Environmental Impact Assessment Report
Volume 3, Appendix 7.1: Geophysical and Environmental Offshore Windfarm Survey Volume 4 of 11 Contaminants Report

MarramWind Offshore Wind Farm

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MarramWind

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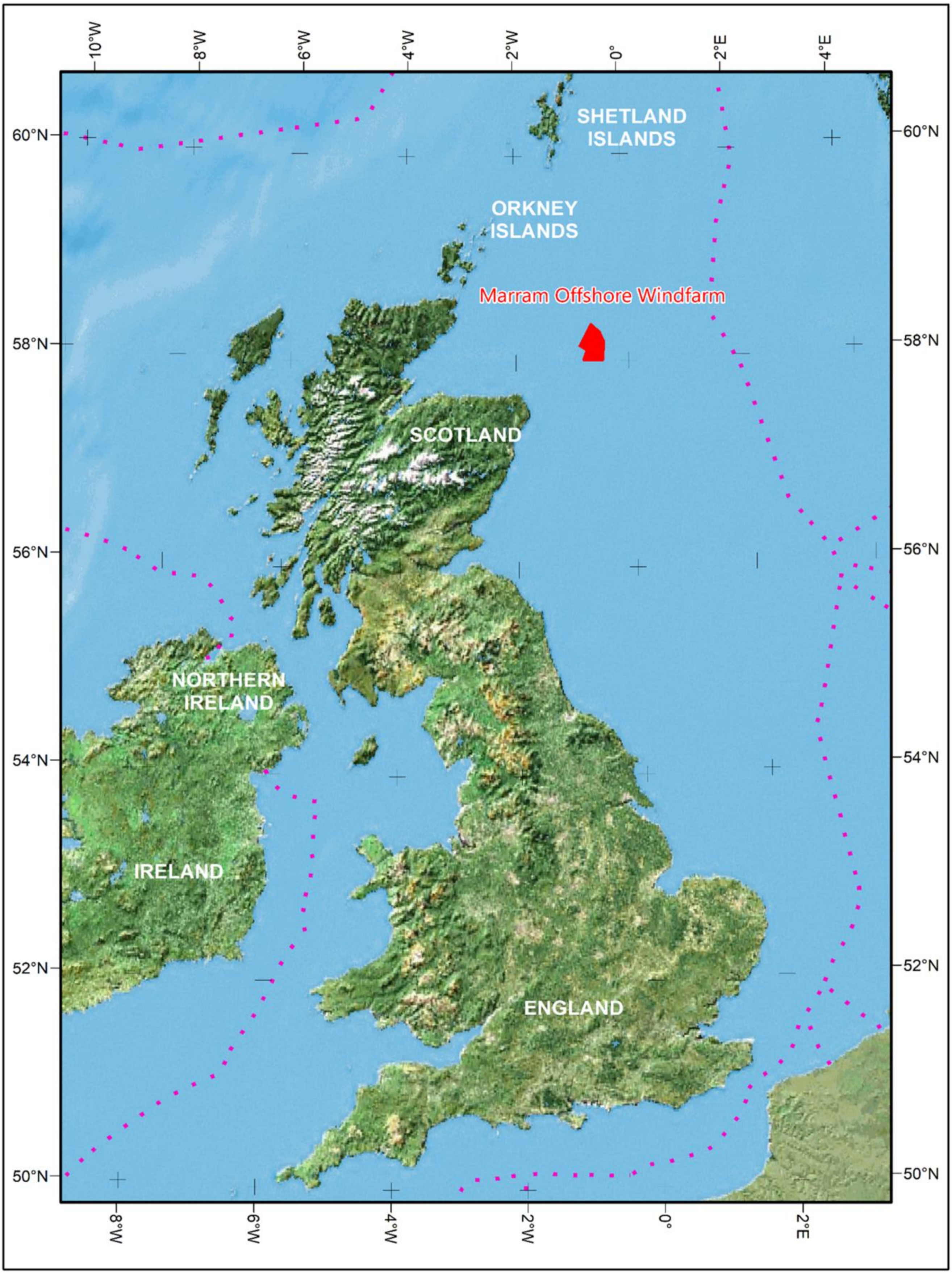
Frontispiece



Executive Summary

Introduction

On the instruction of MarramWind Limited, Fugro performed a site survey including geophysical and environmental data acquisition at the MarramWind Floating Offshore Windfarm Offshore Wind Farm (OWF) in the central North Sea. Operations were conducted onboard the MV Fugro Galaxy and the MV Fugro Venturer during the survey period 27 April to 25 August 2021.

Table S.1 presents the surface coordinates of the MarramWind Offshore Wind Farm extents.

Table S.1: Survey area extents

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Inflection Point	Easting	Northing	Latitude	Longitude
Point 1	637 268.09	6 471 842.95	58° 21′ 57.274″ N	000° 39′ 12.397″ W
Point 2	646 794.72	6 463 190.57	58° 17′ 06.668″ N	000° 29′ 46.536″ W
Point 3	651 296.15	6 452 867.04	58° 11′ 27.711″ N	000° 25′ 34.654″ W
Point 4	650 289.56	6 432 573.66	58° 00′ 33.415″ N	000° 27′ 23.044″ W
Point 5	629 968.90	6 432 462.01	58° 00′ 52.872″ N	000° 48′ 00.250″ W
Point 6	629 558.69	6 434 023.06	58° 01′ 43.743″ N	000° 48′ 22.137″ W
Point 7	632 960.06	6 443 472.89	58° 06′ 45.448″ N	000° 44′ 35.723″ W
Point 8	625 421.95	6 447 956.38	58° 09′ 18.239″ N	000° 52′ 07.297″ W
Notes Coordinates are Client supplied				

Survey Strategy

Four different types of station were designated. Table 2.1 lists each type and number of stations that were to be completed in Blocks A to S.

The geotechnical survey programme comprised 20 Cone Penetration Tests (CPT) and 10 vibrocore (VC) sampling locations. Ten of the 20 CPTs were co-located with the vibrocores; co-located VC and CPT locations were given the prefix '220145_MW_VC_CPT'.

Table S.1: Sampling stations

Station ID	Type	Number	Data and Sample Acquisition
A Stations	Camera and grab	40	Video, stills and PSD/FA/CS and eDNA sediment samples
B Stations	Grab	40	Video and stills (seafloor clearance), PSD/FA/CS and eDNA sediment samples
C Stations	Camera	40	Video and stills
D stations	Water	50	eDNA water sample

Notes
FA = Faunal sample A
PSD = Particle size distribution
CS = Contaminants sample
eDNA = Environmental deoxyribonucleic acid sample

Sediment Chemistry

Sediment samples were analysed for polycyclic aromatic hydrocarbons (PAHs), metal content, polychlorinated biphenyls (PCBs) and organotins. Results were compared to the Marine Scotland Guideline Action Levels (AL1 and AL2).

The concentrations of PAHs and the sum of the 7 PCB congeners were below the respective AL1 and AL2 values across the survey area.

The concentrations of metals were below their respective AL2 values. However, arsenic exceeded the AL1 in one core section and chromium exceeded the AL1 value in five core sections.

The concentrations of dibutyltin (DBT) and tributyltin (TBT) were below the Marine Scotland AL1 value.

Document Arrangement

Volume No.	Volume Title	Fugro Document No.
Volume 1	Geophysical Final Report	220154-OWF-01
Volume 2	Benthic Survey Interpretive Report	220154-OWF-02
Volume 3	Geophysical Benthic Interpretive Report	220154-OWF-03
Volume 4	**Contaminants Report**	**220154-OWF-04**
Volume 5	Seismic Data Processing Report	220154-OWF-05
Volume 6	Geophysical Field Operations Report (this Volume)	220154-OWF-06
Volume 7	Geotechnical Factual Data Report	220154-OWF-07
Volume 8	Vertebrate Metabarcoding Results	220154-OWF-08
Volume 9	Fish Metabarcoding Results	220154-OWF-09
Volume 10	Marine Water Eukaryote Metabarcoding Results	220154-OWF-10
Volume 11	Sediment Invertebrate Metabarcoding Results	220154-OWF-11

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Abbreviations

AL1/AL2	Action Level 1 or 2
CEMP	Coordinated Environmental Monitoring Programme
CM	Central meridian
COP	Coal pit formation
CPT	Cone penetration tests
CS	Contaminant sample
DBT	Dibutyltin
eDNA	Environmental deoxyribonucleic acid sample
ETRS89	European Terrestrial Reference System 1989
FA	Faunal sample A
FIS	Fisher formation
FM	Formation
LAT	Lowest Astronomical Tide
MAG	Magnetometer
MBT	Monobutyltin
MRV	Minimum reporting value
MV	Motor vessel
OSPAR	Oslo and Paris Commision
OWF	Offshore windfarm
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyls
Ph	Phytane
Pr	Pristane
Pr/Ph	Ratio of pristane to phytane
PSD	Particle size distribution
RSD	Relative standard deviation
SD	Standard deviation
SSS	Side scan sonar
SWAT	Switchway formation
TBT	Tributyltin
USBL	Ultra short baseline
US EPA	United States Environmental Protection Agency
US EPA 16	United States Environmental Protection Agency’s 16 priority PAH pollutants
UTM	Universal Transverse Mercator
VC	Vibrocore
VHF	Very high frequency
WGS 84	World Geodetic System 1984

1. Introduction

1.1 General Project Description

On the instruction of MarramWind Limited, Fugro performed a geophysical and environmental survey at the proposed MarramWind Floating Offshore Windfarm. The survey area was located in the central North Sea. Operations were conducted onboard the MV Fugro Galaxy and the MV Fugro Venturer during the survey period 27 April to 25 August 2021.To aid better data management, the survey program was divided into 19 blocks (A to S). The MV Fugro Galaxy was assigned blocks (A to J) and the MV Fugro Venturer blocks (K to S).

The MarramWind Floating Offshore Windfarm (OWF) site survey was carried out to identify and map geological conditions and foundation feasibility for a Floating Wind Turbine Generator (FWTG).

Table 1.1 presents the survey area extent.

Table 1.1: Survey area extents

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Inflection Point	Easting	Northing	Latitude	Longitude
Point 1	637 268.09	6 471 842.95	58° 21′ 57.274″ N	000° 39′ 12.397″ W
Point 2	646 794.72	6 463 190.57	58° 17′ 06.668″ N	000° 29′ 46.536″ W
Point 3	651 296.15	6 452 867.04	58° 11′ 27.711″ N	000° 25′ 34.654″ W
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Point 5	629 968.90	6 432 462.01	58° 00′ 52.872″ N	000° 48′ 00.250″ W
Point 6	629 558.69	6 434 023.06	58° 01′ 43.743″ N	000° 48′ 22.137″ W
Point 7	632 960.06	6 443 472.89	58° 06′ 45.448″ N	000° 44′ 35.723″ W
Point 8	625 421.95	6 447 956.38	58° 09′ 18.239″ N	000° 52′ 07.297″ W
Notes Coordinates are Client supplied				

The MarramWind Floating Offshore Windfarm site survey included a shallow geophysical survey, seismic survey, geotechnical survey, habitat assessment, a benthic characterisation survey and a contaminants survey. This report details the results of the contaminants survey. Appendix A outlines the guidelines for use of this report.

1.2 Scope of Work

The contaminants survey was conducted to establish whether any contaminant hotspots are present within windfarm area. Grab samples were taken as part of the geophysical campaign and vibrocore samples were taken as part of the geotechnical campaign. Sub-samples for contaminant testing were taken from grab and vibrocore (VC) samples to establish chemical properties of the sediment.

1.3 Environmental Quality Standards for Sediment Chemical Concentrations

The Marine Scotland Action Levels (ALs) are non-statutory guidelines for assessment of disposal of dredged materials to sea. In general, concentrations below Marine Scotland AL1 values are of no concern, whilst concentrations above Marine Scotland AL2 values indicate that dredged material is unsuitable for disposal at sea. Values between Marine Scotland AL1 and AL2 may require further investigatory work prior to a disposal decision (Marine Scotland, 2017).

1.4 Coordinate Reference System

All coordinates detailed in this report are referenced to European Terrestrial Reference System 1989 (ETRS89) Universal Transverse Mercator (UTM) Zone 30N central meridian (CM) 3° West. Table 1.2 provides the detailed geodetic and projection parameters.

Table 1.2: Project geodetic and projection parameters

Global Positioning System Geodetic Parameters*								
Datum:			International Terrestrial Reference Frame 2014					
Spheroid:			GRS 1980					
Semi major axis:			A=6 378 137.000 m					
Reciprocal flattening:			1/f = 298.257 222 101					
Local Datum Geodetic Parameters †								
Datum:			European Terrestrial Reference System 1989					
Spheroid:			GRS 1980					
Semi major axis:			A = 6 378 137.00 m					
Reciprocal flattening:			1/f = 298.257 222 101					
Datum Transformation Parameters from ITRF2014 to ETRS89 – Coordinate Frame Rotation Convention ‡								
Shift dX:	+0.05595	m	Rotation rX:	-0.0027134	arc sec	Scale Factor:	0.00349485 ppm	
Shift dY:	+0.05345	m	Rotation rY:	-0.0164143	arc sec			
Shift dZ:	-0.09785	m	Rotation rZ:	+0.0265309	arc sec			
Project Projection Parameters								
Grid Projection:			Universal Transverse Mercator (UTM)					
UTM Zone:			UTM Zone 30N					
Central Meridian:			003° 00′ 00″ West					
Latitude of Origin:			00° 00′ 00″ North					
False Easting:			500 000 m					
False Northing:			0 m					
Scale factor on Central Meridian:			0.9996					
Units:			Metre					

Notes
* = Fugro Starfix navigation software uses WGS 84 geodetic parameters as a primary datum for any geodetic calculations
† = Source: MarramWind Limited
‡ = This is the right-hand coordinate frame rotation used by the Fugro Starfix navigation software

2. Survey Strategy

Environmental sampling stations were predetermined by the client and selected to provide spatial coverage of the survey area. Four different types of station were designated. Table 2.1 lists each type and the number of stations that were to be completed in Blocks A to S. It should be noted that the camera work carried out for the B stations was for seafloor clearance only.

Table 2.1: Sampling stations

Station ID	Type	Number	Data and Sample Acquisition
A Stations	Camera and grab	40	Video, stills and PSD/FA/CS and eDNA sediment samples
B Stations	Grab	40	Video and stills (seafloor clearance), PSD/FA/CS and eDNA sediment samples
C Stations	Camera	40	Video and stills
D stations	Water	50	eDNA water sample

Notes
FA = Faunal sample A
PSD = Particle size distribution
CS = Contaminants sample
eDNA = Environmental deoxyribonucleic acid sample

After geophysical data had been acquired, the side scan sonar (SSS) and bathymetric data were reviewed by the onboard environmental scientists in conjunction with the onboard geophysicists. Using this data, the pre-selected stations were then micro-sited to ensure that all sediment types and habitats would be surveyed. Camera transects were proposed so that all features of interest would be captured. Particular emphasis was placed on locating areas of potential conservation value (e.g. Annex I listed habitats), on boundaries between areas of differing sonic reflectivity, bathymetric highs and lows and areas characteristic of the general background conditions of the site. Locations for potential infrastructure were also prioritised for sampling. Stations with the suffix (_a) indicate that the station has been relocated. Fifty-eight transects were proposed to investigate potential seafloor features identified on the geophysical data.

