



**Aughinish**  
**Baseline Characterisation Report**

**Produced by**

**AQUAFAC International Services Ltd**

**Prepared for**  
**Malachy Walsh & Partners**  
**On behalf of**  
**Rusal Aughinish**

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## 1. Executive Summary

AQUAFAC International Services Ltd. was commissioned by Malachy Walsh & Partners on behalf of Rusal Aughinish to carry out a baseline assessment of the area around the jetty at Aughinish as part of a proposed dredging campaign. Sediment characterisation was also required from the dredge areas. The dredging site is located within the River Shannon and River Fergus Estuaries SPA (Site Code IE004077) and Lower Shannon SAC (Site Code IE002165). Also located near the dredge site is c. 10.9km southwest Stacks to Mullaghereirk Mountains, West Limerick Hills and Mount Eagles SPA (Site Code IE004161), c. 12.36 southeast Curraghchase Woods SAC (Site Code IE000174), c. 4.6km southeast Barrigone SAC (Site Code IE000432) and c. 8.8km southeast Askeaton Fen Complex SAC (Site Code IE002279).

Sediment samples were taken at eight stations for macrofauna (animals that live within the seabed sediments and that are greater than 1mm in size), granulometry and organic carbon. Of these, three stations located within the proposed dredging areas were also analysed for radiological and chemical composition.

All macrofaunal species recorded are typically of the silt/clay habitat that contain high levels of organic enrichment. Some of the main dominants of the assemblage include the following major groups: sea anemones (1), nematodes (1), nemertean (1), marine worms (120), crustaceans (2), and molluscs (3). The granulometric results showed that the sediments around the pier are relatively uniform with all sediments being defined as silt and fine/medium sand. The biggest variation was found at station 8 which was 89.5% fine/medium sand and 10.5% silt. All other stations were close to 50/50 between fine/ medium sand and silt.

Organic carbon levels ranged from 2.75% to 6.68% which is not considered high for sediments with a high silt content. The lowest organic carbon level was found at station 8 which is expected due to its lower silt content.

The radiological analysis was carried out on a composite sample of stations 1, 2 and 3. The radiological results were low and do not give rise to any radiological hazard.

The chemical analysis found that all parameter except Zinc, Nickel, Arsenic and PAH  $\Sigma 16$  were below Irish action limits. Nickel and Arsenic were both above the lower Irish action limit at station 3 but did not exceed the upper limit. PAH  $\Sigma 16$  was above the lower Irish action limits for station 2, there are currently no upper Irish action limit for this parameter. Zinc was found to have exceed the upper Irish action limit at station 1.

The final approval for suitability to dispose of at sea lies with the EPA (under advice from the Marine Institute).

## **2. Introduction**

AQUAFAC International Services Ltd. was commissioned by Malachy Walsh & Partners on behalf of Rusal Aughinish to carry out a baseline assessment of the area around the jetty at Aughinish as part of a proposed dredging campaign. Sediment characterisation was also required from the dredge areas in line with Cronin *et al.* (2006) 'Guidelines for the assessment of dredge material for disposal in Irish waters'.

The dredging site is located within the River Shannon and River Fergus Estuaries SPA (Site Code IE004077) and Lower Shannon SAC (Site Code IE002165). Also located near the dredge site is c. 10.9km southwest Stacks to Mullaghereirk Mountains, West Limerick Hills and Mount Eagles SPA (Site Code IE004161), c. 12.36 southeast Curraghchase Woods SAC (Site Code IE000174), c. 4.6km southeast Barrigone SAC (Site Code IE000432) and c. 8.8km southeast Askeaton Fen Complex SAC (Site Code IE002279).

## **3. Description of Proposed Works**

The areas to be plough dredged can be seen in Figure 2.1. The quantities to be dredged will be in the region of 16,000 tonnes. As the areas will be plough dredged, the dredge areas will also act as the dumpsites. It is proposed to carry out the proposed dredging in late spring – early summer. Currently, an application for a Dumping At Sea licence is being completed for submission to the EPA.



Figure 3.1: Location of dredge areas.

## 4. Materials & Methods

### 4.1. *Sampling Procedure*

All sampling took place on the 25<sup>th</sup> November 2015. AQUAFACt has in-house standard operational procedures for benthic sampling and these were followed for this project. Additionally, the recently published MESH report on “Recommended standard methods and procedures” were adhered to.

In total, 8 locations were sampled within and around the dredge areas (see Figure 3.1). All 8 sites were sampled for the subtidal faunal assessment (including grain size analysis and organic carbon analysis) and Stations 1 - 3 were sampled for the sediment characterisation survey. Station coordinates and depths can be seen in Table 3.1. Samples were retrieved using a 0.025m<sup>2</sup> van Veen grab.

Two replicate grab samples were collected at 7 of the 8 faunal analysis. A faunal sample could not be collected at Station 1 due to difficulties in retrieving a sample in the grab possibly due to large heavy burdened ships displacing sediment as they dock.

Each sample was 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. Very stiff clay was fragmented very carefully by hand. 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 immediately with Eosin-briebrich scarlet and fixed immediately in with 4% w/v buffered formaldehyde solution (10% w/v buffered formaldehyde solution for very organic mud). These samples were ultimately preserved in 70% alcohol upon return to the laboratory. The grab sampler was cleaned between stations to prevent cross contamination.

An additional sample was collected at all 8 stations for grain size analysis and organic carbon content.

All sampling jars were marked externally with date, station number, sample number and survey reference number and placed in a cooler box.

The sediment characterisation survey involved collecting grab samples at Stations 1 to 3 in the dredge areas - 2 of these stations which were selected by the Marine Institute had to be relocated as the sites

of the original samples were occupied by vessels. Appendix 1 shows the requirements of the Marine Institute. The grab samples were divided up for contaminant analysis, radiological analysis organic carbon content, particle size analysis, sediment density and moisture content. All sampling jars were marked externally with date, station number, sample number and survey reference number and placed in a cooler box. Table 3.3 shows the required determinands at each station.

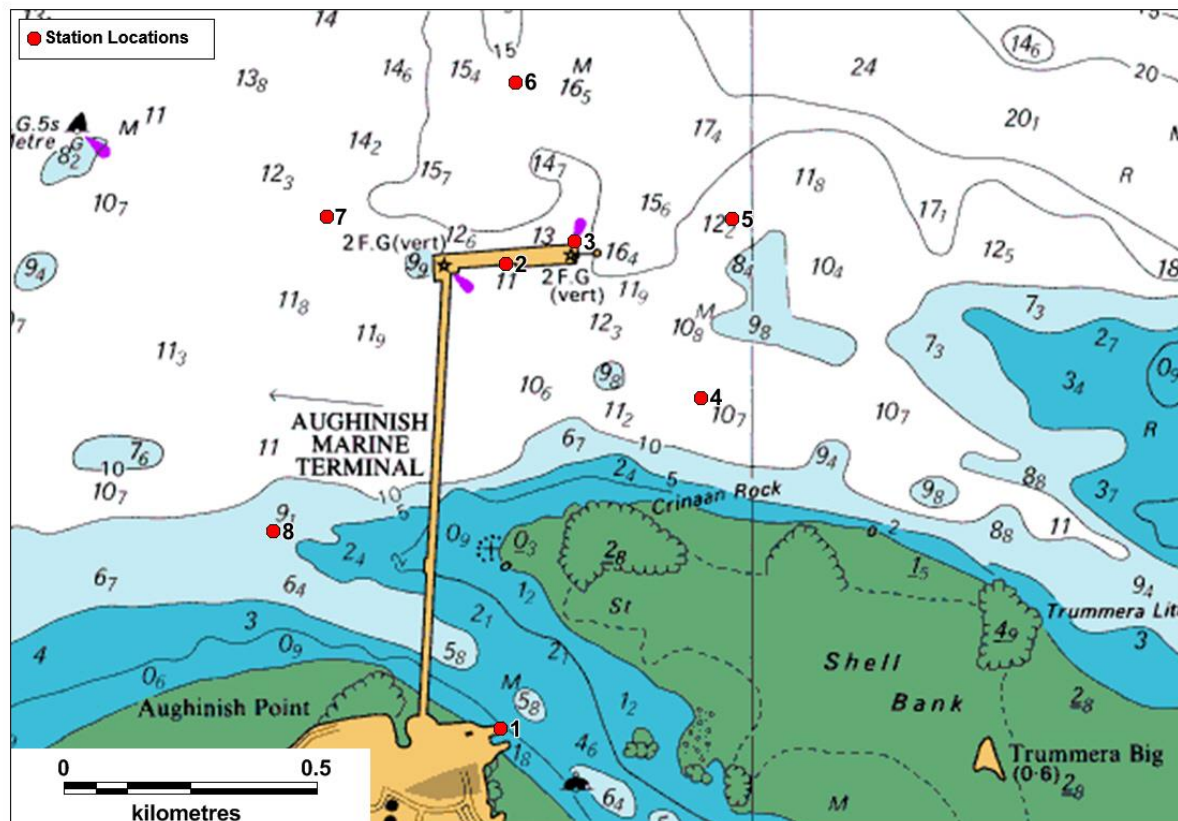


Figure 4.1: Station locations

Table 4.1: Coordinates of faunal grab sampling stations.

Station	Longitude	Latitude	Requirements
1	-9.05795	52.63691	Fauna & Chemistry
2	-9.05779	52.64514	Fauna & Chemistry
3	-9.05578	52.64555	Fauna & Chemistry
4	-9.0521	52.64278	Fauna
5	-9.0512	52.64594	Fauna
6	-9.05751	52.64837	Fauna
7	-9.06303	52.64599	Fauna
8	-9.06457	52.64041	Fauna

## **4.2. Sample Processing**

### **4.2.1. Fauna**

All faunal samples were 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, nemertean, 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.

### **4.2.2. Sediment**

Once back in the lab, all sediment samples for the analysis of organics and contaminants were sent to the Environmental Scientifics Group Limited in Staffordshire. A composite of the Stations 1, 2 and 3 was sent to the RPII for radiological analysis. Organic carbon by Loss on Ignition for the faunal samples was carried out by ALS Labs in Loughrea. AQUAFAC carried out the particle size analysis and moisture and density content as described below.

#### **4.2.2.1. Particle Size Analysis (PSA)**

AQUAFAC 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 100°C 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.

#### 4.2.2.2. *Moisture Content & Density*

Moisture content was taken as the percentage weight difference between the wet and dried sediment. Sediment density was calculated by placing a fixed volume (100 ml) of sediment in a volumetric cylinder and weighing the contents.

#### 4.2.2.3. *Organic Matter*

All organic matter samples from the faunal survey were sent to ALS Labs for analysis. The following methodology was used:

1. The collected sediments were transferred to aluminium trays, homogenised by hand and dried in an oven at 100° C for 24 hours.
2. A sample of dried sediment was placed in a mortar and pestle and ground down to a fine powder.
3. 1g of this ground sediment was weighed into a pre-weighed crucible and placed in a muffle furnace at 450°C for a period of 6 hours.
4. The sediment samples were then allowed to cool in a desiccator for 1 hour before being weighed again.

The organic content of the sample was determined by expressing as a percentage of the weight of the sediment after ignition over the initial weight of the sediment.

#### 4.2.2.4. Chemical Analysis

The following methodologies were employed by ESG method code in brackets.

- Total Organic Carbon analysis: carbonate removal and sulphurous acid/combustion at 800°C/NDIR. (WSLM59)
- Carbonate content analysis: acid based titration to preset pH, (ANC)
- Total hydrocarbons: marine specification by GC-FID. (TPHSED)
- Organotins are extracted into an acidified solvent, derivatised with sodium tetraborate and then solvent extracted into hexane. The samples are cleaned up by SPE and the analysis is carried out by GC-MS/MS.
- Metal analysis: microwave assisted hydrofluoric acid digestion followed by ICPMS quantification, (SEDMS) and microwave assisted hydrofluoric acid digestion followed by ICPOES quantification, (SEDOES) for Al and Ai.
- PAH analysis: DTI specification by GC-MS, (PAHSED)
- PCB analysis: solvent extraction and determination by GCECD, (PCBCONEC).
- Organochlorine pesticides: sonicated extraction followed by GCMS analysis in selective ion monitoring mode, (PESTSW)

All tests were carried out on the <2mm fraction.

