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EIAR Volume 4: Offshore Infrastructure Technical Appendices

Appendix 4.3.3-2

Marine Intertidal Ecological Survey, Shanganagh & Poolbeg, Co. Dublin

Kish Offshore Wind Ltd

RWE SLR GoBe APEM Group

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Marine Intertidal Ecological Survey,
Shanganagh & Poolbeg,
Co. Dublin

Produced by

AQUAFACT International Services Ltd

On behalf of

Kish Offshore Wind Ltd & Bray Offshore Wind Ltd

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AQUAFACT

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1. Introduction

AQUAFACT International Services Ltd. was commissioned by Kish Offshore Wind Ltd. and Bray Offshore Wind Ltd. to carry out a marine intertidal ecological assessment at Shanganagh and Poolbeg, Co. Dublin for the Dublin Array Offshore Wind Farm. Two locations at Shanganagh and one location at Poolbeg were investigated as proposed land fall locations for the Dublin Array. This work was required to provide a robust baseline characterisation of the sites and to supplement the existing ecological data that exists across the area of interest. An area around the Dublin Array and its proposed land fall route was originally surveyed in 2002 and re-characterised in 2008. AQUAFACT was subsequently contracted in 2017 to carry out a further characterisation of a new proposed land fall route on the southern extent of the Shanganagh/Shankill Beach. Since then, a further two land fall routes (one at Poolbeg and one at the northern extent of the Shanganagh/Shankill Beach) have been proposed. A re-visit to the 2017 Shanganagh landfall as well as a full characterisation of the 2 new land fall locations is the focus of this report.

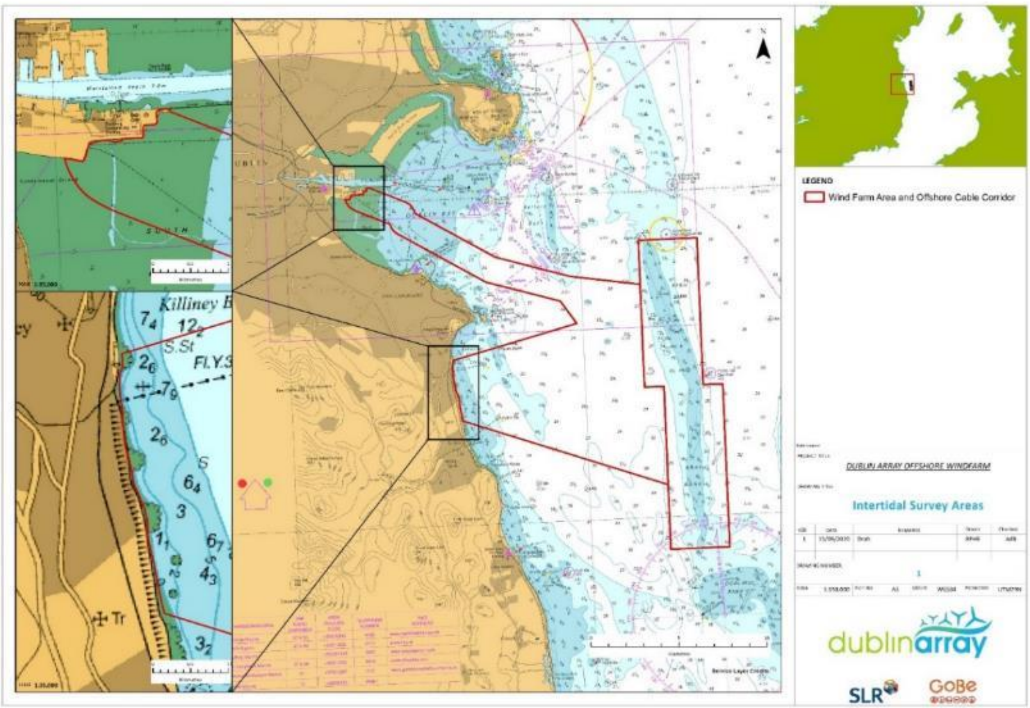

Figure 1.1: Location of study areas, Poolbeg and Shanganagh, Co. Dublin.

2. Materials & Methods

2.1. Intertidal Survey Methodology

A characterisation survey of the species and biotopes in the intertidal area of the proposed cable routes and landfall sites was carried out between the 30th March and April 1st 2021 during low spring tide to ensure maximum exposure of the intertidal area. Walkover surveys of each area were conducted prior to the intertidal transect surveys. Low water on the day of the Shanganagh walkover survey (30th March) was at 6:43am and water height at low water was 0.2m; sunrise was at 7.03am. The Poolbeg walkover survey was carried out on April 1st. Low water for this walkover was at 8.12am and water height at low water was 0.33m; sunrise was at 06.58am. The Poolbeg survey area is located in the South Dublin Bay and River Tolka Estuary SPA. There was a commitment made within Foreshore Licence Application FS007029 that surveys within this SPA should be carried out outside the over-wintering bird season (September to March inclusive) after all over-wintering birds have left and prior to the arrival of species for the new over-wintering season. The April 1st walkover and transect surveys at Poolbeg took place outside of this restricted period and a shore bird survey was conducted on 31st March and on morning of April 1st to detect presence of any over-wintering birds prior to commencement of the Poolbeg intertidal survey. None were observed and the decision to proceed was taken.

The walkover surveys were carried out to mean low water in order to derive information on the following – biotope composition, biotope distribution, the extent of sub-features, conservation features and zonation of the shoreline. In addition, any impacts from human activities were target noted and assessed, such as the presence of sewage and other anthropogenic impacts. During the walkover survey, any observations that appeared to be related to ongoing change to the littoral habitat were also recorded. This included erosion/encroachment of embryonic marram dunes, invasive species, localised erosion and sediment accretion. Habitat and biotope boundaries were mapped and detailed records of biotope, sediment character and taxa were made.

Four intertidal transects were surveyed along the path of the proposed cable routes, two transects in the Shanganagh area (Fig 2.1) and two in the Poolbeg area (Fig. 2.2). Along each transect a $0.25m^2$ quadrat was used to survey in the upper, mid and lower shore regions.

Two replicate 15cm diameter cores to a depth of 25cm (where substrata allowed) were also collected along the transect in the upper, mid and lower shore and analysed for infauna. Additional sediment samples were taken at each shore hight for sediment granulometry and sediment chemistry.

The locations of each faunal core sample and sediment sample are presented in Table 2.1 below.

Table 2.1: Coordinates of stations sampled at Shanganagh and Poolbeg for faunal cores and sediment physical and chemical analysis.

Station	Latitude	Longitude
SH1 Upper	53.24366	-6.11228
SH1 Mid	53.24373	-6.11169
SH1 Lower	53.24378	-6.11138
SH2 Upper	53.2286	-6.10821
SH2 Mid	53.2286	-6.10788
SH2 Lower	53.22855	-6.10765
PB1 Upper	53.33625	-6.18748
PB1 Mid	53.33386	-6.18039
PB1 Lower	53.33124	-6.1709
PB2 Upper	53.3364	-6.18601
PB2 Mid	53.3346	-6.17983
PB2 Lower	53.3321	-6.17066

Figure 2.1: Locations of Shanganagh Transects 1 and 2.

Figure 2.2: Locations of Poolbeg Transects 1 and 2.

The samples collected for faunal analysis were carefully and gently sieved on a 1mm mesh sieve as a sediment water suspension for the retention of fauna. Great care was taken during the sieving process in order to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods. The sample residue was carefully flushed into a pre-labelled (internally and externally) container from below. Each label contained the sample code and date. The samples were stained with Eosin-briebrich scarlet and fixed in 4% w/v buffered formaldehyde solution upon returning to the laboratory.

For processing, each faunal core sample was washed of formalin and placed in an illuminated shallow white tray and sorted first by eye to remove large specimens and then sorted under a stereo microscope (x 10 magnification). Following the removal of larger specimens, the samples were placed into Petri dishes, approximately one half teaspoon at a time and sorted using a binocular microscope at x25 magnification.

The fauna was sorted into four main groups: Polychaeta, Mollusca, Crustacea and others. The 'others' group consisted of echinoderms, nematodes, nemerteans, cnidarians and other lesser phyla. The fauna were maintained in stabilised 70% industrial methylated spirit (IMS) following retrieval and identified to species level where practical using a binocular microscope, a compound microscope and all relevant taxonomic keys. After identification and enumeration, specimens were separated and stored to species level.

2.2. Faunal Data analysis

Uni- and multivariate statistical analysis of the faunal data was undertaken using PRIMER v.6 (Plymouth Routines in Ecological Research).

2.2.1. Univariate Indices

Using PRIMER, the faunal data was used to produce a range of univariate indices. Univariate indices are designed to condense species data in a sample into a single coefficient that provides quantitative estimates of biological variability (Heip *et al*., 1998; Clarke and Warwick, 2001). Univariate indices can be categorised as primary or derived indices.
Primary biological indices used in the current study include:

1. number of taxa (S) in the samples and
2. number of individuals (N) in the samples.

Derived biological indices, which are calculated based on the relative abundance of species in samples, used in the study include:

3. Margalef's species richness index (D) (Margalef, 1958),

$$D = \frac{S - 1}{\log_2 N}$$

where: N is the number of individuals and S is the number of species
Margalef's species richness is a measure of the total number of species present for a given number of individuals.

4. Pielou's Evenness index (J) (Pielou, 1977)

$$J = \frac{H'(\text{observed})}{H'_{max}}$$

where: H'_{max} is the maximum possible diversity, which could be achieved if all species were equally abundant (= $\log_2 S$)

Pielou's evenness is a measure of how evenly the individuals are distributed among different species.

5. Shannon-Wiener diversity index (H') (Pielou, 1977)

$$H' = -\sum_{i=1}^{S} p_i (\log_2 p_i)$$

where: p_I is the proportion of the total count accounted for by the i^{th} taxa

Shannon-Wiener diversity index takes both species abundance and species richness into account to quantify diversity (Shannon & Wiener, 1949).

6. The Shannon-Wiener based Effective Number of Species (ENS) (Hill, 1973; Jost, 2006)

$$H = \exp(H')$$

where H' is the Shannon-Wiener diversity index.

The Shannon-Wiener index diversity index is converted to ENS to reflect 'true diversities' (Hill, 1973, Jost, 2006) that can then be compared across communities (MacArthur, 1965; Jost, 2006). The ENS is equivalent to the number of equally abundant species that would be needed in each sample to give the same value of a diversity index, *i.e.* Shannon-Weiner Diversity index. The ENS behaves as one would intuitively expect when diversity is doubled or halved, while other standard indices of diversity do not (Jost, 2006). If the ENS of one community is twice that of another then it can be said that that community is twice as diverse as the other.

2.2.2. Multivariate Analysis

The PRIMER programme (Clarke & Warwick, 2001) was used to carry out multivariate analyses on the station-by-station faunal data. All species abundance data from the grab surveys was square root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER. The square root transformation allows the intermediate abundant species to play a part in the similarity calculation. Various ordination and clustering techniques can then be applied to the similarity matrix to determine the relationship between the samples.

Multidimensional scaling (MDS) is a technique that ordinates samples as points in 2D or 3D space based on similarity in species distribution data. MDS performed on the Bray-Curtis similarity matrix produce ordination maps whereby the placement of samples reflects the similarity of their biological communities, rather than their simple geographical location (Clarke & Warwick, 2001).

An indication of how well the similarity matrix is represented by the ordination is given by stress values calculated by comparing the interpoint distances in the similarity matrix with the corresponding interpoint distances on the ordinations. Perfect or near perfect matches are rare in field data, especially in the absence of a single overriding forcing factor such as an organic enrichment gradient. Stress values increase, not only with the reducing dimensionality (lack of clear forcing structure), but also with increasing quantity of data (it is a sum of the squares type regression coefficient). Clarke & Warwick (2001) have provided a classification of the reliability of MDS plots based on stress values, having compiled simulation studies of stress value behaviour and archived empirical data. This classification generally holds well for ordinations of the type used in this study. Their classification is given below:

Stress value < 0.05: Excellent representation of the data with no prospect of misinterpretation.

- Stress value < 0.10: Good representation, no real prospect of misinterpretation of overall structure, but very fine detail may be misleading in compact subgroups.
- Stress value < 0.20: This provides a useful picture, but detail may be misinterpreted particularly nearing 0.20.
- Stress value 0.20 to 0.30: This should be viewed with scepticism, particularly in the upper part of the range, and discarded for a small to moderate number of points such as < 50.
- Stress values > 0.30: The data points are close to being randomly distributed in the ordination and not representative of the underlying similarity matrix.

Each stress value must be interpreted both in terms of its absolute value and the number of data points. In the case of this study, the moderate number of data points indicates that the stress value can be interpreted more or less directly. While the above classification is arbitrary, it does provide a framework that has proved effective in this type of analysis.

Hierarchical Agglomerative Clustering (HAC) is used to cluster samples based on between-sample similarities into groups in dendrograms. Similarity Profiling (SIMPROF) is used to test if differences between HAC derived similarity-based clusters are significant. Similarity Percentages (SIMPER) analysis can be used to determine the characterising species of each cluster of stations identified either arbitrarily (by eye) from HAC dendrograms or statistically using SIMPROF testing (Clarke and Warwick, 2001; Clarke and Gorley, 2006; Anderson *et al.*, 2008).

The species, which are responsible for the grouping of samples in CLUSTER analyses, were identified using the PRIMER programme SIMPER (Clarke & Warwick, 1994). This programme determined the percentage contribution of each species to the dissimilarity/similarity within and between each sample group.

2.3. Sediment Analysis

2.3.1. Sampling Procedure

On the 31st March 2021, 6 sediment stations along 2 intertidal transects were sampled at 3 shore heights (upper shore, mid shore and lower shore) on Shanganagh/Shankill Beach for physical and chemical analysis. Subsequently on the 1st April 2021, 6 sediment stations along 2 intertidal transects were sampled at 3 shore heights (upper shore, mid shore and lower shore) on Poolbeg Beach for physical and chemical analysis. The analysis required can be seen in Table 2.2.

Table 2.2: Sediment Determinants.

Determinant	
Total organic carbon	Lead
Granulometry	Arsenic
Density	Cadmium
Mercury	Dibutyltin
Zinc	Tributyltin
Nickel	Lindane
Copper	HCB
Chromium	PCB 7
Aluminum	PAH
Lithium	TEH

Samples were taken in the same locations as the intertidal fauna core samples sampled at Shanganagh and Poolbeg and the locations of the stations are presented in Table 2.1 above. The sediment samples taken at each of the stations was divided as follows:

For Physical sediment analysis by AQUAFACT Ltd.:

1. Into labelled 1l plastic bags for sediment grain size analysis.

For Chemical analysis by SOCOTEC:

2. Into 500ml Plastic tub.
3. Into 2 x 120ml amber glass.

2.3.2. Sample Processing

Once back in the lab., all sediment samples for the analysis of moisture content, organics and contaminants were sent to the SOCOTEC Laboratories in Burton on Trent. AQUAFACT carried out the particle size analysis as described below.

2.3.2.1. Particle Size Analysis (PSA)

AQUAFACT carried out the PSA analysis in-house using the following methodology:

1. Approximately 100g of dried sediment (previously washed in distilled water and dried) was weighed out and placed in a labelled 1L glass beaker to which 100ml of a 6 percent hydrogen peroxide solution was added. This was allowed to stand overnight in a fume hood.
2. The beaker was placed on a hot plate and heated gently. Small quantities of hydrogen peroxide were added to the beaker until there was no further reaction. This peroxide treatment removed any organic material from the sediment which can interfere with grain size determination.
3. The beaker was then emptied of sediment and rinsed into a 63µm sieve. This was then washed with distilled water to remove any residual hydrogen peroxide. The sample retained on the sieve was then carefully washed back into the glass beaker up to a volume of approximately 250ml of distilled water.
4. 10ml of sodium hexametaphosphate solution was added to the beaker and this solution was stirred for ten minutes and then allowed to stand overnight. This treatment helped to dissociate the clay particles from one another.
5. The beaker with the sediment and sodium hexametaphosphate solution was washed and rinsed into a 63µm sieve. The retained sample was carefully washed from the sieve into a labelled aluminium tray and placed in an oven for drying at 100ºC for 24 hours.

6. The dried sediment was then passed through a Wentworth series of analytical sieves (>8,000 to 63µm; single phi units). The weight of material retained in each sieve was weighed and recorded. The material which passed through the 63µm sieve was also weighed and the value added to the value measured in Point 5 (above).
7. The total silt/clay fraction was determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages.
8. The following range of particle sizes: <63µm, 63<125µm, 125<250µm, 250<500µm, 500<1000µm, 1000<2000µm, 2000<4000µm and 4000<8000µm were reported.

Table 2.3 shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes (Table 2.3), were used in the analysis.

Table 2.3: The classification of sediment particle size ranges into size classes (adapted from Buchanan, 1984)

Range of Particle Size	Classification	Phi Unit
<63µm	Silt/Clay	>4 Ø
63-125 µm	Very Fine Sand	4 Ø, 3.5 Ø
125-250 µm	Fine Sand	3 Ø, 2.5 Ø
250-500 µm	Medium Sand	2 Ø, 1.5 Ø
500-1000 µm	Coarse Sand	1 Ø, 1.5 Ø
1000-2000 µm (1 – 2mm)	Very Coarse Sand	0 Ø, -0.5 Ø
2000 – 4000 µm (2 – 4mm)	Very Fine Gravel	-1 Ø, -1.5 Ø
4000 -8000 µm (4 – 8mm)	Fine Gravel	-2 Ø, -2.5 Ø
8 -64 mm	Medium, Coarse & Very Coarse Gravel	-3 Ø to -5.5 Ø
64 – 256 mm	Cobble	-6 Ø to -7.5 Ø
>256 mm	Boulder	< -8 Ø

2.3.2.2. Moisture Content

Moisture content was taken as the percentage weight difference between the wet and dried sediment.

2.3.2.3. *Chemical Analysis*

The following methodologies were employed by SOCOTEC Burton-upon-Trent:

- Total Organic Carbon analysis: carbonate removal and sulphurous acid/combustion at 800°C/NDIR.
- Carbonate content analysis: acid based titration to preset pH.
- Total Hydrocarbons: (GCFID) Documented in-house method using marine specification by GC-FID.
- Organotins: Documented in-house method OGSNSED
- Metal analysis: using HF boric extraction followed by ICPMS (As, Cd, Cu, Pb and Hg) and by ICPOES (Al, Fe, Li, Mn, Cr, Ni, Zn and Ti).
- OCP & PCB analysis: Documented in-house method using GCQQQ.
- PAH analysis: Documented in-house method using DTI specification by GC-MS.

All tests were carried out on the <2mm fraction. The Limits of detection can be seen in Table 2.4

Metals exhibiting toxic effects at elevated concentrations include:

- arsenic
- copper
- cadmium
- chromium
- lead
- mercury
- nickel
- zinc.

