Galway Harbour Company

Galway Harbour Extension

Environmental Impact Statement

Chapter 7

Flora & Fauna

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GLOSSARY, ABBREVIATIONS & DEFINITIONS

ARPD	Apparent Redox Potential Discontinuity
Bathymetric	Of or relating to measurements of the depths of oceans or lakes
Benthic	That portion of the marine environment inhabited by organisms living at or near the bottom of the ocean
CEFAS	The Centre for Environment Fisheries and Aquaculture Science
Chart Datum	A chart datum is the level of water that charted depths displayed on a nautical chart are measured from
Coriolis Effect	An effect whereby a mass moving in a rotating system experiences a force perpendicular to the direction of motion and to the axis of rotation
cSAC	candidate Special Area of Conservation
Epifauna	Animals living on the surface of the seabed or a riverbed, or attached to submerged objects or aquatic animals or plants
Eulittoral	The intertidal zone that extends between the high tide line (on a Spring tide) to the low tide line (usually on a Neap tide).
GPS	Global Positioning Satellite
Granulometry	The measurement of the size distribution in a collection of grains
Gyre	Any large system of rotating ocean currents, particularly those involved with large wind movements
IBA	Important Bird Area
IFI	Inland Fisheries Ireland
Infauna	The animals living in the sediments of the ocean floor or river or lake beds
Intertidal	Of or being the region between the high tide mark and the low tide mark
MDS	Multi-Dimensional Scaling
Neritic	Of, relating to, or denoting the shallow part of the sea near a coast and overlying the continental shelf
North Atlantic Drift	A continuation of the Gulf Stream across the Atlantic Ocean and along the coast of northwestern Europe
OSI	Organism Sediment Index
PCB	Polychlorinated biphenyl
ppm	parts per million
psu	Practical Salinity Units
Refusal Depth	Depth to bedrock
RIB	Rigid Inflatable Boat
Ruggedised	Produce in a version designed to withstand rough usage
SBR	Surface Boundary Roughness
SCUBA	Self Contained Underwater Breathing Apparatus
Sedimentation	The phenomenon of sediment or gravel accumulating
Smolt	A young salmon (or trout) after the parr stage, when it becomes silvery and migrates to the sea for the first time
SPA	Special Protection Area
SPI	Sediment Profile Imaging
Subtidal	The benthic ocean environment below low tide that is always covered by water.
Velocity	The speed of something in a given direction

7 FLORA AND FAUNA

7.1 INTRODUCTION

Galway Bay is generally shallow, with a depth of often less than 40 m, but it reaches depths in excess of 80–90 m west of the Aran Islands. Inner Galway Bay, which can be simply defined as that part of the bay to the east of a line drawn from Black Head in Co. Clare to Spiddal in Co. Galway, is generally less than 20 m in depth, but can be up to 30 m deep in small areas. The predicted mean tidal ranges for the inner bay are 1.9 m for Neap tides and 4.3 m for Spring tides.

The main flow of water into Galway Bay (driven by prevailing southwesterly and westerly winds) is through South Sound (between Inisheer and the north Clare coast), with lesser flows through Foul Sound and Gregory Sound (Booth, 1975; Harte *et al.*, 1982). The water forced into the bay leaves by travelling along the south Connemara coast and exiting from North Sound. The rotation caused by these movements of water into and out of the Inner Galway Bay area generates an anticlockwise gyre (Booth, 1975; Harte *et al.*, 1982; Lei, 1995). It is also possible that there is a second, smaller anticlockwise gyre in the northeastern part (*i.e.* to the north of Tawin Island) of Inner Galway Bay. Figure 7.1.1 shows these water movements on a map of Galway Bay. Surface and bottom salinity values within Inner Galway Bay range from 15 to 35 psu (Practical Salinity Units) and 29 to 35 psu respectively (Lei, 1995).

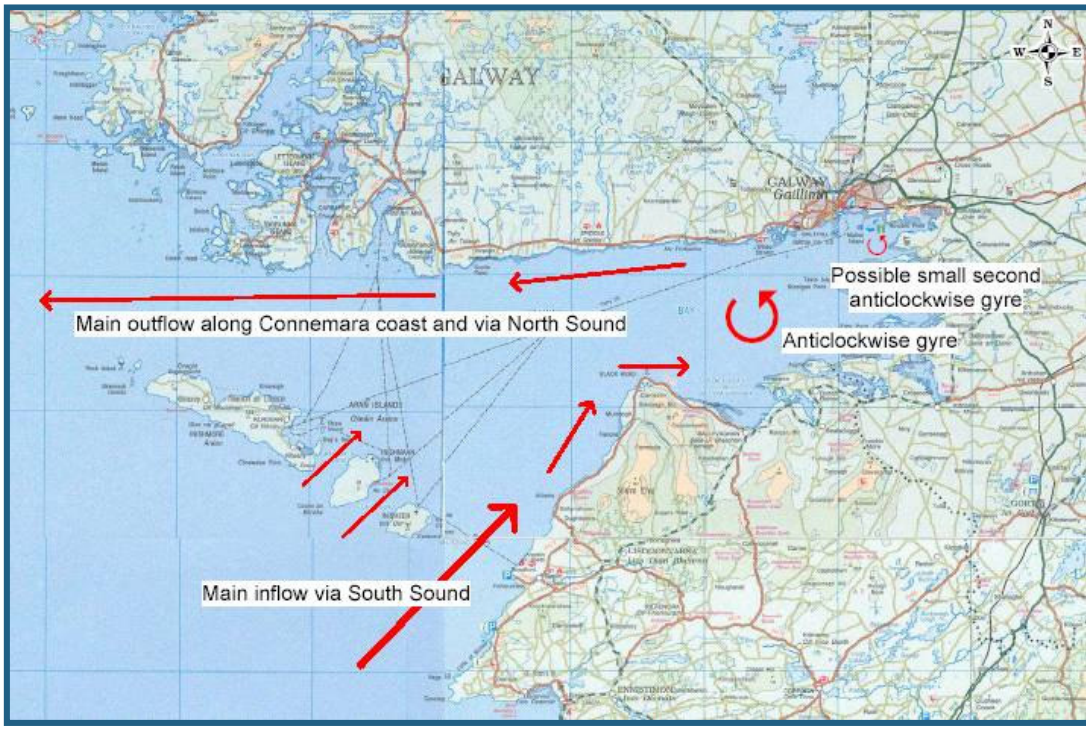


Figure 7.1.1 - Water flows and gyres in Galway Bay

By far the largest freshwater input into Galway Bay is from the River Corrib. This river is the outfall for Lough Corrib, which is the second largest lake in Ireland and which covers 8,990 ha. At its northern end Lough Corrib is separated by a narrow neck of land from Lough Mask (nearly half the size of Lough Corrib), which flows into it via an underground channel. To the north of Lough Mask is Lough Carra (also of considerable size), which flows into Lough Mask at Keel Bridge. Into these three large lakes flow some 320 km of streams, so that the River Corrib discharges the drainage of over 3,100 km^2 of catchment area (Grimble, 1913).
The River Corrib has a summer minimum flow of 25 – 50 m^3s^{-1} and a Winter maximum flow of 250 – 300 m^3s^{-1} (Solan, 2000). Assuming an average constant flow rate of 100 m^3s^{-1}, 3.16 X 10^9 m^3 of freshwater is draining into Galway Bay per year. The Corrib plume flows south from the

river mouth, then west around Mutton Island, before dispersing along the north shore of Galway Bay (Booth, 1975), where it is detectable as far west as the vicinity of Furbo. Salinity in the vicinity of the mouth of the River Corrib is very variable and the River Corrib plume continually depresses the surface salinity along the northern shore of the bay, whilst other more minor rivers (*e.g.* at Barna and Spiddal) have more localised effects (O'Connor *et al*., 1993).

7.2 BACKGROUND TO METHODOLOGY

Baseline information upon which to conduct an impact assessment was collated from a number of sources. These included desk studies of published literature, published and unpublished reports, and direct consultation with relevant authorities, through the use of historic independent data and on the basis of site specific survey work over a number of years. A compilation of some of the raw survey data is supplied in Appendix 7 which shows the overview of surveys and data, providing a historic picture of the ecology of Galway Bay. More detailed information regarding methodologies is included within relevant subsections. Figure 7.2.1 shows all sensitive receptors in relation to flora and fauna.

Figure 7.2.1 - Sensitive Receptors in relation to Flora and Fauna

7.3 DESIGNATED SITES

Galway Bay is designated as a candidate Special Area of Conservation (cSAC) under the EU Habitats Directive and as a Special Protection Area (SPA) under the EU Birds Directive. The qualifying interests for both habitats and species for the cSAC and the special conservation interest bird species for the SPA are listed in the following two tables.

7.3.1 Qualifying Interests and Conservation Objectives

The qualifying interest habitats and species of the Galway Bay Complex cSAC are presented in Table 7.3.1 below:

Annex I Habitats	Annex II Species
Mudflats and sandflats not covered by seawater at low tide [1140]	Otter (*Lutra lutra*) [1355]
Coastal lagoons* [1150]	Harbour Seal (*Phoca vitulina*) [1365]
Large shallow inlets and bays [1160]	
Reefs [1170]	
Perennial vegetation of stony banks [1220]	
Salicornia and other annuals colonizing mud and sand [1310]	
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]	
Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	
Turloughs* [3180]	
Juniperus communis formations on heaths or calcareous grasslands [5130]	
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6210]	
Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae** [7210]	
Alkaline fens [7230]	

Table 7.3.1 - Qualifying Interests of Galway Bay cSAC

*Annex I Priority Habitat

The conservation objectives for the Galway Bay Complex cSAC are shown in full in Appendix 7.1 and can be summarized as follows:

'*to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected*' (as listed above) (NPWS, 2013).

The special conservation interest species of the Inner Galway Bay SPA are presented in Table 7.3.2 below:

Scientific Name	Common Name	Population Status*
Gavia immer (Wintering)	Great Northern Diver	International
Phalacrocorax carbo (Wintering and breeding)	Cormorant	National
Ardea cinerea (Wintering)	Grey Heron	
Branta bernicla hrota (Wintering)	Light-bellied Brent Goose	International
Anas penelope (Wintering)	Wigeon	National
Anas crecca (Wintering)	Teal	National
Anas clypeata (Wintering)	Shoveler	National
Mergus serrator (Wintering)	Red-breasted Merganser	National
Charadrius hiaticula (Wintering)	Ringed Plover	National
Pluvialis apricaria (Wintering)	Golden Plover	National
Vanellus vanellus (Wintering)	Lapwing	National
Calidris alpina (Wintering)	Dunlin	National
Limosa laponica (Wintering)	Bar-tailed Godwit	National
Numenius arquata (Wintering)	Curlew	National
Tringa totanus (Wintering)	Redshank	National
Arenaria interpres (Wintering)	Turnstone	National
Larus ridibundus (Wintering)	Black-headed Gull	
Larus canus (Wintering)	Common Gull	
Sterna sandvicensis (breeding)	Sandwich Tern	
Sterna hirundo (breeding)	Common Tern	

Table 7.3.2 - Special Conservation Interests of Inner Galway Bay SPA

* Based on Colhoun, 2001; Crowe, 2005

The conservation objectives of Inner Galway Bay SPA are shown in full in Appendix 7.1 and can be summarized as follows:

'*to maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA*' (as listed above) (NPWS, 2013).

There are two other Natura sites close to the proposed development and these are Lough Corrib cSAC and Lough Corrib SPA. The qualifying interests and special conservation interests are presented in the following two tables.

The Qualifying Interests of the Lough Corrib cSAC are presented in Table 7.3.3 below:

Annex I Habitats	Annex II Species
Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3110]	Slender naiad (*Najas flexilis*) [1833]
Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]	Shining Sickle Moss (*Drepanocladus vernicosus*) [1393]
Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]	Otter (*Lutra lutra*) [1355]
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6210]	Lesser Horseshoe Bat (*Rhinolophus hipposideros*) [1303]
Molinia meadows on calcareous, peaty or clavey-silt-laden soils (*Molinion caeruleae*) [6410]	Salmon (*Salmo salar*) [1106]
Active raised bogs* [7110]	Brook Lamprey (*Lampetra planeri*) [1096]
Degraded raised bogs still capable of natural regeneration [7120]	Sea Lamprey (*Petromyzon marinus*) [1095]
Depressions on peat substrates of the *Rhynchosporion* [7150]	White-clawed Crayfish (*Austropotamobius pallipes*) [1092]
Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae** [7210]	Freshwater Pearl Mussel (*Margaritifera margaritifera*) [1029]
Petrifying Springs with tufa formation (C*ratoneurion*)* [7220]	
Alkaline fens [7230]	
Limestone pavements* [8240]	
Old sessile oak woods with *Ilex* and *Blechnum* in British Isles [91A0]	
Bog woodland* [91D0]	

Table 7.3.3 - Qualifying Interests of Lough Corrib cSAC

The conservation objectives of Lough Corrib cSAC are:
'*to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected*' (as listed above) (NPWS, 2011).

Scientific Name	Common Name	Population Status*
Phalacrocorax carbo (Wintering and breeding)	Cormorant	National
Larus canus (Wintering)	Common Gull	
Sterna sandvicensis (breeding)	Sandwich Tern	
Sterna hirundo (breeding)	Common Tern	

Table 7.3.4 - Special Conservation Interests of Lough Corrib SPA

As part of the Natura Impact Statement (NIS), these sites and a number of others were examined to determine if any of their conservation objectives would be affected by the proposed development. Please refer to the NIS document for this review.

7.4 FLORA IN THE EXISTING ENVIRONMENT

A map showing the habitats present within the proposed footprint of the development and immediate surrounding area are shown in Drawings 2139-2110 & 2139-2111.

7.4.1 Habitats within the Site of the Proposed Development

7.4.1.1 Marine Habitats

The intertidal area can generally be described as a sheltered shore with the whole of the eulittoral being covered in seaweeds. Small patches of lichen (*Caloplaca, Verrucaria*) and *Pelvetia canaliculata* (*ca* 5%) were observed on rocks above high water and in the upper shore respectively. *Fucus spiralis* (*ca* 20%) was present close to the top of the shore while *Fucus vesiculosus* (*ca* 30%) and *Fucus ceranoides* (*ca* 10%), were present from the top of the shore to the mid shore. *Ascophyllum nodosum* (80%) covered the bulk of the mid-eulittoral along with *Polysiphonia lanosa*. Patches of *Chondrus crispus* were noted throughout the mid shore and *Ulva* sp. (formerly *Enteromorpha*) was observed on the boulders of the revetment wall and down the shore. *Ulva lactuca* was observed on the lower shore. *Fucus serratus* (*ca* 30%) was noted low down on the shore nearest the water's edge. The substrate along the western boundary consisted predominantly of gravels and pebbles with boulders scattered throughout. The shore extended to 20 m along this boundary.

Annexed habitats within the site of the proposed development are described below:

Mudflats and sandflats not covered by seawater at low tide (1140). It is an Annex I habitat located within the footprint of the development but its occurrence there is not exclusive to that area. The area represents ca 0.16% of the total Galway Bay cSAC.

Reefs (1170) – It is an Annex I habitat located within the footprint of the development but is present throughout the SAC. The reef habitat lies within the area of mud flat listed above.

AS NPWS describes the intertidal community at the proposed development site as "fucoid-dominated intertidal reef complex", these two habitats are considered together.

Figure 7.4.1 shows the distribution of these annexed marine habitats.

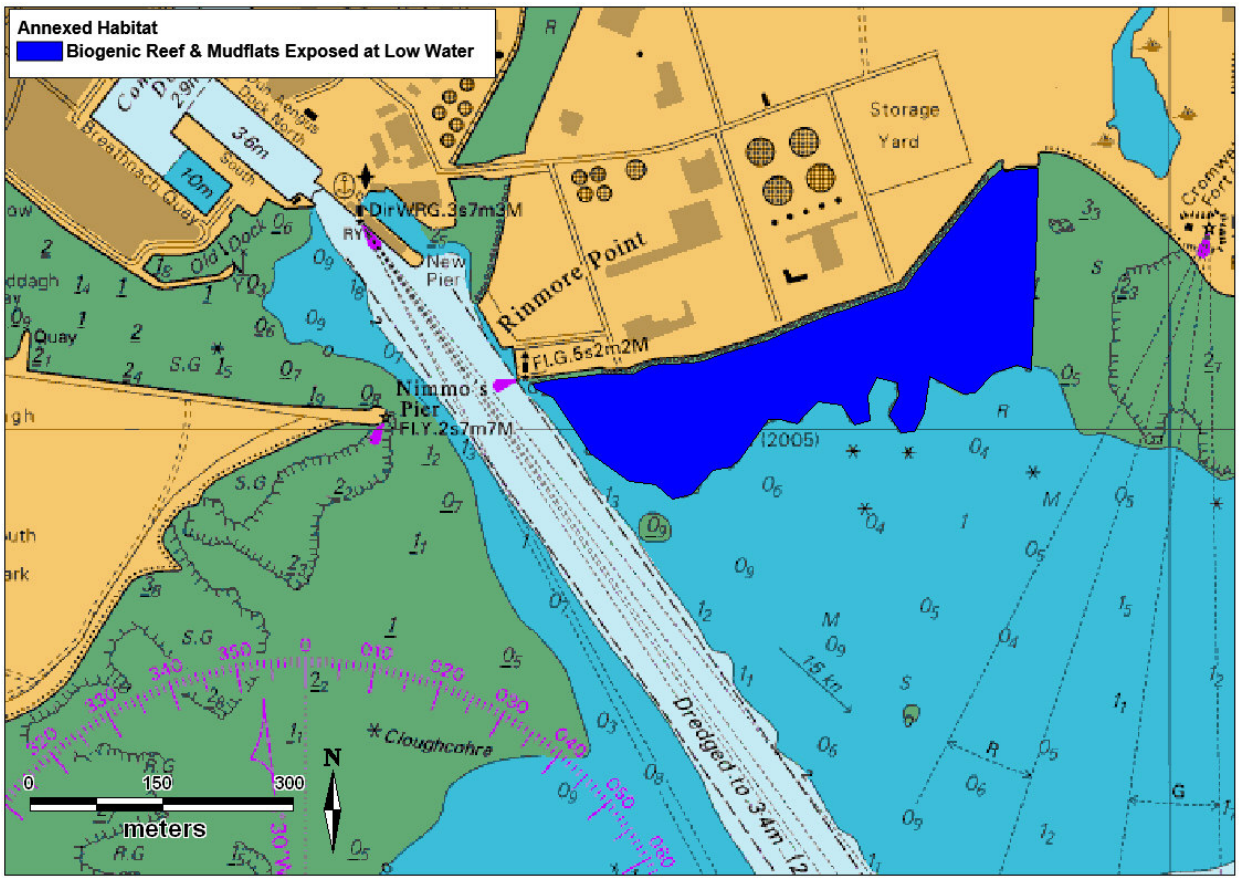


Figure 7.4.1 - Habitat map of annexed marine habitats in and around the proposed development

7.4.1.2 Terrestrial Habitats

The majority of the terrestrial habitats within the site of the proposed development comprise those associated with human disturbance and development, including spoil and bare ground, Recolonising bare ground and buildings and artificial surfaces. The terrestrial habitats present, as classified according to the scheme detailed in Fossitt (2000) are outlined below:

Spoil and bare ground (ED2)	4.34 ha
Buildings and artificial surfaces (BL3)	3.76 ha
Recolonising bare ground (ED3)	0.26 ha
Scrub (WS1)	0.11 ha
Sea walls, piers and jetties (CC1)	570 m

Gravel trackways, open gravel areas and existing rail track bed within the site has been classified as Spoil and bare ground habitat. The vegetation cover is less than 50% and the plant species found were mainly ruderal weed species that quickly establish in cleared stony environments. Areas of finished hard standing and tarmacadam roads have been classified as artificial surfaces. Vegetation is often either completely absent or confined to occasional ruderal weeds growing in cracks and crevices. A large spoil heap in the south-eastern corner of the terrestrial part of the development site has been classified as recolonising bare ground. The vegetation cover on this spoil heap was greater than 50% and contained many of the common species found in areas of spoil and bare ground.

A small area of land on the existing railway embankment has been classified as scrub. The vegetation was dominated by Common Sallow (*Salix cinerea* ssp. *oleifolia*), Hawthorn (*Crataegus monogyna*) and Goat Willow (*Salix caprea*), with some areas of Bramble (*Rubus*

fruticosus agg.) with Nettle (*Urtica dioica*). The rock armour that forms the wall of the reclaimed harbour park area has been classified as a sea wall habitat. The rock armour consists of an embankment made of large boulders that stands between the littoral zone and the infilled reclaimed area. The boulders at the bottom of the walling are covered by seawater at high tide and there is some growth of epiphytic marine algae. There is sparse vegetation, consisting of many of the species found in the spoil and bare ground areas, growing between the rocks and boulders at the top of the sea wall.

The diversity of terrestrial habitats within the site is poor and much of the area has been or is still subject to human disturbance. None of the plants that are found in this area of particular conservation significance, some of them being introduced or escaped alien species. There are no annexed terrestrial habitats within the site of the proposed development.

7.4.1.3 Habitats in the Surrounding Area

A zone of potential influence was established to assist in the ecological impact assessment process. This included an area within the bay, determined as follows:

In order to predict the extent of marine habitat that will be affected by the proposed development in terms of variations in velocity, shear bed stress, turbidity and salinity, the modelled output for these parameters was examined (Chapter 8 of the EIS presents details of the modelling of velocity, shear bed stress, suspended sediment plume and salinity). These figures show that variations in velocity are restricted to within the upper area west of the new development and as a consequence this same area is that affected by shear bed stress. Examination of output data showing variations in salinity indicate that there is little change in the area affected by the construction of the new development due to its present variability. What these predictions do show is that salinities in the area to east of the new development will increase. The largest area affected by the development is that caused by sediments brought into suspension during construction and for this reason, this parameter was used to map the zone of potential influence. Figure 7.4.2 is a conservative representation of this area *i.e.* the figure includes more area affected than the modelled predictions. It should be noted that as part of mitigation measures, dredging of sediments close to the mouth of Lough Atalia will be restricted to periods of ebb tides. This is to ensure that suspended sediments will not enter the lough.

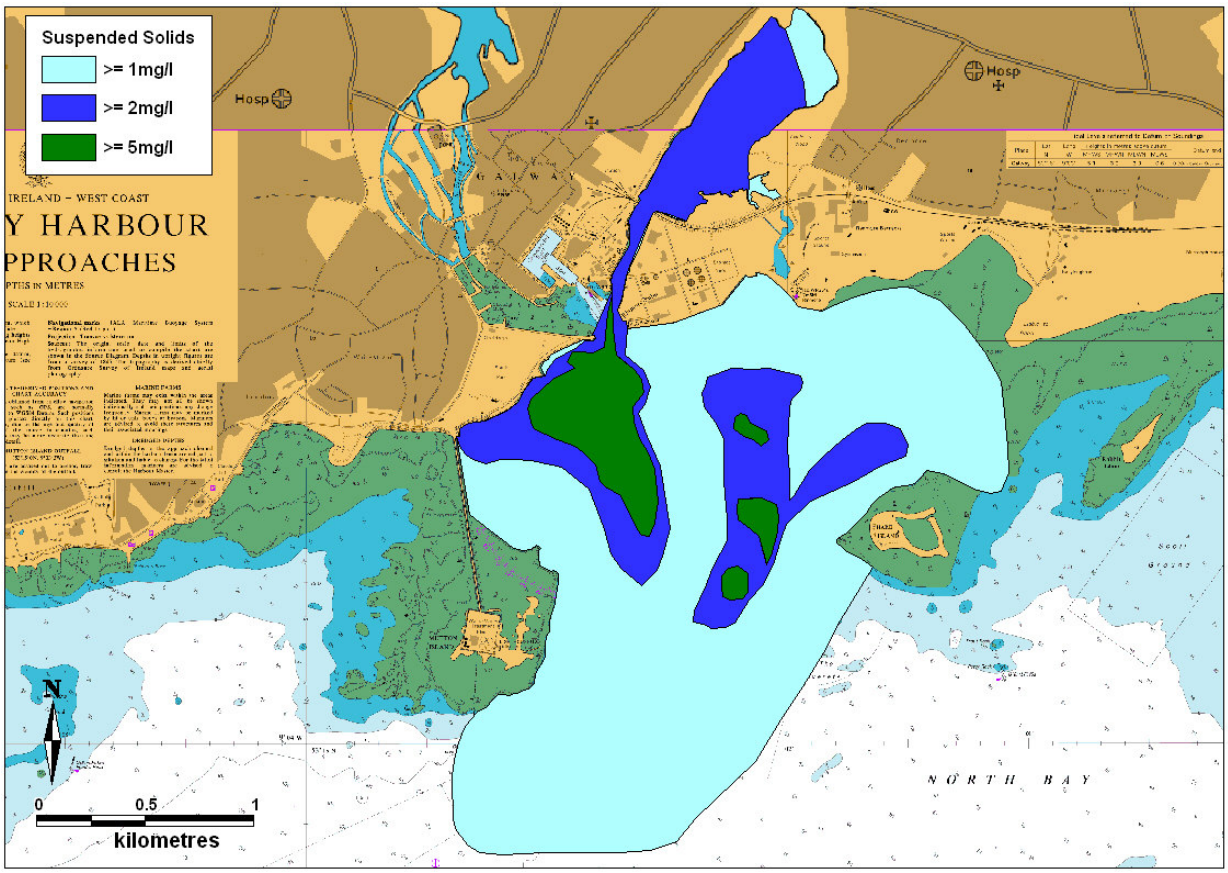


Figure 7.4.2 - Zone of potential influence

7.4.1.3.1 Terrestrial habitats in zone of potential influence

A review of habitats in the surrounding area within a zone of potential influence by the development was undertaken. The assessment concentrated mainly on habitats within the zone of potential influence, in the Galway Bay Complex cSAC, focussing on habitats that would be considered linked to those on Annex I of the EU Habitats Directive.

