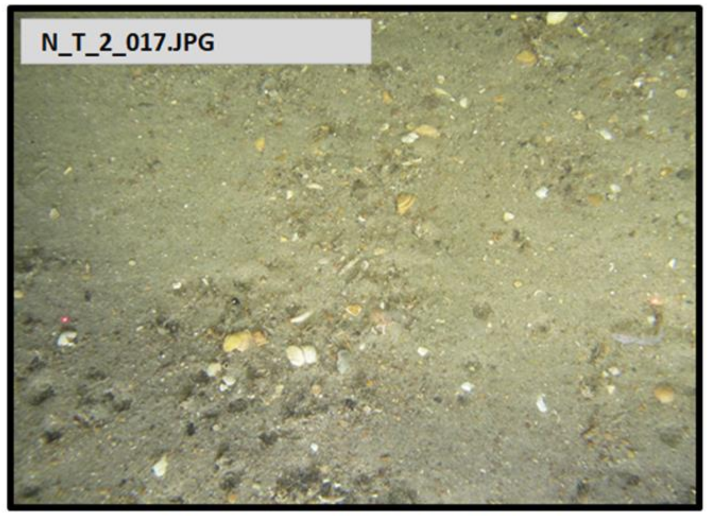


Photo Position: 721613 mE, 5955020 mN



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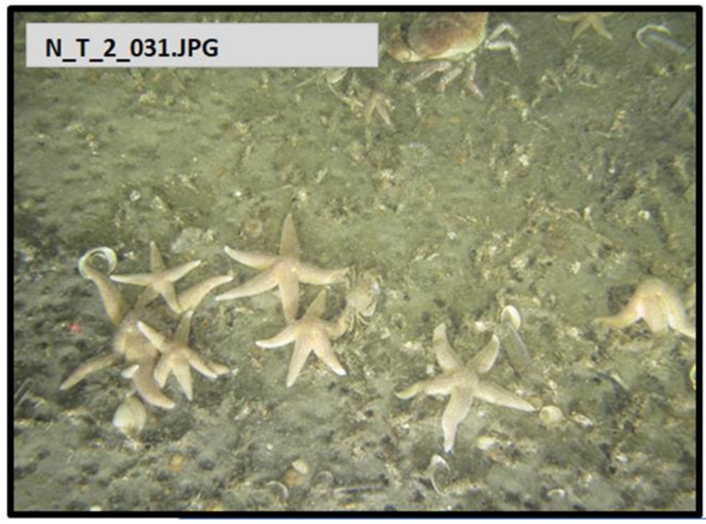

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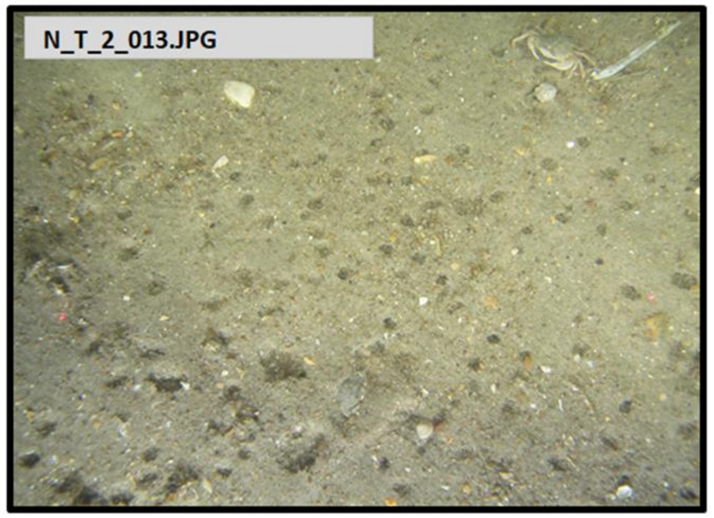

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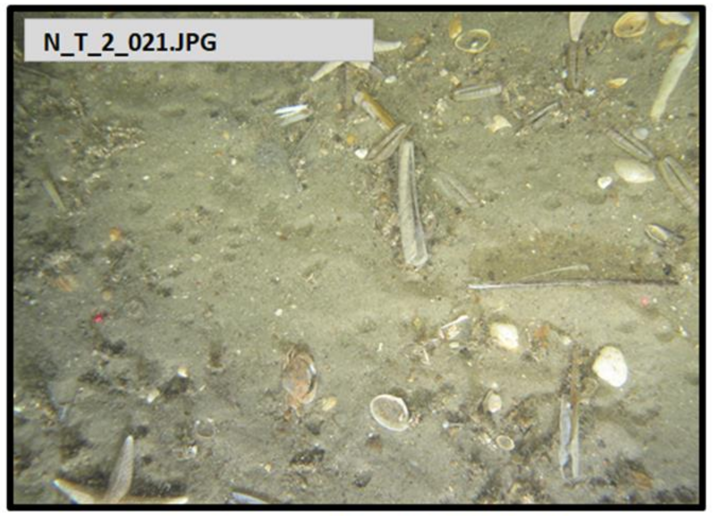

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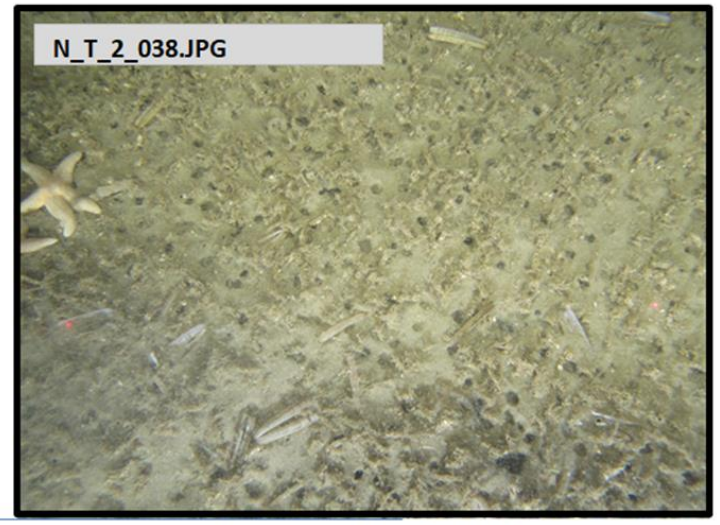

Photo Position: 721630 mE, 5955137 mN

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Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: North Transect 3

Survey Area: N5a

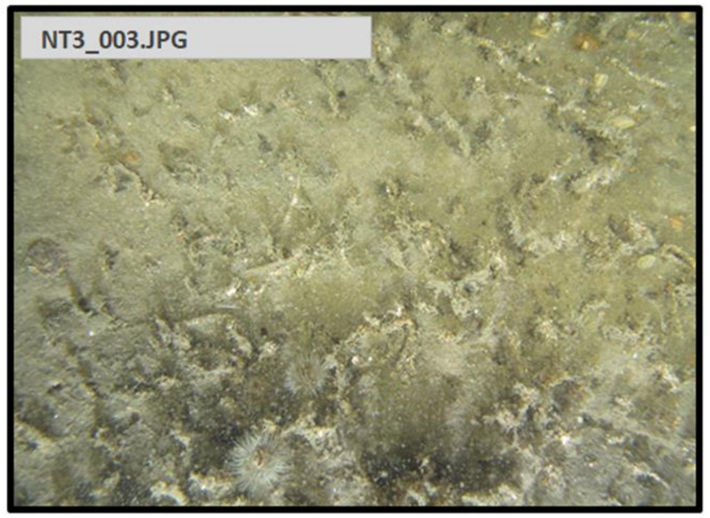
No. of Stills: 50 | Mins of Video: 13 | Track Length: 175m

Site Selection Criteria
Investigating transition from mixed to high reflectivity sediment.

Analogue Interpretation
Area of variable reflectivity, some apparent scarring on seabed.

Sediment Description
Slightly gravelly/shelly coarse sand forming irregular ripples or Lanice conchilega aggregations.

Conspicuous Fauna
Cnidaria: *Metridium senile* (Plumose Anemone), Ceriantidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), *Pagurus bernhardus* (Common hermit crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus*. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Gobiidae sp., Pleuronectiformes sp., Actinopterygii sp., *Eutrigla gurnardus* (Grey gurnard).



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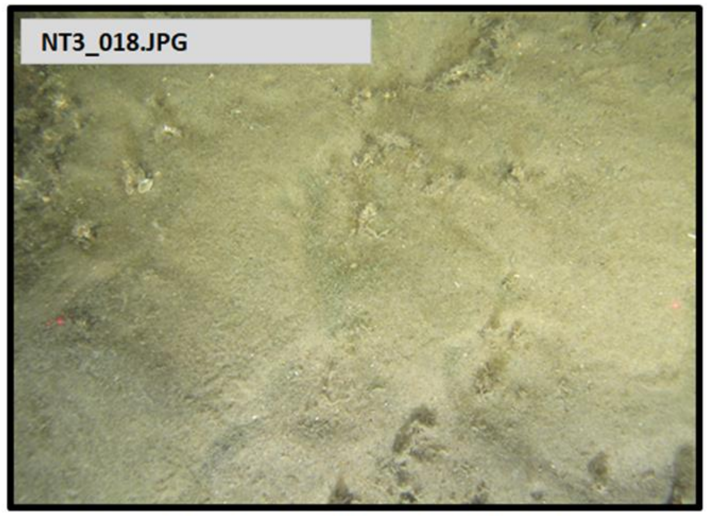

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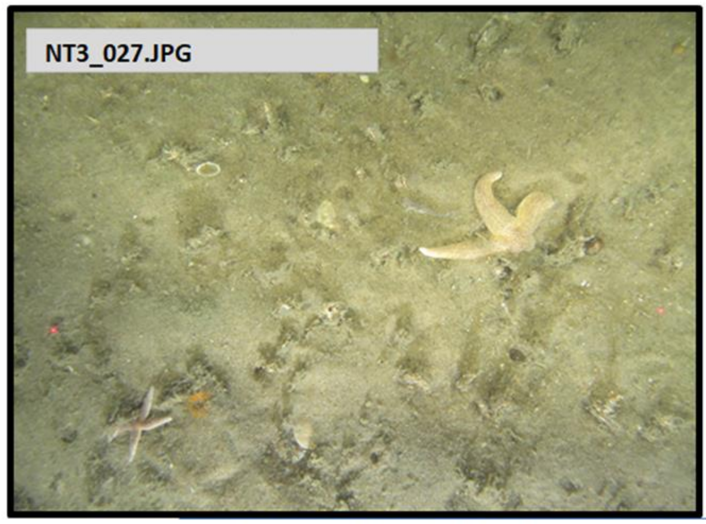

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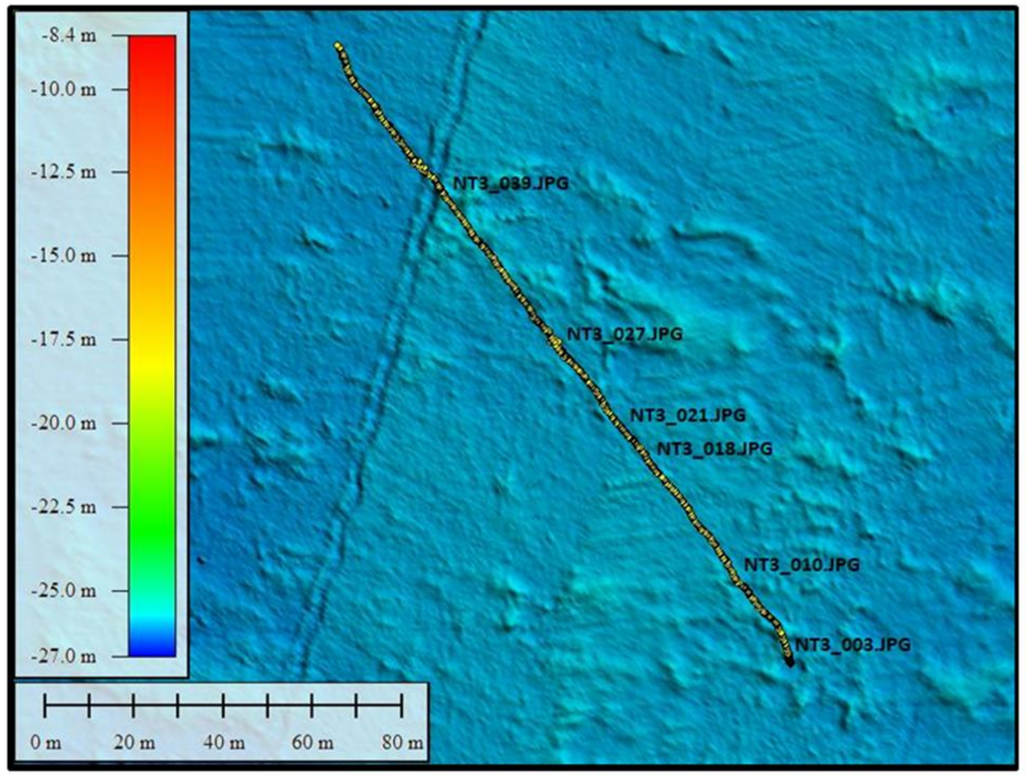

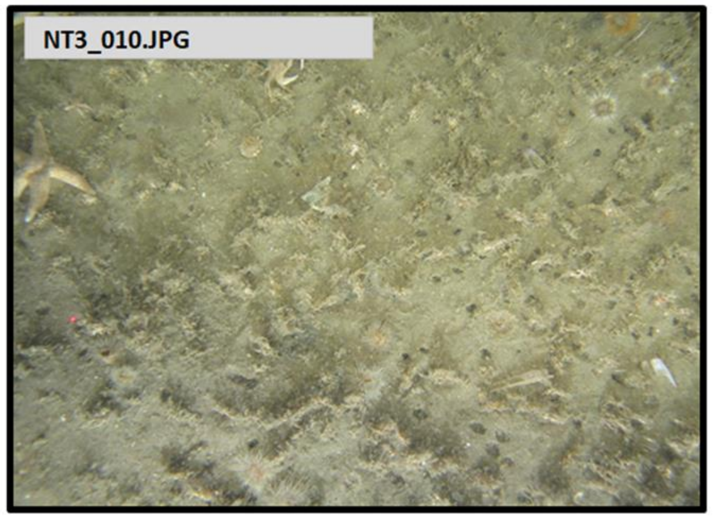

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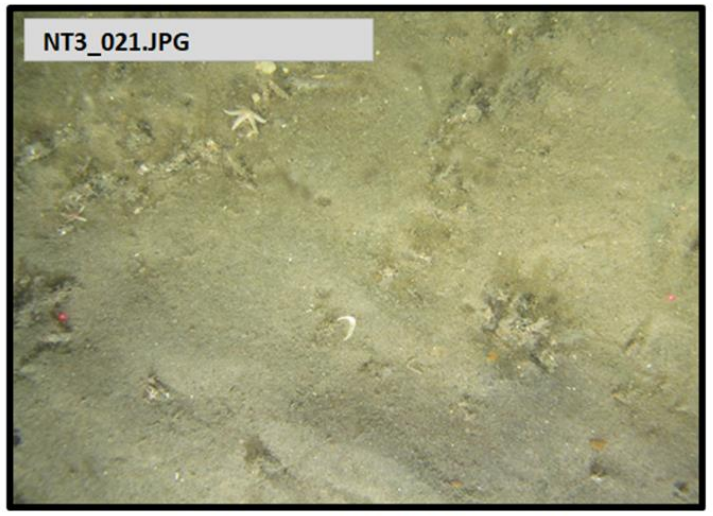

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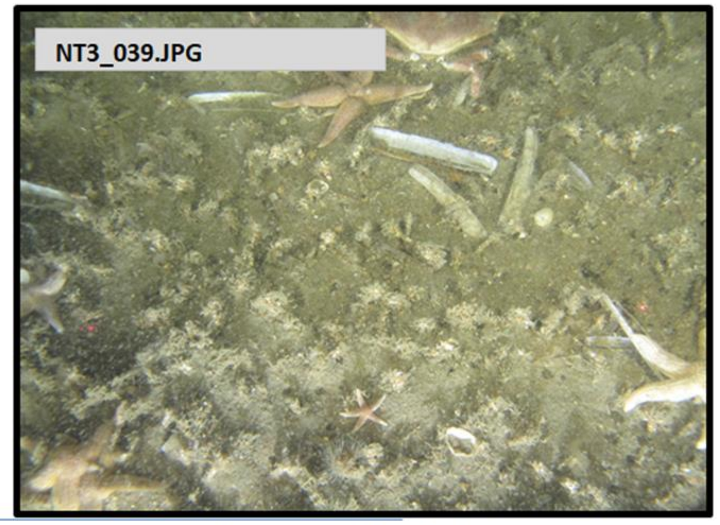
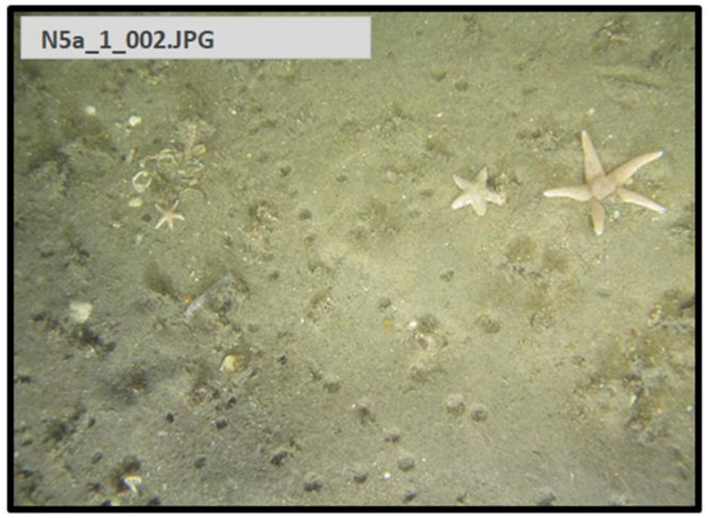


Photo Position: 721852 mE, 5954480 mN

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East



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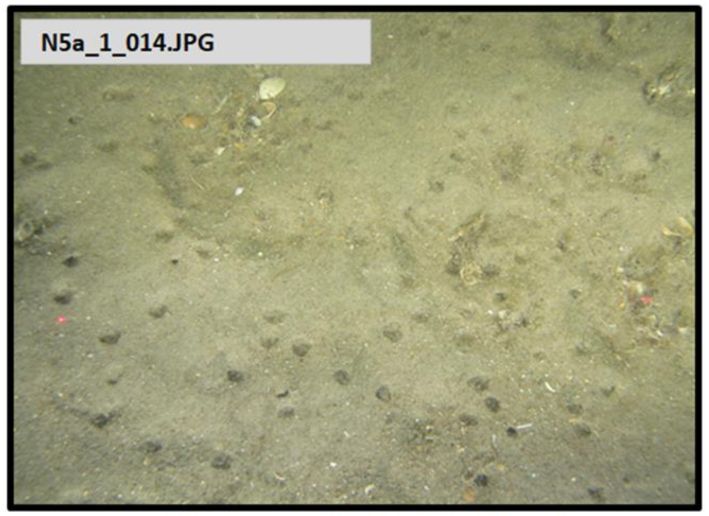

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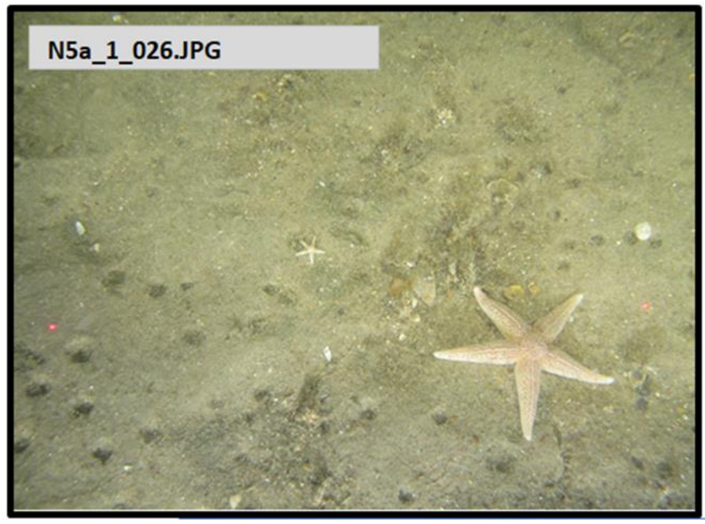


Photo Position: 721616 mE, 5954677 mN

Habitat Summary Information: N5a Transect 1

Survey Area: N5a

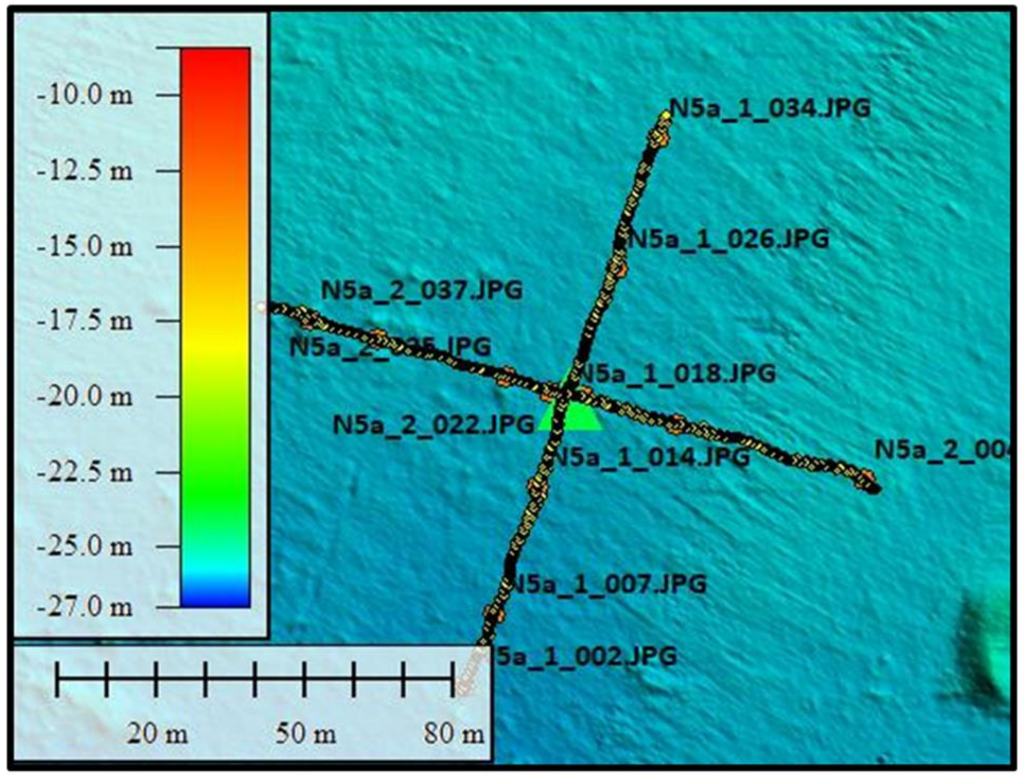
No. of Stills: 35 **Mins of Video: 9** **Track Length: 130m**

Site Selection Criteria
Transect across original N5a well location.

Analogue Interpretation
Area of low reflectivity with some scarring.

Sediment Description
Slightly gravelly/shelly coarse sand.

Conspicuous Fauna
Cnidaria: *Metridium senile* (Plumose Anemone), Ceriantheae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus*. **Mollusca:** *Sepiola* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Pleuronectiformes sp., Actinopterygii sp., *Eutrigla gurnardus* (Grey gurnard).



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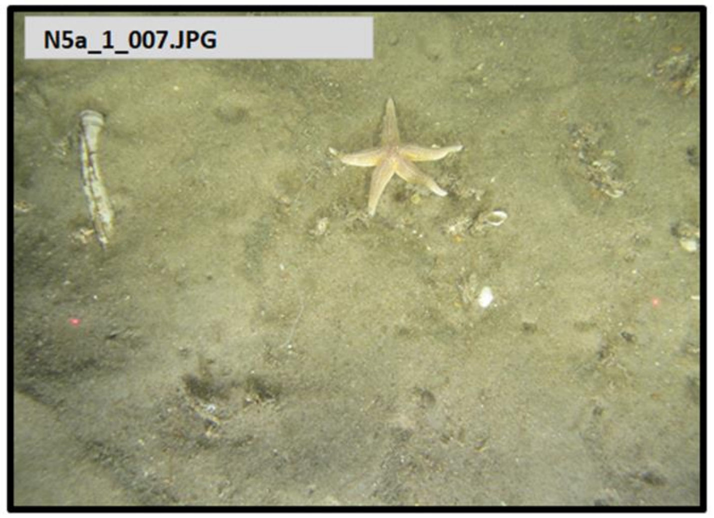

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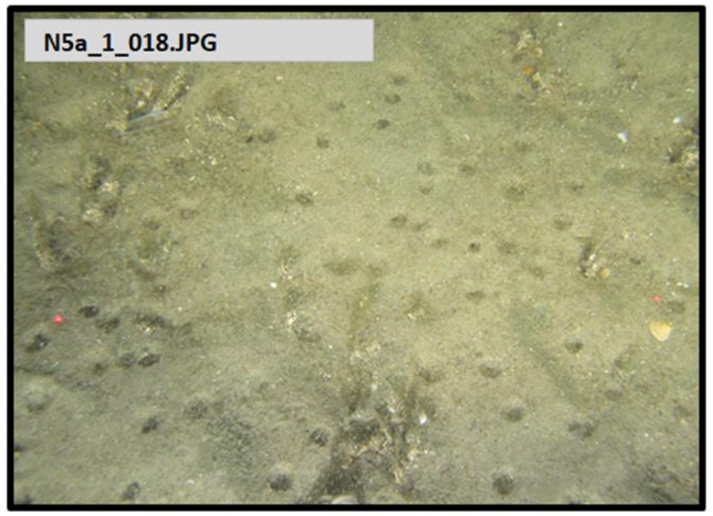


Photo Position: 721606 mE, 5954649 mN

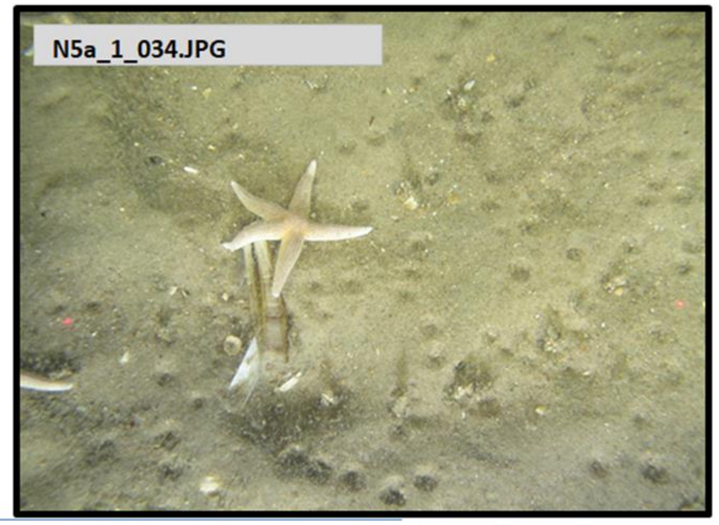


Photo Position: 721625 mE, 5954705 mN

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: N5a Transect 2

Survey Area: N5a

No. of Stills: 39 | Mins of Video: 9 | Track Length: 130m

Site Selection Criteria
Transect across original N5a well location.

Analogue Interpretation
Area of low reflectivity with some scarring.

Sediment Description
Slightly gravelly/shelly coarse sand and aggregations of *Lanice conchilega* .

Conspicuous Fauna
Cnidaria: *Metridium senile* (Plumose Anemone), Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus* . **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Pleuronectiformes sp., Actinopterygii sp.

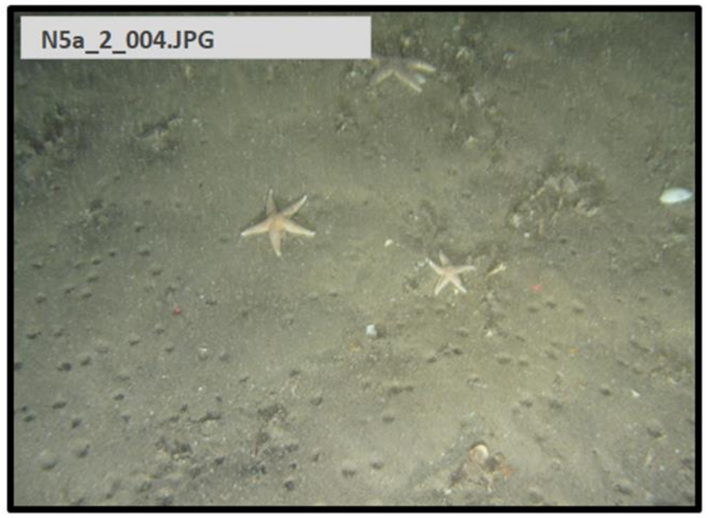


Photo Position: 721613 mE, 5955020 mN

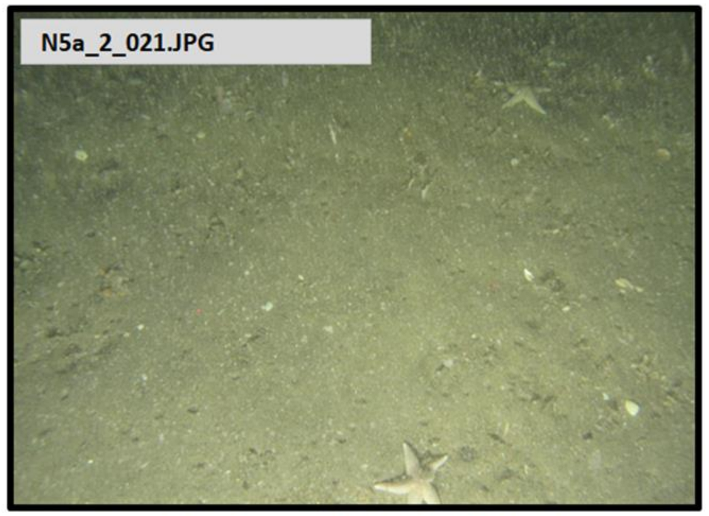
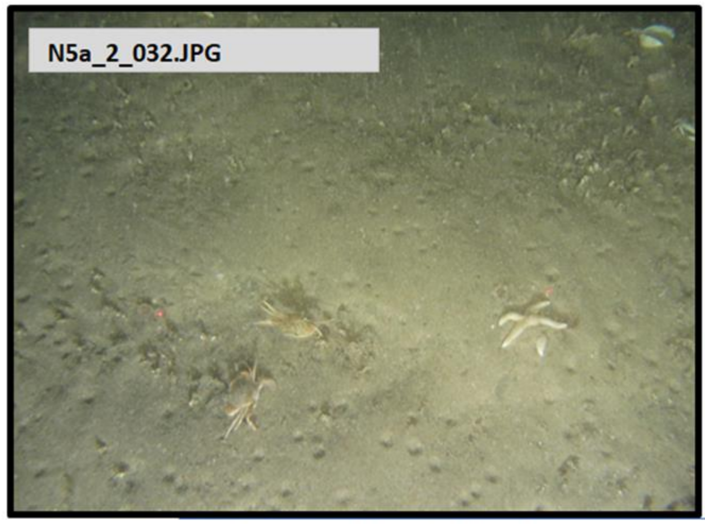


Photo Position: 721620 mE, 5955057 mN



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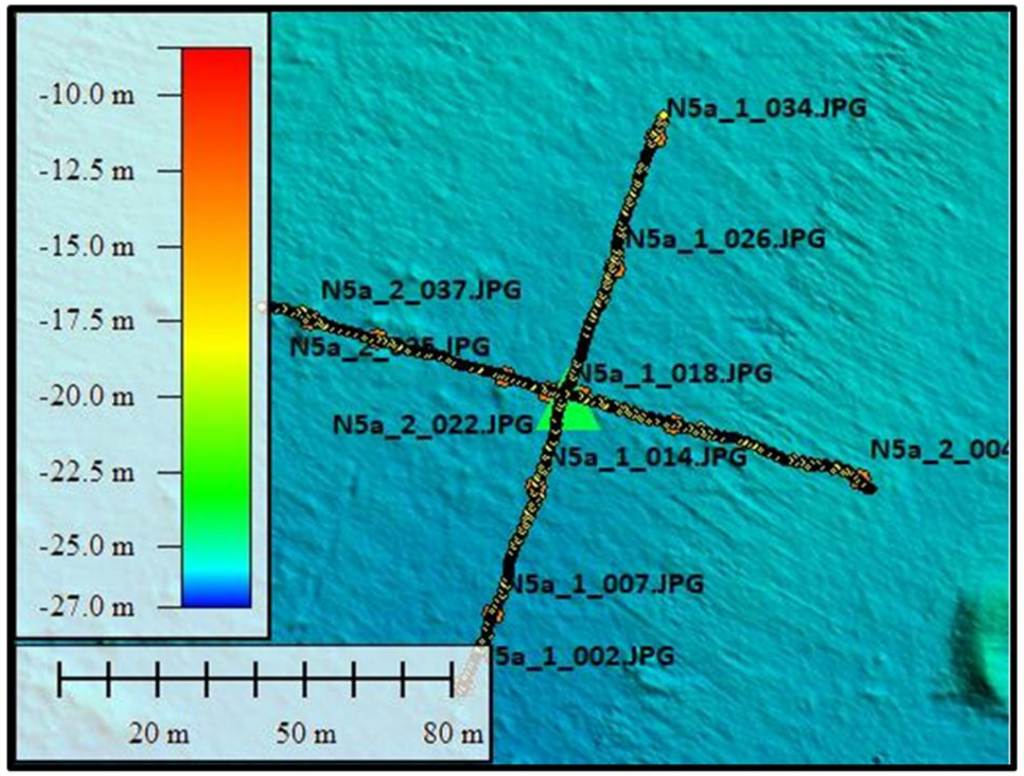


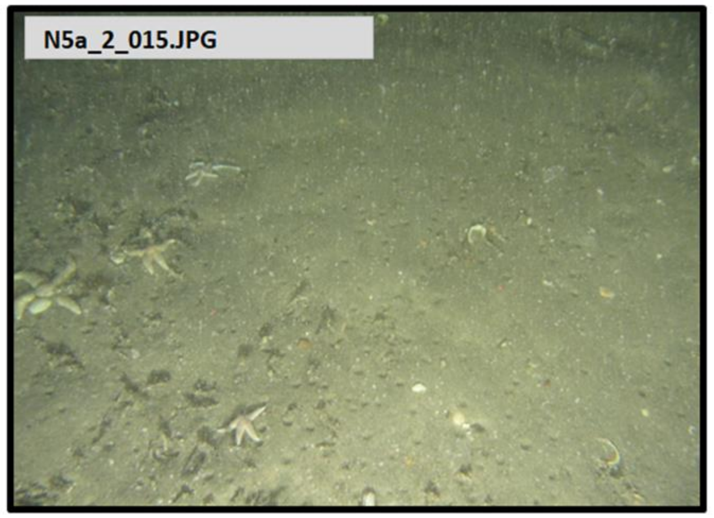


Photo Position: 721616 mE, 5955043 mN

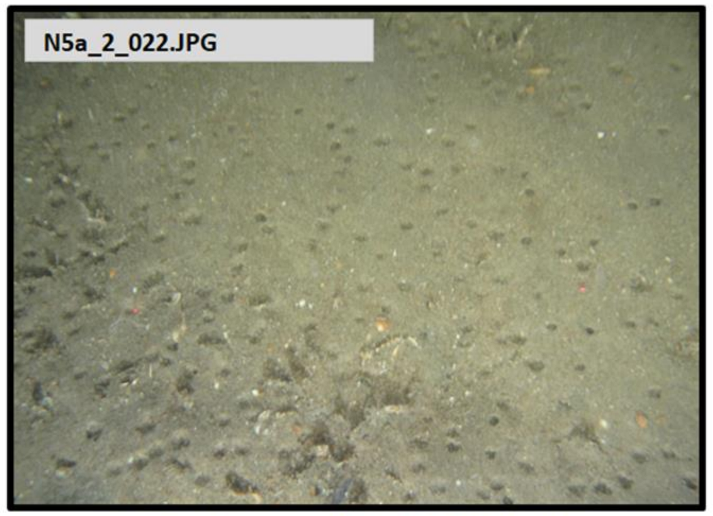


Photo Position: 721621 mE, 5955070 mN

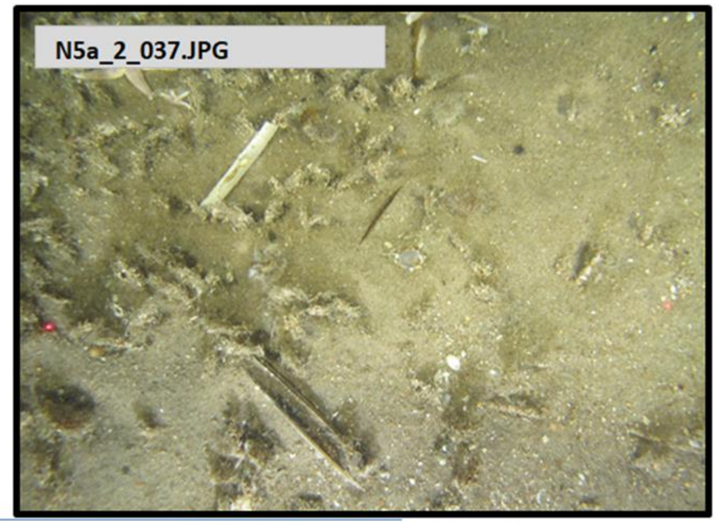


Photo Position: 721630 mE, 5955137 mN

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

APPENDIX F - DATA PRESENTATION, LABORATORY AND STATISTICAL ANALYSES

Particle Size Distribution

The samples recovered from each site were analysed by BSL which is accredited under the National Marine Biological Association Quality Control scheme (NMBAQC) for PSA analysis.

The sample was homogenised and split into a small sub-sample for laser diffraction and the remaining material was passed through stainless steel sieves with mesh apertures of 8000µm, 4000µm, 2000µm and 1000µm. In most cases almost the entire sample would pass through the sieve stack, but any material retained on the sieve, such as small shells, shell fragments and stones were removed, and the weight was recorded.

The smaller sub-sample was wet screened through a 1000µm sieve and determined using a Malvern Mastersizer 2000 particle sizer according to Standard Operating Procedures (SOP). The results obtained by a laser sizer have been previously validated by comparison with independent assessment by wet sieving (Hart, 1996). The range of sieve sizes, together with their Wentworth classifications are given in Table A. For additional quality control, all datasets were run through the Mastersizer in triplicate and the variations in sediment distributions assessed to be within the 95% percentile.

The separate assessments of the fractions above and below 1000µm were combined using a computer programme. This followed a manual input of the sieve results for fractions 16-8mm, 8-4mm, 4-2mm and 2-1mm fractions and the electronic data captured by the Mastersizer below 1000µm.

This method defines the particle size distributions in terms of Phi mean, median, fraction percentages (i.e. coarse sediments, sands and fines), sorting (mixture of sediment sizes) and skewness (weighting of sediment fractions above and below the mean sediment size; Folk 1954).

Formulae and classifications for particle calculations made are given overleaf:

Graphic Mean (M) - a very valuable measure of average particle size in Phi units (Folk & Ward, 1957).

$$M = \frac{\phi 16 + \phi 50 + \phi 84}{3}$$

Where *M = The graphic mean particle size in Phi*

ø = the Phi size of the 16th, 50th and 84th percentile of the sample

Table A: Phi and Sieve Apertures with Wentworth and Folk Classifications

Aperture in Microns	Aperture in Phi Unit	Sediment Description	
		Wentworth (1922)	Folk (1954)
8000	-3	Pebble	Gravel
4000	-2		
2000	-1	Granule	
1400	-0.5	Very Coarse Sand	Sands
1000	0		
710	0.5	Coarse Sand	
500	1		
355	1.5	Medium Sand	
250	2		
180	2.5	Fine Sand	
125	3		
90	3.5	Very Fine Sand	
63	4		
44	4.5	Coarse Silt	Mud
31.5	5		
22	5.5	Medium Silt	
15.6	6		
11	6.5	Fine Silt	
7.8	7		
5.5	7.5	Very Fine Silt	
3.9	8		
2	9	Clay	
1	10		

Sorting (D) – the inclusive graphic standard deviation of the sample is a measure of the degree of sorting (Table B).

$$D = \frac{\phi 84 + \phi 16}{4} + \frac{\phi 95 + \phi 5}{6.6}$$

where *D = the inclusive graphic standard deviation*

ø = the Phi size of the 84th, 16th, 95th and 5th percentile of the sample

Table B: Sorting Classifications

Sorting Coefficient (Graphical Standard Deviation)	Sorting Classifications
0.00 < 0.35	Very well sorted
0.35 < 0.50	Well sorted
0.50 < 0.71	Moderately well sorted
0.71 < 1.00	Moderately sorted
1.00 < 2.00	Poorly sorted
2.00 < 4.00	Very poorly sorted
4.00 +	Extremely poorly sorted

- **Skewness (S)** – the degree of asymmetry of a frequency or cumulative curve (Table C).

$$S = \frac{\varnothing 84 + \varnothing 16 - (\varnothing 50)}{2(\varnothing 84 - \varnothing 16)} + \frac{\varnothing 95 + \varnothing 5 - 2(\varnothing 50)}{2(\varnothing 95 - \varnothing 5)}$$

where *S = the skewness of the sample*
ø = the Phi size of the 84th, 16th, 50th, 95th and 5th percentile of the sample

Table C: Skewness Classifications

Skewness Coefficient	Mathematical Skewness	Graphical Skewness
+1.00 > +0.30	Strongly positive	Strongly coarse skewed
+0.30 > +0.10	Positive	Coarse skewed
+0.10 > -0.10	Near symmetrical	Symmetrical
-0.10 > -0.30	Negative	Fine skewed
-0.30 > -1.00	Strongly negative	Strongly fine skewed
Skewness Coefficient	Mathematical Skewness	Graphical Skewness
+1.00 > +0.30	Strongly positive	Strongly coarse skewed

- **Graphic Kurtosis (K) –** The degree of peakedness or departure from the 'normal' frequency or cumulative curve (Table D).

$$K = \frac{\varnothing 95 - \varnothing 5}{2.44(\varnothing 75 - \varnothing 25)}$$

Where *K = Kurtosis*
ø = the Phi size of the 95th, 5th, 75th and 25th percentile of the sample

Table D: Kurtosis Classifications

Kurtosis Coefficient	Kurtosis Classification	Graphical Meaning
0.41 < 0.67	Very Platykurtic	Flat-peaked; the ends are better sorted than the centre
0.67 < 0.90	Platykurtic	

Kurtosis Coefficient	Kurtosis Classification	Graphical Meaning
0.90 < 1.10	Mesokurtic	Normal; bell shaped curve
1.11 < 1.50	Leptokurtic	Curves are excessively peaked; the centre is better sorted than the ends. Graphical Meaning
1.50 < 3.00	Very Leptokurtic	
3.00 +	Extremely Leptokurtic	
Kurtosis Coefficient	Kurtosis Classification	

Sediment Total Organic Carbon (TOC) and Total Organic Matter (TOM)

Organic matter and carbon contents sediments were analysed using a combination of tests. These include Total Carbon (TC), analysed using a known weight of dried soil and combusted at 1300°C and the amount of Carbon determined by Infra-Red detection, Total Organic Matter by loss on ignition (TOM; see below) and Total Organic Carbon (TOC; see below). In addition to the standard accreditation as outlined below, additional analytical quality control (AQC), is carried out with every batch where a soil of known value is determined (every batch of 15 samples or part thereof). Blank determinations are also carried out routinely where required.

Total Organic Carbon was analysed using an Eltra combustion method. This method is used for total carbon analysis of dried, crushed rock powder and environmental soil samples. The samples are previously treated with 10% HCl to remove inorganic carbon (Carbonates) before washing to remove residual acids and further dried. The Carbon Analyser heats the sample in a flow of oxygen and any carbon present is converted to carbon dioxide which is measured by infra-red absorption. The percentage carbon is then calculated with respect to the original sample weight. The range for the method is 0.01% - 100%. The method is currently being evaluated under the United Kingdom Accreditation Service (UKAS) accreditation scheme.

TOM was analysed using 1g of air dried and ground sample (<200µm) placed in a crucible and dried in an oven at 50±2.5°C until constant weight was achieved. The final sample weight was recorded to the nearest 0.01% and the sample was allowed to cool in a desiccator. The sample was then placed in a muffle furnace and heated to 440±25°C for four hours. The crucible was removed from the furnace and allowed to cool to room temperature in a desiccator. Thereafter, the crucible was reweighed and the percentage loss on ignition calculated. This test is reported to 0.01% and is accredited under the UKAS scheme.

Hydrocarbon Concentrations (Total Hydrocarbon Concentrations and Aliphatics)

General Precautions

High purity solvents were used throughout the analyses. Solvent purity was assessed by evaporating an appropriate volume to 1ml and analysing the concentrate by GC for general hydrocarbons, target n-alkanes and aromatics. All glassware and extraction sundries were cleaned prior to use by thorough rinsing with hydrocarbon-free deionised water followed by two rinses with dichloromethane. All glassware was heated in a high temperature oven at 450°C for six hours.

Extraction Procedure for Hydrocarbons

Each analytical sample (15±0.1g) was spiked with an internal standard solution containing the following components: aliphatics - heptamethylnonane, 1-chlorooctadecane and squalane. The sample was then wet vortex extracted using three successive aliquots of dichloromethane (DCM)/methanol. The extracts were combined and water partitioned to remove the methanol and any excess water from the sample.

Solvent extracts were chemically dried and then reduced to approximately 1ml using a Kuderna Danish evaporator with micro Snyder.

Column Fractionation for Aliphatic and Aromatic Fractions

The concentrated extract was transferred to a pre-conditioned flash chromatography column containing approximately 1g of activated Silica gel. The compounds were eluted with 3ml of Pentane/DCM (2:1). An aliquot of the extract was then taken and analysed for THC content and individual n-alkanes by large volume injection GC-FID.

Quality Control Samples

The following quality control samples were prepared with the batches of sediment samples:

- A method blank comprising 15±0.1g of baked anhydrous sodium sulphate (organic free) treated as a sample.
- A matrix matched standard sample consisting of 15±0.1g baked sand spiked with Florida mix and treated as sample.
- A sample duplicate - any one sample from the batch, dependent upon available sample mass, analysed in duplicate.

Hydrocarbon Analysis

Analysis of total hydrocarbons and aliphatics was performed by using an Agilent 6890 with an FID detector. Appropriate column and GC conditions were used to provide sufficient chromatographic separation of all analytes and the required sensitivity.

Carbon Preference Index

The carbon preference index is calculated as follows:

$$CPI = \frac{\text{odd homologues } (nC_{11} \text{ to } nC_{35})}{\text{even homologues } (nC_{10} \text{ to } nC_{34})}$$

Petrogenic/Biogenic (or P/B) Ratio

The Petrogenic/Biogenic Ratio is calculated as follows:

$$\text{P/B Ratio} = \frac{P = \text{sum of } nC_{10} \text{ to } nC_{20}}{B = \text{sum of } nC_{21} \text{ to } nC_{35}}$$

Calibration and Calculation

GC techniques require the use of internal standards in order to obtain quantitative results. The technique requires addition of non-naturally occurring compounds to the sample, allowing correction for varying recovery.

Target analytes concentrations were calculated by comparison with the nearest eluting internal standards. A relative response factor was applied to correct the data for the differing responses of target analytes and internal standards. Response factors were established prior to running samples, from solutions containing USEPA(16) PAHs + Dibenzothiophene for the GC-MS, Florida mix (even n-Alkanes nC10-nC40) for individual GC-FID targets and a Diesel/Mineral Oil mix for total oil determination.

Heavy and Trace Metal Concentrations

Sample Digestion Procedure

Easily Leachable (Aqua Regia) Extraction – Ba, Al, Cr, Cu, Ni, Zn, As, Pb, Sn, V, Se, Co & Cd)

Approximately 1g of the sediment was accurately weighed out and transferred to a beaker and wet with approximately 20ml of distilled water. Hydrochloric acid (6ml) and Nitric acids (2ml) were added, and the covered sample left to digest for four hours in a steam bath.

After digestion, the sample was filtered through a Whatman 542 filter paper into a 100ml standard flask. The watch-glass and beaker were rinsed thoroughly, transferring the washings to the filter paper. The filter paper was rinsed until the volume was approximately 90ml. The filter funnel was rinsed into the flask and then the flask was made up to volume and mixed well. The filtrate was then analysed by ICP-OES and/or ICP-MS.

Microwave Assisted Digestion Procedure

The air-dried and ground sediment sample is digested with concentrated hydrofluoric/nitric acids and hydrogen peroxide in a Teflon digestion vessel. The microwave digestion process involves a two-stage extraction process. The digest is made up to 100ml in a Gradplex flask.

The mean detection limits are given in Table E for microwave assisted hydrofluoric acid (HF) digestions.

Table E: Heavy Metals - Mean Detection Limits (MDL)

Analyte	Unit	MDL
Al	$\mu g.g^{-1}$	10
As	$\mu g.g^{-1}$	0.5
Ba	$\mu g.g^{-1}$	1
Cd	$\mu g.g^{-1}$	0.2
Cr	$\mu g.g^{-1}$	2
Cu	$\mu g.g^{-1}$	2
Fe	$\mu g.g^{-1}$	45
Hg	$\mu g.g^{-1}$	0.01
Li	$\mu g.g^{-1}$	2
Ni	$\mu g.g^{-1}$	2
Pb	$\mu g.g^{-1}$	1.5
Sn	$\mu g.g^{-1}$	1
Sr	$\mu g.g^{-1}$	5
V	$\mu g.g^{-1}$	1
Zn	$\mu g.g^{-1}$	3

ICPMS	ICPOES	TMMS

Mercury Digestion Procedure

Approximately 1g of the sediment was accurately weighed and transferred to a beaker. Hydrogen peroxide (10ml of 30 volumes) was added, and the covered sample left to digest for 0.5 hour in the fume cupboard. 10ml of nitric acid was added and the sample placed on the hotplate for one hour.

After digestion, the sample was filtered through a Whatman 542 filter paper into a 100ml standard flask. The watch-glass and beaker were rinsed thoroughly, transferring the washings to the filter paper. The filter paper was rinsed until the volume was approximately 90ml. Subsequently, the filter funnel was rinsed into the flask and then the flask was made up to 100ml volume and mixed well. The filtrate was then analysed by ICP-MS.

Macro-invertebrate Analysis

Methodology

All macrofaunal determination was carried by BSL or BSL contracted specialist taxonomist with vast experience in the identification of macrofaunal samples undertaken in shallow and deep-water environments (such as Southern North Sea, Channel Island, Ireland, Scotland, Faroes and sub-Antarctic waters) and the survey region.

Benthic sediment samples were thoroughly washed with freshwater on a 500µm sieve to remove traces of formalin, placed in gridded, white trays and then hand sorted by eye followed by binocular microscope, to remove all fauna. Sorted organisms were preserved in 70% industrial methylated spirit (IMS) and 5% glycerol. Where possible, all organisms were identified to species level according to appropriate keys for the region. Colonial and encrusting organisms were recorded by presence alone and, where colonies could be identified as a single example, these were also recorded, although these datasets have not been considered in the overall analysis of the material. The presence of anthropogenic components was also recorded where relevant.

All taxa were distinguished by species but identified to at least family level where possible. Nomenclature for species names were allocated either when identity was confirmed, allocated as “cf.” when apparently identifying to a known species but confirmation was not possible (for example, incomplete specimens or descriptions), or allocated as “aff.” when close to but distinct from a described species. The terms “indet.” refers to being unable to identify to a lower taxon and “juv” as a juvenile to that species, genus or family.

Quality Assurance

Benthic Solutions is committed to total quality control from the start of a project to its completion and demonstrates this through its ISO 9001:2004 accredited Quality Management System. All samples taken or received by the company were given a unique identification number. All analytical methods were carried out according to recognised standards for marine analyses. All taxonomic staff are fully qualified to post-doctorate level. Documentation is maintained that indicates the stage of analysis that each sample has reached. A full reference collection of all specimens has been retained for further clarification of putative species groups where/if required. BSL is a participant in the NMBAQC quality assurance scheme.

Digital datasets are kept for all sites in the form of excel spreadsheets (by sample and by station) on BSL’s archive computer. This system is duplicated onto a second archive drive in case of electronic failure. These datasets will be stored in this way for a minimum of three years, or transferred to storage disk (data CD or DVD).

Data Standardisation and Analyses

In accordance to OSPAR Commission (2004) guidelines, all species falling into juvenile, colonial, planktonic of meiofaunal taxa are excluded from the full analyses within the dataset. This helps to reduce the variability of data undertaken during different periods within the year, or where minor changes may occur or where some groups may only be included in a non-quantitative fashion, such as presence/absence. Certain taxa, such as the Nematoda, normally associated with meiofauna, were included where individuals greater than 10mm were recorded. The following primary and univariate parameters were calculated for each all data by stations and sample (Table F).

Table F: Primary and Univariate Parameter Calculations

Variable	Parameter	Formula	Description
Total Species	S	Number of species recorded	Species richness
Total Individuals	N	Number of individuals recorded	Sample abundance
Shannon-Wiener Index	H(s)	$H(s) = -\sum_{i=1}^{s} (Pi)(\log_2 Pi)$ where s = number of species & Pi = proportion of total sample belonging to *i*th species.	Diversity: using both richness and equitability, recorded in log 2.
Simpsons Diversity	1-Lambda	$Lambda = \sum \left[\frac{ni(ni-1)}{N(N-1)} \right]$ where ni = number of individuals in the *i*th species & N = total number of individuals	Evenness, related to dominance of most common species (Simpson, 1949)
Pielou's Equitability	J	$J = \frac{H(s)}{(\log S)}$ where s = number of species & H(s) = Shannon-Wiener diversity index.	Evenness or distribution between species (Pielou, 1969)
Margalef's Richness	D_{Mg}	$D_{Mg} = \frac{(S-1)}{(\log N)}$ where s = number of species & N = number of individuals.	Richness derived from number of species and total number of individuals (Clifford & Stevenson, 1975)

In addition to univariate methods of analysis, data for both sample replicates and stations were analysed using multivariate techniques. These serve to reduce complex species-site data to a form that is visually interpretable. A multivariate analysis was based on transformed data (double square root) to detect any improved relationships when effects of dominance were reduced. The basis for multivariate analyses was based upon the software PRIMER.

Similarity Matrices and Hierarchical Agglomerative Clustering: A similarity matrix is used to compare every individual sample replicate and/or stations with each other. The coefficient used in this process is based upon Bray Curtis (Bray & Curtis, 1957), considered to be the most suitable for community data. These are subsequently assigned into groups of replicates and/or stations according to their level of similarity and clustered together based upon a Group Average Method into a dendrogram of similarity.

Non-Metric Multidimensional Scaling (n-MDS): n-MDS is currently widely used in the analysis of spatial and temporal change in benthic communities (e.g. Warwick & Clarke, 1991). The recorded observations from data were exposed to computation of triangular matrices of similarities between all pairs of samples. The similarity of every pair of sites was computed using the Bray-Curtis index on transformed data. Clustering was by a hierarchical agglomerative method using group average sorting, and the results are presented as a dendrogram and as a two-dimensional ordination plot. The degree of distortion involved in producing an ordination gives an indication of the adequacy of the n-MDS representation and is recorded as a stress value as outline in Table G.

Table G: Inference from n-MDS Stress Values

n-MDS Stress	Adequacy of Representation for Two-Dimensional Plot
≤0.05	Excellent representation with no prospect of misinterpretation.
>0.05 to 0.1	Good ordination with no real prospect of a misleading interpretation.
>0.1 to 0.2	Potentially useful 2-d plot, though for values at the upper end of this range too much reliance should not be placed on plot detail; superimposition of clusters should be undertaken to verify conclusions.
>0.2 to 0.3	Ordination should be treated with scepticism. Clusters may be superimposed to verify conclusions, but ordinations with stress values >2.5 should be discarded. A 3-d ordination may be more appropriate.
>0.3	Ordination is unreliable with points close to being arbitrarily placed in the 2-d plot. A 3-d ordination should be examined.

SIMPER: the n-MDS clustering program is used to analyse differences between sites. SIMPER enables those species responsible for differences to be identified by examining the contribution of individual species to the similarity measure. As all sites grouped within a single cluster, this program was subsequently not used.

Bioaccumulation Curve Estimates are undertaken using **Chao-1 (S^*_1)**. This is a formula that estimates how many additional species would be needed to sample all of the asymptotic species richness of a region, based on the samples acquired. It calculates this by comparing the number of species that occur in one sample with those that occur in two samples where;

$$S^*_1 = S_{obs} + (a^2/2b)$$

S_{obs} is the number of species observed

a is the number of species observed just once

b is the number of species observed just twice

RELATE – Is non-parametric Mantel test that looks at the relationship between two matrices (often biotic and environmental). This shows the degree of seriation, an alternative to cluster analysis, which looks for a sequential pattern in community change. The test computes Spearman's rank correlation coefficient (ρ) between the corresponding elements of each pair of matrices to produce a correlation statistic present between the two datasets, the significance of the correlation determined by a permutation procedure (Clarke & Gorley, 2006).

SIMPROF (similarity profile) test - analyses data for significant clusters that show evidence of a multivariate pattern in data that are *a priori* unstructured, i.e. single samples from each site. The test works by comparing samples which have been ranked and ordered by resemblance against an expected profile which is obtained by permuting random species (variables) across the set of samples, a mean of 1000 permutations is taken to produce an expected result for null structure with rare and common species displaying the same pattern. If the actual data deviates outside the 95% limits of the expected profile then there is evidence for significant structure and vice versa. The 'significant structure' is well represented on a dendrogram which will also show the clusters containing that lack significant differentiation (null structure), (Clarke & Gorley, 2006).

Normalisation

Normalisation is a procedure used here to correct concentrations for the influence of the natural variability in sediment composition (i.e. grain size, organic matter and mineralogy). Natural and anthropogenic contaminants tend to show a much higher affinity to fine particulate matter compared to coarse (OSPAR, 2009) due to the increased adsorption capacity of organic matter and clay minerals. In sites where there is variability in grain size between stations, effects of sources of contamination will at least partly be obscured by grain size differences.

Normalisation can be performed through linear regression or by simple contaminant/normaliser ratios

Linear regression normalisation takes into account the possible presence of contaminants and co-factors. The binding capacity of the sediments can be related to the content of fines (primary co-factor) in the sediments. The level of fines can be represented by the contents of major elements of the clay fraction such as aluminium (secondary co-factor). Figure A represents the general model for normalisation of the contaminants

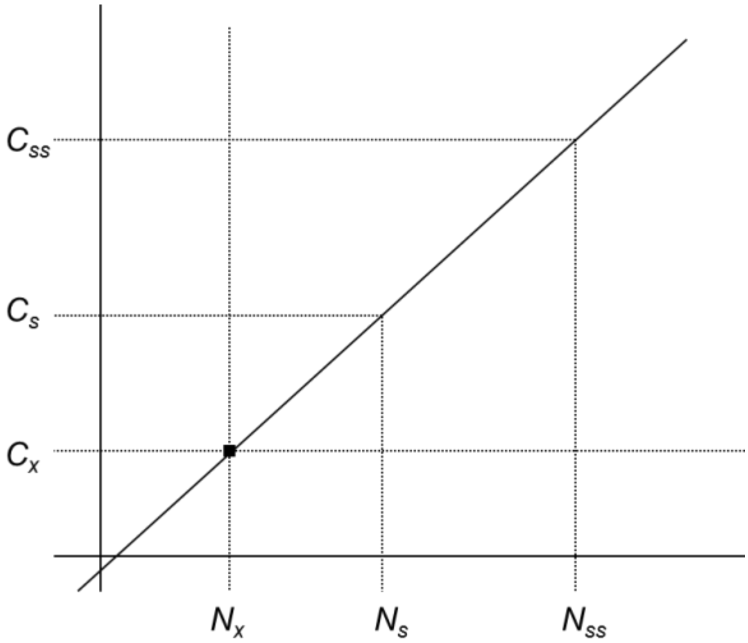


Figure A: Relation Between the Contaminant C and the Cofactor N

Cx and Nx represent the contaminant and the co-factor contents, respectively, in pure sand. The regression line will always originate from this point and pivot depending on the sampled contaminant concentrations (Cs and Ns). These 'pivot values' are derived from the statistical analysis of contaminant concentrations in pure sand

The linear relationship between the pivot point and the sampled concentrations allows determination of the contaminant content for any preselected co-factor content (Nss) by interpolation and extrapolation. When comparing to the OSPAR BCs and BACs the secondary cofactors for normalisation are 50 000 µgg-1 of Al for metals and 2.5% TOC when normalising organics. The slope of the regression line (PL) can be represented by Equation 1, which can then be re-arranged to give the contaminant content Css that is normalised to Nss in Equation 2.

Cx and Nx represent the contaminant and the co-factor contents, respectively, in pure sand. The regression line will always originate from this point and pivot depending on the sampled contaminant concentrations (Cs and Ns). These 'pivot values' are derived from statistical analysis of contaminant concentrations in pure sand.

The linear relationship between the pivot point and the sampled concentrations allows the determination of the contaminant content for any preselected co-factor content (Nss) by interpolation and extrapolation. When comparing to the OSPAR BCs and BACs the secondary cofactors for normalisation are 50ppm of Li for metals and 2.5% TOC when normalising organics. The slope of the regression line (PL) can be represented by Equation 1, which can then be re-arranged to give the contaminant content Css that is normalised to Nss in **Equation 2**.

$$PL = \frac{dC}{dN} = \frac{C_s - C_x}{N_s - N_x} = \frac{C_{ss} - C_x}{N_{ss} - N_x}$$

Equation 1: Slope of the regression line expressed in terms of N_{ss}

$$PL = \frac{dC}{dN} = \frac{C_s - C_x}{N_s - N_x} = \frac{C_{ss} - C_x}{N_{ss} - N_x}$$

Equation 1: Slope of the Regression Line Expressed in Terms of N_{ss}

$$C_{ss} = (C_s - C_x)\frac{N_{ss} - N_x}{N_s - N_x} + C_x$$

Equation 2: Rewritten Equation Giving the Contaminant Content C_{ss} normalised to N_{ss}

Equation 2: Rewritten equation giving the contaminant content *C_{ss}* normalised to *N_{ss}*

Normalisation of Metals

This method is limited by the sampled concentration of the contaminant. If a measured concentration falls below the Cx 'pivot value' for that metal or if the concentration of Li falls below the Nx 'pivot value', the method will give a skewed result (often a negative concentration). The pivot values for the contaminants are given in Table H.

This method is limited by the sampled concentration of the contaminant. If a measured concentration falls below the Cx 'pivot value' for that metal or if the concentration of Al falls below the Nx 'pivot value', the method will give a skewed result (often a negative concentration). The pivot values for the contaminants are given in Table C.4.

Table H: Pivot Values for Metals with OSPAR Background Concentrations (CSEMP, 2013)

Metal	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Z
N_x or C_x (µg.g^{-1})	14,000	5	0.03	13	3	0	4	9	13

Table C.4: Pivot Values for Metals with OSPAR Background Concentrations (CSEMP, 2013)

Metal	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
N_x or Cx (µgg^{-1})	14 000	5	0.03	13	3	0	4	9	13

If a metal is found to be below these values the alternative method of a simple ratio between contaminant/normaliser can be used (Equation 3).

$$C_{ss} = \frac{N_{ss}}{N_s} C_s$$

Equation 3: Ratio Method for the Normalisation of a Contaminant

If a metal is found to be below these values the alternative method of a simple ratio between contaminant/normaliser can be used (Error! Reference source not found.).

$$C_{ss} = \frac{N_{ss}}{N_s} C_s$$

Equation 3: Ratio method for the normalisation of a contaminant.

Bibliography

Bray, J.R. and Curtis, J.T., 1957. An ordination of the upland forest communities of Southern Wisconsin. Ecol. Monogr. 27: 325-349.

Clarke, K.R. and Gorley, R.N., 2001 and 2006. PRIMER v5 (& v6): User manual/tutorial, PRIMER-E, Plymouth UK, 91pp & 192pp.

Folk, R.L., 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology 62: 344-349.

Folk, R.L. and Ward, W.C., 1957. Brazos River Bar: A Study in the Significance of Grain Size Parameters. Journal of Sedimentary Research 27: 3-26.

Hart, B., 1996. Ecological Monitoring Unit - Confirmation of the reproducibility of the Malvern Mastersizer Microplus Laser Sizer and comparison of its output with the Malvern 3600E sizer. Brixham Environmental Laboratory report BL2806/B.

OSPAR Commission, 2004. OSPAR guidelines for monitoring the environmental impact of offshore oil and gas activities. Meeting of the OSPAR Offshore Industries Committee (OIC), 15 – 19 March, 2004.

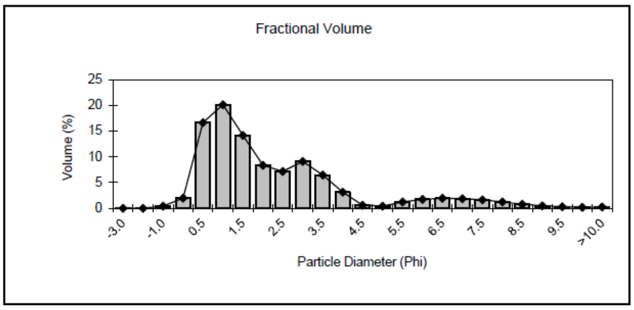
Pielou, E.C., 1969. An introduction to mathematical ecology. Wiley, New York.

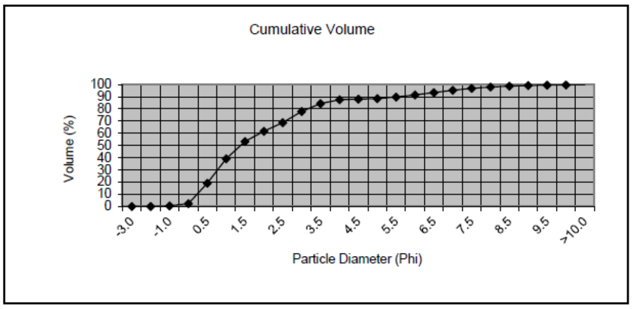
Simpson, E.H., 1949. Measurement of diversity. Nature, 163, 688.

Warwick, R.M. and Clarke, K.R., 1991. A comparison of some methods for analysing changes in benthic community structure. J. Mar. Biol. Ass. U.K. 71: 225-244.

APPENDIX G - PARTICLE SIZE DISTIBUTIONS

Sample No.:	GRAB_P_0	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 10:01

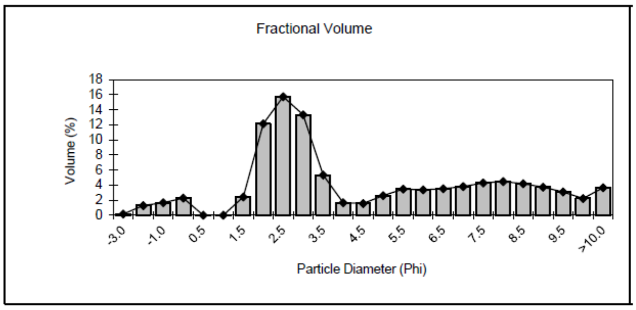


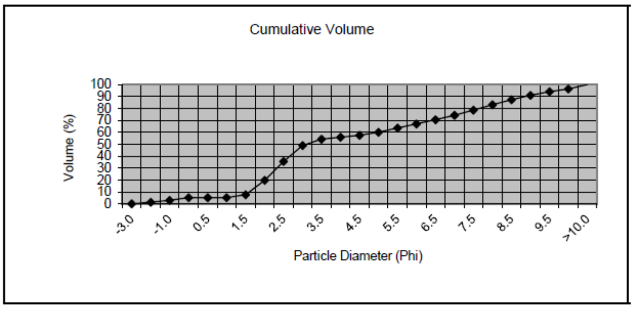


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.00	0.0	
2.0000	-1.0	0.40	0.4	Granule
1.0000	0.0	1.98	2.4	V.Coarse Sand
0.7100	0.5	16.63	19.0	Coarse Sand
0.5000	1.0	20.12	39.1	
0.3550	1.5	14.19	53.3	Medium Sand
0.2500	2.0	8.36	61.7	
0.1800	2.5	7.16	68.9	Fine Sand
0.1250	3.0	9.10	78.0	
0.0900	3.5	6.45	84.4	V.Fine Sand
0.0630	4.0	3.13	87.5	
0.0440	4.5	0.60	88.1	Coarse Silt
0.0315	5.0	0.41	88.5	
0.0220	5.5	1.20	89.7	Medium Silt
0.0156	6.0	1.72	91.5	
0.0110	6.5	1.94	93.4	Fine silt
0.0078	7.0	1.85	95.3	
0.0055	7.5	1.62	96.9	V.Fine Silt
0.0039	8.0	1.21	98.1	
0.0028	8.5	0.77	98.9	Coarse Clay
0.0020	9.0	0.46	99.3	
0.0014	9.5	0.27	99.6	Medium Clay
0.0010	10.0	0.18	99.8	
<0.001	>10.0	0.23	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.301	0.382	1.73
Median	0.389		1.36
Sorting Coefficient	**Value** 1.80	**Inference** Poorly Sorted	
Skewness	0.49	Very Positive (Coarse)	
Kurtosis	1.29	Leptokurtic	
% Fines	12.47%	Medium Sand	
% Sands	87.13%		
% Gravel	0.40%		

Sample No.:	GRAB_P_1	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 10:35

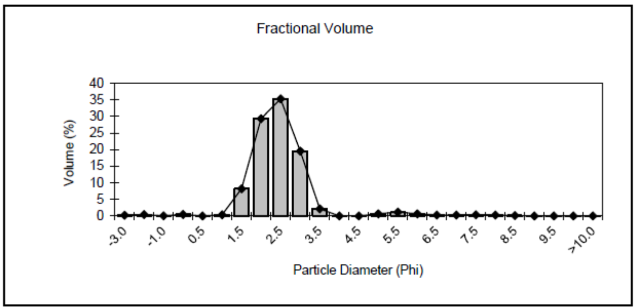


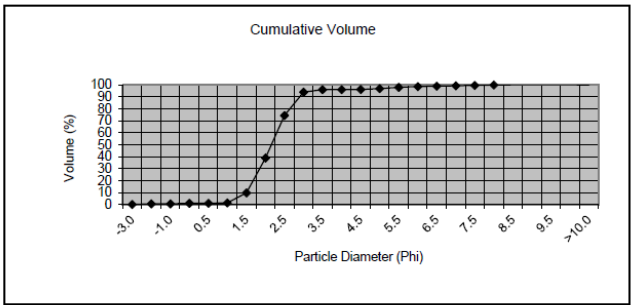


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.17	0.2	Pebble
4.0000	-2.0	1.29	1.5	
2.0000	-1.0	1.65	3.1	Granule
1.0000	0.0	2.28	5.4	V.Coarse Sand
0.7100	0.5	0.00	5.4	Coarse Sand
0.5000	1.0	0.01	5.4	
0.3550	1.5	2.43	7.8	Medium Sand
0.2500	2.0	12.13	20.0	
0.1800	2.5	15.73	35.7	Fine Sand
0.1250	3.0	13.34	49.0	
0.0900	3.5	5.33	54.4	V.Fine Sand
0.0630	4.0	1.66	56.0	
0.0440	4.5	1.55	57.6	Coarse Silt
0.0315	5.0	2.62	60.2	
0.0220	5.5	3.46	63.7	Medium Silt
0.0156	6.0	3.38	67.0	
0.0110	6.5	3.53	70.6	Fine silt
0.0078	7.0	3.81	74.4	
0.0055	7.5	4.30	78.7	V.Fine Silt
0.0039	8.0	4.48	83.1	
0.0028	8.5	4.20	87.3	Coarse Clay
0.0020	9.0	3.72	91.1	
0.0014	9.5	3.08	94.1	Medium Clay
0.0010	10.0	2.22	96.4	
<0.001	>10.0	3.64	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.050	0.374	4.33
Median	0.119		3.08
Sorting Coefficient	**Value** 3.07	**Inference** Very Poorly Sorted	
Skewness	0.46	Very Positive (Coarse)	
Kurtosis	0.82	Platykurtic	
% Fines	43.98%	Coarse Silt	
% Sands	52.92%		
% Gravel	3.11%		

Sample No.:	GRAB_P_2	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 10:49

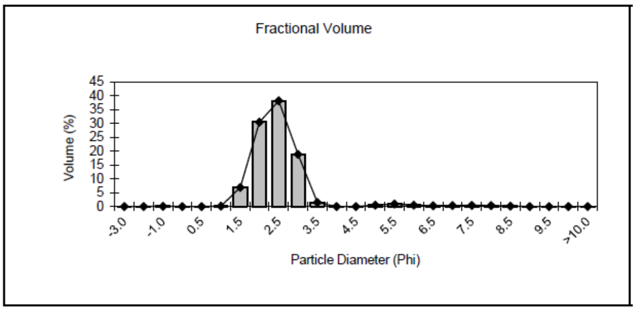


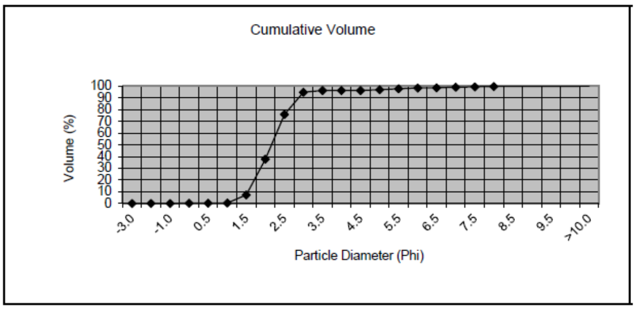


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.26	0.3	Pebble
4.0000	-2.0	0.41	0.7	
2.0000	-1.0	0.09	0.8	Granule
1.0000	0.0	0.49	1.2	V.Coarse Sand
0.7100	0.5	0.00	1.2	Coarse Sand
0.5000	1.0	0.37	1.6	
0.3550	1.5	8.23	9.8	Medium Sand
0.2500	2.0	29.28	39.1	
0.1800	2.5	35.27	74.4	Fine Sand
0.1250	3.0	19.56	94.0	
0.0900	3.5	2.16	96.1	V.Fine Sand
0.0630	4.0	0.00	96.1	
0.0440	4.5	0.01	96.1	Coarse Silt
0.0315	5.0	0.67	96.8	
0.0220	5.5	1.17	98.0	Medium Silt
0.0156	6.0	0.65	98.6	
0.0110	6.5	0.30	98.9	Fine silt
0.0078	7.0	0.30	99.2	
0.0055	7.5	0.37	99.6	V.Fine Silt
0.0039	8.0	0.31	99.9	
0.0028	8.5	0.10	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.227	0.114	2.14
Median	0.228		2.13
Sorting	**Value**	**Inference**	
Coefficient	0.59	Moderately Well Sorted	
Skewness	0.05	Symmetrical	
Kurtosis	1.10	Mesokurtic	
% Fines	3.88%	Fine Sand	
% Sands	95.37%		
% Gravel	0.75%		

Sample No.:	GRAB_P_3	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 10:59

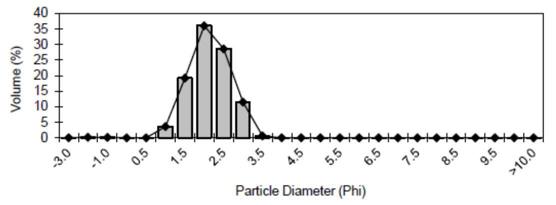


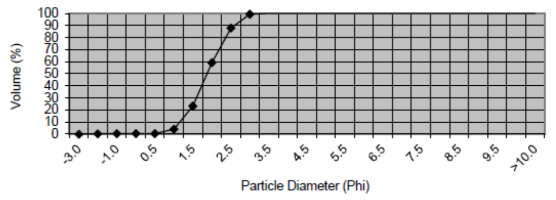


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.03	0.0	
2.0000	-1.0	0.09	0.1	Granule
1.0000	0.0	0.06	0.2	V.Coarse Sand
0.7100	0.5	0.00	0.2	Coarse Sand
0.5000	1.0	0.14	0.3	
0.3550	1.5	6.94	7.3	Medium Sand
0.2500	2.0	30.51	37.8	
0.1800	2.5	38.21	76.0	Fine Sand
0.1250	3.0	18.88	94.9	
0.0900	3.5	1.49	96.4	V.Fine Sand
0.0630	4.0	0.00	96.4	
0.0440	4.5	0.01	96.4	Coarse Silt
0.0315	5.0	0.55	96.9	
0.0220	5.5	0.95	97.9	Medium Silt
0.0156	6.0	0.53	98.4	
0.0110	6.5	0.29	98.7	Fine silt
0.0078	7.0	0.35	99.0	
0.0055	7.5	0.43	99.5	V.Fine Silt
0.0039	8.0	0.35	99.8	
0.0028	8.5	0.17	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.226	0.101	2.14
Median	0.228		2.14
Sorting	**Value**	**Inference**	
Coefficient	0.52	Moderately Well Sorted	
Skewness	0.03	Symmetrical	
Kurtosis	1.02	Mesokurtic	
% Fines	3.64%	Fine Sand	
% Sands	96.23%		
% Gravel	0.13%		

Sample No.:	GRAB_P_4	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 11:09



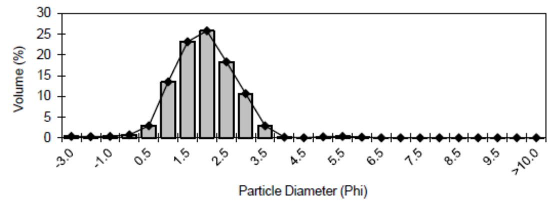


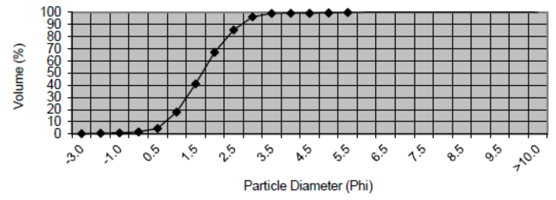
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.25	0.2	
2.0000	-1.0	0.18	0.4	Granule
1.0000	0.0	0.00	0.4	V.Coarse Sand
0.7100	0.5	0.00	0.4	Coarse Sand
0.5000	1.0	3.60	4.0	
0.3550	1.5	19.25	23.3	Medium Sand
0.2500	2.0	36.03	59.3	
0.1800	2.5	28.58	87.9	Fine Sand
0.1250	3.0	11.48	99.4	
0.0900	3.5	0.65	100.0	V.Fine Sand
0.0630	4.0	0.00	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.278	0.131	1.85
Median	0.277		1.85

Sorting	Value	Inference
Coefficient	0.54	Moderately Well Sorted
Skewness	0.02	Symmetrical
Kurtosis	0.99	Mesokurtic
% Fines	0.00%	Medium Sand
% Sands	99.58%	
% Gravel	0.42%	

Sample No.:	GRAB_P_5	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 11:18



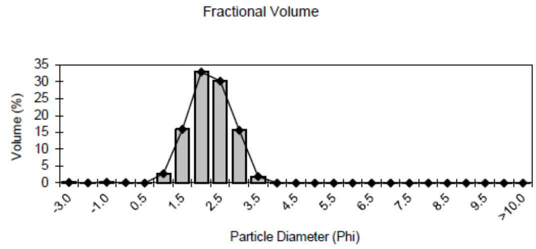


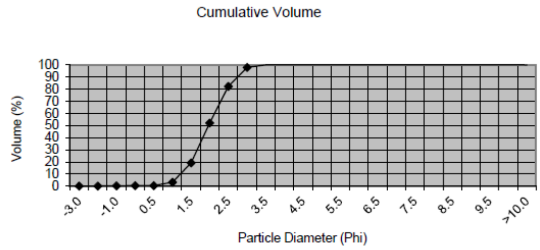
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.36	0.4	Pebble
4.0000	-2.0	0.29	0.7	
2.0000	-1.0	0.36	1.0	Granule
1.0000	0.0	0.73	1.7	V.Coarse Sand
0.7100	0.5	2.90	4.6	Coarse Sand
0.5000	1.0	13.52	18.2	
0.3550	1.5	23.18	41.3	Medium Sand
0.2500	2.0	25.81	67.1	
0.1800	2.5	18.36	85.5	Fine Sand
0.1250	3.0	10.67	96.2	
0.0900	3.5	2.90	99.1	V.Fine Sand
0.0630	4.0	0.15	99.2	
0.0440	4.5	0.01	99.2	Coarse Silt
0.0315	5.0	0.27	99.5	
0.0220	5.5	0.34	99.8	Medium Silt
0.0156	6.0	0.16	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.316	0.216	1.66
Median	0.320		1.64

Sorting	Value	Inference
Coefficient	0.75	Moderately Sorted
Skewness	0.05	Symmetrical
Kurtosis	0.94	Mesokurtic
% Fines	0.78%	Medium Sand
% Sands	98.21%	
% Gravel	1.01%	