The Limits of detection can be seen in Table 3.3.

**Table 4:2: Limits of Detection**

Parameter	Unit	LOD
Hydrocarbons	mg/kg	0.001
Mercury	mg/kg	0.08
Aluminium	mg/kg	10.0
Arsenic	mg/kg	0.05
Cadmium	mg/kg	0.02
Chromium	mg/kg	2.0
Copper	mg/kg	2.0
Lead	mg/kg	1.5
Lithium	mg/kg	2.0
Nickel	mg/kg	2.0
Zinc	mg/kg	3.0
OCP	mg/kg	0.001-0.01
OCP (HCH & HCB)	µg/kg	0.1
PAH	µg/kg	1.0
PCBs	µg/kg	1.0

Parameter	Unit	LOD
DBT	mg/kg	0.005
TBT	mg/kg	0.002

### 4.3. Data Analysis

Statistical evaluation of the faunal data was undertaken using PRIMER v.6 (Plymouth Routines in Ecological Research). Univariate statistics in the form of diversity indices are calculated. Numbers of species and numbers of individuals per sample will be calculated and the following diversity indices will be utilised:

- 1) Margalef's species richness index (D) (Margalef, 1958),

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

where: N is the number of individuals

S is the number of species

- 2) 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 ( $= \log_2 S$ )

- 3) 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  $i^{\text{th}}$  taxa

- 4) Simpson's Diversity Index (Simpson, 1949)

$$1 - \lambda' = 1 - \{ \sum_i N_i (N_i - 1) \} / \{ N(N - 1) \}$$

where N is the number of individuals of species i.

Species richness is a measure of the total number of species present for a given number of individuals. Evenness is a measure of how evenly the individuals are distributed among different species. The Shannon-Wiener index incorporates both species richness and the evenness component of diversity (Shannon & Weaver, 1949) and Simpson's index is a more explicit measure of the latter, i.e. the proportional numerical dominance of species in the sample (Simpson, 1949).

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 was used in order to allow the intermediate abundant species to play a part in the similarity calculation. All species/abundance data from the samples was used to prepare a Bray-Curtis similarity matrix. The similarity matrix was then be used in classification/cluster analysis. The aim of this analysis was to find “natural groupings’ of samples, i.e. samples within a group that are more similar to each other, than they are similar to samples in different groups (Clarke & Warwick, *loc. cit.*). The PRIMER programme CLUSTER carried out this analysis by successively fusing the samples into groups and the groups into larger clusters, beginning with the highest mutual similarities then gradually reducing the similarity level at which groups are formed. The result was represented graphically in a dendrogram, the x-axis representing the full set of samples and the y-axis representing similarity levels at which two samples/groups are said to have fused. SIMPROF (Similarity Profile) permutation tests were incorporated into the CLUSTER analysis to identify statistically significant evidence of genuine clusters in samples which are *a priori* unstructured.

The Bray-Curtis similarity matrix was also be subjected to a non-metric multi-dimensional scaling (MDS) algorithm (Kruskal & Wish, 1978), using the PRIMER programme MDS. This programme produced an ordination, which is a map of the samples in two- or three-dimensions, whereby the placement of samples reflects the similarity of their biological communities, rather than their simple geographical location (Clarke & Warwick, 2001). With regard to stress values, they give an indication of how well the multi-dimensional similarity matrix is represented by the two-dimensional plot. They are calculated by comparing the interpoint distances in the similarity matrix with the corresponding interpoint distances on the 2-d plot. 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 (*loc. cit.*) 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 2-d 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 2-d 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 2-d 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.

The species, which are responsible for the grouping of samples in cluster and ordination 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.

## 5. Results

### 5.1. *Fauna*

#### 5.1.1. Community Analysis

The taxonomic identification of the benthic infauna across all 8 stations sampled at the Aughinish site yielded a total count of 29 taxa including damaged and unidentified individuals, ascribed to six phyla. A complete listing of the taxa abundance is provided in Appendix 1. Of the taxa present, some were identified to species level, the remaining taxa could not be identified to species level because they were juvenile, partially damaged or impossible to identify. The 29 taxa enumerated belonged to the following major groups: Anthozoa (1), Nematoda (1), Nemertea (1), Annelida: Polychaeta (19), Annelida: Oligochaeta (3), Crustacea (2), and Mollusca (3).

#### 5.1.1.1. *Univariate Analysis*

Univariate statistical analyses were carried out on the combined replicate station-by-station faunal data. The following parameters were calculated (see Table 3.2): taxon numbers, number of individuals, richness (d), diversity (H') and evenness (J). No samples were collected at station 1 (STN1) and analysis of the sediment from station 3 (STN3) yielded no macrofauna. The remaining stations were generally species-poor. The number of taxa recorded ranged from 1 (STN7) to 16 (STN4) and were recorded in relatively low abundances (from 2 individuals in STN5 and 7 to 49 specimens in STN4). Diversity and evenness indices were generally low across all stations: Margalef's richness (d) ranged from 0 (STN7) to 3.85 (STN4); Shannon Weiner diversity (H') ranged from 0 (STN7) to 3.64 (STN1) while Evenness (J) ranged from 0.79 (STN4) to 1 (STN8). Considering the low diversity and abundance of macrofauna recorded in most stations any interpretation of these values (evenness in particular) should be conducted with caution.

**Table 5:1: Macrofaunal diversity and evenness indices calculated for grab sampling stations at Aughinish, Co. Limerick.**

Station	No. Taxa	No. Individuals	Richness (d)	Shannon Weiner Diversity (H')	Evenness (J)	Station
STN1	N/A	N/A	N/A	N/A	N/A	STN1
STN2	15	47	3.64	2.43	0.90	STN2
STN3	0	0	-	-	-	STN3
STN4	16	49	3.85	2.19	0.79	STN4
STN5	2	2	1.44	0.69	0.92	STN5
STN6	5	8	1.92	1.49	0.93	STN6
STN7	1	2	0	0	N/A	STN7
STN8	4	4	2.16	1.39	1	STN8

#### 5.1.1.2. *Multivariate Analysis*

The MDS plot and CLUSTER dendrogram are displayed in Figures 4.1 and 4.2 respectively. The stress value of the MDS was 0, usually regarded as an indication of good representation of the data. The MDS showed three main station groupings indicating multivariate similarities in faunal community composition between samples from stations 2 and 4 (forming the significantly distinct group d, see SIMPROF results) and stations 6 and 8 (SIMPROF group d). The remaining stations (3, 5 and 7, those with few or no faunal returns) did not group in a distinct manner.

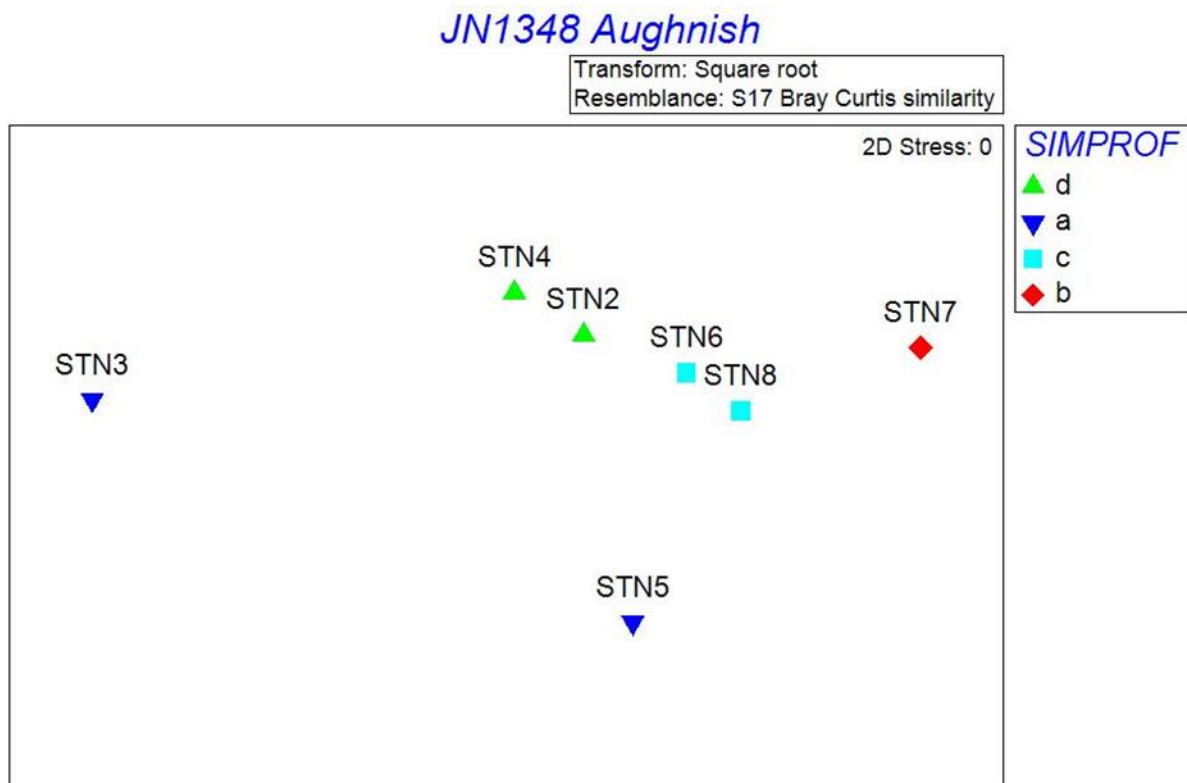
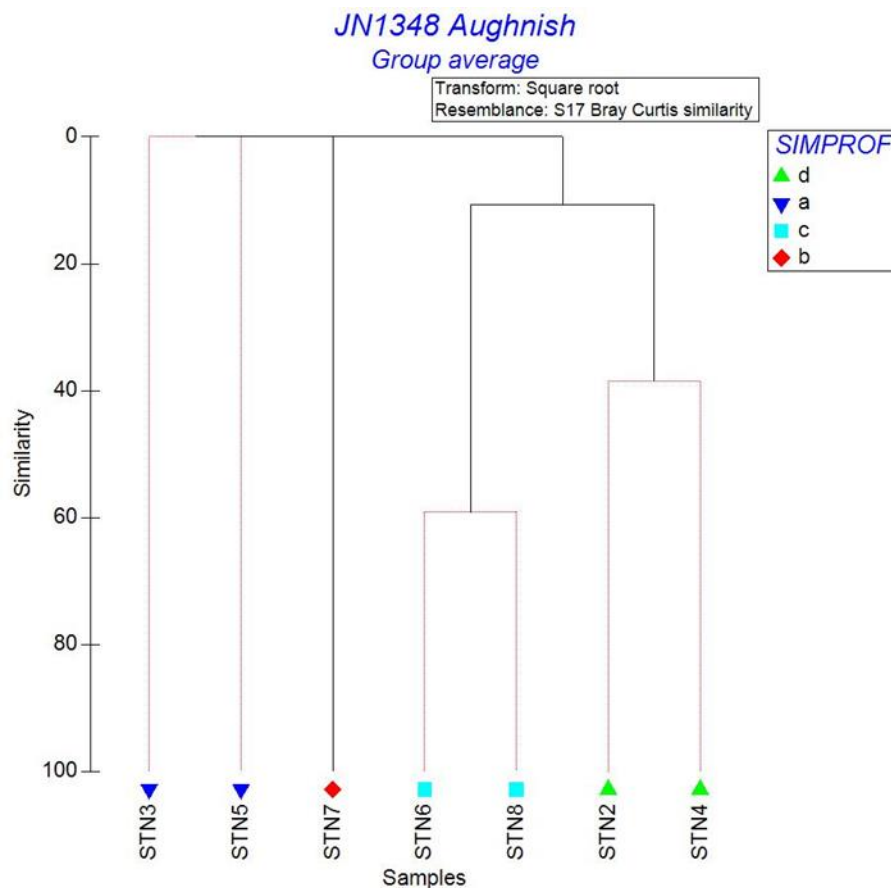


Figure 5.1 MDS plot for stations sampled at the Aughnish site.