Lough Atalia and its surrounding vegetation was considered, in addition to Renmore Lough. This area is included within the Galway Bay Complex cSAC as shown in Drawing 2139-2104. Lough Atalia is a body of estuarine water in Galway City that is approximately 40 ha in extent. To the south of the railway bridge there is a narrow (50-75 m wide) rocky shore outlet to the sea.

The terrestrial habitats surrounding Lough Atalia are as follows:

Lower & Upper Saltmarsh (CM1/CM2)	9.4 ha
Shingle and gravel banks (CB1)	0.3 ha
Amenity grassland (GA2)	3.5 ha
Dry meadows and grassy verges (GS2)	2.4 ha
Improved agricultural grassland (GA1)	1.6 ha
Scrub (WS1)	1.6 ha
Flower beds and borders (BC4)	0.3 ha
Stone walls and other stonework (BL1)	490 m
Sea walls, piers and jetties (CC1)	570 m

The area along the east and southeastern shore of Lough Atalia was classified as Lower and Upper Salt marsh (CM1/CM2). The area contained Sea Aster (*Aster tripolium*), Sea Plantain (*Plantago maritima*), Common Scurvy-grass (*Cochleria officinalis*), Creeping Bent (*Agrostis stolonifera*), Red Fescue (*Festuca rubra*), Sea Rush (*Juncus maritimus*), Sea Club-rush

(*Bolboschoenus maritimus*) and Saltmarsh Rush (*Juncus gerardi*). There were also some small patches or beds of Reed (*Phragmites australis*), although these were not considered large enough to classify separately as Reed and large sedge swamps (FS1). This area of saltmarsh occupies the fringe of the eastern side of Lough Atalia and its south-eastern corner. It is a mosaic of lower and upper saltmarsh that is equivalent to both the EU Habitats Directive Annex I habitats 'Atlantic salt meadows (Natura 2000 Code 1330)' and 'Mediterranean salt meadows (Natura 2000 Code 1410)'.

Grassland habitats comprise much of the remaining terrestrial habitat surrounding Lough Atalia, including Amenity grassland (GA2), Dry meadows and grassy verges (GS2) and Improved agricultural grassland areas. Mown and managed Amenity grassland lines the western fringe of Lough Atalia by the side of Lough Atalia Road and at the northern end by the Huntsman public house. There are some areas of this habitat dominated by False Oat-grass (*Arrhenatherium elatius*) and Couch-grass (*Agropyron repens*), with other herbs and punctuated with occasional patches of Bramble (*Rubus fruticosus* agg.), on the eastern side of Lough Atalia between Lakeshore Drive and the water. This habitat does not correspond to an annexed habitat.

A small area of improved agricultural grassland is located on higher ground on the eastern side of Lough Atalia. This area can be reached via an old farm track and is the site of a number of large metal containers associated with a sailing club. This area does not appear to have been much used for grazing recently and the hedges do not seem to have recently been cut. The whole area (except where the containers are placed and where sailing club activities keep the ground open) is likely to revert to scrub unless management is undertaken to prevent this.

In addition to grassland and saltmarsh, there are several areas of scrub at Lough Atalia, particularly in the south-east corner near to the railway line. Species present included Gorse (*Ulex europaeus*), Common Sallow (*Salix cinerea* ssp. *oleifolia*), Whitebeam (*Sorbus* spp.) and Hawthorn (*Crataegus monogyna*). There are also a number of small garden plots on the western side of Lough Atalia between Lough Atalia Road and the water. These gardens belong to the houses opposite them on the other side of Lough Atalia Road and are considered Flower bed and border habitat (BC4). Drystone walls act as boundary markers and stock barriers for old fields on the eastern side of Lough Atalia between Lakeshore Drive and the water. This habitat is classified as Stonewalls and other stonework (BL1) in accordance with Fossitt (2000). Stone sea walling at the northern end of Lough Atalia in the vicinity of the Huntsman public house is considered Sea wall, pier and jetties (CC1) habitat. None of the above corresponds to Annex I habitats and none of the species identified are considered rare or protected.

Table 7.4.1 lists the Annex I Habitats (EU Habitats Directive) present within the zone of potential influence.

Habitat Type	Location and Area	Natura Habitat Link
Saltmarsh (CM1/CM2)	9.4 ha by Lough Atalia (E130970 N225220)	Atlantic salt meadows (Natura 2000 Code 1330)' and 'Mediterranean salt meadows (Natura 2000 Code 1410)'
	Small patches over shingle at the western edge of Renmore Beach (E130930 224800)	Atlantic salt meadows (Natura 2000 Code 1330)
	Small area at (E131300 N224650)	Atlantic salt meadows (Natura 2000 Code 1330)
	Small areas surrounding Renmore Lough (E131070 N224910)	Atlantic salt meadows (Natura 2000 Code 1330)
Lagoons and saline lakes (CW1)	Renmore Lough, 0.7 ha (E131070 N224910) Lough Atalia, 40 ha (E130740 N225340)	Coastal lagoons (Natura 2000 Code 1150)' *priority*
Sea inlets and bays (MW2)	Inner bay area 368 ha	Large shallow inlets and bays (Natura 2000 Code 1160)
Shingle and gravel banks (CB1)	Shingle/cobble bank at top of Renmore Beach (E131070 N224790), along South Park and at Mutton Island	Perennial vegetation of stony banks (Natura 2000 Code 1220)
Shingle and gravel shores (LS1)	Thin strip at strandline at Renmore Beach (E131010 N224810)	Annual vegetation of drift lines (Natura 2000 Code 1210)
Marine Annexed Habitats		
Reefs [1170]	Scattered sections within intertidal area	Reefs [1170]

Table 7.4.1 - Annexed Habitats in the Zone of Potential Influence

7.4.1.3.2 Lough Atalia and Renmore Lough

Lough Atalia and Renmore Lough lie in the inner part of Galway Bay and are defined as "lagoons" within the EU Habitats Directive. Lagoons are listed as priority habitats in this Directive. As these water bodies lie close to the site of a proposed extension of Galway Harbour, an assessment of the possible impact of the proposed development on the ecology of both water bodies was undertaken.

A review of existing salinity data and information collected as part of this study showed that recorded salinities ranged from 0.4 to 29.4 psu (practical salinity unit). The calculated full range of salinities is from zero to 30.0 psu. Initial results from a broad scale 2 dimensional hydrodynamic model indicated that salinities might decrease and for this reason, a fine scale 3 dimensional modelling study was carried out (See Chapter 8 of the EIS).

This report describes the conservation status, morphology, bathymetry, current speeds and directions, salinity and biology of Lough Atalia and Renmore Lough. The species recorded in each water body are listed and are then discussed individually in terms of their salinity tolerances. The discussion at the end of the report comments on the likely effect the predicted temporal decreases in salinity may have on the conservation status of the water bodies.

7.4.2 Conservation Status

Both water bodies lie within Galway Bay candidate Special Area of Conservation (cSAC) and Lough Atalia only lies within the Galway Bay Special Protection Area (SPA) (see Figure 7.4.3). However, habitat quality in both is poor and in a review of Irish lagoons, Oliver (2007) states that "Lough Atalia is an "estuarine" lagoon and most of the bed of the lagoon appears to be bare, soft mud. It is also highly polluted, so that even on hard surfaces very few algal plants were found. Based on aquatic vegetation, the site is regarded as of no conservation value as a coastal lagoon." Oliver (*loc. cit.)* did not survey Renmore Lough.

The conservation objectives for Galway Bay cSAC and SPA were recently published by National Parks and Wildlife and the section on lagoons in the cSAC is presented in the following Table 7.4.2.

Conservation Objectives for Lagoons in Galway Bay cSAC		
Annex I Habitat	**Coastal lagoons* [1150]**	**Assessment of Impact**
Measure : Hectares	**Attribute:** Habitat Area **Target**: Permanent habitat increasing or stable. Area stable, subject to slight natural variation. Favourable reference area 76.7ha. Notes. Areas calculated from spatial data derived from Oliver (2007). Site codes IL037, IL038, IL039, IL046, IL047, IL048, IL049, IL050, IL051, and IL052. N.B. There may be more, as yet unmapped, lagoons within this cSAC.	No change to habitat area
Measure : Occurrence	**Attribute:** Habitat distribution **Target:** No decline, subject to natural processes. Notes. Site codes IL037, IL038, IL039, IL046, IL047, IL048, IL049, IL050, IL051, and IL052 in Oliver (2007). N.B. There may be more, as yet unmapped, lagoons within this SAC.	No change to habitat distribution.
Measure : Practical salinity unit (psu)	**Attribute**: Salinity regime **Target:** Median annual salinity and temporal variation within natural ranges maintained. Notes. The lagoons in the site vary from oligohaline to euhaline. Lough Atalia and Renmore Lough are poikilohaline systems (see Table 6.5 for definitions).	Fluctuations on the existing variability possible though deemed not to have any impact on the functioning of the ecosystem.
Measure: Water depth	**Attribute:** Hydrological regime **Target:** Current annual water level fluctuations and minima maintained within natural ranges. Note. Most of the lagoons listed for the site are considered to be shallow; however, Aughinish and Lough Atalia do have deeper (at least 3m) parts.	Water levels will be maintained and will not be altered by the development.

Table 7.4.2 - Conservation Objectives for lagoons in Galway bay cSAC

Conservation Objectives for Lagoons in Galway Bay cSAC		
Annex I Habitat	**Coastal lagoons* [1150]**	**Assessment of Impact**
Measure: Barrier	**Attribute:** Barrier **Target:** Permeability of barrier maintained. Appropriate hydrological connections between lagoons and sea, including where necessary, appropriate management. Notes. The lagoons within this site exhibit a variety of barrier types including cobble/shingle, karst and artificial embankment/causeway. Several are recorded as having sluices.	There will be no impact on the barrier/sill.
Measure: Chlorophyll a	**Attribute**: Water Quality (Chlorophyll a) **Target:** Annual median chlorophyll a reduced within natural ranges and less than 5µg/l. Note. Target based on Roden and Oliver (2010).	There will be no impact on chlorophyll a.
Measure: Phosphorous	**Attribute:** Water Quality (MRP: Molybdate reducing Phosphorous) Target: Annual median MRP reduced within natural ranges 0.1mg/l. Note. Target based on Roden and Oliver (2010).	The development will not alter MRP levels.
Measure: Nitrogen	**Attribute:** Water Quality (DIN; dissolved inorganic Nitrogen) **Target:** Annual median DIN a reduced within natural ranges and less than 0.15mg/l. Note. Target based on Roden and Oliver (2010).	The development will not alter DIN level.
Measure: Macrophytic growth	**Attribute:** Depth of Macrophyte Colonisation **Target:** Increase colonization to maximum depth. Note. Macrophyte colonisation at least 2m depth.	Development will not alter macrophyte communities
Measure: Floral diversity	**Attribute:** Typical Plant Species **Target:** Maintain number and extent of listed lagoonal specialists, subject to natural variation. Note. Species listed in Oliver (2007).	The development will not alter floral lagoonal specialists.
Measure: Faunal diversity	**Attribute**: Typical Animal Invertebrate Species **Target:** Maintain listed lagoon specialists, subject to natural variation. Note. Species listed in Oliver (2007).	The development will not alter faunal lagoonal specialists.
Measure: Negative indicator species	**Attribute:** Negative Indicator Species **Target:** Negative indicator species absent or under control. Note. Low salinity, shallow water and elevated nutrient levels increase the threat of accelerated encroachment by reed beds.	The development will not alter negative indicator species.

Table 7.4.2 contd/:. Conservation Objectives for lagoons in Galway Bay cSAC.

Turbidity is not listed in the conservation objectives as an attribute. However, sediments suspended during the dredging operations have the potential to enter the lagoon on flooding tides. As a result of the oceanographic conditions within the lagoon, this sediment will not be remobilised and will be retained within it. The result could be the loss of water depth (*ca* 10mm) in the northeastern section of the lagoon. This will be mitigated by permitting dredging only under ebbing tides.

Figure 7.4.3 - Lough Atalia and Renmore Lough within the cSAC and SPA

7.4.3 Description of Lough Atalia and Renmore Lough.

Lough Atalia and its small off-shoot, Renmore Lough comprises an area of ca 40 ha of Inner Galway Bay (see Figure 7.4.4). Given the presence of at least 3 lagoonal specialists in the Lough Atalia/Renmore Lough water body, the wide variability in salinities and the fact that it only partially empties, this habitat falls within the definition of a lagoon. Lagoons are listed in Annex I of the Habitats Directive as a priority habitat, 'Coastal Lagoons' (Natura 2000 Code 1150).

Figure 7.4.4 - Lough Atalia and Renmore Lough

Lough Atalia has a narrow channel to the south-west connecting it with Inner Galway Bay (see Figure 7.4.4). There is a shallow sill at the entrance to the lough (see Figure 7.4.7) which restricts full tidal flow into it. This corresponds to the characterisation by Healy (2003) of lagoons being at least partially separated from, while still having exchange of water, with the sea. The presence of the sill in Lough Atalia leads to an asymmetrical tide of ca nine hours ebb and three hours flood. The sill also acts to retain water at low tide with approximately 80% of the lough remaining inundated at low tide (Oliver, 2007). Such asymmetrical tides are typical of water bodies with significant sills and other examples in Co. Galway are Curanroo, Lough Rusheen, several other Lough Atalias in Connemara and Salt Lake, Clifden. Some systems *e.g.* Inverbeg and Loch Aneera, both in Kilkieran Bay, only receive salt water on equinoctial Spring tides. This denser water sinks underneath the lighter freshwater and lies on the lake bed where it becomes anoxic. However, due to the significant flows into and out of Lough Atalia, anoxia in the water column does not occur. The intertidal, muddy area in the northern part of Lough Atalia is relatively small in comparison to the large area of water retained.

The connection channel (Figure 7.4.4) has undergone a number of changes in the last *ca* 150 years. It was partially narrowed as part of the construction of the railway line into Galway City in the 1860s by the building of an abutment on the eastern side and two piers to support the rail bridge. Further alterations occurred in the 1960s and 90s when the sides of the channel (between the railway bridge and a newly constructed road bridge to the south allowing access to

the Galway Enterprise Park and southwards) were straightened. Other changes include the construction of storm water overflows at the northern and eastern end of the lough. There is a freshwater well on the western side of the lagoon called St. Augustine's Well.

Renmore Lough (Figure 7.4.4) is connected to the south-east of Lough Atalia via a cut channel under the railway. It was historically connected to Lough Atalia by a natural channel but this was closed up when the railway line was built and a small channel was opened ca 100m to the west of the original access point and this goes under the railway line to join the main body of Lough Atalia (Figure 7.4.4). The water level in Renmore Lough is ca 1 m higher than the top of the culvert under the railway line (marked on Figure 7.4.4 as "Present Connection"). This indicates that sea water rarely accesses Renmore Lough from Lough Atalia.

7.4.4 Bathymetry

A bathymetric survey of Lough Atalia was carried out using a Precision SonarMite Echo Sounder in conjunction with a Trimble® GeoXT™ to record depths within Lough Atalia. Depths are mostly shallow (less that 1 m) but there is a deeper area towards the south-western section of the mouth with depths of up to ca 4m and which can reach >5.5m at high water (see Figure 7.4.5). This figure also shows a blow up of the access channel into Lough Atalia from the open sea. Its narrow width, shallow depths and sill (coloured in gold) all restrict ingress of water into Lough Atalia and give rise to the asymmetrical tides noted above.

Depths of Renmore Lough, taken at a neap low water 14/03/2012 ranged between 0.15-0.85 and for this reason, a vessel-based bathymetric survey was not possible.

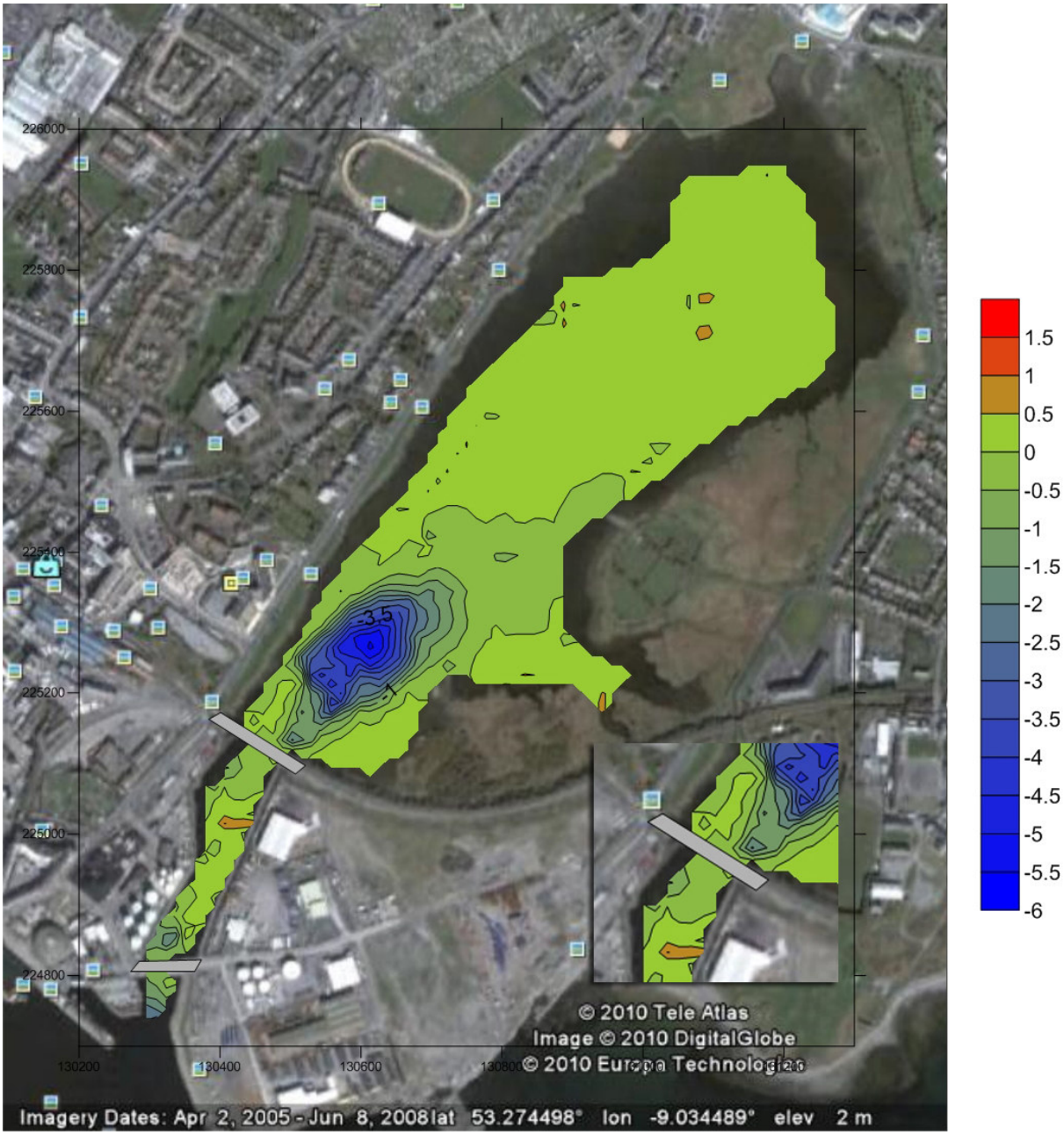


Figure 7.4.5 - Bathymetry of Lough Atalia.

7.4.5 Current speeds and directions

Current flow at the mouth of Lough Atalia was measured by deploying a continuous recording current meter between 8 January and 1 February 2013 and for a second period between 11 March and 25 March 2013 (see Figure 7.4.9 for location and Appendix 7.2 for graphical representation of data).

There is greater water flow near the south-western mouth of the lough compared to its north-eastern head. The increased velocity of water at the mouth is caused by water movement over the sill and these forces are less in waters towards the north-eastern end. Hydrodynamic model output shows Lough Atalia to have greater and more variable velocities during spring tides. Velocities around the mouth vary from 0.15 - 3m/s with lower velocities in the rest of the lough often at the minimum of 0m/s but sometimes rising to 0.05m/s in the centre. Weak water currents compared to those of estuaries are a characteristic of lagoons (Healy, 2003). The water velocity patterns result in the sediment at the mouth comprising gravel, compared to the soft muds found towards the north-eastern end.

Directions of flow are northeast on a rising tide and southwest on a falling tide.

Run off and seepage from land flows into Renmore Lough in accordance with levels of rain fall. Because Renmore Lough is perched (+1m above mean high water neap), water flows out of it into Lough Atalia for a much longer period than water flows into it (see Figure 7.4.7 for cross sections from the sea into Lough Atalia and from Lough Atalia into Renmore Lough). It is only under highest astronomical Spring tides that sea water can access Renmore Lough.