The geotechnical survey programme comprised 20 Cone Penetration Tests (CPT) and 10 vibrocore sampling locations. Ten of the 20 CPTs were co-located with the vibrocores; co-located VC and CPT locations were given the prefix '220145_MW_VC_CPT'.

Tables 2.2 and 2.3 provide the coordinates, data to be acquired and rationale for each location. Acceptable sampling accuracy was agreed with the client representative as within 20 m of the target location. Figure 2.1 provides a spatial display of the proposed survey locations overlain on the SSS mosaic.

Table 2.2: Proposed sampling locations for grabs

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
A2	636 066.1	6 433 866.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A3	641 967.0	6 433 953.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A7	635 978.7	6 439 767.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A12	638 885.4	6 442 761.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A13	644 786.2	6 442 848.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A17	644 742.6	6 445 799.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A19	629 947.1	6 448 531.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A20_a	635 226.1	6 447 034.6	Relocated to an area of rippled sand	Video, stills FA, PSD, CS, eDNA
A21	641 748.3	6 448 705.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A22	647 649.3	6 448 793.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A25	644 655.0	6 451 699.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A26	650 555.9	6 451 787.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A30	647 561.7	6 454 694.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A33	644 785.8	6 457 415.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A36	647 474.1	6 460 594.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A40_a	638 888.2	6 469 941.6	Relocated to be covered by transect BTR01	Video, stills FA, PSD, CS, eDNA
B2	639 016.5	6 433 909.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B5	638 972.8	6 436 860.2	Client predefined station and covered by transect NTR01	Video, stills FA, PSD, CS, eDNA
B9	638 929.1	6 439 810.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
B10	645 949.9	6 440 887.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B12	641 835.9	6 442 804.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B14	629 990.9	6 445 580.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B17	647 693.0	6 445 842.7	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B23	629 903.3	6 451 481.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B25	641 704.6	6 451 656.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B26	647 605.5	6 451 743.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B28	638 710.8	6 454 563.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B30	632 766.2	6 457 426.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B35	638 623.2	6 460 464.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B39_a	636 026.1	6 465 716.9	Relocated to be covered by transect BTR03	Video, stills FA, PSD, CS, eDNA
Notes PSD = Particle size distribution FA = Faunal sample A CS = Contaminants sample eDNA = Environmental deoxyribonucleic acid				

Table 2.3: Proposed sampling locations for cores

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_01a 0-15cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS
VC_CPT_01a 50-65cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS
VC_CPT_01a 100-115cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_01a 150-165cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS
VC_CPT_01a 200-215cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS
VC_CPT_01a 250-265cm	644 476.9	6 456 676.7	Test base SWAT FM boundary, thin to absent COP, sample FIS underneath sample Holocene. 2.5 m SE from MAG line	CS
VC_CPT_04 0-15cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 50-65cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 100-115cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 150-165cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 200-215cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 250-265cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 300-315cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 350-365cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 400-415cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_04 450-465cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 500-515cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_04 550-565cm	641 310.4	6 447 086.9	VC location to sample mobile sediments (sediment ridges) and Holocene channel at 2.2 m? SWAT/ COP boundary. 0.8 m NW and 4.3 m SE from MAG lines	CS
VC_CPT_06 0-15cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_06 50-65cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_06 100-115cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_06 150-165cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_06 200-215cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_06 250-265cm	633 786.2	6 436 308.4	Test SWAT/COP boundaries, possible FIS	CS
VC_CPT_09 0-15cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 50-65cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 100-115cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 150-165cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 200-215cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 250-265cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 300-315cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 350-365cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 400-415cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 450-465cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line.	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_09 500-515cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_09 550-565cm	634 508.9	6 448 227.9	Sample megaripples (mobile sediment) and SWAT. 4 m E of MAG line	CS
VC_CPT_10a 0-15cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 50-65cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 100-115cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 150-165cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 200-215cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 250-265cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_10a 300-315cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
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Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_10a 550-565cm	632 038.7	6 447 805.2	Sample Holocene and sample 'sand ribbon' - looks more like a localised high with internal layering underneath. Sample SWAT underneath 5 m SE of MAG line	CS
VC_CPT_13 0-15cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 50-65cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 100-115cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 150-165cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 200-215cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 250-265cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 300-315cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 350-365cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 400-415cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_13 450-465cm	634 078.8	6 460 695.7	Sample Swatchway, test internal layering, Coal Pit and underlying unit., 5.5 m W of nearest MAG line	CS
VC_CPT_14a 0-15cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_14a 50-65cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_14a 100-115cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_14a 150-165cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_14a 200-215cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_14a 250-265cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_14a 300-315cm	626 141.2	6 447 894.8	Sample Holocene & test stiff clays (BGS) within SWAT. 3.5 m SE of MAG line	CS
VC_CPT_15 0-15cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 50-65cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 100-115	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 150-165cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 200-215cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 250-265cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 300-315cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 350-365cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 400-415cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 450-465cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_15 500-515cm	634 447.7	6 464 978.0	To sample Holocene, Witch Ground Fm & underlying Swatchway Fm. On SBP cross-line intersection, 1.4 m W, 4.8 m E of MAG lines	CS
VC_CPT_19 0-15cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Sample Acquisition
VC_CPT_19 50-65cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 100-115cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 150-165cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 200-215cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 250-265cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 300-315cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 350-365cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 400-415cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 450-465cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 500-515cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_19 550-565cm	641 954.2	6 436 734.4	Test SWAT/COP boundaries. Could be coarse deposits. 4 m NW of MAG line	CS
VC_CPT_20a 0-15cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 50-65cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 100-115cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 150-165cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 200-215cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 250-265cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
VC_CPT_20a 300-315cm	632 919.7	6 442 315.1	Test mod-high amplitude response and base of SWAT. 4m NW of MAG line	CS
Notes CS = Contaminants sample MAG = Magnetometer FM = Formation SWAT = Switchway formation FIS = Fisher formation COP =Coal pit formation				

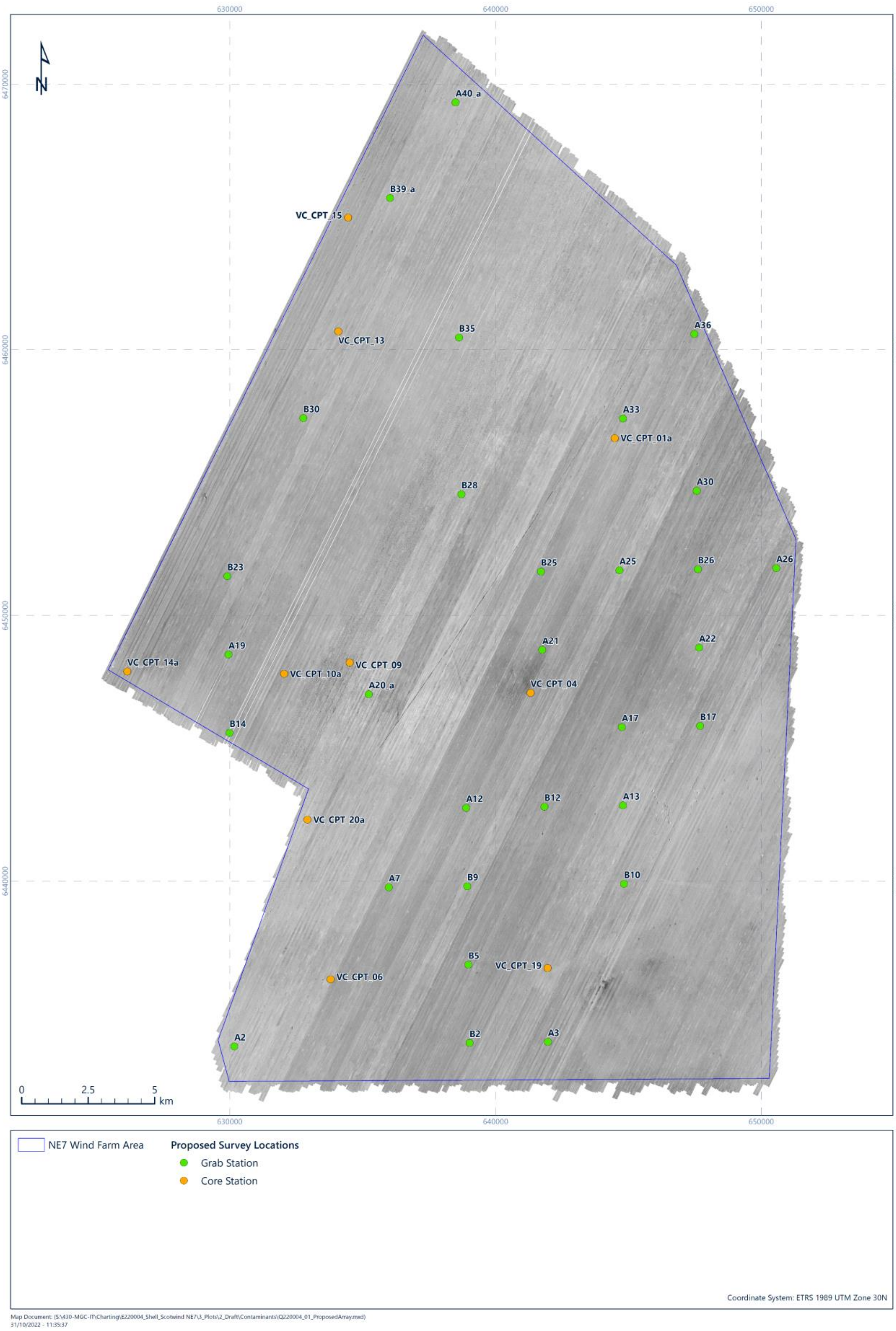

Figure 2.1: Proposed survey locations overlaid on a side scan sonar mosaic

3. Methods

3.1 Survey Methods

3.1.1 Sediment Sampling

3.1.1.1 Grabs

Seafloor samples were acquired using a 0.1 m^2 dual van Veen grab.

Operational procedures for grab sampling were as follows:

- The 0.1 m^2 dual van Veen grab was prepared for operations prior to arrival on station. An ultra short baseline (USBL) beacon was attached to the grab frame. The Bridge communicated to the deck via a very high frequency (VHF) radio when the vessel was steady and on location, and the grab was deployed from the starboard A-frame;
- When the engineer operating the winch observed that the grab had reached the seafloor (evidenced through a distinct slackening of the wire rope and snatch block), the online surveyor was informed (via VHF radio) and a fix was taken;
- On recovery to the deck, the sample was inspected and judged acceptable or otherwise (see below for rejection criteria);
- Once accepted, a grab sample was retained for faunal analysis and one grab sample was retained and sub-sampled for contaminants samples;
- Deck logs were completed for each sample acquired (including no samples) with: date, time, sample number, fix number, sediment type, depth and colour of strata in the sediment (if any) using Munsell colour codes, odour (i.e. H_2S), bioturbation or debris.

Samples were considered unacceptable in the following instances:

- Evidence of sediment washout caused through improperly closed grab jaws or inspection hatch;
- Sediment sample taken on an angle; where the grab jaws have not been parallel to the seafloor when the grab fired;
- Disruption of the sample through striking the side of the vessel;
- Sample represented less than approximately 7 cm bite depth of the grab (unless deemed acceptable by the client representative);
- Sample is more than 20 m from the target location (unless deemed acceptable by the client representative);
- Deemed unacceptable by the client representative for any other reason.

Further details on survey methodology are available within Appendix B.

3.1.1.2 Cores

Seafloor CPTs were performed using Fugro's Seacalf 75 system. This system has a thrust capacity of 75 kN.

The CPT rig was configured with 6 m push string. Cones with a projected area of 10 cm^2 and a 5 tonne capacity were used for testing, with pore-water pressure measurements made on the shoulder of the cone. Corresponding α and β values for the cones used were 0.75 and 0.0, respectively.

Digital signals from the cones were transmitted from the seafloor unit and stored for subsequent computer processing and included:

i. Penetration;

ii. Cone resistance (q_c);

iii. Sleeve friction (f_s);

iv. Pore-water pressure (u);

Cones used on this project were calibrated prior to mobilisation in the Fugro onshore laboratory in Nootdorp, The Netherlands.

Vibrocores were performed using a High-Performance Corer (HPC ™) with a 6 m barrel fitted with a translucent PVC plastic liner 88.8 mm in diameter.

Table 3.1 presents general CPT acquisition and processing information. A full description of the geotechnical sampling and testing procedure is presented in the geotechnical report (220154-OWF-FR-05).

Table 3.1: Cone penetration testing

Seafloor CPT Apparatus	
Thrust Machine	75 kN thrust capacity block drive unit (Seacalf 75)
Mounting of Thrust Machine	Seafloor frame
Reaction Equipment	Ballast reaction frame
Penetrometer Type	10 cm^2 (CP10) piezocone penetrometer
Test Results	
Data Processing	Fugro Discovery GeoVisual
Water Depth Reference	Ultra-short baseline system
Depth Reference Level	Lowest Astronomical Tide (LAT)

3.2 Laboratory Methods

Brief analytical methodologies are described in the following subsections. Further descriptions of the analytical methodologies are detailed in Appendix B.

3.2.1 Sediment Hydrocarbons

The sediment samples were analysed for hydrocarbon content including polycyclic aromatic hydrocarbons (PAHs), specifically the United States Environmental Protection Agency's 16 priority PAH pollutants (US EPA 16 PAHs) and alkylated PAHs.

3.2.2 Sediment Metals

The sediment samples were analysed using an aqua regia digest technique. This provides a strong partial digest, releasing into solution metals associated with the fines fraction within the sediments (but does not extract all trace elements associated with the coarse fraction). The concentrations of metals released by an aqua regia digest are typically considered indicative of those influencing biological interactions, as the released metals are not incorporated into the mineral matrix and are therefore potentially available for biological uptake.

3.2.3 Sediment Polychlorinated Biphenyls

Sediment samples were analysed using accelerated solvent extraction.

Further details are presented in Appendix B.2.2.

3.2.4 Sediment Organotins

Sediment samples were analysed using solvent extraction and derivatisation.

Further details are presented in Appendix B.2.3.

4. Results

4.1 Field Operations

4.1.1 Seafloor Sampling

Grab samples were successfully acquired at all 30 proposed stations. Vibrocores were successfully acquired at all 10 locations. A complete suite of samples (one faunal sample, one particle size distribution (PSD) sample, one contaminants sample and one sediment eDNA sample) was retained at all stations for the grabs (Table 4.2). A complete suite of samples (one contaminants sample) was retained at all stations for the cores (Table 4.2). The deepest sample for VC19 was collected beyond 6m depth, we could not be certain that this sample was taken from undisturbed sediments, so it has not been included in the body of the report. Results for analysis of this section are available in Appendix C. Figure 4.1 shows the completed survey locations.