Sample No.:	GRAB_P_6	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 11:40

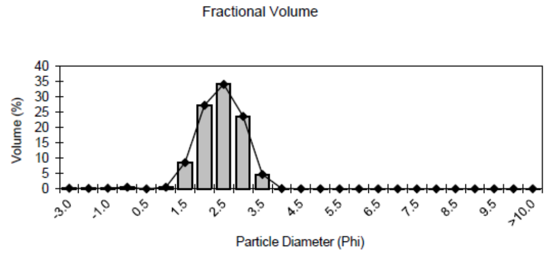


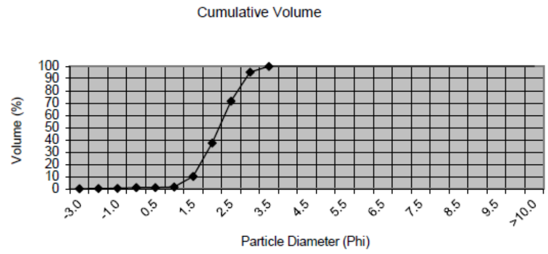


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.17	0.2	Pebble
4.0000	-2.0	0.08	0.2	
2.0000	-1.0	0.23	0.5	Granule
1.0000	0.0	0.14	0.6	V.Coarse Sand
0.7100	0.5	0.00	0.6	Coarse Sand
0.5000	1.0	2.77	3.4	
0.3550	1.5	15.94	19.3	Medium Sand
0.2500	2.0	32.88	52.2	
0.1800	2.5	30.20	82.4	Fine Sand
0.1250	3.0	15.64	98.1	
0.0900	3.5	1.95	100.0	V.Fine Sand
0.0630	4.0	0.00	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.258	0.131	1.95
Median	0.257		1.96
Sorting	Value	Inference	
Coefficient	0.56	Moderately Well Sorted	
Skewness	-0.01	Symmetrical	
Kurtosis	0.97	Mesokurtic	
% Fines	0.00%	Medium Sand	
% Sands	99.53%		
% Gravel	0.47%		

Sample No.:	GRAB_P_7	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 11:50

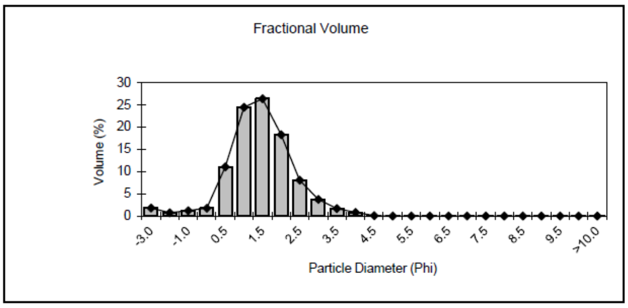


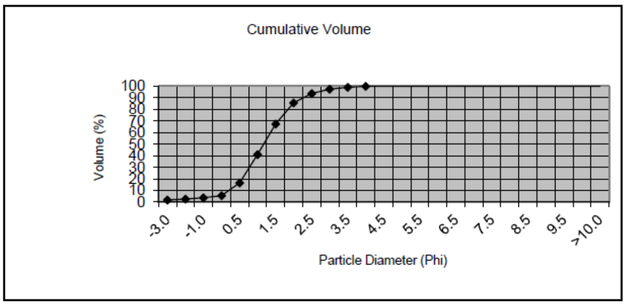


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.20	0.2	Pebble
4.0000	-2.0	0.17	0.4	
2.0000	-1.0	0.25	0.6	Granule
1.0000	0.0	0.52	1.1	V.Coarse Sand
0.7100	0.5	0.00	1.1	Coarse Sand
0.5000	1.0	0.54	1.7	
0.3550	1.5	8.58	10.3	Medium Sand
0.2500	2.0	27.23	37.5	
0.1800	2.5	34.10	71.6	Fine Sand
0.1250	3.0	23.59	95.2	
0.0900	3.5	4.75	99.9	V.Fine Sand
0.0630	4.0	0.06	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.224	0.114	2.16
Median	0.224		2.16
Sorting	Value	Inference	
Coefficient	0.56	Moderately Well Sorted	
Skewness	-0.04	Symmetrical	
Kurtosis	0.94	Mesokurtic	
% Fines	0.00%	Fine Sand	
% Sands	99.38%		
% Gravel	0.62%		

Sample No.:	GRAB_P_8	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 12:02



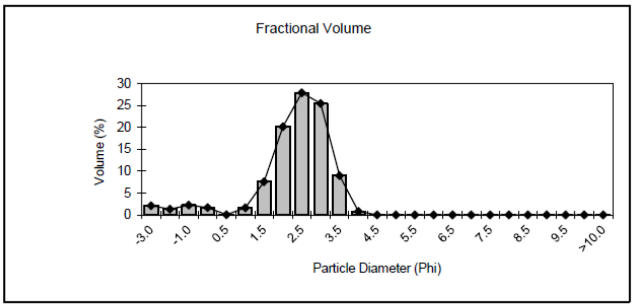


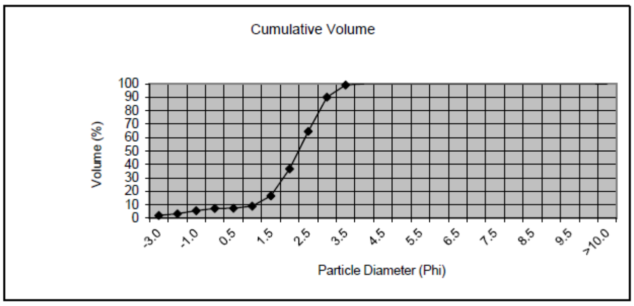
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	1.80	1.8	Pebble
4.0000	-2.0	0.73	2.5	
2.0000	-1.0	1.21	3.7	Granule
1.0000	0.0	1.78	5.5	V.Coarse Sand
0.7100	0.5	11.06	16.6	Coarse Sand
0.5000	1.0	24.42	41.0	
0.3550	1.5	26.36	67.4	Medium Sand
0.2500	2.0	18.25	85.6	
0.1800	2.5	8.05	93.7	Fine Sand
0.1250	3.0	3.75	97.4	
0.0900	3.5	1.68	99.1	V.Fine Sand
0.0630	4.0	0.81	99.9	
0.0440	4.5	0.11	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.439	0.374	1.19
Median	0.450		1.15

Sorting	Value	Inference
Coefficient	0.83	Moderately Sorted
Skewness	0.03	Symmetrical
Kurtosis	1.19	Leptokurtic
% Fines	0.11%	Medium Sand
% Sands	96.14%	
% Gravel	3.74%	

Sample No.:	GRAB_P_9	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 12:14



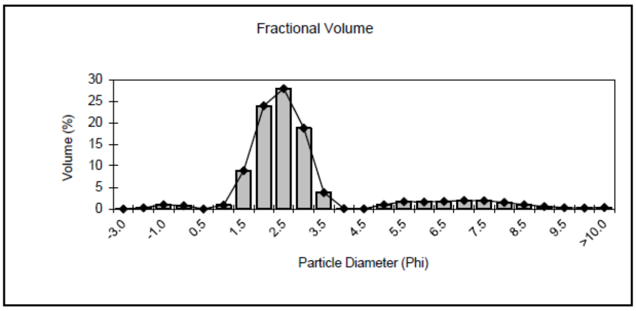


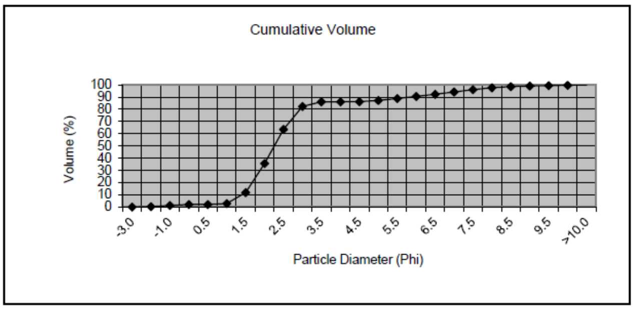
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	2.09	2.1	Pebble
4.0000	-2.0	1.34	3.4	
2.0000	-1.0	2.23	5.7	Granule
1.0000	0.0	1.67	7.3	V.Coarse Sand
0.7100	0.5	0.07	7.4	Coarse Sand
0.5000	1.0	1.63	9.0	
0.3550	1.5	7.58	16.6	Medium Sand
0.2500	2.0	20.17	36.8	
0.1800	2.5	27.94	64.7	Fine Sand
0.1250	3.0	25.47	90.2	
0.0900	3.5	9.01	99.2	V.Fine Sand
0.0630	4.0	0.78	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.223	0.797	2.17
Median	0.217		2.20

Sorting	Value	Inference
Coefficient	1.05	Poorly Sorted
Skewness	-0.32	Very Negative(fine)
Kurtosis	1.93	Very Leptokurtic
% Fines	0.00%	Fine Sand
% Sands	94.33%	
% Gravel	5.67%	

Sample No.:	GRAB_P_10	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 12:26

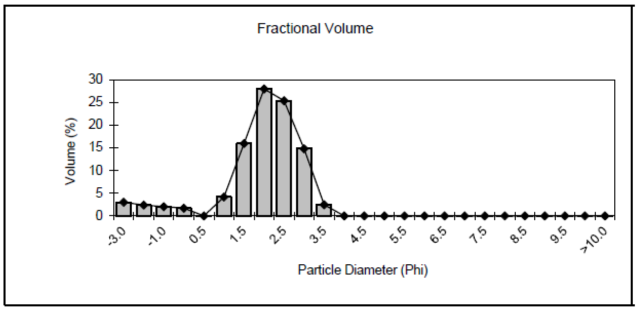


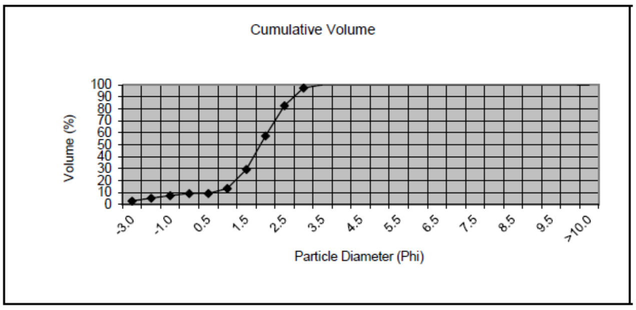


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.24	0.2	
2.0000	-1.0	0.98	1.2	Granule
1.0000	0.0	0.74	2.0	V.Coarse Sand
0.7100	0.5	0.00	2.0	Coarse Sand
0.5000	1.0	0.90	2.9	
0.3550	1.5	8.88	11.7	Medium Sand
0.2500	2.0	23.96	35.7	
0.1800	2.5	27.92	63.6	Fine Sand
0.1250	3.0	18.76	82.4	
0.0900	3.5	3.80	86.2	V.Fine Sand
0.0630	4.0	0.07	86.2	
0.0440	4.5	0.03	86.3	Coarse Silt
0.0315	5.0	0.97	87.2	
0.0220	5.5	1.68	88.9	Medium Silt
0.0156	6.0	1.61	90.5	
0.0110	6.5	1.75	92.3	Fine silt
0.0078	7.0	1.94	94.2	
0.0055	7.5	1.92	96.1	V.Fine Silt
0.0039	8.0	1.50	97.6	
0.0028	8.5	0.95	98.6	Coarse Clay
0.0020	9.0	0.55	99.1	
0.0014	9.5	0.32	99.5	Medium Clay
0.0010	10.0	0.22	99.7	
<0.001	>10.0	0.32	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.199	0.162	2.33
Median	0.214		2.22
Sorting	**Value**	**Inference**	
Coefficient	1.32	Poorly Sorted	
Skewness	0.41	Very Positive (Coarse)	
Kurtosis	2.45	Very Leptokurtic	
% Fines	13.76%	Fine Sand	
% Sands	85.02%		
% Gravel	1.22%		

Sample No.:	GRAB_P_11	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 12:38

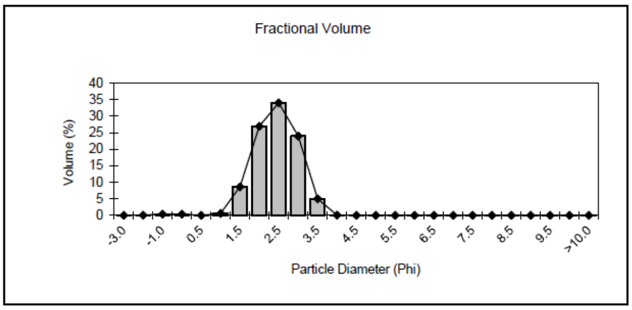


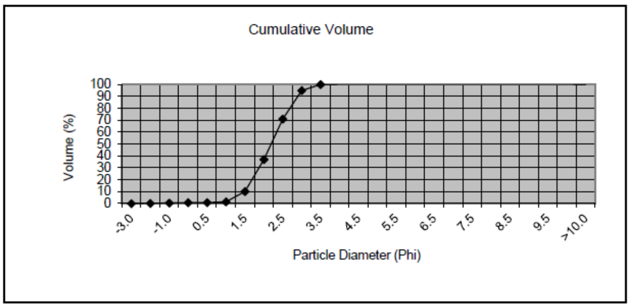


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	3.05	3.0	Pebble
4.0000	-2.0	2.40	5.4	
2.0000	-1.0	2.03	7.5	Granule
1.0000	0.0	1.72	9.2	V.Coarse Sand
0.7100	0.5	0.02	9.2	Coarse Sand
0.5000	1.0	4.19	13.4	
0.3550	1.5	15.95	29.4	Medium Sand
0.2500	2.0	27.96	57.3	
0.1800	2.5	25.38	82.7	Fine Sand
0.1250	3.0	14.80	97.5	
0.0900	3.5	2.49	100.0	V.Fine Sand
0.0630	4.0	0.00	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.285	1.489	1.81
Median	0.278		1.85
Sorting	**Value**	**Inference**	
Coefficient	1.14	Poorly Sorted	
Skewness	-0.34	Very Negative(fine)	
Kurtosis	2.17	Very Leptokurtic	
% Fines	0.00%	Medium Sand	
% Sands	92.52%		
% Gravel	7.48%		

Sample No.:	GRAB_P_12	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 12:50

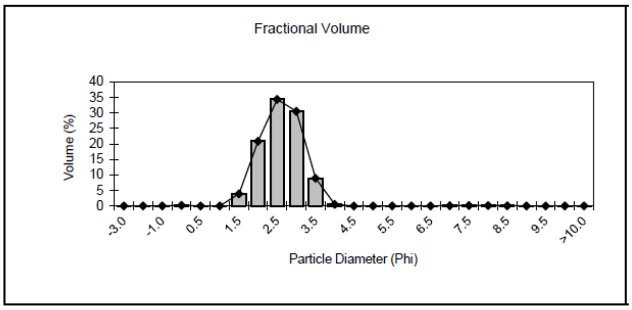


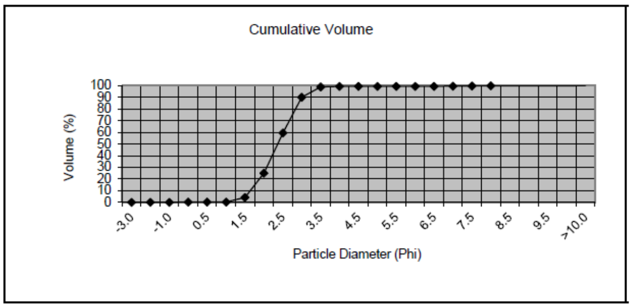


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.09	0.1	
2.0000	-1.0	0.33	0.4	Granule
1.0000	0.0	0.36	0.8	V.Coarse Sand
0.7100	0.5	0.00	0.8	Coarse Sand
0.5000	1.0	0.62	1.4	
0.3550	1.5	8.59	10.0	Medium Sand
0.2500	2.0	26.95	36.9	
0.1800	2.5	34.03	71.0	Fine Sand
0.1250	3.0	23.97	94.9	
0.0900	3.5	4.99	99.9	V.Fine Sand
0.0630	4.0	0.08	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.223	0.112	2.16
Median	0.223		2.16
Sorting	**Value**	**Inference**	
Coefficient	0.56	Moderately Well Sorted	
Skewness	-0.04	Symmetrical	
Kurtosis	0.94	Mesokurtic	
% Fines	0.00%	Fine Sand	
% Sands	99.58%		
% Gravel	0.42%		

Sample No.:	GRAB_P_13	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 14:00

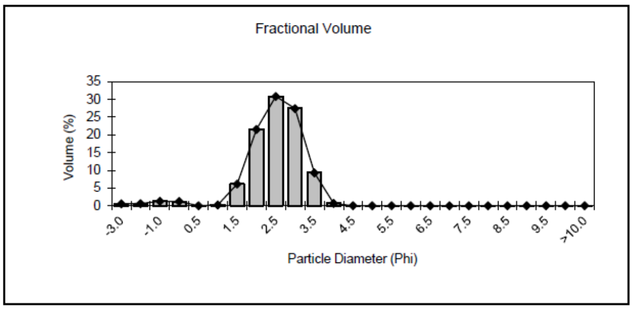


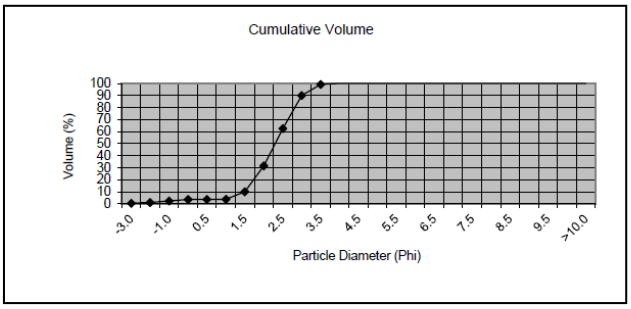


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.03	0.0	
2.0000	-1.0	0.03	0.1	Granule
1.0000	0.0	0.23	0.3	V.Coarse Sand
0.7100	0.5	0.00	0.3	Coarse Sand
0.5000	1.0	0.02	0.3	
0.3550	1.5	3.94	4.2	Medium Sand
0.2500	2.0	20.84	25.1	
0.1800	2.5	34.38	59.5	Fine Sand
0.1250	3.0	30.54	90.0	
0.0900	3.5	8.96	99.0	V.Fine Sand
0.0630	4.0	0.52	99.5	
0.0440	4.5	0.00	99.5	Coarse Silt
0.0315	5.0	0.00	99.5	
0.0220	5.5	0.00	99.5	Medium Silt
0.0156	6.0	0.00	99.5	
0.0110	6.5	0.00	99.5	Fine silt
0.0078	7.0	0.08	99.6	
0.0055	7.5	0.17	99.7	V.Fine Silt
0.0039	8.0	0.18	99.9	
0.0028	8.5	0.09	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.200	0.093	2.32
Median	0.199		2.33
Sorting	**Value**	**Inference**	
Coefficient	0.54	Moderately Well Sorted	
Skewness	0.02	Symmetrical	
Kurtosis	0.99	Mesokurtic	
% Fines	0.52%	Fine Sand	
% Sands	99.42%		
% Gravel	0.07%		

Sample No.:	GRAB_P_14	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 14:11

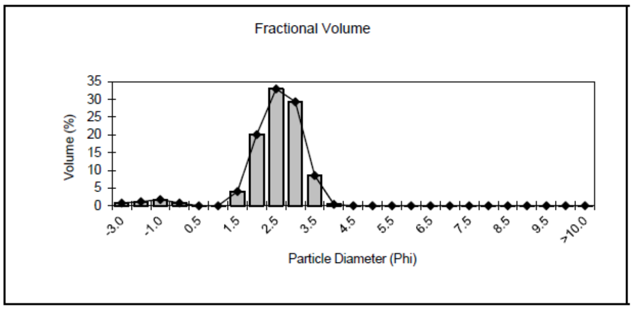


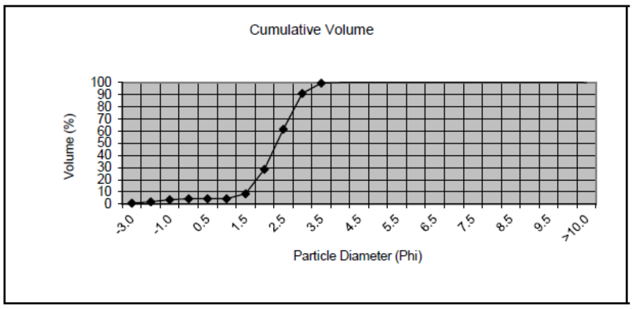


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.57	0.6	Pebble
4.0000	-2.0	0.64	1.2	
2.0000	-1.0	1.28	2.5	Granule
1.0000	0.0	1.21	3.7	V.Coarse Sand
0.7100	0.5	0.00	3.7	Coarse Sand
0.5000	1.0	0.24	3.9	
0.3550	1.5	6.17	10.1	Medium Sand
0.2500	2.0	21.56	31.7	
0.1800	2.5	30.90	62.6	Fine Sand
0.1250	3.0	27.49	90.1	
0.0900	3.5	9.27	99.3	V.Fine Sand
0.0630	4.0	0.67	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.210	0.127	2.25
Median	0.208		2.26
Sorting Coefficient	**Value** 0.64	**Inference** Moderately Well Sorted	
Skewness	-0.07	Symmetrical	
Kurtosis	1.02	Mesokurtic	
% Fines	0.00%	Fine Sand	
% Sands	97.52%		
% Gravel	2.49%		

Sample No.:	GRAB_P_15	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 14:22

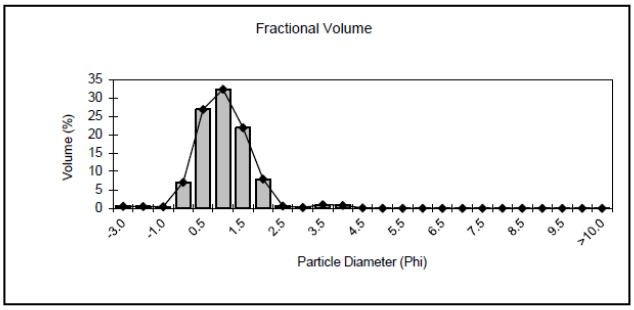


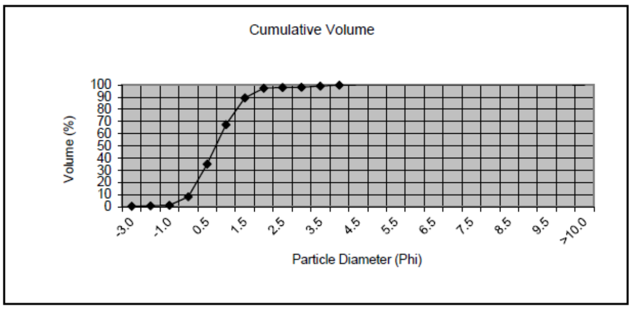


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.80	0.8	Pebble
4.0000	-2.0	1.15	1.9	
2.0000	-1.0	1.77	3.7	Granule
1.0000	0.0	0.77	4.5	V.Coarse Sand
0.7100	0.5	0.00	4.5	Coarse Sand
0.5000	1.0	0.03	4.5	
0.3550	1.5	4.07	8.6	Medium Sand
0.2500	2.0	20.11	28.7	
0.1800	2.5	33.02	61.7	Fine Sand
0.1250	3.0	29.34	91.1	
0.0900	3.5	8.52	99.6	V.Fine Sand
0.0630	4.0	0.42	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.208	0.125	2.27
Median	0.205		2.29
Sorting Coefficient	**Value** 0.62	**Inference** Moderately Well Sorted	
Skewness	-0.10	Negative (Fine)	
Kurtosis	1.11	Mesokurtic	
% Fines	0.00%	Fine Sand	
% Sands	96.29%		
% Gravel	3.71%		

Sample No.:	GRAB_C_0	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 16:02

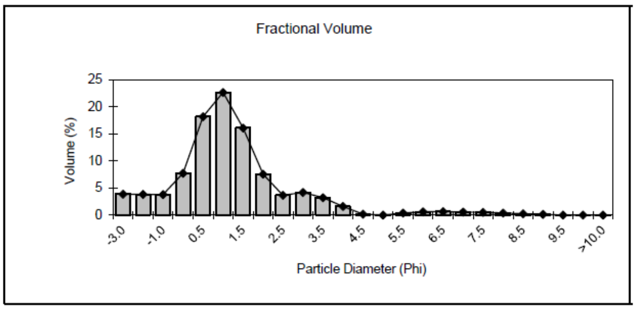


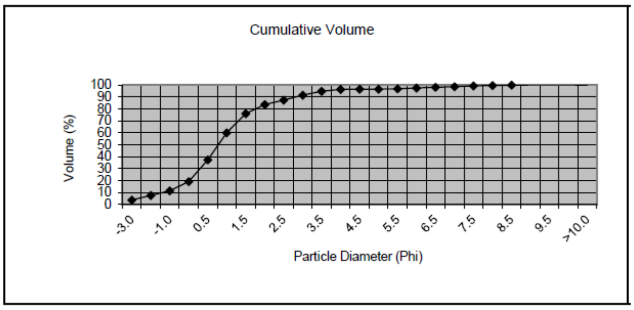


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.51	0.5	Pebble
4.0000	-2.0	0.43	0.9	
2.0000	-1.0	0.41	1.3	Granule
1.0000	0.0	7.03	8.4	V.Coarse Sand
0.7100	0.5	26.85	35.2	Coarse Sand
0.5000	1.0	32.32	67.5	
0.3550	1.5	21.89	89.4	Medium Sand
0.2500	2.0	7.94	97.4	
0.1800	2.5	0.59	98.0	Fine Sand
0.1250	3.0	0.20	98.2	
0.0900	3.5	0.96	99.1	V.Fine Sand
0.0630	4.0	0.79	99.9	
0.0440	4.5	0.10	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.604	0.390	0.73
Median	0.614		0.70
Sorting	**Value**	**Inference**	
Coefficient	0.67	Moderately Well Sorted	
Skewness	0.00	Symmetrical	
Kurtosis	1.14	Leptokurtic	
% Fines	0.11%	Coarse Sand	
% Sands	98.55%		
% Gravel	1.35%		

Sample No.:	GRAB_C_1	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 14:37

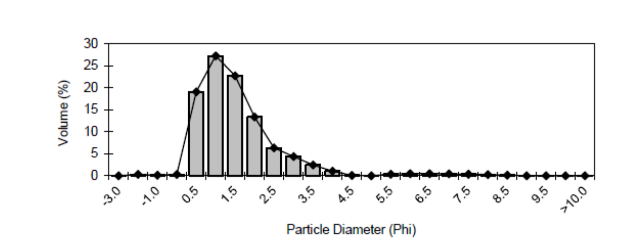


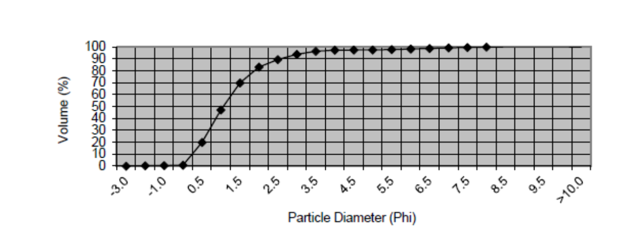


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	3.86	3.9	Pebble
4.0000	-2.0	3.83	7.7	
2.0000	-1.0	3.81	11.5	Granule
1.0000	0.0	7.71	19.2	V.Coarse Sand
0.7100	0.5	18.18	37.4	Coarse Sand
0.5000	1.0	22.64	60.0	
0.3550	1.5	16.07	76.1	Medium Sand
0.2500	2.0	7.55	83.6	
0.1800	2.5	3.64	87.3	Fine Sand
0.1250	3.0	4.19	91.5	
0.0900	3.5	3.23	94.7	V.Fine Sand
0.0630	4.0	1.59	96.3	
0.0440	4.5	0.17	96.5	Coarse Silt
0.0315	5.0	0.02	96.5	
0.0220	5.5	0.39	96.9	Medium Silt
0.0156	6.0	0.60	97.5	
0.0110	6.5	0.63	98.1	Fine silt
0.0078	7.0	0.57	98.7	
0.0055	7.5	0.51	99.2	V.Fine Silt
0.0039	8.0	0.40	99.6	
0.0028	8.5	0.26	99.9	Coarse Clay
0.0020	9.0	0.14	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.589	2.173	0.76
Median	0.593		0.75
Sorting	**Value**	**Inference**	
Coefficient	1.59	Poorly Sorted	
Skewness	-0.05	Symmetrical	
Kurtosis	1.97	Very Leptokurtic	
% Fines	3.70%	Coarse Sand	
% Sands	84.80%		
% Gravel	11.50%		

Sample No.:	GRAB_C_2	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 14:47

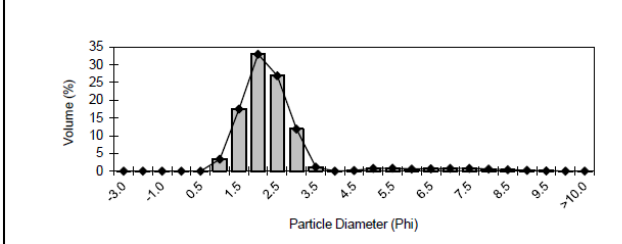


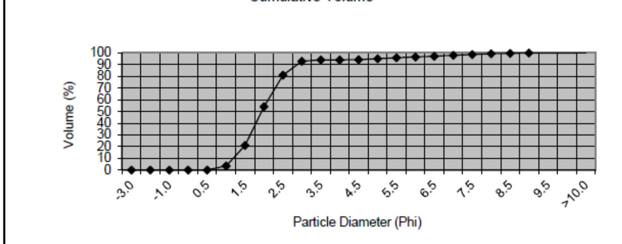


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.32	0.3	
2.0000	-1.0	0.16	0.5	Granule
1.0000	0.0	0.29	0.8	V.Coarse Sand
0.7100	0.5	19.05	19.8	Coarse Sand
0.5000	1.0	27.24	47.1	
0.3550	1.5	22.70	69.8	Medium Sand
0.2500	2.0	13.35	83.1	
0.1800	2.5	6.33	89.4	Fine Sand
0.1250	3.0	4.39	93.8	
0.0900	3.5	2.47	96.3	V.Fine Sand
0.0630	4.0	1.05	97.4	
0.0440	4.5	0.10	97.4	Coarse Silt
0.0315	5.0	0.03	97.5	
0.0220	5.5	0.34	97.8	Medium Silt
0.0156	6.0	0.48	98.3	
0.0110	6.5	0.49	98.8	Fine silt
0.0078	7.0	0.43	99.2	
0.0055	7.5	0.37	99.6	V.Fine Silt
0.0039	8.0	0.27	99.9	
0.0028	8.5	0.15	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.446	0.313	1.16
Median	0.481		1.06
Sorting	**Value**	**Inference**	
Coefficient	0.89	Moderately Sorted	
Skewness	0.29	Positive(Coarse)	
Kurtosis	1.16	Leptokurtic	
% Fines	2.65%	Medium Sand	
% Sands	96.87%		
% Gravel	0.48%		

Sample No.:	GRAB_C_3	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 15:03

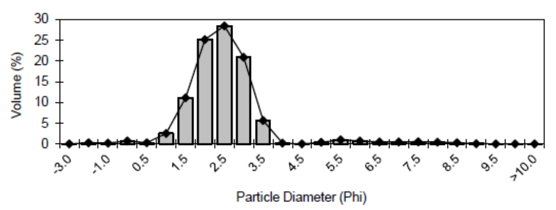


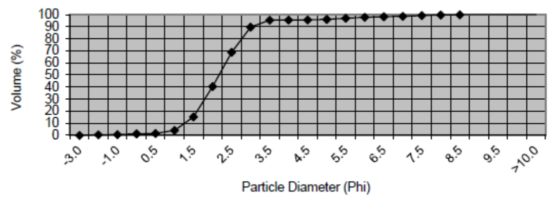


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.00	0.0	
2.0000	-1.0	0.03	0.0	Granule
1.0000	0.0	0.03	0.1	V.Coarse Sand
0.7100	0.5	0.00	0.1	Coarse Sand
0.5000	1.0	3.41	3.5	
0.3550	1.5	17.57	21.0	Medium Sand
0.2500	2.0	33.01	54.1	
0.1800	2.5	26.94	81.0	Fine Sand
0.1250	3.0	11.90	92.9	
0.0900	3.5	1.14	94.0	V.Fine Sand
0.0630	4.0	0.00	94.0	
0.0440	4.5	0.19	94.2	Coarse Silt
0.0315	5.0	0.78	95.0	
0.0220	5.5	0.83	95.8	Medium Silt
0.0156	6.0	0.62	96.5	
0.0110	6.5	0.66	97.1	Fine silt
0.0078	7.0	0.76	97.9	
0.0055	7.5	0.76	98.7	V.Fine Silt
0.0039	8.0	0.60	99.3	
0.0028	8.5	0.40	99.7	Coarse Clay
0.0020	9.0	0.26	99.9	
0.0014	9.5	0.08	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.259	0.154	1.95
Median	0.263		1.93
Sorting	**Value**	**Inference**	
Coefficient	0.91	Moderately Sorted	
Skewness	0.30	Very Positive (Coarse)	
Kurtosis	2.00	Very Leptokurtic	
% Fines	5.97%	Medium Sand	
% Sands	94.00%		
% Gravel	0.03%		

Sample No.:	GRAB_C_4	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 15:12



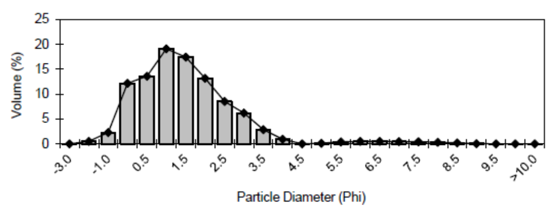


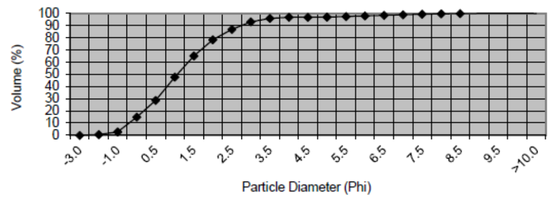
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.32	0.3	
2.0000	-1.0	0.22	0.5	Granule
1.0000	0.0	0.73	1.3	V.Coarse Sand
0.7100	0.5	0.30	1.6	Coarse Sand
0.5000	1.0	2.54	4.1	
0.3550	1.5	11.12	15.2	Medium Sand
0.2500	2.0	25.15	40.4	
0.1800	2.5	28.45	68.8	Fine Sand
0.1250	3.0	20.92	89.8	
0.0900	3.5	5.66	95.4	V.Fine Sand
0.0630	4.0	0.22	95.6	
0.0440	4.5	0.00	95.6	Coarse Silt
0.0315	5.0	0.40	96.0	
0.0220	5.5	0.99	97.0	Medium Silt
0.0156	6.0	0.71	97.7	
0.0110	6.5	0.48	98.2	Fine silt
0.0078	7.0	0.47	98.7	
0.0055	7.5	0.52	99.2	V.Fine Silt
0.0039	8.0	0.45	99.7	
0.0028	8.5	0.29	100.0	Coarse Clay
0.0020	9.0	0.05	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.223	0.142	2.16
Median	0.226		2.14

Sorting	Value	Inference
Coefficient	0.70	Moderately Well Sorted
Skewness	0.06	Symmetrical
Kurtosis	1.05	Mesokurtic
% Fines	4.36%	Fine Sand
% Sands	95.10%	
% Gravel	0.54%	

Sample No.:	GRAB_C_5	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 15:22



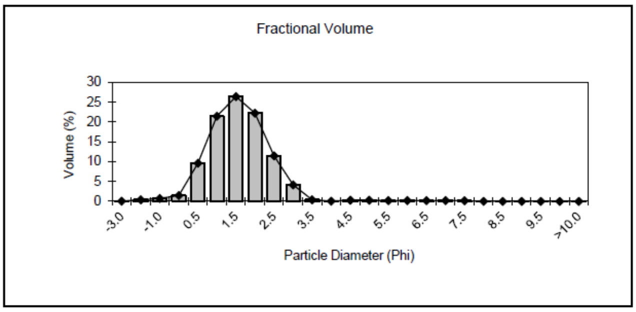


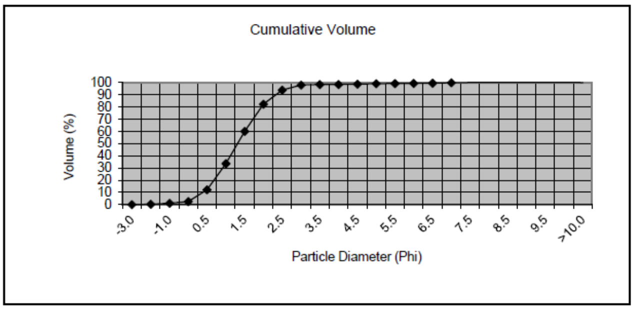
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.51	0.5	
2.0000	-1.0	2.31	2.8	Granule
1.0000	0.0	12.17	15.0	V.Coarse Sand
0.7100	0.5	13.63	28.6	Coarse Sand
0.5000	1.0	19.10	47.7	
0.3550	1.5	17.44	65.2	Medium Sand
0.2500	2.0	13.17	78.3	
0.1800	2.5	8.54	86.9	Fine Sand
0.1250	3.0	6.22	93.1	
0.0900	3.5	2.89	96.0	V.Fine Sand
0.0630	4.0	0.95	96.9	
0.0440	4.5	0.01	96.9	Coarse Silt
0.0315	5.0	0.12	97.1	
0.0220	5.5	0.41	97.5	Medium Silt
0.0156	6.0	0.50	98.0	
0.0110	6.5	0.52	98.5	Fine silt
0.0078	7.0	0.49	99.0	
0.0055	7.5	0.43	99.4	V.Fine Silt
0.0039	8.0	0.33	99.7	
0.0028	8.5	0.21	99.9	Coarse Clay
0.0020	9.0	0.06	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.458	0.610	1.13
Median	0.481		1.06

Sorting	Value	Inference
Coefficient	1.20	Poorly Sorted
Skewness	0.09	Symmetrical
Kurtosis	1.13	Leptokurtic
% Fines	3.07%	Medium Sand
% Sands	94.11%	
% Gravel	2.82%	

Sample No.:	GRAB_C_6	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 15:31

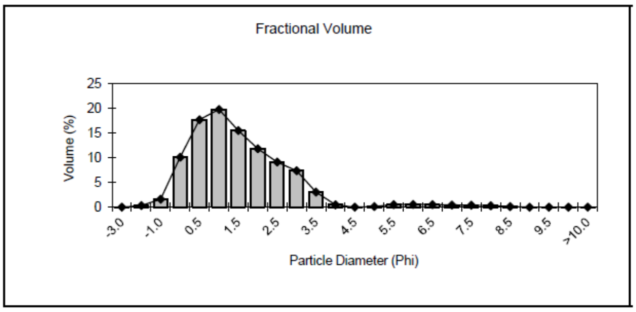


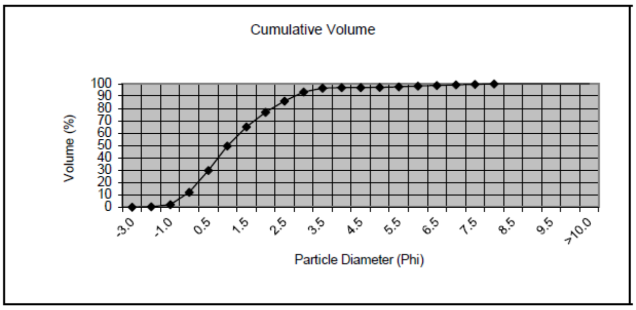


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.05	0.0	Pebble
4.0000	-2.0	0.39	0.4	
2.0000	-1.0	0.74	1.2	Granule
1.0000	0.0	1.45	2.6	V.Coarse Sand
0.7100	0.5	9.62	12.2	Coarse Sand
0.5000	1.0	21.49	33.7	
0.3550	1.5	26.42	60.2	Medium Sand
0.2500	2.0	22.26	82.4	
0.1800	2.5	11.46	93.9	Fine Sand
0.1250	3.0	4.13	98.0	
0.0900	3.5	0.41	98.4	V.Fine Sand
0.0630	4.0	0.03	98.4	
0.0440	4.5	0.31	98.8	Coarse Silt
0.0315	5.0	0.28	99.0	
0.0220	5.5	0.20	99.2	Medium Silt
0.0156	6.0	0.18	99.4	
0.0110	6.5	0.22	99.6	Fine silt
0.0078	7.0	0.21	99.8	
0.0055	7.5	0.17	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.405	0.277	1.30
Median	0.411		1.28
Sorting	**Value**	**Inference**	
Coefficient	0.75	Moderately Sorted	
Skewness	0.05	Symmetrical	
Kurtosis	0.98	Mesokurtic	
% Fines	1.56%	Medium Sand	
% Sands	97.26%		
% Gravel	1.18%		

Sample No.:	GRAB_C_7	**Operator**	DW
Source Data:	ONE Dyas	**Date&Time:**	12/06/2019 15:41

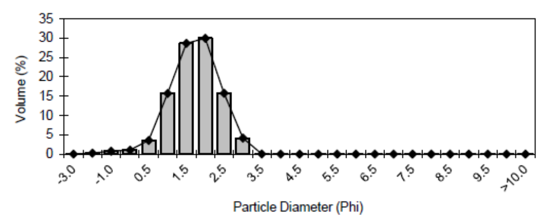


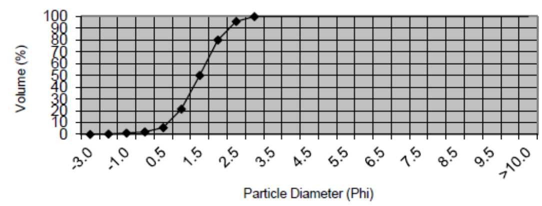


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.32	0.3	
2.0000	-1.0	1.62	1.9	Granule
1.0000	0.0	10.12	12.1	V.Coarse Sand
0.7100	0.5	17.69	29.7	Coarse Sand
0.5000	1.0	19.77	49.5	
0.3550	1.5	15.51	65.0	Medium Sand
0.2500	2.0	11.83	76.9	
0.1800	2.5	9.13	86.0	Fine Sand
0.1250	3.0	7.37	93.4	
0.0900	3.5	3.06	96.4	V.Fine Sand
0.0630	4.0	0.51	96.9	
0.0440	4.5	0.00	96.9	Coarse Silt
0.0315	5.0	0.16	97.1	
0.0220	5.5	0.54	97.6	Medium Silt
0.0156	6.0	0.57	98.2	
0.0110	6.5	0.52	98.7	Fine silt
0.0078	7.0	0.46	99.2	
0.0055	7.5	0.40	99.6	V.Fine Silt
0.0039	8.0	0.29	99.9	
0.0028	8.5	0.15	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	**mm**	**StDev (mm)**	**Phi**
Mean (MZ)	0.449	0.551	1.16
Median	0.496		1.01
Sorting	**Value**	**Inference**	
Coefficient	1.17	Poorly Sorted	
Skewness	0.15	Positive(Coarse)	
Kurtosis	1.05	Mesokurtic	
% Fines	3.08%	Medium Sand	
% Sands	94.99%		
% Gravel	1.94%		

Sample No.:	GRAB_C_8	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 15:50



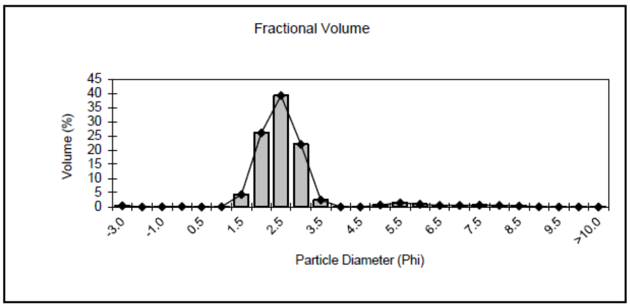


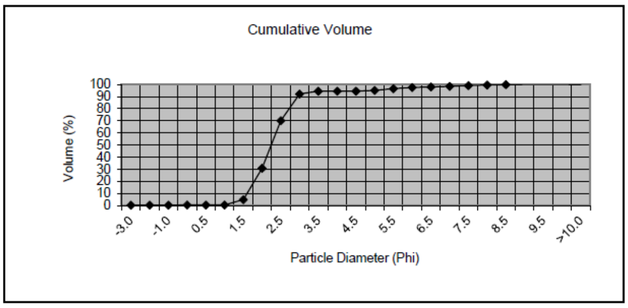
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.28	0.3	
2.0000	-1.0	0.75	1.0	Granule
1.0000	0.0	1.07	2.1	V.Coarse Sand
0.7100	0.5	3.56	5.7	Coarse Sand
0.5000	1.0	15.73	21.4	
0.3550	1.5	28.68	50.1	Medium Sand
0.2500	2.0	29.95	80.0	
0.1800	2.5	15.79	95.8	Fine Sand
0.1250	3.0	4.14	99.9	
0.0900	3.5	0.06	100.0	V.Fine Sand
0.0630	4.0	0.00	100.0	
0.0440	4.5	0.00	100.0	Coarse Silt
0.0315	5.0	0.00	100.0	
0.0220	5.5	0.00	100.0	Medium Silt
0.0156	6.0	0.00	100.0	
0.0110	6.5	0.00	100.0	Fine silt
0.0078	7.0	0.00	100.0	
0.0055	7.5	0.00	100.0	V.Fine Silt
0.0039	8.0	0.00	100.0	
0.0028	8.5	0.00	100.0	Coarse Clay
0.0020	9.0	0.00	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.361	0.213	1.47
Median	0.355		1.49

Sorting	Value	Inference
Coefficient	0.64	Moderately Well Sorted
Skewness	-0.06	Symmetrical
Kurtosis	0.99	Mesokurtic
% Fines	0.00%	Medium Sand
% Sands	98.97%	
% Gravel	1.03%	

Sample No.:	GRAB_C3_0	Operator	ER
Source Data:	ONE Dyas	Date&Time:	20/06/2019 09:14



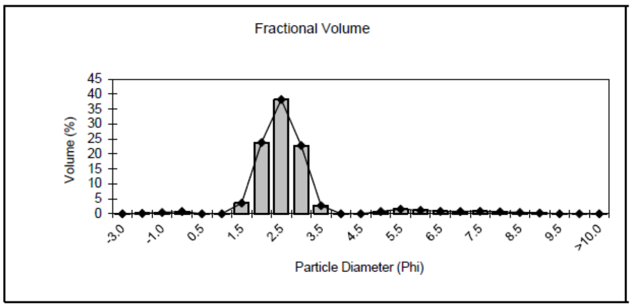


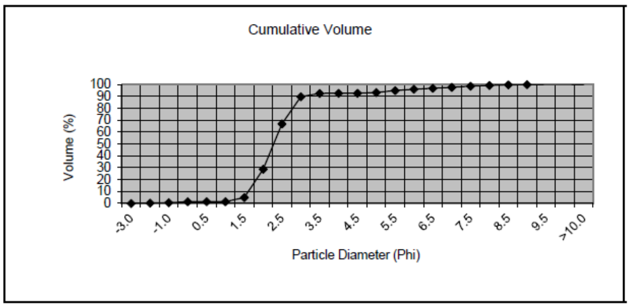
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.41	0.4	Pebble
4.0000	-2.0	0.00	0.4	
2.0000	-1.0	0.06	0.5	Granule
1.0000	0.0	0.12	0.6	V.Coarse Sand
0.7100	0.5	0.00	0.6	Coarse Sand
0.5000	1.0	0.02	0.6	
0.3550	1.5	4.33	4.9	Medium Sand
0.2500	2.0	26.02	31.0	
0.1800	2.5	39.20	70.2	Fine Sand
0.1250	3.0	22.00	92.2	
0.0900	3.5	2.40	94.6	V.Fine Sand
0.0630	4.0	0.01	94.6	
0.0440	4.5	0.00	94.6	Coarse Silt
0.0315	5.0	0.68	95.2	
0.0220	5.5	1.37	96.6	Medium Silt
0.0156	6.0	0.89	97.5	
0.0110	6.5	0.53	98.0	Fine silt
0.0078	7.0	0.52	98.6	
0.0055	7.5	0.59	99.1	V.Fine Silt
0.0039	8.0	0.49	99.6	
0.0028	8.5	0.31	99.9	Coarse Clay
0.0020	9.0	0.05	100.0	
0.0014	9.5	0.00	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.214	0.108	2.23
Median	0.216		2.21

Sorting	Value	Inference
Coefficient	0.77	Moderately Sorted
Skewness	0.31	Very Positive (Coarse)
Kurtosis	1.91	Very Leptokurtic
% Fines	5.44%	Fine Sand
% Sands	94.09%	
% Gravel	0.47%	

Sample No.:	GRAB_C3_1	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 16:11



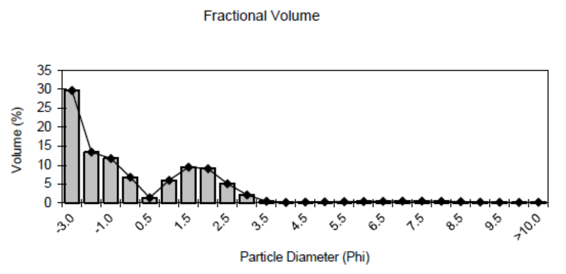


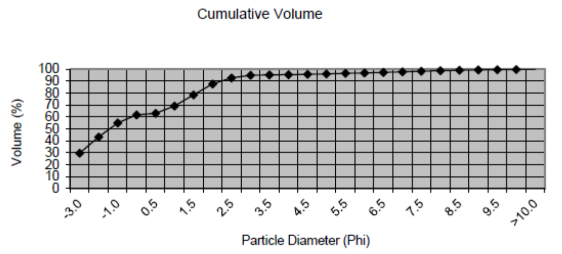
Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	0.00	0.0	Pebble
4.0000	-2.0	0.17	0.2	
2.0000	-1.0	0.44	0.6	Granule
1.0000	0.0	0.79	1.4	V.Coarse Sand
0.7100	0.5	0.00	1.4	Coarse Sand
0.5000	1.0	0.01	1.4	
0.3550	1.5	3.55	5.0	Medium Sand
0.2500	2.0	23.83	28.8	
0.1800	2.5	38.18	67.0	Fine Sand
0.1250	3.0	22.82	89.8	
0.0900	3.5	2.78	92.6	V.Fine Sand
0.0630	4.0	0.01	92.6	
0.0440	4.5	0.00	92.6	Coarse Silt
0.0315	5.0	0.75	93.3	
0.0220	5.5	1.56	94.9	Medium Silt
0.0156	6.0	1.16	96.1	
0.0110	6.5	0.83	96.9	Fine silt
0.0078	7.0	0.80	97.7	
0.0055	7.5	0.86	98.5	V.Fine Silt
0.0039	8.0	0.72	99.3	
0.0028	8.5	0.46	99.7	Coarse Clay
0.0020	9.0	0.26	100.0	
0.0014	9.5	0.02	100.0	Medium Clay
0.0010	10.0	0.00	100.0	
<0.001	>10.0	0.00	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	0.208	0.111	2.27
Median	0.211		2.24

Sorting	Value	Inference
Coefficient	0.90	Moderately Sorted
Skewness	0.34	Very Positive (Coarse)
Kurtosis	2.27	Very Leptokurtic
% Fines	7.41%	Fine Sand
% Sands	91.98%	
% Gravel	0.62%	

Sample No.:	GRAB_C3_2	Operator	DW
Source Data:	ONE Dyas	Date&Time:	12/06/2019 16:21



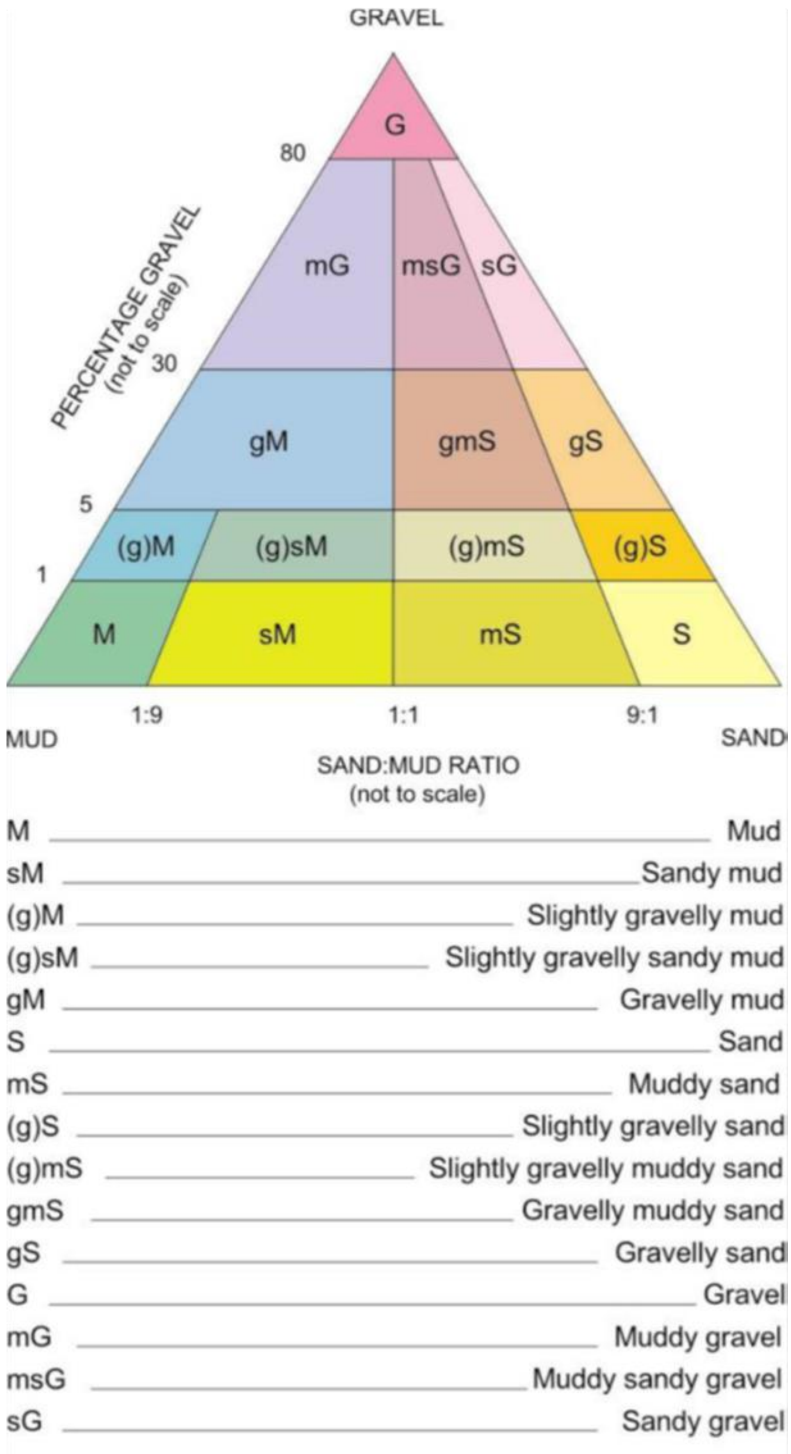


Aperture (mm)	Aperture (Phi unit)	Percentage Fractional	Cumulative	Sediment Description
8.0000	-3.0	29.70	29.7	Pebble
4.0000	-2.0	13.46	43.2	
2.0000	-1.0	11.76	54.9	Granule
1.0000	0.0	6.82	61.7	V.Coarse Sand
0.7100	0.5	1.37	63.1	Coarse Sand
0.5000	1.0	6.02	69.1	
0.3550	1.5	9.45	78.6	Medium Sand
0.2500	2.0	9.04	87.6	
0.1800	2.5	5.09	92.7	Fine Sand
0.1250	3.0	2.16	94.9	
0.0900	3.5	0.45	95.3	V.Fine Sand
0.0630	4.0	0.17	95.5	
0.0440	4.5	0.27	95.7	Coarse Silt
0.0315	5.0	0.32	96.1	
0.0220	5.5	0.38	96.4	Medium Silt
0.0156	6.0	0.41	96.9	
0.0110	6.5	0.48	97.3	Fine silt
0.0078	7.0	0.50	97.8	
0.0055	7.5	0.50	98.3	V.Fine Silt
0.0039	8.0	0.45	98.8	
0.0028	8.5	0.37	99.2	Coarse Clay
0.0020	9.0	0.29	99.5	
0.0014	9.5	0.21	99.7	Medium Clay
0.0010	10.0	0.14	99.8	
<0.001	>10.0	0.20	100.0	Fine Clay

Graphical	mm	StDev (mm)	Phi
Mean (MZ)	2.154	6.512	-1.11
Median	2.835		-1.50

Sorting	Value	Inference
Coefficient	2.41	Very Poorly Sorted
Skewness	0.27	Positive(Coarse)
Kurtosis	0.64	Very Platykurtic
% Fines	4.52%	Granule
% Sands	40.57%	
% Gravel	54.91%	

Modified Folk Classification



Folk and Wentworth Classifications

Station	Folk Classification	Wentworth Classification
Grab_P_0	Medium Sand	Muddy sand
Grab_P_1	Coarse Silt	Slightly gravelly muddy sand
Grab_P_2	Fine Sand	Sand
Grab_P_3	Fine Sand	Sand
Grab_P_4	Medium Sand	Sand
Grab_P_5	Medium Sand	Slightly gravelly sand
Grab_P_6	Medium Sand	Sand
Grab_P_7	Fine Sand	Sand
Grab_P_8	Medium Sand	Slightly gravelly sand
Grab_P_9	Fine Sand	Slightly gravelly sand
Grab_P_10	Fine Sand	Slightly gravelly muddy sand
Grab_P_11	Medium Sand	Gravelly sand
Grab_P_12	Fine Sand	Sand
Grab_P_13	Fine Sand	Sand
Grab_P_14	Fine Sand	Slightly gravelly sand
Grab_P_15	Fine Sand	Slightly gravelly sand
Grab_C_0	Coarse Sand	Slightly gravelly sand
Grab_C_1	Medium Sand	Gravelly sand
Grab_C_2	Medium Sand	Sand
Grab_C_3	Fine Sand	Sand
Grab_C_4	Medium Sand	Sand
Grab_C_5	Medium Sand	Slightly gravelly sand
Grab_C_6	Medium Sand	Slightly gravelly sand
Grab_C_7	Medium Sand	Slightly gravelly sand
Grab_C_8	Coarse Sand	Slightly gravelly sand
Grab_C3_0	Fine Sand	Sand
Grab_C3_1	Fine Sand	Sand
Grab_C3_2	Granule	Muddy sandy gravel

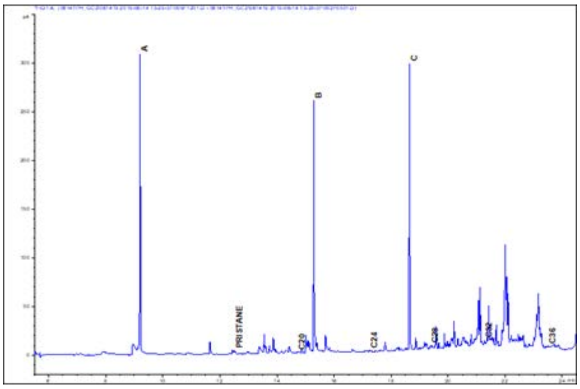
APPENDIX H - TOTAL ALIPHATIC CONCENTRATIONS (µg.kg^{-1})

Station	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
nC10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC11	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC12	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC13	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC14	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC15	2.21	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC16	1.99	2.58	<1	<1	<1	<1	<1	<1	<1	<1
nC17	6.87	7.73	3.53	3.18	1.30	1.70	<1	2.03	4.44	2.85
Pristane	7.12	5.78	1.51	1.69	<1	<1	<1	<1	<1	2.02
nC18	1.37	5.99	<1	<1	<1	<1	<1	<1	<1	<1
Phytane	<1	1.16	<1	<1	<1	<1	<1	<1	<1	<1
nC19	1.38	11.2	<1	<1	<1	<1	<1	<1	<1	<1
nC20	<1	32.3	<1	<1	<1	<1	<1	<1	<1	<1
nC21	<1	15.4	<1	<1	<1	<1	<1	<1	<1	<1
nC22	<1	20.9	<1	<1	<1	<1	<1	<1	<1	<1
nC23	<1	50.4	<1	<1	<1	<1	<1	<1	<1	<1
nC24	1.54	35.5	<1	<1	<1	<1	<1	<1	<1	<1
nC25	<1	109	<1	<1	<1	<1	<1	<1	<1	<1
nC26	2.49	31.2	<1	<1	<1	<1	<1	<1	<1	<1
nC27	2.28	118	2.79	3.68	<1	<1	<1	<1	<1	3.13
nC28	2.22	35.2	1.72	<1	<1	<1	<1	<1	<1	<1
nC29	2.11	149	6.44	<1	<1	<1	<1	<1	<1	<1
nC30	<1	16.4	4.82	1.76	<1	<1	<1	1.40	<1	<1
nC31	4.02	149	17.2	11.3	<1	3.35	1.51	2.44	<1	2.30
nC32	3.88	9.04	6.98	3.72	<1	2.02	<1	1.60	<1	<1
nC33	5.36	82.1	6.92	4.85	<1	<1	<1	1.49	<1	<1
nC34	2.13	11.2	13.2	13.3	<1	2.12	1.99	1.28	<1	<1
nC35	6.97	19.8	4.92	2.16	<1	1.35	<1	1.79	<1	<1
nC36	<1	13.0	3.43	3.12	<1	3.13	<1	<1	<1	<1
nC37	<1	6.05	1.55	1.39	<1	<1	<1	2.22	<1	<1
Total Oil (µg.kg^{-1})	**4693**	**13647**	**5166**	**4051**	**1621**	**1933**	**1959**	**1640**	**718**	**1185**
Total n-alkanes (µg.kg^{-1})	**46.8**	**931**	**73.5**	**48.4**	**1.30**	**13.7**	**3.49**	**14.2**	**4.44**	**8.29**

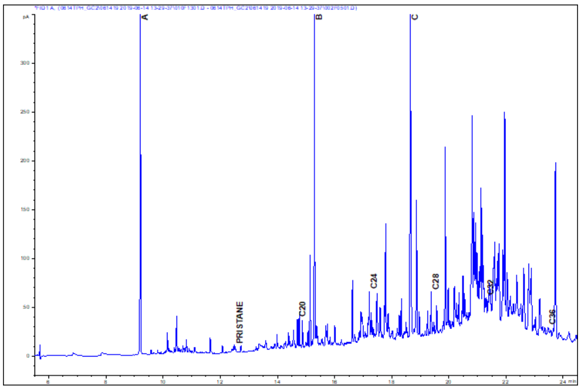
Station	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15
nC10	<1	<1	<1	<1	<1	<1
nC11	<1	<1	<1	<1	<1	<1
nC12	<1	<1	<1	<1	<1	<1
nC13	<1	<1	<1	<1	<1	<1
nC14	<1	<1	<1	<1	<1	<1
nC15	<1	<1	<1	<1	<1	2.73
nC16	<1	<1	<1	<1	<1	<1
nC17	2.56	1.64	1.42	<1	<1	1.49
Pristane	3.39	<1	1.59	4.88	4.83	3.54
nC18	<1	<1	<1	<1	<1	1.60
Phytane	<1	<1	<1	<1	<1	<1
nC19	<1	<1	<1	<1	<1	<1
nC20	<1	<1	<1	<1	<1	<1
nC21	<1	<1	<1	<1	<1	<1
nC22	<1	<1	<1	<1	<1	<1
nC23	<1	<1	<1	<1	<1	<1
nC24	<1	<1	<1	<1	<1	<1
nC25	<1	<1	<1	1.68	1.35	<1
nC26	<1	<1	<1	<1	<1	<1
nC27	1.85	1.68	1.92	3.49	2.37	<1
nC28	<1	<1	<1	1.75	3.12	<1
nC29	2.57	<1	1.55	4.21	5.83	3.44
nC30	4.79	1.60	3.17	5.32	6.21	<1
nC31	1.87	1.53	2.80	23.1	9.08	1.95
nC32	1.53	<1	<1	1.87	3.05	<1
nC33	2.33	1.76	1.58	3.94	2.24	1.60
nC34	<1	1.31	<1	2.68	<1	<1
nC35	<1	1.50	<1	3.13	<1	<1
nC36	<1	1.94	<1	5.02	<1	<1
nC37	<1	1.93	<1	<1	<1	<1
Total Oil (µg.kg^{-1})	**2,541**	**2,006**	**2,014**	**5,167**	**3,337**	**1,255**
Total n-alkanes (µg.kg^{-1})	**17.5**	**14.9**	**12.4**	**56.2**	**33.3**	**12.8**

Station	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
nC10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC11	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC12	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC13	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC14	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC15	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
nC16	<1	<1	<1	<1	2.10	1.59	<1	<1	<1	1.98	1.20	<1
nC17	<1	<1	<1	<1	2.87	2.51	<1	1.41	<1	1.61	<1	<1
Pristane	2.31	<1	<1	1.45	3.82	1.09	<1	1.19	<1	3.62	1.13	4.69
nC18	1.39	1.46	<1	<1	1.37	2.64	<1	1.72	<1	<1	1.14	<1
Phytane	<1	1.34	<1	<1	<1	<1	<1	<1	<1	<1	1.37	<1
nC19	<1	<1	<1	<1	2.25	<1	<1	<1	<1	1.31	3.40	1.72
nC20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8.31	<1
nC21	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.91	<1
nC22	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.11	1.39
nC23	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.52	<1
nC24	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	9.07	4.52
nC25	2.02	<1	<1	1.22	<1	<1	<1	<1	<1	<1	1.13	2.03
nC26	1.27	<1	<1	<1	<1	<1	<1	<1	1.74	<1	8.21	6.35
nC27	<1	<1	2.46	2.92	3.08	<1	1.84	1.82	2.56	6.00	6.40	4.12
nC28	1.50	<1	1.39	2.17	1.04	<1	<1	<1	<1	<1	11.3	7.46
nC29	4.96	2.91	3.73	5.19	5.50	2.39	3.46	3.03	3.05	11.7	38.3	37.6
nC30	4.61	7.86	5.94	3.32	5.76	1.26	1.80	2.09	<1	3.84	7.89	13.5
nC31	1.55	2.77	2.14	3.40	3.32	<1	<1	1.52	<1	19.1	25.8	7.53
nC32	1.27	<1	<1	<1	<1	<1	<1	<1	<1	1.39	1.15	22.1
nC33	2.13	5.92	5.05	1.60	<1	1.39	1.06	1.58	<1	7.03	8.17	8.54
nC34	2.03	<1	<1	<1	<1	1.01	1.62	<1	<1	9.51	4.92	1.02
nC35	<1	3.02	1.64	<1	<1	<1	<1	<1	<1	1.51	4.47	8.68
nC36	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.97	2.23	2.70
nC37	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.16	1.37	2.25
Total Oil (µg.kg^{-1})	**1277**	**1914**	**5167**	**2472**	**2664**	**1210**	**873**	**1230**	**974**	**5855**	**6092**	**5634**
Total n-alkanes (µg.kg^{-1})	**22.7**	**23.9**	**22.4**	**19.8**	**27.3**	**12.8**	**9.78**	**13.2**	**7.35**	**72.1**	**152**	**131**

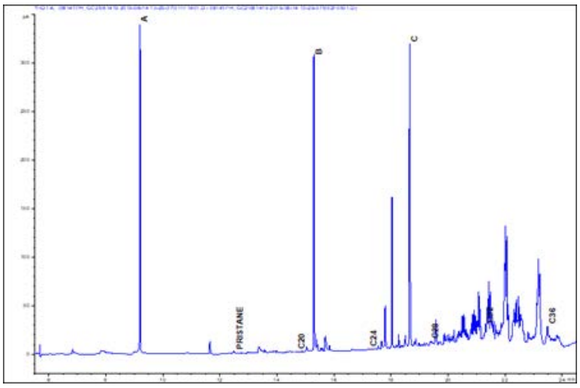
APPENDIX I - GC FID TRACES (SATURATES)



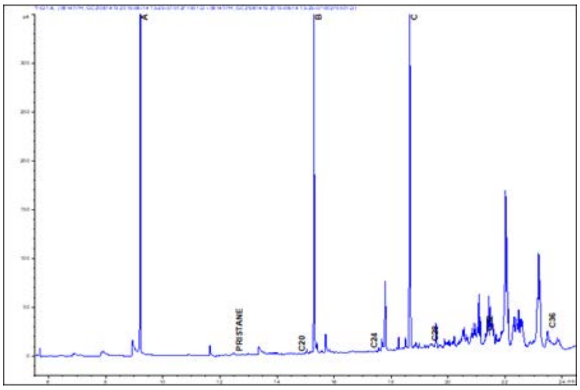
GRAB_P_0



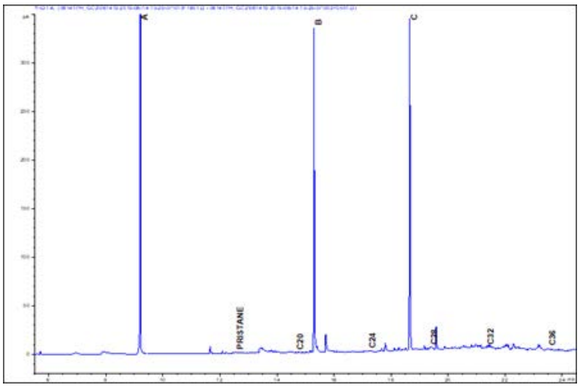
GRAB_P_1



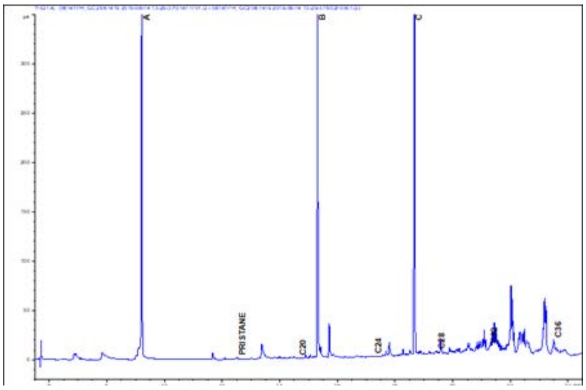
GRAB_P_2



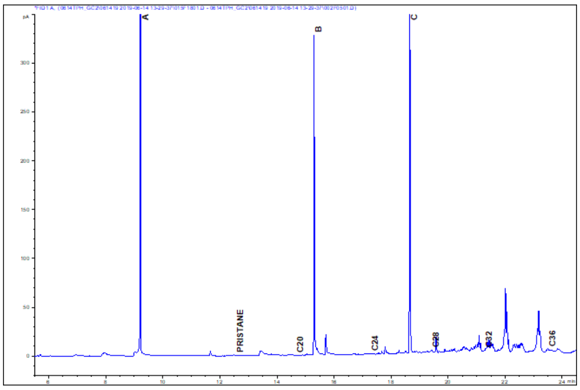
GRAB_P_3



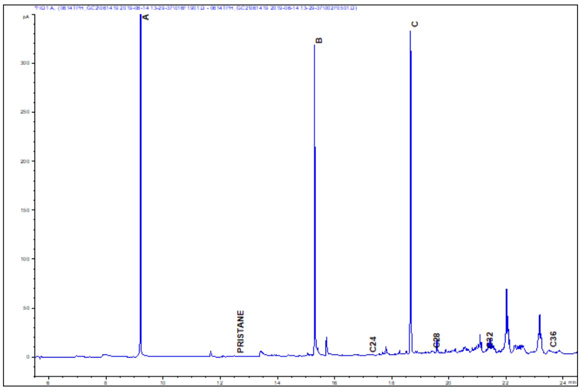
GRAB_P_4



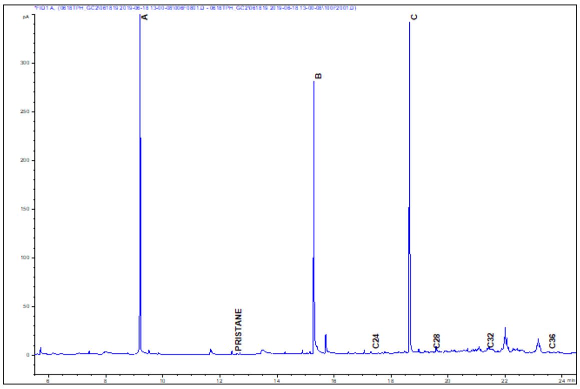
GRAB_P_5



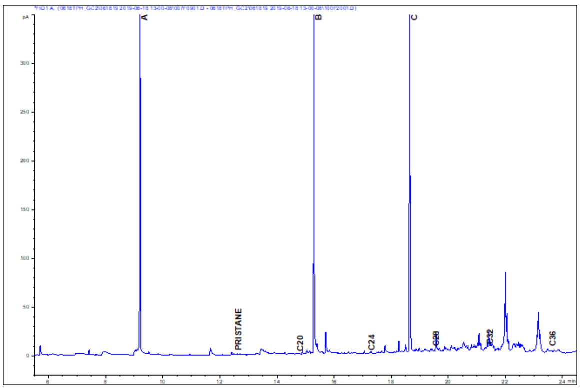
GRAB_P_6



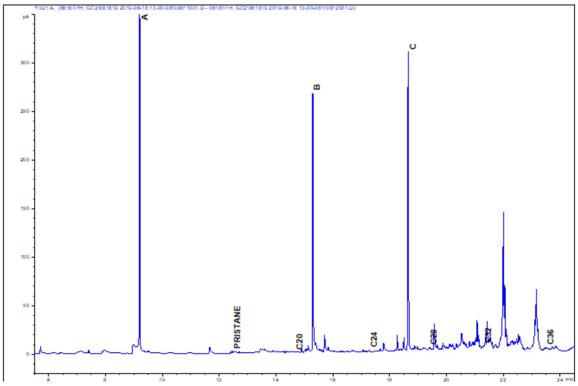
GRAB_P_7



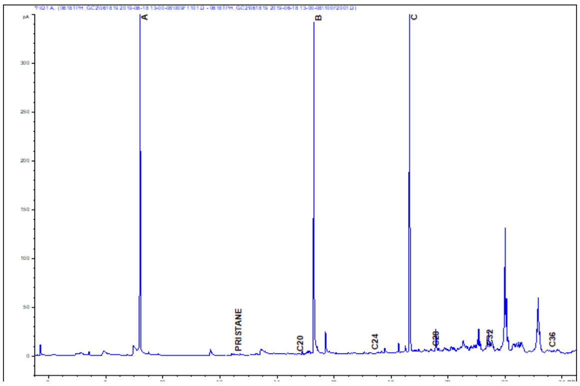
GRAB_P_8



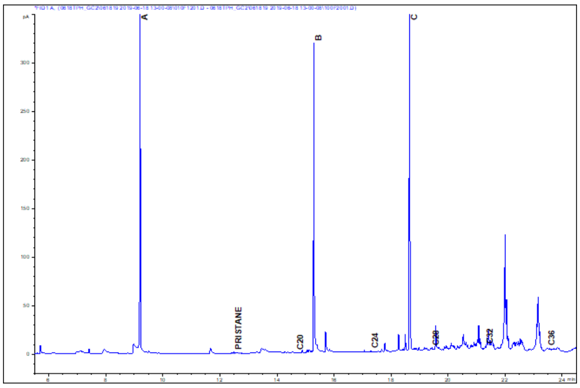
GRAB_P_9



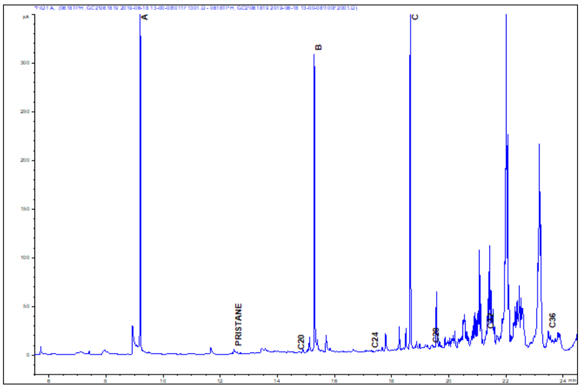
GRAB_P_10



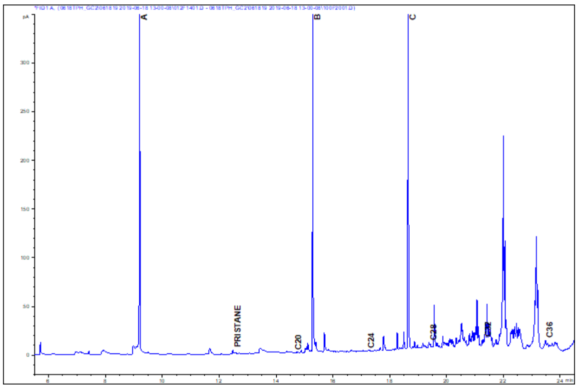
GRAB_P_11



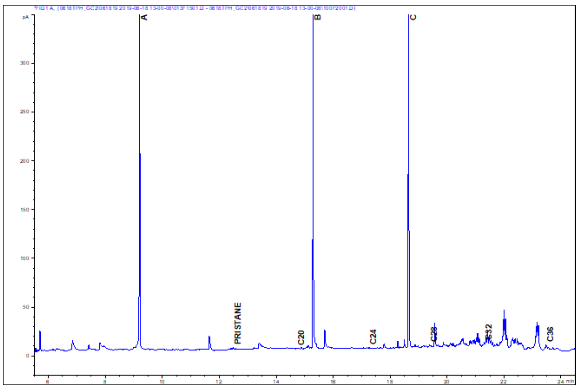
GRAB_P_12



GRAB_P_13



GRAB_P_14



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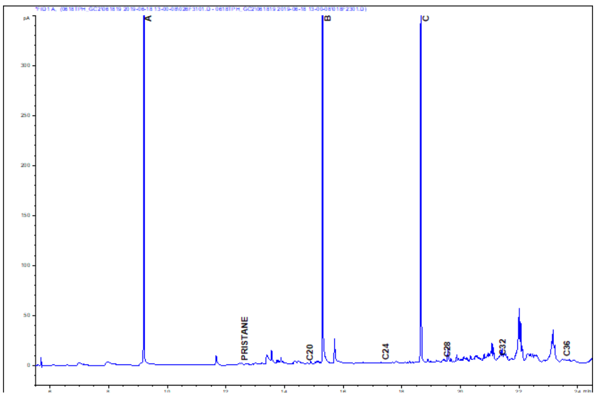
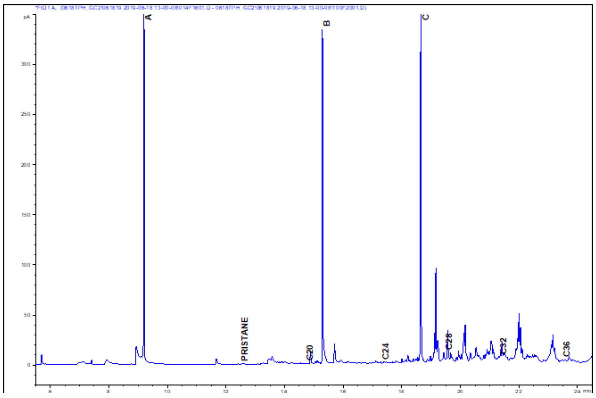
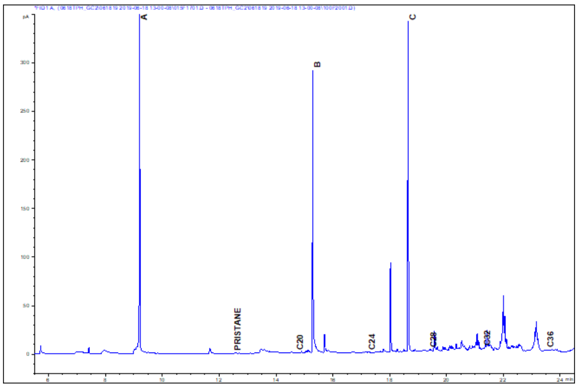