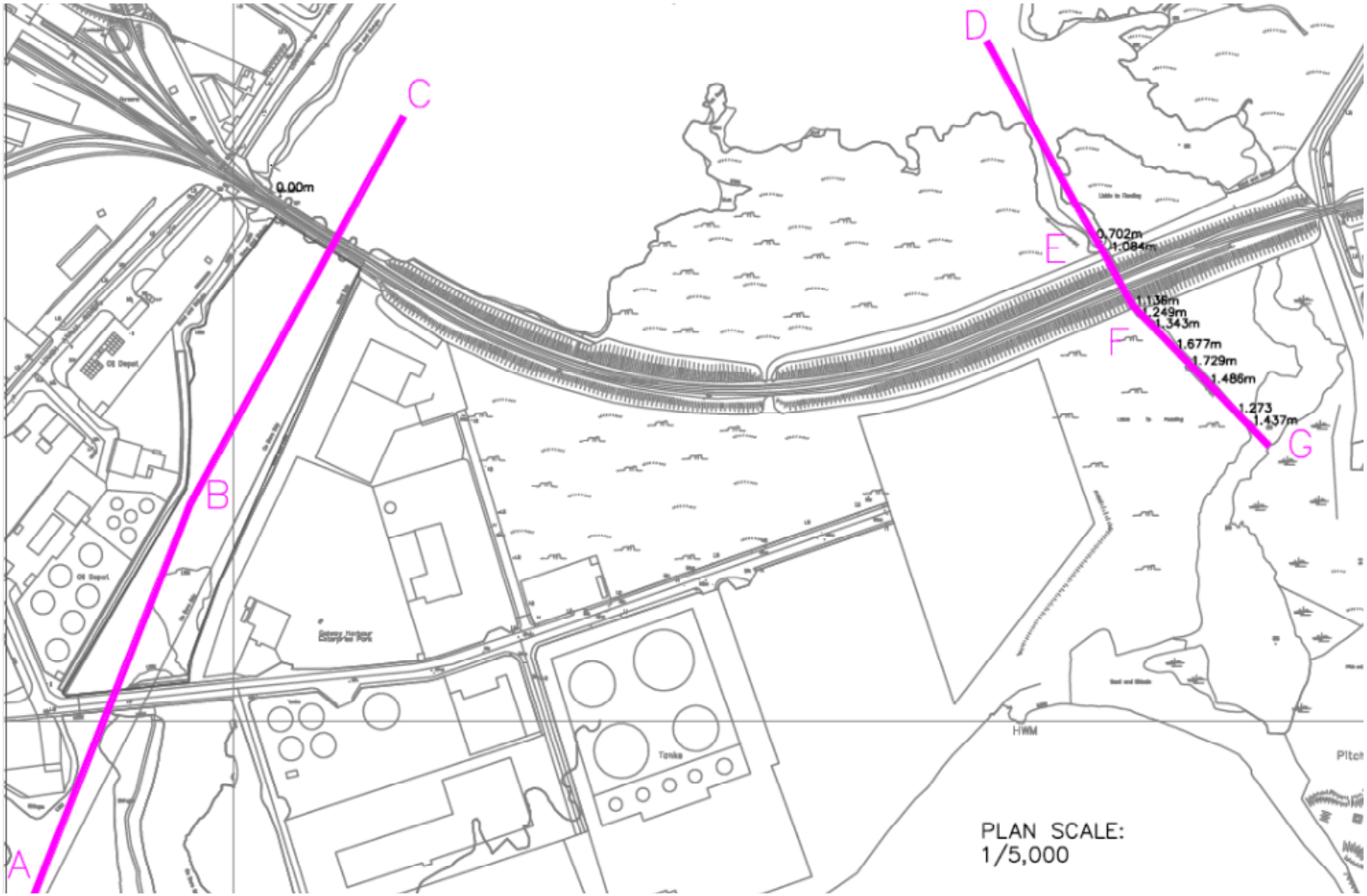


Figure 7.4.6 - Plan of Channels:

Plan of Channels:
Open Sea to Lough Atalia A-B-C
Lough Atalia to Renmore Lough D-E-F-G

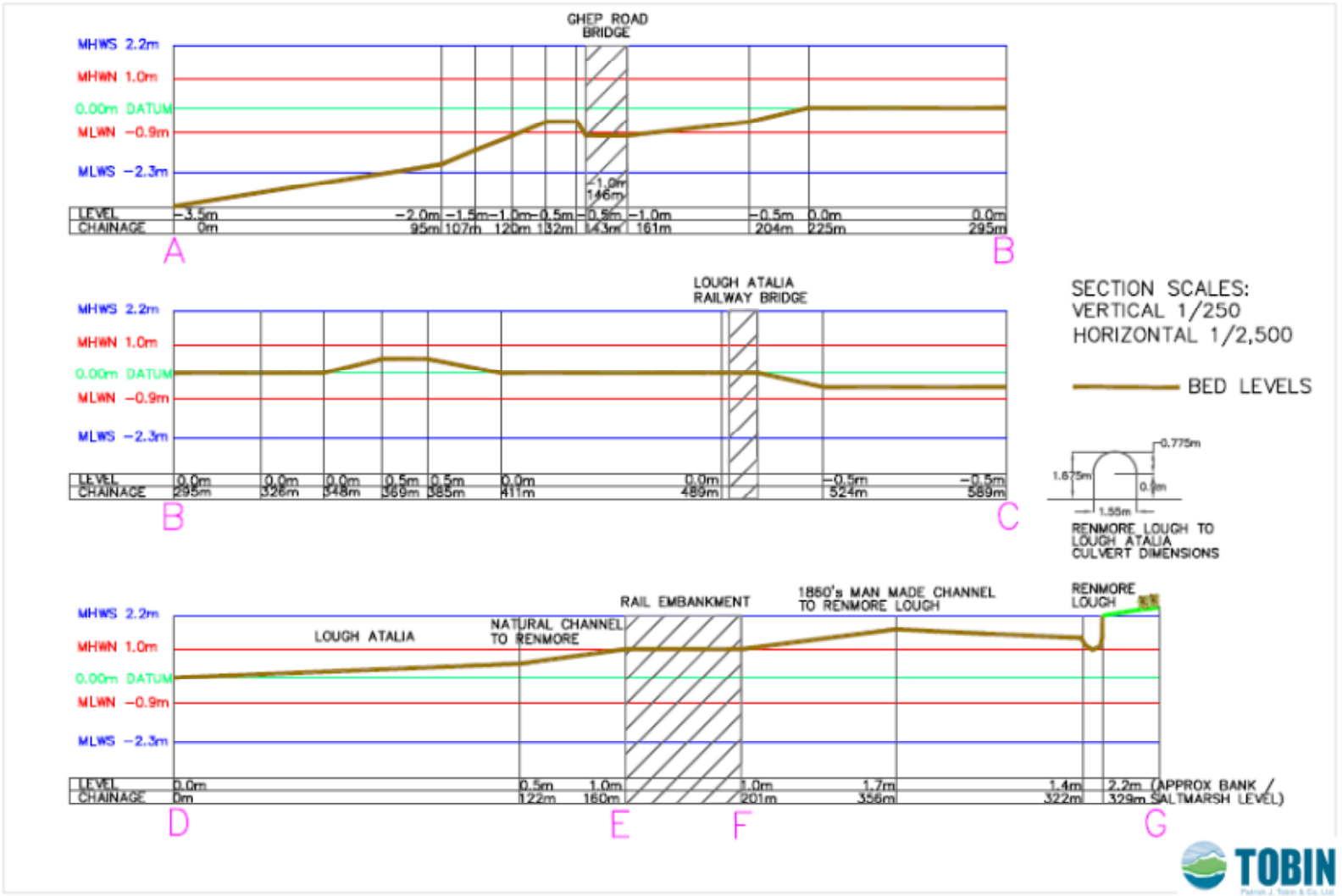


Figure 7.4.7 - Long section of channel from the open sea to Lough Atalia and from Lough Atalia to Renmore Lough

7.4.6 Salinity

Existing data reported by Sotillo *et al.* (2011) and data collected by AQUAFACT were used to describe the salinity conditions in both Lough Atalia and Renmore Lough. Sotillo *et al.* (2011) used a field probe to record values at different depths and locations while the AQUAFACT surveys included both a field probe deployed along the shoreline (surface readings only) and from a boat (at 50 cms depth intervals) and *in situ* continuous recording salinity meters. The different survey types and durations are listed below. Figure 7.4.8 shows the initial location of 21 profile stations used to describe salinity in profile while Figure 7.4.9 shows the locations of the reduced 10 profiling stations.

Shore Surveys
In August 2011, salinity measurements were taken at 4 stations on the western shore of Lough Atalia.

Between 12 September 2011 and 29 November 2011, salinity measurements were recorded at Renmore Lough, on 5 separate occasions. Further salinity measurements were recorded at Renmore Lough between 5th March 2012 and 2nd May 2012 on 14 separate occasions. A salinity measurement was also taken at a site located on the NE shore of Lough Atalia, as part of the 2012 surveys.

Between 14th January 2013 and 24th January 2013, salinity measurements were recorded at the south and north ends of Renmore Lough.

On 6th March 2013, salinity measurements were taken at the bridge over the mouth of Lough Atalia, between 9am and 5pm, at 15 minute intervals, with readings recorded at surface, 0.5m, 1m, 1.5m, and 2m depth.

Boat Surveys
In August 2011, 7 vertical salinity profiles were taken along a transect from south to north Lough Atalia.

In March 2012, depth measurements were taken in Renmore Lough along a transect from north to south.

At 21 stations located in Lough Atalia, salinity measurements were taken by boat on 5 separate occasions, between 4th April 2012 and 4th May 2012.

At 10 stations in Lough Atalia, salinity was measured by boat on 8 separate occasions, between 4th December 2012 and 24th January 2013. Fauna and sediment samples for particle size analysis and organic carbon were taken at these 10 stations on 4th December 2012.

Continuous current and salinity recordings
Current metering using a bottom mounted, upward looking Acoustic Doppler Current Profiler, (ADCP) and salinity readings were recorded between 8 January 2013 and 1 February 2013, and between 11 March 2013 and 25 March 2013. Figure 7.4.10 shows how these meters were deployed. Readings were recorded every 30 minutes.

Figure 7.4.8 - Figure showing the 21 stations where salinity profiles were recorded with a probe

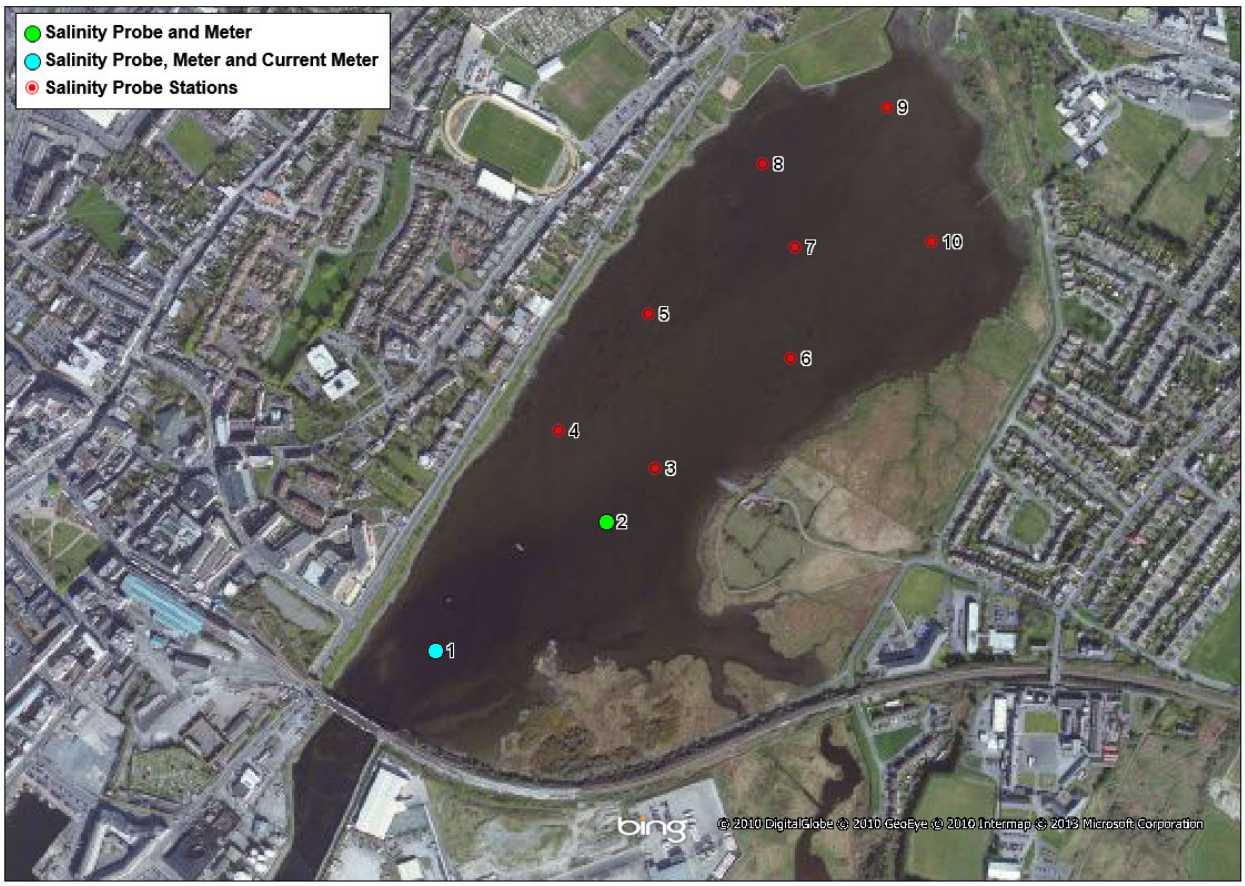


Figure 7.4.9 - Figure showing the 10 stations where salinity profiles using a probe were collected, the two sites where continuous recording meters for both salinity and the single site where the continuous recording current meter was deployed

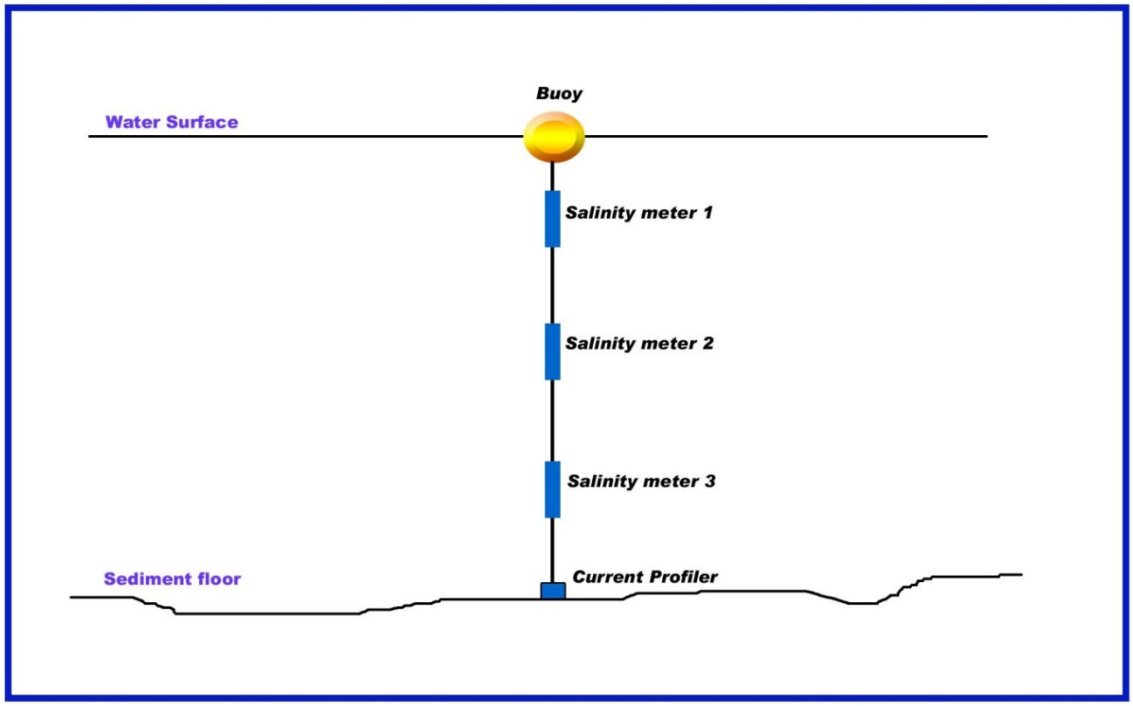


Figure 7.4.10 - Diagram showing layout of current and salinity meter strings

Results of some of the data collected using the probe are presented in Appendix 7.2 along with data and graphs collected by the continuous recording meters over the period March 11th – 25th, 2013.

During the study period, salinities within Lough Atalia ranged from 0.4 to 29.4 psu (practical salinity unit). Over the course of Spring-Neap tidal cycles, surface salinities range from 0.4 to 28.8 psu and bottom salinities range from 10 to 29.4 psu. Surface salinities are generally lower near the southern end of the lough where the mouth is located. However, low surface salinities were also recorded towards the northern end of the lough. Salinities increase with depth, leading to the highest salinities being recorded at the deepest areas of the lough. The low values at the northern end reflect the effects of surface run off. Low surface salinities recorded at the mouth are due to Corrib River water being brought in to the lough by flooding tides. There is some evidence to suggest the formation of a temporary halocline (halocline = a strong discontinuity in salinity with depth) in Lough Atalia under conditions of low mixing which disappears in high mixing conditions such as during a flooding tide.

Salinity in Renmore Lough ranged from 2.2 to 23.9 psu and extreme values were recorded at its northern end. As noted above in the section on bathymetry and shown in Figure 7.4.5, it is only under highest astronomical tides that water can access Renmore Lough from Lough Atalia and it is the salinity characteristics of this inflowing water that regulates salinity within the Lough. If the River Corrib is in spate at the time of these high tides, salinities will be lowered (as in the recording of 2.2 psu above) whereas if River Corrib flow is low, the salinity of inflowing water from Lough Atalia into Renmore Lough will be high (23.9 psu recorded above).The salinities within Renmore Lough remain more or less constant between the southerly end and the northerly end (averaging 10.3-10.4 psu), which is further from the sea, suggesting that there are no pathways directly between the sea and Renmore Lough through the narrow land bank.

The extensive range of salinities recorded both in Lough Atalia and Renmore Lough classifies them as poikilohaline systems (poikilohaline = high variability in salinities). Millar *et al*. (1990) note that mean salinity values range from 0 – 35 psu and comment that lagoonal species are usually quite tolerant of a wide salinity range.

Salinity Units ppt and psu

It should be noted that the salinity measurement data referred to in this report are in the units of psu, whereas the hydrodynamic salinity model TELEMAC-3D refers to salinities in grams of salt per kilogram of solution (g/l or parts per thousand (ppt)). The modern oceanographic definition of salinity is the Practical Salinity Scale of 1978 (PSS-78). The numeric unit from PSS-78 is psu (practical salinity unit) and is distinct from the previous physical quantity ppt (kg salt per kg water in parts per thousand). Salinity values in ppt and psu are nearly equivalent by design, and for the purposes of this assessment can be treated as equivalent.

7.4.7 Turbidity

Turbidity measurements returned a value of 0 NTU (Nephelometric Turbidity Units).This value of 0 NTU was also measured in Galway Bay and on Wolfe Tone Bridge at the mouth of the River Corrib. Secchi disc measurements taken in Lough Atalia resulted in a visible reading off bottom for most stations due to the shallow depths. At the deeper stations, Secchi values of 2.5 to 2.75m were recorded. As Renmore Lough is less than 1 m depth and the sea bed could be seen on each site visit, Secchi disc measurements were not made.

7.4.8 Flora and fauna

49 taxa of flora and fauna recorded in Lough Atalia and Renmore Lough is shown in Table 7.4.3. Taxa only recorded within Renmore Lough are coded with R.L. (= Renmore Lough). This table was compiled from surveys by Oliver (2007), Sotillo *et al*., (2011) and AQUAFACT (2010 - 2013). *Chaetomorpha linum, Jaera nordmanni* and *Palaemonetes varians* are considered to be lagoonal specialist species (Healy, 2003; Oliver, 2007). The numeral in the column on the extreme right is given to direct the reader to the species' salinity tolerance given in Section 7.4.9 below.

Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo *et al.,* 2011 and AQUAFACT surveys)			
Phylum	**Division/Class**	**Species**	
Plantae	Chlorophycota	*Chaetomorpha linum*	1
		Enteromorpha sp.	2
		Ulva lactuca	3
	Phaeophycota	*Fucus serratus*	4
		Fucus spiralis	5
		Fucus vesiculosus	6
		Pelvetia canaliculata	7
	Rhodophycota	*Ceramium sp.*	8
		Chondrus crispus	9
	Xanthophyceae	*Vaucheria* sp.	10
	Angiosperm	*Ruppia* sp.	11
Cnidaria	Hydrozoa	*Cordylophora caspia*	12
Nematoda		Indet.	13

Table 7.4.3 - Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo et al., 2011 and AQUAFACT surveys)

Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo *et al.,* 2011 and AQUAFACT surveys)			
Phylum	**Division/Class**	**Species**	
Annelida	Polychaeta	*Hediste* (*Nereis*) *diversicolor*	14
		Polydora ciliata	15
		Pygospio elegans	16
	Oligochaeta	*Nais sp.*	17
		Heterochaeta costata (R.L.)	18
Crustacea	Cirripedia	*Elminius modestus*	19
	Copepoda	*Nitokra spinipes* (R.L.)	20
		Cyclopoida	21
	Mysidacea	*Neomysis integer*	22
		Praunus flexuosus	23
	Isopoda	*Jaera nordmanni*	24
		Jaera albifrons	25
		Asellus sp (R.L.)	26
	Amphipoda	*Allomelita pellucida*	27
		Melita palmata	28
		Gammarus duebeni	29
		Gammarus salinus	30
		Gammarus indet.	
	Decapoda	*Palaemon elegans*	31
		Palaemonetes varians	32
		Crangon crangon	33
		Carcinus maenas	34
	Ostracoda	*Cyprideis torosa* (R.L.)	35
Acarina		Indet	36
Insecta	Diptera	Chironomidae indet.	37
	Odonata	Zygoptera (R.L.)	38
	Coleoptera	Dytiscidae (R.L.)	39
Mollusca	Pulmonata	*Peringia* (*Hydrobia*) *ulvae*	40
	Gastropoda	*Ecrobia (Hydrobia) ventrosa* (R.L.)	41
Bryozoa	Gymnolaemata	*Bowerbankia gracilis*	42
		Alcyonidium gelatinosum	43

Table 7.4.3 contd/ : Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo *et al.*, 2011 and AQUAFACT surveys)

Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo *et al.,* 2011 and AQUAFACT surveys)			
Phylum	**Division/Class**	**Species**	
Pisces	Osteichthyes	*Chelon labrosus*	44
		Platichthys flesus	45
		Pomatoschistus microps	46
		Gasterosteus aculeatus (R.L.)	47
		Antherina presbyter	48
		Anguilla anguilla (R.L.)	49

Table 7.4.3 contd/. : Flora and fauna recorded in Lough Atalia and Renmore Lough (based on Oliver, 2007; Sotillo *et al.*, 2011 and AQUAFACT surveys)

A benthic survey using a 0.025 m^2 grab and a 1 mm mesh was undertaken to quantitatively assess the sea bed fauna and sediments in Lough Atalia. 2 grabs were taken for faunal identification at the 10 sites shown in Figure 7.4.11 below and a further sample was taken for grain size and organic carbon content. During the field work when samples were being collected, except for Station 1, there was a strong smell of hydrogen sulphide from all samples collected and the sediment was black. Both these features indicate anoxic, sedimentary conditions.

Figure 7.4.11 - Benthic grab station location map for Lough Atalia

The faunal analyses returned exceptionally low numbers of taxa and numbers of individuals with only 8 species being recorded at 4 stations. The following 7 species (and their densities) were recorded at Station 1: *Jaera nordmanni* (15), *Allomelita pellucida* (4), *Gammarus* sp (8), *Gammarus salinus* (13), Oligochaeta (3), *Pygospio elegans* (1) and *Polydora ciliata* (4). Station 3 returned only two specimens of *Melita palmata* and Station 5 and 9 returned only 1 specimen each of *Gammarus salinus*. Stations 2, 4, 6, 7, 8 and 10 had no fauna at all.

Table 7.4.4 shows the results of the analyses of grain size (as percentages) and organic carbon (right hand column as %) from the same 10 stations. Station 1 had by far the highest amount of coarse sediment with almost 70% being gravel. All other stations were characterised by low amounts of coarse sediment and high percentages of fine, very fine and silt clays. Organic carbon levels ranges from 10.05 at Station 1 to 18.96 at Station 2. The mean value was 14.89.

Results of granulometric (%) and organic carbon (LOI%) analyses on 10 sediment samples collected in Lough Atalia.								
Station	Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt-Clay	Organic Carbon
1	69.2	7.1	8.2	9.4	3.3	1.5	1.3	10.05
2	0.5	1.9	7	15	20.1	20.4	35	18.96
3	1	3.9	7.2	13.2	17	11.7	45.9	16.02
4	0.2	1.5	7.6	15.9	15.8	13.4	45.5	18.14
5	0.5	1	4.7	9	16.2	21.5	47.2	13.87
6	1	3.5	5.2	8.9	14.4	10.6	56.4	11.57
7	1.2	1	3.6	8.9	13.4	9.2	62.8	13.55
8	0	0	0.4	0.7	14.3	16.6	68.1	13.33
9	0.7	1.8	6.8	14.6	16.6	8.5	50.9	17.64
10	0.6	3.6	10.2	14.5	15.1	15.1	40.9	15.81

Table 7.4.4 - Results of granulometric (%) and organic carbon (LOI%) analyses on 10 sediment samples collected in Lough Atalia

Aquatic fauna from Renmore Lough was surveyed on 4th and 12th October 2011. Twelve invertebrate and three vertebrate taxa were recorded. Many taxa such as *Hediste diversicolor*, Chironomidae, *Ecrobia* (*Hydrobia*) *ventrosa*, *Anguilla anguilla* and *Gasterosteus aculeatus* are commonly occurring lagoonal species. Healy (2003) considers *Ecrobia ventrosa* and *Ruppia* sp. as characteristic lagoonal species. The former was present at all three stations in this survey, while the latter was recorded by Oliver (2007). *Palaemon varians* while also found in estuaries, is considered by Oliver (2007) be a characteristic lagoonal species. Other taxa such as *Hediste diversicolor, Palaemon varians* and Chironomidae are common marine or estuarine species which tolerate large salinity ranges. The Crustacea showed the most taxa present while there was only one species of mollusc, *i.e. E. ventrosa*, recorded.