The metals lithium, aluminium and manganese are included because their concentrations reflect the natural geochemistry of the area and can help to explain variations in the levels of other metals i.e., they can be used as normalisers. (Cronin *et al.,* 2006).

Table 2.4: Limits of Detection.

Parameter	Unit	LOD
Hydrocarbons	µg/kg	1
Mercury	mg/kg	0.01
Aluminium	mg/kg	10
Iron	mg/kg	10
Arsenic	mg/kg	1
Cadmium	mg/kg	0.1
Chromium	mg/kg	0.5
Copper	mg/kg	2
Lead	mg/kg	2
Lithium	mg/kg	0.5
Nickel	mg/kg	0.5
Zinc	mg/kg	3
OCP	µg/kg	0.1
PAH	µg/kg	1
PCBs	µg/kg	0.08
DBT	µg/kg	1
TBT	µg/kg	1

3. Benthic Intertidal Ecology Results

3.1. Shanganagh

3.1.1. Shanganagh Walkover survey

The Shanganagh walkover survey was conducted by two AQUAFACT ecological surveyors on the morning of the 30th March 2021. The survey area extended from the north end of Hackettsland Bay Beach southwards along Shanganagh Beach and on to Shankill Beach in the south at the Woodbrook Golf club. The total length of the shore surveyed was 3.5km. The boundaries of each biotope identified were mapped using GPS and are presented in Figure 3.1. Figures 3.4 and 3.9 illustrate the biotopes of the northern and southern stretches of Shanganagh/Shankill Beach images of the different biotopes. Table 3.1 list the biotopes encountered during the walkover survey of Shanganagh.

Table 3.1: Biotopes recorded during Shanganagh walkover survey.

JNCC Biotope code	Description
LS.LCS.Sh.BarSh	Barren littoral shingle
LS.LSa.MoSa.BarSa	Barren littoral coarse sand
LS.LSa.MuSa.Lan	*Lanice conchilega* in littoral sand
LS.LSa.FiSa.Po.Aten	Polychaetes and *Angulus tenuis* in littoral fine sand
LR.FLR.Eph.EphX	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweed on moderately exposed lower eulittoral rock
LR.MLR.BF.Fser.R /LR.FLR.Eph.EphX mosaic	A biotope exhibiting elements of both of these biotopes
IR.MIR.KR.Ldig.Bo	*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders

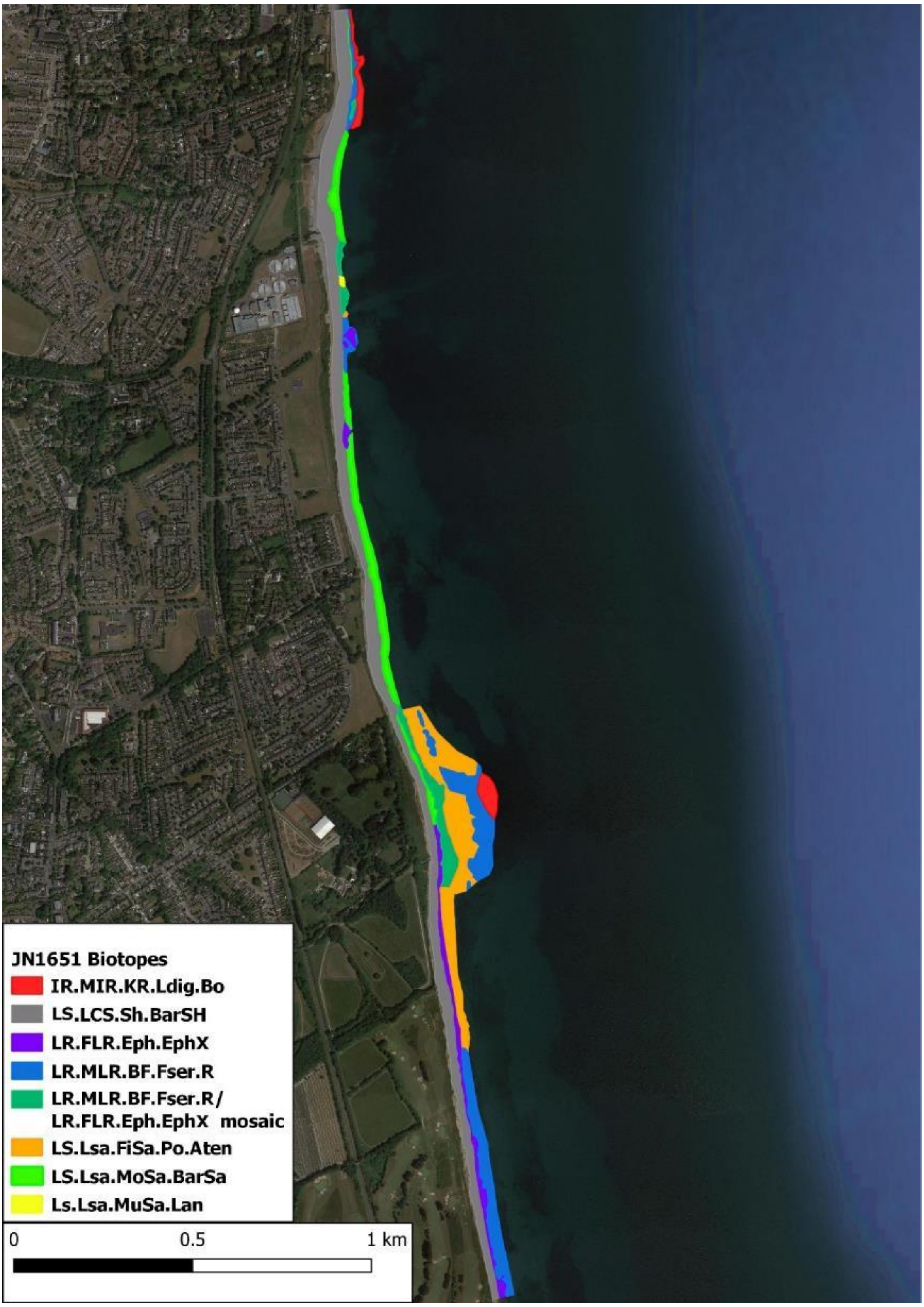

Figure 3.1: Intertidal biotopes recorded on Shanganagh/Shankill Beach on March 30th 2021.

3.1.1.1. Barren Littoral Shingle

The upper shore to the mid shore region is classified as Barren littoral shingle (LS.LCS.Sh.BarSh) and extends the whole length of the beach as illustrated in Figure 3.1 above. In the Hackettsland Bay Beach area to the north of Shanganagh waste water treatment plant the substrate type was cobbles with coarser pebbles in the mid shore. The Shanganagh River enters the sea just to the north of the Shanganagh waste water treatment point and flows over the cobbles. The Barren littoral shingle biotope was backed by the soft clay cliff on the upper shore (which started at the waster water treatment plant and continued to the southern end of the survey area), the sediment type contained a higher proportion of finer material including pebbles, gravel and coarse sand. Figure 3.2 illustrates the nature of this biotope in the Hackettsland Bay Beach area. Sediment type in this biotope was classified according to Folk (1954) as sandy gravel consisting of 42-52% gravel, 42-57% very coarse, coarse, medium and fine sand with little or no very fine sand or silt-clay. As the name indicates this type of shore supports virtually no macrofauna in their very mobile and freely draining substratum.

Figure 3.2: Barren Littoral Shingle biotope in the Hackettsland Bay Beach area north of Shanganagh WWT.

3.1.1.2. Barren Littoral Coarse Sand

This biotope (LS.LSa.MoSa.BarSa) is encountered along much of the northern Shanganagh Beach area just below the Barren Littoral shingle biotope where upper shore merges into the middle to lower shore and the sediment particle size decreases. Like Barren Littoral shingle this biotope supports little or no macrofauna, although dig overs returned small numbers of enchytraeid oligochaetes. Figure 3.3 below illustrates this biotope along the shoreline, photographed when the tide was coming in.

Figure 3.3: Barren Littoral shingle in upper shore merging into Barren Littoral coarse sand in mid to lower shore.

3.1.1.3. Lanice conchilega in littoral sand

This biotope (LS.LSa.MuSa.Lan) was encountered in a small patch in the northern stretch of the Shanganagh Beach. This biotope usually occurs on flats of medium fine sand, most often on the lower shore. It also occurs on the lower part of a predominately rocky or boulder shore where patches of sand occurs between scattered boulders, cobbles and pebbles. This is the case here and boulder and cobbles to the north and south of this small biotope patch affords some shelter from strong wave action. Numbers of *Lanice conchilega* tubes in this area were approximately 15-20/m^2. Figure 3.4 below illustrates this biotope and indicates where it was located.

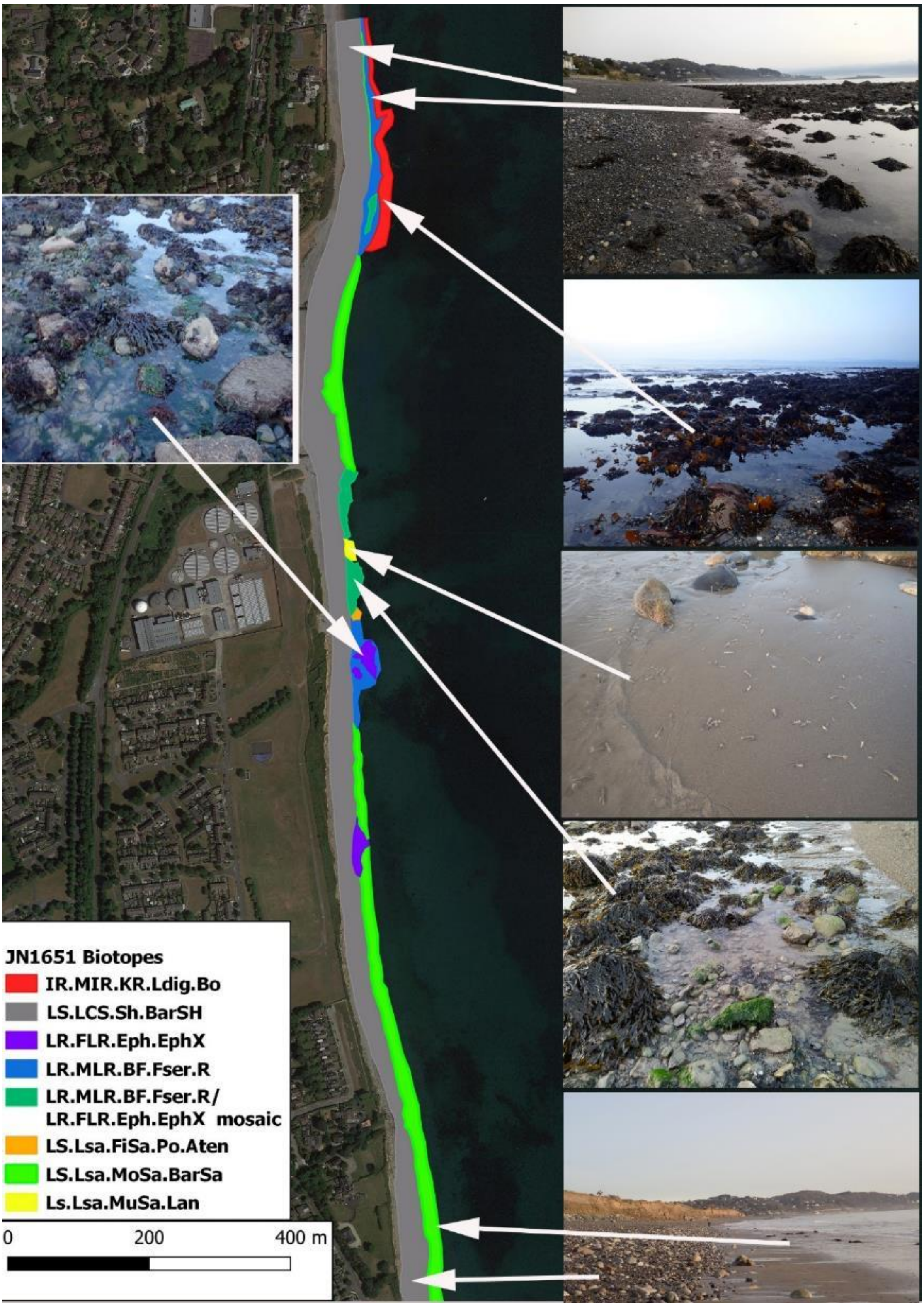

Figure 3.4: Detail of intertidal biotopes in northern extent of Shanganagh/Shankill Beach.

3.1.1.4. *Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata*

This biotope (LR.FLR.Eph.EphX, Figure 3.5) occurs in the mid shore of the Shanganagh/Shankill Beach typically in a narrow band of large boulders and cobbles covered with ephemeral green algae (*Ulva intestinalis* and *Ulva lactuca*), and some *Porphyra umbilicalis* and other red filamentous algae. Boulders have sparse covering of barnacles (*Semibalanus balanoides* and *Austrominius modestus*) and limpets (*Patella vulgata*). This biotope is frequently found merging into the next biotope discussed, *Fucus serratus* and red seaweed on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser.R).

Figure 3.5: Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata biotope, Shanganagh Beach.

3.1.1.5. *Fucus serratus and red seaweed on moderately exposed lower eulittoral rock*

This biotope (LR.MLR.BF.Fser.R) (Figure 3.6) is very common along Shanganagh/Shankill Beach in the lower shore. It typically occurs on moderately exposed lower eulittoral bedrock characterized by mosaics of the wrack *Fucus serratus* and turf-forming red seaweeds including *Osmundea pinnatifida*, *Mastocarpus stellatus* or *Corallina officinalis* (d'Avack & Tyler-Walters, 2015). The distribution of this biotope on Shanganagh/Shankill Beach can be seen in Figures 3.4 and 3.9. It is found in association with boulders and cobbles as well as clay boulders that have been eroded from the cliff face and been colonised by macroalgae in the lower shore (Figure 3.7). Underneath the canopy a number of other red seaweeds were recorded including *Palmaria palmata*, *Lomentaria articulata*, *Ceramium* spp., *Rhodothamniella floridula* and *Delesseria sanguinea*. Green seaweeds recorded include *Cladophora rupestris*, *Ulva intestinalis* and *Ulva lactuca.* The bryozoan *Electra pilosa* was recorded on the fronds of *Fucus serratus.* Other fauna included limpets (*Patella vulgata*), periwinkles (*Littorina obtusata* and *L. saxatilis*), barnacles (*Semibalanus balanoides* and *Austrominius modestus*) and beadlet anemones (*Actinia equina*).

Figure 3.6: *Fucus serratus* in the lower shore, Shanganagh. (LR.MLR.BF.Fser.R biotope).

Figure 3.7: *Fucus serratus* and red seaweed on moderately exposed lower eulittoral rock. On clay boulder in lower shore Shanganagh.

3.1.1.6. Mosaic biotope

Frequently a mosaic of LR.MLR.BF.Fser.R and LR.FLR.Eph.EphX occurred where elements of both biotopes were recorded. This mosaic occurred throughout the length of Shanganagh/Shankill Beach where the substrate was of large boulders and cobbles and the extent of the biotope is illustrated in Figures 3.4 and 3.9.

3.1.1.7. Polychaetes and Angulus tenuis in littoral fine sand

This biotope (LS.LSa.FiSa.Po.Aten) illustrated in Figure 3.5 was recorded in several stretches along the Shanganagh/Shankill Beach. Figure 3.6 illustrates its location in the southern stretch of Shanganagh Beach. It typically occurs in moderately exposed or sheltered beaches of medium and fine, usually clean, sand, though the sediment may on rare occasions contain a small silt and clay fraction. The sediment is relatively stable, remains damp throughout the tidal cycle, and contains little organic matter. The biotope occurs mainly on the lower part of the shore, and relatively frequently on the mid-shore (Ashley, 2016). On Shanganagh/Shankill Beach this biotope primarily occurs in the lower shore below boulders and cobbles of the LR.MLR.BF.Fser.R and LR.FLR.Eph.EphX biotopes. Sediment type in this biotope was classified according to Folk (1954) as sand consisting of 8.4% medium sand and 90.7% fine and very fine sand. Dig overs of this biotope in the northern stretch of Shanganagh Beach where it was located just below the LS.LCS.Sh.BarSh biotope returned sparse *Macomangulus tenuis* (2 individuals/m^2). It is likely that this biotope continues into the subtidal.

Figure 3.8: Polychaetes and *Angulus tenuis* in littoral fine sand biotope, Shanganagh Beach.

3.1.1.8. Laminaria digitata and under-boulder fauna on sublittoral fringe boulders

This biotope (IR.MIR.KR.Ldig.Bo) occurred in the extreme low water and was recorded in two locations along the Shanganagh/Shankill Beach during the walkover survey. The extent of this biotope recorded during the walkover survey can been see in Figures 3.4 and 3.9. This *Laminaria digitata* biotope (Figure 3.10) is found on moderately exposed to sheltered boulder shores. Upper surfaces of the boulders are colonized by dense *Laminaria digitata*, beneath which are a variety of seaweeds including *Mastocarpus stellatus, Chondrus crispus*, *Palmaria palmata, Lomentaria articulata*, *Osmundea pinnatifida, Rhodothamniella floridula,* encrusting red algae, *Cladophora rupestris* and *Ulva intestinalis*. The sugar kelp (*Saccharina latissima*) was occasionally recorded in the northern area of this biotope. Fauna recorded include calcareous tube worms (*Spirobranchus* spp.), porcelain crabs (*Porcellana platycheles*) and shore crabs (*Carcinus maenas*), anemones (*Actinia equina*) and limpets (*Patella vulgata*). In the southern area of this biotope close to the beach access from Quin's Road, a local man, Andrew Beck and his family spotted a live octopus in this kelp biotope. This was likely the curled octopus (*Eldone cirrhosa*) which has been recorded from this area in recent years. It is likely that this biotope continues into the subtidal on suitable rocky substrate.