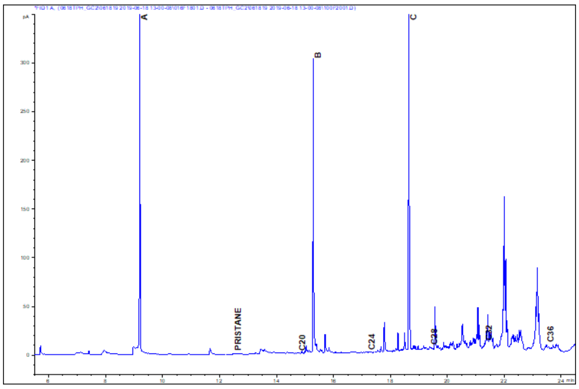
GRAB_C_0



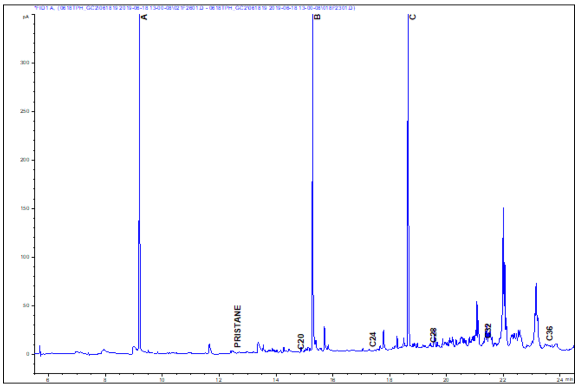
GRAB_C_1



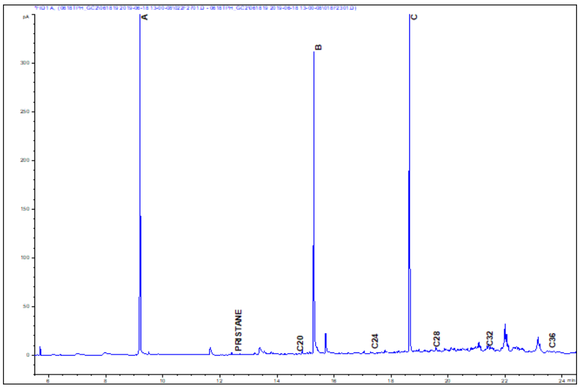
GRAB_C_2



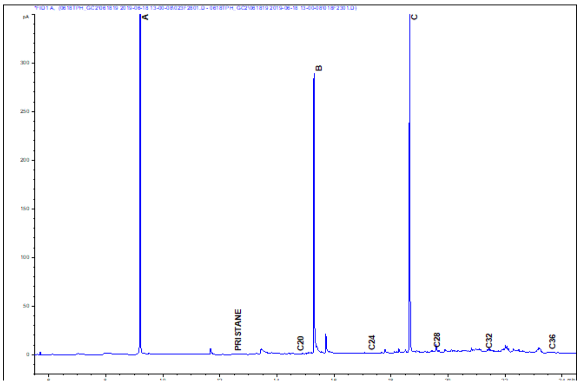
GRAB_C_3



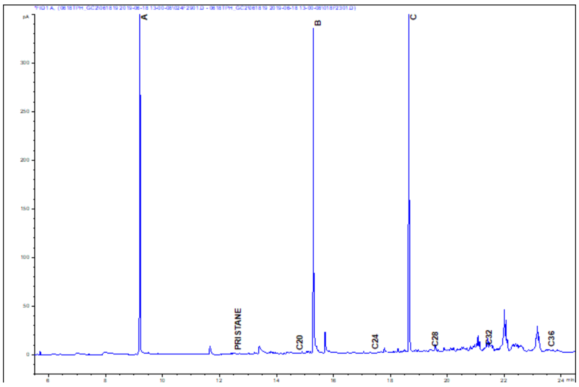
GRAB_C_4



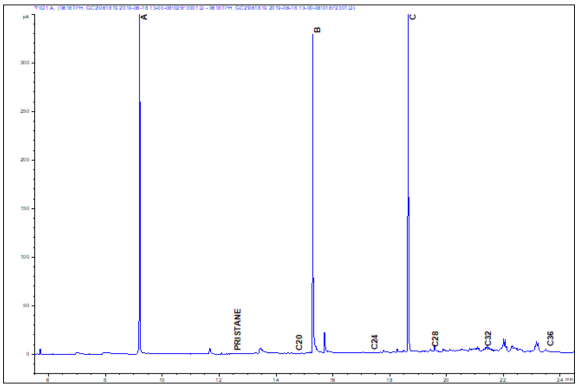
GRAB_C_5



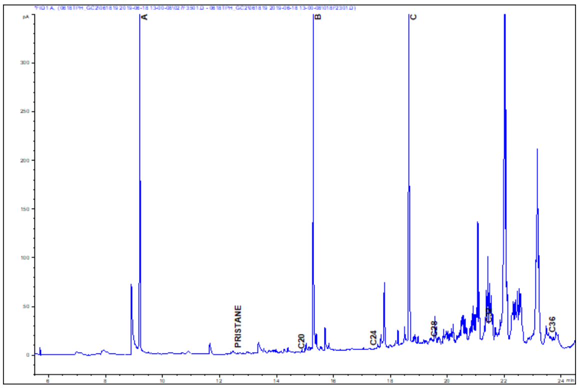
GRAB_C_6



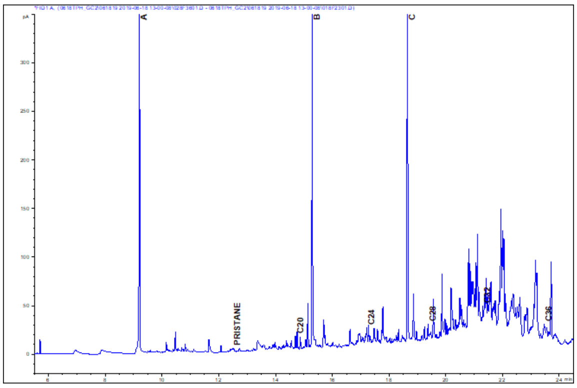
GRAB_C_7



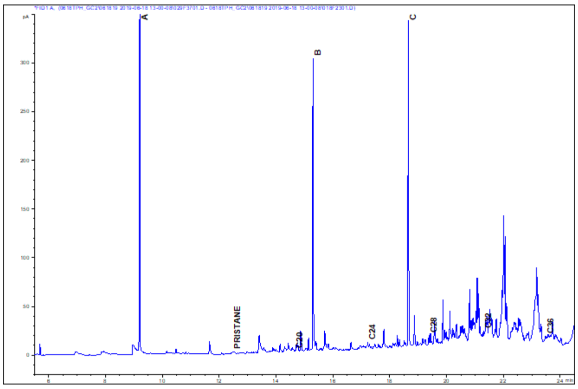
GRAB_C_8



GRAB_C3_0



GRAB_C3_1



GRAB_C3_2

APPENDIX J - POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATION (µg.kg^{-1})

Station	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
Naphthalene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
C1 Naphthalenes	1.39	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 Naphthalenes	2.42	1.95	1.67	1.32	<1	<1	<1	<1	1.35	<1
C3 Naphthalenes	1.42	1.66	<1	<1	<1	<1	<1	<1	<1	<1
C4 Naphthalenes	<1	2.26	<1	<1	<1	<1	<1	<1	<1	<1
Sum Naphthalenes	5.23	5.87	1.67	1.32	0.00	0.00	0.00	0.00	1.35	0.00
Phenanthrene / Anthracene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 178	1.59	2.46	<1	<1	<1	<1	<1	<1	<1	<1
C2 178	<1	2.53	<1	<1	<1	<1	<1	<1	<1	<1
C3 178	<1	1.40	<1	<1	<1	<1	<1	<1	<1	<1
Sum 178	1.59	6.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenzothiophene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
C1 Dibenzothiophenes	<1	1.52	<1	<1	<1	<1	<1	<1	<1	<1
C2 Dibenzothiophenes	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
C3 Dibenzothiophenes	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum Dibenzothiophenes	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoranthene / Pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 202	<1	2.93	<1	<1	<1	<1	<1	<1	<1	<1
C2 202	<1	5.15	<1	<1	<1	<1	<1	<1	<1	<1
C3 202	<1	4.51	<1	<1	<1	<1	<1	<1	<1	<1
Sum 202	0.00	12.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzoanthracene / Chrysene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 228	<1	4.65	<1	<1	<1	<1	<1	<1	<1	<1
C2 228	<1	5.50	<1	<1	<1	<1	<1	<1	<1	<1
Sum 228	0.00	10.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzofluoranthenes / Benzopyrenes	0.00	5.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 252	<1	3.92	<1	1.44	<1	<1	<1	<1	<1	<1
C2 252	<1	11.9	<1	<1	<1	<1	<1	<1	<1	<1
Sum 252	0.00	21.2	0.00	1.44	0.00	0.00	0.00	0.00	0.00	0.00
Dibenzoanthracene / Indenopyrene / Benzoperylene	0.00	4.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 276	<1	2.39	<1	<1	<1	<1	<1	<1	<1	<1
C2 276	<1	1.84	<1	<1	<1	<1	<1	<1	<1	<1
Sum 276	0.00	9.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of all PAHs	**6.82**	**66.8**	**1.67**	**2.76**	**0.00**	**0.00**	**0.00**	**0.00**	**1.35**	**0.00**
Sum of NPD fraction	**6.82**	**13.78**	**1.67**	**1.32**	**0.00**	**0.00**	**0.00**	**0.00**	**1.35**	**0.00**
NPD/4-6 Ring PAH Ratio	**-**	**0.26**	**-**	**0.92**	**-**	**-**	**-**	**-**	**-**	**-**

Station	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15
Naphthalene	<1	<1	<1	<1	<1	<1
C1 Naphthalenes	1.46	<1	<1	<1	<1	1.51
C2 Naphthalenes	2.07	4.34	1.92	2.77	1.94	2.31
C3 Naphthalenes	<1	<1	<1	<1	<1	2.27
C4 Naphthalenes	<1	<1	<1	<1	<1	2.04
Sum Naphthalenes	3.53	4.34	1.92	2.77	1.94	8.13
Phenanthrene / Anthracene	0.00	0.00	0.00	0.00	0.00	0.00
C1 178	<1	<1	<1	1.42	<1	<1
C2 178	<1	<1	<1	<1	<1	<1
C3 178	<1	<1	<1	<1	<1	<1
Sum 178	0.00	0.00	0.00	1.42	0.00	0.00
Dibenzothiophene	<1	<1	<1	<1	<1	<1
C1 Dibenzothiophenes	<1	<1	<1	<1	<1	<1
C2 Dibenzothiophenes	<1	<1	<1	<1	<1	<1
C3 Dibenzothiophenes	<1	<1	<1	<1	<1	<1
Sum Dibenzothiophenes	0.00	0.00	0.00	0.00	0.00	0.00
Fluoranthene / Pyrene	0.00	0.00	0.00	0.00	0.00	0.00
C1 202	<1	<1	<1	<1	<1	<1
C2 202	<1	<1	<1	<1	<1	<1
C3 202	<1	<1	<1	<1	<1	<1
Sum 202	0.00	0.00	0.00	0.00	0.00	0.00
Benzoanthracene / Chrysene	0.00	0.00	0.00	0.00	0.00	0.00
C1 228	<1	<1	<1	<1	<1	<1
C2 228	<1	<1	<1	<1	<1	<1
Sum 228	0.00	0.00	0.00	0.00	0.00	0.00
Benzofluoranthenes / Benzopyrenes	0.00	0.00	0.00	0.00	0.00	0.00
C1 252	<1	<1	<1	<1	<1	<1
C2 252	<1	<1	<1	<1	<1	<1
Sum 252	0.00	0.00	0.00	0.00	0.00	0.00
Dibenzoanthracene / Indenopyrene / Benzoperylene	0.00	0.00	0.00	0.00	0.00	0.00
C1 276	<1	<1	<1	<1	<1	<1
C2 276	<1	<1	<1	<1	<1	<1
Sum 276	0.00	0.00	0.00	0.00	0.00	0.00
Sum of all PAHs	**3.53**	**4.34**	**1.92**	**4.19**	**1.94**	**8.13**
Sum of NPD fraction	**3.53**	**4.34**	**1.92**	**4.19**	**1.94**	**8.13**
NPD/4-6 Ring PAH Ratio	-	-	-	-	-	-

Station	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8
Naphthalene	<1	<1	<1	<1	<1	<1	<1	<1	<1
C1 Naphthalenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 Naphthalenes	<1	<1	<1	1.46	<1	<1	<1	<1	<1
C3 Naphthalenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
C4 Naphthalenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum Naphthalenes	0.00	0.00	0.00	1.46	0.00	0.00	0.00	0.00	0.00
Phenanthrene / Anthracene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 178	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 178	<1	<1	<1	<1	<1	<1	<1	<1	<1
C3 178	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum 178	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenzothiophene	<1	<1	<1	<1	<1	<1	<1	<1	<1
C1 Dibenzothiophenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 Dibenzothiophenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
C3 Dibenzothiophenes	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum Dibenzothiophenes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluoranthene / Pyrene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 202	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 202	<1	<1	<1	<1	<1	<1	<1	<1	<1
C3 202	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum 202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzoanthracene / Chrysene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 228	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 228	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum 228	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzofluoranthenes / Benzopyrenes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 252	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 252	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum 252	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dibenzoanthracene / Indenopyrene / Benzoperylene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1 276	<1	<1	<1	<1	<1	<1	<1	<1	<1
C2 276	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum 276	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of all PAHs	**0.00**	**0.00**	**0.00**	**1.46**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Sum of NPD fraction	**0.00**	**0.00**	**0.00**	**1.46**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
NPD/4-6 Ring PAH Ratio	-	-	-	-	-	-	-	-	-

Station	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
Naphthalene	<1	<1	<1
C1 Naphthalenes	<1	<1	<1
C2 Naphthalenes	2.09	<1	<1
C3 Naphthalenes	<1	<1	<1
C4 Naphthalenes	<1	<1	<1
Sum Naphthalenes	2.09	0.00	0.00
Phenanthrene / Anthracene	0.00	0.00	0.00
C1 178	<1	<1	<1
C2 178	<1	<1	<1
C3 178	<1	<1	<1
Sum 178	0.00	0.00	0.00
Dibenzothiophene	<1	<1	<1
C1 Dibenzothiophenes	<1	<1	<1
C2 Dibenzothiophenes	<1	<1	<1
C3 Dibenzothiophenes	<1	<1	<1
Sum Dibenzothiophenes	0.00	0.00	0.00
Fluoranthene / Pyrene	0.00	0.00	0.00
C1 202	<1	1.76	<1
C2 202	<1	2.59	1.52
C3 202	<1	1.56	<1
Sum 202	0.00	5.91	1.52
Benzoanthracene / Chrysene	0.00	0.00	0.00
C1 228	<1	3.53	1.51
C2 228	<1	2.76	<1
Sum 228	0.00	6.29	1.51
Benzofluoranthenes / Benzopyrenes	0.00	0.00	0.00
C1 252	<1	1.57	<1
C2 252	<1	3.42	3.37
Sum 252	0.00	4.99	3.37
Dibenzoanthracene / Indenopyrene / Benzoperylene	0.00	1.33	0.00
C1 276	<1	1.33	<1
C2 276	<1	<1	<1
Sum 276	0.00	2.66	0.00
Sum of all PAHs	**2.09**	**19.9**	**6.41**
Sum of NPD fraction	**2.09**	**0.00**	**0.00**
NPD/4-6 Ring PAH Ratio	**-**	**-**	**-**

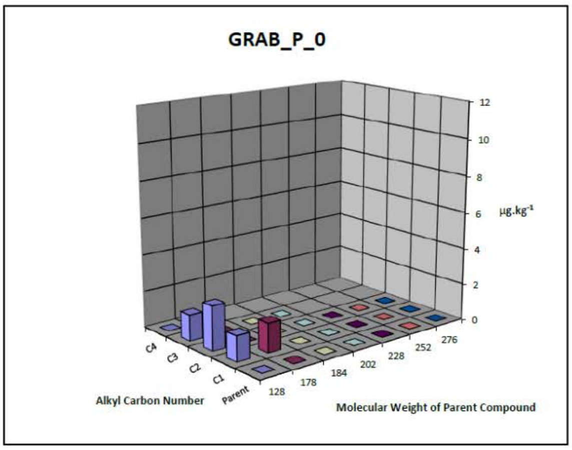
APPENDIX K - POLYCYCLIC AROMATIC HYDROCARBON CONCENTRATION: EPA (µg.kg^{-1})

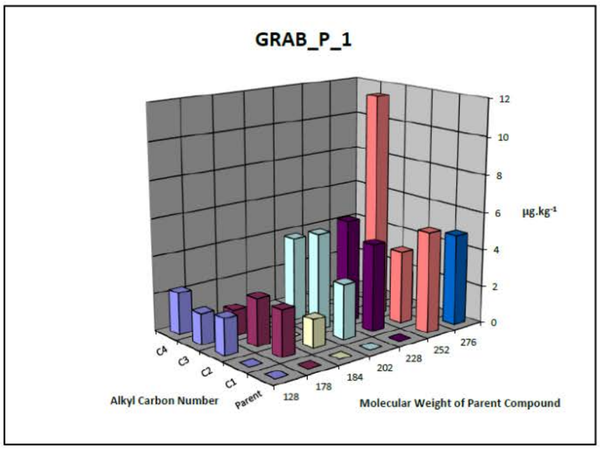
Station	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
Naphthalene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Acenaphthylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Acenaphthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluorene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Phenanthrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzothiophene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pyrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[a]anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chrysene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[b]fluoranthene	<1	2.03	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[k]fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[e]pyrene	<1	1.77	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[a]pyrene	<1	1.56	<1	<1	<1	<1	<1	<1	<1	<1
Perylene	1.76	49.0	<1	<1	<1	<1	<1	<1	<1	<1
Indeno[123,cd]pyrene	<1	1.74	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzo[a,h]anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[ghi]perylene	<1	3.13	<1	<1	<1	<1	<1	<1	<1	<1

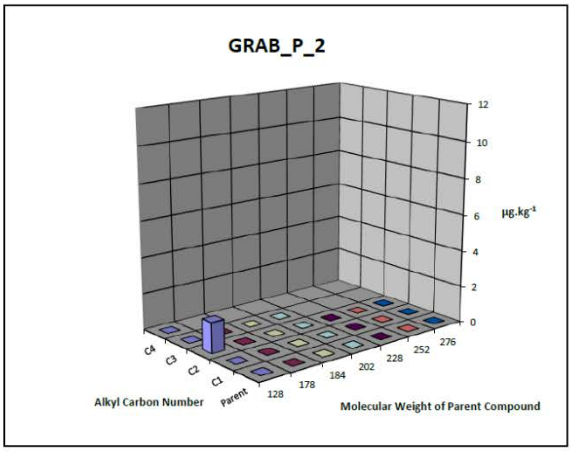
Station	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15
Naphthalene	<1	<1	<1	<1	<1	<1
Acenaphthylene	<1	<1	<1	<1	<1	<1
Acenaphthene	<1	<1	<1	<1	<1	<1
Fluorene	<1	<1	<1	<1	<1	<1
Phenanthrene	<1	<1	<1	<1	<1	<1
Dibenzothiophene	<1	<1	<1	<1	<1	<1
Anthracene	<1	<1	<1	<1	<1	<1
Fluoranthene	<1	<1	<1	<1	<1	<1
Pyrene	<1	<1	<1	<1	<1	<1
Benzo[a]anthracene	<1	<1	<1	<1	<1	<1
Chrysene	<1	<1	<1	<1	<1	<1
Benzo[b]fluoranthene	<1	<1	<1	<1	<1	<1
Benzo[k]fluoranthene	<1	<1	<1	<1	<1	<1
Benzo[e]pyrene	<1	<1	<1	<1	<1	<1
Benzo[a]pyrene	<1	<1	<1	<1	<1	<1
Perylene	<1	<1	<1	<1	<1	<1
Indeno[123,cd]pyrene	<1	<1	<1	<1	<1	<1
Dibenzo[a,h]anthracene	<1	<1	<1	<1	<1	<1
Benzo[ghi]perylene	<1	<1	<1	<1	<1	<1

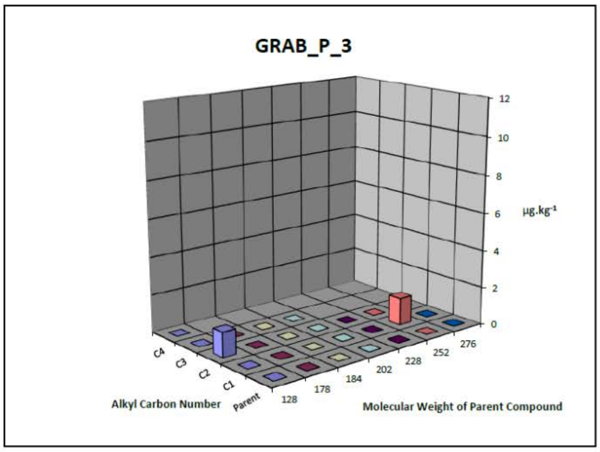
Station	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
Naphthalene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Acenaphthylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Acenaphthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluorene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Phenanthrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzothiophene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Pyrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[a]anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chrysene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[b]fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[k]fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[e]pyrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[a]pyrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Perylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	61.6	21.1
Indeno[123,cd]pyrene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dibenzo[a,h]anthracene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Benzo[ghi]perylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.33	<1

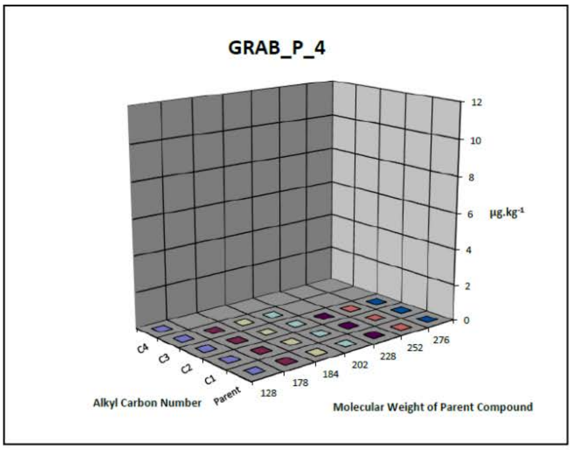
APPENDIX L - POLYCYCLIC AROMATIC HYDROCARBON: PARENTS COMPOUNDS AND ALKYL DERIVATIVES

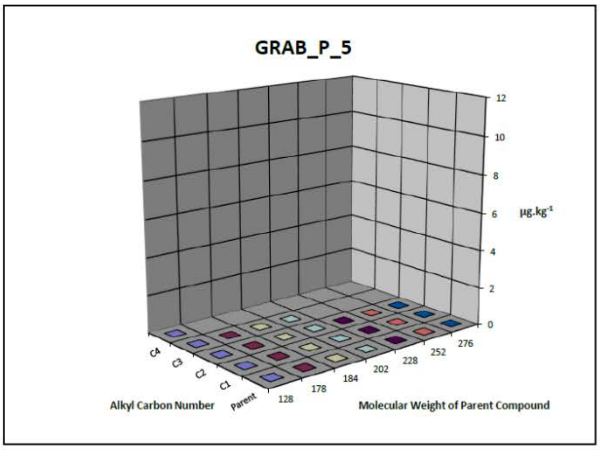


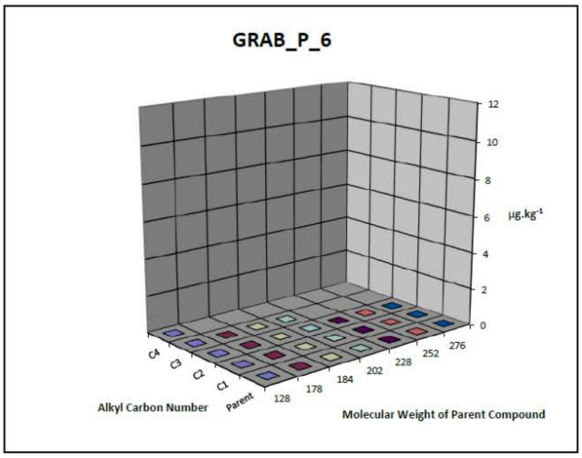


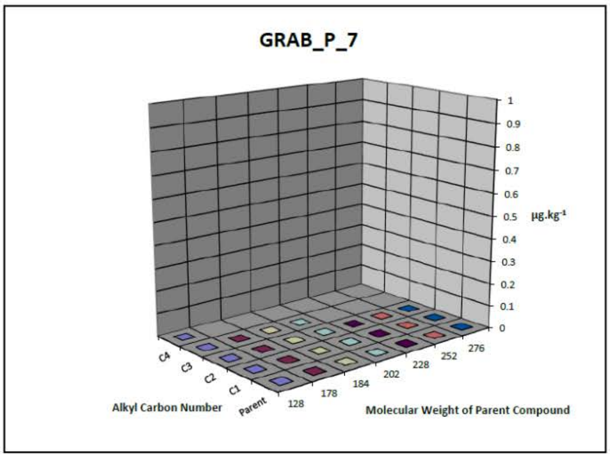


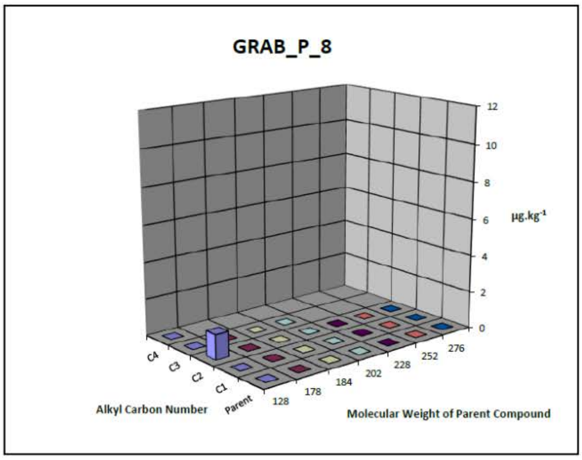


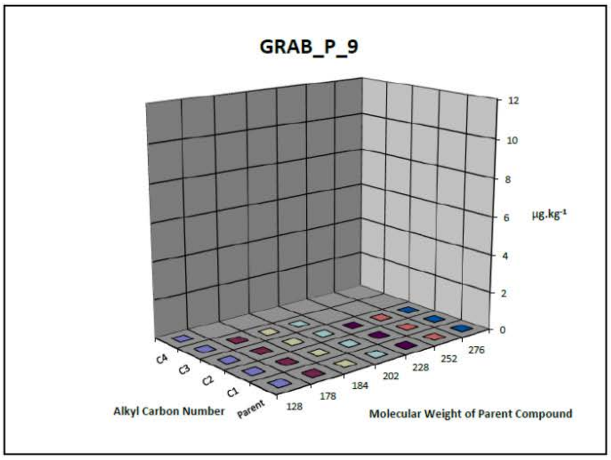


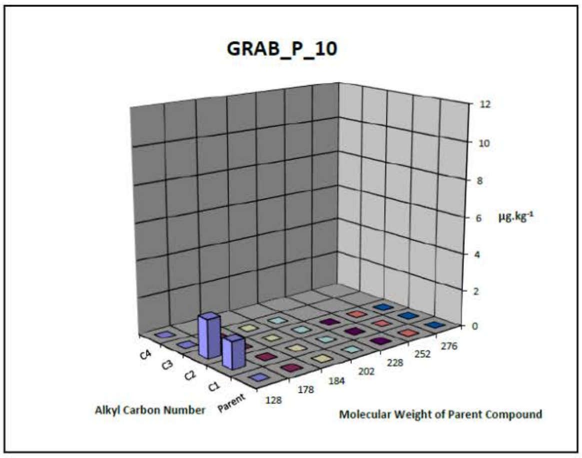


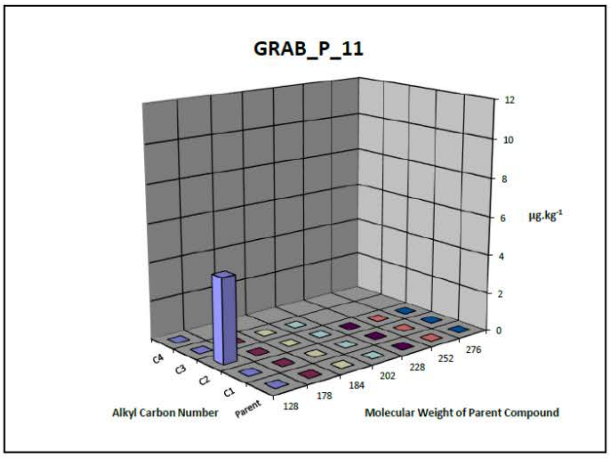

GRAB_P_6
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

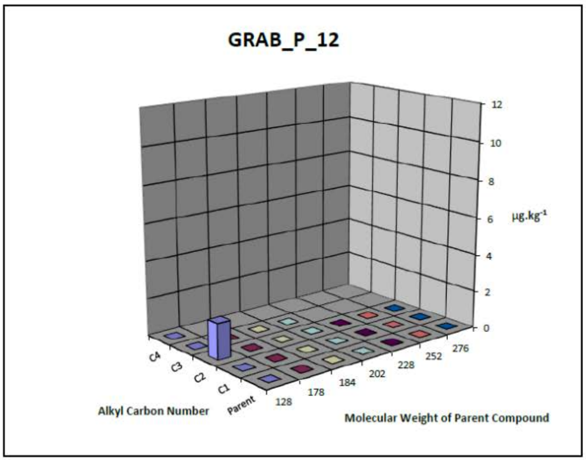

GRAB_P_7
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

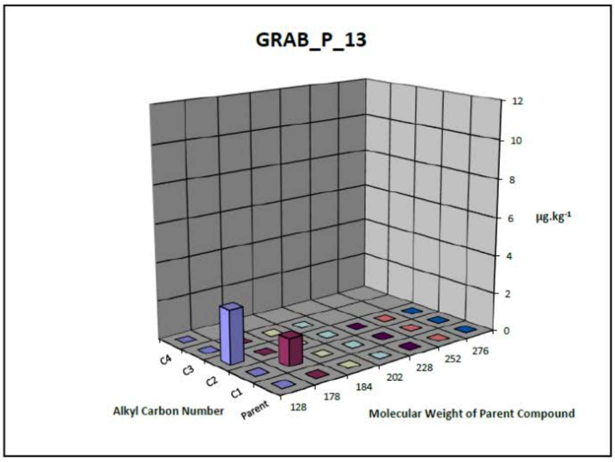

GRAB_P_8
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

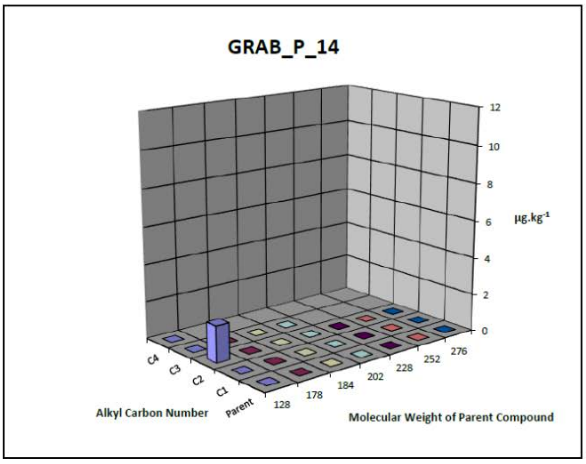

GRAB_P_9
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

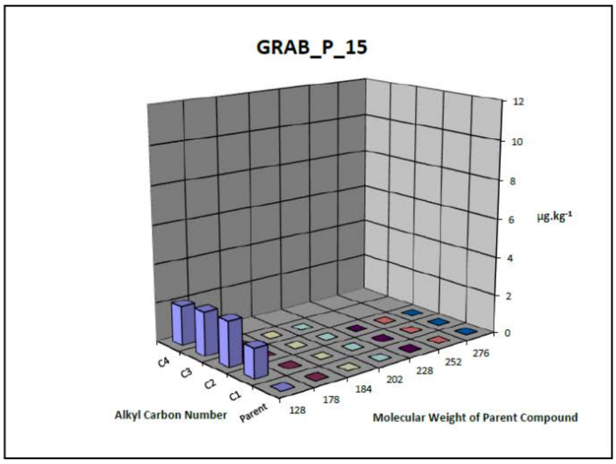

GRAB_P_10
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

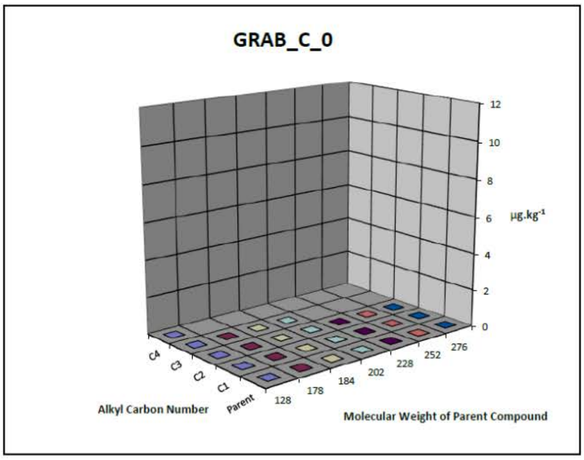

GRAB_P_11
µg.kg⁻¹
Alkyl Carbon Number
Molecular Weight of Parent Compound

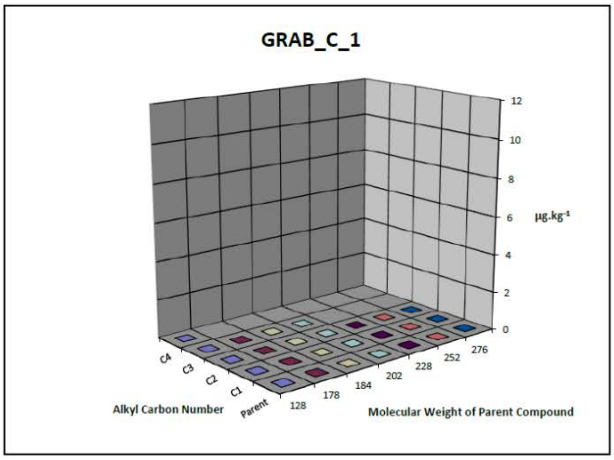

GRAB_P_12
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

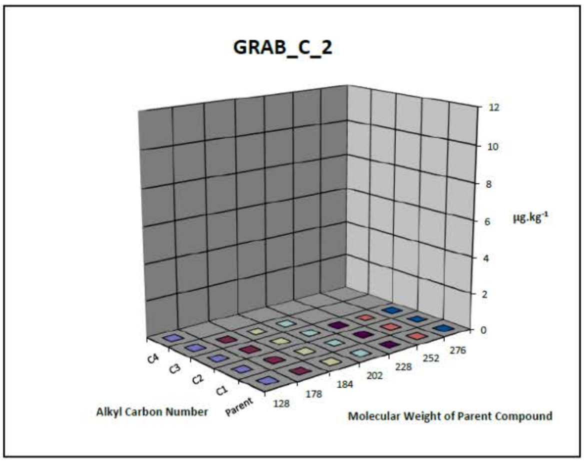

GRAB_P_13
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

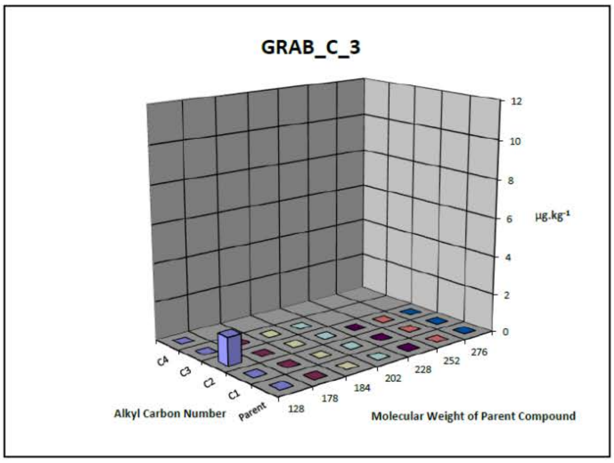

GRAB_P_14
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

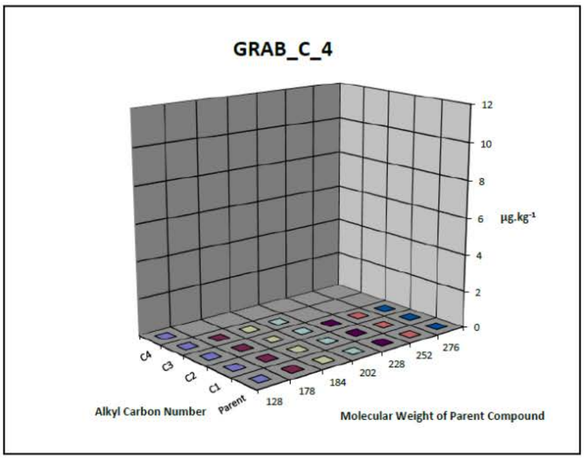

GRAB_P_15
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

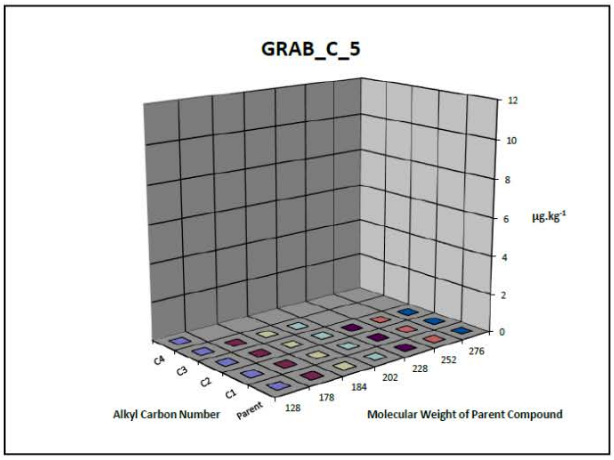

GRAB_C_0
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

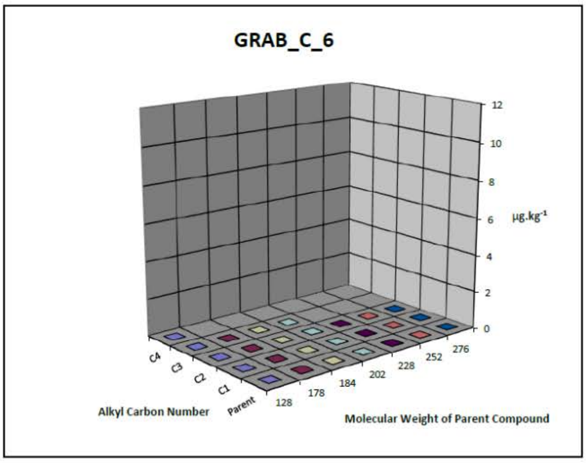

GRAB_C_1
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

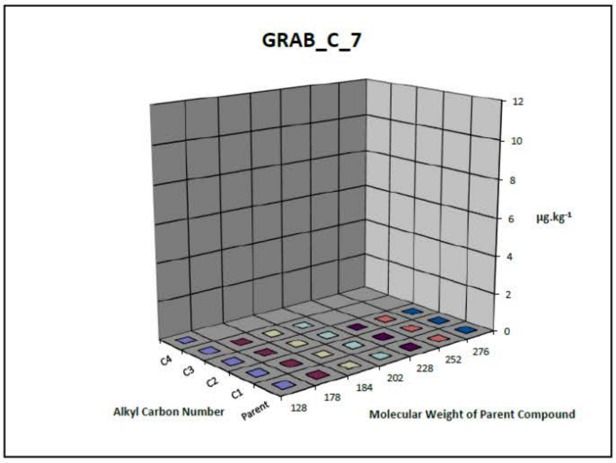

GRAB_C_2
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

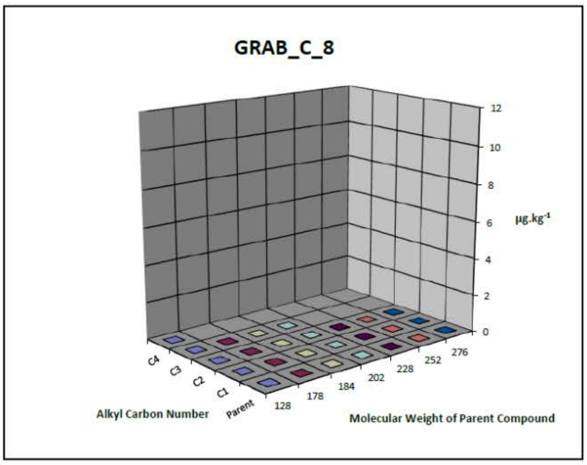

GRAB_C_3
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

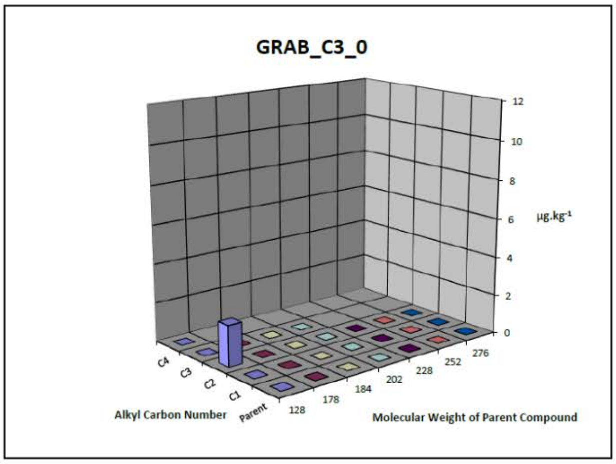

GRAB_C_4
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

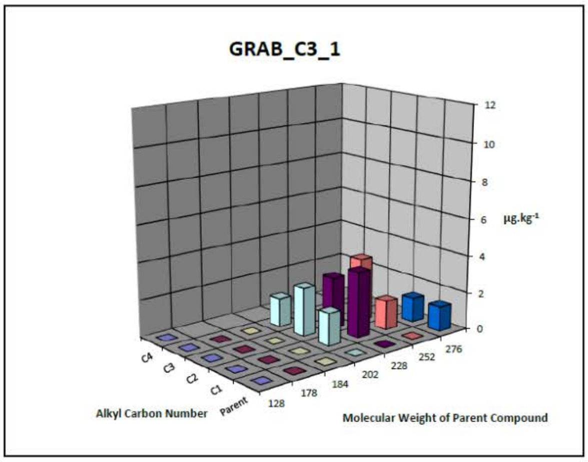

GRAB_C_5
µg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

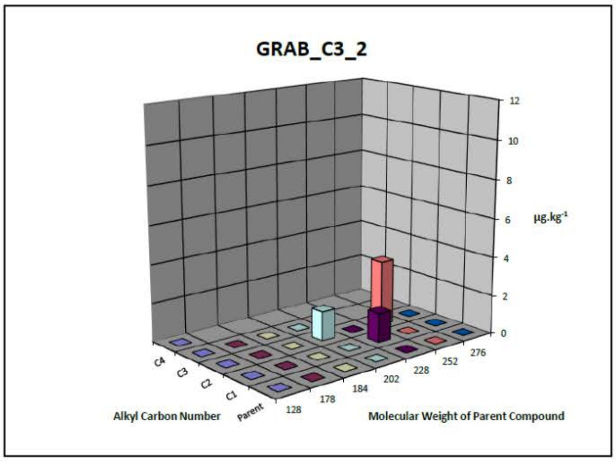

GRAB_C_6
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound


GRAB_C_7
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound


GRAB_C_8
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound


GRAB_C3_0
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound


GRAB_C3_1
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound


GRAB_C3_2
μg.kg-1
Alkyl Carbon Number
Molecular Weight of Parent Compound

APPENDIX M - MACROFAUNAL SPECIES LIST

1917 ONE N5A Data Matrix **BSL Project 1917 ONE**

AphiaID	Phylum	Taxa	Authority	GRAB_P_0_F1	GRAB_P_0_F2	GRAB_P_1_F1	GRAB_P_1_F2	GRAB_P_2_F1	GRAB_P_2_F2	GRAB_P_3_F1	GRAB_P_3_F2	GRAB_P_4_F1	GRAB_P_4_F2	GRAB_P_5_F1	GRAB_P_5_F2	GRAB_P_6_F1	GRAB_P_6_F2	GRAB_P_7_F1	GRAB_P_7_F2	GRAB_P_8_F1	GRAB_P_8_F2
Infaunal Species																					
1360	Cnidaria	Actiniaria																			
100994	Cnidaria	Sagartia troglodytes	(Price in Johnston, 1847)			1	1	2													
117561	Cnidaria	Euphysa aurata	Forbes, 1848												2						1
793	Platyhelminthes	Platyhelminthes	Minot, 1876																		
799	Nematoda	Nematoda		399	516	33	111	3			1	3	1		2			2	3	1	1
152391	Nemertea	Nemertea		16	13	1	3	2							1		2		7		1
129211	Annelida	Capitella	Blainville, 1828				1								1				1		
129892	Annelida	Mediomastus fragilis	Rasmussen, 1973	5	3		5														
129220	Annelida	Notomastus	M. Sars, 1851																		
152217	Annelida	Chaetozone christiei	Chambers, 2000				2	2	1	2	1	2		4	2		2	8	7		
130041	Annelida	Protodorvillea kefersteini	(McIntosh, 1869)	1	1																
110377	Annelida	Echiurus echiurus	(Pallas, 1766)																		
336908	Annelida	Glycera fallax	Quatrefages, 1850				1														
130130	Annelida	Glycera tridactyla	Schmarda, 1861	1	4																
130143	Annelida	Goniadella bobrezkii	(Annenkova, 1929)	1	3															3	1
129313	Annelida	Microphthalmus	Mecznikow, 1865																	4	1
130269	Annelida	Magelona johnstoni	Fiege, Licher & Mackie, 2000				2	2	19	5	4	1	1	2	3			1	1		
130355	Annelida	Nephtys caeca	(Fabricius, 1780)	1	1																
130357	Annelida	Nephtys cirrosa	Ehlers, 1868			1			3	3	1	3	7		3		4	1	7		
130359	Annelida	Nephtys hombergii	Savigny in Lamarck, 1818								1								1		
130375	Annelida	Eunereis longissima	(Johnston, 1840)	3	2	1															
137349	Annelida	Grania	Southern, 1913	27	58															4	2
2036	Annelida	Oligochaeta	Grube, 1850																		
137571	Annelida	Tubificoides benedii	(d'Udekem, 1855)			2	3														
137582	Annelida	Tubificoides pseudogaster	(Dahl, 1960)																		
130491	Annelida	Ophelia borealis	Quatrefages, 1866			2	3								2	7	22	2	1	3	9
130512	Annelida	Travisia forbesii	Johnston, 1840								1						1				
130537	Annelida	Scoloplos armiger	(Müller, 1776)	2	1	6	19			4	2	5		13	13	2	8	16	14	5	4
129427	Annelida	Owenia	Delle Chiaje, 1844															1	1		
326605	Annelida	Aricidea (Aricidea) wassi	Pettibone, 1965									1				1					
152367	Annelida	Lagis koreni	Malmgren, 1866	64	122	6	7										1		1		
130599	Annelida	Pholoe baltica	Örsted, 1843		3	2	1														
130601	Annelida	Pholoe inornata	Johnston, 1839		1																
130616	Annelida	Eteone longa	(Fabricius, 1780)		4		1					1			1			3	4		
129446	Annelida	Eumida	Malmgren, 1865	18	11			2									1	2	8		
130649	Annelida	Hesionura elongata	(Southern, 1914)		1																
334512	Annelida	Phyllodoce mucosa	Örsted, 1843					1											2		
334514	Annelida	Phyllodoce rosea	(McIntosh, 1877)																		
130711	Annelida	Poecilochaetus serpens	Allen, 1904	1																	
129472	Annelida	Polygordius	Schneider, 1868																		
130749	Annelida	Gattyana cirrhosa	(Pallas, 1766)	14	32														1		
1044546	Annelida	Malmgrenia bicki	Barnich, Dietrich, Hager & Fiege, 2017	3	1																
130707	Annelida	Pisione remota	(Southern, 1914)	7	4																
131072	Annelida	Sigalion mathildae	Audouin & Milne Edwards in Cuvier, 1830																1		
131107	Annelida	Aonides paucibranchiata	Southern, 1914	34	95		1								1						3
131169	Annelida	Pseudopolydora pulchra	(Carazzi, 1893)																		
131170	Annelida	Pygospio elegans	Claparède, 1863																		
131171	Annelida	Scolelepis bonnieri	(Mesnil, 1896)							1	2		1				1		1	1	2
334741	Annelida	Scolelepis (Scolelepis) foliosa	(Audouin & Milne Edwards, 1833)																		

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AphiaID	Phylum	Taxa	Authority	GRAB_P_0_F1	GRAB_P_0_F2	GRAB_P_1_F1	GRAB_P_1_F2	GRAB_P_2_F1	GRAB_P_2_F2	GRAB_P_3_F1	GRAB_P_3_F2	GRAB_P_4_F1	GRAB_P_4_F2	GRAB_P_5_F1	GRAB_P_5_F2	GRAB_P_6_F1	GRAB_P_6_F2	GRAB_P_7_F1	GRAB_P_7_F2	GRAB_P_8_F1	GRAB_P_8_F2
Infaunal Species																					
131184	Annelida	Spio goniocephala	Thulin, 1957										2	4	6		12	1		7	9
131185	Annelida	Spio martinensis	Mesnil, 1896																		
596189	Annelida	Spio symphyta	Meißner, Bick & Bastrop, 2011	2	3																
131187	Annelida	Spiophanes bombyx	(Claparède, 1870)	1	2	3	7	4	3	8	4		1	4	36	19	16	44	39		
327985	Annelida	Exogone naidina	Örsted, 1845	3	4																
129659	Annelida	Myrianida	Milne Edwards, 1845																2		
131452	Annelida	Syllis prolifera	Krohn, 1852														1	1			
131495	Annelida	Lanice conchilega	(Pallas, 1766)	261	179			7			1		3	1	2	3	3	4	3		3
150520	Arthropoda	Nymphon brevirostre	Hodge, 1863																		
106215	Arthropoda	Balanus crenatus	Bruguière, 1789							3											
1080	Arthropoda	Copepoda	Milne Edwards, 1840			1	4														2
102788	Arthropoda	Abludomelita obtusata	(Montagu, 1813)	5	7														1		
102012	Arthropoda	Aora gracilis	(Spence Bate, 1857)																		
236495	Arthropoda	Apolochus neapolitanus	(Della Valle, 1893)		3																
103058	Arthropoda	Bathyporeia elegans	Watkin, 1938					1	4	6	9	1	2	4	8	3		5	11		
103060	Arthropoda	Bathyporeia guilliamsoniana	(Spence Bate, 1857)						1	1				2	4		1	1	3	1	
101742	Arthropoda	Bathyporeia	Lindström, 1855												18				5		
101839	Arthropoda	Caprella linearis	(Linnaeus, 1767)																		
101857	Arthropoda	Pariambus typicus	(Krøyer, 1844)	2	7														5		
102433	Arthropoda	Jassa marmorata	Holmes, 1905																		
102783	Arthropoda	Megaluropus agilis	Hoek, 1889									1									
101764	Arthropoda	Metopa	Boeck, 1871																		
103166	Arthropoda	Stenothoe marina	(Spence Bate, 1857)																		
102380	Arthropoda	Microprotopus maculatus	Norman, 1867	5	18													1	12		
102139	Arthropoda	Nototropis falcatus	(Metzger, 1871)														1				
102916	Arthropoda	Pontocrates altamarinus	(Spence Bate & Westwood, 1862)																		
102917	Arthropoda	Pontocrates arcticus	G.O. Sars, 1895					1	1			2		1		2	1		3		
103226	Arthropoda	Urothoe brevicornis	Spence Bate, 1862													1	1				
103235	Arthropoda	Urothoe poseidonis	Reibish, 1905						6	4		1		23	10	1	1				
110445	Arthropoda	Bodotria scorpioides	(Montagu, 1804)	1	13																
110465	Arthropoda	Cumopsis goodsir	(Van Beneden, 1861)																1		
110472	Arthropoda	Diastylis bradyi	Norman, 1879					1											1		
422916	Arthropoda	Monopseudocuma gilsoni	(Bacescu, 1950)			1	1	9	6			8					9		4		
110627	Arthropoda	Pseudocuma (Pseudocuma) longicorne	(Bate, 1858)																1		
118216	Arthropoda	Gyge branchialis	Cornalia & Panceri, 1861																		
136486	Arthropoda	Tanaissus lilljeborgi	(Stebbing, 1891)						1	1	6	23	15	14	15	14	10	26	30		1
107552	Arthropoda	Crangon crangon	(Linnaeus, 1758)				1														
107688	Arthropoda	Processa modica	Williamson in Williamson & Rochanaburanon, 1979		1																
107739	Arthropoda	Upogebia deltaura	(Leach, 1816)																		
107345	Arthropoda	Macropodia rostrata	(Linnaeus, 1761)																		
107232	Arthropoda	Pagurus bernhardus	(Linnaeus, 1758)																		
107473	Arthropoda	Pinnotheres pisum	(Linnaeus, 1767)	1																	
107281	Arthropoda	Thia scutellata	(Fabricius, 1793)																		

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AphiaID	Phylum	Taxa	Authority	GRAB_P_0_F1	GRAB_P_0_F2	GRAB_P_1_F1	GRAB_P_1_F2	GRAB_P_2_F1	GRAB_P_2_F2	GRAB_P_3_F1	GRAB_P_3_F2	GRAB_P_4_F1	GRAB_P_4_F2	GRAB_P_5_F1	GRAB_P_5_F2	GRAB_P_6_F1	GRAB_P_6_F2	GRAB_P_7_F1	GRAB_P_7_F2	GRAB_P_8_F1	GRAB_P_8_F2
Infaunal Species																					
139557	Mollusca	Diaphana minuta	T. Brown, 1827	2	5																
867492	Mollusca	Hermania scabra	(O. F. Müller, 1784)	1																	
141638	Mollusca	Embletonia pulchra	(Alder & Hancock, 1844)																		
141641	Mollusca	Tergipes tergipes	(Forsskål in Niebuhr, 1775)																		
138952	Mollusca	Caecum glabrum	(Montagu, 1803)																		
139718	Mollusca	Epitonium clathratulum	(Kanmacher, 1798)																		
141690	Mollusca	Tornus subcarinatus	(Montagu, 1803)																		
138831	Mollusca	Goodallia triangularis	(Montagu, 1803)																		
139604	Mollusca	Donax vittatus	(da Costa, 1778)					1					1			1	1		1		
345281	Mollusca	Kurtiella bidentata	(Montagu, 1803)		1		2								1				1		
146952	Mollusca	Tellimya ferruginosa	(Montagu, 1808)					6	9	9		2		3	3						
140301	Mollusca	Spisula solida	(Linnaeus, 1758)																		
140687	Mollusca	Aequipecten opercularis	(Linnaeus, 1758)																		
876640	Mollusca	Ensis leei	M. Huber, 2015	3	1							1	1								
141433	Mollusca	Abra alba	(W. Wood, 1802)	117	243	43	69	1						1	1				7		1
146907	Mollusca	Fabulina fabula	(Gmelin, 1791)			2	1		4		1						1				
880017	Mollusca	Limecola balthica	(Linnaeus, 1758)																		
878470	Mollusca	Macomangulus tenuis	(da Costa, 1778)									1						1			
138549	Mollusca	Thracia	Blainville, 1824		1																
141908	Mollusca	Chamelea striatula	(da Costa, 1778)						1	1											
156961	Mollusca	Petricolaria pholadiformis	(Lamarck, 1818)																		
1789	Phoronida	Phoronida	Hatschek, 1888			4	75	1	1												
123776	Echinodermata	Asterias rubens	Linnaeus, 1758	1	1																
124392	Echinodermata	Echinocardium cordatum	(Pennant, 1777)					1	2	1	1			1	1	1					
124929	Echinodermata	Ophiura ophiura	(Linnaeus, 1758)																		
104906	Chordata	Branchiostoma lanceolatum	(Pallas, 1774)	2	3		3				1										
			S	32	37	16	24	18	15	14	15	16	11	14	23	12	22	18	35	9	15
			N	1004	1368	109	324	47	62	49	36	56	35	77	136	55	100	120	191	29	41
			d	4.49	4.99	3.20	3.98	4.42	3.39	3.34	3.91	3.73	2.81	2.99	4.48	2.75	4.56	3.55	6.47	2.38	3.77
			J'	0.539	0.567	0.656	0.602	0.891	0.831	0.900	0.868	0.759	0.764	0.806	0.798	0.765	0.800	0.696	0.811	0.915	0.868
			H'(log2)	2.69	2.96	2.63	2.76	3.72	3.25	3.43	3.39	3.04	2.64	3.07	3.61	2.74	3.57	2.90	4.16	2.90	3.39
			1-Lambda'	0.755	0.794	0.750	0.781	0.920	0.865	0.908	0.897	0.805	0.780	0.846	0.883	0.804	0.892	0.798	0.915	0.879	0.894

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AphialD	Phylum	Taxa	Authority	GRAB_P_9_F1	GRAB_P_9_F2	GRAB_P_10_F1	GRAB_P_10_F2	GRAB_P_11_F1	GRAB_P_11_F2	GRAB_P_12_F1	GRAB_P_12_F2	GRAB_P_13_F1	GRAB_P_13_F2	GRAB_P_14_F1	GRAB_P_14_F2	GRAB_P_15_F1	GRAB_P_15_F2	GRAB_C_0_F1	GRAB_C_0_F2
Infaunal Species																			
1360	Cnidaria	Actiniaria																	
100994	Cnidaria	Sagartia troglodytes	(Price in Johnston, 1847)																
117561	Cnidaria	Euphysa aurata	Forbes, 1848																
793	Platyhelminthes	Platyhelminthes	Minot, 1876																
799	Nematoda	Nematoda		6	8		3	10	2					7		1		235	201
152391	Nemertea	Nemertea		2	1						2		1	3				11	56
129211	Annelida	Capitella	Blainville, 1828		2		1	4	1	1	1	2	3	13	2				
129892	Annelida	Mediomastus fragilis	Rasmussen, 1973															1	1
129220	Annelida	Notomastus	M. Sars, 1851																
152217	Annelida	Chaetozone christiei	Chambers, 2000		2					3	2	2	2	7		2			
130041	Annelida	Protodorvillea kefersteini	(McIntosh, 1869)																4
110377	Annelida	Echiurus echiurus	(Pallas, 1766)																
336908	Annelida	Glycera fallax	Quatrefages, 1850																
130130	Annelida	Glycera tridactyla	Schmarda, 1861															3	4
130143	Annelida	Goniadella bobrezkii	(Annenkova, 1929)															1	11
129313	Annelida	Microphthalmus	Mecznikow, 1865											3					
130269	Annelida	Magelona johnstoni	Fiege, Licher & Mackie, 2000		1		1	3	1	31	6	87	152	226	109	3	1		
130355	Annelida	Nephtys caeca	(Fabricius, 1780)							1									1
130357	Annelida	Nephtys cirrosa	Ehlers, 1868	1		4	5	3	2	5	3			1		5	3	1	
130359	Annelida	Nephtys hombergii	Savigny in Lamarck, 1818			1					1	1	1	3	1				
130375	Annelida	Eunereis longissima	(Johnston, 1840)					2						1	2				3
137349	Annelida	Grania	Southern, 1913															120	289
2036	Annelida	Oligochaeta	Grube, 1850																
137571	Annelida	Tubificoides benedii	(d'Udekem, 1855)																
137582	Annelida	Tubificoides pseudogaster	(Dahl, 1960)																
130491	Annelida	Ophelia borealis	Quatrefages, 1866	18	7				1	1							1		
130512	Annelida	Travisia forbesii	Johnston, 1840																
130537	Annelida	Scoloplos armiger	(Müller, 1776)	9	10	11	6	10	13	22	34	17	27	42	39	6	17	2	8
129427	Annelida	Owenia	Delle Chiaje, 1844				2			1	9	1	1						
326605	Annelida	Aricidea (Aricidea) wassi	Pettibone, 1965																
152367	Annelida	Lagis koreni	Malmgren, 1866	5	2	1	4		1	2	2	4	12	13	14	5	2		1
130599	Annelida	Pholoe baltica	Örsted, 1843																
130601	Annelida	Pholoe inornata	Johnston, 1839															2	
130616	Annelida	Eteone longa	(Fabricius, 1780)	6	8		7	21	11	9	16	2	11	13	4	3	2	7	1
129446	Annelida	Eumida	Malmgren, 1865				4	1		1				1	3	1		1	
130649	Annelida	Hesionura elongata	(Southern, 1914)															35	18
334512	Annelida	Phyllodoce mucosa	Örsted, 1843								1							1	
334514	Annelida	Phyllodoce rosea	(McIntosh, 1877)																
130711	Annelida	Poecilochaetus serpens	Allen, 1904																
129472	Annelida	Polygordius	Schneider, 1868																6
130749	Annelida	Gattyana cirrhosa	(Pallas, 1766)								1								3
1044546	Annelida	Malmgrenia bicki	Barnich, Dietrich, Hager & Fiege, 2017				1	1											
130707	Annelida	Pisione remota	(Southern, 1914)															34	58
131072	Annelida	Sigalion mathildae	Audouin & Milne Edwards in Cuvier, 1830	3															
131107	Annelida	Aonides paucibranchiata	Southern, 1914															49	124
131169	Annelida	Pseudopolydora pulchra	(Carazzi, 1893)																
131170	Annelida	Pygospio elegans	Claparède, 1863	5	1			1						3	1	17	7		
131171	Annelida	Scolelepis bonnieri	(Mesnil, 1896)									1					2		
334741	Annelida	Scolelepis (Scolelepis) foliosa	(Audouin & Milne Edwards, 1833)																

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AphiaID	Phylum	Taxa	Authority	GRAB_P_9_F1	GRAB_P_9_F2	GRAB_P_10_F1	GRAB_P_10_F2	GRAB_P_11_F1	GRAB_P_11_F2	GRAB_P_12_F1	GRAB_P_12_F2	GRAB_P_13_F1	GRAB_P_13_F2	GRAB_P_14_F1	GRAB_P_14_F2	GRAB_P_15_F1	GRAB_P_15_F2	GRAB_C_0_F1	GRAB_C_0_F2
Infaunal Species																			
131184	Annelida	Spio goniocephala	Thulin, 1957	1				1	2				1			1	1		
131185	Annelida	Spio martinensis	Mesnil, 1896										2		2		2		
596189	Annelida	Spio symphyta	Meißner, Bick & Bastrop, 2011	1	3	1	3		1		2			6	1			32	12
131187	Annelida	Spiophanes bombyx	(Claparède, 1870)	14	32	8	47	15	19	18	28	16	21	42	10	26	20	1	
327985	Annelida	Exogone naidina	Örsted, 1845															2	
129659	Annelida	Myrianida	Milne Edwards, 1845																
131452	Annelida	Syllis prolifera	Krohn, 1852																
131495	Annelida	Lanice conchilega	(Pallas, 1766)	3	4	15	38	34	15	23	33	2	5	54	33	5	2	47	55
150520	Arthropoda	Nymphon brevirostre	Hodge, 1863																
106215	Arthropoda	Balanus crenatus	Bruguière, 1789																
1080	Arthropoda	Copepoda	Milne Edwards, 1840											11	1	5			1
102788	Arthropoda	Abludomelita obtusata	(Montagu, 1813)											2					
102012	Arthropoda	Aora gracilis	(Spence Bate, 1857)																
236495	Arthropoda	Apolochus neapolitanus	(Della Valle, 1893)																
103058	Arthropoda	Bathyporeia elegans	Watkin, 1938	9	10	2		3	2	1	7	1		12	10	34	34		
103060	Arthropoda	Bathyporeia guilliamsoniana	(Spence Bate, 1857)										2	1	7		3		1
101742	Arthropoda	Bathyporeia	Lindström, 1855										3		31		7		
101839	Arthropoda	Caprella linearis	(Linnaeus, 1767)																
101857	Arthropoda	Pariambus typicus	(Krøyer, 1844)			1					1			2	1				1
102433	Arthropoda	Jassa marmorata	Holmes, 1905																
102783	Arthropoda	Megaluropus agilis	Hoek, 1889	1														1	
101764	Arthropoda	Metopa	Boeck, 1871																
103166	Arthropoda	Stenothoe marina	(Spence Bate, 1857)																
102380	Arthropoda	Microprotopus maculatus	Norman, 1867				2	2	4		4			7	2				1
102139	Arthropoda	Nototropis falcatus	(Metzger, 1871)	1		1	1							3	3	9	1		
102916	Arthropoda	Pontocrates altamarinus	(Spence Bate & Westwood, 1862)													2	1		
102917	Arthropoda	Pontocrates arcticus	G.O. Sars, 1895			1				1		1							
103226	Arthropoda	Urothoe brevicornis	Spence Bate, 1862														1		
103235	Arthropoda	Urothoe poseidonis	Reibish, 1905	1	3	1		2	1	3	1	2	2	12	12	2	1		
110445	Arthropoda	Bodotria scorpioides	(Montagu, 1804)											1					
110465	Arthropoda	Cumopsis goodsir	(Van Beneden, 1861)		1														
110472	Arthropoda	Diastylis bradyi	Norman, 1879	3				1				2	1	1	2	3		1	
422916	Arthropoda	Monopseudocuma gilsoni	(Bacescu, 1950)	28	5	22	2	16	7	8	3	6	1	30	13	7		4	
110627	Arthropoda	Pseudocuma (Pseudocuma) longicorne	(Bate, 1858)																
118216	Arthropoda	Gyge branchialis	Cornalia & Panceri, 1861																
136486	Arthropoda	Tanaissus lilljeborgi	(Stebbing, 1891)	9	9	1		4						1					
107552	Arthropoda	Crangon crangon	(Linnaeus, 1758)			1				1									
107688	Arthropoda	Processa modica	Williamson in Williamson & Rochanaburanon, 1979																1
107739	Arthropoda	Upogebia deltaura	(Leach, 1816)																
107345	Arthropoda	Macropodia rostrata	(Linnaeus, 1761)																
107232	Arthropoda	Pagurus bernhardus	(Linnaeus, 1758)							1				1		2			
107473	Arthropoda	Pinnotheres pisum	(Linnaeus, 1767)																
107281	Arthropoda	Thia scutellata	(Fabricius, 1793)																

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AphiaID	**Phylum**	**Taxa**	**Authority**	**GRAB_P_9_F1**	**GRAB_P_9_F2**	**GRAB_P_10_F1**	**GRAB_P_10_F2**	**GRAB_P_11_F1**	**GRAB_P_11_F2**	**GRAB_P_12_F1**	**GRAB_P_12_F2**	**GRAB_P_13_F1**	**GRAB_P_13_F2**	**GRAB_P_14_F1**	**GRAB_P_14_F2**	**GRAB_P_15_F1**	**GRAB_P_15_F2**	**GRAB_C_0_F1**	**GRAB_C_0_F2**
Infaunal Species																			
139557	Mollusca	Diaphana minuta	T. Brown, 1827																
867492	Mollusca	Hermania scabra	(O. F. Müller, 1784)																
141638	Mollusca	Embletonia pulchra	(Alder & Hancock, 1844)																
141641	Mollusca	Tergipes tergipes	(Forsskål in Niebuhr, 1775)																
138952	Mollusca	Caecum glabrum	(Montagu, 1803)																
139718	Mollusca	Epitonium clathratulum	(Kanmacher, 1798)																
141690	Mollusca	Tornus subcarinatus	(Montagu, 1803)																
138831	Mollusca	Goodallia triangularis	(Montagu, 1803)																1
139604	Mollusca	Donax vittatus	(da Costa, 1778)																
345281	Mollusca	Kurtiella bidentata	(Montagu, 1803)					3		25	18	3	63	41	14	7	11		
146952	Mollusca	Tellimya ferruginosa	(Montagu, 1808)			1				9	2			2	5				
140301	Mollusca	Spisula solida	(Linnaeus, 1758)																1
140687	Mollusca	Aequipecten opercularis	(Linnaeus, 1758)																
876640	Mollusca	Ensis leei	M. Huber, 2015	1		4	6					5	8					6	3
141433	Mollusca	Abra alba	(W. Wood, 1802)	2	8		3				8		1	24	10	2		7	4
146907	Mollusca	Fabulina fabula	(Gmelin, 1791)											2					
880017	Mollusca	Limecola balthica	(Linnaeus, 1758)							1				2	2	2	1		
878470	Mollusca	Macomangulus tenuis	(da Costa, 1778)				1								1		1		
138549	Mollusca	Thracia	Blainville, 1824																
141908	Mollusca	Chamelea striatula	(da Costa, 1778)																
156961	Mollusca	Petricolaria pholadiformis	(Lamarck, 1818)																
1789	Phoronida	Phoronida	Hatschek, 1888																
123776	Echinodermata	Asterias rubens	Linnaeus, 1758											1					
124392	Echinodermata	Echinocardium cordatum	(Pennant, 1777)							4	1	1		1	1				
124929	Echinodermata	Ophiura ophiura	(Linnaeus, 1758)											2					
104906	Chordata	Branchiostoma lanceolatum	(Pallas, 1774)															5	5
			S	22	19	17	19	20	16	23	24	19	21	38	29	23	22	25	29
			N	129	117	76	137	137	83	172	186	156	320	597	336	150	121	609	875
			d	4.32	3.78	3.70	3.66	3.86	3.40	4.27	4.40	3.56	3.47	5.79	4.81	4.39	4.38	3.74	4.13
			J'	0.840	0.849	0.766	0.710	0.806	0.807	0.795	0.790	0.590	0.591	0.676	0.734	0.831	0.763	0.630	0.602
			H'(log2)	3.75	3.61	3.13	3.02	3.48	3.23	3.60	3.62	2.50	2.59	3.55	3.57	3.76	3.40	2.93	2.93
			1-Lambda'	0.904	0.889	0.848	0.799	0.881	0.871	0.896	0.892	0.666	0.723	0.828	0.856	0.895	0.863	0.791	0.806

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AphiaID	Phylum	Taxa	Authority	GRAB_ C_1_F1	GRAB_ C_1_F2	GRAB_ C_2_F1	GRAB_ C_2_F2	GRAB_ C_3_F1	GRAB_ C_3_F2	GRAB_ C_4_F1	GRAB_ C_4_F2	GRAB_ C_5_F1	GRAB_ C_5_F2	GRAB_ C_6_F1	GRAB_ C_6_F2	GRAB_ C_7_F1	GRAB_ C_7_F2	GRAB_ C_8_F1	GRAB_ C_8_F2
Infaunal Species																			
1360	Cnidaria	Actiniaria																	
100994	Cnidaria	Sagartia troglodytes	(Price in Johnston, 1847)						5										
117561	Cnidaria	Euphysa aurata	Forbes, 1848														1		
793	Platyhelminthes	Platyhelminthes	Minot, 1876							1		1							
799	Nematoda	Nematoda		229	189	4	3			3	10	60	144	4	3	69	52	1	4
152391	Nemertea	Nemertea		3	7	2	3	1		1		3	17	1		5	12		
129211	Annelida	Capitella	Blainville, 1828																
129892	Annelida	Mediomastus fragilis	Rasmussen, 1973		2	2	19		2	4	11	10	7						
129220	Annelida	Notomastus	M. Sars, 1851	2															
152217	Annelida	Chaetozone christiei	Chambers, 2000					2	9	10	30			2					
130041	Annelida	Protodorvillea kefersteini	(McIntosh, 1869)	2	3							2							
110377	Annelida	Echiurus echiurus	(Pallas, 1766)									1							
336908	Annelida	Glycera fallax	Quatrefages, 1850																
130130	Annelida	Glycera tridactyla	Schmarda, 1861	8	7													1	
130143	Annelida	Goniadella bobrezkii	(Annenkova, 1929)	1	1							1			1	3	6	3	
129313	Annelida	Microphthalmus	Mecznikow, 1865									1							
130269	Annelida	Magelona johnstoni	Fiege, Licher & Mackie, 2000							1	2								
130355	Annelida	Nephtys caeca	(Fabricius, 1780)		1	1					1								
130357	Annelida	Nephtys cirrosa	Ehlers, 1868				2	7	5		2			8	5	3	1	4	2
130359	Annelida	Nephtys hombergii	Savigny in Lamarck, 1818																
130375	Annelida	Eunereis longissima	(Johnston, 1840)	9	8							1	1				2		
137349	Annelida	Grania	Southern, 1913	51	86	38	21					4	6	1	2	17	12	2	3
2036	Annelida	Oligochaeta	Grube, 1850																
137571	Annelida	Tubificoides benedii	(d'Udekem, 1855)						1										
137582	Annelida	Tubificoides pseudogaster	(Dahl, 1960)							1	1					1			
130491	Annelida	Ophelia borealis	Quatrefages, 1866	50	38	8	10	9	37	2	6		2	25	49	8	5	29	29
130512	Annelida	Travisia forbesii	Johnston, 1840																
130537	Annelida	Scoloplos armiger	(Müller, 1776)			6	3		6	10	8	32	22	17	14	2	2	1	4
129427	Annelida	Owenia	Delle Chiaje, 1844					1	6	1	1								
326605	Annelida	Aricidea (Aricidea) wassi	Pettibone, 1965																
152367	Annelida	Lagis koreni	Malmgren, 1866	3	2	4	2		4	11	15	16	8				1		
130599	Annelida	Pholoe baltica	Örsted, 1843							1	1								
130601	Annelida	Pholoe inornata	Johnston, 1839																
130616	Annelida	Eteone longa	(Fabricius, 1780)	5	8	2	1		3		2	2	25			2	2		1
129446	Annelida	Eumida	Malmgren, 1865	1		6	1	3		5	1		3	2	7		2	1	
130649	Annelida	Hesionura elongata	(Southern, 1914)	1	2		2						1						
334512	Annelida	Phyllodoce mucosa	Örsted, 1843	1		1			2	1	1	2	2						
334514	Annelida	Phyllodoce rosea	(McIntosh, 1877)						1										
130711	Annelida	Poecilochaetus serpens	Allen, 1904																
129472	Annelida	Polygordius	Schneider, 1868	3	2														
130749	Annelida	Gattyana cirrhosa	(Pallas, 1766)	3	1		2		1	7		4	1		3		1		
1044546	Annelida	Malmgrenia bicki	Barnich, Dietrich, Hager & Fiege, 2017						1		2								
130707	Annelida	Pisione remota	(Southern, 1914)	11	35							2	3			1			
131072	Annelida	Sigalion mathildae	Audouin & Milne Edwards in Cuvier, 1830																
131107	Annelida	Aonides paucibranchiata	Southern, 1914	241	425	5	4				1	11	1	4		1			1
131169	Annelida	Pseudopolydora pulchra	(Carazzi, 1893)																
131170	Annelida	Pygospio elegans	Claparède, 1863		1														
131171	Annelida	Scolelepis bonnieri	(Mesnil, 1896)						3			1							
334741	Annelida	Scolelepis (Scolelepis) foliosa	(Audouin & Milne Edwards, 1833)									1							

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AphiaID	Phylum	Taxa	Authority	GRAB_C_1_F1	GRAB_C_1_F2	GRAB_C_2_F1	GRAB_C_2_F2	GRAB_C_3_F1	GRAB_C_3_F2	GRAB_C_4_F1	GRAB_C_4_F2	GRAB_C_5_F1	GRAB_C_5_F2	GRAB_C_6_F1	GRAB_C_6_F2	GRAB_C_7_F1	GRAB_C_7_F2	GRAB_C_8_F1	GRAB_C_8_F2
Infaunal Species																			
131184	Annelida	Spio goniocephala	Thulin, 1957				2							1	3				3
131185	Annelida	Spio martinensis	Mesnil, 1896																
596189	Annelida	Spio symphyta	Meißner, Bick & Bastrop, 2011	8	9	10	9		1	3	9	5	2	2		1	1		
131187	Annelida	Spiophanes bombyx	(Claparède, 1870)	1	5	12	36	6	576	11	236	55	73	15	18	5	5	7	6
327985	Annelida	Exogone naidina	Örsted, 1845	1	2	1	6							1			1		
129659	Annelida	Myrianida	Milne Edwards, 1845																
131452	Annelida	Syllis prolifera	Krohn, 1852											1					
131495	Annelida	Lanice conchilega	(Pallas, 1766)	182	128	100	83	29	56	147	90	45	57	33	197	3	34	24	4
150520	Arthropoda	Nymphon brevirostre	Hodge, 1863																
106215	Arthropoda	Balanus crenatus	Bruguière, 1789																
1080	Arthropoda	Copepoda	Milne Edwards, 1840		1		3						6	1	5		8	4	1
102788	Arthropoda	Abludomelita obtusata	(Montagu, 1813)				1		1	1	1	2			1				
102012	Arthropoda	Aora gracilis	(Spence Bate, 1857)																
236495	Arthropoda	Apolochus neapolitanus	(Della Valle, 1893)	1															
103058	Arthropoda	Bathyporeia elegans	Watkin, 1938					1											
103060	Arthropoda	Bathyporeia guilliamsoniana	(Spence Bate, 1857)																2
101742	Arthropoda	Bathyporeia	Lindström, 1855								2								
101839	Arthropoda	Caprella linearis	(Linnaeus, 1767)																
101857	Arthropoda	Pariambus typicus	(Krøyer, 1844)	1		1		4	2	17	2	3			4				
102433	Arthropoda	Jassa marmorata	Holmes, 1905												1				
102783	Arthropoda	Megaluropus agilis	Hoek, 1889							1		1							
101764	Arthropoda	Metopa	Boeck, 1871																
103166	Arthropoda	Stenothoe marina	(Spence Bate, 1857)																
102380	Arthropoda	Microprotopus maculatus	Norman, 1867	1		3	1	2	5	21	6	5	2		1				
102139	Arthropoda	Nototropis falcatus	(Metzger, 1871)																
102916	Arthropoda	Pontocrates altamarinus	(Spence Bate & Westwood, 1862)																
102917	Arthropoda	Pontocrates arcticus	G.O. Sars, 1895						1										
103226	Arthropoda	Urothoe brevicornis	Spence Bate, 1862																
103235	Arthropoda	Urothoe poseidonis	Reibish, 1905						12	10	9	1							
110445	Arthropoda	Bodotria scorpioides	(Montagu, 1804)	1						1		1							
110465	Arthropoda	Cumopsis goodsir	(Van Beneden, 1861)				1						1						
110472	Arthropoda	Diastylis bradyi	Norman, 1879					1		1	1		1			1			
422916	Arthropoda	Monopseudocuma gilsoni	(Bacescu, 1950)	1		1				1	2	2	7		1	2			
110627	Arthropoda	Pseudocuma (Pseudocuma) longicorne	(Bate, 1858)					1						4					
118216	Arthropoda	Gyge branchialis	Cornalia & Panceri, 1861																
136486	Arthropoda	Tanaissus lilljeborgi	(Stebbing, 1891)				2				2			13	1			12	4
107552	Arthropoda	Crangon crangon	(Linnaeus, 1758)	1						1									
107688	Arthropoda	Processa modica	Williamson in Williamson & Rochanaburanon, 1979								1								
107739	Arthropoda	Upogebia deltaura	(Leach, 1816)																
107345	Arthropoda	Macropodia rostrata	(Linnaeus, 1761)																
107232	Arthropoda	Pagurus bernhardus	(Linnaeus, 1758)	1								1							
107473	Arthropoda	Pinnotheres pisum	(Linnaeus, 1767)																
107281	Arthropoda	Thia scutellata	(Fabricius, 1793)		2														

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AphiaID	Phylum	Taxa	Authority	GRAB_C_1_F1	GRAB_C_1_F2	GRAB_C_2_F1	GRAB_C_2_F2	GRAB_C_3_F1	GRAB_C_3_F2	GRAB_C_4_F1	GRAB_C_4_F2	GRAB_C_5_F1	GRAB_C_5_F2	GRAB_C_6_F1	GRAB_C_6_F2	GRAB_C_7_F1	GRAB_C_7_F2	GRAB_C_8_F1	GRAB_C_8_F2
Infaunal Species																			
139557	Mollusca	Diaphana minuta	T. Brown, 1827	1		1													
867492	Mollusca	Hermania scabra	(O. F. Müller, 1784)																
141638	Mollusca	Embletonia pulchra	(Alder & Hancock, 1844)		2														
141641	Mollusca	Tergipes tergipes	(Forsskål in Niebuhr, 1775)																
138952	Mollusca	Caecum glabrum	(Montagu, 1803)	3	1		5		1										
139718	Mollusca	Epitonium clathratulum	(Kanmacher, 1798)									1							
141690	Mollusca	Tornus subcarinatus	(Montagu, 1803)								1								
138831	Mollusca	Goodallia triangularis	(Montagu, 1803)		1		1		2										
139604	Mollusca	Donax vittatus	(da Costa, 1778)												1				
345281	Mollusca	Kurtiella bidentata	(Montagu, 1803)				1												
146952	Mollusca	Tellimya ferruginosa	(Montagu, 1808)			1		3	3	4	4		2		1	2	1		
140301	Mollusca	Spisula solida	(Linnaeus, 1758)	1											1				
140687	Mollusca	Aequipecten opercularis	(Linnaeus, 1758)									1							
876640	Mollusca	Ensis leei	M. Huber, 2015	2	1	1							2			1			
141433	Mollusca	Abra alba	(W. Wood, 1802)		4	1	3	7	7	146	86	74	41		4		6		
146907	Mollusca	Fabulina fabula	(Gmelin, 1791)					4	7	4	8				1				
880017	Mollusca	Limecola balthica	(Linnaeus, 1758)					1											
878470	Mollusca	Macomangulus tenuis	(da Costa, 1778)					1											
138549	Mollusca	Thracia	Blainville, 1824																
141908	Mollusca	Chamelea striatula	(da Costa, 1778)																
156961	Mollusca	Petricolaria pholadiformis	(Lamarck, 1818)																
1789	Phoronida	Phoronida	Hatschek, 1888									1					1		
123776	Echinodermata	Asterias rubens	Linnaeus, 1758									1							
124392	Echinodermata	Echinocardium cordatum	(Pennant, 1777)					1	2	1	2	1	1		1				
124929	Echinodermata	Ophiura ophiura	(Linnaeus, 1758)																
104906	Chordata	Branchiostoma lanceolatum	(Pallas, 1774)	37	14	1	3						1		1				
			S	34	30	24	28	19	29	31	34	36	28	18	25	18	21	12	13
			N	867	988	212	230	84	762	429	557	355	439	135	326	127	156	89	64
			d	4.88	4.21	4.29	4.97	4.06	4.22	4.95	5.22	5.96	4.44	3.47	4.15	3.51	3.96	2.45	2.89
			J'	0.561	0.547	0.622	0.704	0.794	0.348	0.583	0.580	0.693	0.672	0.786	0.490	0.618	0.722	0.752	0.769
			H'(log2)	2.85	2.69	2.85	3.39	3.37	1.69	2.89	2.95	3.58	3.23	3.28	2.28	2.58	3.17	2.70	2.85
			1-Lambda'	0.801	0.751	0.738	0.827	0.851	0.421	0.761	0.766	0.877	0.832	0.868	0.608	0.682	0.826	0.800	0.775