Using the JNCC marine habitat classification, the above assemblage most closely fits the “sublittoral mud in low or reduced salinity (lagoons)” or SS.SMU.SMuLS grouping with the exception of *Arenicola marina, Heterochaeta costata* and *Corophium costata* which were not recorded in either water body.

In the Conservation Objectives for Galway Bay cSAC, the conservation status of Lough Atalia was assessed as 'Unfavourable- Bad' with problems of eutrophication and pollution, the threat of urbanisation, dumping and silting up. A major problem is the water quality at the site (NPWS, 2013).

A three dimensional mathematical model study (see Appendix 7.2 for full report) that was carried out to determine possible changes in salinity due to the construction of the proposed harbour extension predicted that:

- the present range of salinities which vary from 0 to 30 psu, within Lough Atalia will not change,
- the cumulative annual frequency of zero salinity occurring at the southern part of the lagoon *i.e.* close to the mouth, will increase from 7 to 18 hours over an average year and,
- the median salinity will reduce by 1.29 psu from the present value.

The model outputs can be seen in Figures 7.4.12 – 7.4.15 below for 90 (28.5 cumec (m^3/sec), 50 (82 cumec), 10 (200cumec) and 1 (272cumec) percentile flow of the River Corrib over a Neap – Spring cycle. Please note that the scale varies due to the values predicted by the output of the model *e.g.* Figure 7.4.15 the range is from 0 to 5. (*N.B.* Percentile flow is the percentage of time that the flow is greater or equal to a specific flow).

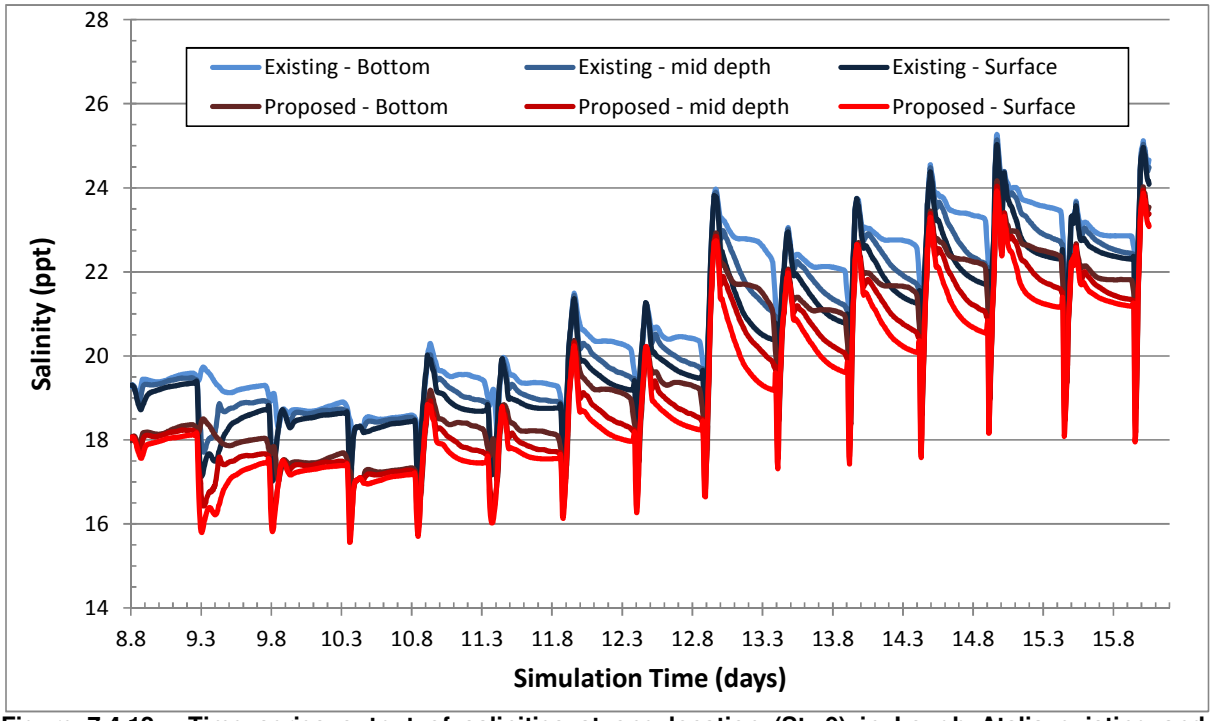


Figure 7.4.12 - Time series output of salinities at one location (St. 9) in Lough Atalia existing and proposed cases Neap to Spring tide under 90-percentile flow (28.5 cumec)

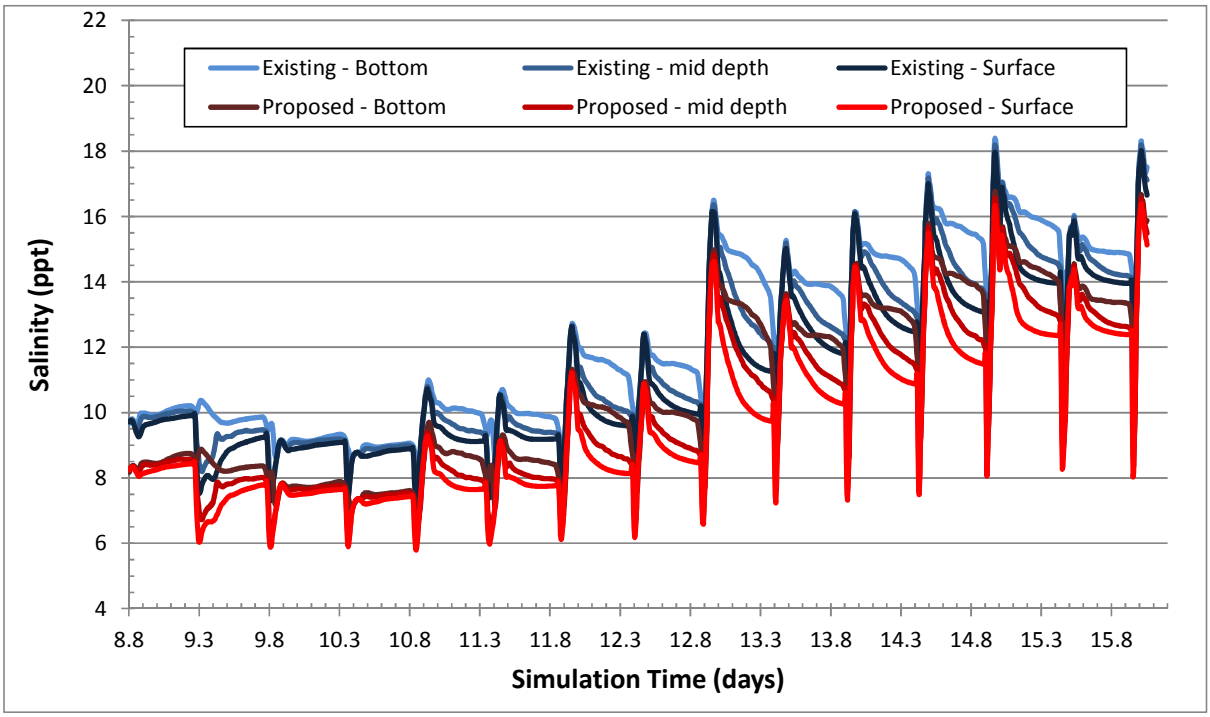


Figure 7.4.13 - Time series output of salinities at one location (St. 9) in Lough Atalia existing and proposed cases Neap to Spring tide under 50-percentile flow (82 cumec)

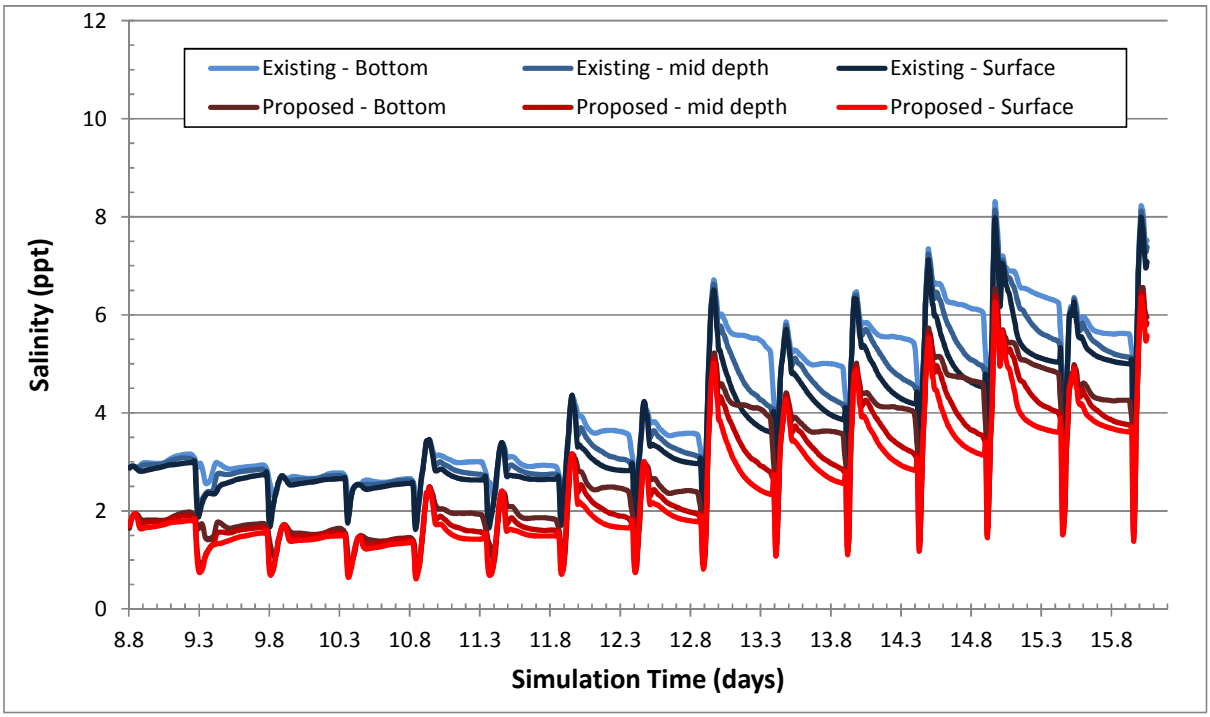


Figure 7.4.14 - Time series output of salinities at one location (St. 9) in Lough Atalia existing and proposed cases Neap to Spring tide under 10-percentile flow (200 cumec)

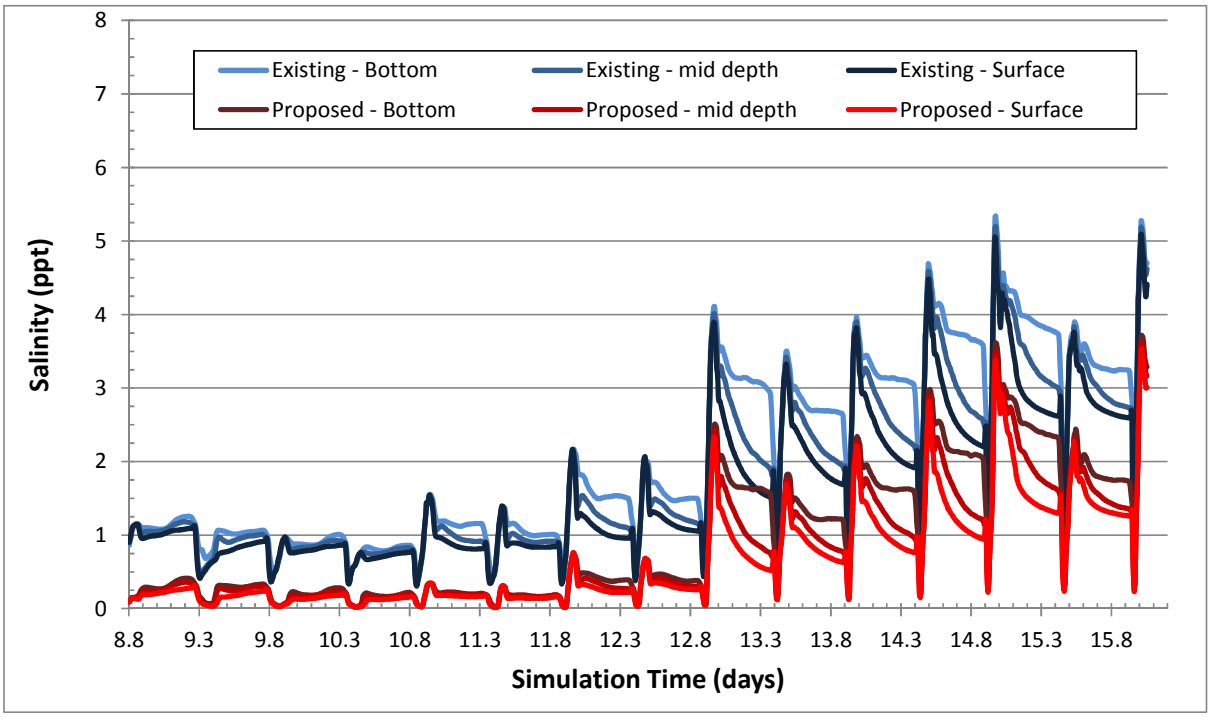


Figure 7.4.15 - Time series output of salinities at one location (St. 9) in Lough Atalia existing and proposed cases Neap to Spring tide under 1-percentile flow (272 cumec)

7.4.9 Potential impacts from the proposed development on floral and faunal species.

In order to determine if the predicted change in salinity could affect the resident flora and fauna recorded in both Lough Atalia and Renmore Lough, the salinity ranges which each species can tolerate was examined and the individual species are discussed below. It should be noted that some of these studies were laboratory-based experiments and species were tested under constant salinity levels for extended periods of time and not under the highly variable salinity levels that occur on each tide and under different River Corrib flow conditions. For information purposes, the practical salinity unit is presented in Table 7.4.5 below.

Practical Salinity Unit for Different Ranges of Salinity		
Salinity Term	**PSU**	**Common Term**
Freshwater	<0.5	Freshwater
Oligohaline	0.51 - 5	Brackish
Mesohaline	5.1 -18	
Polyhaline	18.1 - 30	
Poikilohaline	0 - 35	Poikilohaline
Euryhaline	30.1 - 40	Marine

Table 7.4.5 - Practical salinity scale for different ranges of salinity

The evolution of lagoonal communities appears to relate to the intrinsic variation in salinity within lagoons, both in time (short term) and space (Bamber *et al.,* 2001). In addition, a large number of lagoonal species are closely related to fully marine rather than estuarine or freshwater species, are essentially sublittoral and are tolerant of a wide range of salinity (for example 10 – 45 psu) (Bamber *et al.,* 2001).

de Wit (2011) uses the term poikilohaline for water that ranges from 0 – 35 psu and both Lough Atalia and Renmore Lough fit this category. These terms are used in the following section which examines the salinity tolerances of the species recorded and some other Irish lagoon characteristic species.

Salinity values recorded in Lough Atalia extend the tolerance ranges for many taxa and these are noted in the species' commentary where these apply. N.B. References can be found in Appendix 7.2.

1. *Chaetomorpha linum*
There is some doubt about the taxonomic status of the unattached lagoonal form of this species and it was recorded by Hatch & Healy (1998) as *C. mediterranea* (NPWS, 2012). It is a common, characteristic alga of semi-isolated Irish lagoons, recorded at 49 of the 87 (56.3%) lagoons surveyed (Oliver, 2005). It is considered a poikilohaline species.

2. *Enteromorpha sp*.
Studies on *Enteromorpha intestinalis* (Martins *et al*., 1999) showed that its growth varies along a bell-shaped curve with salinity and that the optimum salinity range for growth is 18–22 psu. *E. intestinalis* showed the lowest growth rates at extreme low salinity values (≤ 3 psu) and for salinity ≤ 1 psu, the alga died. Growth rates at salinities lower than 5 psu and higher than 25 psu were also low, when compared with growth between salinity of 15 and 20 psu, where *E. intestinalis* showed the highest growth rates. It is considered an oligo to polyhaline species.

3. *Ulva lactuca*
Taylor *et al.* (2001) showed that *Ulva lactuca* showed a wide tolerance to salinity, exhibiting growth in 3.4 to 34 psu. It is considered an oligo to polyhaline species.

4. *Fucus serratus* (Serrated wrack)
Fucus serratus can tolerate salinities from 18 – 40 psu (Jackson, 2008). Being intertidal and subject to precipitation, *Fucus serratus* is exposed to a broad range of salinities. This species is able to compensate for these changes in salinity by adjusting internal ion concentrations. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

5. *Fucus spiralis* (Spiral wrack)
Fucus spiralis can tolerate salinity from 10 – 40 psu (White, 2008a). *F. spiralis* can experimentally tolerate salinities of 3 to 34 psu, but it is only found in estuaries down to 10 psu. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

6. *Fucus vesiculosus* (Bladder wrack)
Fucus vesiculosus can tolerate salinity from 11 – 40 psu (White, 2008b). *F. vesiculosus* tolerates a wide range of salinities as evidenced by its penetration into the Baltic. Being an intertidal species, it must withstand occasional conditions of hyposalinity during winter precipitation and hypersalinity during the summer. In the UK, the species tolerates salinity down to 11 psu, below which it is replaced by *Fucus ceranoides* (Suryono & Hardy, 1997). Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

7. *Pelvetia canaliculata* (Channel wrack)
Pelvetia canaliculata can tolerate salinity from 18 – 40 psu (White, 2008c). It must be able to withstand wide variations in salinity because it is usually emerged for long periods of time, during which it will be drenched in freshwater from rainfall. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

8. *Ceramium sp.*
Ceramium sp. can tolerate salinity levels from <18 to 40 psu (Hiscock and Pizzolla, 2007). *Ceramium virgatum* occurs over a very wide range of salinities. The species penetrates almost to

the innermost part of Hardanger Fjord in Norway where it experiences very low salinity values and large salinity fluctuations due to the influence of snowmelt in spring (Jorde & Klavestad, 1963). Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

9. *Chondrus crispus*
Chondrus crispus can tolerate salinities from 18 – 40 psu (Rayment & Pizzola, 2008). Mathieson & Burns (1971) recorded maximum photosynthesis of *Chondrus crispus* in culture at 24 psu, but rates were comparable at 8, 16 and 32 psu. Photosynthesis continued up to 60 psu. Bird *et al.* (1979) recorded growth of Canadian *Chondrus crispus* in culture between 10 and 50 psu, with a maximum at 30 psu. The species would therefore appear to be extremely tolerant of a wide range of salinity conditions. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a poikilohaline species.

10. *Vaucheria* sp.
The genus *Vaucheria* belongs to the class Xanthophyceae (yellow green algae). Christensen, (1987) cultured this genus in salinities ranging from 0 – 60 psu. It is therefore considered a poikilohaline genus.

11. *Ruppia* sp.
Certain species of *Ruppia* (*R. maritima*) grow in soft sediments in sheltered shallow coastal waters from full salinity to nearly fresh water but mainly occur in brackish waters of lagoonal habitats, lochs, estuaries, creeks and pools in salt marshes, wetlands, ditches and lakes (Tyler-Walters, 2001). de Wit (2011) notes that *Ruppia* typically occurs in meso to polyhaline conditions.

12. *Cordylophora caspia*
Cordylophora caspia can survive 0 – 35 psu as resistant stages grow between 0.2 - 30 psu, reproduce between 0.2 to 20 psu and possesses the ability to ionically regulate (Kinne, 1971). In nature, well developed colonies are usually found in water of 2 -12 psu where tidal influence is considerable or between 2 - 6 psu where conditions are constant (Arndt, 1989). It is considered a poikilohaline species.

13. Nematoda
Nematodes are very common species occurring throughout the marine environment. Foster (1998) working on 4 species of intertidal nematode species demonstrated that they all have a capacity to exist in salinities ranging through 3.33, 16.6, 33.33 and 66.66 psu. Nematodes are considered as oligo – to euryhaline species.

14. *Hediste (Nereis) diversicolor*
Hediste diversicolor is a euryhaline species able to tolerate a range of salinities from full sea water down to 5 psu or less (Barnes, 1994). Low salinities (< 8 psu) can have an adverse effect on reproduction (Ozoh & Jones, 1990; Smith 1964). It is considered an oligo to euryhaline species.

15. *Polydora ciliata*
Polydora ciliata is widely distributed around Britain and Ireland. It is a euryhaline species inhabiting both fully marine and estuarine habitats. Gulliksen (1977) found that in an area of the western Baltic Sea, where bottom salinity was between 11.1 and 15 psu, *P. ciliata* was abundant. It is otherwise predominantly found in habitats with salinity range from 18 – 35 psu. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered a meso to euryhaline species.

16. *Pygospio elegans*
Pygospio elegans is common in both marine and brackish waters especially the latter where high abundances have been found at salinities as low as 2 psu (Hempel, 1957). However, according to The Assessment of Climate Change for the Baltic Sea Basin (2008), *P. elegans* was estimated to have a lower tolerance of 7 psu. Other studies (Van Colen *et al.* 2010) have recorded *P.*

elegans in salinity ranges from 16 to 27 psu in the tidal mud flats of Paulinapolder, the Netherlands. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered as a meso to polyhaline species.

17. *Nais sp*.
Members of the genus *Nais* are usually found in low salinity or fresh water environments (Worsfield, 2003). It is considered to be an oligo to mesohaline taxon.

18. *Heterochaeta costata*
Verdonschot (1981) and Verdonschot *et al.* (1982) showed that *Heterochaeta costata* preferred shallow water brackish waters avoiding areas of usually euryhaline salinity. However, Casellato & Poja (1984) regularly recorded *H. costata* at salinities reaching up to 30 psu. It is considered as a meso to polyhaline species.

19. *Elminius modestus*
Austrominius (Elminus) modestus displays its greatest activity, measured as cirral and valve movement, when submerged in salinity concentrations close to that of the sea 33.5 psu (Davenport 1976, Foster 1970) and stops all activity outside of the range 17 – 53 psu (Foster 1970). Barnes & Barnes (1974) reported that embryos of *A. modestus* can fully develop and hatch into functioning nauplii at salinities of 21.4 – 42.8 psu at 20 ℃. This compares to the salinity level, 21 psu, at which Cawthorne & Davenport (1980) found a cessation of larval release. Once released however, the larvae can survive at salinities as low as 9 psu (Cawthorne & Davenport 1980). Dassuncao (2009) showed that the larvae can survive salinities of 20 psu up to that of sea water at ~35 psu in a wide range of temperatures (~9℃ -24℃). Outside of this range, *A. modestus* will most likely be able to still breed in salinities as low as 16 psu, and possibly lower if not maintained for an extended period of time. It is considered as a meso to euryhaline species.

20. *Nitokra spinipes*
N. spinipes is typically benthic and estuarine (de Sousa *et al.,* 2012) in areas with salinity varying between 0.5 and 30 psu (Wulff, 1972; Lotufo & Abessa, 2002). It is considered as a poikilohaline species.

21. Cyclopoida
Small planktonic animals of the subclass Copepoda, Cyclopoida occur in marine, brackish and freshwater environments (Boxshall *et al.* 2012). They are considered as meso to polyhaline species.

22. *Neomysis integer*
Neomysis integer can tolerate salinities from <18 – 30 psu (Budd, 2008b). *N. integer* is a euryhaline species which typically occurs in brackish water habitats and occasionally in freshwater habitats but more rarely in fully marine conditions. *N. integer* adapted successfully to the transition from brackish lagoon to freshwater lagoon in the case of Loch Mor Barvas, Isle of Lewis, Scotland (Barnes, 1994). In laboratory experiments, Kuhlman (1984) reported the lowest salinity tolerance of the species to be lower than 5 psu, and in other studies, it is suggested that *N. integer* tolerates salinities down to 0.5 psu (Koepcke & Kausch, 1996; Barnes, 1994). It is considered as a meso to polyhaline species.

23. *Praunus flexuosus*
A salinity tolerance range of 2–33 psu has been demonstrated, over which the body tissues experience the range 11–28 psu (McCluskey & Heard, 1971).It is considered as an oligo to polyhaline species.

24.*Jaera albifrons*
This species favours sheltered areas and estuarine environments. A study conducted by Jones (1972) showed that *J. albifrons* has very good survival rate in dilute seawater. It is considered as a meso to polyhaline species.