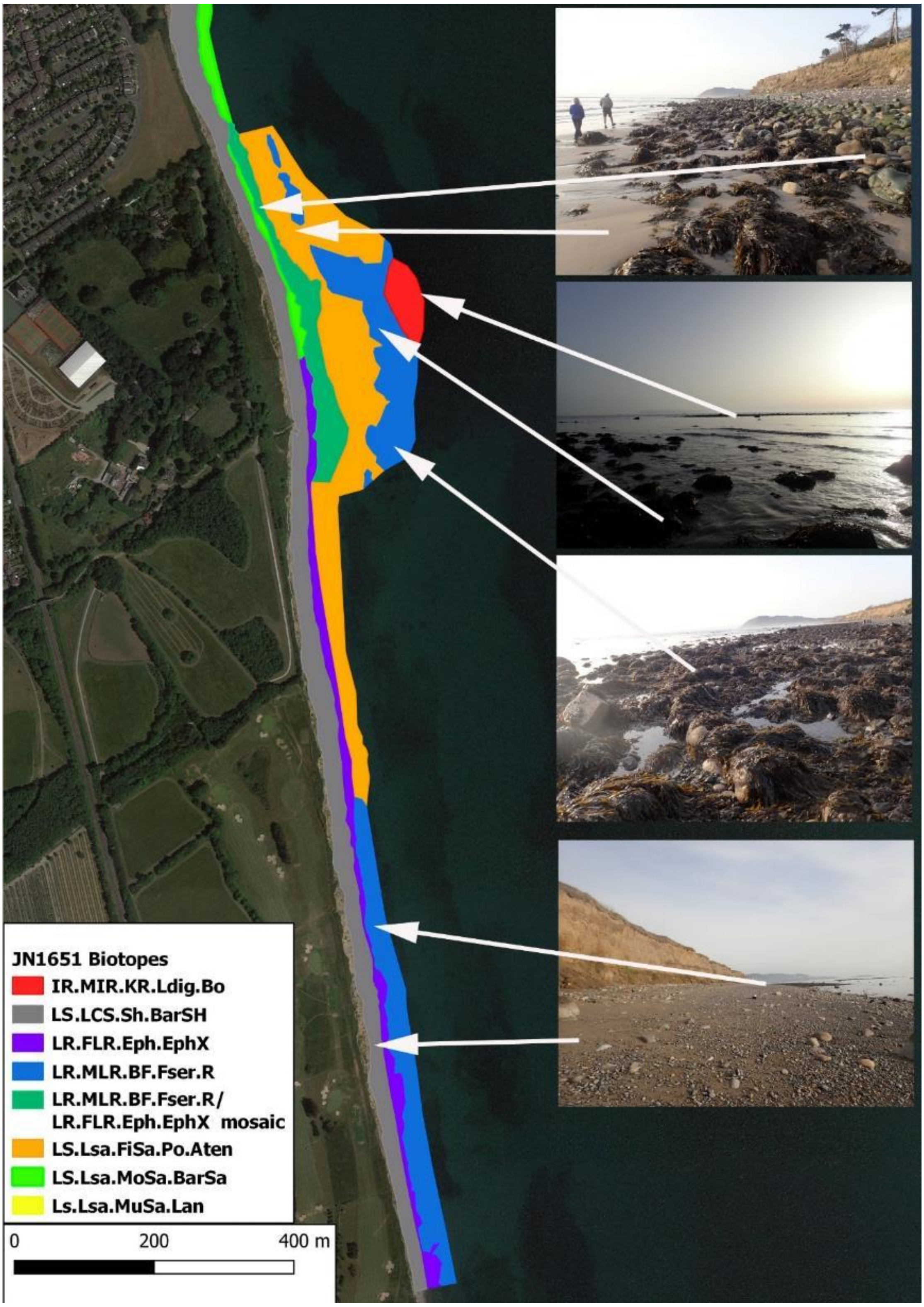

Figure 3.9: Detail of intertidal biotopes in southern extent of Shanganagh/Shankill Beach.

Figure 3.10: *Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders biotope, Shanganagh Beach.

3.1.1.9. Sand martin nest sites.

Over the course of the Shanganagh walkover survey, 3 separate sand martin nest sites were recorded with up to 20 birds in flight into and out of the cliff nests. The cliff face is soft, eroding clay and suited for nest sites. Figure 3.11 illustrates one of these nest sites and the locations are presented in Figure 3.12 below.

Figure 3.11: Sand martin nest site in cliff at Shanganagh/Shankill Beach.

Figure 3.12: Anthropogenic disturbance along Shanganagh/Shankill Beach. Locations of sand martin nest sites also presented.

3.1.1.10. Anthropogenic disturbance

Evidence of anthropogenic disturbance was also recorded during the Shanganagh walkover survey. The locations of these are presented in Figure 3.12 above. They include storm flow discharge pipes (Figure 3.13), drainage pipes exposed by cliff erosion (Figure 3.14), land fill site exposed by cliff erosion, excavation and mounding of beach shingle (Figure 3.15), rock armour coastal protection (Figure 3.16) and beach access steps (Figure 3.17).

Figure 3.13: Storm flow discharge pipe in shore below Shanganagh WWT.

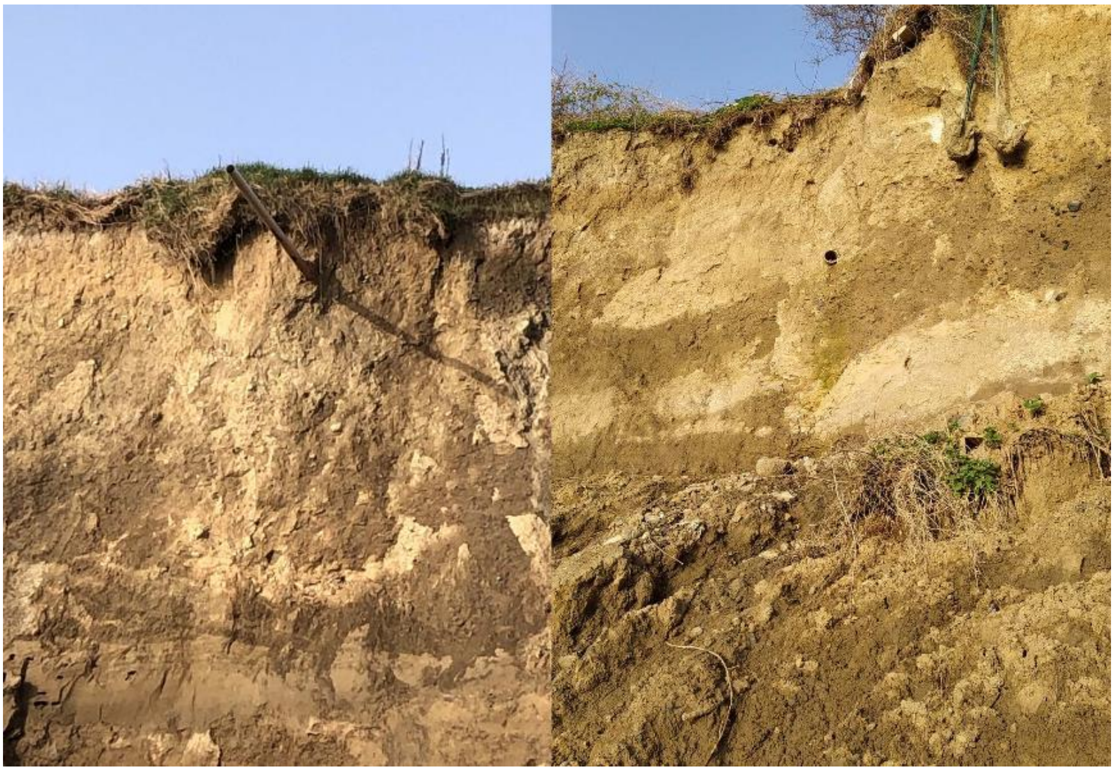

Figure 3.14: Drainage pipes in cliffs exposed by erosion.

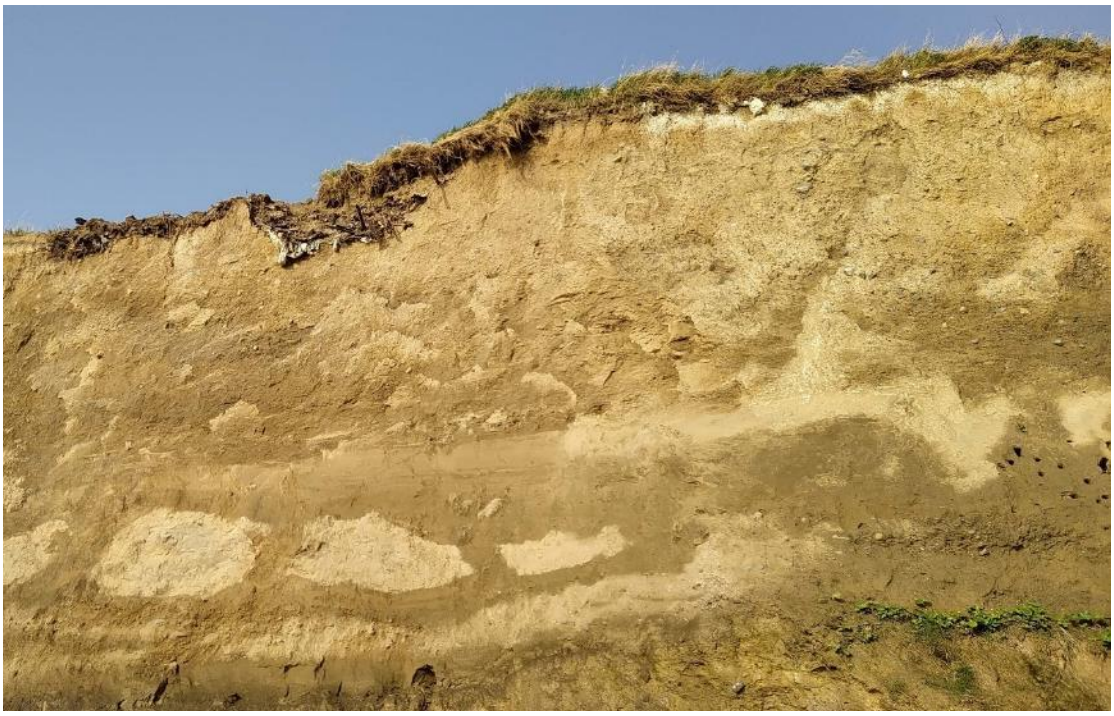

Figure 3.15: Landfill site in top of cliff, exposed by erosion.

Figure 3.16: Shingle piled into man-made mound near mouth of Shanganagh River.

Figure 3.17: Rock armour in upper shore near Shankill Beach access.

Figure 3.18: Shankill Beach access (left) and Quin's Road Beach access.

3.1.1.11. Coastal Erosion

Coastal erosion is a feature of Shanganagh/Shankill Beaches for the entire length of the survey area. It is particularly evident in the numerous recent cliff falls observed. The cliffs are vertical and composed soft clay and stones and high water, particularly during storms, undermines the base of the cliff causing collapse. Figure 3.19 illustrates the locations where recent cliff falls were recorded. Rock armouring has been added to the upper shore in the area around the Shankill Beach access point (Figure 3.17 above). For the remaining length of the beach cliff erosion has exposed drainage pipes and landfill sites and dropped walls and concrete on the shore. In the southern extent of the survey area the remains of the cliff wall from the old Bray-Dublin railway line are visible over 40m from the cliff edge in the lower shore. This is illustrated in Figure 3.20 below.

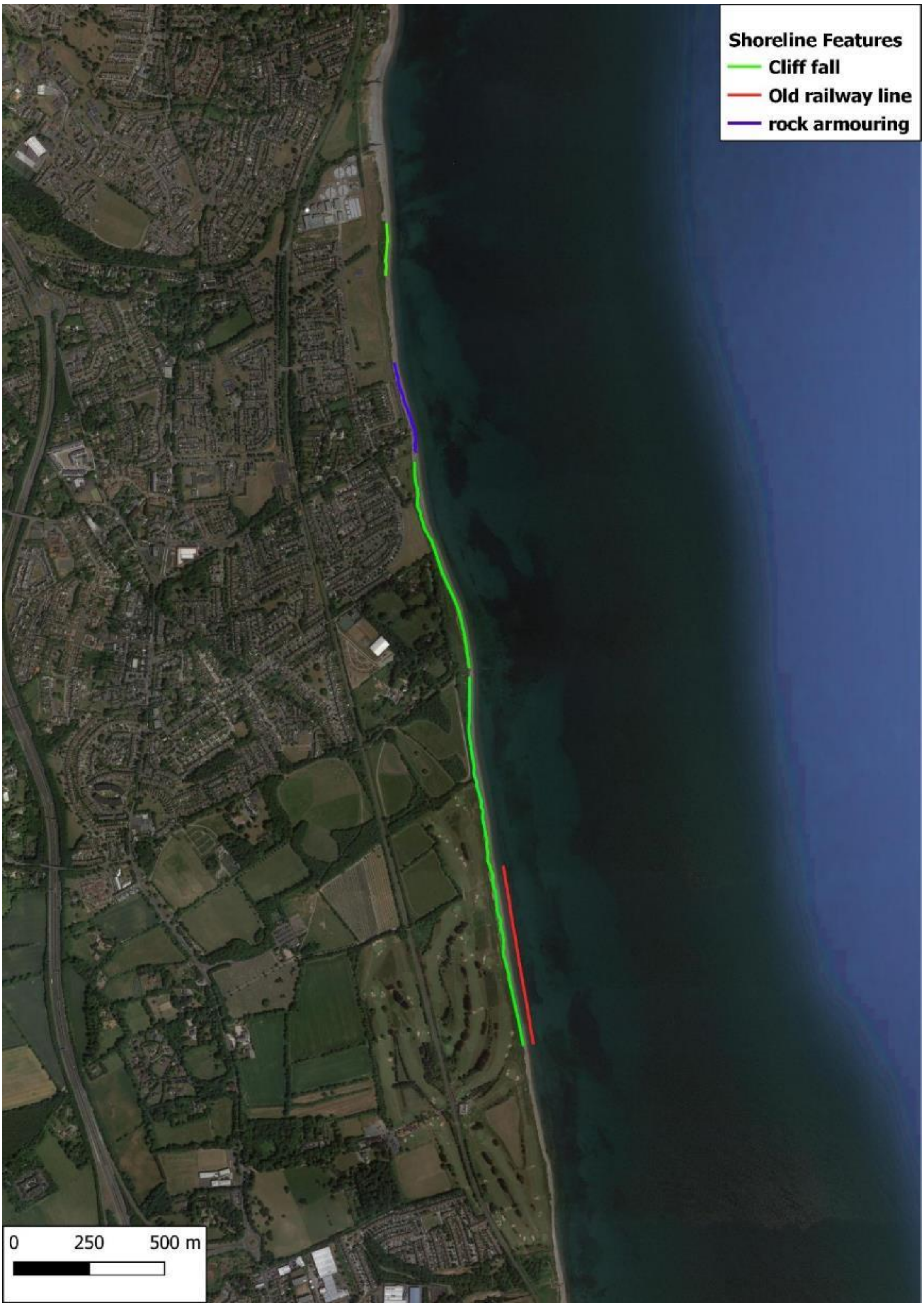

Figure 3.19: Coastal erosion in the Shanganagh/Shankill Beach area.

Figure 3.20: Cliff wall from old Bray-Dublin rail line.

3.1.2. Shanganagh Transect 1

This transect was located less than 100m east of Shanganagh Waste Water Treatment plant (Starting Point: 52.243655°N, 6.112275°W). The start and end points and the quadrat locations can be seen in Figure 3.21. The total length of the transect from upper to lower shore was 65m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 3.22 and a shore profile image is presented in Figure 3.23. This transect was backed by steep soft eroding clay cliffs 8-10m high. The upper strand line at the base of the cliff consisted of cobbles and pebbles, which graded into fine sand over cobbles, then fine gravel and coarser sand further down the shore. The lower shore had eroded clay boulders and medium sand. Sediment and faunal cores were also collected at each shore height and are discussed later (Section 3.1.4 and section 4).

Figure 3.21: Shanganagh Transect 1. Start and End points and quadrat locations.

Figure 3.22: Shanganagh Transect 1. View from upper and lower shores.

Figure 3.23: Shanganagh Transect 1, shore profile.

3.1.2.1. Upper Shore

The upper shore consisted of a boulder-cobble mix with no algal coverage. The drift line at the base of the cliff wall consisted of cobbles with drift *Laminaria digitata* and *Ulva* spp. The cobbles extended from 0m to 4.1m along the transect followed by fine sand over cobbles from 4.1m to 12m. Figure 3.24 shows the quadrat surveyed in the upper shore (2.6m along transect). Talitrid amphipods (6 individuals/0.025m²) were the only fauna recorded. This biotope corresponds with JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle' (EUNIS A2.111).

Figure 3.24: Shanganagh Transect 1. Upper Shore Quadrat.

3.1.2.2. Mid Shore

The mid shore consisted of cobbles, boulders and coarse gravel with no algal cover. The cobbles and coarse gravel extends from 12m to 32.5m along the transect. Within the mid shore quadrat (25m along transect) no flora or fauna were recorded. Figure 3.25 shows the mid shore quadrat. This biotope corresponds with JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle' (EUNIS A2.111).

Figure 3.25: Shanganagh Transect 1. Mid Shore Quadrat.

3.1.2.3. Lower Shore

The lower shore substrate consisted of medium sand with eroded clay boulders and cobbles. A *Fucus serratus* algal band extends from 34.5m to 68m into subtidal. The lower shore quadrat (68m along quadrat) contained *Chondrus crispus* (<10% coverage), *Palmaria palmata* (<5% coverage), *Cladophora* spp. (10% coverage), *Ceramium* spp. (<5% coverage), *Delesseria sanguinea* (<5% coverage) and *Electra pilosa* on *Chondrus crispus* (<1% coverage). Fauna observed included *Lanice conchilega* (5 individuals/0.025m). Figure 3.26 shows the quadrat surveyed on the lower shore. Though no *Fucus serratus* was recorded in the quadrat, this biotope corresponds with elements of the JNCC biotope 'LR.MLR.BF.Fser.R *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock' (EUNIS A1.2141) as well as elements of the JNCC biotope ‘LR.FLR.Eph.EphX Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata’ (EUNIS A2.821).

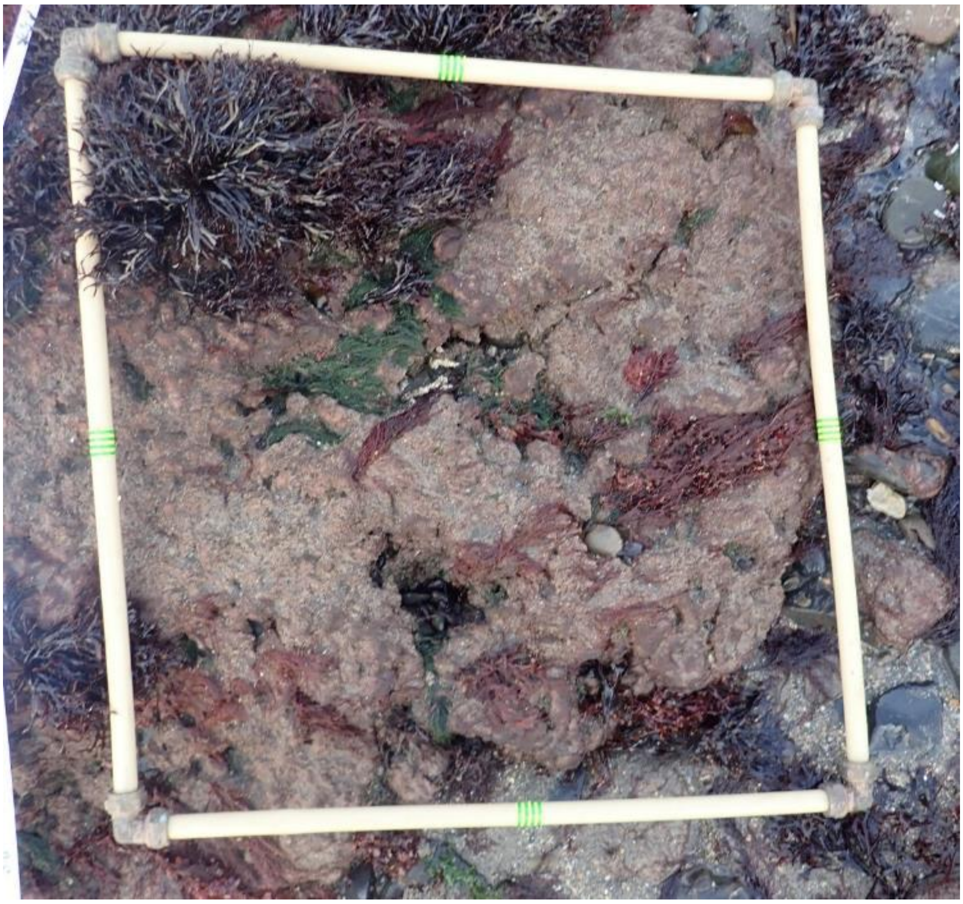

Figure 3.26 Shanganagh Transect 1. Lower Shore Quadrat.