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AphiaID	Phylum	Taxa	Authority	GRAB_C3_0_F1	GRAB_C3_0_F2	GRAB_C3_1_F1	GRAB_C3_1_F2	GRAB_C3_2_F1	GRAB_C3_2_F2	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
Infaunal Species																			
1360	Cnidaria	Actiniaria						5											
100994	Cnidaria	Sagartia troglodytes	(Price in Johnston, 1847)		1			2	7		2	2							
117561	Cnidaria	Euphysa aurata	Forbes, 1848				1								2			1	
793	Platyhelminthes	Platyhelminthes	Minot, 1876						1										
799	Nematoda	Nematoda				4	11	418	686	915	144	3	1	4	2		5	2	14
152391	Nemertea	Nemertea			2	1	13	11	20	29	4	2			1	2	7	1	3
129211	Annelida	Capitella	Blainville, 1828								1				1		1		2
129892	Annelida	Mediomastus fragilis	Rasmussen, 1973			3	2	4	32	8	5								
129220	Annelida	Notomastus	M. Sars, 1851																
152217	Annelida	Chaetozone christiei	Chambers, 2000	8	8				1		2	3	3	2	6	2	15		2
130041	Annelida	Protodorvillea kefersteini	(McIntosh, 1869)							2									
110377	Annelida	Echiurus echiurus	(Pallas, 1766)																
336908	Annelida	Glycera fallax	Quatrefages, 1850								1								
130130	Annelida	Glycera tridactyla	Schmarda, 1861							5									
130143	Annelida	Goniadella bobrezkii	(Annenkova, 1929)					1	1	4								4	
129313	Annelida	Microphthalmus	Mecznikow, 1865															5	
130269	Annelida	Magelona johnstoni	Fiege, Licher & Mackie, 2000	26	33						2	21	9	2	5		2		1
130355	Annelida	Nephtys caeca	(Fabricius, 1780)							2									
130357	Annelida	Nephtys cirrosa	Ehlers, 1868			1					1	3	4	10	3	4	8		1
130359	Annelida	Nephtys hombergii	Savigny in Lamarck, 1818										1				1		
130375	Annelida	Eunereis longissima	(Johnston, 1840)				3	9	4	5	1								
137349	Annelida	Grania	Southern, 1913			2	14	18	13	85								6	
2036	Annelida	Oligochaeta	Grube, 1850					3											
137571	Annelida	Tubificoides benedii	(d'Udekem, 1855)								5								
137582	Annelida	Tubificoides pseudogaster	(Dahl, 1960)		1														
130491	Annelida	Ophelia borealis	Quatrefages, 1866	32	15			109	31		5				2	29	3	12	25
130512	Annelida	Travisia forbesii	Johnston, 1840										1			1			
130537	Annelida	Scoloplos armiger	(Müller, 1776)		2	3	1	8	15	3	25		6	5	26	10	30	9	19
129427	Annelida	Owenia	Delle Chiaje, 1844	1													2		
326605	Annelida	Aricidea (Aricidea) wassi	Pettibone, 1965	1		1								1		1			
152367	Annelida	Lagis koreni	Malmgren, 1866	2	2	3	5	1	5	186	13					1	1		7
130599	Annelida	Pholoe baltica	Örsted, 1843			1			11	3	3								
130601	Annelida	Pholoe inornata	Johnston, 1839					3	1	1									
130616	Annelida	Eteone longa	(Fabricius, 1780)	1	2	2		3		4	1			1	1		7		14
129446	Annelida	Eumida	Malmgren, 1865					3		29		2				1	10		
130649	Annelida	Hesionura elongata	(Southern, 1914)							1									
334512	Annelida	Phyllodoce mucosa	Örsted, 1843						1			1					2		
334514	Annelida	Phyllodoce rosea	(McIntosh, 1877)																
130711	Annelida	Poecilochaetus serpens	Allen, 1904							1									
129472	Annelida	Polygordius	Schneider, 1868																
130749	Annelida	Gattyana cirrhosa	(Pallas, 1766)				1	14	11	46							1		
1044546	Annelida	Malmgrenia bicki	Barnich, Dietrich, Hager & Fiege, 2017							4									
130707	Annelida	Pisione remota	(Southern, 1914)							11									
131072	Annelida	Sigalion mathildae	Audouin & Milne Edwards in Cuvier, 1830	2													1		3
131107	Annelida	Aonides paucibranchiata	Southern, 1914			5	5	9	4	129	1				1			3	
131169	Annelida	Pseudopolydora pulchra	(Carazzi, 1893)					1											
131170	Annelida	Pygospio elegans	Claparède, 1863																6
131171	Annelida	Scolelepis bonnieri	(Mesnil, 1896)				1						3	1		1	1	3	
334741	Annelida	Scolelepis (Scolelepis) foliosa	(Audouin & Milne Edwards, 1833)																

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AphiaID	Phylum	Taxa	Authority	GRAB_C3_0_F1	GRAB_C3_0_F2	GRAB_C3_1_F1	GRAB_C3_1_F2	GRAB_C3_2_F1	GRAB_C3_2_F2	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
Infaunal Species																			
131184	Annelida	Spio goniocephala	Thulin, 1957											2	10	12	1	16	1
131185	Annelida	Spio martinensis	Mesnil, 1896																
596189	Annelida	Spio symphyta	Meißner, Bick & Bastrop, 2011			1	2	1	2	5									4
131187	Annelida	Spiophanes bombyx	(Claparède, 1870)	90	54	136	80	27	31	3	10	7	12	1	40	35	83		46
327985	Annelida	Exogone naidina	Örsted, 1845							7									
129659	Annelida	Myrianida	Milne Edwards, 1845						1								2		
131452	Annelida	Syllis prolifera	Krohn, 1852				1		1							1	1		
131495	Annelida	Lanice conchilega	(Pallas, 1766)		6	19	10	92	36	440		7	1	3	3	6	7	3	7
150520	Arthropoda	Nymphon brevirostre	Hodge, 1863					3	5										
106215	Arthropoda	Balanus crenatus	Bruguière, 1789						3				3						
1080	Arthropoda	Copepoda	Milne Edwards, 1840			1		9	5		5							2	
102788	Arthropoda	Abludomelita obtusata	(Montagu, 1813)					9	3	12							1		
102012	Arthropoda	Aora gracilis	(Spence Bate, 1857)					1											
236495	Arthropoda	Apolochus neapolitanus	(Della Valle, 1893)							3									
103058	Arthropoda	Bathyporeia elegans	Watkin, 1938	1								5	15	3	12	3	16		19
103060	Arthropoda	Bathyporeia guilliamsoniana	(Spence Bate, 1857)		1	2	1					1	1		6	1	4	1	
101742	Arthropoda	Bathyporeia	Lindström, 1855		1		1								18		5		
101839	Arthropoda	Caprella linearis	(Linnaeus, 1767)						1										
101857	Arthropoda	Pariambus typicus	(Krøyer, 1844)					1	1	9							5		
102433	Arthropoda	Jassa marmorata	Holmes, 1905																
102783	Arthropoda	Megaluropus agilis	Hoek, 1889		1									1					1
101764	Arthropoda	Metopa	Boeck, 1871						1										
103166	Arthropoda	Stenothoe marina	(Spence Bate, 1857)					2											
102380	Arthropoda	Microprotopus maculatus	Norman, 1867				1	5	1	23							13		
102139	Arthropoda	Nototropis falcatus	(Metzger, 1871)													1			1
102916	Arthropoda	Pontocrates altamarinus	(Spence Bate & Westwood, 1862)																
102917	Arthropoda	Pontocrates arcticus	G.O. Sars, 1895	1								2		2	1	3	3		
103226	Arthropoda	Urothoe brevicornis	Spence Bate, 1862													2			
103235	Arthropoda	Urothoe poseidonis	Reibish, 1905	1	8							6	4	1	33	2			4
110445	Arthropoda	Bodotria scorpioides	(Montagu, 1804)			1		4	2	14									
110465	Arthropoda	Cumopsis goodsir	(Van Beneden, 1861)			2	1										1		1
110472	Arthropoda	Diastylis bradyi	Norman, 1879									1					1		3
422916	Arthropoda	Monopseudocuma gilsoni	(Bacescu, 1950)	7	1	3	3	1			2	15		8		9	4		33
110627	Arthropoda	Pseudocuma (Pseudocuma) longicorne	(Bate, 1858)	1													1		
118216	Arthropoda	Gyge branchialis	Cornalia & Panceri, 1861						1										
136486	Arthropoda	Tanaissus lilljeborgi	(Stebbing, 1891)	3		10	9	1				1	7	38	29	24	56	1	18
107552	Arthropoda	Crangon crangon	(Linnaeus, 1758)	1							1								
107688	Arthropoda	Processa modica	Williamson in Williamson & Rochanaburanon, 1979							1									
107739	Arthropoda	Upogebia deltaura	(Leach, 1816)			1			3										
107345	Arthropoda	Macropodia rostrata	(Linnaeus, 1761)						1										
107232	Arthropoda	Pagurus bernhardus	(Linnaeus, 1758)				1		1										
107473	Arthropoda	Pinnotheres pisum	(Linnaeus, 1767)							1									
107281	Arthropoda	Thia scutellata	(Fabricius, 1793)																

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AphiaID	Phylum	Taxa	Authority	GRAB_C3_0_F1	GRAB_C3_0_F2	GRAB_C3_1_F1	GRAB_C3_1_F2	GRAB_C3_2_F1	GRAB_C3_2_F2	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9
Infaunal Species																			
139557	Mollusca	Diaphana minuta	T. Brown, 1827							7									
867492	Mollusca	Hermania scabra	(O. F. Müller, 1784)							1									
141638	Mollusca	Embletonia pulchra	(Alder & Hancock, 1844)																
141641	Mollusca	Tergipes tergipes	(Forsskål in Niebuhr, 1775)					1	3										
138952	Mollusca	Caecum glabrum	(Montagu, 1803)						2										
139718	Mollusca	Epitonium clathratulum	(Kanmacher, 1798)																
141690	Mollusca	Tornus subcarinatus	(Montagu, 1803)																
138831	Mollusca	Goodallia triangularis	(Montagu, 1803)																
139604	Mollusca	Donax vittatus	(da Costa, 1778)									1		1		2	1		
345281	Mollusca	Kurtiella bidentata	(Montagu, 1803)							1	2				1		1		
146952	Mollusca	Tellimya ferruginosa	(Montagu, 1808)	19	13							15	9	2	6				
140301	Mollusca	Spisula solida	(Linnaeus, 1758)																
140687	Mollusca	Aequipecten opercularis	(Linnaeus, 1758)					1											
876640	Mollusca	Ensis leei	M. Huber, 2015							4				2					1
141433	Mollusca	Abra alba	(W. Wood, 1802)	3	1	11	4	62	75	360	112	1			2		7	1	10
146907	Mollusca	Fabulina fabula	(Gmelin, 1791)	2							3	4	1			1			
880017	Mollusca	Limecola balthica	(Linnaeus, 1758)																
878470	Mollusca	Macomangulus tenuis	(da Costa, 1778)											1			1		
138549	Mollusca	Thracia	Blainville, 1824							1				0					
141908	Mollusca	Chamelea striatula	(da Costa, 1778)									1	1	0					
156961	Mollusca	Petricolaria pholadiformis	(Lamarck, 1818)				3						0	0					
1789	Phoronida	Phoronida	Hatschek, 1888		1	5			73		79	2	0	0					
123776	Echinodermata	Asterias rubens	Linnaeus, 1758							2			0	0					
124392	Echinodermata	Echinocardium cordatum	(Pennant, 1777)	1	2							3	2	0	2	1			
124929	Echinodermata	Ophiura ophiura	(Linnaeus, 1758)										0	0	0	0			
104906	Chordata	Branchiostoma lanceolatum	(Pallas, 1774)		1	1				5	3		1	0	0	0			
			S	20	21	24	24	34	39	40	26	24	20	21	24	25	38	16	26
			N	203	156	219	174	842	1096	2372	433	109	85	91	213	155	311	70	246
			d	3.58	3.96	4.27	4.46	4.90	5.43	5.02	4.12	4.90	4.28	4.43	4.29	4.76	6.45	3.53	4.54
			J'	0.627	0.699	0.526	0.675	0.545	0.460	0.543	0.601	0.850	0.868	0.737	0.795	0.764	0.735	0.858	0.823
			H'(log2)	2.71	3.07	2.41	3.10	2.77	2.43	2.89	2.83	3.90	3.75	3.24	3.64	3.55	3.86	3.43	3.87
			1-Lambda'	0.754	0.817	0.602	0.767	0.718	0.595	0.783	0.785	0.913	0.916	0.804	0.895	0.878	0.878	0.891	0.912

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AphiaID	Phylum	Taxa	Authority	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
Infaunal Species																					
1360	Cnidaria	Actiniaria																			5
100994	Cnidaria	Sagartia troglodytes	(Price in Johnston, 1847)										5						1		9
117561	Cnidaria	Euphysa aurata	Forbes, 1848														1			1	
793	Platyhelminthes	Platyhelminthes	Minot, 1876											1	1						1
799	Nematoda	Nematoda		3	12			7	1	436	418	7		13	204	7	121	5		15	1104
152391	Nemertea	Nemertea				2	1	3		67	10	5	1	1	20	1	17	0	2	14	31
129211	Annelida	Capitella	Blainville, 1828	1	5	2	5	15													
129892	Annelida	Mediomastus fragilis	Rasmussen, 1973							2	2	21	2	15	17					5	36
129220	Annelida	Notomastus	M. Sars, 1851								2										
152217	Annelida	Chaetozone christiei	Chambers, 2000			5	4	7	2				11	40		2			16		1
130041	Annelida	Protodorvillea kefersteini	(McIntosh, 1869)							4	5				2						
110377	Annelida	Echiurus echiurus	(Pallas, 1766)												1						
336908	Annelida	Glycera fallax	Quatrefages, 1850																		
130130	Annelida	Glycera tridactyla	Schmarda, 1861							7	15							1			
130143	Annelida	Goniadella bobrezkii	(Annenkova, 1929)							12	2				1	1	9	3			2
129313	Annelida	Microphthalmus	Mecznikow, 1865					3							1						
130269	Annelida	Magelona johnstoni	Fiege, Licher & Mackie, 2000	1	4	37	239	335	4					3					59		
130355	Annelida	Nephtys caeca	(Fabricius, 1780)			1				1	1	1		1							
130357	Annelida	Nephtys cirrosa	Ehlers, 1868	9	5	8		1	8	1		2	12	2		13	4	6		1	
130359	Annelida	Nephtys hombergii	Savigny in Lamarck, 1818	1		1	2	4													
130375	Annelida	Eunereis longissima	(Johnston, 1840)		2			3		3	17				2		2			3	13
137349	Annelida	Grania	Southern, 1913							409	137	59			10	3	29	5		16	31
2036	Annelida	Oligochaeta	Grube, 1850																		3
137571	Annelida	Tubificoides benedii	(d'Udekem, 1855)										1								
137582	Annelida	Tubificoides pseudogaster	(Dahl, 1960)											2			1		1		
130491	Annelida	Ophelia borealis	Quatrefages, 1866		1	1			1		88	18	46	8	2	74	13	58	47		140
130512	Annelida	Travisia forbesii	Johnston, 1840																		
130537	Annelida	Scoloplos armiger	(Müller, 1776)	17	23	56	44	81	23	10		9	6	18	54	31	4	5	2	4	23
129427	Annelida	Owenia	Delle Chiaje, 1844	2		10	2						7	2					1		
326605	Annelida	Aricidea (Aricidea) wassi	Pettibone, 1965																1	1	
152367	Annelida	Lagis koreni	Malmgren, 1866	5	1	4	16	27	7	1	5	6	4	26	24		1		4	8	6
130599	Annelida	Pholoe baltica	Örsted, 1843											2						1	11
130601	Annelida	Pholoe inornata	Johnston, 1839							2											4
130616	Annelida	Eteone longa	(Fabricius, 1780)	7	32	25	13	17	5	8	13	3	3	2	27		4	1	3	2	3
129446	Annelida	Eumida	Malmgren, 1865	4	1	1		4	1	1	1	7	3	6	3	9	2	1			3
130649	Annelida	Hesionura elongata	(Southern, 1914)							53	3	2			1						
334512	Annelida	Phyllodoce mucosa	Örsted, 1843			1				1	1	1	2	2	4						1
334514	Annelida	Phyllodoce rosea	(McIntosh, 1877)										1								
130711	Annelida	Poecilochaetus serpens	Allen, 1904																		
129472	Annelida	Polygordius	Schneider, 1868							6	5										
130749	Annelida	Gattyana cirrhosa	(Pallas, 1766)			1				3	4	2	1	7	5	3	1			1	25
1044546	Annelida	Malmgrenia bicki	Barnich, Dietrich, Hager & Fiege, 2017	1	1								1	2							
130707	Annelida	Pisione remota	(Southern, 1914)							92	46				5		1				
131072	Annelida	Sigalion mathildae	Audouin & Milne Edwards in Cuvier, 1830																2		
131107	Annelida	Aonides paucibranchiata	Southern, 1914							173	666	9		1	12	4	1	1		10	13
131169	Annelida	Pseudopolydora pulchra	(Carazzi, 1893)																		1
131170	Annelida	Pygospio elegans	Claparède, 1863		1			4	24		1										
131171	Annelida	Scolelepis bonnieri	(Mesnil, 1896)				1		2				3		1					1	
334741	Annelida	Scolelepis (Scolelepis) foliosa	(Audouin & Milne Edwards, 1833)												1						

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Infaunal Species

AphiaID	Phylum	Taxa	Authority	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
131184	Annelida	Spio goniocephala	Thulin, 1957		3		1		2			2				4		3			
131185	Annelida	Spio martinensis	Mesnil, 1896				2	2	2												
596189	Annelida	Spio symphyta	Meißner, Bick & Bastrop, 2011	4	1	2		7		44	17	19	1	12	7	2	2			3	3
131187	Annelida	Spiophanes bombyx	(Claparède, 1870)	55	34	46	37	52	46	1	6	48	582	247	128	33	10	13	144	216	58
327985	Annelida	Exogone naidina	Örsted, 1845							2	3	7				1	1				
129659	Annelida	Myrianida	Milne Edwards, 1845																		1
131452	Annelida	Syllis prolifera	Krohn, 1852													1				1	1
131495	Annelida	Lanice conchilega	(Pallas, 1766)	53	49	56	7	87	7	102	310	183	85	237	102	230	37	28	6	29	128
150520	Arthropoda	Nymphon brevirostre	Hodge, 1863																		8
106215	Arthropoda	Balanus crenatus	Bruguière, 1789																		3
1080	Arthropoda	Copepoda	Milne Edwards, 1840					12	5	1	1	3			6	6	8	5		1	14
102788	Arthropoda	Abludomelita obtusata	(Montagu, 1813)					2				1	1	2	2	1					12
102012	Arthropoda	Aora gracilis	(Spence Bate, 1857)																		1
236495	Arthropoda	Apolochus neapolitanus	(Della Valle, 1893)								1										
103058	Arthropoda	Bathyporeia elegans	Watkin, 1938	2	5	8	1	22	68				1						1		
103060	Arthropoda	Bathyporeia guilliamsoniana	(Spence Bate, 1857)				2	8	3	1								2	1	3	
101742	Arthropoda	Bathyporeia	Lindström, 1855				3	31	7					2					1	1	
101839	Arthropoda	Caprella linearis	(Linnaeus, 1767)																		1
101857	Arthropoda	Pariambus typicus	(Krøyer, 1844)	1		1		3		1	1	1	6	19	3	4					2
102433	Arthropoda	Jassa marmorata	Holmes, 1905													1					
102783	Arthropoda	Megaluropus agilis	Hoek, 1889							1				1	1				1		
101764	Arthropoda	Metopa	Boeck, 1871																		1
103166	Arthropoda	Stenothoe marina	(Spence Bate, 1857)																		2
102380	Arthropoda	Microprotopus maculatus	Norman, 1867	2	6	4		9		1	1	4	7	27	7	1				1	6
102139	Arthropoda	Nototropis falcatus	(Metzger, 1871)	2				6	10												
102916	Arthropoda	Pontocrates altamarinus	(Spence Bate & Westwood, 1862)						3												
102917	Arthropoda	Pontocrates arcticus	G.O. Sars, 1895	1		1	1						1						1		
103226	Arthropoda	Urothoe brevicornis	Spence Bate, 1862						1												
103235	Arthropoda	Urothoe poseidonis	Reibish, 1905	1	3	4	4	24	3				12	19	1				9		
110445	Arthropoda	Bodotria scorpioides	(Montagu, 1804)					1			1			1	1					1	6
110465	Arthropoda	Cumopsis goodsir	(Van Beneden, 1861)									1			1					3	
110472	Arthropoda	Diastylis bradyi	Norman, 1879		1		3	3	3	1			1	2	1		1				
422916	Arthropoda	Monopseudocuma gilsoni	(Bacescu, 1950)	24	23	11	7	43	7	4	1	1		3	9	1	2		8	6	1
110627	Arthropoda	Pseudocuma (Pseudocuma) longicorne	(Bate, 1858)										1			4			1		
118216	Arthropoda	Gyge branchialis	Cornalia & Panceri, 1861																		1
136486	Arthropoda	Tanaissus lilljeborgi	(Stebbing, 1891)	1	4			1				2		2		14		16	3	19	1
107552	Arthropoda	Crangon crangon	(Linnaeus, 1758)	1		1					1			1					1		
107688	Arthropoda	Processa modica	Williamson in Williamson & Rochanaburanon, 1979							1				1							
107739	Arthropoda	Upogebia deltaura	(Leach, 1816)																	1	3
107345	Arthropoda	Macropodia rostrata	(Linnaeus, 1761)																		1
107232	Arthropoda	Pagurus bernhardus	(Linnaeus, 1758)			1		1	2		1				1					1	1
107473	Arthropoda	Pinnotheres pisum	(Linnaeus, 1767)																		
107281	Arthropoda	Thia scutellata	(Fabricius, 1793)								2										

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AphiaID	Phylum	Taxa	Authority	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14	GRAB_P_15	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
Infaunal Species																					
139557	Mollusca	Diaphana minuta	T. Brown, 1827								1	1									
867492	Mollusca	Hermania scabra	(O. F. Müller, 1784)																		
141638	Mollusca	Embletonia pulchra	(Alder & Hancock, 1844)								2										
141641	Mollusca	Tergipes tergipes	(Forsskål in Niebuhr, 1775)																		4
138952	Mollusca	Caecum glabrum	(Montagu, 1803)								4	5	1								2
139718	Mollusca	Epitonium clathratulum	(Kanmacher, 1798)												1						
141690	Mollusca	Tornus subcarinatus	(Montagu, 1803)											1							
138831	Mollusca	Goodallia triangularis	(Montagu, 1803)							1	1	1	2								
139604	Mollusca	Donax vittatus	(da Costa, 1778)													1					
345281	Mollusca	Kurtiella bidentata	(Montagu, 1803)		3	43	66	55	18			1									
146952	Mollusca	Tellimya ferruginosa	(Montagu, 1808)	1		11		7				1	6	8	2	1	3		32		
140301	Mollusca	Spisula solida	(Linnaeus, 1758)							1	1					1					
140687	Mollusca	Aequipecten opercularis	(Linnaeus, 1758)												1						1
876640	Mollusca	Ensis leei	M. Huber, 2015	10			13			9	3	1			2		1				
141433	Mollusca	Abra alba	(W. Wood, 1802)	3		8	1	34	2	11	4	4	14	232	115	4	6		4	15	137
146907	Mollusca	Fabulina fabula	(Gmelin, 1791)					2					11	12		1			2		
880017	Mollusca	Limecola balthica	(Linnaeus, 1758)			1		4	3				1								
878470	Mollusca	Macomangulus tenuis	(da Costa, 1778)	1				1	1				1								
138549	Mollusca	Thracia	Blainville, 1824																		
141908	Mollusca	Chamelea striatula	(da Costa, 1778)																		
156961	Mollusca	Petricolaria pholadiformis	(Lamarck, 1818)																	3	
1789	Phoronida	Phoronida	Hatschek, 1888												1		1		1	5	73
123776	Echinodermata	Asterias rubens	Linnaeus, 1758					1							1						
124392	Echinodermata	Echinocardium cordatum	(Pennant, 1777)			5	1	2					3	3	2	1			3		
124929	Echinodermata	Ophiura ophiura	(Linnaeus, 1758)					2													
104906	Chordata	Branchiostoma lanceolatum	(Pallas, 1774)							10	51	4			1	1			1	1	
			S	27	23	31	25	41	30	38	42	35	36	40	45	32	27	16	30	33	49
			N	213	220	358	476	933	271	1484	1855	442	846	986	794	461	283	153	359	393	1938
			d	4.85	4.08	5.10	3.89	5.85	5.18	5.07	5.45	5.58	5.19	5.66	6.59	5.05	4.61	2.98	4.93	5.36	6.34
			J'	0.711	0.774	0.765	0.574	0.686	0.775	0.575	0.523	0.639	0.397	0.598	0.642	0.554	0.653	0.736	0.611	0.568	0.481
			H'(log2)	3.38	3.50	3.79	2.67	3.67	3.80	3.02	2.82	3.28	2.05	3.18	3.53	2.77	3.10	2.94	3.00	2.87	2.70
			1-Lambda'	0.849	0.881	0.902	0.712	0.841	0.885	0.812	0.783	0.793	0.513	0.820	0.863	0.714	0.782	0.803	0.785	0.684	0.658

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AphiaID	Phylum	Taxa	Authority	GRAB_P_0_F1	GRAB_P_0_F2	GRAB_P_1_F1	GRAB_P_1_F2	GRAB_P_2_F1	GRAB_P_2_F2	GRAB_P_3_F1	GRAB_P_3_F2	GRAB_P_4_F1	GRAB_P_4_F2	GRAB_P_5_F1	GRAB_P_5_F2	GRAB_P_6_F1	GRAB_P_6_F2
Epifaunal Species																	
1606	Cnidaria	Campanulariidae	Johnston, 1836														
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)		P				P								
1599	Cnidaria	Corynidae	Johnston, 1836		P												
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758														
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758														
13552	Cnidaria	Leptothecata	Cornelius, 1992														
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)														
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)			P											
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P	P		P	P	P	P	P	P	P	P		
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876	P				P									
Damaged Species																	
939	Annelida	Polynoidae	Kinberg, 1856	12													
913	Annelida	Spionidae	Grube, 1850														
101389	Arthropoda	Ischyroceridae	Stebbing, 1899	2													
101	Mollusca	Gastropoda	Cuvier, 1795														
105	Mollusca	Bivalvia	Linnaeus, 1758		2												
Juvenile Species																	
2	Animalia	Animalia			P		P			P	P						P
129370	Annelida	Nephtys	Cuvier, 1817		2		2										1
1082	Arthropoda	Cirripedia	Burmeister, 1834							1							
106674	Arthropoda	Caridea	Dana, 1852														
1130	Arthropoda	Decapoda	Latreille, 1802	1	1										1		
230	Mollusca	Mactridae	Lamarck, 1809		1												
247	Mollusca	Myidae	Lamarck, 1809	12	17												
211	Mollusca	Mytilidae	Rafinesque, 1815	1													
213	Mollusca	Pectinidae	Rafinesque, 1815	1	3												
138333	Mollusca	Ensis	Schumacher, 1817	6	7												
235	Mollusca	Tellinidae	Blainville, 1814	1			1	6	13	4							
123080	Echinodermata	Asteroidea	de Blainville, 1830	121	187	3	2	3						1	2		
123160	Echinodermata	Echinidae	Gray, 1825	1	1												
852322	Echinodermata	Spatangoida	Gray, 1825		3					1						1	
123084	Echinodermata	Ophiuroidea	Gray, 1840		2												
1839	Chordata	Ascidiacea	Blainville, 1824	1	6			1				3					
Others																	
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)														

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AphiaID	Phylum	Taxa	Authority	GRAB_ P_7_F1	GRAB_ P_7_F2	GRAB_ P_8_F1	GRAB_ P_8_F2	GRAB_ P_9_F1	GRAB_ P_9_F2	GRAB_ P_10_F1	GRAB_ P_10_F2	GRAB_ P_11_F1	GRAB_ P_11_F2	GRAB_ P_12_F1	GRAB_ P_12_F2	GRAB_ P_13_F1	GRAB_ P_13_F2
Epifaunal Species																	
1606	Cnidaria	Campanulariidae	Johnston, 1836														
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)		P												
1599	Cnidaria	Corynidae	Johnston, 1836														
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758														
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758														
13552	Cnidaria	Leptothecata	Cornelius, 1992													P	
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)														
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)											P			
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P			P	P	P	P	P	P	P	P		
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876							P		P					
Damaged Species																	
939	Annelida	Polynoidae	Kinberg, 1856														
913	Annelida	Spionidae	Grube, 1850														
101389	Arthropoda	Ischyroceridae	Stebbing, 1899												1		
101	Mollusca	Gastropoda	Cuvier, 1795														
105	Mollusca	Bivalvia	Linnaeus, 1758														
Juvenile Species																	
2	Animalia	Animalia				P	P		P						P		P
129370	Annelida	Nephtys	Cuvier, 1817		1			3	2						1		
1082	Arthropoda	Cirripedia	Burmeister, 1834														
106674	Arthropoda	Caridea	Dana, 1852														
1130	Arthropoda	Decapoda	Latreille, 1802										1				1
230	Mollusca	Mactridae	Lamarck, 1809			1				8						10	
247	Mollusca	Myidae	Lamarck, 1809														
211	Mollusca	Mytilidae	Rafinesque, 1815		1												
213	Mollusca	Pectinidae	Rafinesque, 1815	1	2												
138333	Mollusca	Ensis	Schumacher, 1817														
235	Mollusca	Tellinidae	Blainville, 1814														
123080	Echinodermata	Asteroidea	de Blainville, 1830		5			1			3	6		1	2		
123160	Echinodermata	Echinidae	Gray, 1825														
852322	Echinodermata	Spatangoida	Gray, 1825		6						1						
123084	Echinodermata	Ophiuroidea	Gray, 1840		1												
1839	Chordata	Ascidiacea	Blainville, 1824			1											
Others																	
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)														

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AphiaID	Phylum	Taxa	Authority	GRAB_P_14_F1	GRAB_P_14_F2	GRAB_P_15_F1	GRAB_P_15_F2	GRAB_C_0_F1	GRAB_C_0_F2	GRAB_C_1_F1	GRAB_C_1_F2	GRAB_C_2_F1	GRAB_C_2_F2	GRAB_C_3_F1	GRAB_C_3_F2	GRAB_C_4_F1	GRAB_C_4_F2
Epifaunal Species																	
1606	Cnidaria	Campanulariidae	Johnston, 1836														
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)									P		P	P	P	
1599	Cnidaria	Corynidae	Johnston, 1836														
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758													P	
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758														
13552	Cnidaria	Leptothecata	Cornelius, 1992														
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)														
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)														
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P	P	P	P	P	P	P	P	P	P	P	P	P
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876	P	P					P				P			
Damaged Species																	
939	Annelida	Polynoidae	Kinberg, 1856														
913	Annelida	Spionidae	Grube, 1850							1							
101389	Arthropoda	Ischyroceridae	Stebbing, 1899													1	1
101	Mollusca	Gastropoda	Cuvier, 1795														
105	Mollusca	Bivalvia	Linnaeus, 1758					3									
Juvenile Species																	
2	Animalia	Animalia		P			P					P	P	P		P	P
129370	Annelida	Nephtys	Cuvier, 1817														3
1082	Arthropoda	Cirripedia	Burmeister, 1834				1										
106674	Arthropoda	Caridea	Dana, 1852	1													
1130	Arthropoda	Decapoda	Latreille, 1802	1	1									1			1
230	Mollusca	Mactridae	Lamarck, 1809					3	1	21		3					
247	Mollusca	Myidae	Lamarck, 1809					10	2	4	3						
211	Mollusca	Mytilidae	Rafinesque, 1815			1					1	1					
213	Mollusca	Pectinidae	Rafinesque, 1815														
138333	Mollusca	Ensis	Schumacher, 1817					9	1	11	3	2					1
235	Mollusca	Tellinidae	Blainville, 1814											3	4	4	13
123080	Echinodermata	Asteroidea	de Blainville, 1830	10			1	3	5	57	7	11	11	5	2	16	5
123160	Echinodermata	Echinidae	Gray, 1825														
852322	Echinodermata	Spatangoida	Gray, 1825													1	1
123084	Echinodermata	Ophiuroidea	Gray, 1840					1		2		1	1				
1839	Chordata	Ascidiacea	Blainville, 1824					6	12		1	2	2				
Others																	
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)														

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AphiaID	Phylum	Taxa	Authority	GRAB_C_5_F1	GRAB_C_5_F2	GRAB_C_6_F1	GRAB_C_6_F2	GRAB_C_7_F1	GRAB_C_7_F2	GRAB_C_8_F1	GRAB_C_8_F2	GRAB_C3_0_F1	GRAB_C3_0_F2	GRAB_C3_1_F1	GRAB_C3_1_F2	GRAB_C3_2_F1	GRAB_C3_2_F2
Epifaunal Species																	
1606	Cnidaria	Campanulariidae	Johnston, 1836													P	P
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)	P		P	P			P	P			P	p	P	
1599	Cnidaria	Corynidae	Johnston, 1836														
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758													P	P
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758													P	P
13552	Cnidaria	Leptothecata	Cornelius, 1992														
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)	P		P		P									
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)	P												P	
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P	P	P	P	P	P	P			P	P	P	P
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876			P	P		P	P						P	
Damaged Species																	
939	Annelida	Polynoidae	Kinberg, 1856														
913	Annelida	Spionidae	Grube, 1850														
101389	Arthropoda	Ischyroceridae	Stebbing, 1899	1	1		1		4	1						4	5
101	Mollusca	Gastropoda	Cuvier, 1795							1							1
105	Mollusca	Bivalvia	Linnaeus, 1758														
Juvenile Species																	
2	Animalia	Animalia					P	P					P		P	P	P
129370	Annelida	Nephtys	Cuvier, 1817		1		1		1						2		
1082	Arthropoda	Cirripedia	Burmeister, 1834														
106674	Arthropoda	Caridea	Dana, 1852													1	
1130	Arthropoda	Decapoda	Latreille, 1802									1	1				
230	Mollusca	Mactridae	Lamarck, 1809		1			7									
247	Mollusca	Myidae	Lamarck, 1809		2			2								4	6
211	Mollusca	Mytilidae	Rafinesque, 1815			1									1	7	22
213	Mollusca	Pectinidae	Rafinesque, 1815			1			2								1
138333	Mollusca	Ensis	Schumacher, 1817	1					1								
235	Mollusca	Tellinidae	Blainville, 1814									17	6		1		
123080	Echinodermata	Asteroidea	de Blainville, 1830	9	5	11	24	1	7	3		1				28	26
123160	Echinodermata	Echinidae	Gray, 1825														
852322	Echinodermata	Spatangoida	Gray, 1825	1													
123084	Echinodermata	Ophiuroidea	Gray, 1840				1					2					
1839	Chordata	Ascidiacea	Blainville, 1824	8	6	3	7	16	6	1	5			1		11	5
Others																	
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)	1													

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AphiaID	Phylum	Taxa	Authority	GRAB_P_0	GRAB_P_1	GRAB_P_2	GRAB_P_3	GRAB_P_4	GRAB_P_5	GRAB_P_6	GRAB_P_7	GRAB_P_8	GRAB_P_9	GRAB_P_10	GRAB_P_11	GRAB_P_12	GRAB_P_13	GRAB_P_14
Epifaunal Species																		
1606	Cnidaria	Campanulariidae	Johnston, 1836															
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)	P		P					P							
1599	Cnidaria	Corynidae	Johnston, 1836	P														
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758															
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758															
13552	Cnidaria	Leptothecata	Cornelius, 1992														P	
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)															
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)		P											P		
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P	P	P	P	P		P		P	P	P	P		P
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876	P		P								P	P			P
Damaged Species																		
939	Annelida	Polynoidae	Kinberg, 1856	12														
913	Annelida	Spionidae	Grube, 1850															
101389	Arthropoda	Ischyroceridae	Stebbing, 1899	2												1		
101	Mollusca	Gastropoda	Cuvier, 1795															
105	Mollusca	Bivalvia	Linnaeus, 1758	2														
Juvenile Species																		
2	Animalia	Animalia		P	P		P			P		P	P			P	P	P
129370	Annelida	Nephtys	Cuvier, 1817	2	2					1	1		5			1		
1082	Arthropoda	Cirripedia	Burmeister, 1834				1											
106674	Arthropoda	Caridea	Dana, 1852															1
1130	Arthropoda	Decapoda	Latreille, 1802	2					1						1		1	2
230	Mollusca	Mactridae	Lamarck, 1809	1								1		8			10	
247	Mollusca	Myidae	Lamarck, 1809	29														
211	Mollusca	Mytilidae	Rafinesque, 1815	1							1							
213	Mollusca	Pectinidae	Rafinesque, 1815	4							3							
138333	Mollusca	Ensis	Schumacher, 1817	13														
235	Mollusca	Tellinidae	Blainville, 1814	1	1	19	4											
123080	Echinodermata	Asteroidea	de Blainville, 1830	308	5	3			3		5		1	3	6	3		10
123160	Echinodermata	Echinidae	Gray, 1825	2														
852322	Echinodermata	Spatangoida	Gray, 1825	3			1			1	6			1				
123084	Echinodermata	Ophiuroidea	Gray, 1840	2							1							
1839	Chordata	Ascidiacea	Blainville, 1824	7		1		3				1						
Others																		
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)															

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AphiaID	Phylum	Taxa	Authority	GRAB_P_15	GRAB_C_0	GRAB_C_1	GRAB_C_2	GRAB_C_3	GRAB_C_4	GRAB_C_5	GRAB_C_6	GRAB_C_7	GRAB_C_8	GRAB_C3_0	GRAB_C3_1	GRAB_C3_2
Epifaunal Species																
1606	Cnidaria	Campanulariidae	Johnston, 1836													P
117368	Cnidaria	Clytia hemisphaerica	(Linnaeus, 1767)				P	P	P	P	P		P		P	P
1599	Cnidaria	Corynidae	Johnston, 1836													
117913	Cnidaria	Sertularia cupressina	Linnaeus, 1758						P							P
117994	Cnidaria	Tubularia indivisa	Linnaeus, 1758													P
13552	Cnidaria	Leptothecata	Cornelius, 1992													
111604	Bryozoa	Alcyonidium parasiticum	(Fleming, 1828)							P	P	P				
111351	Bryozoa	Conopeum reticulum	(Linnaeus, 1767)							P						P
111355	Bryozoa	Electra pilosa	(Linnaeus, 1767)	P	P	P	P	P	P	P	P	P	P		P	P
111622	Bryozoa	Hypophorella expansa	Ehlers, 1876			P		P			P	P	P			P
Damaged Species																
939	Annelida	Polynoidae	Kinberg, 1856													
913	Annelida	Spionidae	Grube, 1850			1										
101389	Arthropoda	Ischyroceridae	Stebbing, 1899						2	2	1	4	1			9
101	Mollusca	Gastropoda	Cuvier, 1795										1			1
105	Mollusca	Bivalvia	Linnaeus, 1758		3											
Juvenile Species																
2	Animalia	Animalia		P			P	P	P		P	P		P	P	P
129370	Annelida	Nephtys	Cuvier, 1817						3	1	1	1			2	
1082	Arthropoda	Cirripedia	Burmeister, 1834	1												
106674	Arthropoda	Caridea	Dana, 1852													1
1130	Arthropoda	Decapoda	Latreille, 1802					1	1					2		
230	Mollusca	Mactridae	Lamarck, 1809		4	21	3			1		7				
247	Mollusca	Myidae	Lamarck, 1809		12	7				2		2				10
211	Mollusca	Mytilidae	Rafinesque, 1815	1		1	1				1				1	29
213	Mollusca	Pectinidae	Rafinesque, 1815								1	2				1
138333	Mollusca	Ensis	Schumacher, 1817		10	14	2		1	1		1				
235	Mollusca	Tellinidae	Blainville, 1814			0		7	17	0				23	1	
123080	Echinodermata	Asteroidea	de Blainville, 1830	1	8	64	22	7	21	14	35	8	3	1		54
123160	Echinodermata	Echinidae	Gray, 1825													
852322	Echinodermata	Spatangoida	Gray, 1825						2	1						
123084	Echinodermata	Ophiuroidea	Gray, 1840		1	2	2				1			2		
1839	Chordata	Ascidiacea	Blainville, 1824		18	1	4			14	10	22	6		1	16
Others																
126928	Chordata	Pomatoschistus minutus	(Pallas, 1770)							1						

APPENDIX N - SPEARMAN'S CORRELATION

Spearman's Correlation Coefficient (Two-tailed)

Number of Data Points	28
p=0.05, 95% Significant	0.375
p=0.01, 99% Significant	0.483
p=0.001, 99.9% Significant	0.598

	Water Depth (m)	Distance to shore (km)	Mean (mm)	Sorting	Skewness	Kurtosis	% Fines	% Sands	% Gravel	Total Organic Carbon (% w/w C)	Total Organic Matter (% w/w)	Moisture Content (%)	Total Oil (ng.g-1)	Total n alkanes (ng.g-1)	Carbon Preference Index	P/B Ratio	Pr/Ph Ratio	Proportion of Alkanes (%)	Total PAHs (ng.g-1)	NPD PAHs (ng.g-1)	UMC (ng.g-1)
Water Depth (m)		0.803	0.357	0.448	0.564	0.153	0.589	-0.442	-0.175	0.235	0.143	0.142	0.279	0.340	0.130	-0.143	0.271	0.311	-0.076	-0.224	0.291
Distance to shore (km)			0.367	0.286	0.508	0.141	0.595	-0.336	-0.198	0.266	0.161	0.107	0.292	0.434	-0.050	-0.075	0.234	0.457	-0.120	-0.194	0.304
Mean (mm)				0.255	-0.028	-0.015	-0.012	-0.022	0.270	-0.431	-0.532	-0.510	-0.425	-0.261	-0.338	-0.170	-0.396	0.004	-0.528	-0.573	-0.414
Sorting					0.481	0.402	0.570	-0.808	0.525	0.356	0.318	0.094	0.116	0.246	0.043	0.291	0.295	0.249	0.178	0.026	0.124
Skewness						0.125	0.890	-0.513	-0.306	0.473	0.413	0.110	0.530	0.490	0.109	0.080	0.395	0.323	0.286	0.104	0.536
Kurtosis							0.272	-0.494	0.105	0.179	0.110	0.155	-0.019	0.082	-0.086	0.201	-0.008	-0.028	0.137	0.164	-0.013
% Fines								-0.723	-0.123	0.583	0.558	0.084	0.557	0.675	0.079	0.156	0.387	0.559	0.350	0.158	0.558
% Sands									-0.413	-0.581	-0.570	-0.103	-0.357	-0.530	-0.073	-0.364	-0.362	-0.473	-0.447	-0.220	-0.361
% Gravel										0.009	0.057	-0.210	-0.344	-0.088	-0.149	0.231	0.072	0.193	-0.026	-0.115	-0.340
Total Organic Carbon (% w/w C)											0.861	0.392	0.664	0.780	0.162	0.203	0.462	0.621	0.568	0.346	0.861
Total Organic Matter (% w/w)												0.409	0.719	0.772	0.113	0.242	0.487	0.516	0.640	0.403	0.715
Moisture Content (%)													0.445	0.221	0.171	0.076	0.346	-0.103	0.223	0.262	0.448
Total Oil (ng.g-1)														0.859	0.228	-0.034	0.447	0.394	0.830	0.394	0.999
Total n alkanes (ng.g-1)															0.219	0.100	0.447	0.748	0.596	0.339	0.855
Carbon Preference Index																0.073	0.177	0.157	0.359	0.460	0.226
P/B Ratio																	0.066	0.165	0.100	0.064	-0.034
Pr/Ph Ratio																		0.447	0.419	0.103	0.447
Proportion of Alkanes (%)																			0.335	0.055	0.385
Total PAHs (ng.g-1)																				0.800	0.672
NPD PAHs (ng.g-1)																					0.385
UMC (ng.g-1)																					
Arsenic (mg/kg)																					
Cadmium (mg/kg)																					
Chromium (mg/kg)																					
Copper (mg/kg)																					
Lead (mg/kg)																					
Mercury (mg/kg)																					
Nickel (mg/kg)																					
Vanadium (mg/kg)																					
Zinc (mg/kg)																					
Aluminium (mg/kg)																					
Iron (mg/kg)																					
Barium (mg/kg)																					
Tin (mg/kg)																					
No. of Species per 0.2m2 (S)																					
No. of Individuals per 0.2m2 (N)																					
Richness (Margalef)																					
Evenness (Pielou's Evenness)																					
Shannon-Wiener Diversity (H' (log2))																					
Simpsons Diversity (1-Lambda')																					

	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Vanadium (mg/kg)	Zinc (mg/kg)	Aluminium (mg/kg)	Iron (mg/kg)	Barium (mg/kg)	Tin (mg/kg)	No. of Species per 0.2m2 (S)	No. of Individuals per 0.2m2 (N)	Richness (Margalef)	Evenness (Pielou's Evenness)	Shannon-Wiener Diversity (H' (log2))	Simpsons Diversity (1-Lambda')
Water Depth (m)	0.544	-0.179	-0.087	0.383	0.255	0.170	0.282	0.361	-0.208	0.043	0.591	0.403	0.236	0.270	0.383	0.148	-0.576	-0.598	-0.566
Distance to shore (km)	0.704	-0.320	-0.061	0.353	0.336	0.002	0.305	0.460	-0.177	0.057	0.661	0.377	0.258	0.198	0.314	0.092	-0.436	-0.429	-0.355
Mean (mm)	-0.003	-0.201	-0.712	-0.031	-0.436	-0.316	-0.302	-0.255	-0.649	-0.555	-0.013	-0.241	-0.322	0.214	0.195	0.149	-0.190	-0.215	-0.169
Sorting	0.276	0.031	-0.022	0.169	0.086	-0.043	0.308	0.228	-0.280	0.140	0.226	0.238	0.322	0.392	0.429	0.161	-0.463	-0.418	-0.409
Skewness	0.476	-0.339	0.302	0.367	0.480	0.200	0.483	0.402	-0.068	0.279	0.608	0.467	0.298	0.233	0.273	0.139	-0.495	-0.489	-0.507
Kurtosis	0.077	-0.410	-0.120	0.067	-0.076	-0.250	-0.024	0.094	-0.281	-0.080	-0.044	-0.095	-0.298	0.079	0.049	0.039	-0.099	-0.072	-0.079
% Fines	0.575	-0.350	0.323	0.311	0.555	0.122	0.592	0.558	-0.119	0.408	0.720	0.595	0.298	0.285	0.362	0.142	-0.537	-0.534	-0.478
% Sands	-0.396	-0.021	-0.270	-0.126	-0.355	-0.034	-0.497	-0.472	0.103	-0.433	-0.432	-0.466	-0.298	-0.333	-0.350	-0.164	0.400	0.363	0.334
% Gravel	-0.137	0.388	-0.162	0.025	-0.267	-0.157	0.034	-0.025	-0.262	-0.037	-0.252	-0.123	0.179	0.137	0.062	0.068	0.090	0.103	0.125
Total Organic Carbon (% w/w C)	0.430	0.070	0.694	0.216	0.711	0.367	0.738	0.525	0.291	0.773	0.503	0.668	0.331	0.224	0.364	0.081	-0.365	-0.272	-0.321
Total Organic Matter (% w/w)	0.499	0.153	0.790	0.112	0.759	0.334	0.776	0.683	0.456	0.855	0.548	0.663	0.349	0.236	0.282	0.164	-0.223	-0.108	-0.146
Moisture Content (%)	0.268	0.062	0.336	-0.005	0.339	0.297	0.168	0.191	0.303	0.263	0.103	0.065	0.322	-0.069	0.095	-0.164	-0.046	-0.040	0.035
Total Oil (ng.g-1)	0.668	0.109	0.743	-0.036	0.869	0.444	0.678	0.695	0.500	0.735	0.729	0.555	0.322	0.187	0.294	0.146	-0.331	-0.253	-0.293
Total n alkanes (ng.g-1)	0.661	0.094	0.852	0.127	0.834	0.350	0.791	0.764	0.268	0.785	0.777	0.712	0.322	0.332	0.464	0.222	-0.442	-0.332	-0.350
Carbon Preference Index	-0.113	0.493	0.318	0.357	0.143	0.120	0.277	0.227	0.198	0.266	0.033	0.256	0.294	0.091	0.212	0.036	-0.265	-0.245	-0.329
P/B Ratio	-0.008	0.025	0.254	0.003	0.081	-0.204	0.254	0.189	-0.036	0.333	0.052	0.331	0.016	0.232	0.085	0.222	0.141	0.365	0.302
Pr/Ph Ratio	0.290	0.200	0.415	0.411	0.385	0.364	0.451	0.346	0.211	0.413	0.382	0.449	0.708	-0.010	0.070	-0.057	-0.222	-0.275	-0.272
Proportion of Alkanes (%)	0.387	0.057	0.389	0.332	0.517	0.224	0.682	0.553	-0.002	0.562	0.625	0.728	0.322	0.334	0.452	0.204	-0.467	-0.406	-0.391
Total PAHs (ng.g-1)	0.201	0.375	0.656	0.035	0.562	0.301	0.460	0.502	0.422	0.646	0.288	0.376	0.300	-0.037	0.070	-0.112	-0.076	-0.140	-0.113
NPD PAHs (ng.g-1)	0.056	0.305	0.478	0.025	0.365	0.094	0.213	0.312	0.456	0.423	0.053	0.125	0.308	-0.202	-0.058	-0.284	0.130	0.052	0.124
UMC (ng.g-1)	0.675	0.109	0.735	-0.030	0.864	0.433	0.674	0.699	0.493	0.725	0.728	0.545	0.322	0.193	0.293	0.157	-0.328	-0.246	-0.290
Arsenic (mg/kg)		-0.120	0.381	0.089	0.727	0.199	0.578	0.810	0.304	0.458	0.828	0.450	0.326	0.359	0.418	0.269	-0.445	-0.305	-0.290
Cadmium (mg/kg)			0.291	-0.014	0.088	0.210	0.132	0.112	0.345	0.272	-0.166	0.041	0.389	0.068	0.063	0.069	0.083	0.121	0.074
Chromium (mg/kg)				0.095	0.827	0.482	0.788	0.648	0.730	0.902	0.487	0.649	0.323	0.135	0.125	0.181	-0.097	0.050	-0.069
Copper (mg/kg)					0.097	0.113	0.375	0.247	-0.082	0.045	0.145	0.301	0.331	0.153	0.221	0.117	-0.318	-0.313	-0.373
Lead (mg/kg)						0.583	0.840	0.770	0.564	0.830	0.762	0.898	0.324	0.326	0.373	0.271	-0.358	-0.185	-0.245
Mercury (mg/kg)							0.464	0.179	0.364	0.442	0.316	0.396	0.225	0.060	0.166	-0.008	-0.270	-0.298	-0.337
Nickel (mg/kg)								0.780	0.417	0.854	0.727	0.812	0.336	0.484	0.515	0.404	-0.476	-0.265	-0.395
Vanadium (mg/kg)									0.441	0.707	0.779	0.640	0.321	0.405	0.427	0.371	-0.388	-0.216	-0.262
Zinc (mg/kg)										0.646	0.300	0.350	0.322	0.001	0.014	0.070	0.053	0.153	0.053
Aluminium (mg/kg)											0.623	0.821	0.322	0.309	0.346	0.263	-0.247	-0.062	-0.158
Iron (mg/kg)												0.765	0.323	0.336	0.427	0.254	-0.505	-0.430	-0.421
Barium (mg/kg)													0.323	0.448	0.520	0.356	-0.500	-0.327	-0.399
Tin (mg/kg)														-0.100	0.060	-0.226	-0.107	-0.203	-0.107
No. of Species per 0.2m2 (S)															0.983	0.910	0.702	-0.263	-0.440
No. of Individuals per 0.2m2 (N)																0.647	0.857	0.549	0.631
Richness (Margalef)																	-0.467	0.008	-0.228
Evenness (Pielou's Evenness)																		0.851	0.909
Shannon-Wiener Diversity (H' (log2))																			0.917
Simpsons Diversity (1-Lambda')																			

APPENDIX O - AQA CERTIFICATION OF LABORATORIES

UKAS TESTING 1252 Accredited to ISO/IEC 17025:2005	**Schedule of Accreditation** issued by **United Kingdom Accreditation Service** 2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK
	SOCOTEC UK Limited **Issue No:** 083 **Issue date:** 28 March 2018
Testing performed at main address only	

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
SOILS (cont'd)	Chemical Tests (cont'd)	
SOILS **(includes made ground)**	Aluminium Arsenic Cadmium Chromium Cobalt Copper Iron Lead Manganese Molybdenum Nickel Vanadium Zinc	Documented In-House Method based on Blue Book Methods for the Examination of Waters and Associated Materials. Determination of Metals in Soils, Sediments and Sewage Sludge and Plants using ICP-OES, No ICPSOIL
SOILS (includes made ground)	Calcium Magnesium Sodium Potassium Strontium Phosphorus	
SOILS (includes made ground)	Antimony Arsenic Cadmium Chromium Cobalt Copper Lead Manganese Mercury Molybdenum Nickel Selenium Thallium Uranium Zinc	Documented In-House Method using ICPMS, No ICPMSS
MARINE SEDIMENTS	Arsenic Tin Lead Copper	Documented in house method: ICPSEDEXT - Hydrofluoric acid digestion followed by ICPMSSED analysis by ICPMS

UKAS TESTING 1252 Accredited to ISO/IEC 17025:2005	**Schedule of Accreditation** issued by **United Kingdom Accreditation Service** 2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK
	SOCOTEC UK Limited **Issue No:** 083 **Issue date:** 28 March 2018
Testing performed at main address only	

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
	Chemical Tests (cont'd)	
MARINE SEDIMENTS (cont'd)	Aluminium Barium Iron Manganese Strontium Chromium Nickel Vanadium Zinc	Documented in house method: ICPSEDEXT - Hydrofluoric acid digestion followed by ICPSED analysis by ICP-OES
SOILS and made-ground	Quantification of Phenol and its methylated isomers below: Methylphenols Dimethylphenols Trimethylphenols Total phenols	PHENUVHPLC by methanol/water extraction and HPLC with UV detection
MARINE SEDIMENTS	Vanadium Chromium Manganese Nickel Copper Zinc Arsenic Cadmium Tin Mercury Lead	Documented in-house method SEDMEXT & SEDMS by Microwave Assisted Hydrofluoric Acid Digestion and ICPMS Quantification
	Aluminium Barium Beryllium Iron Manganese Phosphorus Strontium Chromium Copper Vanadium Zinc Nickel	Documented in-house method SEDMEXT & SEDOES by Microwave Assisted Hydrofluoric Acid Digestion and ICPOES Quantification

1252 Accredited to ISO/IEC 17025:2005	**Schedule of Accreditation** issued by **United Kingdom Accreditation Service** 2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK **SOCOTEC UK Limited** **Issue No:** 083 **Issue date:** 28 March 2018
Testing performed at main address only	

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used
	Chemical Tests (cont'd)	
MARINE SEDIMENT	PAH's in include: Naphthalene Acenaphthylene Acenaphthene Fluorene Phenanthrene Anthracene Dibenzthiophene Fluoranthene Pyrene Benzo(a)anthracene Chrysene/Triphenylene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(e)pyrene Benzo(a)pyrene Indeno(123-cd)pyrene Dibenzo(ah)anthracene Benzo(ghi)perylene	Documented in house method - HCEXTSED by Solvent Extraction and Method PAHSED Determination By GC-MS(SIM)
	Arsenic Cadmium Chromium Cobalt Copper Lead Manganese Mercury Nickel Zinc	Documented in house method ICPEXT for Aqua Regia extraction and ICPMSS for ICP-MS analysis

United Kingdom Accreditation Service

ACCREDITATION CERTIFICATE

TESTING LABORATORY
No. 1252

SOCOTEC UK Limited

is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005 - General Requirements for the competence of testing and calibration laboratories.

This accreditation demonstrates technical competence for a defined scope as detailed in and at the locations specified in the schedule to this certificate, and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated April 2017).

The schedule to this certificate is an essential accreditation document and from time to time may be revised and reissued by the United Kingdom Accreditation Service. The most recent issue of the schedule of accreditation, which bears the same accreditation number as this certificate, is available from the UKAS website www.ukas.com.

This accreditation is subject to continuing conformity with United Kingdom Accreditation Service requirements. The absence of a schedule on the UKAS website indicates that the accreditation is no longer in force.

Accreditation Manager, United Kingdom Accreditation Service

Initial Accreditation date
6 October 1992

This certificate issued on
17 October 2017

UKAS is appointed as the sole national accreditation body for the UK by The Accreditation Regulations 2009 (SI No 3155/2009) and operates under a Memorandum of Understanding (MoU) with the Department for Business, Energy & Industrial Strategy (BEIS)

APPENDIX P - SERVICE WARRANTY

This report, with its associated works and services, has been designed solely to meet the requirements of the contract agreed with you, our client. If used in other circumstances, some or all of the results may not be valid and we can accept no liability for such use. Such circumstances include different or changed objectives, use by third parties, or changes to, for example, station conditions or legislation occurring after completion of the work. In case of doubt, please consult Benthic Solutions Limited. Please note that all charts, where applicable should not be used for navigational purposes.

N5a Development

Title	**Habitat Assessment Survey Report**
GEOxyz Report No.	LU0022H-553-RR-04
ONE Report No.	N05A-7-10-0-70019-01
Revision	2.1

2.1	30/10/2019	Final Issue	PC	PC	SD	
2.0	20/09/2019	Final Issue	HB	PC	SD	
1.0	19/07/2019	First Issue	HB	PC		
Revision	Date	Description of Revision	Author	Checked	Approved	Approved Client

REVISION HISTORY

The screen version of this document is always the CONTROLLED COPY. When printed it is considered a FOR INFORMATION ONLY copy, and it is the holder's responsibility that they hold the latest valid version.

The table on this page can be used to explain the reason for the revision and what has changed since the previous revision.

Rev.	Reason for revision	Changes from previous version
1.0	First Issue	N/A
2.0	Approved by Client	None
2.1	Approved by Client	Comments on EBS report required small adaptions to this report as there is overlapping content. Changes from previous version: • Modifcation of text describing H1110 habitat type in order to correlate the observed faunal communities with the characterising species for the H1110_C habitat subtype. • Reference to Zostera marina beds has been removed from the relevant text.

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ABBREVIATIONS

The abbreviations listed in Table 1 are used within this report. Where abbreviations used in this document are not included in Table 1, it may be assumed that they are either equipment brand names or company names.

Table 1 Abbreviations used in this document

	Description		Description
2DHR	2-Dimensional High Resolution	OSPAR	Oslo/Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
BSL	Benthic Solutions Limited	OWF	Offshore Windfarm
CNS	Central North Sea	PC	Physico-chemical grab sample
CPT	Cone Penetrometer Test	PPP	Precise Point Positioning
EBS	Environmental Baseline Survey	PPS	Pulse per second
ED50	European Datum 1950	ROV	Remotely Operated Vehicle
F1/F2/F3	Fauna grab samples 1, 2 and 3	SBP	Sub-Bottom Profiler
GNSS	Global Navigation Satellite System	SSS	Side Scan Sonar
HAS	Habitat Assessment Survey	UHR	Ultra-High Resolution
KP	Kilometre Post	UKCS	United Kingdom Continental Shelf
LAT	Lowest Astronomical Tide	USBL	Ultra-short Baseline
LED	Light Emitting Diode	UTC	Universal Time Coordinated
MAG	Magnetometer	UTM	Universal Transverse Mercator
MBES	Multibeam Echosounder	VC	Vibro-core
NGT	Noordgastransport	VORF	Vertical Offshore Reference Frames
MSL	Mean Sea Level	WGS84	World Geodetic System 1984
ONE	Oranje-Nassau Energie		

1 INTRODUCTION

1.1 PROJECT OVERVIEW

GEOxyz was contracted by Oranje Nassau Energie (ONE) to undertake a range of geophysical, geotechnical and environmental surveys in block N5A of the Dutch Sector, comprising a site survey and two route surveys (Figure 1 and Table 2):

- Site survey (1km x 1km) over the N5A exploration well which will be developed by emplacement of the N5A Platform.
- Cable route survey (9km x 1km) from proposed N5A Platform to Riffgat Offshore Windfarm (OWF) Transformer Station.
- Pipeline route survey (15km x 1km) for proposed gas export pipeline from N5A Platform to with a proposed cable route corridor between the N5A Platform location and the Noordgastransport (NGT) hot tap location.

The geophysical surveys comprised acquisition of multibeam echosounder (MBES), side scan sonar (SSS), magnetometer (MAG) and sub-bottom profiler (SBP) data over the site and routes with Sparker multi-channel seismic data also acquired over the site survey area. An additional 4km x 1km cable route survey and 1km x 1km rig site survey was completed for a potential alternative location of the N5a platform upon request from the client.

The environmental survey work comprised a habitat assessment and environmental baseline survey and was carried out by GeoXYZ Offshore UK Limited, supported by Benthic Solutions Ltd (BSL).

Table 2: Proposed N5A Platform, N5A to Riffgat Cable Route and N5A to NGT Hot Tap Route Locations

ED50, UTM 31N, CM 3° E					
Proposed Location	KP	Easting (m)	Northing (m)	Latitude	Longitude
N5A Platform	0.000	721 607.00	5 954 650.00	53° 41' 32.347" N	06° 21' 23.281" E
End of Route – Riffgat Windpark Transformer Station Location	8.681	730 081.00	5 954 988.00	53° 41' 30.080" N	06° 29' 05.312" E
End of Route – NGT hot tap Location	14.675	718 409.00	5 940 429.00	53° 33' 57.806" N	06°17' 53.314" E

Survey operations were performed onboard the survey vessel Geo-Ocean III (Appendix A) between the 1st and 15th May 2019.

The objectives of the environmental survey were as follows:

- Identify UKCS sensitive environmental habitats and species (e.g. Annex I Habitats).
- Acquire baseline data to assess the sediment physico-chemical and biological characteristics within the survey area.

This report provides the results of the environmental habitat assessment over the N5a site survey areas (original and alternative) and associated cable and pipeline route survey corridors.

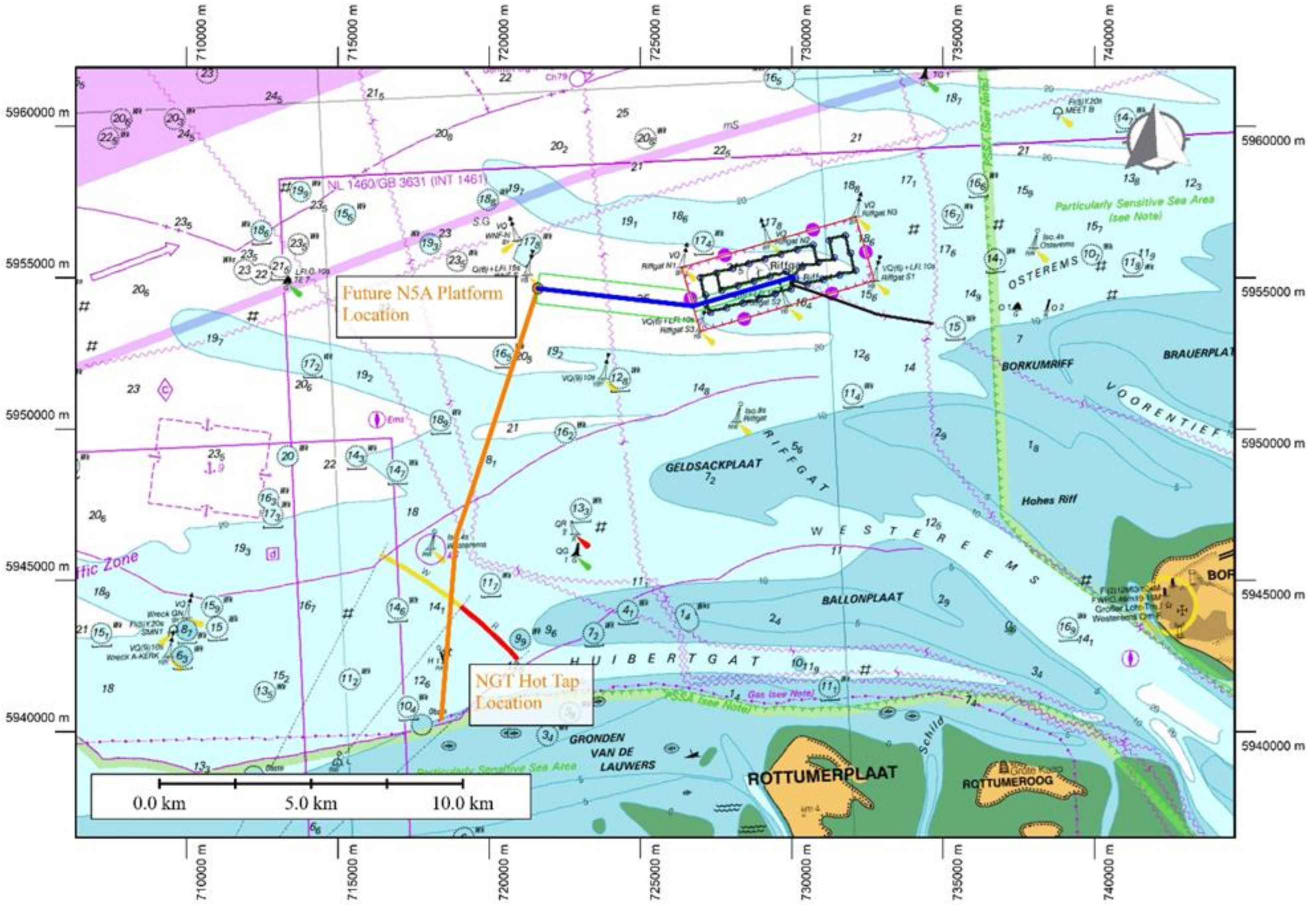


Figure 1: Project location overview

1.2 SCOPE OF WORK

There were three main work areas for geophysical, geotechnical and environmental surveys as described in N5A-7-10-0-70000-01-05 - Pipeline Route and Platform Area Survey Scope. These were:

- Platform Survey Future N5A location;
- Pipeline Route Survey from the future N5A platform location to a subsea hot-tap tie-in at the NGT pipeline near KP 142.1(orange line in Figure 1 above);
- Cable Route Survey from the future N5A platform location to the Riffgat transformer station (blue line in Figure 1 above).

The following surveys were required by ONE and are described in more detail in Table 3:

- Geophysical Pipeline and Power Cable Route Surveys;
- Geotechnical Pipeline and Power Cable Route Surveys;
- Environmental Pipeline and Power Cable Route surveys including the Platform Area;
- Geophysical Platform Area Survey.

Table 3: Detailed scope of work for each area

Scope	N5A Platform site	Hot Tap Pipeline Route	Riffgat Cable Route
Geophysical Analogue	MBES, SSS, MAG, SBP	MBES, SSS, MAG, SBP	MBES, SSS, MAG, SBP
Geophysical Digital	Multi-channel sparker 80 m depth		
Environmental	Two grab samples within the platform site survey area	Grab sampling each km	Grab sampling each km (including within Riffgat OWF)
Shallow Geotechnical		VC each km	VC each km

The geophysical survey works were divided between two vessels, with the Geo Ocean III carrying out operations in water deeper than around 10 to 15m LAT and the Geo Surveyor VIII completing operations in the shallower sections.

The survey areas were further broken down into 5 section where there were natural turning points on routes and separate surveys such as the N5A Site survey.

- Area 1 – Southern part of pipeline route
- Area 2 – Northern part of pipeline route
- Area 3 – Western part of cable route
- Area 4 – Eastern part of cable route
- Area 5 – N5A site survey area
- *Alternative N5A Site (Added workscope)*
- *Alternative Cable Route C3 (Added workscope)*

1.2.1 Objectives

The survey objectives were to:

- Accurately determine water depths and seabed topography;
- Provide information on seabed and sub-seabed conditions to ensure the safe emplacement and operation of the proposed pipeline, cable route and platform;
- Assess the area for the presence of any potential sensitive habitats or species, to include EC Habitats Directive (97/62/EC) Annex I habitats and OSPAR threatened and declining habitats and/or species (OSPAR, 2008);
- Acquire environmental baseline samples across the survey area to establish a benchmark against which potential future impacts could be assessed;
- Assess the route corridor for the possible presence of anomalies and boulders/debris that may impede pipelay or cable installation;
- Identify any seabed and sub-seabed features or obstructions.

1.3 GEODETIC PARAMETERS

1.3.1 Horizontal Reference

Table 4: Geodetic parameters

Geodetic Parameters	
Spheroid	International 1924
Semi-major axis	6378388.297
Semi-minor axis	6356911.946
Datum	European Datum 1950 (ED50)
Projection	Universal Transverse Mercator (UTM)
False Easting	500000.00
False Northing	0.00
Central Meridian	3° East
Central Scale Factor	0.9996
Latitude of Origin	0°
Grid Zone	31 North
Datum Transformation WGS84 – ED50	
dx	+ 89.5m
dy	+93.8m
dz	+123.1m
Rx	0.0
Ry	0.0
Rz	-0.156
Scale	-1.2ppm

1.3.2 Vertical Reference

All water depths have been reduced to LAT using the UKHO VORF model. MSL is 1.6m above LAT within the survey area.

2 SURVEY OPERATIONS AND DATA REVIEW

2.1 SUMMARY OF SURVEY OPERATIONS

Between the 01st April and 15th May 2019, a geophysical, geotechnical and environmental survey was completed for the N5a Development Project – Pipeline Route and Platform Area Survey aboard the Geo Ocean III. An overview of the survey operations is given in Table 5.

Table 5: Overview of survey operations

Survey Operations Geo Ocean III– N5A Site, Cable Route and Pipeline Route Survey		
1	29/04/2019	Alongside Eemshaven Completed demobilisation from previous project commenced mobilisation for One-Dyas project. Completed Survey Positioning, MRU and SVP Comparisons
2	30/04/2019	Completed mobilisation of personnel to vessel Completed all vessel crew inductions Completed kick-off meeting and mobilisation HIRA review Completed transit to work location Completed Vessel DP trials
3	01/05/2019	Completed Recce line through pipeline route and location. MBES calibration location identified Completed MBES calibration SSS verification completed Muster Drill completed Started analogue survey acquisition on northern section of pipeline route (Area 2)
4	02/05/2019	Continued analogue survey acquisition on northern section of pipeline route (Area 2) Started Vibro-coring operations on northern section of pipeline route (Area 2) Continued analogue survey acquisition cross lines only on northern section of pipeline route (Area 2) Carried out 3 Environmental Camera observations on environmental sample locations on northern section of pipeline route (Area 2) Continued analogue survey acquisition cross lines only on northern section of pipeline route and western section of cable route. (Area 2 and Area 3)
5	03/05/2019	Continued analogue survey acquisition cross lines only on western section of cable route. (Area 3) Stopped operations due to increasing weather affecting data. Carried out 5 Environmental Camera observations on environmental sample locations on northern section of pipeline route (Area 2) Stopped due to weather rising out of safe working limits for operations Standing by on weather
6	04/05/2019	Standing by on weather
7	05/05/2019	Standing by on weather
8	06/05/2019	Standing by on weather Completed Drop Camera locations on northern section of pipeline route (Area 2) Commenced Grab Sample locations on northern section of pipeline route (Area 2) Stopped Grab Sampling due to rigging issue
9	07/05/2019	Resumed analogue survey acquisition on northern section of pipeline route (Area 2) Stopped analogue survey acquisition on northern section of pipeline route (Area 2) Thruster Technician onboard to fix thruster issue and returned to shore Completed Vibro-core operations on northern section of pipeline route (Area 2)
10	08/05/2019	Completed Environmental Grab Sampling operations on northern section of pipeline route (Area 2) Completed analogue survey acquisition on northern section of pipeline route (Area 2) Commenced N5A UHR Site Survey (Area 5)
11	09/05/2019	Completed N5A UHR Site Survey (Area 5) Acquired one-line analogue survey acquisition on western section of cable route (Area 3)

Survey Operations Geo Ocean III– N5A Site, Cable Route and Pipeline Route Survey		
		Completed analogue survey acquisition on eastern section of cable route (Area 4) Completed Geotechnical Vibro-cores on eastern section of cable route (Area 4) Completed Environmental Video Photography and Grab Sampling operations on eastern section of cable route (Area 4) Re-commenced analogue survey acquisition on western section of cable route (Area 3)
12	10/05/2019	Completed analogue survey acquisition on western section of cable route (Area 3) Completed Geotechnical Vibro-cores on western section of cable route (Area 3) Completed N5A UHR Site Survey reshoots (Area 5)
13	11/05/2019	Completed additional environmental video and photography transects on N5A Site Survey location. Completed Environmental Video Photography and Grab Sampling operations on western section of cable route (Area 3) Commenced Geotechnical Vibro-cores on southern section of pipeline route (Area 1) Commenced Environmental Video Photography on southern section of pipeline route (Area 1)
14	12/05/2019	Completed Environmental Video Photography and Grab Sampling operations on southern section of pipeline route (Area 1) Completed Geotechnical Vibro-cores on southern section of pipeline route (Area 1) Commenced analogue survey acquisition on southern section of pipeline route (Area 1) and infill on northern pipeline route (area 2)
15	13/05/2019	Completed analogue survey acquisition on southern section of pipeline route (Area 1) and infill on northern pipeline route (area 2) Completed analogue survey acquisition on alternative cable route (C3)
16	14/05/2019	Completed Alternative N5A UHR Site Survey Completed Geotechnical Vibro-cores on alternative N5A site and cable route (C3) Completed Environmental Video Photography and Grab Sampling operations on alternative N5A site and cable route (C3)
17	15/05/2019	Arrived in Eemshaven Demobilisation Completed

2.2 GEOPHYSICAL DATA

Analogue geophysical data acquired by GEOxyz during the survey were used for site selection as no previous geophysical data were available for the survey area. This data was reviewed onboard by BSL and camera transects were selected to target any habitats and boundaries across the survey area, with particular attention paid to the investigation of potential Annex I habitats protected under the EU Habitats Directive. Where features of interest occurred in close proximity to one of the environmental sampling stations, based on the rationale outlined in the scope of work, this station was to be moved slightly to provide additional ground-truthing data for the feature of interest.

The following datasets were available for review during the preparation of this report:

- Bathymetry, reduced and processed offshore to provide a digital terrain model where major bathymetric features and minor bathymetric changes could be identified and highlighted. This included the identification of large features (e.g. linear ridges of cobbles and boulders) and seabed infrastructure (e.g. existing pipelines).
- Side scan sonar (SSS) with data run at both high (400kHz) and low (100kHz) frequencies at ranges varying from 75m to 125m with digital rendering onto a seabed mosaic of the area (100KHz) for review. Changes in sediment type and hardness, along with features observed through low level relief and discrete objects could also be delineated.

2.3 ENVIRONMENTAL GROUND-TRUTHING AND SAMPLING

The environmental sampling strategy was defined by the client prior to the commencement of the survey. Sampling locations along the pipeline and cable routes were positioned every kilometre from the proposed N5a well locations to the shore and to the Riffgat offshore wind farm (Figure 2). Two stations (Grab_P_0 and Grab_P_7) along the pipeline route were repositioned to cover areas of interest identified from the sidescan sonar record (Table 6). At each of these sampling locations a drop-down video assessment was conducted before grab sampling, with video footage acquired at all stations apart from Grab_P_14 where the visibility severely reduced. Additional camera transects were conducted over the proposed N5a well locations and additional areas of interest identified following review of the sidescan sonar record (Table 7).

Seabed video footage was acquired along eight camera transects using a Seabug camera system mounted within a BSL camera sled frame equipped with a separate strobe, and LED lamps. The camera unit itself is capable of acquiring images at 14.7MP resolution but was set to a resolution of 5MP (2592 x 1944 pixels) to optimise image upload times during camera operation.

A BSL Double grab (double Van Veen) was used for seabed sampling, requiring two successful deployments at each location. A maximum of three 'no sample' deployments was allowed at each station before abandoning. A 0.1m^2 Day Grab was used on the first deployment, before switching to the BSL Double grab for all remaining deployments at the client's request.