25. *Jaera nordmanni*
Jaera nordmanni was proposed as a characteristic lagoonal species for Ireland by Oliver and Healy (1998). This isopod was recorded at 24 of the 87 lagoons surveyed (27.6%) and may occur at others where it was not recorded due to the fact that only adult males are easily identified. This species may occur in freshwater, as in L. Errol, Cape Clear, Co. Cork. It has been described in England (Barnes 1994, Hayward and Ryland 1995) as occurring in streams flowing down the shoreline on south and west coasts only. All records in Ireland are from West Cork to Donegal. It is considered as an oligo to polyhaline species.

26. *Asellus sp*.
Asellus is found in rivers, streams and standing water particularly where there are plenty of stones under which it hides although not where the water is strongly acidic. *Asellus* is relatively tolerant of a range of pollutants and has been used as an indicator of water quality (Whitton, 1982).This is a freshwater to oligohaline species.

27*. Allomelita pellucida*
Allomelita pellucida is an intertidal species which can be found in brackish waters usually living as a part of interstitial or epibenthic communities of soft sediments (Hosie, 2008). It is considered as an oligo to mesohaline species.

28. *Melita palmata*
M. palmata is a common and abundant inhabitant of brackish, lagoon and estuarine environments along the European coasts of the Atlantic (Lincoln, 1979). *M. palmata* is usually observed where the influence of fresh water is stronger, for example, lagoons and river mouths due to its tolerance to a wide range of salinities (Karaman, 1982). It is considered as an oligo to mesohaline species.

29. *Gammarus duebeni*
A brackish-water species with wide salinity tolerance: found on rocky shores in pools near to high water with freshwater influence, in estuaries amongst vegetation and in freshwater streams and lakes (Bousfield, 1973). Bettison and Davenport (1976) studied salinity preferences of gammarid amphipods. They showed that *Gammarus duebeni* showed little avoidance of any particular sea water concentration. It is considered as an oligo to polyhaline species.

30. *Gammarus salinus*
This is a euryhaline species and is tolerant of salinities as low as 2 psu and as high as 30 psu, but it is most abundant at 10 psu. Bulnheim (1984) recorded the respiratory response of *Gammarus salinus* in response to an acute salinity change, from 30 to 10 psu, respiration rate moderately increased after an initial shock like response and initially specimens were quiescent as they acclimated to the decreased salinity but recovered within 24 hours. It is considered as an oligo to polyhaline species.

31. *Palaemon elegans*
Yazdani *et al.* (2010) showed that more than 50% of prawns survived at 1 to 30 psu salinity range, while above and below this range, less than 50% survived within 24 hours. Salinities between 8–18 psu were found to be the optimum range for *P. elegans*. It is considered as an oligo to mesohaline species.

32. *Palaemonetes varians*
This is a decapod crustacean and is listed as a characteristic lagoonal species in the U.K. by Barnes (1989) and Bamber (1997), but apparently is no longer regarded as such (NPWS, 2012). Although found in estuaries, this species appears to be far more characteristic of lagoons in Ireland, found in 64 of the 87 lagoons surveyed (73.6%) and may require a lagoonal environment for reproduction. It is considered as an oligo to polyhaline species.

33. *Crangon crangon*
Neal (2008) and McClusky *et al*. (1982) recorded that *Crangon crangon* can tolerate salinities of 7-40 psu and can survive extremes if previously acclimated to the high or low end of its tolerance. For example, individuals acclimated to 40 psu survived 50 psu for 38 hours in comparison 16 hours by those previously acclimated to 7 psu (McClusky *et al*., 1982). Lloyd & Yonge (1947) found that *Crangon crangon* can tolerate salinities of 7-40 psu and can survive fresh water for up to 8 hours. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered as a meso to euryhaline species.

34. *Carcinus maenas*
Carcinus maenas can tolerant salinities between 4 - 40 psu (Neal & Pizzola, 2008; Crothers, 1968; Ameyaw-Akumfi & Naylor, 1987) and has a preference for 27-40 psu. It is considered as a meso to polyhaline species.

35. *Cyprideis torosa*
The ostracod *Cyprideis torosa* is a well known and characteristic inhabitant of many brackish water areas throughout Europe. It can be described as a tolerant species to salinity change. Heip (1976) investigated the community structure of *C. torosa* in a brackish water ecosystem with a salinity of 15 psu. This increased to 22 psu over time with no apparent change to the community. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is a meso to polyhaline species.

36. Acarina
Acarines are extremely diverse. They live in practically every habitat and include freshwater, marine and terrestrial species. Some species can tolerate moderate salinity but do not occur in highly saline waters (Harvey, 1998).They are an oligo to mesohaline species.

37. Chironomidae
The family *Chironomidae* occur in all the types of freshwater habitat (streams, rivers, lakes and ponds), many are terrestrial or semi-terrestrial and some are marine. A study conducted by Bervoets *et al.* (1996) showed that a species belonging to *Chironomidae* (*Chironomus riparius*l) had appeared to be very tolerant to an increase in salinity. It is considered as a meso to polyhaline family.

***38. Zygoptera* (larvae)**
There are 20 families of Zygoptera and about 2,500 species. They are found to have an aquatic larval stage. There are a few truly marine species, several that live in brackish water, and many that survive in arid regions where the larvae can develop quickly in the warm waters of temporary ponds before they dry up (Brooks, 2000). They considered as meso to polyhaline species.

39. Dytiscidae
Dysticids or diving beetles, live in fresh to oligohaline water.

40. *Peringia (Hydrobia) ulvae*
Peringia (Hydrobia) ulvae has a salinity tolerance from <18 – 40 psu (Jackson, 2000). The species is found in a wide range of salinities. Its occurrence in Lough Atalia extends its known salinity tolerance range. It is considered as a meso to polyhaline species.

41. *Ecrobia (Hydrobia) ventrosa*
This is a gastropod mollusc commonly found in brackish lagoons and ditches and generally not on the open coast (NPWS, 2012). It was recorded at 18 of the 87 (20.7%) lagoons surveyed up to 2006. de Wit (2011) states that *E. ventrosa* occurs in lower salinity waters than its congener *E. ulvae.* It is considered as an oligo to polyhaline species.

42. *Bowerbankia gracilis*
Typical habitats for this species include seagrasses, drift algae, oyster reef, dock, pilings, breakwaters, and man-made debris. *Bowerbankia gracilis* has been collected in areas of the Indian River Lagoon where salinity was below 30 psu and is generally considered to be euryhaline (Winston 1995). Nair (1992) studied the tolerance of *B. gracilis* in varying salinities where zooids exposed to the highest salinity (37.5 psu) were initially very active but the activity declined slowly, reaching a mortality rate of 40% by the end of the experiment. In 35 psu, colonies were active during the first 13 hours and at the end of the experiment the survival rate declined to 90%. In 30 and 25 psu, colonies were very active and healthy throughout the duration of the experiment, showing 100% survival. Zooids in 20 and 15 psu were active during the first few hours followed by a decline in survival rate. The mortality rate of zooids in 10 psu increased during the first hour, reaching 40% after 4 hours, with no active zooids in the colony. In 7.5 psu, the zooids were very inactive even in the initial hours and the percentage surviving after 24 hours declined to 15%. In 3.75 psu, mortality reached 90% within 30 minutes and at the end of 5th hour the specimens were found protruded with distorted tentacles.

43. *Alcyonidium gelatinosum*
Alcyonidium gelatinosum occurs commonly on the undersides of rocks and *Fucus serratus* plants in the intertidal zone and on bedrock down into the shallow sublittoral. *A. gelatinosum* has been recorded in salinities up to 29 – 32 psu (Oliver, 2005). Its occurrence in Lough Atalia extends its known salinity tolerance range. It is a polyhaline species.

44. *Chelon labrosus* (Thicklip Grey Mullet*)*
Grey mullet are often stocked in brackish coastal lagoons to improve fish yield (Ravagnan, 1992) and are introduced into freshwater lakes and reservoirs to create new fisheries (Ben Tuvia *et al.* 1992). Cardona *et al.* (2008) reported that *C. labrosus* dominated (in Mediterranean estuaries) the assemblage where salinity levels were lower than 13 psu. Hotos & Vlahos (1998) carried out experiments on *C. labrosus* fry which revealed that the fry could tolerate salinities up to 40 psu, 20% mortality occurred at 45 psu and 100% mortality above 70 psu. Therefore the range for *C. labrosus* is taken to be <13 to 40 psu. *C. labrosus* can be seen near Wolf Tone Bridge along the River Corrib. It is an oligo to euryhaline species.

45. *Platichthys flesus* (European flounder)
Platichthys flesus is usually found on muddy seabeds from the low shore to depths exceeding 50 m. The European flounder can also be found in estuaries (Pizzolla 2005). Lundgreen *et al.* (2008) studied *P. flesus* and its physiological mechanisms involved in acclimation to variable salinity and oxygen levels and their interaction. The fish were acclimated for 2 weeks to freshwater (1 psu), brackish water (11 psu) or full strength seawater (35 psu). Results showed that gill pace and blood did not change in relation to salinity and remained stable. They can be regularly seen in the River Corrib near Wolf Tone Bridge. It is considered as a meso to polyhaline species.

46. *Pomatoschistus microps* (Common Goby)
Pomatoschistus microps has been recorded in salinities as low as 4 psu (Barnes, 1994) and has been noted to tolerate salinities from about 8 to 80 psu (Riley, 2003). Its occurrence in Lough Atalia extends its known salinity tolerance range. It is an oligo to euryhaline species.

47. *Gasterosteus aculeatus* (Three-spined Stickleback)
They are common in estuaries and coastal lagoons around Britain and Ireland and in fully marine conditions from the northern Irish Sea and North Sea northwards. Described as an anadromous species, *G. aculeatus* may inhabit marine or freshwater environments (Tyler-Walters 2003). It is an oligo to euryhaline species.

48. *Atherina presbyter* (Sand Smelt)
The highest abundances of *A. presbyter* recorded by Pombo *et al.* (2005) were at salinity levels of between 28.0 and 32.0 psu. It is a polyhaline species.

49. *Anguilla anguilla* (European Eel)
The species is catadromous, living in fresh water but migrates to marine waters to breed (Freyhof & Kottelat, 2010) and it is therefore tolerant of salinity levels from freshwater to euryhaline conditions.

7.4.10 Conclusions

Biological communities of coastal lagoons are derived from:-

1. Marine species that can tolerate dilution of seawater,
2. Freshwater species that can tolerate a measure of salinity and
3. A group of brackish water species that are "distinctly more characteristic of lagoonal habitats than of estuaries or salt marshes" (Oliver, 2005).

The latter are referred to as lagoonal specialists and are broadly equivalent to the category of species inhabiting 'blocked brackish water' in the Netherlands and elsewhere (Verhoeven 1980a) and the species characterising 'brackish lentic communities' in Denmark (Muus 1967). Lists of lagoonal specialists have been compiled in the U.K. *e.g.* Barnes 1989a; Davidson *et al*. 1991; Bamber *et al* .1992b; Smith & Laffoley 1992; Downie 1996; JNCC, 1996; Bamber *et al*. 2001b have varied in content as species have been added or deleted, depending on the opinion of various authors. Healy (2003) lists Irish characteristic lagoonal species.

According to de Wit (2011) , species which inhabit lagoons have evolved to survive wide ranging salinity levels and this author goes on to state that because of the high fluctuations in salinity, biodiversity is lower than is found in more moderately fluctuating coastal environments. Wijeratne *et al.* (2004) working in Chilaw Lagoon, west coast of Sri Lanka, note that salinities in the lagoon are strongly influenced by seasonal variations in river discharge and vary from zero to 35 psu. Newton and Mudge who worked in Portugal on the Ria Formosa recorded somewhat similar variations in salinity with a low of 13 and a maximum of 36.5 psu. Natural England (2010) in a report on UK lagoons notes that salinities can vary from 0 to 40 psu and also comments that significant variation in salinity will be the norm in coastal saline lagoons over distances of centimetres and within time spans of minutes. It appears therefore that the natural variations recorded in Lough Atalia and Renmore Lough are typical of similar systems all around the world and that such variation relates to the flow of the River Corrib, the tidal cycle and the stage of the tide.

Natural England lists a number of lagoonal specialist taxa that are protected under the UK Wildlife and Countryside Act. These are *Lamprothamnium papulosum, Cara canescens, Clavopsella navis, Edwardsia ivelli, Nematostella vectnensis, Victorella pavida, Armandia cirrhosa, Alkmaria rominjii, Gammarus insensibilis* and *Tenellia adspersa.* None of these taxa have been recorded from either Lough Atalia or Renmore Lough.

A review of species and where they occur in Lough Atalia clearly shows that the bed of the Lough is very species poor with six of the ten sites surveyed returning no fauna and two of the remaining four only returning 1 species each. The station nearest the open sea returned 7 species. The more biologically diverse area is the intertidal zone. However, as noted in Oliver (2007), Lough Atalia is of no conservation value.

Research from a wide range of sources within this document has outlined the tolerances capable of the species found within Lough Atalia and Renmore Lough. All fauna listed have been shown to exhibit levels of resilience towards salinity change well within the temporary changes predicted by the mathematical model output. Indeed, salinities recorded in Lough Atalia extend the tolerance ranges for many taxa by quite an amount. The mathematical model predicts that the current cumulative annual 7 hours of zero psu may extend to 18 hours at the southern part of the lagoon over the period of a year. The impact of additional temporary, seasonal and spatially restricted decreases in salinity to 0 psu within parts of the ecosystems will not affect their status or their ecological functioning.

7.4.10.1 Flora in the surrounding area

A search was made in the *New Atlas of the British & Irish Flora* (Preston *et al*., 2002) to find which rare or unusual plant species had been recorded in the relevant 10 km squares M22 and M32, in which the site is situated, during the 1987-1999 atlas survey carried out by the Botanical Society of the British Isles (BSBI). The search included the vascular plants that are listed in Annex II of the EU Habitats Directive, the Flora (Protection) Order of 1999, or which are mentioned in the NPWS site synopses. Two of the species protected under the Order were recorded as present in M22: Slender Cottongrass (*Eriophorum gracile*) and Small White Orchid (*Pseudorchis albida*). Small White Orchid was the only species recorded in M32 that is also mentioned on the Flora Protection Order (1999). Small White Orchid has been recorded on a variety of habitats including upland grassland habitats, streamsides and on recently burnt peatlands. Slender Cottongrass grows in wet habitats such as bogs, mires and fens.

The reference to Slender Cottongrass is from a record at Tonabrucky bog, approximately 5 km from the proposed development site. The development is unlikely to have this protected species within the development area due to lack of suitable habitat, or to have any indirect impacts on the species. Similarly, the record for Small White Orchid is from a site at Doughiska. More recent surveys have failed to find the species which is likely due to development within the area over the past 5 – 10 years. The development site does not provide suitable habitat for this species and therefore no impacts on this species are deemed likely, either directly or indirectly, as a result of the proposed development.

Comments were received on a previous planning application regarding a record for Russian Lettuce (*Lactuca tartarica*). This is known to have been recorded on the shingle bank at the back of Renmore Beach. It is an alien that has been known from the early 20th century (Webb *et al*., 1996). The same authors claim that this is the only site, but the species has been seen in flower at Mutton Island in the last 2 years by the author. It is a curiosity only and has no special status or protection.

7.5 FAUNA IN THE EXISTING ENVIRONMENT

7.5.1 Benthic Fauna – Intertidal Survey

7.5.1.1 Methodology

The intertidal survey was carried out over low water on the 6th July 2004 and the same areas were revisited on August 13th 2011 (see Figure 7.5.1). During Phase I of the GHEP development 7.55 ha of foreshore were reclaimed and as a result, the top of the surveyed shore consists of a high revetment wall of large boulders. Observations of the flora and fauna of the foreshore and any bird species present were recorded from the western boundary along the Lough Atalia Channel to the eastern boundary at Renmore Beach. Algal and invertebrate densities were determined *in situ* and are given after each of the species recorded. Algal density is represented by % cover, while abundance of invertebrates uses the SACFOR abundance scale *i.e*. S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare. P = Present, is used when no meaningful abundance can be assigned *i.e.* when species are incidentally collected with other species.

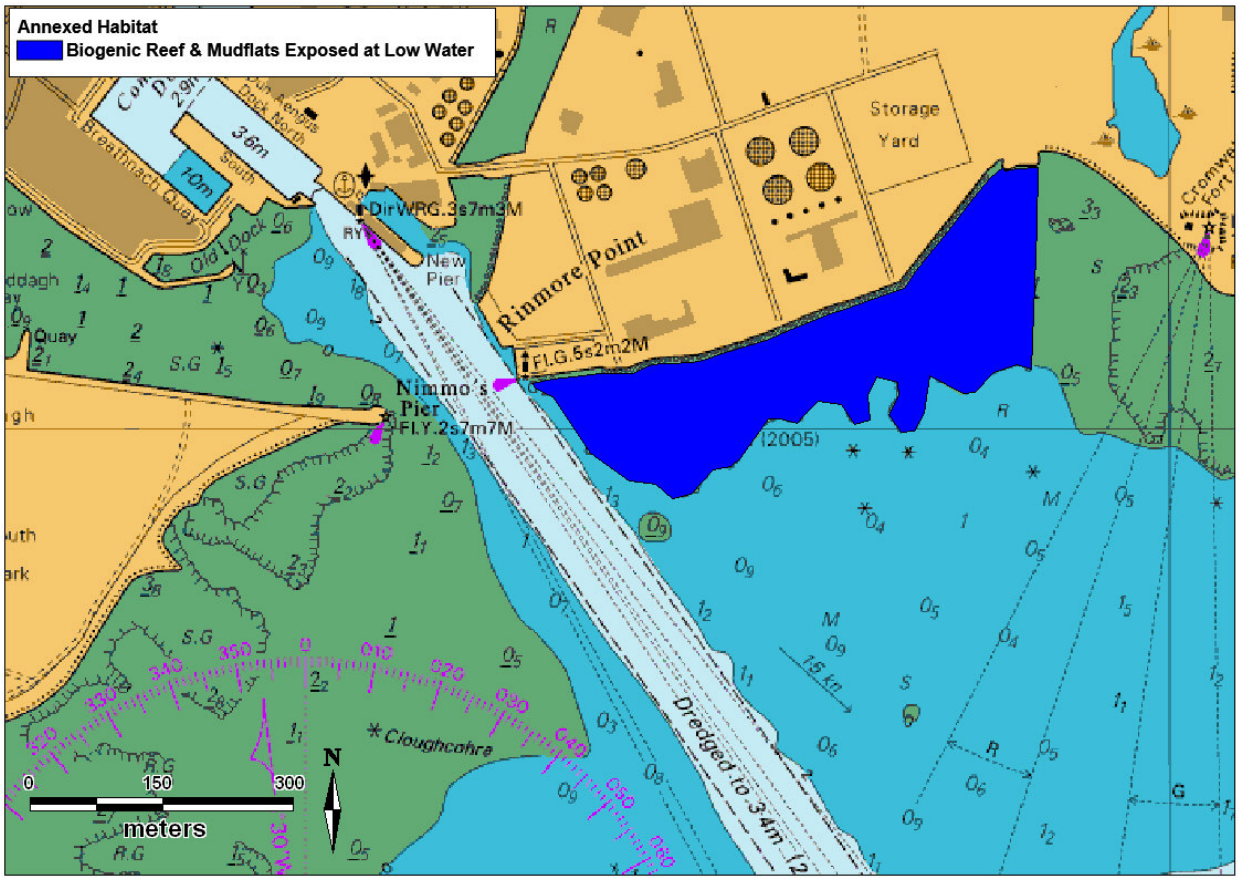


Figure 7.5.1 - Habitat map of annexed marine habitats in and around the proposed development

7.5.1.2 Results

The intertidal area can generally be described as a sheltered shore with the whole of the eulittoral being covered in seaweeds. Small patches of lichen (*Caloplaca, Verrucaria*) and *Pelvetia canaliculata* (*ca* 5%) were observed on rocks above high water and in the upper shore respectively. *Fucus spiralis* (*ca* 20%) was present close to the top of the shore while *Fucus vesiculosus* (*ca* 30%) and *Fucus ceranoides* (*ca* 10%), were present from the top of the shore to the mid shore. *Ascophyllum nodosum* (80%) covered the bulk of the mid-eulittoral along with *Polysiphonia lanosa*. Patches of *Chondrus crispus* were noted throughout the mid shore and *Ulva* sp. (formerly *Enteromorpha*) was observed on the boulders of the revetment wall and down the shore. *Ulva lactuca* was observed on the lower shore. *Fucus serratus* (*ca* 30%) was noted low down on the shore nearest the water's edge. The substrate along the western boundary consisted predominantly of gravels and pebbles with boulders scattered throughout. The shore extended to 20 m along this boundary.

Faunal species were generally low in number and densities. Those observed were mostly recorded toward the lower shore and included the periwinkles *Littorina littorea* (O) and *Littorina obtusata* (P), the barnacle *Semibalanus balanoides* (C) and the bivalves *Mytilus edulis* (C) and *Cerastoderma edule* (O). Crustacean species observed consisted of *Corophium* sp. (C) and the brown shrimp *Crangon crangon* (C). *Arenicola marina* casts (*ca* 10 m^2) were noted at low water. Mussels occur in aggregations which can be described as biogenic reefs and represent an Annex 1 habitat as described within the EU Habitats Directive.

7.5.2 Benthic Fauna & Sediments – Subtidal Survey

7.5.2.1 Station locations

In the initial sedimentological survey of the existing Galway Harbour Inner Dock in November 2000, four stations were sampled within the docks for grain size and heavy metals and a fifth sample was collected from the layby (behind the Harbour Master's office – see Figure 7.5.2) for grain size, heavy metals, organochlorine pesticides and PCB's, as requested by ABP.

In a further survey in 2004, 22 stations shown in Figure 7.5.3 below were sampled for sedimentological analysis and for macrofauna. Sediment probings were carried out at 12 No. pre-selected locations [as shown on Figure 7.5.4] to assess the depth of sediment in the area under consideration for the development.