SIMPROF analysis revealed four statistically significant groupings between the nine stations sampled, linked by solid lines in the CLUSTER dendrogram (Figure 4.2). Red lines between stations indicated non-statistically significant relationships. However, statistical significance and similarity values following SIMPER and SIMPROF multivariate comparison should be taken with caution due to the poor returns from the majority of samples collected at the survey site.



**Figure 5.2 Dendrogram produced from cluster analysis, Aughnish dredging site.**

The communities at Stations 3 and 5 (**Group a**) had very few (STN5) or no taxa (STN3) resulting in no between and within-station similarity scores (0%). The two taxa found in the sediment samples collected at Station 5 were the polychaete *Protodorvillea kefersteini* (1 specimen) and the oligochaete *Tubificoides amplivastus* (1 specimen). The polychaete *P. kefersteini* is a species indifferent to organic enrichment always present in low densities with no significant variations over time. Tubificid oligochaetes such as *T. amplivastus* are first order opportunists, deposit feeders that thrive in organically enriched, reduced sediments.

Station 7 (**Group b**) separated at 9.01% similarity from the remaining stations. Only one taxon was present in the samples, the amphipod *Corophium volutator* (just two individuals). These are surface deposit-feeders belonging assigned regarded as a Type III species according to Borja *et al.* (2008). Type III taxa are soft-bottom organisms tolerant to excess organic matter that, although present under a variety of conditions, thrive in slightly unbalanced situations (*e.g.* increased organic enrichment from anthropogenic sources).

**Group c** (Stations 6 and 8) had average within-group SIMPER similarity of 59% and branch out as a cluster group at 10.67% similarity. Group c contained 6 taxa (4 of which were present twice or less) comprising 12 individuals. There were three taxa accounting for just over 99.99% of the total between station similarity, led by the polychaete *Prionospio* sp. (33.33% similarity contribution), unidentified mytilids (probably *Mytilus edulis* spat, 33.33%) and the bivalves *Macoma balthica* (33.33% contribution). Other species included the polychaete *Euclymene oerstedii* and the gastropod *Peringia ulvae*. The majority of the species belonging to the genus *Prionospio* are second-order opportunistic species, deposit feeders that thrive present under slight to pronounced disturbed situations (Borja *et al.* 2008). *Mytilus edulis*, *M. balthica* and *P. ulvae* can be found in a variety of environmental conditions but are generally stimulated by the presence of excess organic matter. The polychaete *E. oerstedii* (only one specimen) is a Type I organism according to Borja *et al.* (2008). Type I species are regarded as very sensitive to organic enrichment and normally present under unpolluted conditions.

The SIMPROF **group d** was formed by samples from Stations 2 and 4 with an average within-group similarity of 38.55%. The group also separated at 38.55% similarity from the remaining stations. The faunal assemblage for this group was dominated by cirratulids (damaged thus impossible to identify to species level; 21.24% contribution to the group similarities), *Scoloplos armiger* (also a polychaete, 15.02%), nematodes and nemerteans (21.34% contribution), nephtyid polychaetes (21.34% contribution), capitellids (*Capitella* sp. complex, 10.62%) and tubificid oligochaetes (*T. pseudogaster* agg., 10.62%). Cirratulid polychaetes Second-order opportunistic species (slight to pronounced unbalanced situations). The polychaete *S. armiger*, nematodes and nemerteans can be found under most environmental conditions but are more common in situation of excess organic matter loads. Nephtyid polychaetes (such as *N. longosetosa*, found in these samples) are species not generally affected by organic enrichment and include suspension feeders and scavengers. Finally, capitellid polychaetes and oligochaetes are Type V species, opportunistic taxa that thrive under polluted conditions.

## 5.2. Turbidity

Four stations were sampled for turbidity and the latitude and longitude of each is presented in Table 4.2. Station one is located downstream of Aughinish near Foynes Port. Station 2 is located on the opposite side of the estuary to Aughinish and west of Shannon Airport. Station 3 is located just outside the pier at Aughinish and Station 4 is located further upstream near Bunratty.

**Table 5:2 Turbidity stations**

	Lat	Long
S1	52.6268	-9.1349
S2	52.6999	-9.0011
S3	52.64866	-9.05336
S4	52.6808	-8.8203

The turbidity at all stations increased with depth with bottom levels significantly higher at stations 2 and 3. Station 2 recorded the highest turbidity at 280.8 NTU. Station 1 had the lowest turbidity at 20.2 NTU and also had the smallest increase with depth.

Some research has been carried out on the putative relationship between Nephelometric Turbidity Units (NTUs) and Suspended Solids as mg/l (SS). There is, however, no direct linear relationship between NTU and TSS in mg/L. The particles that make up turbidity vary in shape and size and reflect light in different ways. Large particles can often be missed in measuring NTU turbidity if they are few in number. Estimates of the relationship between NTU and SS in published papers (Thackston, E.L., 2000; Transportation Alberta, no publication date), range from ca 2:1 to ca 3:1. For the purposes of this report, a value of 2.5: 1 has been adopted.

**Table 5:3 Turbidity Results**

	Date	Time	Depth	NTU	SS*
<b>S1</b>	23/11/2015	10:41:30	0.4	20.2	50.5
	23/11/2015	10:41:44	1.8	21.7	54.3
	23/11/2015	10:42:00	3.7	22.6	56.5
<b>S2</b>	23/11/2015	10:08:36	0.2	47.9	119.8
	23/11/2015	10:08:51	1	46.6	116.5
	23/11/2015	10:09:04	1.5	280.8	702.0
<b>S3</b>	23/11/2015	11:28:46	0.2	38.8	97.0
	23/11/2015	11:28:56	1.1	41.7	104.3

	Date	Time	Depth	NTU	SS*
	23/11/2015	11:29:07	2.5	85.9	214.8
	23/11/2015	11:29:18	3.9	180.7	451.8
	23/11/2015	11:29:29	4.4	255.5	638.8
<b>S4</b>	23/11/2015	12:14:30	0.3	30.1	75.3
	23/11/2015	12:14:42	1.3	32.1	80.3
	23/11/2015	12:14:53	2.6	42	105.0
	23/11/2015	12:15:05	3.1	52.2	130.5

\*Total suspended solids estimated from using 2.5:1 conversion factor.

### 5.3. *Sediment*

#### 5.3.1. **Faunal Survey**

##### 5.3.1.1. *Granulometry*

Table 4.4 shows the granulometric data from the 8 stations sampled as part of the faunal survey. Fine gravel ranged from 0 at most stations except Stations 5 and 6 where it was 0.5 and 0.1% respectively. Very fine gravel ranged from 0 (ST 1, 3, 4, 8) to 1.3% (ST 5). Very coarse sand ranged from 0 (ST 1, 3, 7, 8) to 0.5% (ST 5, 6). Coarse sand ranged from 0 (1, 3, 7) to 4.5% (ST 4). Medium sand ranged from 0.6 (ST 3) to 20.1% (ST 4). Fine sand ranged from 11 (ST 5) to 39.1% (ST 8). Very fine sand ranged from 17.6 (ST 4) to 48.1 (ST 8) and Silt-clay ranged from 10.5 (ST 8) to 50.9% (ST 3). Sediment classification according to Folk (1954) consisted of silt and fine/ very fine sand.

**Table 5:4: Granulometric data from the faunal survey.**

Station	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 (125-250µm)	Very Fine Sand (62.5-125µm)	Silt-Clay (<63µm)	Folk (1954)
ST 1	0	0	0	0	1.8	14.5	36.1	47.5	Silt
ST 2	0	0.1	0.1	0.6	15.9	12.3	22.4	48.7	Silt
ST 3	0	0	0	0	0.6	13.5	35	50.9	Silt
ST 4	0	0	0.2	4.5	20.1	12.8	17.6	44.7	Silt
ST 5	0.5	1.3	0.5	1.7	19.8	11	18	47.2	Silt
ST 6	0.1	0.4	0.5	1.8	13.9	14.3	20.3	48.6	Silt
ST 7	0	0.2	0	0	10.7	19.1	26.3	43.7	Silt
ST 8	0	0	0	0.3	2	39.1	48.1	10.5	Fine & very fine sand

### 5.3.1.2. Organic Carbon

Table 4.5 shows the organic carbon results for the 8 stations sampled during the faunal survey. Organic matter values by Loss on Ignition ranged from 2.75 at Station 8 to 6.68% at Station 4.

**Table 5:5: Organic carbon results for the faunal stations**

Station	Organic Carbon
ST 1	3.17
ST 2	4.39
ST 3	3.24
ST 4	6.68
ST 5	5.03
ST 6	3.21
ST 7	4.28
ST 8	2.75

### 5.3.2. Sediment Characterisation Survey

#### 5.3.2.1. Physical Properties

Table 4.6 shows the particle size analysis results (a detailed breakdown of all fractions can be seen in Table 4.4). Gravel content ranged from 0 (ST 1, 3, 4, 8) to 1.8% (ST 5). Sand content ranged from 49.1% (ST 3) to 89.5% (ST 8). Silt-clay content ranged from 10.5% (ST 8) to 50.9% (ST 3). Moisture content and density were calculated for ST 1, 2 and 3 as they are located within the dredging area. Moisture content ranged from 45.09% (ST 2) to 53.55% (ST 3). Density ranged from 1.30 g/ml (ST 2 and 3) to 1.48 g/ml (ST 1).

**Table 5:6: Physical properties of sediment**

Station	% Gravel (>2mm)	% Sand (63µm-2mm)	Silt-Clay (<63µm)	Moisture %	Density (g/ml)	Description
ST 1	0	52.4	47.5	47.38	1.48	grey brown muddy sand, no smell
ST 2	0.1	51.3	48.7	45.09	1.30	soft mud, black, slight smell
ST 3	0	49.1	50.9	53.55	1.30	soft mud, grey, no smell
ST 4	0	55.2	44.7			soft mud, grey, no smell
ST 5	1.8	51	47.2			soft mud, grey, no smell
ST 6	0.5	50.8	48.6			soft mud, grey, no smell
ST 7	0.2	56.1	43.7			soft mud, grey, no smell
ST 8	0	89.5	10.5			grey brown muddy sand, no smell

### **5.3.3. Radiological Properties**

The preliminary results indicate that dumping of these materials at sea will not result in a radiological hazard. Results can be seen in Appendix 4.

### **5.3.4. Chemical Properties**

Table 4.7 shows the results from the chemical analysis. Appendix 3 contains the laboratory report. Table 4.8 shows the results with relevance to Irish Action Levels.

Cadmium, Chromium, Copper, Lead and mercury are below lower Irish action limits at all stations. Arsenic and Nickle are above Lower Irish Action Limit a ST 3 but below for ST 1 & 2. Zinc is above the Upper Irish Action Limit for ST 1 but below lower limit for ST 2 & 3.  $\Sigma$  TBT & DBT is below lower Irish action limits at all stations and PAH ( $\Sigma 16$ ) is also below lower limit for ST 1 & 3 but above Lower limit for ST 2. PCB individual congeners,  $\Sigma$  ICES 7, HCB and Lindane (Gamma HCH) are all below lower Irish action limits at all station.

