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Impacts on the receiving Environment.

Maintenance Dredging & Dumping at Sea

Aughinish Alumina Jetty

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1 INTRODUCTION

Malachy Walsh and Partners were commissioned by Aughinish Aluminium to complete an application for a Dumping at Sea (DAS) permit. Part of that application requires the preparation of an assessment on the impacts of the proposed dredging on the receiving environment.

The following sections of this report identifies potential impacts on the environment

2 IMPACTS ON THE RECEIVING ENVIRONMENT.

This section addresses the potential impacts on the environment related to the maintenance dredging and associated dumping at sea activities for the area adjacent to the existing commercial jetty at Aughinish Alumina Co Limerick.

It is informed by the following reports which are also included in the application documentation.

- Natura Impact Statement (NIS) by Malachy Walsh & Partners.
- Sediment Transport Model prepared by Hydroenvironmental Ltd
- Baseline Characterisation Report by Aquafact
- Archaeological Impact Assessment by Lar Dunne Archaeology
- Review of existing reports and records
- Review of existing Bathymetry surveys provided by Aughinish Alumina Ltd and SFPC.
- Marine Mammal Risk Assessment by IWDG Consulting
- Commentary on sediment transport Modelling by Pat Parle Coastal Engineer

3 LOCATION OF DREDGING AND DUMPING AT SEA.

3.1 SITE LOCATION AND DESCRIPTION

Aughinish Alumina Ltd operates an industrial scale alumina refinery at Aughinish Island, Askeaton, Co Limerick. The facility has a dedicated marine jetty structure which is used for the importation of bauxite raw material and for export of the finished alumina product. The jetty is frequented by large cargo ships on all year round basis.

The jetty was constructed with the benefit of a foreshore licence/lease and that original capital works project included capital dredging to form a new access channel, berthing and manoeuvring area for cargo ships approaching the jetty. The design depths were -12.2 CD on the approach channel, -12.2 on the inner berth and manoeuvring area and -14.5 in the outer berth. Over time sediment will accumulate on the sea bed at different locations, adjacent to and under the jetty structure, within the berths and in the wider area. This comes about due the natural deposition and movement of material within the estuary. In an around the jetty you also have the impacts from propeller thrust from cargo ships and tugs. This then requires maintenance dredging to remove high points on the seabed and to maintain design navigational depths.

Currently there is a requirement for maintenance dredging as there are a number of high points adjacent to the jetty in Area A, B and C and these locations can be seen on drawing number 17076-6002A. The bed levels and high points can be seen on drawings 17076-6005A and 6006A. The permit application drawings also include the previously granted foreshore lease/licence area in order to allow for flexibility in the maintenance dredging process. Over time high points may also accumulate outside of the three target areas identified.

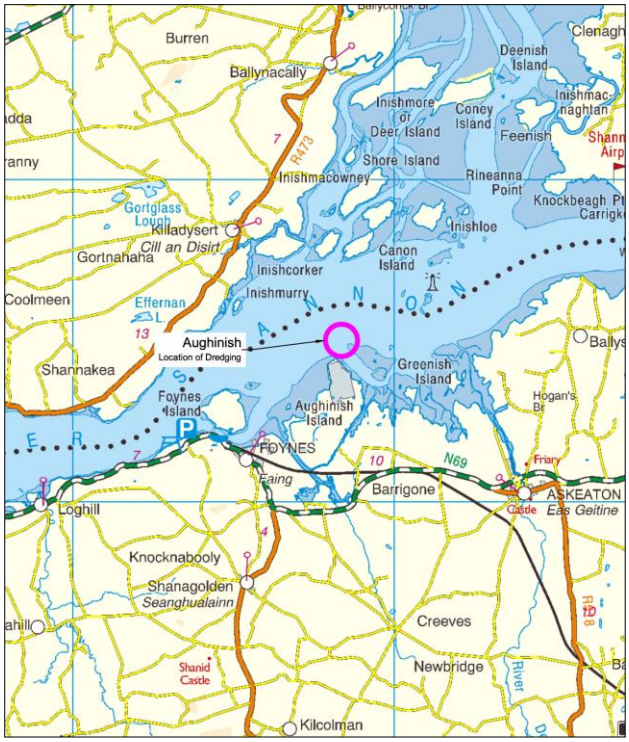

Figure 1. Location of dredging and Dumping at sea at Aughinish Jetty, Co Limerick.