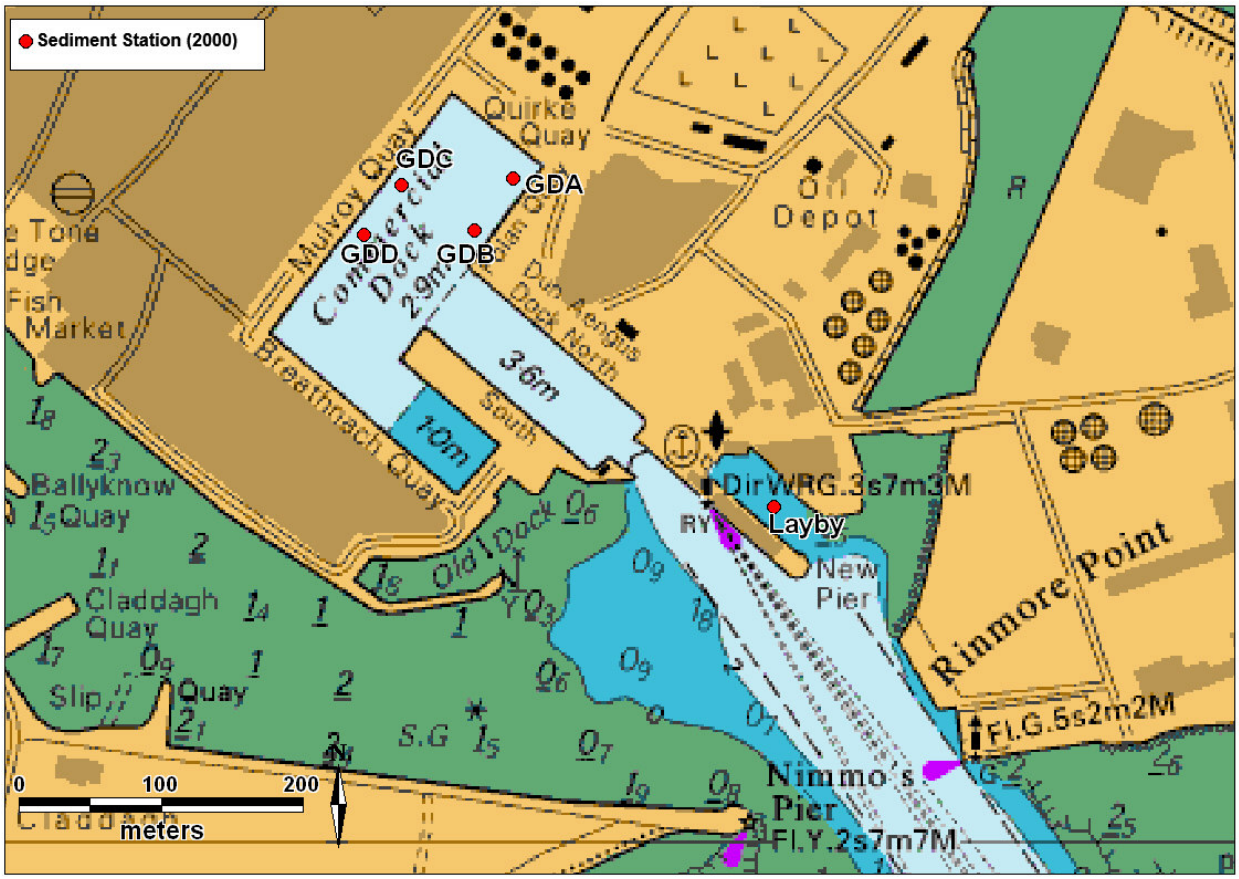


Figure 7.5.2 - Sediment stations sampled in 2000 in the docks and layby

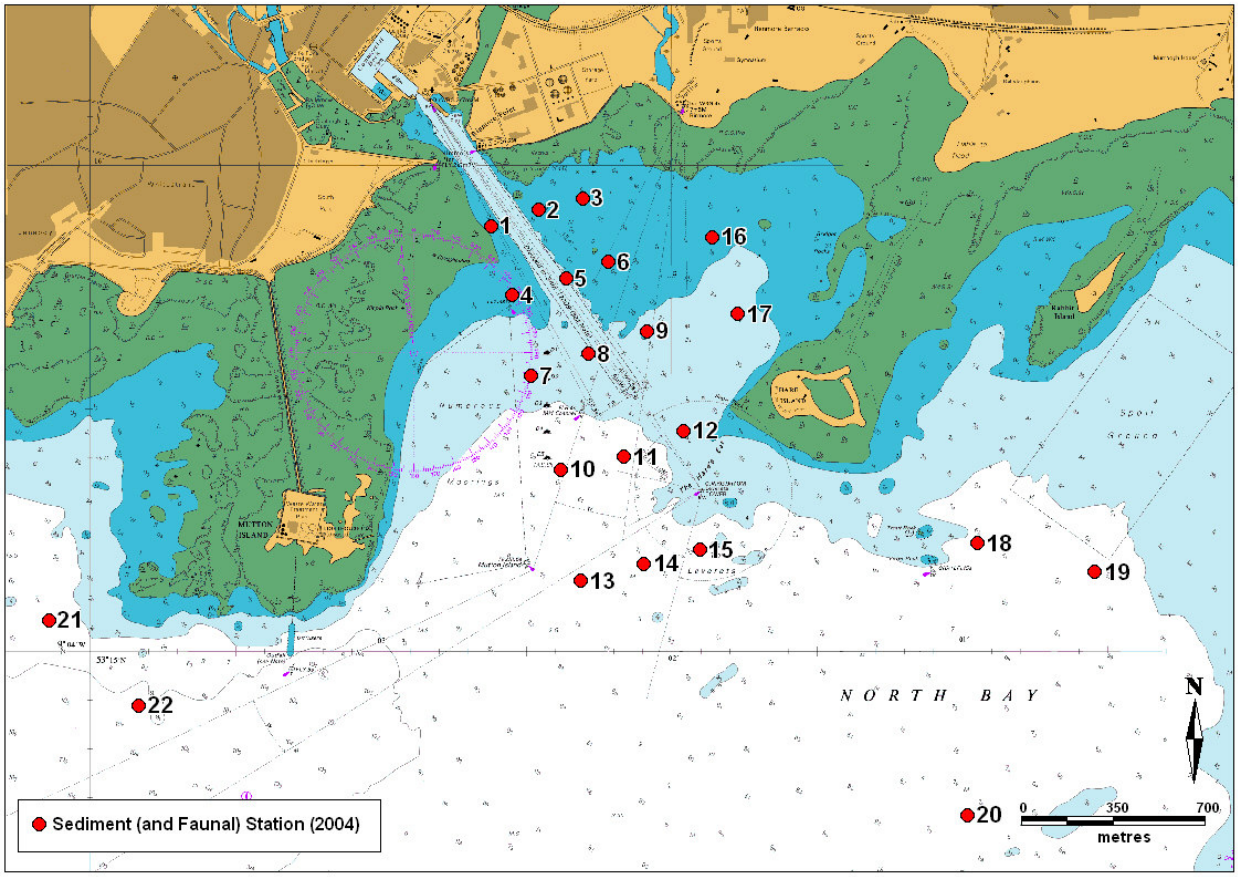


Figure 7.5.3 - Sediment (and faunal) stations sampled in 2004

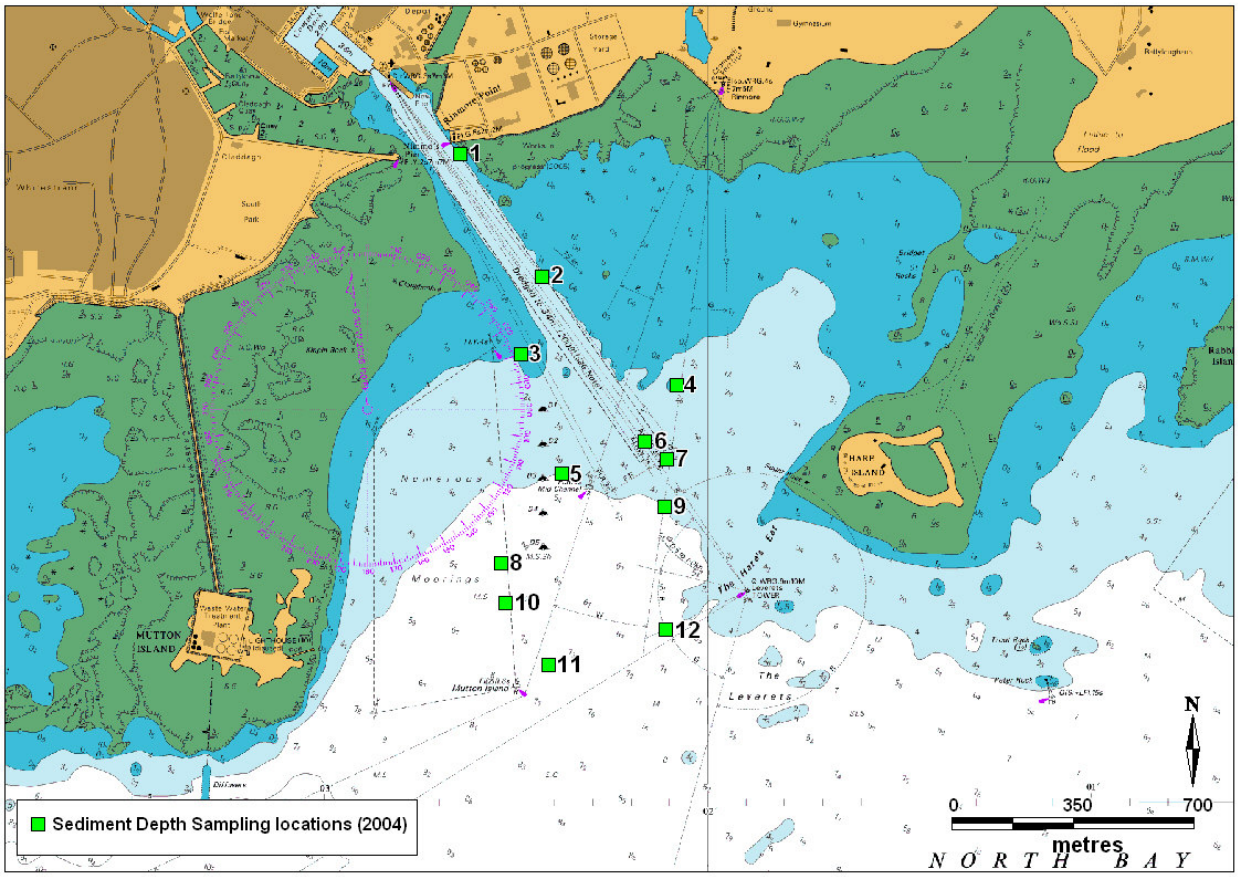


Figure 7.5.4 - Sediment depth sampling locations, 2004

Because of the many iterations in design and layout of the new structure, it was decided to carry out an additional benthic survey for sediment type and macrofauna in February 2010 using the same field, laboratory and statistical methodologies as for the previous survey. Figure 7.5.5 shows the location of the additional 12 stations.

An Bord Pleanála, in its scoping document for the EIS recommended that sediment samples be collected off South Park, which has served as a municipal dump some decades previously, to determine any evidence of contaminants. Marine sediment samples were collected at South Park in May 2011 and the station location can also be seen in Figure 7.5.5.

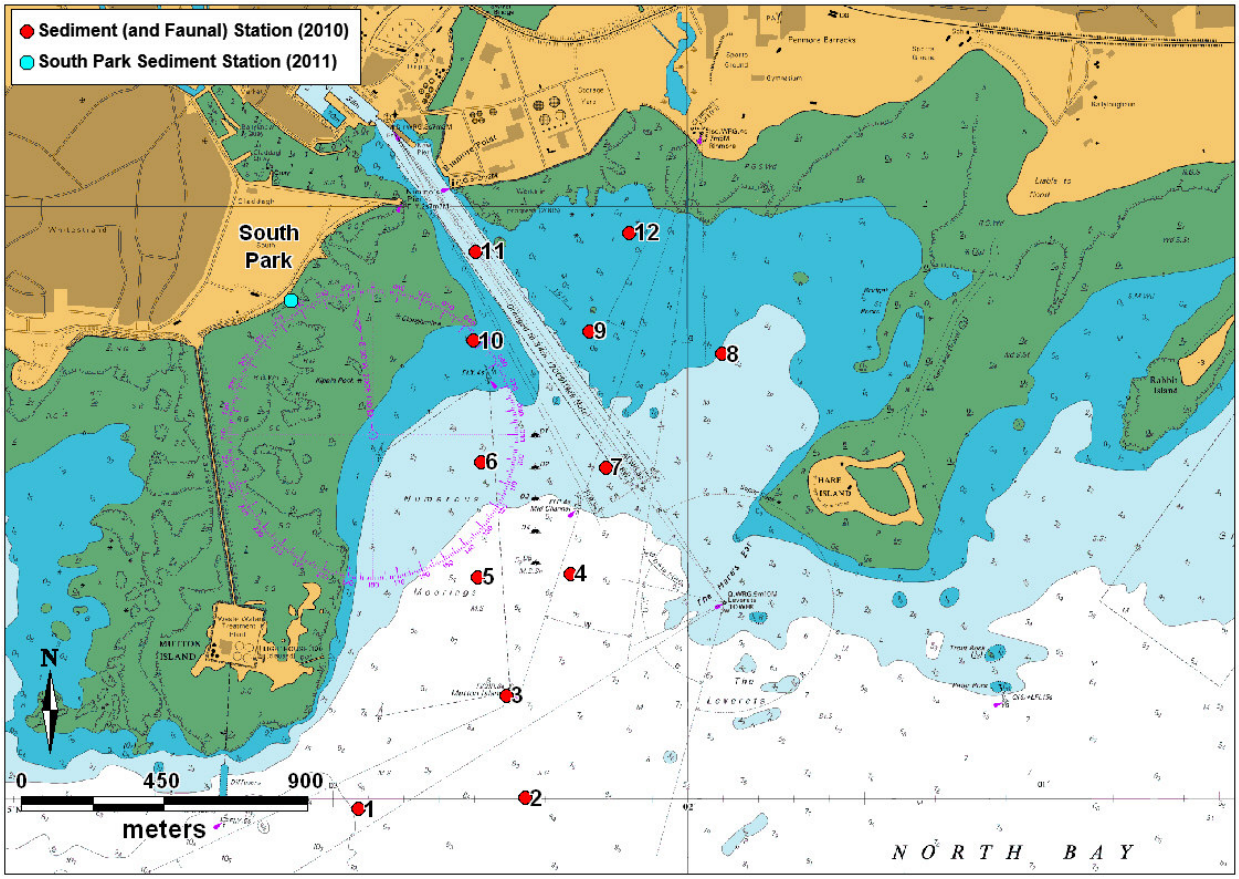


Figure 7.5.5 - Sediment and macrofauna stations sampled in 2010 and South Park sediment site sampled in May 2011

7.5.2.2 Methodology

7.5.2.2.1 Sedimentology

All sediment samples were collected using a van Veen grab sampler and each sediment sample was split into sub-samples for physical (sediment granulometry) and chemical (heavy metals, organics) characteristics. The granulometric and heavy metal samples were taken using a plastic spoon. The organic samples were taken using a metal spoon. All samples were frozen at -20°C pending analysis. Granulometric analysis was carried out by laser particle sizing. All chemical analyses were carried out by The Environmental Agency laboratory in Lllanelli, Wales and Complete Lab Solutions, Rosmuc, Co. Galway.

In order to assess the depth of sediment in the area under consideration for the development, AQUAFACT divers probed the sediments to refusal using a 4 metre probe. GPS was used to locate the new probing station positions.

7.5.2.2.2 Macrofauna

The following methodology was used in the two macrofaunal surveys. The first survey was carried out in July 2004 and comprised of 22 stations (see Figure 7.5.3), while the second was carried out in February 2010 and included of 12 stations (see Figure 7.5.4). Two replicate van Veen grab samples were taken at each station sampled. Measurements of sediment depth were taken in a diagonal transect across the grab surface using a clean plexiglass ruler. Data on each sample, *e.g.* station number, water depth, date, depth of sediment, smell, colour and visible macrofauna were logged in a field notebook. The faunal returns were sieved on a 1mm mesh sieve, stained with a vital dye, fixed with 10% buffered formalin and preserved in 70% alcohol. Samples were then sorted under a microscope (x 10 magnification), into five main groups: Polychaeta, Mollusca, Crustacea, Echinodermata and others. The taxa were then identified to species level where possible. All faunal nomenclature follows that of the World Register of Marine Species (WoRMS) website (http://www.marinespecies.org/) accessed on 17/08/2012.

All replicate data were combined to give a total for each station. A data matrix of all the faunal data was compiled and later used for statistical analyses. Faunal analysis was carried out using the PRIMER ® (Plymouth Routines in Multivariate Ecological Research) program.

Univariate statistics in the form of diversity indices were calculated. The following diversity indices were calculated:

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).

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

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 ith taxa

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 diversity index incorporates both of these parameters. Richness ranges from 0 (low richness) to 12 (high richness), evenness ranges from 0 (low evenness) to 1 (high evenness), diversity ranges from 0 (low diversity) to 5 (high diversity).

The PRIMER ® manual (Clarke & Warwick, 2001) was used to carry out multivariate analyses on the station-by-station faunal data. All species/abundance data were fourth root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER ®. The fourth root transformation was used in order to down-weigh the importance of the highly abundant species and allow the mid-range and rarer species to play a part in the similarity calculation. The similarity matrix was then 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 ® program 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 is 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 subjected to a non-metric multi-dimensional scaling (MDS) algorithm (Kruskal & Wish, 1978), using the PRIMER ® program MDS. This program produces 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 and 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 were 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.

7.5.2.2.3 Sediment Profile Imagery

In addition to the benthic sampling, replicate Sediment Profile Images (SPI) were taken of the seafloor at each of the 22 stations surveyed in 2004 (Figure 7.5.3) to aid with the description of current sea floor conditions. Operation and rationale of the SPI apparatus are outlined in Appendix 7.4. A colour slide film (50 ASA) was used to capture the images, these were subsequently developed as diapositives and analysed using a dedicated image analyses system. The following parameters were measured from each image:

- sediment type expressed as major grain size mode;
- prism penetration depth which gives an indication of relative sediment compaction;
- Sediment Boundary Roughness (SBR) which indicates the degree the physical disturbance or biotic activity at the sediment water boundary;

- sediment apparent Redox Potential Discontinuity depth (aRPD);
- infaunal Successional Status (S.S);
- additional parameters such as the presence of a fine flocculent sediment layer, mud clasts faecal pellets, epifauna (surface living animals), infaunal borrows and tubes, microbial aggregations, outgassing of sediments (due to production of hydrogen sulphide and ammonia as by-products of anaerobic metabolism);
- calculation of a mean organism sediment index (OSI); and
- calculation of Benthic Habitat Quality (BHQ).

7.5.3 Results

7.5.3.1 Sedimentology

7.5.3.1.1 Granulometry

The grain size analysis results from the 4 samples collected from the existing inner docks and layby can be seen below in Table 7.5.1. Sediments in the layby were dominated by silt-clay (81.8%) and sediments within the docks ranged from sandy mud to muddy sand to muddy and sandy gravel.

Sediment grain size results from the docks and layby.					
Grain Size	**GDA**	**GDB**	**GDC**	**GDD**	**Layby**
Gravel % (>2000 µm)	<0.1	0.7	42	67.3	<0.1
Sand % (2000 – 63 µm)	38.6	75.4	24.9	21.8	19.2
Silt & Clay % (<63 µm)	61.4	23.9	32.7	10.9	81.8

Table 7.5.1 - Grain size results from the docks and layby

The sediment sampled at the 22 locations during the 2004 survey ranged from silt to medium sand, with very little coarse sand or gravel present. The majority of stations were dominated by very fine sand. The results of the quantitative granulometric analysis can be seen in Appendix 7.5. According to Folk (1954), sand and muddy sand were present in the survey area in 2004. Station 4 contained the highest percentage of silt material (44.62%), Station 19 contained the highest percentage of very fine sand (34.91%), Station 3 contained the highest percentage of fine sand (65.87%) and Station 21 contained the highest percentage of medium sand (42.82%). Gravel was not present at any station; however, Station 7 did have a high percentage of very coarse sand (28.59%).

The 2010 survey classified sediments as sandy mud, muddy sand, slightly gravelly sandy mud, slightly gravelly muddy sand and slightly gravelly sand according to Folk (1954). The majority of stations were dominated by silt-clay (S1 – S6, S8 and S11). The remaining stations were dominated by very fine sand (S7, S9, S10 and S12).

Station S6 contained the highest percentage of gravel (3%). Station S5 contained the highest percentage of very coarse sand (13.1%), coarse sand (12.3%) and medium sand (8.9%). Station S12 contained the highest percentage of fine sand (12.8%). Station S9 contained the highest percentage of very fine sand (75.4%) and station S3 contained the highest percentage of silt-clay (71%). Figure 7.5.6 shows these results in graphical form and the quantitative granulometric analysis results can be seen in Appendix 7.5.

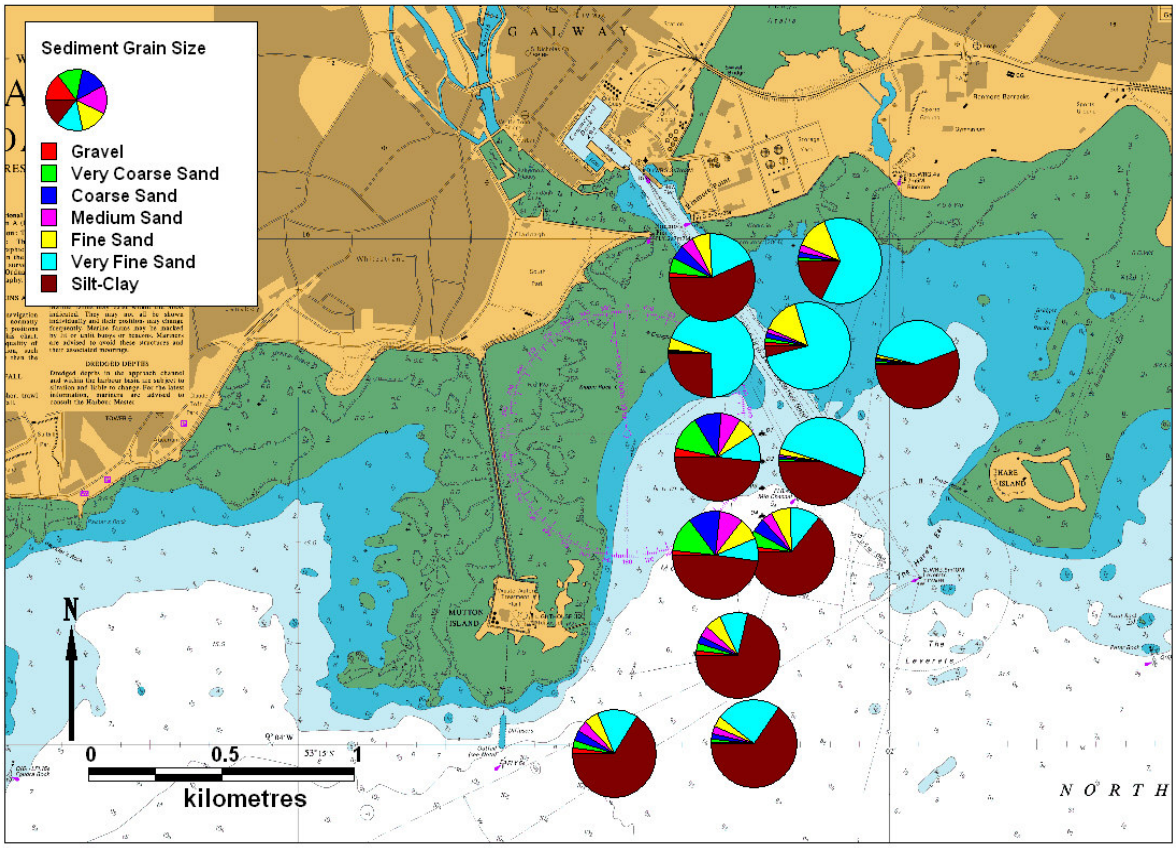


Figure 7.5.6 - Proportions of grain sizes in sediments surveyed in Galway Bay in 2010

Table 7.5.2 shows the refusal depths recorded in 2004 by divers at 12 locations (see Figure 7.5.4) in the proposed development area. The majority of the area is characterised by depths of at least 4 m with only 3 locations returning depths of 1.8 m or less.

Location of sediment sample stations and refusal depths				
Station	**Longitude**	**Latitude**	**Depth (m)**	**Comment**
1	09.02.649	53 16.014	1.7	Soft Mud over a gravel layer before rock
2	09 02.434	53 15.822	1.8	Soft Mud over rock
3	09 02.490	53 15.701	>4.0	Sandy muddy bottom over soft mud
4	09 02.084	53 15.652	>4.0	Sandy Shelly mud overlying soft mud
5	09 02.385	53 15.513	>4.0	Soft muddy bottom with intermittent stones
6	09 02.166	53 15.563	>4.0	Soft muddy bottom
7	09 02.109	53 15.536	>4.0	Soft muddy bottom
8	09 02.542	53 15.374	>4.0	Mud overlying gravel at 1m with underlying soft mud
9	09 02.117	53 15.462	>4.0	Soft mud interspersed with stones
10	09 02.530	53 15.312	>4.0	Soft mud interspersed with stones
11	09 02.419	53 15.215	>4.0	Uniform soft mud
12	09 02.114	53 15.269	0.75	Mud overlying coarse sand overlying rock

Table 7.5.2 - Location of sediment sampling stations and refusal depths.

7.5.3.1.2 Sediment Chemistry

The sediment chemistry results from the layby can be seen in Table 7.5.3 and Table 7.5.4 shows the heavy metal results from within the docks. The upper and lower proposed guidance values for sediment quality can also be seen in these tables (Cronin *et al.,* 2006). In the layby, all organochlorine pesticides were <0.01 µg/kg and all PCBs were <1 µg/kg and within guidance levels where available. Total organic carbon levels were high at 3.69% and of the metals, zinc had the highest concentration (717.4 mg/kg). Zinc exceeded the upper guidance level (Cronin *et al.,* 2006). Cadmium levels within the docks ranged from 0.9 (Station GDA) to 5.7 mg/kg (Station GDC). Copper levels ranged from 26 (GDA) to 117 mg/kg (GDC). Lead levels ranged from 167.5 (GDA) to 1088 mg/kg (GDC). Zinc levels ranged from 159.6 (GDA) to 886 mg/kg (GDC). Chromium levels ranged from 4.1 (GDA) to 14.4 mg/kg (GDC). Cadmium and copper levels exceeded the upper guidance level at Station GDC and lead and zinc exceeded the upper guidance level at Stations, GDB, GDC and GDD.