Table 4.1: Completed sediment sampling stations for the grabs

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Depth [m LAT]	Sample Acquisition
A2	636 067.6	6 433 865.9	105	FA, PSD, CS. eDNA
A3	641 967.8	6 433 956.1	105	FA, PSD, CS. eDNA
A7	635 979.6	6 439 771.1	106	FA, PSD, CS. eDNA
A12	638 884.3	6 442 762.2	106	FA, PSD, CS. eDNA
A13	644 786.0	6 442 850.7	119	FA, PSD, CS. eDNA
A17	644 743.0	6 445 798.7	113	FA, PSD, CS. eDNA
A19	629 946.5	6 448 530.1	100	FA, PSD, CS. eDNA
A20_a	635 226.7	6 447 025.1	92	FA, PSD, CS. eDNA
A21	641 748.8	6 448 704.6	99	FA, PSD, CS. eDNA
A22	647 649.3	6 448 794.6	110	FA, PSD, CS. eDNA
A25	644 655.7	6 451 698.1	113	FA, PSD, CS. eDNA
A26	650 557.3	6 451 780.8	112	FA, PSD, CS. eDNA
A30	647 562.8	6 454 691.6	115	FA, PSD, CS. eDNA
A33	644 784.4	6 457 418.1	112	FA, PSD, CS. eDNA
A36	647 475.2	6 460 587.5	115	FA, PSD, CS. eDNA
A40_a	638 888.1	6 469 940.5	117	FA, PSD, CS. eDNA
B2	639 018.2	6 433 911.3	103	FA, PSD, CS. eDNA
B5	638 974.3	6 436 861.0	102	FA, PSD, CS. eDNA
B9	638 930.7	6 439 804.6	105	FA, PSD, CS. eDNA
B10	645 940.9	6 440 859.7	117	FA, PSD, CS. eDNA
B12	641 835.2	6 442 801.0	101	FA, PSD, CS. eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Depth [m LAT]	Sample Acquisition
B14	629 991.3	6 445 578.9	105	FA, PSD, CS. eDNA
B17	647 693.0	6 445 843.5	111	FA, PSD, CS. eDNA
B23	629 902.7	6 451 482.3	107	FA, PSD, CS. eDNA
B25	641 705.5	6 451 654.1	105	FA, PSD, CS. eDNA
B26	647 605.9	6 451 742.7	114	FA, PSD, CS. eDNA
B28	638 708.7	6 454 561.7	102	FA, PSD, CS. eDNA
B30	632 766.5	6 457 428.4	106	FA, PSD, CS. eDNA
B35	638 624.5	6 460 462.4	107	FA, PSD, CS. eDNA
B39_a	636 027.1	6 465 717.7	112	FA, PSD, CS. eDNA

Notes
LAT = Lowest Astronomical Tide
PSD = Particle size distribution
FA = Faunal sample A
CS = Contaminants sample
eDNA = Environmental deoxyribonucleic acid

Table 4.2: Completed sediment sampling stations for the cores

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Penetration / Recovery [m]	Sample Acquisition
VC_CPT_01a 0-15cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_01a 50-65cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_01a 100-115cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_01a 150-165cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_01a 200-215cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_01a 250-265cm	644 477.7	6 456 680.9	3.28 / 2.75	CS
VC_CPT_04 0-15cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 50-65cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 100-115cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 150-165cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 200-215cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 250-265cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 300-315cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 350-365cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 400-415cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 450-465cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_04 500-515cm	641 306.5	6 447 083.7	6.00 / 5.74	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Penetration / Recovery [m]	Sample Acquisition
VC_CPT_04 550-565cm	641 306.5	6 447 083.7	6.00 / 5.74	CS
VC_CPT_06 0-15cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_06 50-65cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_06 100-115cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_06 150-165cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_06 200-215cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_06 250-265cm	633 782.8	6 436 305.9	4.42 / 2.82	CS
VC_CPT_09 0-15cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 50-65cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 100-115cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 150-165cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 200-215cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 250-265cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 300-315cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 350-365cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 400-415cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 450-465cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 500-515cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_09 550-565cm	634 506.2	6 448 224.7	6.00 / 5.67	CS
VC_CPT_10a 0-15cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 50-65cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 100-115cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 150-165cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 200-215cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 250-265cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 300-315cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 350-365cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 400-415cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 450-465cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 500-515cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_10a 550-565cm	632 041.9	6 447 808.1	6.00 / 5.86	CS
VC_CPT_13 0-15cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 50-65cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 100-115cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 150-165cm	634 077.7	6 460 692.7	6.00 / 4.85	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Penetration / Recovery [m]	Sample Acquisition
VC_CPT_13 200-215cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 250-265cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 300-315cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 350-365cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 400-415cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_13 450-465cm	634 077.7	6 460 692.7	6.00 / 4.85	CS
VC_CPT_14a 0-15cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 50-65cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 100-115cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 150-165cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 200-215cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 250-265cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_14a 300-315cm	626 138.7	6 447 893.2	5.10 / 3.90	CS
VC_CPT_15 0-15cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 50-65cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 100-115	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 150-165cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 200-215cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 250-265cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 300-315cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 350-365cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 400-415cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 450-465cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_15 500-515cm	634 448.2	6 464 982.5	6.00 / 5.35	CS
VC_CPT_19 0-15cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 50-65cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 100-115cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 150-165cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 200-215cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 250-265cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 300-315cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 350-365cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 400-415cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 450-465cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_19 500-515cm	641 953.6	6 436 736.3	6.00 / 5.55	CS

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Penetration / Recovery [m]	Sample Acquisition
VC_CPT_19 550-565cm	641 953.6	6 436 736.3	6.00 / 5.55	CS
VC_CPT_20a 0-15cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 50-65cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 100-115cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 150-165cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 200-215cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 250-265cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
VC_CPT_20a 300-315cm	632 920.4	6 442 310.9	4.90 / 4.12	CS
Notes CS = Contaminants sample				

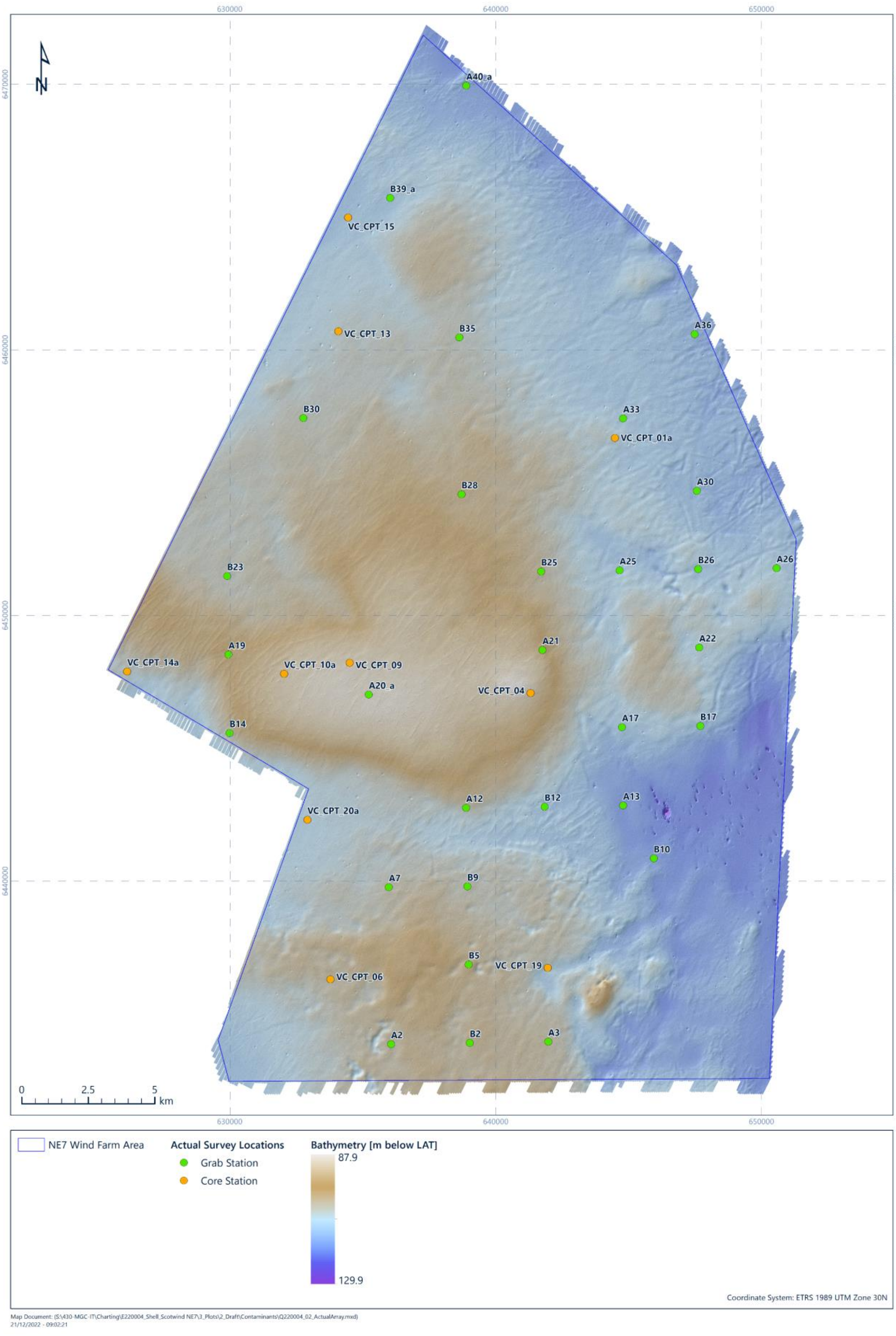

Figure 4.1: Completed survey locations overlaid on bathymetry

4.2 Sediment Chemistry

4.2.1 Sediment Hydrocarbons

Relative standard deviation (RSD) values have been provided to indicate the extent of variability in the dataset. For the purpose of this report, a RSD of less than 30 % will be considered low variability, 30 % to 70 % will be considered moderate variability and more than 70 % will be considered high variability.

4.2.1.1 Sediment Aromatic Hydrocarbon Content

Total 2 to 6 ring PAH concentrations are calculated as the sum of individual PAHs, some of which were less than the minimum reporting value (MRV). Consequently, the total 2 to 6 ring PAH concentration is assigned as a less than value. However, the concentrations of the individual PAHs that were less than the MRV are unlikely to significantly influence the total 2 to 6 ring PAH concentrations. Therefore, for the purposes of this report, total 2 to 6 ring PAH and US EPA 16 PAH concentrations are treated as absolute values to provide comparison between stations.

Grab samples

Table 4.3 summarises the total concentrations of aromatic hydrocarbons, including the US EPA 16 PAHs. Figure 4.2 shows the spatial distribution of total 2 to 6 PAHs across the survey area. Appendix D.1 presents the individual aromatic hydrocarbon and their alkyl homologue concentrations across the MarramWind Floating Offshore Windfarm survey area, including the US EPA 16 PAH concentrations with threshold values where available.

Total 2 to 6 ring PAH concentrations ranged from < 23.6 ng/g (station A20_a) to 117 ng/g (station A13).

Total US EPA 16 PAH concentrations ranged from < 9.7 ng/g (station A20_a) to < 46.8 ng/g (station B39_a).

Core samples

Table 4.4 summarises the total concentrations of aromatic hydrocarbons, including the US EPA 16 PAHs. Appendix D.1 presents the individual aromatic hydrocarbon and their alkyl homologue concentrations across the MarramWind Floating Offshore Windfarm survey area, including the US EPA 16 PAH concentrations with threshold values where available.

Total 2 to 6 ring PAH concentrations ranged from < 4.3 ng/g (core section VC_CPT_01a 250-265cm) to 245 ng/g (core section VC_CPT_20a 200-215cm).

Total US EPA 16 PAH concentrations ranged from < 1.6 ng/g (core section VC_CPT_01a 250-265cm) to 69.2 ng/g (core section VC_CPT_19 0-15cm).

Table 4.3: Summary of sediment aromatic hydrocarbon analysis for the grab samples

PAH [ng/g of Dry Sediment]	A2	A3	A7	A12	A13	A17	A19	A20_a	A21	A22	A25	A26	A30	A33	A36	A40_a
Naphthalene	0.6	0.4	0.5	0.8	0.8	1.3	0.5	0.2	0.3	1.2	0.6	0.7	0.8	0.6	0.5	0.8
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.1	< 0.1	< 0.1
Acenaphthene	0.1	0.1	< 0.1	0.1	0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fluorene	0.3	0.2	0.6	0.3	0.4	0.5	0.2	0.1	0.2	0.3	0.3	0.3	0.4	0.3	0.3	0.4
Phenanthrene	1.4	1.2	1.1	1.6	2.4	2.7	1.0	0.3	1.0	2.7	1.7	1.6	2.0	1.8	1.6	2.0
Anthracene	0.1	0.1	0.1	0.1	0.2	0.3	0.2	< 0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2
Fluoranthene	1.5	1.3	1.3	1.3	2.6	2.5	2.2	0.4	0.8	1.8	2.0	1.8	2.2	2.1	1.7	2.1
Pyrene	1.0	0.8	0.8	0.9	1.7	1.7	1.7	0.2	0.5	1.2	1.3	1.2	1.4	1.4	1.1	1.4
Benzo[a]anthracene	0.7	0.6	0.6	0.7	1.2	1.3	1.3	0.2	0.5	0.9	1.0	0.9	1.1	1.1	0.8	1.0
Chrysene	0.7	0.7	0.6	0.7	1.2	1.4	1.2	0.2	0.5	1.0	1.0	0.9	1.0	1.0	0.8	0.9
Benzo[b]fluoranthene	6.5	5.6	5.2	5.4	10.2	8.5	5.9	2.1	3.8	8.0	8.2	7.7	9.8	8.4	8.0	9.4
Benzo[k]fluoranthene	1.8	1.6	1.5	1.5	3.0	2.4	1.7	0.6	1.0	2.3	2.3	2.2	2.7	2.4	2.2	2.6
Benzo[a]pyrene	1.2	1.1	1.0	1.1	2.1	1.9	1.5	0.4	0.7	1.5	1.6	1.6	1.7	1.5	1.2	1.6
Indeno[1,2,3-cd]pyrene	6.1	5.7	4.8	5.5	10.6	8.6	4.9	2.4	3.8	7.7	7.6	8.3	8.7	7.1	6.3	7.7
Benzo[ghi]perylene	5.0	4.7	3.9	4.6	8.8	7.1	3.9	2.0	3.1	6.3	6.1	6.8	6.8	5.5	5.0	6.2
Dibenzo[ah]anthracene	0.7	0.7	0.6	0.7	1.3	1.1	0.6	0.3	0.5	0.9	0.9	1.0	1.0	0.8	0.7	0.9
Total US EPA 16 PAH	**< 27.8**	**< 24.9**	**< 22.8**	**< 25.4**	**46.7**	**41.5**	**< 27.0**	**< 9.7**	**< 17.0**	**< 36.1**	**< 35.0**	**35.4**	**40.0**	**34.4**	**< 30.5**	**< 37.4**
Total 2 to 6 Ring PAH	**75.5**	**63.6**	**59.1**	**78.0**	**117**	**107**	**65.2**	**< 23.6**	**50.1**	**98.4**	**88.8**	**87.9**	**101**	**86.5**	**76.5**	**96.2**

