Neptun Deep Project

Final Geotechnical Interpretative Report Platform

Prepared By:	Fugro Geoconsulting Limited
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Neptun Deep Project

Final Geotechnical Interpretative Report Platform

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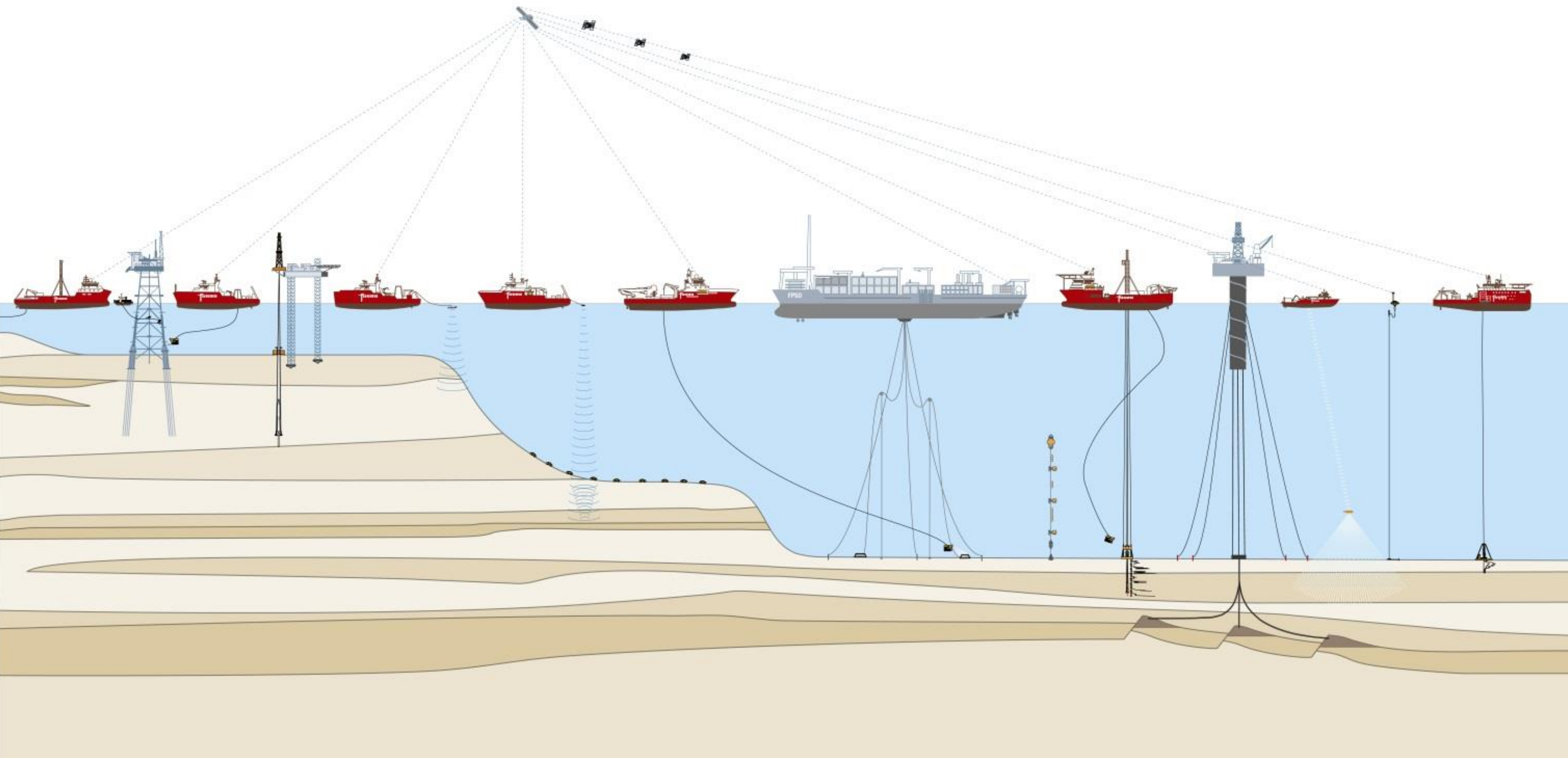
FUGRO

Platform Geotechnical Interpretive Report
Neptun Deep Survey
Pelican South Field

Fugro Document No.: 173570-05b(02)
Issue Date: 4 June 2018

ExxonMobil Exploration and Production Romania Limited

Final Report



FUGRO

Platform Geotechnical Interpretive Report
Neptun Deep Survey

Pelican South Field

Black Sea, Romania

Fugro Document No: 173570-05b (02)

Prepared for: ExxonMobil Exploration and Production Romania Limited

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Date: 4 June 2018

ExxonMobil Exploration and Production Romania Limited
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Bucharest
Romania

Dear Yvonne Moret and Patrick Lee,

Neptun Deep Survey
Pelican South Field, Black Sea, Romania

We have the pleasure of submitting the Platform Geotechnical Interpretive Report for Neptun Deep Survey. This report presents the interpreted geotechnical soil parameters, static axial pile capacity analysis, soil response springs and pile driveability analysis for the piles to be installed at the proposed Platform G location.

This report was prepared by Martin Gichura and Charles Bloore under the supervision of Mike Rattley and Alain Puech.

We hope that you find this report to your satisfaction; should you have any queries, please do not hesitate to contact us.

Yours Sincerely,
Fugro GB Marine Limited

Martin Gichura
Geotechnical Project Engineer

Distribution: One electronic copy to Yvonne Moret and Patrick Lee

QUALITY ASSURANCE RECORD

Section	Prepared By	Checked By	Approved By
Main text	MG/CB	DB/RWS/GML	MR/AP
Plates following the main text	MG	DB	MR
Appendix A – Guidelines On Use Of Report	Fugro	Fugro	Fugro

Notes:

The personnel stated above were responsible for preparing, checking and approving this report

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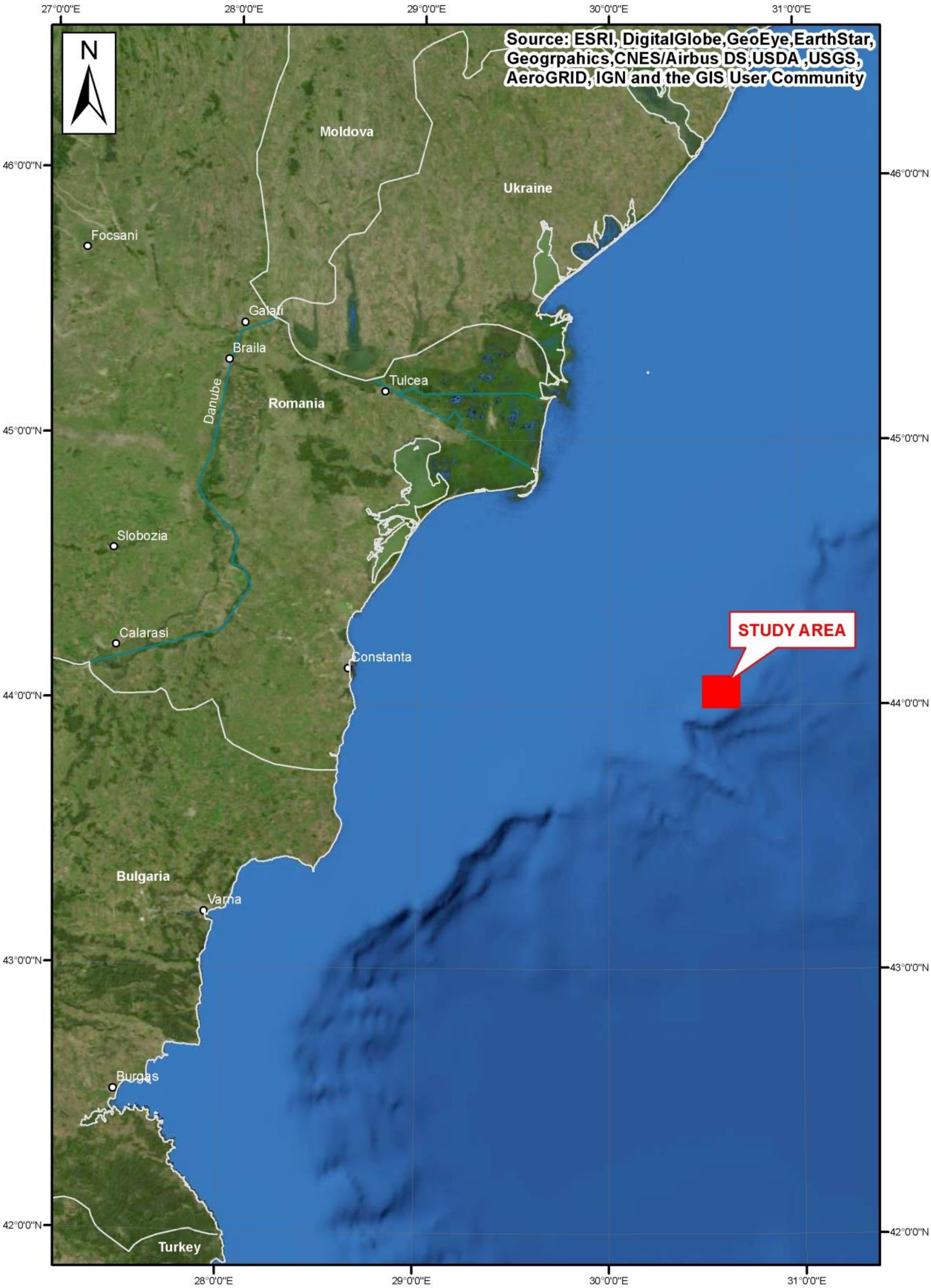
REPORT ISSUE LOG

Issue No.	Status	Reason for Issue/Reissue	Comments on Content	Date
01	Draft	First issue to client	Awaiting client comments	14 May 2018
02	Final	Final	Update of Draft report based on client comments	4 June 2018



FRONTISPIECE

EXECUTIVE SUMMARY

Introduction

ExxonMobil Exploration and Production Romania Limited (ExxonMobil) is developing the Pelican South Field and Domino Field in the Romanian sector of the Black Sea.

ExxonMobil requested Fugro GB Marine Limited (Fugro) to perform a geotechnical site investigation to provide soils information at the Pelican South Field and Domino Field. The fieldwork was performed from the MV Fugro Synergy from 28 December 2017 to 8 February 2018.

This report contains geotechnical parameters derived from the laboratory test data and engineering analyses for the proposed Platform G Location.

This report presents:

i. Design soil parameters for axial pile capacity and pile installation analysis derived from the In situ and laboratory testing data report (Fugro, 2018a);
ii. Axial pile capacity analysis and soil response spring data;
iii. Pile installation analysis.

Geotechnical Data

Geotechnical data from four boreholes at the proposed Platform G location were used to derive the design soil parameters presented in this report. Table S.1 summarises the borehole data used in this assessment.

Table S.1: Summary of Borehole Details

<table>
<tr><th rowspan="2">Borehole Name</th><th rowspan="2">Easting[a] [mE]</th><th rowspan="2">Northing[a] [mN]</th><th colspan="3">Water Depth[b] [m MSL]</th><th rowspan="2">Termination Depth [m BML]</th><th rowspan="2">Comment</th></tr>
<tr><th>Echosounder</th><th>Pressure sensor</th><th>Drill String</th></tr>
<tr><td>PG-BH-01</td><td>547 043</td><td>4 877 341</td><td>123.7</td><td>123.6</td><td>123.9</td><td>9.93</td><td>-</td></tr>
<tr><td>PG-BH-01a</td><td>547 037</td><td>4 877 343</td><td>123.7</td><td>123.7</td><td>123.9</td><td>125.9</td><td>Bump over (6.4 m) due to heading change</td></tr>
<tr><td>PG-BH-02</td><td>547 079</td><td>4 877 278</td><td>123.9</td><td>123.3</td><td>123.8</td><td>65.4</td><td>-</td></tr>
<tr><td>PG-BH-02a</td><td>547 079</td><td>4 877 286</td><td>123.9</td><td>123.7</td><td>123.8</td><td>100.5</td><td>Bump over (7.6 m) due to mechanical issues with seabed frame</td></tr>
<tr><td>PG-PH-01</td><td>547 039</td><td>4 858 029</td><td>123.5</td><td>123.7</td><td>123.4</td><td>40.0</td><td>Pilothole</td></tr>
<tr><td colspan="8">Notes:
a = Coordinate system WGS84 TM 30E
MSL = Mean sealevel
BML = Below mudline</td></tr>
</table>

Geological Setting

The proposed Platform G location is located on the shelf break in approximately 124 m water depth. This location was sensitive to changes in sea level throughout the quaternary.

At the proposed platform G location shallow gas is predicted to be present. Shallow gas observations were made during the drilling of the pilot hole and boreholes. These observations included bubbles of gas escaping from around the drill string during sampling and testing of PG-BH-01/01a, and the presence of gas within the samples following extrusion in the laboratory at all four locations.

Throughout the proposed Platform G location boreholes, changes in the structure of the clay samples were observed. The resulting soil fabrics are interpreted to represent changes in the post-depositional history of the sediment, including the presence or previous occurrence of gas within the sediment. The soil fabric may affect the strength of the sediment, depending on the specimen orientation and mode of shearing. Due to these soil structure variations there is a significant variance between index strength measurements, and the interpreted CPT and onshore laboratory test strength test measurements.

Design Soil Parameters

The following design soil parameters were derived and are presented in this report.

i. Water Content (w)
ii. Total Unit Weight (γ)
iii. Cone penetration test (CPT) Cone Resistance (q_c)
iv. Undrained Shear Strength (s_u)
v. Relative Density (D_r)
vi. Friction Angle ($\emptyset'$)
vii. Overconsolidation Ratio (OCR)
viii. Strain at 50% Peak Deviator Stress (ε_{50})
ix. Remoulded Strength (s_{ur})
x. Strength Sensitivity (S_t)

Low estimate (LE), best estimate (BE) and high estimate (HE) design soil profiles were derived to the depth of interest. The design profiles presented in this report are applicable specifically to the analyses presented in this report and should be carefully reviewed for any other purpose.

Engineering Analysis

The following engineering analyses were performed for the proposed Platform G location:

i. Axial pile capacity analysis;
ii. Soil response spring analysis;
iii. Pile driveability analysis.

Engineering analysis was performed for two piles sizes:

i. 2.134 m outer diameter pile with 50 mm uniform wall thickness;
ii. 2.438 m outer diameter pile with 50 mm uniform wall thickness.

Axial pile capacity analysis was performed to the full soil profile depth of 125.9 m BML which is the termination depth of the deepest borehole.

Pile Capacity Analysis

Axial pile capacity analysis was performed according to API (2011). Table S.2 summarises the calculated characteristic (unfactored) static axial pile capacities.

Table S.2: Summary of Characteristic Static Axial Pile Capacity

Piles	Outer Diameter [m]	Pile Penetration [m BML]	Shaft Friction [MN]	Total End Bearing[a] [MN]	Characteristic Static Pile Capacity[b]	
					Compression [MN]	Tension [MN]
Pile 1	2.143	125.9	99.5	8.0	107.5	99.5
Pile 2	2.438	125.9	113.5	10.5	124.0	113.5

Notes:
All values are unfactored
BML = Below mudline
a = End bearing only for compression loading only. Friction applies to both compression and tension loading
b = Capacity values presented are unfactored

Axial and lateral soil springs in clay and sand were derived based on API (2011) recommendations.

Pile Installation Analysis

Pile driveability analyses were performed for the Menck MHU 500T, MHU 800S and MHU3000 hammers. Best estimate (BE) soil resistance to driving (SRD) profiles were generated using the Toolan and Fox (1977) method. Table S.3 summarises the pile driveability results for the hammers analysed.

Table S.3: Summary of Pile Driveability Results

Hammer	Hammer Efficiency [%]	Self-Weight Penetration [m BML]	Expected Maximum Achievable Pile Penetration[a] [m BML]	
			2.134 m OD Pile	2.438 m OD Pile
Menck MHU 500T	90	9.5 – 13.5	94.0	91.0
Menck MHU 800S	90	9.7 – 14.2	99.0	97.5
Menck MHU 3000	90	15.0 – 21.2	112.5[b]	112.5[b]

Notes:
Driving pile refusal criteria were in accordance with the criteria defined in ISO (2007)
BML = Below mudline
OD = Outer diameter
a = Expected maximum achievable pile penetrations based on a pile refusal of 200 blows/0.25 m for continuous driving
b = Blow counts and induced stresses during pile driving through the dense sand layer should be monitored during installation

The Toolan and Fox (1977) SRD method does not consider friction fatigue and hence the blow counts presented in this report may be considered cautious for the pile lengths analysed but the outcomes considered are considered to be indicative for pile penetration and hammer selection.

Large self-weight penetrations are predicted. Therefore, significant care should be taken when commencing driving.

Fugro recommends that during and following pile installation signs of shallow gas should be monitored (e.g. gas bubbles formation along or inside the pile). If gas release is observed, then a potential remedial procedure which may be considered is drilling of relief wells to mitigate against the risk of pile down-drag.

CONTENTS

APPENDICES

TABLES IN THE MAIN TEXT

FIGURES IN THE MAIN TEXT

PLATES FOLLOWING THE MAIN TEXT

ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
BC	Boxcore

BE	Best estimate
BHA	Bottom-hole assembly
BML	Below mudline
BP	Before present
CAU	Anisotropically consolidated undrained triaxial
CID	Isotropically consolidated drained
CM	Central meridian
CPT	Cone penetration test
CRS	Constant Rate of Strain Oedometer
DSS	Direct Simple Shear
ERP	Emergency Response Plan
ExxonMobil	ExxonMobil Exploration Production Romania Ltd
FC	Fall cone
HE	High estimate
ISO	International Standards Organization
Ka BP	Thousand years before present
LAT	Lowest Astronomical Tide
LDPC	Large Diameter Piston Core
LE	Low estimate
LGM	Last Glacial Maximum
LV	Laboratory vane
LVr	Remoulded laboratory vane
MC	Moisture content
MSL	Mean Sea Level
MV	Marine Vessel
NE	North East
OCR	Overconsolidation ratio
OD	Outer Diameter
OED	Incremental oedometer
PC	Piston Core
PEP	Project Execution Plan
PP	Pocket penetrometer
SBF	Seabed Frame
SD	Standard deviation
SGMP	Shallow Gas Management Plan
SH	Shear wave
SRD	Soil Resistance to Driving
SSHE	Safety, Security, Health and Environment Plan
TM	Transverse Mercator
TN	Technical Note
TV	Torvane
ULS	Ultimate Limit State
UTC	Coordinated universal time
UTM	Universal Transverse Mercator
UU	Unconsolidated undrained triaxial
UUr	Remoulded unconsolidated undrained triaxial
WC	Water content
WGS	World geographic system

1. INTRODUCTION

1.1 Project Setting

The Neptun Deep development area is located within the Neptun Block, Black Sea, offshore Romania. The proposed development comprises a Platform Location (Platform G) at is approximately 124 m water depth tied to deep water drill centers by a flowline. The deepwater (Domino) drill centers are positioned in approximately 900 m water depth, 23 km south-east of the proposed Platform G location and Pelican South Drill Center. A second flowline runs from the Pelican Drill Center to the Platform. A production pipeline runs from the proposed platform location to shore. Figure 1.1 presents an overview of the proposed development.

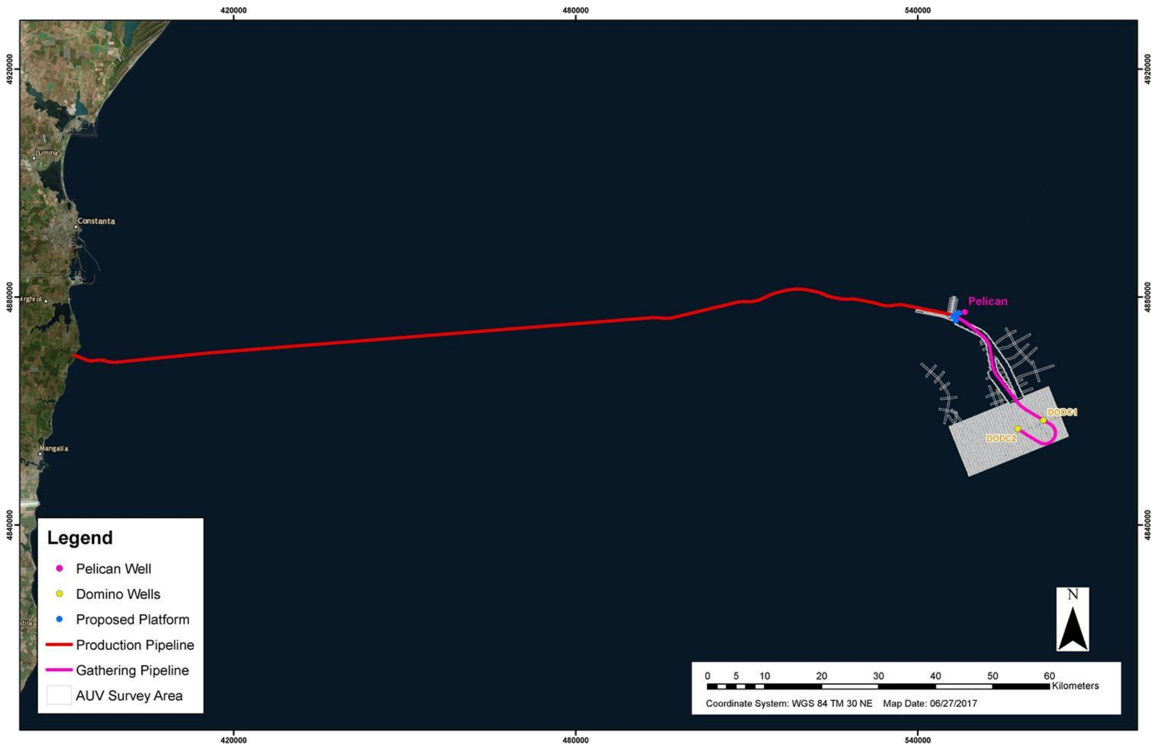


Figure 1.1: Main planned infrastructure associated with the Neptun Deep development area

1.2 Project Summary

ExxonMobil Exploration and Production Romania Ltd (ExxonMobil) contracted Fugro to acquire and report a geotechnical site survey for the proposed Platform G location, flowline route and three drill centres in the Neptun Block, Black Sea, offshore Romania. This work was carried out under Marine Site Survey order A2552390. Call Off 2 Change Order 6.

The scope of work comprised:

i. 4 seabed cone penetration tests (CPT);
ii. 7 sampling boreholes;
iii. 7 CPT boreholes;
iv. 14 combined sampling and in situ testing boreholes
v. 4 Pilot holes.

The site investigation was performed from the MV Fugro Synergy between 28 December 2017 and 08 February 2018.

The geotechnical data were acquired to assess the sub-seafloor conditions and to provide data for input to foundation design. This report forms part of a series of reports for the geotechnical site investigation; these reports are detailed in Table 1.1.

Table 1.1: Reporting Structure

<table>
<tr><th>Type</th><th colspan="2">Deliverable</th></tr>
<tr><td rowspan="5">Engineering / Interpretive</td><td colspan="2">WORK PACKAGE 4
INTERPRETIVE REPORTS</td></tr>
<tr><td>Integrated Report Update
Report Number: 173570-08</td><td>Slope Stability and Debris Flow Run-Out Modelling Update Report
Report Number: 173570-09</td></tr>
<tr><td>Geological Interpretative Report
Report Number: 173570-06</td><td>Site Response Analysis
Report Number: 173570-07</td></tr>
<tr><td>Geotechnical Interpretive Report Pelican Drill Center
Report Number: 173570-05a</td><td>Geotechnical Interpretive Report Platform
Report Number: 173570-05b</td></tr>
<tr><td>Geotechnical Interpretive Report Domino Drill Center
Report Number: 173570-05c</td><td>Geotechnical Interpretive Report Pipeline and Flowlines
Report Number: 173570 -05d</td></tr>
<tr><td rowspan="5">Factual</td><td colspan="2">WORK PACKAGE 3
FACTUAL/LABORATORY REPORT</td></tr>
<tr><td colspan="2">Laboratory and In situ Testing Data report
Report Number: 173570-04</td></tr>
<tr><td colspan="2">WORK PACKAGE 3
FIELD/RESULTS REPORTS</td></tr>
<tr><td>Operations Report
Report No.: 173570-01</td><td>MMO Report
Report No.: 173570-02</td></tr>
<tr><td colspan="2">Field Data Report
Report No.: 173570-03</td></tr>
<tr><td>Preliminary Data</td><td colspan="2">Preliminary Interpretation Technical Note
TN-173570-05</td></tr>
<tr><td rowspan="2">Execution</td><td>Project Execution Plan
Document No.: 173570-PEP</td><td>Safety, Security, Health and Environmental Plan
Document No.: 173570-SSHE</td></tr>
<tr><td>Emergency Response Plan
Document No.: 173570 -ERP</td><td>Shallow Gas Management Plan
Document No.: 173570-SGMP</td></tr>
</table>

1.3 Scope of Report

This report presents the geotechnical soil parameters for each defined geotechnical soil unit, for use in pile capacity analyses, derivation of soil response springs and pile drivability assessment of the piles to be installed at the proposed Platform G location. The following tasks were performed to present the results in this report:

i. Evaluation and interpretation of the geotechnical data for the platform location as presented in the laboratory and in situ testing Data Report (Fugro, 2018a);
ii. Derivation of representative design soil parameters for engineering analyses;
iii. Determination of axial pile capacity profiles in compression and tension according to the API (2011) design method;
iv. Generation of axial (t-z and Q-z) soil response spring data for a single pile based on API (2011) recommendations using axial capacity profiles derived in item iii.;
v. Development of lateral (p-y) soil response spring data for a single pile based on API (2011) recommendations;
vi. Derivation of soil resistance at the time of driving (SRD) using the Alm and Hamre (2001) recommendations;
vii. Prediction of pile driveability using the SRD derived in item (vi).

1.4 Data Sources

This report uses the results of the geotechnical site investigation to assess the soil conditions for the proposed Platform G location in the Pelican South Field. Table 1.2 presents the coordinates of the proposed Platform G location.

Table 1.2: Planned Platform Location

Description	Easting	Northing
Planned Platform G	547 062	4 877 318
Notes: Please refer to Table 1.4 for the appropriate coordinates reference system		

The data used in the preparation of this report were obtained during an offshore site investigation, including in situ tests and laboratory testing, and from the subsequent onshore laboratory testing programme. Details of the site investigation are presented in Fugro Document No. 173570-03(02) (Fugro, 2018b) and details of the laboratory testing programme are presented in Fugro Document No. 173570-04(03) (Fugro, 2018a). Table 1.3 summarises the boreholes completed at the Planned Platform G. Figure 1.2 shows the Platform G and the associated boreholes summarised in Table 1.3.

Table 1.3: Summary of the Geotechnical Locations at the Planned Platform Location

Location	Termination Depth [m BML]	Easting[a] [m]	Northing[a] [m]	Water Depth[b] [m MSL]	Sampling and Testing Details
PG-BH-01	9.93	547042.96	4877341.44	123.7	2 CPTs and 4 Pistons
PG-BH-01a[b]	125.90	547036.79	4877343.17	123.7	27 CPTs, 38 WIPs and 8 Pistons
PG-PH-01[b]	40.00	547038.99	4877349.63	123.9	Pilot hole, No testing
PG-BH-02[b]	65.35	547078.53	4877278.33	123.9	14 CPTs and 24 Pistons
PG-BH-02a[b]	100.45	547078.86	4877285.92	123.5	8 CPTs, 10 WIPs and 4 Pistons

Notes:
Excludes unsuccessful attempts
BML = Below mudline
CPT = Cone penetration test
Piston = 1 m PISTON SAMPLER®
Piston Liner = 3 m PISTON SAMPLER® with inner liner
WIP = Wireline push sampler
a = = Please refer to Table 1.4 for the appropriate coordinates reference system
b = = Based on echosounder measurements
b = Grouting completed

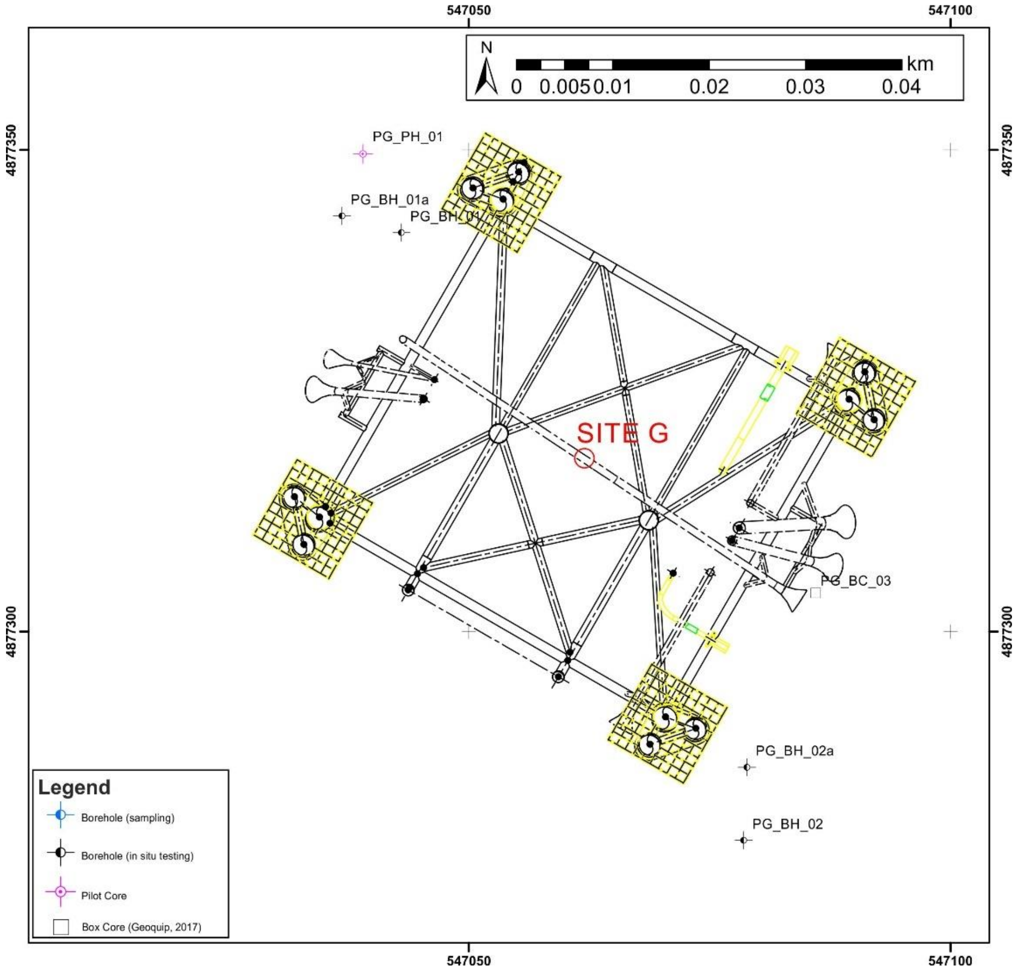


Figure 1.2: Location of Geotechnical Boreholes and Planned Platform Layout

1.5 Project Coordinate Reference System

Table 1.4 presents the geodetic parameters for this project.

Table 1.4: Project Coordinate Reference System Parameters

Geodetic Datum	
Datum	WGS84
Ellipsoid	WGS84
Semi-major axis	6 378 137.000 m
Semi-minor axis	6 356 752.314245179
Inverse flattening	$^1/_f$ = 298.257223563
Angular unit	Degrees
Map Projection	
Projection system	TM 30 NE
Central meridian	30º 00′ 00.00″ east
Latitude of origin	0º north
False easting	500 000.0 m
False northing	0.0 m
Scale factor on central meridian	0.9996
Linear unit	Metres

1.6 Guidelines on Use of Report

Appendix A (guidelines on use of report) outlines the limitations of this report, in terms of a range of considerations including, but not limited to, its purpose, its scope, the data on which it is based, its use by third parties, possible future changes in design procedures and possible changes in the conditions at the site with time. It represents a clear exposition of the constraints which apply to all reports issued by Fugro. It should be noted that the Guidelines do not in any way supersede the terms and conditions of the contract between Fugro and ExxonMobil.

2. GEOLOGICAL SETTING

2.1 General

Fugro (2015a) provides a comprehensive geological model for the Neptun Block based on a literature review and the results of the geohazard core logging (Fugro, 2014, 2015a). An updated geological setting will be presented in the updated integrated report for the site (Fugro Report number 173570-8) This section details the geological setting for the proposed Platform G location.

The north-western Black Sea is characterised by a wide shelf extending approximately 160 km from the Romanian coast. The Romanian continental slope dips gently to the south-east and is incised by a number of canyons. The largest of these canyons, the Viteaz canyon, is located west of the Neptun block. Canyons in the area were active sediment transport pathways, or subject to down-canyon processes during various time periods as a result of changes in sea level, sediment source and the position of the Danube delta. The proposed Platform G location is situated in between 123.5 m and 123.9 m water depth on the shelf edge. Water depth range is based on measurements taken from echosounder at the borehole locations (Table 1.3).

Geological processes in the Neptun block were controlled by global sea level change during the Quaternary. Figure 2.1 presents the sea level curve for the late Quaternary showing the changing water level in the Black Sea and environmental conditions over the last 40,000 years. The age dates presented in this section are based on publicly available data and the results of earlier phases of geohazard core logging (Fugro, 2014, 2015a). No site-specific age dating was carried out on sediments from the Platform G location.

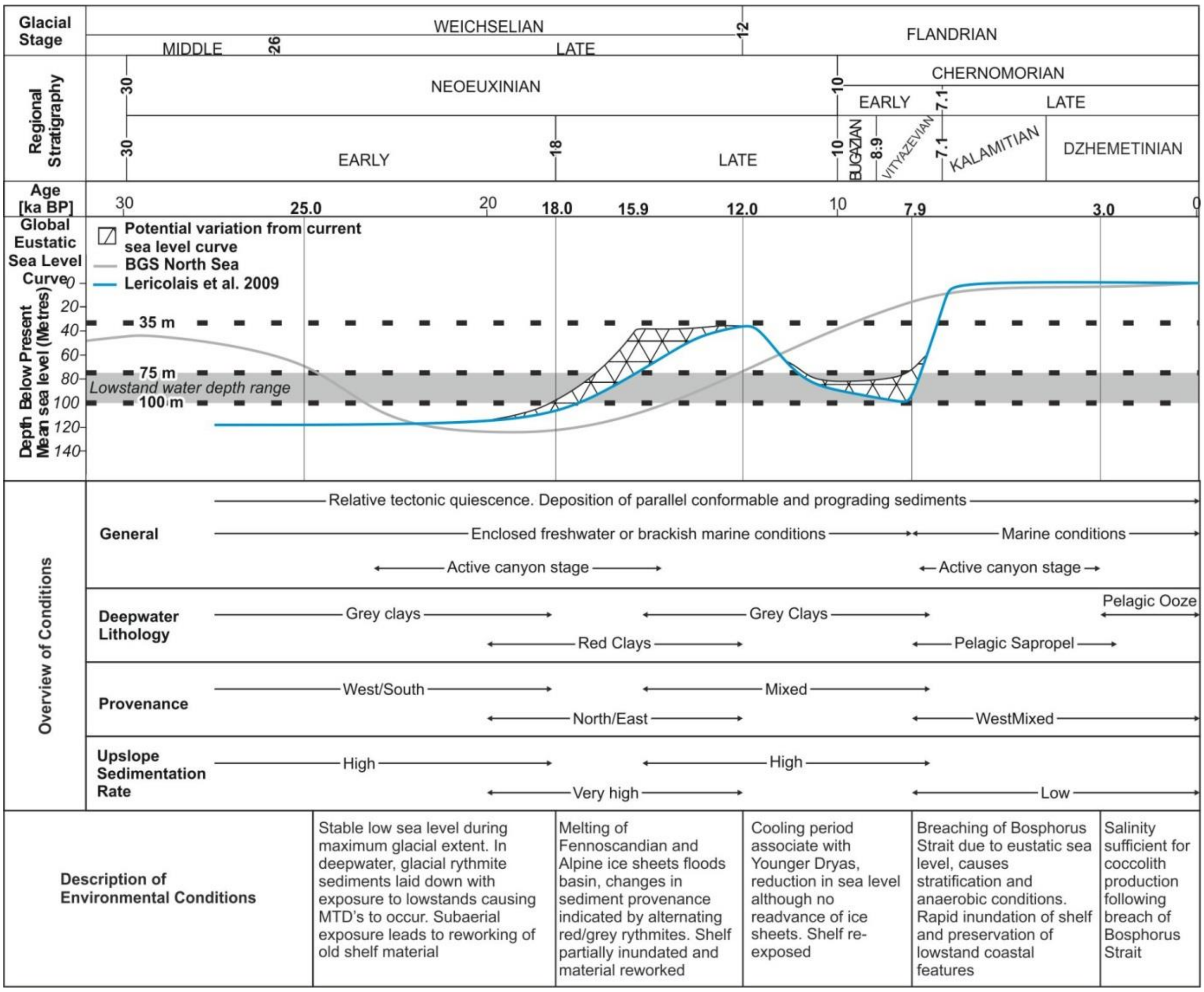


Figure 2.1: Sea level curve for the Neptun Block

Up to 8 ka (thousand years) BP the Black Sea was a fresh water lake fed by rivers from across Eastern Europe and Turkey, with its water level controlled by the advance and retreat of ice sheets. During this time sediment deposition in the deeper water areas was predominantly lacustrine clay. Global sea level rise at 8 ka BP, and the reconnection of the Bosphorus Strait and the flooding of the Black Sea led to the deposition of organic rich clay (sapropel) and coccolith ooze. The organic rich sapropel is not preserved in water depths less than 200 m; however, the shell rich surface layer observed at the proposed Platform G location represents the recent marine depositional environment following the flooding of the Black Sea.

Earlier lowstand events during the Younger Dryas (12.0 ka to 7.9 ka BP) and the last glacial maximum (25 ka to 30 ka BP) resulted in periods of higher sediment input which are interpreted to relate to greater canyon activity and slope instability. During these lowstands the proposed Platform G location is likely to have been in a nearshore or shallow marine environment.

The boreholes at the proposed Platform G location are likely to have sampled a number of different sea level and environmental changes that took place during the quaternary; these are observable in the chemical test results. Due to the absence of age dating in these sediment or publicly available boreholes in the Black Sea it is not possible to tie these units to particular events.

2.2 Site-specific Geological Setting

The proposed Platform G location is located on the shelf break in approximately 124 m water depth. This location is sensitive to changes in sea level throughout the Quaternary. Changes in sedimentary environment can be observed in variation of the chemical proprieties (Section 4.8) and the presence or absence of shell fragments

The sediment types identified in the boreholes reflect changes in the depositional environment at the shelf location and show the transition between a marine (oxygenated) and lacustrine (anoxic) environment.

Section 3.3 presents the geotechnical soil units sampled and tested at the proposed platform location. Section 3.4 presents details of the site-specific geological features that are present that need to be considered when designing foundations. Table 2.1 summarises the interpreted depositional environment for each geotechnical soil unit at the proposed Platform G location.

Table 2.1: Summary of Interpreted Depositional Environment

Geotechnical Unit	Depth to base of unit [m BML]		Description	Interpreted Depositional Environment
	PG-BH01/01a	PG-BH02/02a		
I	0.70	0.96	Extremely low strength to low strength CLAY	Reworking of underlying sediments following flooding of the Black Sea due to the influx of Mediterranean water
II	23.68	24.40	Low strength to medium strength foliated and fissured calcareous silty CLAY increasing to medium to high strength clay with partings of dark grey silt and medium- to widely-spaced laminae to thin beds of sand	Transitional marine/deltaic environment with periodic input of sand – the presence of biogenic gas suggests high input organic material breaking down to produce methane – interpreted to be deposited during last glacial maximum lowstand
III	41.49	41.60	Medium dense to dense slightly silty fine SAND with thick beds of high strength to very high strength CLAY	Nearshore high energy environment during a period of sea level fall during the quaternary
IV	112.50	100.45*	Medium strength to very high strength foliated dark greenish grey calcareous CLAY with partings and thin laminae of grey silt with closely- to widely-spaced medium beds of sand	Deepwater marine environment during the quaternary, shell- rich layers suggest the transition between oxic and anoxic conditions
V	124.10	-	Dense to very dense dark grey calcareous silica medium SAND	Nearshore high energy environment during a period of sea level fall during the quaternary
VI	125.90*	-	Very high strength CLAY	Marine environment

Notes:
Units are preliminary and may change following onshore laboratory testing
* = End of Borehole

3. GEOTECHNICAL PROFILE

3.1 General

This section details the geotechnical soil units observed in the boreholes at the proposed Platform G location.

3.2 Borehole Data

Four boreholes at two locations were drilled at the proposed Platform G location. Table 3.1 presents details of the boreholes used in this study. Downhole cone penetration tests (CPT) and sampling were performed in each of these boreholes.

Table 3.1: Geotechnical Boreholes Drilled at the Proposed Platform G Locations

Borehole Name	Easting[a] [mE]	Northing[a] [mN]	Water Depth[b] [m MSL]			Termination Depth [m BML]	Comment
			Echosounder	Pressure sensor	Drill String		
PG-BH-01	547 043	4 877 341	123.7	123.6	123.9	9.93	-
PG-BH-01a	547 037	4 877 343	123.7	123.7	123.9	125.9	Bump over (6.4 m) due to heading change
PG-BH-02	547 079	4 877 278	123.9	123.3	123.8	65.4	-
PG-BH-02a	547 079	4 877 286	123.9	123.7	123.8	100.5	Bump over (7.6 m) due to mechanical issues with seabed frame
PG-PH-01	547 039	4 858 029	123.5	123.7	123.4	40.0	Pilothole

Notes:
a = Coordinate system WGS84 TM 30E
MSL = Mean sealevel
BML = Below mudline
Planned Platform G location is at 547 062 mE 4 877 318 mN (Table 1.2). Figure 1.2 shows location of planned Platform G and geotechnical boreholes

Fugro (2018a) presents the geotechnical borehole logs, laboratory data and in situ CPT test data for the proposed Platform G boreholes.

3.3 Geotechnical Soil Units

There is good continuity between the four boreholes with the same geotechnical soil units observed in each of the boreholes. Table 3.2 presents the geotechnical soil units observed and the unit elevations for each borehole.

Table 3.2: Geotechnical Soil Units Observed in the Boreholes at the Platform G Location

Geotechnical Unit	Depth to base of unit [m BML]		Description
	PG-BH01/01a	PG-BH02/02a	
I	0.70	0.96	Extremely low strength to low strength CLAY
II	23.68	24.40	Low strength to medium strength foliated and fissured calcareous silty CLAY increasing to medium to high strength clay with partings of dark grey silt and medium- to widely-spaced laminae to thin beds of sand
III	41.49	41.60	Medium dense to dense slightly silty fine SAND with thick beds of high strength to very high strength CLAY
IV	112.50	100.45*	Medium strength to very high strength foliated dark greenish grey calcareous CLAY with partings and thin laminae of grey silt with closely- to widely-spaced medium beds of sand
V	124.10	-	Dense to very dense dark grey calcareous silica medium SAND
VI	125.90[a]	-	Very high strength CLAY

Notes:
Units are preliminary and may change following onshore laboratory testing
BML = Below mudline
a = End of Borehole

3.4 Geological Considerations

The boreholes exhibited geological features that require consideration when developing design soil parameters, these are discussed in Sections 3.4.1 to 3.4.2.

3.4.1 Shallow Gas

The proposed Platform G location is situated where shallow gas is interpreted to be present in the subsurface (Fugro, 2017). Before drilling the sampling and testing boreholes, a pilot hole was completed to provide an indication of the presence of shallow gas for the purposes of ALARP (as low as reasonably practicable) risk reduction for borehole drilling and sampling. Interpretation of the available geophysical data suggests that gas is present within sand and silt layers within Geotechnical Soil Unit II (Fugro, 2017). Geotechnical Soil Unit II is sampled to be present between 0.70 m and 24.4 m below mudline (BML) at the proposed Platform G location.

During the drilling of the pilot hole no gas was observed. However, during the drilling of the boreholes at the proposed Platform G location, observations were made regarding the presence of shallow gas. These included bubbles of gas escaping from around the drill string during sampling and testing of PG BH-01/01a, and the presence of gas within the samples following extrusion in the laboratory at all four locations. Table 3.3 presents the observations which were interpreted to be related to the escape of shallow gas within the sediments at the Platform G borehole locations.

Table 3.3: Summary of Observations of Shallow Gas During Drilling at Platform G

Borehole	Depth [m BML]	Comment from Drillers Logs	Duration [min]	Mud Pressure [bar]	Comment
PG-BH01a	17.0	Gas bubbles observed during CPT Test - bubbles seen on SBF camera while recovering CPT too	5	0.375	Gas escaping from silt and sand layers into the borehole. The depth of test being performed when the observation was made may not represent the origin-depth of the gas
	22.0	Gas bubbles observed at SBF camera following CPT test	4	0.500	
	97.5	Gas bubbles observed at SBF camera following CPT test	5	0.166	
PG-BH02/02a	-	No observations of shallow gas during drilling	-	-	No bubbles were observed escaping around the drill pipe at the seabed frame. Gas is interpreted to be present in the silt and sand layers. There are less sand and silt layers present in Unit II in PG-BH02 than PG-BH01 therefore less gas is interpreted to be present.
PG-PH-01 (Pilothole)	-	No observations of shallow gas during drilling		-	

Notes:
BML = Below mudline
SBF = Seabed frame
CPT = Cone penetration test

The escaping bubbles of gas from PG-BH-01/01a were identified on the seabed frame camera and were observed to persist for up to five minutes on three CPT tests following retraction of the CPT tool. It is interpreted that the gas escaping into the borehole may not be sourced from the depth where the test occurred and may be the result of gas escaping from sand or silt layers at shallower depths in the borehole, specifically Geotechnical Soil Unit II, and migrating to seafloor. There were no indicators of shallow gas blistering or escaping from within the samples whilst in the onshore laboratory, with no recorded gas alarms.

For PG-BH-02/02a there was no evidence of shallow gas escaping from the borehole during drilling.

CPT data were reviewed for evidence of shallow gas, where the presence of free-gas in more permeable layers (i.e. silty sand) may be identified as local overpressures (in excess of hydrostatic), where the free gas prevents the development of pore pressure reductions due to dilation.

Figure 3.1 and Figure 3.2 present the CPT pore pressure and cone resistance data against the interpreted borehole logs for Geotechnical Soil Unit II in BH01 and BH02/02a, respectively. In these figures, higher permeability layers are indicated by spikes in the CPT q_c profiles. The most significant spikes are generally accompanied by pore pressure measurements which fall toward or below the hydrostatic profile, indicating a tendency for dilation in the sands which is not prevented by the presence of free gas. This finding is consistent with the observations summarised in Table 3.3, which indicate a limited presence of free gas in permeable layers at the BH01a location. The bubbling observed after retrieval of the CPT may be due to the swabbing pressure at extraction of the tool. This would indicate that the fluid is quasi saturated in gas and that a small variation in total pressure causes exsolution. However, if no decrease in pressure is applied, free gas is not present. This is supported by the measured capacity of the sands to react against dilation by generating reductions in pore pressure, as noted above.

Figure 3.3 and Figure 3.4 present the same data for Geotechnical Soil Unit III in BH01 and BH02/02a, respectively. In this case a clear trend for measured pore water pressure below hydrostatic values is observed, indicating low potential for occurrence of free gas within Geotechnical Soil Unit III at these locations, also supported by the observational evidence summarised in Table 3.3.