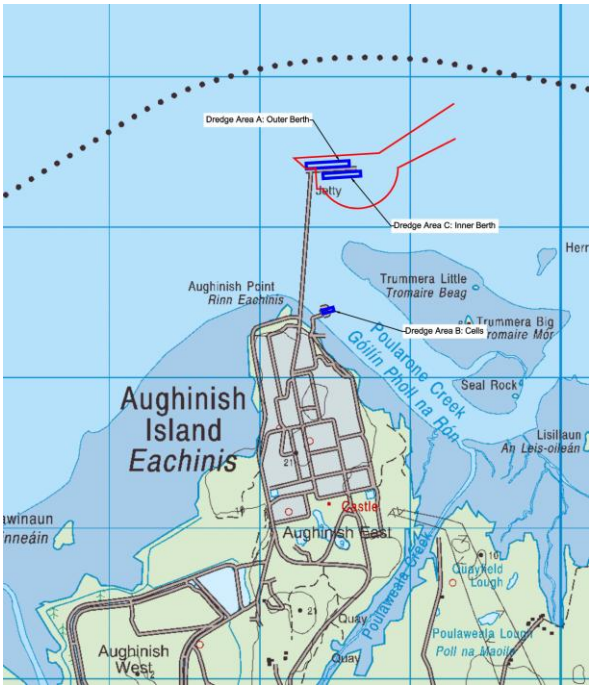

Figure 2. Areas of proposed maintenance dredging

4 EXISTING ENVIRONMENT

The existing environment is described under a series of topics in the following sections.

4.1 BATHYMETRY

When the original industrial facility and jetty was constructed capital dredging was undertaken and this established new bed levels for the approach, berths and manoeuvring area. The design depths were -12.2 CD on the approach channel, -12.2 on the inner berth and manoeuvring area and -14.5 in the outer berth. Aughinish Alumina regularly undertake bathymetry soundings at the jetty and adjacent areas. In addition SFPC would have undertaken bathymetry surveys at the jetty overtime. Copies of surveys were provided by both parties to MWP. Drawing 17076-6005A and 6006A show the existing bed survey levels and it is clear from this that there are a number of high points above the original design depths. Prior to the dredging commencing and addition a bed level survey will be completed to assist in focussing the dredge effort in the optimum locations. There will also be progress surveys to make sure design depths are achieved. Upon completion a post dredge survey will be completed.

Drawing 17076 – 6007A shows the admiralty chart and the sea bed levels at the jetty and within the wider surrounding areas.

4.2 MARINE SEDIMENTS

Aquafact were engaged to complete a baseline characterisation report. The followings paragraphs are extracts from the report completed by Aquafact. Part of that report and assessment included a series of grab samples for both Fauna and sediments. The locations of the sampling are shown in Figure 3 below.

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. The grab samples were divided up for contaminant analysis, radiological analysis organic carbon content, particle size analysis, sediment density and moisture content.