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	**Below AL1 value**	**Above AL1 value**

PAH [ng/g of Dry Sediment]	B2	B5	B9	B10	B12	B14	B17	B23	B25	B26	B28	B30	B35	B39_a	Marine Scotland (2017)
															AL1
Naphthalene	0.6	0.2	0.4	0.7	1.2	0.4	0.6	0.8	0.7	1.0	0.5	0.6	0.5	0.7	100
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	100
Acenaphthene	< 0.1	< 0.1	< 0.1	0.1	0.1	< 0.1	0.1	0.1	< 0.1	0.1	< 0.1	0.1	0.1	0.1	100
Fluorene	0.2	0.1	0.2	0.4	0.4	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.4	100
Phenanthrene	1.2	0.7	1.0	2.1	2.0	1.2	1.4	1.5	0.9	1.6	1.0	1.6	1.3	1.8	100
Anthracene	0.1	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2	100
Fluoranthene	1.3	1.2	1.1	1.9	2.4	1.1	1.6	1.5	1.1	2.0	1.0	1.7	1.4	2.5	100
Pyrene	0.8	0.8	0.7	1.2	1.8	0.7	1.0	1.1	0.7	1.2	0.7	1.1	0.9	1.6	100
Benzo[a]anthracene	0.6	0.6	0.5	0.9	1.3	0.5	0.8	0.8	0.5	0.9	0.5	0.8	0.7	1.2	100
Chrysene	0.6	0.7	0.5	0.8	1.2	0.5	0.7	0.7	0.5	0.9	0.6	0.8	0.6	1.1	100
Benzo[b]fluoranthene	6.3	4.1	5.1	7.7	7.2	5.0	7.3	6.3	5.1	9.1	4.6	7.3	6.5	11.2	100
Benzo[k]fluoranthene	1.6	1.1	1.3	2.1	1.9	1.3	2.0	1.6	1.4	2.5	1.3	2.0	1.8	3.2	100
Benzo[a]pyrene	0.9	0.7	0.8	1.3	1.5	0.8	1.3	1.1	0.9	1.6	0.8	1.3	1.2	2.1	100
Indeno[1,2,3-cd]pyrene	4.1	2.5	3.6	5.7	4.8	3.8	6.2	4.4	4.5	7.5	4.0	6.1	6.3	10.7	100
Benzo[ghi]perylene	3.1	2.0	2.8	4.5	3.8	3.0	5.0	3.5	3.3	5.6	3.1	4.5	5.0	8.6	100
Dibenzo[ah]anthracene	0.5	0.3	0.4	0.6	0.6	0.4	0.7	0.5	0.5	0.8	0.4	0.7	0.7	1.3	10
Total US EPA 16 PAH	< 22.1	< 15.5	< 18.7	< 30.3	30.5	< 19.2	< 29.0	< 24.4	< 20.6	< 35.4	< 20.0	< 29.2	< 27.4	< 46.8	-
Total 2 to 6 Ring PAH	60.3	38.3	48.7	88.2	86.6	52.3	73.9	69.9	52.4	91.4	50.5	80.5	71.1	115	-

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	Below AL1 value	Above AL1 value

Table 4.4: Summary of sediment aromatic hydrocarbon analysis for the core samples

PAH [ng/g of Dry Sediment]	VC_CPT_01a 0-15cm	VC_CPT_01a 50-65cm	VC_CPT_01a 100-115cm	VC_CPT_01a 150-165cm	VC_CPT_01a 200-215cm	VC_CPT_01a 250-265cm	VC_CPT_04 0-15cm	VC_CPT_04 50-65cm	VC_CPT_04 100-115cm	VC_CPT_04 150-165cm	VC_CPT_04 200-215cm	VC_CPT_04 250-265cm	VC_CPT_04 300-315cm	VC_CPT_04 350-365cm	VC_CPT_04 400-415cm	VC_CPT_0 4 450-465cm
Naphthalene	0.5	0.3	0.3	0.3	0.4	< 0.1	0.2	0.1	0.4	0.2	0.2	0.2	0.3	0.4	0.4	0.4
Acenaphthylene	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	0.1	0.1	0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.1	0.1
Fluorene	0.3	0.2	0.2	0.3	0.3	< 0.1	0.1	< 0.1	0.3	0.1	0.1	0.1	0.2	0.3	0.3	0.4
Phenanthrene	1.6	1.0	1.2	1.5	1.9	< 0.1	0.3	0.3	1.5	0.6	0.7	0.6	1.1	1.7	1.5	1.8
Anthracene	0.2	0.1	0.1	0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.1	0.1
Fluoranthene	3.0	0.5	0.5	0.7	0.8	< 0.1	0.4	0.1	0.5	0.2	0.3	0.3	0.8	1.2	1.0	1.3
Pyrene	2.0	0.7	0.8	1.0	1.1	< 0.1	0.3	0.1	0.6	0.2	0.3	0.4	1.0	1.5	1.3	1.8
Benzo[a]anthracene	1.3	0.3	0.4	0.4	0.5	< 0.1	0.2	0.1	0.3	0.1	0.2	0.2	0.3	0.5	0.4	0.5
Chrysene	0.8	0.3	0.4	0.5	0.7	< 0.1	0.2	0.1	0.4	0.2	0.3	0.3	0.3	0.5	0.4	0.5
Benzo[b]fluoranthene	13.8	1.2	1.4	1.7	2.4	0.1	2.1	0.3	1.1	0.4	0.6	0.7	1.2	2.0	1.5	2.0
Benzo[k]fluoranthene	3.9	0.2	0.2	0.2	0.4	< 0.1	0.6	< 0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.3
Benzo[a]pyrene	2.4	0.3	0.4	0.4	0.6	< 0.1	0.3	0.1	0.3	0.2	0.2	0.3	0.4	0.7	0.5	0.6
Indeno[1,2,3-cd]pyrene	11.8	0.4	0.4	0.4	0.6	< 0.1	2.4	0.1	0.3	0.2	0.3	0.3	0.5	0.8	0.7	0.8
Benzo[ghi]perylene	8.9	0.7	0.8	0.8	1.2	< 0.1	1.7	0.1	0.8	0.4	0.7	0.6	1.1	1.7	1.4	1.5
Dibenzo[ah]anthracene	1.3	0.1	0.1	0.1	0.2	< 0.1	0.3	< 0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Total US EPA 16 PAH	**52.0**	**< 6.5**	**< 7.4**	**< 8.6**	**< 11.4**	**< 1.6**	**< 9.4**	**< 2.0**	**< 7.0**	**< 3.3**	**< 4.4**	**< 4.5**	**< 7.8**	**< 12.1**	**< 10.2**	**< 12.4**
Total 2 to 6 Ring PAH	**117**	**54.8**	**62.1**	**72.7**	**107**	**< 4.3**	**< 22.4**	**< 10.0**	**50.5**	**25.3**	**32.6**	**33.1**	**71.5**	**109**	**88.1**	**113**

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	Below AL1 value	Above AL1 value

PAH [ng/g of Dry Sediment]	VC_CPT_04 500-515cm	VC_CPT_04 550-565cm	VC_CPT_06 0-15cm	VC_CPT_06 50-65cm	VC_CPT_06 100-115cm	VC_CPT_06 150-165cm	VC_CPT_06 200-215cm	VC_CPT_06 250-265cm	VC_CPT_09 0-15cm	VC_CPT_09 50-65cm	VC_CPT_09 100-115cm	VC_CPT_09 150-165cm	VC_CPT_09 200-215cm	VC_CPT_09 250-265cm	VC_CPT_09 300-315cm	VC_CPT_09 350-365cm
Naphthalene	0.5	0.6	1.3	0.7	0.5	0.8	0.5	0.3	0.2	0.4	0.4	0.5	0.4	0.4	0.4	0.5
Acenaphthylene	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	< 0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1
Fluorene	0.4	0.4	0.3	0.5	0.4	0.4	0.3	0.3	0.1	0.4	0.4	0.4	0.3	0.4	0.3	0.4
Phenanthrene	1.7	2.2	1.9	2.5	2.0	1.7	1.4	1.2	0.6	1.9	1.8	1.8	1.6	1.8	1.7	2.5
Anthracene	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	< 0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Fluoranthene	1.3	1.5	2.8	2.1	1.7	1.6	1.3	1.4	0.7	1.0	1.1	1.0	0.9	1.0	0.9	1.3
Pyrene	1.8	2.1	2.2	2.5	2.2	2.3	1.9	1.8	0.5	1.6	1.7	1.5	1.4	1.5	1.4	1.8
Benzo[a]anthracene	0.5	0.6	1.3	0.9	0.6	0.6	0.4	0.4	0.3	0.6	0.5	0.5	0.5	0.6	0.5	0.7
Chrysene	0.6	0.8	0.9	0.7	0.6	0.7	0.5	0.5	0.3	0.7	0.6	0.6	0.5	0.6	0.6	0.8
Benzo[b]fluoranthene	2.0	2.5	12.6	2.9	2.3	2.2	1.9	1.8	3.2	2.3	2.1	2.2	2.1	2.3	2.0	2.5
Benzo[k]fluoranthene	0.3	0.4	3.7	0.5	0.4	0.4	0.4	0.4	0.9	0.4	0.3	0.4	0.3	0.4	0.3	0.4
Benzo[a]pyrene	0.7	0.8	2.5	1.0	0.9	1.0	0.8	0.8	0.5	0.8	0.7	0.7	0.7	0.7	0.7	0.9
Indeno[1,2,3-cd]pyrene	0.9	1.2	12.8	1.3	1.2	1.6	1.4	1.5	3.1	1.1	1.0	1.0	0.9	0.9	0.9	1.2
Benzo[ghi]perylene	1.7	2.3	10.6	2.3	2.3	3.1	2.6	2.7	2.5	2.3	2.2	2.0	1.8	1.9	1.9	2.7
Dibenzo[ah]anthracene	0.2	0.3	1.6	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Total US EPA 16 PAH	< 12.9	< 16.2	54.9	< 18.7	< 15.8	< 17.2	< 14.1	< 13.8	< 13.6	< 14.1	< 13.5	< 13.2	< 12.0	< 13.1	< 12.2	< 16.5
Total 2 to 6 Ring PAH	119	148	129	146	136	170	141	144	34.0	119	130	116	106	111	105	141

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	**Below AL1 value**	**Above AL1 value**

PAH [ng/g of Dry Sediment]	VC_CPT_09 400-415cm	VC_CPT_09 450-465cm	VC_CPT_09 500-515cm	VC_CPT_09 550-565cm	VC_CPT_10a 0-15cm	VC_CPT_10a 50-65cm	VC_CPT_10a 100-115cm	VC_CPT_10a 150-165cm	VC_CPT_10a 200-215cm	VC_CPT_10a 250-265cm	VC_CPT_10a 300-315cm	VC_CPT_10a 350-365cm	VC_CPT_10a 400-415cm	VC_CPT_10a 450-465cm	VC_CPT_10a 500-515cm	VC_CPT_10 a 550-565cm
Naphthalene	0.3	0.4	0.4	0.2	0.3	0.4	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.5	0.2
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	0.1	0.1	0.1	< 0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fluorene	0.2	0.3	0.3	0.2	0.1	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2
Phenanthrene	1.2	1.3	1.4	1.1	0.8	1.5	1.9	1.6	1.3	1.4	1.4	1.4	1.4	0.8	1.5	0.9
Anthracene	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fluoranthene	0.7	0.8	0.8	0.7	1.1	0.6	0.5	0.5	0.9	1.0	1.0	0.9	0.9	0.6	1.1	0.7
Pyrene	1.0	1.1	1.1	1.0	0.9	1.1	0.6	0.8	1.2	1.3	1.3	1.1	1.2	0.8	1.4	0.9
Benzo[a]anthracene	0.3	0.4	0.4	0.3	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.5	0.3
Chrysene	0.4	0.6	0.4	0.4	0.3	0.6	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.3	0.5	0.4
Benzo[b]fluoranthene	1.4	1.6	1.6	1.4	4.8	1.7	1.1	1.2	1.6	1.8	1.8	1.5	1.7	1.0	2.0	1.1
Benzo[k]fluoranthene	0.2	0.2	0.2	0.2	1.3	0.4	0.2	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.2
Benzo[a]pyrene	0.3	0.4	0.3	0.3	0.7	0.7	0.3	0.4	0.4	0.5	0.5	0.4	0.5	0.3	0.6	0.4
Indeno[1,2,3-cd]pyrene	0.5	0.6	0.4	0.4	3.5	1.1	0.3	0.4	0.6	0.7	0.7	0.6	0.7	0.5	0.9	0.6
Benzo[ghi]perylene	0.9	1.1	0.7	0.5	2.8	1.8	0.7	0.9	1.3	1.5	1.5	1.1	1.4	1.0	2.1	1.3
Dibenzo[ah]anthracene	0.1	0.1	0.1	0.1	0.4	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total US EPA 16 PAH	< 7.8	< 9.2	< 8.4	< 7.1	< 17.7	< 11.1	< 7.7	< 7.9	< 9.6	< 10.5	< 10.5	< 9.2	< 10.1	< 6.7	< 12.2	< 7.7
Total 2 to 6 Ring PAH	70.1	82.4	75.7	66.7	46.1	69.5	49.9	53.3	83.4	94.1	97.0	80.0	84.8	54.8	107	70.1

Notes

Concentrations expressed in ng/g dry sediment

US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	**Below AL1 value**	**Above AL1 value**