**Table 5:7: Chemical properties of sediment**

<b>Determinand</b>	<b>Unit</b>	<b>ST1</b>	<b>ST2</b>	<b>ST3</b>
carbonate % dry matter	%	21.1	19.7	14.6
total organic carbon	%	0.83	1.08	1.61
total petroleum hydrocarbons by GCFID (C10 - C40)	mg/kg	27.4	75.4	48.1
dibutyltin (DBT)	mg/kg	<0.005	<0.005	<0.005
tributyltin (TBT)	mg/kg	<0.002	<0.002	<0.00421
aluminium	mg/kg	20000	27000	51600
arsenic	mg/kg	7.40	8.60	10.40
cadmium	mg/kg	0.5	0.4	0.5
chromium	mg/kg	31.80	46.70	57.30
copper	mg/kg	6.10	10.70	10.60
lead	mg/kg	36.60	25.90	30.90
lithium	mg/kg	12.00	15.70	21.80
mercury	mg/kg	<0.08	<0.08	<0.08
nickel	mg/kg	12.60	18.80	24.00
zinc	mg/kg	472.00	105.00	80.40
naphthalene	ug/kg	4.3	45.8	5.0
acenaphthylene	ug/kg	1.1	16.3	1.4
acenaphthene	ug/kg	2.0	306.5	1.8
fluorene	ug/kg	3.4	269.8	4.3

Determinand	Unit	ST1	ST2	ST3
phenanthrene	ug/kg	18.5	1268.1	15.4
dibenzothiophene	ug/kg	2.4	98.3	2.8
anthracene	ug/kg	4.8	191.3	4.0
fluoranthene	ug/kg	32.0	3168.9	28.2
pyrene	ug/kg	24.1	2656.7	21.9
benzo(a)anthracene	ug/kg	13.5	2211.2	14.4
chrysene	ug/kg	17.6	2260.1	17.3
benzo(b)fluoranthene	ug/kg	12.4	2354.4	29.9
benzo(k)fluoranthene	ug/kg	11.8	1307.1	12.9
benzo(a)pyrene	ug/kg	12.3	2011.8	17.7
indeno(1,2,3-c,d)pyrene	ug/kg	10.4	1629.9	22.0
dibenzo(a,h)anthracene	ug/kg	1.9	234.0	4.5
benzo(g,h,i)perylene	ug/kg	11.8	1229.1	18.8
aldrin	ug/kg	<2.0	<2.0	<2.0
alpha-hexachlorocyclohexane (alpha-HCH)	ug/kg	<2.0	<2.0	<2.0
beta-hexachlorocyclohexane (beta-HCH, beta-BHC)	ug/kg	<2.0	<2.0	<2.0
Delta- hexachlorocyclohexane (beta HCH)	ug/kg	<2.0	<2.0	<2.0
Gamma-hexachlorocyclohexane (Gamma-HCH) (Lindane)	ug/kg	<0.1	<0.1	<0.1
hexachlorobenzene (HCB)	ug/kg	<0.1	<0.1	<0.1

Determinand	Unit	ST1	ST2	ST3
cis-chlordane	ug/kg	<2.0	<2.0	<2.0
trans-chlordane	ug/kg	<2.0	<2.0	<2.0
dieldrin	ug/kg	<5.0	<5.0	<5.0
endrin	ug/kg	<3.0	<3.0	<3.0
endosulfan I	ug/kg	<1.0	<1.0	<1.0
endosulfan II	ug/kg	<10.0	<10.0	<10.0
o,p'-DDD	ug/kg	<5.0	<5.0	<5.0
p,p'-DDD	ug/kg	<5.0	<5.0	<5.0
o,p'-DDT	ug/kg	<3.0	<3.0	<3.0
p,p'-DDT	ug/kg	<5.0	<5.0	<5.0
o,p'-DDE	ug/kg	<2.0	<2.0	<2.0
p,p'-DDE	ug/kg	<5.0	<5.0	<5.0
trifluralin	ug/kg	<10.0	<10.0	<10.0
2,4,4'-trichlorobiphenyl (PCB congener 28)	ug/kg	<1.0	<1.0	<1.0
2,2',5,5'-tetrachlorobiphenyl (PCB congener 52)	ug/kg	<1.0	<1.0	<1.0
2,2',4,5,5'-pentachlorobiphenyl (PCB congener 101)	ug/kg	<1.0	<1.0	<1.0
2,3',4,4',5-pentachlorobiphenyl (PCB congener 118)	ug/kg	<1.0	<1.0	<1.0
2,2',3,4,4',5-hexachlorobiphenyl (PCB 138)	ug/kg	<1.0	<1.0	<1.0
2,2',4,4',5,5'-hexachlorobiphenyl (PCB 153)	ug/kg	<1.0	<1.0	<1.0
2,2',3,4,4',5,5'-heptachlorobiphenyl (PCB 180)	ug/kg	<1.0	<1.0	<1.0

**Table 5:8: Results with reference to Irish Action Limits**

Parameter	Units (dry wt) Note 2	Sampling points		
		ST 1	ST 2	ST 3
Arsenic	mg kg <sup>-1</sup>	7.40	8.60	10.40
Cadmium	mg kg <sup>-1</sup>	0.5	0.4	0.5
Chromium	mg kg <sup>-1</sup>	31.80	46.70	57.30
Copper	mg kg <sup>-1</sup>	6.10	10.70	10.60
Lead	mg kg <sup>-1</sup>	36.60	25.90	30.90
Mercury	mg kg <sup>-1</sup>	<0.08	<0.08	<0.08
Nickel	mg kg <sup>-1</sup>	12.60	18.80	24.00
Zinc	mg kg <sup>-1</sup>	472.00	105.00	80.40
Σ TBT & DBT Note 3	mg kg <sup>-1</sup>	<0.007	<0.007	<0.009
γ-HCH (Lindane) Note 4	µg kg <sup>-1</sup>	<0.1	<0.1	<0.1
HCB Note 5	µg kg <sup>-1</sup>	<0.1	<0.1	<0.1
PCB (individual congeners of ICES 7) Note 6	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 028				
PCB 052	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 101	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 138	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 153	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 180	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB 118	µg kg <sup>-1</sup>	<1.0	<1.0	<1.0
PCB (Σ ICES 7) Note 6	µg kg <sup>-1</sup>	<7.0	<7.0	<7.0
PAH (Σ 16) Note 7	µg kg <sup>-1</sup>	181.79	21161.09	219.58
Total Extractable Hydrocarbons	g kg <sup>-1</sup>	0.0274	0.0754	0.0481
	Exceed Lower Irish Action Limit			
	Exceeds Upper Irish Action Limit			

- 
- Note 1:** Applicants should highlight in Table B.1 any results which exceed either the upper or lower Irish action levels. Action levels are published in: *Cronin et al. 2006. Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters. Marine Environment & Health Series, No. 24. Marine Institute.*
- Note 2:** Total sediment <2 mm
- Note 3:** Sum of tributyl tin and dibutyl tin
- Note 4:** 1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\alpha$ ,5 $\alpha$ ,6 $\beta$ -hexachlorocyclohexane
- Note 5:** Hexachlorobenzene
- Note 6:** ICES 7 polychlorinated biphenyls: PCB 28, 52, 101, 118, 138, 153, 180.
- Note 7:** Polyaromatic hydrocarbons (measured as individual compounds): Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(ah)anthracene, Benzo(ghi)perylene, Indeno(123-cd)pyrene.

## 6. Fisheries and Aquaculture

There are four aquaculture sites in the vicinity of Aughinish (Figure 6.1). An intensive oyster site (T07/007) is located east of station 1 *ca.* 560m, intensive oyster and mussel site (T07/012A) *ca.* 1.7km east of station 1, extensive mussel site (T07/014A) *ca.* 4.5km east of station 1 and extensive oyster site (T07/010A) 1.5km west of station 1. It is unknown whether or not these sites are active. The closest designated shellfish waters is *ca.* 27.2km west of the Aughinish at the Ballylongford. A study of the marine atlas showed that the closest fishing ground is Pot fishing for shrimp *ca.* 19.6 Km west of Aughinish. The marine atlas does not show any spawning grounds inside of the Shannon estuary. Atlantic salmon spawn in the tributaries of the lower Shannon, with the River Fergus being important for spring salmon and the Mulkear catchment excels as a grilse fishery (Lower River Shannon SAC site synopsis).

Due to the historic nature of dredging in the Shannon estuary and in the Aughinish area in particular with no reported impact on local fisheries, the proposed dredging is not expected to cause any impact.

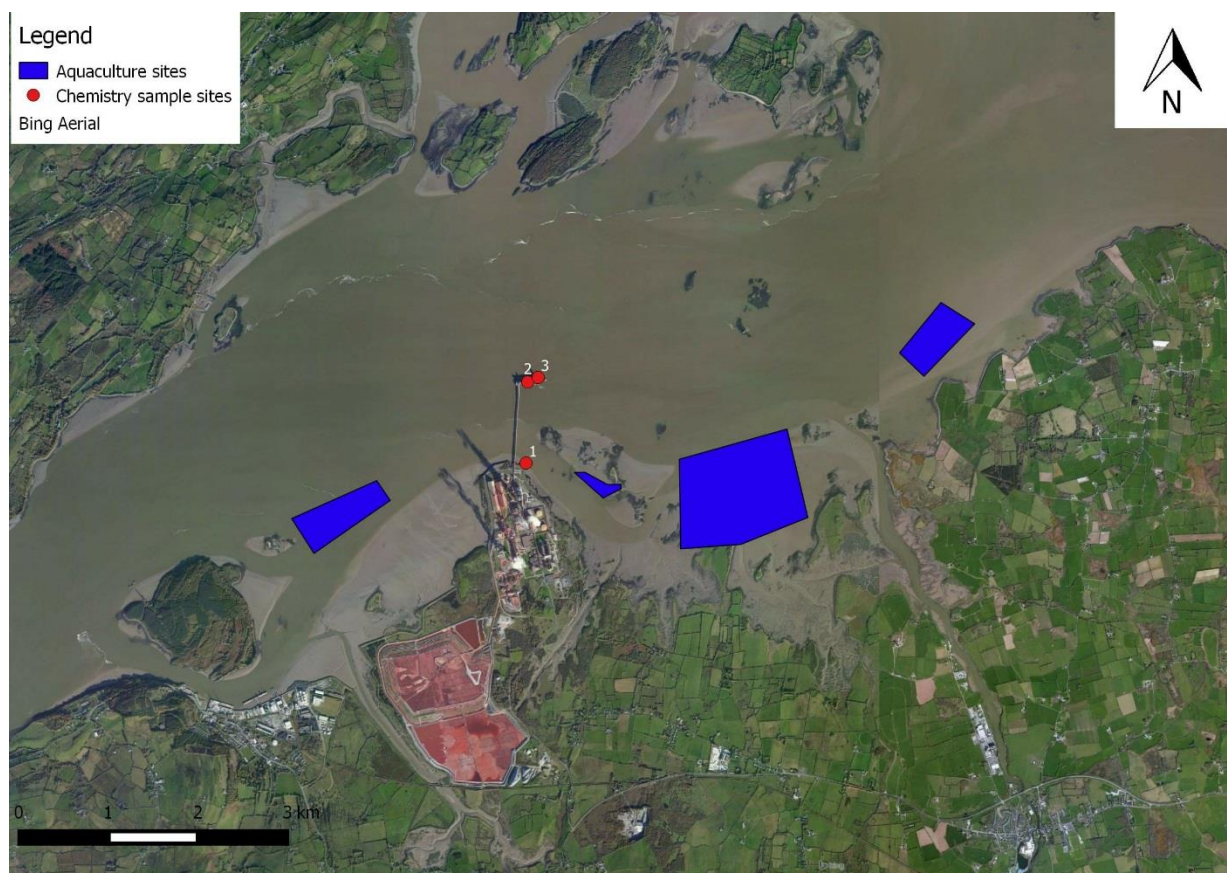


Figure 6.1 Aquaculture sites located near Aughinish pier.

## 7. Discussion

The sediment type within the vicinity of the pier was uniform with all but Station 8 recording silt. The sediment type at station 8 which was located to the east of the pier near the shore was fine sand. All sediments were classified as fine sand or silt by Folk (1954). Gravel and coarse sand fractions were extremely low throughout. Depths within the dredging area ranged between 11 and 14 m and outside they ranged from 1 to 16m.

All species observed are typically of the silt/clay habitat that contain high levels of organic enrichment. Some of the main dominants of the assemblage include the following major groups: Anthozoa (1), Nematoda (1), Nemertea (1), Annelida: Polychaeta (19), Annelida: Oligochaeta (3), Crustacea (2), and Mollusca (3). Due to the low diversity and abundance of macrofauna recorded at most stations the level of interpretation is limited.

The sediments from the dredge area were classified as silt throughout by Folk (1954) being dominated by silt-clay and very fine sand for the most part. Depths in the dredge area ranged from 11 to 14m. Two metals, Arsenic and Nickel, exceeded the lower Irish action limits at Station 3 and Zinc exceeded the upper Irish action limit at Station 1 by *ca* 15%. PAH ( $\Sigma 16$ ) exceeded the lower Irish action limit at Station 2. However, given the small volumes of material to be dredged (16,000t), it is likely that the environmental impact of these levels of both Zinc and PAH on the receiving environment will be low. Additionally, even though the recorded Zinc level is over the Irish action limit, this metal is not considered to be as toxic as other metals. The final approval for suitability to dispose of at sea lies with the EPA (under advice from the Marine Institute).