Table 6: Summary of drop-down camera and grab sampling locations for survey area

ED50, UTM 31N, CM 3° E								
Station	Rationale	Type	Easting (m)	Northing (m)	PC	F1	F2	F3
Grab_P_0	Pipeline Route - Positioned at 1km intervals	EBS/HAS	721619	5954453	Y	Y	Y	Y
Grab_P_1	Moved from KP in order to investigate area of high reflectivity sediment	EBS/HAS	721325	5953791	Y	Y	Y	Y
Grab_P_2	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720981	5952752	Y	Y	Y	Y
Grab_P_3	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720669	5951801	Y	Y	Y	Y
Grab_P_4	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720355	5950850	Y	Y	Y	Y
Grab_P_5	Pipeline Route - Positioned at 1km intervals	EBS/HAS	720041	5949900	Y	Y	Y	Y
Grab_P_6	Pipeline Route - Positioned at 1km intervals	EBS/HAS	719729	5948950	Y	Y	Y	Y
Grab_P_7	Moved from KP to investigate mixed reflectivity sediment	EBS/HAS	719347	5948023	Y	Y	Y	Y
Grab_P_8	Pipeline Route - Positioned at 1km intervals	EBS/HAS	719105	5947052	Y	Y	Y	Y
Grab_P_9	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718861	5945912	Y	Y	Y	Y
Grab_P_10	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718779	5944917	Y	Y	Y	Y
Grab_P_11	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718695	5943920	Y	Y	Y	Y
Grab_P_12	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718614	5942923	Y	Y	Y	Y
Grab_P_13	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718532	5941927	Y	Y	Y	Y
Grab_P_14	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718450	5940930	Y	Y	Y	Y
Grab_P_15	Pipeline Route - Positioned at 1km intervals	EBS/HAS	718366	5939933	Y	Y	Y	Y
Grab_C_0	Original Cable Route and N5a well centre location	EBS/HAS	721610	5954652	Y	Y	Y	Y
Grab_C_1	Original Cable Route – Positioned at 1km intervals	EBS/HAS	722604	5954538	Y	Y	Y	Y
Grab_C_2	Original Cable Route – Positioned at 1km intervals	EBS/HAS	723596	5954425	Y	Y	Y	Y
Grab_C_3	Original Cable Route – Positioned at 1km intervals	EBS/HAS	724588	5954315	Y	Y	Y	Y

ED50, UTM 31N, CM 3° E								
Grab_C_4	Original Cable Route – Positioned at 1km intervals	EBS/HAS	725579	5954203	Y	Y	Y	Y
Grab_C_5	Original Cable Route – Positioned at 1km intervals	EBS/HAS	726575	5954089	Y	Y	Y	Y
Grab_C_6	Original Cable Route – Positioned at 1km intervals	EBS/HAS	727355	5954245	Y	Y	Y	Y
Grab_C_7	Original Cable Route – Positioned at 1km intervals	EBS/HAS	728149	5954477	Y	Y	Y	Y
Grab_C_8	Original Cable Route – Positioned at 1km intervals	EBS/HAS	729107	5954756	Y	Y	Y	Y
Grab_C3_0	Secondary Cable Route and N5a second potential well centre location	EBS/HAS	722288	5953018	Y	Y	Y	Y
Grab_C3_1	Secondary Cable Route – Positioned to investigate mixed reflectivity sediment	EBS/HAS	723809	5953378	Y	Y	Y	Y
Grab_C3_2	Secondary Cable Route – Positioned to investigate high reflectivity sediment	EBS/HAS	725337	5953741	Y	Y	Y	Y

Table 7: Summary of camera transect locations for the survey area

ED50, UTM 31N, CM 3° E								
Transect	Rationale	SOL/ EOL	Date and time	Depth (m)	Easting (m)	Northing (m)	No. Stills	Video footage (mm:ss)
Grab P_0	Investigating area of mixed reflectivity sediment	SOL	02/05/2019 17:15:11	30	721647	595443	27	07:13
		EOL	02/05/2019 17:22:21	31	721591	595447		
North Transect 1	Investigating transition from mixed to high reflectivity sediment	SOL	11/05/2019 00:49:10	29	721486	595468	30	10:11
		EOL	11/05/2019 00:59:10	29	721363	595463		
North Transect 2	Investigating transition from low to mixed reflectivity sediment	SOL	11/05/2019 00:06:17	30	721609	595499	41	12:49
		EOL	11/05/2019 00:18:59	28	721631	595515		
North Transect 3	Investigating transition from mixed to high reflectivity sediment	SOL	11/05.2019 02:04:48	29	721902	595440	50	12:29
		EOL	11/05/2019 02:17:13	29	721802	595455		
N5a Transect 1	Transect across original N5a well location	SOL	11/05/2019 01:38:05	29	721585	595458	35	08:37
		EOL	11/05/2019 01:46:38	29	721626	595470		
N5a Transect 2	Transect across original N5a well location	SOL	11/05/2019 01:16:28	28	721668	595463	39	09:13
		EOL	11/05/2019 01:25:35	29	721544	595466		
Grab_C3_0	Transect across second proposed N5a well location	SOL	14/05/2019 21:51:02	24	722231	595298	36	09:15
		EOL	14/05/2019 22:00:14	25	722335	595304		
Grab_C3_2	Investigating area of high reflectivity sediment	SOL	14/05/2019 20:46:00	25	725366	595361	37	12:36
		EOL	14/05/2019 20:58:53	25	725326	595378		

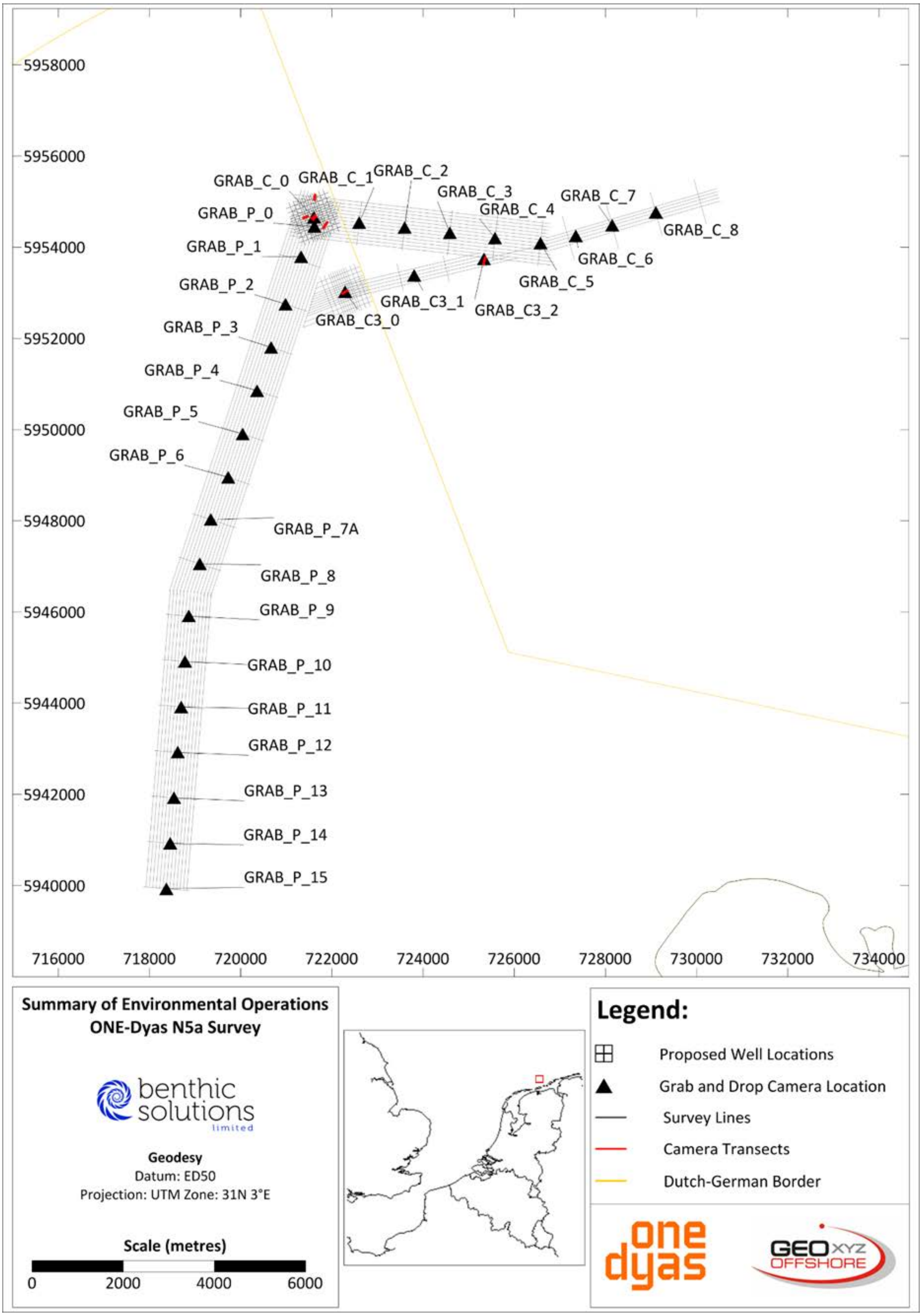


Figure 2: Survey strategy overview

2.4 HABITAT INVESTIGATION

2.4.1 Habitat Classification

A marine biotope classification system for British waters was developed by Connor *et al.* (2004) from data acquired during the JNCC Marine Nature Conservation Review (MNCR) and subsequently revised by Parry *et al.* (2015) to provide improved classification of deep-sea habitats. The resultant combined JNCC (2015) classification system forms the basis of the European Nature Information Service Habitat Classification (EUNIS, 2013), albeit with differing habitat coding nomenclature, which has compiled habitat information from across Europe into a single database. The two classification systems are both based around the same hierarchical analysis. Initially abiotic habitats are defined at four levels. Biological communities are then linked to these (at two lower levels) to produce a biotope classification. (Connor *et al*., 2004; EUNIS, 2013).

Habitat descriptions have been interpreted from the side scan sonar and bathymetric data acquired during the current survey, in conjunction with additional information on seabed sediment types and faunal communities from seabed photography and grab sampling. Global Mapper V20 GIS software was used to review side scan sonar mosaic (Geotiff) and multibeam bathymetry data (Geotiff and xyz) and to delineate areas of different seabed habitats.

2.4.2 Assessment of Sensitive Habitats

The Netherlands is a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979). To meet their obligations under the convention, the European Community Habitats Directive was adopted in 1992. The provisions of the Directive require Member States to introduce a range of measures including the protection of species listed in the Annexes; to undertake surveillance of habitats and species and produce a report every six years on the implementation of the Directive. The 189 habitats listed in Annex I of the Directive and the 788 species listed in Annex II, are to be protected by means of a network of sites. Each Member State is required to prepare and propose a national list of sites, which will be evaluated in order to form a European network of Sites of Community Importance (SCIs). These will eventually be designated by Member States as Special Areas of Conservation (SACs), and along with Special Protection Areas (SPAs) classified under the EC Birds Directive (2009), form a network of protected areas known as Natura 2000. The Directive was amended in 1997 by a technical adaptation Directive and latterly by the Environment Chapter of the Treaty of Accession 2003.

Based on the above, the OSPAR list of threatened and/or declining species and habitats and Annex I habitats of particular relevance to this region of UK waters are:

- Biogenic reefs formed by *Sabellaria spinulosa* (the Ross Worm); and,
- Sandbanks which are slightly covered by sea water all the time

Stony reefs are an Annex I habitat and are protected under the EU habitats directive. Sampling location Grab_C3_2 showed a high proportion of cobbles and boulders, and consequently a stony reef assessment was conducted. The seabed camera ground-truthing data were assessed for potential stony reefs using the criteria proposed by Irving (2009). While the Irving (2009) criteria have been approved by the UK regulators for application in UK waters, they have not been explicitly approved by the Netherlands authorities but are used here as they provide a useful basis for semi-quantitative assessment of potential Annex I stony reef habitat. The Irving (2009) method breaks down the assessment criteria into measures of reef 'quality' or 'reefiness' as outlined in Table 8. This is based on a minimum cobble size of 64mm being present and indicating relief above the natural seabed where >10% of the matrix are cobble related and a minimum surface area of around 25m^2 is recorded.

The stony reef assessment was based on HD video and stills taken during the camera transects. Stills were acquired when the camera frame landed on the seabed for one or more seconds in order to obtain the best possible image quality, while the changes in coverage and density of cobbles/boulders were estimated during the video data analysis.

Table 8: Summary of resemblance to a stony reef, as summarised in Irving (2009)

Measure of 'reefiness'	NOT a reef	Low(c)	Medium	High
Composition(a)	<10%	10-40%	40-95%	>95%
Elevation(b)	Flat seabed	<64mm	64mm-5m	>5m
Extent (m^2)	<25m^2	>25m^2	>25m^2	>25m^2
Biota	Dominated by infauna			>80% of species are epifauna

(a) Diameter of cobbles / boulders being greater than 64mm. Percentage cover relates to a minimum area of 25m^2. This 'composition' characteristic also includes 'patchiness'.
(b) Minimum height (64mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed.
(c) When determining if the seabed is considered as Annex I stony reef, a 'low' scored (in any category), would require a strong justification for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive.

The Irving (2009) stony reef protocol was split into separate assessments of reef 'structure' and 'overall reefiness' using a method developed by BSL staff (Table 9 and Table 10). This provided a reef structure value that could be then assessed against extent, where applicable, to provide a measure of overall 'reefiness' as illustrated in Table 10. As separate thresholds for 'Low', 'Medium' and 'High' stony reef extent were not given in Irving (2009), the overall 'reefiness' is determined by reef structure provided that the extent of the stony reef covers a minimum of 25m^2.

Table 9: Stony Reef Structure Matrix (after Irving, 2009)

Reef Structure Matrix			Elevation			
			Flat	<64mm	64mm-5m	>5m
			Not a Reef	Low	Medium	High
Composition	<10%	Not a reef	NOT A REEF	NOT A REEF	NOT A REEF	NOT A REEF
	10-40%	Low	NOT A REEF	LOW	LOW	LOW
	40-95%	Medium	NOT A REEF	LOW	MEDIUM	MEDIUM
	>95%	High	NOT A REEF	LOW	MEDIUM	HIGH

Table 10: Overall Stony Reefiness matrix (structure vs extent)

Overall Reefiness Matrix			Reef Structure (incl. Composition and Elevation)			
			Not a Reef	Low	Medium	High
Extent (m^2)	<25	Not a Reef	NOT A REEF	NOT A REEF	NOT A REEF	NOT A REEF
	>25	Low - High	NOT A REEF	LOW	MEDIUM	HIGH

In evaluating the ground-truthed stony patches, Irving (2009) also recommended that the associated biota was considered, indicating that areas dominated by infauna should be considered 'Not a Reef' whereas areas where greater than 80% of species were epifaunal should be considered to show 'High' reefiness, but no recommendations were given as to the proportion of infauna and epifauna warranting classification of 'Low' or 'Medium' reefiness. In practise, it is not practical to assess the proportion of infaunal and epifaunal species in a quantitative manner. This cannot be undertaken from seabed camera data (i.e. video footage or still photographs) as only the larger epifauna and emergent infauna are visible. To accurately quantify the proportion of infauna and epifauna species, it would be necessary to take large enough samples to include both the stony material (i.e. cobbles and boulders) and the surrounding sediment matrix, with sufficient replication to provide confidence in the resultant data. This would likely involve sampling with a large volume sampler such as a clam dredge and could significantly impact the integrity of the cobble/boulder patch. As such the biota associated with stony patches from the current survey has been described in a qualitatively.

3 RESULTS AND INTERPRETATION

3.1 BATHYMETRY

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the bathymetry across the survey site and route corridors.

Bathymetry data were acquired using an R2 Sonics 2022 multi-beam echo sounder for the site and an R2Sonic 2024 multi-beam echo sounder for the two route surveys. All bathymetry data have been reduced to LAT, which was 1.6m below MSL within the survey area, and are presented at a 0.5m x 0.5m bin size.

3.1.1 N5A to NGT Hot Tap Pipeline Route

Water depths along the proposed N5A to NGT Hot Tap pipeline route ranged between 9.8m LAT at KP0.000 and 26.4m LAT at KP14.675, with the seabed shoaling gently towards the southern end of the proposed pipeline route. A series of natural troughs trending west-north-west to east-south-east occurred within the survey corridor, crossing the proposed pipeline route, the largest of which was approximately 250m wide.

A variety of anthropogenic debris/wreck and areas of disturbed seabed were evident on the bathymetry data:

- Two prominent features interpreted as shipwrecks surrounded by seabed scouring; the largest (40.1m x 12.8m x 1.1m) occurred at approximately KP2.462, 369m west-north-west of the proposed route and the other (19.1m x 12.9m x 0.2m) occurred at approximately KP2.373, 339m west-north-west of the proposed route.
- Three semi-circular features with 1m of positive relief, interpreted as being related to previous drilling activity, were observed on bathymetry data. These were observed at the start of the proposed route between KP0.009 and KP0.089, offset by 90m to the east-south-east at their closest approach. These features lay within a 30m radius of each other and exhibited average dimensions of 30m x 30m.
- Three existing cables and one pipeline were expected to cross the proposed pipeline route but were not observed on the bathymetry data.

3.1.2 N5A to Riffgat Cable Route

The seabed shoaled gently towards the east-north-east end of the proposed N5A to Riffgat cable route with water depths ranging between 26.0m at KP0.280 and 19.6m KP7.941. A series of natural troughs, predominantly trending north-west to south-east, crossed the proposed cable route from approximately KP5.158 to KP8.681 and were interpreted to be related to tidal/current processes.

Three semi-circular features with 1m of positive relief, interpreted as being related to previous drilling activity, were imaged in the bathymetry data. These were positioned at the start of the proposed route between KP0.085 and KP0.168; at their minimum offset from the route they were approximately 27m south-south-west. They were positioned within a 30m radius and had average dimensions of 30m x 30m.

The Norned cable was observed crossing the proposed cable route at KP 2.313 trending north-north-west to south-south-east.

3.2 SEABED FEATURES

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the seabed features across the survey area, focussing on features of particular relevance to the environmental baseline and habitat assessment of the survey area.

Side scan sonar data were acquired with an Edgetech 4200 system operating at 100kHz/400kHz with between 75m and 200m per channel range. This was supplemented by swathe bathymetry data gridded to 0.5m bin size.

3.2.1 N5A Site

Seabed sediments across the N5A survey area were expected to comprise 'fine sand with shell fragments'. An area of 'coarse sand and shell with a high density of sand mason worms and razor clams' was evident in the north of the survey area, while an area of 'coarse sand with pebbles and cobbles' was present in the south. The uppermost sand unit was merely a veneer and the boundary between the sand and the underlying clay outcrops was arbitrary with the potential for some clay to outcrop in the areas interpreted as sand.

Outcrops of clay were interpreted within the survey area, showing a positive relief of up to 0.5m above background seabed levels. Elsewhere accumulations of coarse sand and gravel were also observed on the bathymetry as having positive relief above the ambient seabed, with some accumulations likely to be caused by the stabilising effect of high densities of sand mason worms and razor clams on the seabed.

Within the survey area there was no existing infrastructure other than the previously drilled N5 Well. Seabed scars up to 1.1m high from the rig whilst over the N5-Ruby wellsite were observed on the bathymetry and side scan sonar data. Numerous magnetometer anomalies were observed within this area, however no wellhead or other evidence of the drilling location could be observed at seabed.

3.2.2 N5A to NGT Hot Tap Pipeline Route

Seabed sediments along the proposed pipeline route corridor were expected to comprise 'fine sand and shell fragments', with occasional areas of 'coarse sand and shell fragments'.

Bedforms were not imaged in the sonar or bathymetry records. However, photographs taken along the route as part of the environmental survey showed clear seabed rippling over the majority of the survey corridor.

Numerous objects interpreted as boulders and items of debris were observed within the proposed pipeline route corridor. Most of the objects interpreted as boulders occurred towards the north of the survey corridor area and coincided with areas of clay exposure.

The most significant objects identified on the sonar records were two interpreted shipwrecks, the largest (40.1m x 12.8m x 1.1m) occurring at approximately KP2.462, 369m west-north-west of the proposed route and the other (19.1m x 12.9m x 0.2m) at approximately KP2.373, 339m west-north-west of the proposed route.

Three existing cables and one pipeline were expected to cross the proposed pipeline route but were not observed on the bathymetry data.

3.2.3 N5A to Riffgat Cable Route

Seabed sediments along the proposed pipeline route corridor were expected to comprise fine to coarse SAND, with occasional areas of 'coarse sand and clay with pebbles and cobbles' and 'coarse sand with pebbles and cobbles'. Approaching the Riffgate Wind Park, the seabed sediments were dominated by 'coarse sand and shell fragments' with occasional patches of 'coarse sand with pebbles and cobbles'.

Bedforms were not imaged in the sonar or bathymetry records. However, photographs taken along the proposed route corridor as part of the environmental survey clearly showed ripples covering the majority of the seabed within the survey corridor area.

There were numerous objects interpreted as boulders within the proposed pipeline route corridor. Most of the objects, interpreted as boulders occur towards the north of the survey corridor in an area coinciding with areas of clay exposure.

3.3 SHALLOW SOILS

The following text was adapted from the survey reports for the N5A site (LU-0022H-553-RR-01), N5A to NGT Hot Tap pipeline route (LU-0022H-553-RR-02) and N5A to Riffgat cable route (LU-0022H-553-RR-07) to provide an overview of the shallow soils across the survey area, focussing on the upper layers of relevance to interpretation of the seabed sediment distribution and bathymetric features.

Interpretation of shallow soils across the survey area was based upon pinger and sparker data. Additional information was gained from vibrocore logs and borehole N5-1, 90m south of the proposed Platform Location acquired by Fugro in November 2016. Vibrocore VC_P_0 is at the proposed Platform Location.

3.3.1 N5A Site

The uppermost mappable unit was confirmed as SAND in the vibrocore logs. Where mapped in the western parts of the survey area this unit was under 1.5m thick. This surficial SAND unit was only mappable when thicker than 0.5m and was likely to be present outside the mapped area but at thicknesses below 0.5m.

Three sub units within the Quaternary sequence were interpreted within the area based on the acoustic nature of the sparker data. The uppermost unit, (besides surficial sand mapped from the Pinger data), interpreted within the survey area is a chaotic unit, interpreted to comprise dense to very dense medium to coarse SAND with traces of shell fragments (as sampled within the borehole). Within the survey area, the reflector which correlates with the base of this unit undulates between 1.2m and 18.0m below seabed.

3.3.2 N5A to NGT Hot Tap Pipeline Route

This unit of fine to medium grained SAND generally thicken to the south. It was absent (or less than 0.5m thick) from KP 0.430 to KP 0.450 and KP 0.757 to KP 1.045. South of KP 5.951 the base of the mapped unit becomes indistinct to the point of being unmappable, at this point the unit was approximately 9m thick.

The mapped unit was sub-cropped by a sequence of variable composition. Vibrocore logs show that this sub-crop predominantly comprises silty fine SAND except for the area north of KP 1.246 where the subcrop was more clay prone and was interpreted to be the infill of a broad channel.

3.3.3 N5A to Riffgat Cable Route

This unit of fine to medium grained SAND generally thickened to the east. West of the route AC at KP 5.156 the unit was approximately 0.5 to 1m thick or absent/unmappably thin, east of this point the unit locally exceeds a thickness of 2m.

Vibrocore logs showed that the mapped unit was sub-cropped by clay prone deposits from KP0 to KP 3.357, interpreted to be the infill of a broad channel. From KP 3.357 to the end of the route the mapped unit was subcropped by fine SAND.

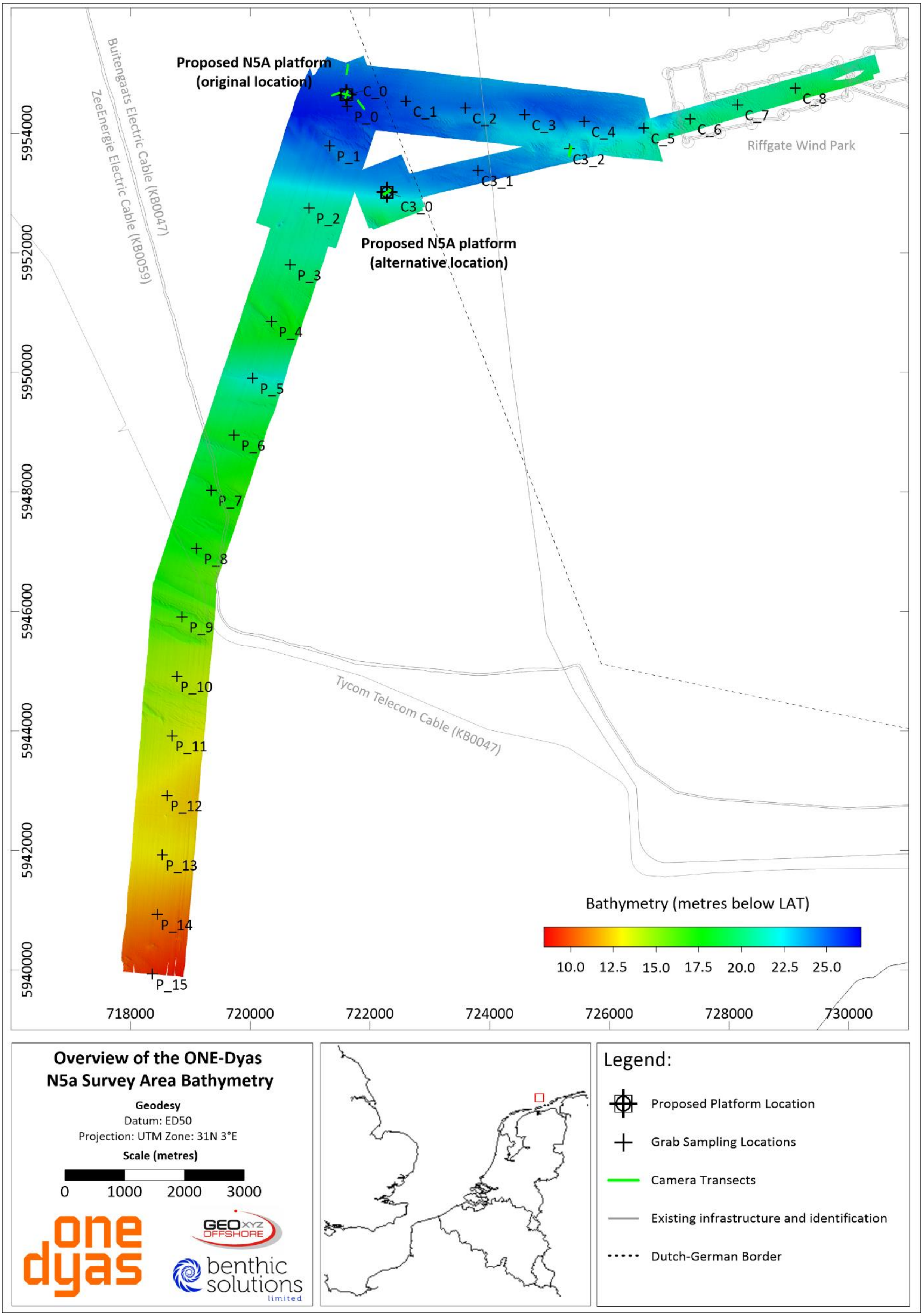


Figure 3: N5A Site and Route Survey Bathymetry

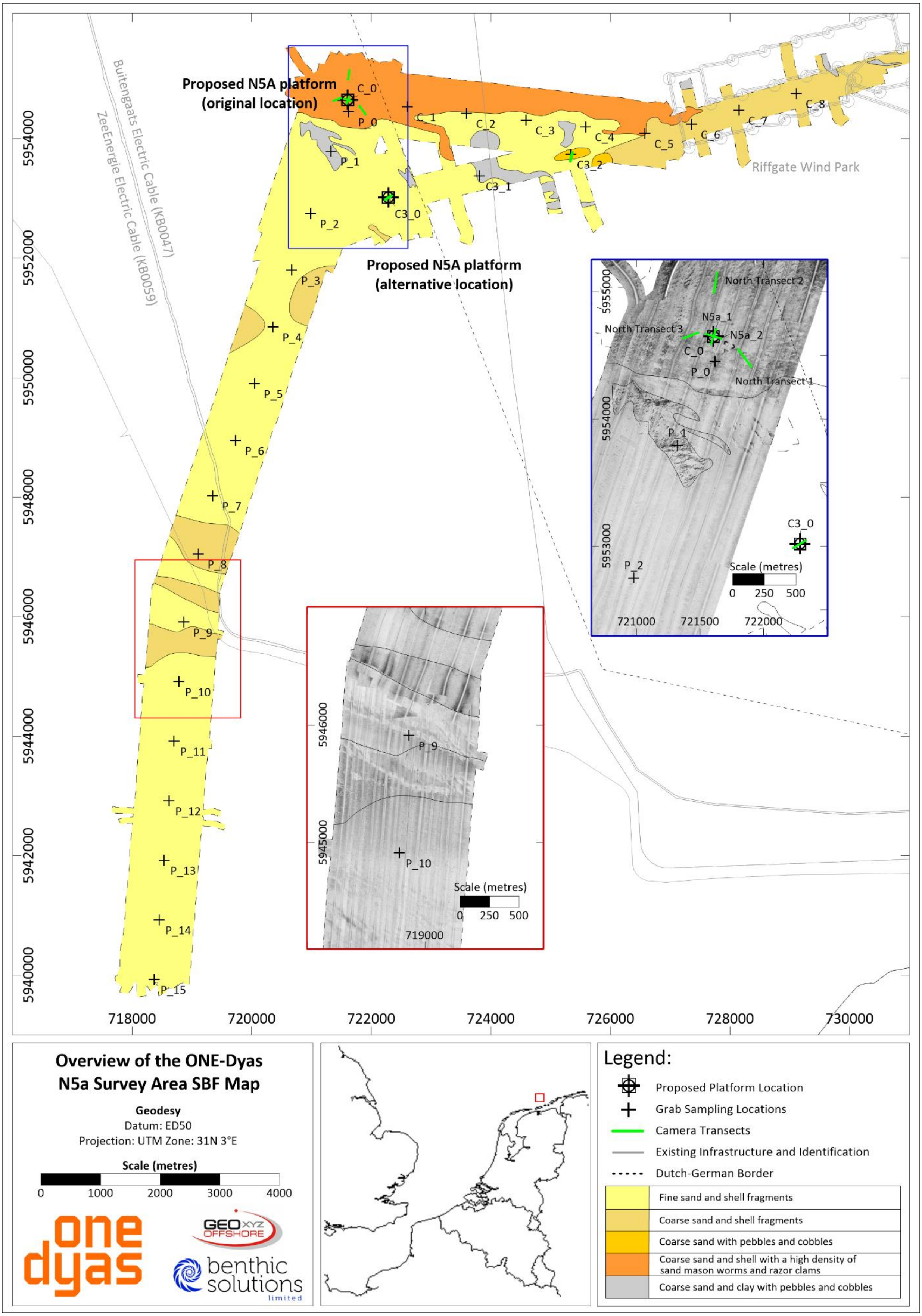


Figure 4: Interpreted N5A Site and Route Seabed Features

3.3.4 N5A Site

The seabed within the N5A site survey area sloped gently to the west. The minimum water depth was 23.7m LAT in the NNE of the survey area, while the maximum depth was 26.6m LAT in the WSW. Small areas with relief of up to 0.4m were observed on the bathymetry data with measured gradients of up 6° on their flanks, which were interpreted to be largely due to outcropping clays.

3.4 HABITAT ASSESSMENT

3.4.1 Video/Photographic Survey

A total of twenty-eight drop-down camera deployments and eight camera transects were conducted within the combined N5A development site and route survey area. The camera ground-truthing was undertaken to investigate the distribution of different seabed habitats and associated fauna, while additionally assessing the presence or absence of potential sensitive habitats and species. Drop-down camera deployments were undertaken to provide additional data on the composition of the seabed sediment and associated visible fauna. In contrast, the camera transects were selected to investigate areas of different acoustic facies on the side scan sonar record and/or bathymetric features evident on the MBES data. The ground-truthing stations and transects are listed in Table 6 and Table 7, respectively, and their locations are shown in Figure 2 to Figure 4, with summary photopages included in Appendix H.

Seabed video and photographic data were acquired using a Seabug camera system mounted within a BSL camera sled frame equipped with a separate strobe, and LED lamps. The Seabug is capable of acquiring images at 14.7MP resolution but was set to a resolution of 5MP (2592 x 1944 pixels) to optimise image upload times during camera operation. (see Appendix B and D).

Video and camera ground-truthing along all of the transects confirmed the presence of sand-dominated substrate throughout the site and route survey areas. While the dominant sediment type was 'fine sand and shell fragments', several patches of coarser sediment were present across the survey area. The N5A site and route survey corridor to the Riffgate Wind Park showed increasingly coarse sediment, including areas of gravel (>2mm), pebble (>4mm) and cobble (>64mm) in addition to sporadic clay outcrops. The area of coarser substrate along the northern edge of the N5A site and the route survey corridor to the Riffgate Wind Park also supported significant densities of sand mason worms (*Lanice conchilega*) and razor clams (*Ensis* sp., possibly *E. leei*). Although both *L. conchilega* and *E. leei* were observed elsewhere within the N5A site and along the route to the wind park, they were less numerous and more patchily distributed outside the area of the delineated area of 'coarse sand and shell with a high density of sand mason worms and razor clams'. Habitat assessment logs for each of the nineteen camera transects locations are included in Appendix E.

Conspicuous epifauna showed moderate diversity and density for a predominantly mobile sandy seabed. Camera ground-truthing stations and transects across all mapped seabed habitats showed a similar species assemblage including frequent observations of sand mason worms (*Lanice conchilega*) and common starfish (*Asterias rubens*). Other species observed more sporadically throughout the combined N5A site and route survey area included razor clams (*Ensis* sp. possibly *E. leei*), burrowing anemones (Cerianthidae), swimming crabs (*Liocarcinus* sp.), masked crabs (*Corystes cassivelaunus*), hermit crabs (Paguridae sp.), edible crabs (*Cancer pagurus*), brittlestars (Ophiuridae), gobies (Gobiidae), dragonets (*Callionymus lyra*), flatfish (Pleuronectiformes) and sandeels (*Ammodytes* sp.).

Areas of coarser substrate, including the delineated area of 'coarse sand and shell with a high density of sand mason worms (*L. conchilega*) and razor clams (suspected *E. leei*)', were characterized by higher abundances of all of the aforementioned fauna with additional observations of plumose anemones (*Metridium senile*), unidentified anemones (Actiniaria), cuttlefish (Sepiidae), European squid (*Loligo vulgaris*), common dab (*Limanda limanda*) and grey gurnard (*Eutriglia gurnardus*).

Example photographs of the common and/or conspicuous faunal groups encountered during the N5A development survey are provided in Appendix F.

3.4.2 General Habitats

Video and still photography ground-truthing from twenty-eight drop-down camera deployments and eight camera transects confirmed the presence of a predominantly sandy seabed with spatial variability in the proportions of shell fragments, coarse substrate (gravel, pebbles and cobbles) and outcropping clay. In addition, an areas of coarse substrate along the northern edge of the survey area supported high densities of sand mason worms (*Lanice conchilega*) and razor clams (suspected *Ensis leei*).

Habitats were identified using a combination of field observations, detailed review of video footage and still images. Based on the ground-truthing data obtained from the N5A development site and route survey area, four EUNIS habitat classifications were assigned: 'Infralittoral fine sand' (A5.23), 'Infralittoral coarse sediment' (A5.13), 'Infralittoral Mixed Sediment' (A5.43) and 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137). The habitat classifications for the N5A development survey area are illustrated in Figure 9.

'Infralittoral Fine Sand' (A5.23)

Habitats dominated by fine sand with variable levels of shell debris were dominant across the survey area, being observed on the majority of environmental camera drops and transects within the N5A site and route survey area. These areas were represented by relatively smooth and low reflectivity side scan sonar data and were classified as the 'fine sand and shell fragments' seabed features type (Section 3.2 and Figure 4) and the EUNIS level 4 'Infralittoral fine sand' (A5.23) habitat type (Figure 9).

'Infralittoral fine sand' habitat is typically characterised by clean sands which occur in shallow water, either on the open coast or in tide-swept channels of marine inlets in water depths of around 0 to 20m. The habitat typically lacks a significant seaweed component and is characterised by robust fauna, particularly amphipods (*Bathyporeia*) and robust polychaetes including *Nephtys cirrosa* and *Lanice conchilega*. Within the N5A development survey area, this habitat comprised clean rippled sands in water depths of approximately 13 to 30m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral fine sand' included low to moderate densities the sand mason worm (*L. conchilega*) throughout, in addition to several other taxa characteristic of this EUNIS habitat, including common starfish (*Asterias rubens*), swimming crab (*Liocarcinus*) and hermit crabs (Paguridae). Other fauna observed within areas of this habitat included lugworms (*Arenicola* sp.), masked crab (*Corystes cassivellaunus*), edible crab (*Cancer pagurus*), razor clams (*Ensis* sp.), brittlestars (Ophiuridae), gobies (Gobiidae), dragonets (*Callionymus lyra*), flatfish (Pleuronectiform). Further taxa evident from grab samples included occasional sandeel (Ammodytidae), heart urchins (*Echinocardium cordatum*), ragworms (*Nereis* spp.), unidentified sea urchins (spatangoid) and porcelain crab (Portunidae).

Review of the seabed camera and grab sample data indicated that the mapped distribution of 'infralittoral fine sand' (A5.23) habitat was fairly accurate. Only station P_9 showing more coarse sandy sediment than would be expected for 'infralittoral fine sand' habitat but, as this sampling station was located within an area of alternating bands of 'infralittoral fine sand' and 'infralittoral coarse sand', it is to be expected that there will be some discrepancies in this area. Some sporadic patches of higher density *L. conchilega* aggregations were evident on seabed camera data from mapped areas of 'infralittoral fine sand' but these were insufficiently widespread or dense to warrant classification as 'Dense Lanice conchilega and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat.

Example images of 'Infralittoral Fine Sand (A5.23) habitat are given below in Figure 5, the expected extent of the habitat is mapped in Figure 9 and example images for conspicuous fauna and each ground-truthing deployment and are provided in Appendices F and H, respectively.

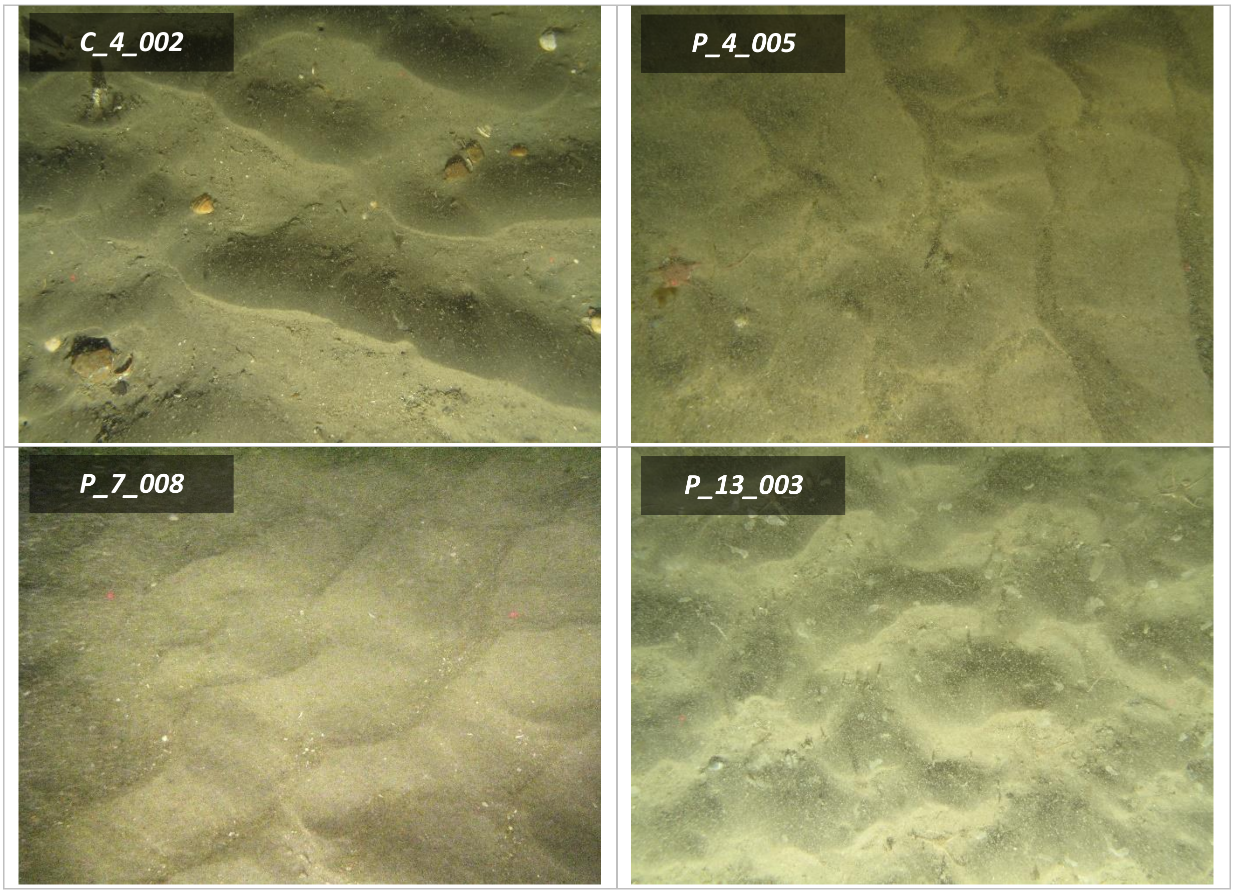


Figure 5: Example images of 'Infralittoral fine sand' (A5.23)

'Infralittoral Coarse Sediment' (A5.13)

Habitats dominated by coarse sand and moderate levels of shell debris and, occasionally, with gravel and pebbles were found in several patches across the combined N5A development site and route survey area, ground-truthed by stations C_5 to C_7, P_8 and P_9. These areas were represented by relatively smooth but low to moderate reflectivity side scan sonar data and were classified as the 'coarse sand and shell fragments' seabed features type (Section 3.2 and Figure 4) and the EUNIS level 4 'infralittoral coarse sediment' (A5.13) habitat type (Figure 9). Seven patches of 'infralittoral coarse sediment' were mapped, including a large patch on the route survey corridor around the Riffgate Wind Park and a further six smaller patches along the N5A to NGT Hot Tap pipeline route.

'Infralittoral coarse sediment' habitat is typically characterised by coarse sand, gravelly sand, shingle or gravel which are subject to disturbance by tidal streams and wave action in water depths of around 0 to 20m. The habitat is characterised by a robust fauna of infaunal polychaetes such as *Chaetozone setosa* and *Lanice* *conchilega*, cumacean crustacea such as *Iphinoe trispinosa* and *Diastylis bradyi*, and venerid bivalves. Within the N5A development survey area, this habitat comprised rippled coarse shelly sands, sometimes with a discernible gravel and/or pebble content in water depths of approximately 19 to 30m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral fine sand' included low to moderate densities the sand mason worm (*L. conchilega*) throughout, in addition to common starfish (*Asterias rubens*), which are both characteristic species for this EUNIS habitat. The majority of other characterising taxa for this habitat are infaunal species are not effectively assessed from seabed camera ground-truthing.

Review of the seabed camera and grab sample data indicated that the mapped distribution of 'infralittoral coarse sediment' (A5.13) habitat was fairly accurate, but with two exceptions. Station C_0 was classified as 'infralittoral coarse sediment' habitat but was located within an area of 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat, while station C_8 was classified as 'infralittoral fine sand' habitat but was located within an area of 'infralittoral coarse sediment'. Both of these exceptions reflect the heterogenous nature of the seabed habitats within the survey area.

Example images of 'infralittoral coarse sediment (A5.13) habitat are given below in Figure 6, the expected extent of the habitat is mapped in Figure 9 and example images for conspicuous fauna and each ground-truthing deployment and are provided in Appendices F and H, respectively.

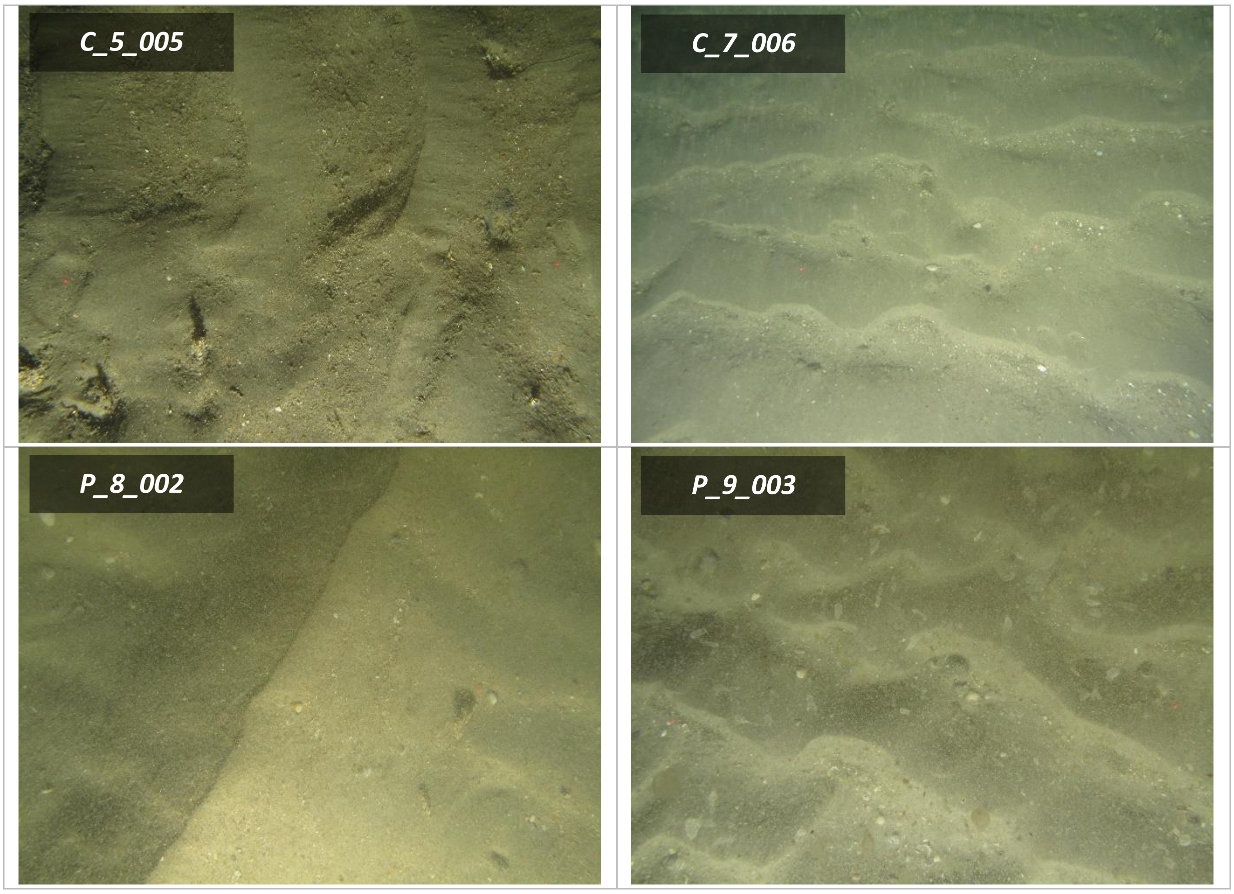


Figure 6: Example images of 'Infralittoral coarse sediment' (A5.13)

'Infralittoral Mixed Sediment' (A5.43)

Habitats dominated by coarse gravelly sand with pebbles, cobbles and, in some areas exposed clay clasts, were found delineated in ten patches across the combined N5A development site and N5A to Riffgate route survey area. These areas were classified as the 'coarse sand with pebbles and cobbles' seabed features type (Section 3.2 and Figure 4) and the EUNIS level 4 'infralittoral mixed sediment' (A5.43) habitat type (Figure 9). Two patches located midway along the N5A to Riffgate cable route showed moderate to high reflectivity side scan sonar signatures but showed no evidence of clay on ground-truthing data from station C3_2. A further ten patches along the N5A to Riffgate route showed similar mottled side scan sonar signatures and may include exposed clay, as evident from ground-truthing at stations P_1 and C3_1 over two of the patches.

'Infralittoral mixed sediment' habitat is typically characterised by mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in mud, sand or gravel in water depths of around 0 to 30m. Due to the variable nature of the sediment type, a wide array of communities are reported to be found in areas of mixed sediment, including those characterised by bivalves, polychaetes and file shells. Within the N5A development survey area, this habitat comprised coarse gravelly sand with pebbles, cobbles and sometimes with the addition of exposed clay clasts, in water depths of approximately 24 to 27m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'infralittoral fine sand' included common starfish (*Asterias rubens*) and burrowing anemones (Cerianthidae) which are both characteristic species for this EUNIS habitat. Seabed ad grab sample photographs from station C3_1 show numerous holes within the exposed clay clasts which may indicate the presence of boring piddock bivalves (typically *Pholas dactylus* or *Barnea candida*), although no live individuals could be discerned from the seabed or grab sample photographs. While piddocks are not protected by legislation, they are not widespread in the marine environment and would therefore be worthy of note if recorded within the macrofaunal analysis dataset at these stations. In the absence of confirmed piddock presence at these stations, the 'infralittoral mixed sediment' (A5.43) habitat has been assigned, however, this should be amended to 'piddocks with a sparse associated fauna in sublittoral very soft chalk or clay' (A4,231) habitat if piddocks are identified in the grab samples.

Example images of 'infralittoral coarse sediment (A5.13) habitat are given below in Figure 7, the expected extent of the habitat is mapped in Figure 9 and example images for conspicuous fauna and each ground-truthing deployment and are provided in Appendices F and H, respectively.

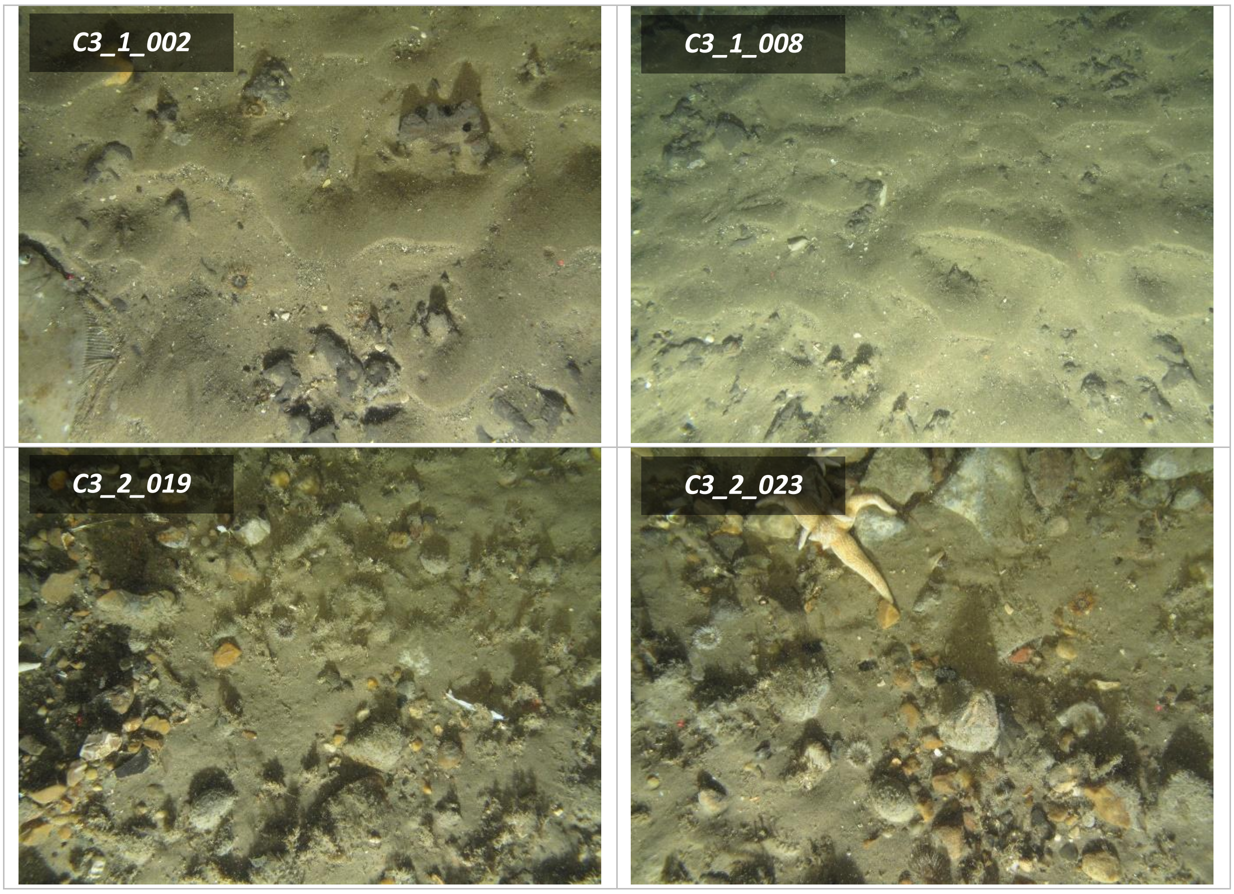


Figure 7: Example images of 'Infralittoral mixed sediment' (A5.43)

'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137)

Habitats dominated by gravelly, shelly coarse sand with moderate to high densities of *Lanice conchilega* were evident at several ground-truthing locations (stations C_1, C_2 and P_0, and transects N5A_1, N5A_2, NT_1, NT_2 and NT_3) within the N5A site and to the east along the N5A to Riffgate Wind Park route. These areas were represented by mottled low to high reflectivity side scan sonar data and were classified as the 'coarse sand and shell with a high density of sand mason worms and razor clams' seabed features type (Section 3.2 and Figure 4) and the EUNIS level 4 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat type (Figure 9). This habitat was delineated in a single large area along the northern edge of the combined N5A survey area.

'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' habitat is typically characterised by coarse sand, gravelly sand, shingle or gravel which are subject to disturbance by tidal streams and wave action in water depths of around 0 to 20m. The habitat is characterised by high densities of *L. conchilega*, which are thought to stabilise the seabed and allow the development of a more diverse associated faunal community. Within the N5A development survey area, this habitat comprised gravelly, shelly coarse sands in water depths of approximately 28 to 29m, slightly exceeding the typically expected range.

Visible fauna from camera ground-truthing within areas of 'dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' included moderate to high densities the sand mason worm (*L. conchilega*) throughout. Razor clams (*Ensis* sp.) are also associated with this habitat and were seen in very high densities on the majority of ground-truthing data for this habitat. Preliminary review of macrofaunal sample data indicated that the majority of, if not all, the razor clams are the Atlantic jackknife clam (*Ensis leei* – synonyms include *Ensis arcuatus* and *Ensis americanus*). In addition, a number of other characterising taxa for this EUNIS habitat were observed, including common starfish (*Asterias rubens*), lugworms (*Arenicola* sp.), hermit crabs (Paguridae) and swimming crabs (*Liocarcinus*). The majority of other characterising taxa for this habitat are infaunal species are not effectively assessed from seabed camera ground-truthing.

Review of the seabed camera and grab sample data indicated that the mapped distribution of 'dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat was fairly accurate, with the exception of station C_0 which was classified as 'infralittoral coarse sediment' habitat but was located within an area of 'dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat. However, the mapped area of this habitat is expected to be highly heterogenous and will likely include areas of all other mapped habitats from this survey.

Example images of 'dense Lanice conchilega and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137) habitat are given below in Figure 8, the expected extent of the habitat is mapped in Figure 9 and example images for conspicuous fauna and each ground-truthing deployment and are provided in Appendices F and H, respectively.

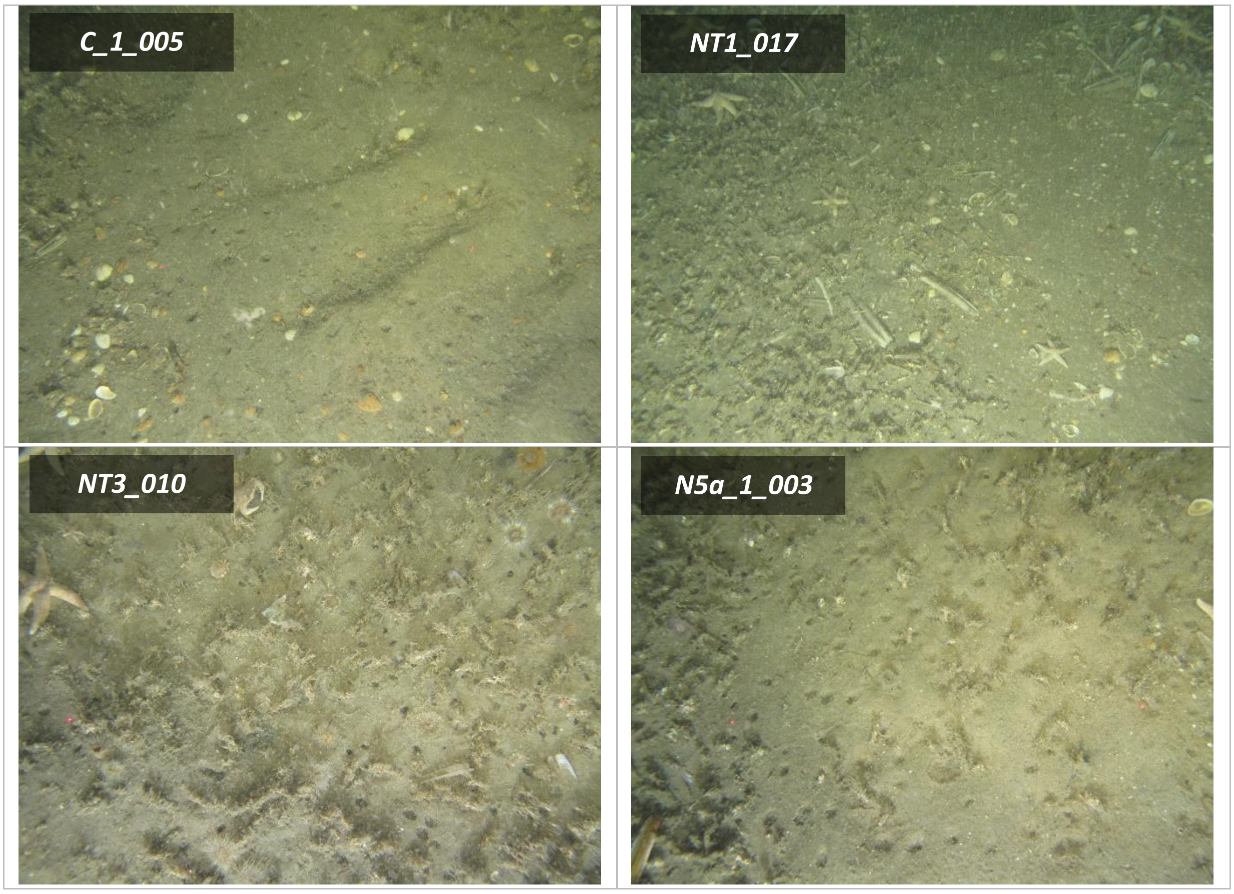


Figure 8: Example images of Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137)

3.4.3 Potential Sensitive Habitats and Species

There are a number of potential sensitive habitats and species which are listed by one or more International Conventions, European Directives or UK Legislation (Appendix G) and are known to occur in the wider region (southern North Sea), including:

- Biogenic reefs formed by the ross worm *Sabellaria spinulosa* (EC Habitats Directive Annex I and OSPAR threatened and declining habitat);
- Stony reefs formed by aggregations of cobbles and/or boulders (EC Habitats Directive Annex I);
- 'Sandbanks which are slightly covered by sea water all the time' (EC Habitats Directive Annex I).

Biogenic Reef Habitat

The most likely biogenic reef habitats to occur in sandy habitats in the southern North Sea are biogenic reefs formed by the polychaete worm *Sabellaria spinulosa*, also known as the ross worm. Ross worms build tubes from sand and shell fragments and where large numbers can form reefs. *Sabellaria spinulosa* form reef-like or agglomerations of sand tubes that act to stabilise cobble, pebble and gravel habitats, providing a consolidated habitat for epibenthic species. The aggregations of the tube-building polychaete worm are solid (albeit fragile), and can form large structures at least several centimetres thick, raised above the surrounding seabed, and persist for many years. A such they provide a biogenic habitat that allows many other associated species to become established (Holt et al., 1998 Foster-Smith and White, 2001, Gubbay, 2007).

These reefs are ecologically important as they provide a habitat for a wide range of other seabed dwelling organisms and as such can support a greater biodiversity than the surrounding area. Due to their conservation importance they are listed as an EC Habitats Directive Annex I habitat (Habitats Directive 1992 & 1997) and an OSPAR (2008) threatened and declining habitat. However, no evidence of *S. spinulosa* aggregations was seen on any of the video transect data from the survey area, including transects over areas of high or variable reflectivity coarse or mixed sediments.

While *Lanice conchilega* beds are not listed by either the EC Habitats Directive (EC, 2013) or OSPAR (2008) as protected habitats, Rabaut et al. (2007) highlighted the role of *L. conchilega* as 'ecosystem engineers' which act to stabilise otherwise mobile seabed substrates and facilitate the development of more diverse macrofaunal communities (Rabaut et al, 2007). Furthermore, it has been suggested that Lanice conchilega beds meet the qualifying criteria for inclusion as EC Habitats Directive Annex I habitats (Rabaut et al, 2009).

Stony Reef Habitat

Stony reefs are defined by the Habitats Directive as comprising 'areas of boulders (>256mm diameter) or cobbles (64mm – 256mm diameter) which arise from the seafloor and provide suitable substratum for the attachment of algae and/or animal species' (EC, 2013).

The seabed video footage was analysed to assess broad habitat changes across the survey area, and to identify areas any with potential for stony reef habitats (See Appendix E). Only one seabed camera transect (Station C3_2) within the N5A development survey area exhibited any potential for consideration as a potential stony reef (EC, 2013). As such, the video footage from station C3_2 was assessed further using the BSL-modified stony reef assessment method (after Irving, 2009). While the Irving (2009) criteria have been approved by the UK regulators for application in UK waters, they have not been explicitly approved by the Netherlands authorities. However, this method has been used here as a useful basis for semi-quantitative assessment of potential Annex I stony reef habitat.

As detailed in Section 2.4.2, there were three criteria that were assessed to estimate the quality of potential stony reef, including composition (%), elevation (mm) and the extent. Video footage and still photographs were first reviewed to assess the 'stony reef structure' using a combination of the composition and elevation measures (Table 11). The results of reef structure analysis are summarised in Table 11, and highlighted the limited potential for the area to be classified as a stony reef due to the low percentage cover and elevation of cobbles (>64mm diameter) in this area. As such, this area is not considered to be sufficiently noteworthy to be classified as an EC Habitats Directive Annex I stony reef.

Table 11: Summary of stony reef structure assessment

Station	Easting	Northing	Length (m)	Sediment type	Stony Reefiness (After Irving 2009)		
					Composition (% cover cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Stony Reef Structure Classification
C3_2	725 366	5 953 610	61.3	Coarse sand ripples with small shell fragments that have accumulated between ripples	Not a Reef	Not a Reef	Not Reef
	725 352	5 953 670					
	725 352	5 953 670	17.7	Cobbles overlying coarse sand with occasional boulders	25	10	Low
	725 347	5 953 687					
	725 347	5 953 688	24.7	Coarse sand with cobbles	10	5	Not a Reef
	725 343	5 953 712					
	725 343	5 953 712	44.2	Occasional cobble overlying coarse sand and infrequent boulders	10	5	Not a Reef
	725 333	5 953 755					
	725 333	5 953 755	30.3	Cobbles overlying coarse sand with occasional boulders	30	20	Low
	725 326	5 953 785					

Shallow Sandbanks Habitat

Sandbanks which are slightly covered by sea water all the time are sandy sediments that are permanently covered by seawater and typically at depths less than 20m (LAT) and are of conservation value as they can host maerl beds as well as being typically colonised by a range of burrowing fauna, epifauna and sand eels, which are an important food source for many birds. Although much of the survey area is shallower than 20m LAT, there were no defined sandbank features in this area (Figure 1).

Due to the variety of H1110 habitat in the Netherlands, the Dutch government decided to subdivide this into three subtypes; H1110_A Wadden Sea, H1110_B North Sea and H1110_C Offshore (Noordzeeloket, 2019). Habitat H1110_C is of most relevance to the current survey area representing permanently flooded sandbanks in water depths of up to 40m, with the Dogger Bank being the main area currently protected under this habitat subtype offshore of the Netherlands. At present, no habitat profile document has been finalised for habitat subtype H1110_C. However, some key characteristics for compiling this profile document are available in Jak et al., (2009), with requirements including the presence of sandy seabed and species characteristic of H1110_C habitat (Table 12).

With the sediments within the survey area being classified within one of three Folk designations of 'sand', 'slightly gravelly sand' and 'gravelly sand', the N5A Development survey sediments can be considered to be sufficiently sandy to meet the requirements of the H1110_C habitat subtype. Review of the macrofauna species dataset together with the grab sample and seabed video logs for the current survey, showed that several of the species characteristic of the H1110_C habitat subtype were present within the survey area. In particular, sandmason worms (*Lanice conchilega*) and bathyporeid amphipods (*Bathyporeia guilliamsoniana*, *B. elegans* and *Bathyporeia* spp.) were recorded in almost all grab samples from the survey area. Other characterising species for the permanently flooded sandbank H1110_C habitat subtype present within the survey area included the polychaete *Sigalion mathildae* and sandeels (*Ammodytes marinus*).

With both the sediment type and associated fauna present within the survey area meeting the requirements outlined by Jak et al., (2009), it is possible that the survey area will be considered to represent EC Habitats Directive Annex I habitat subtype H1110_C (permanently flooded sandbank) throughout N5A Development site and route survey areas. However, there is currently insufficient information in the public domain to pre-empt this decision.

Table 12: Species characteristic of permanently flooded sandbank – Netherlands habitat subtype H1110_C

Species Group	Common Name	Species Name	Description
Polychaete	**Sandmason**	***Lanice conchilega***	**Species occurring on sand substrate**
Polychaete	**na**	***Sigalion mathildae***	**Mainly occurring in clean sandy substrates, Dogger Bank one of the areas where the species occurs.**
Crustacea	**Sand digger shrimp**	***Bathyporeia guilliamsoniana***	**Epiphytes in clean sand and on Dogger Bank**
Crustacea	**Sand digger shrimp**	***Bathyporeia elegans***	**Occurring in coarse, clean, low-fines sediments**
Crustacea	Cumacean	*Iphinoe trispinosa*	Specific for sand from Dogger Bank
Echinodermata	Brittlestar	*Acrocnida brachiata*	Occurring in high densities in clean sand up to a depth of 40 m
Echinodermata	Pea urchin	*Echinocyamus pusillus*	Found in coarse sand and fine gravel enriched with detritus
Mollusca	Ocean quahog	*Arctica islandica*	Occurs on edges of the Dogger Bank - long-lived species
Mollusca	Common whelk	*Buccinum undatum*	Occurs on mixed substrate – long-lived species
Mollusca	Bivalve	*Mactra coralina*	Long-lived species that feeds on particles from the water column. Found in fine to coarse sand
Fish	**Lesser sandeel**	***Ammodytes marinus***	**Occurring in fine sand. An important food source for birds, fish and marine mammals**
Fish	Lesser weaver	*Trachinus vipera*	Specific to sand, where they lie buried subsurface
Ray	Thornback ray	*Raja clavata*	Residual population. Long-lived species
Fish	Plaice	*Pleuronectes platessa*	Generally found on sandy substrate. Common species

Note: species occurring within the N5a Development survey area are shown in **bold** font type.

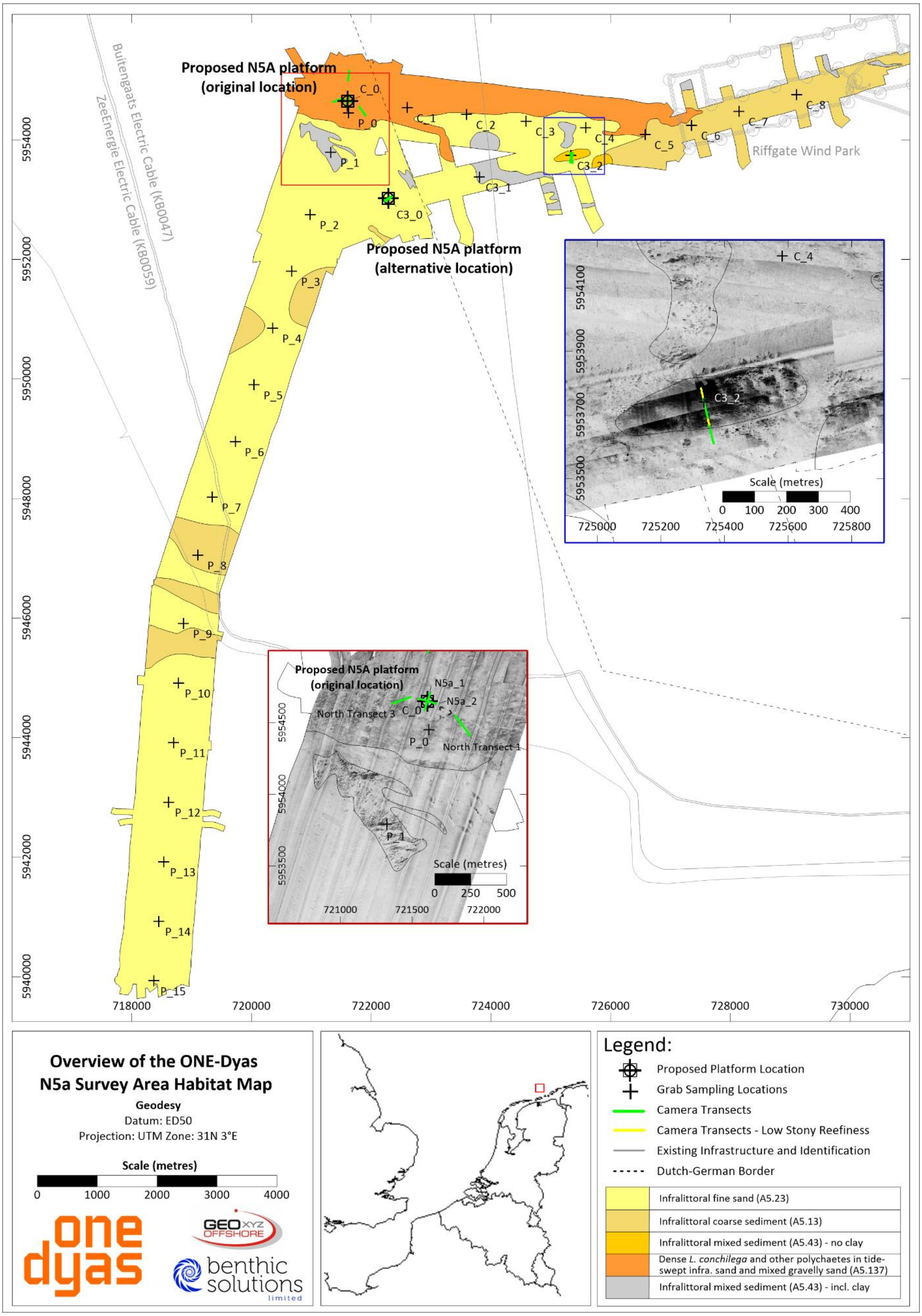


Figure 9: N5A Site and Route Habitat Distribution

4 CONCLUSION

The seabed sediment within the combined N5A site and route survey area ranged from a minimum of approximately 9.8m LAT at KP0.000 on the N5A to NGT Hot Tap pipeline route to a maximum of 26.4m LAT at KP14.675. Both the N5A to NGT Hot Tap pipeline route and N5A to Riffgat cable route were crossed by a series of natural troughs trending west-north-west to east-south-east.

The seabed features within the combined site and route survey area were interpreted from a combination of geophysical and environmental ground-truthing data to comprise five main seabed feature types:

- 'Fine sand and shell fragments' was the dominant sediment type across the combined survey area;
- 'Coarse sand and shell fragments' was delineated in a large area around the Riffgate Wind Park and in six smaller patches along the routes;
- 'Coarse sand with pebbles and cobbles' was present in two small patches midway along the N5A to Riffgate Wind Park cable route;
- 'Coarse sand and shell with a high density of sand mason worms and razor clams' was seen in a single large area along the northern edge of the N5A site and the N5A to Riffgate Wind Park cable route;
- 'Coarse sand and clay with pebbles and cobbles' was interpreted to be present in ten small patches within the N5A site and along the N5A to Riffgate Wind Park cable route.

Based on review of the seabed camera and grab sampling data obtained during the N5A development site and route survey area, four EUNIS habitat classifications were assigned: 'Infralittoral fine sand' (A5.23), 'Infralittoral coarse sediment' (A5.13), 'Infralittoral Mixed Sediment' (A5.43) and 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (A5.137). Each of the assigned EUNIS habitat types corresponded to one of the interpreted seabed features types, with the exception of the 'infralittoral mixed sediment' (A5.43) EUNIS habitat, which was assigned to two seabed features types – 'Coarse sand with pebbles and cobbles' and 'Coarse sand and clay with pebbles and cobbles'.

Although a single patch of cobbles was observed within the survey area, there was deemed to be insufficient cover or elevation of cobbles to warrant consideration as a potential EC Habitats Directive Annex I stony reef habitat (after Irving, 2009).

The seabed sediments within the survey area were characterised by sand-dominated and supported several species listed by Jak et al., (2009) as being characteristic of the EC Habitats Directive Annex I permanently submerged sandbank habitat (subtype H1110_C). At present there is insufficient publicly available information to confirm classification of the survey area as the H1110_C habitat subtype, but it is possible that the survey area will be classified as such.

While *Lanice conchilega* beds are not currently listed as protected habitats, they are known to act as 'ecosystem engineers' (Rabaut et al., 2007) and have been suggested for inclusion as EC Habitats Directive Annex I habitats (Rabaut et al, 2009).

No other protected habitats or species were observed within the survey area, based on review of the acquired geophysical data and environmental ground-truthing by grab sampling and seabed photography.

5 REFERENCES

Connor, D. W., Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northen, K. O. and Reker, J. B. 2004. The Marine Habitat Classification for Britain and Ireland. Version 04.05. Peterborough, JNCC.

EC, 2013. Interpretation Manual of European Union Habitats. EUR 28. April 2013 [Online].]. Available from: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf.

EUNIS, 2013. The European Nature Information Service. Available from: http://eunis.eea.europa.eu/habitats.jsp.

Foster-Smith, R.L. & White, W.H. 2001. *Sabellaria spinulosa* reef in The Wash and North Norfolk Coast cSAC and its approaches: Part I, mapping techniques and ecological assessment. English Nature Research Reports, Number 545. 53pp.

Gubbay, S., 2007. Defining and managing *Sabellaria spinulosa* reefs: Report of an inter-agency workshop 1-2 May, JNCC Report No 405.

Holt, T.J., Rees, E.I., Hawkins, S.J. & Seed, R. 1998. Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association of Marine Science (UK Marine SACs Project). 170pp.Habitats Directive (European Community), 1992, 1997. Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.

Irving, R. 2009. The identification of the main characteristics of stony reef habitats under the Habitats Directive. JNCC Report No. 432. 42pp.

Jak, R.G., Bos, O.G., Witbaard, R. & Lindeboom, H.J. 2009. Conservation objectives for Natura 2000 sites (SACs and SPAs) in the Dutch sector of the North Sea. IMARES – Institute for Marine Resources & Ecosystem Studies. Report number C065/09.

JNCC. 2015. The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online]. [Date accessed]. Available from: jncc.defra.gov.uk/MarineHabitatClassification.

Noordzeeloket, 2019. Habitat type H1110C on the Dogger Bank[Online]. [Date accessed]. Available from: https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/doggersbank/dogger-bank/habitattype/.

OSPAR, 2008. Descriptions of habitats on the OSPAR list of threatened and/or declining species and habitats. OSPAR Convention for the Protection of the Marine Environment of the North-east Atlantic. Reference Number: 2008-07. 8pp.

Parry, M.E.V., K.L. Howell, B.E. Narayanaswamy, B.J. Bett, D.O.B. Jones, D.J. Hughes, N. Piechaud, H. Ellwood, N. Askew, C. Jenkins And E. Manca. 2015. A Deep-sea Section for the Marine Habitat Classification of Britain and Ireland. JNCC report 530. In: **JNCC. 2015.** The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online].

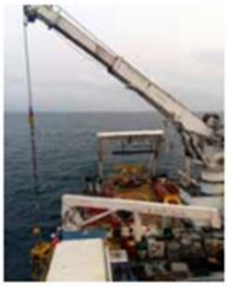
Rabaut, M., Guilini, K., Van Hoey, G., Vincx, M., Degraer, S. 2007. A bioengineered soft-bottom environment: the impact of *Lanice conchilega* on the benthic species-species densities and community structure. Estuar. Coastal Shelf Sci. doi:10.1016/j.ecss.2007.05.041.

Rabaut, M., Vincx. M. and Degraer, S. 2009. Do Lanice conchilega (sandmason) aggregations classify as reefs? Quantifying habitat modifying effects. Helgol Mar Res (2009) 63:37–46. DOI 10.1007/s10152-008-0137-4.

APPENDIX A – GEO OCEAN III

GEO OCEAN III

Offshore Survey & Support Vessel



SUPPORT ACTIVITIES / VESSEL CAPABILITIES

The GEO OCEAN III is a multi-disciplined DP II offshore survey vessel. With her specifically selected equipment and capabilities for the North Sea survey and light construction support activities, she is the ideal candidate for our Oil & Gas and Renewables clients.

The vessel is equipped with 56 berths, Offshore crane, Survey and ROV systems. Equipment can be rapidly deployed using the large Stern A-Frame, crane or through the 6 x6 m moonpool via the dedicated A-frame and 30t AHC winch. All together making the Geo Ocean III a dynamic platform for subsea operations.

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GEO OCEAN III

Offshore Survey & Support Vessel

TECHNICAL SPECIFICATION

General

Name	Geo Ocean III
Flag	Luxembourg
Port Registry	Luxembourg
Call Sign	LXGP
IMO Number	9285586
Classification	LLOYDS - HULL – MACH
Vessel Type	Survey Vessel SV
Special Service:	Fire fighting ship / Fire fighting 1 Waterspray / Oil Recovery / Stand by rescue
Unrestricted navigation	AUT-UMS - ALM - DYNAPOS-AM/AT-R; SDS

Dimensions and Construction

Builder	De Hoop
Built	2004
LOA	77,30 m
Width Moulded	18 m
Depth Moulded	7,40 m
Draft min. / max.	3,80 m/6,10 m
Gross Tonnage	3,722
Moonpool	6 m x 6m

Accommodation

Total Berths	56 persons
Total Cabins	32
Single cabins	8 x 1 person
Double cabins	24 x 2 persons
Offices	1 x Dedicated Online 1 x Dedicated Offline / Conference room 1 x Client Office 1 x OCM Office 1 x 3rd Party Office
Hospital	1 x Hospital
Other Facilities	Galley, Large Mess room, 2 x day room, Gymnasium, Dirty Mess

Capacities & delivery Rates

Main Deck area:	670 m²
Hangar Deck:	290 m²
Mezzanine Deck Area:	268 m²
Max Deck Loading	Main Deck 5t/m² Mezzanine Deck 2t/m²
Max Deck Load	1,300 t @ 1m above deck
Fuel oil (capacity - transfer):	1,105m³ - 100m³/h @ 8bars
Drill or Water ballast (capacity - transfer):	1,350m³ - 40m³/h @ 4.5bars
Antiheeling (capacity - transfer):	250m³ - 2 x 500m³/h
Fresh water (capacity - transfer):	495 m3 - 40 m³/h @ 4.5bars
Oil recovery:	324 m³
Foam:	24 m³

Safety Equipment

Fi-Fi:	Class 1
Pumps:	2 x 1,200m³/h
Monitors:	2 x 1,200m³/h
Fast Rescue Craft:	1 x Seabear 23 MKII
Rescue capacity:	150 persons in tropical area

MACHINERY & PERFORMANCE

Propulsion - Machinery

Main propulsion:	2 x 1,800 kW FP Azimuth thrusters
Main Engines:	4 x 1360kW Caterpillar
Tunnel thrusters:	1 x Insert manufacturer 780 kW
Fwd Azimuth	1 x Rolls Royce 600kW retractable

SPEED & CONSUMPTION (Information only)

Service Speed	10 kts
Max Speed	12 kts

Fuel consumption

Stand-by in port:	2t/day
Survey Speed:	7t/day
DPII:	6t/day

Deck Equipment and Cranes

Main Crane:	SMST telescopic 40t @ 9m - 6t @ 23.5m
Winch Capacity:	40t / 40t - 200m
Deck Crane	4.5t @9m Man-riding
Stern A- Frame :	54t @ 8m outreach
Max launching Dims	8m clearance up / 10m wide opening
Offshore capacity:	54t @ 8m outreach
Winch Capacity	30t / 30t - 1,500m - AHC
Moonpool A-Frame	30t
Winch Capacity	30t / 30t - 1,500m - AHC
Tuggers:	1 x 10t & 1 x 30t
Capstans:	2 x 5t
Deck Service Air Supply:	66 m³/h @ 8 bars
Deck Power Supply:	3 x 265 kW - 480 VAC /60Hz

Navigation and Dynamic Positioning

DP System:	GE DP21 + IJS
Type:	DP 2
Reference 1:	DGPS 1 Fugro Seastar 9205
Reference 2:	DGPS 2 Fugro Seastar 9205
Reference 3:	G4 and XP2 corrections USBL
Reference 4:	Kongsberg Fan Beam
Primary Heading/motion/INS	POSMV 320 Ocean Master
Secondary Heading/motion/INS	POSMV 320 Ocean master
Subsea Positioning	Sonardyne Ranger 2 c/w 6G HPT 5000

Survey Suite and Offline software

Survey Suite	QINSY EIVA
Offline Software	QINSy, NaviSuite, Beamworks, Oasis Montaj (UXO marine), Visual works, Autodesk, Arc GIS,
Video Distribution	4k ultra high definition
Audio comms	Canford clear comms

Survey Sensors

MBES	Hull Mounted (Optional Dual head) R2Sonic 2024 UHR
Single Beam	XXXXXXX
Sound Velocity Sensor	Valeport Swift
Sidescan Sonar	Edgetech 2200
Sub Bottom Profiler	Silas, Depending on requirements

Subsea Equipment

WROV	1 x 150HP WROV
IROV	Mezzanine deck configured for rapid mobilisation 1 x Seaeye Cougar
Vibrocorer	3/6m electric/hydraulic systems as required
CPT	Optional 1.5 – 20t systems (Neptune or Manta type as required)

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APPENDIX B – BSL SAMPLING EQUIPMENT

BSL DOUBLE GRAB

BSL DOUBLE GRAB

- **General Specifications**
  - 2 x 0.1m^2 Sample Area
  - Total Stainless Steel Construction
  - Adjustable weight
  - Proven performance in 2000m depth
  - Flat Pack for Air Freighting

- **Services**

The BSL Double Grab was designed and built by BSL in 2007 to carry out more efficient grab sampling operations in very deep waters. It is also routinely used for projects where multiple replicates are required or where both chemical and biological analysis are needed from the same deployment. This multi-purpose sampling tool is ideal for shallow water and deep water operations alike, halving the ship-time required to acquire sample replicates in moderate water depths.

Recovery

Made of stainless steel, the grab can be ballasted with additional lead weights, for operations in deeper waters, strong currents or compacted sediments. The two pairs of extended stainless steel arms increase the leverage on closure to the buckets, but these can be fouled by coarser gravels.

Both buckets have hinged doors fully enclosing the samples on recovery but allowing the scientist access to the undisturbed sample prior to emptying the sampler. Each bucket has the capacity to collect samples of approximately 15L.