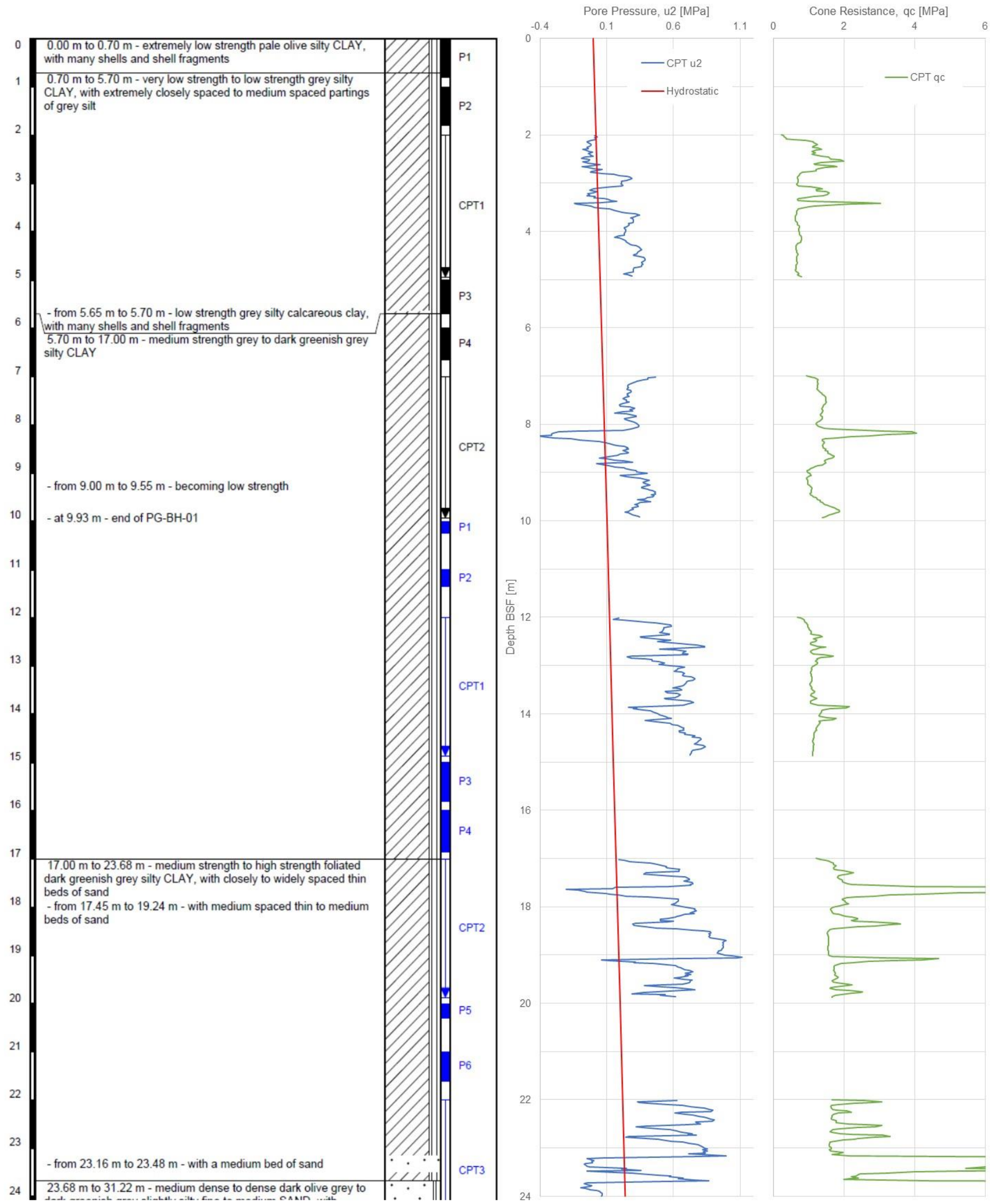


Figure 3.1: CPT data and logs within Geotechnical Soil Unit II at the PG-BH-01 location

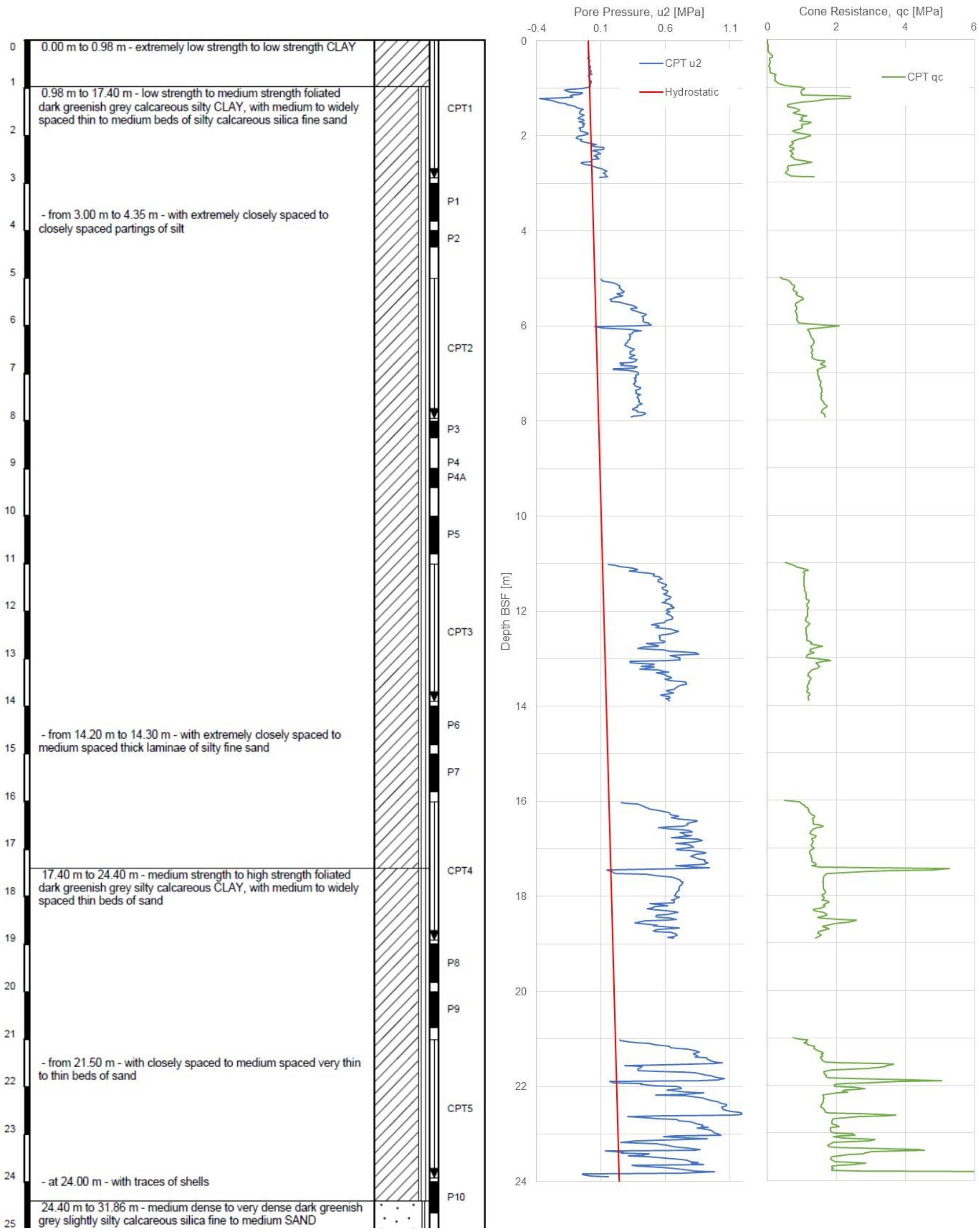


Figure 3.2: CPT data and logs within Geotechnical Soil Unit II at the PG-BH-02/02a locations

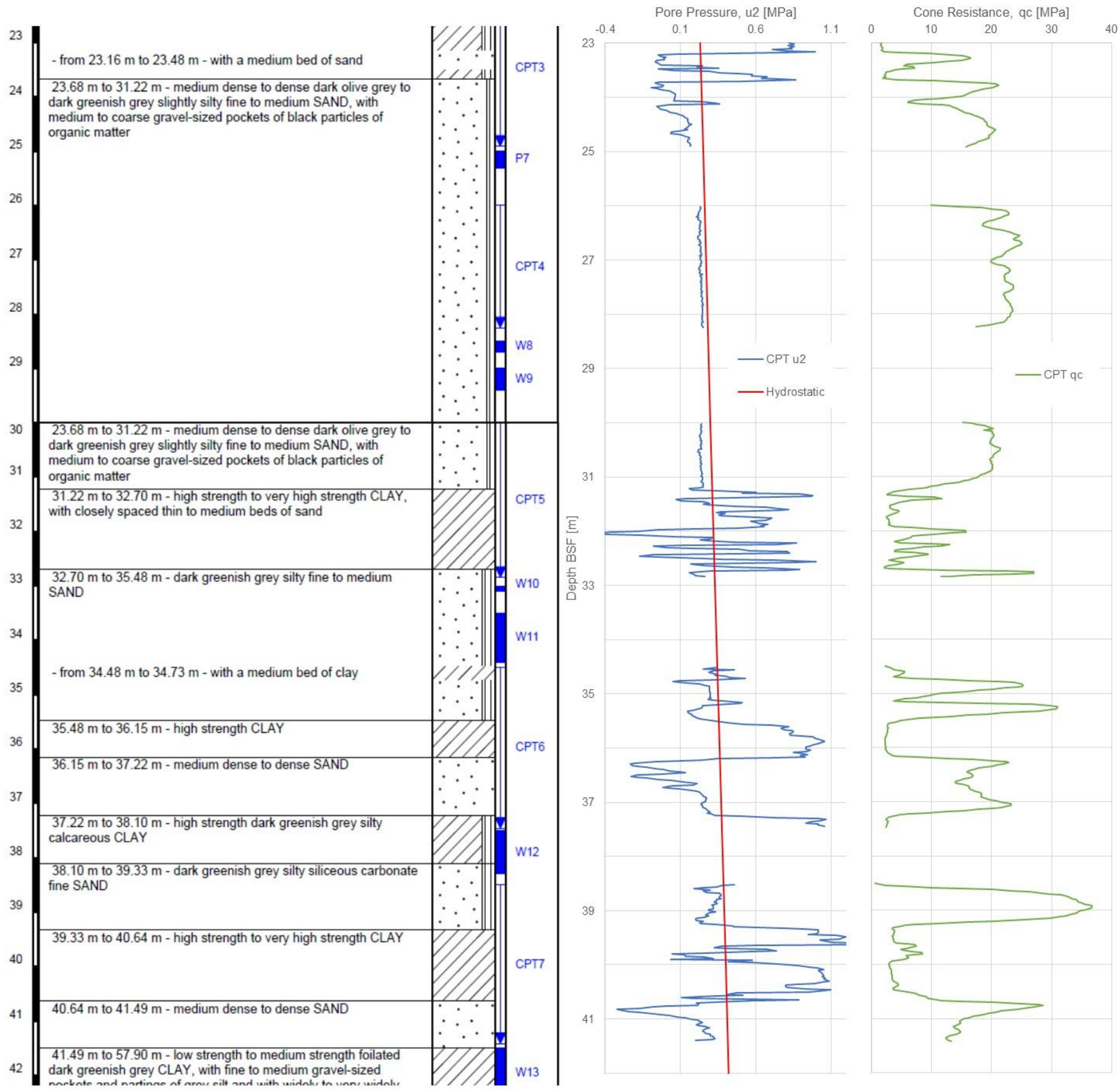


Figure 3.3: CPT data and logs within Geotechnical Soil Unit III at the PG-BH-01 location

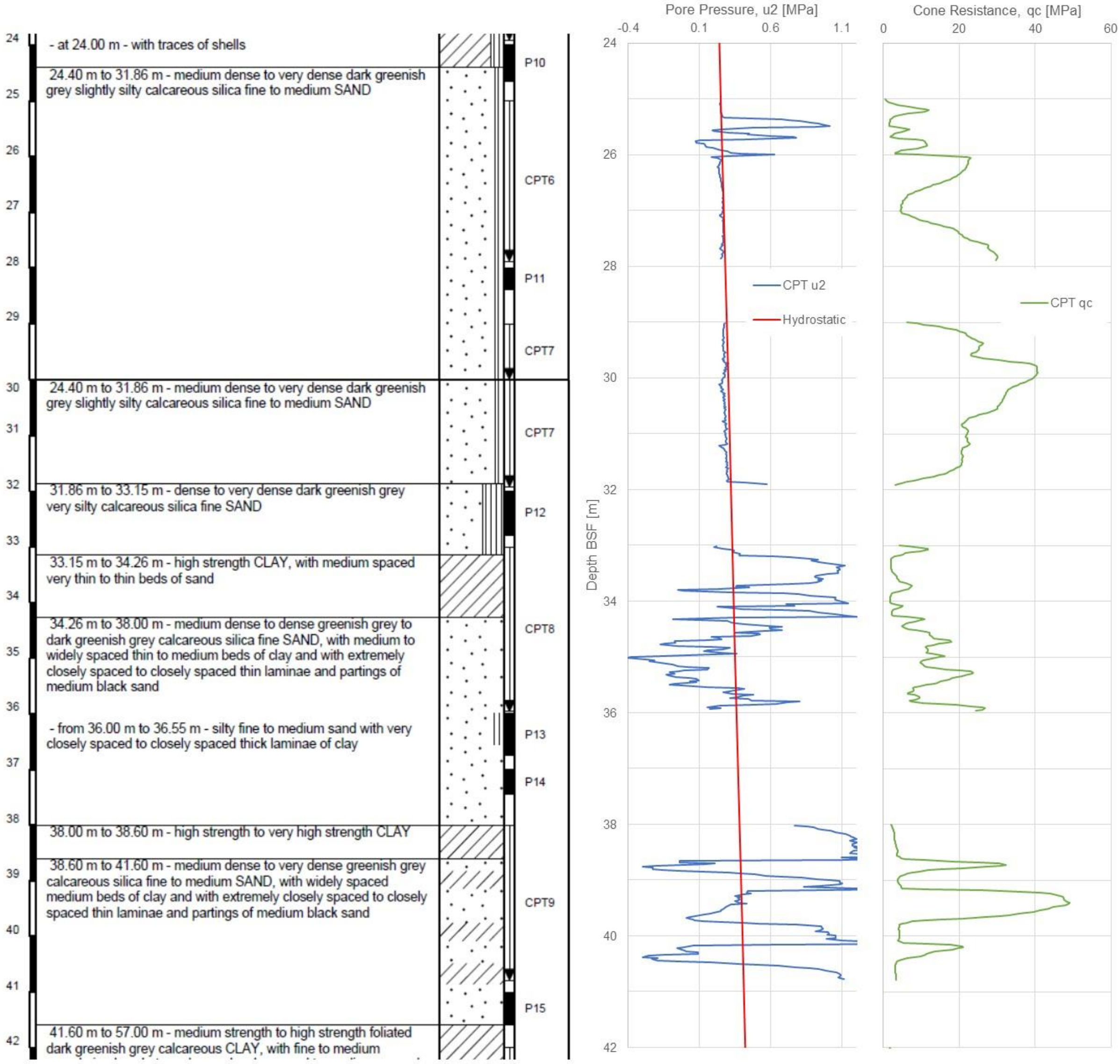
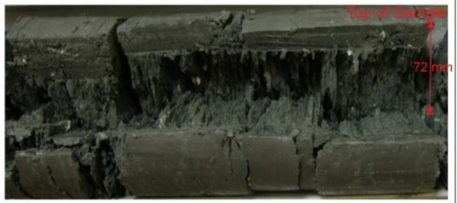


Figure 3.4: CPT data and logs within Geotechnical Soil Unit III at the PG-BH-02/02a locations

3.4.2 Soil Structure Observations

Throughout the proposed Platform G location boreholes changes in the structure of the clay samples were observed. The resulting soil fabrics are interpreted to represent changes in the post-depositional history of the sediment, including the presence or previous occurrence of gas within the sediment. The soil fabric should be considered when interpreting geotechnical laboratory test results as these will affect the strength of the sediment, depending on the specimen orientation and mode of shearing. Due to these soil structure variations there is a significant variance between strength measurements from index tests carried out offshore and the interpreted CPT profiles (See Section 4.4.2); strength profiles based on general correlation to CPT cone resistance may be expected to be more representative of the variations in the in situ soil strength. Onshore laboratory testing, including consolidated tests, carried out as part of the onshore laboratory testing programme should be used as a better indicator of the strength of the clay than index testing at these locations. Figure 3.5 presents examples of the soil fabric observed from samples taken at the proposed Platform G location. Figure 3.6 presents example of Geotechnical Unit III for comparison

Soil Structure Photographs

Unit	Depth [m BML]	Observation	Photograph
II	11.30	Fissured soil fabric fissures are discontionous sub-horizontal to vertical	
II	15.00	Fissured soil fabric fissures are discontinous sub horizonal sample splits along vertical fissure	
IV	75.50	Blocky to fissured fabirc, fissures are laterally discontinous and sub-horizontal	
IV	100.5	Foliated fabric well developed parallel horizontal foliations	

Soil Structure Photographs

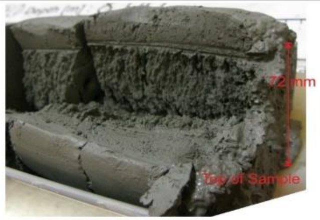
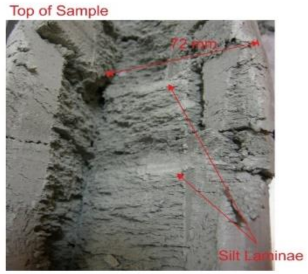
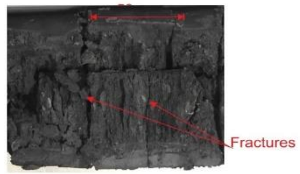
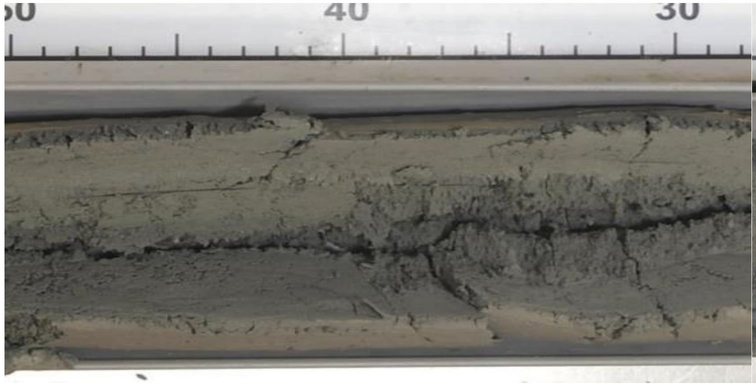
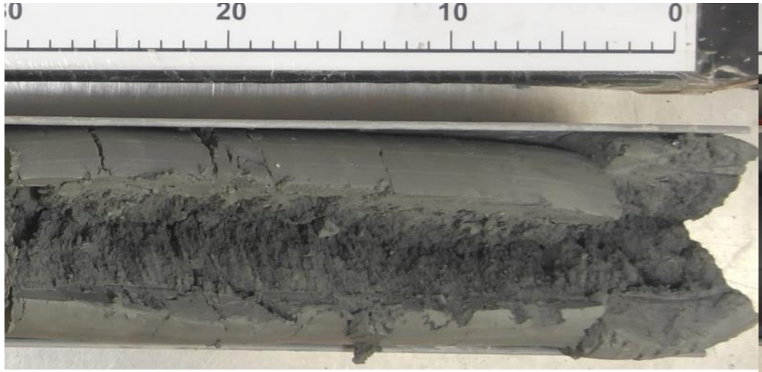
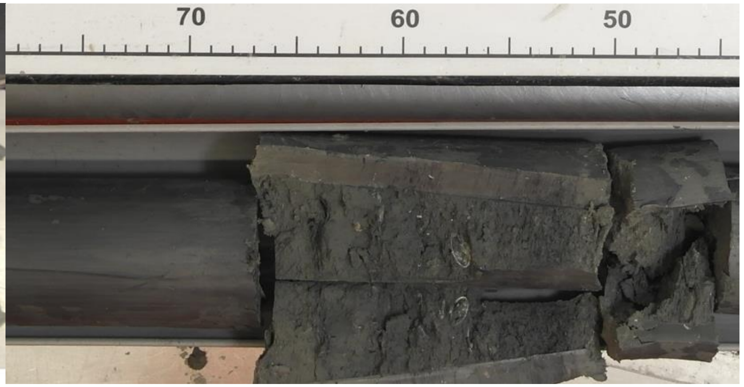
Unit	Depth [m BML]	Observation	Photograph
II	8.50	Fissured to foliated soil fabric fissures are discontionous sub-horizontal to horizontal	
II	20.50	Fissured soil fabric fissures are discontinuous sub horizontal with thick laminae of silt	
IV	55.20	Blocky to foliated soil fabric with thick lamina of silt fissures are sub-horizontal to horizontal	
IV	86.00	Blocky to foliated silty clay with sub-horizonatal fractures	

Figure 3.5: Soil fabrics observed at PG-BH-01/01a (left) and PG-BH-02/02a (right)



(A) (B)





(C) (D)

Figure 3.6: Example photographs of Geotechnical Soil Units II, III and IV. A: Geotechnical Soil Unit III, slightly silty fine sand (PG-BH-01a at 33.8 m; B: Geotechnical Soil Unit III, slightly silty fine to medium sand (PG-BH-02 at 28.3 m); C: Geotechnical Soil Unit II, sandy clay (PG-BH-01 at 5.3 m) and D: Geotechnical Soil Unit IV, silty clay (PG-BH-01a at 87.0 m)

4. INTERPRETATION AND EVALUATION OF GEOTECHNICAL DATA

4.1 Introduction

This section presents an interpretation and evaluation of the soil parameters at the proposed Platform G location within the Pelican field. The soil parameters discussed in this section are summarised in plates following the main text of this report. The plates present a selection of individual and/or composite plots with recommended representative low estimate (LE), best estimate (BE) and high estimate (HE) parameter profiles applicable for the foundation analyses presented in this report. The parameters profiles were derived statistically according to GL-DNV (2015) where appropriate and by engineering judgement.

The soil parameters discussed in this report were evaluated based on the geotechnical soil unitisation described in Section 3.3. No soil sampling was performed in Geotechnical Soil Unit VI and therefore only design soil properties defined either directly from or by correlation to CPT data are provided within this soil unit, with the exception of soil unit weight, which was required for the foundation analyses presented in this report.

LE and HE terms are used to represent a credible indication of the low and high distribution of the representative geotechnical parameters of the soil, with engineering judgement applied. It should be noted that the LE and HE terms are not necessarily lower or upper bound soil properties but rather recommended low or high values, which could be used as reference during derivation of soil parameters for soil capacity or the soil resistance for installation assessment, respectively.

The BE profile for a soil parameter is typically based on a statistical average of the available data from the geotechnical site investigations and subsequent laboratory testing. Experience based engineering judgement is applied as required to provide a representative BE profile.

4.2 Basic Soil Physical Properties

4.2.1 General

This section presents the following basic physical soil properties:

i. Moisture content;
ii. Particle density;
iii. Total unit weight;
iv. Plasticity data;

Sections 4.2.2 to 4.2.5 discusses the basic physical soil properties derived from field data and laboratory test data. In general, the basic physical soil properties are relatively consistent within the soil units and only minor data scatter is observed.

4.2.2 Water Content

Plate 1 presents water content (w) data versus depth plot. The LE, BE and HE design lines were derived statistically from the available data and using engineering judgement for each soil unit to identify outliers. The data presented indicates that:

i. The highest water content is observed in Geotechnical Soil Unit I with water content ranging from 64 % to 122 %;
ii. The water content ranges in Geotechnical Soil Unit II is observed to vary with depth. Between 0.8 m and 5.7 m BML the water content ranges from 32 % to 40 %. Between 5.7 m and 24.4 m BML the water content ranges from 29 % to 37 %. The elevated water content between 0.8 m and 5.7 m BML in the upper part of Geotechnical Soil Unit II is expected to have occurred as a result of the influx of saline rich porewater from higher salinity seawater following the breach of the Bosporus (see also Section 4.8.4) and is reflected in the design lines provided;
iii. The HE water content in Geotechnical Soil Unit III is taken to be consistent with that observed in the upper part of Soil Unit IV, despite the fact that Geotechnical Soil Unit III is identified as a sand while Geotechnical Soil Unit IV is identified as a clay. However, Soil Unit III is identified to have thick beds of clay. The HE bound in Soil Unit III is therefore representative of the occurrence of clay beds within this unit;
iv. Variable water content in Geotechnical Soil Unit IV is expected to be a result of changes in the depositional environment. These variations generally correlate well with the noted occurrence of silt and shell-fragments (Figure 4.1), and changes in chemical composition of the soil (see Section 4.8).

4.2.3 Particle Density

Plate 2 presents the particle density data versus depth profile. The LE, BE and HE soil profiles were determined by engineering judgement.

The particle density data is generally consistent within expected bounds for the various geotechnical soil units. Insufficient data was available to correlate observed variations in water content and unit weight in Soil Unit IV with changes in particle density. However, since variation in these parameters is considered to occur due to changes in depositional environment, rather than a variation in source material, it was considered that the particle density should remain relative constant with depth and this is reflected in the design profiles provided. The particle density BE profile was used to derive unit weight from water content data.

4.2.4 Unit Weight

Plate 3 presents the total unit weight (γ) data with depth. The unit weight data were determined from:

i. Volume-mass calculations from undisturbed samples;
ii. Measured water content and unitised BE particle density values.

Unit weight based on measured water content was generally higher than the volume-mass unit weights. The volume-mass unit weight measurements may have been affected by the presence of shallow gas in the sand and silt partings as noted in Section 3.4.1. Therefore, unit weight design lines were generally biased to data calculated from measured water content and particle density measurements.

From approximately 80 m BML in Soil Unit IV, the calculated γ are significantly higher than the volume-mass unit weights. This depth interval corresponds to a measured increase in biogenic methane gas, caused by a change in the depositional environment (see Section 4.9). This elevated presence of gas which may have compromised the volume-mass measurements.

BE submerged unit weight (γ') was determined from γ and used in axial pile capacity analysis, generation of soil response springs and pile installation analysis. Equation 4.1 describes the calculation of γ'.

$$\gamma' = \gamma - \gamma_w$$

Equation 4.1

Where:
γ_w = Unit weight of seawater (taken to be ~10.0 kN/m^3)

Fugro (2016) presents the pore-fluid salinity testing performed in the Neptun field. Results of the salinity tests show a general trend of decreasing pore-fluid salinity with depth. However, no tests were performed on samples in 2016 or 2018 to determine the effect of pore fluid salinity on the geotechnical properties of the samples. Therefore, a unit weight of seawater of 10 kN/m^3 was used in the analysis presented in this report. Fugro recommends performing a detailed assessment of the effects of seawater salinity on geotechnical soil properties.

4.2.5 Plasticity Data

Composite plots of plastic limit (W_p) and liquid limit (W_L) data were delineated into soil units and used to determine representative parameter profiles of plasticity index (I_p). The LE, BE and HE design lines for I_p were derived from the available data for each soil unit.

Plate 4 presents the plastic limit and liquid limit plot. Plate 5 presents the plasticity index versus depth plot. Equation 4.2 describes the calculation of I_p from the W_L and W_p.

$$I_p = W_L - W_p$$

Equation 4.2

Plate 6 presents the BS5930 plasticity chart. The clay soil units at the proposed Platform G location are determined to be predominantly of intermediate to high plasticity.

In the top 5.70 m BML within Soil Unit II a lower soil plasticity is inferred from the measured data which is not necessarily consistent with higher water content and lower unit weight values inferred for the same depth range. Although the plasticity data is limited, it is expected that the presence of silt partings, as noted in the borehole logs, will have affected the plasticity of the soils across this depth interval. This is reflected in the design profiles provided.

Variable plasticity in Soil Unit IV is expected to be a result of changes in the depositional environment. These variations correlate well with variations in moisture content and unit weight and considering the noted occurrence of shell-fragments (Figure 4.1) and changes in chemical composition of the soil (see Section 4.9).

Liquidity index (I_L) was derived from the plasticity data and water content (w). It relates the water content of a fine-grained soil to its plasticity data. Equation 4.3 describes the calculation of I_L:

$$I_L = \frac{w - W_P}{I_P}$$

Equation 4.3

Plates 7 presents I_L versus depth. The I_L plot shows that the I_L is generally decreasing with depth. Variations within Soil Unit IV are consistent with previous observations regarding the influence of changes in depositional environment. The I_L values observed are generally not indicative of a potential for extreme sensitivity or extremely low remoulded strength in the clay units present at the proposed Platform G location. However, I_L values approaching 1.0 are noted close to mudline in Soil Unit II. This is expected to have limited impact for design of deep driven jacket piles but should be considered further for jacket mudmat (temporary) stability.

4.3 In Situ Testing

Downhole CPT data acquired in the boreholes at the proposed Platform G location were used in deriving cone resistance (q_c) and sleeve friction (f_s) profiles. Correlations to CPT test data were also used to derive indicative undrained shear strength (s_u), relative density (D_r), overconsolidation ratio (OCR) and soil strength sensitivity (S_t) data.

4.3.1 Measured Cone Resistance Profile

Measured cone resistance data was derived from CPT data presented in Fugro (2018b). Plate 8 presents the unitised q_c data and the determined LE, BE and HE q_c profiles. Plate 9 presents the unitised q_c on an enhanced scale. The design profiles were determined based on engineering judgement. The LE q_c profile was used in deriving the s_u and D_r for pile capacity analysis and the HE profile was used for pile installation assessment and reference for D_r profiling for input into driveability analysis.

The measured q_c data was used to derive OCR as described in Section 4.5.2.

Within Geotechnical Soil Unit III only LE and HE q_c design profiles are provided. Theses profile represent the strength variation through the interbedded sand and clay units and highlight the different sand and clay characteristics. The LE q_c profile within Geotechnical Soil Unit III represents a predominantly clay (undrained) response adopted for the pile capacity analysis presented in this report while the HE q_c profile represents a predominantly sand (drained) response for the pile driveability analysis presented in this report. Other design profile variations within Soil Unit III, including a BE profile, are specific to the engineering analysis considered and should be derived based on the objectives of the analysis being performed. Hence these are not included in this report.

4.3.2 Sleeve Friction

Plate 10 presents the CPT sleeve friction with depth and a BE design profile derived using engineering judgement. The f_s data was used as a reference in deriving remoulded undrained shear strength and strength sensitivity (see Section 4.4.4 and Section 4.4.5, respectively).

f_s was also used in pile installation analysis to calculate the soil resistance during driving (SRD) in clay soil units (see Section 5.9.2).

4.4 Monotonic Undrained Shear Strength

4.4.1 General

This section details the methods used to determine monotonic undrained shear strength (s_u) for each soil unit present at the proposed Platform G location. LE, BE and HE s_u profiles were derived based on engineering judgement.

A LE design line of the s_u data was derived for pile capacity and soil spring analysis, considering the inherent variability in the data. A HE design line of the s_u data was derived for pile installation assessment. Plate 11 presents the s_u data and the derived LE, BE and HE design lines.

Geotechnical Soil Unit III which consists of interbedded sand and clay layers was modelled as clay (undrained) for pile capacity analysis and sand for pile installation assessment. The s_u within Geotechnical Soil Unit III was determined from q_c as described in Section 4.4.3.

4.4.2 Undisturbed Undrained Shear Strength from Laboratory Data

The s_u data were obtained from laboratory vane (LV) and unconsolidated undrained (UU) triaxial tests performed in the offshore laboratory. Direct simple shear (DSS) test data, UU and anisotropically consolidated undrained (CAU) triaxial test data from the onshore laboratory testing were also used in determining s_u in clay soil units.

The s_u design profiles were biased on the direct simple shear (DSS), unconsolidated undrained and consolidated undrained laboratory test data within Geotechnical Soil Units I, II, IV. s_u from q_c was also used to inform the LE design profile in Geotechnical Soil Unit III and LE, BE and HE in Geotechnical Soil Unit VI where laboratory test data was not available.

Index strength test data from pocket penetrometer (PP) and torvane (TV) data were not considered representative of the soil strength due to the potential influence of soil structure and soil type on the measurements from these tests. A generally lower s_u was obtained from index tests (PP and TV) than from LV, DSS, UU and CPT. This is interpreted to be due to the high silt content and well developed subhorizontal to vertical fissure in the sediments in Geotechnical Soil Unit II. In Geotechnical Soil Unit IV horizontal to subhorizontal foliations are present in the soil which act as a failure surface for the TV tests. Further soil fabric observations are noted in Section 3.4.2. Therefore, PP and TV measurements were not considered in deriving the s_u design profiles provided.

4.4.3 Undisturbed Undrained Shear Strength from Cone Penetration Test Data

Undrained shear strength (s_u) was measured directly from laboratory testing and was also inferred from CPT data using Equation 4.4:

$$s_u = q_n / N_{kt}$$

Equation 4.4

Where:
q_n= Net cone resistance [kPa]
N_{kt}= Empirical factor relating cone resistance to undrained shear strength

N_{kt} factors of 15 to 20 were used to derive characteristic LE and HE s_u values from q_c data for input to pile capacity and pile installation analyses. Further review of the N_{kt} factors and detailed calibration of these values may be required for design progression or for strength profiling in Soil Unit II for mudmat (temporary) stability analysis.

4.4.4 Remoulded Undrained Shear Strength

The remoulded (s_{uR}) was measured using remoulded LV (LVr) and remoulded UU (UUr) test results. Plate 12 presents a composite plot for all geotechnical units. The s_{uR} design profiles were derived from the S_t design profiles described in Section 4.4.5 as input to pile driveability analyses and should be reviewed for input to any other engineering analysis. The HE S_t profile was used to derive the LE s_{uR} design profile while the LE S_t was used to derive the HE s_{uR} profile.

The residual LV test is prepared using the vane to remould the soil after the undisturbed test, as outlined in ASTM D4648 (1982). The LVr test consists of removal of the soil from the sample tube, physically remoulding the soil with a spatula, replacing the remoulded soil into a suitable container and testing as outlined in ExxonMobil G004 (2015). Four LVr tests between 56.0 m and 68.0 m BML were wetted up (i.e. subject to water content increases) for completion of thixotropy tests and were ignored in deriving the s_{uR} profiles provided for driveability analysis.

s_{ur} was also calculated from I_L according to Wroth (1979). Equation 4.5 describes the calculation of s_{ur} from I_L.

$$s_{ur} = 1.7\left[10^{2(1-I_L)}\right]$$

Equation 4.5

Values of s_{uR} were also determined from CPT f_s. According to Lunne et al., (1997) f_s from an electric cone is approximately equal to the s_{uR}. In this report LE s_{uR} is considered to be inferred from 2/3 f_s based on Fugro experience.

A large degree of variability is observed in the LV data. Generally, the results from UUr tests plot towards the upper bound of the dataset. The s_{ur} bounds have been calculated from the sensitivity data and are generally fit well with the results of the LV and UU tests.

4.4.5 Strength Sensitivity

The strength sensitivity (S_t) is calculated from the ratio of s_u to s_{ur}. The S_t was assessed based on undisturbed and remoulded LV and UU test results. Equation 4.6 was used to derive S_t from CPT data based on the recommendations of Schmertmann (1978).

$$S_t = {}^{N_s}\!/_{R_f}$$

Equation 4.6

Where:
N_s = Factor relating S_t to R_f
R_f = Measured friction ratio as determined from q_c and f_s

N_s factors of 3.5 and 9 were considered for derivation of S_t within Soil Unit II, given observations of elevated liquidity index in this unit. A N_s of 3.5 was considered in soil units IV and VI.

Plate 13 presents the strength sensitivity data and LE, BE and HE design profiles. The S_t profile derived from CPT data generally matches reasonable well with the available UU test data. For Soil Units II S_t profiles were selected using engineering judgement. The LE S_t. was based on the UU while the HE S_t. was tentatively based on a review of the LV tests results. For soil units IV and VI LE, BE and HE S_t. profiles were based on UU test data and CPT correlation. As also noted in Section 4.4.4, four LVr tests between 56.0 m and 68.0 m BML were ignored for derivation of design profiles, due to specimens being wetted up for thixotropic testing.

4.4.6 Strain At 50 % Peak Deviator Stress

Values of axial strain at 50 % maximum deviator stress in a triaxial test (ε_{50}) were derived from UU and CAU triaxial test data. Plate 14 presents the ε_{50} data and design profile used for lateral capacity analyses. A single BE design soil profile was derived for lateral soil spring analyses based on engineering judgement. In Soil Unit II the BE design line follows an average to the available CAU data. In Soil Unit IV this design line generally follows the lower bound to the available UU data.

ε_{50} values derived from UU test data generally show a high degree of scatter. The range of ε_{50} values considered by Reese et al. (1975) and Matlock (1970) are included on Plate 14, for reference. Further discussion on considerations for derivation of pile response data is included in Section 5.8.2.2.

4.5 In Situ Stresses and Stress History

4.5.1 General

This section presents the inferred stress history parameters for the proposed Platform G location. The following one-dimensional consolidation laboratory tests were performed to determine the stress history at the platform location.

i. Constant rate of strain (CRS) consolidation tests;
ii. Incremental oedometer consolidation tests results.

Results of the consolidation tests are presented in the laboratory and in situ testing data report (Fugro, 2018b) and were used to determine the stress history parameters.

4.5.2 Overconsolidation Ratio

Overconsolidation ratio (OCR) was derived from the preconsolidation pressure (p'_c) or maximum additional overburden pressure ($\Delta p'$) and estimated effective overburden pressure (p'_0). Equation 4.7 describes the calculation of OCR.

$$OCR = \frac{p'_c}{p'_0} = \frac{(p'_0 + \Delta p)}{p'_0}$$

Equation 4.7

The one-dimensional consolidation test data were used to derive p'_c based on the Casagrande (1936) method. Values of p'_0 were determined from the BE submerged unit weight assuming fully saturated soils and hydrostatic soil conditions.

In addition to the oedometer test data, OCR was also indirectly assessed from p'_0 and s_u determined from UU, CAU and DSS tests. Equation 3.4 describes the relationship used to estimate OCR, from s_u and p'_0 (Mayne, 1980):

$$OCR = \left(\frac{\left({s_u}/{p'_0}\right)_{oc}}{\left({s_u}/{p'_0}\right)_{nc}}\right)^{1/\lambda_0}$$

Equation 4.8

Where:
s_u = Undrained shear strength [kPa]
p'_0 = Effective overburden pressure [kPa]
$(s_u/p'_0)_{OC}$ = Ratio for overconsolidated soil
$(s_u/p'_0)_{NC}$ = Ratio for normally consolidated soil (taken as ~0.25)
λ_0 = 0.85

The strength ratio adopted for normally consolidated soil of 0.25 was selected based on general review of the available laboratory strength data.

OCR was also inferred from CPT data using the method outlined by Powell et al. (1988) where the shape of the normalised cone resistance (Q_t) profile is taken into account. Equation 4.9 and Equation 4.10 describe the calculation of OCR according to Powell et al. (1988).

$$OCR = Q_t \times k$$

Equation 4.9

Where:
k = An empirical constant [~0.2 to 0.22]
Q_t = Normalised cone resistance [MPa]

$$Q_t = \left(\frac{q_t - \sigma_{vo}}{\sigma'_{vo}}\right)$$

Equation 4.10

Where:
q_t = Total cone resistance [MPa]
σ_{v0} = Total overburden pressure [kPa]
σ'_{v0} = Effective overburden pressure [kPa]

Plate 15 presents the measured and derived apparent OCR using the above methods along with the recommended representative parameter profile. The BE design line was biased toward data from CRS consolidation tests. This design line infers that some small degree of structure may be present for the clay soils within Soil Unit IV, where the geological stress history infers OCR~1.

4.6 Relative Density

Relative density (D_r) was interpreted for the sand soils present in Geotechnical Soil Units III and V. D_r was determined from q_c using the Jamiolkowski et al. (2003) method for saturated sands. Plate 16 presents the D_r data.

The derived LE, BE and HE D_r design lines are representative for clean sand intervals within Geotechnical Soil Unit III and therefore do not consider the very low values indicated within the clay beds. D_r was used to infer internal friction angle ranges and skin friction limits according to API (2011) guidance.

4.7 Friction Angle

4.7.1 Internal Friction Angle

Internal friction angles (ϕ') were inferred from CID test data and from D_r based on general API (2011) recommendations. Plate 17 presents the ϕ' data and LE and HE design profiles. The design profiles were derived based on engineering judgement.

In Geotechnical Soil Unit III the LE ϕ' profiles were reduced by 5° based on the recommendations of API (2011) to account for the high fines content within this interbedded unit, as noted in the borehole descriptions and observed in the PSD test results.

The LE ϕ' design profile in sand was used to determine unit friction limits for pile capacity analysis based on API (2011). The HE ϕ' design profile was used for derivation of SRD for use in driveability analysis.

4.7.2 Soil-Pile Interface Friction Angle

Since no direct laboratory measurements were available, soil-pile interface friction angles (δ) were determined in sand for input to pile driveability assessment according to guidance provided API (2011). Equation 4.11 was used to determine δ from ϕ'.

$$\delta = \phi' - 5°$$

Equation 4.11

Plate 17 presents the δ design profiles derived according to Equation 4.11.

4.8 Chemical Composition

The chemical composition and salinity content tests were generally performed in accordance with the procedures presented in BS 1377. Table 4.1, Table 4.2 and Table 4.3 summarise the chemical content results per geotechnical soil unit. The results of the chemical composition will be briefly discussed in this report, where these tests can be used to further update the geological model for the site they will be discussed in the updated integrated report for the site (Fugro report number 173570-8).

The observed changes in chemistry are interpreted to have been caused by multiple transitions from freshwater to marine environments and agree with the geological model for the Neptun Block.

Table 4.1: Carbonate Content and Organic Content Test Results

Geotechnical Soil Unit	Carbonate Content [% as $CaCO_3$]		Organic Content [%]	
	Result Range	Number of Tests	Result Range	Number of Tests
II	8.0 – 12.7	8	0.9 – 1.4	6
III	5.9 – 11.6	3	0.8	1
IV	3.2 – 14.0	17	0.8 – 1.7	9
V	8.40 – 10.2	2	-	-

Table 4.2: Chloride Content Test Results

Geotechnical Soil Unit	Chloride Content [mg/l]	
	Result Range	Number of Tests
II	76 – 490	3
III	-	-
IV	-	-
V	-	-

Table 4.3: pH and Sulphate Content Test Results

Geotechnical Soil Unit	pH [-]		Sulphate Content [%]	
	Result Range	Number of Tests	Result Range	Number of Tests
II	8.0 – 8.7	7	28 – 100	7
III	-	-	-	-
IV	8.3 – 8.8	14	45 – 130	16
V	-	-	-	-

4.8.1 Carbonate Content

Plate 18 presents the composite carbonate content versus depth plot for all geotechnical soil units. Carbonate content tests were performed with the results expressed as a percentage by mass of carbonate (CO_3). Table 4.1 summarises the carbonate content data. The results range from 3.2 % to 14.0 %. Values are all considered low, with only small variations seen with depth. Geotechnical Soil Unit III and Unit IV show relatively uniform carbonate content. Geotechnical Soil Unit V shows more variability in carbonate content with a peak at approximately 80 m BML, described as extremely closely spaced to very closely spaced thin to thick laminae of black clay in the borehole logs, and smaller increases in carbonate content at approximately 100 m. These increases in carbonate content correlate with layers of shell fragments in the sediment. These layers represent possible changes in depositional environment where there was higher productivity and better preservation of the shell material in the sediment.

Carbonate in soils may result in a range of effects from light cementation between grains of soil to formation of lenses of highly cemented material that may affect the mechanical behaviour of the soils. As stated above, low carbonate contents were observed from the test results and no cemented beds were identified from offshore testing. Therefore, the impact of these carbonate contents on the soil response and related foundation analyses is expected to be low.

Figure 4.1: Example of shell-fragments in Geotechnical Soil Unit IV at 101.05 m PG-BH-01a

4.8.2 Organic Content

Plate 19 present the results of total organic content testing. Total organic content ranges from 0.8 % to 1.7 %. Table 4.1 summarises the organic content. Based on the BS 5930 (2015) soil classification, the measured range indicates that the samples tested are organic. This range is low as organic content testing was not completed on these geotechnical soil units during earlier surveys at the site. The inorganic nature of the sediments suggests that the sediments were deposited in an oxygenated shallow water environment without the stratification that is present in the Black Sea now. The highest organic content values were observed between 80 m and 112 m in Geotechnical Soil Unit IV, described as extremely closely spaced to very closely spaced thin to thick laminae of black clay in the borehole logs.

4.8.3 Chloride Content

Plate 20 present a composite plot of aqueous chloride content versus depth for locations at the proposed Platform G location. Table 4.2 summarises the chloride content. Only 3 tests were performed, all within Geotechnical Soil Unit II. A large degree of scatter is observed in the results. However, the general trend shows a decrease in chloride content with depth, this decrease is consistent with the sediments of Geotechnical Soil Unit II deposited in a freshwater lacustrine environment with the uppermost sediments showing an elevated chloride content due to the influx of higher salinity seawater following the breach of the Bosporus and the migration of chloride-rich porewater through the sediment column over the past 8200 years (Riboulot et al., 2018).

Chloride can cause an accelerated corrosion of steel. Results of the laboratory testing shows a general decrease in chloride content with depth. Measures to mitigate corrosion of steel due to chloride corrosion should be applied such as use of high yield steel piles or increasing wall thickness of piles.

4.8.4 Sulphate Content and pH

Plate 21 presents and Table 4.3 summarises sulphate content at the proposed Platform G location. Plate 22 presents and Table 4.3 summarises the pH at the proposed Platform G location. Sulphate content for Geotechnical Soil Unit II and IV is highly variable and ranges from 28 % to 130 %.

Sulphate values are interpreted to be elevated in Geotechnical Soil Unit II close to seafloor as a result of the influx of saline rich porewater from the higher salinity seawater following the breach of the Bosporus. Within Geotechnical Soil Unit IV there is some scatter in the sulphate content interpreted to be a result of changes in the depositional environment, these correlate with changes in carbonate content, shell fragments and organic content.

Sulphates can cause corrosion of steel and cracking of concrete due to chemical changes. Sulphates must be in solution to cause corrosion. Therefore, soil permeability and ground water mobility will have the greatest bearing on the severity of corrosion by sulphates. Geotechnical Soil Units III and IV are the most permeable units due to the high sand contents. Therefore, mitigation measures should be put in place to reduce the effect of corrosion of steel due to sulphates such as use of high yield steel piles or increasing wall thickness of piles.

The pH ranges between 8.00 to 8.70 across all samples; this is consistent with samples deposited in in a freshwater to marine environment. The highest tested pH values were in Geotechnical Soil Unit II close to seafloor and in Geotechnical Soil Unit IV between 80 m and 90 m. This trend matches the trend observed in the other chemical tests in the sediment.

4.9 Headspace Gas and Carbon Isotope Analysis.

Headspace gas analysis was carried out on 25 samples at the proposed Platform G location. Table 4.4 summarises the test results. Plate 23 presents the headspace gas results versus depth.

Table 4.4: Headspace Gas Analysis and Carbon Isotope Analysis Test Results

Geotechnical Soil Unit	Headspace Gas Analysis (Methane C1) [ppm]		Carbon Isotope Ratio (Methane C1) [13C versus 12C, δ13C]	
	Result Range	Number of Tests	Result Range	Number of Tests
II	1112.5 to 15066.32.	11	-50.2 to -83.5	6
IV	13.04 to 20084.61	15	-62.1 to -70.9	4

Notes:
ppm = Parts per million

The headspace gas values show that Methane (C1) is present in Geotechnical Soil Unit II and IV. The volume of gas is generally higher in Geotechnical Soil Unit II; however, there is more scatter in the results. Geotechnical Soil Unit IV shows lower levels of headspace gas than Geotechnical Soil Unit II; however, there is a step change in the volume of gas at 75 m BML reducing to a lower volume at

95.5 m BML. This is interpreted to be caused due by a change in the depositional environment at this depth, which is observable in the results of the other chemical tests. The volumes of gas observed in the sediment are similar to those observed in samples obtained during the 2014 geotechnical site investigation (Fugro, 2015b).

The carbon isotope ratio is calculated from the ratio of methane ethane and propane and is used to provide an origin for the gas (Equation 4.12).

$$C1/(C2 + C3)$$

Equation 4.12

Where:
$C1$ = Methane
$C2$ = Ethane
$C3$ = Propane

The carbon isotope ratio suggests that the methane in the sediment is biogenic in origin. The limited range in the measured carbon isotope ratio suggests that the methane in the sample has undergone the same process. Figure 4.2 shows the relationship between the Carbon isotope and the origin of the gas.

Previous testing carried out on samples from Neptun block (Fugro 2015b) suggested a Biogenic origin for the samples, this is supported by recent data from scientific cruises adjacent to the Neptun Block (Ifremer, 2015).