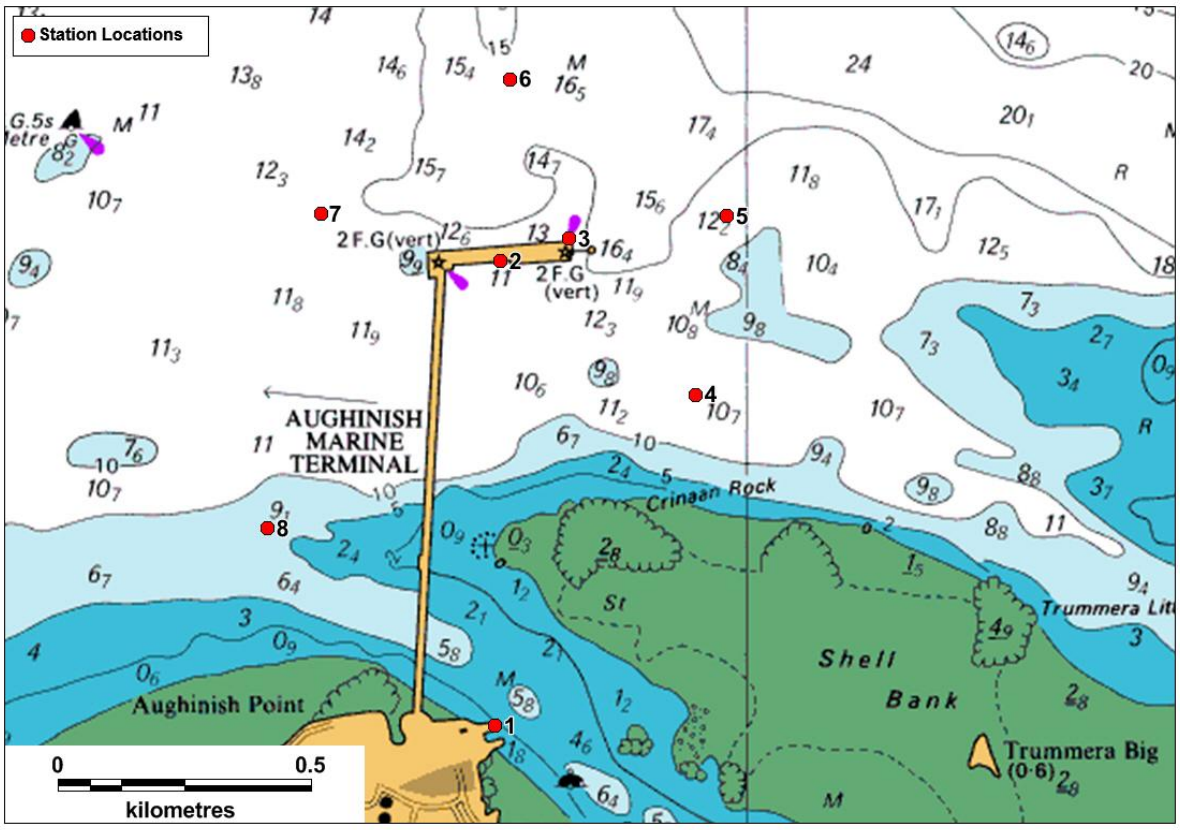

Figure 3.: Sampling Station locations

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. AQUAFACT carried out the particle size analysis and moisture and density content analysis.

4.2.1 Granulometry

Table 1 below sets out 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% respectfully. 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 1: 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	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

4.2.2 Physical Properties

Table 2 below sets out 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 where 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 2: 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**

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.

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.

4.3 BENTHIC ECOLOGY

Aquafact completed a baseline site characterisation report which included an assessment of the baseline benthic or aquatic ecology. The following paragraphs are extracts from that report. The Aquafact report which is included with the permit application contains more detailed information and results.

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 Mollus*ca* (3).

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.

4.4 TURBIDITY

Four stations were sampled for turbidity and the latitude and longitude of each is presented in Table 3. 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 3 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, n.d.), 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 4 blow sets out the results from the turbidity surveys.

Table4: Turbidity Results

	Date	Time	Depth	NTU	SS*
S1	**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**
S2	**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**
S3	**23/11/2015**	**11:28:46**	**0.2**	**38.8**	**97.0**
	23/11/2015	**11:28:56**	**1.1**	**41.7**	**104.3**
	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**
S4	**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.