Sediment chemistry results from the layby				
Category	**Parameter**	**Layby**	**Lower Guidance Level***	**Upper Guidance Level***
Carbon	TOC %	3.69	n/a	n/a
	Carbonate (% as CO3)	20.4	n/a	n/a
Heavy Metals	Mercury (mg/kg)	0.33	0.2	0.7
	Arsenic (mg/kg)	9.99	9	70
	Cadmium (mg/kg)	1.11	0.7	4.2
	Copper (mg/kg)	53	40	110
	Lead (mg/kg)	89	60	218
	Zinc (mg/kg)	717.4	160	410
	Chromium (mg/kg)	17.3	120	370
	Nickel (mg/kg)	14.4	21	60
	Iron (%)	1.26	n/a	n/a
	Manganese (mg/kg)	187	n/a	n/a
	Inorganic Tin (mg/kg)	<0.1	n/a	n/a
	Dibutyl Tin (mg/kg)	<0.02	Σ TBT & DBT = 0.1	Σ TBT & DBT = 0.5
	Tributyl Tin (mg/kg)	<0.02		
Fats/Organic Solvents	Oil, Fats & Grease (mg/kg)	11100	n/a	n/a
	Naphthalene (mg/kg)	0.086	n/a	n/a
Organochlorine Pesticides (µg/kg)	Tecnazene	<0.01	n/a	n/a
	Trifluralin	<0.01	n/a	n/a
	Alpha-HCH (Lindane)	<0.01	n/a	n/a
	Hexachlorbenzene	<0.01	0.3	1
	Beta-HCH (Lindane)	<0.01	n/a	n/a
	Quintozene	<0.01	n/a	n/a
	Triallate	<0.01	n/a	n/a
	Chlorothalonil	<0.01	n/a	n/a
	Heptachlor	<0.01	n/a	n/a
	Aldrin	<0.01	n/a	n/a
	Triadimefon	<0.01	n/a	n/a
	Pendimethalin	<0.01	n/a	n/a

Table 7.5.3 - Sediment chemistry results from the layby.

Sediment chemistry results from the layby				
Category	Parameter	Layby	Lower Guidance Level*	Upper Guidance Level*
	Heptachlor epoxide	<0.01	n/a	n/a
	o,p-DDE	<0.01	n/a	n/a
	Endosulfan I	<0.01	n/a	n/a
	p,p-DDE	<0.01	n/a	n/a
	Dieldrin	<0.01	n/a	n/a
	p,p-TDE (DDD)	<0.01	n/a	n/a
	Endosulfan II	<0.01	n/a	n/a
	o,p-TDT (DDD)	<0.01	n/a	n/a
	o,p-DDT	<0.01	n/a	n/a
	p,p-DDT	<0.01	n/a	n/a
	Endosulfan Sulphate	<0.01	n/a	n/a
	o,p-Methoxychlor	<0.01	n/a	n/a
	p,p-Methoxychlor	<0.01	n/a	n/a
	Permethrin	<0.01	n/a	n/a
PCBs (µg/kg)	PCB Congener 28	<1	Individual congeners of ICES 7 = 1 Σ ICES 7 = 7	Individual congeners of ICES 7 = 180 Σ ICES 7 = 1260
	PCB Congener 52	<1		
	PCB Congener 101	<1		
	PCB Congener 118	<1		
	PCB Congener 153	<1		
	PCB Congener 138	<1		
	PCB Congener 180	<1		

Table 7.5.3 contd/. - Sediment chemistry results from the layby.
* = Proposed guidance values from Cronin *et al.,* 2006.
n/a = Guidance level not available

Heavy metal results from the docks						
Heavy Metal	GDA	GDB	GDC	GDD	Lower Guidance Level*	Upper Guidance Level*
Cadmium (mg/kg)	0.9	2.8	5.7	3.1	0.7	4.2
Copper (mg/kg)	26	62.8	117	75.2	40	110
Lead (mg/kg)	167.5	489.3	1088	591	60	218
Zinc (mg/kg)	159.6	465	886	492	160	410
Chromium (mg/kg)	4.1	10.1	14.4	13	120	370

Table 7.5.4 Metals results from the docks
* = Proposed guidance values from Cronin *et al.,* 2006.

The complete sedimentary log of data collected from the 22 stations sampled in 2004 is presented in Appendix 7.6. Organic carbon values ranged from <1.0 g/kg (<0.1%) (Station 6) to 52 g/kg (5.2%) (Station 7). A suite of heavy metals were analysed: Mercury, Vanadium, Titanium, Iron, Magnesium, Aluminium, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Nickel and Zinc. Mercury concentrations ranged from 0.006 (Station 21) to 0.24 mg/kg (Station 2). Vanadium ranged from 6.7 (Station 10) to 44.5 mg/kg. (Station 7) Titanium ranged from 8.8 (Station 4) to 417 mg/kg (Station 3). Iron ranged from 3700 (S6) to 18,300 mg/kg (Station 7). Magnesium ranged from 4050 (Station 5) to 9520 mg/kg (Station 14). Aluminium ranged from 2280 (Station 6) to 14900 mg/kg (Station 11). Arsenic ranged from <0.1 (Station 5) to 9 mg/kg (Station 2). Cadmium ranged from 0.066 (Station 6) to 0.820 mg/kg (Station 7). Chromium ranged from 5.2 (Station 6) to 30.7 mg/kg (Station 7). Copper ranged from 2.6 (Station 21) to 28.6 mg/kg (Station 2). Lead ranged from 4.5 (Station 6) to 58.7 mg/kg (Station 2). Manganese ranged from 92.2 (Station 6) to 224 mg/kg (Station 7). Nickel ranged from 1.6 (Station 3) to 19.4 mg/kg (Station 7). Zinc ranged from 10.5 (Station 21) to 88.8 mg/kg (S2). All metals levels were lower than the upper guidance level and all (with the exception of Cadmium at one station [Station 7]) were lower than the lower guidance level also (Cronin *et al.,* 2006*).*

Tributyl tin ranged from <8 (Station 6 and Station 9) to 15.4 µg/kg (Station 5) (below the lower guidance level of Cronin *et al.* (2006)). Solids ranged from 46.2 (Station 7) to 80% (Station 21). Dieldrin, Endosulphan α, Endosulphan β and HCH γ values were <7.6 µg/kg at all stations. Permethrin values were <15.2 µg/kg at all stations. Acenaphthene values were <19 µg/kg at all stations. Acenapthylene values were < 20.9 µg/kg at all stations with the exception of stations 12, 13 and 19. Values at these stations were 47.2, 59.3 and 85.5 µg/kg respectively. Anthracene values were < 20 µg/kg at all stations except Stations 2 (28.4 µg/kg), 7 (20.8 µg/kg), 10 (27.2 µg/kg), 12 (31.4 µg/kg), 13 (27.6 µg/kg), 16 (51.1 µg/kg), 18 (38.8 µg/kg) and Station19 (66.2 µg/kg). Fluoranthene values ranged from < 20 µg/kg (Stations 3, 5-6, 9, 17 and 21) to a maximum of 270 µg/kg (Station 19). Fluorene values were < 20 µg/kg at all stations except Stations 2 (22.6 µg/kg), 16 (21.7 µg/kg), 18 (23.7 µg/kg) and Station 19 (33.2 µg/kg). Naphthalene values were < 19 µg/kg at all stations. Phenanthrene values ranged from < 20 µg/kg (stations 3-6, 9, 14-17, 20-22) to a maximum of 133.5 µg/kg (Station 18). Pyrene values ranged from <20 µg/kg (Stations 3, 5-6, 9, 14, 17, 21) to a maximum of 253.1 µg/kg (Station 19). Benz-[A]-Anthracene values ranged from <20 µg/kg (Stations 3, 5-6, 9, 14-17, 20-22) to 158.9 µg/kg (Station 19). Benzo (B) Fluoranthene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 9, 14, 16-17, 20-22) to 143.5 µg/kg (Station 19). Benzo (K) Fluoranthene values ranged from < 20 µg/kg (Stations 1, 3, 5-6, 8-9, 14-17, 20-22) to 107.2 µg/kg (Station 19). Benzo (A) Pyrene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 9, 14, 16-17, 20-22) to 212.2 µg/kg (Station 19). Benzo (E) Pyrene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 9, 14-17, 20-22) to 131.1 µg/kg (Station 19). Benzo (Ghi) Perylene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 8-9, 14-17, 20-22) to 117.3 µg/kg (Station 19). Chrysene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 9, 14-17, 20-22) to 145.4 µg/kg (Station 19). Indeno-{1,2,3-CD]-Pyrene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 9, 14, 16-17, 21-22) to 154.4 µg/kg (Station 19). Perylene values ranged from <20 µg/kg (Stations 1, 3, 5-6, 8-9, 12-17, 20-22) to 60.4 µg/kg (Station 19).

The values for the PCB Congeners 028, 052, 101, 118, 138, 153 and 180 were < 10 µg/kg at all stations with the exception of Station 8 where the values for congeners 138, 153 and 180 were 14.8, 12.8 and <20.1 µg/kg respectively. All PCBs and PAHs (Σ16 lower guidance of 4000 µg/kg) were below guidance levels (Cronin *et al.,* 2006).

Table 7.5.5 shows the results of the marine sediment samples collected from South Park in May 2011 and the lower and upper guidance levels of Cronin *et al.* (2006). All levels were below the lower guidance level of Cronin *et al.* (2006).

South Park marine sediment results					
Parameter	Unit	Sample 1	Sample 2	Lower Guidance Level*	Upper Guidance Level*
Arsenic (solids)	mg/kg	1.1	<1.0	9	70
Cadmium (solids)	mg/kg	<0.20	<0.20	0.7	4.2
Chromium (solids)	mg/kg	2.8	2.1	120	370
Copper (solids)	mg/kg	5.1	5.1	40	110
Extractable HC/DRO (C8-C40) Soil	mg/kg	<50	<50	1000	
Fats, Oils & Greases (soil)	mg/l	<5	<5		
Lead (solids)	mg/kg	2.1	5.3	60	218
Mercury (solids)	mg/kg	<0.35	<0.35	0.2	0.7
Nickel (solids)	mg/kg	<1.0	<1.0	21	60
PRO (C5-C12) Soil	mg/kg	<5	<5		
Zinc (solids)	mg/kg	18	16	160	410

Table 7.5.5 - Marine sediments analysed from South Park, May 2011
* = Proposed guidance values from Cronin *et al.,* 2006.

Further discussion on all of these results can be found in Section 7.5.4 Discussion.

7.5.3.2 Macrofauna (2004 Survey)

The taxonomic identification of the benthic infauna across all 22 stations (see Figure 7.5.3) sampled in the 2004 survey yielded a total count of 190 species, ascribed to 11 phyla. A complete listing of these species is provided in Appendix 7.3. Of the 190 species enumerated, 81 were polychaetes (segmented worms), 52 were crustaceans (crabs, shrimps, prawns), 37 were molluscs (mussels, cockles, snails *etc.*), 9 were echinoderms (brittlestars, sea cucumbers), 2 species were chelicerate (sea spiders), 1 species was a chordate (sea squirts and tunicates) and 1 species was a phoronid (horseshoe worm). Seven species were grouped as others; this group consisted of cnidarians (jellyfish, corals), nematodes (round worms), nemerteans and sipunculids (unsegmented worms). Numbers of species and numbers of individuals were generally low throughout the study area.

7.5.3.2.1 Univariate Analyses

Univariate statistical analyses were carried out on the station-by-station faunal data. The following parameters were calculated and can be seen in Table 7.5.6, species numbers, number of individuals, richness, evenness and diversity. Species numbers ranged from 2 (Station 2) to 54 (Station 21). Number of individuals ranged from 6 (Station 2) to 327 (Station 22). Richness ranged from 0.56 (Station 2) to 10.38 (Station 21). Evenness ranged from 0.33 (Station 7) to 0.9 (Station 11). Diversity ranged from 0.65 (Station 2) to 4.73 (Station 21).

Diversity indices for all faunal stations					
Station	No. species	No. individuals	Richness	Evenness	Diversity
1	11	37	2.77	0.75	2.58
2	2	6	0.56	0.65	0.65
3	26	257	4.51	0.63	2.95
4	12	25	3.42	0.81	2.90
5	35	93	7.50	0.89	4.55
6	12	26	3.38	0.75	2.70
7	6	105	1.07	0.33	0.85
8	13	30	3.53	0.85	3.15
9	12	28	3.30	0.83	2.98

Table 7.5.6 Diversity indices for all 22 stations sampled in the initial survey

Diversity indices for all faunal stations					
Station	No. species	No. individuals	Richness	Evenness	Diversity
10	16	58	3.69	0.86	3.44
11	17	44	4.23	0.90	3.67
12	24	55	5.74	0.86	3.93
13	45	228	8.10	0.86	4.70
14	25	169	4.68	0.72	3.36
15	22	158	4.15	0.81	3.63
16	12	30	3.23	0.81	2.91
17	16	56	3.73	0.82	3.29
18	30	114	6.12	0.83	4.08
19	20	72	4.44	0.80	3.47
20	25	103	5.18	0.84	3.89
21	54	165	10.38	0.82	4.73
22	38	327	6.39	0.76	4.00

Table 7.5.6 contd/. Diversity indices for all 22 stations sampled in the initial survey

7.5.3.2.2 Multivariate Analyses

The dendrogram and the MDS plot can be seen in Figures 7.5.7 and 7.5.8 respectively. SIMPROF analysis revealed 10 statistically significant groupings between the 22 stations (the red lines in the dendrogram connect the stations within a group and the black lines connect the different groups). It can be seen from these that stations 1, 2, 4 and 7 (Groups a, b, c and d) were not considered to be similar in biological make-up, not only to each other but also to any other stations.

Group a (Station 2) separated from all other stations at a similarity level of 6.49%. The reason for this separation was due to the very low faunal abundance level at this station. Only 2 species comprising 6 individuals were recorded: the bivalve *Kurtiella bidentata* (83.3% of the faunal abundance) and the polychaete *Ampharete* sp. (16.7% faunal abundance).

Group b (Station 7) separated from all the remaining groups at a similarity level of 9.2%. This was due to the fact that the polychaete *Phyllochaetopterus anglicus* was the only species recorded in appreciable numbers. This species accounted for 86.7% of the faunal abundance at this station.

Group c (Station 1) separated from all the remaining stations at a similarity level of 12.64%. This station contained 11 species and 37 individuals. Two species accounted for 65% of the faunal abundance at this station: the bivalve *Angulus fabula* (45.9% of the faunal abundance) and the polychaete *Spio* sp. (18.9% of the faunal abundance).

Group d (Station 4) separated from the remaining stations at a similarity level of 17.65%. This station contained 12 species and 25 individuals. Two species accounted for 60% of the faunal abundance at this station: the polychaete *Nephtys* sp. (32% of the faunal abundance) and the bivalve *Abra prismatica* (28% of the faunal abundance).

Group e (Stations 3, 5, 18 and 21) formed at a similarity level of 29.22%. SIMPER analysis revealed that these stations grouped together due to the presence of the bivalves *Venus casina* and *Abra alba,* the polychaetes *Nephtys* sp., the amphipod *Ampelisca brevicornis* and the bivalve *Thracia phaseolina.* This group contained 100 species comprising 629 individuals. *Thracia phaseolina* (20% faunal abundance) and *Crassicorophium crassicorne* (14.6% faunal abundance) were the main dominants of this group.

Group f (Stations 6, 9, 16 and 17) formed at a 35.19% similarity level. SIMPER analysis revealed that these stations grouped together due to the presence of *Ampelisca brevicornis, Nephtys* sp. and the polychaete *Melinna palmata.* This group contained 34 species comprising 140 individuals. *Ampelisca brevicornis* (37.1% faunal abundance) and *Melinna palmata* (9.3% faunal abundance) were the main dominants of this group.

Group g (Station 13) separated from the remaining stations at a similarity level of 38.13%. This station contained 45 species and 228 individuals. The top three dominant species at this station were: the bivalve *Kurtiella bidentata* (16.7% of the faunal abundance) and the polychaetes *Euclymene oerstedii* (10.5% of the faunal abundance) and *Melinna palmata* (7.9% of the faunal abundance).

Group h (Stations 10, 12, 14, 15 and 22) formed at a similarity level of 40.94%. SIMPER analysis revealed that these stations grouped together due to the presence of *Ampelisca brevicornis, Melinna palmata, Venus casina,* the bivalve *Nucula nucleus and Kurtiella bidentata.* This group contained 63 species comprising 767 individuals. *Kurtiella bidentata* (22% faunal abundance) and *Melinna palmata* (19% faunal abundance) were the main dominants of this group.

Group i (Stations 8 and 11) formed at a similarity level of 37.1%. SIMPER analysis revealed that these stations grouped together due to the presence of *Nephtys* sp., *Melinna palmata* and *Amphiura.* This group contained 24 species comprising 74 individuals. *Kurtiella bidentata* (13.5% faunal abundance), the polychaete *Notomastus latericeus* (10.8% faunal abundance) and *Melinna palmata* (10.8% faunal abundance) were the main dominants of this group.

Group j (Stations 19 and 20) formed at a similarity level of 34.34%. SIMPER analysis revealed that these stations grouped together due to the presence of *Ampelisca brevicornis*, *Nephtys* sp., *Nephtys kersivalensis* and the bivalves *Thyasira flexuosa* and *Abra nitida*. This group contained 37 species comprising 175 individuals. *Melinna palmata* (16.6% faunal abundance) and *Ampelisca brevicornis* (16% faunal abundance) were the main dominants of this group.

These delineations were also preserved in the MDS plot. The stress value of the MDS ordination is 0.18; this provides a useful 2d picture, but detail may be misinterpreted.

Table 7.5.7 shows the top 5 characterising/dominant species for each group. Where groups contained more than 1 station then the characterising species were determined from the SIMPER analyses and the characterising species from the groups that contained only 1 station were determined from the faunal abundance data. Sediment type according to Folk (1954) can also be seen in Table 7.5.7. Figure 7.5.9 shows the relative locations of the faunal groupings within the study area in 2004. An overall macrofaunal discussion can be found in Section 7.5.4.2 Macrofauna.

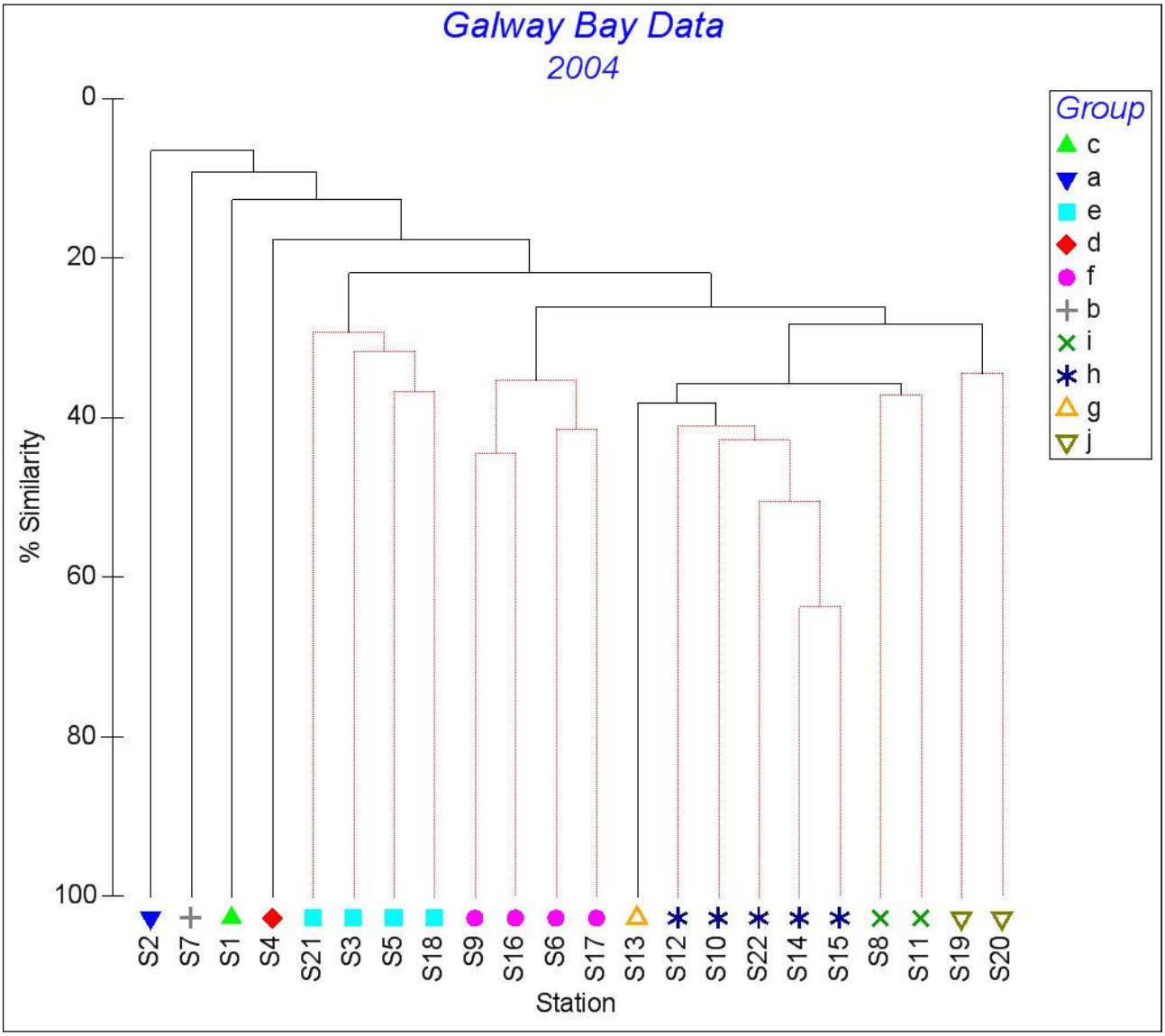


Figure 7.5.7 - Dendrogram of all 22 stations initially sampled in Galway Bay in 2004

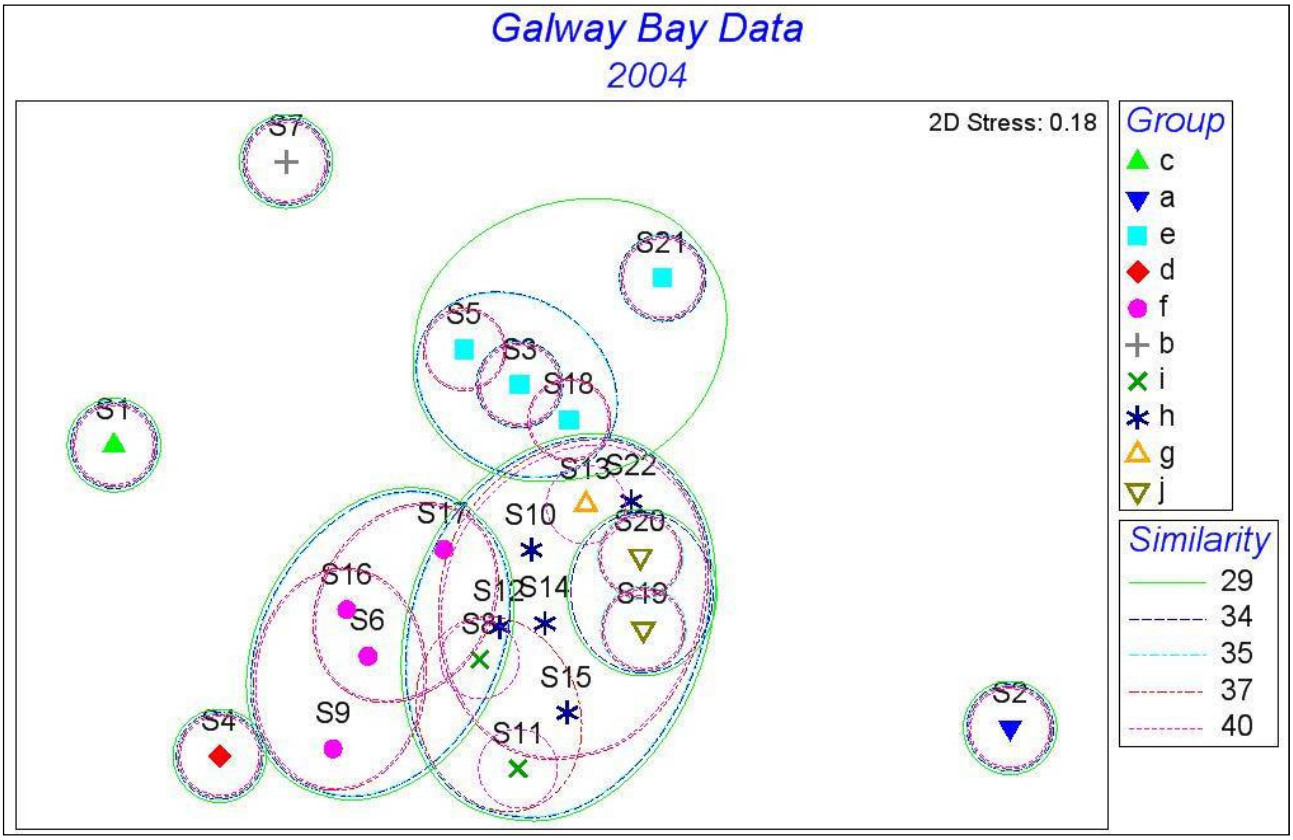


Figure 7.5.8 - MDS ordination of all 22 stations initially sampled in Galway Bay in 2004