3.1.3. Shanganagh Transect 2

This transect was located approximately 200m south of Quinn's Road Beach access Ardmore (Starting Point: 53.22860°N, 6.10818°W). The start and end points and the quadrat locations can be seen in Figure 3.27. The total length of the transect from upper to lower shore was 37m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 3.28 and a shore profile image in Figure 3.29. This transect was backed by steep soft eroding clay cliffs 8-10m high. The upper strand line at the base of the cliff consisted of eroded clay, cobbles and pebbles, which graded into coarse sand over cobbles and boulders, then coarse gravel and and cobbles, and boulders further lower down the shore. Sediment and faunal cores were also collected at each shore height and are discussed later (Section 3.1.4 and Section 4).

Figure 3.27: Shanganagh Transect 2. Start and End points and quadrat locations.

Figure 3.28: Shanganagh Transect 2. View upper and lower shore.

Figure 3.29: Shanganagh Transect 2, shore profile.

3.1.3.1. Upper Shore

The upper shore consisted of a coarse sand and pebble mix. The upper shore has a band of coarse sand over pebbles and cobbles that extends from 0m – 9.6m. Within the upper shore quadrat (3.5m along transect) no flora or fauna were recorded. Figure 3.30 shows the quadrat surveyed on the upper shore. The upper shore at this location can be classified as JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle' biotope (EUNIS code A2.111).

Figure 3.30: Shanganagh Transect 2. Upper Shore Quadrat.

3.1.3.2. Mid Shore

The mid shore consisted of cobbles and coarse gravel from 9.6m to 14.8 and cobbles and sparse boulders extend from 14.8m to 27m. Within the mid shore quadrat (19m along transect), no flora or fauna were recorded. Figure 3.31 shows the quadrat surveyed in the mid shore. The upper shore at this location can be classified as JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle' biotope (EUNIS code A2.111).

Figure 3.31: Shanganagh Transect 2. Mid Shore Quadrat.

3.1.3.3. Lower Shore

The lower shore consisted of a boulder field interspersed with cobbles and coarse sand extending from 37m to 35m+. Some sparse large boulders on the lower shore (at 26.5m down shore) had patches of *Fucus vesiculosus* on their tops as well as some filamentous green and red algae. Within the 0.25m^2 quadrat (at 36.5m along transect) the following fauna were found – *Actinia equina* (1 individual), *Lanice conchilega* (3), and *Spirobranchus lamarcki* (<5% coverage). Figure 3.32 shows the quadrat surveyed in the lower shore. This biotopes corresponds to the JNCC 'LS.LCS.Sh.BarSh Barren littoral shingle' biotope (EUNIS code A2.111) with elements of 'LR.FLR.Eph.EphX Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata' (EUNIS A2.821). Beyond the lower shore quadrat into the subtidal the substrate is of fine to medium sand and corresponds to the JNCC biotope 'LS.LSa.FiFa.Po.Aten Polychaetes and *Angulus tenuis* in littoral fine sand' (EUNIS code A2.2312)

Figure 3.32: Shanganagh Transect 2. Lower Shore Quadrat.

3.1.4. Shanganagh Intertidal Core Fauna

The taxonomic identification of the benthic infauna across all 6 intertidal stations sampled by core along the 2 Shanganagh transects yielded a total count of 10 taxa ascribed to 3 phyla and consisting of 61 individuals. Of the 10 taxa identified, 6 were identified to species level. The remaining 4 could not be identified to species level due to the fact that they were juveniles or damaged. The full faunal abundance species list can be seen in Appendix 1.

Of the 10 taxa recorded, 5 were annelids (segmented worms), 4 were arthropods (amphipods, copepods) and 1 was a mollusc (mussel).

3.1.4.1. Univariate Analysis

Univariate statistical analyses were carried out on the combined replicate station-by-station faunal data. The following parameters were calculated and can be seen in Table 3.2: species numbers, number of individuals, richness, evenness, Shannon-Weiner diversity and Effective

Species Number (ENS). As some of the stations contained only 1 (Sh2 MID) or fewer (Sh1 UPP & Sh2 UPP) individuals, Richness, Evenness, and Diversity could not be calculated for these stations. Species numbers ranged from 0 (Sh1 UPP & Sh2 UPP) to 8 (Sh1 LWR). Number of individuals ranged from 0 (Sh1 UPP & Sh2 UPP) to 38 (Sh1 LWR). Richness ranged from 0.34 (Sh1 MID) to 1.92 (Sh1 LWR). Evenness ranged from 0.31 (Sh1 MID) to 0.81 (Sh2 LWR). Shannon-Wiener diversity ranged from 0.21 (Sh1 MID) to 1.12 (Sh1 LWR). Effective species number ranged from 1.23 (Sh1 MID) to 3.07 (Sh1 LWR) indicating that Station Sh1 LWR is almost 2.5 times more diverse than Station Sh1 MID.

Table 3.2: Shanganagh univariate measures of community structure.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Weiner Diversity	Effective Species Number
	S	N	d	J'	H'(loge)	EXP(H')
Sh1 UPP	0	0	n.a.	n.a.	n.a.	n.a.
Sh1 MID	2	18	0.34	0.31	0.21	1.23
Sh1 LWR	8	38	1.92	0.54	1.12	3.07
Sh2 UPP	0	0	n.a.	n.a.	n.a.	n.a.
Sh2 MID	1	1	n.a.	n.a.	n.a.	n.a.
Sh2 LWR	2	4	0.72	0.81	0.56	1.75

Due to the sparse returns in the faunal cores at Shanganagh, particularly in the upper shore areas, multivariate analysis could not be carried out on the faunal data. This sparsity of fauna is to be expected where the biotope is classified as LS.LCS.Sh.BarSh Barren littoral shingle.

3.2. Poolbeg

3.2.1. Poolbeg Walkover survey

The Poolbeg walkover survey was conducted by two AQUAFACT ecological surveyors on the morning of the 1st April 2021. The survey area extended along the upper shore at the Great South wall carpark in the east along Shelly Banks Beach and Poolbeg Beach to the south western end of Irishtown Nature Park and out to the Spring tide low water mark approximately 1.3km down the shore. As there was the potential for the presence of overwintering birds on this site (South Dublin Bay and River Tolka Estuary SPA) a bird survey was carried out in the hour before the walkover survey to assess presence of birds. No overwintering birds were detected at this stage and it was decided to proceed with the survey. The boundaries of each biotope identified were mapped using GPS and are presented in Figures 3.33, below.

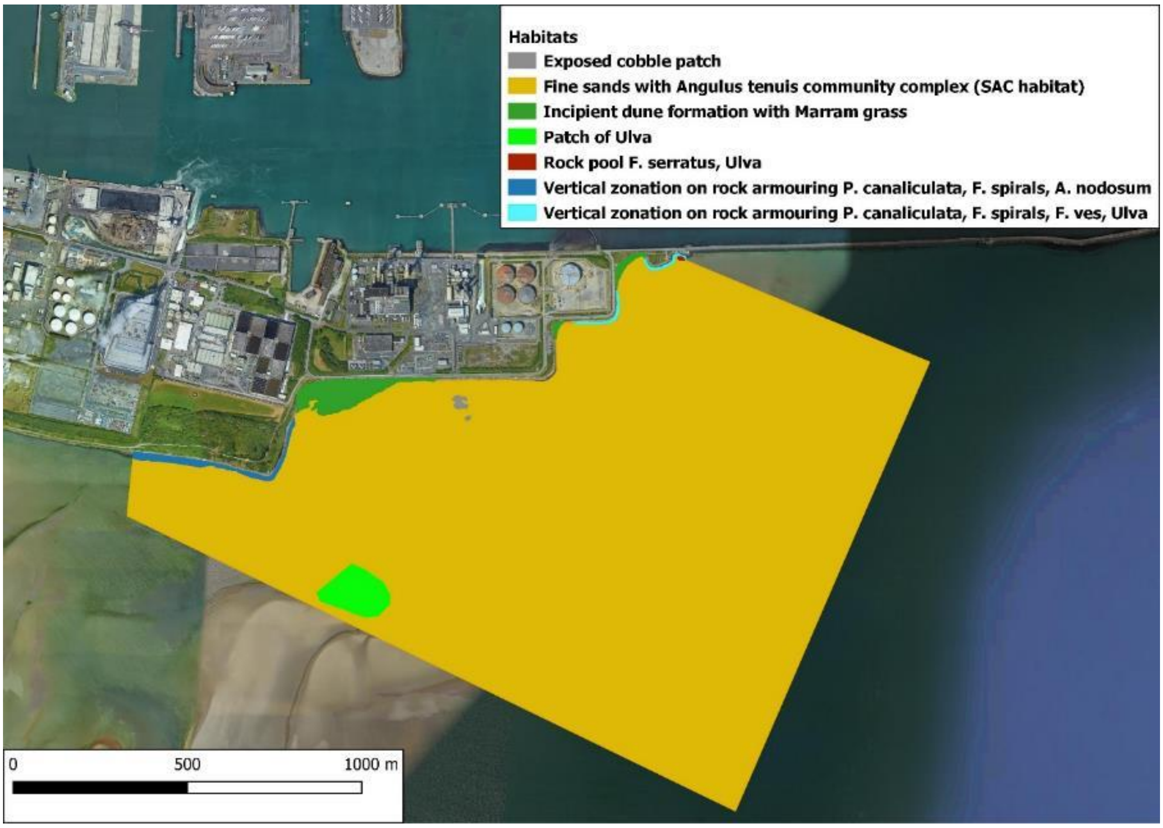

Figure 3.33: Poolbeg biotope map.

3.2.1.1. Fine sands with Angulus tenuis community complex

From the upper shore to the lower shore the principal biotope recorded over the majority of the survey area can be classified as 'Fine sands with *Angulus tenuis* community complex' (Figure 3.34). This biotope was described in the characterising document for the South Dublin Bay SAC (NPWS, 2013). The sediment of this community complex is predominantly fine sands (52.7% to 99.4% very fine and fine sand) with negligible amounts of silt-clay (<0.2%). Quantities of coarse material are generally low (coarse sand <1.1%, gravel <0.22%), occasional increases of coarser fractions are attributed to localised deposits of shell debris. The distinguishing species of this community are the bivalve *Macomangulus tenuis* (previously *Angulus tenuis*) and the polychaetes *Scoloplos armiger*, *Pygospio elegans* and *Nephtys cirrosa.* These species are not uniformly distributed across the site and are generally recorded in low abundances. *Lanice conchilega* and *Arenicola marina* also commonly occur (NPWS, 2013).

Figure 3.34: Fine sands with *Angulus tenuis* community complex at Poolbeg Beach.

In the lower shore, in the main tidal drainage channel approximately 600m south of Poolbeg Beach a large patch of *Ulva* spp. was recorded (Figure 3.35). This location was surveyed at the end of the day as the tide was returning. The nature of the channel means that the area is not visible from the upper shore and on approaching the location it was noted that approximately 15 Brent Geese were feeding on the *Ulva* there. The decision was taken not to GPS record the full extent of boundary of this *Ulva* patch in order to prevent disturbance of the birds. It should be noted that Poolbeg and Sandymount strand are popular areas for dog walkers and upwards of 20 dogs and owners were recorded on the shore during the walkover and transect surveys. This concealed *Ulva* patch seems to offer some protection from disturbance. NPWS (2013) description of the 'Fine sands with *Angulus tenuis* community complex' biotope indicates that *Ulva* spp. is also recorded as 'occasional to abundant on the mid and lower shores of Sandymount'. Along the tidal channel to the west of this *Ulva* patch the cockles (*Cerastoderma edule*) were recorded on the sediment surface at a density of about 5-6/m^2.

Figure 3.35: Patch of *Ulva* sp. with feeding birds.

An area of cobbles (Figure 3.36) of approximately 2,000 m^2 was recorded in the upper shore to the south of Poolbeg power station, 40m south of the access road. This cobble substrate consisted of tightly packed cobbles and coarse pebbles with fine sand and shell debris. Fauna was scarce with occasional calcareous tube worms (*Spirobranchus* spp.). It is uncertain what the full extent of this area of cobbles is as much of it was covered with sand.

Figure 3.36: Cobble patch south of Poolbeg power station.

3.2.1.2. Incipient Marram grass dunes

Incipient Marram grass dunes are forming in three locations in the upper shore of the survey area. These locations are at Poolbeg Beach (Figure 3.37), at the Shelly Banks Beach access (Figure 3.38) and the Great South Wall Beach access (Figure 3.39). The largest are the dunes forming at Poolbeg Beach. The Marram grass dunes are above the high water mark and exhibit moderate littering.

Figure 3.37: Incipient Marram grass dunes at Poolbeg Beach.

Figure 3.38: Incipient Marram grass dunes at Shelly Banks Beach access.

Figure 3.39: Incipient Marram grass dunes near the Great South Wall Beach access.

3.2.1.3. Rock armour with epiflora and epifauna

Rock armour is employed throughout the upper shore survey area to counteract coastal erosion. Large granite boulders and other rock debris are placed at the top of the shore from the Great South wall in the north east along the top of the shore towards Irishtown Nature park with a break in the rock armour protection in the areas of marram grass dunes at Poolbeg Beach and Great South wall dunes. The locations of the rock armour can be seen in Figure 3.40 below.

East of Poolbeg Beach to Great South Wall dunes this rock armour is of large boulders. In this Poolbeg Beach area these rocks are above highwater and devoid of flora and fauna. In the Shelly Bank area the rock armour has a canopy of macroalgae and a vertical zonation of *Pelvetia canaliculata, Ulva* sp. *Fucus spiralis, Porphyra umbilicalis* and occasional *Fucus vesiculosus* (Figure 3.41). Fauna includes the barnacles *Semibalanus balanoides* and *Austrominius modestus,* the periwinkles *Littorina saxatilis* and *L. obtusata* and the springtail *Anurida maritima* (Figure 3.42). This vertical zonation contains elements of several JNCC biotopes typically found on rocky shores but compressed into narrow vertical bands. They include 'LR.MLR.BF.PelB *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock' (EUNIS A1.211) and 'LR.MLR.BF.FspiB *Fucus spiralis* on exposed to moderately exposed upper eulittoral rock' (EUNIS A1.212). This biotope zonation continues on the rock armour along the Great South wall.

Figure 3.40: Location of Rock armour in the Poolbeg survey area.

Figure 3.41: Vertical zonation on rock armour in Poolbeg upper shore at Shelly Bank.

Figure 3.42: Barnacle cover on rock armour in Poolbeg upper shore at Shelly Bank.

The rock armour on the southern and eastern upper shore at Irishtown Nature Park are smaller and less uniform than the large boulders described above. The area of the Irishtown Nature park is the location of a landfill site from the 1960s. Figure 3.43 illustrates the embankment of the Irishtown Nature park with landfill material at the base and rock armour in the form of large concrete structures, concrete rubble and stone. The strandline contains rocks with coverage of lichens (*Hydropunctata maura* (formerly *Verrucaria maura*) and *Caloplaca marina*) and *Ulva* sp. The upper shore can be described as 'LR.LLR.F.Pel *Pelvetia canaliculata* on sheltered littoral fringe rock' (EUNIS A1.311) above 'LR.LLR.F.Fspi *Fucus spiralis* on sheltered upper eulittoral rock' (EUNIS A1.312). In the mid shore the substrate changes to cobbles, and coarse pebbles with elements of 'LR.LLR.F.Asc.X *Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata' (EUNIS A1.3142). A large broken metal pipe was recorded on the mid to lower shore (Figure 3.44). In the lower shore the biotope can again be described as 'Fine sands with *Angulus tenuis* community complex'.

Figure 3.43: Rock armour rubble in the upper shore at Irishtown Nature park.

Figure 3.44: Concrete rubble and metal pipe in Irishtown Nature park mid shore.

A rock pool habitat has formed around some of the rock armour boulders that have been deposited on the upper shore in the vicinity of the Great South Wall car park (Figure 3.45). Water remains pooled here at low water. The substrate is of boulders and cobbles over fine and medium sand with some shell debris. Boulders are encrusted with barnacles (*Semibalanus balanoides* and *Austrominius modestus*) as well as the limpet *Patella vulgata,* the dog whelk *Nucella lapillus,* and the periwinkles *Littorina saxatilis* and *L. obtusata*. Macroalgal cover includes *Fucus spiralis, Ulva* sp. and *Porphyra umbilicalis* on the boulders and stones in the rock pool.

Figure 3.45: Rock pool formed around upper shore rock armour. Great South Wall car park.

3.2.2. Poolbeg Transect 1

This transect was located on Poolbeg Beach 175m south of Poolbeg Power Station (Starting Point: 53.33739°N, 6.18787°W). The start and end points and the quadrat locations can be seen in Figure 3.46. The total length of the transect from upper to lower shore was 1380m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 3.47. This transect was backed by rock armour 2-3m high with some marram grass and cordyline trees between the rock and the access road to the Great South wall (Figure 3.48). The upper strand line at the base of the rock armour consisted of fine sand and shell debris and the high tide strandline on the day of the survey was within 1m of the rock armour where thousands of sand mason (*Lanice conchilega*) tubes had washed up. The substrate consisted of fine sand with sand ripples from the upper shore down to the lower shore with evidence of fauna including *Lanice conchilega* tube and *Arenicola marina* (lugworm) casts. Sediment and faunal cores were also collected at each shore height and are discussed later (Section 3.2.4 and Section 4).

Figure 3.46: Poolbeg Transects 1 and 2. Start and End points and Quadrat locations along Transects.

Figure 3.47: Poolbeg Transect 1. View from upper and lower shore.

Figure 3.48: Strandline and rock armour above Poolbeg Transects.