## 8. References

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## **Appendix 1**

### **Marine Institute Sampling Requirements**



Rinville  
Oranmore  
Co Galway  
Tel: +353 91 387200

Dr Brendan O'Connor,  
Aquafact International Services  
Liosban Industrial Estate  
Galway

06 November 2015

Dear Brendan,

Details are given below of the recommended chemistry sampling and analysis for the dredging operations at Auginish, based on your email that confirms maximum quantities to be dredged of 16,000m<sup>3</sup>. Three surface samples are recommended for the full suite of analyses, as detailed below. Sample locations are indicated in Figure 1, below.

Samples should be taken and appropriately stored, according to the OSPAR JAMP Guidelines for Monitoring Contaminants in Sediments (2011 edition, OSPAR Reference No: 2002-16).

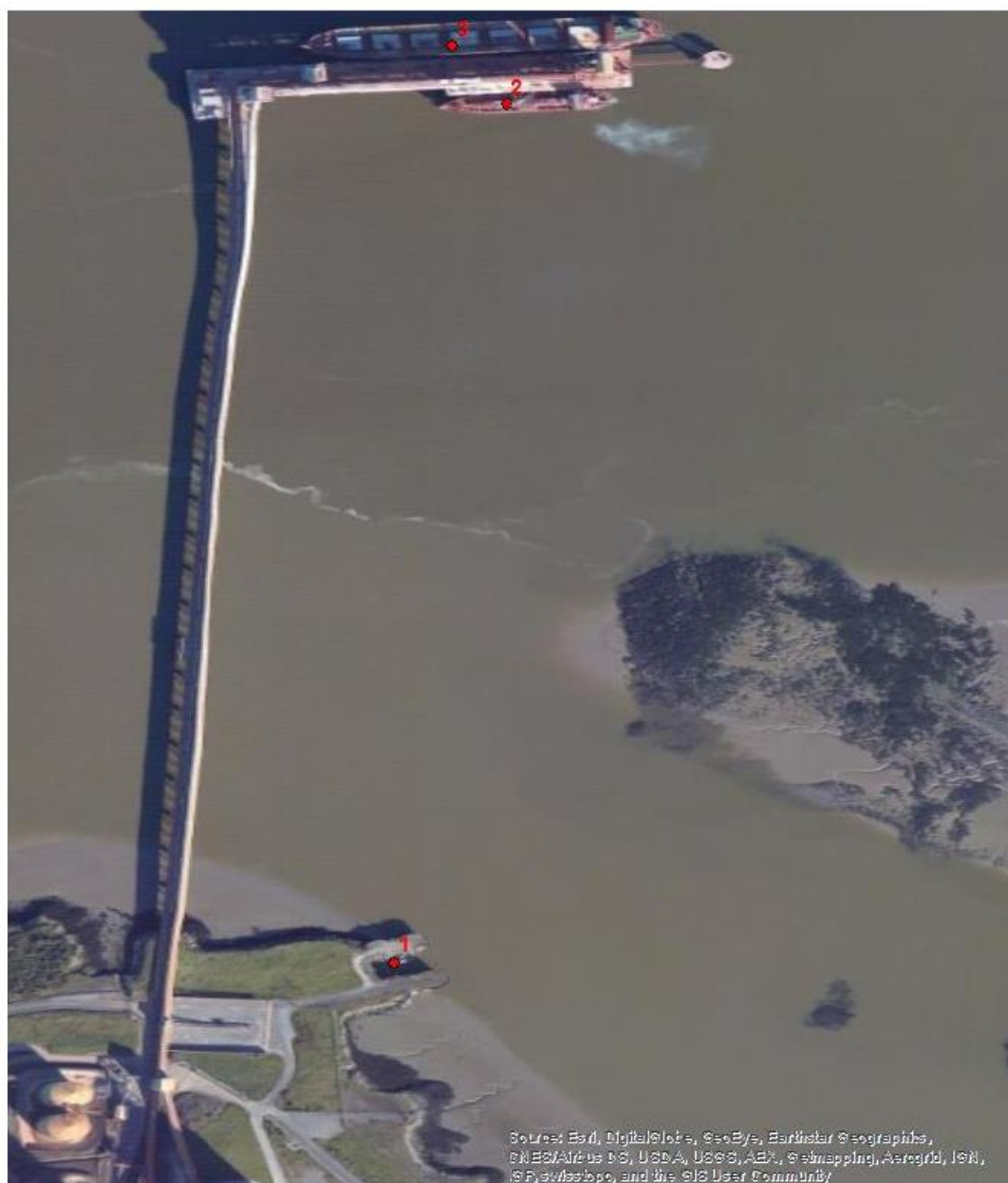
Please supply your analysing lab with a copy of this plan as it is important that they can meet the quality requirements set out in sections 3 and 4, below.

If you need clarification on anything, please don't hesitate to contact me.

Best regards,

---

Margot Cronin  
Marine Environment Chemist



**Figure 1.** Sample locations for sediment chemistry, Auginish

#### 1.0 Sample location and analyses required:

Sample No.	Longitude (W)*	Latitude (N)*	Depth	Parameters for analysis
1	-9.057948	52.636909	Surface	1, 2, 3, 4a, 4b, 4c, 4d, 4e, 4f, 4g

Sample No.	Longitude (W)*	Latitude (N)*	Depth	Parameters for analysis
2	-9.056881	52.645045	Surface	1, 2, 3, 4a, 4b, 4c, 4d, 4e, 4f, 4g
3	-9.057389	52.645582	Surface	1, 2, 3, 4a, 4b, 4c, 4d, 4e, 4f, 4g

\* Coordinates in WGS84

## 2.0 Parameter Code:

1. Visual inspection, to include colour, texture, odour, presence of animals etc
2. Water content, density (taking into account sample collection and handling)
3. Granulometry including % gravel (> 2mm fraction), % sand (< 2mm fraction) and % mud (< 63µm fraction).
4. The following determinants in the sand-mud (< 2mm) fraction \* :
  - a) total organic carbon
  - b) carbonate
  - c) mercury, arsenic, cadmium, copper, lead, zinc, chromium, nickel, lithium, aluminium.
  - d) organochlorines including γ-HCH (Lindane) and PCBs (to be reported as the 7 individual CB congeners: 28, 52, 101, 118, 138, 153, and 180).
  - e) total extractable hydrocarbons.
  - f) tributyltin (TBT) and dibutyltin (DBT)
  - g) Polycyclic aromatic hydrocarbons (PAH) - Acenaphthene, Acenaphthylene, Anthracene, Benzo (a) anthracene, Benzo (a) pyrene, Benzo (b) fluoranthene, Benzo (ghi) perylene, Benzo (k) fluoranthene, Chrysene, Dibenzo (a,h) anthracene, Flourene, Fluoranthene, Indeno 1,2,3 – cd pyrene, Naphthalene, Phenanthrene, Pyrene.
  - h) Toxicity tests (Microtox or whole sediment bioassay) using appropriate representative aquatic species. (This requirement will depend on the results of the chemical analyses.)

\*where the gravel fraction (> 2mm) constitutes a significant part of the total sediment, this should be taken into account in the calculation of the concentrations.

## 3.0 Important notes:

- 3.1 Details of the methodologies used must be furnished with the results. This should include sampling, sub sampling and analytical methods used for each determinant
- 3.2 Appropriate marine CRM are to be analysed during each batch of analyses and the results to be reported along with sample results.
- 3.3 The required detection limits for the various determinants are given below.

Contaminant	Concentration	Units (dry wt)
Mercury	0.05	mg kg <sup>-1</sup>
Arsenic	1.0	mg kg <sup>-1</sup>
Cadmium	0.1	mg kg <sup>-1</sup>

Contaminant	Concentration	Units (dry wt)
Copper	5.0	mg kg <sup>-1</sup>
Lead	5.0	mg kg <sup>-1</sup>
Zinc	10	mg kg <sup>-1</sup>
Chromium	5.0	mg kg <sup>-1</sup>
Nickel	15	mg kg <sup>-1</sup>
Total extractable hydrocarbons	10.0	mg kg <sup>-1</sup>
TBT and DBT (not organotin)	0.01	mg kg <sup>-1</sup>
PCB – individual congener	1.0	µg kg <sup>-1</sup>
OCP – individual compound	1.0	µg kg <sup>-1</sup>
PAH – individual compound	20	µg kg <sup>-1</sup>

#### 4.0 Reporting requirements

Reports should include the following information

- 4.1 Date of sampling
- 4.2 Location of samples in WGS84.
- 4.3 Treatment of samples and indication of sub sampling, compositing etc.
- 4.4 Tabulated geophysical and chemical test results
- 4.5 Completed excel spreadsheet for results (from EPA Dumping at Sea website)
- 4.6 Summary method details
- 4.7 Method performance specifications: Limit of detection, Precision, Bias
- 4.8 Clear expression of units and indication of wet weight or dry weight basis
- 4.9 Blanks & in-house references to be run with each sample batch, and reported with sample results.
- 4.10 Appropriate Certified Reference Materials (CRM) to be run with each sample batch, and reported in full with sample results.
- 4.11 If determinant is not detected, report less than values, and indicate LoD/ LoQ used.  
Other quality assurance information (e.g. accreditation status)

**Appendix 2**  
**Infaunal Species List**

Station	ST 2	ST 3	ST 4	ST 5	ST 6	ST 7	ST 8
Anthozoa (indet)	5	0	0	0	0	0	0
Nematoda	6	0	1	0	0	0	0
Nemertea	1	0	1	0	0	0	0
<i>Streptosyllis websteri</i>	0	0	1	0	0	0	0
<i>Myrianida sp.</i>	0	0	1	0	0	0	0
<i>Nephtys sp.</i>	4	0	1	0	0	0	0
<i>Nephtys longosetosa</i>	1	0	1	0	3	0	0
<i>Protodorvillea kefersteini</i>	0	0	0	1	0	0	0
<i>Leitoscoloplos mammosus</i>	2	0	0	0	0	0	0
<i>Scoloplos armiger</i>	4	0	2	0	0	0	0
<i>Paradoneis lyra</i>	1	0	0	0	0	0	0
<i>Prionospio sp.</i> (partial/damaged)	0	0	0	0	1	0	1
Cirratulidae (partial/damaged)	10	0	4	0	0	0	0
<i>Aphelochaeta marioni</i>	0	0	8	0	0	0	0
<i>Pherusa plumosa</i>	1	0	0	0	0	0	0
Capitellidae (partial/damaged)	0	0	1	0	0	0	0
<i>Capitella sp. complex</i>	1	0	1	0	0	0	0
<i>Notomastus latericeus</i>	0	0	12	0	0	0	0
<i>Euclymene oerstedii</i>	0	0	0	0	1	0	0
Ampharetidae	0	0	1	0	0	0	0
<i>Ampharete acutifrons</i>	1	0	0	0	0	0	0
<i>Ampharete lindstroemi</i>	0	0	1	0	0	0	0
<i>Tubificoides amplivastus</i>	0	0	0	1	0	0	0
<i>Tubificoides benedii</i>	0	0	12	0	0	0	0
<i>Tubificoides pseudogaster</i> agg.	4	0	1	0	0	0	0
<i>Corophium volutator</i>	0	0	0	0	0	2	0
<i>Carcinus maenas</i>	0	0	0	0	0	0	0
<i>Peringia ulvae</i>	0	0	0	0	0	0	1
Mytilidae (juv)	4	0	0	0	2	0	1
<i>Macoma balthica</i>	2	0	0	0	1	0	1