PAH [ng/g of Dry Sediment]	VC_CPT_13 0-15cm	VC_CPT_13 50-65cm	VC_CPT_13 100-115cm	VC_CPT_13 150-165cm	VC_CPT_13 200-215cm	VC_CPT_13 250-265cm	VC_CPT_13 300-315cm	VC_CPT_13 350-365cm	VC_CPT_13 400-415cm	VC_CPT_13 450-465cm	VC_CPT_14a 0-15cm	VC_CPT_14a 50-65cm	VC_CPT_14a 100-115cm	VC_CPT_14a 150-165cm	VC_CPT_14a 200-215cm	VC_CPT_14 a 250-265cm
Naphthalene	0.6	0.4	0.4	0.5	0.5	0.3	0.5	0.3	0.3	0.5	0.6	0.6	0.5	0.5	0.5	0.5
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	< 0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2
Fluorene	0.3	0.2	0.4	0.3	0.4	0.3	0.5	0.4	0.3	0.5	0.3	0.4	0.3	0.4	0.4	0.4
Phenanthrene	1.8	1.2	1.8	1.7	2.1	1.5	2.7	1.9	1.8	2.6	1.6	1.9	1.7	2.3	2.4	2.2
Anthracene	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2
Fluoranthene	2.8	0.4	1.0	1.0	1.3	0.9	1.1	1.0	1.0	1.4	2.8	0.9	0.7	1.4	1.5	1.5
Pyrene	1.7	0.4	1.6	1.5	1.9	1.4	1.6	1.6	1.5	2.3	2.1	1.4	1.2	2.0	2.1	2.1
Benzo[a]anthracene	1.3	0.2	0.5	0.4	0.5	0.4	0.7	0.5	0.4	0.6	1.4	0.5	0.5	0.7	0.8	0.8
Chrysene	0.9	0.3	0.7	0.6	0.7	0.6	0.9	0.7	0.5	0.9	0.9	0.5	0.7	0.7	0.7	0.7
Benzo[b]fluoranthene	13.3	1.2	2.2	1.8	2.4	1.8	3.1	2.1	1.9	2.8	12.6	2.0	1.9	2.8	3.0	3.2
Benzo[k]fluoranthene	3.7	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.4	3.5	0.3	0.3	0.3	0.4	0.3
Benzo[a]pyrene	2.4	0.3	0.6	0.6	0.7	0.5	1.0	0.7	0.6	0.9	1.9	0.5	0.7	0.5	0.6	0.5
Indeno[1,2,3-cd]pyrene	13.4	0.8	0.8	0.8	1.0	0.6	1.1	0.8	0.8	1.3	8.7	0.7	0.9	0.6	0.7	0.5
Benzo[ghi]perylene	10.8	1.1	2.0	1.9	2.5	1.6	1.6	1.8	2.0	3.2	5.7	1.3	2.1	1.0	1.2	0.7
Dibenzo[ah]anthracene	1.5	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.4	1.0	0.2	0.3	0.2	0.2	0.1
Total US EPA 16 PAH	< 54.9	< 7.1	< 12.8	< 11.9	< 14.9	< 10.7	< 15.9	< 12.6	< 11.9	< 18.3	43.5	< 11.5	< 12.1	< 13.9	< 15.0	< 14.0
Total 2 to 6 Ring PAH	118	36.1	114	102	125	85.5	132	103	98.0	147	98.3	85.4	88.9	111	120	109

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	**Below AL1 value**	**Above AL1 value**

PAH [ng/g of Dry Sediment]	VC_CPT_14a 300-315cm	VC_CPT_15 0-15cm	VC_CPT_15 50-65cm	VC_CPT_15 100-115	VC_CPT_15 150-165cm	VC_CPT_15 200-215cm	VC_CPT_15 250-265cm	VC_CPT_15 300-315cm	VC_CPT_15 350-365cm	VC_CPT_15 400-415cm	VC_CPT_15 450-465cm	VC_CPT_15 500-515cm	VC_CPT_19 0-15cm	VC_CPT_19 50-65cm	VC_CPT_19 100-115cm	VC_CPT_19 150-165cm
Naphthalene	0.3	0.6	0.5	0.5	0.6	0.3	0.3	0.6	0.5	0.6	0.4	0.5	0.7	0.5	0.6	0.6
Acenaphthylene	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fluorene	0.3	0.3	0.3	0.4	0.5	0.2	0.2	0.4	0.5	0.4	0.4	0.3	0.4	0.3	0.4	0.4
Phenanthrene	1.4	1.7	1.8	1.9	2.4	1.1	1.1	2.5	2.4	2.2	2.1	1.9	2.7	1.7	2.3	2.0
Anthracene	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.4	0.1	0.1	0.1
Fluoranthene	1.0	3.0	0.6	0.6	0.8	0.4	0.4	0.8	0.9	0.8	1.1	0.8	4.2	0.5	1.0	1.0
Pyrene	1.4	1.9	0.7	1.0	1.2	0.7	0.9	1.2	1.5	1.3	1.5	1.1	3.2	0.5	1.7	1.7
Benzo[a]anthracene	0.4	1.4	0.3	0.4	0.7	0.5	0.5	0.7	0.7	0.6	0.5	0.5	2.1	0.3	0.7	0.7
Chrysene	0.5	0.8	0.4	0.5	0.8	0.4	0.5	0.8	0.9	0.8	0.7	0.7	1.4	0.4	0.6	0.5
Benzo[b]fluoranthene	1.9	11.1	1.4	1.5	2.0	1.2	1.2	2.1	2.5	2.0	2.1	1.8	16.0	1.1	2.1	2.1
Benzo[k]fluoranthene	0.2	3.3	0.2	0.2	0.3	0.2	0.2	0.4	0.4	0.3	0.3	0.3	4.7	0.2	0.4	0.3
Benzo[a]pyrene	0.4	2.2	0.3	0.4	0.7	0.4	0.4	0.8	0.9	0.7	0.6	0.6	3.5	0.3	0.9	0.6
Indeno[1,2,3-cd]pyrene	0.4	10.5	0.4	0.4	0.7	0.6	0.6	1.1	1.2	1.0	0.8	0.7	15.2	0.7	1.1	0.7
Benzo[ghi]perylene	0.7	8.3	0.8	1.0	1.7	1.3	1.3	2.6	2.9	2.4	2.0	1.8	12.6	1.1	2.5	1.3
Dibenzo[ah]anthracene	0.1	1.3	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.3	0.2	0.2	1.9	0.2	0.3	0.2
Total US EPA 16 PAH	**< 9.3**	**46.8**	**< 8.1**	**< 9.2**	**< 12.9**	**< 7.8**	**< 8.1**	**< 14.6**	**< 16.1**	**13.8**	**< 13.1**	**< 11.5**	**69.2**	**< 8.1**	**< 14.9**	**< 12.4**
Total 2 to 6 Ring PAH	**77.1**	**99.8**	**47.5**	**56.8**	**78.3**	**62.6**	**64.8**	**112**	**129**	**111**	**105**	**83.1**	**163**	**46.9**	**112**	**88.6**

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	**Below AL1 value**	**Above AL1 value**

PAH [ng/g of Dry Sediment]	VC_CPT_19 200-215cm	VC_CPT_19 250-265cm	VC_CPT_19 300-315cm	VC_CPT_19 350-365cm	VC_CPT_19 400-415cm	VC_CPT_19 450-465cm	VC_CPT_19 500-515cm	VC_CPT_19 550-565cm	VC_CPT_20a 0-15cm	VC_CPT_20a 50-65cm	VC_CPT_20a 100-115cm	VC_CPT_20a 150-165cm	VC_CPT_20a 200-215cm	VC_CPT_20a 250-265cm	VC_CPT_20a 300-315cm	Marine Scotland (2017) AL1
Naphthalene	0.4	0.4	0.4	0.4	0.1	0.4	0.5	0.6	1.0	0.7	0.5	0.5	1.2	0.3	0.6	100
Acenaphthylene	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	100
Acenaphthene	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.2	100
Fluorene	0.3	0.3	0.3	0.2	0.1	0.3	0.4	0.3	0.5	0.4	0.4	0.4	0.9	0.3	0.6	100
Phenanthrene	1.6	1.6	1.3	1.5	0.4	1.5	2.1	1.5	2.9	2.6	2.0	2.0	5.1	1.2	2.7	100
Anthracene	0.1	0.1	0.1	0.1	< 0.1	0.1	0.2	0.1	0.4	0.1	0.1	0.1	0.3	0.1	0.2	100
Fluoranthene	1.1	1.3	1.1	0.7	0.4	0.6	1.3	0.9	4.7	0.7	0.7	1.0	2.7	1.2	1.9	100
Pyrene	1.8	1.9	1.9	1.0	0.6	0.9	2.0	1.6	3.3	0.8	1.0	2.0	5.2	1.8	2.9	100
Benzo[a]anthracene	0.6	0.6	0.5	0.5	0.2	0.4	0.7	0.5	2.6	0.5	0.5	0.6	1.7	0.4	0.8	100
Chrysene	0.6	0.6	0.5	0.6	0.3	0.7	0.9	0.6	1.9	0.5	0.7	0.7	1.6	0.6	1.0	100
Benzo[b]fluoranthene	1.9	2.0	1.7	1.6	0.7	1.6	2.4	2.0	14.6	1.3	1.6	2.1	5.5	1.6	3.0	100
Benzo[k]fluoranthene	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.4	4.4	0.2	0.3	0.3	0.9	0.3	0.5	100
Benzo[a]pyrene	0.7	0.8	0.6	0.7	0.4	0.7	0.9	0.8	3.6	0.5	0.7	0.7	2.1	0.6	1.1	100
Indeno[1,2,3-cd]pyrene	1.1	1.3	0.9	1.0	0.6	1.0	1.3	1.2	15.2	0.6	0.8	0.9	2.5	1.1	1.7	100
Benzo[ghi]perylene	2.3	2.6	1.6	2.1	1.0	2.3	2.8	2.1	11.4	1.3	1.9	1.9	3.5	2.1	3.8	100
Dibenzo[ah]anthracene	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.3	1.9	0.2	0.3	0.3	0.7	0.3	0.5	10
Total US EPA 16 PAH	< 13.3	< 14.5	< 11.6	< 11.2	< 5.5	< 11.3	< 16.4	< 13.1	68.7	< 10.6	< 11.7	< 13.7	< 34.4	< 12.1	< 21.6	-
Total 2 to 6 Ring PAH	116	137	113	97.0	47.5	86.9	138	113	166	68.1	74.5	105	245	108	173	-

Notes
Concentrations expressed in ng/g dry sediment
US EPA 16 PAH = United States Environmental Protection Agency's 16 priority PAH pollutants

Key	Below AL1 value	Above AL1 value

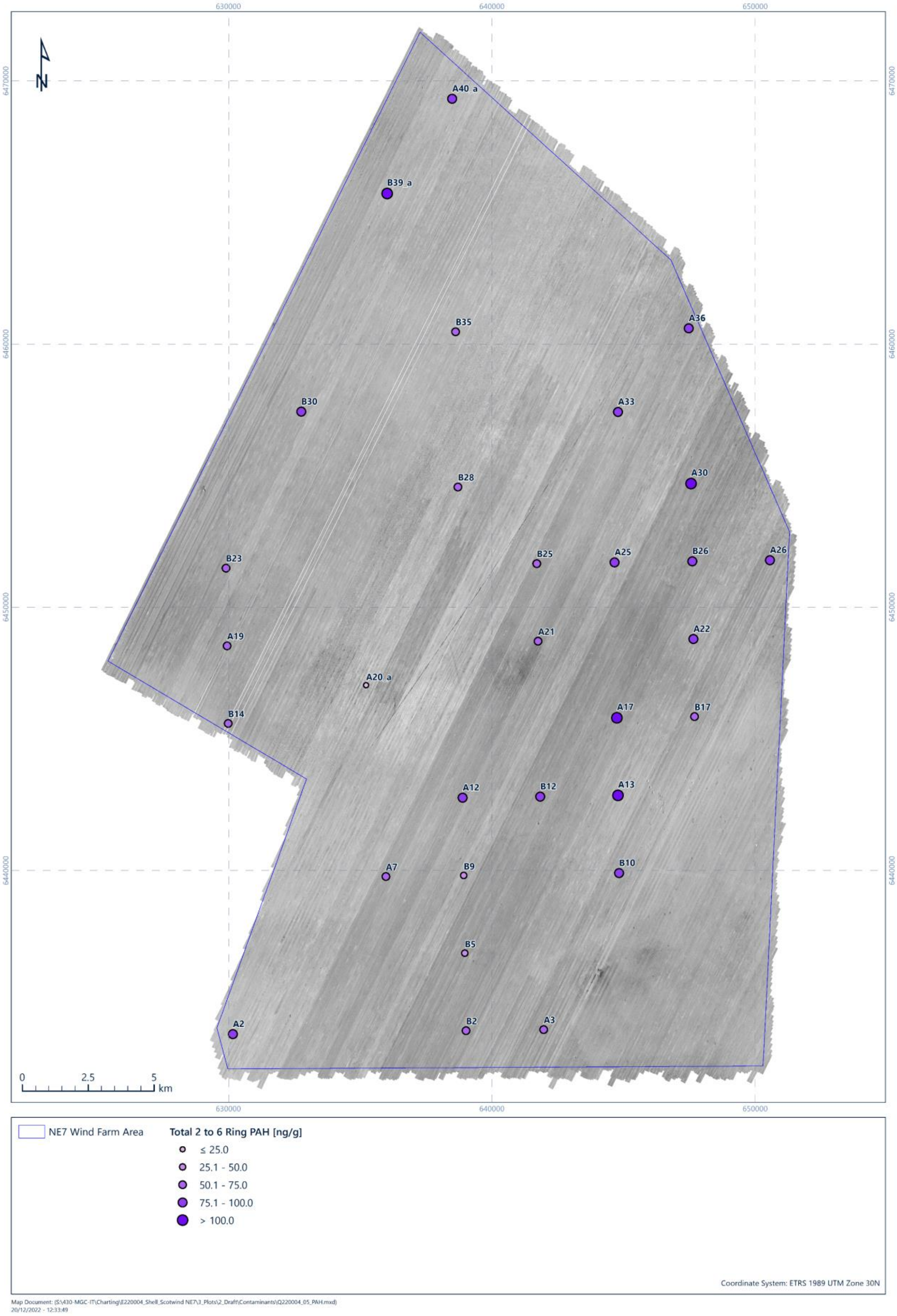

Figure 4.2: Spatial distribution of Total 2 to 6 PAH

4.2.2 Sediment Metals

4.2.2.1 Grab samples

Table 4.5 summarises the concentrations of the extractable metals in the sediment samples from an aqua regia digest. Figures 4.3 and 4.4 show the spatial distribution of arsenic and chromium across the survey area.

All metals concentrations were below the respective Marine Scotland guideline action levels (AL1 and AL2).

Aluminium concentrations displayed the highest variability (RSD of 45 %). Aluminium concentrations ranged from 1.94 µg/g (station A19) to 9.72 µg/g (station A20_a), with a mean of 2.90 µg/g.

The lowest variability of metal concentrations was recorded for mercury for which concentrations were less than the MRV (< 0.03 µg/g).

The remaining metals analysed had low variability, with RSD values ranging from 20 % (chromium and lead) to 28 % (nickel).