3.2.2.1. Upper Shore

The upper shore consisted of fine sand in sand ripples. The upper shore quadrat was located 131m down the transect. At the upper end of the shore, approximately 2m below the rock armour density of lugworm casts (*Arenicola marina*) was 10-15/m^2. This density decreased to approximately 4-5/m^2 in the vicinity of the upper shore quadrat. Figure 3.49 shows the quadrat from the upper shore. No flora was recorded and fauna from the quadrat consisted of two *Arenicola marina* casts. The biotope in this upper shore area can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

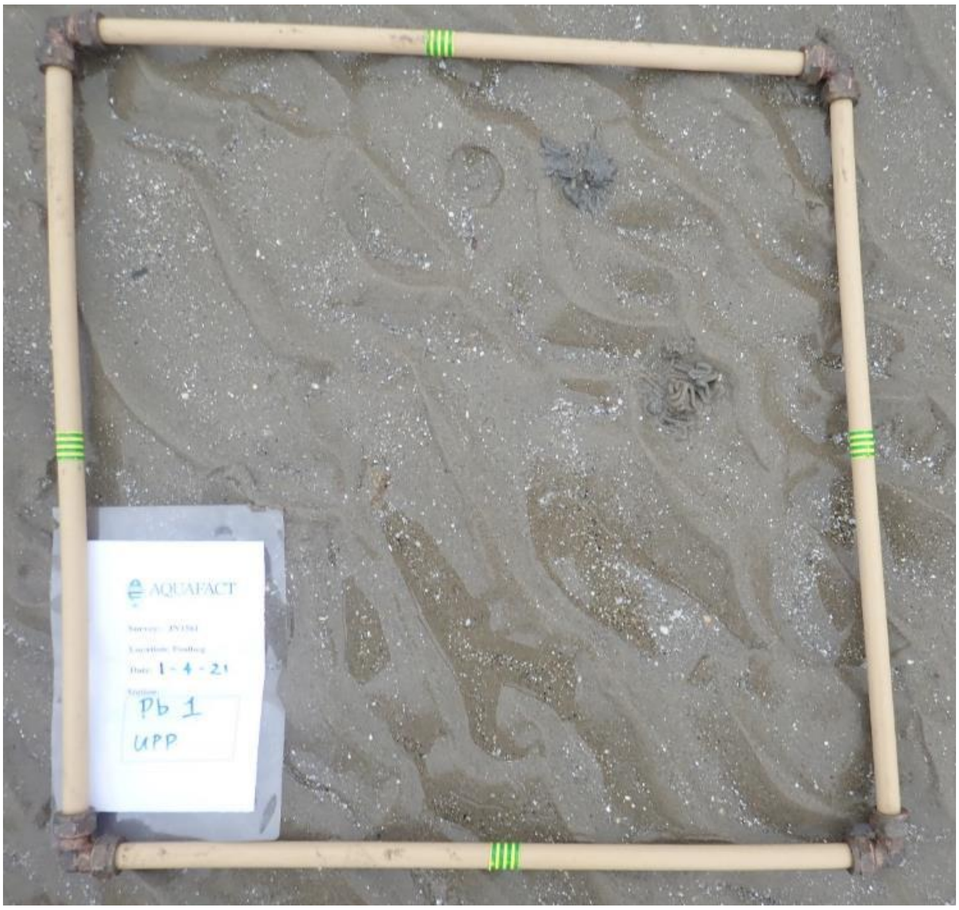

Figure 3.49: Poolbeg Transect 1. Upper Shore Quadrat.

3.2.2.2. Mid Shore

The mid shore also consisted of fine sand in sand ripples. The mid shore quadrat was located 673m down the transect. *Arenicola marina* casts in the mid shore area were at a density of approximately 3-4/m^2. Figure 3.50 shows the quadrat from the mid shore. No flora was recorded and fauna from the quadrat consisted of one *Arenicola marina* cast and one *Lanice conchilega*. The biotope in this mid shore area can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

Figure 3.50: Poolbeg Transect 1. Mid Shore Quadrat.

3.2.2.3. Lower Shore

The lower shore consisted of fine sand in sand ripples with some surface shell debris. Sediment colour was grey brown. The lower shore quadrat was located 1380m down the transect. Figure 3.51 shows the quadrat from the lower shore. No flora was recorded and fauna from the quadrat consisted of two *Arenicola marina* casts and one *Lanice conchilega*. The biotope in this lower shore area can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

Figure 3.51: Poolbeg Transect 1. Lower Shore Quadrat.

3.2.3. Poolbeg Transect 2

This transect (Starting Point: 53.33738°N, 6.18637°W) was located on Poolbeg Beach 175m south of Poolbeg Power Station and approximately 100m east of Poolbeg Transect 1. The start and end points and the quadrat locations can be seen in Figure 3.46 above. The total length of the transect from upper to lower shore was 1245m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 3.52. This transect was backed by rock armour 2-3m high with some marram grass between the rock and the access road to the Great South wall (Figure 3.53). The upper strand line at the base of the rock armour consisted of medium sand and shell debris. The substrate consisted of fine sand with sand ripples from the upper shore down to the lower shore with evidence of fauna including *Lanice conchilega* tube and *Arenicola marina* (lugworm) casts. A large patch of cobbles covered in fine and medium sand (Figure 3.54) was located in the upper shore between the strandline and the upper shore quadrat location. This was mapped out in the walkover survey as described above.

Figure 3.52: Poolbeg Transect 2. View from upper and lower shore.

Figure 3.53: Rock armour in upper shore at Poolbeg Transect 2.

Figure 3.54: Patch of cobbles in the upper shore of Poolbeg Transect 2.

3.2.3.1. Upper Shore

The upper shore consisted of fine sand in sand ripples with a patch of cobbles in the upper shore stretching from 47m to 110m along the transect. The upper shore quadrat was located 125m down the transect. At the upper end of the shore, approximately 2m below the rock armour density of lugworm casts (*Arenicola marina*) was 10-15/m^2. This density decreased to approximately 4-5/m^2 in the vicinity of the upper shore quadrat. Figure 3.55 shows the quadrat from the upper shore. No flora was recorded and fauna from the quadrat consisted of one *Arenicola marina* cast. The biotope in this upper shore area can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

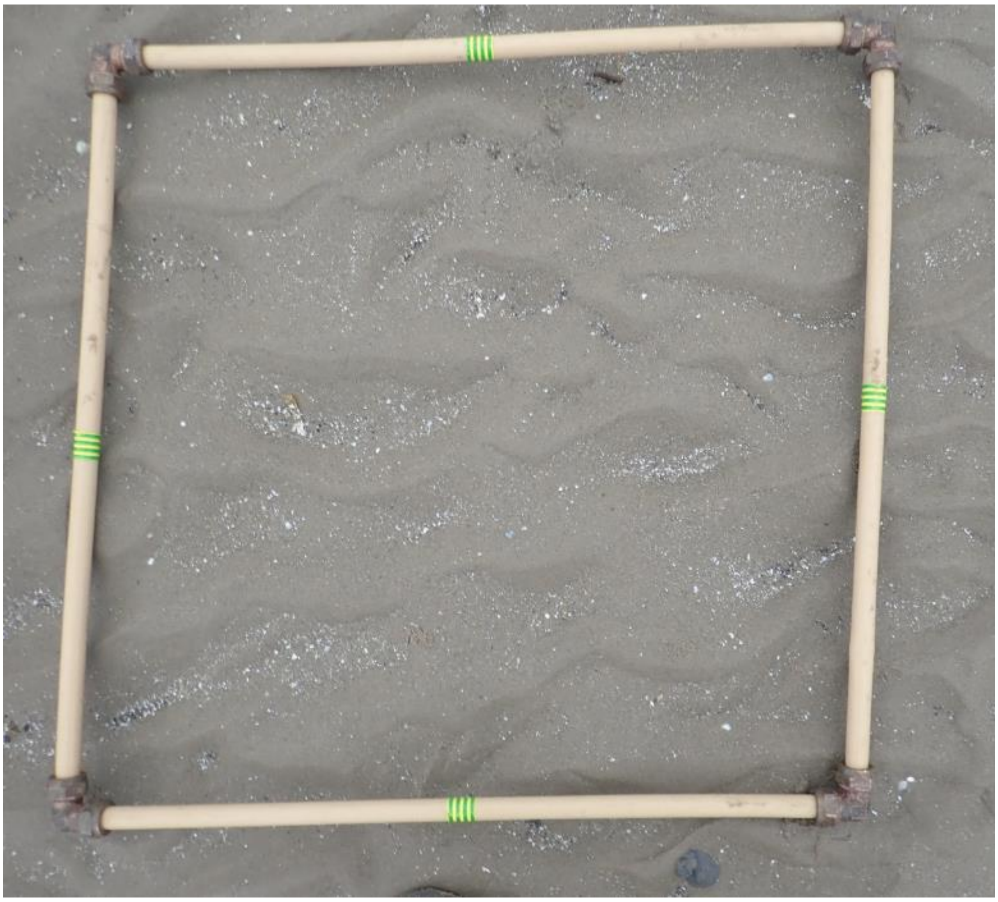

Figure 3.55: Poolbeg 2. Upper Shore Quadrat.

3.2.3.2. Mid Shore

The mid shore also consisted of fine sand in sand ripples. The mid shore quadrat was located 577m down the transect. *Arenicola marina* casts in the mid shore area were at a density of approximately 3-4/m^2. Figure 3.56 shows the quadrat from the mid shore. No flora was recorded and fauna from the quadrat consisted of one *Arenicola marina* cast. The biotope in this mid shore area can be classified as ‘Fine sands with *Angulus tenuis* community complex’ as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

Figure 3.56: Poolbeg 2. Mid Shore Quadrat.

3.2.3.3. Lower Shore

The lower shore consisted of fine sand in sand ripples with some surface shell debris. Sediment colour was grey brown. The lower shore quadrat was located 1245m down the transect. Figure 3.57 shows the quadrat from the lower shore. No flora was recorded and fauna from the quadrat consisted of three *Lanice conchilega*. The biotope in this lower shore area can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013).

Figure 3.57: Poolbeg 2. Lower Shore Quadrat.

3.2.4. Poolbeg Intertidal Core Fauna

The taxonomic identification of the benthic infauna across all 6 intertidal stations sampled by core along the 2 Poolbeg transects yielded a total count of 32 taxa ascribed to 5 phyla and consisting of 145 individuals. Of the 32 taxa identified, 26 were identified to species level. The remaining 6 could not be identified to species level since they were indeterminate, juveniles or damaged. The full faunal abundance species list can be seen in Appendix 1.

Of the 32 taxa recorded, 1 was a nematode (round worm), 1 was a nemertean (ribbon worm), 18 were annelids (segmented worms), 8 were arthropods (amphipods, cumaceans), and 4 were molluscs (gastropods and bivalves).

3.2.4.1. Univariate Analysis

Univariate statistical analyses were carried out on the combined replicate station-by-station faunal data. The following parameters were calculated and can be seen in Table 3.3: species numbers, number of individuals, richness, evenness, Shannon-Wiener diversity and Effective

Species Number (ENS). Species numbers ranged from 9 (Pb2 UPP and Pb2 MID) to 13 (Pb1 LWR). Number of individuals ranged from 11 (Pb2 UPP) to 41 (Pb1 MID). Richness ranged from 2.31 (Pb2 MID) to 3.49 (Pb1 LWR). Evenness ranged from 0.69 (Pb1 MID) to 0.96 (Pb1 UPP). Shannon-Wiener diversity ranged from 1.71 (Pb1 MID) to 2.27 (Pb1 LWR). Effective species number ranged from 5.53 (Pb1 MID) to 9.72 (Pb1 LWR) indicating that Station Pb1 LWR is just over 1.7 times more diverse than Station Pb1 MID. Figure 3.58 presents these univariate indices in graph form.

Table 3.3: Poolbeg univariate measures of community structure.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Wiener Diversity	Effective Species Number
	S	N	d	J’	H’(loge)	EXP(H’)
Pb1 UPP	10	14	3.41	0.96	2.21	9.08
Pb1 MID	12	41	2.96	0.69	1.71	5.53
Pb1 LWR	13	31	3.49	0.89	2.27	9.72
Pb2 UPP	9	11	3.34	0.95	2.10	8.15
Pb2 MID	9	32	2.31	0.79	1.73	5.62
Pb2 LWR	10	30	2.65	0.90	2.07	7.92

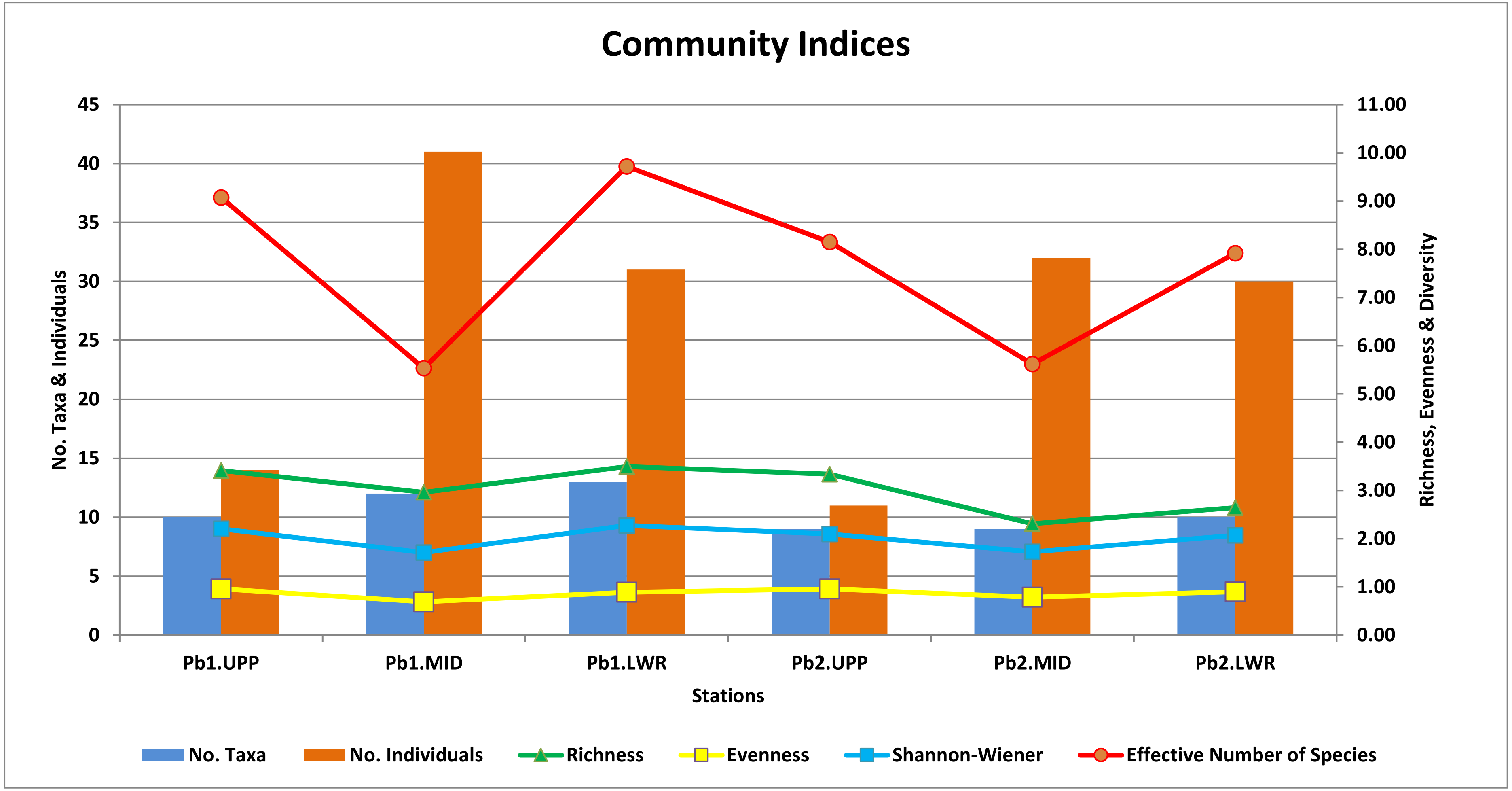

Figure 3.58: Community indices of Poolbeg intertidal core fauna. Diversity is expressed in Shannon-Wiener diversity and Effective Number of Species.

3.2.4.2. Multivariate Analysis

The same data set used above for the univariate analyses was also used for the multivariate analyses. The dendrogram and the MDS plot can be seen in Figures 3.59 and 3.60 respectively. SIMPROF analysis revealed 3 statistically significant groupings between the 6 stations (the samples connected by red lines cannot be significantly differentiated). The stress level on the MDS plot indicates an excellent representation of the data with no prospect of misinterpretation of overall structure.

A clear divide (81.14% dissimilarity) can be seen between **Group a** and **Groups b** and **c**.

Group a consisted of the upper shore stations Pb1 UPP and Pb2 UPP. This group separated from all other groups at a 18.86% similarity level. Group a had a within group similarity of 53.84%. This group contained 14 taxa comprising 25 individuals. Of the 14 taxa, 11 were present twice or less. Five species accounted for 64% of the faunal abundance: the amphipod *Bathyporeia pilosa* (6 individuals, 24% abundance), Nemertea (3 individuals, 12% abundance), the polychaete *Pygospio elegans* (3 individuals, 12% abundance), the isopod *Eurydice pulchra* (2 individuals, 8% abundance), and the bivalve *Macomangulus tenuis* (formerly *Angulus tenuis*) (2 individuals, 8% abundance). *Bathyporeia pilosa, Eurydice pulchra* and *Macomangulus tenuis* are very sensitive to organic enrichment and present under unpolluted conditions. *Pygospio elegans* and Nemertea are tolerant to excess organic matter enrichment, typically occurring under normal conditions but their populations are stimulated by organic enrichment. The biotope of Group a can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013). It also has elements of the JNCC biotopes 'LS.LSA.FiSa.Po.Aten Polychaetes and *Angulus tenuis* in littoral fine sands' (EUNIS A2.2312).

Group b consisted of stations Pb1 LWR and Pb2 LWR. Group b had a within group similarity of 64.52% and was most similar to Group c, but only at a level of 31.83%. This group contained 15 taxa comprising 61 individuals. Of the 15 taxa, 6 were present twice or less. Five species accounted for just over 65% of the faunal abundance: the polychaetes *Notomastus latericeus* (14 individuals, 22.95% abundance), *Nephtys cirrosa* (4 individuals, 6.56% abundance) and *Spio martinensis* (4 individuals, 6.56% abundance), and the amphipods *Bathyporeia elegans* (13 individuals, 21.31% abundance) and *Pontocrates arcticus* (5 individuals, 8.2% abundance). *Bathyporeia elegans* is very sensitive to organic enrichment and present under unpolluted conditions. *P. arcticus* and *N. cirrosa* are indifferent to disturbance, typically present in low densities with non-significant variations over time. *N. latericeus* and *S. martinensis* are tolerant to excess organic matter enrichment, typically occurring under normal conditions but their populations are stimulated by organic enrichment. The biotope of Group b can be classified as 'Fine sands with *Angulus tenuis* community complex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013). It also has elements of the JNCC biotopes 'LS.LSA.FiSa.Po.Ncir *Nephtys cirrosa*-dominated littoral fine sands' (EUNIS A2.2313).