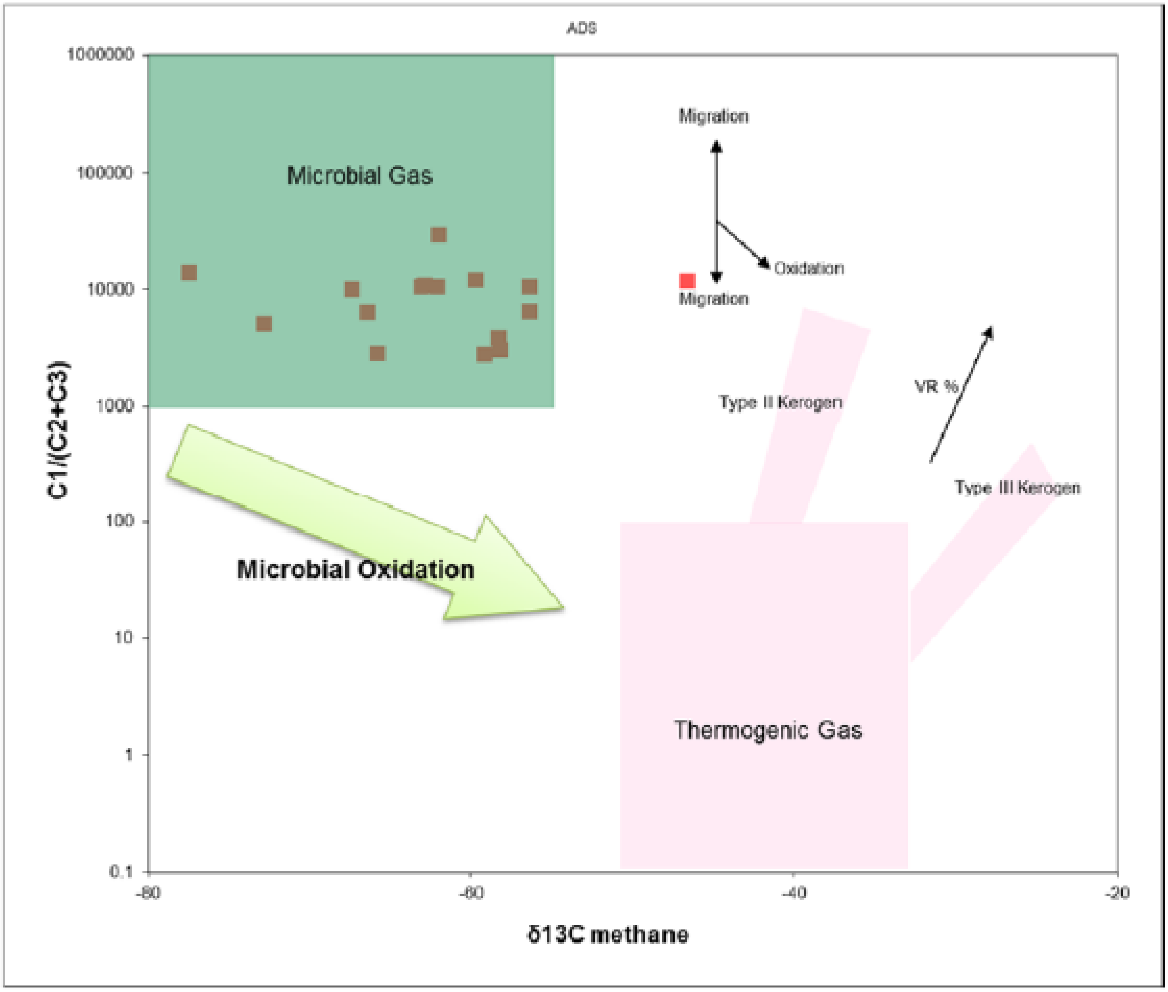


Figure 4.2: Carbon isotope characterisation, (Bernard Diagram) from Fugro 2015b The results of the tests plot in the upper left side of the figure and are typical of gas of microbial origin.

5. ENGINEERING ANALYSIS

5.1 General

This section summarises the axial pile capacity, soil response spring and pile driveability analyses performed at the proposed Platform G location.

Section 4 presents the derivation of the design soil parameters used in the engineering analyses. The design soil parameters for axial pile capacity analysis are presented on Plate 24 and for driveability analysis are presented on Plate 25.

Geotechnical Soil Unit III was observed to consist of interbedded sand and clay layers. In the analyses presented in this report, Geotechnical Soil Unit III was modelled as clay (undrained) for pile capacity and soil spring analyses as this was assumed to be the governing drainage condition for the range of critical loading rates (i.e. due to wave loading). Geotechnical Soil Unit III was modelled as drained for driveability analyses assuming the drained sand response is critical for pile driving.

5.2 Impact of Shallow Gas

The proposed Platform G location is in an area where shallow gas is interpreted to be present. Interpretation of the available data suggests that gas is present within the Geotechnical Soil Unit II sand and silt layers. Based on this interpretation and considering the observations given in Section 3.4.1, the following considerations were applied to the pile capacity and soil spring analyses.

i. A 20 % reduction of vertical effective stress (approximately 10 % reduction in ultimate shaft friction) was applied to the entire thickness of Geotechnical Soil Units I and II;
ii. A shaft friction limit of 81 kPa was applied within Unit III based on API (2011) recommendations for dense (silty) sand.

The above considerations are considered suitable for axial pile capacity and soil response spring generation.

Pile down-drag may occur after pile installation due to migration of free-gas through geotechnical soil units in areas of the site where shallow gas is present. There is potential for this process to occur at the proposed Platform G location after pile installation given the previous interpretation of shallow gas extents from the geophysical and imaging data. It is therefore recommended that during and following pile installation signs of shallow gas should be monitored (e.g. gas bubbles formation along or inside the pile). If gas release is observed, then one of the potential remedial mitigation procedures that may be considered is the drilling of relief wells which may alleviate the risk of pile down-drag after platform installation. Specification of relief well drilling is dependent on the severity of the gas release observed and is beyond the scope of this report. Pile down-drag was not explicitly considered in the axial pile capacity and installation analysis presented in this report, although generally cautious reductions to predict pile shaft friction were applied throughout Geotechnical Soil Units I and II.

5.3 Pile Geometry and Penetration Depth

ExxonMobil (2017) provided the geometry of the piles to be installed at the proposed platform G location. ExxonMobil requested pile capacity analysis be performed for the full soil profile of 125.9 m

BML which represents the depth to the deepest borehole. Table 5.1 summarises the pile geometry adopted for pile capacity and soil spring analyses.

Table 5.1: Pile Geometry and Penetration Depths

Pile	Pile Penetration[a] [m BML]	Outer Diameter [m]	Wall Thickness [mm]
Pile 1	125.9	2.134	50
Pile 2	125.9	2.438	50

Note:
a = Axial pile capacity estimted to the depth of the deepest borehole
BML = Below mudline

Pile driveability analysis was performed for a penetration depth of up to 125.9 m BML. Pile driveability analyses was performed for a 2.134 m and 2.438 m outer diameter piles with uniform wall thickness of 50 mm.

5.4 Scour

Two types of scour are typically considered for pile capacity analyses:

i. Global scour of the seabed soils, which reduces the effective overburden stresses at any given depth in the soil, leading to a reduction in frictional capacity;
ii. Local scouring and/or slotting around the pile, which reduces the length of pile in contact with the soil and leads to a reduction in frictional capacity and lateral stiffness response.

For calculation of axial pile capacity and derivation of axial and lateral soil-spring data, a total scour of 1.5 pile diameters was assumed based on API (2011). The total scour depth was considered as local scour. No global scour assumed.

5.5 Axial Pile Capacity

5.5.1 General

Axial pile capacity was performed according to the recommendations of API (2011).

The unit shaft friction in clay was calculated by application of a dimensionless factor (α) to the s_u according to API (2011) recommendations and no limits were applied to ultimate unit shaft friction values. However, in the interbedded sand and clay layer within Unit III, which was modelled as undrained, a unit friction limit of 81 kPa was cautiously applied conservatively due to the uncertainty in the behaviour of the interbedded sand and clays.

The unit shaft friction in sand was calculated by application of a shaft friction factor (β) to the effective overburden pressure according to API (2011) recommendations. Friction limits were applied to the unit friction in other sand layers as recommended by API (2011). The shaft friction in both clay and sand was taken to be equal in compression and tension.

The unit end bearing values in clay were derived according to the recommendations of API (2011) and no limits were placed on the calculated end bearing.

The unit end bearing in sand layers were derived using a dimensionless end bearing factor (N_q) and taking into account the end bearing limits recommended by API (2011).

5.6 Plugging Behaviour

The static axial pile capacity of an open ended steel pipe pile is dependent on the plugging behaviour. Two plugging conditions as defined by API (2011) are considered:

i. Unplugged: This is where the end bearing acts on the pile wall annulus only;
ii. Plugged: This is where the end bearing is assumed to act over the entire cross section of the pile.

To determine the characteristic static axial pile capacity, the lesser of the plugged and unplugged capacities are considered. The piles analysed at the proposed Platform G location are predicted to plug from 11.4 m BML for the 2.134 m OD pile and 12.4 m BML for the 2.438 m OD pile.

5.7 Pile End Bearing Rounding

API (2011) recommends that some end bearing modification may be required to account for the influence of a weaker layer above a stronger layer or for a stronger layer above a weaker layer.

At the top of a stronger layer, the whole end bearing may not be applicable as the shearing envelope also affects the weaker layer above.

Table 3.2 presents the soil descriptions of the geotechnical soil units observed at the proposed platform location. At the proposed Platform G location, the soil profile consists of extremely low to very high strength clays and loose to medium dense sands. At the top of the sand layer, the whole tip resistance may not be applicable as the shear envelope also affects the weaker clay layer above. The calculation of total end bearing considered the influence of the weaker layer over the stronger layer, which may affect the pile tip. At the bottom of the sand layer, the end bearing may be reduced to prevent the risk of punch through These considerations are often termed as end bearing rounding. Figure 5.1 illustrates the application of the end bearing rounding from a weaker layer to a stronger layer and a stronger layer to a weaker layer.

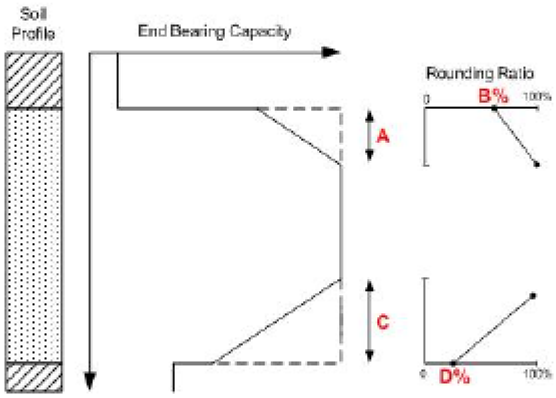


Figure 5.1: End Bearing Rounding

The variables A, B, C and D in Figure 5.1 represent:

- A: The thickness affected by rounding where end bearing builds up;
- B: The minimum rounding value where end bearing builds up.
- C: The thickness affected by rounding to prevent punch through;
- D: The minimum rounding value to prevent punch through.

Table 5.2 summarises the rounding values applied which are consistent with API (2011) recommendations.

Table 5.2: Summary of Rounding Values Applied as Described in Figure 5.1

End Bearing Build Up		Punch through Considerations	
A	**B**	**C**	**D**
2 OD	50 %	3 OD	0 %
Notes: OD = Outer diameter			

5.7.1 Results

Axial pile capacity according to API (2011) was performed using the low estimate design soil parameters presented on Plate 24 and pile geometries summarised in Table 5.1.

Plate 26 presents the derived unit shaft friction. The unit shaft friction profiles for both piles analysed are the same and hence the lines are coincident on the plot. Plate 27 presents the total shaft friction for both piles.

Plate 28 presents the total end bearing capacity profiles for both piles. Pile end bearing rounding effects as discussed in Section 5.7 can be observed within Geotechnical Soil Unit V sand.

Plate 29 presents the characteristic static axial pile capacities in compression and tension. Table 5.3 summarises the characteristic static axial pile capacities for a pile penetrating to 125.9 m BML.

Table 5.3: Characteristic Static Axial Pile Capacity

Piles	Outer Diameter	Pile Penetration	Shaft Friction	Total End Bearing[a]	Characteristic Static Pile Capacity[b]	
					Compression	Tension
	[m]	[m BML]	[MN]	[MN]	[MN]	[MN]
Pile 1	2.143	125.9	99.5	8.0	107.5	99.5
Pile 2	2.438	125.9	113.5	10.5	124.0	113.5

Notes:
Low estimate design soil parameters used in axial pile capacity analysis
All values are unfactored
BML = Below mudline
a = End bearing only for compression loading only. Friction applies to both compression and tension loading
b = Capacity values presented are unfactored

It should be noted that pile group effects and the effects of cyclic loading were not considered as part of the analysis presented in this report. API (2011) states that generally for pile spacings less than eight diameters, group effects have to be evaluated. In Fugro's experience pile spacings greater than 3.5 pile diameters are typically acceptable for small numbers of piles (≤ 3) to avoid pile group efficiencies less than 1.0. Pile group stiffness effects are dependent on the number of piles within a group, pile group arrangement, and the axial and lateral forces applied. API (2011) also states cyclic loads can increase or decrease the axial pile capacity and soil stiffness due to the rates and repeated changes in the applied cyclic loads.

It is recommended that the effects of cyclic loading and pile group interaction are considered as part of detailed design for the platform piles

5.8 Soil Response Springs

5.8.1 Axial Soil Response Springs

5.8.1.1 General

The relationship between axial pile load and axial pile deflection can be calculated using an appropriate structural model in which the pile is represented with an appropriate axial stiffness according to the depth Below mudline. The reaction of the soil along the pile shaft is represented as a series of non-linear springs acting at discrete points along the external length of the pile. These springs are termed t-z soil springs.

The end resistance of the soil to static loading is represented by a Q-z soil spring. The generated Q-z soil springs can be used during structural design to assess the foundation axial load-deflection response at the pile tip.

The t-z and Q-z soil spring data were derived in accordance with API (2011) recommendations, based on unfactored static axial capacity predictions in clay and sand. Frictional capacity degradation resulting from cyclic loading was not analysed. The soil spring data presented in this report are for the pile geometry and penetration depths specified in Table 5.1.

Digital soil spring data are attached to this report and can be accessed on this link.

5.8.1.2 Axial Soil Spring (T-Z) Data

The t-z soil springs follow the derivation approach given by API (2011) to the peak resistance (t_{max}). These springs incorporate a degradation effect of load capacity at large deflections which is defined in API (2011) as $^{t}/_{t_{max}}$ equal to 0.7.

The t-z soil spring data for external shaft friction were calculated for compression and tension load cases. Plates 30 to 36 present the t-z soil spring data in compression and tension for the 2.134 m OD pile. Plates 37 to 43 present the t-z soil spring data in compression and tension for the 2.438 m OD pile

It should be noted that the external shaft friction values (t) presented in the curve data are provided as a unit shaft friction in kilonewtons per square metre (kN/m^2).

5.8.1.3 Tip Soil Spring (Q-Z) Data

Q-z soil spring data represent the response of the soil to axial loading at the tip of the pile and were derived in accordance with API (2011) recommendations. Q-z soil spring data are not dependent on the relative spring spacing; therefore, end resistance values (Q) are presented as total end bearing in meganewtons (MN).

Plate 36 presents the Q-z soil spring data for the 2.134 m OD pile and Plate 43 presents the Q-z soil spring data for the 2.438 m OD pile at the propose platform G.

5.8.2 Pile Lateral Soil Spring Data

5.8.2.1 General

The lateral response of a pile subjected to horizontal static or cyclic shear loads can be calculated using an appropriate structural model in which the pile is represented with an appropriate bending stiffness at each depth below mudline. The reaction of the soil is represented as a series of non-linear springs (p-y soil springs) and act at discrete points along the length of the pile.

The API (2011) recommendations were applied to generate lateral load-deflection (p-y) spring data, which may be used by a structural designer for assessing the lateral load-deflection response of the pile. The p-y soil spring data in this report represent the reaction of the soil along the pile.

Digital soil spring data are attached to this report and can be accessed on this link.

5.8.2.2 Lateral (P-Y) Soil Spring Data

Lateral pile response (p-y) soil spring data are calculated as a function of:

i. Pile outer diameter (OD);
ii. Effective unit weight (y');
iii. Internal friction angle (ϕ′) in sand;
iv. Undrained shear strength (s_u) in clay.
v. Axial strain at 50 % of the maximum deviator stress (ε_{50}) from triaxial test data in clay;

ε_{50} values ranging between 1.2 and 0.3 were used to derive the p-y soil response springs presented in this report. The ε_{50} values derived were compared with the values presented by Reese et al. (1975) and Matlock et al. (1970). Reese et al. (1975) used ε_{50} values in the range of 0.4 % to 0.7 % for s_u values ranging between 50 kPa and 400 kPa for highly overconsolidated clays. Matlock (1970) used ε_{50} values ranging between 0.5 (for sensitive or brittle clays) and 2.0 % (for unconsolidated or remoulded clays) for s_u values ranging between 50 kPa and 200 kPa. The s_u of the clays at the proposed Platform G location are observed to range between 35 kPa and 250 kPa which compares favourably to the s_u used by Matlock. Hence the Matlock method was applied to derive the p-y springs in clay.

The method used to generate p-y soil spring data in clay follows the recommendations of Matlock (1970) for soft clay, incorporating the subsequent modifications for stiff clay (Bhattacharya et al., 2006). This modification involves disregarding the peak soil resistance point of the p-y soil spring data for stiff or very stiff clays above the transition depth. The transition depth is the level below which soil failure by plastic flow around the pile in a horizontal plane becomes more critical than a wedge-type failure mechanism. For the purpose of p-y calculation, stiff or very stiff clay was defined as clay with an s_u greater than 96 kPa. These methods also require the input of an empirical dimensionless coefficient (J). A J value of 0.25 was adopted for this site, in accordance with conventional North Sea practice.

The p-y soil spring data in sand were derived in accordance with the recommendations of API (2011) and the guidance presented by O'Neill and Murchison (1983).

Plates 44 to 49 present the static and cyclic p-y soil spring data for the 2.134 m OD pile and Plates 50 to 55 present the static and cyclic p-y soil spring data for the 2.438 m OD pile.

Values of lateral load (p) are quoted as load per unit length (MN/m) of pile for a given pile size. The actual spring resistance can be obtained by multiplying the element length by the quoted value of p at any particular elevation.

No material or resistance factors were applied for the p-y soil spring data. This will be acceptable only where the design penetration of the pile is not governed by the ultimate limit state (ULS) lateral load case.

5.9 Pile Driveability

5.9.1 General

Pile driving analyses were performed to evaluate driveability of the piles at the proposed Platform G location. ExxonMobil selected the Menck MHU500T and MHU800S hammers for this pile driveability analysis. The Menck MHU3000 hammer was evaluated following ExxonMobil request for Fugro to evaluate a third hammer based on Fugro experience. It is noted that the actual hammer(s) to be used for pile installation will be chosen by the Offshore Installation Contractor. Pile driveability analysis should be updated once the actual hammers are known.

Table 5.1 summarises the pile geometry and pile penetration depth analysed. Plate 25 summarises the HE design soil parameters applied in driveability analyses. The driveability analyses included:

i. Assessment of soil resistance to driving (SRD)
ii. Predict blow count versus depth profiles for the proposed hammers;
iii. Extract driving induced stresses from the driveability analysis.

Soil resistance to driving (SRD) predictions were made using the Fugro modified Toolan and Fox (1977) method described in Section 5.9.2.

The analyses were carried out for:

i. 2.134 m (84″) OD open ended pile with 50 mm uniform WT and total weight of 2.8 MN
ii. 2.438 m (96″) OD open ended pile with 50 mm uniform WT and total pile weight of 3.2 MN

Pile driveability analysis was performed to a pile penetration depth of 125.9 m BML for both piles.

5.9.2 Soil Resistance to Driving (SRD)

Profiles of the BE and HE SRD were derived using the Fugro-modified Toolan and Fox (1977) method and considering HE soil parameters presented in Section 4. The BE SRD profile represents pile installation under continuous driving operations. The HE SRD profile represents a reasonable upper bound resistance which allows for temporary SRD increases due to short driving interruptions.

SRD is calculated as the sum of the total shaft friction and total end bearing resistance for a given pile penetration depth. The total shaft friction is the unit friction multiplied by the embedded shaft area. The total end bearing is the unit end bearing multiplied by the gross end bearing area. Table 5.4 summarises the Fugro-modified Toolan and Fox (1977) method calculation procedures for unit shaft resistance and unit end resistance in clay and sand.

Plate 56 presents the predicted BE and HE SRD profiles. Plates 57 to 60 presents the tabulated SRD data for the 2.134 m OD and 2.438 m OD piles.

Table 5.4: Fugro Modified Toolan and Fox (1977) SRD Method

Soil Resistance	Soil Type	Best Estimate (BE) Conditions	High Estimate (HE) Conditions
Unit Shaft Friction, q_f	Clay	$Minimum\begin{pmatrix}\frac{s_u}{4.5}\\ ^2/_3 . f_s\end{pmatrix}$	$Minimum\begin{pmatrix}\frac{s_u}{3.0}\\ f_s\end{pmatrix}$
	Sand	$Minimum\begin{pmatrix}0.5.\sigma'_v.tan\delta\\ \frac{q_c}{300}\\ ^2/_3 . f_s\\ ISO\ (2007)\ limit\end{pmatrix}$	$Minimum\begin{pmatrix}0.7.\sigma'_v.tan\delta\\ \frac{q_c}{100}\\ f_s\\ ISO\ (2007)\ limit\end{pmatrix}$
Unit End Bearing, q_b	Clay	$Minimum\begin{pmatrix}BE\ q_c\\ 15.s_u\end{pmatrix}$	$Minimum\begin{pmatrix}HE\ q_c\\ 20.s_u\end{pmatrix}$
	Sand	$Minimum\begin{pmatrix}q_{c(nc)} = 61\sigma'_v{}^{0.71e^{2.91D_r}}\\ BE\ q_c\\ Limit\ of\ 50\ MPa\end{pmatrix}$	$Minimum\begin{pmatrix}HE\ q_c\\ Limit\ of\ 90\ MPa\end{pmatrix}$

Notes:
s_u = Undrained shear strength
f_s = Cone penetrometer test (CPT) sleeve friction
σ'_v = Effective vertical stress
δ = Soil-pile interface friction angle
q_c = CPT cone tip resistance
$q_{c(nc)}$ = Equivalent normally consolidated q_c
D_r = Relative density (calculated using Jamiolkowski et al. (2003) method)

5.9.3 Wave-Equation Analysis

Pile drivability analyses were performed using a wave-equation analysis to assess the interaction of the pile, soil and hammer. Wave-equation analyses were performed using the commercially available one-dimensional wave-equation program GRLWEAP® (2010). In this analysis, the pile and hammer are modelled as a series of springs and masses whilst the soil is modelled as a series of springs and dashpots (Smith, 1962).

Pile drivability analysis was performed to target pile penetration depths described in Section 5.9.1. The piles were modelled to be driving under water with a specific gravity of 8.54 m/s^2. Blow count profiles are representative of the BE SRD profiles calculated in Section 5.9.2.

It should be noted that damping and quake values used in driveability analysis are specific to the SRD method applied in the analysis. Therefore, the quake and damping values input into the wave-equation analysis in this report were based on the values presented by Hirsch (1973) as specified by Toolan and Fox (1977).

Basic hammer parameters for the Menck MHU500T, Menck MHU800S and Menck MHU3000 driving hammer for input into the wave-equation model were based on the manufacturer's data in the GRLWEAP® (2010) database. The maximum hammer efficiency was modelled as 90 % energy transfer for the Menck hammers. The hammers were modelled as driving in air.

5.9.4 Pile Driving Refusal Criteria

The pile driving refusal criteria according to ISO (2007) was applied. ISO (2007) defines pile driving refusal in hard clays and dense sands as when any one of the following occur:

i. Blow counts exceed 125 blows per 0.25 m for 1.5 m continuous driving or a minimum of 200 blows per 0.25 m for 0.5 m continuous driving;
ii. Blow counts exceed 325 blows per 0.25 m in the last 0.25 m interval at the end of driving;
iii. Blow counts exceed 325 blows per 0.25 m for 0.5 m at restart of driving after a stoppage of 1 hour or longer.

If there has been a delay of more than 1 hour in driving operations, the refusal criteria above should not apply until the pile has been advanced at least 0.3 m. Additionally, if the pile exceeds four times the hammer ram weight, the blow counts listed above should be increased proportionally; however, in no case should the blow count exceed 800 blows per 0.152 m.

Note that where pile driving becomes difficult, the definition of pile refusal criteria may not to be based solely on the blow count values. The driving stresses induced in the pile during driving should be taken into account, ensuring the steel yield strength of the pile is not exceeded and/or that pile fatigue is considered.

5.9.5 Predicted Blow Count Versus Depth Profiles

Pile driveability analyses were performed using GRLWEAP® (2010) to evaluate the performance of the Menck MHU500T, MHU800S and MHU3000 driving hammers for BE SRD conditions representing continuous driving operations. The hammers were also evaluated for HE SRD conditions which allow for temporary increases in soil resistance occurring during short driving delays. The blow count data presented for the HE SRD are therefore not continuous driving curves but represent an anticipated upper limit to initial blow counts occurring following restart of driving.

Plates 61 and 62 presents the blow count profiles for the Menck MHU500T hammer at different scales, Plates 63 and 64 presents the blow count profiles for the Menck MHU800S hammer at different scales and Plates 65 and 66 presents the blow count profiles for the Menck MHU3000 hammer at different scales. Table 5.5 summarises the blow counts per 0.25 m at expected achievable pile penetration for continuous driving conditions.

Table 5.5: Summary of Blow Counts per 0.25 m at Final Pile Penetration Depths

Hammer	Hammer Efficiency [%]	Self-Weight Penetration [m BML]	Expected Maximum Achievable Pile Penetration[a] [m BML]	
			2.134 m OD Pile	2.438 m OD Pile
Menck MHU 500T	90	9.5 – 13.5	94.0	91.0
Menck MHU 800S	90	9.7 – 14.2	99.0	97.5
Menck MHU 3000	90	15.0 – 21.2	112.5[b]	112.5[b]

Notes:
Driving pile refusal criteria were in accordance with the criteria defined in ISO (2007)
BML = Below mudline
OD = Outer diameter
a = Expected maximum achievable pile penetrations based on a pile refusal of 200 blows/0.25 m for continuous driving
b = Blow counts and induced stresses during pile driving through the dense sand layer should be monitored during installation

The results of the driveability analyses shows that the MHU500T and MHU800S hammers can drive both piles to a penetration depth of at least 100.0 m BML considering BE (continuous) driving conditions. The MHU3000 hammer can drive both piles to 112.5 m BML. However, the very high blow counts and stresses in the piles may require to be monitored closely to avoid exceeding the pile fatigue limits.

It should be noted that the Toolan and Fox SRD method does not consider friction fatigue effects and hence the blow counts presented in this report may be considered cautious for the pile lengths analysed but the outcomes considered are considered to be indicative for pile penetration and hammer selection.

5.9.6 Pile Self-Weight Penetration

The weight of the pile and hammer will cause penetration of the pile through the soil if the resistance offered by the soil is less than the total applied force. Examination of the predicted blow count versus depth curves, which account for the weight of the pile and hammer, show that a self-weight penetration may occur of the pile and hammer. Table 5.6 summarises the self-weight penetration of the pile and hammer predicted.

Table 5.6: Self-weight Penetration of Pile and Hammer

Pile	Self-weight Penetration of Pile and Hammer [m BML]					
	Menck MHU500T		Menck MHU800S		Menck MHU3000	
	BE	HE	BE	HE	BE	HE
2.134 m OD	13.5	9.6	14.2	9.9	21.2	16.0
2.438 m OD	13.3	9.5	13.9	9.7	20.3	15.0

Notes:
BE = Considering Best Estimate SRD
HE =Considering High estimate SRD
OD = Outer Diameter
BML = Below mudline

It should be noted that low blow counts (up to approximately 10 blows per 0.25 m pile penetration) are predicted at shallow penetration. There may be a risk of extended self-weight penetration and higher than expected penetration for low energy single hammer blows. To reduce risk of uncontrolled pile penetration, precautions must be taken such as application of single hammer blows and gradual increase in hammer operational energy.

5.9.7 Pile Stresses During Driving

During installation, the pile will be subjected to stresses by hammer blows. The maximum compressive and tensile stresses can be determined using the wave-equation analysis. The sum of the stresses due to the impact of the hammer and the stresses due to axial force and bending moments shall not exceed the specified minimum yield strength of the steel.

Driving-induced stresses in compression and tension were derived at each 1.0 m elevation above pile toe in the wave equation model are attached to this report pdf and can be accessed on this link. Pile driving bending moments were not considered. Table 5.7 summarises the peak stress ranges at expected achievable maximum penetration depths (Table 6.2) along the pile for continuous driving conditions.

Table 5.7: Peak Stress Range

Hammer	Operational Efficiency [%]	SRD	Peak Stress Range [MPa]	
			2.134 m OD Pile	2.438 m OD Pile
MHU500T	90	BE	292	278
MHU800S	90	BE	305	298
MHU3000	90	BE	335	331

Fugro recommends that pile fatigue analysis is performed to assess pile fatigue damage as a result of pile driving. Stress ranges from pile installation should be calculated for critical elevations along the pile, which should be combined with predicted blow count data to assess fatigue damage due to pile driving using appropriate S-N curves recommended by DNV-RP-C203 (2012). Note that additional pile fatigue due to environmental loading should be considered as part of a separate in-place loading assessment.

However, further driveability analyses are required to allow a detailed assessment of pile fatigue damage during installation. These analyses may consider driving behaviour across a wider range of hammer operational efficiencies and final pile geometries.

5.9.8 Driving Shoe

Driving shoes are used to assist piles penetrate through hard layers or to reduce driving resistances hence allowing greater penetration of the piles. If driving shoes are to be considered the effect of the driving shoe on the pile capacity and the stresses generated in the transition point between the driving shoe and pile are to be evaluated.

It is understood that the piles at the platform G location may penetrate to depths greater than 90.0 m BML. Therefore, a driving shoe may be considered. However, for this report a driving shoe was not considered.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 General

ExxonMobil requested Fugro to perform pile capacity analysis and generate soil response springs for two specified piles at the proposed Platform G location. Driveability analysis was also performed for three candidate hammers.

6.2 Geotechnical Data

Geotechnical data from four boreholes at the proposed Platform G location were used to derive the design soil parameters for the analysis presented in this report.

At the proposed Platform G location shallow gas is predicted to be present. Shallow gas observations were made during the drilling of the pilot holes and boreholes. These observations included bubbles of gas escaping from around the drill string during sampling and testing of PG-BH-01/01a, and the presence of gas within the samples following extrusion in the laboratory at all four locations.

Low estimate (LE), best estimate (BE) and high estimate (HE) design soil profiles were derived to the depth of interest. Due to the presence of shallow gas, the following considerations were applied to the pile capacity and soil spring analyses.

i. A 20 % reduction of vertical effective stress within Unit II (approximately 10 % reduction in ultimate shaft friction);
ii. A shaft friction limit of 81 kPa was applied within Unit III based on API (2011) recommendations for dense (silty) sand.

6.3 Engineering Analysis

Engineering analyses was performed for two piles sizes:

i. 2.134 m (84″) outer diameter pile with 50 mm uniform wall thickness;
ii. 2.438 m (96″) outer diameter pile with 50 mm uniform wall thickness.

Axial pile capacity analyses was performed to the full soil profile of 125.9 m BML which is the termination depth of the deepest borehole.

6.3.1 Pile Capacity Analysis

Axial pile capacity analysis was performed according to API (2011). Table 6.1 summarises the calculated characteristic (unfactored) static axial pile capacities.

Table 6.1: Summary of Static Axial Pile Capacity Results

Piles	Outer Diameter [m]	Pile Penetration [m BML]	Shaft Friction [MN]	Total End Bearing[a] [MN]	Characteristic Static Pile Capacity[b]	
					Compression [MN]	Tension [MN]
Pile 1	2.143	125.9	99.5	8.0	107.5	99.5
Pile 2	2.438	125.9	113.5	10.5	124.0	113.5

Notes:
All values are unfactored
BML = Below mudline
a = End bearing only for compression loading only. Friction applies to both compression and tension loading
b = Capacity values presented are unfactored

It should be noted that pile group effects and the effects of cyclic loading were not considered as part of this analysis. It is recommended that the effects of cyclic loading and pile groups be considered as part of platform design then effects of pile groups to pile capacity should be considered.

Axial and lateral soil springs were derived based on API (2011) recommendations.

6.3.2 Pile Installation Analysis

Pile driveability analyses were performed for the Menck MHU 500T, MHU 800S and MHU3000 hammers. Highest expected (HE) soil resistance to driving (SRD) profiles were generated using the Alm and Hamre (2001) method. Table 6.2 summarises the pile driveability results for the two hammers analysed.

Table 6.2: Summary of Pile Driveability Results

Hammer	Hammer Efficiency [%]	Self-Weight Penetration [m BML]	Expected Maximum Achievable Pile Penetration[a] [m BML]	
			2.134 m OD Pile	2.438 m OD Pile
Menck MHU 500T	90	9.5 – 13.5	94.0	91.0
Menck MHU 800S	90	9.7 – 14.2	99.0	97.5
Menck MHU 3000	90	15.0 – 21.2	112.5[b]	112.5[b]

Notes:
Driving pile refusal criteria were in accordance with the criteria defined in ISO (2007)
BML = Below mudline
OD = Outer diameter
a = Expected maximum achievable pile penetrations based on a pile refusal of 200 blows/0.25 m for continuous driving
b = Blow counts and induced stresses during pile driving through the dense sand layer should be monitored during installation

It should be noted that the Toolan and Fox SRD method does not consider friction fatigue effects and the blow counts presented in this report may be considered cautious for the pile lengths analysed but the outcomes are considered to be indicative for pile penetration and hammer selection.

Large self-weight penetrations are predicted. Therefore, significant care should be taken when commencing driving.

Fugro recommends that during and following pile installation signs of shallow gas should be monitored (e.g. gas bubbles formation along or inside the pile). If gas release is observed, then a potential remedial procedure which may be considered is drilling of relief wells to mitigate against the risk of pile down-drag.

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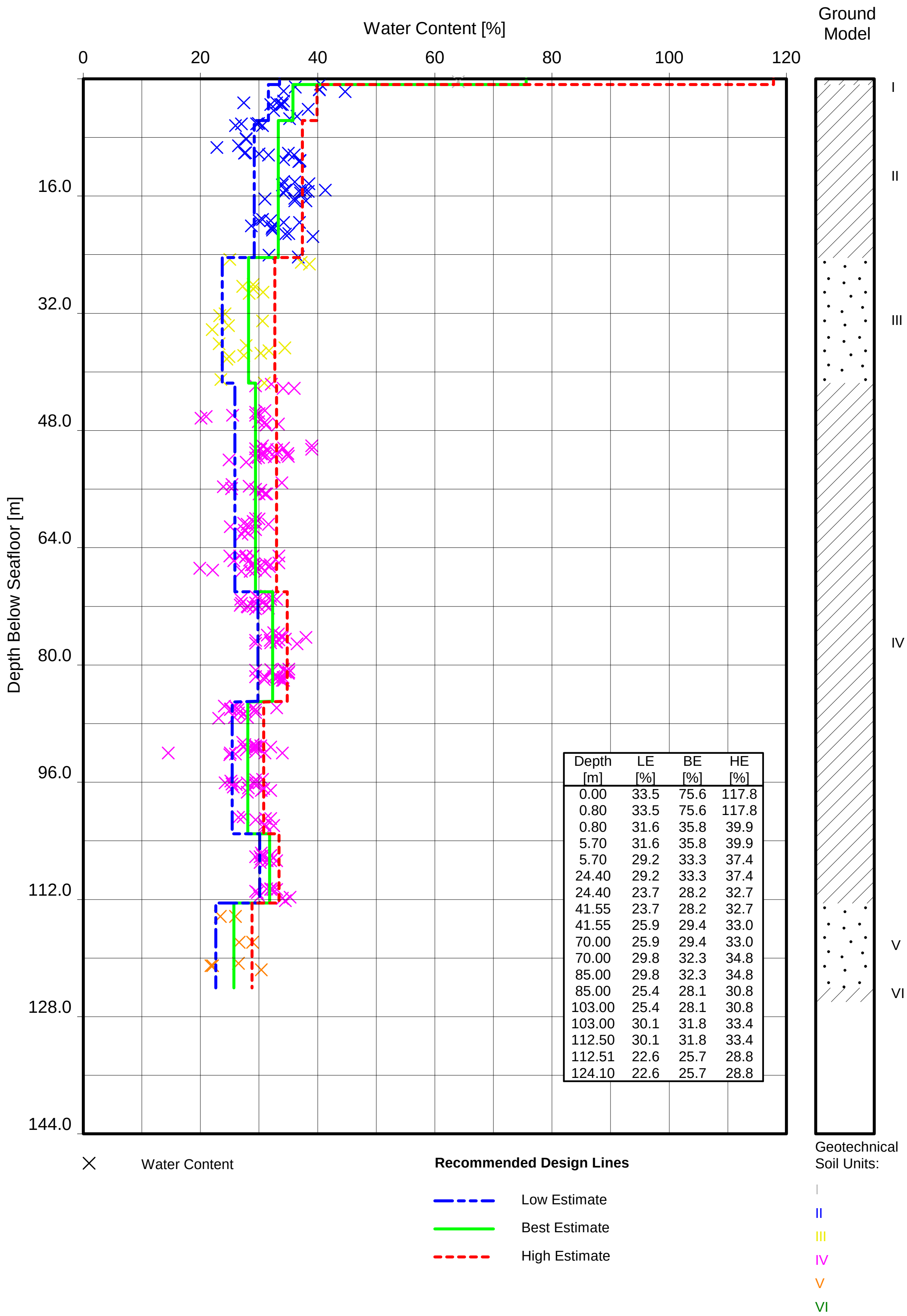
LIST OF PLATES



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5.70	31.6	35.8	39.9
5.70	29.2	33.3	37.4
24.40	29.2	33.3	37.4
24.40	23.7	28.2	32.7
41.55	23.7	28.2	32.7
41.55	25.9	29.4	33.0
70.00	25.9	29.4	33.0
70.00	29.8	32.3	34.8
85.00	29.8	32.3	34.8
85.00	25.4	28.1	30.8
103.00	25.4	28.1	30.8
103.00	30.1	31.8	33.4
112.50	30.1	31.8	33.4
112.51	22.6	25.7	28.8
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WATER CONTENT VERSUS DEPTH
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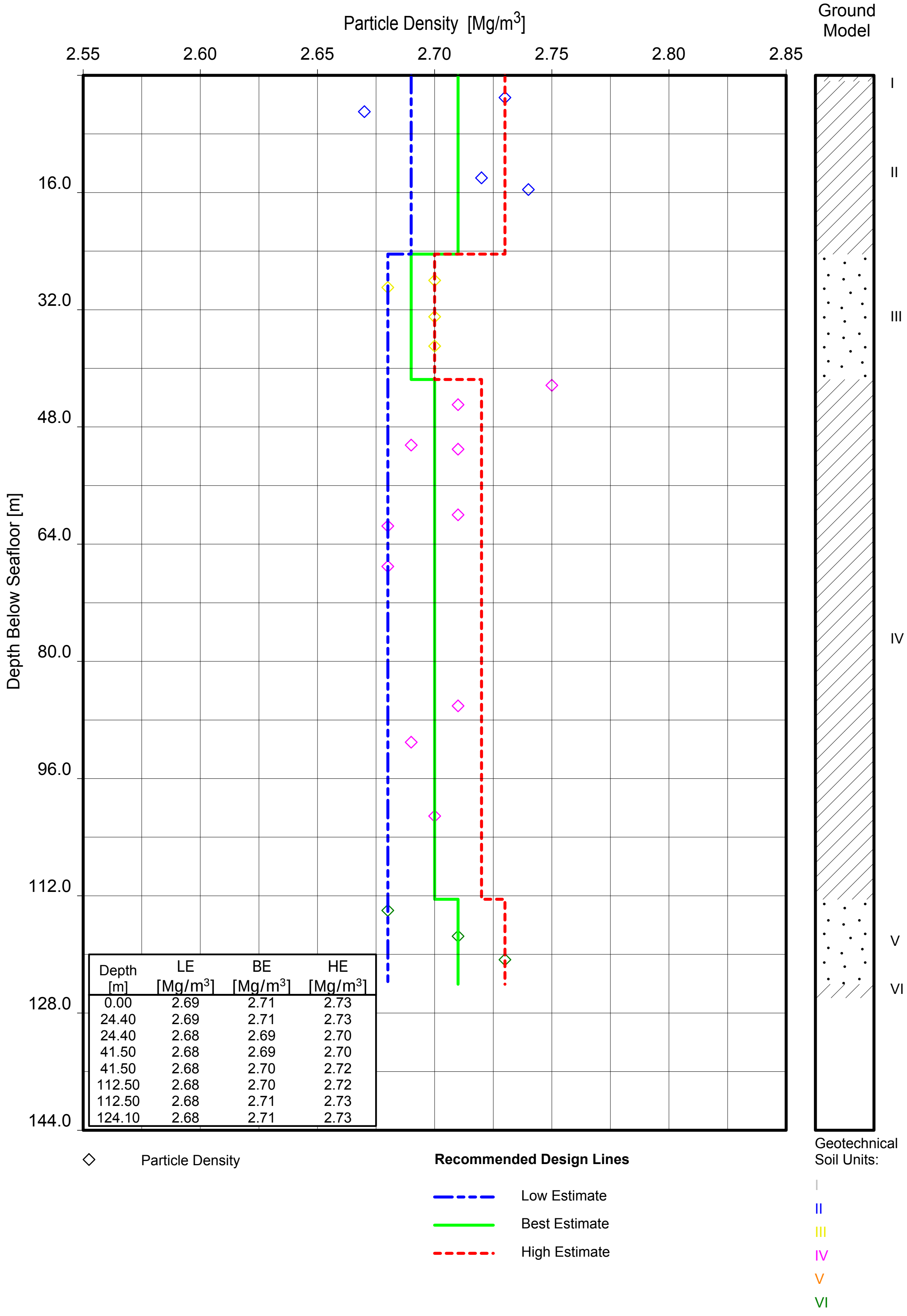

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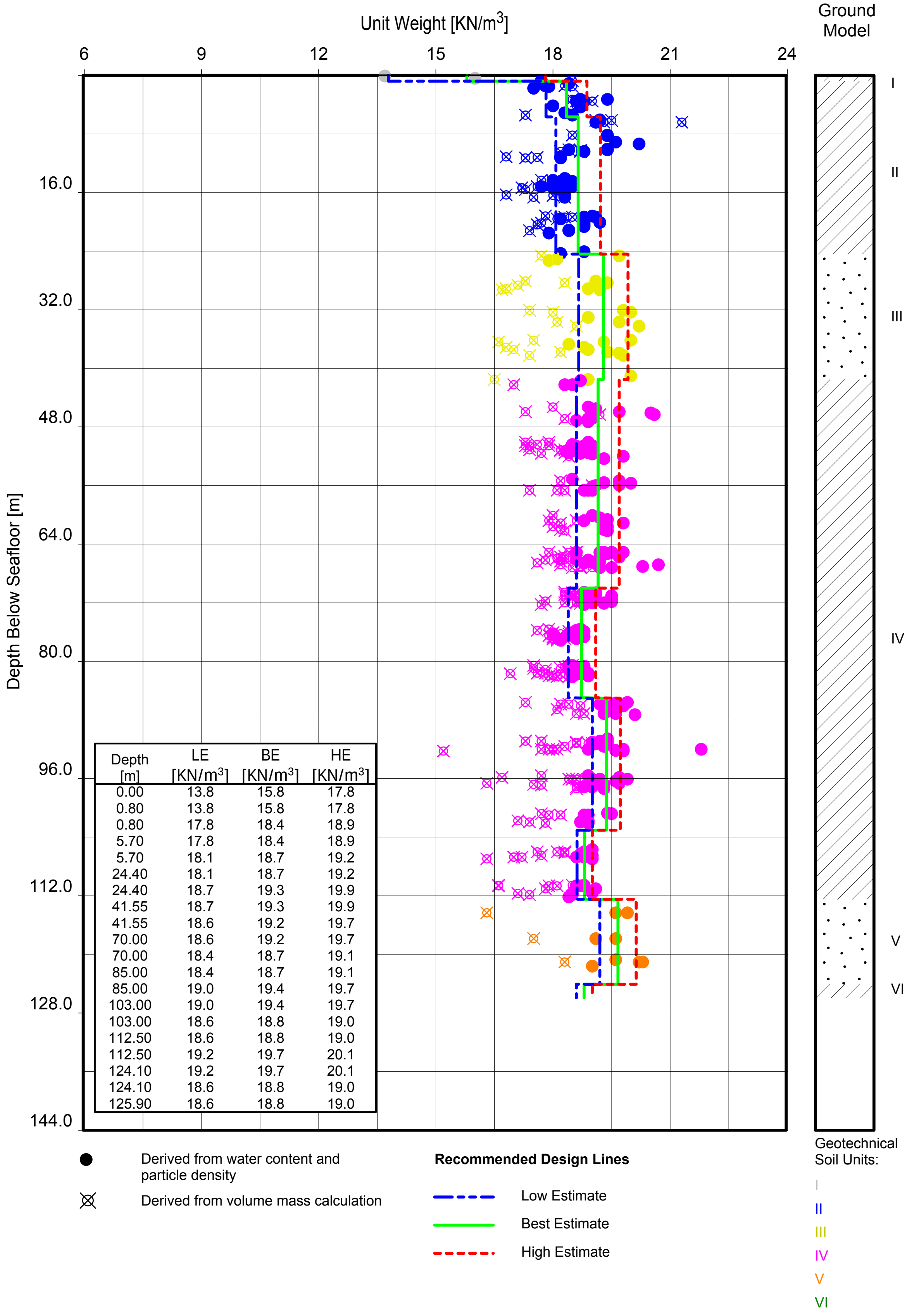
PARTICLE DENSITY VERSUS DEPTH
Platform G, Neptun Deep Survey