Table 4.5: Summary of sediment metals analysis for the grab samples

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
A2	2.75	0.04	12.9	2.2	< 0.03	6.0	4.0	11.6
A3	2.31	0.03	9.81	1.7	< 0.03	4.4	3.2	9.2
A7	2.48	0.04	12.3	2.0	< 0.03	6.2	3.7	11.8
A12	2.78	0.03	11.1	1.6	< 0.03	5.1	3.1	10.0
A13	2.84	0.05	15.8	2.7	< 0.03	8.4	4.9	15.2
A17	2.73	0.03	11.9	2.1	< 0.03	6.2	3.9	12.0
A19	1.94	0.03	9.41	1.7	< 0.03	4.2	2.8	8.7
A20_a	9.72	0.03	11.3	0.9	< 0.03	2.4	5.9	7.1
A21	2.87	0.02	8.86	1.3	< 0.03	3.4	3.0	7.7
A22	2.53	0.03	10.2	1.9	< 0.03	5.5	3.8	10.6
A25	2.51	0.03	11.0	2.0	< 0.03	5.9	3.6	11.1
A26	2.37	0.04	13.9	2.3	< 0.03	6.9	4.2	13.2
A30	2.62	0.04	13.8	2.8	< 0.03	7.3	4.4	13.5
A33	2.80	0.03	13.7	2.2	< 0.03	6.9	4.8	12.9
A36	2.65	0.04	16.7	2.8	< 0.03	8.3	5.0	15.9
A40_a	2.98	0.06	19.1	3.3	< 0.03	9.7	5.8	17.7
B2	2.92	0.03	11.5	1.8	< 0.03	5.2	3.8	10.6
B5	2.70	0.04	10.5	1.6	< 0.03	4.5	3.5	10.0
B9	2.58	0.03	11.1	1.5	< 0.03	4.8	3.4	9.5
B10	2.86	0.04	16.3	2.6	< 0.03	8.0	4.8	15.1
B12	2.58	0.03	11.4	1.6	< 0.03	5.2	3.4	10.1
B14	2.73	0.03	13.1	2.0	< 0.03	5.8	3.9	11.6
B17	2.61	0.04	14.6	2.3	< 0.03	7.2	4.6	13.8
B23	2.41	0.04	13.6	2.0	< 0.03	6.3	4.0	12.0
B25	2.66	0.02	9.54	1.2	< 0.03	3.9	3.2	8.0
B26	3.34	0.04	15.3	2.5	< 0.03	7.4	4.8	14.4

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
B28	2.23	0.02	8.84	1.2	< 0.03	3.7	2.9	7.5
B30	2.58	0.03	12.0	1.8	< 0.03	5.7	3.7	11.4
B35	3.09	0.04	13.9	2.0	< 0.03	6.2	4.2	12.4
B39_a	2.81	0.04	16.3	2.6	< 0.03	7.7	4.9	15.1
Minimum	**1.94**	**0.02**	**8.84**	**0.9**	**< 0.03**	**2.4**	**2.8**	**7.1**
Maximum	**9.72**	**0.06**	**19.1**	**3.3**	**< 0.03**	**9.7**	**5.9**	**17.7**
Median	**2.68**	**0.03**	**12.2**	**2.0**	**-**	**6.0**	**3.9**	**11.6**
Mean	**2.90**	**0.03**	**12.7**	**2.0**	**-**	**6.0**	**4.0**	**11.7**
SD	**1.32**	**0.009**	**2.58**	**0.55**	**-**	**1.66**	**0.81**	**2.68**
RSD	**45**	**25**	**20**	**27**	**-**	**28**	**20**	**23**
Marine Scotland Guideline Action Levels								
AL1	**20**	**0.4**	**50**	**30**	**0.25**	**30**	**50**	**130**
AL2	**70**	**4**	**370**	**300**	**1.5**	**150**	**400**	**600**

Notes
Concentrations expressed in µg/g dry sediment

As = Arsenic	Cd = Cadmium	Cr = Chromium
Cu = Copper	Hg = Mercury	Ni = Nickel
Pb = Lead	Zn = Zinc	SD = Standard deviation
AL1 = Action level 1	AL2 = Action level 2	RSD = Relative Standard Deviation

Key	Below AL1 value	Above AL1 value	Above AL2 value

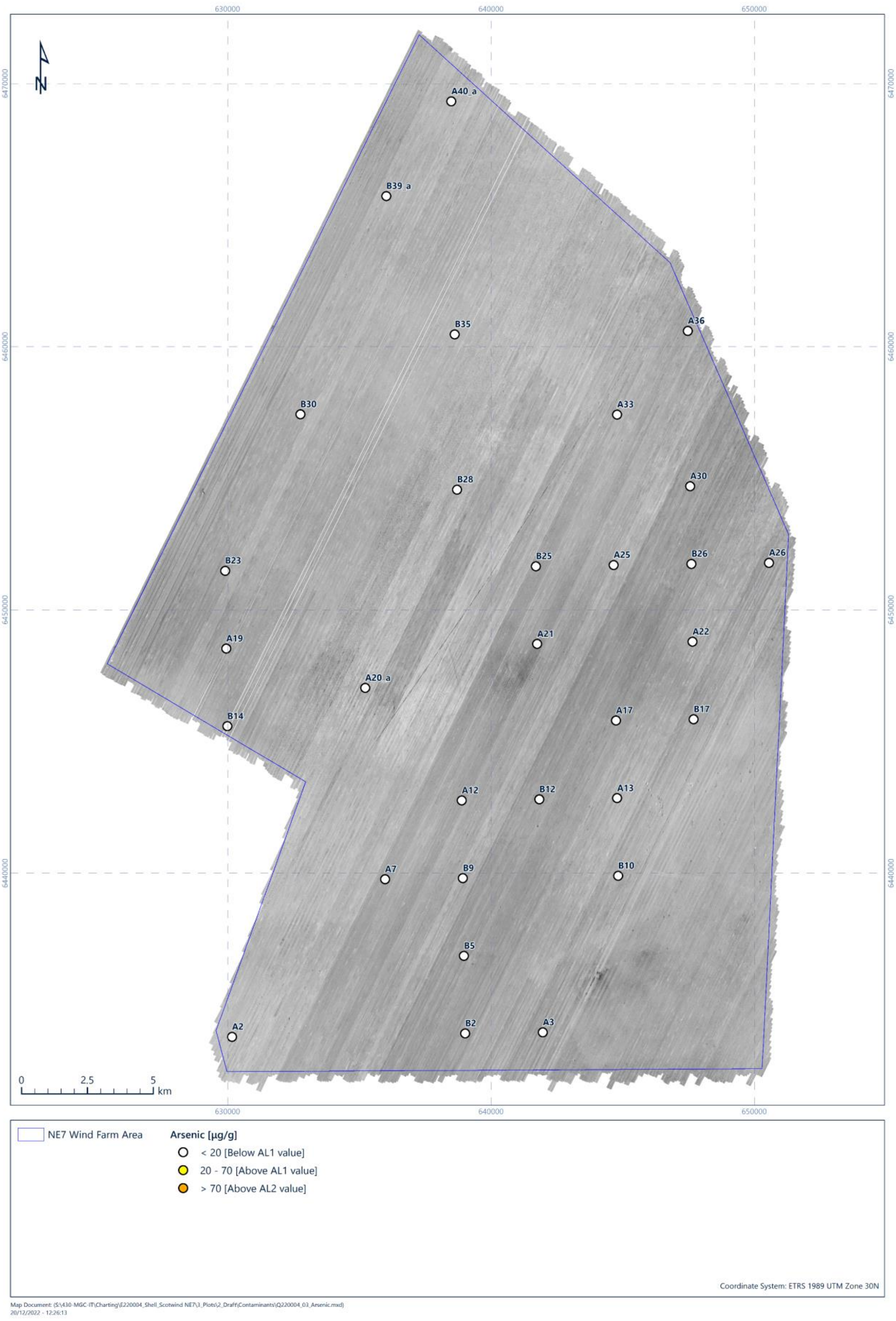

Figure 4.3: Spatial distribution of Arsenic

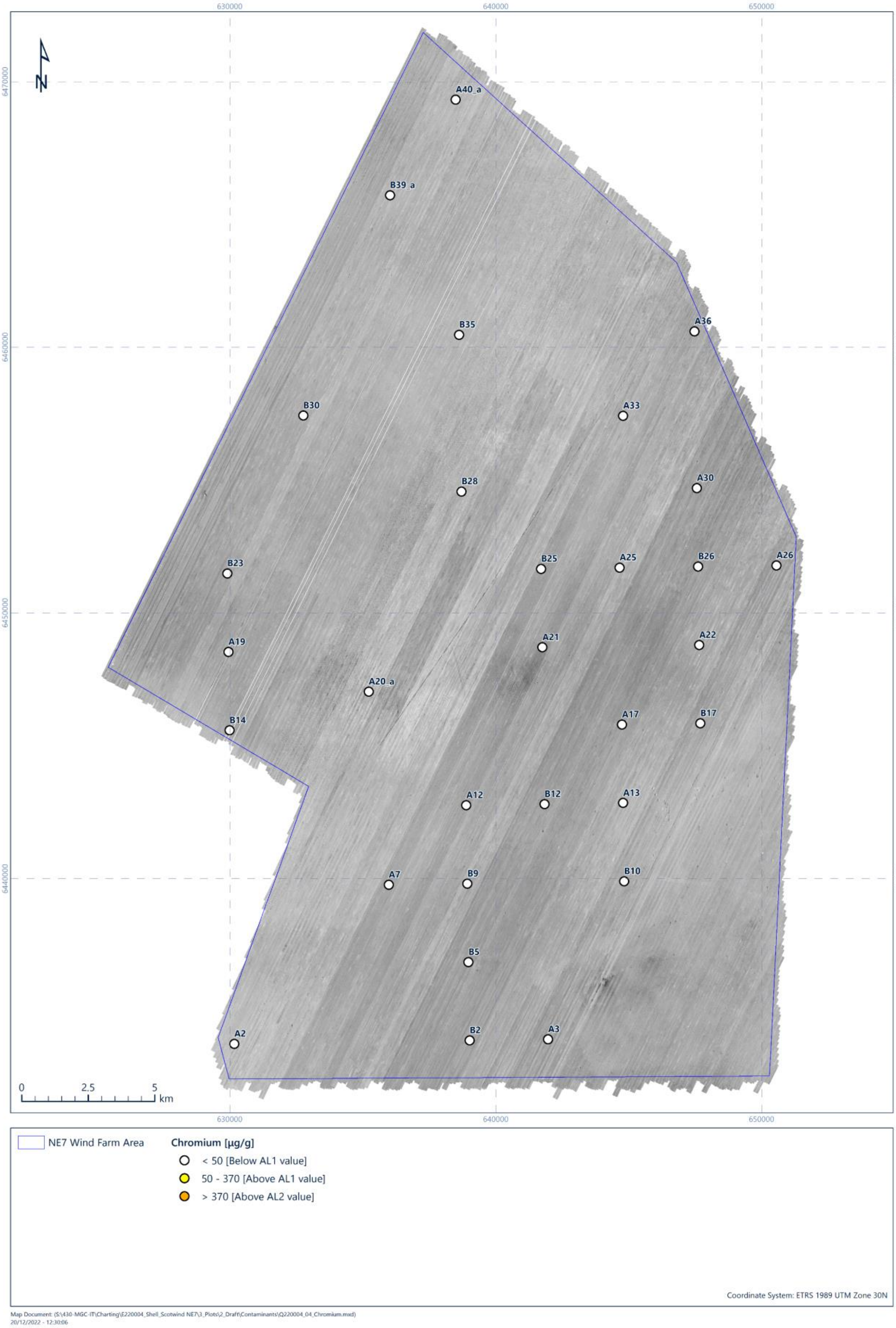

Figure 4.4: Spatial distribution of Chromium

4.2.2.2 Core samples

Table 4.7 summarises the concentrations of the extractable metals in the core sections from an aqua regia digest.

AL1 Marine Scotland guideline action levels were exceeded in one sample (core section VC_CPT_14a 100-115cm) for arsenic and five samples (core sections VC_CPT_13 450-465cm, VC_CPT_14a 100-115cm, VC_CPT_14a 150-165cm, VC_CPT_14a 250-265cm and VC_CPT_15 100-115) for chromium.

The highest variability of metal concentration was recorded for copper which had RSD of 51 % and concentrations ranging from 0.5 µg/g (core section VC_CPT_01a 250-265cm) to 17.7 µg/g (core section VC_CPT_10a 300-315cm), with a mean of 9.55 µg/g.

The lowest variability of metal concentrations was recorded for mercury for which concentrations were less than the MRV (< 0.03 µg/g).

The remaining metals analysed had moderate variability, with RSD values ranging from 38 % (cadmium) to 44 % (nickel and zinc).

Table 4.6: Summary of sediment metals analysis for the core samples

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC_CPT_01a 0-15cm	2.52	0.04	13.0	1.9	< 0.03	5.9	4.1	11.9
VC_CPT_01a 50-65cm	8.29	0.07	36.7	10.3	< 0.03	17.8	9.8	42.0
VC_CPT_01a 100-115cm	7.63	0.10	38.7	11.5	< 0.03	18.8	10.5	46.6
VC_CPT_01a 150-165cm	9.13	0.06	43.1	12.1	< 0.03	21.0	11.5	49.4
VC_CPT_01a 200-215cm	7.40	0.07	28.2	7.9	< 0.03	13.9	7.8	33.7
VC_CPT_01a 250-265cm	3.88	0.01	3.05	0.5	< 0.03	1.0	1.3	2.7
VC_CPT_04 0-15cm	5.34	0.05	16.1	1.1	< 0.03	3.6	4.6	17.4
VC_CPT_04 50-65cm	4.68	< 0.01	9.45	1.0	< 0.03	2.5	3.8	7.4
VC_CPT_04 100-115cm	4.05	0.02	7.46	1.2	< 0.03	3.3	2.6	7.3
VC_CPT_04 150-165cm	3.14	0.01	5.37	1.2	< 0.03	2.5	2.0	5.9
VC_CPT_04 200-215cm	3.56	0.01	6.77	1.4	< 0.03	3.3	2.2	6.8
VC_CPT_04 250-265cm	3.55	0.02	6.29	1.2	< 0.03	2.9	2.0	6.5
VC_CPT_04 300-315cm	6.40	0.07	37.2	13.6	< 0.03	19.7	9.5	41.6
VC_CPT_04 350-365cm	6.63	0.07	36.7	10.3	< 0.03	18.6	9.3	40.2

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC_CPT_04 400-415cm	8.28	0.07	38.2	11.2	< 0.03	19.9	9.9	43.6
VC_CPT_04 450-465cm	8.38	0.07	36.1	10.6	< 0.03	19.6	9.4	40.4
VC_CPT_04 500-515cm	7.32	0.07	39.8	13.7	< 0.03	20.9	10.1	44.3
VC_CPT_04 550-565cm	7.03	0.08	39.4	11.4	< 0.03	20.4	9.7	43.7
VC_CPT_06 0-15cm	2.13	0.04	11.1	1.8	< 0.03	5.6	3.9	10.4
VC_CPT_06 50-65cm	6.51	0.08	41.9	13.1	< 0.03	21.9	10.7	47.4
VC_CPT_06 100-115cm	6.88	0.08	42.3	12.6	< 0.03	23.4	10.3	45.3
VC_CPT_06 150-165cm	8.49	0.10	47.0	14.2	< 0.03	22.9	11.1	48.7
VC_CPT_06 200-215cm	8.00	0.12	45.9	14.3	< 0.03	22.7	11.1	49.4
VC_CPT_06 250-265cm	7.61	0.10	39.2	12.8	< 0.03	20.2	9.5	43.2
VC_CPT_09 0-15cm	3.76	0.02	11.9	1.2	< 0.03	3.0	4.8	8.0
VC_CPT_09 50-65cm	7.23	0.08	39.6	12.1	< 0.03	20.3	10.9	45.9
VC_CPT_09 100-115cm	7.24	0.11	39.6	11.8	< 0.03	20.1	10.4	44.4
VC_CPT_09 150-165cm	7.05	0.08	38.9	11.6	< 0.03	19.6	10.3	43.5
VC_CPT_09 200-215cm	6.97	0.06	36.5	10.3	< 0.03	18.5	10.1	41.6
VC_CPT_09 250-265cm	7.06	0.08	37.8	11.2	< 0.03	18.9	9.9	43.2
VC_CPT_09 300-315cm	6.80	0.07	36.1	11.0	< 0.03	18.7	9.7	46.9
VC_CPT_09 350-365cm	7.15	0.10	37.3	11.8	< 0.03	19.4	10.3	45.0
VC_CPT_09 400-415cm	7.19	0.09	36.5	11.5	< 0.03	19.0	10.8	44.4
VC_CPT_09 450-465cm	11.9	0.08	37.8	11.6	< 0.03	19.7	10.3	43.9
VC_CPT_09 500-515cm	7.40	0.08	41.3	11.8	0.04	22.1	10.2	45.2
VC_CPT_09 550-565cm	7.44	0.10	40.2	11.8	0.03	21.6	10.6	47.6
VC_CPT_10a 0-15cm	5.75	0.19	10.2	1.9	< 0.03	4.9	3.5	11.8
VC_CPT_10a 50-65cm	2.82	0.02	7.27	1.7	< 0.03	3.9	2.7	8.0
VC_CPT_10a 100-115cm	3.62	0.03	8.87	2.0	< 0.03	4.9	2.9	10.3
VC_CPT_10a 150-165cm	6.66	0.06	36.6	11.4	< 0.03	20.0	11.6	44.0