Group c consisted of stations Pb1 MID and Pb2 MID. Group c had a within group similarity of 56.87% and was most similar to Group b, but only at a level of 31.83%. This group contained 16 taxa comprising 73 individuals. Of the 16 taxa, 10 were present twice or less. Five species accounted for just over 82% of the faunal abundance: the bivalve *Macomangulus tenuis* (34 individuals, 46.58% abundance), the polychaetes *Spio martinensis* (14 individuals, 19.18% abundance), *Nephtys cirrosa* (4 individuals, 5.48% abundance) and *Pygospio elegans* (4 individuals, 5.48% abundance) and the cumacean *Cumopsis goodsir* (4 individuals, 5.48% abundance). *M. tenuis* is very sensitive to organic enrichment and present under unpolluted conditions *N. cirrosa* and *Cumopsis goodsir* are indifferent to disturbance, typically present in low densities with non-significant variations over time. *S. martinensis* and *P. elegans* are tolerant of disturbance, they occur under normal conditions, but their populations are stimulated by organic enrichment. The biotope of Group c can be classified as 'Fine sands with *Angulus tenuis* community compex' as described in the characterising document for the South Dublin Bay SAC (NPWS, 2013). It also has elements of the JNCC biotopes 'LS.LSA.FiSa.Po.Aten Polychaetes and *Angulus tenuis* in littoral fine sands' (EUNIS A2.2312) and 'LS.LSA.FiSa.Po.Ncir *Nephtys cirrosa*-dominated littoral fine sands' (EUNIS A2.2313).

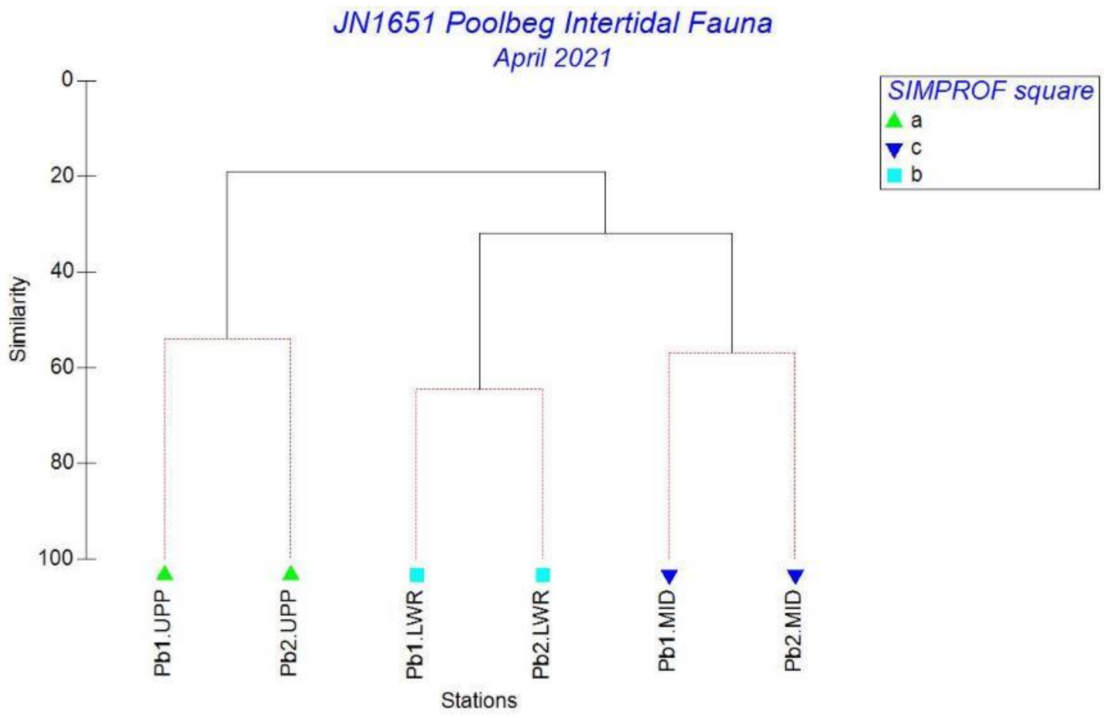

Figure 3.59: Dendrogram produced from Cluster analysis.

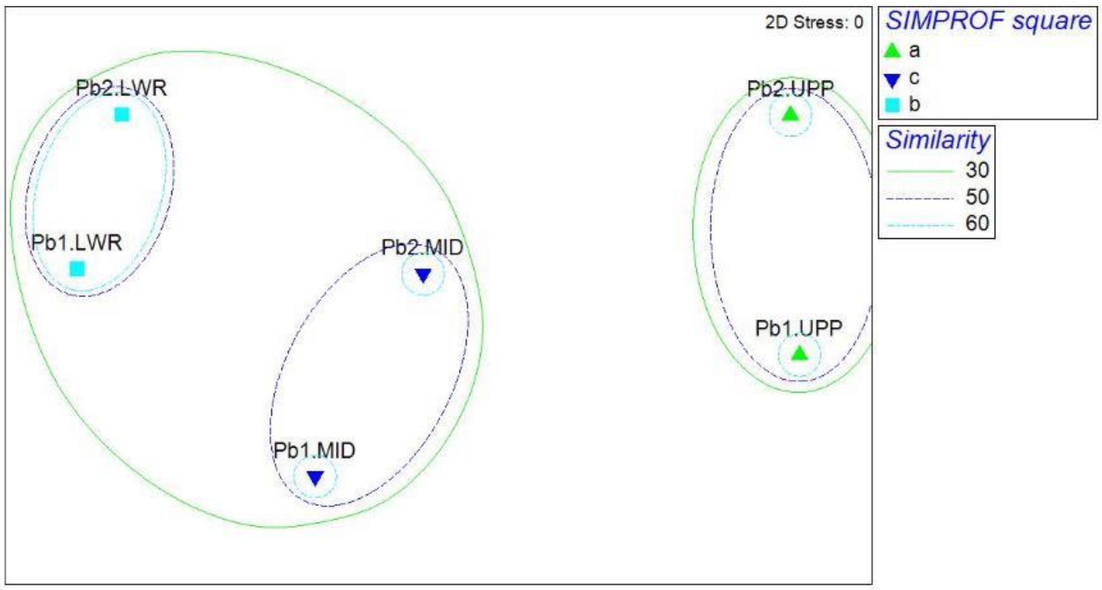

Figure 3.60: MDS plot.

4. Sediment Physical / Chemical Results

Appendix 2 contains the full AQUAFACT Particle Size analysis statistics. Appendix 3 contains the laboratory report showing the full set of results from SOCOTEC including Certified Reference Material (CRM) that were run with each analysis.

4.1. Visual Inspection

Tables 4.1 and 4.2 describe the visual inspection information for Shanganagh and Poolbeg respectively and includes colour and sediment type. Samples were taken from the areas of the intertidal quadrats photographed and described above (sections 3.1.2, 3.13, 3.2.2 and 3.2.3).

Table 4.1: Shanganagh sediment sample visual Inspection

Station	Description	Station	Description
Sh1 Upp	Sandy gravel with cobbles and medium sand. No redox visible. No smell.	**Sh2 Upp**	Sandy gravel with cobbles and medium sand. Grey colour. No redox visible. No smell.
Sh1 Mid	Sandy gravel with cobbles and very coarse sand. No redox visible. No smell.	**Sh2 Mid**	Sandy gravel with cobbles and coarse sand. Grey colour. No redox visible. No smell.
Sh1 Lwr	Slightly gravelly sand with medium to coarse sand. No redox visible. No smell.	**Sh2 Lwr**	Fine sand. Brown surface colour. No redox visible. No smell.

Table 4.2: Poolbeg sediment sample visual Inspection

Station	Description	Station	Description
Pb1 Upp	Fine sand. Brown grey colour. Redox @ 7cm. No smell.	**Pb2 Upp**	Fine sand. Brown grey colour. Redox @ 5cm. No smell.
Pb1 Mid	Fine sand. Brown grey colour. Redox @ 5cm. No smell.	**Pb2 Mid**	Fine sand. Brown grey colour No redox visible. No smell.
Pb1 Lwr	Slightly gravelly sand with fine sand. Brown grey colour. No redox visible. No smell.	**Pb2 Lwr**	Slightly gravelly sand with fine sand. Brown grey colour. No redox visible. No smell.

4.2. Particle Size Analysis

Tables 4.3 and 4.4 shows the granulometry results broken down into % gravel (>2mm), sand (<2mm >63µm) and mud (<63µm) for Shanganagh and Poolbeg respectively. At Shanganagh gravel was the dominant substrate in the upper and mid shore with values ranged from 42.3% (Sh1 Upp) to 70.8% (Sh1 Mid). Sand was the dominant substrate in the lower shore stations (Sh1 Lwr with 98.6% and Sh2 Lwr with 99.9%). Silt-clay was not a feature at any of the Shanganagh stations with all values <0.2%. At Poolbeg, gravel amounts were low and ranged from 0.1% (Pb1 Upp & Pb2 Upp) to 3.2% (Pb1 Lwr). Sand was the dominant substrate in all stations and ranged from 96.5% (Pb1 Lwr) to 99.9% (Pb2 Upp). Silt-clay was not a feature at any of the Poolbeg stations with all values <0.3%.

The full results of the Particle Size analysis for Shanganagh and Poolbeg presented in Tables 4.5 and 4.6 respectively and the full PSA sample statistics are presented in Appendix 2.

Table 4.3: Shanganagh Granulometry results

Station	% Gravel (>2mm)	% Sand (<2mm - > 63µm)	% Silt-Clay (<63µm)
SH1 Upper	42.2	57.5	0.1
SH1 Mid	70.8	29.2	0.1
SH1 Lower	1.3	98.6	0.2
SH2 Upper	52.25	47.23	0.1
SH2 Mid	70.63	29.2	0.1
SH2 Lower	0	99.9	0.1

Table 4.4: Poolbeg Granulometry results

Station	% Gravel (>2mm)	% Sand (<2mm - > 63µm)	% Silt-Clay (<63µm)
PB1 Upper	0.1	99.8	0.1
PB1 Mid	0.2	99.7	0.1
PB1 Lower	3.2	96.5	0.3
PB2 Upper	0.1	99.9	0.1
PB2 Mid	0.2	99.7	0.1
PB2 Lower	2.9	96.8	0.2

Table 4.5: Shanganagh Sediment characteristics of the benthic faunal stations sampled.

Station	>8mm	Fine Gravel (4-8mm)	Very Fine Gravel (2-4mm)	Very Coarse Sand (1-2mm)	Coarse Sand (0.5-1mm)	Medium Sand (0.25-0.5mm)	Fine Sand (125-250mm)	Very Fine Sand (62.5-125mm)	Silt-Clay (<63mm)	Folk (1954)
SH1 Upper	19.8	13.8	8.6	6.9	10.1	30.5	9.7	0.3	0.1	Sandy Gravel
SH1 Mid	0	42.4	28.4	13.2	4	7.1	4.7	0.2	0.1	Sandy Gravel
SH1 Lower	0	0.6	0.7	4.2	21	58.2	12.9	2.3	0.2	Slightly Gravelly Sand
SH2 Upper	22.76	25.4	4.09	5.63	11.35	23.78	6.17	0.3	0.1	Sandy Gravel
SH2 Mid	32.18	18.24	20.21	23.33	1.76	1.55	2.23	0.33	0.1	Sandy Gravel
SH2 Lower	0	0	0	0.2	0.5	8.5	84.6	6.1	0.1	Sand

Table 4.6: Poolbeg Sediment characteristics of the benthic faunal stations sampled.

Station	>8mm	Fine Gravel (4-8mm)	Very Fine Gravel (2-4mm)	Very Coarse Sand (1-2mm)	Coarse Sand (0.5-1mm)	Medium Sand (0.25-0.5mm)	Fine Sand (125-250mm)	Very Fine Sand (62.5-125mm)	Silt-Clay (<63mm)	Folk (1954)
PB1 Upper	0	0	0.1	0.6	2.4	4.4	79.7	12.7	0.1	Sand
PB1 Mid	0	0.1	0.1	0.4	0.5	1.4	75.5	21.9	0.1	Sand
PB1 Lower	0	1.4	1.8	1.5	1	1	60.7	32.3	0.3	Slightly Gravelly Sand
PB2 Upper	0	0	0.1	0.3	0.7	3.2	86.1	9.6	0.1	Sand
PB2 Mid	0	0	0.2	0.4	0.8	1.5	78.2	18.8	0.1	Sand
PB2 Lower	0	1.5	1.4	1.4	1.3	1.5	70.2	22.4	0.2	Slightly Gravelly Sand

4.3. Moisture Content.

The water content for Shanganagh and Poolbeg can be seen in Tables 4.7 and 4.8 respectively. Values ranged from 3.4% (Sh2 MID) to 28.5% (Sh2 LWR) for Shanganagh moisture content and from 19.4% (Pb1 Upp) to 27.9 (Pb1 MID & Pb2 LWR) for Poolbeg.

Table 4.7: Shanganagh Moisture content.

Station	Moisture Content (%)
SH1 Upper	5.4
SH1 Mid	5.0
SH1 Lower	26.2
SH2 Upper	7.6
SH2 Mid	3.4
SH2 Lower	28.5

Table 4.8: Poolbeg Moisture content

Station	Moisture Content (%)
PB1 Upper	19.4
PB1 Mid	27.9
PB1 Lower	27.2
PB2 Upper	26.5
PB2 Mid	26.3
PB2 Lower	27.9

4.4. Total Organic Carbon

Tables 4.9 and 4.10 show the total organic carbon results for Shanganagh and Poolbeg respectively. Values ranged from 0.1% (Sh2 Lwr) to 0.22% (Sh2 MID) for Shanganagh and 0.07% (Pb2 Upp & Pb2 Upp) to 0.1% (Pb1 Lwr) for Poolbeg.

Table 4.9: Shanganagh Total organic carbon results.

Station	TOC (%)	Carbonate Equivalent (%CO3)
SH1 Upper	0.13	10.2
SH1 Mid	0.18	15.2
SH1 Lower	0.14	9.96
SH2 Upper	0.14	11.9
SH2 Mid	0.22	20.8
SH2 Lower	0.10	6.84

Table 4.10: Poolbeg Total organic carbon results.

Station	TOC (%)	Carbonate Equivalent (%CO3)
PB1 Upper	0.07	4.44
PB1 Mid	0.09	4.20
PB1 Lower	0.10	5.64
PB2 Upper	0.07	2.52
PB2 Mid	0.08	3.00
PB2 Lower	0.11	5.16

4.5. *Metals*

Tables 4.11 and 4.12 shows the metal results[1] for Shanganagh and Poolbeg respectively.

Table 4.11: Shanganagh Metal results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
Hg	mg/kg	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Al	mg/kg	15900	19100	16800	18100	17100	20200
Pb	mg/kg	14.9	12.2	15.5	18.6	18.1	16.5
As	mg/kg	34.4	41.6	44.8	47.0	54.7	59.6
Cd	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	mg/kg	18.6	26.3	23.1	24.5	30.2	21.9
Cu	mg/kg	11.9	14.9	11.6	13.8	13.6	13.0
Li	mg/kg	23.2	20.9	21.4	20.7	20.2	23.7
Ni	mg/kg	11.4	18.4	13.7	15.8	19.1	12.3
Zn	mg/kg	42.1	43.5	46.5	46.3	51.9	45.2

Table 4.12: Poolbeg Metal results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
Hg	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Al	mg/kg	14900	15700	15100	14400	15700	15200
Pb	mg/kg	10.0	10.3	12.9	10.3	9.2	12.9
As	mg/kg	59.3	56.5	54.9	51.8	50.0	50.3
Cd	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr	mg/kg	19.3	27.5	91.5	19.2	26.1	80.4
Cu	mg/kg	8.6	11.0	9.5	9.1	10.4	9.5
Li	mg/kg	14.3	13.3	13.0	12.9	13.2	12.7
Ni	mg/kg	8.1	8.6	13.1	8.3	9.5	12.1
Zn	mg/kg	30.2	32.1	43.6	33.6	34.4	43.5

1

Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252 (see Appendix 3).

4.6. *Organochlorines and PCBs*

Tables 4.13 and 4.14 show the organochlorines including ɣ-HCH (Lindane) for Shanganagh and Poolbeg respectively. Tables 4.15 and 4.16 show the PCB results for Shanganagh and Poolbeg respectively.

Table 4.13: Shanganagh Organochlorine results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
DDE-pp	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDD-pp[2]	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDT-pp	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCH Alpha	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCH Beta[2]	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCH Gamma	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCB	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 4.14: Poolbeg Organochlorine results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
DDE-pp	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.32
DDD-pp[2]	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.41
DDT-pp	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.53
Dieldrin	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.24
HCH Alpha	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCH Beta[2]	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.31
HCH Gamma	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	0.27
HCB	ug/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table 4.15: Shanganagh PCB Results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
PCB 028	ug/kg	0.12	0.14	<0.08	<0.08	0.1	<0.08
PCB 052	ug/kg	0.15	0.15	<0.08	0.09	0.12	<0.08

[2] The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. The remaining data gives the Laboratory confidence that the test has performed satisfactorily, and that the validity of the data may not have been significantly affected. However, in line with SOCOTEC UK QMS policy we have removed accreditation, where applicable, from the affected analytes (BHCH & DDD). These circumstances should be taken into consideration when utilising the data. (see Appendix 3).

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
PCB 101	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB 118	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB 138	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB 153	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
PCB 180	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

Table 4.16: Poolbeg PCB Results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
PCB 028	**ug/kg**	<0.08	0.19	<0.08	<0.08	<0.08	0.32
PCB 052	**ug/kg**	<0.08	0.2	0.09	<0.08	0.09	0.39
PCB 101	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	0.28
PCB 118	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	0.28
PCB 138	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	0.18
PCB 153	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	0.21
PCB 180	**ug/kg**	<0.08	<0.08	<0.08	<0.08	<0.08	0.18

4.7. Total Extractable Hydrocarbons

Tables 4.17 and 4.18 show the total extractable hydrocarbon results for Shanganagh and Poolbeg respectively. Values ranged from 0.768mg/kg (Sh1 MID) to 2.82mg/kg (Sh1 LWR) for Shanganagh and from 1.95mg/kg (Pb1 MID) to 5.21mg/kg (Pb2 LWR) for Poolbeg.