Deployment

Direct access to sample

Grab stand and sample trays

Shipping weight	200kg
Shipping dimension	0.4* to 1.2 x 1 x 0.2m
Specifications	920 x 920 x 1000mm

*if sampler is dismantled for freighting

QMS ISO 9001 REGISTERED FIRM

Please contact us for any further information, our team will be happy to help you.

Benthic Solutions, Elanco Works, Marsh Road, Hoveton, Norwich, NR12 8UH, UK

Tel : +44 (0) 1603 784726 Mail: info@benthicsolutions.com www.benthicsolutions.com

BSL DAY GRAB

Benthic Solutions

BSL MODIFIED DAY GRAB

- **General Specifications**
  - 0.1m^2 Sample Area
  - Total Stainless Steel Construction
  - Adjustable weight
  - Compact Design
  - Proven performance in 1000m depth
  - Modified for One Man Operation

- **Services**

Day grabs comprise of two stainless bucket sections which are mounted within a stainless steel frame. On contact with the seabed, a trigger bar is pushed upwards via pressure plates allowing the buckets to close under the gravity of the unit through a pulley system. This controlled contact and closure once on the seabed helps ensure sample disturbance is minimised. The top of the grab is covered by two catch-closed inspection doors also made of stainless steel. The doors allow direct access to the sample inside the grab when closed, and protect the sample from the grab movement through the water column during recovery.

Our Day grab sampler (offset design) was originally modified by BSL's principle scientist in the early 1990s to improve penetration and reduce sample disturbance and contamination. These grabs are fitted with additional but removable stainless steel coated lead weights which can provide better penetration in more compacted substrates, but can also be removed to prevent over-penetration of the sampler in softer sediments.

A further extended bucket lip reduces sediment washout during retrieval. The unit can be supplied with a stand allowing for easy sample access and handling. A further modification that was made provided an efficient closure system to allow arming by a single person. This modified Day grab has become the standard operating tool for the North Sea.

The grab is relatively simple to operate in almost any water depth. The (0.1m²) grabs have been constructed with stainless steel throughout making this grab ideal for accurate assessment of the chemical properties of sea floor sediments.

Shipping weight	250kg
Shipping dimension	1.5 x 1 x 1m
Specifications	800 x 800 x 850mm

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Benthic Solutions

BSL WILSON AUTO-SIEVER

WILSON AUTOSIEVER ©

*Best practice** for benthic samples

General Specifications

The *Wilson* Autosiever is a semi-automated sieving table for reducing benthic sediment samples offshore in a routine and controlled manner.

- Reduces time consuming and laborious sample handling in the field
- Reduces personnel numbers required for benthic processing
- Reduces damage to biological material during processing
- Well proven field performance on benthic surveys worldwide
- Standardises sample processing
- Robust stainless steel construction that dismantles for storage or freighting

Services

The *Wilson* Autosiever (WAS) was initially designed in the late 1980s by Ian Wilson (BSL Director), but was implemented from the early 1990s as the preferred benthic processing tool for all sampling operations by a major UK based environmental survey contractor. The system was subsequently commercialised and made available for purchase to other operators and users following the success of the trial at an NMBAQC workshop in 1997*.

The WAS system was designed to standardise all sieving operations between surveys and personnel, increasing the efficiency of the sample handling and processing without compromising the quality of the biology recovered.

Its simple yet unique and revolutionary design enables its employment from small vessels and large ships alike and in a variety of different sediment conditions, ranging from coarse heterogenic substrates down to soft clays and silts.

Cited as *best practice* for biological processing*, the WAS system has become the preferred tool for a large number of organisations that routinely carry out benthic surveys. Systems are currently being employed around the world (including UK, Ireland, Norway, Netherlands, Germany, France, Australia, Africa and South America) by a multitude of different users including survey companies, fish farms, government institutes and agencies, laboratories, universities and environmental consultancies.

Shipping weight	80kg
Shipping dimension	1 x 0.8 x 0.3m

* Proudfoot, R.K., Elliott, M., Dyer, M.F., Barnett, B.E, Allen, J.H., Proctor, N.L, Cutts, N.D., Nikitik, C., Turner, G. Breen, J. Hemmingway, K.L and Mackie, T., 1997. Collection and Processing of macrobenthic samples from soft sediments; a best practice review. Proceedings of the Humber Benthic Field Methods Workshop, Hull University.

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Benthic Solutions, Elanco Works, Marsh Road, Hoveton, Norwich, NR12 8UH, UK
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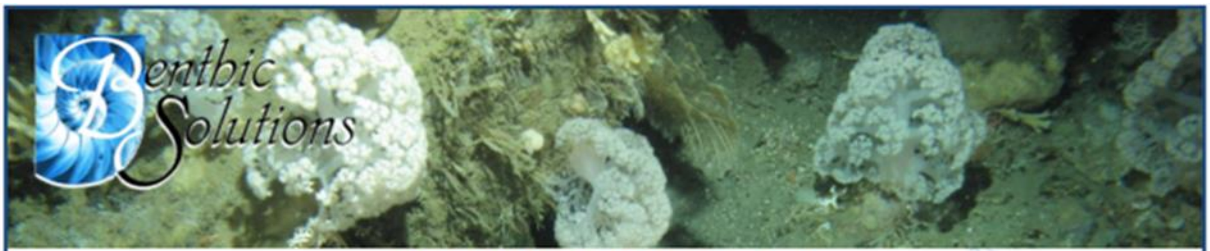
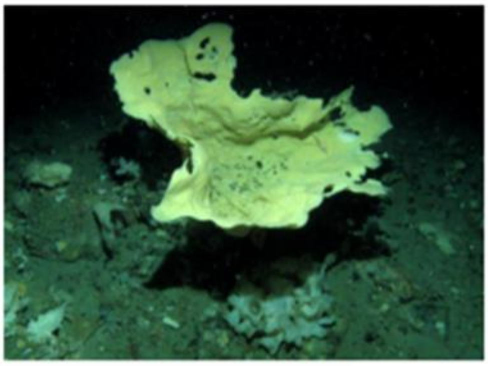
Benthic Solutions

STR SEABUG CAMERA SYSTEM



UNDERWATER CAMERA – Seabug
Seabed Monitoring & Underwater Real-time Footage

- **General Specifications**
  - Flexible deployment scenarios
  - Depth rated to 3500m
  - Digital streaming target video
  - Video overlay on video data
  - Uses vessel existing sonar cabling



- **Services**

The deep water camera system is based on a Sonar Equipment Services Seabug which was developed in conjunction with Benthic Solutions Limited in 2010. The system is based upon 14.7 megapixel digital stills camera operated from the surface via a single armoured coaxial or twisted pair cable. Typically, this utilises an existing sonar cable on the survey vessel through a multiport multiplexer carrier system to a control consol.

The system provides continuous targeting video data streamed to the surface where a computer is used to trigger the stills camera system remotely as required. These systems are fitted with inbuilt strobe units which can be deployed in a drop-down frame mounted configuration, or towed seabed sled (pictured). Seabed video is illuminated by 4 or 6 dedicated LED lamps with the camera orientated at an oblique or a downward looking aspect.

The system provides a very high quality digital image and is an ideal tool for ground truthing, habitat mapping and detailed seabed classification surveys from vessels in water depths in excess of 3km. Examples of previous projects include regional deep water surveys looking at iceberg keel scar, deep water coral and sponge communities and regional environmental habitat mapping assessments.

Shipping weight	200kg *
Shipping dimension	2 x 1 x 0.2m *
Specifications	2 x 1 x 1m *

**as multiple configurations are available, values shown indicate the maximum*

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BSL MOD4 UNDERWATER CAMERA SYSTEM

UNDERWATER CAMERA – MOD4
Seabed Monitoring & Underwater Real-time Footage

- **General Specifications**
  - Flexible deployment scenarios
  - Depth rated to 4500m
  - Superior stills and streaming video quality
  - Near zero-delay shutter release
  - Unattended time lapse photography
  - Solutions for very low visibility environments

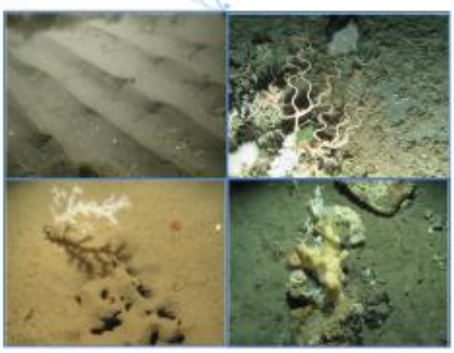
- **4 Camera Configurations**
  1. Deepwater real time
  2. Shallow water real time
  3. Ultra deepwater timelapse
  4. Remote timelapse

- **4 Deployment Configurations**
  1. Towed system (deep to shallow)
  2. Bed-hop ultra deep water
  3. Remote mooring timelapse
  4. Poor visibility freshwater lens

- **Services**

Benthic Solutions Ltd have an array of underwater cameras for various deployment scenarious. Our latest development (MOD4) is the most flexible camera to date. For water depths of less than 400m it is capable of communicating with the surface via a multicore umbilical cable, which provides a very high quality live view of the seabed. Zero-delay still images of 24 megapixels can be captured and transmitted to the surface for instant review.

For deeper waters the camera can be controlled via an armoured coax cable, of the type commonly used for towing sidescan sonar. A theoretical maximum cable length of 12km can be used. In this setup, the live feed quality is slightly reduced. To compensate for this an additional 1080p 30fps camera can be added if very high quality seabed video footage is desired.



High output lighting has been developed using the latest LED technology. 2x 2200 lumen lamps provide flood lighting ahead of the camera for video streaming, whilst a multi-head strobe system (up to three heads) can be utilised in TTL configuration to give perfectly exposed under water still images.

Benthic Solutions can also provide different camera frames suitable for seabed towing or 'drop down' use. These can be small and lightweight, or larger with increased ballast for deep water scenarios.

Shipping weight	200kg *
Shipping dimension	2 x 1 x 0.2m *
Specifications	2 x 1 x 1m *

**as multiple configurations are available, values shown indicate the maximum*

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APPENDIX C – LOG SHEETS

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
1	GRAB_P_0	Day grab	29	17:43:00	06/05/2019	85%	F1	2 x 3L bucket		shells, sand	*Lanice. conchilega*, *Asterias rubens*, *Nereis*
2	GRAB_P_0	DVV	29	18:20:00	06/05/2019	60% 50%	F2 PC	2 x 3L bucket Bags and jars		sand, small pieces of shells	*L. conchilega*, *A. rubens*, *Nereis*
3	GRAB_P_0	DVV	29	18:45:00	06/05/2019	60%	F3	3 x 3L bucket		sand, small pieces of shells	*L. conchilega*, *A. rubens*, *Nereis*
4	GRAB_P_1	DVV	27	20:12:00	06/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		clay	*L. conchilega*
5	GRAB_P_1	DVV	27	20:26:00	06/05/2019	N/S	N/S	N/S	Cobbles		
6	GRAB_P_1	DVV	27	20:40:00	06/05/2019	70% 50%	F2 F3	1 x 3L bucket 1 x 3L bucket		sand and clay	Polychaetes, Shell debris
7	GRAB_P_2	DVV	24	21:15:00	06/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		fine sand	*Echinocardium cordatum*, sandeel
8	GRAB_P_2	DVV	24	21:50:00	06/05/2019	60% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket	Flatfish in grab jaws, photo taken, discarded overboard. Grab seal not compromised so used for fauna	fine sand	Sandeel, polychaetes, flatfish poss. turbot
9	GRAB_P_3	DVV	23	22:56:00	06/05/2019	N/S	N/S	N/S	Block came down, strops broken, operations stopped		
10	GRAB_P_3	DVV	24	02:05:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars	Weight added to arms	fine sand	*E. cordatum*
11	GRAB_P_3	DVV	24	02:15:00	08/05/2019	60% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		fine sand	Sandeel, *E. cordatum*
12	GRAB_P_4	DVV	22	02:45:00	08/05/2019	60% 50%	PC F1	1 x 1L bucket Bags and jars		fine sand	*L. conchilega*
13	GRAB_P_4	DVV	21	03:03:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		fine sand	*L. conchilega*

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
14	GRAB_P_5	DVV	20	03:31:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Sand and shell	*E. cordatum*, razor clam
15	GRAB_P_5	DVV	20	03:42:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Sand and shell	*L. conchilega*
16	GRAB_P_6	DVV	21	04:29:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Fine sand	*E. cordatum* (damaged)
17	GRAB_P_6	DVV	22	04:41:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell fragments	Polychaetes, *Nereis*, *L. conchilega*, fish (damaged)
18	GRAB_P_7	DVV	22	05:09:00	08/05/2019	N/S	N/S	N/S	No sample, triggered but empty		
19	GRAB_P_7	DVV	22	05:22:00	08/05/2019	N/S	N/S	N/S	No sample, did not trigger		
20	GRAB_P_7	DVV	21	05:25:00	08/05/2019	N/S	N/S	N/S	No sample, did not trigger		
21	GRAB_P_7	DVV	21	05:27:00	08/05/2019	50% 50%	PC F1	1 x 1L bucket Bags and jars		Fine sand with minor shell debris	*L. conchilega*, polychaetes
22	GRAB_P_7	DVV	21	05:37:00	08/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell debris, small amounts of mud/clay	Abundant *L. conchilega*, polychaetes
23	GRAB_P_8	DVV	21	06:01:00	08/05/2019	N/S	N/S	N/S			
24	GRAB_P_8	DVV	21	06:03:00	08/05/2019	N/S	N/S	N/S			
25	GRAB_P_8	DVV	20	06:04:00	08/05/2019	70% 70%	PC F1	1 x 5L bucket Bags and jars		Coarse sand with shell fragments	Polychaetes
26	GRAB_P_8	DVV	21	06:12:00	08/05/2019	70% 60%	F2 F3	1 x 5L bucket 1 x 5L bucket		Coarse sand with shell fragments	*L. conchilega*
27	GRAB_C_8	DVV	24	19:00:00	09/05/2019	80% 80%	PC F1	1 x 1L bucket Bags and jars		Coarse sand with shell fragments	*L. conchilega*
28	GRAB_C_8	DVV	24	19:15:00	09/05/2019	80% 80%	F2 F3	1 x 1L bucket 1 x 1L bucket		Coarse sand with shell fragments	*L. conchilega*
29	GRAB_C_7	DVV	24	19:30:00	09/05/2019	70%, 70%	PC F1	3 x 3L bucket Bags and jars		Coarse sand with shell fragments	No conspicuous fauna

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
30	GRAB_C_7	DVV	24	19:45:00	09/05/2019	N/S	N/S	N/S	Deployed but no sample, not triggering		
31	GRAB_C_7	DVV	24	20:05:00	09/05/2019	70% 80%	F2 F3	2 x 5L bucket 2 x 5L bucket		Coarse sand with shell fragments	No conspicuous fauna
32	GRAB_C_6	DVV	24	20:27:00	09/05/2019	60% 80%	PC F1	1 x 3L bucket Bags and jars		Coarse sand with shell fragments	No conspicuous fauna
33	GRAB_C_6	DVV	24	21:05:00	09/05/2019	80%, 80%	F2 F3	1 x 3L bucket 1 x 3L bucket		Coarse sand with shell fragments	Urchin
34	GRAB_C_5	DVV	25	05:37:00	11/05/2019	40% 70%	PC F1	1 x 3L + 1x5L bucket Bags and jars		Coarse sand with shell fragments	Gobidae, *Asterias*, Lancelet. *L. conchilega*
35	GRAB_C_5	DVV	25	05:42:00	11/05/2019	70% 70%	F2 F3	2 x 5L bucket 1 x 5L + 1x 3L bucket		Coarse sand with shell fragments	*L. conchilega*, polychaetes, spatangoid
36	GRAB_C_4	DVV	28	06:40:00	11/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell debris	*L. conchilega*, polychaetes, spatangoid
37	GRAB_C_4	DVV	28	07:01:00	11/05/2019	70% 70%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	*L. conchilega*, polychaetes, spatangoid
38	GRAB_C_3	DVV	28	07:29:00	11/05/2019	N/S	N/S	N/S	Did not trigger		
39	GRAB_C_3	DVV	28	07:36:00	11/05/2019	70% 70%	PC F1	1 x 1L bucket Bags and jars		Very fine sand with minor shell debris	*L. conchilega,* polychaetes
40	GRAB_C_3	DVV	28	07:47:00	11/05/2019	N/S	N/S	N/S	Triggered but no sample		
41	GRAB_C_3	DVV	28	07:49:00	11/05/2019	70% 70%	F2 F3	1 x 1L bucket 1 x 1L bucket		Very fine sand with minor shell debris and soft clay	Anemones, *L. conchilega*, polychaetes, A rubens, spatangoid
42	GRAB_C_2	DVV	27	08:15:00	11/05/2019	70% 70%	PC F1	1 x 5L bucket Bags and jars		Coarse sand and clay	*L conchilega* and polychaetes
43	GRAB_C_2	DVV	28	08:27:00	11/05/2019	70% 40%	F2 F3	1 x 5L bucket 1 x 3L bucket	Razor clams in jaws (F3)	Coarse sand	Razor clams, *L. conchilega*, polychaetes. Lancelet

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
44	GRAB_C_1	DVV	28	08:55:00	11/05/2019	60% 60%	PC F1	1 x 3L + 1x5L bucket Bags and jars		Coarse sand and abundant shell debris	Lancelet and polychaetes
45	GRAB_C_1	DVV	28	09:04:00	11/05/2019	60% 40%	F2 F3	1 x 5L bucket 1 x 5L bucket	Razor clams in jaws (F3)	Coarse sand and abundant shell debris	*L. conchilega*, lancelet, polychaetes, porcelain crab
46	GRAB_C_0	DVV	29	09:32:00	11/05/2019	90% 90%	PC F1	2 x 5L bucket Bags and jars	Label for F2 in F1 bucket (2 of 2)	Coarse sand	*L. conchilega*, razor clams and polychaetes
47	GRAB_C_0	DVV	29	09:41:00	11/05/2019	90% 90%	F2 F3	2 x 5L bucket 2 x 5L bucket	Label for F3 in F2 bucket (1 of 2)	Coarse sand	*L. conchilega*, razor clams and polychaetes
48	GRAB_P_15	DVV	13	02:15:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell	Polychaetes
49	GRAB_P_15	DVV	13	02:20:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell	Polychaetes, sandeel
50	GRAB_P_14	DVV	14	03:05:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell	*Asterias*, Spatangoid, *Ophiura*
51	GRAB_P_14	DVV	14	03:10:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell	Spatangoid, *Ophiura*
52	GRAB_P_13	DVV	16	03:30:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with minor shell debris	Polychaetes
53	GRAB_P_13	DVV	16	03:45:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with minor shell debris	*Nereis*, *L. conchilega*, *Ophiura*, Spatangoids
54	GRAB_P_12	DVV	16	04:32:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell debris	*Nereis*, *L. conchilega*, Spatangoids
55	GRAB_P_12	DVV	16	04:42:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell debris	*Nereis*, *L. conchilega*, Spatangoids
56	GRAB_P_11	DVV	17	05:03:00	12/05/2019	70% 70%	PC F1	1 x 3L bucket Bags and jars		Fine sand with significant shell debris	*L. conchilega*
57	GRAB_P_11	DVV	17	05:13:00	12/05/2019	70% 70%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with significant shell debris	*L. conchilega*
58	GRAB_P_10	DVV	17	05:35:00	12/05/2019	60% 60%	PC F1	1 x 1L bucket Bags and jars		Fine sand with shell debris	Polychaetes, *L. conchilega*, *Nereis*

Cast	Station	Sampler Used	Water Depth (m)	Time	Date	Volume Recovered (mm box depth)	Sample Name	Container Type and Quantity	Comments	Sediment Description/Stratification	Conspicuous Fauna/Comments
59	GRAB_P_10	DVV	17	05:44:00	12/05/2019	60% 60%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	Polychaetes, *L. conchilega*
60	GRAB_P_9	DVV	19	06:05:00	12/05/2019	60% 60%	PC F1	1 x 3L bucket Bags and jars		Fine sand with shell debris	*Nereis*
61	GRAB_P_9	DVV	19	06:13:00	12/05/2019	60% 60%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with shell debris	Polychaetes
62	GRAB_C3_0	DVV	24	22:43:00	14/05/2019	60% 60%	PC F1	1x1L bucket		Fine sand with shell debris	*E. cordatum*
63	GRAB_C3_0	DVV	24	22:59	14/05/2019	50% 50%	F2 F3	1 x 1L bucket 1 x 1L bucket		Fine sand with shell debris	*E. cordatum*
64	GRAB_C3_1	DVV	25	23:36:00	14/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		Fine sand with clay beneath	Polychaetes. Poss. piddock holes in clay but no piddocks evident
65	GRAB_C3_1	DVV	25	23:45:00	14/05/2019	50% 50%	F2 F3	1 x 3L bucket 1 x 3L bucket		Fine sand with clay beneath	Polychaetes. Poss. piddock holes in clay but no piddocks evident
66	GRAB_C3_2	DVV	25	00:13:00	15/05/2019	NS NS			Cobbles in jaws		
67	GRAB_C3_2	DVV	25	00:20:00	15/05/2019	50% 50%	PC F1	1 x 3L bucket Bags and jars		sandy gravel	Polychaetes hydroids
68	GRAB_C3_2	DVV	25	00:29:00	15/05/2019	50% NS	F2	1x5L bucket	Cobble in jaws of one bucket	sandy gravel	Polychaetes hydroids
69	GRAB_C3_2	DVV	25	00:36:00	15/05/2019	45%	F3	1x1L bucket	Cobble in jaws of one bucket	sandy gravel	Polychaetes hydroids

APPENDIX D – FIELD OPERATIONS AND SURVEY METHODS

SEABED PHOTOGRAPHY AND VIDEO

Seabed video footage was acquired at 10 transects using a STR Seabug Underwater camera system mounted within a BSL camera sled equipped with a separate strobe, and LED lamps. The camera unit itself is capable of acquiring images at 24MP resolution but was set to a resolution of 5MP (2592 x 1944 pixels) to optimise image upload times during camera operation.

Once at the seabed, the camera would be moved along the length of the transect at no more than 0.5 knots. Stills Photographs were captured remotely using a surface control unit via a sonar cable to the camera system. Still images were uploaded in real time, and saved to the laptop via specialist software. Live video footage, overlaid with the date, time, position and site details was viewed in real-time, and recorded directly onto a media storage device and to the laptop via specialist software. The live video stream was used to assist with targeting of the stills camera. HD footage was saved internally by the video camera; data was downloaded at the end of each day of camera operations and backed-up onto a hard drive.

Full camera specifications can be found in the table below.

Standard Features	Comment
Image Resolution	5 to 14.7 megapixel (up to 4,416 x 3,312 pixels)
Light Sensitivity setting	ISO 60-1600 Auto/Manual Selected
Sensor Type	1 / 1.8” format high density CCD sensor
Light source	4 x 1000 lumen controllable LED lamps Stills strobe TTL controller
Typical settings	Aperture priority at F8, Shutter speed typically 1/125th second, Auto flash mode (TTL)
Framing Video Used	320 Line / 50 Hz PAL
Control System	SES Multiport DTS
Manufacturer	STR
Other sensors	Depth sensor and compass

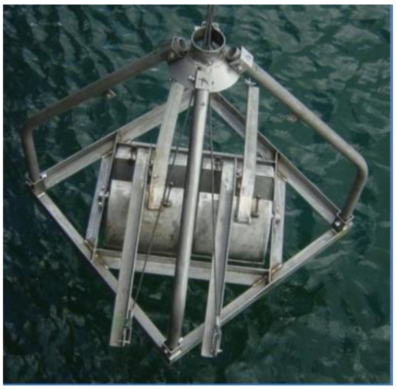
STR Seabug Underwater Camera Specifications

Another STR Seabug underwater camera system was also supplied as a backup. This camera was not used during operations.

GRAB SAMPLING

The BSL double grab was designed and built by BSL for operations in soft sediments, compacted sands and shallow stiff clays. This device consists of two 0.1m^2 samplers set into a ballasted frame, reducing the time required to obtain multiple replicates at a single station.

A BSL Double grab was used for seabed sampling Seagull site and route survey. Two successful deployments were required at each location. Three consecutive 'no sample' deployments were agreed to be the maximum number of attempts at any location before abandoning it. The inner stainless grab buckets were cleaned before deployment at any new station to avoid contamination.



BSL Double Grab

Samples were subject to quality control on recovery and were retained in the following circumstances:

- Water above sample was undisturbed;
- Bucket closure complete (no sediment washout);
- Sampler was retrieved perfectly upright;
- Inspection/access doors had closed properly;
- No disruption of sample;
- Sample was taken inside the acceptable target range (<15m);
- Sample size was greater than 6 litres (ca. 40% of the sampler's capacity);
- No hagfish (*Myxine glutinosa*) and/or mucus coagulants.

Key observations from samples included colour, sediment classification, layering (including redox discontinuity layers), smell (including the presence of H_2S), obvious fauna, evidence of bioturbation and anthropogenic debris.

APPENDIX E – HABITAT ASSESSMENT

ED50, UTM 31N, CM 3° E												
								Stony Reefiness (After Irving 2009)				
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix	Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
Grab_C_0				N5a_1_018.jpg, N5a_1_019.jpg, N5a_2_021.jpg, N5a_1_022.jpg	Coarse sand and shell fragments	*Asterias rubens*, *Lanice conchilega*	30	n/a	n/a	n/a	n/a	Infralittoral coarse Sediment (A5.13)
Grab_C_1	722598	5954539	11/05/19 02:56:48	Grab_C_1_005.jpg	Coarse sand and shell fragments with *Lanice conchilega* assemblages	*Asterias rubens*, *Liocarcinus* sp., *Lanice conchilega*, Decapoda	28	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	722599	5954538	11/05/19 02:57:27									
Grab_C_2	723694	5954422	11/05/19 03:28:13	Grab_C_2_002.jpg	Coarse sand and shell fragments with *Lanice conchilega* assemblages	*Asterias rubens*, *Liocarcinus* sp., *Lanice conchilega*, *Loligo vulgaris*	28	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	723596	5954422	11/05/19 03:29:04									
Grab_C_3	724589	5954311	11/05/19 04:08:03	Grab_C_3_003.jpg	Fine to medium sand ripples with shell fragments accumulated between ripples	*Asterias rubens*, *Liocarcinus* sp., *Lanice conchilega*	28	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	724590	5954310	11/05/19 04:10:35									
Grab_C_4	725582	5954199	11/05/19 04:34:40	Grab_C_4_002.jpg	Fine to medium sand ripples with shell fragments accumulated between ripples	*Asterias rubens*, *Lanice conchilega*, *Arenicola* sp., Decapoda	28	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	725581	5954200	11/05/19 04:37:18									
Grab_C_5	726576	5954086	11/05/19 05:01:59	Grab_C_5_002.jpg	Coarse sand ripples with small shell fragments accumulated between ripples	*Asterias rubens*, *Liocarcinus sp.*, *Lanice conchilega*, poss. *Callionymus lyra*	25	n/a	n/a	n/a	n/a	Infralittoral coarse Sediment (A5.13)
	726573	5954088	11/05/19 05:05:12									

<table>
<tr><th colspan="14">ED50, UTM 31N, CM 3° E</th></tr>
<tr><th rowspan="2">Station</th><th rowspan="2">Easting (m)</th><th rowspan="2">Northing (m)</th><th rowspan="2">Date & Time</th><th rowspan="2">Example Photograph (file name)</th><th rowspan="2">Sediment type</th><th rowspan="2">Conspicuous fauna</th><th rowspan="2">Depth (m)</th><th colspan="3">Stony Reefiness (After Irving 2009)</th><th rowspan="2">Overall Reef Structure</th><th rowspan="2">EUNIS Habitat Classification with SBF/Habitat Map Colour Code</th></tr>
<tr><th>Composition (% cover of cobbles/ boulders)</th><th>Elevation (of cobbles/ boulders in cm)</th><th>Reef Structure Matrix</th></tr>
<tr><td rowspan="2">Grab_C_6</td><td>727352</td><td>5954243</td><td>09/05/19 17:05:54</td><td rowspan="2">Grab_C_6_002.jpg</td><td rowspan="2">Coarse sand ripples with small shell fragments accumulated between ripples</td><td rowspan="2">Lanice conchilega</td><td rowspan="2">24</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">Infralittoral coarse Sediment (A5.13)</td></tr>
<tr><td>727353</td><td>5954242</td><td>09/05/19 17:06:30</td></tr>
<tr><td rowspan="2">Grab_C_7</td><td>728147</td><td>5954477</td><td>09/05/19 17:33:39</td><td rowspan="2">Grab_C_7_004.jpg</td><td rowspan="2">Coarse sand ripples with small shell fragments accumulated between ripples</td><td rowspan="2">Lanice conchilega, Asterias rubens</td><td rowspan="2">24</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">Infralittoral coarse Sediment (A5.13)</td></tr>
<tr><td>728148</td><td>5954477</td><td>09/05/19 17:34:26</td></tr>
<tr><td rowspan="2">Grab_C_8</td><td>729105</td><td>5954755</td><td>09/05/19 18:00:57</td><td rowspan="2">Grab_C_8_005.jpg</td><td rowspan="2">Fine to medium sand ripples with small shell fragments accumulated between ripples</td><td rowspan="2">Poss. Gobiidae, Asterias rubens, Lanice conchilega</td><td rowspan="2">24</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">Infralittoral fine sand (A5.23)</td></tr>
<tr><td>729108</td><td>5954757</td><td>09/05/19 18:01:58</td></tr>
<tr><td rowspan="2">Grab_C3_0</td><td>722231</td><td>5952984</td><td>14/05/19 21:51:01</td><td rowspan="2">Grab_C3_0_002.jpg</td><td rowspan="2">Fine to medium sand ripples with small shell fragments accumulated between ripples</td><td rowspan="2">Asterias rubens, Lanice conchilega, Decapoda, Ammodytes sp., Corystes cassivelaunus, Gobiidae, Ophiura ophiura</td><td rowspan="2">24</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">Infralittoral fine sand (A5.23)</td></tr>
<tr><td>722336</td><td>5953047</td><td>14/05/19 22:00:16</td></tr>
<tr><td rowspan="2">Grab_C3_1</td><td>723807</td><td>5953379</td><td>14/05/19 21:23:19</td><td rowspan="2">Grab_C3_1_001.jpg</td><td rowspan="2">Coarse shelly sand with partially buried cobbles and slight sand ripples</td><td rowspan="2">Pleuronectiform, Asterias rubens</td><td rowspan="2">24</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td rowspan="2">Infralittoral mixed sediment (A5.43) – incl. clay</td></tr>
<tr><td>723808</td><td>5953379</td><td>14/05/19 21:24:23</td></tr>
<tr><td rowspan="4">Grab_C3_2</td><td>725366</td><td>5953610</td><td>14/05/19 20:46:00</td><td rowspan="2">Grab_C3_2_0014jpg</td><td rowspan="2">Fine to medium sand ripples with small shell fragments that have accumulated between ripples</td><td rowspan="4">Lanice conchilega, Asterias rubens, poss. Callionymus lyra, Pleuronectiformes, Ammodytes sp., Paguridae, Decapoda, Metridium senile, Cancer pagurus, Actiniaria, Liocarcinus</td><td rowspan="4">25</td><td rowspan="2">Not a Reef</td><td rowspan="2">Not a Reef</td><td rowspan="2">Not Reef</td><td rowspan="2">Not a Reef</td><td rowspan="2">Infralittoral fine sand (A5.23)</td></tr>
<tr><td>725352</td><td>5953670</td><td>14/05/19 20:51:34</td></tr>
<tr><td>725352</td><td>5953670</td><td>14/05/19 20:51:35</td><td rowspan="2">Grab_C3_2_020.jpg</td><td rowspan="2">Cobbles overlying coarse sand with occasional boulders</td><td rowspan="2">25</td><td rowspan="2">10</td><td rowspan="2">Low</td><td rowspan="2">Low</td><td rowspan="2">Infralittoral mixed sediment (A5.43) - no clay</td></tr>
<tr><td>725347</td><td>5953687</td><td>14/05/2019 20:52:38</td></tr>
</table>

ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
	725347	5953688	14/05/2019 20:52:39	Grab_C3_2_021.jpg	Coarse sand with cobbles	sp., Cerianthidae, *Sertularia* sp.		10	5	Not a Reef	Not a Reef	Infralittoral mixed sediment (A5.43) - no clay
	725343	5953712	14/05/2019 20:54:08									
	725343	5953712	14/05/2019 20:54:09	Grab_C3_2_028.jpg	Occasional cobble over lying coarse sand and infrequent boulders			10	5	Not a Reef	Not a Reef	Infralittoral mixed sediment (A5.43) - no clay
	725333	5953755	14/05/2019 20:57:02									
	725333	5953755	14/05/2019 20:57:03	Grab_C3_2_035.jpg	Cobbles overlying coarse sand with occasional boulders			30	20	Low	Low	Infralittoral mixed sediment (A5.43) - no clay
	725326	5953785	14/05/2019 20:58:50									
Grab_P_0	721647	5954431	02/05/19 17:15:09	Grab_P_0_021.jpg	Coarse sand littered with shell fragments and *Lanice conchilega* assemblages	*Asterias rubens*, *Lanice conchilega*, Decapoda, Paguridae, Actiniaria, Gobiidae, Cerianthidae	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721595	5954473	02/05/19 17:22:22									
Grab_P_1	721323	5953795	02/05/19 19:00:12	Grab_P_1_006.jpg	Coarse sand with cobbles	Cerianthidae, *Asterias rubens*, Bryozoa	27	n/a	n/a	n/a	n/a	Infralittoral mixed sediment (A5.43) – incl. clay
	721325	5953794	02/05/19 19:01:32									
Grab_P_2	720981	5952753	02/05/19 20:00:37	Grab_P_2_002.jpg	Fine to medium shelly sand with sand ripples	*Lanice conchilega*, *Corystes cassivelaunus*	24	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	720980	5952752	02/05/19 20:02:04									
Grab_P_3	720668	5951799	06/05/19 15:43:57	Grab_P_3_007.jpg	Fine to medium sand forming ripples	*Corystes cassivelaunus*, *Asterias rubens*, *Lanice conchilega*	24	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	720666	5951799	06/05/19 15:47:09									
Grab_P_4	720245	5950807	03/05/19 15:07:42	Grab_P_4_005.jpg	Fine to medium sand formed into sand ripples	Asteroidea, Ophiuroid	22	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	720355	5950855	03/05/19 15:10:32									

ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
Grab_P_5	720036	5949903	03/05/19 13:36:49	Grab_P_5_004.jpg	Fine to medium shelly sand with rare cobbles	Paguridae, *Lanice conchilega, Asterias rubens*	20	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	720036	5949903	03/05/19 13:38:12									
Grab_P_6	719725	5948952	03/05/19 13:04:18	Grab_P_6_004.jpg	Fine to medium sand with irregular ripples	*Lanice conchilega*, Pleuronectiform	22	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	719729	5948948	03/05/19 13:08:36									
Grab_P_7	719412	5948000	03/05/19 11:18:23	Grab_P_7_005.jpg	Fine to medium sand with irregular ripples	*Lanice conchilega, Callionymus lyra*, Ophiuroid	21	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	719411	5948003	03/05/19 11:22:22									
Grab_P_8	719099	5947048	03/05/19 12:05:32	Grab_P_8_005.jpg	Coarse sand and shell debris with irregular ripples	*Lanice conchilega*	21	n/a	n/a	n/a	n/a	Infralittoral coarse Sediment (A5.13)
	719094	5947051	03/05/19 12:07:34									
Grab_P_9	718861	5945913	11/05/19 22:31:48	Grab_P_9_002.jpg	Coarse sand and shell debris with irregular ripples	*Asterias rubens, Lanice conchilega, Corystes cassivelaunus*, Actinopterygii	19	n/a	n/a	n/a	n/a	Infralittoral coarse Sediment (A5.13)
	718862	5945911	11/05/19 22:33:08									
Grab_P_10	718778	5944917	11/05/19 23:01:57	Grab_P_10_003.jpg	Fine to medium sand	*Asterias rubens, Lanice conchilega*	17	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	718778	5944917	11/05/19 23:04:14									
Grab_P_11	718697	5943920	11/05/19 23:30:17	Grab_P_11_009.jpg	Fine to medium sand and shell debris with irregular ripples	Brachyura, *Lanice conchilega*	17	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	718697	5943920	11/05/19 23:32:11									
Grab_P_12	718614	5942925	11/05/19 23:58:12	Grab_P_12_002.jpg	Fine to medium sand and shell debris with irregular ripples	*Asterias rubens, Lanice conchilega, Callionymus lyra*, Gobiidae, *Actiniaria*, Brachyura, *Cancer pagurus, Liocarcinus sp.*	16	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	718615	5942922	12/05/19 00:00:03									

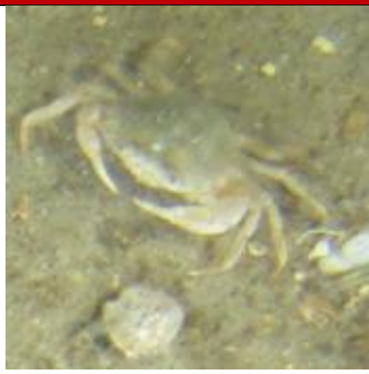
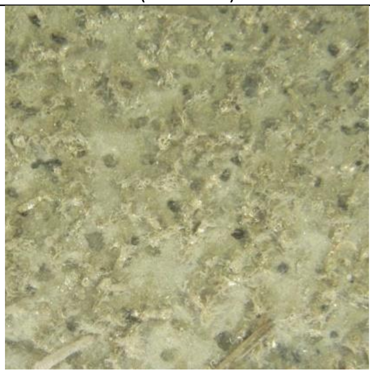
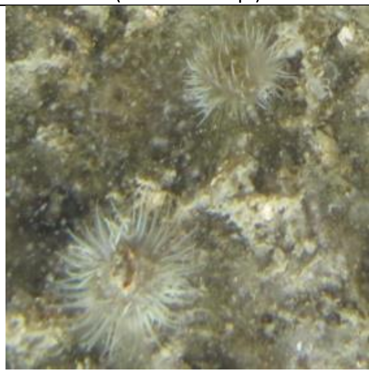
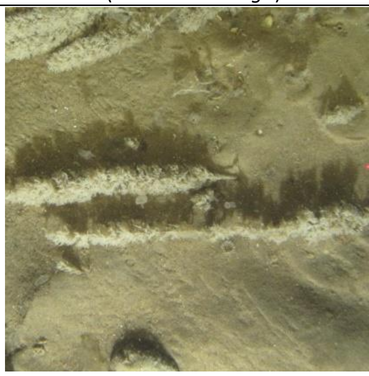
ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
Grab_P_13	718531	5941926	12/05/19 00:30:02	Grab_P_13_005.jpg	Fine to medium sand with irregular ripples	*Asterias rubens*, Ophiuroids, *Lanice conchilega*	16	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	718533	5941928	12/05/19 00:31:30									
Grab_P_14			No visibility									
Grab_P_15	718366	5939934	12/05/19 01:53:30	Grab_P_15_005.jpg	Fine to medium sand with irregular ripples	*Lanice conchilega*, Actinopterygii	13	n/a	n/a	n/a	n/a	Infralittoral fine sand (A5.23)
	718366	5939933	12/05/19 01:55:09									
N5a_1	721585	5954589	11/05/19 01:38:04	N5a_1_014.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed	*Lanice conchilega*, *Ensis* 'burrows', *Leptothecata*, *Actiniaria*, *Cancer pagurus*, *Callionymus lyra*, Paguridae, Actinopterygii, Sepiida, Pleuronectiform, Brachyura, *Sepiola* spp., *Cancer pagurus*, *Metridium senile*, *Ensis* sp., *Liocarcinus sp.*, Ceriantharidae	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721626	5954710	11/05/19 01:46:42									
N5a_2	721669	5954631	11/05/19 01:16:25	N5a_2_002.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed	*Asterias rubens*, *Lanice conchilega*, *Cancer pagurus*, Actiniaria, Paguridae, *Ensis sp.*, *Cancer pagurus*, *Pagurus bernhardus*, Brachyura, *Callionymus lyra*, *Metridium senile*,	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721555	5954667	11/05/19 01:24:59									
	721554	5954667	11/05/19 01:25:00	N5a_2_038.jpg				n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-

ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
	721552	5954668	11/05/19 01:25:15		Large boulder surrounded by Ensis shells	*Liocarcinus sp.*, Ceriantinidae						swept infralittoral sand and mixed gravelly sand (A5.137)
	721551	5954668	11/05/19 01:25:16	N5a_2_039.jpg	Coarse sand ripples			n/a	n/a	n/a	n/a	Infralittoral coarse Sediment (A5.13)
	721544	5954669	11/05/19 01:25:39									
North Transect 1	721487	5954681	11/05/19 00:49:09	N_T_1_002.jpg	Slightly gravelly/shelly coarse sand forming irregular ripples. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed	*Asterias rubens*, *Lanice conchilega*, *Cancer pagurus*, *Pagurus bernhardus*, Actiniaria, Paguridae, *Ensis* sp., Brachyura, Actinopterygii, *Cancer pagurus*, Pleuronectiform, *Limanda limanda*, *Liocarcinus* sp., Ceriantinidae	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721425	5954656	11/05/19 00:55:02									
	721425	5954656	11/05/19 00:55:03	N_T_1_021.jpg	Dense aggregations of *Lanice conchilega*, *Asterias rubens* and *Ensis* shells on gravelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed.			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721392	5954643	11/05/19 00:57:24									
	721391	5954643	11/05/19 00:57:25	N_T_1_028.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721363	5954633	11/05/19 00:59:20									

ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
North Transect 2	721609	5954992	11/05/19 00:06:16	N_T_2_003.jpg	Slightly gravelly/shelly coarse sand forming irregular ripples. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed	*Asterias rubens, Lanice conchilega, Cancer pagurus, Pagurus bernhardus, Cancer pagurus, Pleuronectiform, Callionymus lyra, Bachyura, Actiniaria, Sepiidae, Liocarcinus sp., Ceriantхidae*	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721618	5955031	11/05/19 00:10:55									
	721617	5955032	11/05/19 00:10:56	N_T_2_014.jpg	Gravelly/shelly coarse sand forming irregular ripples. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721625	5955086	11/05/19 00:14:33									
	721625	5955086	11/05/19 00:14:34	N_T_2_038.jpg	Dense aggregations of *Lanice conchilega*, *Asterias rubens* and *Ensis* shells on gravelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed.			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721631	5955141	11/05/19 00:18:28									
	721631	5955142	11/05/19 00:18:29	N_T_2_041.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721632	5955153	11/05/19 00:19:05									

ED50, UTM 31N, CM 3° E												
Station	Easting (m)	Northing (m)	Date & Time	Example Photograph (file name)	Sediment type	Conspicuous fauna	Depth (m)	Stony Reefiness (After Irving 2009)			Overall Reef Structure	EUNIS Habitat Classification with SBF/Habitat Map Colour Code
								Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders in cm)	Reef Structure Matrix		
North Transect 3	721902	5954408	11/05/19 02:04:47	N_T_3_010.jpg	Dense aggregations of *Lanice conchilega*, *Asterias rubens* and *Ensis* shells on gravelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed.	*Asterias rubens, Lanice conchilega, Cancer pagurus, Pagurus bernhardus, Cancer pagurus, Pleuronectiform, Actiniaria, Gobiidae, Paguridea, Ensis sp., Limanda, Metridium senile, Liocarcinus sp., Eutrigla gurnardus, Ceriantidae*	29	n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721888	5954432	11/05/19 02:07:32									
	721887	5954432	11/05/19 02:07:33	N_T_3_018.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721865	5954461	11/05/19 02:09:55									
	721865	5954461	11/05/19 02:09:56	N_T_3_039.jpg	Dense aggregations of *Lanice conchilega*, *Asterias rubens* and *Ensis* shells on gravelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed.			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721824	5954518	11/05/19 02:14:38									
	721823	5954519	11/05/19 02:14:39	N_T_3_050.jpg	Slightly gravelly/shelly coarse sand. 'Burrows' formed by *Ensis* retracting below surface when the camera sled comes into contact with the seabed. Infrequent boulders.			n/a	n/a	n/a	n/a	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand (A5.137)
	721801	5954551	11/05/19 02:17:16									

APPENDIX F – CONSPICUOUS SPECIES EXAMPLES FROM SEABED PHOTOGRAPHY

Examples of Conspicuous Fauna		
 Common Starfish (*Asterias rubens*)	 Atlantic Jackknife Clam (*Ensis leei*)	 Swimming Crab (*Liocarcinus* sp.)
 The Edible Crab (*Cancer pagurus*)	 Sand mason worm (*Lanice conchilega*)	 Burrowing anemones (Cerianthidae)
 Hermit Crab (Paguridae)	 Hydroids (*Sertularia*)	 Barnacles on an Edible Crab (Cirripedia and *Cancer pagurus*)
 Sand Eel (*Ammodytes sp.*)	 Burrowing Brittlestar (Ophiuroid)	 Common Dragonet (*Callionymus lyra*)

APPENDIX G – REGIONAL STANDARDS AND BACKGROUND INFORMATION

UK BIODIVERSITY ACTION PLAN

In 1994, the UK published its Biodiversity Action Plan (UKBAP) for the protection and sustainable use of biodiversity. This plan combined new and existing conservation initiatives on objectives for conserving and enhancing species and habitats as well as promoting public awareness and contributing to international conservation efforts. Following the initial strategy publication, 391 Species Action Plans (SAPs) and 45 Habitat Action Plans (HAPs) were later published for the UK's most threatened (i.e. "priority") species and habitats. These plans describe the status of each habitat and species, outlines the threats they face, set targets and objectives for their management, and propose actions necessary to achieve recovery.

Key UKBAP Habitats that may occur in an open water marine environment are as follows:

- Deep-sea Sponge Communities
- Fragile Sponge and Anthozoan Communities on Subtidal Rocky Habitats
- Blue and Horse Mussel Beds
- Mud Habitats in Deep Water
- *Sabellaria spinulosa* Reefs

The UKBAP habitat most likely to occur in the wider region around the current survey area is deep sea sponge communities. Although sponge communities are usually found in water depths greater than 250 m there have been significant sponge aggregations recorded in depths below 30 m (UKBAP, 2008).

OSPAR COMMISSION

At its Biodiversity Committee (BDC) meeting in 2003, OSPAR agreed to proceed with a programme to collate existing data on the distribution of fourteen key habitats, as part of a wider programme to develop measures for their protection and conservation. The UK agreed to compile the relevant data for its own marine waters and submit these for collation into composite maps on the distribution of each habitat type across the whole OSPAR area. The work is being coordinated by the Joint Nature Conservation Committee (JNCC).

EUROPEAN HABITATS DIRECTIVE

The United Kingdom is a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). To meet their obligations under the convention, the European Community Habitats Directive was adopted in 1992. The provisions of the Directive require Member States to introduce a range of measures including the protection of species listed in the Annexes; to undertake surveillance of habitats and species and produce a report every six years on the implementation of the Directive. The 189 habitats listed in Annex I of the Directive and the 788 species listed in Annex II, are to be protected by means of a network of sites.

Each Member State is required to prepare and propose a national list of sites, which will be evaluated in order to form a European network of Sites of Community Importance (SCIs). These will eventually be designated by Member States as Special Areas of Conservation (SACs), and along with Special Protection Areas (SPAs) classified under the EC Birds Directive, form a network of protected areas known as Natura 2000. The Directive was amended in 1997 by a technical adaptation Directive and latterly by the Environment Chapter of the Treaty of Accession 2003.

The implementation of the Habitats Directive (EHD; 92/43/EEC) in offshore waters commenced in 2000 and highlighted a number of potential habitats for which SACs may be selected in UK offshore waters. The Annex I habitats which are particularly prevalent in this region of UK waters are submarine structures formed by leaking gases.

The Habitats Directive introduces a precautionary principle for protected areas whereby projects can only be permitted where no adverse effect on the integrity of the site can be shown.

The Emerald Network was developed in 1989 within the framework of the Bern Convention (1979), and is an ecological network which comprises areas of special conservation interest (ASCIs; Council of Europe, 2015). The objective of this network is to achieve ensure survival of the species and habitats which require site-specific protection. The EUNIS habitat of "sublittoral sediment" has been designated a resolution 4 habitat type which is used for the designation of Emerald sites throughout Europe where relevant to sensitive habitats or species.

IUCN RED LIST SPECIES

The IUCN Red List classifies species into categories based on their assessed risk of extinction for a particular region. This would assign species to any of the following categories classified as a Red List species; extinct (EX), extinct in the wild (EW), regionally extinct (RE), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT) or data deficient (DD). Species categorised as CR, EN or VU are additionally described as threatened (IUCN, 2014; Keith *et al.,* 2013).

APPENDIX H – SAMPLE AND SEABED PHOTOGRAPHS

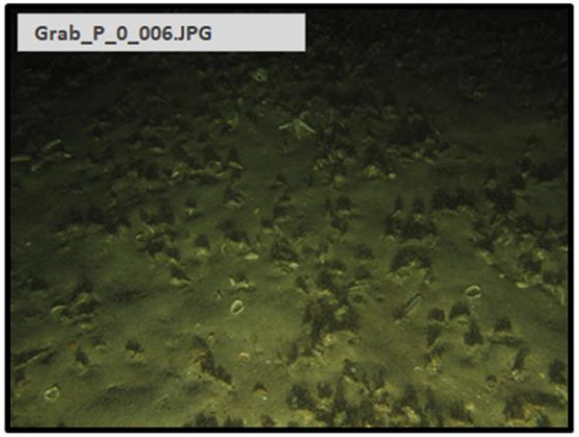


Photo Position: 721647 mE, 5954429 mN

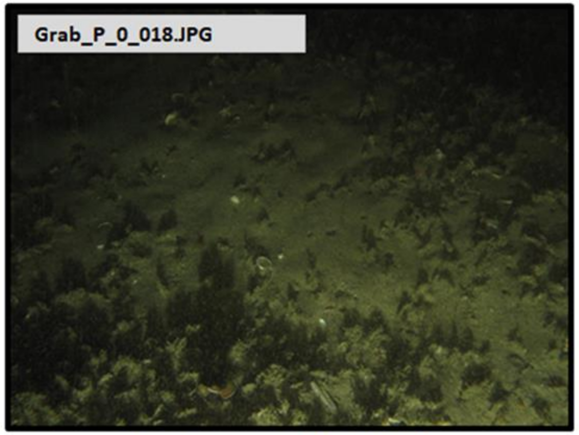


Photo Position: 721620 mE, 5954456 mN

Habitat Summary Information: Grab_P_0

Survey Area: N5a Pipeline

No. of Stills: 27 **Mins of Video: 7** **Track Length: 70m**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals. Investigating area of mixed reflectivity sediment.

Analogue Interpretation

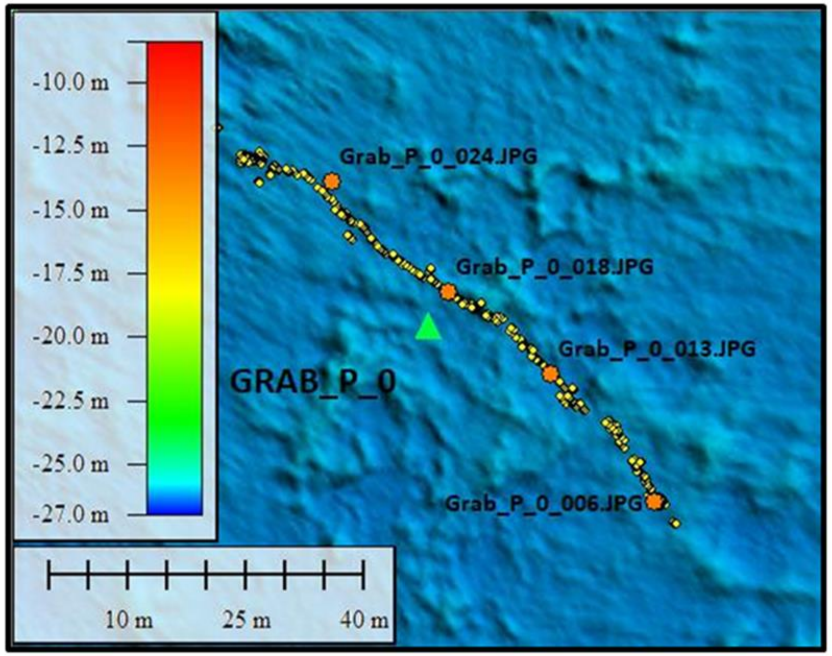
Variable mixed reflectivity with many raised areas.

Sediment Description

Coarse sand littered with shell fragments and lanice conchilega assemblages.

Conspicuous Fauna

Cnidaria: Actiniaria sp., *Cerianthus* sp., Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** Paguridae sp., Decapoda sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Gobiidae sp.



onedyas benthic solutions limited GEOXYZ OFFSHORE

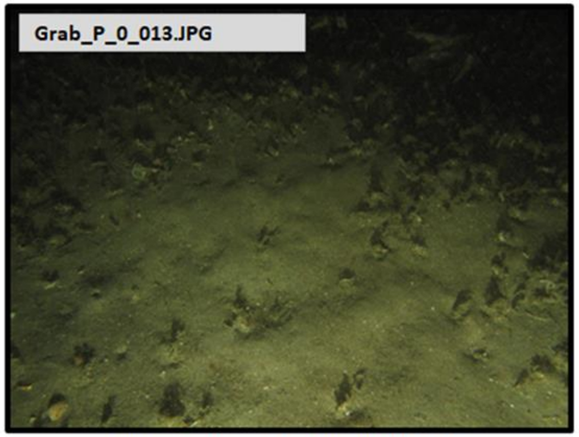


Photo Position: 721634 mE, 5954446 mN

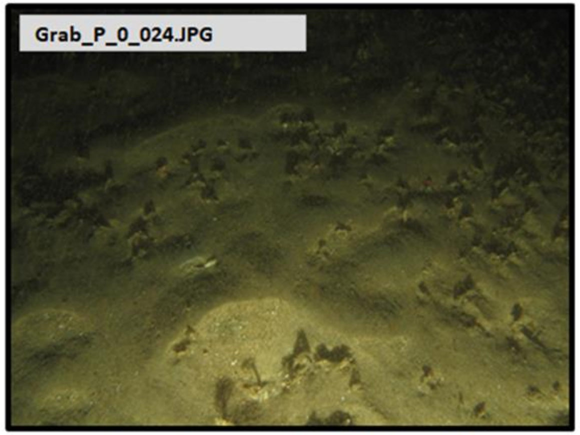


Photo Position: 721606 mE, 5954470 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

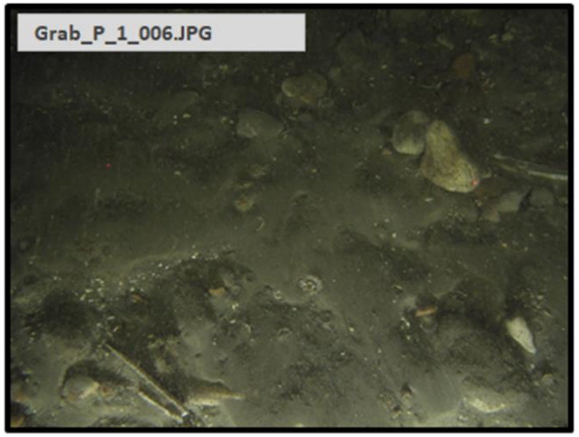


Photo Position: 721325 mE, 5953794 mN

Habitat Summary Information: Grab_P_01

Survey Area: N5a Pipeline

No. of Stills: 1 | **Mins of Video: 2** | **Track Length: DDV**

Site Selection Criteria

Moved from KP in order to investigate area of high reflectivity sediment.

Analogue Interpretation

Area of mixed high reflectivity.

Sediment Description

Coarse sand with cobbles.

Conspicuous Fauna

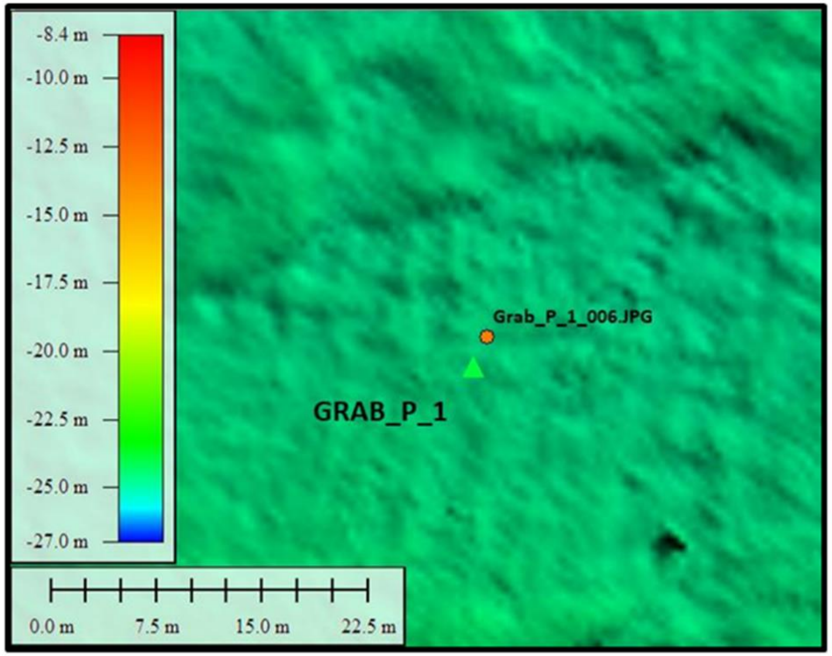
Cnidaria: *Cerianthus* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Bryozoa:** Bryozoa sp.

Only one image taken

Photo Position: 0 mE, 0 mN

Only one image taken

Photo Position: 0 mE, 0 mN



Only one image taken

Photo Position: 0 mE, 0 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_02

Survey Area: N5a Pipeline

No. of Stills: 5 | Mins of Video: 2 | Track Length: DDV

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse shelly sand with sand ribble bedform.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab).

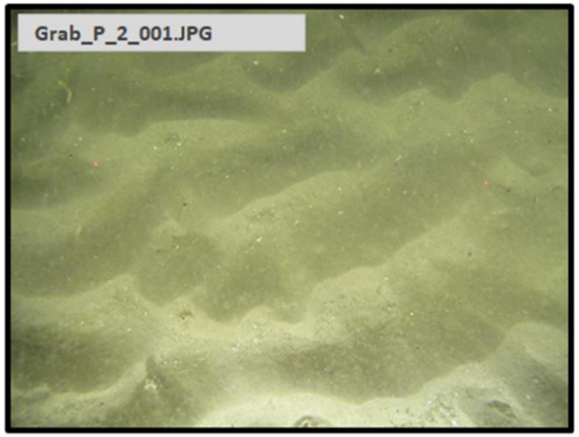


Photo Position: 720980 mE, 5952753 mN

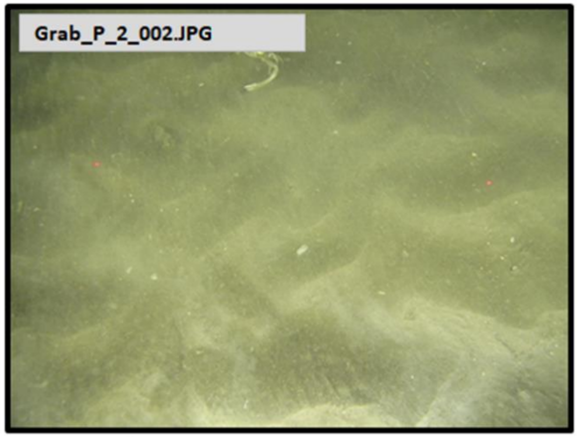


Photo Position: 720979 mE, 5952754 mN

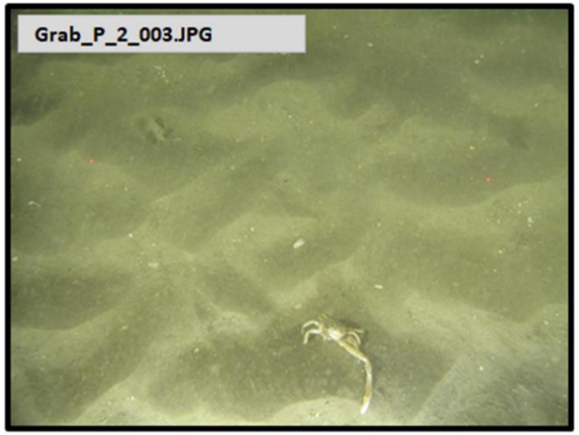


Photo Position: 720977 mE, 5952755 mN

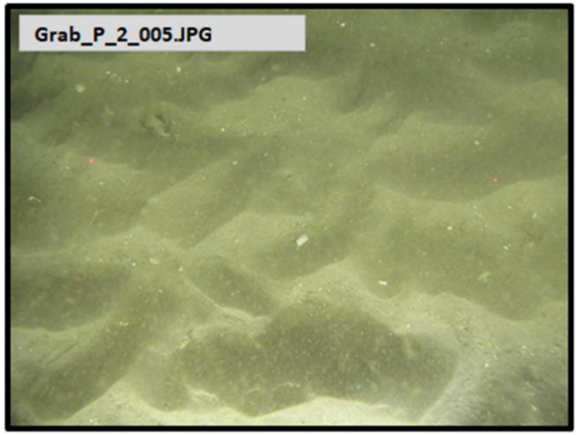
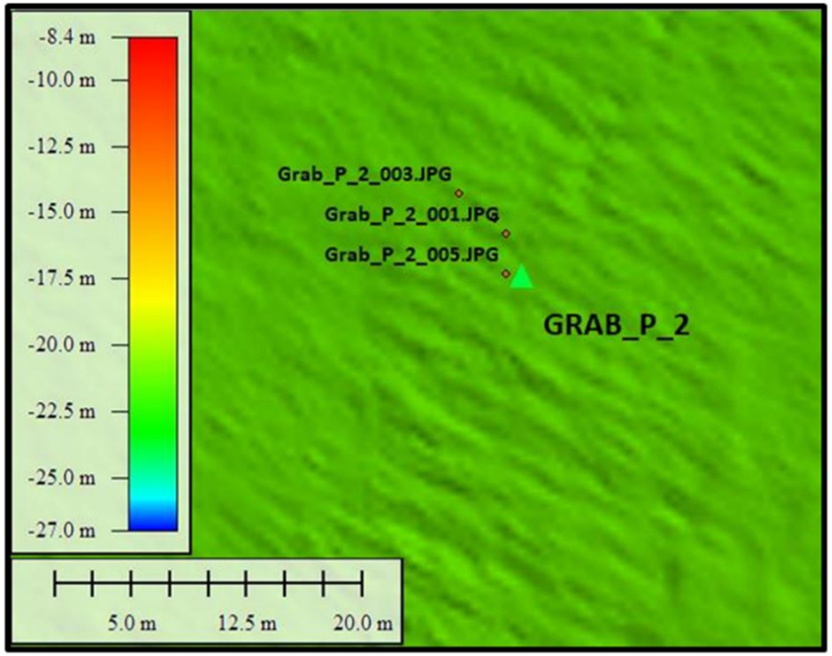
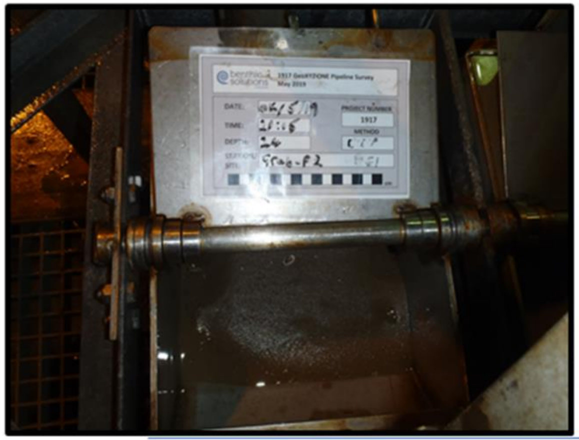


Photo Position: 720980 mE, 5952750 mN





Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

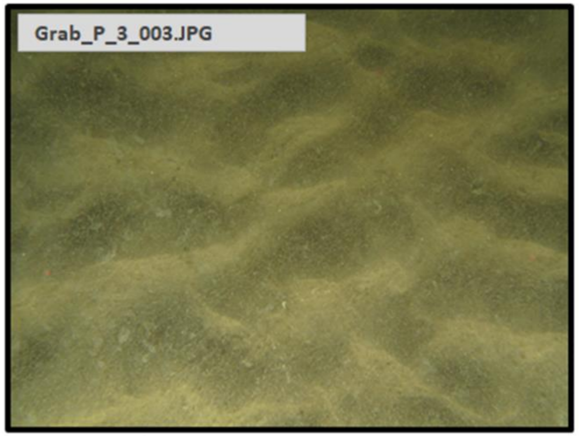


Photo Position: 720668 mE, 5951799 mN

Habitat Summary Information: Grab_P_03

Survey Area: N5a Pipeline

No. of Stills: 10 | Mins of Video: 3 | Track Length: DDV

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand forming ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab). **Echinodermata:** *Asterias rubens* (Common starfish).

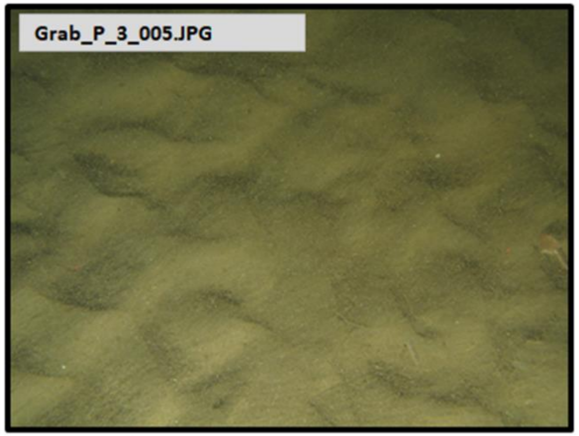


Photo Position: 720664 mE, 5951796 mN

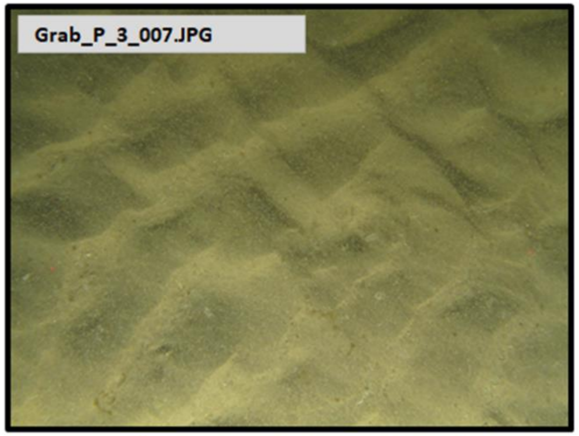
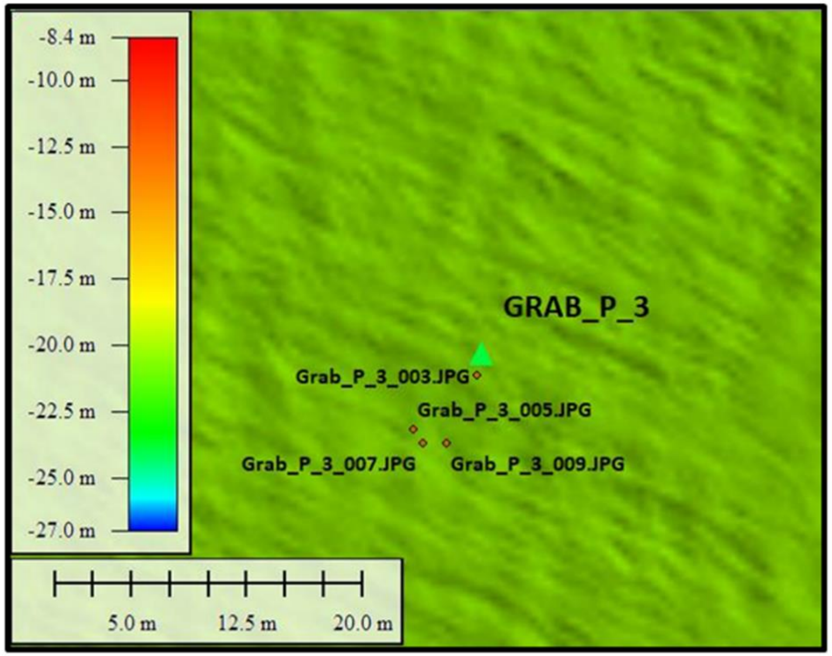


Photo Position: 720664 mE, 5951795 mN



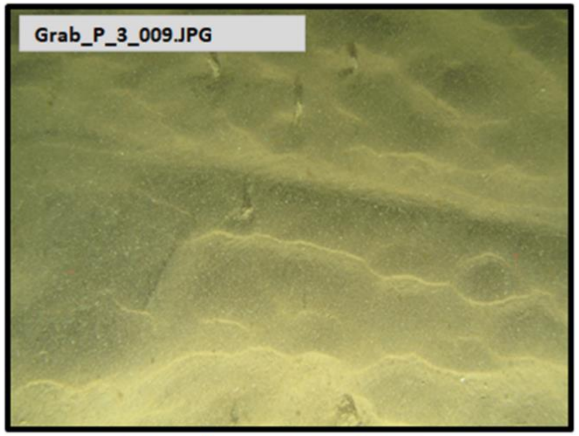


Photo Position: 720666 mE, 5951795 mN

Sediment Example Image

Grab Location | Camera Track | Selected Underwater Still

Sieved Sample Image

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_04

Survey Area: N5a Pipeline

No. of Stills: 10 | Mins of Video: 3 | Track Length: DDV

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of variable reflectivity indicating rippling.

Sediment Description

Coarse sand formed into sand ripples.

Conspicuous Fauna

Echinodermata: *Asterias rubens* (Common starfish), Ophiurida sp.

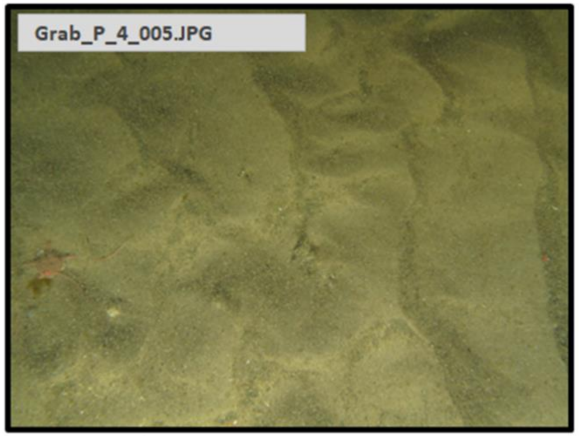


Photo Position: 720356 mE, 5950850 mN

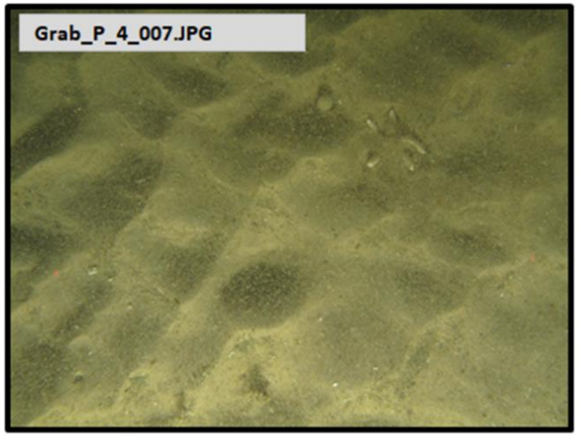


Photo Position: 720355 mE, 5950850 mN

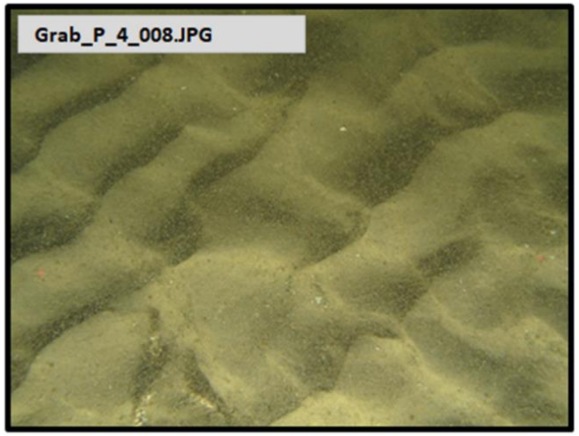


Photo Position: 720355 mE, 5950853 mN

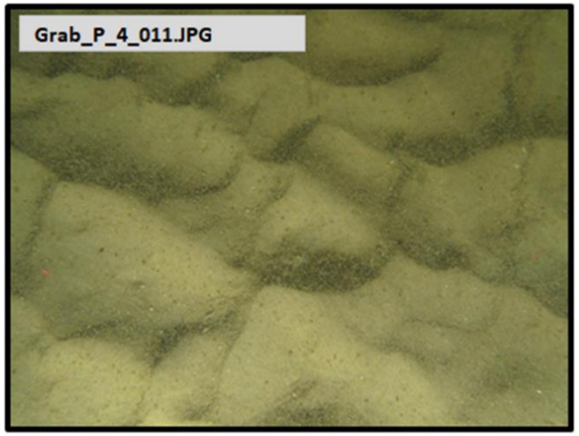
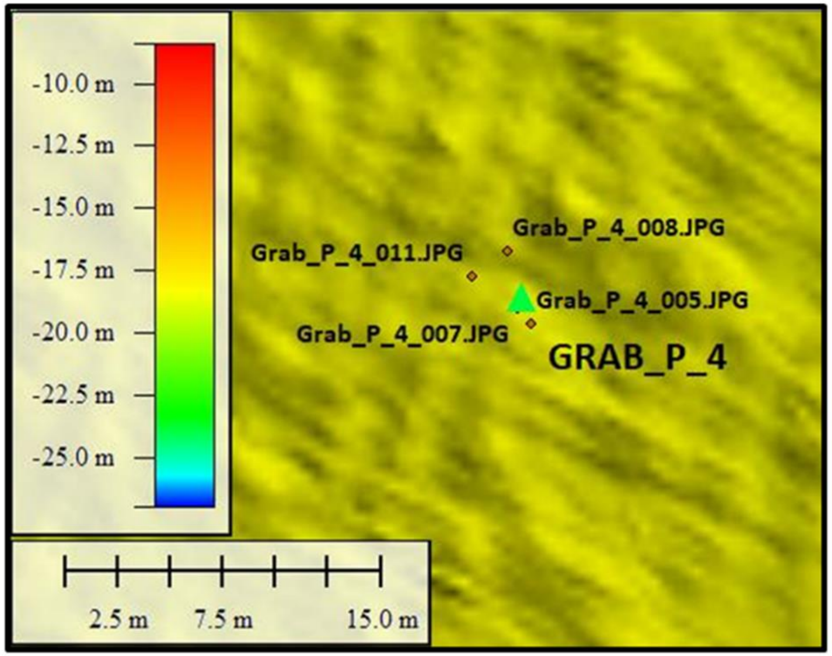


Photo Position: 720353 mE, 5950852 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_P_05

Survey Area: N5a Pipeline

No. of Stills: 16 | **Mins of Video: 2** | **Track Length: DDV**

Grab_P_5_004.JPG

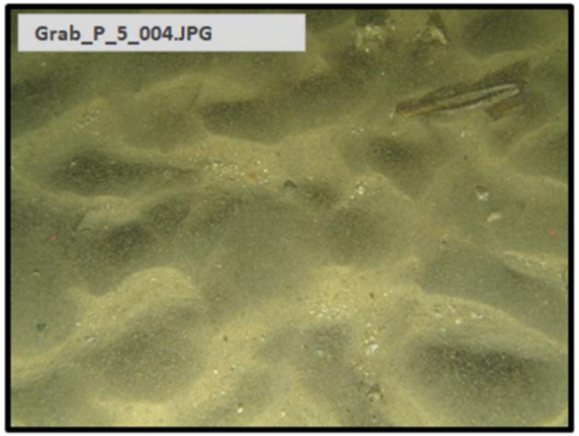


Photo Position: 720039 mE, 5949902 mN

Grab_P_5_007.JPG

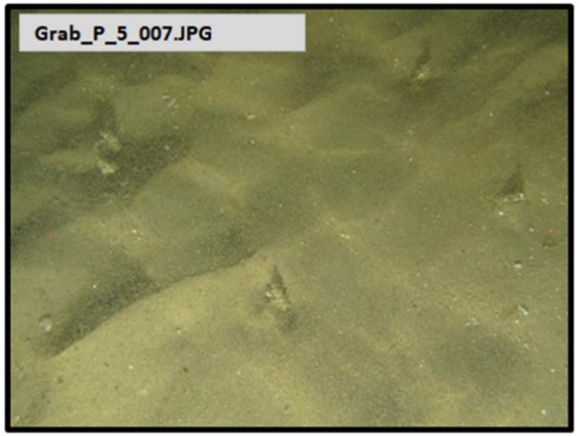


Photo Position: 720044 mE, 5949893 mN

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of low, variable reflectivity.

Sediment Description

Coarse shelly sand with rare cobbles.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Paguridae sp. **Echinodermata:** *Asterias rubens* (Common starfish).

Grab_P_5_010.JPG

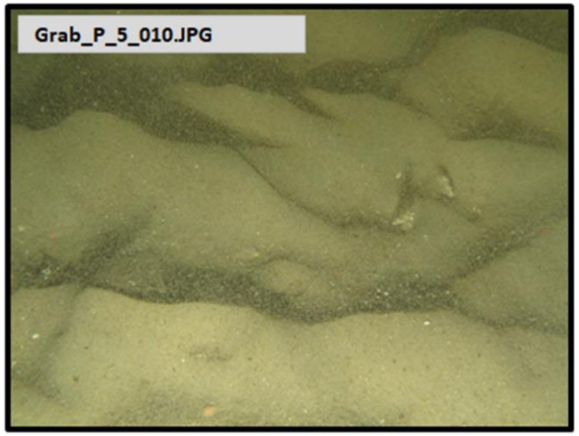
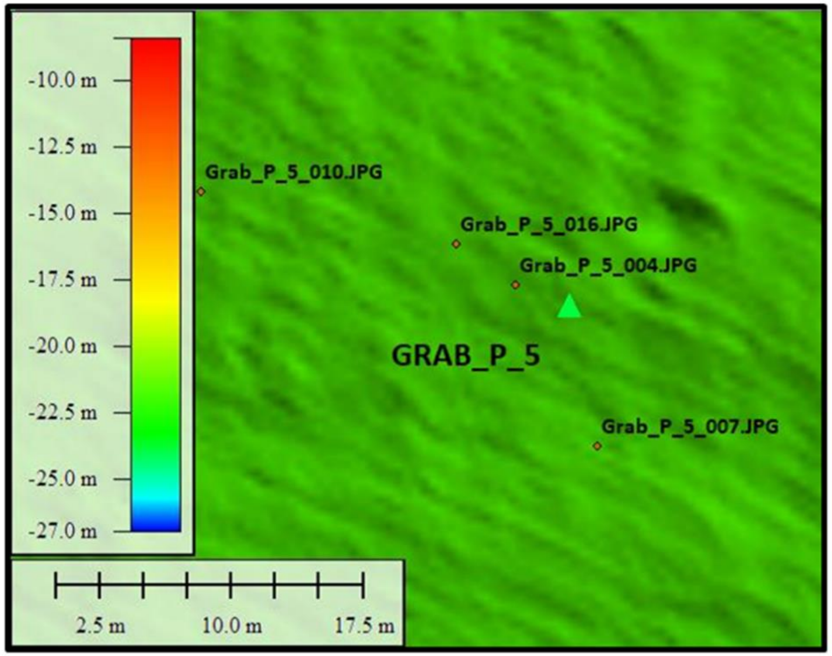


Photo Position: 720021 mE, 5949907 mN



Grab_P_5_016.JPG

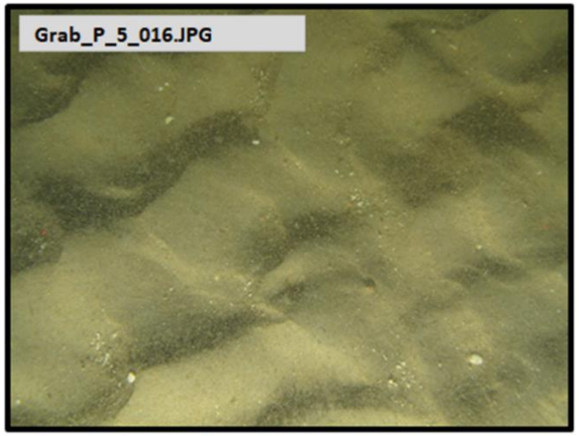


Photo Position: 720036 mE, 5949904 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_06

Survey Area: N5a Pipeline

No. of Stills: 12 | Mins of Video: 4 | Track Length: DDV

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of slightly variable reflectivity.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Chordata:** Pleuronectiformes sp.