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC_CPT_10a 200-215cm	8.21	0.08	42.7	12.9	< 0.03	23.0	11.4	47.8
VC_CPT_10a 250-265cm	8.27	0.11	46.4	14.4	< 0.03	25.1	12.6	52.2
VC_CPT_10a 300-315cm	9.53	0.10	49.4	17.7	< 0.03	26.3	12.6	55.4
VC_CPT_10a 350-365cm	7.72	0.10	42.5	12.9	< 0.03	22.8	11.3	49.8
VC_CPT_10a 400-415cm	7.37	0.08	40.8	12.6	< 0.03	22.2	10.8	46.5
VC_CPT_10a 450-465cm	8.38	0.09	46.0	13.7	< 0.03	24.6	12.1	50.5
VC_CPT_10a 500-515cm	7.47	0.08	43.5	13.2	< 0.03	22.3	10.5	47.7
VC_CPT_10a 550-565cm	7.75	0.08	43.0	13.1	< 0.03	22.0	10.4	46.0
VC_CPT_13 0-15cm	2.17	0.04	11.9	2.1	< 0.03	6.6	4.3	12.2
VC_CPT_13 50-65cm	3.56	0.09	15.5	2.4	< 0.03	8.7	3.2	13.7
VC_CPT_13 100-115cm	7.52	0.09	39.2	11.8	< 0.03	21.9	10.5	47.1
VC_CPT_13 150-165cm	7.68	0.07	38.3	11.3	< 0.03	21.3	10.5	45.7
VC_CPT_13 200-215cm	8.75	0.10	46.6	14.8	< 0.03	25.4	12.8	55.8
VC_CPT_13 250-265cm	7.27	0.07	34.2	10.2	< 0.03	19.2	9.5	41.2
VC_CPT_13 300-315cm	8.38	0.07	39.4	11.8	< 0.03	21.8	13.4	47.2
VC_CPT_13 350-365cm	8.32	0.12	40.0	11.8	< 0.03	22.3	12.1	49.5
VC_CPT_13 400-415cm	10.7	0.07	31.3	9.0	< 0.03	17.4	9.1	37.4
VC_CPT_13 450-465cm	9.65	0.10	53.0	16.0	< 0.03	29.2	14.2	63.6
VC_CPT_14a 0-15cm	2.20	0.04	12.5	2.1	< 0.03	6.8	4.2	13.3
VC_CPT_14a 50-65cm	7.27	0.10	49.2	16.0	< 0.03	24.9	12.6	53.6
VC_CPT_14a 100-115cm	21.6	0.07	51.0	15.6	< 0.03	26.0	13.7	58.6
VC_CPT_14a 150-165cm	8.73	0.09	51.0	16.1	< 0.03	26.9	13.6	58.8
VC_CPT_14a 200-215cm	8.89	0.08	48.9	14.9	< 0.03	24.5	12.8	53.9
VC_CPT_14a 250-265cm	9.36	0.08	55.4	17.7	< 0.03	28.5	14.8	63.0
VC_CPT_14a 300-315cm	8.41	0.08	44.1	13.6	< 0.03	23.3	11.8	51.1
VC_CPT_15 0-15cm	2.36	0.06	14.8	2.5	< 0.03	8.0	4.3	13.7

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC_CPT_15 50-65cm	4.35	0.08	20.1	3.8	< 0.03	12.1	4.5	20.4
VC_CPT_15 100-115	11.7	0.07	51.5	13.3	< 0.03	29.7	13.7	57.5
VC_CPT_15 150-165cm	5.72	0.07	44.3	13.5	< 0.03	25.3	14.4	55.5
VC_CPT_15 200-215cm	8.45	0.09	35.8	13.2	< 0.03	18.7	9.9	42.9
VC_CPT_15 250-265cm	7.78	0.09	40.0	14.1	< 0.03	20.8	10.9	48.8
VC_CPT_15 300-315cm	5.45	0.04	23.6	7.2	< 0.03	12.3	7.0	27.5
VC_CPT_15 350-365cm	7.16	0.07	39.1	11.8	< 0.03	20.5	10.3	44.3
VC_CPT_15 400-415cm	8.37	0.08	42.3	13.9	< 0.03	22.1	10.9	48.8
VC_CPT_15 450-465cm	6.58	0.08	33.2	9.9	< 0.03	18.6	11.4	40.8
VC_CPT_15 500-515cm	6.83	0.06	26.9	7.7	< 0.03	15.1	9.7	32.0
VC_CPT_19 0-15cm	2.70	0.06	10.3	1.7	< 0.03	5.7	3.6	9.7
VC_CPT_19 50-65cm	3.98	0.09	15.2	2.3	< 0.03	8.6	3.2	13.2
VC_CPT_19 100-115cm	6.80	0.08	33.6	10.8	< 0.03	18.3	9.0	40.1
VC_CPT_19 150-165cm	7.57	0.07	39.4	13.1	< 0.03	21.0	10.7	46.5
VC_CPT_19 200-215cm	5.88	0.08	32.2	10.4	< 0.03	16.4	8.2	35.9
VC_CPT_19 250-265cm	7.05	0.08	31.6	10.1	< 0.03	17.4	8.1	36.5
VC_CPT_19 300-315cm	7.84	0.13	34.0	11.6	< 0.03	18.3	9.0	40.3
VC_CPT_19 350-365cm	5.23	0.07	22.9	7.3	< 0.03	12.1	6.0	26.5
VC_CPT_19 400-415cm	2.63	0.04	8.67	2.0	< 0.03	4.0	2.1	9.1
VC_CPT_19 450-465cm	5.15	0.05	24.9	6.8	< 0.03	19.3	6.4	27.0
VC_CPT_19 500-515cm	4.82	0.05	26.1	8.4	< 0.03	13.8	7.0	30.5
VC_CPT_19 550-565cm	5.21	0.06	24.1	7.5	< 0.03	12.3	6.5	27.9
VC_CPT_20a 0-15cm	2.06	0.04	12.8	2.2	< 0.03	6.8	4.4	12.7
VC_CPT_20a 50-65cm	3.66	0.08	16.3	2.9	< 0.03	9.3	3.9	15.5
VC_CPT_20a 100-115cm	6.04	0.05	32.3	10.2	< 0.03	17.4	10.4	40.0
VC_CPT_20a 150-165cm	5.88	0.05	35.0	11.1	< 0.03	18.3	9.9	40.9

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC_CPT_20a 200-215cm	6.87	0.07	43.8	14.3	< 0.03	23.5	12.3	50.8
VC_CPT_20a 250-265cm	7.15	0.08	35.3	11.6	< 0.03	18.8	9.6	40.1
VC_CPT_20a 300-315cm	6.35	0.07	35.8	10.8	< 0.03	18.8	9.8	40.4
Minimum	**2.06**	**0.01**	**3.05**	**0.50**	**< 0.03**	**1.00**	**1.30**	**2.70**
Maximum	**21.6**	**0.19**	**55.4**	**17.7**	**< 0.03**	**29.7**	**14.8**	**63.6**
Median	**7.06**	**0.07**	**36.7**	**11.4**	**-**	**19.1**	**9.9**	**43.1**
Mean	**6.67**	**0.07**	**32.2**	**9.55**	**-**	**16.9**	**8.8**	**36.6**
SD	**2.66**	**0.028**	**13.6**	**4.83**	**-**	**7.41**	**3.49**	**16.3**
RSD	**40**	**38**	**42**	**51**	**-**	**44**	**40**	**44**
Marine Scotland Guideline Action Levels								
AL1	**20**	**0.4**	**50**	**30**	**0.25**	**30**	**50**	**130**
AL2	**70**	**4**	**370**	**300**	**1.5**	**150**	**400**	**600**

Notes
Concentrations expressed in µg/g dry sediment
As = Arsenic; Cd = Cadmium; Cr = Chromium
Cu = Copper; Hg = Mercury; Ni = Nickel
Pb = Lead; Zn = Zinc; SD = Standard deviation
AL1 = Action level 1; AL2 = Action level 2; RSD = Relative Standard Deviation

Key	Below AL1 value	Above AL1 value	Above AL2 value

4.2.3 Sediment Polychlorinated Biphenyls

4.2.3.1 Grab samples

Table 4.7 summarises the concentrations of PCBs in the sediment samples.

The sum of the 7 congeners was below the Marine Scotland Guideline AL1 (20 ng/g) at all stations.

Table 4.7: Summary of polychlorinated biphenyls (PCBs) analysis for the grab samples

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
A2	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A3	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A7	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A12	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A13	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A17	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A19	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A20_a	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A21	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A22	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
A25	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A26	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A30	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A33	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A36	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
A40_a	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B2	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B5	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B9	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B10	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B12	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B14	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B17	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B23	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B25	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B26	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B28	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B30	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B35	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
B39_a	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
Minimum	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.140**
Maximum	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.140**
Median	-	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	-	-
SD	-	-	-	-	-	-	-	-
RSD	-	-	-	-	-	-	-	-
Marine Scotland Guideline Action Levels								
AL1	-	-	-	-	-	-	-	20
AL2	-	-	-	-	-	-	-	180

Notes
Concentrations expressed in ng/g dry weight
SD = Standard deviation
AL1 = Action Level 1
AL2 = Action Level 2

Key	**Below AL1 value**	**Above AL1 value**	**Above AL2 value**

4.2.3.2 Core samples

Table 4.8 summarises the concentrations of PCBs in the core sections.

The sum of the 7 congeners was below the Marine Scotland Guideline AL1 (20 µg/g) at all stations

Table 4.8: Summary of polychlorinated biphenyls (PCBs) analysis for the core samples

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
VC_CPT_01a 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_01a 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_01a 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_01a 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_01a 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_01a 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_04 500-515cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
VC_CPT_04 550-565cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_06 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 500-515cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_09 550-565cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
VC_CPT_10a 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 500-515cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_10a 550-565cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_13 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
VC_CPT_14a 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_14a 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 0-15cm	0.055	0.027	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.182
VC_CPT_15 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 100-115	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_15 500-515cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
VC_CPT_19 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 350-365cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 400-415cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 450-465cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 500-515cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_19 550-565cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 0-15cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 50-65cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 100-115cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 150-165cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 200-215cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 250-265cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
VC_CPT_20a 300-315cm	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.140
Minimum	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.140**
Maximum	**0.055**	**0.027**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.020**	**< 0.140**
Median	-	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	-	-
SD	-	-	-	-	-	-	-	-
RSD	-	-	-	-	-	-	-	-
Marine Scotland Guideline Action Levels								
AL1	-	-	-	-	-	-	-	**20**
AL2	-	-	-	-	-	-	-	**180**
Notes Concentrations expressed in ng/g dry weight								

Station	PCB - 028	PCB - 052	PCB - 101	PCB - 118	PCB - 138	PCB - 153	PCB - 180	Total ICES 7 PCBs
SD = Standard deviation AL1 = Action Level 1 AL2 = Action Level 2								

Key	Below AL1 value	Above AL1 value	Above AL2 value

4.2.4 Sediment Organotins

4.2.4.1 Grab samples

Table 4.9 summarises the concentrations of organotins in the sediment samples.

The organotins analysed included dibutyltin (DBT) and tributyltin (TBT). All concentrations were below the Marine Scotland AL1 value (100 ng/g).

Table 4.9: Summary of organotins analysis for the grab samples

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
A2	< 0.400	< 0.400
A3	< 0.400	< 0.400
A7	< 0.400	< 0.400
A12	< 0.400	< 0.400
A13	< 0.400	< 0.400
A17	< 0.400	< 0.400
A19	< 0.400	< 0.400
A20_a	< 0.400	< 0.400
A21	< 0.400	< 0.400
A22	< 0.400	< 0.400
A25	< 0.400	< 0.400
A26	< 0.400	< 0.400
A30	< 0.400	< 0.400
A33	< 0.400	< 0.400
A36	< 0.400	< 0.400
A40_a	< 0.400	< 0.400
B2	< 0.400	< 0.400
B5	< 0.400	< 0.400
B9	< 0.400	< 0.400
B10	< 0.400	< 0.400
B12	< 0.400	< 0.400
B14	< 0.400	< 0.400
B17	< 0.400	< 0.400
B23	< 0.400	< 0.400

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
B25	< 0.400	< 0.400
B26	< 0.400	< 0.400
B28	< 0.400	< 0.400
B30	< 0.400	< 0.400
B35	< 0.400	< 0.400
B39_a	< 0.400	< 0.400
Minimum	**< 0.400**	**< 0.400**
Maximum	**< 0.400**	**< 0.400**
Median	-	-
Mean	-	-
SD	-	-
RSD	-	-
Marine Scotland Guideline Action Levels		
AL1	**100**	**100**
Notes Concentrations expressed as ng/g dry weight (as cation) SD = Standard Deviation AL1 = Action Level 1		
Key	**Below AL1 value**	**Above AL1 value**

4.2.4.2 Core samples

Table 4.10 summarises the concentrations of organotins in the core sections.

The organotins analysed included dibutyltin (DBT) and tributyltin (TBT). All concentrations were below the Marine Scotland AL1 value (100 ng/g).