**Appendix 3**  
**Results from ESG lab**

Method Codes	Detection Limit	Units	ID Number	S1571637	S1571638	S1571639	S1571809	S1571810
			Description	ST1	ST2	ST3	QC Blank	Reference Material (% Recovery)
SEDMS	0.5	mg/kg	Arsenic (HF-MW-MS)	7.4	8.6	10.4	<0.5	109
SEDMS	0.2	mg/kg	Cadmium (HF-MW-MS)	0.5	0.4	0.5	<0.2	187
SEDMS	2	mg/kg	Chromium (HF-MW-MS)	31.8	46.7	57.3	<2	112
SEDMS	2	mg/kg	Copper (HF-MW-MS)	6.1	10.7	10.6	<2	109
SEDMS	1.5	mg/kg	Lead (HF-MW-MS)	36.6	25.9	30.9	<1.5	107
SEDMS	0.08	mg/kg	Mercury (HF-MW-MS)	<0.08	<0.08	<0.08	<0.08	95
SEDMS	2	mg/kg	Nickel (HF-MW-MS)	12.6	18.8	24	<2	100
SEDMS	3	mg/kg	Zinc (HF-MW-MS)	472	105	80.4	<3	110
SEDOES	10	mg/kg	Aluminium(Sediments HF-MW-OES)	20000	27000	51600	<10	85
SEDOES	2	mg/kg	Lithium(Sediments HF-MW-OES)	12	15.7	21.8	<2	87
ANC		%	Carbonate %	21.1	19.7	14.6		98
WSLM59	0.04	% M/M	Total Organic Carbon	0.83	1.08	1.61	<0.04	103

Polyaromatic Hydrocarbon Concentrations (ng/g dry weight basis)

PAH Fraction	# PAH	Sample ID :		CL1571809 QC Blank	CL1571810 Reference Material (% Recovery)	CL1571637 ST1	CL1571638 ST2	CL1571639 ST3
		Station :	Mass					
Naphthalene	1		128	<1	109.7	4.3	45.8	5.0
C1 Naphthalenes			142	<1	209.1	8.0	62.8	8.5
C2 Naphthalenes			156	<1		8.8	78.7	11.4
C3 Naphthalenes			170	<1		7.5	67.1	8.3
C4 Naphthalenes			184	<1		5.5	25.8	6.6
Sum Naphthalenes				0		34	280	40
Phenanthrene / Anthracene	2		178	<1	207.4	23.3	1459.5	19.5
C1 178			192	<1		15	314	20
C2 178			206	<1		16	128	19
C3 178			220	<1		9	68	13
Sum 178				0		64	1970	72
Dibenzthiophene			184	<1	110	2	98	3
C1 Dibenzthiophenes			198	<1		3	37	4
C2 Dibenzthiophenes			212	<1		5	29	6
C3 Dibenzthiophenes			226	<1		5	16	4
Sum Dibenzthiophenes				0		16	180	17
Fluoranthene / pyrene	2		202	<1	199	56	5826	50
C1 202			216	<1		21	1026	20
C2 202			230	<1		16	454	19
C3 202			244	<1		12	155	15
Sum 202				0		105	7461	104
Benanthracene / chrysene	2		228	<1	183	31	4471	32
C1 228			242	<1		12	812	21
C2 228			256	<1		7	306	17
Sum 228				0		50	5589	70
Benzfluoranthenes / benzopyrenes	3		252	<1	352	47	7007	78
C1 252			266	<1		17	1172	35
C2 252			280	<1		6	463	12
Sum 252				0		71	8642	125
Aranthranthenes / indenopyrene / benzperylene	3		276	<1	252	24	3093	45
C1 276			290	<1		2	3	1
C2 276			304	<1		<1	31	67
Sum 276				0		26	3127	114
Sum of all fractions				0		365	27249	540
Sum of NPD fraction				0		114	2430	128
NPD / 4-6 ring PAH ratio				#DIV/0!		0.45	0.10	0.31

Polyaromatic Hydrocarbon Concentrations (ng/g dry weight basis)

EPA 16 PAHs

PAH	Sample ID :		CL1571809 QC Blank	CL1571810 Reference Material (% Recovery)	CL1571637		CL1571638		CL1571639	
	Station :	Mass			ST1	ST2	ST1	ST2	ST3	ST3
Naphthalene	128		<1	109.7	4.3	45.8				5.0
Acenaphthylene	152		<1	105.5	1.1	16.3				1.4
Acenaphthene	154		<1	113.6	2.0	306.5				1.8
Fluorene	166		<1	125.0	3.4	269.8				4.3
Phenanthrene	178		<1	106.3	18.5	1268.1				15.4
Dibenzothiophene	184		<1	109.8	2.4	98.3				2.8
Anthracene	178		<1	101.1	4.8	191.3				4.0
Fluoranthene	202		<1	100.0	32.0	3168.9				28.2
Pyrene	202		<1	99.4	24.1	2656.7				21.9
Benzo[a]anthracene	228		<1	88.0	13.5	2211.2				14.4
Chrysene	228		<1	95.1	17.6	2260.1				17.3
Benzo[b]fluoranthene	252		<1	81.4	12.4	2354.4				29.9
Benzo[k]fluoranthene	252		<1	104.0	11.8	1307.1				12.9
Benzo[a]pyrene	252		<1	90.0	12.3	2011.8				17.7
Indeno[1,2,3-cd]pyrene	276		<1	73.4	10.4	1629.9				22.0
Dibenzof[a,h]anthracene	278		<1	81.4	1.9	234.0				4.5
Benzo[ghi]perylene	276		<1	97.4	11.8	1229.1				18.8

## AREA RECOVERIES

### n-alkanes (ng/g)

Sample ID : Station :	CL1571809 QC Blank	CL1571810 Reference Material (% Recovery)	CL1571637 ST1	CL1571638 ST2	CL1571639 ST3
Alkane					
nC10	<1	115.1	<1	26.0	12.0
nC11	<1	<0.04	<1	9.1	8.6
nC12	<1	115.7	<1	52.2	7.7
nC13	<1	<0.04	1.1	2.7	2.0
nC14	<1	92.8	4.6	13.9	10.1
nC15	<1	<0.04	18.4	62.3	8.9
nC16	<1	113.2	6.6	56.2	6.7
nC17	<1	<0.04	8.3	47.4	34.0
pristane	<1	<0.04	<1	22.4	14.0
nC18	<1	119.8	10.5	30.6	14.1
phytane	<1	<0.04	10.5	20.4	12.1
nC19	<1	<0.04	78.0	34.7	76.8
nC20	<1	120.1	14.1	3.1	1.9
nC21	<1	<0.04	29.0	<1	44.3
nC22	<1	104.2	21.7	159.5	38.9
nC23	<1	<0.04	84.7	297.6	125.3
nC24	<1	107.6	41.7	133.3	57.0
nC25	<1	<0.04	130.7	125.3	199.2
nC26	<1	104.7	51.0	33.4	59.5
nC27	<1	<0.04	258.2	275.3	355.0
nC28	<1	108.9	39.5	29.5	76.4
nC29	<1	<0.04	359.4	379.5	484.3
nC30	<1	109.2	21.4	113.4	38.5
nC31	<1	<0.04	239.3	303.9	393.1
nC32	<1	108.4	35.8	124.5	34.5
nC33	<1	<0.04	123.3	110.4	180.4
nC34	<1	113.6	41.3	43.3	3.6
nC35	<1	<0.04	22.0	41.7	19.9
nC36	<1	111.5	10.2	19.9	6.2
nC37	<1	<0.04	7.8	11.7	6.1
Total Oil (ug/kg)	32.6	0.0	27,440.6	75,373.2	48,079.9
Total n alkanes (ng/g)	0	1,545	1,658	2,540	2,305
Carbon Preference Index	#DIV/0!	0.00	4.56	2.03	5.28
Pristane	<1	<0.04	<1	22	14
Phytane	<1	<0.04	10	20	12
Pristane / phytane ratio				1.1	1.2

Note: sample data are NOT blank corrected

## Polychlorinated Biphenyls (congeners)

**Customer and Site Details:**  
**Job Number:**  
**QC Batch Number:**  
**Directory:**  
**Method:**

Aquafact International Services Ltd: Aughinish  
S15\_8293  
151257  
1211PCB.GC8  
Ultrasonic

<b>Matrix:</b>	SOIL
<b>Date Booked in:</b>	04-Dec-15
<b>Date Extracted:</b>	10-Dec-15
<b>Date Analysed:</b>	14-Dec-15

\* This sample data is not UKAS accredited.

[illegible]

## Organochlorine Pesticides by GCMS (SIM)

<b>Customer and Site Details:</b>	Aquafact International Services Ltd: Aughinish		
<b>Sample Details:</b>	ST1	<b>Job Number:</b>	s15_8293
<b>LIMS ID Number:</b>	CL1571637	<b>Date Booked in:</b>	04-Dec-15
<b>QC Batch Number:</b>	150045	<b>Date Extracted:</b>	14-Dec-15
<b>Quantitation File:</b>	1211CCC1.D	<b>Date Analysed:</b>	15-Dec-15
<b>Directory:</b>	\\121415.MS9\	<b>Matrix:</b>	Soil
<b>Dilution:</b>	1	<b>Ext Method:</b>	Soxhlet

Target Compounds	CAS #	R.T. (min)	Concentration ug/kg	% Fit
1,3,5-Trichlorobenzene	108-70-3	-	< 1.0	-
1,2,3-Trichlorobenzene	87-61-6	-	< 1.0	-
2,6-Dichlorobenzonitrile	1194-65-6	-	< 1.0	-
1,2,3,4-Tetrachlorobenzene	634-66-2	-	< 1.0	-
Pentachlorobenzene	608-93-5	-	< 1.0	-
Tecnazene	117-18-0	-	< 3.0	-
Trifluralin	1582-09-8	-	< 10.0	-
Alpha-HCH	319-84-6	-	< 2.0	-
Hexachlorobenzene	118-74-1	-	< 0.1	-
Beta-HCH	319-85-7	-	< 2.0	-
Gamma-HCH	58-89-9	-	< 0.1	-
Propyzamide	23950-58-5	-	< 2.0	-
Chlorthalonil	1897-45-6	-	< 2.0	-
Triallate	2303-17-5	-	< 2.0	-
Delta-HCH	319-86-8	-	< 2.0	-
Heptachlor	76-44-8	-	< 3.0	-
Aldrin	309-00-2	-	< 2.0	-
Triadimefon	43121-43-3	-	< 2.0	-
Pendimethalin	40487-42-1	-	< 10.0	-
Heptachlorepoxyde	1024-57-3	-	< 2.0	-
Trans-Chlordane	5103-74-2	-	< 2.0	-
Isodrin	465-73-6	-	< 2.0	-
O,P'-DDE	3424-82-6	-	< 2.0	-
Cis-Chlordane	5103-71-9	-	< 2.0	-
Endosulfan I	959-98-8	-	< 1.0	-
P,P'-DDE	72-55-9	-	< 5.0	-
Dieldrin	60-57-1	-	< 5.0	-
O,P'-DDD	53-19-0	-	< 5.0	-
Endrin	72-20-8	-	< 3.0	-
Endosulfan II	33213-65-9	-	< 10.0	-
P,P'-DDD	72-54-8	-	< 5.0	-
O,P'-DDT	789-02-6	-	< 3.0	-
Endosulfan Sulfate	1031-07-8	-	< 5.0	-
P,P'-DDT	50-29-3	-	< 5.0	-
Endrin Ketone	53494-70-5	-	< 30.0	-
Methoxychlor	72-43-5	-	< 5.0	-
Cis-Permethrin	52645-53-1	-	< 3.0	-
Trans-Permethrin	51877-74-8	-	< 3.0	-

Internal Standards	% Area
Naphthalene-d8	18
Phenanthrene-d10	24
Perylene-d12	13

Surrogates	% Rec
Gamma-HCH-d6	D
P,P'-DDT-d8	D

## Organochlorine Pesticides by GCMS (SIM)

<b>Customer and Site Details:</b>	Aquafact International Services Ltd: Aughinish		
<b>Sample Details:</b>	ST2	<b>Job Number:</b>	S15_8293
<b>LIMS ID Number:</b>	CL1571638	<b>Date Booked in:</b>	04-Dec-15
<b>QC Batch Number:</b>	150045	<b>Date Extracted:</b>	14-Dec-15
<b>Quantitation File:</b>	1211CCC1.D	<b>Date Analysed:</b>	15-Dec-15
<b>Directory:</b>	\\121415.MS9\	<b>Matrix:</b>	Soil
<b>Dilution:</b>	1	<b>Ext Method:</b>	Soxhlet