4.5 FISHERIES AND AQUACULTURE

There are four aquaculture sites in the vicinity of Aughinish (Figure 4 below). 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).

Figure 4. Aquaculture sites located near Aughinish pier.

4.6 PROPOSED DREDGING

4.7 POTENTIAL ENVIRONMENTAL IMPACTS

This section outlines the potential impacts that could arise when the maintenance dredging is being undertaken at Aughinish.

Maintenance Dredging will be undertaken by means of a bed leveller or plough dredger. The plough dredger makes adjustments to the sea bed level by moving material along the sea bed and by

mobilising sediment in the water column which is then distributed by the natural currents of the area. The purpose of maintenance dredging is as follows:

- to maintain design and navigational depths for shipping
- to allow for the full use of the length of the jetty structure and manoeuvring area with a new unloader being provided on the jetty structure.

Typically maintenance dredging can take place at different times of year depending on the opportunities for scheduled maintenance on the jetty and the navigational areas being free of shipping. The DAS permit application is based on a maximum annual dredging quantity of 8000m3/16,000tonnes.

Maintenance dredging could be undertaken three or four time per year depending on the accumulation of material on the sea bed, its location and its impact on navigation. Dredging events would typically be over a 4 to 5 day period and the volumes could vary between 1000m^3 and 6000m^3. The dredging duration over a few days means that any impacts are temporary, short term and localised in nature.

The application relates to an annual maximum dredge volume of 8,000m^3 or 16,000 tonnes and is being requested for a period of 8 years.

The potential impacts to Natura 2000 have been discussed in detail in Natura Impact Statement which is enclosed with the application.

The following is a list of potential impacts that may arise due to dredging operations:

- Loss and alteration of seabed habitat and associated species at the location of the dredge/deposition areas, which lie within an Natura 2000 site
- Water quality impacts from increased suspended sediment and turbidity levels in the water column at the dredge location
- Disturbance to species through smothering from the deposition of suspended solids
- Temporary noise disturbance from dredging plant
- Water quality impacts from accidental oil spill associated with fuelling activities of the suction hopper dredger

The following sections address each of the potential impacts outlined above.

4.7.1 Loss and alteration of seabed habitat

The loss of habitat relates to both the physical footprint on the sea bed and also relates to the communities/species that live within. The area that is being dredged is dynamic in that there is constant deposition of material within the area due to the natural coastal cycle.

The plough dredge method will move material from high points in a number of areas adjacent to the jetty structure and within the footprint of an area contained within the original granted foreshore

lease area. Ploughing will move material on the bed and will also raise material into suspension within the water body. The dredging will focus on defined or individual high points or plateaus where material has accumulated over time. The material in these areas is moving and being deposited within the system as part of the normal hydrodynamic or coastal processes. The areas that are to be levelled to the design type represent a minute fraction of the overall seabed habitat of this type within the estuary. In effect the dredging is moving material within the system. Once complete the natural tidal cycle will continue the process of deposition on the bed once more.

Accordingly there is no loss of habitat; rather there is a temporary disturbance or alteration to the bed profile in the areas where bed level adjustment needs to be completed. There will be some small scale loss of the species that exist within the upper layer off the seabed, but this loss is deemed small and insignificant given the abundance of this habitat type in this location. Such loss would occur naturally during storms where there is significant movement of sea bed material due to erosion from storm activity and strong localised currents.

4.7.2 Water quality impacts from increased suspended sediment and turbidity levels in the water column at the dredge site

During the 3 or 4 day dredge events there will be a localised increase in turbidity as the plough moves and mobilises material into the water column. This in effect will generate a localised dredge plume in the immediate vicinity of the dredge vessel. The material in suspension or in the plume will disperse over a number of tidal cycle. The tidal currents are strong in this location and the Sediment transport model completed by Hydro Environmental explains how the material will disperse across the estuary. As part of the Baseline Characterisation Report Aquafact undertook background turbidity and suspended sediment sampling. In addition the material on the bed was characterised in that report as a mixture of sand and silt/clay. Background suspended sediment concentrations inferred from the Aquafact Survey indicate that the majority of existing levels are in the range 100 to 150mg/l, with some lower levels of 50mg/l and some higher levels considerably in excess of 250mg/l.