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5.70	18.1	18.7	19.2
24.40	18.1	18.7	19.2
24.40	18.7	19.3	19.9
41.55	18.7	19.3	19.9
41.55	18.6	19.2	19.7
70.00	18.6	19.2	19.7
70.00	18.4	18.7	19.1
85.00	18.4	18.7	19.1
85.00	19.0	19.4	19.7
103.00	19.0	19.4	19.7
103.00	18.6	18.8	19.0
112.50	18.6	18.8	19.0
112.50	19.2	19.7	20.1
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UNIT WEIGHT VERSUS DEPTH
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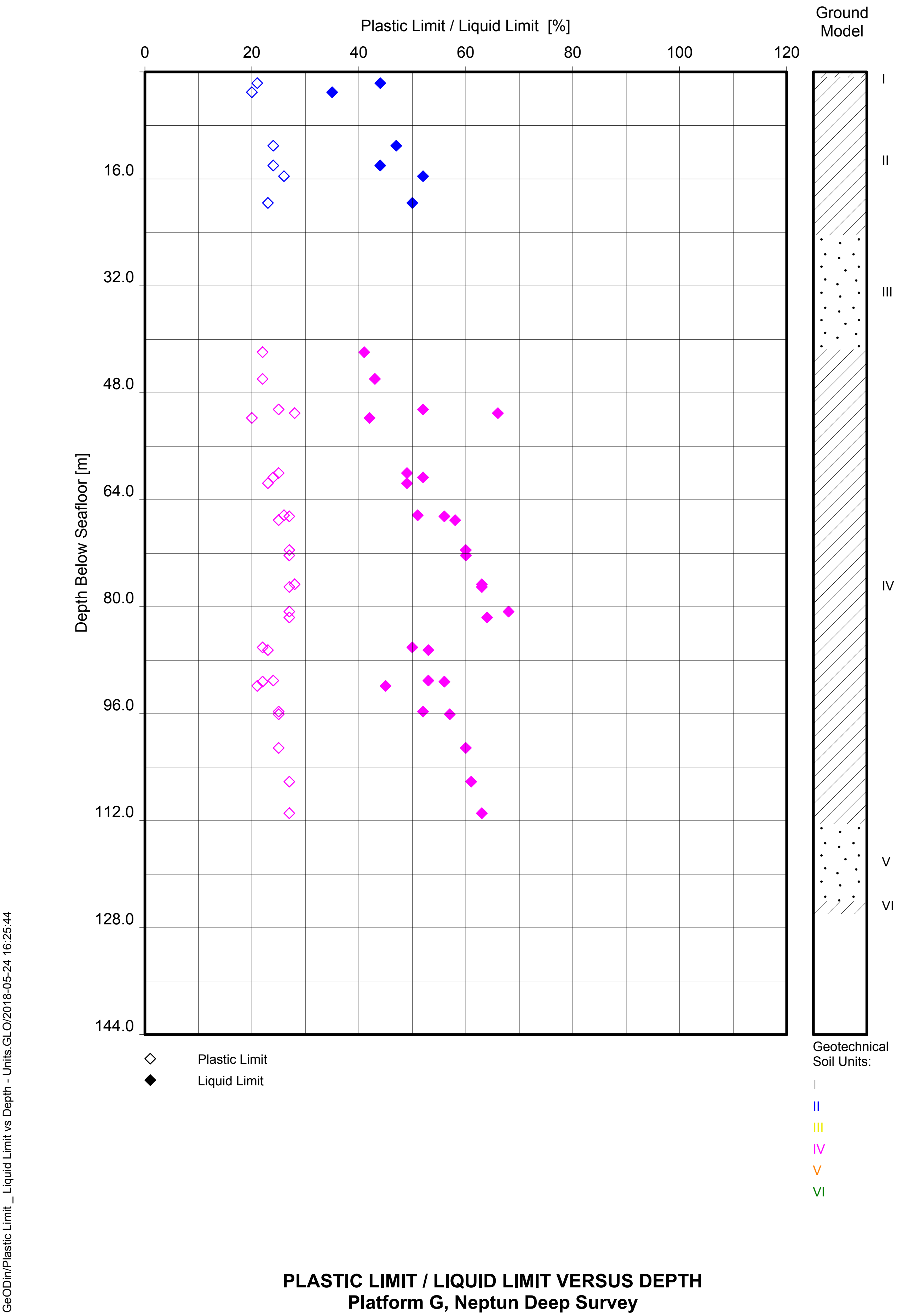
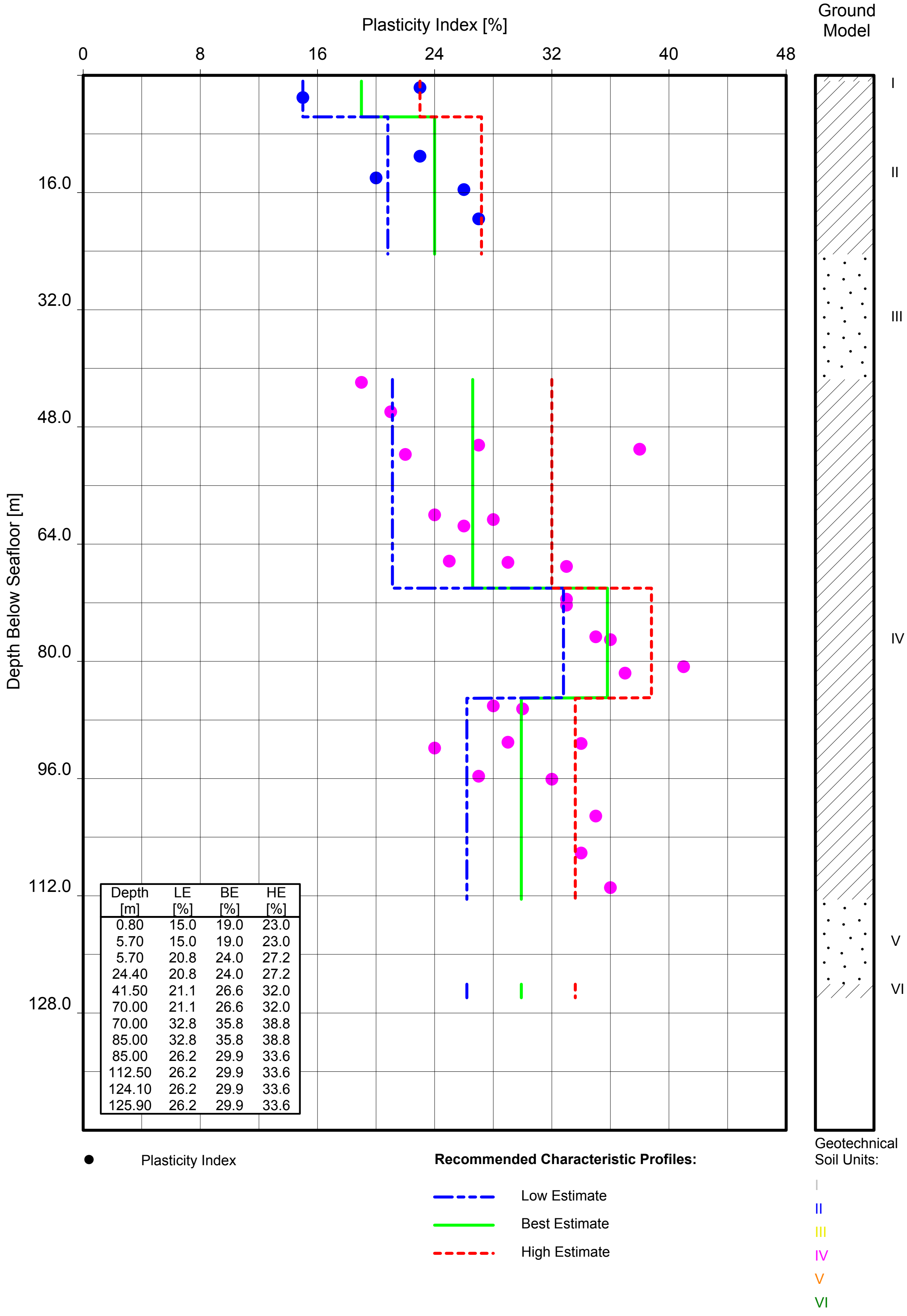


PLASTIC LIMIT / LIQUID LIMIT VERSUS DEPTH
Platform G, Neptun Deep Survey



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24.40	20.8	24.0	27.2
41.50	21.1	26.6	32.0
70.00	21.1	26.6	32.0
70.00	32.8	35.8	38.8
85.00	32.8	35.8	38.8
85.00	26.2	29.9	33.6
112.50	26.2	29.9	33.6
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125.90	26.2	29.9	33.6

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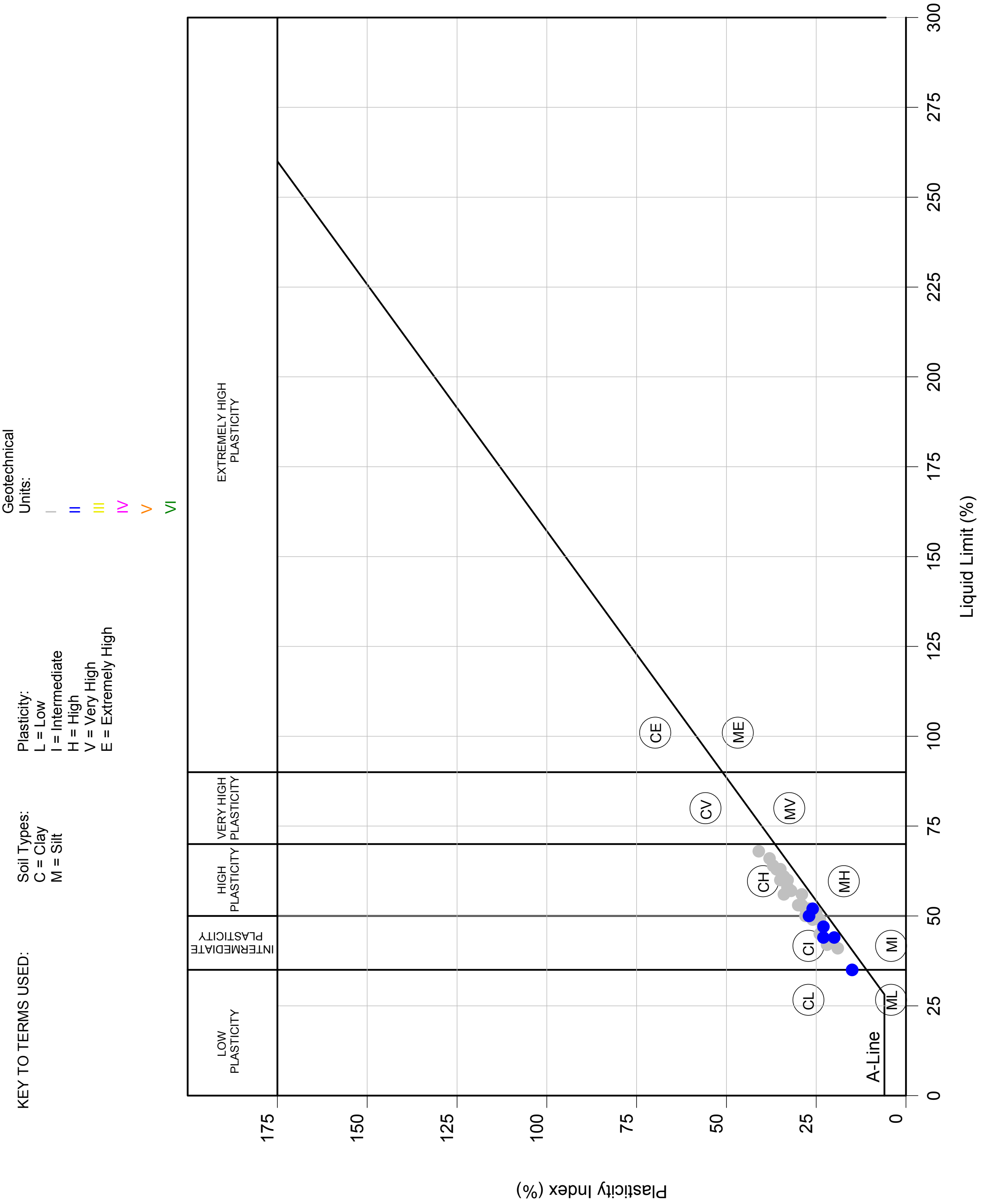
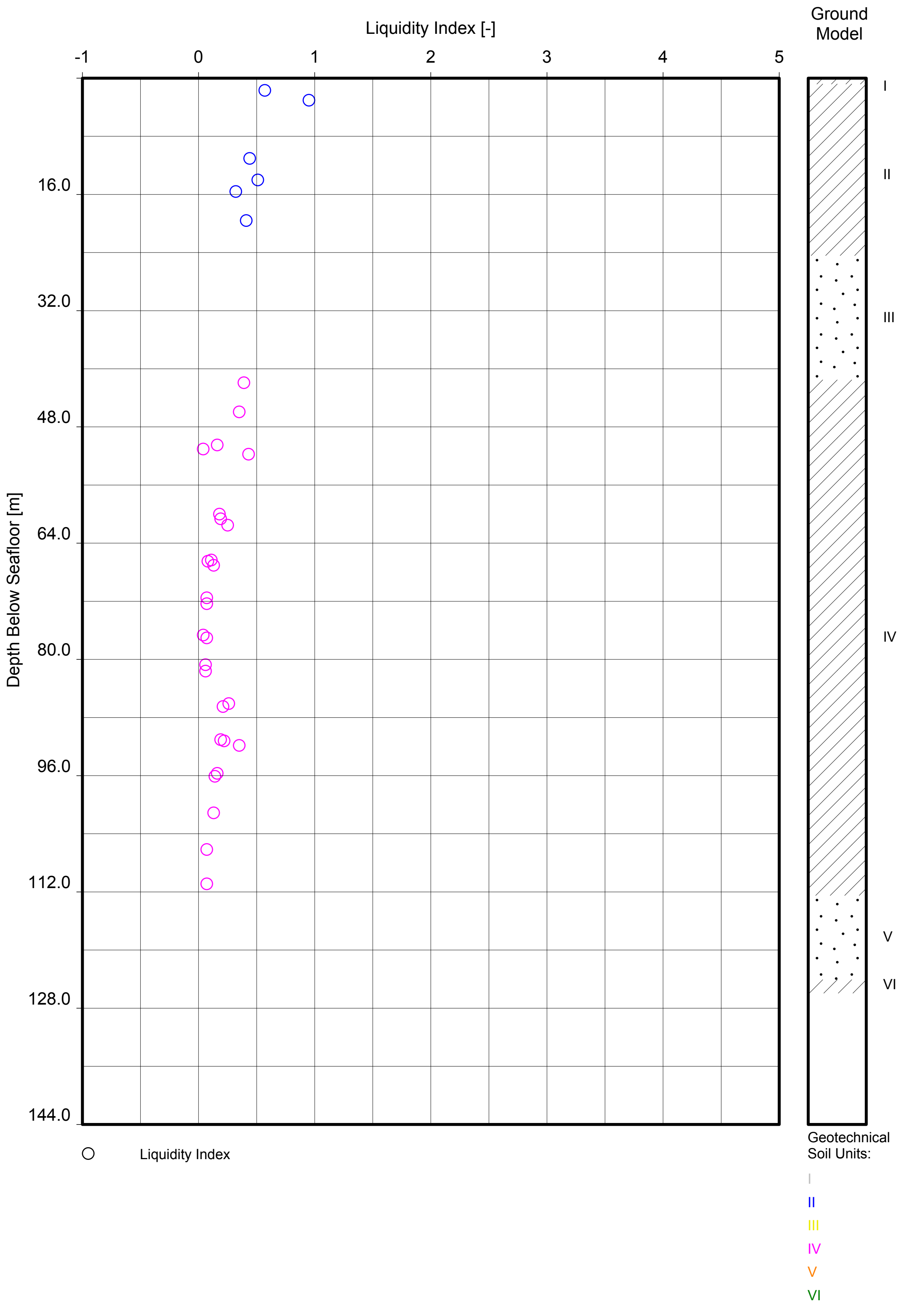
PLASTICITY INDEX VERSUS DEPTH
Platform G, Neptun Deep Survey

GeODin/Plasticity Chart Large Scale - Date: 04-05-2018 Made By: CB



PLASTICITY CHART (BS 5930)
Platform G
All Geotechnical Units



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LIQUIDITY INDEX VERSUS DEPTH
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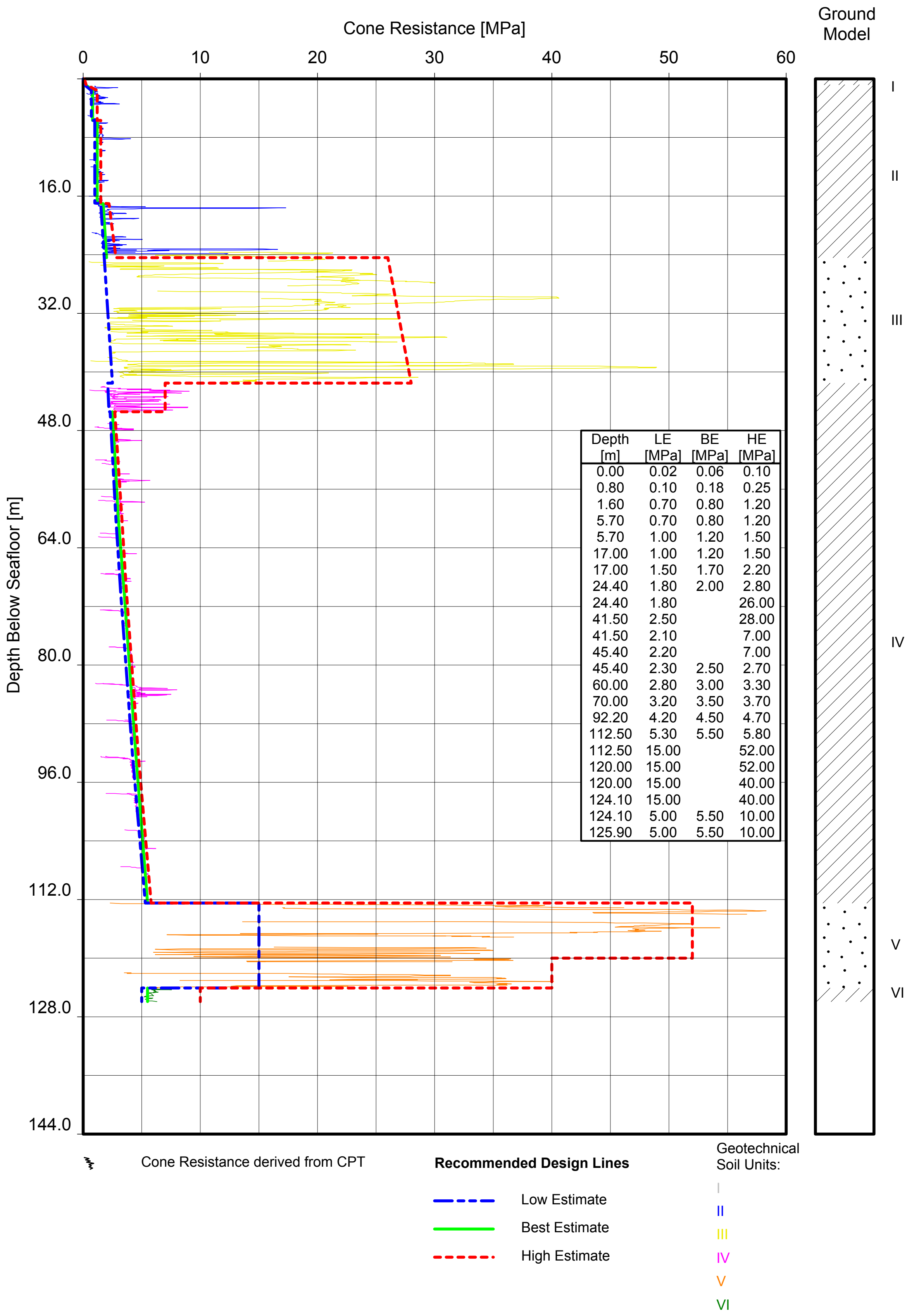

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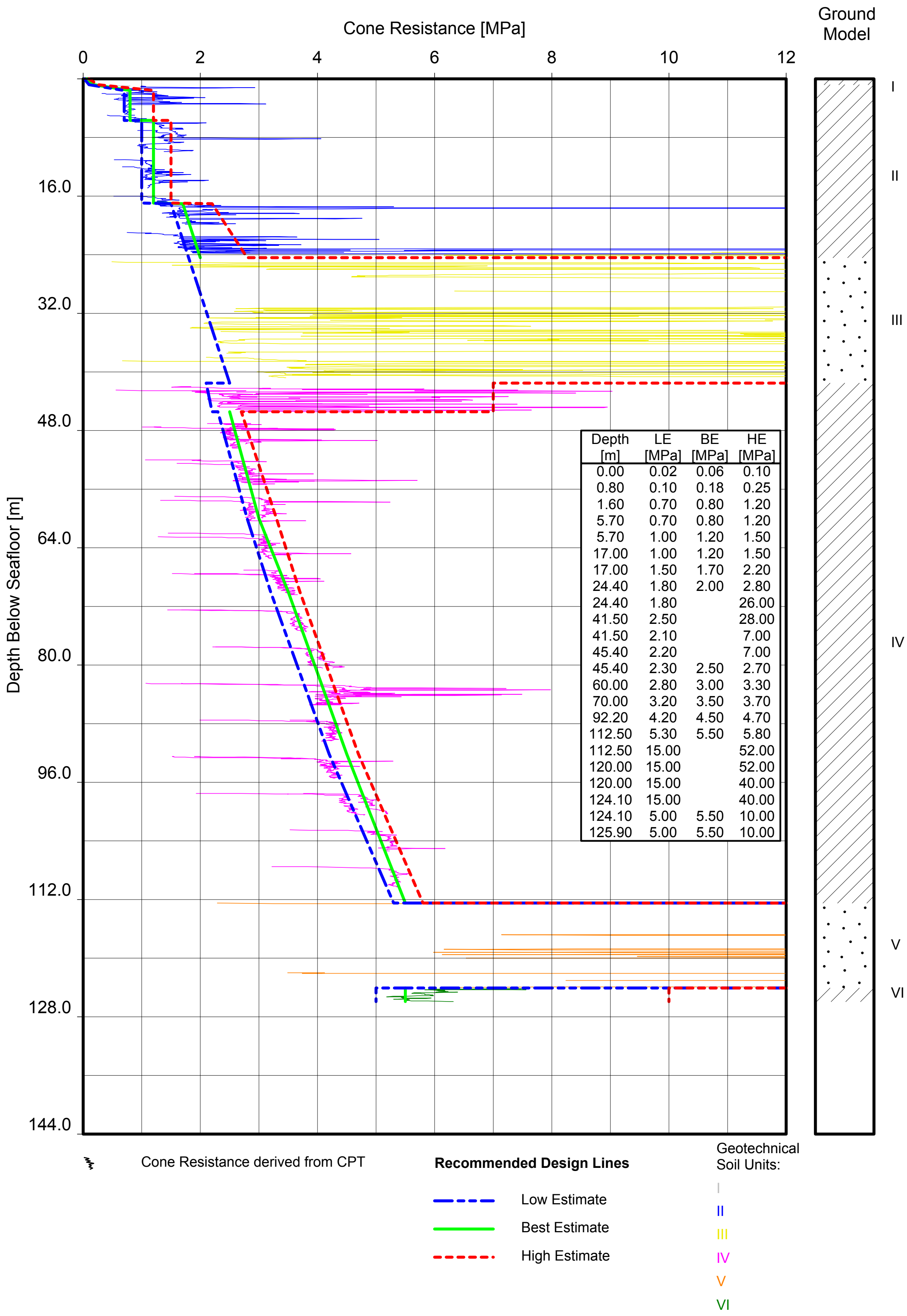
5.70	0.70	0.80	1.20
5.70	1.00	1.20	1.50
17.00	1.00	1.20	1.50
17.00	1.50	1.70	2.20
24.40	1.80	2.00	2.80
24.40	1.80		26.00
41.50	2.50		28.00
41.50	2.10		7.00
45.40	2.20		7.00
45.40	2.30	2.50	2.70
60.00	2.80	3.00	3.30
70.00	3.20	3.50	3.70
92.20	4.20	4.50	4.70
112.50	5.30	5.50	5.80
112.50	15.00		52.00
120.00	15.00		52.00
120.00	15.00		40.00
124.10	15.00		40.00
124.10	5.00	5.50	10.00
125.90	5.00	5.50	10.00

GeODin/Cone Resistance vs Depth - Units_Soil_Stick.GLO/2018-05-24 16:17:47

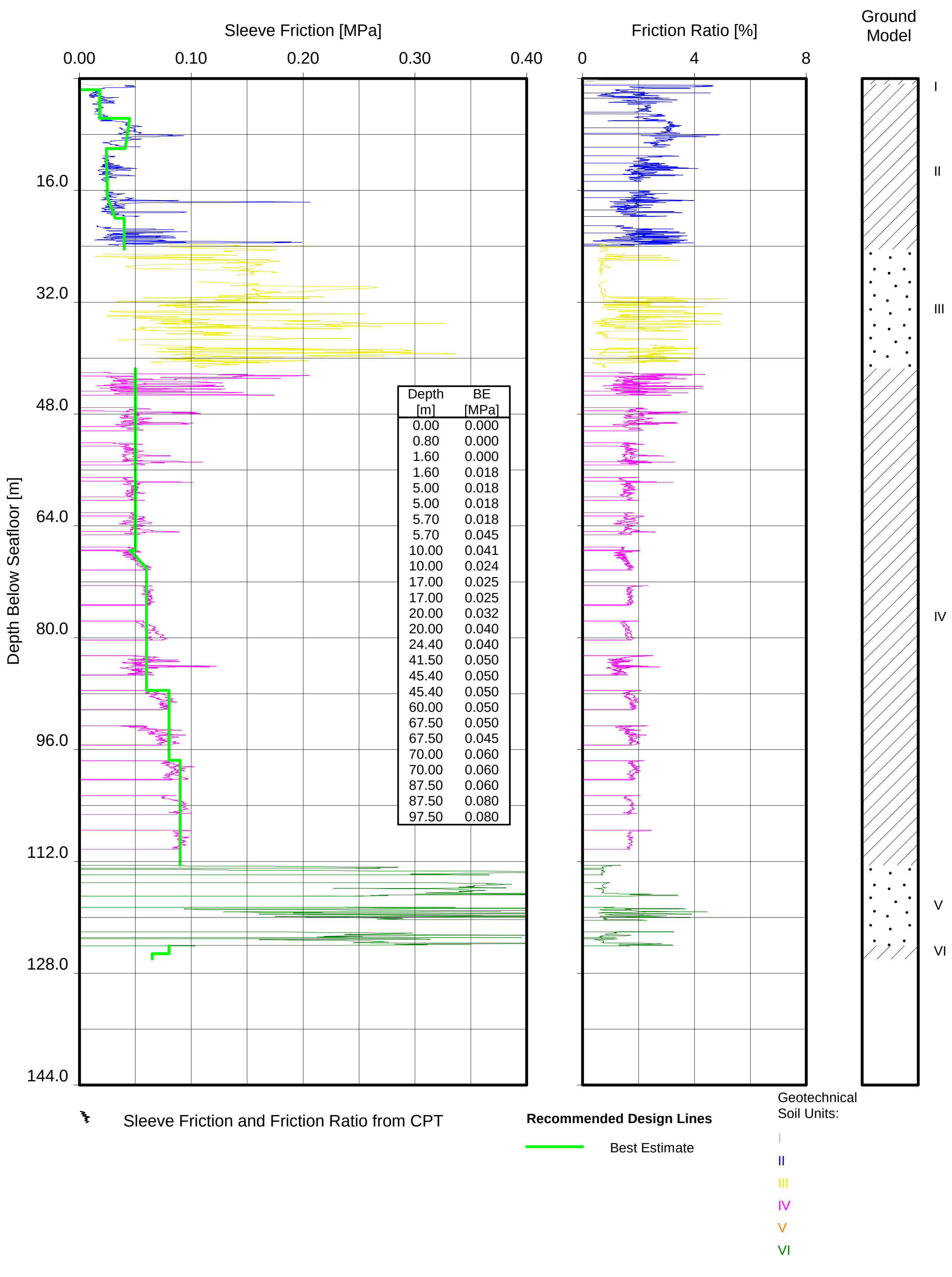
CONE RESISTANCE VERSUS DEPTH
Platform G, Neptun Deep Survey



Depth [m]	LE [MPa]	BE [MPa]	HE [MPa]
0.00	0.02	0.06	0.10
0.80	0.10	0.18	0.25
1.60	0.70	0.80	1.20
5.70	0.70	0.80	1.20
5.70	1.00	1.20	1.50
17.00	1.00	1.20	1.50
17.00	1.50	1.70	2.20
24.40	1.80	2.00	2.80
24.40	1.80		26.00
41.50	2.50		28.00
41.50	2.10		7.00
45.40	2.20		7.00
45.40	2.30	2.50	2.70
60.00	2.80	3.00	3.30
70.00	3.20	3.50	3.70
92.20	4.20	4.50	4.70
112.50	5.30	5.50	5.80
112.50	15.00		52.00
120.00	15.00		52.00
120.00	15.00		40.00
124.10	15.00		40.00
124.10	5.00	5.50	10.00
125.90	5.00	5.50	10.00

GeODin/Cone Resistance vs Depth - Units_Soil_Stick.GLO/2018-05-24 16:18:20

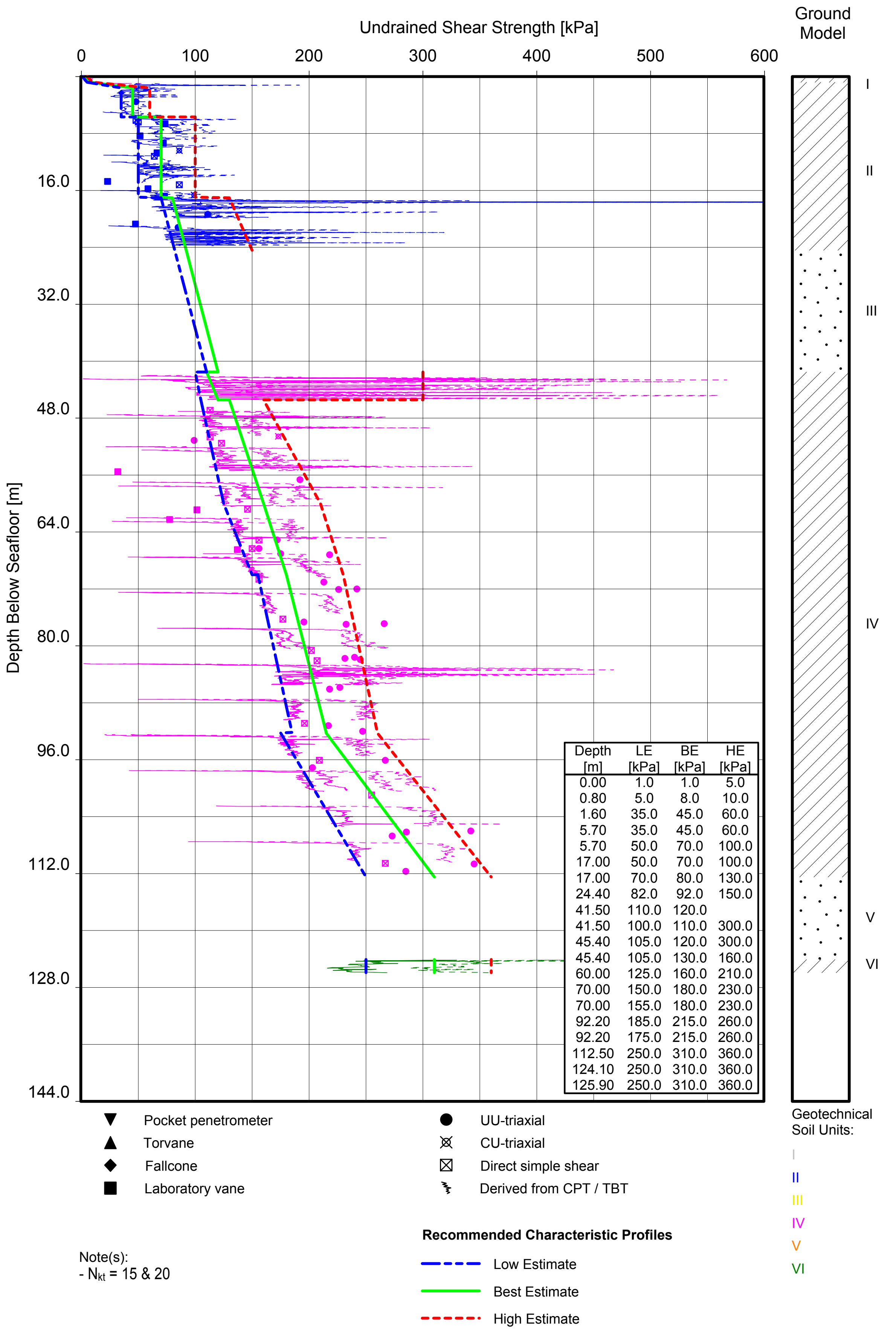
CONE RESISTANCE VERSUS DEPTH
Platform G, Neptun Deep Survey



Depth [m]	BE [MPa]
0.00	0.000
0.80	0.000
1.60	0.000
1.60	0.018
5.00	0.018
5.00	0.018
5.70	0.018
5.70	0.045
10.00	0.041
10.00	0.024
17.00	0.025
17.00	0.025
20.00	0.032
20.00	0.040
24.40	0.040
41.50	0.050
45.40	0.050
45.40	0.050
60.00	0.050
67.50	0.050
67.50	0.045
70.00	0.060
70.00	0.060
87.50	0.060
87.50	0.080
97.50	0.080

GeODin/Sleeve Friction.GLO/2018-05-29 13:08:30

SLEEVE FRICTION AND FRICTION RATIO VERSUS DEPTH
Platform G, Neptun Deep Survey

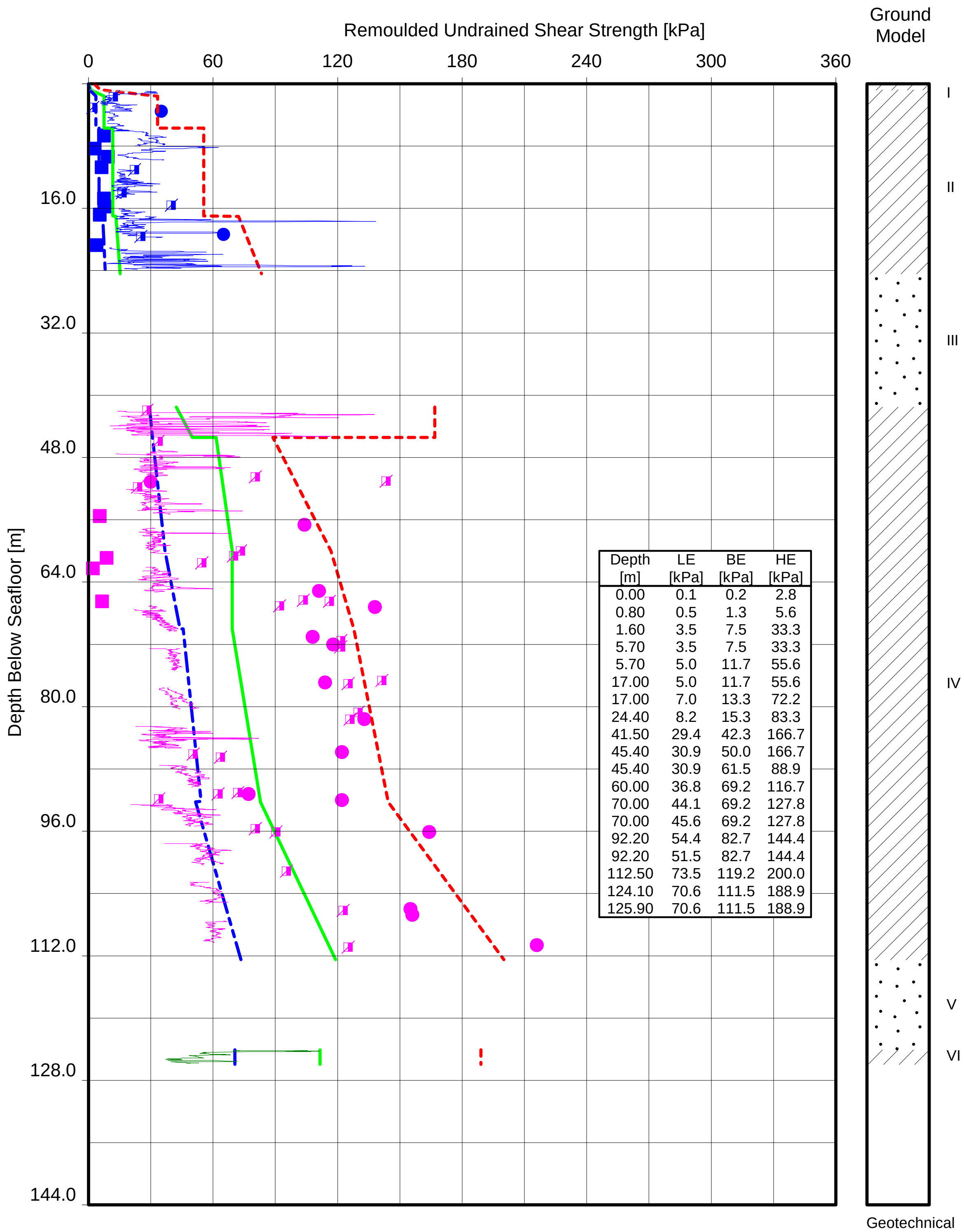


Depth [m]	LE [kPa]	BE [kPa]	HE [kPa]
0.00	1.0	1.0	5.0
0.80	5.0	8.0	10.0
1.60	35.0	45.0	60.0
5.70	35.0	45.0	60.0
5.70	50.0	70.0	100.0
17.00	50.0	70.0	100.0
17.00	70.0	80.0	130.0
24.40	82.0	92.0	150.0
41.50	110.0	120.0	
41.50	100.0	110.0	300.0
45.40	105.0	120.0	300.0
45.40	105.0	130.0	160.0
60.00	125.0	160.0	210.0
70.00	150.0	180.0	230.0
70.00	155.0	180.0	230.0
92.20	185.0	215.0	260.0
92.20	175.0	215.0	260.0
112.50	250.0	310.0	360.0
124.10	250.0	310.0	360.0
125.90	250.0	310.0	360.0

Note(s):
- N_{kt} = 15 & 20

GeODin/Undrained Shear Strength versus Depth.GLO/2018-05-24 16:40:04

UNDRAINED SHEAR STRENGTH VERSUS DEPTH
Platform G, Neptun Deep Survey



Depth [m]	LE [kPa]	BE [kPa]	HE [kPa]
0.00	0.1	0.2	2.8
0.80	0.5	1.3	5.6
1.60	3.5	7.5	33.3
5.70	3.5	7.5	33.3
5.70	5.0	11.7	55.6
17.00	5.0	11.7	55.6
17.00	7.0	13.3	72.2
24.40	8.2	15.3	83.3
41.50	29.4	42.3	166.7
45.40	30.9	50.0	166.7
45.40	30.9	61.5	88.9
60.00	36.8	69.2	116.7
70.00	44.1	69.2	127.8
70.00	45.6	69.2	127.8
92.20	54.4	82.7	144.4
92.20	51.5	82.7	144.4
112.50	73.5	119.2	200.0
124.10	70.6	111.5	188.9
125.90	70.6	111.5	188.9

Key of Symbols:

- Fallcone
- Laboratory Vane
- UU-triaxial
- Liquidity Index

In situ data:

2/3 Sleeve friction (fs) - Cone penetration test (CPT) data

Note(s):
For the calculation of suR from the liquidity index, a representative value from the water content design profile was used.

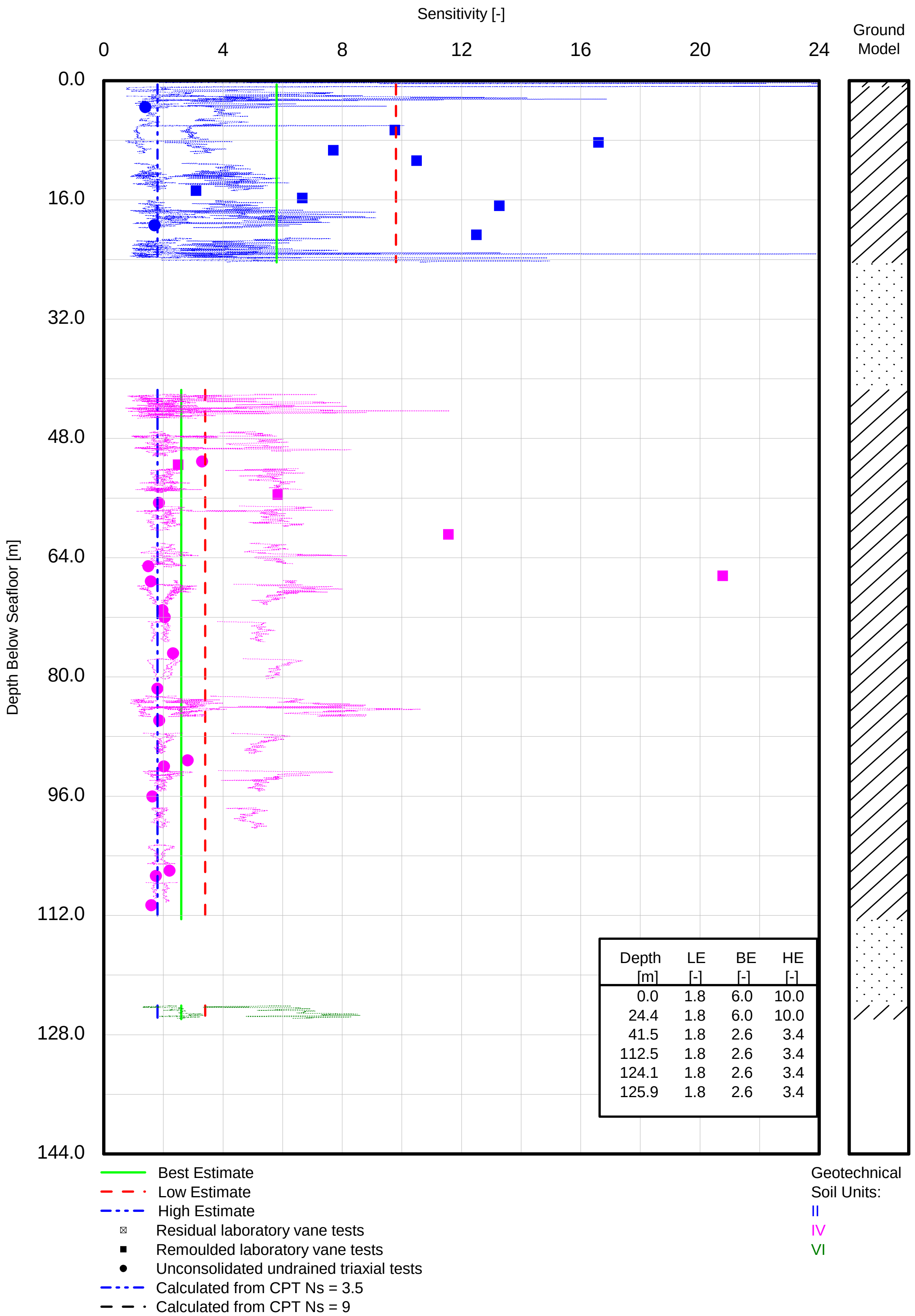
Recommended Characteristic Profiles

- Low Estimate
- Best Estimate
- High Estimate

Geotechnical Soil Units:
I
II
III
IV
V
VI

GeODin/Su(R) rev1 vs Depth - All Units.GLO/2018-05-29 10:05:19

REMOULDED UNDRAINED SHEAR STRENGTH VERSUS DEPTH
Platform G, Neptun Deep Survey

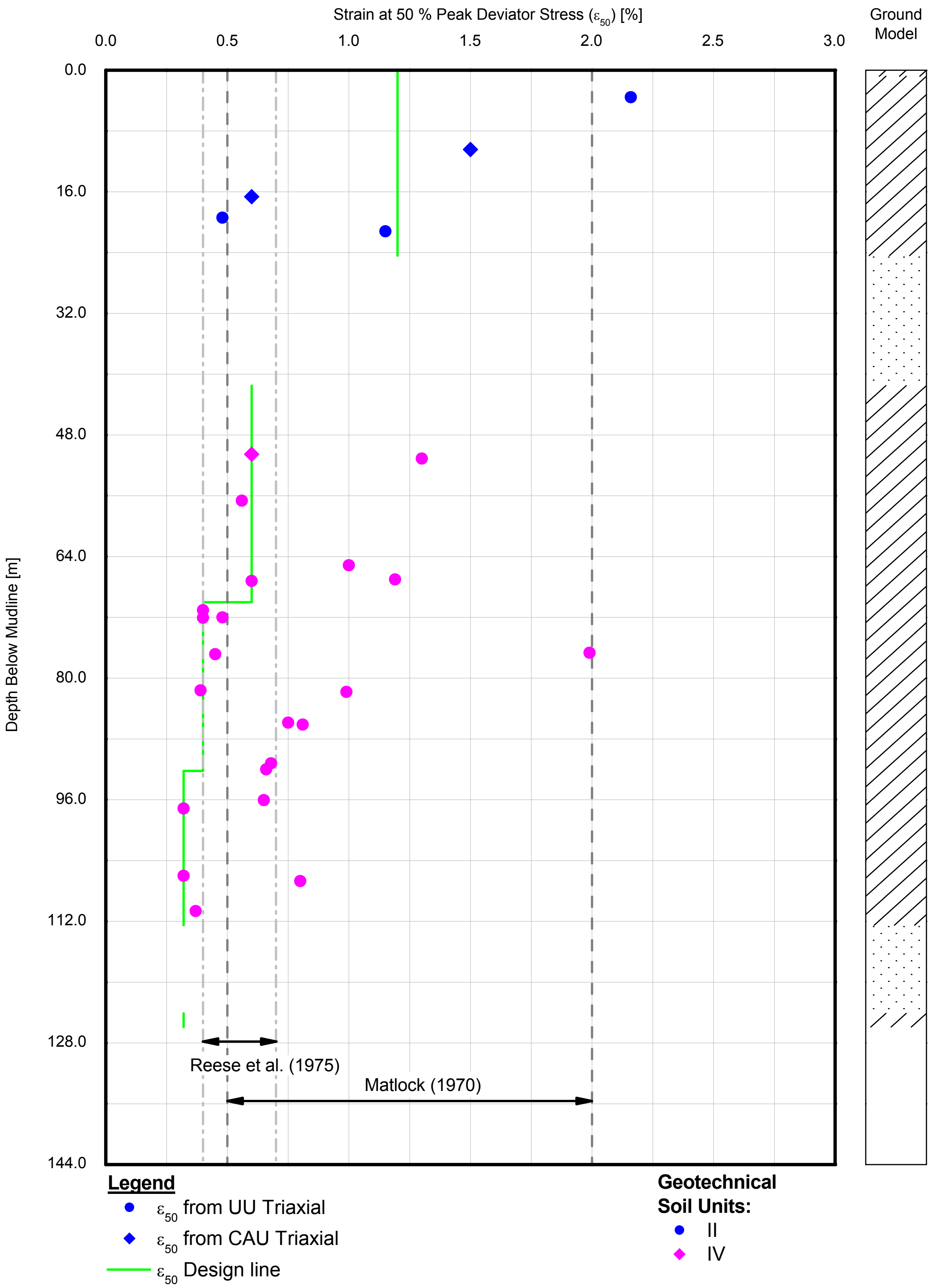


Depth [m]	LE [-]	BE [-]	HE [-]
0.0	1.8	6.0	10.0
24.4	1.8	6.0	10.0
41.5	1.8	2.6	3.4
112.5	1.8	2.6	3.4
124.1	1.8	2.6	3.4
125.9	1.8	2.6	3.4