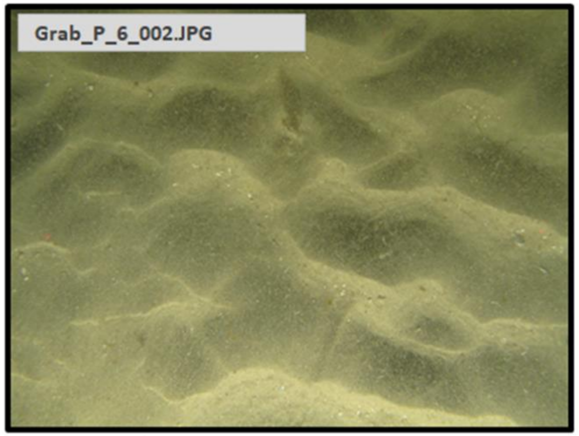


Photo Position: 719727 mE, 5948952 mN

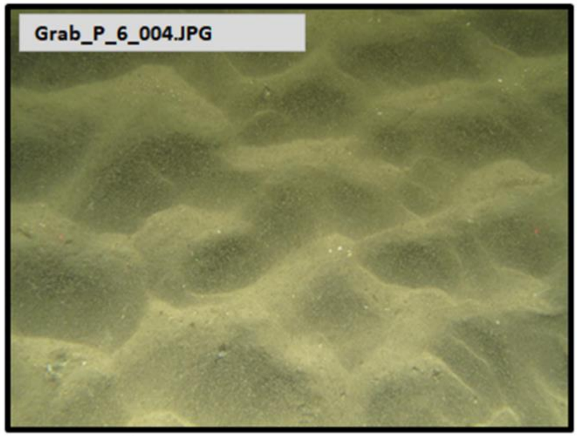


Photo Position: 719728 mE, 5948952 mN

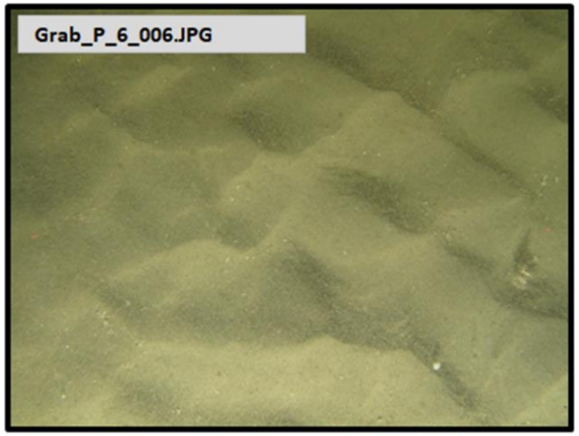


Photo Position: 719688 mE, 5948930 mN

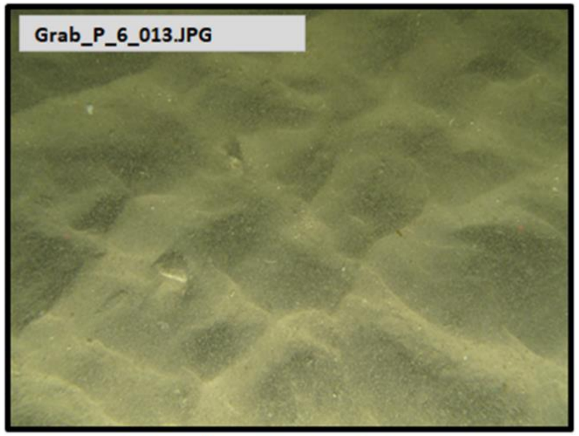
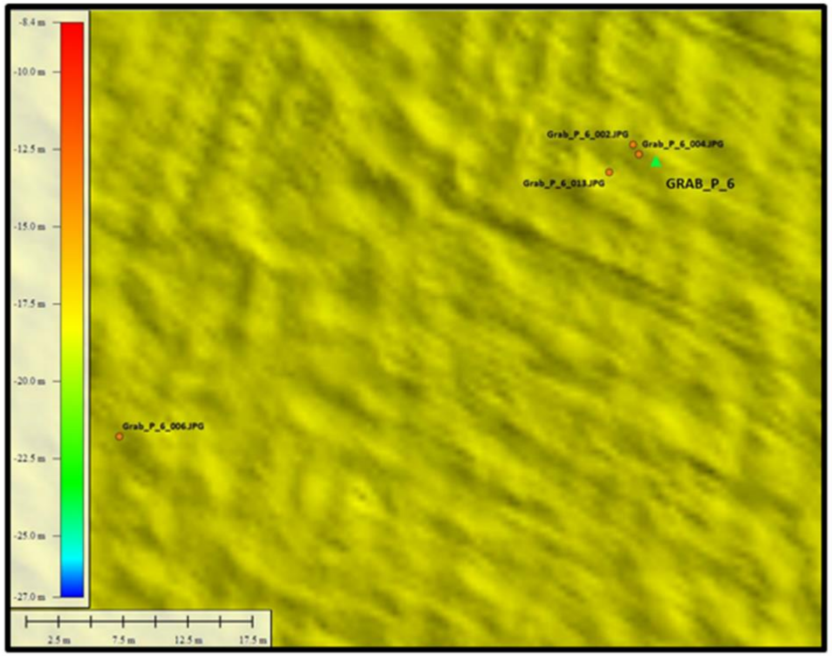


Photo Position: 719726 mE, 5948950 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_07

Survey Area: N5a Pipeline

No. of Stills: 7   Mins of Video: 4   Track Length: DDV

Site Selection Criteria

Moved from KP to investigate mixed reflectivity sediment.

Analogue Interpretation

Area of variable reflectivity with scars in seabed.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** Ophiurida sp. **Chordata:** *Callionymus lyra* (Common dragonet).

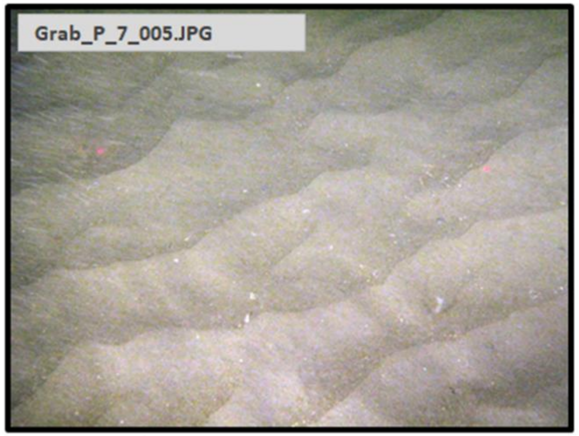


Photo Position: 719408 mE, 5948019 mN

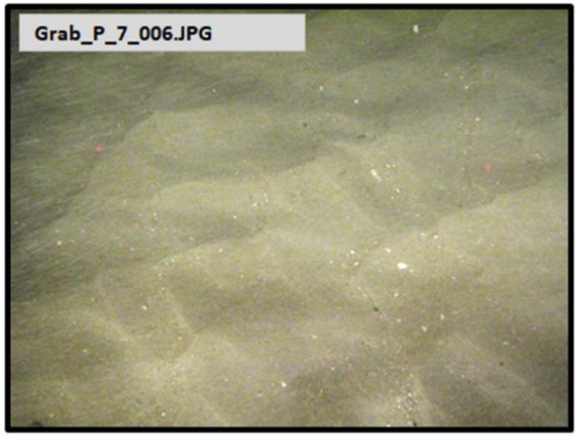


Photo Position: 719411 mE, 5948002 mN

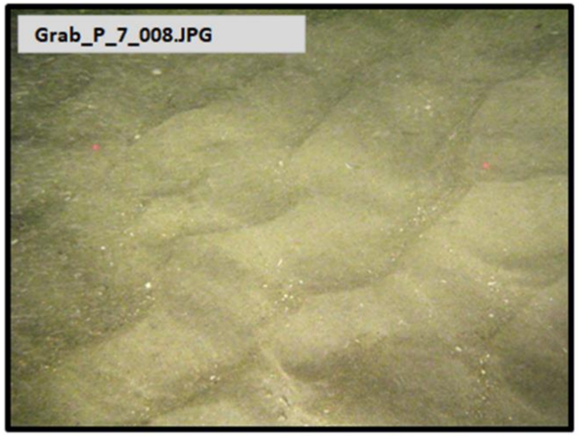
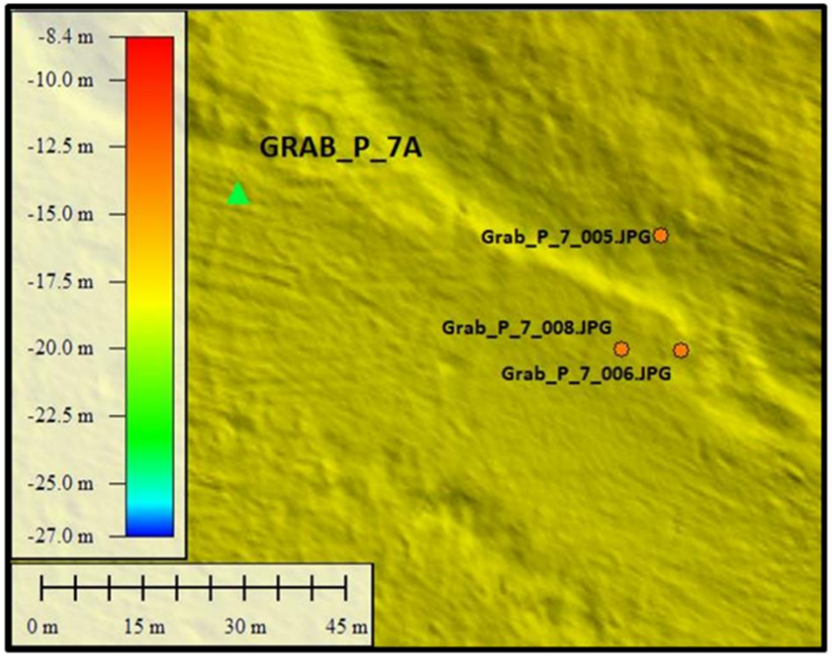
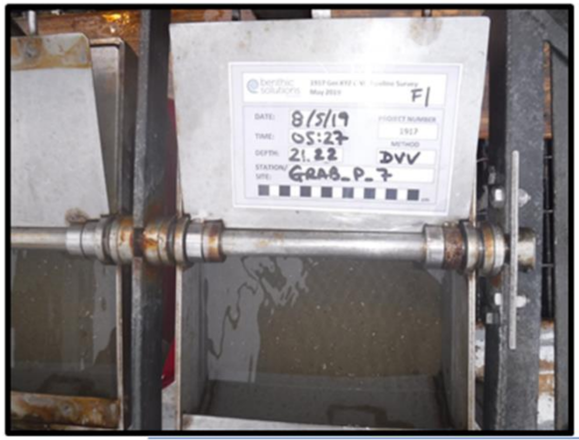


Photo Position: 719403 mE, 5948002 mN



Only 3 good quality seabed images



Sediment Example Image

Sieved Sample Image

Grab Location   Camera Track   Selected Underwater Still

Geodetic Infomation: Datum: ED50   Projection: UTM   Zone: 31 North   Central Meridian: 3° East

Habitat Summary Information: Grab_P_08

Survey Area: N5a Pipeline

No. of Stills: 6 **Mins of Video: 2** **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand and rare shell debris with irregular ripples

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason).

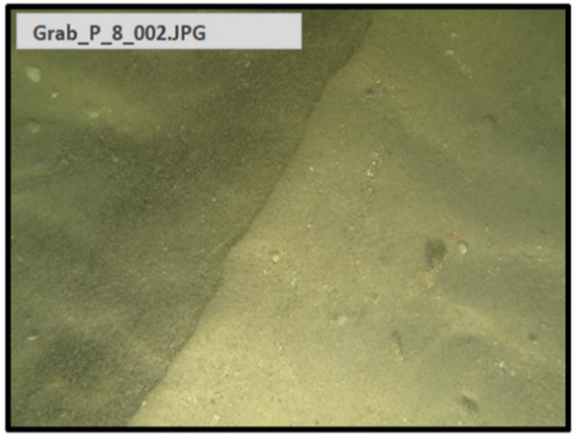


Photo Position: 719097 mE, 5947051 mN

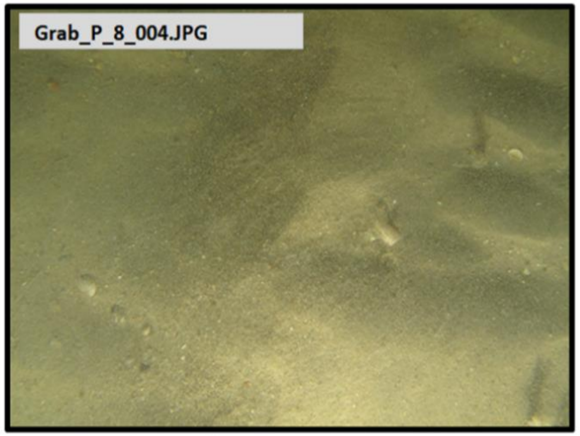


Photo Position: 719076 mE, 5947050 mN

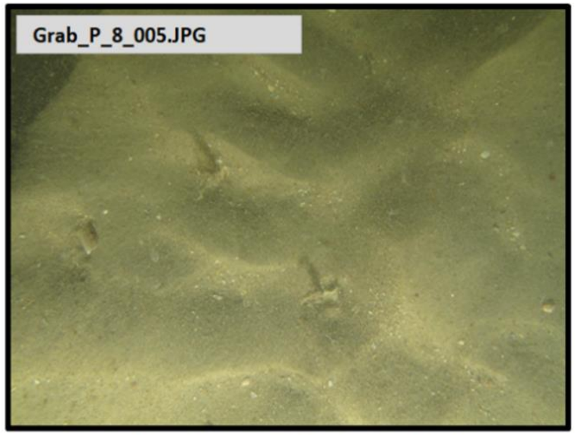


Photo Position: 719125 mE, 5947049 mN

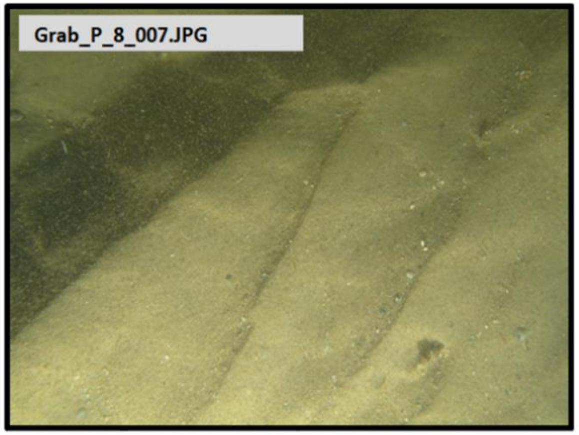
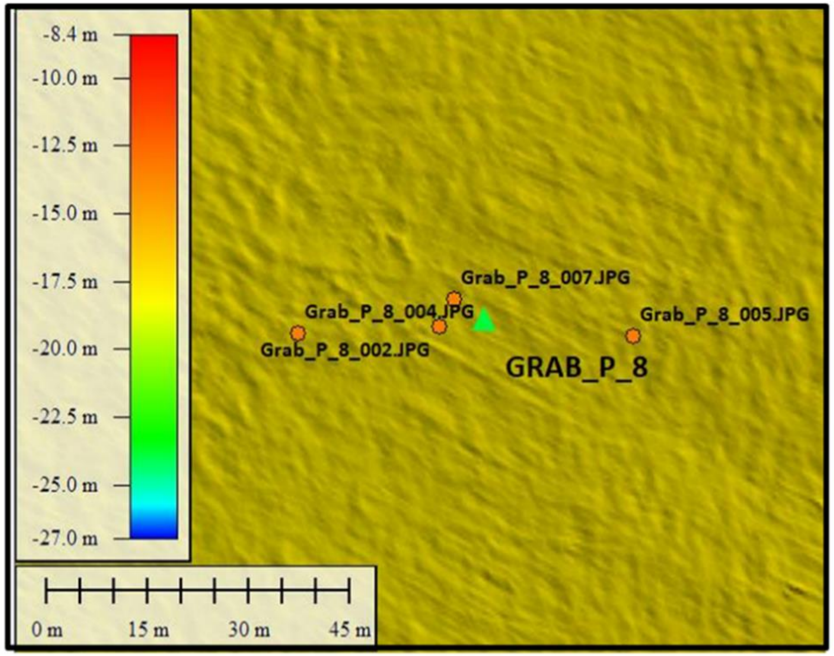


Photo Position: 719099 mE, 5947055 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

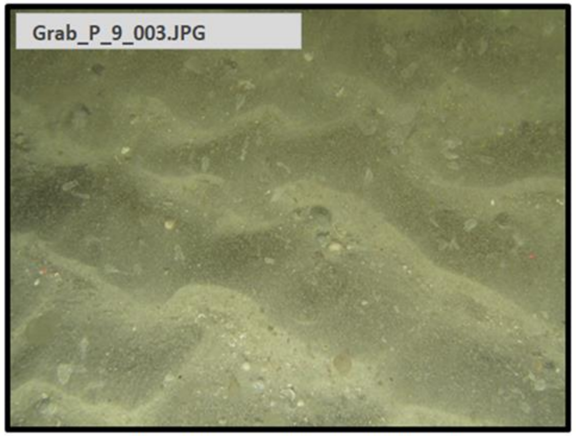


Photo Position: 718861 mE, 5945912 mN

Habitat Summary Information: Grab_P_09

Survey Area: N5a Pipeline

No. of Stills: 6 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Variable reflectivity with scars in seabed.

Sediment Description

Coarse sand and rare shell debris with irregular ripples

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Corystes cassivelaunus* (Masked crab). **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Actinopterygii sp.

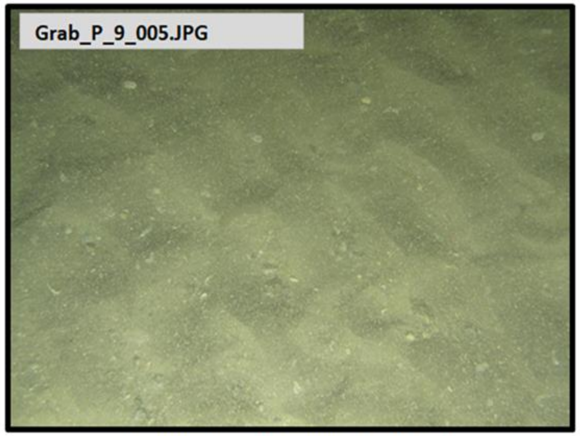


Photo Position: 718862 mE, 5945911 mN

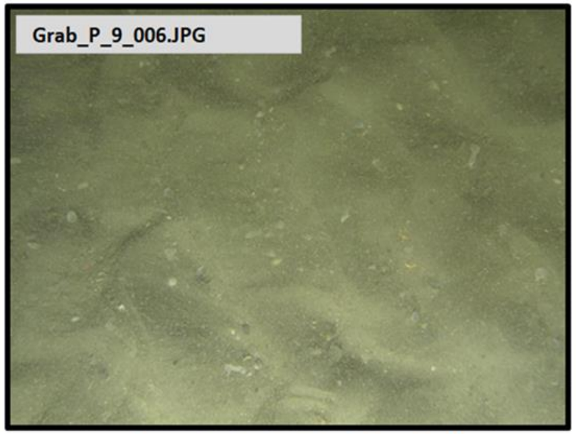
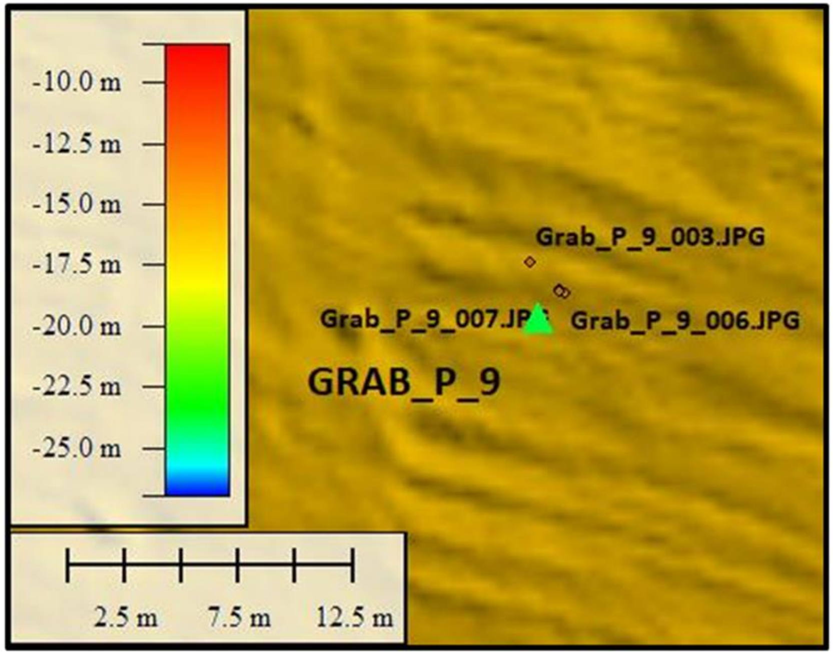


Photo Position: 718863 mE, 5945911 mN



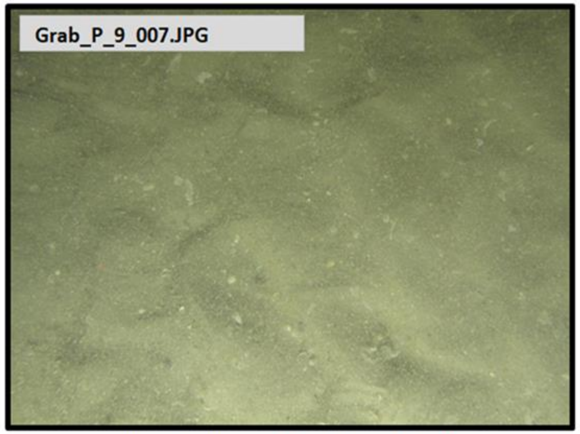


Photo Position: 718862 mE, 5945911 mN

Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_P_010

Survey Area: N5a Pipeline

No. of Stills: 8 | **Mins of Video: 2** | **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Area of variable reflectivity.

Sediment Description
Coarse sand.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

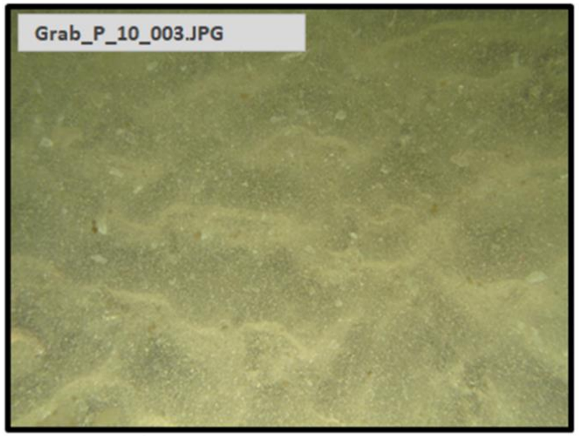


Photo Position: 718778 mE, 5944917 mN

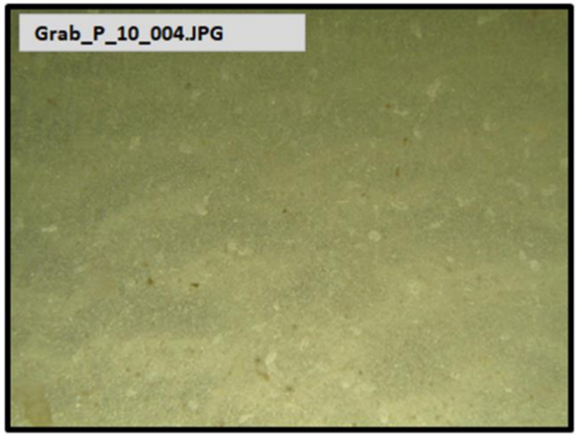


Photo Position: 718778 mE, 5944917 mN

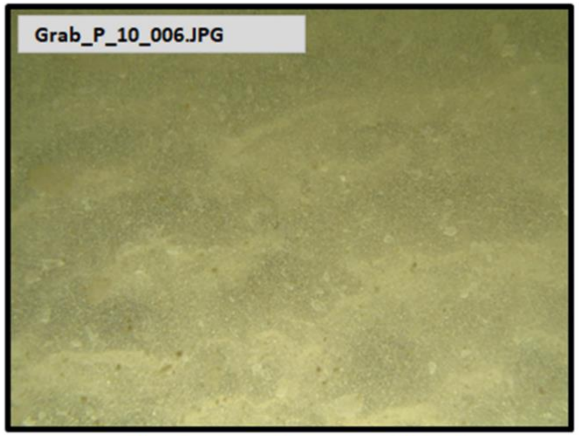


Photo Position: 718778 mE, 5944917 mN

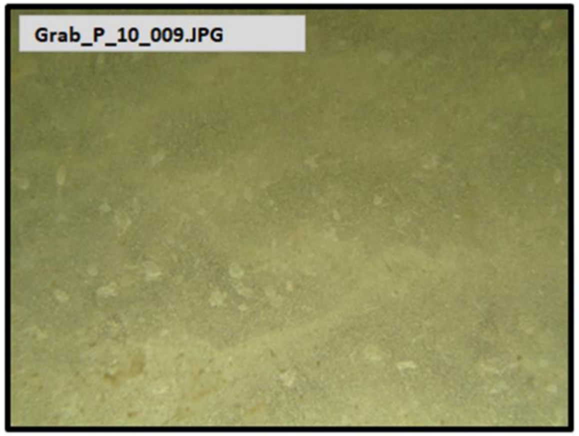
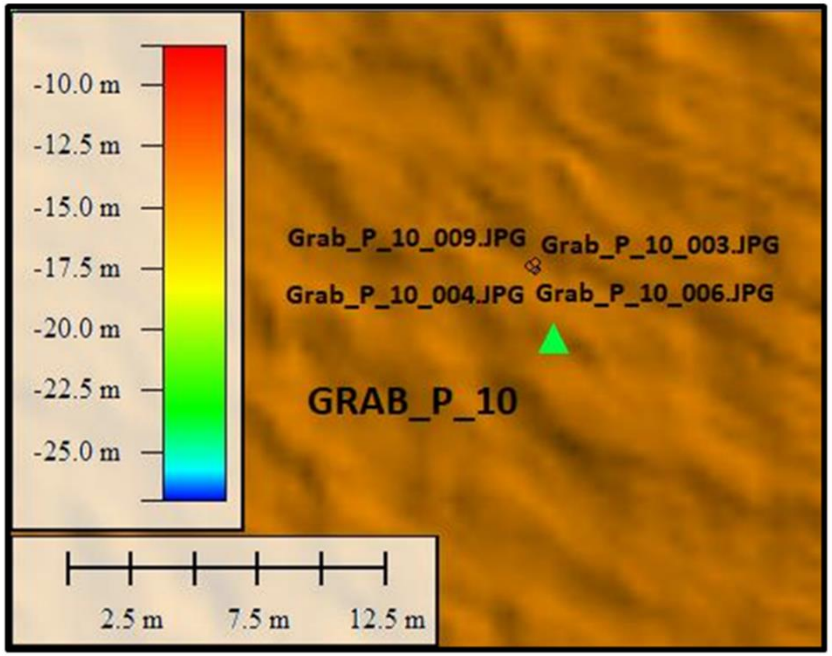


Photo Position: 718778 mE, 5944917 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_011

Survey Area: N5a Pipeline

No. of Stills: 8 | Mins of Video: 2 | Track Length: DDVm

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Brachyura sp.

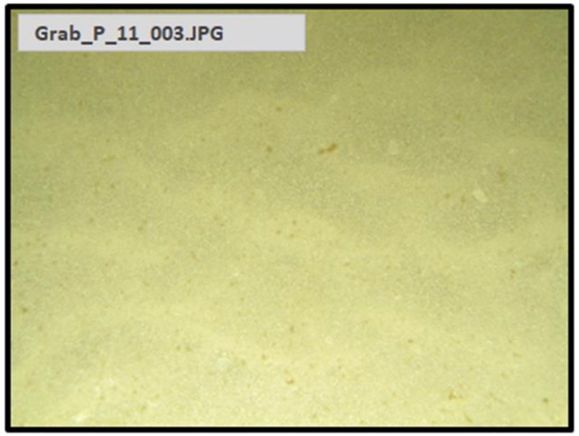


Photo Position: 718696 mE, 5943920 mN

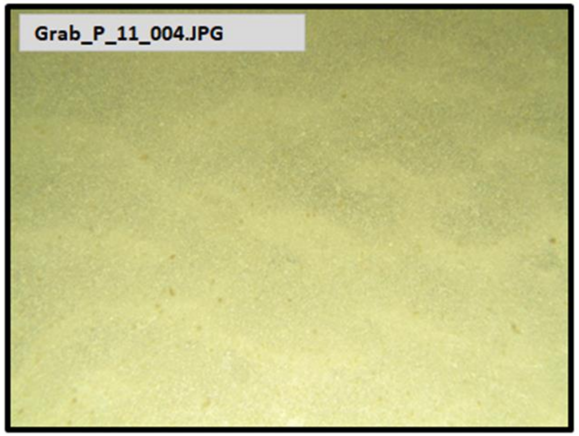


Photo Position: 718696 mE, 5943920 mN

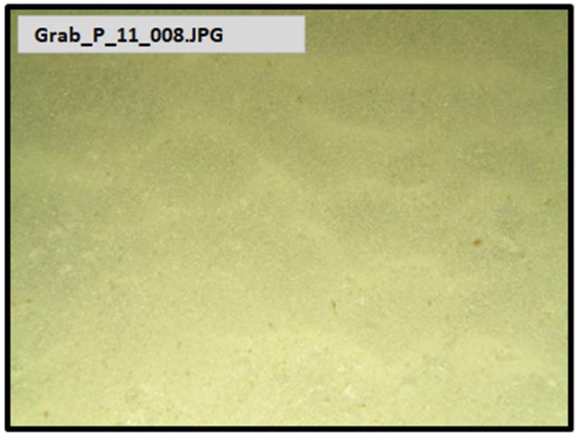


Photo Position: 718697 mE, 5943920 mN

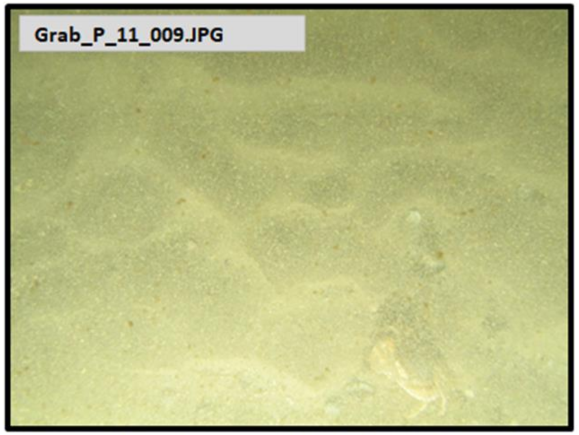
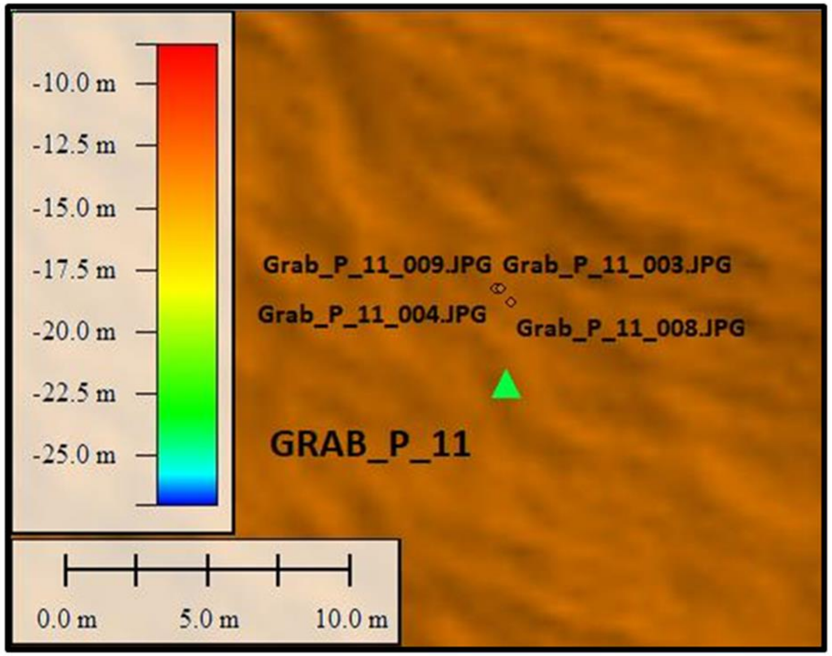


Photo Position: 718697 mE, 5943920 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

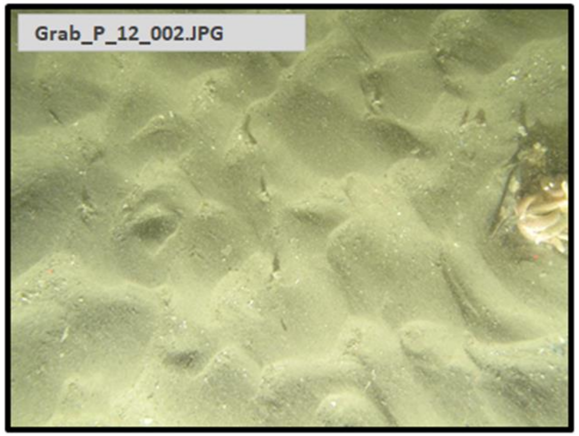


Photo Position: 718613 mE, 5942924 mN

Habitat Summary Information: Grab_P_012

Survey Area: N5a Pipeline

No. of Stills: 8 | **Mins of Video: 2** | **Track Length: DDV**

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of variable reflectivity with depressions.

Sediment Description

Coarse sand and rare shell debris with irregular ripples.

Conspicuous Fauna

Cnidaria: Actiniaria sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus depurator* (Sandy swimming crab), Brachyura sp, *Cancer maenus*. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Gobiidae sp.

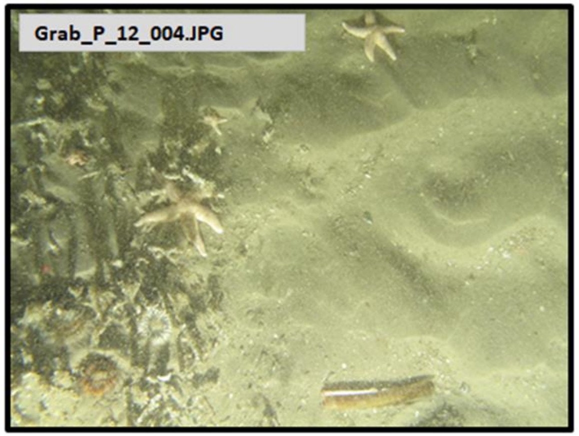


Photo Position: 718614 mE, 5942924 mN

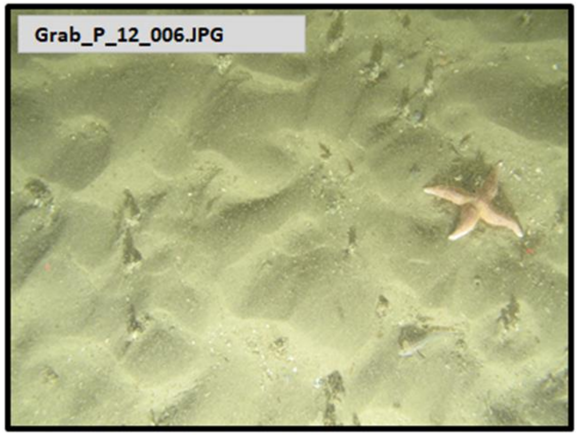
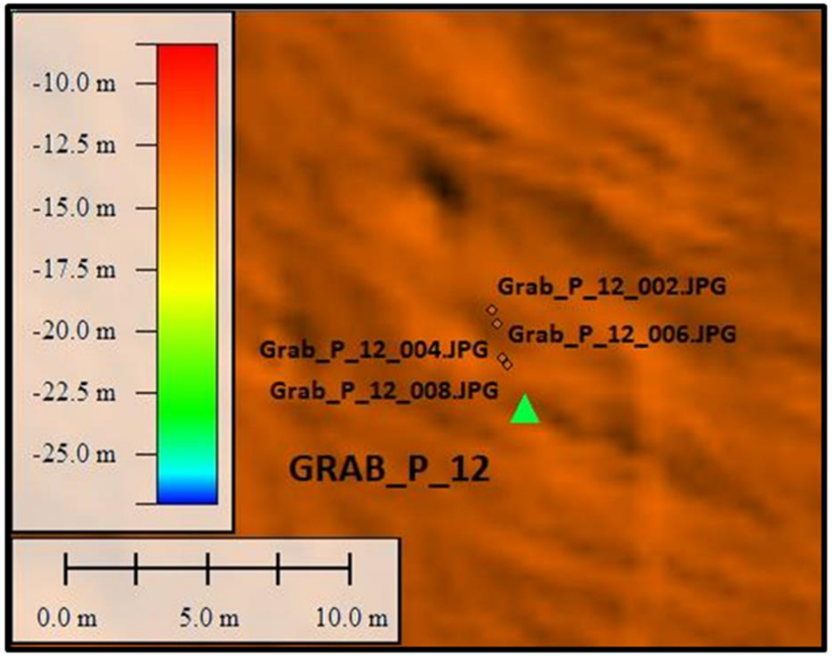


Photo Position: 718614 mE, 5942923 mN



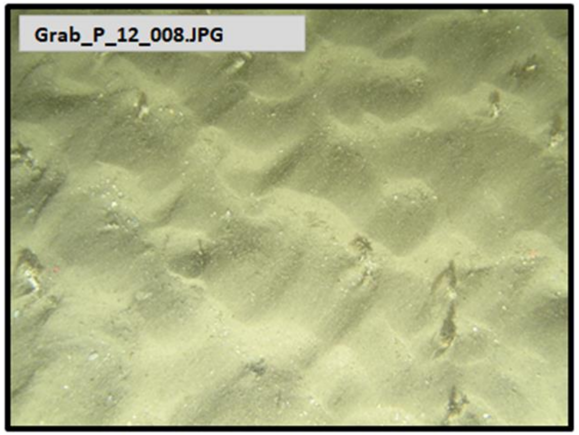
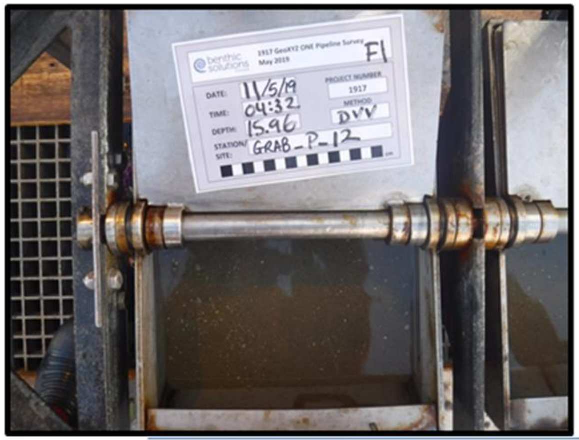


Photo Position: 718614 mE, 5942922 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_013

Survey Area: N5a Pipeline

No. of Stills: 7 | Mins of Video: 2 | Track Length: DDV

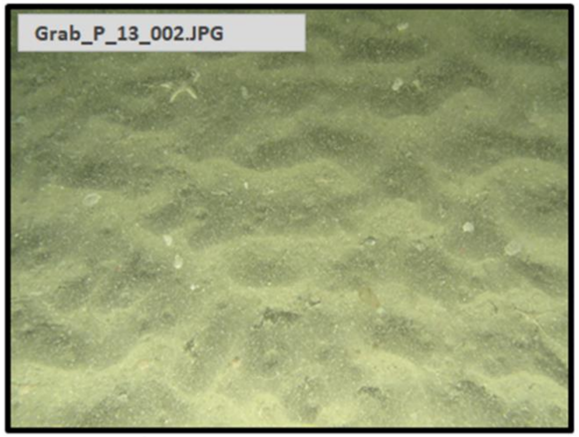


Photo Position: 718531 mE, 5941926 mN

Site Selection Criteria

Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation

Area of low reflectivity with some potential scarring.

Sediment Description

Coarse sand with irregular ripples.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish), Ophiurida sp.

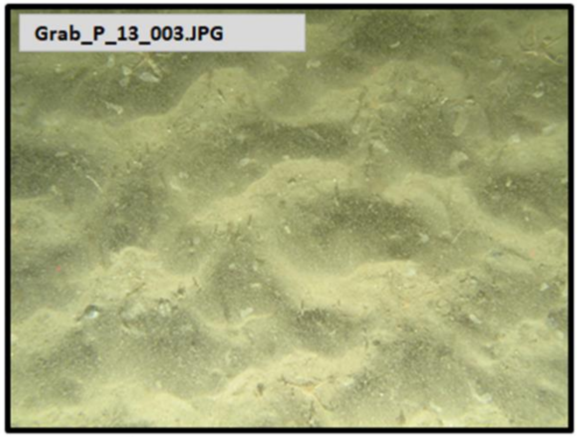


Photo Position: 718531 mE, 5941926 mN

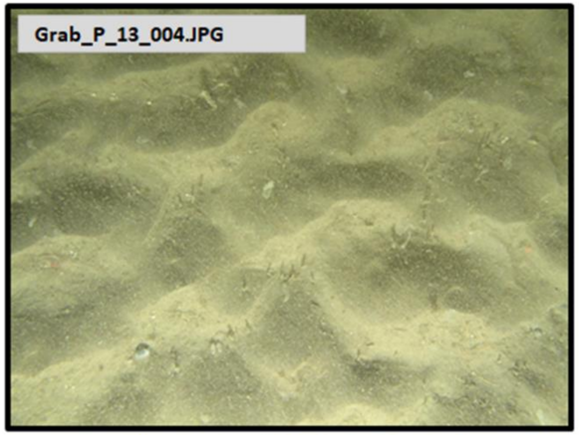
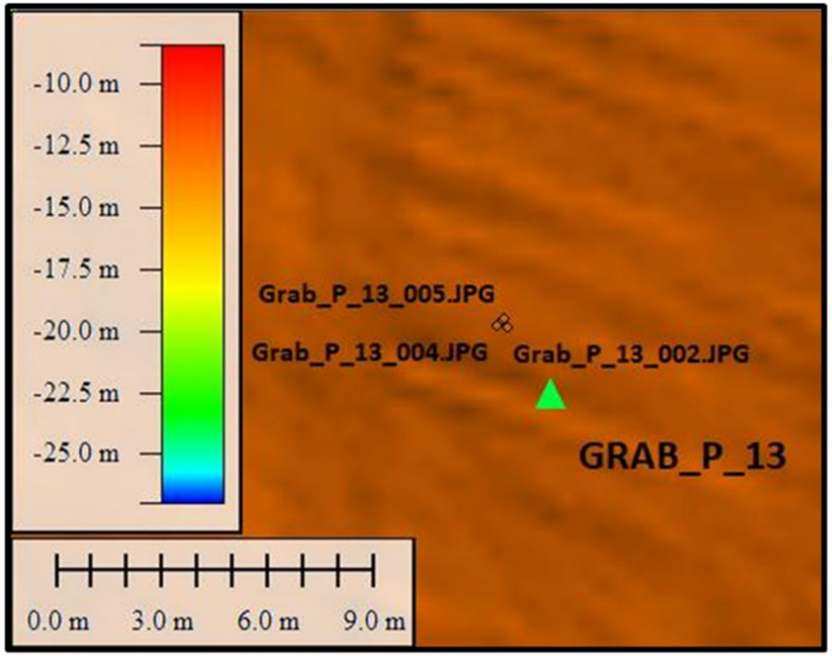


Photo Position: 718531 mE, 5941926 mN



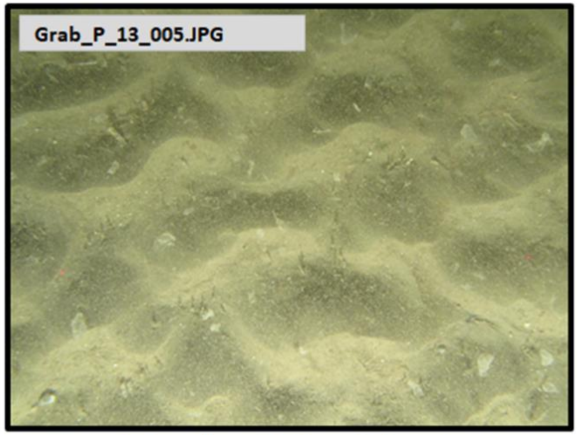
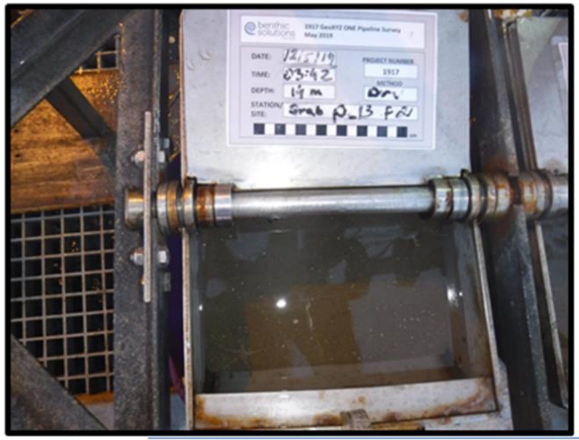


Photo Position: 718531 mE, 5941926 mN



Sediment Example Image

Grab Location | Camera Track | Selected Underwater Still

Sieved Sample Image

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_014

Survey Area: N5a Pipeline

No. of Stills: 5 | **Mins of Video: 1** | **Track Length: DDV**

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity

Sediment Description
No visiblity

Conspicuous Fauna
No visibility

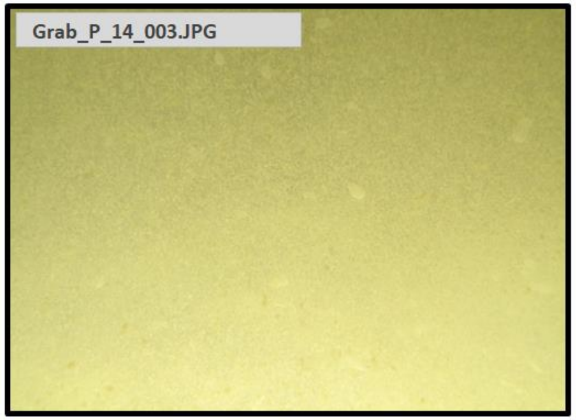


Photo Position: 718449 mE, 5940928 mN

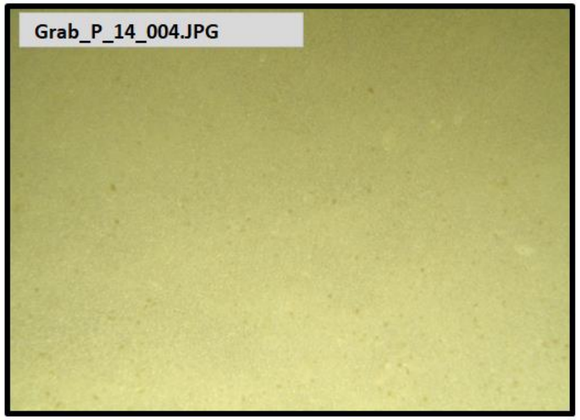


Photo Position: 718451 mE, 5940927 mN

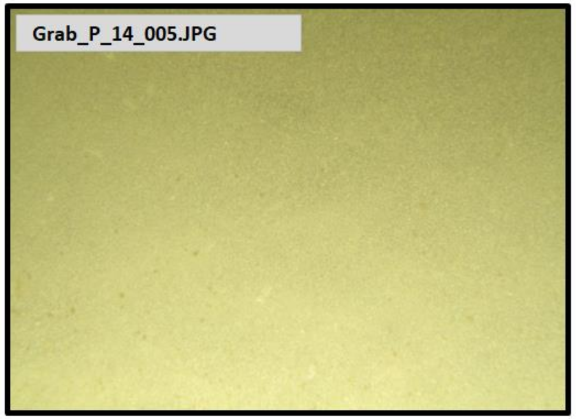


Photo Position: 718450 mE, 5940928 mN

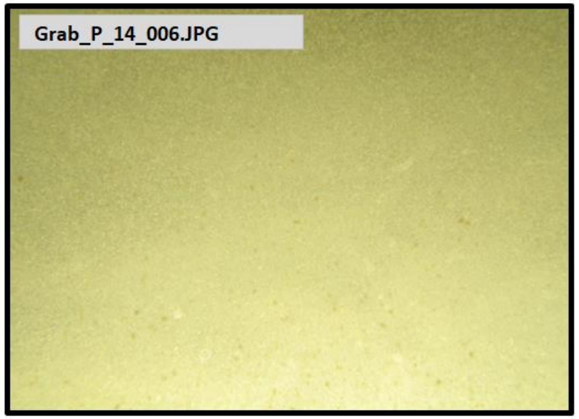
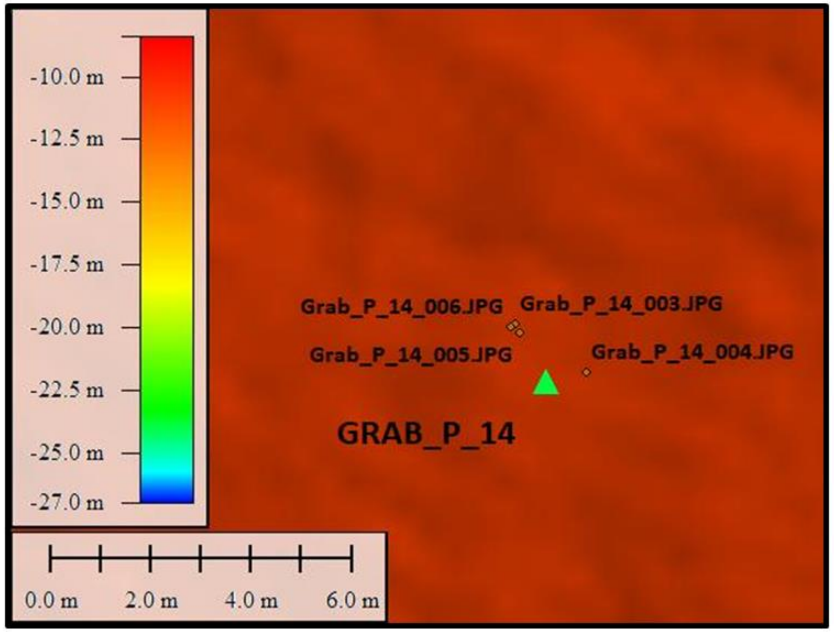
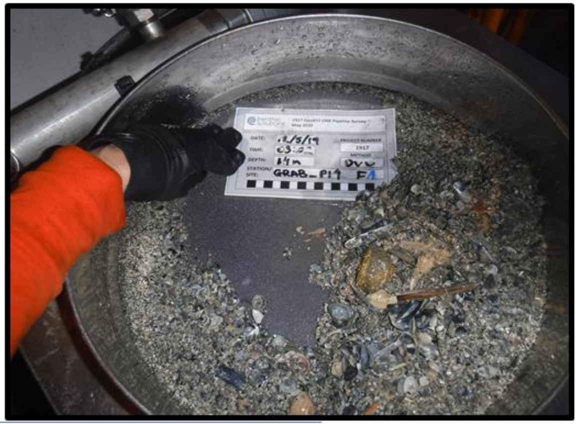


Photo Position: 718449 mE, 5940928 mN




Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_P_015

Survey Area: N5a Pipeline

No. of Stills: 5 | **Mins of Video:** 2 | **Track Length:** DDV

Site Selection Criteria
Pipeline Route - Positioned at 1km intervals.

Analogue Interpretation
Low reflectivity.

Sediment Description
Coarse sand with irregular ripples.

Conspicuous Fauna
Annelida: *Lanice conchilega* (Sand Mason). **Chordata:** Actinopterygii sp.

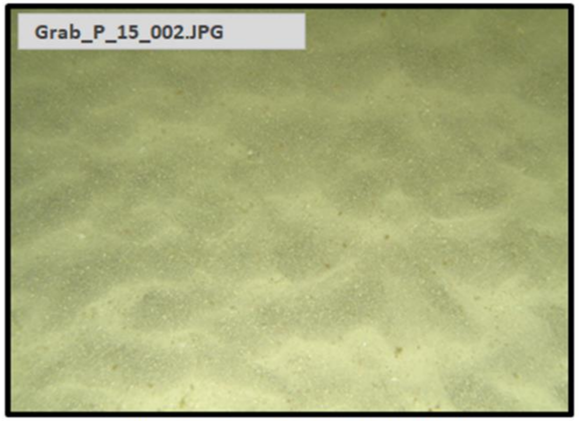


Photo Position: 718366 mE, 5939934 mN

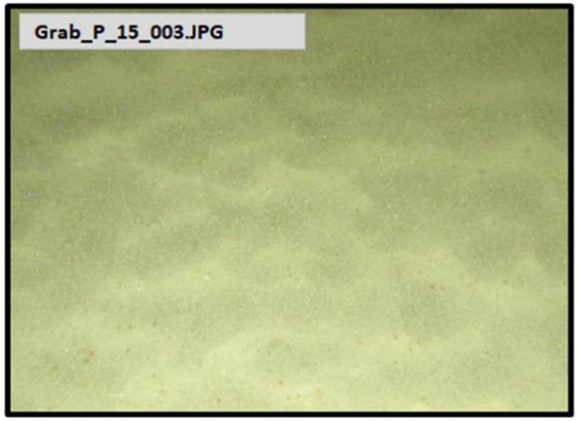


Photo Position: 718366 mE, 5939934 mN

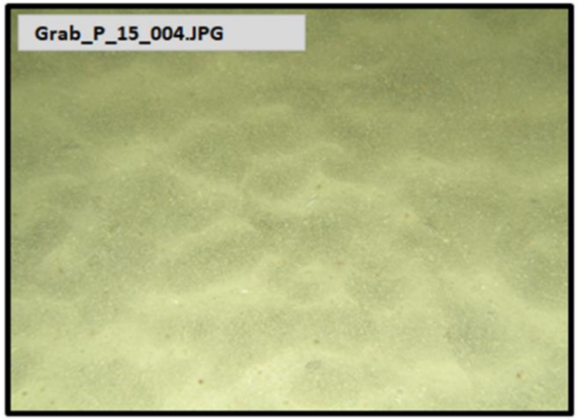


Photo Position: 718366 mE, 5939934 mN

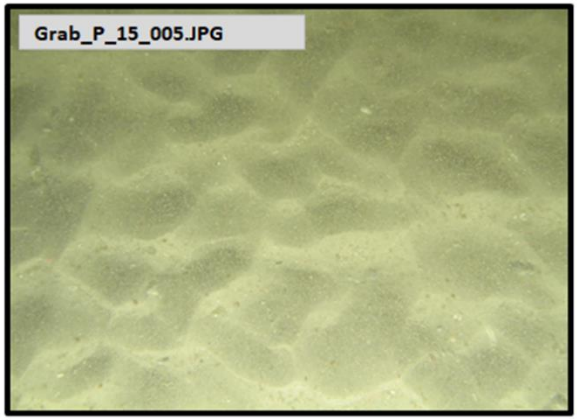
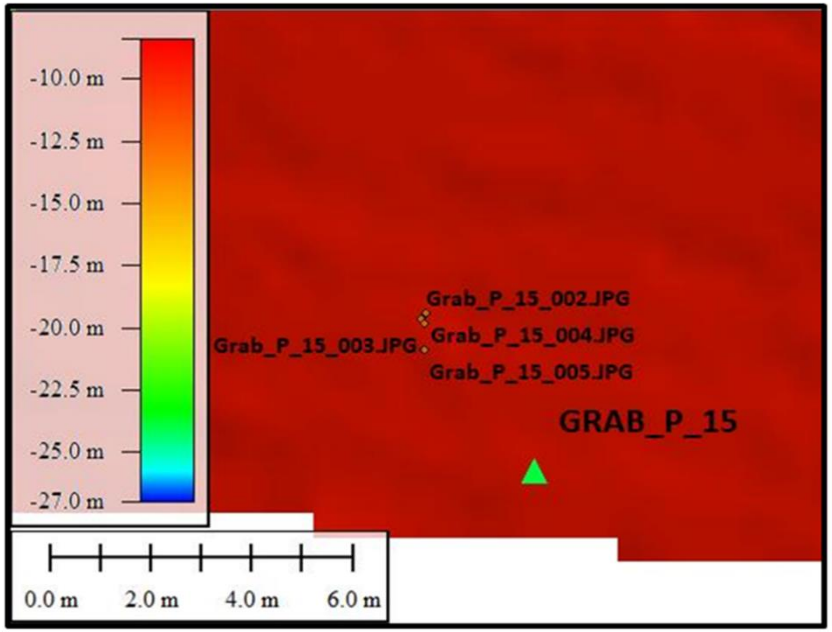


Photo Position: 718366 mE, 5939933 mN




Sediment Example Image

Grab Location | Camera Track | Selected Underwater Still


Sieved Sample Image

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_C_0

Survey Area: N5a Cable Route

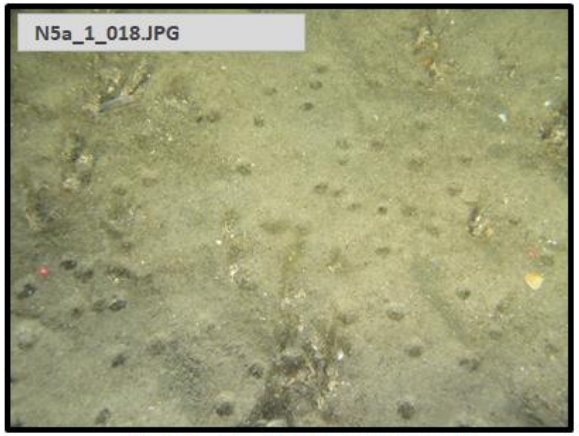


Photo Position: 721606 mE, 5954649 mN

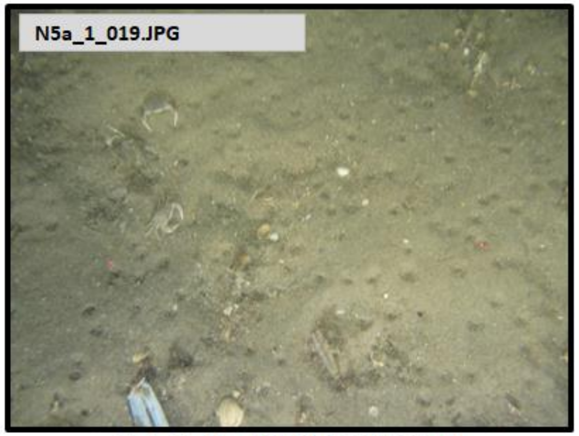


Photo Position: 721607 mE, 5954652 mN

Site Selection Criteria

Original Cable Route and N5a well centre location. Covered using transect N5a_1 and N5a_2.

Analogue Interpretation

Low reflectivity.

Sediment Description

Slightly gravelly/shelly coarse sand.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

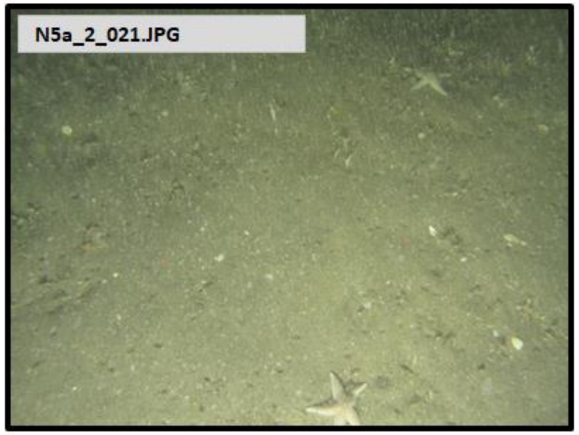


Photo Position: 721610 mE, 5954650 mN

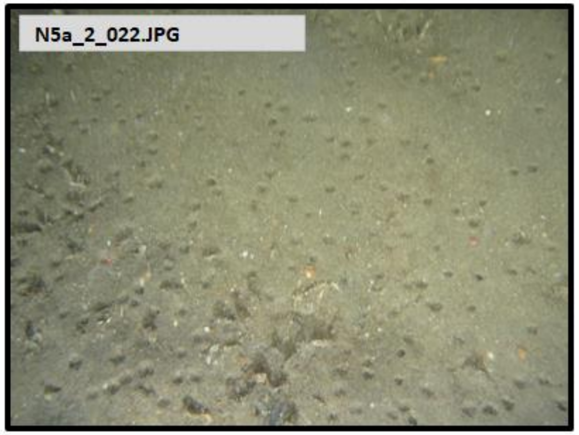
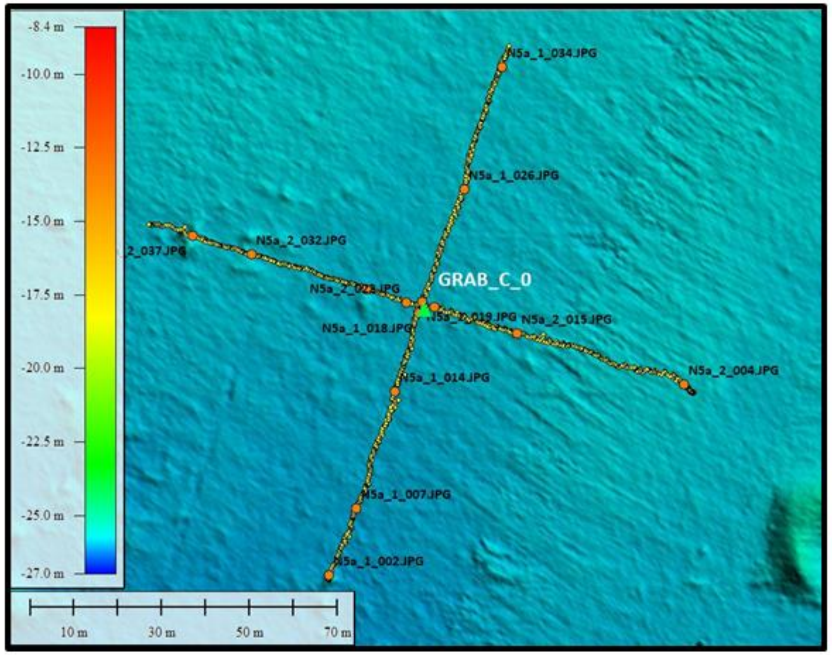


Photo Position: 721603 mE, 5954651 mN



Sediment Example Image


Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

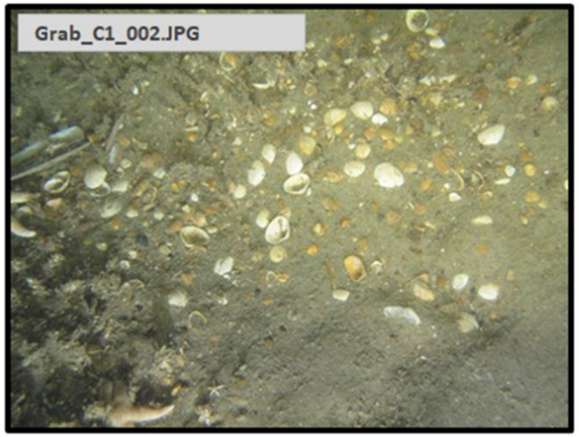


Photo Position: 722598 mE, 5954539 mN

Habitat Summary Information: Grab_C_01

Survey Area: N5a Cable Route

No. of Stills: 2 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Area of variable high reflectivity with raised area near Grab location.

Sediment Description

Coarse sand littered with shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp, *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish).

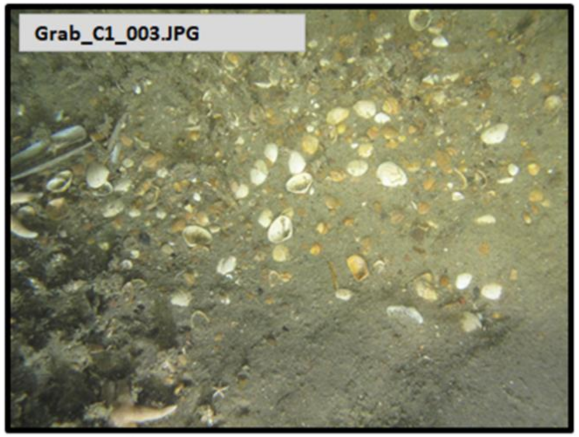


Photo Position: 722598 mE, 5954539 mN

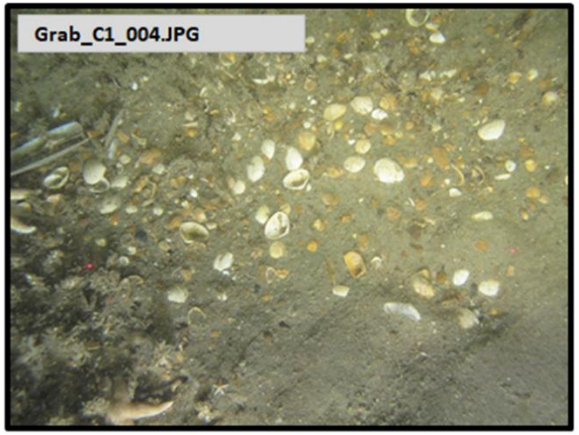
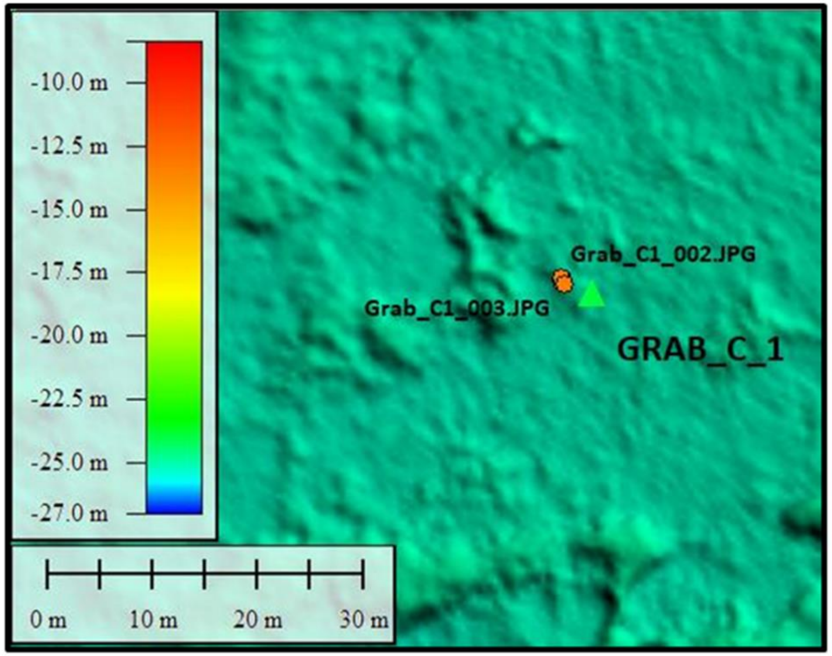


Photo Position: 0 mE, 0 mN



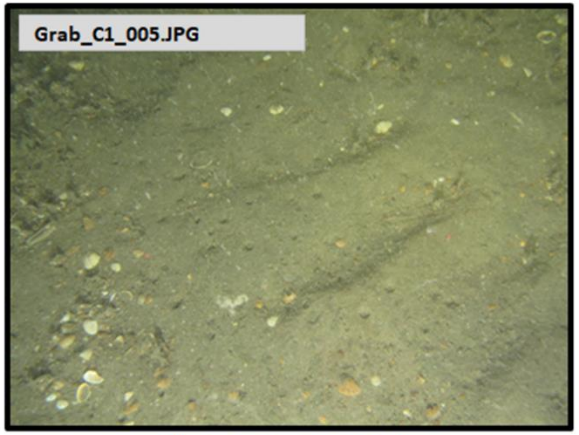


Photo Position: 0 mE, 0 mN

Sediment Example Image

Sieved Sample Image

Grab Location · Camera Track · Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_02

Survey Area: N5a Cable Route

No. of Stills: 5 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Area of variable reflectivity.

Sediment Description

Coarse sand.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Mollusca:** *Loligo vulgaris* . **Echinodermata:** *Asterias rubens* (Common starfish).

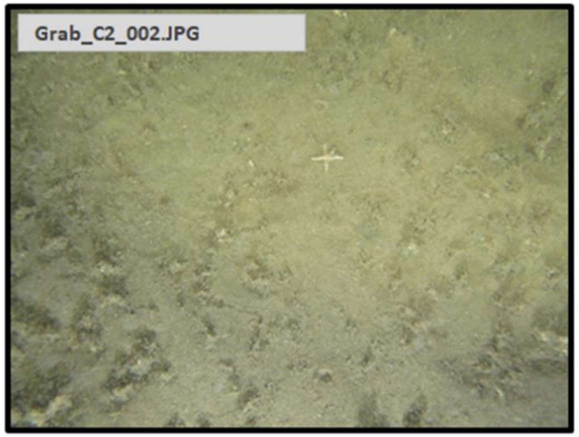


Photo Position: 723594 mE, 5954423 mN

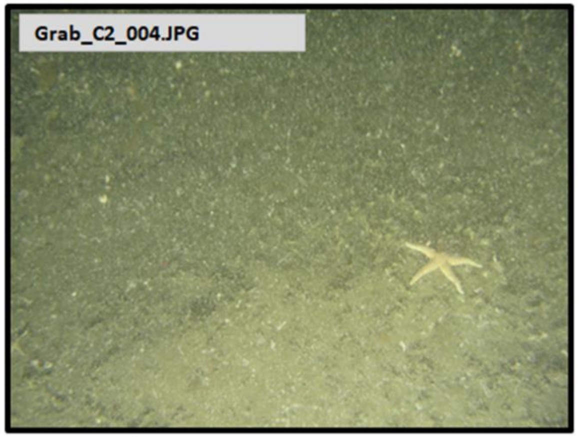


Photo Position: 723594 mE, 5954423 mN

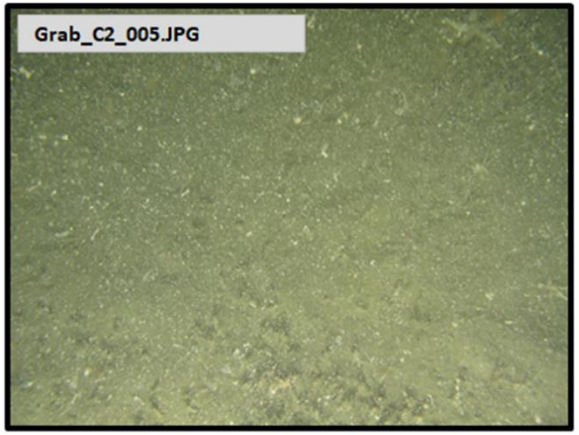


Photo Position: 723596 mE, 5954422 mN

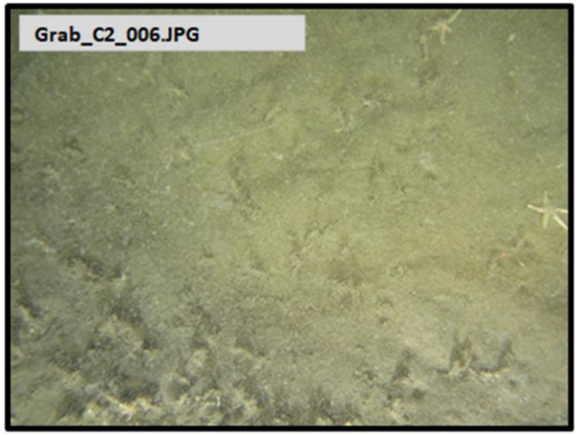
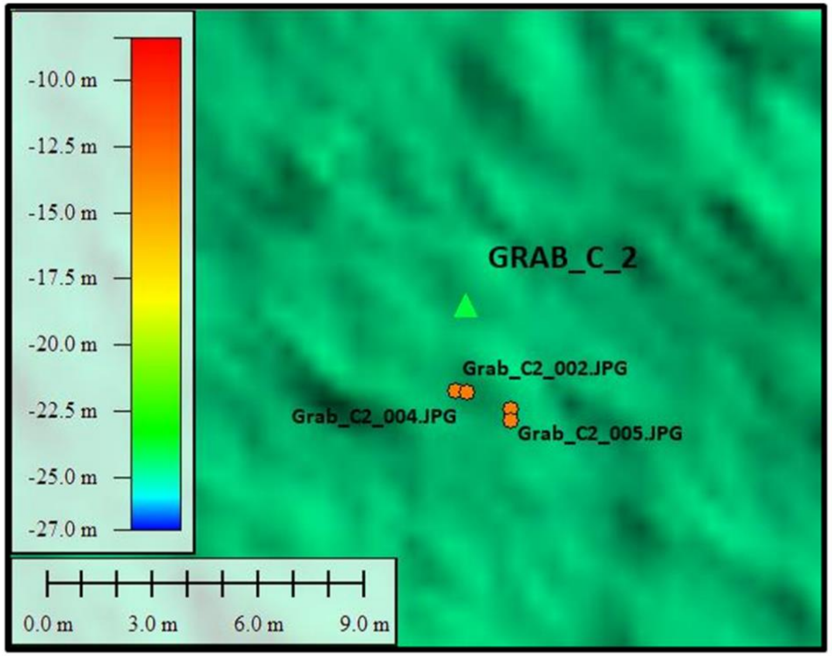


Photo Position: 723596 mE, 5954422 mN



Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_03

Survey Area: N5a Cable Route

No. of Stills: 8 | **Mins of Video: 3** | **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish).

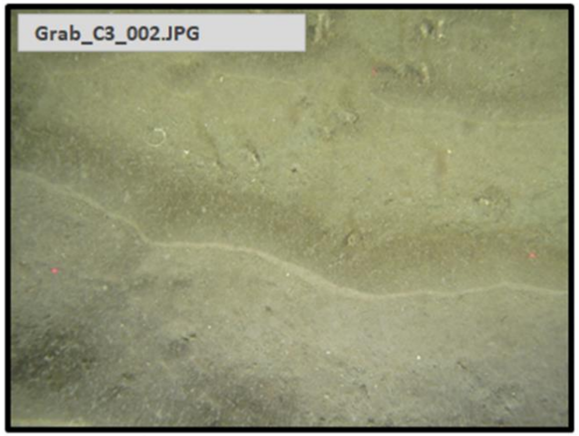


Photo Position: 724589 mE, 5954311 mN

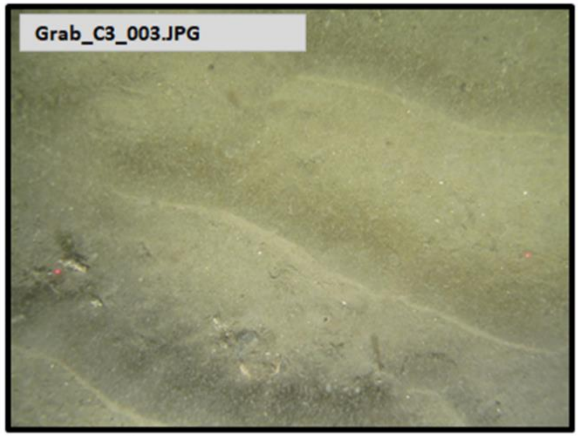


Photo Position: 724589 mE, 5954311 mN

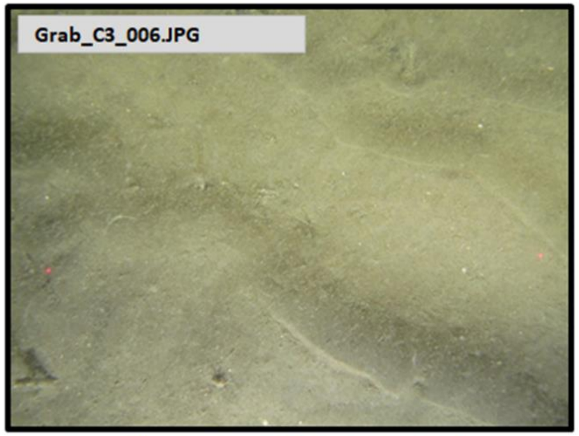


Photo Position: 724589 mE, 5954312 mN

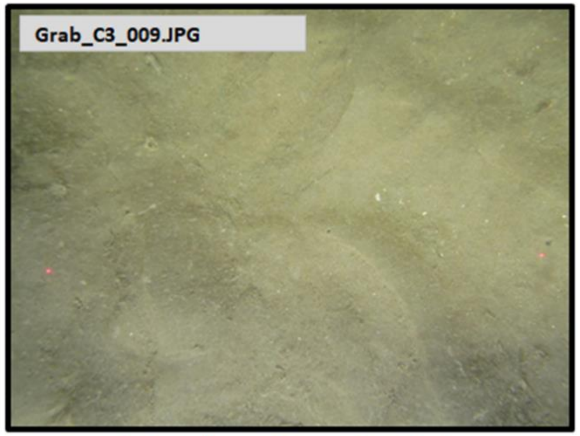
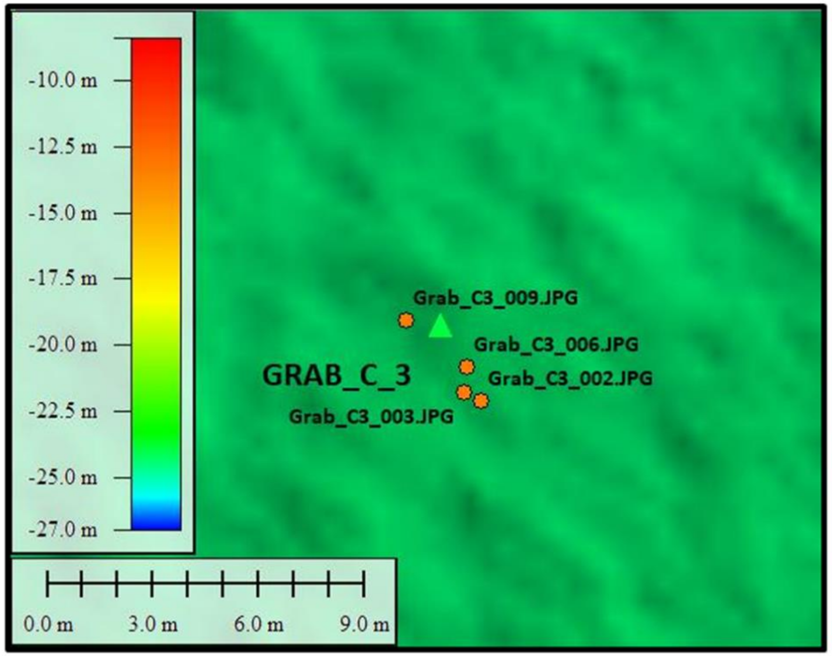


Photo Position: 724587 mE, 5954313 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_C_04

Survey Area: N5a Cable Route

No. of Stills: 9 **Mins of Video: 3** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp. **Echinodermata:** *Asterias rubens* (Common starfish).