Table 4.17: Shanganagh Total extractable hydrocarbon results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
Hydrocarbons	**mg/kg**	0.917	0.768	2.82	1.160	0.782	2.08

Table 4.18: Poolbeg Total extractable hydrocarbon results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
Hydrocarbons	**mg/kg**	2.12	1.95	3.65	2.04	3.81	5.21

4.8. Dibutyl and Tributyl Tin.

Tables 4.19 and 4.20 show the dibutyl and tributyl tin results for Shanganagh and Poolbeg respectively.

Table 4.19: Shanganagh Dibutyl and tributyl tin results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
DBT	**µg/Kg**	<1	<1	<1	<1	<1	<1
TBT	**µg/Kg**	<1	<1	<1	<1	<1	<1

Table 4.20: Poolbeg Dibutyl and tributyl tin results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 [3]Lwr	Pb2 [3]Upp	Pb2 [3]Mid	Pb2 [3]Lwr
DBT	**µg/Kg**	<1	<1	<5	<5	<5	<5
TBT	**µg/Kg**	<1	<1	<5	<5	<5	<5

4.9. Polyaromatic Hydrocarbons

Tables 4.21 and 4.22 show the PAH results for Shanganagh and Poolbeg respectively.

Table 4.21: Shanganagh PAH results.

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
PAH Acenaphthene	**ug/kg**	<1	<1	<1	<1	<1	1.65
PAH Acenaphthylene	**ug/kg**	<1	<1	<1	<1	<1	<1
PAH Anthracene	**ug/kg**	<1	<1	1.23	2.15	<1	5.09
PAH Benzo a anthracene	**ug/kg**	<1	2.03	4.28	8.66	<1	13.5
PAH Benzo (a) pyrene	**ug/kg**	<1	<1	3.85	8.94	<1	11.2
PAH Benzo b fluoranthene	**ug/kg**	1.09	<1	3.69	6.52	<1	9.18

3

The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated. (see Appendix 3).

Determinant		Sh1 Upp	Sh1 Mid	Sh1 Lwr	Sh2 Upp	Sh2 Mid	Sh2 Lwr
PAH Benzo ghi perylene	ug/kg	1.04	<1	3.73	7.76	<1	10.0
PAH Benzo k fluoranthene	ug/kg	<1	<1	2.9	4.47	<1	6.76
PAH Chrysene[4] (inc. Triphenylene)	ug/kg	2.05	1.87	5.34	9.45	1.58	15.5
PAH Dibenzo a,h anthracene	ug/kg	<1	<1	<1	1.8	<1	1.79
PAH Fluoranthene	ug/kg	1.43	1.32	8.17	15.5	<1	28.2
PAH Fluorene	ug/kg	<1	<1	<1	<1	<1	1.48
PAH Indeno 1,2,3 – cd pyrene	ug/kg	<1	<1	3.28	7.36	<1	9.69
PAH Naphthalene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Phenanthrene	ug/kg	2.53	2.29	5.16	8.29	2.02	19.0
PAH Pyrene	ug/kg	1.55	1.43	7.67	12.9	<1	22.6
∑ 16 PAH	ug/kg	9.69	8.94	49.3	93.8	3.6	155.64

Table 4.22: Poolbeg PAH results.

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
PAH Acenaphthene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Acenaphthylene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Anthracene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Benzo a anthracene	ug/kg	<1	1.88	<1	<1	<1	<1
PAH Benzo (a) pyrene	ug/kg	<1	1.96	<1	<1	<1	<1
PAH Benzo b fluoranthene	ug/kg	<1	1.63	1.22	1.12	1.15	1.08
PAH Benzo ghi perylene	ug/kg	<1	2.48	1.39	<1	1.08	1.16
PAH Benzo k fluoranthene	ug/kg	<1	1.82	<1	<1	<1	<1
PAH Chrysene[4] (inc. Triphenylene)	ug/kg	<1	2.76	1.01	1.21	<1	<1
PAH Dibenzo a,h anthracene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Fluoranthene	ug/kg	<1	2.68	<1	1.27	1.13	<1

4

Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene). This should be taken into consideration when utilising the data. (see Appendix 3)

Determinant		Pb1 Upp	Pb1 Mid	Pb1 Lwr	Pb2 Upp	Pb2 Mid	Pb2 Lwr
PAH Fluorene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Indeno 1,2,3 – cd pyrene	ug/kg	<1	2.41	1.43	<1	1.26	1.28
PAH Naphthalene	ug/kg	<1	<1	<1	<1	<1	<1
PAH Phenanthrene	ug/kg	<1	1.01	<1	1.63	<1	<1
PAH Pyrene	ug/kg	1.14	2.98	<1	1.26	1.16	1.11
∑ 16 PAH	ug/kg	1.14	21.61	5.05	6.49	5.78	4.63

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Appendix 1
Intertidal Core Species List

JN1651 Dublin Array - Shanganagh							
Station	**AphiaID**	**Sh1.UPP**	**Sh1.MID**	**Sh1.LWR**	**SH2.UPP**	**Sh2.MID**	**Sh2.LWR**
ANNELIDA	882						
POLYCHAETA	883						
PHYLLODOCIDA	892						
Glyceridae	952						
Glycera tridactyla	130130	0	0	1	0	0	0
SPIONIDA	889						
Spionidae	913						
Malacoceros vulgaris	131134	0	0	3	0	0	3
Pygospio elegans	131170	0	0	1	0	0	0
CAPITELLIDA	890						
OPHELIIDA	891						
Opheliidae	924						
Ophelia rathkei	130496	0	0	27	0	0	0
OLIGOCHAETA	2036						
HAPLOTAXIDA	2118						
Enchytraeidae	2038						
Enchytraeidae	2038	0	17	1	0	1	0
ARTHROPODA	1065						
CRUSTACEA	1066						
COPEPODA	1080						
CYCLOPOIDA	1101						
Cyclopoida (damaged)	1101	0	0	1	0	0	0
HARPACTICOIDA	1102						
Canuellidae	115141						
Canuella perplexa	115723	0	0	3	0	0	0
AMPHIPODA	1135						
Pontoporeiidae	101406						
Bathyporeia elegans	103058	0	0	0	0	0	1
Melitidae	101397						
Melitidae (damaged)	101397	0	1	0	0	0	0
MOLLUSCA	51						
BIVALVIA	105						
MYTILIDA	210						
Mytilidae	211						
Mytilidae (juv)	211	0	0	1	0	0	0

JN1651 Dublin Array - Poolbeg							
Station	**AphiaID**	**Pb1.UPP**	**Pb1.MID**	**Pb1.LWR**	**Pb2.UPP**	**Pb2.MID**	**Pb2.LWR**
NEMATODA	799						
Nematoda	799	1	0	0	0	0	0
NEMERTEA	152391	0	0	0	0	0	0
Nemertea (indet)	152391	2	0	0	1	0	0
ANNELIDA	882	0	0	0	0	0	0
POLYCHAETA	883	0	0	0	0	0	0
PHYLLODOCIDA	892	0	0	0	0	0	0
Phyllodocidae	931	0	0	0	0	0	0
Eteone longa aggregate	130616	0	0	0	0	1	0
Phyllodoce mucosa	334512	0	1	0	0	0	0
Glyceridae	952	0	0	0	0	0	0
Glycera tridactyla	130130	0	0	0	0	0	2
Nephtyidae	956	0	0	0	0	0	0
Nephtys sp. (juv)	129370	0	0	1	0	0	0
Nephtys cirrosa	130357	0	3	1	1	1	3
Nephtys hombergii	130359	0	0	0	0	3	0
Nephtys kersivalensis	130363	0	1	0	0	0	0
ORBINIIDA	884	0	0	0	0	0	0
Orbiniidae	902	0	0	0	0	0	0
Orbinia sertulata	130523	0	1	1	0	0	0
Scoloplos armiger	130537	0	0	1	0	0	0
SPIONIDA	889	0	0	0	0	0	0
Spionidae	913	0	0	0	0	0	0
Pygospio elegans	131170	2	2	0	1	2	0
Scolelepis sp.	129623	0	0	0	1	0	0
Scolelepis (Scolelepis) squamata	157566	0	0	0	1	0	0
Spio martinensis	131185	0	5	3	0	9	1
Spiophanes bombyx	131187	0	0	0	0	1	3
CAPITELLIDA	890	0	0	0	0	0	0
Capitellidae	921	0	0	0	0	0	0
Capitella sp. complex	129211	0	1	1	0	0	0
Notomastus latericeus	129898	0	0	5	0	0	9
OPHELIIDA	891	0	0	0	0	0	0
Opheliidae	924	0	0	0	0	0	0
Ophelia rathkei	130496	1	0	0	0	0	0
OLIGOCHAETA	2036	0	0	0	0	0	0
HAPLOTAXIDA	2118	0	0	0	0	0	0
Naididae	2039	0	0	0	0	0	0
Tubificoides amplivasatus	137570	0	1	0	0	0	0
ARTHROPODA	1065	0	0	0	0	0	0
CRUSTACEA	1066	0	0	0	0	0	0
MALACOSTRACA	1071	0	0	0	0	0	0
AMPHIPODA	1135	0	0	0	0	0	0
Oedicerotidae	101400	0	0	0	0	0	0
Pontocrates arcticus	102917	0	0	3	0	0	2
Atylidae	146525	0	0	0	0	0	0
Nototropis swammerdamei	488966	0	0	1	0	0	1
Pontoporeiidae	101406	0	0	0	0	0	0
Bathyporeia sp. (damaged)	101742	1	0	0	0	0	0
Bathyporeia elegans	103058	1	0	8	0	0	5

JN1651 Dublin Array - Poolbeg							
Station	**AphiaID**	**Pb1.UPP**	**Pb1.MID**	**Pb1.LWR**	**Pb2.UPP**	**Pb2.MID**	**Pb2.LWR**
Bathyporeia pilosa	103068	3	0	0	3	0	0
ISOPODA	1131	0	0	0	0	0	0
Cirolanidae	118273	0	0	0	0	0	0
Eurydice pulchra	118852	1	0	0	1	0	0
CUMACEA	1137	0	0	0	0	0	0
Bodotriidae	110378	0	0	0	0	0	0
Cumopsis goodsir	110465	1	2	0	0	2	0
Pseudocumatidae	110384	0	0	0	0	0	0
Monopseudocuma gilsoni	422916	0	1	3	0	0	0
MOLLUSCA	51	0	0	0	0	0	0
GASTROPODA	101	0	0	0	0	0	0
LITTORINIMORPHA	382213	0	0	0	0	0	0
Hydrobiidae	120	0	0	0	0	0	0
Peringia ulvae	151628	0	1	0	0	0	0
BIVALVIA	105	0	0	0	0	0	0
CARDIIDA	869602	0	0	0	0	0	0
Cardiidae	229	0	0	0	0	0	0
Cerastoderma edule	138998	0	0	0	1	0	0
Tellinidae	235	0	0	0	0	0	0
Macomangulus tenuis	878470	1	22	2	1	12	2
Donacidae	236	0	0	0	0	0	0
Donax vittatus	139604	0	0	1	0	1	2

Appendix 2
Particle Size Analysis

Sample Statistics

	SHANGANAGH	SH1 Lower	SH1 Mid	SH1 Upper	SH2 Lower	SH2 Mid	SH2 Upper
	SAMPLE TYPE:	Trimodal, Moderately Sorted	Polymodal, Poorly Sorted	Polymodal, Very Poorly Sorted	Unimodal, Well Sorted	Polymodal, Poorly Sorted	Polymodal, Very Poorly Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Sandy Gravel	Sandy Gravel	Sand	Sandy Gravel	Sandy Gravel
	SEDIMENT NAME:	Slightly Very Fine Gravelly Medium Sand	Sandy Fine Gravel	Sandy Medium Gravel	Well Sorted Fine Sand	Sandy Medium Gravel	Sandy Fine Gravel
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	420.2	2925.3	3026.9	164.9	4752.1	3735.8
	SORTING (σ_a):	442.0	1745.9	3601.6	73.11	3579.1	3656.1
	SKEWNESS (Sk_a):	6.654	-0.146	0.998	7.217	0.400	0.597
	KURTOSIS (K_a):	61.04	1.498	2.376	88.15	1.490	1.836
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	331.6	2053.1	1135.7	153.7	3118.7	1610.8
	SORTING (σ_g):	1.846	2.774	4.489	1.361	2.833	4.442
	SKEWNESS (Sk_g):	0.215	-1.362	0.171	0.190	-0.932	-0.222
	KURTOSIS (K_g):	7.749	4.334	1.577	17.90	4.352	1.554
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	1.593	-1.038	-0.184	2.702	-1.641	-0.688
	SORTING (σ_ϕ):	0.884	1.472	2.166	0.445	1.502	2.151
	SKEWNESS (Sk_ϕ):	-0.215	1.362	-0.171	-0.190	0.932	0.222
	KURTOSIS (K_ϕ):	7.749	4.334	1.577	17.90	4.352	1.554
FOLK AND WARD METHOD (μm)	MEAN (M_G):	358.4	2071.5	1164.0	151.0	3534.7	1839.0
	SORTING (σ_G):	1.693	2.589	4.518	1.303	2.626	4.420
	SKEWNESS (Sk_G):	0.357	-0.420	0.364	0.036	-0.260	-0.277
	KURTOSIS (K_G):	1.272	0.970	0.618	2.406	0.632	0.605
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	1.480	-1.051	-0.219	2.728	-1.822	-0.879
	SORTING (σ_I):	0.760	1.373	2.176	0.382	1.393	2.144
	SKEWNESS (Sk_I):	-0.357	0.420	-0.364	-0.036	0.260	0.277
	KURTOSIS (K_G):	1.272	0.970	0.618	2.406	0.632	0.605
FOLK AND WARD METHOD (Description)	MEAN:	Medium Sand	Very Fine Gravel	Very Coarse Sand	Fine Sand	Very Fine Gravel	Very Coarse Sand
	SORTING:	Moderately Sorted	Poorly Sorted	Very Poorly Sorted	Well Sorted	Poorly Sorted	Very Poorly Sorted

	SHANGANAGH	SH1 Lower	SH1 Mid	SH1 Upper	SH2 Lower	SH2 Mid	SH2 Upper
	SKEWNESS:	Very Coarse Skewed	Very Fine Skewed	Very Coarse Skewed	Symmetrical	Fine Skewed	Fine Skewed
	KURTOSIS:	Leptokurtic	Mesokurtic	Very Platykurtic	Very Leptokurtic	Very Platykurtic	Very Platykurtic
	MODE 1 (μm):	302.5	4800.0	302.5	152.5	9600.0	302.5
	MODE 2 (μm):	605.0	2400.0	605.0		1200.0	605.0
	MODE 3 (μm):	152.5	1200.0	152.5		2400.0	152.5
	MODE 1 (ϕ):	1.747	-2.243	1.747	2.737	-3.243	1.747
	MODE 2 (ϕ):	0.747	-1.243	0.747		-0.243	0.747
	MODE 3 (ϕ):	2.737	-0.243	2.737		-1.243	2.737
	D_{10} (μm):	154.6	320.2	179.2	127.1	1059.7	262.8
	D_{50} (μm):	308.0	2557.4	690.6	151.0	4033.7	2448.6
	D_{90} (μm):	658.5	5172.4	9452.9	179.4	10088.8	9666.8
	(D_{90} / D_{10}) (μm):	4.260	16.15	52.75	1.412	9.520	36.78
	(D_{90} - D_{10}) (μm):	503.9	4852.2	9273.7	52.32	9029.1	9404.0
	(D_{75} / D_{25}) (μm):	1.934	3.657	16.66	1.240	6.557	16.62
	(D_{75} - D_{25}) (μm):	247.5	3335.9	4642.6	32.60	7309.8	5116.3
	D_{10} (ϕ):	0.603	-2.371	-3.241	2.479	-3.335	-3.273
	D_{50} (ϕ):	1.699	-1.355	0.534	2.728	-2.012	-1.292
	D_{90} (ϕ):	2.694	1.643	2.480	2.976	-0.084	1.928
	(D_{90} / D_{10}) (ϕ):	4.469	-0.693	-0.765	1.201	0.025	-0.589
	(D_{90} - D_{10}) (ϕ):	2.091	4.014	5.721	0.497	3.251	5.201
	(D_{75} / D_{25}) (ϕ):	1.987	0.149	-0.761	1.121	0.127	-0.659
	(D_{75} - D_{25}) (ϕ):	0.952	1.871	4.058	0.311	2.713	4.055
	% GRAVEL:	1.3%	70.7%	42.3%	0.0%	70.7%	52.5%
	% SAND:	98.5%	29.2%	57.6%	99.9%	29.2%	47.4%
	% MUD:	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
	% V COARSE GRAVEL:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

	SHANGANAGH	SH1 Lower	SH1 Mid	SH1 Upper	SH2 Lower	SH2 Mid	SH2 Upper
	% COARSE GRAVEL:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% MEDIUM GRAVEL:	0.0%	0.0%	19.8%	0.0%	32.2%	22.9%
	% FINE GRAVEL:	0.6%	42.4%	13.8%	0.0%	18.3%	25.5%
	% V FINE GRAVEL:	0.7%	28.4%	8.6%	0.0%	20.2%	4.1%
	% V COARSE SAND:	4.2%	13.2%	6.9%	0.2%	23.3%	5.7%
	% COARSE SAND:	21.0%	4.0%	10.1%	0.5%	1.8%	11.4%
	% MEDIUM SAND:	58.1%	7.1%	30.6%	8.5%	1.6%	23.9%
	% FINE SAND:	12.9%	4.7%	9.7%	84.6%	2.2%	6.2%
	% V FINE SAND:	2.3%	0.2%	0.3%	6.1%	0.3%	0.3%
	% V COARSE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% COARSE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% MEDIUM SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% FINE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% V FINE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% CLAY:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