Origin v7.03./ ### / 29/05/2018 17:55:51

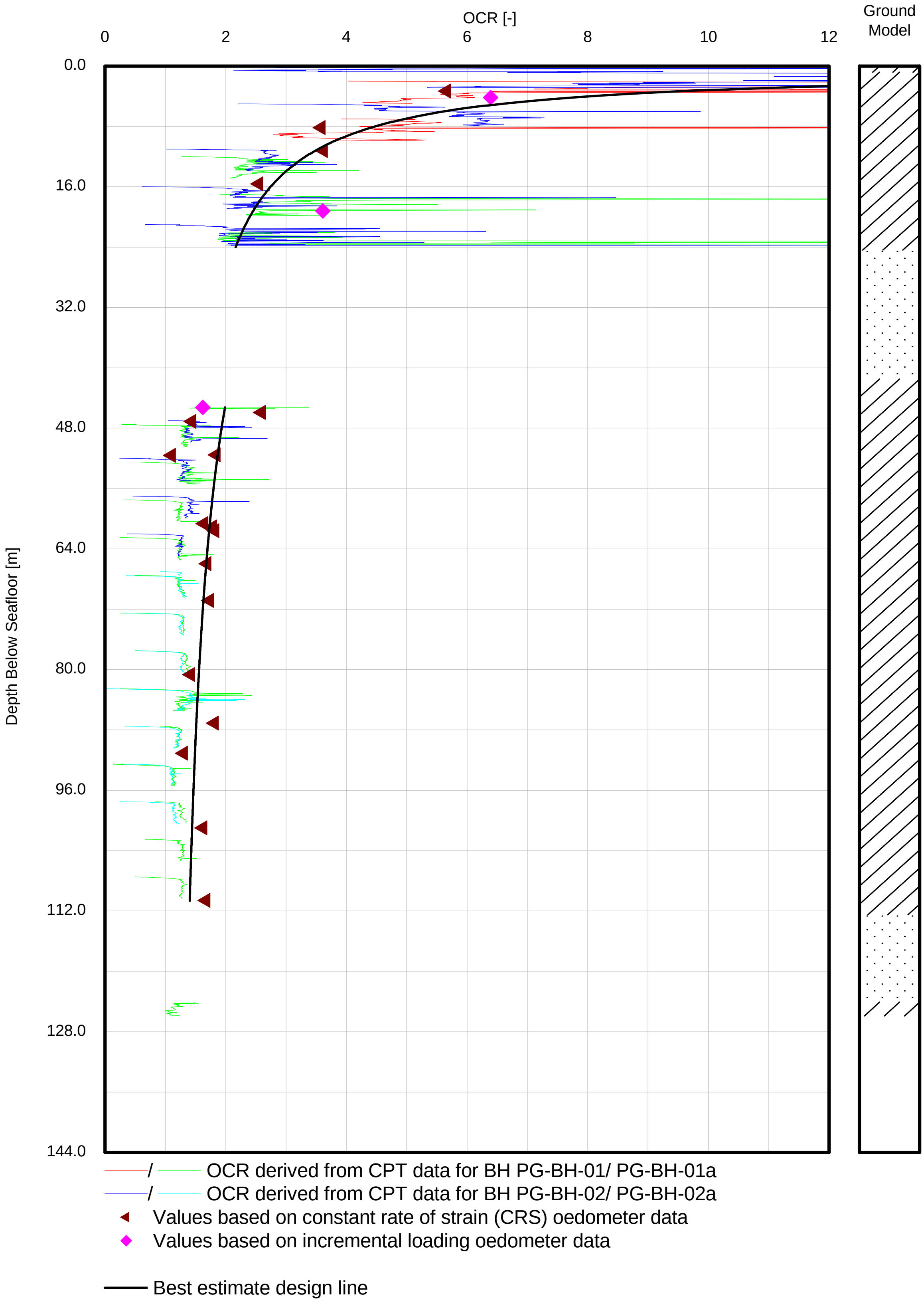
SENSITIVITY VERSUS DEPTH

Platform G, Neptun Deep Survey



Strain at 50 % Peak Deviator Stress (ε_{50}) versus Depth

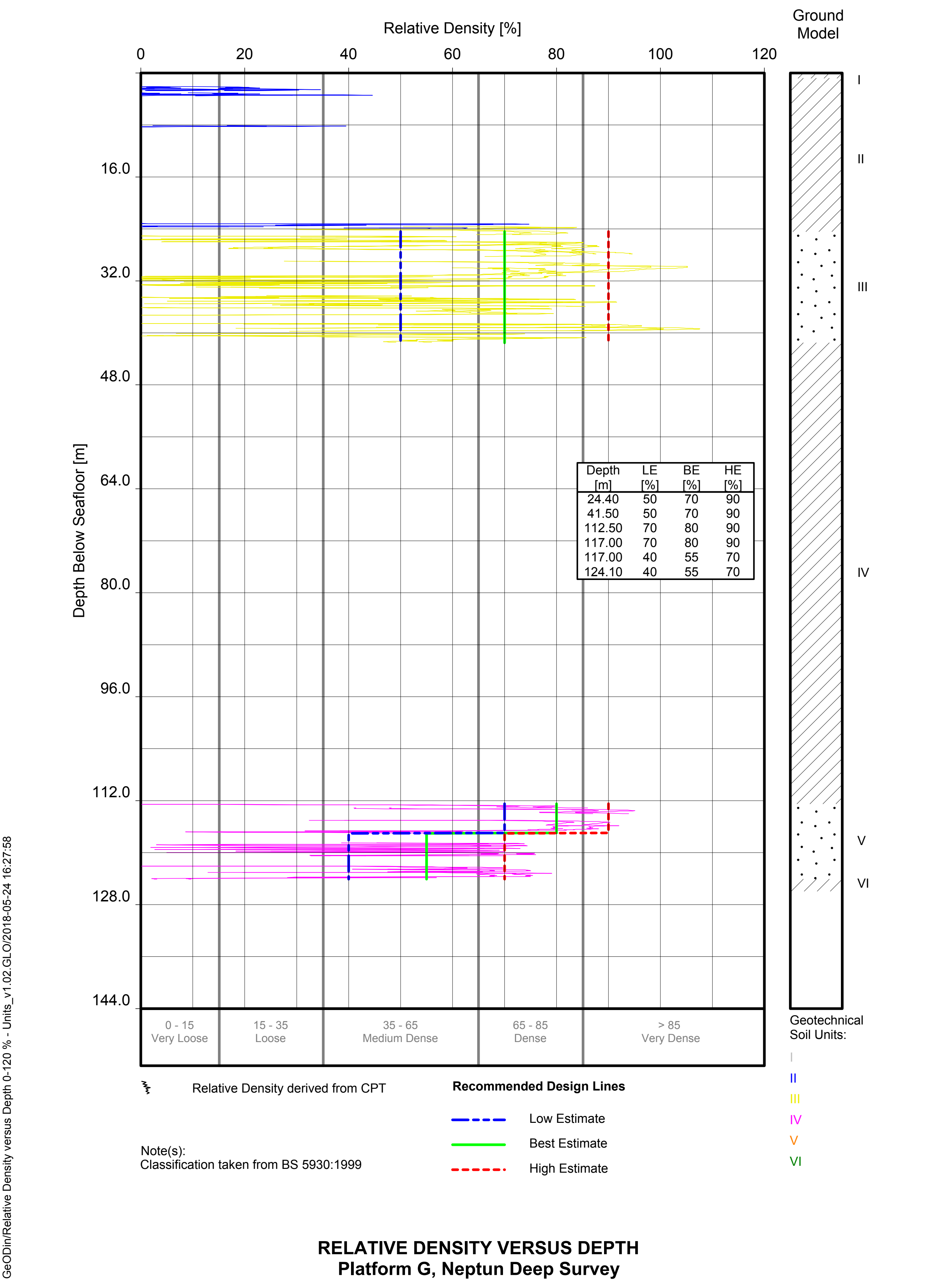
PG-BH-01/01a and PG-BH-02/02a
Platform G, Neptun Deep Survey



Overconsolidation Ratio (OCR) versus Depth

PG-BH-01/01a and PG-BH-02/02a

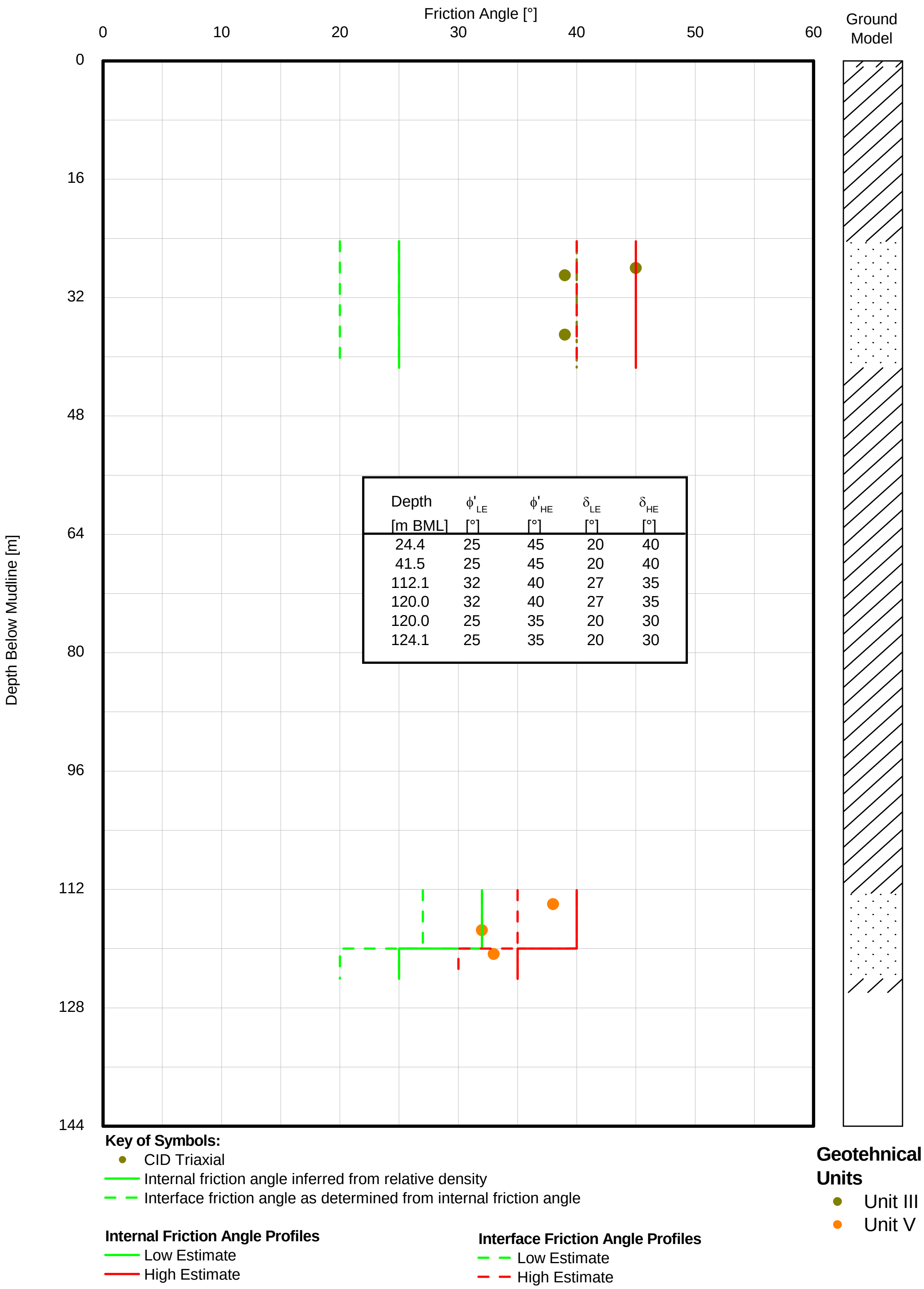
Platform G, Neptun Deep Survey



Depth [m]	LE [%]	BE [%]	HE [%]
24.40	50	70	90
41.50	50	70	90
112.50	70	80	90
117.00	70	80	90
117.00	40	55	70
124.10	40	55	70

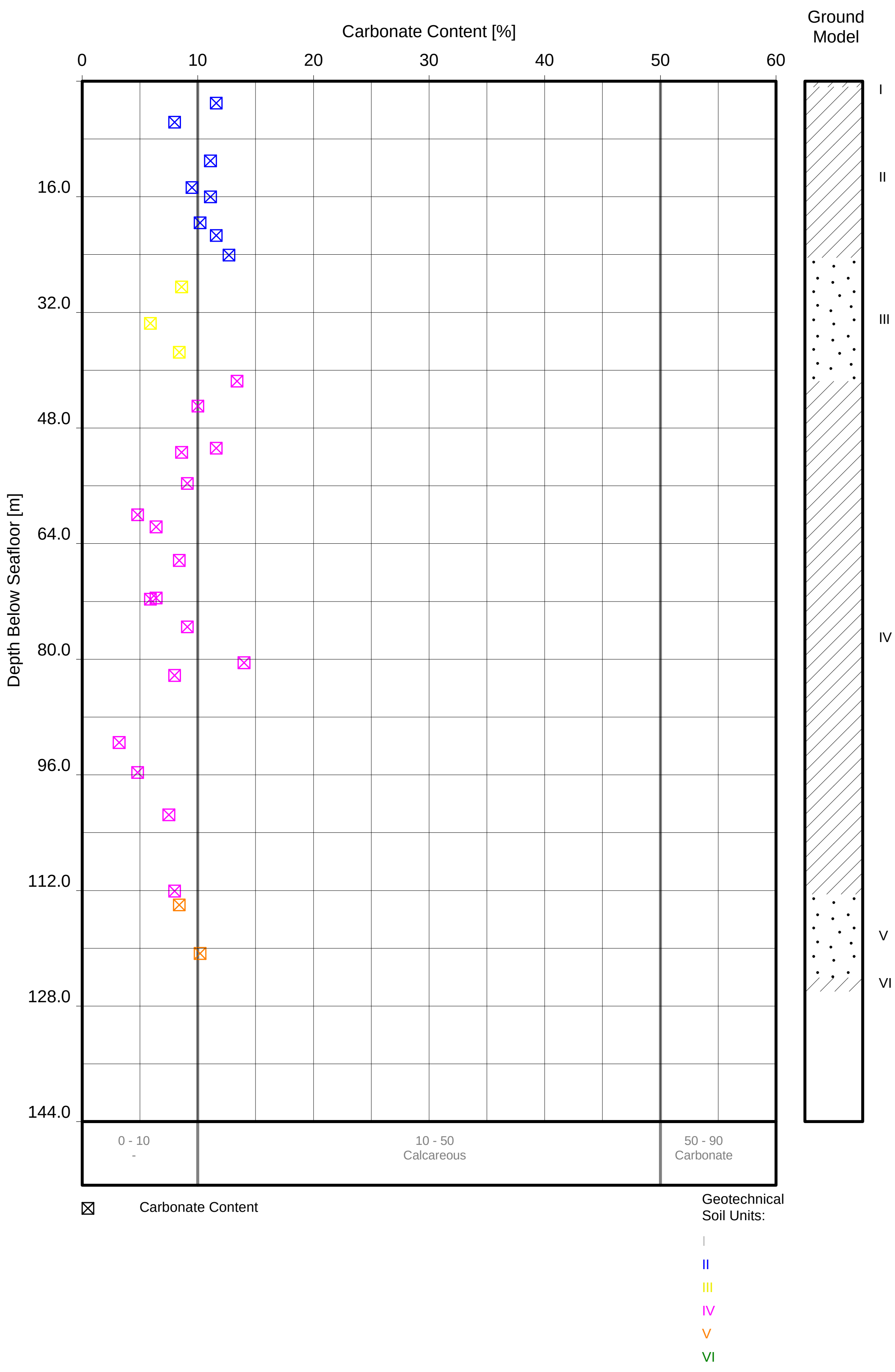
Note(s):
Classification taken from BS 5930:1999

RELATIVE DENSITY VERSUS DEPTH
Platform G, Neptun Deep Survey



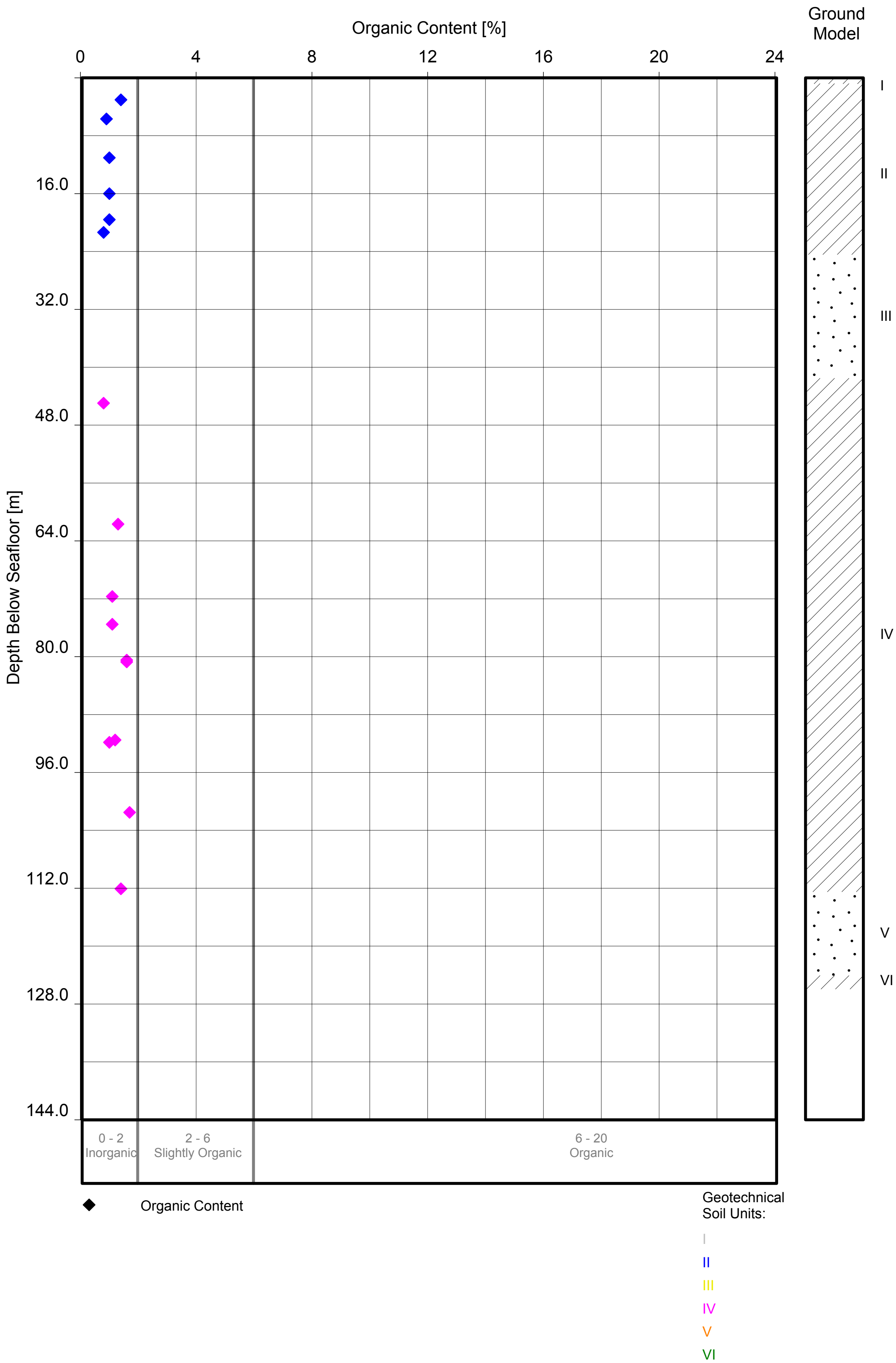
Depth [m BML]	ϕ'_{LE} [°]	ϕ'_{HE} [°]	δ_{LE} [°]	δ_{HE} [°]
24.4	25	45	20	40
41.5	25	45	20	40
112.1	32	40	27	35
120.0	32	40	27	35
120.0	25	35	20	30
124.1	25	35	20	30

FRICTION ANGLES
Proposed Platform G
PG-BH-01/01a and PG-BH-02/02a
Neptun Deep Survey, Pelican South Field



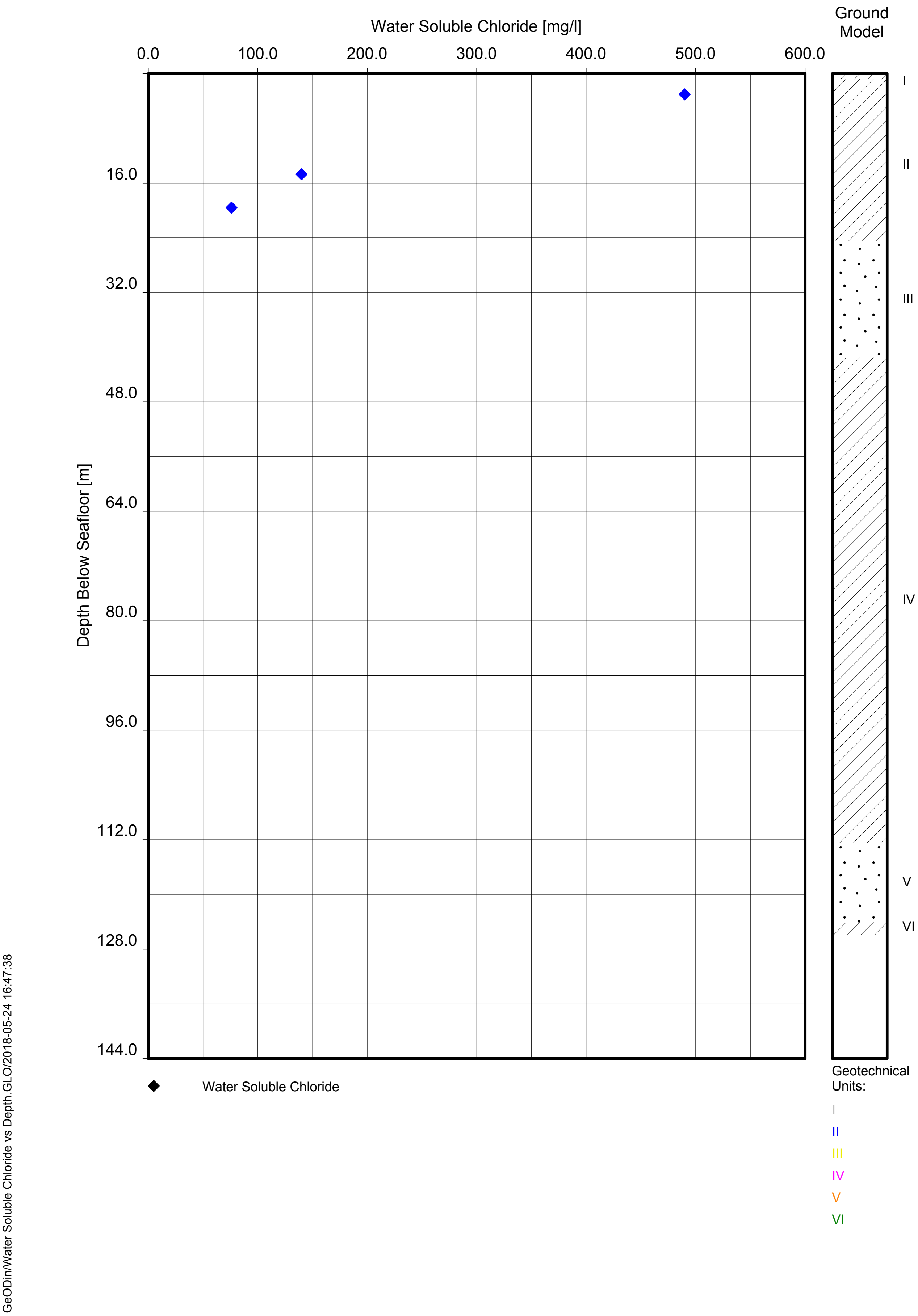
GeODin/Carbonate Content vs Depth.GLO/2018-05-29 13:15:05

CARBONATE CONTENT VERSUS DEPTH
Platform G, Neptun Deep Survey

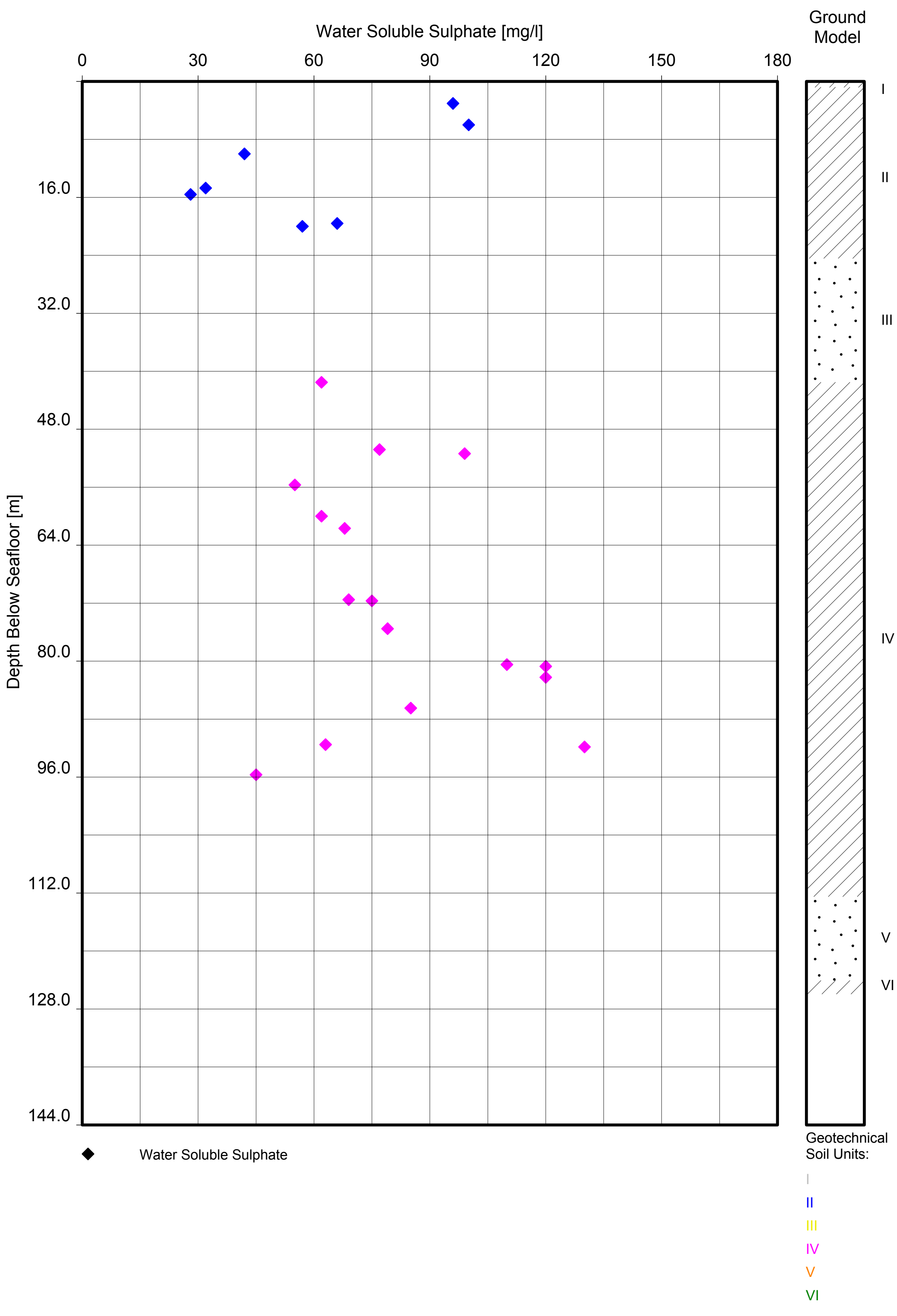


GeODin/Organic Content vs Depth.GLO/2018-05-24 16:22:09

ORGANIC CONTENT VERSUS DEPTH
Platform G, Neptun Deep Survey

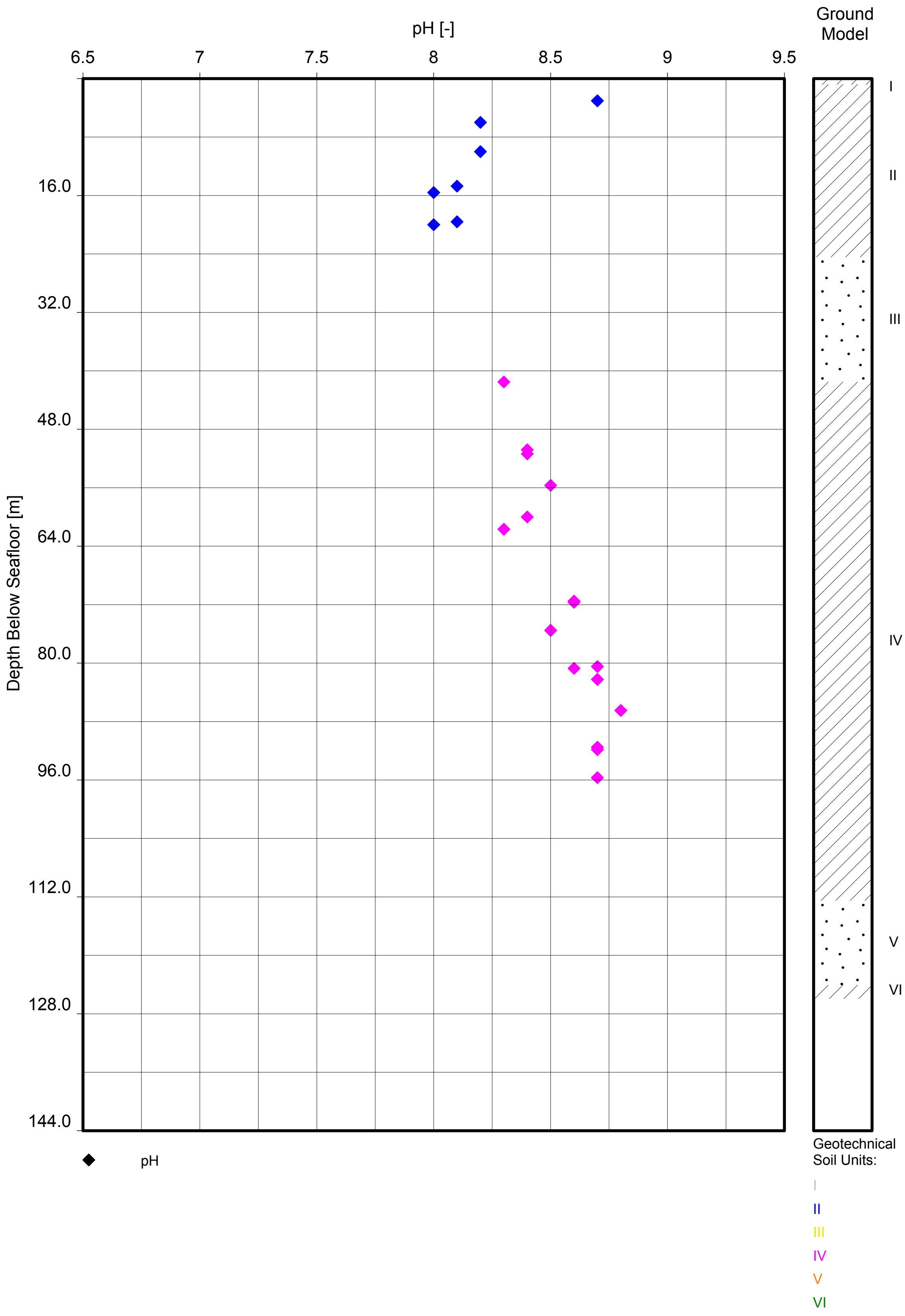


WATER SOLUBLE CHLORIDE VERSUS DEPTH
Platform G, Neptun Deep Survey



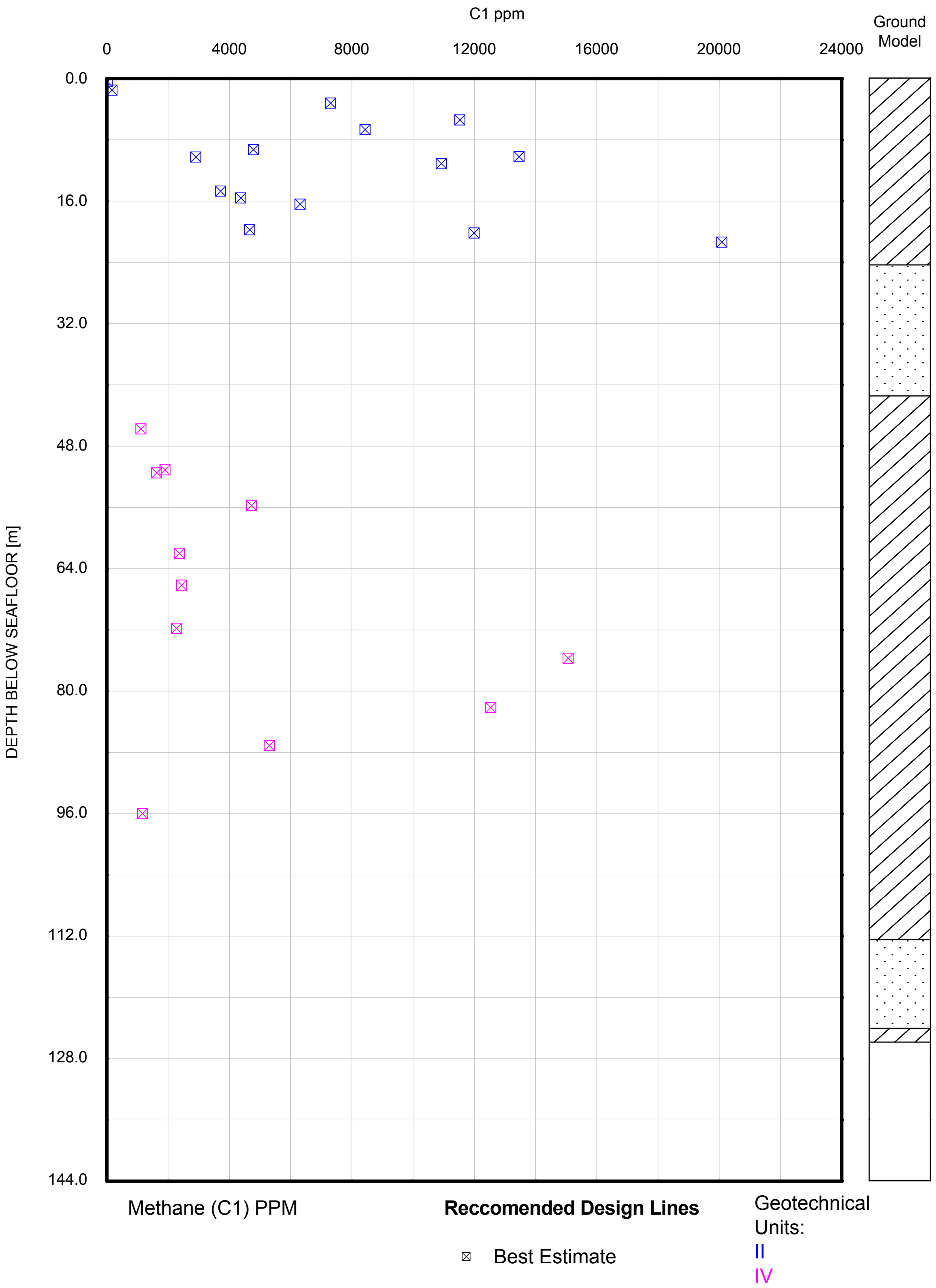
GeODin/Water Soluble Sulphate.GLO/2018-05-24 16:46:13

WATER SOLUBLE SULPHATE VERSUS DEPTH
Platform G, Neptun Deep Survey



GeODin/pH vs Depth - Units.GLO/2018-05-24 16:25:06

pH VERSUS DEPTH
Platform G, Neptun Deep Survey



HEADSPACE GAS VERSUS DEPTH
Methane (C1) PARTS PER MILLION
Platform G, Neptun Deep Survey

Depth [m BSF]	Soil Type	Unit Weight (γ) [kN/m^3]	Measured Cone Tip Resistance (q_c) [MPa]	Undrained Shear Strength (s_u) [kPa]	Relative Density [%]	ϕ' [°]	ε_{50} [%]	Limit Shaft Friction [kPa]
0.0	Clay	15.8	0.0	1 (0.9)			1.2	
0.8	Clay	15.8	0.1	5 (4.5)			1.2	
0.8	Clay	18.4	0.1	5 (4.5)			1.2	
1.6	Clay	18.4	0.7	35 (31.5)			1.2	
5.7	Clay	18.4	0.7	35 (31.5)			1.2	
5.7	Clay	18.7	1.0	50 (45)			1.2	
17.0	Clay	18.7	1.0	50 (45)			1.2	
17.0	Clay	18.7	1.5	70 (63)			1.2	
24.4	Clay	18.7	1.8	82.1 (73.9)			1.2	
24.4	Clay\ Sand*	19.3	1.8	82	50	30	0.6	81.0
27.0	Clay\ Sand*	19.3	1.9	86	50	30	0.6	81.0
27.0	Clay\ Sand*	19.3	1.9	86	50	30	0.6	81.0
31.5	Clay\ Sand*	19.3	2.1	94	50	30	0.6	81.0
31.5	Clay\ Sand*	19.3	2.1	94	50	30	0.6	81.0
36.0	Clay\ Sand*	19.3	2.3	101	50	30	0.6	81.0
36.0	Clay\ Sand*	19.3	2.3	101	50	30	0.6	81.0
41.5	Clay\ Sand*	19.3	2.5	110	50	30	0.6	81.0
41.5	Clay	19.2	2.1	100			0.6	
45.4	Clay	19.2	2.2	105			0.6	
45.4	Clay	19.2	2.3	105			0.6	
60.0	Clay	19.2	2.8	125			0.6	
60.0	Clay	19.2	2.8	125			0.6	
70.0	Clay	19.2	3.2	150			0.6	
70.0	Clay	18.7	3.4	155			0.4	
85.0	Clay	18.7	3.9	175			0.4	
85.0	Clay	19.4	3.9	175			0.4	
92.2	Clay	19.4	4.2	185			0.4	
92.2	Clay	19.4	4.0	175			0.3	
103.0	Clay	19.4	4.7	215			0.3	
103.0	Clay	18.8	4.7	215			0.3	
112.5	Clay	18.8	5.3	250			0.3	
112.5	Sand	19.7	15.0		70	32		
120.0	Sand	19.7	15.0		70	32		
120.0	Sand	19.7	15.0		40	25		
124.1	Sand	19.7	15.0		40	25		
124.1	Clay	18.8	5.0	250			0.3	
125.2	Clay	18.8	5.0	250			0.3	
125.2	Clay	18.8	5.0	250			0.3	
125.9	Clay	18.8	5.0	250			0.3	

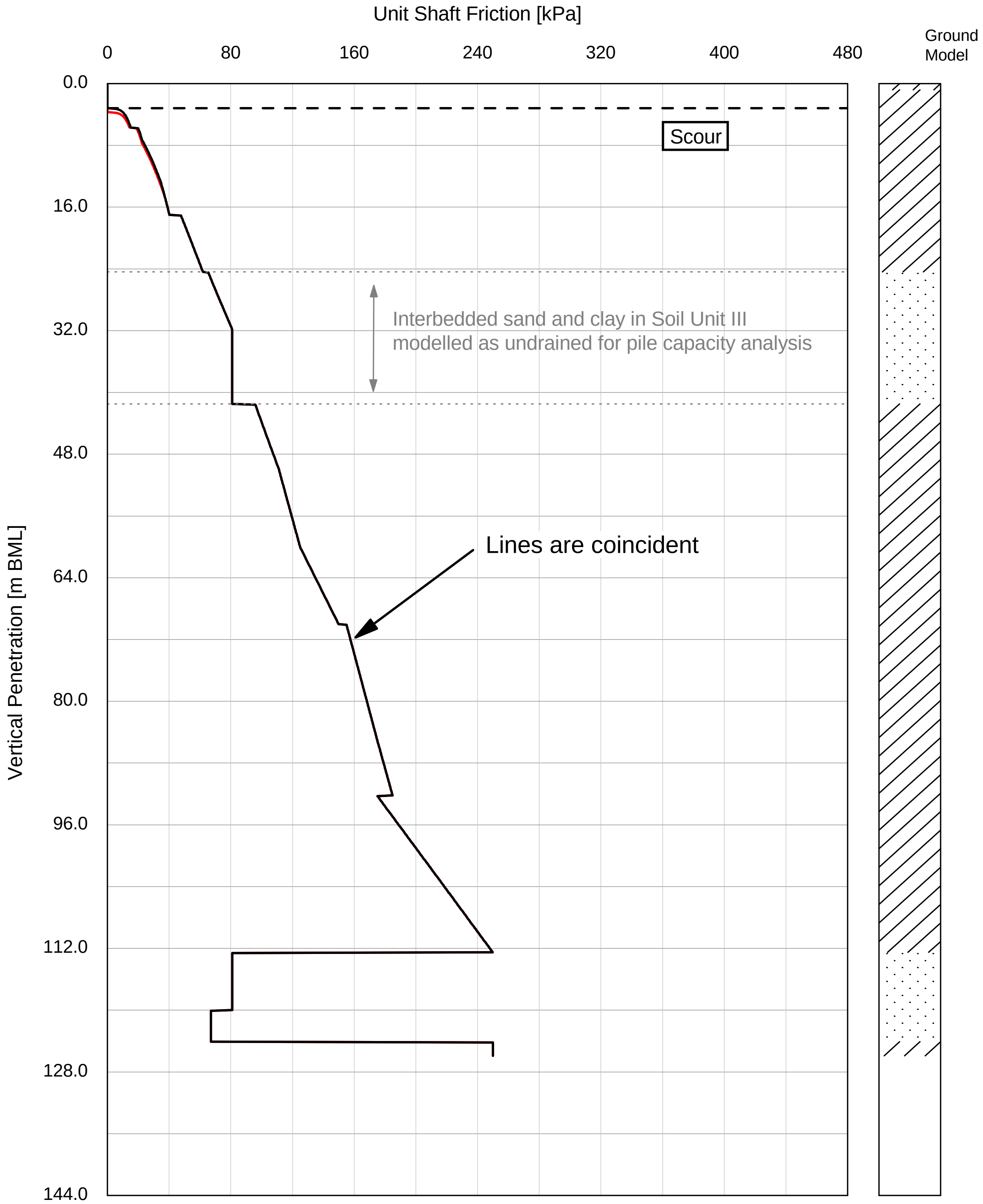
BSF = Below seafloor
ϕ' = Internal friction angle
ε_{50} = Strain at 50 % peak deviator stress
* = This layer modelled as undrained for pile capacity analysis
( ) = Undrained shear strength reduced by 10% to account for gas migration

LOW ESTIMATE DESIGN SOIL PARAMETERS FOR PILE CAPACITY ANALYSIS
PLATFORM G GEOTECHNICAL INTERPRETIVE REPORT
NEPTUN DEEP SURVEY

Depth [m BSF]	Soil Type	Unit Weight (γ) [kN/m^3]	Measured Cone Tip Resistance (q_c) [MPa]	Sleeve Friction (fs) [kPa]	Undrained Shear Strength (s_u) [kPa]	Relative Density [%]	ϕ' [°]	δ' [°]
0.0	Clay	15.8	0.1	0.0	5			
0.8	Clay	15.8	0.3	0.0	10			
0.8	Clay	18.4	0.3	0.0	10			
1.6	Clay	18.4	1.2	0.0	60			
1.6	Clay	18.4	1.2	18.0	60			
5.7	Clay	18.4	1.2	18.0	60			
5.7	Clay	18.7	1.5	45.0	100			
10.0	Clay	18.7	1.5	41.0	100			
10.0	Clay	18.7	1.5	24.0	100			
17.0	Clay	18.7	1.5	25.0	100			
17.0	Clay	18.7	2.2	25.0	130			
20.0	Clay	18.7	2.4	32.0	138			
20.0	Clay	18.7	2.4	40.0	138			
24.4	Clay	18.7	2.8	40.0	150			
24.4	Sand	19.3	26.0			90	40	35
27.0	Sand	19.3	26.3			90	40	35
27.0	Sand	19.3	26.3			90	40	35
31.5	Sand	19.3	26.8			90	40	35
31.5	Sand	19.3	26.8			90	40	35
36.0	Sand	19.3	27.4			90	40	35
36.0	Sand	19.3	27.4			90	40	35
41.5	Sand	19.3	28.0			90	40	35
41.5	Clay	19.2	7.0	50.0	400			
45.4	Clay	19.2	7.0	50.0	400			
45.4	Clay	19.2	2.7	50.0	160			
60.0	Clay	19.2	3.3	50.0	210			
60.0	Clay	19.2	3.3	50.0	210			
67.5	Clay	19.2	3.6	50.0	225			
67.5	Clay	19.2	3.6	45.1	225			
70.0	Clay	19.2	3.7	60.0	230			
70.0	Clay	18.7	3.7	60.0	230			
85.0	Clay	18.7	4.4	60.0	250			
85.0	Clay	19.4	4.4	60.0	250			
92.2	Clay	19.4	4.7	80.0	260			
92.2	Clay	19.4	4.5	80.0	260			
97.5	Clay	19.4	4.8	80.0	286			
97.5	Clay	19.4	4.8	90.0	286			
103.0	Clay	19.4	5.2	90.0	313			
103.0	Clay	18.8	5.2	90.0	313			
112.5	Clay	18.8	5.8	90.0	360			
112.5	Sand	19.7	52.0			90	40	35
120.0	Sand	19.7	52.0			90	40	35
120.0	Sand	19.7	40.0			70	35	30
124.1	Sand	19.7	40.0			70	35	30
124.1	Clay	18.8	10.0	80.0	360			
125.2	Clay	18.8	10.0	80.0	360			
125.2	Clay	18.8	10.0	65.0	360			
125.9	Clay	18.8	10.0	65.0	360			

Notes:
BSF = Below seafloor
ϕ' = Internal friction angle
d' - Interface frtction angle

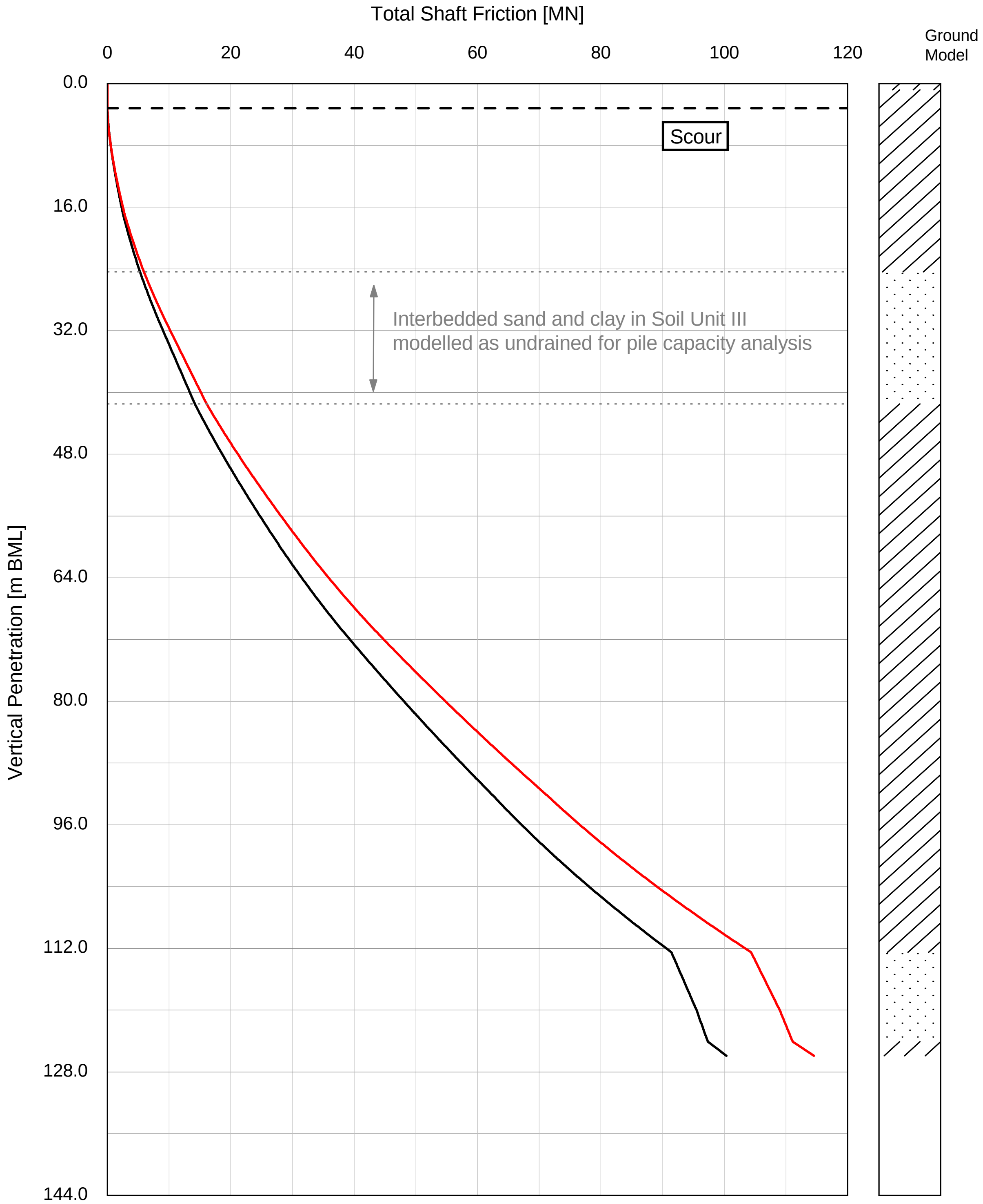
HIGH ESTIMATE DESIGN SOIL PARAMETERS FOR PILE DRIVEABILITY ANALYSIS
PLATFORM G GEOTECHNICAL INTERPRETIVE REPORT
NEPTUN DEEP SURVEY



Unit Shaft Friction in Compression Profile:
2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness
2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Note:
Unit shaft friction profile provided for a pile penetrating to 125.9 m BML
A 10 % reduction to the unit shaft friction was applied throughout Geotechnical Soil Units I and II