Target Compounds	CAS #	R.T. (min)	Concentration ug/kg	% Fit
1,3,5-Trichlorobenzene	108-70-3	-	< 1.0	-
1,2,3-Trichlorobenzene	87-61-6	-	< 1.0	-
2,6-Dichlorobenzonitrile	1194-65-6	-	< 1.0	-
1,2,3,4-Tetrachlorobenzene	634-66-2	-	< 1.0	-
Pentachlorobenzene	608-93-5	-	< 1.0	-
Tecnazene	117-18-0	-	< 3.0	-
Trifluralin	1582-09-8	-	< 10.0	-
Alpha-HCH	319-84-6	-	< 2.0	-
Hexachlorobenzene	118-74-1	-	< 0.1	-
Beta-HCH	319-85-7	-	< 2.0	-
Gamma-HCH	58-89-9	-	< 0.1	-
Propyzamide	23950-58-5	-	< 2.0	-
Chlorthalonil	1897-45-6	-	< 2.0	-
Triallate	2303-17-5	-	< 2.0	-
Delta-HCH	319-86-8	-	< 2.0	-
Heptachlor	76-44-8	-	< 3.0	-
Aldrin	309-00-2	-	< 2.0	-
Triadimefon	43121-43-3	-	< 2.0	-
Pendimethalin	40487-42-1	-	< 10.0	-
Heptachlorepoxyde	1024-57-3	-	< 2.0	-
Trans-Chlordane	5103-74-2	-	< 2.0	-
Isodrin	465-73-6	-	< 2.0	-
O,P'-DDE	3424-82-6	-	< 2.0	-
Cis-Chlordane	5103-71-9	-	< 2.0	-
Endosulfan I	959-98-8	-	< 1.0	-
P,P'-DDE	72-55-9	-	< 5.0	-
Dieldrin	60-57-1	-	< 5.0	-
O,P'-DDD	53-19-0	-	< 5.0	-
Endrin	72-20-8	-	< 3.0	-
Endosulfan II	33213-65-9	-	< 10.0	-
P,P'-DDD	72-54-8	-	< 5.0	-
O,P'-DDT	789-02-6	-	< 3.0	-
Endosulfan Sulfate	1031-07-8	-	< 5.0	-
P,P'-DDT	50-29-3	-	< 5.0	-
Endrin Ketone	53494-70-5	-	< 30.0	-
Methoxychlor	72-43-5	-	< 5.0	-
Cis-Permethrin	52645-53-1	-	< 3.0	-
Trans-Permethrin	51877-74-8	-	< 3.0	-

Internal Standards	% Area
Naphthalene-d8	16
Phenanthrene-d10	22
Perylene-d12	13

Surrogates	% Rec
Gamma-HCH-d6	D
P,P'-DDT-d8	D

## Organochlorine Pesticides by GCMS (SIM)

<b>Customer and Site Details:</b>	Aquafact International Services Ltd: Aughinish		
<b>Sample Details:</b>	ST3	<b>Job Number:</b>	S15_8293
<b>LIMS ID Number:</b>	CL1571639	<b>Date Booked in:</b>	04-Dec-15
<b>QC Batch Number:</b>	150045	<b>Date Extracted:</b>	14-Dec-15
<b>Quantitation File:</b>	1211CCC1.D	<b>Date Analysed:</b>	15-Dec-15
<b>Directory:</b>	\\121415.MS9\	<b>Matrix:</b>	Soil
<b>Dilution:</b>	1	<b>Ext Method:</b>	Soxhlet

Target Compounds	CAS #	R.T. (min)	Concentration ug/kg	% Fit
1,3,5-Trichlorobenzene	108-70-3	-	< 1.0	-
1,2,3-Trichlorobenzene	87-61-6	-	< 1.0	-
2,6-Dichlorobenzonitrile	1194-65-6	-	< 1.0	-
1,2,3,4-Tetrachlorobenzene	634-66-2	-	< 1.0	-
Pentachlorobenzene	608-93-5	-	< 1.0	-
Tecnazene	117-18-0	-	< 3.0	-
Trifluralin	1582-09-8	-	< 10.0	-
Alpha-HCH	319-84-6	-	< 2.0	-
Hexachlorobenzene	118-74-1	-	< 0.1	-
Beta-HCH	319-85-7	-	< 2.0	-
Gamma-HCH	58-89-9	-	< 0.1	-
Propyzamide	23950-58-5	-	< 2.0	-
Chlorthalonil	1897-45-6	-	< 2.0	-
Triallate	2303-17-5	-	< 2.0	-
Delta-HCH	319-86-8	-	< 2.0	-
Heptachlor	76-44-8	-	< 3.0	-
Aldrin	309-00-2	-	< 2.0	-
Triadimefon	43121-43-3	-	< 2.0	-
Pendimethalin	40487-42-1	-	< 10.0	-
Heptachlorepoxyde	1024-57-3	-	< 2.0	-
Trans-Chlordane	5103-74-2	-	< 2.0	-
Isodrin	465-73-6	-	< 2.0	-
O,P'-DDE	3424-82-6	-	< 2.0	-
Cis-Chlordane	5103-71-9	-	< 2.0	-
Endosulfan I	959-98-8	-	< 1.0	-
P,P'-DDE	72-55-9	-	< 5.0	-
Dieldrin	60-57-1	-	< 5.0	-
O,P'-DDD	53-19-0	-	< 5.0	-
Endrin	72-20-8	-	< 3.0	-
Endosulfan II	33213-65-9	-	< 10.0	-
P,P'-DDD	72-54-8	-	< 5.0	-
O,P'-DDT	789-02-6	-	< 3.0	-
Endosulfan Sulfate	1031-07-8	-	< 5.0	-
P,P'-DDT	50-29-3	-	< 5.0	-
Endrin Ketone	53494-70-5	-	< 30.0	-
Methoxychlor	72-43-5	-	< 5.0	-
Cis-Permethrin	52645-53-1	-	< 3.0	-
Trans-Permethrin	51877-74-8	-	< 3.0	-

Internal Standards	% Area
Naphthalene-d8	23
Phenanthrene-d10	24
Perylene-d12	9

Surrogates	% Rec
Gamma-HCH-d6	D
P,P'-DDT-d8	D

## Organochlorine Pesticides by GCMS (SIM)

<b>Customer and Site Details:</b>	Aquafact International Services Ltd: Aughinish		
<b>Sample Details:</b>	CL1571809	<b>Job Number:</b>	s15_8293
<b>LIMS ID Number:</b>	BLKS150045	<b>Date Booked in:</b>	04-Dec-15
<b>QC Batch Number:</b>	150045	<b>Date Extracted:</b>	14-Dec-15
<b>Quantitation File:</b>	1211CCC1.D	<b>Date Analysed:</b>	15-Dec-15
<b>Directory:</b>	\\121415.MS9\	<b>Matrix:</b>	Soil
<b>Dilution:</b>	200	<b>Ext Method:</b>	Sep. Funnel

Target Compounds	CAS #	R.T. (min)	Concentration ug/kg	% Fit
1,3,5-Trichlorobenzene	108-70-3	-	< 1.0	-
1,2,3-Trichlorobenzene	87-61-6	-	< 1.0	-
2,6-Dichlorobenzonitrile	1194-65-6	-	< 1.0	-
1,2,3,4-Tetrachlorobenzene	634-66-2	-	< 1.0	-
Pentachlorobenzene	608-93-5	-	< 1.0	-
Tecnazene	117-18-0	-	< 3.0	-
Trifluralin	1582-09-8	-	< 10.0	-
Alpha-HCH	319-84-6	-	< 2.0	-
Hexachlorobenzene	118-74-1	-	< 0.1	-
Beta-HCH	319-85-7	-	< 2.0	-
Gamma-HCH	58-89-9	-	< 0.1	-
Propyzamide	23950-58-5	-	< 2.0	-
Chlorthalonil	1897-45-6	-	< 2.0	-
Triallate	2303-17-5	-	< 2.0	-
Delta-HCH	319-86-8	-	< 2.0	-
Heptachlor	76-44-8	-	< 3.0	-
Aldrin	309-00-2	-	< 2.0	-
Triadimefon	43121-43-3	-	< 2.0	-
Pendimethalin	40487-42-1	-	< 10.0	-
Heptachlorepoxyde	1024-57-3	-	< 2.0	-
Trans-Chlordane	5103-74-2	-	< 2.0	-
Isodrin	465-73-6	-	< 2.0	-
O,P'-DDE	3424-82-6	-	< 2.0	-
Cis-Chlordane	5103-71-9	-	< 2.0	-
Endosulfan I	959-98-8	-	< 1.0	-
P,P'-DDE	72-55-9	-	< 5.0	-
Dieldrin	60-57-1	-	< 5.0	-
O,P'-DDD	53-19-0	-	< 5.0	-
Endrin	72-20-8	-	< 3.0	-
Endosulfan II	33213-65-9	-	< 10.0	-
P,P'-DDD	72-54-8	-	< 5.0	-
O,P'-DDT	789-02-6	-	< 3.0	-
Endosulfan Sulfate	1031-07-8	-	< 5.0	-
P,P'-DDT	50-29-3	-	< 5.0	-
Endrin Ketone	53494-70-5	-	< 30.0	-
Methoxychlor	72-43-5	-	< 5.0	-
Cis-Permethrin	52645-53-1	-	< 3.0	-
Trans-Permethrin	51877-74-8	-	< 3.0	-

Internal Standards	% Area
Naphthalene-d8	29
Phenanthrene-d10	31
Perylene-d12	18

Surrogates	% Rec
Gamma-HCH-d6	D
P,P'-DDT-d8	D

## Organochlorine Pesticides by GCMS (SIM)

<b>Customer and Site Details:</b>	Aquafact International Services Ltd: Aughinish		
<b>Sample Details:</b>	CL1571810	<b>Job Number:</b>	S15_8293
<b>LIMS ID Number:</b>	RMS150045	<b>Date Booked in:</b>	04-Dec-15
<b>QC Batch Number:</b>	150045	<b>Date Extracted:</b>	14-Dec-15
<b>Quantitation File:</b>	1211CCC1.D	<b>Date Analysed:</b>	15-Dec-15
<b>Directory:</b>	\\121415.MS9\	<b>Matrix:</b>	Soil
<b>Dilution:</b>	200	<b>Ext Method:</b>	Sep. Funnel

Target Compounds	CAS #	R.T. (min)	% Recovery	% Fit
1,3,5-Trichlorobenzene	108-70-3	4.40	58.90	M
1,2,3-Trichlorobenzene	87-61-6	5.06	51.00	M
2,6-Dichlorobenzonitrile	1194-65-6	-	63.00	M
1,2,3,4-Tetrachlorobenzene	634-66-2	6.73	60.00	61
Pentachlorobenzene	608-93-5	7.84	65.00	53
Tecnazene	117-18-0	8.45	91.40	81
Trifluralin	1582-09-8	8.78	51.20	M
Alpha-HCH	319-84-6	9.56	72.00	M
Hexachlorobenzene	118-74-1	9.28	65.80	51
Beta-HCH	319-85-7	9.55	98.20	M
Gamma-HCH	58-89-9	9.55	128.00	89
Propyzamide	23950-58-5	9.65	98.10	M
Chlorthalonil	1897-45-6	-	5.57	M
Triallate	2303-17-5	9.90	68.30	M
Delta-HCH	319-86-8	10.01	104.00	M
Heptachlor	76-44-8	10.97	49.80	M
Aldrin	309-00-2	11.37	75.80	51
Triadimefon	43121-43-3	11.23	70.00	M
Pendimethalin	40487-42-1	11.51	50.10	M
Heptachlorepoxyde	1024-57-3	11.61	109.00	M
Trans-Chlordane	5103-74-2	12.01	46.50	M
Isodrin	465-73-6	11.81	82.30	M
O,P'-DDE	3424-82-6	12.26	53.00	M
Cis-Chlordane	5103-71-9	-	51.40	M
Endosulfan I	959-98-8	12.32	75.30	72
P,P'-DDE	72-55-9	12.80	177.00	M
Dieldrin	60-57-1	12.60	49.50	M
O,P'-DDD	53-19-0	12.82	134.00	M
Endrin	72-20-8	12.94	121.00	92
Endosulfan II	33213-65-9	12.99	72.60	M
P,P'-DDD	72-54-8	13.26	121.00	68
O,P'-DDT	789-02-6	13.26	57.50	M
Endosulfan Sulfate	1031-07-8	-	38.90	M
P,P'-DDT	50-29-3	-	64.60	M
Endrin Ketone	53494-70-5	13.83	142.00	M
Methoxychlor	72-43-5	13.94	46.00	50
Cis-Permethrin	52645-53-1	15.10	77.80	M
Trans-Permethrin	51877-74-8	15.10	59.90	95