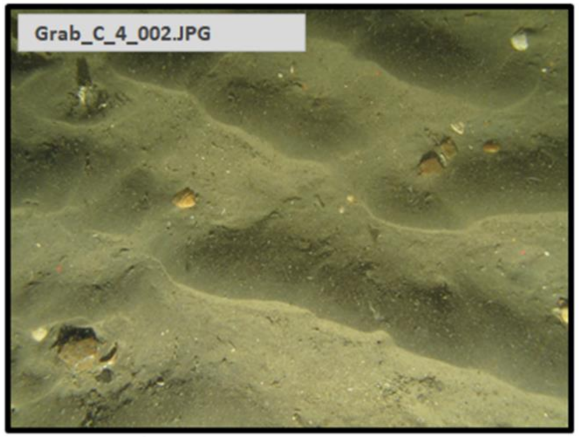


Photo Position: 725582 mE, 5954199 mN

Photo Position: 725583 mE, 5954200 mN

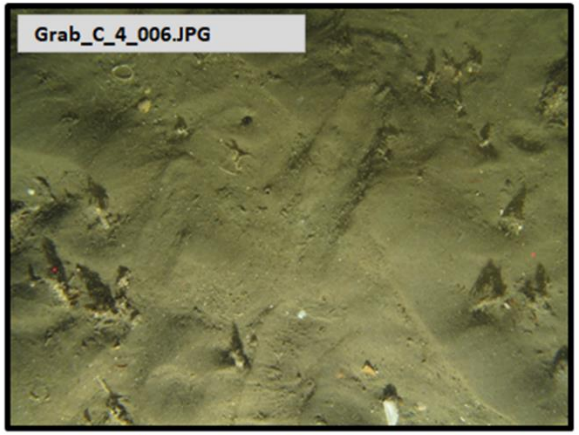


Photo Position: 725582 mE, 5954202 mN

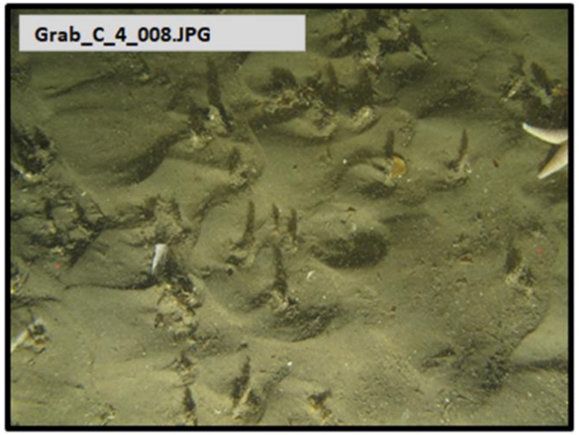
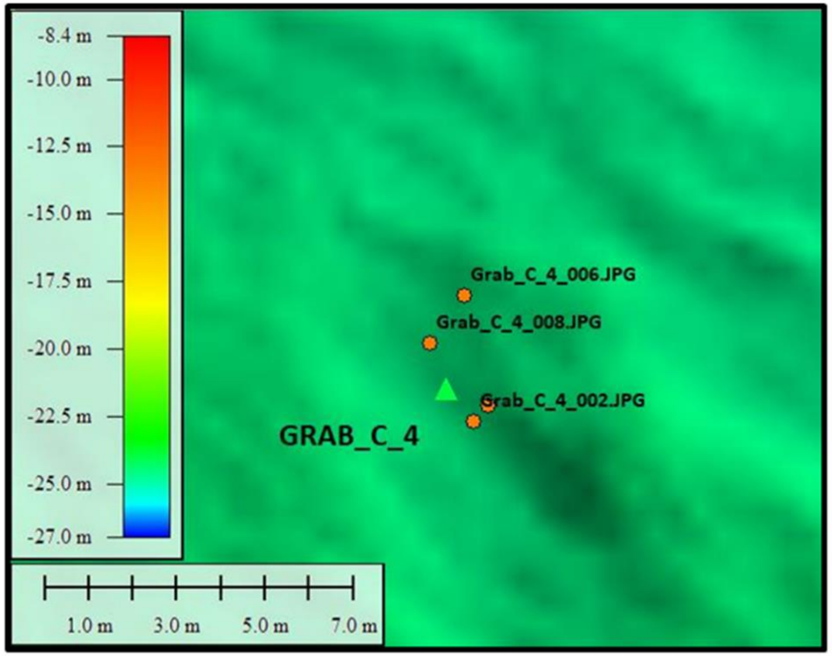


Photo Position: 725581 mE, 5954201 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C_05

Survey Area: N5a Cable Route

No. of Stills: 9 | Mins of Video: 3 | Track Length: DDV

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** *Liocarcinus* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** possibly *Callionymus lyra* (Common dragonet).

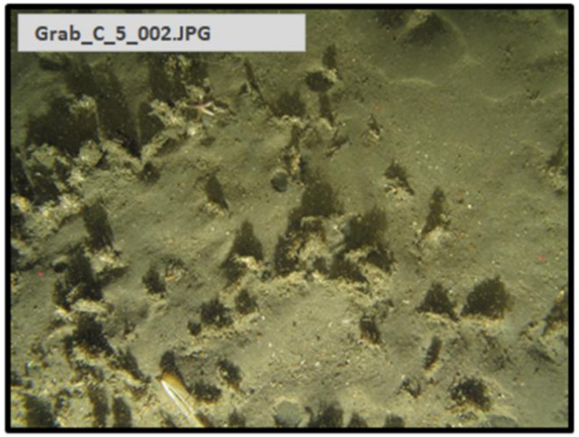


Photo Position: 726576 mE, 5954087 mN

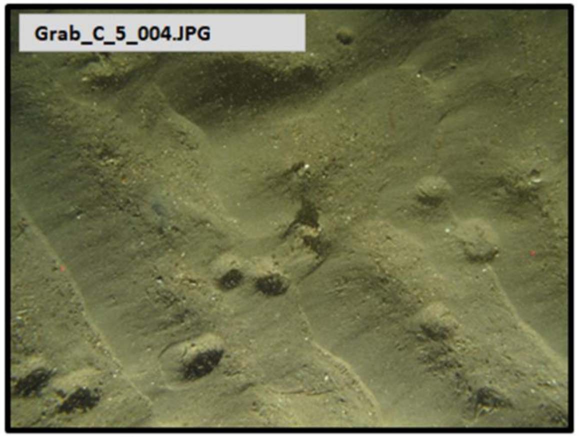


Photo Position: 726578 mE, 5954083 mN

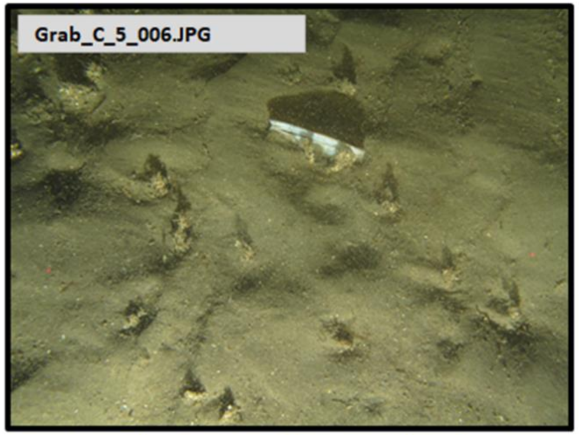


Photo Position: 726575 mE, 5954088 mN

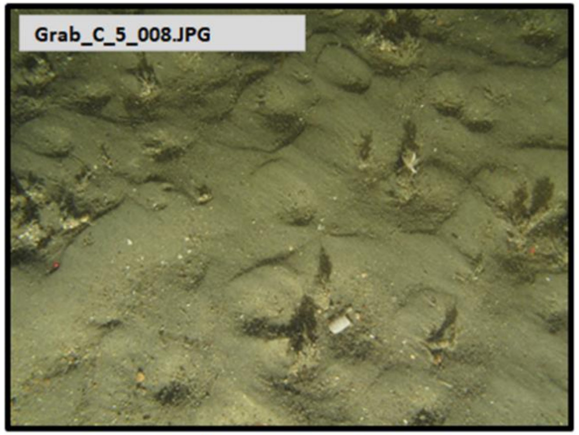
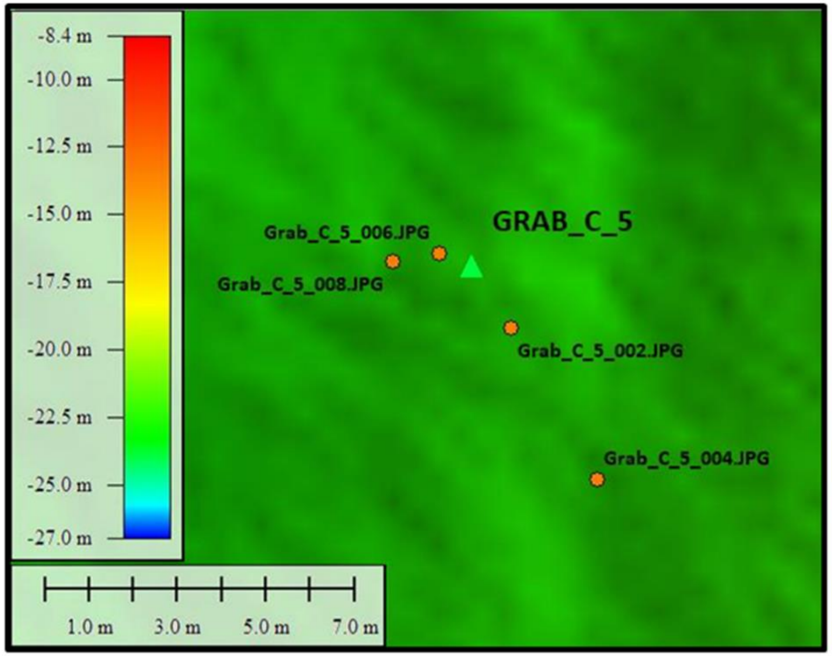


Photo Position: 726574 mE, 5954088 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: Grab_C_06

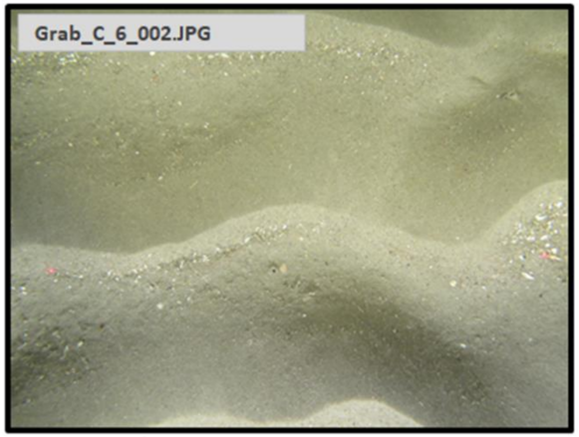


Photo Position: 727352 mE, 5954243 mN

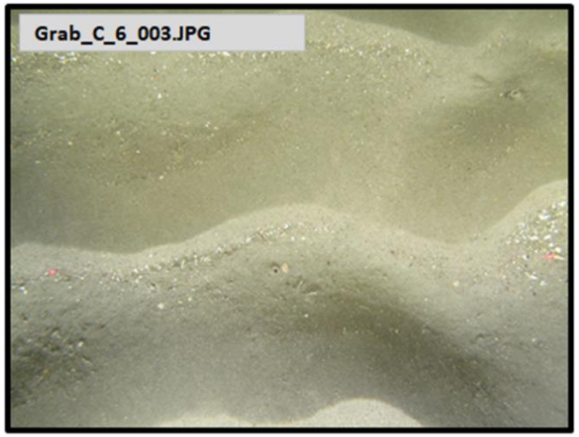


Photo Position: 727352 mE, 5954243 mN

Survey Area: N5a Cable Route

No. of Stills: 4 | Mins of Video: 1 | Track Length: DDV

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason).

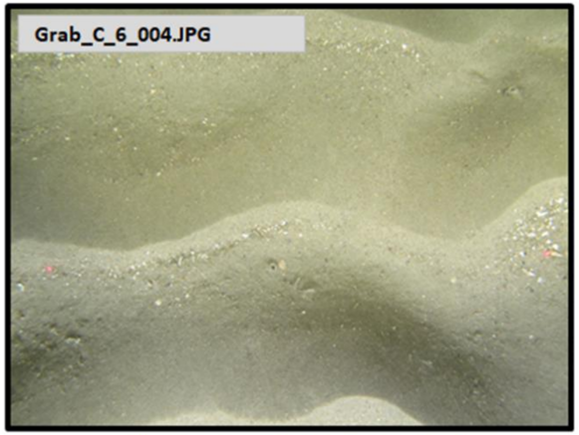


Photo Position: 727352 mE, 5954242 mN

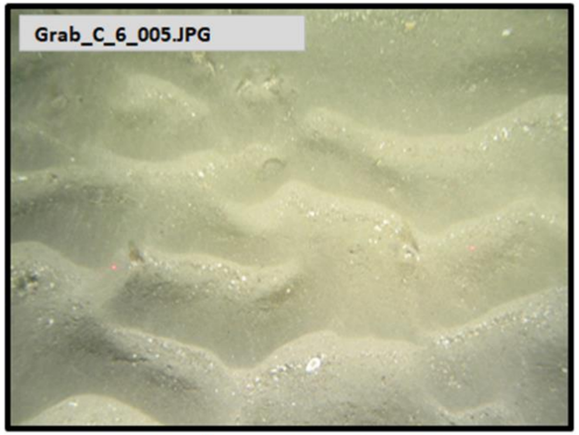
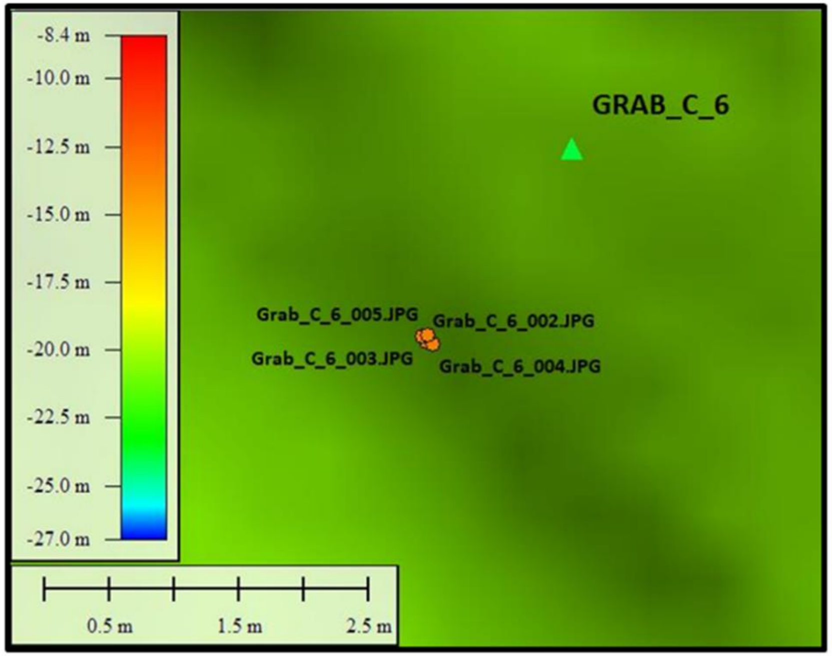


Photo Position: 727352 mE, 5954243 mN



Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

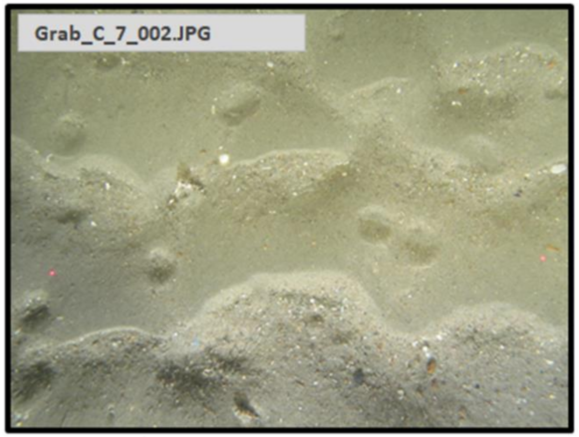


Photo Position: 728147 mE, 5954477 mN

Habitat Summary Information: Grab_C_07

Survey Area: N5a Cable Route

No. of Stills: 5 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish).

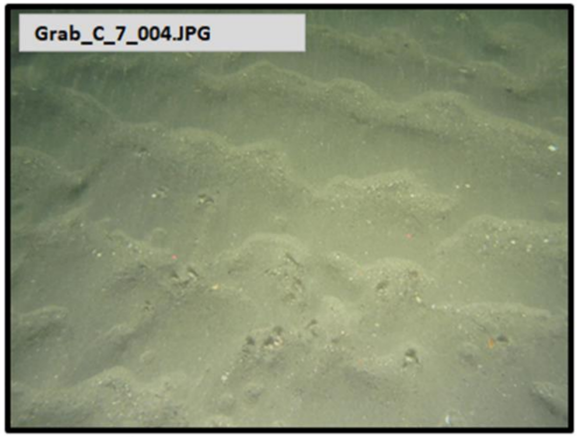


Photo Position: 728147 mE, 5954477 mN

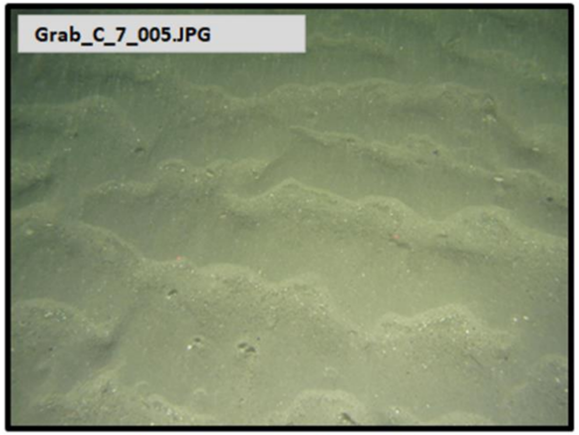
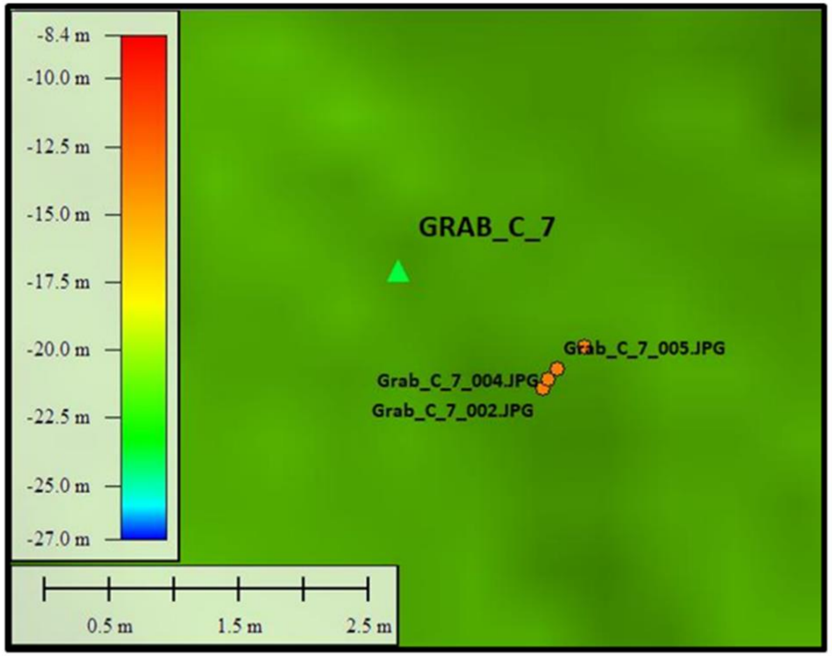


Photo Position: 728147 mE, 5954477 mN



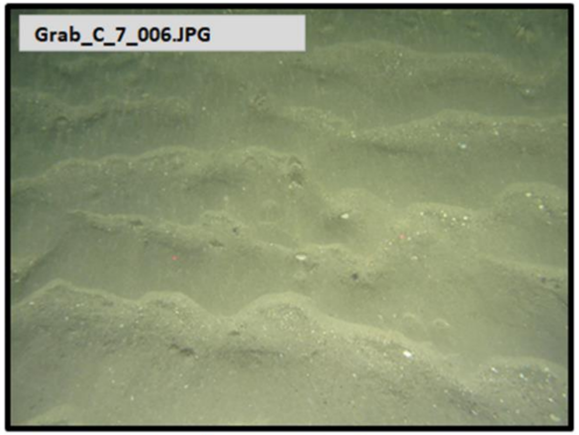
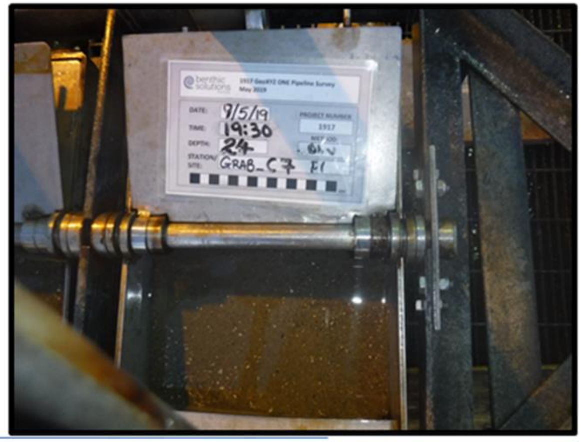


Photo Position: 728148 mE, 5954477 mN

Sediment Example Image



Sieved Sample Image

Grab Location · Camera Track · Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

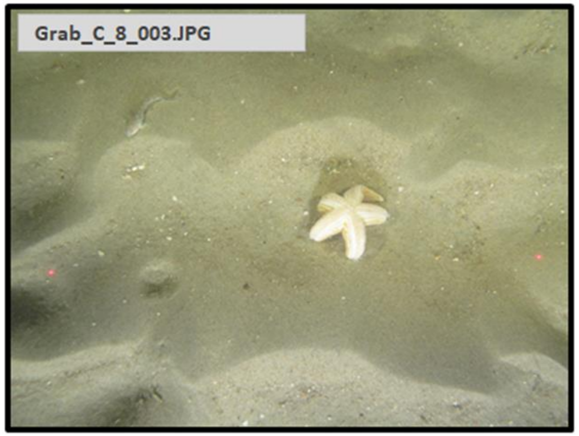


Photo Position: 729107 mE, 5954755 mN

Habitat Summary Information: Grab_C_08

Survey Area: N5a Cable Route

No. of Stills: 5 Mins of Video: 1 Track Length: DDV

Site Selection Criteria

Original Cable Route – Positioned at 1km intervals.

Analogue Interpretation

Low reflectivity.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** Gobiidae sp.

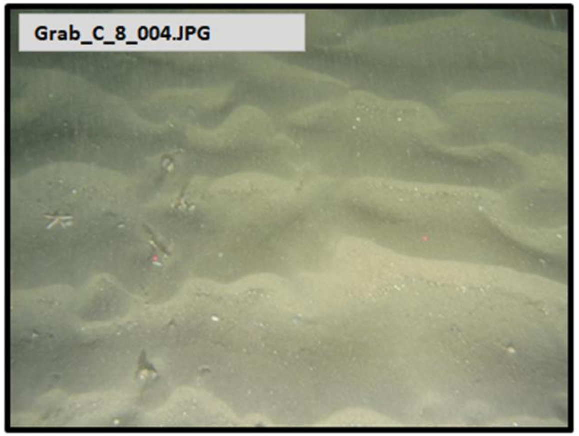


Photo Position: 729107 mE, 5954756 mN

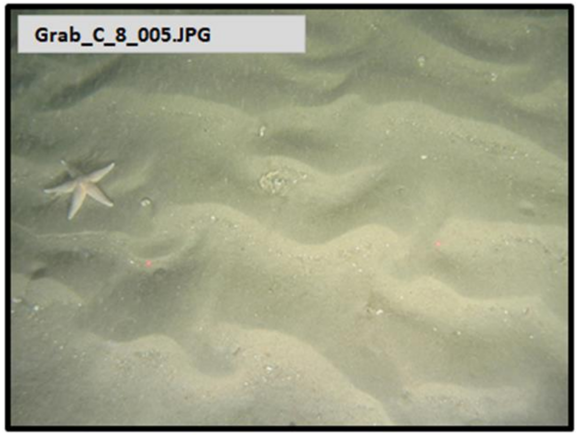
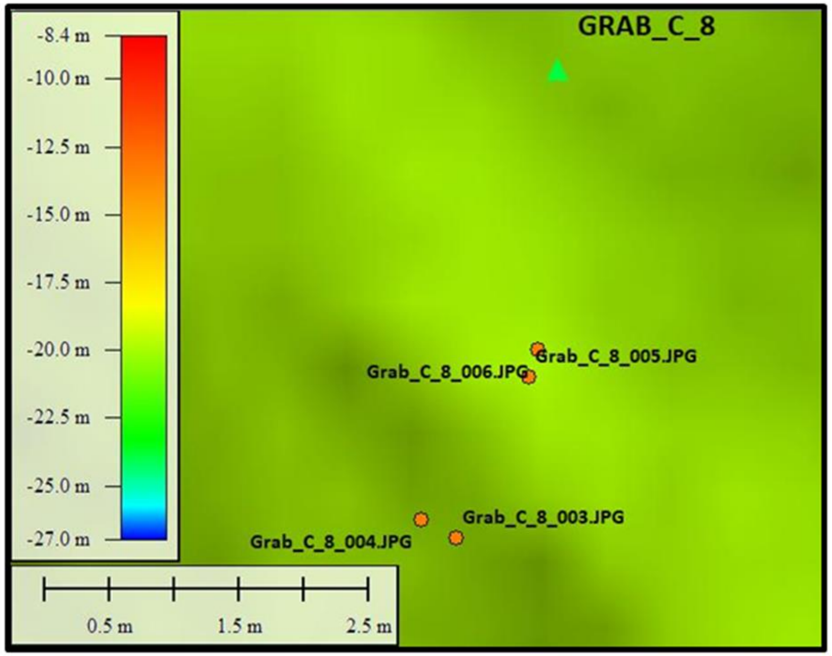


Photo Position: 729108 mE, 5954757 mN



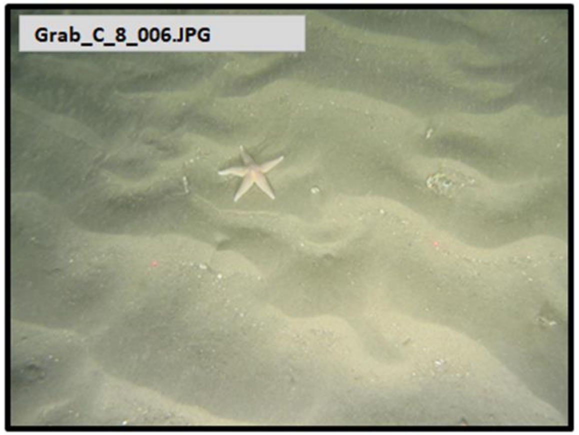


Photo Position: 729108 mE, 5954757 mN

Sediment Example Image

Sieved Sample Image

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C3_0

Survey Area: N5a Cable Route

No. of Stills: 36 Mins of Video: 9 Track Length: 125m

Site Selection Criteria

Secondary Cable Route and N5a second potential well centre location.

Analogue Interpretation

No analogue data.

Sediment Description

Coarse sand ripples with small shell fragments that have accumulated within each sand furrow.

Conspicuous Fauna

Annelida: *Lanice conchilega* (Sand Mason). **Arthropoda:** Decapoda sp., *Corystes cassivelaunus* (Masked crab). **Echinodermata:** *Asterias rubens* (Common starfish), *Ophiura* sp. **Chordata:** Gobiidae sp., *Ammodytes* sp. (Sand eel).

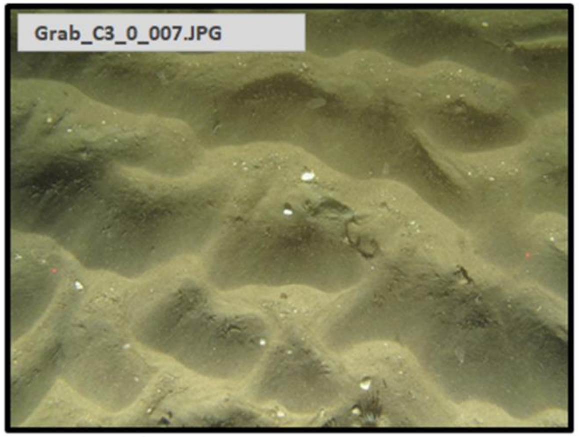


Photo Position: 722245 mE, 5952995 mN

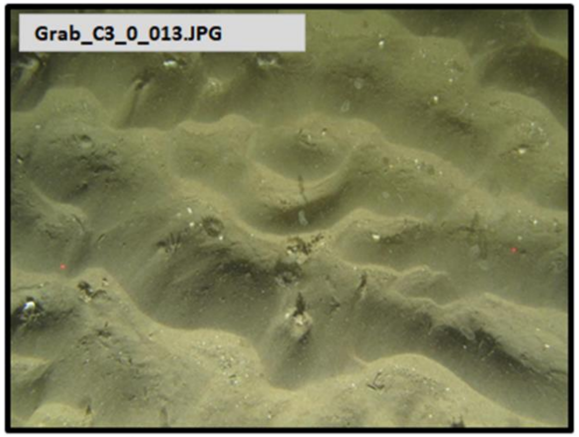


Photo Position: 722260 mE, 5953002 mN

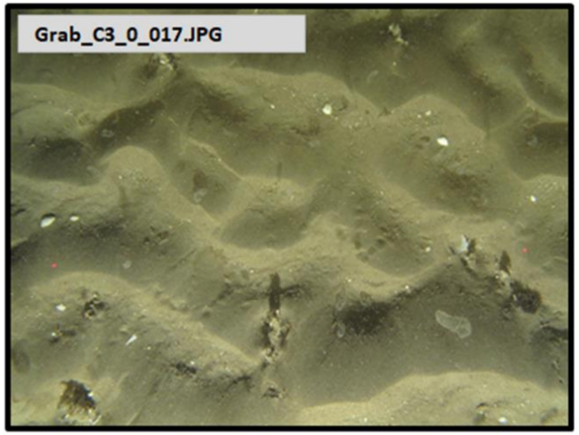


Photo Position: 722274 mE, 5953011 mN

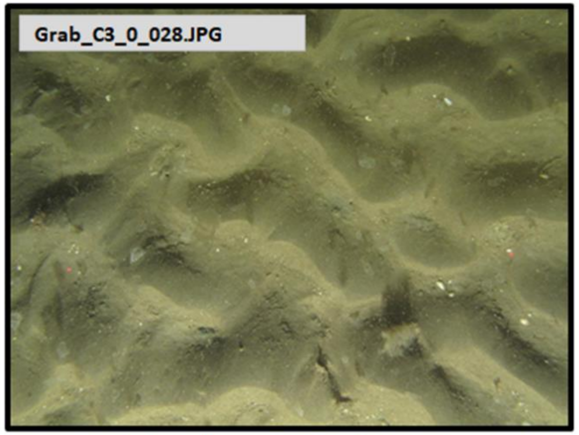
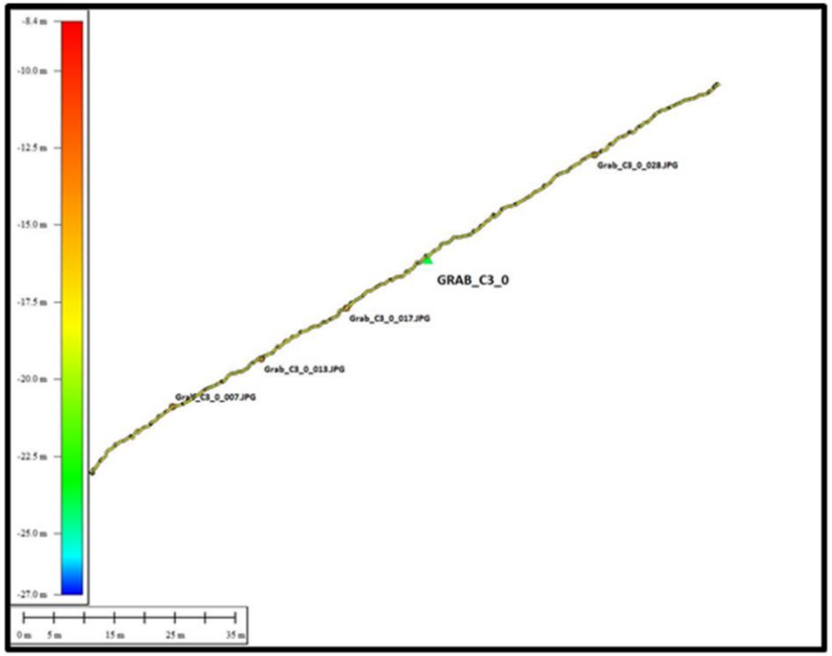


Photo Position: 722315 mE, 5953036 mN



Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Grab_C3_1_002.JPG

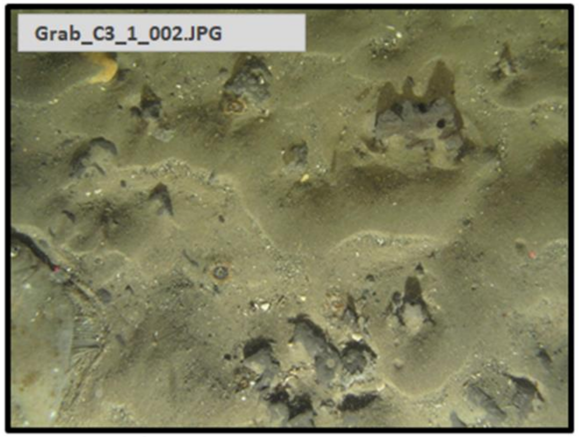


Photo Position: 723807 mE, 5953379 mN

Grab_C3_1_006.JPG

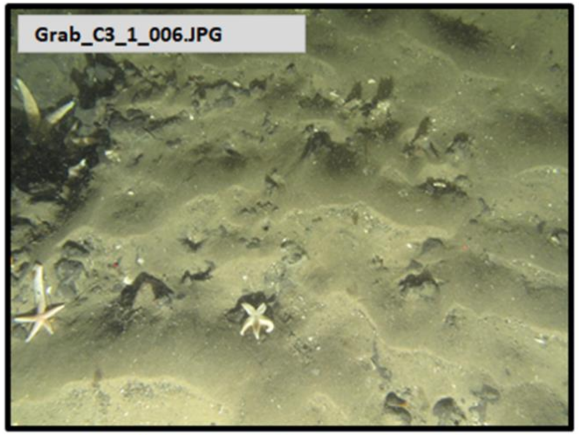


Photo Position: 723808 mE, 5953379 mN

Sediment Example Image

Habitat Summary Information: Grab_C3_01

Survey Area: N5a Cable Route

No. of Stills: 7 **Mins of Video: 1** **Track Length: DDV**

Site Selection Criteria

Secondary Cable Route – Positioned to investigate mixed reflectivity sediment.

Analogue Interpretation

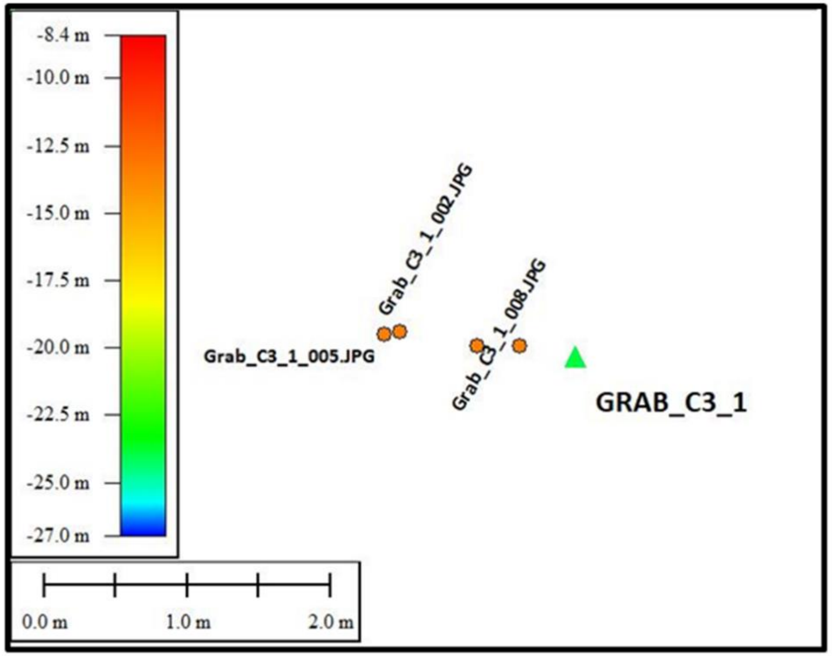
No analogue data.

Sediment Description

Coarse shelly sand with partly buried cobbles and slight sand waves.

Conspicuous Fauna

Echinodermata: *Asterias rubens* (Common starfish). **Chordata:** Pleuronectiformes sp.



Grab Location | Camera Track | Selected Underwater Still

Grab_C3_1_005.JPG

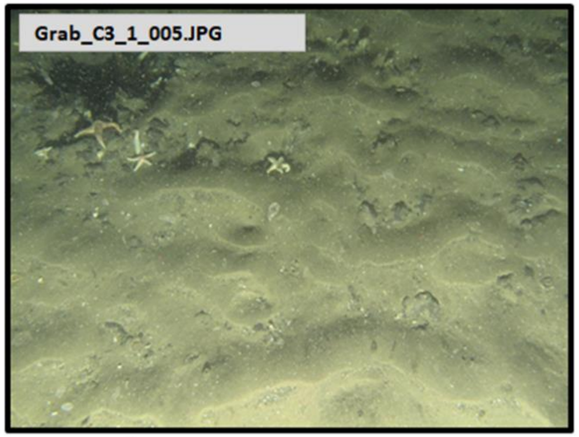


Photo Position: 723807 mE, 5953379 mN

Grab_C3_1_008.JPG

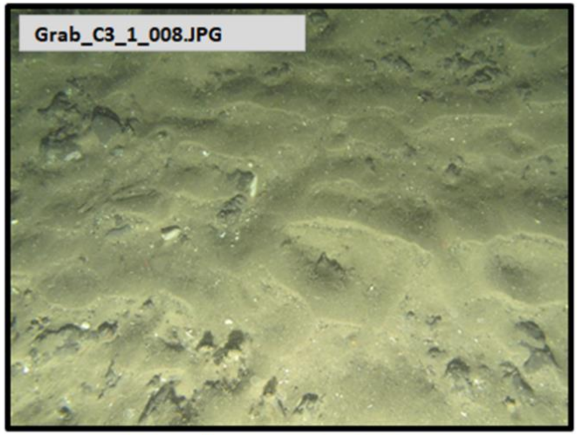


Photo Position: 723808 mE, 5953379 mN

Sieved Sample Image

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: Grab_C3_02

Survey Area: N5a Cable Route

No. of Stills: 37 **Mins of Video: 13** **Track Length: 180m**

Site Selection Criteria

Secondary Cable Route – Positioned to investigate high reflectivity sediment.

Analogue Interpretation

Area of variable reflectivity, scarring on seabed (analogue data only available for half of camera line).

Sediment Description

Gravelly and shelly coarse sand.

Conspicuous Fauna

Cnidaria: *Metridium senile* (Plumose Anemone), Actiniaria sp., Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., Decapoda sp., Liocarcinus sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** possibly *Callionymus lyra* (Common dragonet), *Ammodytes* sp. (Sand eel), Pleuronectiformes sp.

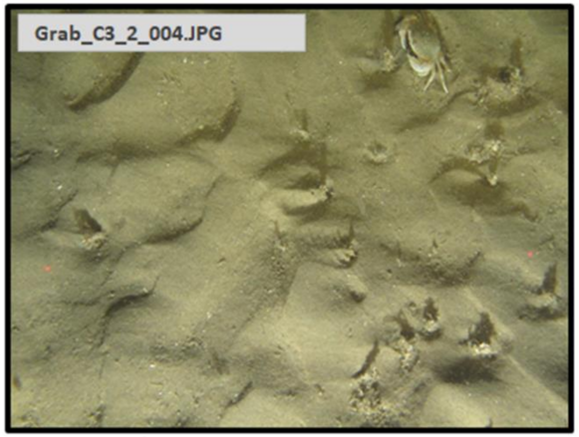


Photo Position: 725364 mE, 5953617 mN

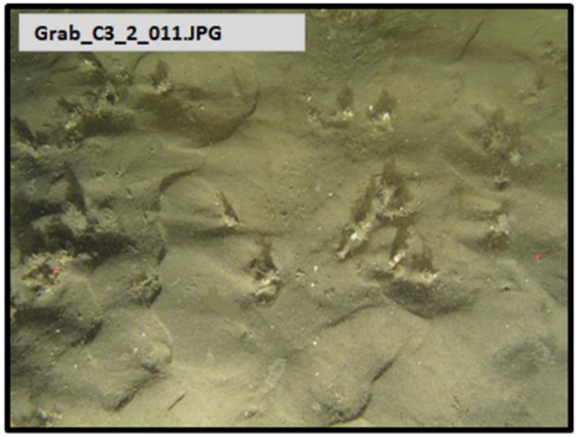


Photo Position: 725359 mE, 5953640 mN

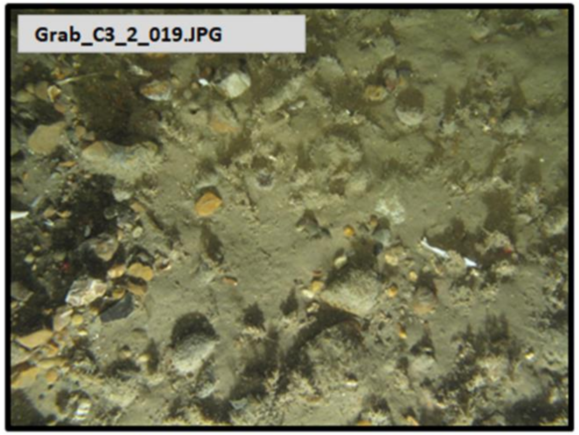


Photo Position: 725352 mE, 5953671 mN

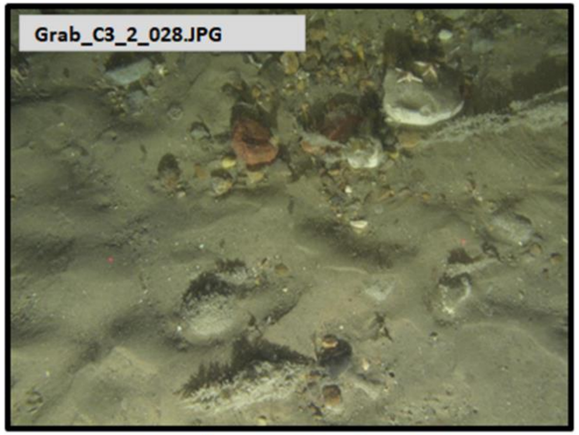
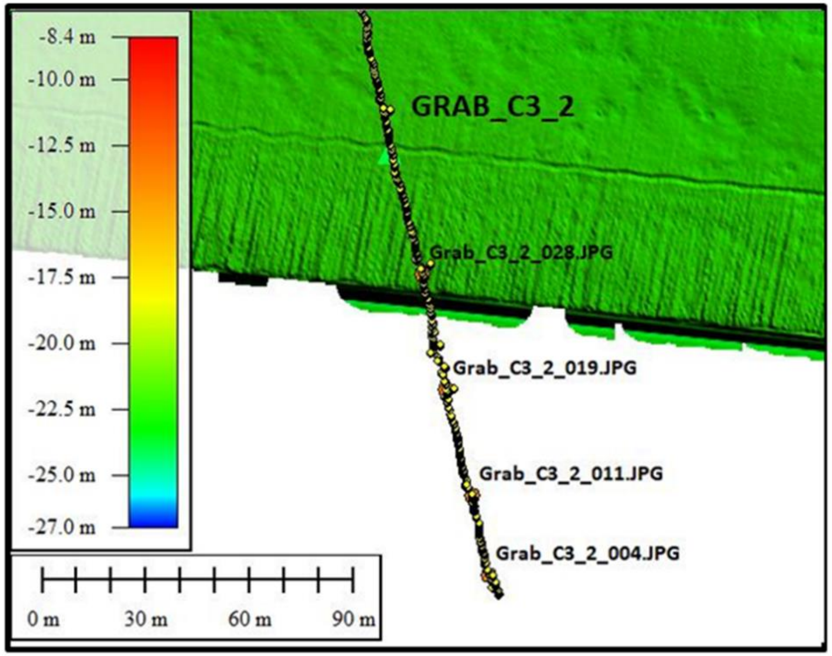


Photo Position: 725345 mE, 5953704 mN



Sediment Example Image

Sieved Sample Image

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

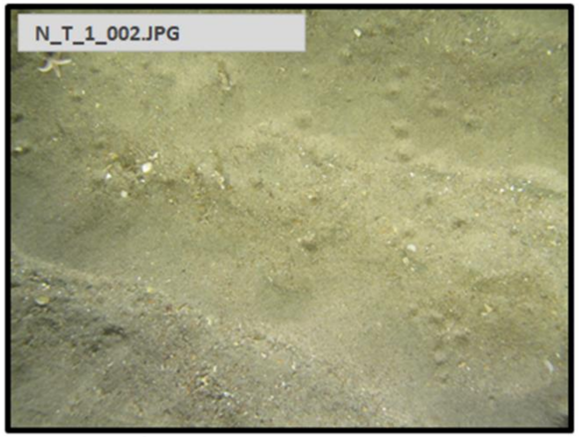


Photo Position: 721487 mE, 5954680 mN

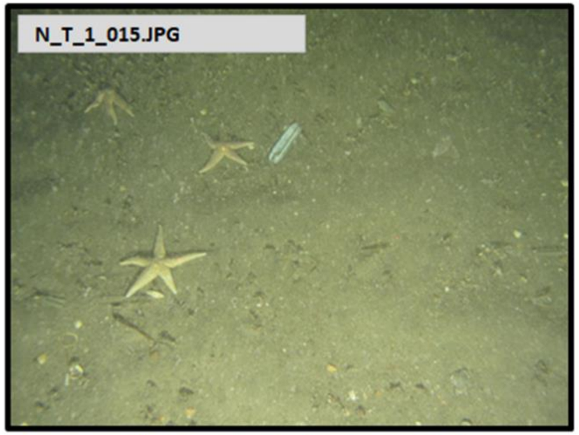


Photo Position: 721432 mE, 5954659 mN

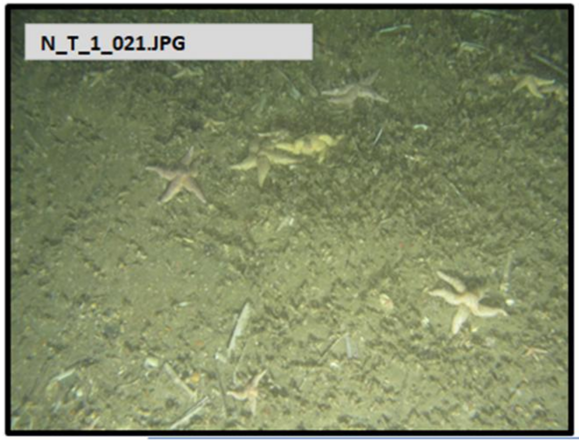


Photo Position: 721406 mE, 5954650 mN

Habitat Summary Information: North Transect 1

Survey Area: N5a

No. of Stills: 30 **Mins of Video: 10** **Track Length: 135m**

Site Selection Criteria

Investigating transition from mixed to high reflectivity sediment.

Analogue Interpretation

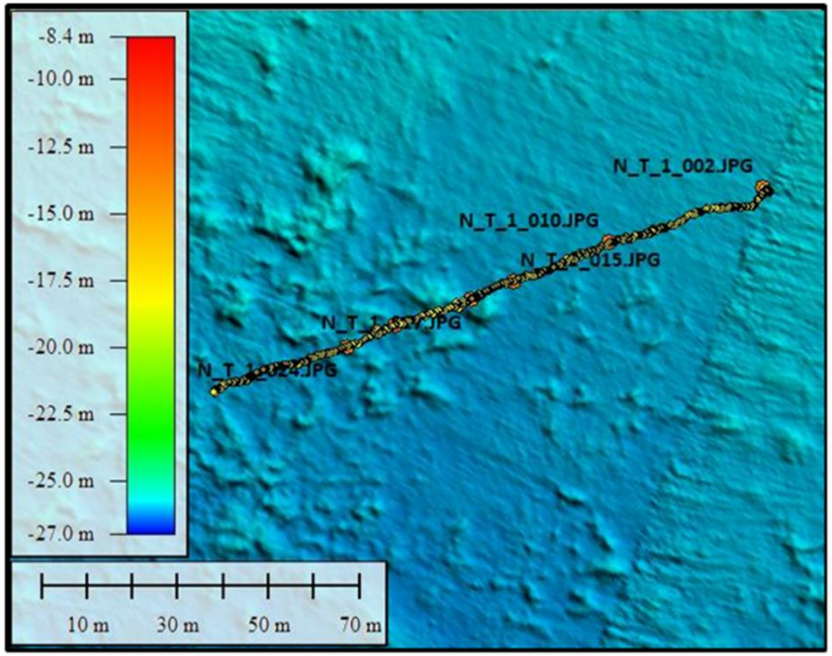
Area of higher, variable reflectivity with many raised areas.

Sediment Description

Slightly gravelly/shelly coarse sand forming irregular ripples or *Lanice conchilega* aggregations.

Conspicuous Fauna

Cnidaria: Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), *Pagurus bernhardus* (Common hermit crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus* . **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Limanda limanda* (Dab), Pleuronectiformes sp., Actinopterygii sp.



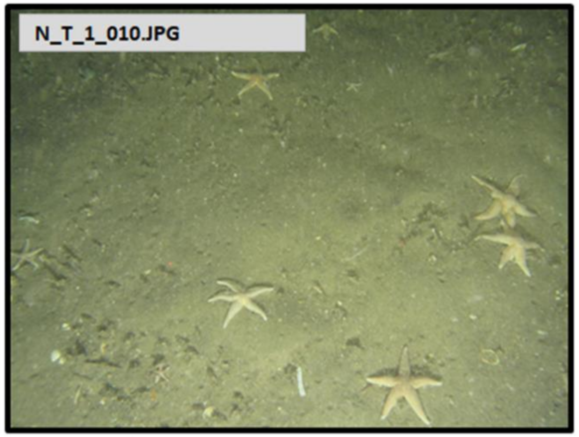


Photo Position: 721453 mE, 5954668 mN

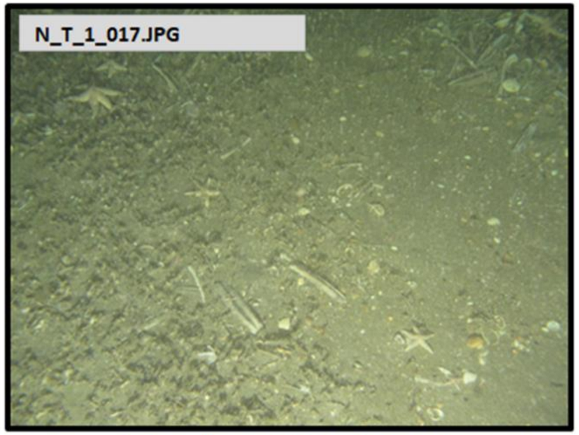


Photo Position: 721423 mE, 5954655 mN

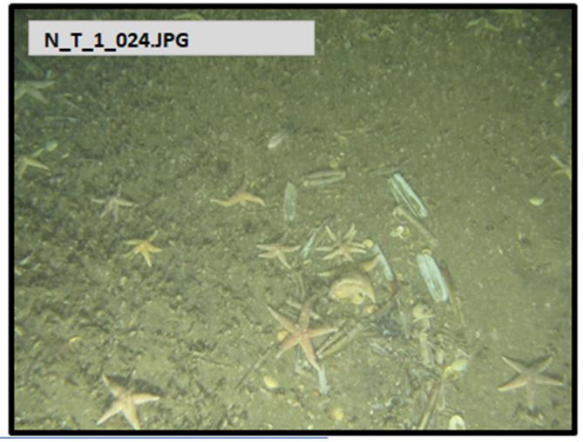


Photo Position: 721395 mE, 5954645 mN

Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: North Transect 2

Survey Area: N5a

No. of Stills: 41 | Mins of Video: 13 | Track Length: 165m

Site Selection Criteria

Investigating transition from low to mixed reflectivity sediment.

Analogue Interpretation

Area of higher, variable reflectivity with raised areas.

Sediment Description

Slightly gravelly/shelly coarse sand forming irregular ripples or *Lanice conchilega* aggregations.

Conspicuous Fauna

Cnidaria: Cerianthidae sp, Cerianthidae sp. **Annelida:** *Lanice conchilega* . **Arthropoda:** *Cancer pagurus* , *Pagurus bernhardus* , Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus* . **Echinodermata:** *Asterias rubens* . **Chordata:** *Callionymus lyra* , Pleuronectiformes sp., Actinopterygii sp.

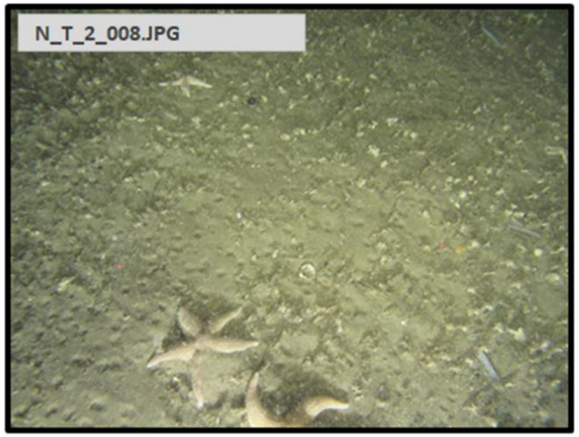


Photo Position: 721613 mE, 5955020 mN

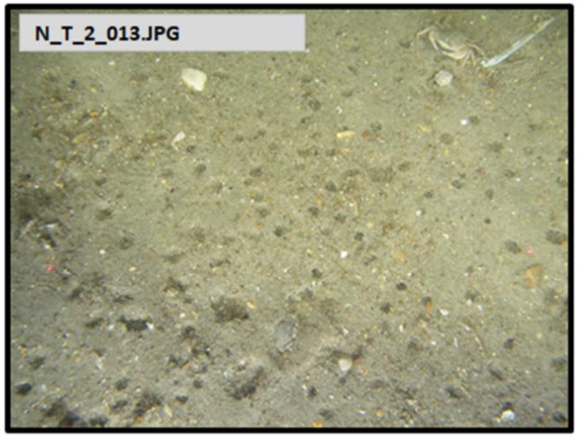


Photo Position: 721616 mE, 5955043 mN

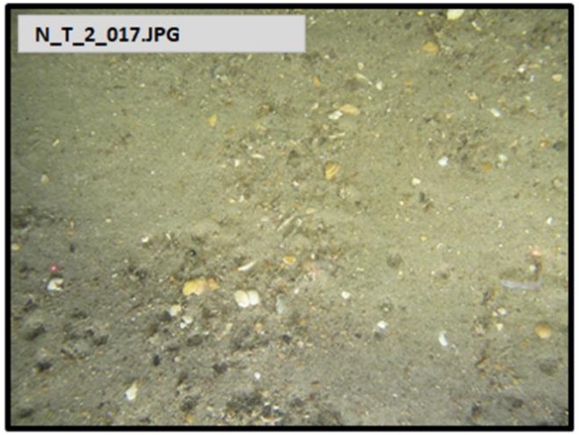


Photo Position: 721620 mE, 5955057 mN

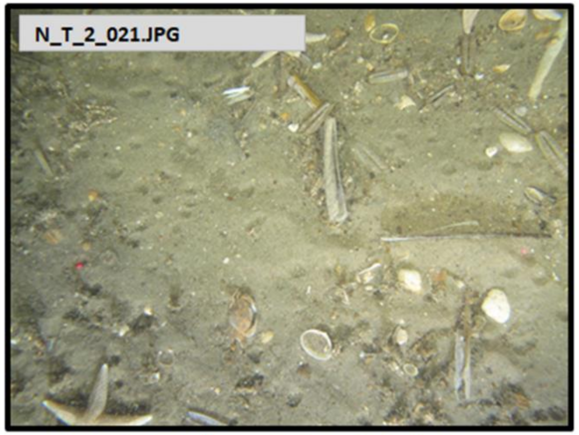


Photo Position: 721621 mE, 5955070 mN

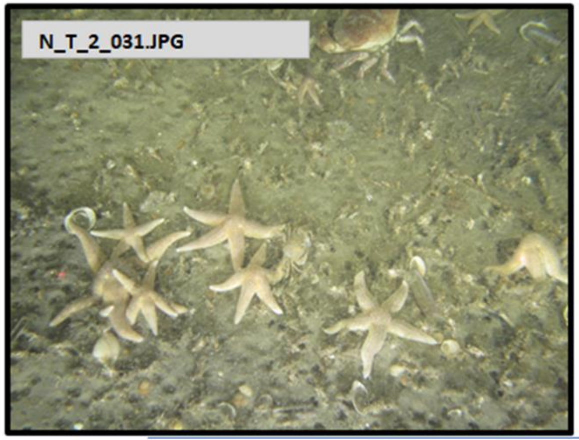


Photo Position: 721628 mE, 5955108 mN

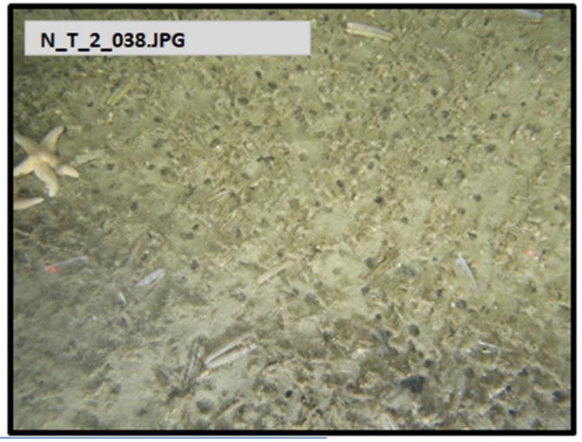
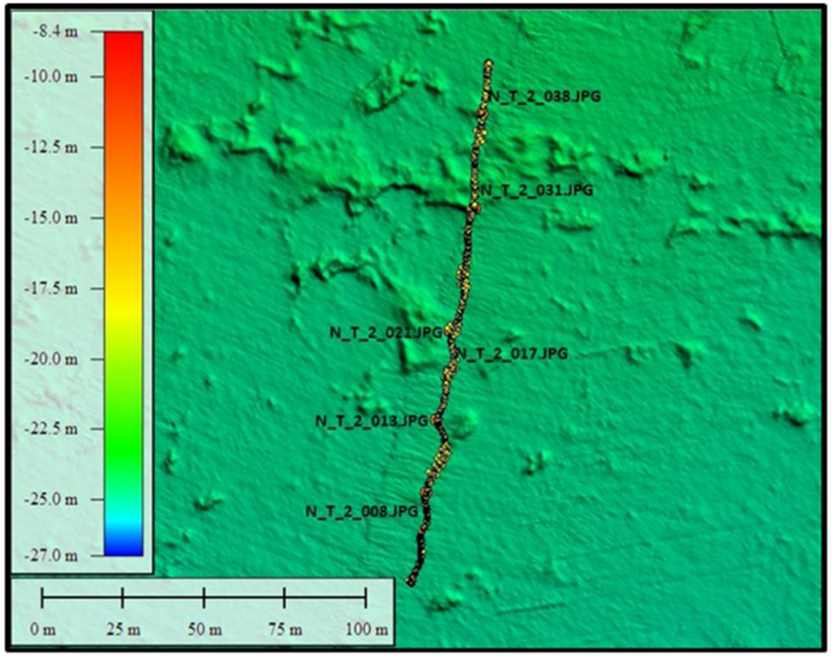


Photo Position: 721630 mE, 5955137 mN



Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

Habitat Summary Information: North Transect 3

Survey Area: N5a

No. of Stills: 50 **Mins of Video: 13** **Track Length: 175m**

Site Selection Criteria

Investigating transition from mixed to high reflectivity sediment.

Analogue Interpretation

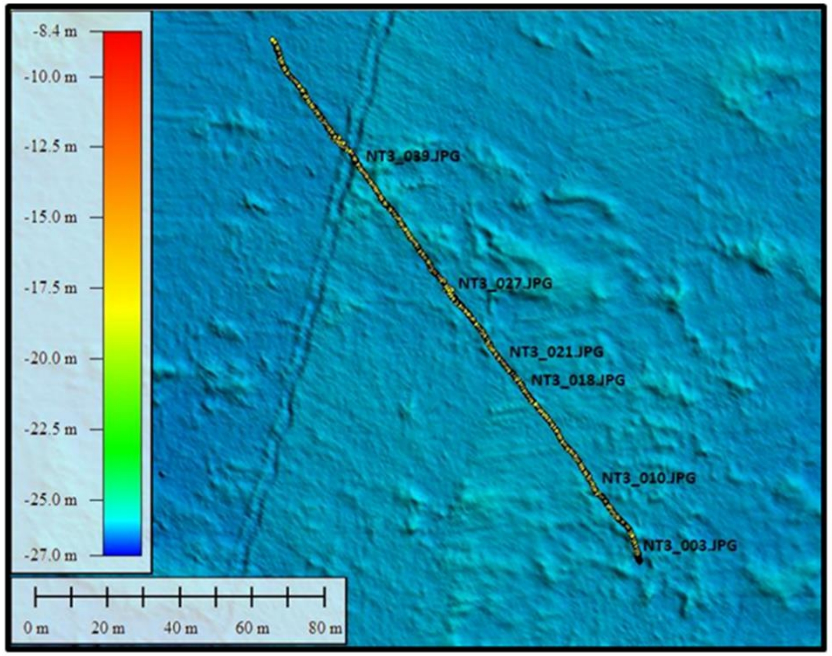
Area of variable reflectivity, some apparent scarring on seabed.

Sediment Description

Slightly gravelly/shelly coarse sand forming irregular ripples or Lanice conchilega aggregations.

Conspicuous Fauna

Cnidaria: *Metridium senile* (Plumose Anemone), Ceriantharia sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), *Pagurus bernhardus* (Common hermit crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus*. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Gobiidae sp., Pleuronectiformes sp., Actinopterygii sp., *Eutrigla gurnardus* (Grey gurnard).



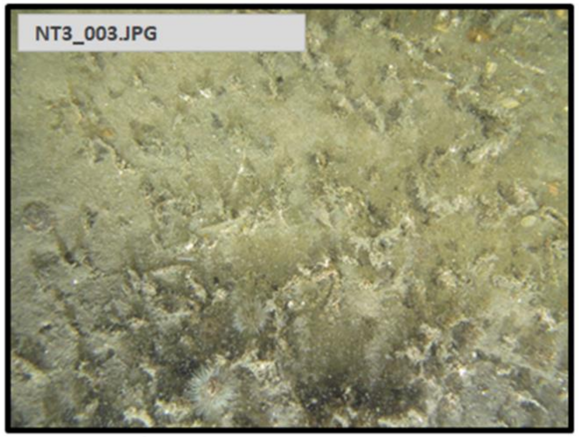


Photo Position: 721903 mE, 5954408 mN

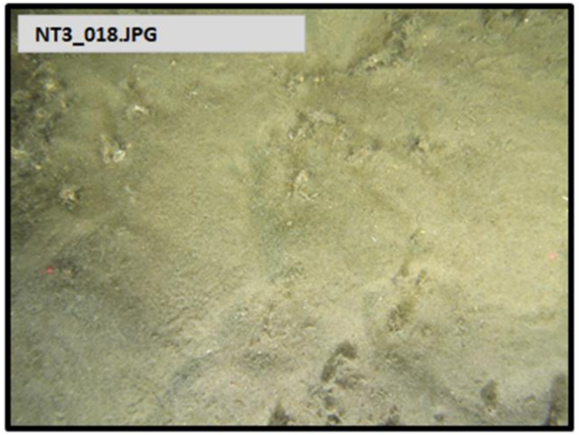


Photo Position: 721872 mE, 5954453 mN

Photo Position: 721852 mE, 5954480 mN

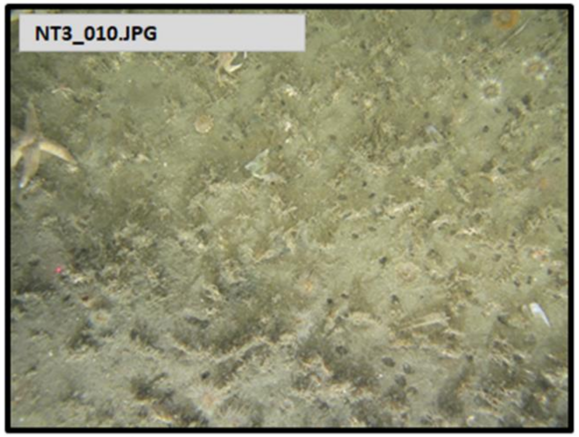


Photo Position: 721891 mE, 5954426 mN

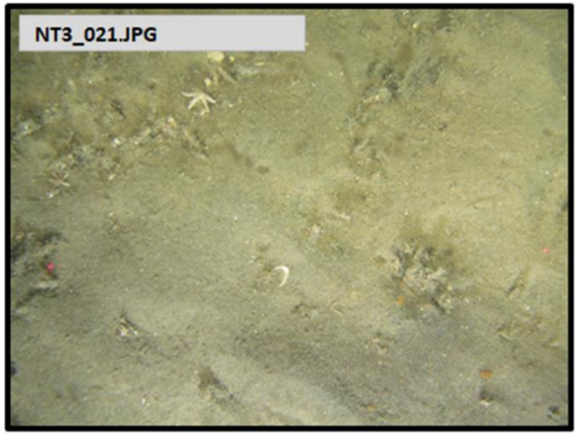


Photo Position: 721866 mE, 5954461 mN

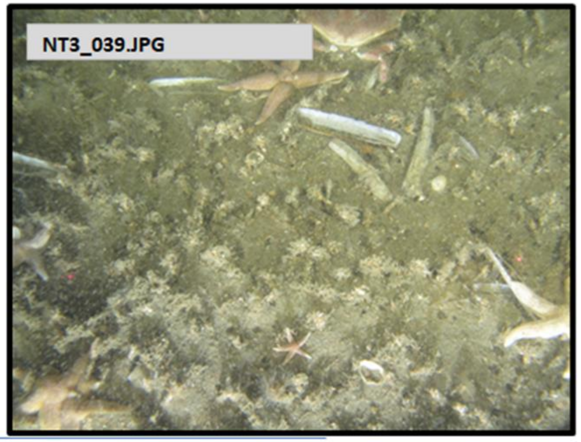


Photo Position: 721852 mE, 5954480 mN

Grab Location Camera Track Selected Underwater Still

Geodetic Infomation: Datum: ED50 Projection: UTM Zone: 31 North Central Meridian: 3° East

Habitat Summary Information: N5a Transect 1

Survey Area: N5a

No. of Stills: 35 **Mins of Video: 9** **Track Length: 130m**

Site Selection Criteria

Transect across original N5a well location.

Analogue Interpretation

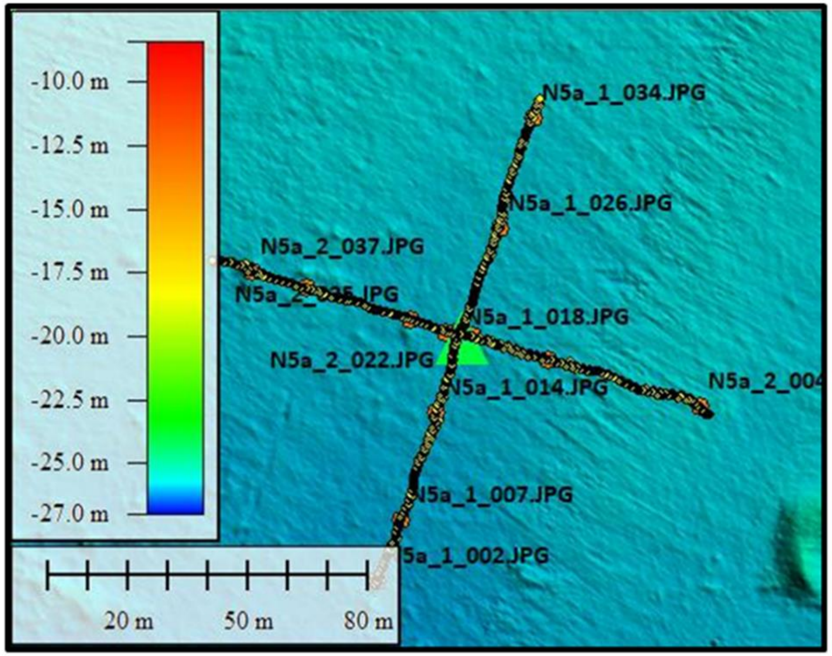
Area of low reflectivity with some scarring.

Sediment Description

Slightly gravelly/shelly coarse sand.

Conspicuous Fauna

Cnidaria: *Metridium senile* (Plumose Anemone), Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus* . **Mollusca:** *Sepiola* sp. **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Pleuronectiformes sp., Actinopterygii sp., *Eutrigla gurnardus* (Grey gurnard).



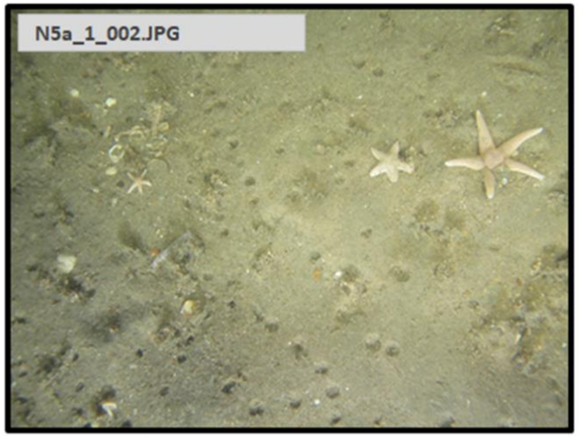


Photo Position: 721585 mE, 5954589 mN

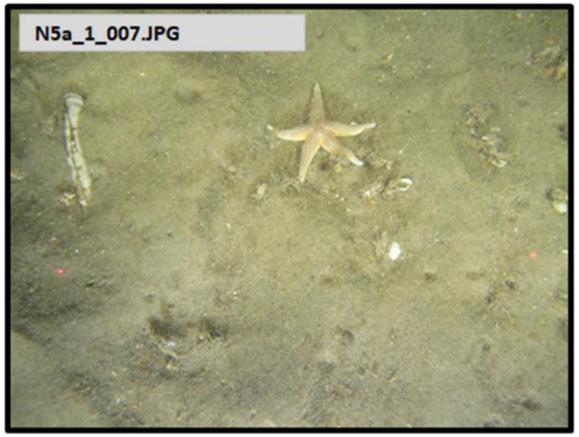


Photo Position: 721592 mE, 5954605 mN

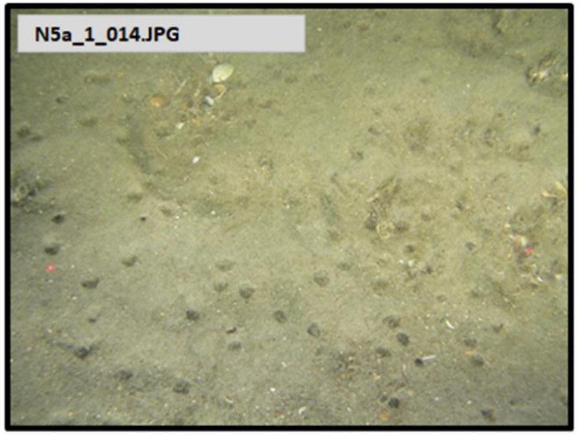


Photo Position: 721600 mE, 5954631 mN

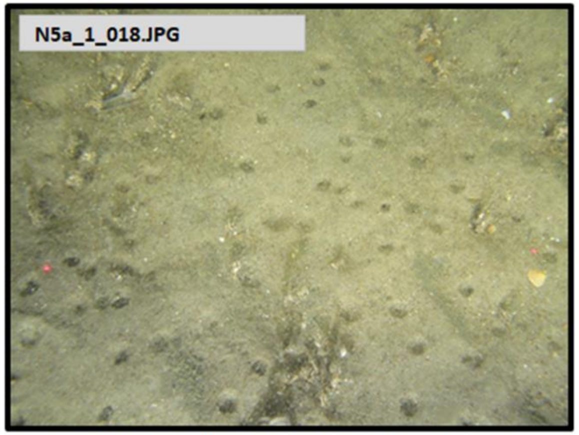


Photo Position: 721606 mE, 5954649 mN

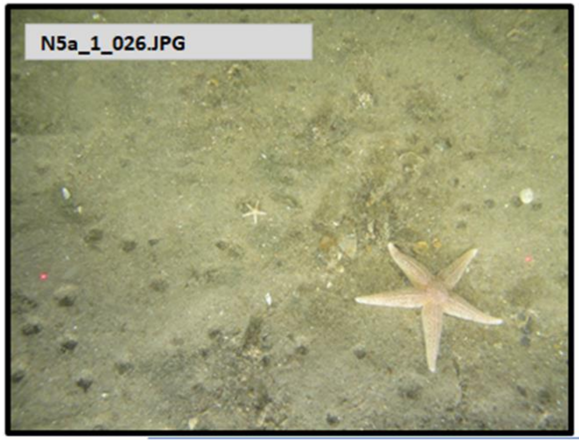


Photo Position: 721616 mE, 5954677 mN

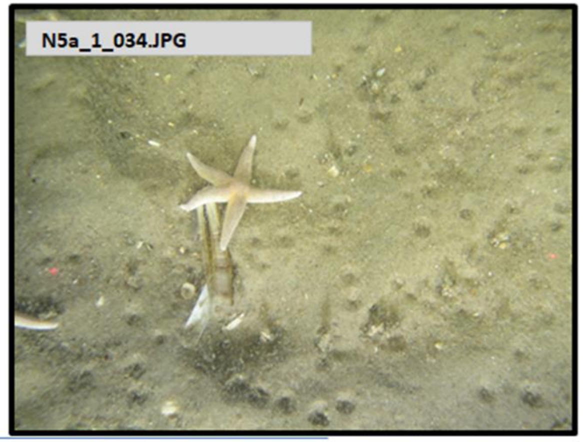


Photo Position: 721625 mE, 5954705 mN

Grab Location   Camera Track   Selected Underwater Still

Geodetic Infomation: Datum: ED50   Projection: UTM   Zone: 31 North   Central Meridian: 3° East

Habitat Summary Information: N5a Transect 2

Survey Area: N5a

No. of Stills: 39 | Mins of Video: 9 | Track Length: 130m

Site Selection Criteria

Transect across original N5a well location.

Analogue Interpretation

Area of low reflectivity with some scarring.

Sediment Description

Slightly gravelly/shelly coarse sand and aggregations of *Lanice conchilega* .

Conspicuous Fauna

Cnidaria: *Metridium senile* (Plumose Anemone), Cerianthidae sp. **Annelida:** *Lanice conchilega* (Sand Mason). **Arthropoda:** *Cancer pagurus* (Edible crab), Paguridae sp., *Liocarcinus* sp., Brachyura sp., *Cancer maenus* . **Echinodermata:** *Asterias rubens* (Common starfish). **Chordata:** *Callionymus lyra* (Common dragonet), Pleuronectiformes sp., Actinopterygii sp.

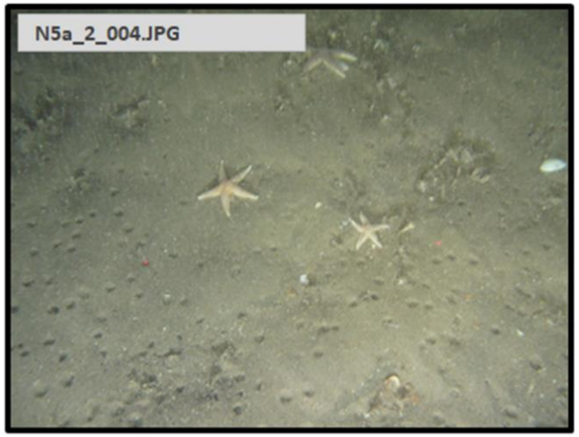


Photo Position: 721613 mE, 5955020 mN

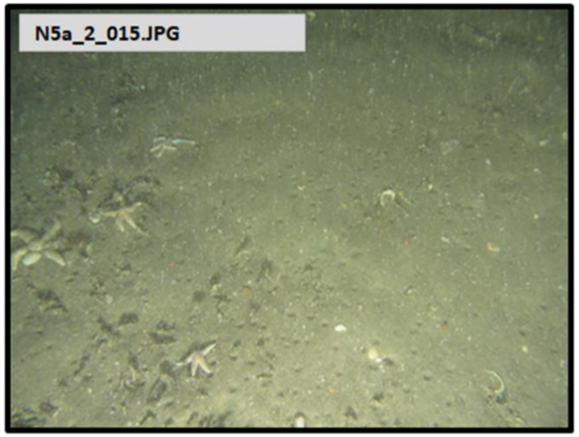


Photo Position: 721616 mE, 5955043 mN

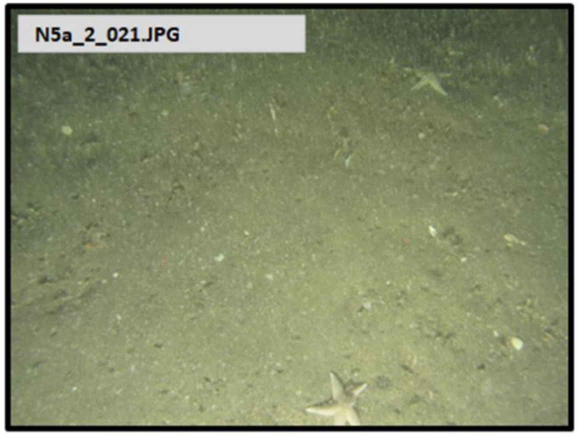


Photo Position: 721620 mE, 5955057 mN

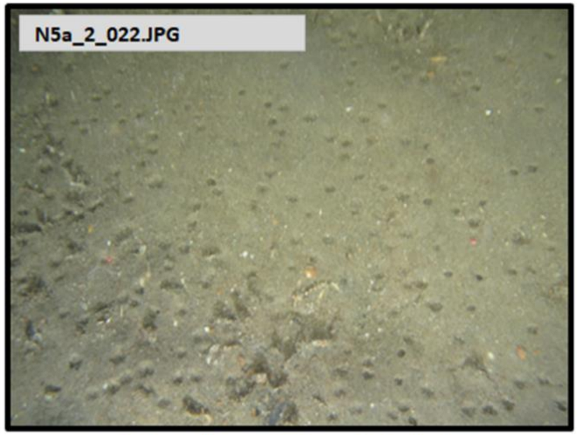


Photo Position: 721621 mE, 5955070 mN

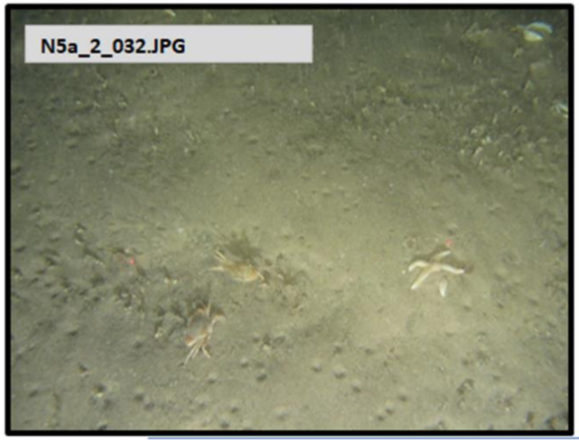


Photo Position: 721628 mE, 5955108 mN

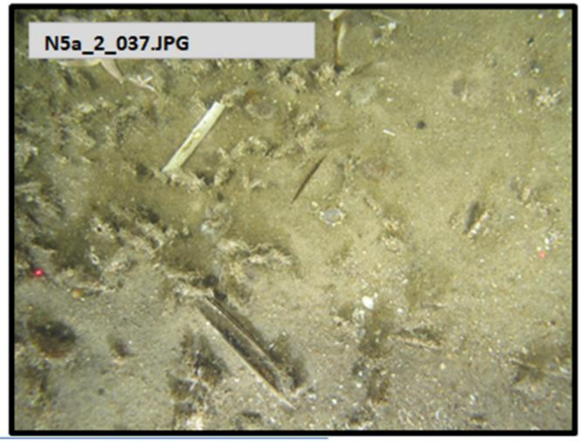
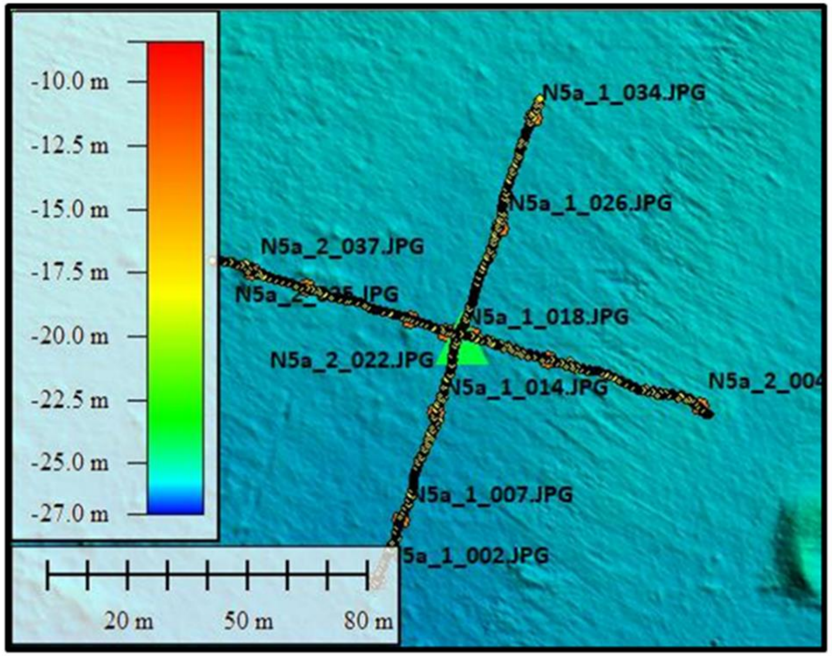


Photo Position: 721630 mE, 5955137 mN



Grab Location | Camera Track | Selected Underwater Still

Geodetic Infomation: Datum: ED50 | Projection: UTM | Zone: 31 North | Central Meridian: 3° East

APPENDIX I – SERVICE WARRANTY

This report, with its associated works and services, has been designed solely to meet the requirements of the contract agreed with you, our client. If used in other circumstances, some or all of the results may not be valid and we can accept no liability for such use. Such circumstances include different or changed objectives, use by third parties, or changes to, for example, site conditions or legislation occurring after completion of the work. In case of doubt, please consult Benthic Solutions Limited. Please note that all charts, where applicable should not be used for navigational purposes.