	POOLBEG	PB1 Lower	PB1 Mid	PB1 Upper	PB2 Lower	PB2 Mid	PB2 Upper
	SAMPLE TYPE:	Bimodal, Moderately Sorted	Bimodal, Well Sorted	Bimodal, Well Sorted	Bimodal, Moderately Sorted	Bimodal, Well Sorted	Unimodal, Very Well Sorted
	TEXTURAL GROUP:	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
	SEDIMENT NAME:	Slightly Very Fine Gravelly Fine Sand	Slightly Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand	Slightly Very Fine Gravelly Fine Sand
METHOD OF MOMENTS Arithmetic (μm)	MEAN $(\bar{x}_a)$:	254.8	151.2	168.7	259.3	152.6	158.4
	SORTING (σ_a):	635.2	183.5	134.3	635.1	132.5	105.0
	SKEWNESS (Sk_a):	5.864	18.93	8.134	6.062	12.03	13.23
	KURTOSIS (K_a):	39.12	439.4	99.94	41.10	182.0	239.2
METHOD OF MOMENTS Geometric (μm)	MEAN $(\bar{x}_g)$:	138.2	132.7	148.2	148.1	136.1	145.8
	SORTING (σ_g):	2.120	1.474	1.507	2.029	1.460	1.377
	SKEWNESS (Sk_g):	2.528	1.285	1.300	2.732	1.082	0.850
	KURTOSIS (K_g):	12.46	19.57	13.12	13.95	17.28	23.45
METHOD OF MOMENTS Logarithmic (ϕ)	MEAN $(\bar{x}_\phi)$:	2.855	2.914	2.754	2.755	2.877	2.778
	SORTING (σ_ϕ):	1.084	0.559	0.592	1.021	0.546	0.461
	SKEWNESS (Sk_ϕ):	-2.528	-1.285	-1.300	-2.732	-1.082	-0.850
	KURTOSIS (K_ϕ):	12.46	19.57	13.12	13.95	17.28	23.45
FOLK AND WARD METHOD (μm)	MEAN (M_G):	121.0	125.4	148.2	126.1	127.7	148.3
	SORTING (σ_G):	1.730	1.386	1.344	1.674	1.371	1.225
	SKEWNESS (Sk_G):	-0.077	-0.547	0.002	-0.113	-0.548	-0.279
	KURTOSIS (K_G):	1.391	1.626	2.580	3.409	1.665	1.672
FOLK AND WARD METHOD (ϕ)	MEAN (M_Z):	3.047	2.996	2.754	2.987	2.969	2.753
	SORTING (σ_I):	0.791	0.471	0.427	0.743	0.455	0.293
	SKEWNESS (Sk_I):	0.077	0.547	-0.002	0.113	0.548	0.279
	KURTOSIS (K_G):	1.391	1.626	2.580	3.409	1.665	1.672
FOLK AND	MEAN:	Very Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand	Fine Sand
	SORTING:	Moderately Sorted	Well Sorted	Well Sorted	Moderately Sorted	Well Sorted	Very Well Sorted

	POOLBEG	PB1 Lower	PB1 Mid	PB1 Upper	PB2 Lower	PB2 Mid	PB2 Upper
WARD METHOD (Description)	SKEWNESS:	Symmetrical	Very Fine Skewed	Symmetrical	Fine Skewed	Very Fine Skewed	Fine Skewed
	KURTOSIS:	Leptokurtic	Very Leptokurtic	Very Leptokurtic	Extremely Leptokurtic	Very Leptokurtic	Very Leptokurtic
	MODE 1 (μm):	152.5	152.5	152.5	152.5	152.5	152.5
	MODE 2 (μm):	76.50	76.50	76.50	76.50	76.50	
	MODE 3 (μm):						
	MODE 1 (ϕ):	2.737	2.737	2.737	2.737	2.737	2.737
	MODE 2 (ϕ):	3.731	3.731	3.731	3.731	3.731	
	MODE 3 (ϕ):						
	D_{10} (μm):	70.12	74.02	83.19	73.63	76.02	125.2
	D_{50} (μm):	138.8	143.1	148.2	144.1	144.5	148.3
	D_{90} (μm):	176.5	173.6	178.0	177.3	174.1	175.7
	(D_{90} / D_{10}) (μm):	2.517	2.345	2.139	2.408	2.291	1.404
	(D_{90} - D_{10}) (μm):	106.3	99.57	94.76	103.7	98.12	50.54
	(D_{75} / D_{25}) (μm):	1.949	1.273	1.257	1.296	1.263	1.236
	(D_{75} - D_{25}) (μm):	78.51	34.64	33.97	37.49	33.77	31.49
	D_{10} (ϕ):	2.503	2.526	2.490	2.496	2.522	2.509
	D_{50} (ϕ):	2.849	2.805	2.754	2.795	2.791	2.753
	D_{90} (ϕ):	3.834	3.756	3.587	3.764	3.718	2.998
	(D_{90} / D_{10}) (ϕ):	1.532	1.487	1.440	1.508	1.474	1.195
	(D_{90} - D_{10}) (ϕ):	1.331	1.230	1.097	1.268	1.196	0.489
	(D_{75} / D_{25}) (ϕ):	1.366	1.132	1.127	1.144	1.128	1.118
	(D_{75} - D_{25}) (ϕ):	0.962	0.348	0.330	0.374	0.336	0.306
	% GRAVEL:	3.2%	0.2%	0.1%	2.9%	0.2%	0.1%
	% SAND:	96.5%	99.7%	99.8%	96.9%	99.7%	99.8%
	% MUD:	0.3%	0.1%	0.1%	0.2%	0.1%	0.1%
	% V COARSE GRAVEL:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

	POOLBEG	PB1 Lower	PB1 Mid	PB1 Upper	PB2 Lower	PB2 Mid	PB2 Upper
	% COARSE GRAVEL:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% MEDIUM GRAVEL:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% FINE GRAVEL:	1.4%	0.1%	0.0%	1.5%	0.0%	0.0%
	% V FINE GRAVEL:	1.8%	0.1%	0.1%	1.4%	0.2%	0.1%
	% V COARSE SAND:	1.5%	0.4%	0.6%	1.4%	0.4%	0.3%
	% COARSE SAND:	1.0%	0.5%	2.4%	1.3%	0.8%	0.7%
	% MEDIUM SAND:	1.0%	1.4%	4.4%	1.5%	1.5%	3.2%
	% FINE SAND:	60.7%	75.5%	79.7%	70.3%	78.2%	86.0%
	% V FINE SAND:	32.3%	21.9%	12.7%	22.4%	18.8%	9.6%
	% V COARSE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% COARSE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% MEDIUM SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% FINE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% V FINE SILT:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	% CLAY:	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Appendix 3

SOCOTEC UK

Sediment Chemistry Analysis Report

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00965	
Issue Version	1	
Customer	Aquafact International Services Ltd, 12 Kilkerrin Park, Liosbaun Industrial Estate, Tuam Rd, Galway, Ireland	
Customer Reference	Dublin Bay, IRL	
Date Sampled	31/03/21-01/04/21	
Date Received	07-Apr-21	
Date Reported	28-Apr-21	
Condition of samples	Cold	Satisfactory

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	%	%	% M/M	% M/M
		Method No	ASC/SOP/303	ASC/SOP/303	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	0.2	0.2	0.02	0.12
		Accreditation	UKAS	UKAS	UKAS	No
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**TOC**	**Carbonate Equivalent (%CO3)**
Sh1.UPP	MAR00965.001	Sediment	5.4	94.6	0.13	10.2
Sh1.MID	MAR00965.002	Sediment	5.0	95.0	0.18	15.2
Sh1.LWR	MAR00965.003	Sediment	26.2	73.8	0.14	9.96
Sh2.UPP	MAR00965.004	Sediment	7.6	92.4	0.14	11.9
Sh2.MID	MAR00965.005	Sediment	3.4	96.6	0.22	20.8
Sh2.IWR	MAR00965.006	Sediment	28.5	71.5	0.10	6.84
Pb1.UPP	MAR00965.007	Sediment	19.4	80.6	0.07	4.44
Pb1.MID	MAR00965.008	Sediment	27.9	72.1	0.09	4.20
Pb1.LWR	MAR00965.009	Sediment	27.2	72.8	0.10	5.64
Pb2.UPP	MAR00965.010	Sediment	26.5	73.5	0.07	2.52
Pb2.MID	MAR00965.011	Sediment	26.3	73.7	0.08	3.00
Pb2.LWR	MAR00965.012	Sediment	27.9	72.1	0.11	5.16
		Reference Material (% Recovery)	N/A	N/A	101	92
		QC Blank	N/A	N/A	<0.02	<0.12

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID MAR00965
Issue Version 1
Customer Reference Dublin Bay, IRL

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	1	0.1	0.5	2	2	0.5	3
		Accreditation	UKAS	No	No	UKAS	UKAS	No	No
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic as As**	**Cadmium as Cd**	**Total Chromium as Cr**	**Copper as Cu**	**Lead as Pb**	**Nickel as Ni**	**Zinc as Zn**
Sh1.UPP	MAR00965.001	Sediment	34.4	<0.1	18.6	11.9	14.9	11.4	42.1
Sh1.MID	MAR00965.002	Sediment	41.6	<0.1	26.3	14.9	12.2	18.4	43.5
Sh1.LWR	MAR00965.003	Sediment	44.8	<0.1	23.1	11.6	15.5	13.7	46.5
Sh2.UPP	MAR00965.004	Sediment	47.0	<0.1	24.5	13.8	18.6	15.8	46.3
Sh2.MID	MAR00965.005	Sediment	54.7	<0.1	30.2	13.6	18.1	19.1	51.9
Sh2.IWR	MAR00965.006	Sediment	59.6	<0.1	21.9	13.0	16.5	12.3	45.2
Pb1.UPP	MAR00965.007	Sediment	59.3	<0.1	19.3	8.6	10.0	8.1	30.2
Pb1.MID	MAR00965.008	Sediment	56.5	<0.1	27.5	11.0	10.3	8.6	32.1
Pb1.LWR	MAR00965.009	Sediment	54.9	<0.1	91.5	9.5	12.9	13.1	43.6
Pb2.UPP	MAR00965.010	Sediment	51.8	<0.1	19.2	9.1	10.3	8.3	33.6
Pb2.MID	MAR00965.011	Sediment	50.0	<0.1	26.1	10.4	9.2	9.5	34.4
Pb2.LWR	MAR00965.012	Sediment	50.3	<0.1	80.4	9.5	12.9	12.1	43.5
Certified Reference Material 2702 (% Recovery)			101	102~	101~	107	95	101~	95~
QC Blank			<1	<0.1	<0.5	<2	<2	<0.5	<3

* See Report Notes
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	SOCOTEC Env Chem*	SOCOTEC Env Chem*	SOCOTEC Env Chem*
		Limit of Detection	0.01	10	0.5
		Accreditation	No	UKAS	No
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Mercury as Hg**	**Aluminium as Al**	**Lithium as Li**
Sh1.UPP	MAR00965.001	Sediment	<0.01	15900	23.2
Sh1.MID	MAR00965.002	Sediment	0.01	19100	20.9
Sh1.LWR	MAR00965.003	Sediment	<0.01	16800	21.4
Sh2.UPP	MAR00965.004	Sediment	<0.01	18100	20.7
Sh2.MID	MAR00965.005	Sediment	<0.01	17100	20.2
Sh2.lWR	MAR00965.006	Sediment	<0.01	20200	23.7
Pb1.UPP	MAR00965.007	Sediment	<0.01	14900	14.3
Pb1.MID	MAR00965.008	Sediment	<0.01	15700	13.3
Pb1.LWR	MAR00965.009	Sediment	<0.01	15100	13.0
Pb2.UPP	MAR00965.010	Sediment	<0.01	14400	12.9
Pb2.MID	MAR00965.011	Sediment	<0.01	15700	13.2
Pb2.LWR	MAR00965.012	Sediment	<0.01	15200	12.7
Certified Reference Material 2702 (% Recovery)			99~	102	101
QC Blank			<0.01	<10	<0.5

* See Report Notes

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
Sh1.UPP	MAR00965.001	Sediment	<1	<1
Sh1.MID	MAR00965.002	Sediment	<1	<1
Sh1.LWR	MAR00965.003	Sediment	<1	<1
Sh2.UPP	MAR00965.004	Sediment	<1	<1
Sh2.MID	MAR00965.005	Sediment	<1	<1
Sh2.lWR	MAR00965.006	Sediment	<1	<1
Pb1.UPP	MAR00965.007	Sediment	<1	<1
Pb1.MID	MAR00965.008	Sediment	<1	<1
Pb1.LWR	MAR00965.009	Sediment	<5	<5
Pb2.UPP	MAR00965.010	Sediment	<5	<5
Pb2.MID	MAR00965.011	Sediment	<5	<5
Pb2.LWR	MAR00965.012	Sediment	<5	<5
Certified Reference Material BCR-646 (% Recovery)			94	77
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
Sh1.UPP	MAR00965.001	Sediment	<1	<1	<1	<1	<1	1.09
Sh1.MID	MAR00965.002	Sediment	<1	<1	<1	2.03	<1	<1
Sh1.LWR	MAR00965.003	Sediment	<1	<1	1.23	4.28	3.85	3.69
Sh2.UPP	MAR00965.004	Sediment	<1	<1	2.15	8.66	8.94	6.52
Sh2.MID	MAR00965.005	Sediment	<1	<1	<1	<1	<1	<1
Sh2.lWR	MAR00965.006	Sediment	1.65	<1	5.09	13.5	11.2	9.18
Pb1.UPP	MAR00965.007	Sediment	<1	<1	<1	<1	<1	<1
Pb1.MID	MAR00965.008	Sediment	<1	<1	<1	1.88	1.96	1.63
Pb1.LWR	MAR00965.009	Sediment	<1	<1	<1	<1	<1	1.22
Pb2.UPP	MAR00965.010	Sediment	<1	<1	<1	<1	<1	1.12
Pb2.MID	MAR00965.011	Sediment	<1	<1	<1	<1	<1	1.15
Pb2.LWR	MAR00965.012	Sediment	<1	<1	<1	<1	<1	1.08
Certified Reference Material Quasimeme QPH100MS (% Recovery)			84	128	94	73	77	69
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
Sh1.UPP	MAR00965.001	Sediment	1.04	<1	2.05	<1	1.43	<1
Sh1.MID	MAR00965.002	Sediment	<1	<1	1.87	<1	1.32	<1
Sh1.LWR	MAR00965.003	Sediment	3.73	2.90	5.34	<1	8.17	<1
Sh2.UPP	MAR00965.004	Sediment	7.76	4.47	9.45	1.80	15.5	<1
Sh2.MID	MAR00965.005	Sediment	<1	<1	1.58	<1	<1	<1
Sh2.IWR	MAR00965.006	Sediment	10.0	6.76	15.5	1.79	28.2	1.48
Pb1.UPP	MAR00965.007	Sediment	<1	<1	<1	<1	<1	<1
Pb1.MID	MAR00965.008	Sediment	2.48	1.82	2.76	<1	2.68	<1
Pb1.LWR	MAR00965.009	Sediment	1.39	<1	1.01	<1	<1	<1
Pb2.UPP	MAR00965.010	Sediment	<1	<1	1.21	<1	1.27	<1
Pb2.MID	MAR00965.011	Sediment	1.08	<1	<1	<1	1.13	<1
Pb2.LWR	MAR00965.012	Sediment	1.16	<1	<1	<1	<1	<1
Certified Reference Material Quasimeme QPH100MS (% Recovery)			86	91	80	80	76	82
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.
As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
Sh1.UPP	MAR00965.001	Sediment	<1	<1	2.53	1.55	917
Sh1.MID	MAR00965.002	Sediment	<1	<1	2.29	1.43	768
Sh1.LWR	MAR00965.003	Sediment	3.28	<1	5.16	7.67	2820
Sh2.UPP	MAR00965.004	Sediment	7.36	<1	8.29	12.9	1160
Sh2.MID	MAR00965.005	Sediment	<1	<1	2.02	<1	782
Sh2.IWR	MAR00965.006	Sediment	9.69	<1	19.0	22.6	2080
Pb1.UPP	MAR00965.007	Sediment	<1	<1	<1	1.14	2120
Pb1.MID	MAR00965.008	Sediment	2.41	<1	1.01	2.98	1950
Pb1.LWR	MAR00965.009	Sediment	1.43	<1	<1	<1	3650
Pb2.UPP	MAR00965.010	Sediment	<1	<1	1.63	1.26	2040
Pb2.MID	MAR00965.011	Sediment	1.26	<1	<1	1.16	3810
Pb2.LWR	MAR00965.012	Sediment	1.28	<1	<1	1.11	5210
Certified Reference Material Quasimeme QPH100MS (% Recovery)			82	82	79	81	99~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR00965
Issue Version	1
Customer Reference	Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
Sh1.UPP	MAR00965.001	Sediment	0.12	0.15	<0.08	<0.08	<0.08	<0.08	<0.08
Sh1.MID	MAR00965.002	Sediment	0.14	0.15	<0.08	<0.08	<0.08	<0.08	<0.08
Sh1.LWR	MAR00965.003	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Sh2.UPP	MAR00965.004	Sediment	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08
Sh2.MID	MAR00965.005	Sediment	0.10	0.12	<0.08	<0.08	<0.08	<0.08	<0.08
Sh2.IWR	MAR00965.006	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Pb1.UPP	MAR00965.007	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Pb1.MID	MAR00965.008	Sediment	0.19	0.20	<0.08	<0.08	<0.08	<0.08	<0.08
Pb1.LWR	MAR00965.009	Sediment	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08
Pb2.UPP	MAR00965.010	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Pb2.MID	MAR00965.011	Sediment	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08
Pb2.LWR	MAR00965.012	Sediment	0.32	0.39	0.28	0.28	0.18	0.21	0.18
Certified Reference Material Quasimeme QOR142MS (% Recovery)			98	101	98	103	117	99	72
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Specialist Chemistry, Etwall House, Bretby Business Park, Ashby Road, Bretby, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID MAR00965
Issue Version 1
Customer Reference Dublin Bay, IRL

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		Accreditation	UKAS	N*	UKAS	UKAS	UKAS	UKAS	UKAS	N*
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**AHCH**	**BHCH**	**GHCH**	**DIELDRIN**	**HCB**	**DDE**	**DDT**	**DDD**
Sh1.UPP	MAR00965.001	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sh1.MID	MAR00965.002	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sh1.LWR	MAR00965.003	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sh2.UPP	MAR00965.004	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sh2.MID	MAR00965.005	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sh2.IWR	MAR00965.006	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb1.UPP	MAR00965.007	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb1.MID	MAR00965.008	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb1.LWR	MAR00965.009	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb2.UPP	MAR00965.010	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb2.MID	MAR00965.011	Sediment	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pb2.LWR	MAR00965.012	Sediment	<0.1	0.31	0.27	0.24	<0.1	0.32	0.53	0.41
Certified Reference Material Quasimeme QOR142MS (% Recovery)			95	75~	88	48	75	107	77	109
QC Blank			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

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SOCOTEC

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Issue Version 1
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REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
SOCOTEC Env Chem*	MAR00965.001-012	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ASC/SOP/301	MAR00965.009-012	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/302	MAR00965.001-012	The Primary process control data associated with this Test has not wholly met the requirements of the Laboratory Quality Management System QMS with one or more target analytes falling outside acceptable limits. The remaining data gives the Laboratory confidence that the test has performed satisfactorily and that the validity of the data may not have been significantly affected.However in line with our QMS policy we have removed accreditation, where applicable, from the affected analytes (BHCH & DDD) . These circumstances should be taken into consideration when utilising the data.
ASC/SOP/303/304	MAR00965.001-006, 008-010.	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	Sample Contaminated through Damaged Packaging	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A
D12	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

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Test Report ID	MAR00965
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Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Total Organic Carbon (TOC)	Air dried and seived to <2mm	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Carbonate	Air dried and seived to <2mm	Quantitative digestion with Hydrochloric Acid back titration with 1M Sodium Hydroxide to pH 7
Metals	Air dried and seived to <2mm	HF/Boric extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.
Organochlorine Pesticides (OCPs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichorodiphenyldicloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		