The sediment transport modelling results indicate that the likely worst case additional suspended sediments will be within 100% of the existing suspended sediment values. For the most part additional suspended sediment concentrations would be less than 50mg/l. A mitigating factor with the higher suspended sediment concentrations would be that they tend to cover small areas that move with the tide.

In addition the short term nature of the dredge events occurring at different time of year means that there will not be any large scale movement of material or associated plume at any one time. While the maximum quantity of material to be moved in any one year is 8,000m^3 the reality is that will be made up of a number of smaller localised dredge events.

The levels of increased turbidity and suspended sediment associated with dredge events would be typical of occasional spikes that occur in storm or high flow events where currents will naturally generate significant sediment in suspension and increased turbidity levels. The dredging proposed will not impact on water quality of the estuary.

The proposed dredging is a short term temporary event and the increase in turbidity is manageable and is not deemed significant.

4.7.3 Disturbance to species through smothering from the deposition of suspended solids

This impact relates to the species that live within the sea bed at the dredge location but also to species that are located nearby in the seabed. This aspect has been discussed in the NIS and also in the report completed by Aquafact International which is included in the application.

The effects of the short term dredge campaigns over a year will be localised, temporary and are deemed not significant in terms of potential loss of species due to the movement of bed material. In effect it would be no different than what can naturally occur during sever storm events with high currents and increased estuary flows.

4.7.4 Temporary noise disturbance from dredging plant

There will be some localised noise impacts from the dredging vessel as it works adjacent to the jetty. The jetty at Aughinish is busy all year round with occupancy rates of approximately 90%. There are typically only two weekly periods during the year when scheduled maintenance provides shutdown of the jetty.

The jetty has regular heavy cargo ship traffic associated with the delivery of raw materials in the form of bauxite and the export of finished alumina product. A busy operational jetty such as this has associated background noise levels from the ships that dock at the jetty and due to the unloading equipment and plant associated with the jetty structure and loading and unloading activity.

The plough dredger will generate noise as it operates adjacent to the jetty. The noise generated will not stand out from the natural noise background associated with an active shipping jetty. Rather the noise profile of the plough dredger is small in scale in comparison to the larger cargo ships and noise levels associated with the equipment and loaders that operate in the jetty. In effect this is an industrial area and therefore has an associated level of established background noise.

The dredging events will be short term and temporary and the noise associated with them will not be significant or cause any impacts on the environment.

4.7.5 Water quality impacts from accidental oil spill associated with fuelling activities of the suction hopper dredger

The dredger will require fuelling, but in this instance the plough dredge vessel will be coming to site from its base on the Shannon at Foynes. In this scenario it will be fully fuelled up at the marine depot before steaming to the dredge location at the jetty. So there is complete control in terms of any risk from fuelling.

The dredge captain has a fuel/oil management protocol for the vessel that ensures that there are strict controls for vessel operation, fuelling and servicing. Consequently the risk of spillage is low and the process is manageable within the context of the proposed works.

5 DISCUSSION

The process of dredging and dumping at sea has similar potential impacts. The immediate receptor is the water body and good practice and controls can manage this impact. The use of visual monitoring by a dedicated supervising engineer will allow for control of the dredging process and the associated plume. A marine mammal observer will be adopted for dredge events as proposed in the Marine Mammal Risk Assessment completed by IWDG Consulting.

The short term dredge events will lead to short term temporary insignificant effects on the environment. Good controls and management of the dredge events will ensure that any risks of negative impacts can be avoided.