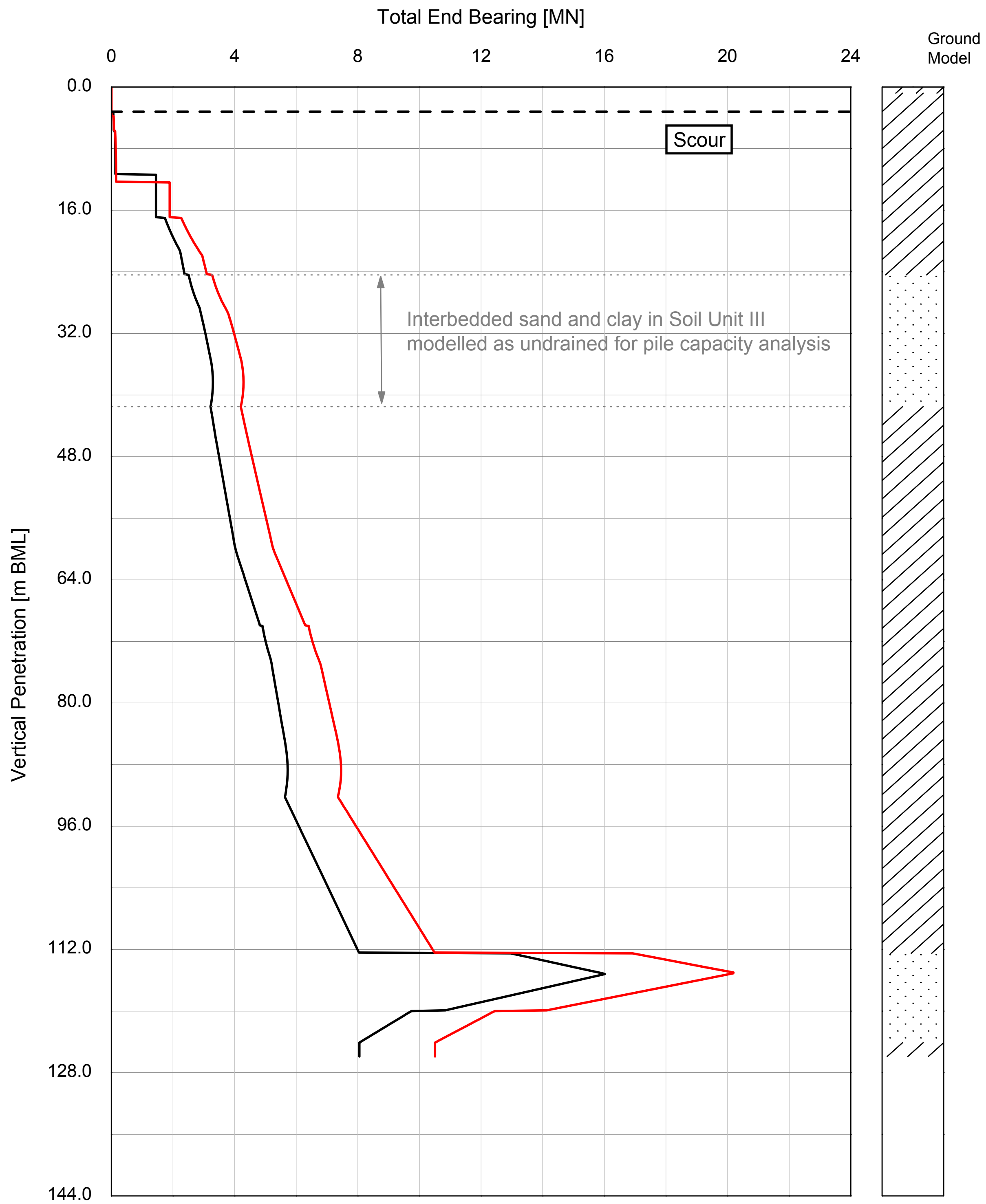
UNIT SHAFT FRICTION
API RP2 GEO DESIGN METHOD (2011)
PROPOSED PLATFORM G, NEPTUN DEEP SURVEY



Unit Shaft Friction in Compression Profile:
2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness
2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Note:
Unit shaft friction profile provided for a pile penetrating to 125.9 m BML
A 10 % reduction to the unit shaft friction was applied throughout Geotechnical Soil Units I and II

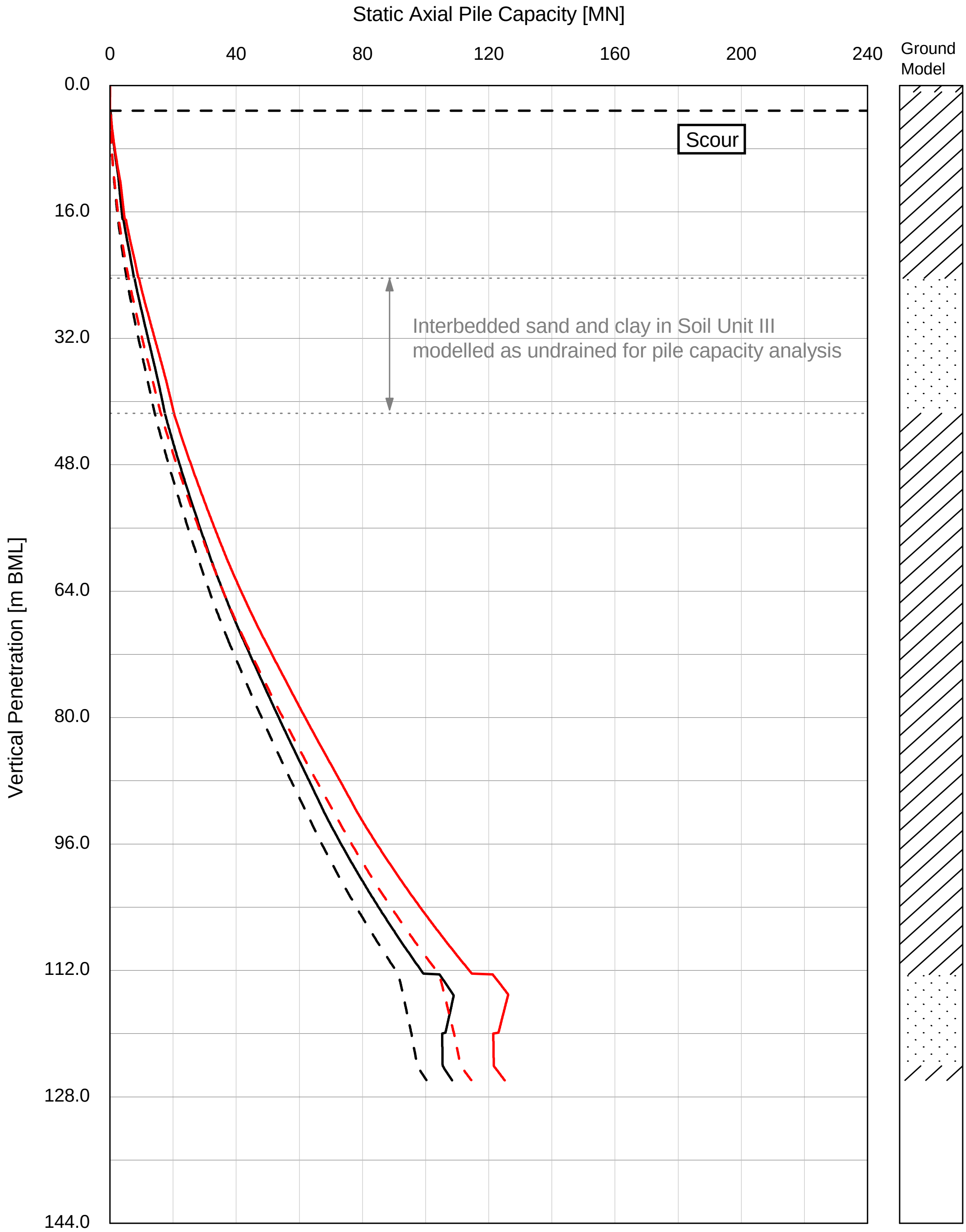
TOTAL SHAFT FRICTION
API RP2 GEO DESIGN METHOD (2011)
PLATFORM G, NEPTUN DEEP SURVEY



Recommended Total End Bearing Profile:
2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness
2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Note:
BML = Below Mudline

TOTAL END BEARING
API RP2 GEO DESIGN METHOD (2011)
PROPOSED PLATFORM G, NEPTUN DEEP SURVEY



Unfactored Static Axial Pile Capacity Profile:
Compression
Tension

2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness
2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Notes:
Piles penetrating to 125.9 m BML

UNFACTORED STATIC AXIAL PILE CAPACITY
API RP2 GEO DESIGN METHOD (2011)
PROPOSED PLATFORM G, NEPTUN DEEP SURVEY

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
3.20	Clay	0.000	0.000	0.000	3.414	6.615	6.615	0.000	12.164	0.000	17.072	0.000	21.340	0.000	42.680	0.000	2134.0
3.30	Clay	0.000	0.000	1.717	3.414	2.862	6.615	4.292	12.164	5.151	17.072	5.723	21.340	4.006	42.680	4.006	2134.0
3.70	Clay	0.000	0.000	2.974	3.414	4.956	6.615	7.434	12.164	8.921	17.072	9.913	21.340	6.939	42.680	6.939	2134.0
4.00	Clay	0.000	0.000	3.379	3.414	5.631	6.615	8.447	12.164	10.137	17.072	11.263	21.340	7.884	42.680	7.884	2134.0
5.00	Clay	0.000	0.000	4.176	3.414	6.960	6.615	10.440	12.164	12.528	17.072	13.920	21.340	9.744	42.680	9.744	2134.0
5.70	Clay	0.000	0.000	4.543	3.414	7.571	6.615	11.356	12.164	13.628	17.072	15.142	21.340	10.599	42.680	10.599	2134.0
5.70	Clay	0.000	0.000	5.996	3.414	9.994	6.615	14.991	12.164	17.989	17.072	19.987	21.340	13.991	42.680	13.991	2134.0
7.00	Clay	0.000	0.000	6.617	3.414	11.029	6.615	16.543	12.164	19.852	17.072	22.057	21.340	15.440	42.680	15.440	2134.0
7.40	Clay	0.000	0.000	6.830	3.414	11.384	6.615	17.076	12.164	20.491	17.072	22.767	21.340	15.937	42.680	15.937	2134.0
8.00	Clay	0.000	0.000	7.315	3.414	12.191	6.615	18.287	12.164	21.944	17.072	24.383	21.340	17.068	42.680	17.068	2134.0
9.00	Clay	0.000	0.000	8.058	3.414	13.430	6.615	20.145	12.164	24.174	17.072	26.860	21.340	18.802	42.680	18.802	2134.0
10.00	Clay	0.000	0.000	8.738	3.414	14.564	6.615	21.845	12.164	26.214	17.072	29.127	21.340	20.389	42.680	20.389	2134.0
11.00	Clay	0.000	0.000	9.369	3.414	15.615	6.615	23.423	12.164	28.107	17.072	31.230	21.340	21.861	42.680	21.861	2134.0
12.00	Clay	0.000	0.000	9.960	3.414	16.600	6.615	24.900	12.164	29.880	17.072	33.200	21.340	23.240	42.680	23.240	2134.0
12.80	Clay	0.000	0.000	10.402	3.414	17.337	6.615	26.005	12.164	31.206	17.072	34.674	21.340	24.271	42.680	24.271	2134.0
12.90	Clay	0.000	0.000	10.457	3.414	17.429	6.615	26.143	12.164	31.372	17.072	34.858	21.340	24.400	42.680	24.400	2134.0
13.00	Clay	0.000	0.000	10.499	3.414	17.499	6.615	26.248	12.164	31.498	17.072	34.998	21.340	24.498	42.680	24.498	2134.0
14.00	Clay	0.000	0.000	10.911	3.414	18.185	6.615	27.277	12.164	32.732	17.072	36.369	21.340	25.458	42.680	25.458	2134.0
15.00	Clay	0.000	0.000	11.307	3.414	18.845	6.615	28.268	12.164	33.922	17.072	37.691	21.340	26.384	42.680	26.384	2134.0
16.00	Clay	0.000	0.000	11.690	3.414	19.484	6.615	29.226	12.164	35.071	17.072	38.968	21.340	27.277	42.680	27.277	2134.0
17.00	Clay	0.000	0.000	12.061	3.414	20.102	6.615	30.153	12.164	36.183	17.072	40.204	21.340	28.143	42.680	28.143	2134.0
17.00	Clay	0.000	0.000	14.322	3.414	23.871	6.615	35.806	12.164	42.967	17.072	47.741	21.340	33.419	42.680	33.419	2134.0
18.00	Clay	0.000	0.000	14.859	3.414	24.765	6.615	37.147	12.164	44.577	17.072	49.530	21.340	34.671	42.680	34.671	2134.0
19.00	Clay	0.000	0.000	15.451	3.414	25.752	6.615	38.628	12.164	46.353	17.072	51.503	21.340	36.052	42.680	36.052	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 1 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
20.00	Clay	0.000	0.000	16.039	3.414	26.732	6.615	40.098	12.164	48.117	17.072	53.464	21.340	37.425	42.680	37.425	2134.0
22.00	Clay	0.000	0.000	17.205	3.414	28.676	6.615	43.014	12.164	51.616	17.072	57.351	21.340	40.146	42.680	40.146	2134.0
24.40	Clay	0.000	0.000	18.590	3.414	30.984	6.615	46.476	12.164	55.771	17.072	61.968	21.340	43.377	42.680	43.377	2134.0
24.40	Clay	0.000	0.000	19.644	3.414	32.740	6.615	49.110	12.164	58.932	17.072	65.480	21.340	45.836	42.680	45.836	2134.0
26.00	Clay	0.000	0.000	20.572	3.414	34.287	6.615	51.431	12.164	61.717	17.072	68.574	21.340	48.002	42.680	48.002	2134.0
27.00	Clay	0.000	0.000	21.188	3.414	35.313	6.615	52.969	12.164	63.563	17.072	70.625	21.340	49.438	42.680	49.438	2134.0
27.00	clay	0.000	0.000	21.250	3.414	35.417	6.615	53.126	12.164	63.751	17.072	70.835	21.340	49.584	42.680	49.584	2134.0
27.80	clay	0.000	0.000	21.713	3.414	36.188	6.615	54.283	12.164	65.139	17.072	72.377	21.340	50.663	42.680	50.663	2134.0
28.00	clay	0.000	0.000	21.829	3.414	36.381	6.615	54.572	12.164	65.486	17.072	72.762	21.340	50.933	42.680	50.933	2134.0
30.00	clay	0.000	0.000	23.108	3.414	38.514	6.615	57.771	12.164	69.325	17.072	77.028	21.340	53.919	42.680	53.919	2134.0
31.50	clay	0.000	0.000	24.064	3.414	40.107	6.615	60.160	12.164	72.192	17.072	80.213	21.340	56.149	42.680	56.149	2134.0
31.50	Clay	0.000	0.000	24.127	3.414	40.211	6.615	60.316	12.164	72.380	17.072	80.422	21.340	56.295	42.680	56.295	2134.0
31.90	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
34.00	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
38.00	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
41.50	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
41.50	Clay	0.000	0.000	28.783	3.414	47.972	6.615	71.959	12.164	86.350	17.072	95.945	21.340	67.161	42.680	67.161	2134.0
44.00	Clay	0.000	0.000	30.087	3.414	50.144	6.615	75.216	12.164	90.260	17.072	100.289	21.340	70.202	42.680	70.202	2134.0
45.40	Clay	0.000	0.000	30.844	3.414	51.407	6.615	77.111	12.164	92.533	17.072	102.814	21.340	71.970	42.680	71.970	2134.0
45.40	Clay	0.000	0.000	30.899	3.414	51.498	6.615	77.247	12.164	92.697	17.072	102.996	21.340	72.097	42.680	72.097	2134.0
48.00	Clay	0.000	0.000	32.280	3.414	53.800	6.615	80.700	12.164	96.840	17.072	107.600	21.340	75.320	42.680	75.320	2134.0
50.00	Clay	0.000	0.000	33.370	3.414	55.616	6.615	83.425	12.164	100.110	17.072	111.233	21.340	77.863	42.680	77.863	2134.0
52.00	Clay	0.000	0.000	34.192	3.414	56.986	6.615	85.479	12.164	102.575	17.072	113.973	21.340	79.781	42.680	79.781	2134.0
56.00	Clay	0.000	0.000	35.836	3.414	59.726	6.615	89.589	12.164	107.507	17.072	119.452	21.340	83.616	42.680	83.616	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 2 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
60.00	Clay	0.000	0.000	37.479	3.414	62.466	6.615	93.699	12.164	112.438	17.072	124.932	21.340	87.452	42.680	87.452	2134.0
60.00	Clay	0.000	0.000	37.538	3.414	62.563	6.615	93.844	12.164	112.613	17.072	125.125	21.340	87.588	42.680	87.588	2134.0
65.00	Clay	0.000	0.000	41.213	3.414	68.688	6.615	103.031	12.164	123.637	17.072	137.375	21.340	96.162	42.680	96.162	2134.0
70.00	Clay	0.000	0.000	44.963	3.414	74.938	6.615	112.406	12.164	134.887	17.072	149.875	21.340	104.912	42.680	104.912	2134.0
70.00	Clay	0.000	0.000	46.520	3.414	77.533	6.615	116.300	12.164	139.560	17.072	155.067	21.340	108.547	42.680	108.547	2134.0
75.00	Clay	0.000	0.000	48.480	3.414	80.800	6.615	121.200	12.164	145.440	17.072	161.600	21.340	113.120	42.680	113.120	2134.0
80.00	Clay	0.000	0.000	50.480	3.414	84.133	6.615	126.200	12.164	151.440	17.072	168.267	21.340	117.787	42.680	117.787	2134.0
85.00	Clay	0.000	0.000	52.480	3.414	87.467	6.615	131.200	12.164	157.440	17.072	174.933	21.340	122.453	42.680	122.453	2134.0
85.00	Clay	0.000	0.000	52.521	3.414	87.535	6.615	131.302	12.164	157.562	17.072	175.069	21.340	122.549	42.680	122.549	2134.0
90.00	Clay	0.000	0.000	54.562	3.414	90.938	6.615	136.406	12.164	163.688	17.072	181.875	21.340	127.312	42.680	127.312	2134.0
92.20	Clay	0.000	0.000	55.479	3.414	92.465	6.615	138.698	12.164	166.438	17.072	184.931	21.340	129.451	42.680	129.451	2134.0
92.20	Clay	0.000	0.000	52.556	3.414	87.593	6.615	131.389	12.164	157.667	17.072	175.185	21.340	122.630	42.680	122.630	2134.0
95.00	Clay	0.000	0.000	55.556	3.414	92.593	6.615	138.889	12.164	166.667	17.072	185.185	21.340	129.630	42.680	129.630	2134.0
100.00	Clay	0.000	0.000	61.111	3.414	101.852	6.615	152.778	12.164	183.333	17.072	203.704	21.340	142.593	42.680	142.593	2134.0
103.00	Clay	0.000	0.000	64.444	3.414	107.407	6.615	161.111	12.164	193.333	17.072	214.815	21.340	150.370	42.680	150.370	2134.0
103.00	Clay	0.000	0.000	64.555	3.414	107.592	6.615	161.388	12.164	193.666	17.072	215.184	21.340	150.629	42.680	150.629	2134.0
110.00	Clay	0.000	0.000	72.182	3.414	120.303	6.615	180.454	12.164	216.545	17.072	240.605	21.340	168.424	42.680	168.424	2134.0
112.50	Clay	0.000	0.000	74.945	3.414	124.908	6.615	187.362	12.164	224.834	17.072	249.816	21.340	174.871	42.680	174.871	2134.0
112.50	Sand	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	81.000	42.680	81.000	2134.0
120.00	Sand	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	81.000	42.680	81.000	2134.0
120.00	Sand	0.000	0.000	20.100	3.414	33.500	6.615	50.250	12.164	60.300	17.072	67.000	21.340	67.000	42.680	67.000	2134.0
124.10	Sand	0.000	0.000	20.100	3.414	33.500	6.615	50.250	12.164	60.300	17.072	67.000	21.340	67.000	42.680	67.000	2134.0
124.10	Clay	0.000	0.000	75.000	3.414	125.000	6.615	187.500	12.164	225.000	17.072	250.000	21.340	175.000	42.680	175.000	2134.0
125.20	Clay	0.000	0.000	75.000	3.414	125.000	6.615	187.500	12.164	225.000	17.072	250.000	21.340	175.000	42.680	175.000	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 3 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
3.20	Clay	0.000	0.000	0.000	3.414	0.000	6.615	0.000	12.164	0.000	17.072	0.000	21.340	0.000	42.680	0.000	2134.0
3.30	Clay	0.000	0.000	1.717	3.414	2.862	6.615	4.292	12.164	5.151	17.072	5.723	21.340	4.006	42.680	4.006	2134.0
3.70	Clay	0.000	0.000	2.974	3.414	4.956	6.615	7.434	12.164	8.921	17.072	9.913	21.340	6.939	42.680	6.939	2134.0
4.00	Clay	0.000	0.000	3.379	3.414	5.631	6.615	8.447	12.164	10.137	17.072	11.263	21.340	7.884	42.680	7.884	2134.0
5.00	Clay	0.000	0.000	4.176	3.414	6.960	6.615	10.440	12.164	12.528	17.072	13.920	21.340	9.744	42.680	9.744	2134.0
5.70	Clay	0.000	0.000	4.543	3.414	7.571	6.615	11.356	12.164	13.628	17.072	15.142	21.340	10.599	42.680	10.599	2134.0
5.70	Clay	0.000	0.000	5.996	3.414	9.994	6.615	14.991	12.164	17.989	17.072	19.987	21.340	13.991	42.680	13.991	2134.0
7.00	Clay	0.000	0.000	6.617	3.414	11.029	6.615	16.543	12.164	19.852	17.072	22.057	21.340	15.440	42.680	15.440	2134.0
7.40	Clay	0.000	0.000	6.830	3.414	11.384	6.615	17.076	12.164	20.491	17.072	22.767	21.340	15.937	42.680	15.937	2134.0
8.00	Clay	0.000	0.000	7.315	3.414	12.191	6.615	18.287	12.164	21.944	17.072	24.383	21.340	17.068	42.680	17.068	2134.0
9.00	Clay	0.000	0.000	8.058	3.414	13.430	6.615	20.145	12.164	24.174	17.072	26.860	21.340	18.802	42.680	18.802	2134.0
10.00	Clay	0.000	0.000	8.738	3.414	14.564	6.615	21.845	12.164	26.214	17.072	29.127	21.340	20.389	42.680	20.389	2134.0
11.00	Clay	0.000	0.000	9.369	3.414	15.615	6.615	23.423	12.164	28.107	17.072	31.230	21.340	21.861	42.680	21.861	2134.0
12.00	Clay	0.000	0.000	9.960	3.414	16.600	6.615	24.900	12.164	29.880	17.072	33.200	21.340	23.240	42.680	23.240	2134.0
12.80	Clay	0.000	0.000	10.402	3.414	17.337	6.615	26.005	12.164	31.206	17.072	34.674	21.340	24.271	42.680	24.271	2134.0
12.90	Clay	0.000	0.000	10.457	3.414	17.429	6.615	26.143	12.164	31.372	17.072	34.858	21.340	24.400	42.680	24.400	2134.0
13.00	Clay	0.000	0.000	10.499	3.414	17.499	6.615	26.248	12.164	31.498	17.072	34.998	21.340	24.498	42.680	24.498	2134.0
14.00	Clay	0.000	0.000	10.911	3.414	18.185	6.615	27.277	12.164	32.732	17.072	36.369	21.340	25.458	42.680	25.458	2134.0
15.00	Clay	0.000	0.000	11.307	3.414	18.845	6.615	28.268	12.164	33.922	17.072	37.691	21.340	26.384	42.680	26.384	2134.0
16.00	Clay	0.000	0.000	11.690	3.414	19.484	6.615	29.226	12.164	35.071	17.072	38.968	21.340	27.277	42.680	27.277	2134.0
17.00	Clay	0.000	0.000	12.061	3.414	20.102	6.615	30.153	12.164	36.183	17.072	40.204	21.340	28.143	42.680	28.143	2134.0
17.00	Clay	0.000	0.000	14.322	3.414	23.871	6.615	35.806	12.164	42.967	17.072	47.741	21.340	33.419	42.680	33.419	2134.0
18.00	Clay	0.000	0.000	14.859	3.414	24.765	6.615	37.147	12.164	44.577	17.072	49.530	21.340	34.671	42.680	34.671	2134.0
19.00	Clay	0.000	0.000	15.451	3.414	25.752	6.615	38.628	12.164	46.353	17.072	51.503	21.340	36.052	42.680	36.052	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 1 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
20.00	Clay	0.000	0.000	16.039	3.414	26.732	6.615	40.098	12.164	48.117	17.072	53.464	21.340	37.425	42.680	37.425	2134.0
22.00	Clay	0.000	0.000	17.205	3.414	28.676	6.615	43.014	12.164	51.616	17.072	57.351	21.340	40.146	42.680	40.146	2134.0
24.40	Clay	0.000	0.000	18.590	3.414	30.984	6.615	46.476	12.164	55.771	17.072	61.968	21.340	43.377	42.680	43.377	2134.0
24.40	Clay	0.000	0.000	19.644	3.414	32.740	6.615	49.110	12.164	58.932	17.072	65.480	21.340	45.836	42.680	45.836	2134.0
26.00	Clay	0.000	0.000	20.572	3.414	34.287	6.615	51.431	12.164	61.717	17.072	68.574	21.340	48.002	42.680	48.002	2134.0
27.00	Clay	0.000	0.000	21.188	3.414	35.313	6.615	52.969	12.164	63.563	17.072	70.625	21.340	49.438	42.680	49.438	2134.0
27.00	clay	0.000	0.000	21.250	3.414	35.417	6.615	53.126	12.164	63.751	17.072	70.835	21.340	49.584	42.680	49.584	2134.0
27.80	clay	0.000	0.000	21.713	3.414	36.188	6.615	54.283	12.164	65.139	17.072	72.377	21.340	50.663	42.680	50.663	2134.0
28.00	clay	0.000	0.000	21.829	3.414	36.381	6.615	54.572	12.164	65.486	17.072	72.762	21.340	50.933	42.680	50.933	2134.0
30.00	clay	0.000	0.000	23.108	3.414	38.514	6.615	57.771	12.164	69.325	17.072	77.028	21.340	53.919	42.680	53.919	2134.0
31.50	clay	0.000	0.000	24.064	3.414	40.107	6.615	60.160	12.164	72.192	17.072	80.213	21.340	56.149	42.680	56.149	2134.0
31.50	Clay	0.000	0.000	24.127	3.414	40.211	6.615	60.316	12.164	72.380	17.072	80.422	21.340	56.295	42.680	56.295	2134.0
31.90	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
34.00	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
38.00	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
41.50	Clay	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	56.700	42.680	56.700	2134.0
41.50	Clay	0.000	0.000	28.783	3.414	47.972	6.615	71.959	12.164	86.350	17.072	95.945	21.340	67.161	42.680	67.161	2134.0
44.00	Clay	0.000	0.000	30.087	3.414	50.144	6.615	75.216	12.164	90.260	17.072	100.289	21.340	70.202	42.680	70.202	2134.0
45.40	Clay	0.000	0.000	30.844	3.414	51.407	6.615	77.111	12.164	92.533	17.072	102.814	21.340	71.970	42.680	71.970	2134.0
45.40	Clay	0.000	0.000	30.899	3.414	51.498	6.615	77.247	12.164	92.697	17.072	102.996	21.340	72.097	42.680	72.097	2134.0
48.00	Clay	0.000	0.000	32.280	3.414	53.800	6.615	80.700	12.164	96.840	17.072	107.600	21.340	75.320	42.680	75.320	2134.0
50.00	Clay	0.000	0.000	33.370	3.414	55.616	6.615	83.425	12.164	100.110	17.072	111.233	21.340	77.863	42.680	77.863	2134.0
52.00	Clay	0.000	0.000	34.192	3.414	56.986	6.615	85.479	12.164	102.575	17.072	113.973	21.340	79.781	42.680	79.781	2134.0
56.00	Clay	0.000	0.000	35.836	3.414	59.726	6.615	89.589	12.164	107.507	17.072	119.452	21.340	83.616	42.680	83.616	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 2 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
60.00	Clay	0.000	0.000	37.479	3.414	62.466	6.615	93.699	12.164	112.438	17.072	124.932	21.340	87.452	42.680	87.452	2134.0
60.00	Clay	0.000	0.000	37.538	3.414	62.563	6.615	93.844	12.164	112.613	17.072	125.125	21.340	87.588	42.680	87.588	2134.0
65.00	Clay	0.000	0.000	41.213	3.414	68.688	6.615	103.031	12.164	123.637	17.072	137.375	21.340	96.162	42.680	96.162	2134.0
70.00	Clay	0.000	0.000	44.963	3.414	74.938	6.615	112.406	12.164	134.887	17.072	149.875	21.340	104.912	42.680	104.912	2134.0
70.00	Clay	0.000	0.000	46.520	3.414	77.533	6.615	116.300	12.164	139.560	17.072	155.067	21.340	108.547	42.680	108.547	2134.0
75.00	Clay	0.000	0.000	48.480	3.414	80.800	6.615	121.200	12.164	145.440	17.072	161.600	21.340	113.120	42.680	113.120	2134.0
80.00	Clay	0.000	0.000	50.480	3.414	84.133	6.615	126.200	12.164	151.440	17.072	168.267	21.340	117.787	42.680	117.787	2134.0
85.00	Clay	0.000	0.000	52.480	3.414	87.467	6.615	131.200	12.164	157.440	17.072	174.933	21.340	122.453	42.680	122.453	2134.0
85.00	Clay	0.000	0.000	52.521	3.414	87.535	6.615	131.302	12.164	157.562	17.072	175.069	21.340	122.549	42.680	122.549	2134.0
90.00	Clay	0.000	0.000	54.562	3.414	90.938	6.615	136.406	12.164	163.688	17.072	181.875	21.340	127.312	42.680	127.312	2134.0
92.20	Clay	0.000	0.000	55.479	3.414	92.465	6.615	138.698	12.164	166.438	17.072	184.931	21.340	129.451	42.680	129.451	2134.0
92.20	Clay	0.000	0.000	52.556	3.414	87.593	6.615	131.389	12.164	157.667	17.072	175.185	21.340	122.630	42.680	122.630	2134.0
95.00	Clay	0.000	0.000	55.556	3.414	92.593	6.615	138.889	12.164	166.667	17.072	185.185	21.340	129.630	42.680	129.630	2134.0
100.00	Clay	0.000	0.000	61.111	3.414	101.852	6.615	152.778	12.164	183.333	17.072	203.704	21.340	142.593	42.680	142.593	2134.0
103.00	Clay	0.000	0.000	64.444	3.414	107.407	6.615	161.111	12.164	193.333	17.072	214.815	21.340	150.370	42.680	150.370	2134.0
103.00	Clay	0.000	0.000	64.555	3.414	107.592	6.615	161.388	12.164	193.666	17.072	215.184	21.340	150.629	42.680	150.629	2134.0
110.00	Clay	0.000	0.000	72.182	3.414	120.303	6.615	180.454	12.164	216.545	17.072	240.605	21.340	168.424	42.680	168.424	2134.0
112.50	Clay	0.000	0.000	74.945	3.414	124.908	6.615	187.362	12.164	224.834	17.072	249.816	21.340	174.871	42.680	174.871	2134.0
112.50	Sand	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	81.000	42.680	81.000	2134.0
120.00	Sand	0.000	0.000	24.300	3.414	40.500	6.615	60.750	12.164	72.900	17.072	81.000	21.340	81.000	42.680	81.000	2134.0
120.00	Sand	0.000	0.000	20.100	3.414	33.500	6.615	50.250	12.164	60.300	17.072	67.000	21.340	67.000	42.680	67.000	2134.0
124.10	Sand	0.000	0.000	20.100	3.414	33.500	6.615	50.250	12.164	60.300	17.072	67.000	21.340	67.000	42.680	67.000	2134.0
124.10	Clay	0.000	0.000	75.000	3.414	125.000	6.615	187.500	12.164	225.000	17.072	250.000	21.340	175.000	42.680	175.000	2134.0
125.20	Clay	0.000	0.000	75.000	3.414	125.000	6.615	187.500	12.164	225.000	17.072	250.000	21.340	175.000	42.680	175.000	2134.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.2 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 3 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	Q1 [MN]	z1 [mm]	Q2 [MN]	z2 [mm]	Q3 [MN]	z3 [mm]	Q4 [MN]	z4 [mm]	Q5 [MN]	z5 [mm]	Q6 [MN]	z6 [mm]	Q7 [MN]	z7 [mm]
90.00	Clay	0.00	0.00	1.427	4.27	2.854	27.74	4.282	89.63	5.138	155.8	5.709	213.4	5.709	2134
92.20	Clay	0.00	0.00	1.408	4.27	2.817	27.74	4.225	89.63	5.07	155.8	5.633	213.4	5.633	2134
94.00	Clay	0.00	0.00	1.462	4.27	2.924	27.74	4.386	89.63	5.263	155.8	5.848	213.4	5.848	2134
96.00	Clay	0.00	0.00	1.522	4.27	3.043	27.74	4.565	89.63	5.478	155.8	6.086	213.4	6.086	2134
98.00	Clay	0.00	0.00	1.581	4.27	3.162	27.74	4.744	89.63	5.692	155.8	6.325	213.4	6.325	2134
100.00	Clay	0.00	0.00	1.641	4.27	3.282	27.74	4.922	89.63	5.907	155.8	6.563	213.4	6.563	2134
103.00	Clay	0.000	0.000	1.730	4.27	3.460	27.74	5.191	89.63	6.229	155.8	6.921	213.4	6.921	2134
105.00	Clay	0.000	0.000	1.790	4.27	3.579	27.74	5.369	89.63	6.442	155.8	7.158	213.4	7.158	2134
108.00	Clay	0.000	0.000	1.878	4.27	3.757	27.74	5.635	89.63	6.762	155.8	7.514	213.4	7.514	2134
110.00	Clay	0.000	0.000	1.938	4.27	3.876	27.74	5.813	89.63	6.976	155.8	7.751	213.4	7.751	2134
112.50	Sand	0.000	0.000	3.240	4.27	6.480	27.74	9.720	89.63	11.664	155.8	12.959	213.4	12.959	2134
115.00	Sand	0.000	0.000	3.956	4.27	7.911	27.74	11.867	89.63	14.240	155.8	15.822	213.4	15.822	2134
118.00	Sand	0.000	0.000	3.233	4.27	6.466	27.74	9.698	89.63	11.638	155.8	12.931	213.4	12.931	2134
120.00	Sand	0.000	0.000	2.435	4.27	4.870	27.74	7.305	89.63	8.766	155.8	9.740	213.4	9.740	2134
122.00	Sand	0.000	0.000	2.229	4.27	4.457	27.74	6.686	89.63	8.023	155.8	8.914	213.4	8.914	2134
124.10	Clay	0.000	0.000	2.012	4.27	4.024	27.74	6.036	89.63	7.243	155.8	8.048	213.4	8.048	2134
125.20	Clay	0.000	0.000	2.012	4.27	4.024	27.74	6.036	89.63	7.243	155.8	8.048	213.4	8.048	2134
125.90	Clay	0.000	0.000	2.012	4.27	4.024	27.74	6.036	89.63	7.243	155.8	8.048	213.4	8.048	2134

Notes:

Q = Mobilised end bearing

z = Axial pile displacement

Axial tip load transfer (Q-z) data derived using low estimate design soil parameters

PILE AXIAL LOAD-TRANSFER (Q-z) DATA

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
3.70	Clay	0.000	0.000	0.000	3.901	0.000	7.558	0.000	13.897	0.000	19.504	0.000	24.380	0.000	48.760	0.000	2438.0
3.80	Clay	0.000	0.000	1.720	3.901	2.867	7.558	4.300	13.897	5.160	19.504	5.733	24.380	4.013	48.760	4.013	2438.0
4.00	Clay	0.000	0.000	2.572	3.901	4.286	7.558	6.430	13.897	7.716	19.504	8.573	24.380	6.001	48.760	6.001	2438.0
5.00	Clay	0.000	0.000	3.846	3.901	6.410	7.558	9.615	13.897	11.538	19.504	12.820	24.380	8.974	48.760	8.974	2438.0
5.70	Clay	0.000	0.000	4.298	3.901	7.164	7.558	10.745	13.897	12.894	19.504	14.327	24.380	10.029	48.760	10.029	2438.0
5.70	Clay	0.000	0.000	5.688	3.901	9.480	7.558	14.220	13.897	17.064	19.504	18.960	24.380	13.272	48.760	13.272	2438.0
7.00	Clay	0.000	0.000	6.398	3.901	10.663	7.558	15.995	13.897	19.194	19.504	21.327	24.380	14.929	48.760	14.929	2438.0
7.80	Clay	0.000	0.000	6.781	3.901	11.301	7.558	16.952	13.897	20.342	19.504	22.602	24.380	15.822	48.760	15.822	2438.0
8.00	Clay	0.000	0.000	6.948	3.901	11.580	7.558	17.371	13.897	20.845	19.504	23.161	24.380	16.213	48.760	16.213	2438.0
9.00	Clay	0.000	0.000	7.732	3.901	12.886	7.558	19.330	13.897	23.195	19.504	25.773	24.380	18.041	48.760	18.041	2438.0
10.00	Clay	0.000	0.000	8.443	3.901	14.072	7.558	21.107	13.897	25.329	19.504	28.143	24.380	19.700	48.760	19.700	2438.0
11.00	Clay	0.000	0.000	9.099	3.901	15.164	7.558	22.747	13.897	27.296	19.504	30.329	24.380	21.230	48.760	21.230	2438.0
12.00	Clay	0.000	0.000	9.710	3.901	16.184	7.558	24.276	13.897	29.131	19.504	32.367	24.380	22.657	48.760	22.657	2438.0
13.00	Clay	0.000	0.000	10.285	3.901	17.142	7.558	25.714	13.897	30.856	19.504	34.285	24.380	23.999	48.760	23.999	2438.0
14.00	Clay	0.000	0.000	10.830	3.901	18.050	7.558	27.076	13.897	32.491	19.504	36.101	24.380	25.271	48.760	25.271	2438.0
14.60	Clay	0.000	0.000	11.139	3.901	18.564	7.558	27.846	13.897	33.415	19.504	37.128	24.380	25.989	48.760	25.989	2438.0
14.70	Clay	0.000	0.000	11.190	3.901	18.650	7.558	27.974	13.897	33.569	19.504	37.299	24.380	26.109	48.760	26.109	2438.0
15.00	Clay	0.000	0.000	11.307	3.901	18.845	7.558	28.268	13.897	33.922	19.504	37.691	24.380	26.384	48.760	26.384	2438.0
16.00	Clay	0.000	0.000	11.690	3.901	19.484	7.558	29.226	13.897	35.071	19.504	38.968	24.380	27.277	48.760	27.277	2438.0
17.00	Clay	0.000	0.000	12.061	3.901	20.102	7.558	30.153	13.897	36.183	19.504	40.204	24.380	28.143	48.760	28.143	2438.0
17.00	Clay	0.000	0.000	14.322	3.901	23.871	7.558	35.806	13.897	42.967	19.504	47.741	24.380	33.419	48.760	33.419	2438.0
18.00	Clay	0.000	0.000	14.859	3.901	24.765	7.558	37.147	13.897	44.577	19.504	49.530	24.380	34.671	48.760	34.671	2438.0
19.00	Clay	0.000	0.000	15.451	3.901	25.752	7.558	38.628	13.897	46.353	19.504	51.503	24.380	36.052	48.760	36.052	2438.0
20.00	Clay	0.000	0.000	16.039	3.901	26.732	7.558	40.098	13.897	48.117	19.504	53.464	24.380	37.425	48.760	37.425	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 1 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
22.00	Clay	0.000	0.000	17.205	3.901	28.676	7.558	43.014	13.897	51.616	19.504	57.351	24.380	40.146	48.760	40.146	2438.0
24.40	Clay	0.000	0.000	18.590	3.901	30.984	7.558	46.476	13.897	55.771	19.504	61.968	24.380	43.377	48.760	43.377	2438.0
24.40	Clay	0.000	0.000	19.644	3.901	32.740	7.558	49.110	13.897	58.932	19.504	65.480	24.380	45.836	48.760	45.836	2438.0
26.00	Clay	0.000	0.000	20.572	3.901	34.287	7.558	51.431	13.897	61.717	19.504	68.574	24.380	48.002	48.760	48.002	2438.0
27.00	Clay	0.000	0.000	21.188	3.901	35.313	7.558	52.969	13.897	63.563	19.504	70.625	24.380	49.438	48.760	49.438	2438.0
27.00	clay	0.000	0.000	21.250	3.901	35.417	7.558	53.126	13.897	63.751	19.504	70.835	24.380	49.584	48.760	49.584	2438.0
28.00	clay	0.000	0.000	21.829	3.901	36.381	7.558	54.572	13.897	65.486	19.504	72.762	24.380	50.933	48.760	50.933	2438.0
30.00	clay	0.000	0.000	23.108	3.901	38.514	7.558	57.771	13.897	69.325	19.504	77.028	24.380	53.919	48.760	53.919	2438.0
30.50	clay	0.000	0.000	23.427	3.901	39.045	7.558	58.567	13.897	70.281	19.504	78.090	24.380	54.662	48.760	54.662	2438.0
31.50	clay	0.000	0.000	24.064	3.901	40.107	7.558	60.160	13.897	72.192	19.504	80.213	24.380	56.149	48.760	56.149	2438.0
31.50	Clay	0.000	0.000	24.127	3.901	40.211	7.558	60.316	13.897	72.380	19.504	80.422	24.380	56.295	48.760	56.295	2438.0
31.90	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
34.00	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
38.00	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
41.50	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
41.50	Clay	0.000	0.000	28.783	3.901	47.972	7.558	71.959	13.897	86.350	19.504	95.945	24.380	67.161	48.760	67.161	2438.0
44.00	Clay	0.000	0.000	30.087	3.901	50.144	7.558	75.216	13.897	90.260	19.504	100.289	24.380	70.202	48.760	70.202	2438.0
45.40	Clay	0.000	0.000	30.844	3.901	51.407	7.558	77.111	13.897	92.533	19.504	102.814	24.380	71.970	48.760	71.970	2438.0
45.40	Clay	0.000	0.000	30.899	3.901	51.498	7.558	77.247	13.897	92.697	19.504	102.996	24.380	72.097	48.760	72.097	2438.0
48.00	Clay	0.000	0.000	32.280	3.901	53.800	7.558	80.700	13.897	96.840	19.504	107.600	24.380	75.320	48.760	75.320	2438.0
50.00	Clay	0.000	0.000	33.370	3.901	55.616	7.558	83.425	13.897	100.110	19.504	111.233	24.380	77.863	48.760	77.863	2438.0
52.00	Clay	0.000	0.000	34.192	3.901	56.986	7.558	85.479	13.897	102.575	19.504	113.973	24.380	79.781	48.760	79.781	2438.0
56.00	Clay	0.000	0.000	35.836	3.901	59.726	7.558	89.589	13.897	107.507	19.504	119.452	24.380	83.616	48.760	83.616	2438.0
60.00	Clay	0.000	0.000	37.479	3.901	62.466	7.558	93.699	13.897	112.438	19.504	124.932	24.380	87.452	48.760	87.452	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 2 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
60.00	Clay	0.000	0.000	37.538	3.901	62.563	7.558	93.844	13.897	112.613	19.504	125.125	24.380	87.588	48.760	87.588	2438.0
65.00	Clay	0.000	0.000	41.213	3.901	68.688	7.558	103.031	13.897	123.637	19.504	137.375	24.380	96.162	48.760	96.162	2438.0
70.00	Clay	0.000	0.000	44.963	3.901	74.938	7.558	112.406	13.897	134.888	19.504	149.875	24.380	104.913	48.760	104.913	2438.0
70.00	Clay	0.000	0.000	46.520	3.901	77.533	7.558	116.300	13.897	139.560	19.504	155.067	24.380	108.547	48.760	108.547	2438.0
75.00	Clay	0.000	0.000	48.480	3.901	80.800	7.558	121.200	13.897	145.440	19.504	161.600	24.380	113.120	48.760	113.120	2438.0
80.00	Clay	0.000	0.000	50.480	3.901	84.133	7.558	126.200	13.897	151.440	19.504	168.267	24.380	117.787	48.760	117.787	2438.0
85.00	Clay	0.000	0.000	52.480	3.901	87.467	7.558	131.200	13.897	157.440	19.504	174.933	24.380	122.453	48.760	122.453	2438.0
85.00	Clay	0.000	0.000	52.521	3.901	87.535	7.558	131.302	13.897	157.562	19.504	175.069	24.380	122.549	48.760	122.549	2438.0
90.00	Clay	0.000	0.000	54.563	3.901	90.938	7.558	136.406	13.897	163.688	19.504	181.875	24.380	127.313	48.760	127.313	2438.0
92.20	Clay	0.000	0.000	55.479	3.901	92.465	7.558	138.698	13.897	166.438	19.504	184.931	24.380	129.451	48.760	129.451	2438.0
92.20	Clay	0.000	0.000	52.556	3.901	87.593	7.558	131.389	13.897	157.667	19.504	175.185	24.380	122.630	48.760	122.630	2438.0
95.00	Clay	0.000	0.000	55.556	3.901	92.593	7.558	138.889	13.897	166.667	19.504	185.185	24.380	129.630	48.760	129.630	2438.0
100.00	Clay	0.000	0.000	61.111	3.901	101.852	7.558	152.778	13.897	183.333	19.504	203.704	24.380	142.593	48.760	142.593	2438.0
103.00	Clay	0.000	0.000	64.444	3.901	107.407	7.558	161.111	13.897	193.333	19.504	214.815	24.380	150.370	48.760	150.370	2438.0
103.00	Clay	0.000	0.000	64.555	3.901	107.592	7.558	161.388	13.897	193.666	19.504	215.184	24.380	150.629	48.760	150.629	2438.0
110.00	Clay	0.000	0.000	72.182	3.901	120.303	7.558	180.454	13.897	216.545	19.504	240.605	24.380	168.424	48.760	168.424	2438.0
112.50	Clay	0.000	0.000	74.945	3.901	124.908	7.558	187.362	13.897	224.834	19.504	249.816	24.380	174.871	48.760	174.871	2438.0
112.50	Sand	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	81.000	48.760	81.000	2438.0
120.00	Sand	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	81.000	48.760	81.000	2438.0
120.00	Sand	0.000	0.000	20.100	3.901	33.500	7.558	50.250	13.897	60.300	19.504	67.000	24.380	67.000	48.760	67.000	2438.0
124.10	Sand	0.000	0.000	20.100	3.901	33.500	7.558	50.250	13.897	60.300	19.504	67.000	24.380	67.000	48.760	67.000	2438.0
124.10	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0
125.20	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0
125.90	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN COMPRESSION (Sheet 3 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
3.70	Clay	0.000	0.000	0.000	3.901	0.000	7.558	0.000	13.897	0.000	19.504	0.000	24.380	0.000	48.760	0.000	2438.0
3.80	Clay	0.000	0.000	1.720	3.901	2.867	7.558	4.300	13.897	5.160	19.504	5.733	24.380	4.013	48.760	4.013	2438.0
4.00	Clay	0.000	0.000	2.572	3.901	4.286	7.558	6.430	13.897	7.716	19.504	8.573	24.380	6.001	48.760	6.001	2438.0
5.00	Clay	0.000	0.000	3.846	3.901	6.410	7.558	9.615	13.897	11.538	19.504	12.820	24.380	8.974	48.760	8.974	2438.0
5.70	Clay	0.000	0.000	4.298	3.901	7.164	7.558	10.745	13.897	12.894	19.504	14.327	24.380	10.029	48.760	10.029	2438.0
5.70	Clay	0.000	0.000	5.688	3.901	9.480	7.558	14.220	13.897	17.064	19.504	18.960	24.380	13.272	48.760	13.272	2438.0
7.00	Clay	0.000	0.000	6.398	3.901	10.663	7.558	15.995	13.897	19.194	19.504	21.327	24.380	14.929	48.760	14.929	2438.0
7.80	Clay	0.000	0.000	6.781	3.901	11.301	7.558	16.952	13.897	20.342	19.504	22.602	24.380	15.822	48.760	15.822	2438.0
8.00	Clay	0.000	0.000	6.948	3.901	11.580	7.558	17.371	13.897	20.845	19.504	23.161	24.380	16.213	48.760	16.213	2438.0
9.00	Clay	0.000	0.000	7.732	3.901	12.886	7.558	19.330	13.897	23.195	19.504	25.773	24.380	18.041	48.760	18.041	2438.0
10.00	Clay	0.000	0.000	8.443	3.901	14.072	7.558	21.107	13.897	25.329	19.504	28.143	24.380	19.700	48.760	19.700	2438.0
11.00	Clay	0.000	0.000	9.099	3.901	15.164	7.558	22.747	13.897	27.296	19.504	30.329	24.380	21.230	48.760	21.230	2438.0
12.00	Clay	0.000	0.000	9.710	3.901	16.184	7.558	24.276	13.897	29.131	19.504	32.367	24.380	22.657	48.760	22.657	2438.0
13.00	Clay	0.000	0.000	10.285	3.901	17.142	7.558	25.714	13.897	30.856	19.504	34.285	24.380	23.999	48.760	23.999	2438.0
14.00	Clay	0.000	0.000	10.830	3.901	18.050	7.558	27.076	13.897	32.491	19.504	36.101	24.380	25.271	48.760	25.271	2438.0
14.60	Clay	0.000	0.000	11.139	3.901	18.564	7.558	27.846	13.897	33.415	19.504	37.128	24.380	25.989	48.760	25.989	2438.0
14.70	Clay	0.000	0.000	11.190	3.901	18.650	7.558	27.974	13.897	33.569	19.504	37.299	24.380	26.109	48.760	26.109	2438.0
15.00	Clay	0.000	0.000	11.307	3.901	18.845	7.558	28.268	13.897	33.922	19.504	37.691	24.380	26.384	48.760	26.384	2438.0
16.00	Clay	0.000	0.000	11.690	3.901	19.484	7.558	29.226	13.897	35.071	19.504	38.968	24.380	27.277	48.760	27.277	2438.0
17.00	Clay	0.000	0.000	12.061	3.901	20.102	7.558	30.153	13.897	36.183	19.504	40.204	24.380	28.143	48.760	28.143	2438.0
17.00	Clay	0.000	0.000	14.322	3.901	23.871	7.558	35.806	13.897	42.967	19.504	47.741	24.380	33.419	48.760	33.419	2438.0
18.00	Clay	0.000	0.000	14.859	3.901	24.765	7.558	37.147	13.897	44.577	19.504	49.530	24.380	34.671	48.760	34.671	2438.0
19.00	Clay	0.000	0.000	15.451	3.901	25.752	7.558	38.628	13.897	46.353	19.504	51.503	24.380	36.052	48.760	36.052	2438.0
20.00	Clay	0.000	0.000	16.039	3.901	26.732	7.558	40.098	13.897	48.117	19.504	53.464	24.380	37.425	48.760	37.425	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 1 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
22.00	Clay	0.000	0.000	17.205	3.901	28.676	7.558	43.014	13.897	51.616	19.504	57.351	24.380	40.146	48.760	40.146	2438.0
24.40	Clay	0.000	0.000	18.590	3.901	30.984	7.558	46.476	13.897	55.771	19.504	61.968	24.380	43.377	48.760	43.377	2438.0
24.40	Clay	0.000	0.000	19.644	3.901	32.740	7.558	49.110	13.897	58.932	19.504	65.480	24.380	45.836	48.760	45.836	2438.0
26.00	Clay	0.000	0.000	20.572	3.901	34.287	7.558	51.431	13.897	61.717	19.504	68.574	24.380	48.002	48.760	48.002	2438.0
27.00	Clay	0.000	0.000	21.188	3.901	35.313	7.558	52.969	13.897	63.563	19.504	70.625	24.380	49.438	48.760	49.438	2438.0
27.00	clay	0.000	0.000	21.250	3.901	35.417	7.558	53.126	13.897	63.751	19.504	70.835	24.380	49.584	48.760	49.584	2438.0
28.00	clay	0.000	0.000	21.829	3.901	36.381	7.558	54.572	13.897	65.486	19.504	72.762	24.380	50.933	48.760	50.933	2438.0
30.00	clay	0.000	0.000	23.108	3.901	38.514	7.558	57.771	13.897	69.325	19.504	77.028	24.380	53.919	48.760	53.919	2438.0
30.50	clay	0.000	0.000	23.427	3.901	39.045	7.558	58.567	13.897	70.281	19.504	78.090	24.380	54.662	48.760	54.662	2438.0
31.50	clay	0.000	0.000	24.064	3.901	40.107	7.558	60.160	13.897	72.192	19.504	80.213	24.380	56.149	48.760	56.149	2438.0
31.50	Clay	0.000	0.000	24.127	3.901	40.211	7.558	60.316	13.897	72.380	19.504	80.422	24.380	56.295	48.760	56.295	2438.0
31.90	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
34.00	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
38.00	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
41.50	Clay	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	56.700	48.760	56.700	2438.0
41.50	Clay	0.000	0.000	28.783	3.901	47.972	7.558	71.959	13.897	86.350	19.504	95.945	24.380	67.161	48.760	67.161	2438.0
44.00	Clay	0.000	0.000	30.087	3.901	50.144	7.558	75.216	13.897	90.260	19.504	100.289	24.380	70.202	48.760	70.202	2438.0
45.40	Clay	0.000	0.000	30.844	3.901	51.407	7.558	77.111	13.897	92.533	19.504	102.814	24.380	71.970	48.760	71.970	2438.0
45.40	Clay	0.000	0.000	30.899	3.901	51.498	7.558	77.247	13.897	92.697	19.504	102.996	24.380	72.097	48.760	72.097	2438.0
48.00	Clay	0.000	0.000	32.280	3.901	53.800	7.558	80.700	13.897	96.840	19.504	107.600	24.380	75.320	48.760	75.320	2438.0
50.00	Clay	0.000	0.000	33.370	3.901	55.616	7.558	83.425	13.897	100.110	19.504	111.233	24.380	77.863	48.760	77.863	2438.0
52.00	Clay	0.000	0.000	34.192	3.901	56.986	7.558	85.479	13.897	102.575	19.504	113.973	24.380	79.781	48.760	79.781	2438.0
56.00	Clay	0.000	0.000	35.836	3.901	59.726	7.558	89.589	13.897	107.507	19.504	119.452	24.380	83.616	48.760	83.616	2438.0
60.00	Clay	0.000	0.000	37.479	3.901	62.466	7.558	93.699	13.897	112.438	19.504	124.932	24.380	87.452	48.760	87.452	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 2 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	t1 [MN/m]	z1 [mm]	t2 [MN/m]	z2 [mm]	t3 [MN/m]	z3 [mm]	t4 [MN/m]	z4 [mm]	t5 [MN/m]	z5 [mm]	t6 [MN/m]	z6 [mm]	t7 [MN/m]	z7 [mm]	t8 [MN/m]	z8 [mm]
60.00	Clay	0.000	0.000	37.538	3.901	62.563	7.558	93.844	13.897	112.613	19.504	125.125	24.380	87.588	48.760	87.588	2438.0
65.00	Clay	0.000	0.000	41.213	3.901	68.688	7.558	103.031	13.897	123.637	19.504	137.375	24.380	96.162	48.760	96.162	2438.0
70.00	Clay	0.000	0.000	44.963	3.901	74.938	7.558	112.406	13.897	134.888	19.504	149.875	24.380	104.913	48.760	104.913	2438.0
70.00	Clay	0.000	0.000	46.520	3.901	77.533	7.558	116.300	13.897	139.560	19.504	155.067	24.380	108.547	48.760	108.547	2438.0
75.00	Clay	0.000	0.000	48.480	3.901	80.800	7.558	121.200	13.897	145.440	19.504	161.600	24.380	113.120	48.760	113.120	2438.0
80.00	Clay	0.000	0.000	50.480	3.901	84.133	7.558	126.200	13.897	151.440	19.504	168.267	24.380	117.787	48.760	117.787	2438.0
85.00	Clay	0.000	0.000	52.480	3.901	87.467	7.558	131.200	13.897	157.440	19.504	174.933	24.380	122.453	48.760	122.453	2438.0
85.00	Clay	0.000	0.000	52.521	3.901	87.535	7.558	131.302	13.897	157.562	19.504	175.069	24.380	122.549	48.760	122.549	2438.0
90.00	Clay	0.000	0.000	54.563	3.901	90.938	7.558	136.406	13.897	163.688	19.504	181.875	24.380	127.313	48.760	127.313	2438.0
92.20	Clay	0.000	0.000	55.479	3.901	92.465	7.558	138.698	13.897	166.438	19.504	184.931	24.380	129.451	48.760	129.451	2438.0
92.20	Clay	0.000	0.000	52.556	3.901	87.593	7.558	131.389	13.897	157.667	19.504	175.185	24.380	122.630	48.760	122.630	2438.0
95.00	Clay	0.000	0.000	55.556	3.901	92.593	7.558	138.889	13.897	166.667	19.504	185.185	24.380	129.630	48.760	129.630	2438.0
100.00	Clay	0.000	0.000	61.111	3.901	101.852	7.558	152.778	13.897	183.333	19.504	203.704	24.380	142.593	48.760	142.593	2438.0
103.00	Clay	0.000	0.000	64.444	3.901	107.407	7.558	161.111	13.897	193.333	19.504	214.815	24.380	150.370	48.760	150.370	2438.0
103.00	Clay	0.000	0.000	64.555	3.901	107.592	7.558	161.388	13.897	193.666	19.504	215.184	24.380	150.629	48.760	150.629	2438.0
110.00	Clay	0.000	0.000	72.182	3.901	120.303	7.558	180.454	13.897	216.545	19.504	240.605	24.380	168.424	48.760	168.424	2438.0
112.50	Clay	0.000	0.000	74.945	3.901	124.908	7.558	187.362	13.897	224.834	19.504	249.816	24.380	174.871	48.760	174.871	2438.0
112.50	Sand	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	81.000	48.760	81.000	2438.0
120.00	Sand	0.000	0.000	24.300	3.901	40.500	7.558	60.750	13.897	72.900	19.504	81.000	24.380	81.000	48.760	81.000	2438.0
120.00	Sand	0.000	0.000	20.100	3.901	33.500	7.558	50.250	13.897	60.300	19.504	67.000	24.380	67.000	48.760	67.000	2438.0
124.10	Sand	0.000	0.000	20.100	3.901	33.500	7.558	50.250	13.897	60.300	19.504	67.000	24.380	67.000	48.760	67.000	2438.0
124.10	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0
125.20	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0
125.90	Clay	0.000	0.000	75.000	3.901	125.000	7.558	187.500	13.897	225.000	19.504	250.000	24.380	175.000	48.760	175.000	2438.0