Table 4.10: Summary of organotins analysis for the core samples

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
VC_CPT_01a 0-15cm	< 0.400	< 0.400
VC_CPT_01a 50-65cm	< 0.400	< 0.400
VC_CPT_01a 100-115cm	< 0.400	< 0.400
VC_CPT_01a 150-165cm	< 0.400	< 0.400
VC_CPT_01a 200-215cm	< 0.400	< 0.400
VC_CPT_01a 250-265cm	< 0.400	< 0.400
VC_CPT_04 0-15cm	< 0.400	< 0.400
VC_CPT_04 50-65cm	< 0.400	< 0.400
VC_CPT_04 100-115cm	< 0.400	< 0.400
VC_CPT_04 150-165cm	< 0.400	< 0.400
VC_CPT_04 200-215cm	< 0.400	< 0.400
VC_CPT_04 250-265cm	< 0.400	< 0.400

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
VC_CPT_04 300-315cm	< 0.400	< 0.400
VC_CPT_04 350-365cm	< 0.400	< 0.400
VC_CPT_04 400-415cm	< 0.400	< 0.400
VC_CPT_04 450-465cm	< 0.400	< 0.400
VC_CPT_04 500-515cm	< 0.400	< 0.400
VC_CPT_04 550-565cm	< 0.400	< 0.400
VC_CPT_06 0-15cm	< 0.400	< 0.400
VC_CPT_06 50-65cm	< 0.400	< 0.400
VC_CPT_06 100-115cm	< 0.400	< 0.400
VC_CPT_06 150-165cm	< 0.400	< 0.400
VC_CPT_06 200-215cm	< 0.400	< 0.400
VC_CPT_06 250-265cm	< 0.400	< 0.400
VC_CPT_09 0-15cm	< 0.400	< 0.400
VC_CPT_09 50-65cm	< 0.400	< 0.400
VC_CPT_09 100-115cm	< 0.400	< 0.400
VC_CPT_09 150-165cm	< 0.400	< 0.400
VC_CPT_09 200-215cm	< 0.400	< 0.400
VC_CPT_09 250-265cm	< 0.400	< 0.400
VC_CPT_09 300-315cm	< 0.400	< 0.400
VC_CPT_09 350-365cm	< 0.400	< 0.400
VC_CPT_09 400-415cm	< 0.400	< 0.400
VC_CPT_09 450-465cm	< 0.400	< 0.400
VC_CPT_09 500-515cm	< 0.400	< 0.400
VC_CPT_09 550-565cm	< 0.400	< 0.400
VC_CPT_10a 0-15cm	< 0.400	< 0.400
VC_CPT_10a 50-65cm	< 0.400	< 0.400
VC_CPT_10a 100-115cm	< 0.400	< 0.400
VC_CPT_10a 150-165cm	< 0.400	< 0.400
VC_CPT_10a 200-215cm	< 0.400	< 0.400
VC_CPT_10a 250-265cm	< 0.400	< 0.400
VC_CPT_10a 300-315cm	< 0.400	< 0.400
VC_CPT_10a 350-365cm	< 0.400	< 0.400
VC_CPT_10a 400-415cm	< 0.400	< 0.400
VC_CPT_10a 450-465cm	< 0.400	< 0.400
VC_CPT_10a 500-515cm	< 0.400	< 0.400
VC_CPT_10a 550-565cm	< 0.400	< 0.400
VC_CPT_13 0-15cm	< 0.400	< 0.400
VC_CPT_13 50-65cm	< 0.400	< 0.400
VC_CPT_13 100-115cm	< 0.400	< 0.400

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
VC_CPT_13 150-165cm	< 0.400	< 0.400
VC_CPT_13 200-215cm	< 0.400	< 0.400
VC_CPT_13 250-265cm	< 0.400	< 0.400
VC_CPT_13 300-315cm	< 0.400	< 0.400
VC_CPT_13 350-365cm	< 0.400	< 0.400
VC_CPT_13 400-415cm	< 0.400	< 0.400
VC_CPT_13 450-465cm	< 0.400	< 0.400
VC_CPT_14a 0-15cm	< 0.400	< 0.400
VC_CPT_14a 50-65cm	< 0.400	< 0.400
VC_CPT_14a 100-115cm	< 0.400	< 0.400
VC_CPT_14a 150-165cm	< 0.400	< 0.400
VC_CPT_14a 200-215cm	< 0.400	< 0.400
VC_CPT_14a 250-265cm	< 0.400	< 0.400
VC_CPT_14a 300-315cm	< 0.400	< 0.400
VC_CPT_15 0-15cm	< 0.400	< 0.400
VC_CPT_15 50-65cm	< 0.400	< 0.400
VC_CPT_15 100-115	< 0.400	< 0.400
VC_CPT_15 150-165cm	< 0.400	< 0.400
VC_CPT_15 200-215cm	< 0.400	< 0.400
VC_CPT_15 250-265cm	< 0.400	< 0.400
VC_CPT_15 300-315cm	< 0.400	< 0.400
VC_CPT_15 350-365cm	< 0.400	< 0.400
VC_CPT_15 400-415cm	< 0.400	< 0.400
VC_CPT_15 450-465cm	< 0.400	< 0.400
VC_CPT_15 500-515cm	< 0.400	< 0.400
VC_CPT_19 0-15cm	< 0.400	< 0.400
VC_CPT_19 50-65cm	< 0.400	< 0.400
VC_CPT_19 100-115cm	< 0.400	< 0.400
VC_CPT_19 150-165cm	< 0.400	< 0.400
VC_CPT_19 200-215cm	< 0.400	< 0.400
VC_CPT_19 250-265cm	< 0.400	< 0.400
VC_CPT_19 300-315cm	< 0.400	< 0.400
VC_CPT_19 350-365cm	< 0.400	< 0.400
VC_CPT_19 400-415cm	< 0.400	< 0.400
VC_CPT_19 450-465cm	< 0.400	< 0.400
VC_CPT_19 500-515cm	< 0.400	< 0.400
VC_CPT_19 550-565cm	< 0.400	< 0.400
VC_CPT_20a 0-15cm	< 0.400	< 0.400
VC_CPT_20a 50-65cm	< 0.400	< 0.400

Station	Dibutyl Tin (DBT)	Tributyl Tin (TBT)
VC_CPT_20a 100-115cm	< 0.400	< 0.400
VC_CPT_20a 150-165cm	< 0.400	< 0.400
VC_CPT_20a 200-215cm	< 0.400	< 0.400
VC_CPT_20a 250-265cm	< 0.400	< 0.400
VC_CPT_20a 300-315cm	< 0.400	< 0.400
Minimum	**< 0.400**	**< 0.400**
Maximum	**< 0.400**	**< 0.400**
Median	-	-
Mean	-	-
SD	-	-
RSD	-	-
Marine Scotland Guideline Action Levels		
AL1	**100**	**100**
Notes Concentrations expressed as ng/g dry weight (as cation) SD = Standard Deviation AL1 = Action Level 1 AL2 = Action Level 2		
Key	**Below AL1 value**	**Above AL1 value**

5. Discussion

5.1 Sediment Chemistry

5.1.1 Sediment Hydrocarbons

5.1.1.1 Aromatic Hydrocarbons

PAHs are widely spread in the environment (Butler et al., 1984) with natural sources occurring primarily through synthesis by plants (Neff, 1979; Sims & Overcash, 1983), related to natural seeps of petroleum (NRC, 1983; Kennicutt et al., 1988) and to formation during natural forest and prairie fires (Youngblood & Blumer, 1975; Wakeham et al., 1980). By far the greatest proportion of PAHs released into the environment are formed during fossil fuel combustion and man made forest and agricultural fires (Edwards, 1983; Sims & Overcash, 1983; Haritash & Kaushik, 2009). PAHs primarily enter marine sediments from atmospheric and riverine inputs and tend to adsorb to suspended inorganic and organic particulate matter, ultimately settling on the seafloor where they accumulate to relatively high concentrations (Latimer & Zheng, 2003; Culotta et al., 2006).

Monitoring of aromatic hydrocarbon type and content is important due to the particularly toxic nature (mutagenic/carcinogenic) of several PAHs, particularly the heavier weight PAHs. The US EPA has identified 16 priority PAHs to be monitored (Keith, 2014) and the CEMP specifies 9 PAHs of specific concern (OSPAR, 2014), which primarily reflect inputs from man-made combustion sources.

PAH concentrations across the survey area were below the Marine Scotland guideline action level (AL1) and therefore not considered to be detrimental to the marine environment.

5.1.2 Sediment Metals

Metals and metalloids occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others have no biological function and therefore are toxic to numerous organisms at certain levels (Paez-Osuna & Ruiz-Fernandez, 1995; Boening, 1999). Metals can enter the environment via natural methods such as riverine transport, coastal discharges, geological weathering and atmospheric fallout (Brady et al., 2015). Other routes into marine sediments are from anthropogenic activities such as direct discharges from industrial activities.

Trace metal contaminants in the marine environment tend to form associations with the non-residual phases of mineral matter, such as iron and manganese oxides and hydroxides, metal sulphides, clays, organics and carbonates (Warren & Zimmerman, 1993; Dang et al., 2015; Wang et al., 2015). Non-residual trace metals are associated with more reactive and available sediment components through processes such as adsorption onto mineral surfaces and organic complexation. Metals associated with these more reactive phases are prone to various environmental interactions and transformations (physical, chemical and biological) potentially increasing their mobility and biological availability (Tessier et al., 1979;

Warren & Zimmerman, 1993; Du Laing et al., 2009). Residual trace metals are defined as those that are part of the crystal structure of the component minerals and are generally unavailable to organisms (de Orte et al., 2018). Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish the more mobile non-residual trace metals from the residual metals held tightly in the sediment lattice (Chester & Voutsinou, 1981), which are of comparatively lesser environmental significance because of their low reactivity and availability.

In this study, an analytical procedure involving the digestion of sediment in aqua regia was employed to analyse the elemental content of the sediments. The aqua regia digest releases for analysis the 'non-residual' heavy metals, which are not incorporated in the mineral matrix and are therefore potentially available for biological uptake.

The bioavailable metals concentrations in the grab samples were below the respective Marine Scotland guideline action levels (AL1 and AL2) and are therefore not considered to be of ecological concern.

In the core samples, arsenic and copper concentrations exceeded the respective Marine Scotland guideline action levels (AL1) in one sample and five samples, respectively. All values were below the AL2 value.

5.1.3 Sediment Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are industrial chemicals used in electrical equipment. They are manufactured by reacting chlorine with biphenyl resulting in the formation of a complex mixture of compounds (known as congeners). The properties of the final product are modified by varying the proportion of chlorine to biphenyl present. In environmental samples PCBs are therefore present as technical mixtures rather than individual compounds. Polychlorinated biphenyls have entered the marine environment by leakage, discharge, recycling, transboundary influx via major rivers and long-range atmospheric transport (Van Wezel et al., 2000). Although the use of PCBs has been banned for many years, they can persist in marine sediments owing to their resistance to degradation (Geyer et al., 1984).

The PCBs analysed in this study were all below their respective MRVs, with the total concentration of all PCBs below the Marine Scotland guideline action levels (AL1 and AL2) for both the core and grab samples.

5.1.4 Sediment Organotins

Organotin compounds have historically been used in marine antifouling products, however their use is now prohibited. Environmental monitoring conducted in the vicinity of locations where vessel maintenance was conducted identified a link between these compounds and the disruption of the reproductive capabilities of a number of gastropod species, leading to these compounds being gradually phased out of use during the 1980s and 1990s.

Since 2003, monitoring of imposex and related effects of TBT in marine snails in OSPAR Regions I, II, III and IV has been undertaken regularly. Although the overall status is improving, marine snails still show pollution effects from TBT over the large parts of the OSPAR area, especially Regions II, III and IV (OSPAR, 2014).

The environmental persistence and fate of TBT is correlated to the specific characteristics of the aquatic ecosystem such as temperature, salinity, pH, suspended matter, microbial populations, flushing rates, etc. Distribution of TBT among the different environmental compartments is regulated by biological, chemical and physical mechanisms. TBT undergoes degradation to DBT, monobutyltin (MBT) and ultimately inorganic tin in the marine environment through processes such as microbial and UV degradation becoming progressively less toxic in the process. TBT is broken down very slowly in sediments, particularly those with low oxygen content where persistence is estimated at tens of decades (Dowson et al., 1996; Gadd, 2000). Since toxicity of the organotins is maximal for the tri-substituted compounds, degradation can essentially be considered a mechanism of detoxification (OSPAR, 2005).

The organotin compounds analysed in this study, specifically DBT and TBT, had concentrations below the Marine Scotland ALs across the survey area and were therefore not considered to be of ecological concern.

5.1.5 Limitations and uncertainties

The data provided in this report represent seafloor conditions at the time of sampling only and may change as the result of depositional/erosional processes that can occur on a range of temporal scales. The principal transport pathway by which contaminants enter the benthic environment is by deposition along with fine sediments and, as such, remobilisation and subsequent deposition processes are a major source of natural variation in benthic contaminant levels. As these processes are likely to change over time, this introduces some uncertainty regarding the long-term validity of the data presented in this report. However, the water depths present at the survey area are likely to result in lower remobilisation rates than the more hydrodynamic shallower areas of the North Sea.

Although the number and location of physico-chemical sampling points was designed to identify the range of contaminants within the NE7 survey area, it is possible that not all spatial variation in the contaminant concentrations has been captured by the sampling plan. Consequently, there may be locations within the survey area where contaminant levels fall outside of the ranges provided within this report.

A further source of uncertainty in the reported data relates to the sampling and subsampling methodologies utilised (sampling bias). To characterise a station, a single bulk sample (grab samples or vibrocores) were acquired, and these were then subsampled to obtain appropriate quantities of material for analysis. Although rigorous QC procedures were followed for all sampling and subsampling, it is possible that not all subsamples analysed were typical of the locality from which they were collected. Further sampling bias was minimised during the analytical process by either analysing subsamples in their entirety, or by homogenising the sediment prior to further subsampling.

6. Conclusions

The aim of this report has been to evaluate the presence of contaminants in the marine environment within the survey area. A review of the environmental data in context with estimated sediment effects threshold values (Marine Scotland, 2017) was also undertaken. Based on the overall assessment of the survey area, the following key conclusions can be stated:

The concentrations of the PAHs analysed were below the Marine Scotland guideline AL1 across the survey area.

The bioavailable metals concentrations in the grab samples were below the respective Marine Scotland guideline action levels (AL1 and AL2) and are therefore not considered to be of ecological concern.

In the core samples, the Marine Scotland guideline action levels (AL1) were exceeded for arsenic in one sample and chromium in five samples.

The sum of the 7 congeners was below the Marine Scotland Guideline AL1 (14 ng/g) in all grab and core samples.

The organotins analysed were DBT and TBT, all having concentrations below the Marine Scotland AL1 value.

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Appendices

Appendix A

Guidelines on Use of Report

Click icon to open the guidelines.

Appendix A
Guidelines

Appendix B

Methodologies

B.1 Survey Methodology

Click icon to open the survey methods.

Appendix B.1
Survey Methods

B.2 Laboratory Analysis

Click icon to open the laboratory analysis methods.

Appendix B.2
Laboratory Analysis

Appendix C

Logs

C.1 Survey Log

Click icon to open the completed logs.

Appendix C1.1 Survey Log Galaxy

Appendix C1.2 Survey Log Venturer

C.2 Grab Log

Click icon to open the completed log.

Appendix C2.1 Grab Log Galaxy

Appendix C2.2 Grab Log Venturer

Appendix D

Sediment Hydrocarbon Analysis

D.1 Aromatic Hydrocarbon Concentrations

D.1.1 Total 2 to 6 Ring PAH Concentrations

Click icon to open the Total 2 to 6 Ring PAH concentrations.

Appendix D.1.1 PAH Grabs

Appendix D.1.1 PAH Cores

MarramWind