Internal Standards	% Area
Naphthalene-d8	23
Phenanthrene-d10	27
Perylene-d12	15

Surrogates	% Rec
Gamma-HCH-d6	D
P,P'-DDT-d8	102

# Organotins

**Customer and Site Details :** Aquafact International Services Ltd - Aughinish

Report Number : s158293

Report Date : 21/12/2015

**Matrix (level) :** Soil  
**Units :** ug/kg

[illegible]

## Additional Report Notes

[illegible]

**Appendix 4**  
**CRM's for ESG results**

ICPMS	Upper Action	Upper Warning	Mean	Lower Warning	Lower Action	Result
Cr	426	381	291	201	156	327.3 mg/kg
Ni	106	94.6	72	49.4	38.1	71 mg/kg
Cu	122	116	104	92.0	86.0	113.5 mg/kg
Zn	497	475	430	385	363	472.2 mg/kg
As	49.8	47.5	43	38.5	36.2	47.1 mg/kg
Cd	0.79	0.74	0.64	0.54	0.49	1.2 mg/kg
Hg	0.51	0.47	0.39	0.31	0.27	0.4 mg/kg
Pb	142	132	125	118	108	134.4 mg/kg
ICPOES	Upper Action	Upper Warning		Lower Warning	Lower Action	
Al	95314	90076	79626	69124	63886	67480 mg/kg
Li	59.9	58.3	55	51.7	50.1	48.04 mg/kg
Carbonate	101.2	99.5	96.19	92.88	91.22	94.27%
Total Organic Carbon	2.009	1.911	1.713	1.515	1.416	1.68%

Mean and Precision are based upon the recovery obtained for the Reference material spike as part of the validation process and represent the expected performance of the method

PAHSED		Lower Action	Lower Warning	Mean	Upper Warning	Upper Action	Results %	Results ng in Sample
Napthalene		457.86	473.06	533.90	549.1	503.5	109.7	549
C1 - Napthalenes		865.59	904.49	1060.11	1099.01	982.30	209.1	1045.5
Acenaphthylene		393.53	424.36	531.30	562.13	477.83	105.5	528
Acenaphthene		457.70	478.30	560.90	581.60	519.60	113.6	568.5
Fluorene		447.60	475.50	587.10	615.00	531.50	125	625.5
Phenanthrene		466.22	495.84	598.62	628.24	547.23	106.3	531
Anthracene		447.30	472.87	561.59	587.16	517.23	101.1	505.5
Dibenzothiophene		518.00	533.40	595.20	610.60	564.30	109.8	549
Fluoranthene		450.21	472.53	549.96	572.28	511.25	100	499.5
Pyrene		446.92	468.56	543.64	565.28	506.10	99.4	496.5
Benz(a)anthracene		332.40	378.50	562.70	608.80	470.60	88	439.5
Chrysene		379.30	418.40	574.80	613.90	496.60	95.1	475.5
Benzo(b)fluoranthene		341.00	378.42	508.21	545.63	443.32	81.4	406.5
Benzo(k)fluoranthene		380.17	424.82	579.72	624.37	502.27	104	520.5
Benzo(e)pyrene		276.19	321.16	477.15	522.12	399.16		
Benzo(a)pyrene		346.48	388.27	533.28	575.07	460.78	90	450
Indeno(123 cd)pyrene		215.34	284.59	524.80	594.05	404.70	73.4	367.5
Dibenzo(ah) anthracene		247.40	313.28	541.84	607.72	427.56	81.4	406.5
Benzo(ghi)perylene		293.13	355.48	571.80	634.15	463.64	97.4	487.5

TPHSED		Lower Action	Lower Warning	Mean %	Upper Warning	Upper Action	Results %	Results ng in Sample
C10		43.74	59.75	91.8	123.78	139.79	115.1	2877.2
C12		69.2	79.7	100.6	121.5	132.0	115.7	2893.3
C14		77.5	83.7	96.1	108.5	114.7	92.8	2321.1
C16		77.5	85.0	100.0	115.0	122.5	113.2	2830.2
C18		91.5	97.6	109.8	122.0	128.1	119.8	2994.1
C20		84.0	91.5	106.7	121.8	129.4	120.1	3001.6
C22		74.8	82.9	99.1	115.3	123.4	104.2	2605.7
C24		78.1	85.1	99.1	113.1	120.1	107.6	2689.7
C26		77.6	84.8	99.2	113.7	120.9	104.7	2616.3
C28		79.9	86.7	100.2	113.8	120.5	108.9	2722.7
C30		83.5	90.3	104.0	117.7	124.6	109.2	2731.2
C32		77.3	84.3	98.3	112.3	119.3	108.4	2710.0
C34		71.8	81.8	101.7	121.7	131.7	113.6	2838.8
C36		73.5	81.3	96.7	112.2	120.0	111.5	2787.0

	Lower Action	Lower Warning	Mean mg/kg	Upper Warning	Upper Action	Results mg/kg
PCB101	0.0141	0.0162	0.0204	0.0246	0.0267	0.022
PCB118	0.0133	0.0152	0.0189	0.0226	0.0245	0.022
PCB138	0.0146	0.0164	0.0201	0.0238	0.0256	0.023
PCB153	0.0134	0.0155	0.0199	0.0243	0.0264	0.022
PCB180	0.013	0.0155	0.0205	0.0255	0.028	0.022
PCB28	0.0138	0.0162	0.021	0.0258	0.0282	0.0208
PCB52	0.01291	0.01533	0.02017	0.02501	0.02743	0.021

	Lower Action	Lower Warning	Mean %	Upper Warning	Upper Action	% Spike Recovery in the sample
1,2,3,4-Tetrachlorobenzene	61.4205	65.4359	73.4667	81.4974	85.5128	60
1,2,3-Trichlorobenzene	61.9384	66.7923	76.5	86.2077	91.0616	51
1,3,5-Trichlorobenzene	58.4236	62.5713	70.8667	79.162	83.3097	58.9
2,6-Dichlorobenzonitrile	50.5888	52.2259	55.5	58.7741	60.4112	63
Aldrin	72.3939	74.807	79.6333	84.4597	86.8728	75.8
Alpha-HCH	52.1152	56.5212	65.3333	74.1454	78.5515	72
Beta-HCH	26.7757	28.1505	30.9	33.6495	35.0243	98.2
Chlorothalonil	-44.833	-24.411	16.4333	57.2776	77.6997	5.57
Cis-Chlordane	61.9339	65.0004	71.1333	77.2663	80.3328	51.4
Cis-Permethrin	40.4554	56.2703	87.9	119.53	135.345	77.8
Dieldrin	85.2709	93.2917	109.333	125.375	133.396	49.5
Endosulfan I	60.2031	63.9354	71.4	78.8646	82.5969	75.3
Endosulfan II	79.4683	88.09	105.333	122.577	131.198	72.6
Endosulfan Sulfate	52.7609	57.3739	66.6	75.8261	80.4391	38.9
Endrin	52.8972	69.1982	101.8	134.402	150.703	121
Endrin Ketone	50.0251	60.7612	82.2333	103.705	114.442	142
Gamma-HCH (Lindane)	56.3334	58.7445	63.5667	68.3888	70.7999	128
Heptachlor	50.8164	56.0665	66.5667	77.0668	82.3169	49.8
Heptachlorepoxyde	61.8469	65.4979	72.8	80.1021	83.7531	109
Hexachlorobenzene	55.8479	61.1986	71.9	82.6014	87.9521	65.8
Isodrin	62.3682	65.6566	72.2333	78.8101	82.0984	82.3
Delta-HCH	48.0804	48.2536	48.6	48.9464	49.1196	104
Methoxychlor	15.9396	29.0153	55.1667	81.318	94.3937	46
O,P'-DDD	69.7042	81.8473	106.133	130.419	142.562	134
O,P'-DDE	53.5481	59.3987	71.1	82.8013	88.6519	53
O,P'-DDT	25.7592	47.0839	89.7333	132.383	153.707	57.5
P,P'-DDD	60.1856	73.6571	100.6	127.543	141.014	121
P,P'-DDE	96.6077	100.072	107	113.928	117.392	177
P,P'-DDT	10.9428	29.2952	66	102.705	121.057	64.6
Pendimethalin	18.9433	33.9955	64.1	94.2045	109.257	50.1
Pentachlorobenzene	59.6345	64.4563	74.1	83.7437	88.5655	65
Propyzamide	10.0063	15.682	27.0333	38.3847	44.0604	98.1
Tecnazene	41.915	49.4544	64.5333	79.6122	87.1517	91.4
Trans-Chlordane	59.8007	63.2782	70.2333	77.1884	80.666	46.5
Trans-Permethrin	42.2265	57.551	88.2	118.849	134.173	59.9
Triadimefon	7.09197	15.6502	32.7667	49.8831	58.4414	70
Triallate	42.4191	52.4571	72.5333	92.6095	102.648	68.3
Trifluralin	20.1053	35.748	67.0333	98.3187	113.961	51.2

Determinand	CAS No	Codes	SOP	Units	Certified Reference Material		AQC spike	
					SEDIMENT		SEDIMENT	
					CRM-646		Spike on clean sediment (20µg/kg)	
					Result	Recovery %	Result	Recovery %
dibutyltin (DBT)	1002-53-5	u	In house	ug/kg DW	56.54	75%	18.70	94
tributyltin (TBT)	56573-85-4	u	In house	ug/kg DW	40.29	84%	18.33	92
triphenyltin (TPT)	78763-54-9		In house	ug/kg DW	n/a	n/a	n/a	n/a

**Appendix 5**  
**Radiological results**



Office of Radiological Protection

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## Preliminary Laboratory Test Report

**Report Date:** 21<sup>st</sup> December 2015

**Samples Tested on Behalf of:** Aqua-Fact International Services Ltd  
12 Kilkerrin Park  
Liosbaun, Tuam Road,  
Galway

**Laboratory Analysis:** High Resolution Gamma Spectrometry with  
appropriate density correction

**Sample Type:** Marine Sediment ex Aughinish

**Date of Receipt:** 2<sup>nd</sup> December 2015

**Date of Analysis:** December 2015

### Results:

ORP Reference	Client Reference	Coordinates		Nuclide	Activity Concentration (Bq/kg, dry) <sup>1</sup>
		Longitude	Latitude		
CT1500867	Station 1	-9.05795	52.63691	K-40	260 ± 30
				I-131	nd
	Station 2	-9.05779	52.64514	Cs-134	nd
	Station 3	-9.05578	52.64555	Cs-137	2.87 ± 0.35
				Ra-226	15.4 ± 2.6
				Ra-228	14.9 ± 1.6

Note:

(1) Quoted uncertainties are ±1 SD counting statistics

(2) nd – not detected



The Office of Radiological Protection received a composite grab sediment sample from Aqua-Fact International Services Ltd. This sample was taken in the Aughinish area in support of application for a Maintenance Dredging Permit (Shannon Port). The sample was prepared by placing an aliquot in a well-defined counting geometry and then measured on a high-resolution gamma spectrometer. Appropriate density corrections were applied to the resultant spectra to take account of the differences in sample density. Dry to wet weight ratio was determined for the sample. Results are quoted on a dry weight basis.



**Ms Máirín O'Colmáin**  
**Senior Technician**  
**Radiation Monitoring Section**

**Notes:**

- This report relates only to the samples tested.
- This report shall not be reproduced except in full, without the approval of the Office
- The following scientific officers may sign test reports on behalf of the laboratory manager: Dr Ciara McMahon, Dr Kevin Kelleher.
- Where applicable, the number following the symbol  $\pm$  is the combined standard uncertainty and not a confidence interval.