Notes:

t = Mobilised soil-pile friction

z = Axial pile displacement

General scour = 0.0 m ; Local Scour = 3.7 m

Axial load transfer (t-z) data derived using low estimate design soil parameters

Soil springs valid for a pile penetration depth of All

Pile inclination (rake) angle of 0°

PILE AXIAL LOAD TRANSFER (t-z) DATA IN TENSION (Sheet 3 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	Q1 [MN]	z1 [mm]	Q2 [MN]	z2 [mm]	Q3 [MN]	z3 [mm]	Q4 [MN]	z4 [mm]	Q5 [MN]	z5 [mm]	Q6 [MN]	z6 [mm]	Q7 [MN]	z7 [mm]
90.00	Clay	0.00	0.00	1.86	4.88	3.72	31.69	5.579	102.4	6.695	178	7.439	243.8	7.439	2438
92.20	Clay	0.00	0.00	1.838	4.88	3.676	31.69	5.514	102.4	6.617	178	7.353	243.8	7.353	2438
94.00	Clay	0.00	0.00	1.908	4.88	3.816	31.69	5.724	102.4	6.869	178	7.633	243.8	7.633	2438
96.00	Clay	0.00	0.00	1.986	4.88	3.972	31.69	5.958	102.4	7.149	178	7.944	243.8	7.944	2438
98.00	Clay	0.00	0.00	2.064	4.88	4.128	31.69	6.191	102.4	7.43	178	8.255	243.8	8.255	2438
100.00	Clay	0.00	0.00	2.142	4.88	4.283	31.69	6.425	102.4	7.71	178	8.566	243.8	8.566	2438
103.00	Clay	0.000	0.000	2.258	4.88	4.517	31.69	6.775	102.4	8.130	178	9.033	243.8	9.033	2438
105.00	Clay	0.000	0.000	2.336	4.88	4.671	31.69	7.007	102.4	8.408	178	9.343	243.8	9.343	2438
108.00	Clay	0.000	0.000	2.452	4.88	4.904	31.69	7.355	102.4	8.826	178	9.807	243.8	9.807	2438
110.00	Clay	0.000	0.000	2.529	4.88	5.058	31.69	7.587	102.4	9.105	178	10.117	243.8	10.117	2438
112.50	Sand	0.000	0.000	4.229	4.88	8.457	31.69	12.686	102.4	15.223	178	16.915	243.8	16.915	2438
115.00	Sand	0.000	0.000	5.048	4.88	10.097	31.69	15.145	102.4	18.174	178	20.194	243.8	20.194	2438
118.00	Sand	0.000	0.000	4.132	4.88	8.264	31.69	12.396	102.4	14.875	178	16.528	243.8	16.528	2438
120.00	Sand	0.000	0.000	3.111	4.88	6.222	31.69	9.333	102.4	11.199	178	12.444	243.8	12.444	2438
122.00	Sand	0.000	0.000	2.874	4.88	5.749	31.69	8.623	102.4	10.348	178	11.497	243.8	11.497	2438
124.10	Clay	0.000	0.000	2.626	4.88	5.252	31.69	7.878	102.4	9.453	178	10.504	243.8	10.504	2438
125.20	Clay	0.000	0.000	2.626	4.88	5.252	31.69	7.878	102.4	9.453	178	10.504	243.8	10.504	2438
125.90	Clay	0.000	0.000	2.626	4.88	5.252	31.69	7.878	102.4	9.453	178	10.504	243.8	10.504	2438

Notes:

Q = Mobilised end bearing

z = Axial pile displacement

Axial tip load transfer (Q-z) data derived using low estimate design soil parameters

PILE AXIAL LOAD-TRANSFER (Q-z) DATA

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
3.20	Clay	0.000	0.000	0.053	6.402	0.076	19.206	0.113	64.020	0.164	192.060	0.227	512.160				
3.30	Clay	0.000	0.000	0.054	6.402	0.077	19.206	0.115	64.020	0.166	192.060	0.230	512.160				
3.70	Clay	0.000	0.000	0.056	6.402	0.081	19.206	0.121	64.020	0.175	192.060	0.243	512.160				
4.00	Clay	0.000	0.000	0.058	6.402	0.084	19.206	0.126	64.020	0.182	192.060	0.252	512.160				
5.00	Clay	0.000	0.000	0.066	6.402	0.095	19.206	0.142	64.020	0.204	192.060	0.283	512.160				
5.70	Clay	0.000	0.000	0.071	6.402	0.102	19.206	0.153	64.020	0.220	192.060	0.305	512.160				
5.70	Clay	0.000	0.000	0.095	6.402	0.138	19.206	0.205	64.020	0.296	192.060	0.411	512.160				
7.00	Clay	0.000	0.000	0.106	6.402	0.153	19.206	0.228	64.020	0.329	192.060	0.457	512.160				
7.40	Clay	0.000	0.000	0.109	6.402	0.158	19.206	0.235	64.020	0.339	192.060	0.471	512.160				
8.00	Clay	0.000	0.000	0.114	6.402	0.165	19.206	0.246	64.020	0.355	192.060	0.492	512.160				
9.00	Clay	0.000	0.000	0.122	6.402	0.177	19.206	0.264	64.020	0.380	192.060	0.527	512.160				
10.00	Clay	0.000	0.000	0.131	6.402	0.188	19.206	0.281	64.020	0.406	192.060	0.563	512.160				
11.00	Clay	0.000	0.000	0.139	6.402	0.200	19.206	0.299	64.020	0.431	192.060	0.598	512.160				
12.00	Clay	0.000	0.000	0.147	6.402	0.212	19.206	0.317	64.020	0.457	192.060	0.633	512.160				
12.80	Clay	0.000	0.000	0.154	6.402	0.221	19.206	0.331	64.020	0.477	192.060	0.662	512.160				
12.90	Clay	0.000	0.000	0.155	6.402	0.222	19.206	0.333	64.020	0.479	192.060	0.665	512.160				
13.00	Clay	0.000	0.000	0.155	6.402	0.223	19.206	0.334	64.020	0.481	192.060	0.668	512.160				
14.00	Clay	0.000	0.000	0.162	6.402	0.233	19.206	0.349	64.020	0.503	192.060	0.697	512.160				
15.00	Clay	0.000	0.000	0.169	6.402	0.243	19.206	0.364	64.020	0.524	192.060	0.727	512.160				
16.00	Clay	0.000	0.000	0.176	6.402	0.253	19.206	0.379	64.020	0.546	192.060	0.757	512.160				
17.00	Clay	0.000	0.000	0.183	6.402	0.263	19.206	0.393	64.020	0.567	192.060	0.787	512.160				
17.00	Clay	0.000	0.000	0.227	6.402	0.328	19.206	0.489	64.020	0.706	192.060	0.979	512.160				
18.00	Clay	0.000	0.000	0.239	6.402	0.344	19.206	0.514	64.020	0.742	192.060	1.029	512.160				
19.00	Clay	0.000	0.000	0.251	6.402	0.362	19.206	0.540	64.020	0.779	192.060	1.080	512.160				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 1 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
20.00	Clay	0.000	0.000	0.263	6.402	0.379	19.206	0.566	64.020	0.816	192.060	1.132	512.160				
22.00	Clay	0.000	0.000	0.287	6.402	0.414	19.206	0.619	64.020	0.893	192.060	1.238	512.160				
24.40	Clay	0.000	0.000	0.318	6.402	0.458	19.206	0.684	64.020	0.987	192.060	1.369	512.160				
24.40	Clay	0.000	0.000	0.341	3.201	0.492	9.603	0.735	32.010	1.060	96.030	1.470	256.080				
26.00	Clay	0.000	0.000	0.364	3.201	0.524	9.603	0.783	32.010	1.130	96.030	1.566	256.080				
27.00	Clay	0.000	0.000	0.378	3.201	0.545	9.603	0.814	32.010	1.174	96.030	1.628	256.080				
27.00	clay	0.000	0.000	0.378	3.201	0.545	9.603	0.814	32.010	1.174	96.030	1.628	256.080				
27.80	clay	0.000	0.000	0.390	3.201	0.562	9.603	0.839	32.010	1.211	96.030	1.679	256.080				
28.00	clay	0.000	0.000	0.391	3.201	0.564	9.603	0.843	32.010	1.216	96.030	1.686	256.080				
30.00	clay	0.000	0.000	0.407	3.201	0.587	9.603	0.877	32.010	1.265	96.030	1.754	256.080				
31.50	clay	0.000	0.000	0.419	3.201	0.604	9.603	0.903	32.010	1.302	96.030	1.805	256.080				
31.50	Clay	0.000	0.000	0.419	3.201	0.604	9.603	0.903	32.010	1.302	96.030	1.805	256.080				
31.90	Clay	0.000	0.000	0.422	3.201	0.608	9.603	0.909	32.010	1.311	96.030	1.817	256.080				
34.00	Clay	0.000	0.000	0.437	3.201	0.630	9.603	0.941	32.010	1.357	96.030	1.882	256.080				
38.00	Clay	0.000	0.000	0.465	3.201	0.671	9.603	1.003	32.010	1.446	96.030	2.005	256.080				
41.50	Clay	0.000	0.000	0.490	3.201	0.707	9.603	1.056	32.010	1.523	96.030	2.113	256.080				
41.50	Clay	0.000	0.000	0.446	3.201	0.643	9.603	0.960	32.010	1.385	96.030	1.921	256.080				
44.00	Clay	0.000	0.000	0.460	3.201	0.663	9.603	0.991	32.010	1.429	96.030	1.982	256.080				
45.40	Clay	0.000	0.000	0.468	3.201	0.675	9.603	1.008	32.010	1.454	96.030	2.017	256.080				
45.40	Clay	0.000	0.000	0.468	3.201	0.675	9.603	1.008	32.010	1.454	96.030	2.017	256.080				
48.00	Clay	0.000	0.000	0.484	3.201	0.698	9.603	1.043	32.010	1.504	96.030	2.085	256.080				
50.00	Clay	0.000	0.000	0.496	3.201	0.716	9.603	1.069	32.010	1.542	96.030	2.138	256.080				
52.00	Clay	0.000	0.000	0.508	3.201	0.733	9.603	1.095	32.010	1.579	96.030	2.190	256.080				
56.00	Clay	0.000	0.000	0.533	3.201	0.768	9.603	1.148	32.010	1.655	96.030	2.296	256.080				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 2 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
60.00	Clay	0.000	0.000	0.557	3.201	0.804	9.603	1.200	32.010	1.731	96.030	2.401	256.080				
60.00	Clay	0.000	0.000	0.557	3.201	0.804	9.603	1.200	32.010	1.731	96.030	2.401	256.080				
65.00	Clay	0.000	0.000	0.613	3.201	0.884	9.603	1.320	32.010	1.904	96.030	2.641	256.080				
70.00	Clay	0.000	0.000	0.669	3.201	0.964	9.603	1.440	32.010	2.077	96.030	2.881	256.080				
70.00	Clay	0.000	0.000	0.691	2.134	0.996	6.402	1.488	21.340	2.147	64.020	2.977	170.720				
75.00	Clay	0.000	0.000	0.721	2.134	1.039	6.402	1.552	21.340	2.239	64.020	3.105	170.720				
80.00	Clay	0.000	0.000	0.750	2.134	1.082	6.402	1.617	21.340	2.331	64.020	3.233	170.720				
85.00	Clay	0.000	0.000	0.780	2.134	1.125	6.402	1.681	21.340	2.424	64.020	3.361	170.720				
85.00	Clay	0.000	0.000	0.780	2.134	1.125	6.402	1.681	21.340	2.424	64.020	3.361	170.720				
90.00	Clay	0.000	0.000	0.811	2.134	1.170	6.402	1.747	21.340	2.520	64.020	3.494	170.720				
92.20	Clay	0.000	0.000	0.825	2.134	1.189	6.402	1.777	21.340	2.562	64.020	3.553	170.720				
92.20	Clay	0.000	0.000	0.780	1.601	1.125	4.802	1.681	16.005	2.424	48.015	3.361	128.040				
95.00	Clay	0.000	0.000	0.826	1.601	1.192	4.802	1.780	16.005	2.567	48.015	3.560	128.040				
100.00	Clay	0.000	0.000	0.909	1.601	1.311	4.802	1.958	16.005	2.824	48.015	3.916	128.040				
103.00	Clay	0.000	0.000	0.958	1.601	1.382	4.802	2.065	16.005	2.978	48.015	4.129	128.040				
103.00	Clay	0.000	0.000	0.958	1.601	1.382	4.802	2.065	16.005	2.978	48.015	4.129	128.040				
110.00	Clay	0.000	0.000	1.073	1.601	1.548	4.802	2.312	16.005	3.335	48.015	4.625	128.040				
112.50	Clay	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	4.801	128.040				
112.50	Sand	0.000	0.000	13.588	8.892	26.232	17.783	46.259	35.567	68.045	84.818						
120.00	Sand	0.000	0.000	14.495	8.892	27.992	17.783	49.415	35.567	72.930	85.227						
120.00	Sand	0.000	0.000	5.703	8.892	11.069	17.783	19.864	35.567	31.072	92.459						
124.10	Sand	0.000	0.000	5.898	8.892	11.450	17.783	20.555	35.567	32.210	92.678						
124.10	Clay	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	4.801	128.040				
125.20	Clay	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	4.801	128.040				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 3 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
3.20	Clay	0.000	0.000	0.053	6.402	0.076	19.206	0.113	64.020	0.164	192.060	0.010	960.300				
3.30	Clay	0.000	0.000	0.054	6.402	0.077	19.206	0.115	64.020	0.166	192.060	0.012	960.300				
3.70	Clay	0.000	0.000	0.056	6.402	0.081	19.206	0.121	64.020	0.175	192.060	0.018	960.300				
4.00	Clay	0.000	0.000	0.058	6.402	0.084	19.206	0.126	64.020	0.182	192.060	0.023	960.300				
5.00	Clay	0.000	0.000	0.066	6.402	0.095	19.206	0.142	64.020	0.204	192.060	0.041	960.300				
5.70	Clay	0.000	0.000	0.071	6.402	0.102	19.206	0.153	64.020	0.220	192.060	0.056	960.300				
5.70	Clay	0.000	0.000	0.095	6.402	0.138	19.206	0.205	64.020	0.296	192.060	0.063	960.300				
7.00	Clay	0.000	0.000	0.106	6.402	0.153	19.206	0.228	64.020	0.329	192.060	0.096	960.300				
7.40	Clay	0.000	0.000	0.109	6.402	0.158	19.206	0.235	64.020	0.339	192.060	0.108	960.300				
8.00	Clay	0.000	0.000	0.114	6.402	0.165	19.206	0.246	64.020	0.355	192.060	0.126	960.300				
9.00	Clay	0.000	0.000	0.122	6.402	0.177	19.206	0.264	64.020	0.380	192.060	0.158	960.300				
10.00	Clay	0.000	0.000	0.131	6.402	0.188	19.206	0.281	64.020	0.406	192.060	0.193	960.300				
11.00	Clay	0.000	0.000	0.139	6.402	0.200	19.206	0.299	64.020	0.431	192.060	0.232	960.300				
12.00	Clay	0.000	0.000	0.147	6.402	0.212	19.206	0.317	64.020	0.457	192.060	0.274	960.300				
12.80	Clay	0.000	0.000	0.154	6.402	0.221	19.206	0.331	64.020	0.477	192.060	0.309	960.300				
12.90	Clay	0.000	0.000	0.155	6.402	0.222	19.206	0.333	64.020	0.479	192.060	0.313	960.300				
13.00	Clay	0.000	0.000	0.155	6.402	0.223	19.206	0.334	64.020	0.481	192.060	0.317	960.300				
14.00	Clay	0.000	0.000	0.162	6.402	0.233	19.206	0.349	64.020	0.503	192.060	0.357	960.300				
15.00	Clay	0.000	0.000	0.169	6.402	0.243	19.206	0.364	64.020	0.524	192.060	0.400	960.300				
16.00	Clay	0.000	0.000	0.176	6.402	0.253	19.206	0.379	64.020	0.546	192.060	0.444	960.300				
17.00	Clay	0.000	0.000	0.183	6.402	0.263	19.206	0.393	64.020	0.567	192.060	0.491	960.300				
17.00	Clay	0.000	0.000	0.227	6.402	0.328	19.206	0.489	64.020	0.706	192.060	0.503	960.300				
18.00	Clay	0.000	0.000	0.239	6.402	0.344	19.206	0.514	64.020	0.742	192.060	0.554	960.300				
19.00	Clay	0.000	0.000	0.251	6.402	0.362	19.206	0.540	64.020	0.779	192.060	0.607	960.300				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 1 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
20.00	Clay	0.000	0.000	0.263	6.402	0.379	19.206	0.566	64.020	0.816	192.060	0.662	960.300				
22.00	Clay	0.000	0.000	0.287	6.402	0.414	19.206	0.619	64.020	0.893	192.060	0.780	960.300				
24.40	Clay	0.000	0.000	0.318	6.402	0.458	19.206	0.684	64.020	0.987	192.060	0.934	960.300				
24.40	Clay	0.000	0.000	0.341	3.201	0.492	9.603	0.735	32.010	1.060	96.030	0.954	480.150				
26.00	Clay	0.000	0.000	0.364	3.201	0.524	9.603	0.783	32.010	1.130	96.030	1.071	480.150				
27.00	Clay	0.000	0.000	0.378	3.201	0.545	9.603	0.814	32.010	1.174	96.030	1.148	480.150				
27.00	clay	0.000	0.000	0.378	3.201	0.545	9.603	0.814	32.010	1.174	96.030	1.148	480.150				
27.80	clay	0.000	0.000	0.390	3.201	0.562	9.603	0.839	32.010	1.211	96.030	1.211	480.150				
28.00	clay	0.000	0.000	0.391	3.201	0.564	9.603	0.843	32.010	1.216	96.030	1.216	480.150				
30.00	clay	0.000	0.000	0.407	3.201	0.587	9.603	0.877	32.010	1.265	96.030	1.265	480.150				
31.50	clay	0.000	0.000	0.419	3.201	0.604	9.603	0.903	32.010	1.302	96.030	1.302	480.150				
31.50	Clay	0.000	0.000	0.419	3.201	0.604	9.603	0.903	32.010	1.302	96.030	1.302	480.150				
31.90	Clay	0.000	0.000	0.422	3.201	0.608	9.603	0.909	32.010	1.311	96.030	1.311	480.150				
34.00	Clay	0.000	0.000	0.437	3.201	0.630	9.603	0.941	32.010	1.357	96.030	1.357	480.150				
38.00	Clay	0.000	0.000	0.465	3.201	0.671	9.603	1.003	32.010	1.446	96.030	1.446	480.150				
41.50	Clay	0.000	0.000	0.490	3.201	0.707	9.603	1.056	32.010	1.523	96.030	1.523	480.150				
41.50	Clay	0.000	0.000	0.446	3.201	0.643	9.603	0.960	32.010	1.385	96.030	1.385	480.150				
44.00	Clay	0.000	0.000	0.460	3.201	0.663	9.603	0.991	32.010	1.429	96.030	1.429	480.150				
45.40	Clay	0.000	0.000	0.468	3.201	0.675	9.603	1.008	32.010	1.454	96.030	1.454	480.150				
45.40	Clay	0.000	0.000	0.468	3.201	0.675	9.603	1.008	32.010	1.454	96.030	1.454	480.150				
48.00	Clay	0.000	0.000	0.484	3.201	0.698	9.603	1.043	32.010	1.504	96.030	1.504	480.150				
50.00	Clay	0.000	0.000	0.496	3.201	0.716	9.603	1.069	32.010	1.542	96.030	1.542	480.150				
52.00	Clay	0.000	0.000	0.508	3.201	0.733	9.603	1.095	32.010	1.579	96.030	1.579	480.150				
56.00	Clay	0.000	0.000	0.533	3.201	0.768	9.603	1.148	32.010	1.655	96.030	1.655	480.150				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 2 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
60.00	Clay	0.000	0.000	0.557	3.201	0.804	9.603	1.200	32.010	1.731	96.030	1.731	480.150				
60.00	Clay	0.000	0.000	0.557	3.201	0.804	9.603	1.200	32.010	1.731	96.030	1.731	480.150				
65.00	Clay	0.000	0.000	0.613	3.201	0.884	9.603	1.320	32.010	1.904	96.030	1.904	480.150				
70.00	Clay	0.000	0.000	0.669	3.201	0.964	9.603	1.440	32.010	2.077	96.030	2.077	480.150				
70.00	Clay	0.000	0.000	0.691	2.134	0.996	6.402	1.488	21.340	2.147	64.020	2.147	320.100				
75.00	Clay	0.000	0.000	0.721	2.134	1.039	6.402	1.552	21.340	2.239	64.020	2.239	320.100				
80.00	Clay	0.000	0.000	0.750	2.134	1.082	6.402	1.617	21.340	2.331	64.020	2.331	320.100				
85.00	Clay	0.000	0.000	0.780	2.134	1.125	6.402	1.681	21.340	2.424	64.020	2.424	320.100				
85.00	Clay	0.000	0.000	0.780	2.134	1.125	6.402	1.681	21.340	2.424	64.020	2.424	320.100				
90.00	Clay	0.000	0.000	0.811	2.134	1.170	6.402	1.747	21.340	2.520	64.020	2.520	320.100				
92.20	Clay	0.000	0.000	0.825	2.134	1.189	6.402	1.777	21.340	2.562	64.020	2.562	320.100				
92.20	Clay	0.000	0.000	0.780	1.601	1.125	4.802	1.681	16.005	2.424	48.015	2.424	240.075				
95.00	Clay	0.000	0.000	0.826	1.601	1.192	4.802	1.780	16.005	2.567	48.015	2.567	240.075				
100.00	Clay	0.000	0.000	0.909	1.601	1.311	4.802	1.958	16.005	2.824	48.015	2.824	240.075				
103.00	Clay	0.000	0.000	0.958	1.601	1.382	4.802	2.065	16.005	2.978	48.015	2.978	240.075				
103.00	Clay	0.000	0.000	0.958	1.601	1.382	4.802	2.065	16.005	2.978	48.015	2.978	240.075				
110.00	Clay	0.000	0.000	1.073	1.601	1.548	4.802	2.312	16.005	3.335	48.015	3.335	240.075				
112.50	Sand	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	3.462	240.075				
112.50	Sand	0.000	0.000	13.588	8.892	26.232	17.783	46.259	35.567	68.045	84.818						
120.00	Sand	0.000	0.000	14.495	8.892	27.992	17.783	49.415	35.567	72.930	85.227						
120.00	Sand	0.000	0.000	5.703	8.892	11.069	17.783	19.864	35.567	31.072	92.459						
124.10	Clay	0.000	0.000	5.898	8.892	11.450	17.783	20.555	35.567	32.210	92.678						
124.10	Clay	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	3.462	240.075				
125.20	Clay	0.000	0.000	1.114	1.601	1.607	4.802	2.401	16.005	3.462	48.015	3.462	240.075				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.2 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 3 of 3)

API RP 2GEO (2011)

2.134 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
3.70	Clay	0.000	0.000	0.060	7.314	0.087	21.942	0.130	73.140	0.187	219.420	0.260	585.120				
3.80	Clay	0.000	0.000	0.061	7.314	0.088	21.942	0.132	73.140	0.190	219.420	0.263	585.120				
4.00	Clay	0.000	0.000	0.063	7.314	0.090	21.942	0.135	73.140	0.195	219.420	0.270	585.120				
5.00	Clay	0.000	0.000	0.071	7.314	0.102	21.942	0.152	73.140	0.220	219.420	0.305	585.120				
5.70	Clay	0.000	0.000	0.076	7.314	0.110	21.942	0.165	73.140	0.237	219.420	0.329	585.120				
5.70	Clay	0.000	0.000	0.104	7.314	0.150	21.942	0.224	73.140	0.322	219.420	0.447	585.120				
7.00	Clay	0.000	0.000	0.116	7.314	0.167	21.942	0.249	73.140	0.359	219.420	0.498	585.120				
7.80	Clay	0.000	0.000	0.123	7.314	0.177	21.942	0.264	73.140	0.381	219.420	0.529	585.120				
8.00	Clay	0.000	0.000	0.125	7.314	0.180	21.942	0.268	73.140	0.387	219.420	0.537	585.120				
9.00	Clay	0.000	0.000	0.134	7.314	0.193	21.942	0.288	73.140	0.415	219.420	0.576	585.120				
10.00	Clay	0.000	0.000	0.143	7.314	0.206	21.942	0.307	73.140	0.443	219.420	0.615	585.120				
11.00	Clay	0.000	0.000	0.152	7.314	0.219	21.942	0.327	73.140	0.471	219.420	0.654	585.120				
12.00	Clay	0.000	0.000	0.161	7.314	0.232	21.942	0.346	73.140	0.499	219.420	0.693	585.120				
13.00	Clay	0.000	0.000	0.170	7.314	0.245	21.942	0.366	73.140	0.527	219.420	0.731	585.120				
14.00	Clay	0.000	0.000	0.179	7.314	0.258	21.942	0.385	73.140	0.556	219.420	0.770	585.120				
14.60	Clay	0.000	0.000	0.184	7.314	0.266	21.942	0.397	73.140	0.572	219.420	0.794	585.120				
14.70	Clay	0.000	0.000	0.185	7.314	0.267	21.942	0.399	73.140	0.575	219.420	0.797	585.120				
15.00	Clay	0.000	0.000	0.187	7.314	0.270	21.942	0.403	73.140	0.582	219.420	0.807	585.120				
16.00	Clay	0.000	0.000	0.195	7.314	0.281	21.942	0.420	73.140	0.605	219.420	0.839	585.120				
17.00	Clay	0.000	0.000	0.202	7.314	0.292	21.942	0.436	73.140	0.629	219.420	0.872	585.120				
17.00	Clay	0.000	0.000	0.251	7.314	0.361	21.942	0.540	73.140	0.779	219.420	1.080	585.120				
18.00	Clay	0.000	0.000	0.263	7.314	0.380	21.942	0.567	73.140	0.818	219.420	1.134	585.120				
19.00	Clay	0.000	0.000	0.276	7.314	0.398	21.942	0.595	73.140	0.858	219.420	1.189	585.120				
20.00	Clay	0.000	0.000	0.289	7.314	0.417	21.942	0.623	73.140	0.898	219.420	1.245	585.120				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 1 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
22.00	Clay	0.000	0.000	0.315	7.314	0.455	21.942	0.680	73.140	0.980	219.420	1.359	585.120				
24.40	Clay	0.000	0.000	0.348	7.314	0.502	21.942	0.750	73.140	1.081	219.420	1.500	585.120				
24.40	Clay	0.000	0.000	0.373	3.657	0.538	10.971	0.804	36.570	1.160	109.710	1.608	292.560				
26.00	Clay	0.000	0.000	0.397	3.657	0.573	10.971	0.856	36.570	1.234	109.710	1.711	292.560				
27.00	Clay	0.000	0.000	0.412	3.657	0.595	10.971	0.888	36.570	1.281	109.710	1.777	292.560				
27.00	clay	0.000	0.000	0.412	3.657	0.595	10.971	0.888	36.570	1.281	109.710	1.777	292.560				
28.00	clay	0.000	0.000	0.429	3.657	0.618	10.971	0.923	36.570	1.331	109.710	1.846	292.560				
30.00	clay	0.000	0.000	0.461	3.657	0.665	10.971	0.994	36.570	1.434	109.710	1.988	292.560				
30.50	clay	0.000	0.000	0.469	3.657	0.677	10.971	1.011	36.570	1.459	109.710	2.023	292.560				
31.50	clay	0.000	0.000	0.479	3.657	0.690	10.971	1.031	36.570	1.487	109.710	2.063	292.560				
31.50	Clay	0.000	0.000	0.479	3.657	0.690	10.971	1.031	36.570	1.487	109.710	2.063	292.560				
31.90	Clay	0.000	0.000	0.482	3.657	0.695	10.971	1.038	36.570	1.497	109.710	2.077	292.560				
34.00	Clay	0.000	0.000	0.499	3.657	0.720	10.971	1.075	36.570	1.551	109.710	2.150	292.560				
38.00	Clay	0.000	0.000	0.532	3.657	0.767	10.971	1.145	36.570	1.652	109.710	2.291	292.560				
41.50	Clay	0.000	0.000	0.560	3.657	0.808	10.971	1.207	36.570	1.740	109.710	2.414	292.560				
41.50	Clay	0.000	0.000	0.509	3.657	0.734	10.971	1.097	36.570	1.582	109.710	2.194	292.560				
44.00	Clay	0.000	0.000	0.526	3.657	0.758	10.971	1.132	36.570	1.633	109.710	2.265	292.560				
45.40	Clay	0.000	0.000	0.535	3.657	0.771	10.971	1.152	36.570	1.661	109.710	2.304	292.560				
45.40	Clay	0.000	0.000	0.535	3.657	0.771	10.971	1.152	36.570	1.661	109.710	2.304	292.560				
48.00	Clay	0.000	0.000	0.553	3.657	0.797	10.971	1.191	36.570	1.718	109.710	2.382	292.560				
50.00	Clay	0.000	0.000	0.567	3.657	0.818	10.971	1.221	36.570	1.761	109.710	2.442	292.560				
52.00	Clay	0.000	0.000	0.581	3.657	0.838	10.971	1.251	36.570	1.804	109.710	2.502	292.560				
56.00	Clay	0.000	0.000	0.609	3.657	0.878	10.971	1.311	36.570	1.891	109.710	2.623	292.560				
60.00	Clay	0.000	0.000	0.637	3.657	0.918	10.971	1.371	36.570	1.978	109.710	2.743	292.560				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 2 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
60.00	Clay	0.000	0.000	0.637	3.657	0.918	10.971	1.371	36.570	1.978	109.710	2.743	292.560				
65.00	Clay	0.000	0.000	0.700	3.657	1.010	10.971	1.509	36.570	2.176	109.710	3.017	292.560				
70.00	Clay	0.000	0.000	0.764	3.657	1.102	10.971	1.646	36.570	2.373	109.710	3.291	292.560				
70.00	Clay	0.000	0.000	0.789	2.438	1.138	7.314	1.701	24.380	2.452	73.140	3.401	195.040				
75.00	Clay	0.000	0.000	0.823	2.438	1.187	7.314	1.774	24.380	2.558	73.140	3.547	195.040				
80.00	Clay	0.000	0.000	0.857	2.438	1.236	7.314	1.847	24.380	2.663	73.140	3.694	195.040				
85.00	Clay	0.000	0.000	0.891	2.438	1.285	7.314	1.920	24.380	2.769	73.140	3.840	195.040				
85.00	Clay	0.000	0.000	0.891	2.438	1.285	7.314	1.920	24.380	2.769	73.140	3.840	195.040				
90.00	Clay	0.000	0.000	0.927	2.438	1.336	7.314	1.996	24.380	2.879	73.140	3.992	195.040				
92.20	Clay	0.000	0.000	0.942	2.438	1.359	7.314	2.030	24.380	2.927	73.140	4.059	195.040				
92.20	Clay	0.000	0.000	0.891	1.829	1.285	5.486	1.920	18.285	2.769	54.855	3.840	146.280				
95.00	Clay	0.000	0.000	0.944	1.829	1.361	5.486	2.034	18.285	2.933	54.855	4.067	146.280				
100.00	Clay	0.000	0.000	1.038	1.829	1.497	5.486	2.237	18.285	3.226	54.855	4.474	146.280				
103.00	Clay	0.000	0.000	1.095	1.829	1.579	5.486	2.359	18.285	3.402	54.855	4.717	146.280				
103.00	Clay	0.000	0.000	1.095	1.829	1.579	5.486	2.359	18.285	3.402	54.855	4.718	146.280				
110.00	Clay	0.000	0.000	1.226	1.829	1.768	5.486	2.642	18.285	3.810	54.855	5.283	146.280				
112.50	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	5.485	146.280				
112.50	Sand	0.000	0.000	15.523	10.158	29.968	20.317	52.849	40.633	77.738	96.901						
120.00	Sand	0.000	0.000	16.560	10.158	31.980	20.317	56.454	40.633	83.320	97.368						
120.00	Sand	0.000	0.000	6.515	10.158	12.646	20.317	22.693	40.633	35.499	105.630						
124.10	Sand	0.000	0.000	6.738	10.158	13.081	20.317	23.483	40.633	36.799	105.881						
124.10	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	5.485	146.280				
125.20	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	5.485	146.280				
125.90	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	5.485	146.280				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

STATIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 3 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
3.70	Clay	0.000	0.000	0.060	7.314	0.087	21.942	0.130	73.140	0.187	219.420	0.012	1097.100				
3.80	Clay	0.000	0.000	0.061	7.314	0.088	21.942	0.132	73.140	0.190	219.420	0.014	1097.100				
4.00	Clay	0.000	0.000	0.063	7.314	0.090	21.942	0.135	73.140	0.195	219.420	0.017	1097.100				
5.00	Clay	0.000	0.000	0.071	7.314	0.102	21.942	0.152	73.140	0.220	219.420	0.036	1097.100				
5.70	Clay	0.000	0.000	0.076	7.314	0.110	21.942	0.165	73.140	0.237	219.420	0.051	1097.100				
5.70	Clay	0.000	0.000	0.104	7.314	0.150	21.942	0.224	73.140	0.322	219.420	0.058	1097.100				
7.00	Clay	0.000	0.000	0.116	7.314	0.167	21.942	0.249	73.140	0.359	219.420	0.092	1097.100				
7.80	Clay	0.000	0.000	0.123	7.314	0.177	21.942	0.264	73.140	0.381	219.420	0.116	1097.100				
8.00	Clay	0.000	0.000	0.125	7.314	0.180	21.942	0.268	73.140	0.387	219.420	0.122	1097.100				
9.00	Clay	0.000	0.000	0.134	7.314	0.193	21.942	0.288	73.140	0.415	219.420	0.156	1097.100				
10.00	Clay	0.000	0.000	0.143	7.314	0.206	21.942	0.307	73.140	0.443	219.420	0.192	1097.100				
11.00	Clay	0.000	0.000	0.152	7.314	0.219	21.942	0.327	73.140	0.471	219.420	0.232	1097.100				
12.00	Clay	0.000	0.000	0.161	7.314	0.232	21.942	0.346	73.140	0.499	219.420	0.276	1097.100				
13.00	Clay	0.000	0.000	0.170	7.314	0.245	21.942	0.366	73.140	0.527	219.420	0.322	1097.100				
14.00	Clay	0.000	0.000	0.179	7.314	0.258	21.942	0.385	73.140	0.556	219.420	0.372	1097.100				
14.60	Clay	0.000	0.000	0.184	7.314	0.266	21.942	0.397	73.140	0.572	219.420	0.404	1097.100				
14.70	Clay	0.000	0.000	0.185	7.314	0.267	21.942	0.399	73.140	0.575	219.420	0.409	1097.100				
15.00	Clay	0.000	0.000	0.187	7.314	0.270	21.942	0.403	73.140	0.582	219.420	0.422	1097.100				
16.00	Clay	0.000	0.000	0.195	7.314	0.281	21.942	0.420	73.140	0.605	219.420	0.469	1097.100				
17.00	Clay	0.000	0.000	0.202	7.314	0.292	21.942	0.436	73.140	0.629	219.420	0.518	1097.100				
17.00	Clay	0.000	0.000	0.251	7.314	0.361	21.942	0.540	73.140	0.779	219.420	0.523	1097.100				
18.00	Clay	0.000	0.000	0.263	7.314	0.380	21.942	0.567	73.140	0.818	219.420	0.575	1097.100				
19.00	Clay	0.000	0.000	0.276	7.314	0.398	21.942	0.595	73.140	0.858	219.420	0.629	1097.100				
20.00	Clay	0.000	0.000	0.289	7.314	0.417	21.942	0.623	73.140	0.898	219.420	0.685	1097.100				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 1 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
22.00	Clay	0.000	0.000	0.315	7.314	0.455	21.942	0.680	73.140	0.980	219.420	0.804	1097.100				
24.40	Clay	0.000	0.000	0.348	7.314	0.502	21.942	0.750	73.140	1.081	219.420	0.959	1097.100				
24.40	Clay	0.000	0.000	0.373	3.657	0.538	10.971	0.804	36.570	1.160	109.710	0.975	548.550				
26.00	Clay	0.000	0.000	0.397	3.657	0.573	10.971	0.856	36.570	1.234	109.710	1.092	548.550				
27.00	Clay	0.000	0.000	0.412	3.657	0.595	10.971	0.888	36.570	1.281	109.710	1.169	548.550				
27.00	clay	0.000	0.000	0.412	3.657	0.595	10.971	0.888	36.570	1.281	109.710	1.169	548.550				
28.00	clay	0.000	0.000	0.429	3.657	0.618	10.971	0.923	36.570	1.331	109.710	1.249	548.550				
30.00	clay	0.000	0.000	0.461	3.657	0.665	10.971	0.994	36.570	1.434	109.710	1.417	548.550				
30.50	clay	0.000	0.000	0.469	3.657	0.677	10.971	1.011	36.570	1.459	109.710	1.459	548.550				
31.50	clay	0.000	0.000	0.479	3.657	0.690	10.971	1.031	36.570	1.487	109.710	1.487	548.550				
31.50	Clay	0.000	0.000	0.479	3.657	0.690	10.971	1.031	36.570	1.487	109.710	1.487	548.550				
31.90	Clay	0.000	0.000	0.482	3.657	0.695	10.971	1.038	36.570	1.497	109.710	1.497	548.550				
34.00	Clay	0.000	0.000	0.499	3.657	0.720	10.971	1.075	36.570	1.551	109.710	1.551	548.550				
38.00	Clay	0.000	0.000	0.532	3.657	0.767	10.971	1.145	36.570	1.652	109.710	1.652	548.550				
41.50	Clay	0.000	0.000	0.560	3.657	0.808	10.971	1.207	36.570	1.740	109.710	1.740	548.550				
41.50	Clay	0.000	0.000	0.509	3.657	0.734	10.971	1.097	36.570	1.582	109.710	1.582	548.550				
44.00	Clay	0.000	0.000	0.526	3.657	0.758	10.971	1.132	36.570	1.633	109.710	1.633	548.550				
45.40	Clay	0.000	0.000	0.535	3.657	0.771	10.971	1.152	36.570	1.661	109.710	1.661	548.550				
45.40	Clay	0.000	0.000	0.535	3.657	0.771	10.971	1.152	36.570	1.661	109.710	1.661	548.550				
48.00	Clay	0.000	0.000	0.553	3.657	0.797	10.971	1.191	36.570	1.718	109.710	1.718	548.550				
50.00	Clay	0.000	0.000	0.567	3.657	0.818	10.971	1.221	36.570	1.761	109.710	1.761	548.550				
52.00	Clay	0.000	0.000	0.581	3.657	0.838	10.971	1.251	36.570	1.804	109.710	1.804	548.550				
56.00	Clay	0.000	0.000	0.609	3.657	0.878	10.971	1.311	36.570	1.891	109.710	1.891	548.550				
60.00	Clay	0.000	0.000	0.637	3.657	0.918	10.971	1.371	36.570	1.978	109.710	1.978	548.550				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 2 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Depth [m BSF]	Soil Type	p1 [MN/m]	y1 [mm]	p2 [MN/m]	y2 [mm]	p3 [MN/m]	y3 [mm]	p4 [MN/m]	y4 [mm]	p5 [MN/m]	y5 [mm]	p6 [MN/m]	y6 [mm]	p7 [MN/m]	y7 [mm]	p8 [MN/m]	y8 [mm]
60.00	Clay	0.000	0.000	0.637	3.657	0.918	10.971	1.371	36.570	1.978	109.710	1.978	548.550				
65.00	Clay	0.000	0.000	0.700	3.657	1.010	10.971	1.509	36.570	2.176	109.710	2.176	548.550				
70.00	Clay	0.000	0.000	0.764	3.657	1.102	10.971	1.646	36.570	2.373	109.710	2.373	548.550				
70.00	Clay	0.000	0.000	0.789	2.438	1.138	7.314	1.701	24.380	2.452	73.140	2.452	365.700				
75.00	Clay	0.000	0.000	0.823	2.438	1.187	7.314	1.774	24.380	2.558	73.140	2.558	365.700				
80.00	Clay	0.000	0.000	0.857	2.438	1.236	7.314	1.847	24.380	2.663	73.140	2.663	365.700				
85.00	Clay	0.000	0.000	0.891	2.438	1.285	7.314	1.920	24.380	2.769	73.140	2.769	365.700				
85.00	Clay	0.000	0.000	0.891	2.438	1.285	7.314	1.920	24.380	2.769	73.140	2.769	365.700				
90.00	Clay	0.000	0.000	0.927	2.438	1.336	7.314	1.996	24.380	2.879	73.140	2.879	365.700				
92.20	Clay	0.000	0.000	0.942	2.438	1.359	7.314	2.030	24.380	2.927	73.140	2.927	365.700				
92.20	Clay	0.000	0.000	0.891	1.829	1.285	5.486	1.920	18.285	2.769	54.855	2.769	274.275				
95.00	Clay	0.000	0.000	0.944	1.829	1.361	5.486	2.034	18.285	2.933	54.855	2.933	274.275				
100.00	Clay	0.000	0.000	1.038	1.829	1.497	5.486	2.237	18.285	3.226	54.855	3.226	274.275				
103.00	Clay	0.000	0.000	1.095	1.829	1.579	5.486	2.359	18.285	3.402	54.855	3.402	274.275				
103.00	Clay	0.000	0.000	1.095	1.829	1.579	5.486	2.359	18.285	3.402	54.855	3.402	274.275				
110.00	Clay	0.000	0.000	1.226	1.829	1.768	5.486	2.642	18.285	3.810	54.855	3.810	274.275				
112.50	Sand	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	3.956	274.275				
112.50	Sand	0.000	0.000	15.523	10.158	29.968	20.317	52.849	40.633	77.738	96.901						
120.00	Sand	0.000	0.000	16.560	10.158	31.980	20.317	56.454	40.633	83.320	97.368						
120.00	Sand	0.000	0.000	6.515	10.158	12.646	20.317	22.693	40.633	35.499	105.630						
124.10	Clay	0.000	0.000	6.738	10.158	13.081	20.317	23.483	40.633	36.799	105.881						
124.10	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	3.956	274.275				
125.20	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	3.956	274.275				
125.90	Clay	0.000	0.000	1.273	1.829	1.836	5.486	2.743	18.285	3.956	54.855	3.956	274.275				

Notes:

p = Lateral resistance per unit length of pile

y = Lateral pile deflection

General scour = 0.0 m ; Local Scour = 3.7 m

Lateral load transfer (p-y) data derived using low estimate design soil parameters

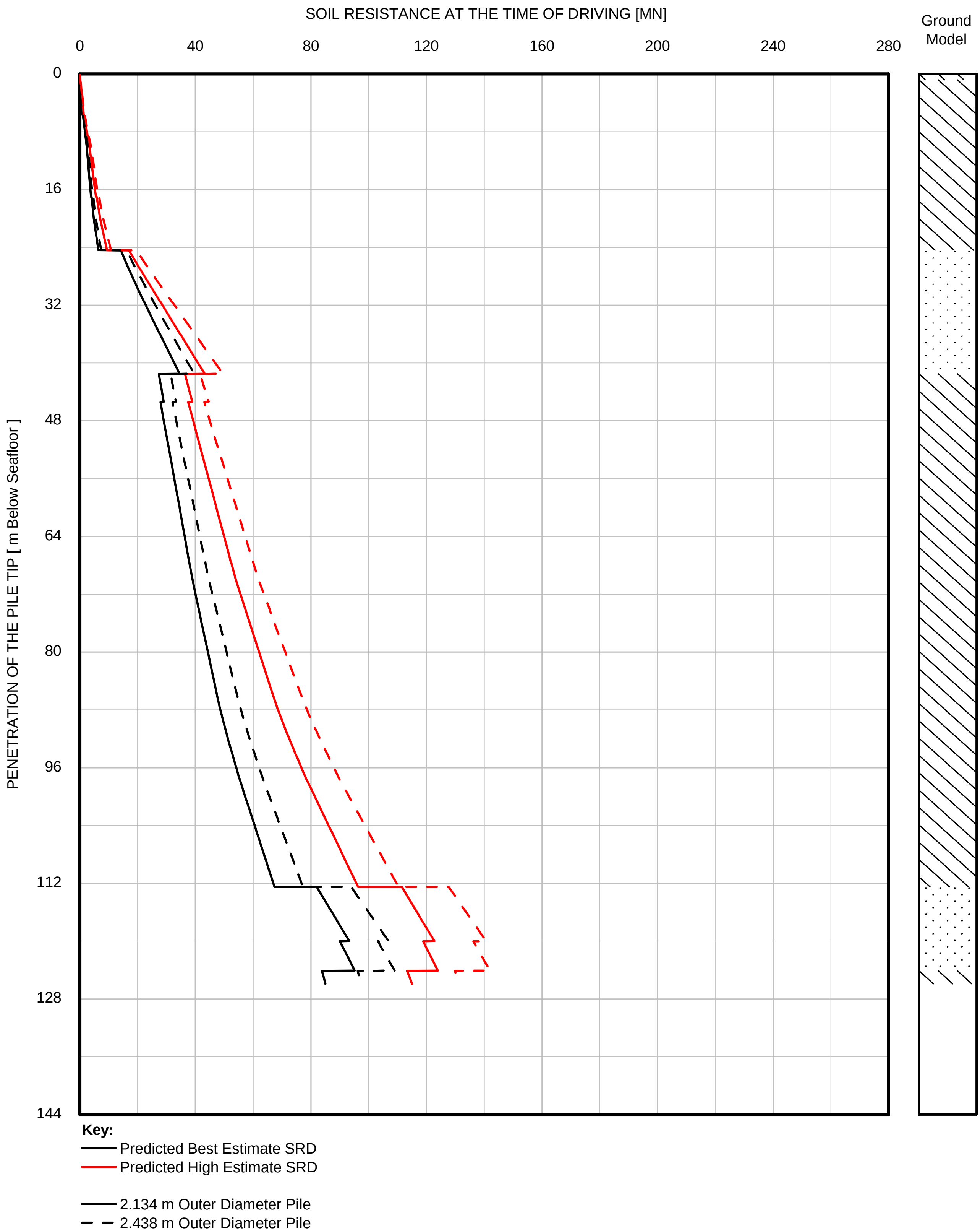
CYCLIC PILE LATERAL LOAD TRANSFER (p-y) DATA (Sheet 3 of 3)

API RP 2GEO (2011)

2.438 m Outer Diameter with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field



SOIL RESISTANCE AT THE TIME OF DRIVING
TOOLAN AND FOX METHOD (1977)
PROPOSED PLATFORM G
NEPTUN DEEP SURVEY, PELICAN SOUTH FIELD

Best Estimate SRD			High Estimate SRD		
Depth	Shaft Friction	End Bearing	Depth	Shaft Friction	End Bearing
[m]	[kN]	[kN]	[m]	[kN]	[kN]
0.1	0.0	27.6	0.1	0.0	36.8
0.8	0.0	49.1	0.8	0.0	65.5
1.6	0.0	291.6	1.6	0.0	388.7
1.6	1.6	294.6	1.6	2.4	392.8
4.0	377.1	294.6	4.0	565.7	392.8
5.7	642.7	294.6	5.7	964.0	392.8
5.7	647.1	491.0	5.7	970.7	491.0
8.0	1312.8	491.0	8.0	1969.2	491.0
10.0	1891.3	491.0	10.0	2836.9	491.0
10.0	1896.3	491.0	10.0	2844.4	491.0
12.0	2315.8	491.0	12.0	3473.5	491.0
14.0	2742.7	491.0	14.0	4113.3	491.0
17.0	3390.6	491.0	17.0	5083.6	491.0
17.0	3395.0	638.6	17.0	5090.2	720.4
20.0	4136.4	678.0	20.0	6202.2	799.4
20.0	4142.6	678.4	20.0	6211.7	800.2
24.4	5673.9	736.4	24.4	8505.7	916.3
24.4	5687.2	8511.6	24.4	8524.7	8511.6
27.0	8352.7	8610.0	27.0	12232.3	8610.0
27.0	8374.4	8610.8	27.0	12262.4	8610.8
30.0	11713.0	8725.4	30.0	16764.8	8725.4
31.5	13436.9	8782.4	31.5	19008.4	8782.4
31.5	13460.3	8783.2	31.5	19038.6	8783.2
34.0	16391.5	8878.6	34.0	22788.0	8878.6
36.0	18757.4	8954.8	36.0	25784.6	8954.8
36.0	18781.3	8955.6	36.0	25814.7	8955.6
38.0	21167.7	9031.8	38.0	28811.3	9031.8
40.0	23586.0	9108.4	40.0	31822.9	9108.4
41.5	25400.7	9165.5	41.5	34066.5	9165.5
41.5	25417.3	1964.1	41.5	34088.1	2291.5
44.0	26503.0	1964.1	44.0	35718.3	2291.5
45.4	27109.1	1964.1	45.4	36628.4	2291.5
45.4	27117.8	786.0	45.4	36641.5	884.1
48.0	28247.1	829.5	48.0	38337.1	918.9
50.0	29119.2	863.1	50.0	39646.5	945.8
52.0	29991.2	896.7	52.0	40955.9	972.7
54.0	30863.3	930.3	54.0	42265.3	999.6
56.0	31735.3	963.9	56.0	43574.7	1026.5
58.0	32607.4	997.6	58.0	44884.1	1053.4
60.0	33475.1	1031.0	60.0	46187.0	1080.1
60.0	33483.8	1031.4	60.0	46200.1	1080.5
62.0	34351.5	1050.9	62.0	47502.9	1106.6
64.0	35223.6	1070.5	64.0	48812.3	1132.7
66.0	36095.6	1090.1	66.0	50121.7	1158.9
67.5	36745.3	1104.7	67.5	51097.2	1178.3
67.5	36753.6	1105.0	67.5	51109.7	1178.7
70.0	37890.2	1129.3	70.0	52816.1	1211.1
70.0	37900.6	1129.4	70.0	52831.9	1211.4
72.0	38942.9	1142.6	72.0	54395.3	1240.7

SOIL RESISTANCE TO DRIVING (Sheet 1 of 2)

Fugro Modified Toolan and Fox (1977) SRD Method

2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Best Estimate SRD			High Estimate SRD		
Depth	Shaft Friction	End Bearing	Depth	Shaft Friction	End Bearing
[m]	[kN]	[kN]	[m]	[kN]	[kN]
74.0	39990.4	1155.9	74.0	55966.6	1270.2
76.0	41038.0	1169.2	76.0	57537.8	1299.7
78.0	42085.5	1182.4	78.0	59109.1	1329.2
80.0	43133.0	1195.7	80.0	60680.4	1358.6
82.0	44180.5	1209.0	82.0	62251.7	1388.1
84.0	45228.0	1222.2	84.0	63822.9	1417.6
86.0	46287.6	1235.5	86.0	65412.4	1447.1
87.5	47130.9	1245.4	87.5	66677.6	1469.1
87.5	47142.6	1245.6	87.5	66695.1	1469.4
90.0	48672.9	1262.1	90.0	68991.4	1506.1
91.0	49329.7	1268.7	91.0	69977.1	1520.9
92.2	50142.8	1276.6	92.2	71197.5	1538.4
92.2	50156.8	1276.9	92.2	71218.4	1473.3
94.0	51406.1	1320.2	94.0	73093.5	1510.8
95.0	52104.0	1344.3	95.0	74141.0	1531.7
96.0	52801.9	1368.5	96.0	75188.5	1552.6
97.5	53841.7	1404.5	97.5	76749.3	1583.8
97.5	53856.6	1405.2	97.5	76771.6	1584.5
99.0	55027.2	1441.2	99.0	78527.5	1615.7
100.0	55812.8	1465.3	100.0	79706.0	1636.6
101.0	56598.5	1489.5	101.0	80884.4	1657.5
102.0	57384.1	1513.7	102.0	82062.9	1678.5
103.0	58169.7	1537.8	103.0	83241.3	1699.4
104.0	58955.4	1562.0	104.0	84419.8	1720.4
105.0	59741.0	1586.2	105.0	85598.3	1741.4
106.0	60526.7	1610.4	106.0	86776.7	1762.3
107.0	61312.3	1634.6	107.0	87955.2	1783.3
108.0	62097.9	1658.8	108.0	89133.6	1804.3
109.0	62883.6	1683.0	109.0	90312.1	1825.2
110.0	63669.2	1707.2	110.0	91490.5	1846.2
111.0	64454.9	1731.4	111.0	92669.0	1867.2
112.5	65625.5	1767.5	112.5	94424.9	1898.4
112.5	65648.4	16367.7	112.5	94451.8	17022.4
114.0	67892.0	16367.7	114.0	96695.4	17022.4
115.0	69397.9	16367.7	115.0	98201.2	17022.4
116.0	70903.7	16367.7	116.0	99707.0	17022.4
117.0	72409.5	16367.7	117.0	101212.9	17022.4
118.0	73915.3	16367.7	118.0	102718.7	17022.4
119.0	75421.1	16367.7	119.0	104224.5	17022.4
120.0	76911.9	16367.7	120.0	105715.2	17022.4
120.0	76939.5	13094.2	120.0	105742.9	13094.2
121.0	78184.0	13094.2	121.0	106987.3	13094.2
122.0	79441.0	13094.2	122.0	108244.3	13094.2
123.0	80698.0	13094.2	123.0	109501.4	13094.2
124.1	82068.1	13094.2	124.1	110871.5	13094.2
124.1	82087.7	1767.7	124.1	110894.6	2356.9
125.2	82841.4	1767.7	125.2	112025.9	2356.9
125.2	82854.1	1767.7	125.2	112044.8	2356.9
125.9	83245.3	1767.7	125.9	112632.1	2356.9

SOIL RESISTANCE TO DRIVING (Sheet 2 of 2)

Fugro Modified Toolan and Fox (1977) SRD Method

2.134 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Best Estimate SRD			High Estimate SRD		
Depth	Shaft Friction	End Bearing	Depth	Shaft Friction	End Bearing
[m]	[kN]	[kN]	[m]	[kN]	[kN]
0.1	0.0	31.6	0.1	0.0	42.2
0.8	0.0	56.3	0.8	0.0	75.0
1.6	0.0	334.1	1.6	0.0	445.5
1.6	1.8	337.6	1.6	2.7	450.1
4.0	432.1	337.6	4.0	648.2	450.1
5.7	736.4	337.6	5.7	1104.6	450.1
5.7	741.5	562.7	5.7	1112.3	562.7
8.0	1504.3	562.7	8.0	2256.5	562.7
10.0	2167.2	562.7	10.0	3250.7	562.7
10.0	2172.9	562.7	10.0	3259.3	562.7
12.0	2653.6	562.7	12.0	3980.2	562.7
14.0	3142.7	562.7	14.0	4713.3	562.7
17.0	3885.2	562.7	17.0	5825.2	562.7
17.0	3890.2	731.7	17.0	5832.7	825.5
20.0	4739.7	776.9	20.0	7107.0	916.0
20.0	4746.9	777.4	20.0	7117.8	916.9
24.4	6501.6	843.8	24.4	9746.5	1050.0
24.4	6516.8	9753.2	24.4	9768.1	9753.2
27.0	9571.0	9866.0	27.0	14016.6	9866.0
27.0	9596.0	9866.9	27.0	14051.1	9866.9
30.0	13421.5	9998.1	30.0	19210.2	9998.1
31.5	15396.9	10063.6	31.5	21781.2	10063.6
31.5	15423.7	10064.4	31.5	21815.7	10064.4
34.0	18782.5	10173.7	34.0	26112.1	10173.7
36.0	21493.5	10261.1	36.0	29545.8	10261.1
36.0	21520.9	10262.0	36.0	29580.3	10262.0
38.0	24255.4	10349.3	38.0	33013.9	10349.3
40.0	27026.5	10437.1	40.0	36464.9	10437.1
41.5	29105.9	10502.5	41.5	39035.8	10502.5
41.5	29124.8	2250.6	41.5	39060.5	2625.7
44.0	30368.9	2250.6	44.0	40928.5	2625.7
45.4	31063.4	2250.6	45.4	41971.3	2625.7
45.4	31073.4	900.6	45.4	41986.3	1013.1
48.0	32367.5	950.5	48.0	43929.3	1053.0
50.0	33366.7	989.0	50.0	45429.7	1083.8
52.0	34366.0	1027.5	52.0	46930.1	1114.6
54.0	35365.3	1066.0	54.0	48430.5	1145.4
56.0	36364.5	1104.6	56.0	49930.9	1176.2
58.0	37363.8	1143.1	58.0	51431.3	1207.0
60.0	38358.1	1181.4	60.0	52924.2	1237.7
60.0	38368.1	1181.8	60.0	52939.2	1238.2
62.0	39362.3	1204.2	62.0	54432.1	1268.0
64.0	40361.6	1226.6	64.0	55932.5	1297.9
66.0	41360.9	1249.1	66.0	57432.9	1327.9
67.5	42105.3	1265.9	67.5	58550.7	1350.2
67.5	42114.8	1266.2	67.5	58565.0	1350.7
70.0	43417.2	1294.0	70.0	60520.4	1387.7
70.0	43429.2	1294.2	70.0	60538.4	1388.1
72.0	44623.5	1309.3	72.0	62329.9	1421.7

SOIL RESISTANCE TO DRIVING (Sheet 1 of 2)

Fugro Modified Toolan and Fox (1977) SRD Method

2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

Best Estimate SRD			High Estimate SRD		
Depth	Shaft Friction	End Bearing	Depth	Shaft Friction	End Bearing
[m]	[kN]	[kN]	[m]	[kN]	[kN]
74.0	45823.8	1324.5	74.0	64130.4	1455.5
76.0	47024.1	1339.7	76.0	65930.8	1489.3
78.0	48224.5	1354.9	78.0	67731.3	1523.0
80.0	49424.8	1370.1	80.0	69531.8	1556.8
82.0	50625.1	1385.3	82.0	71332.3	1590.6
84.0	51825.4	1400.5	84.0	73132.8	1624.4
86.0	53039.6	1415.8	86.0	74954.1	1658.2
87.5	54005.9	1427.1	87.5	76403.8	1683.4
87.5	54019.3	1427.2	87.5	76423.9	1683.7
90.0	55772.8	1446.2	90.0	79055.2	1725.8
91.0	56525.4	1453.8	91.0	80184.6	1742.7
92.2	57457.1	1462.8	92.2	81583.0	1762.8
92.2	57473.1	1463.2	92.2	81607.0	1688.2
94.0	58904.6	1512.7	94.0	83755.6	1731.2
95.0	59704.3	1540.4	95.0	84955.9	1755.1
96.0	60504.0	1568.1	96.0	86156.2	1779.1
97.5	61695.6	1609.3	97.5	87944.7	1814.9
97.5	61712.6	1610.2	97.5	87970.2	1815.6
99.0	63054.0	1651.4	99.0	89982.2	1851.3
100.0	63954.2	1679.1	100.0	91332.6	1875.3
101.0	64854.4	1706.8	101.0	92683.0	1899.3
102.0	65754.7	1734.5	102.0	94033.3	1923.3
103.0	66654.9	1762.1	103.0	95383.7	1947.3
104.0	67555.2	1789.9	104.0	96734.0	1971.4
105.0	68455.4	1817.6	105.0	98084.4	1995.4
106.0	69355.6	1845.3	106.0	99434.8	2019.4
107.0	70255.9	1873.1	107.0	100785.1	2043.4
108.0	71156.1	1900.8	108.0	102135.5	2067.5
109.0	72056.4	1928.5	109.0	103485.9	2091.5
110.0	72956.6	1956.3	110.0	104836.2	2115.5
111.0	73856.8	1984.0	111.0	106186.6	2139.6
112.5	75198.2	2025.3	112.5	108198.6	2175.4
112.5	75224.5	18755.3	112.5	108229.4	19505.5
114.0	77795.4	18755.3	114.0	110800.3	19505.5
115.0	79520.9	18755.3	115.0	112525.8	19505.5
116.0	81246.3	18755.3	116.0	114251.2	19505.5
117.0	82971.8	18755.3	117.0	115976.7	19505.5
118.0	84697.2	18755.3	118.0	117702.2	19505.5
119.0	86422.7	18755.3	119.0	119427.6	19505.5
120.0	88130.9	18755.3	120.0	121135.8	19505.5
120.0	88162.6	15004.2	120.0	121167.5	15004.2
121.0	89588.6	15004.2	121.0	122593.4	15004.2
122.0	91028.9	15004.2	122.0	124033.8	15004.2
123.0	92469.3	15004.2	123.0	125474.2	15004.2
124.1	94039.3	15004.2	124.1	127044.2	15004.2
124.1	94061.7	2025.6	124.1	127070.7	2700.8
125.2	94925.4	2025.6	125.2	128367.0	2700.8
125.2	94939.9	2025.6	125.2	128388.7	2700.8
125.9	95388.2	2025.6	125.9	129061.7	2700.8

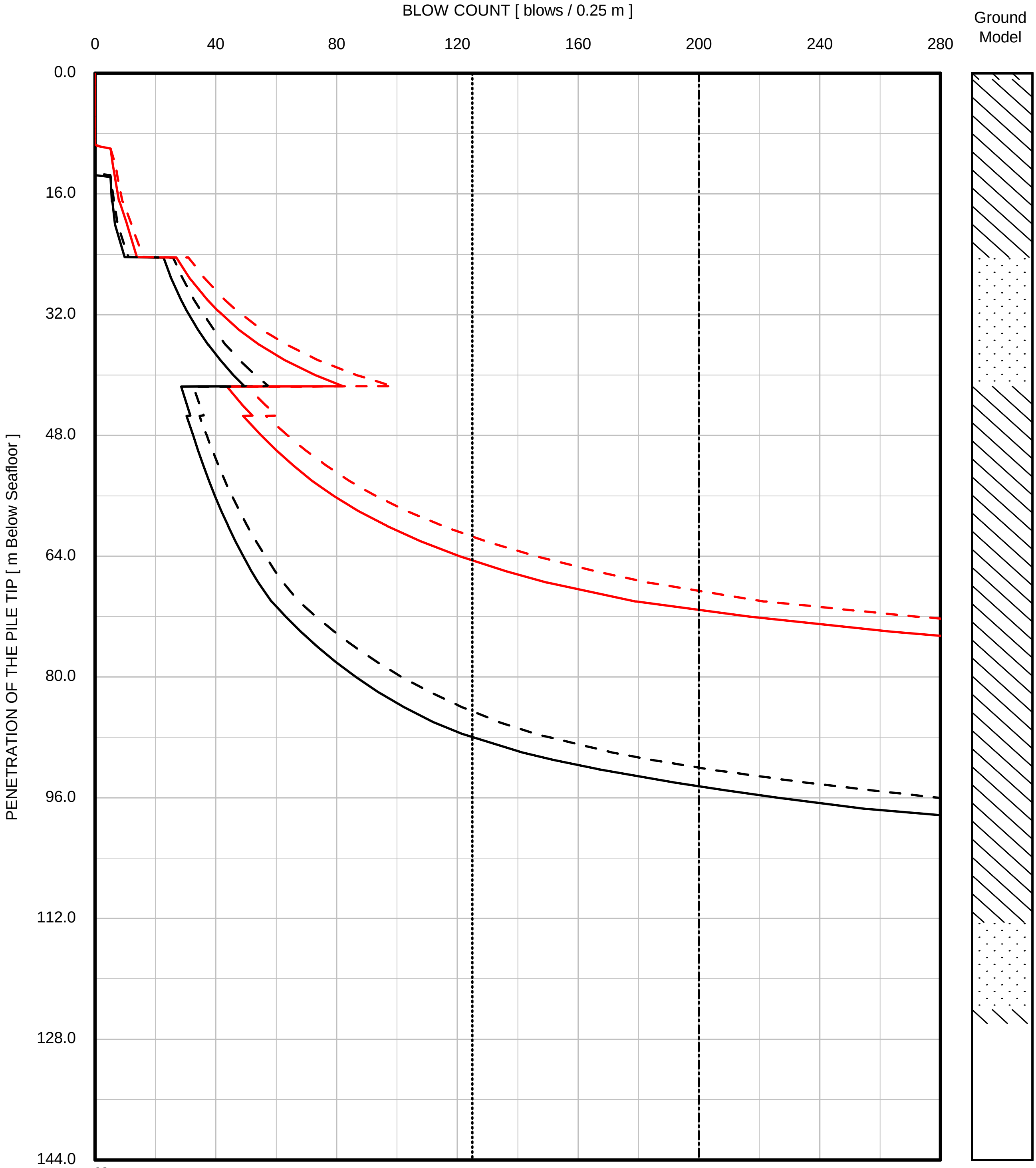
SOIL RESISTANCE TO DRIVING (Sheet 2 of 2)

Fugro Modified Toolan and Fox (1977) SRD Method

2.438 m Outer Diameter Pile with 50 mm Uniform Wall Thickness

Proposed Platform G

Neptun Deep Survey, Pelican South Field

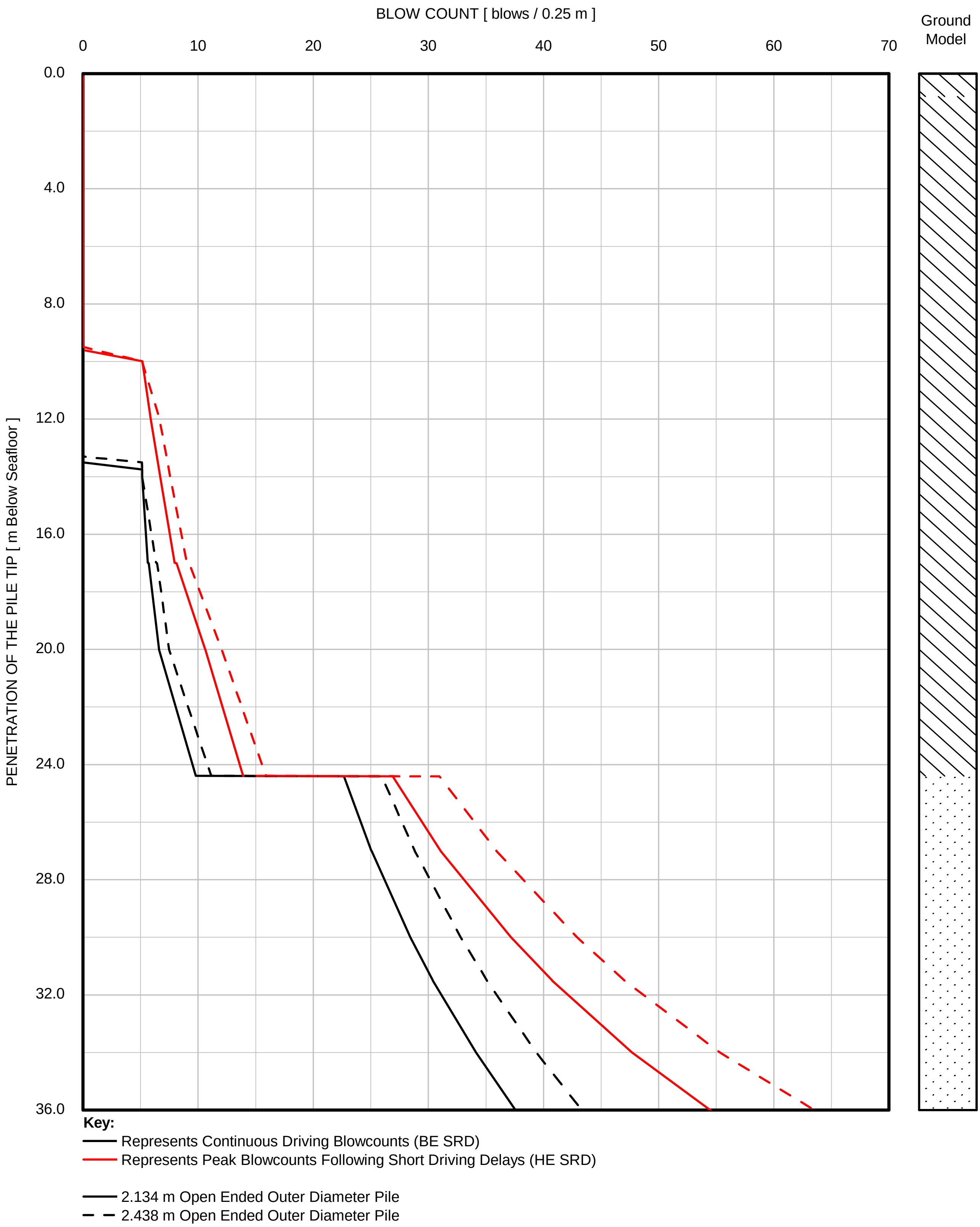


Key:
- Represents Continuous Driving Blowcounts (BE SRD)
- Represents Peak Blowcounts Following Short Driving Delays (HE SRD)

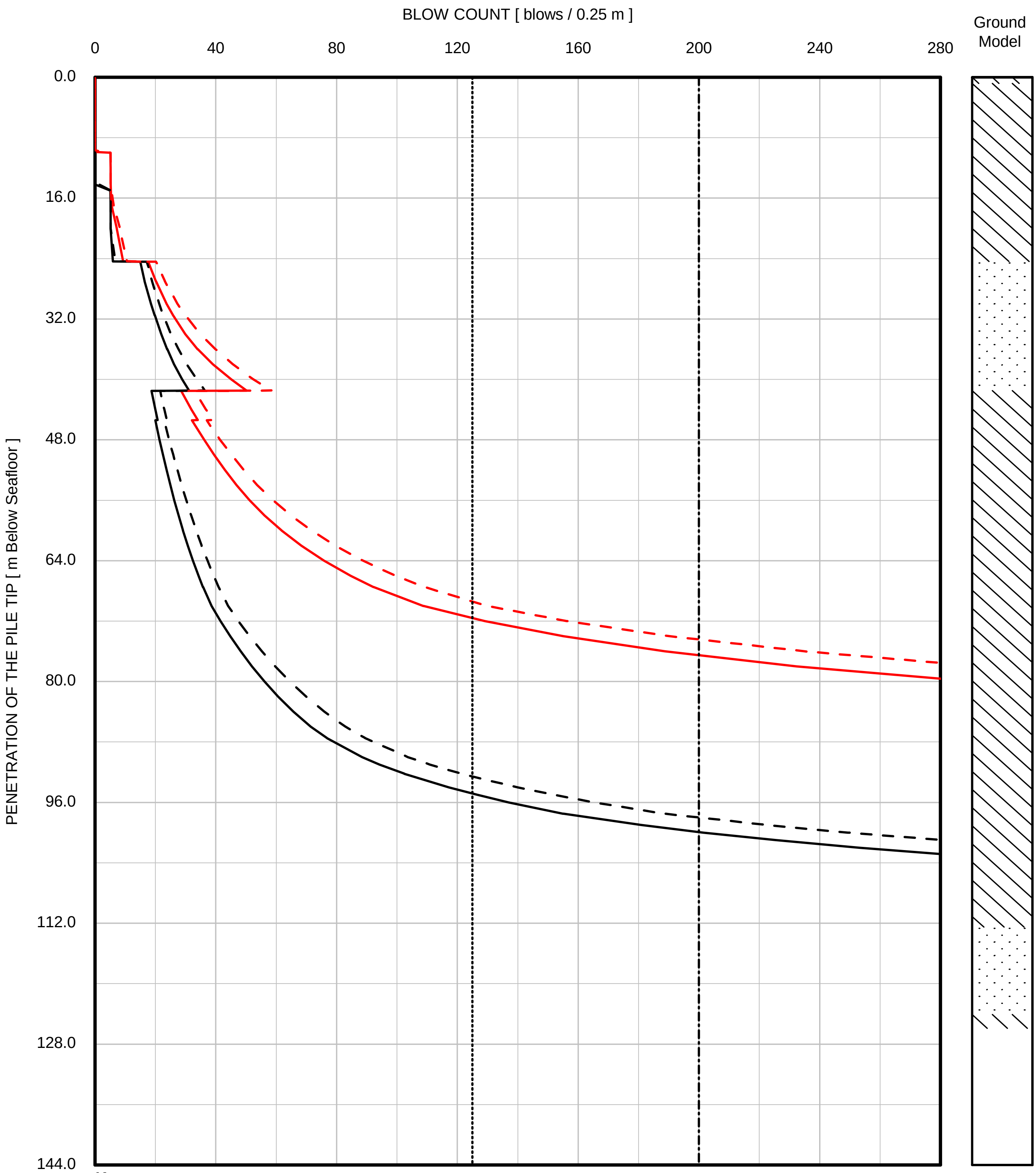
- 2.134 m Open Ended Outer Diameter Pile
- 2.438 m Open Ended Outer Diameter Pile

- Continuous driving blowcount refusal of 125 blows/0.25 m according to ISO (2007)
- Continuous driving blowcount refusal of 200 blows/0.25 m according to ISO (2007)

BLOW COUNT PROFILES PER PENETRATION DEPTH
MENCK MHU500T HAMMER
TOOLAN AND FOX METHOD (1977)
Platform G, Neptun Deep Survey



BLOW COUNT PROFILES PER PENETRATION DEPTH
Enhanced Scale
MENCK MHU500T HAMMER
TOOLAN AND FOX METHOD (1977)
Platform G, Neptun Deep Survey

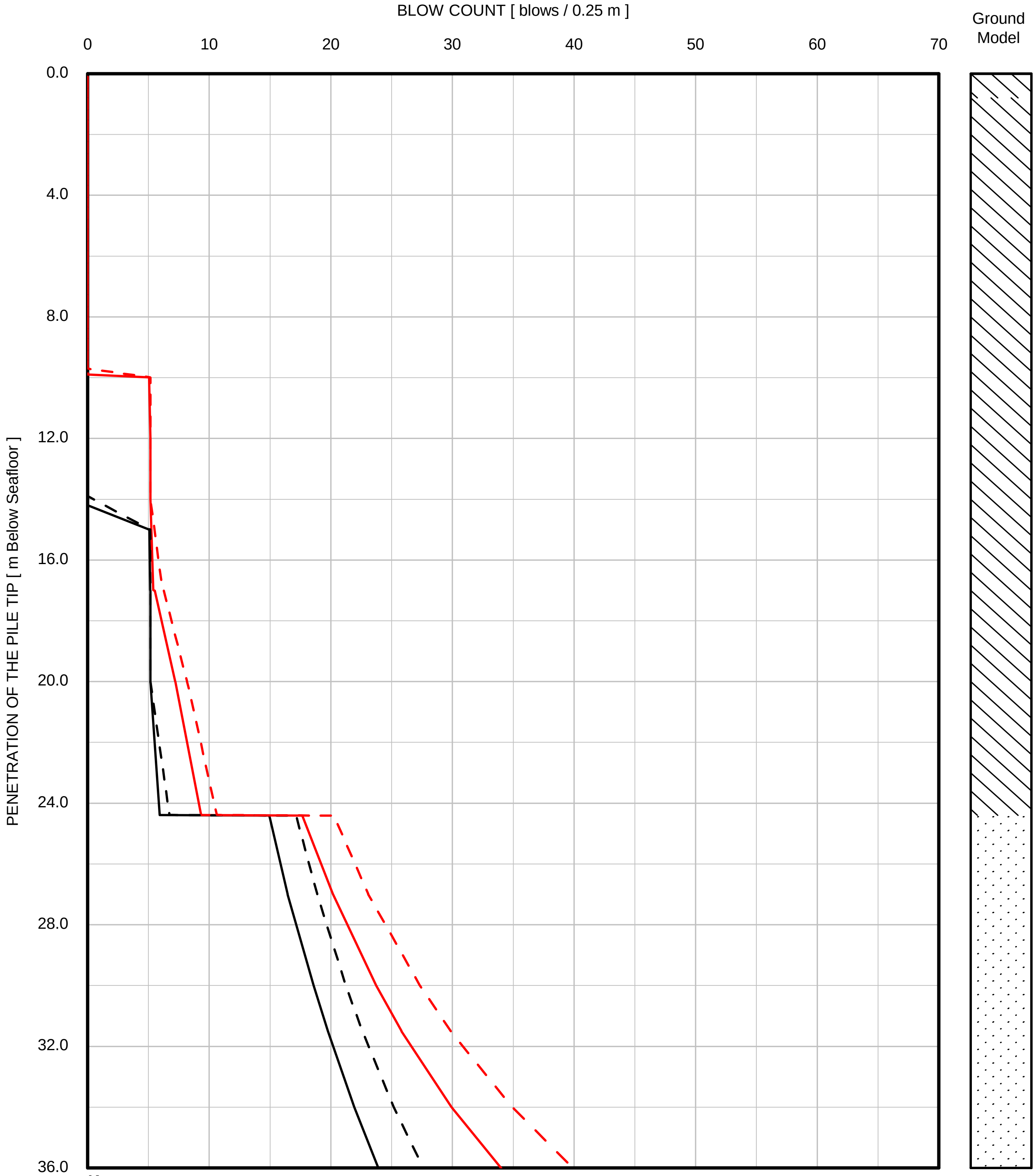


Key:
- Represents Continuous Driving Blowcounts (BE SRD)
- Represents Peak Blowcounts Following Short Driving Delays (HE SRD)

- 2.134 m Open Ended Outer Diameter Pile
- 2.438 m Open Ended Outer Diameter Pile

- Continuous driving blowcount refusal of 125 blows/0.25 m according to ISO (2007)
- Continuous driving blowcount refusal of 200 blows/0.25 m according to ISO (2007)

BLOW COUNT PROFILES PER PENETRATION DEPTH
MENCK MHU800S HAMMER
TOOLAN AND FOX METHOD (1977)
Platform G, Neptun Deep Survey



Key:

- Represents Continuous Driving Blowcounts (BE SRD)
- Represents Peak Blowcounts Following Short Driving Delays (HE SRD)
- 2.134 m Open Ended Outer Diameter Pile
- 2.438 m Open Ended Outer Diameter Pile
- Continuous driving blowcount refusal of 125 blows/0.25 m according to ISO (2007)

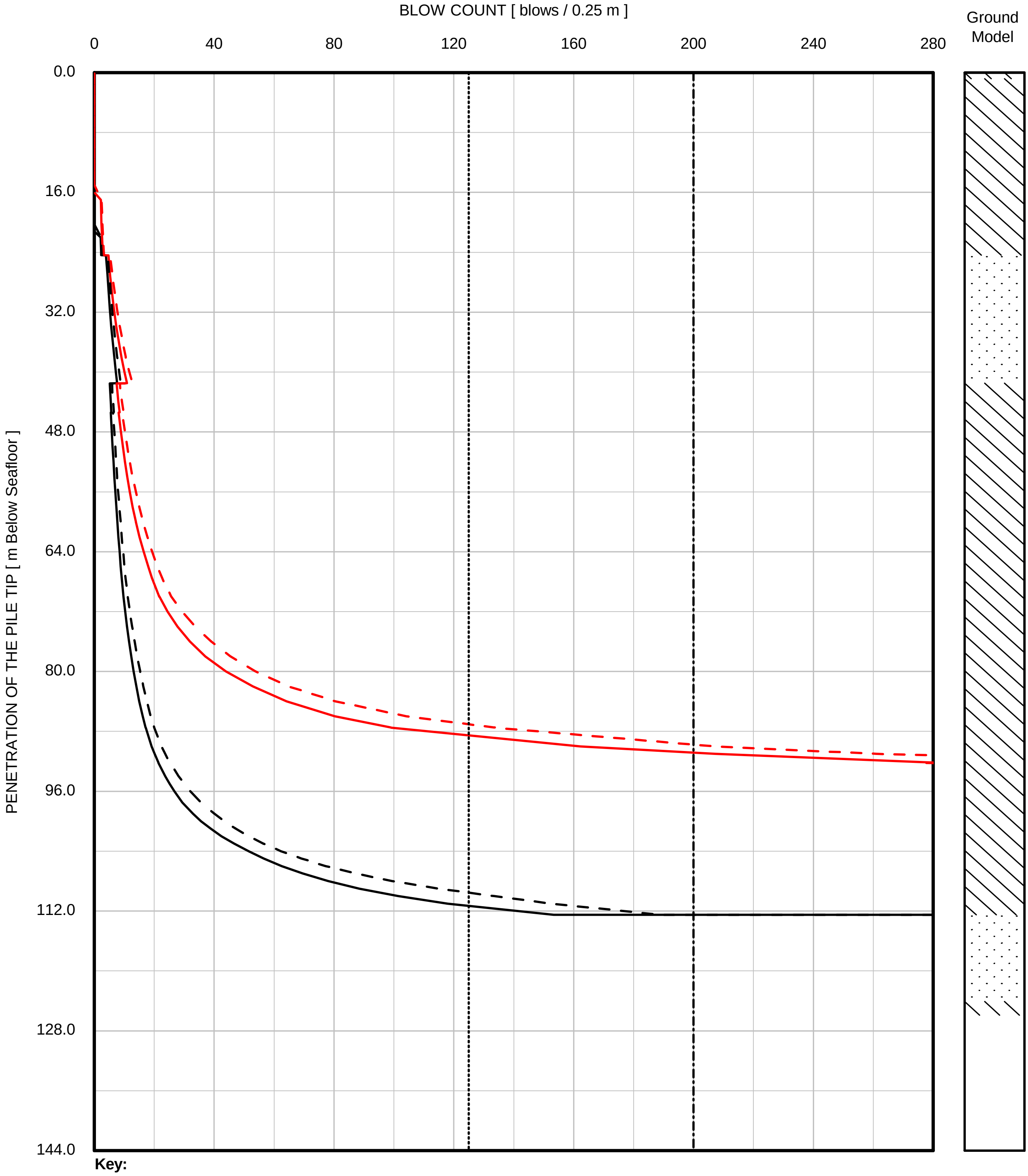
BLOW COUNT PROFILES PER PENETRATION DEPTH

Enhanced Scale

MENCK MHU800S HAMMER

TOOLAN AND FOX METHOD (1977)

Platform G, Neptun Deep Survey

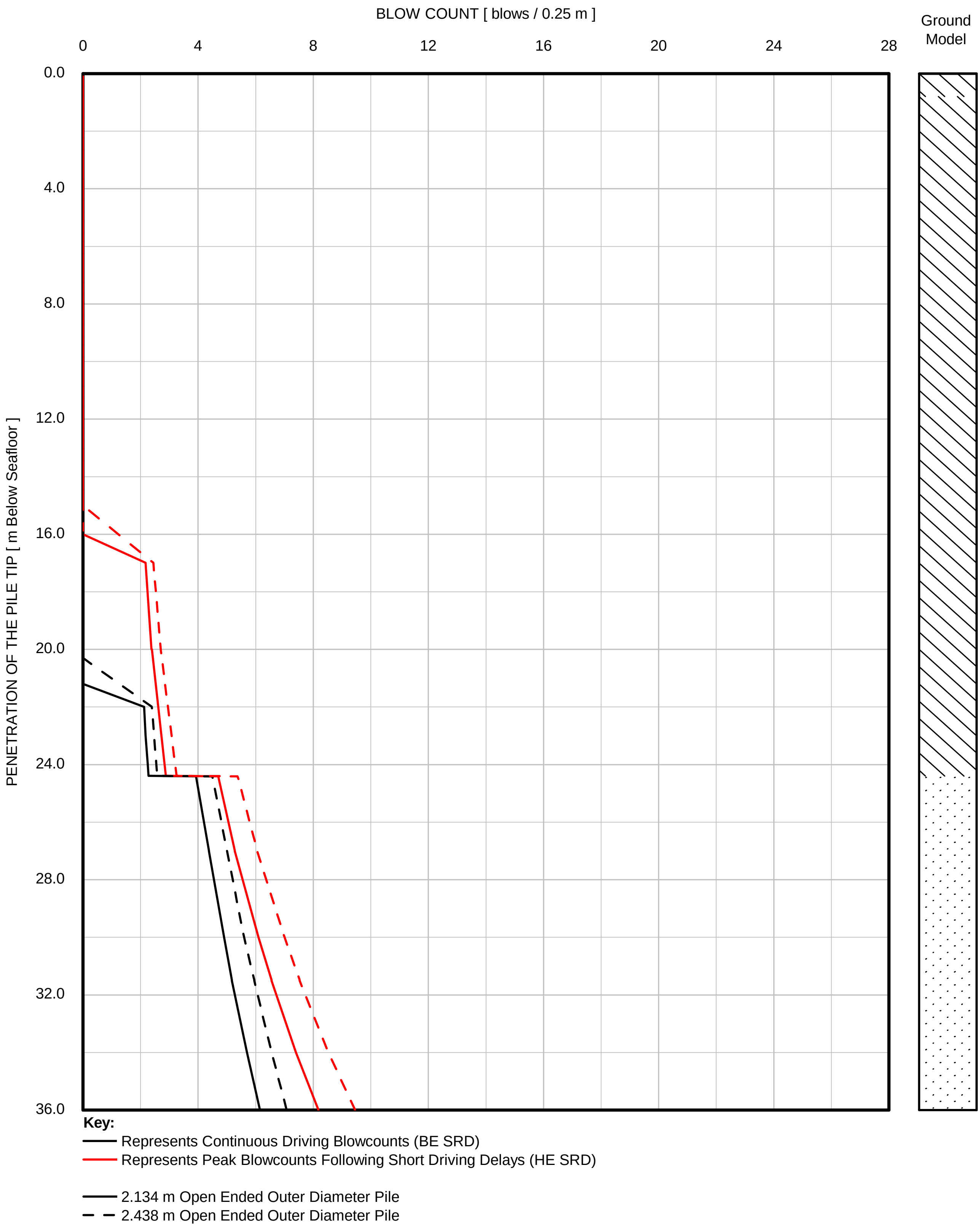


Key:
- Represents Continuous Driving Blowcounts (BE SRD)
- Represents Peak Blowcounts Following Short Driving Delays (HE SRD)

- 2.134 m Open Ended Outer Diameter Pile
- 2.438 m Open Ended Outer Diameter Pile

- Continuous driving blowcount refusal of 125 blows/0.25 m according to ISO (2007)
- Continuous driving blowcount refusal of 200 blows/0.25 m according to ISO (2007)

BLOW COUNT PROFILES PER PENETRATION DEPTH
MENCK MHU3000 HAMMER
TOOLAN AND FOX METHOD (1977)
Platform G, Neptun Deep Survey



BLOW COUNT PROFILES PER PENETRATION DEPTH

Enhanced Scale

MENCK MHU3000 HAMMER

TOOLAN AND FOX METHOD (1977)

Platform G, Neptun Deep Survey

APPENDICES

A. GUIDELINES ON USE OF REPORT

A. GUIDELINES ON USE OF REPORT

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