Characterising/Dominant species for each faunal group									
Group	**Stations**	**Avg. Group Similarity**	**Species**	**Av. Abund**	**Av. Sim**	**Sim/SD***	**Contrib %**	**Cum %**	**Sediment Type#**
a	2	n/a	*Kurtiella bidentata*	n/a	n/a	n/a	83	83	Muddy sand
			Ampharete sp.	n/a	n/a	n/a	17	100	
b	7	n/a	*Phyllochaetopterus anglicus*	n/a	n/a	n/a	87	87	Muddy sand
			Abra alba	n/a	n/a	n/a	5	91	
			Nephtys assimilis	n/a	n/a	n/a	3	94	
			Philine aperta	n/a	n/a	n/a	3	97	
			Macoma balthica	n/a	n/a	n/a	2	99	
c	1	n/a	*Angulus fabula*	n/a	n/a	n/a	46	46	Sand
			Spio sp.	n/a	n/a	n/a	19	65	
			Eumida bahusiensis	n/a	n/a	n/a	5	70	
			Nephtys assimilis	n/a	n/a	n/a	5	76	
			Magelona mirabilis	n/a	n/a	n/a	5	81	
d	4	n/a	*Nephtys* sp.	n/a	n/a	n/a	32	32	Muddy sand
			Abra prismatica	n/a	n/a	n/a	28	60	
			Gattyana cirrosa	n/a	n/a	n/a	4	64	
			Eteone flava	n/a	n/a	n/a	4	68	
			Exogone hebes	n/a	n/a	n/a	4	72	
e	3, 5, 18, 21	31.27	*Thracia phaseolina*	2.13	3.7	3.19	11.83	11.83	Sand & Muddy sand
			Ampelisca brevicornis	1.51	3.08	3.61	9.86	21.69	
			Nephtys sp.	1.38	2.99	4.01	9.57	31.26	
			Venus casina	1.17	2.47	6.9	7.91	39.17	
			Abra alba	1.16	2.41	4.18	7.7	46.87	

Table 7.5.7 - Characterising/dominant species and community classification for the 10 faunal groups identified from the 2004 survey data

Characterising/Dominant species for each faunal group									
Group	Stations	Avg. Group Similarity	Species	Av. Abund	Av. Sim	Sim/SD*	Contrib %	Cum %	Sediment Type#
f	6, 9, 16, 17	37.75	*Ampelisca brevicornis*	1.89	12.08	9.32	31.99	31.99	Sand & Muddy sand
			Melinna palmata	1.29	7.44	7.94	19.71	51.7	
			Nephtys sp.	1.25	7.44	8.04	19.71	71.4	
			Thracia phaseolina	0.8	3.2	0.9	8.49	79.89	
			Hyale pontica	0.5	1.23	0.41	3.26	83.15	
g	13	n/a	*Kurtiella bidentata*	n/a	n/a	n/a	17	17	Muddy sand
			Euclymene oerstedii	n/a	n/a	n/a	11	28	
			Melinna palmata	n/a	n/a	n/a	8	36	
			Abra nitida	n/a	n/a	n/a	6	42	
			Ampelisca brevicornis	n/a	n/a	n/a	5	47	
h	10, 12, 14, 15, 22	45.64	*Kurtiella bidentata*	2.21	5.38	3.49	11.79	11.79	Muddy sand
			Melinna palmata	2.15	5.24	4.58	11.49	23.28	
			Ampelisca brevicornis	1.55	4.17	6.08	9.15	32.42	
			Nucula nucleus	1.51	4.03	3.95	8.82	41.24	
			Venus casina	1.51	3.95	3.96	8.65	49.9	
i	8, 11	37.1	*Nephtys* sp.	1.34	6.72	n/a	18.11	18.11	Muddy sand
			Melinna palmata	1.38	6.72	n/a	18.11	36.21	
			Amphiura filiformis	1.19	6.72	n/a	18.11	54.32	
			Notomastus latericeus	1.31	5.65	n/a	15.23	69.55	
			Ampelisca brevicornis	1.25	5.65	n/a	15.23	84.77	

Table 7.5.7 contd/. Characterising/dominant species and community classification for the 10 faunal groups identified from the 2004 survey data

Characterising/Dominant species for each faunal group									
Group	Stations	Avg. Group Similarity	Species	Av. Abund	Av. Sim	Sim/SD*	Contrib %	Cum %	Sediment Type#
j	19, 20	34.34	*Ampelisca brevicornis*	1.84	5.21	n/a	15.17	15.17	Muddy sand
			Nephtys sp.	1.49	4.93	n/a	14.35	29.52	
			Nephtys kersivalensis	1.47	4.58	n/a	13.35	42.87	
			Thyasira flexuosa	1.41	4.58	n/a	13.35	56.22	
			Abra nitida	1.41	4.58	n/a #	13.35	69.57	

* Cannot be calculated as the group only have 2 stations
n/a = Similarity percentages cannot be calculated on groups with only one station
According to Folk (1954) Classification

Table 7.5.7 contd/. Characterising/dominant species and community classification for the 10 faunal groups identified from the 2004 survey data

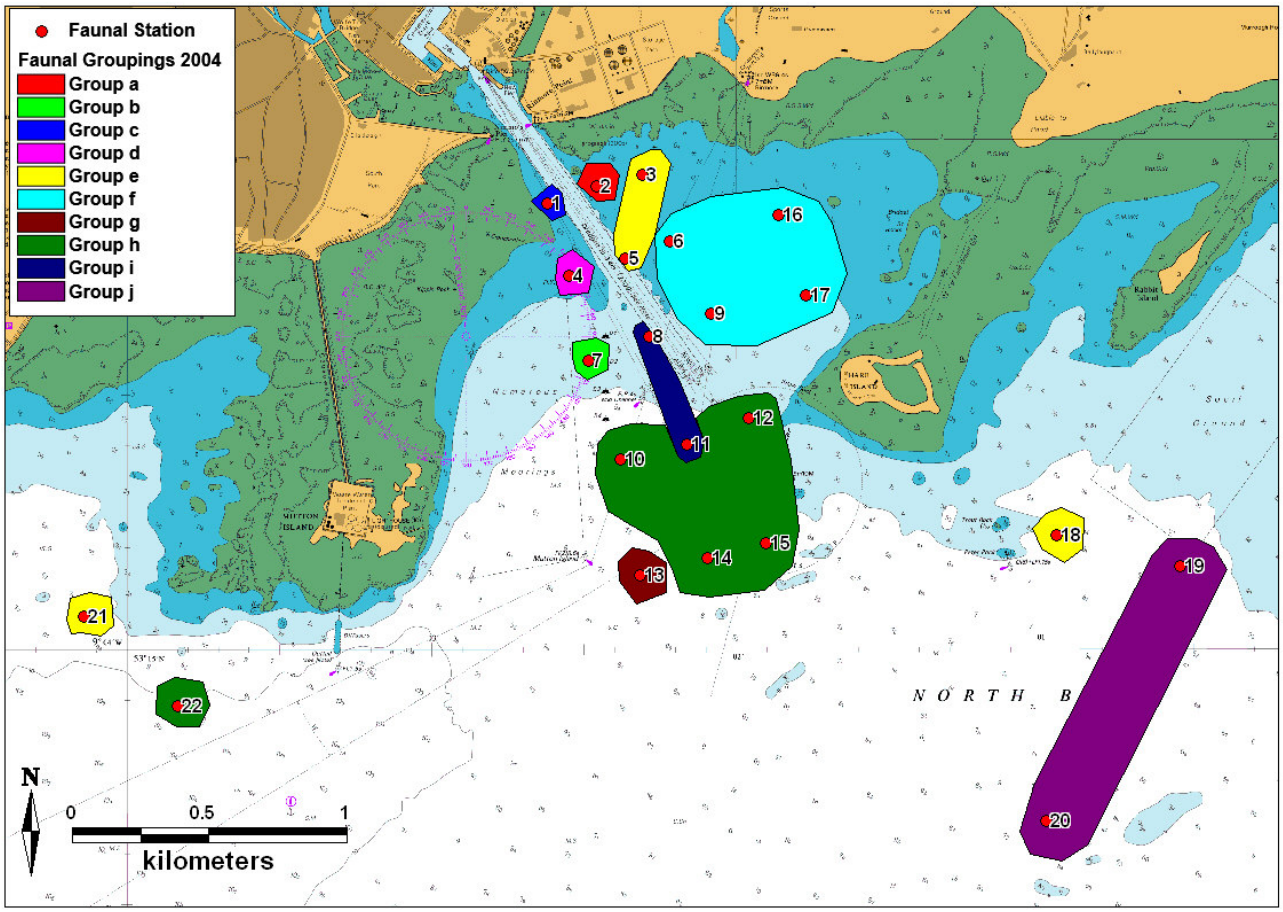


Figure 7.5.9 - Faunal groupings identified from the survey area in 2004

7.5.3.3 Macrofauna (2010 Survey)

The taxonomic identification of the benthic infauna across all 12 stations (see Figure 7.5.4) sampled in the vicinity of Galway Docks yielded a total count of 146 species comprising 2210 individuals, ascribed to 9 phyla. A complete listing of these species abundance is provided in Appendix 7.7.

Of the 146 species enumerated, 81 were annelids (segmented worms), 21 were crustaceans (crabs, shrimps, prawns), 30 were molluscs (mussels, cockles, snails *etc.*), 6 species were echinoderms (brittlestars, sea cucumbers), 2 species were cnidarians (corals, anemones, jellyfish *etc.*), 2 species were spiunculids (peanut worms), 2 species were chelicerates (sea spiders), 1 species was a phoronid (horseshoe worm) and 1 species was a nemertean.

7.5.3.3.1 Univariate Analyses

Univariate statistical analyses were carried out on the combined replicate station-by-station faunal data. The following parameters were calculated and can be seen in Table 7.5.8; species numbers, number of individuals, richness, evenness and diversity. Species numbers ranged from 10 (S6) to 67 (S7). Number of individuals ranged from 15 (S6) to 620 (S2). Richness ranged from 3.32 (S6) to 11.26 (S7). Evenness ranged from 0.56 (S11) to 0.95 (S5). Diversity ranged from 2.2 (S11) to 5.08 (S7).

Diversity indices for all faunal stations					
Station	No. Species	No. Individuals	Richness	Evenness	Diversity
S1	56	299	9.65	0.82	4.75
S2	66	620	10.11	0.58	3.49
S3	50	269	8.76	0.83	4.69
S4	30	128	5.98	0.73	3.58
S5	13	20	4.01	0.95	3.51
S6	10	15	3.32	0.94	3.11
S7	67	351	11.26	0.84	5.08
S8	40	133	7.97	0.84	4.45
S9	22	140	4.25	0.72	3.21
S10	26	114	5.28	0.64	3.00
S11	15	58	3.45	0.56	2.20
S12	21	63	4.83	0.89	3.9

Table 7.5.8 - Diversity indices for the 12 stations sampled in the vicinity of Galway Docks, 2010

7.5.3.3.2 Multivariate Analyses

The dendrogram and the MDS plot can be seen in Figures 7.5.10 and 7.5.11 respectively. SIMPROF analysis revealed 6 statistically significant groupings between the 12 stations (the red lines in the dendrogram connect the stations within a group and the black lines connect the different groups).

It is clear from these figures that S11 (Group I) separated away from all other stations at a similarity level of 12.14%. This was due to the fact that the polychaete *Capitella* sp was the only species recorded in any appreciable numbers. The presence of a dense *Capitella* population has classically been associated with organically enriched and physically disturbed habitats in the marine environment (Warren, 1977; Pearson & Rosenberg, 1978). This is typical of what one would expect in a navigational channel which is disturbed by dredging activity on an infrequent basis.

The remaining stations were 18.19% similar to each other (Groups II, III, IV, V and VI). Group II consisted of stations S5 and S6. These stations were 34.63% similar to each other. SIMPER analysis revealed that these stations grouped together due to the presence of the bivalve *Thyasira flexuosa,* the polychaetes *Scoloplos armiger* and *Spiochaetopterus typicus* and the bivalve *Abra alba* at each station. These two stations had poor species diversity and abundance and in total they contained 19 species comprised of 35 individuals. *Thyasira flexuosa* (20% of the abundance), *Spiochaetopterus typicus* (11.4% of the abundance) and *Scoloplos armiger* (8.6% of the abundance) were the dominant species in this group.

Group III consisted of station S4. This group separated from Groups VI and V at a 38.42% level of similarity. Three species were responsible for 85% of the faunal abundance at this station: *Scoloplos armiger* (37.6% of the faunal abundance), *Thyasira flexuosa* (32.3% of the faunal abundance) and the bivalve *Kurtiella bidentata* (15.1% of the faunal abundance). In total, this station contained 30 species and 128 individuals.

Group IV consisted of station S7. This group separated from Group V at a 47.88% level of similarity. Five species accounted for approximately 50% of the faunal abundance at this station: the polychaetes *Mediomastus fragilis* (14.3% of faunal abundance), *Pholoe inornata* (13.7% of faunal abundance), *Pomatoceros* sp. (7.5% of faunal abundance) and *Pomatoceros triqueter* (7.2% of faunal abundance) and the crustacean *Tanaopsis graciloides* (4.2% of faunal abundance). In total, this station contained 67 species and 351 individuals.

Group V consisted of stations S1, S2 and S3, and had a total group similarity of 61.23%.. SIMPER analysis revealed that these stations grouped together due to the presence of *Thyasira flexuosa,* the polychaetes *Pholoe inornata* and *Melinna palmata,* the ophiuroid *Amphiura filiformis* and the bivaleve *Kurtiella bidentata.* The top four dominant species in this group were the molluscs *Turritella communis* (34.2%) and *Thyasira flexuosa* (15.4%), the polychaete *Pholoe inornata* (10.4%) and the bivalve mollusc *Kurtiella bidentata* (8.2%).

Group IV consisted of stations S8, S9, S10 and S12 and had a total group similarity of 38.25%. SIMPER analysis revealed that these stations grouped together due to the presence of the polychaetes *Scoloplos armiger, Spiophanes bombyx, Nephtys hombergii* and the mollusc *Tellina* sp. The top four dominant species in this group were the molluscs *Tellina* sp. (17.3%), the oligochaete *Tubificoides pseudogaster* agg. (14.2%), the amphipod *Crassicorophium crassicorne* (7.1%) and the polychaete *Pygospio elegans* (6.4%).

These delineations were also preserved in the MDS plot. The stress value of the MDS ordination is 0.08; this results in a good representation of the data with no real prospect of misinterpretation of overall structure, but very fine detail may be misleading in compact subgroups.

Table 7.5.9 shows the top 5 characterising/dominant species for each group. Where groups contained more than 1 station then the characterising species were determined from the SIMPER analyses and the characterising species from the groups that contained only 1 station were determined from the faunal abundance data. Sediment type according to Folk (1954) can also be seen in Table 7.5.9. Figure 7.5.12 shows the relative locations of the faunal groupings within the study area in 2010.

The results of the two macrobenthic infaunal quantitative surveys were similar indicating that any change in benthic conditions in the area is at a low rate. The univariate statistics indicate that faunal diversity and numbers of species are low. This is to be expected in an area that has been subjected to pressures including enrichment from untreated sewage, port channel maintenance operations and fluctuating salinities. An overall macrofaunal discussion can be found in Section 7.5.4.2.

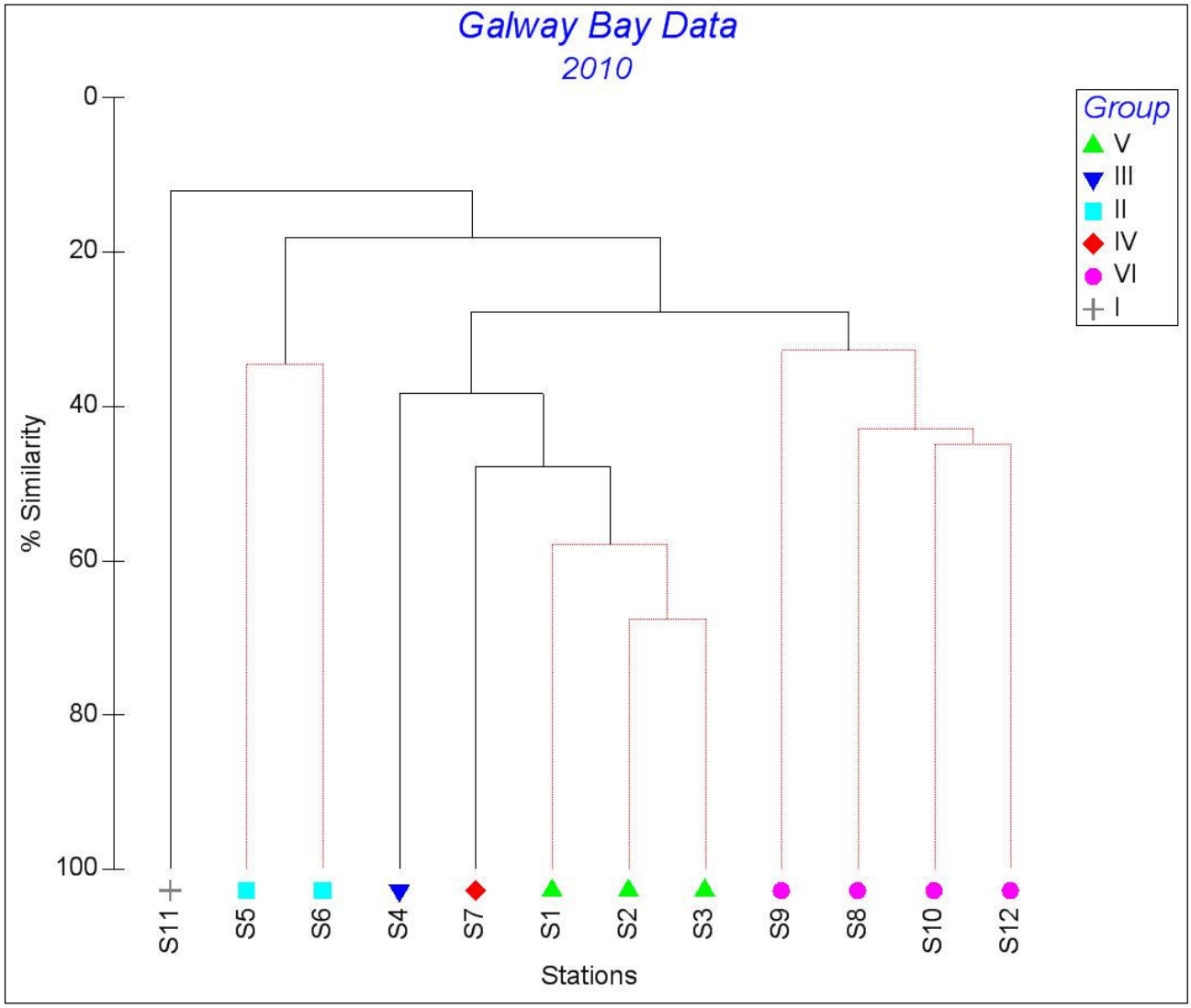


Figure 7.5.10 - Dendrogram showing each station from the 12 stations sampled in the vicinity of Galway Docks, 2010

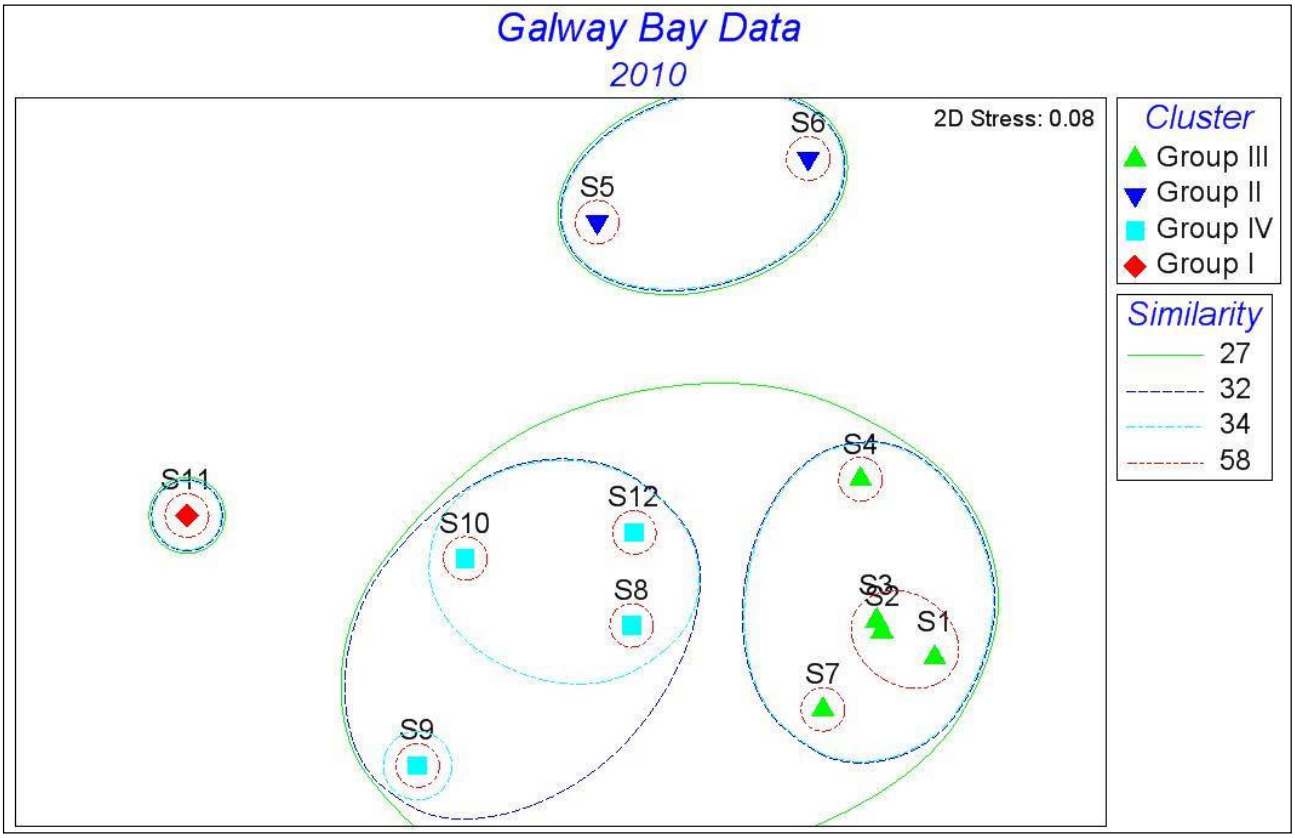


Figure 7.5.11 - MDS ordination showing each station from the 12 stations sampled in the vicinity of Galway Docks, 2010

Characterising/dominant species for each faunal group									
Group	**Stations**	**Avg. Group Similarity**	**Species**	**Av. Abund**	**Av. Sim**	**Sim/SD***	**Contrib %**	**Cum %**	**Sediment Type#**
I	11	n/a	*Mediomastus fragilis*	n/a	n/a	n/a	65.5	65.52	Slightly Gravelly Sandy Mud
			Spio filicornis	n/a	n/a	n/a	5.2	70.69	
			Nephtys cirrosa	n/a	n/a	n/a	3.4	74.14	
			Spionidae sp.	n/a	n/a	n/a	3.4	77.59	
			Pygospio elegans	n/a	n/a	n/a	3.4	81.03	
II	5, 6	34.63	*Thyasira flexuosa*	1.37	10.56	n/a	30.49	30.49	Slightly Gravelly Muddy Sand
			Scoloplos armiger	1.09	8.02	n/a	23.17	53.66	
			Spiochaetopterus typicus	1.16	8.02	n/a	23.17	76.83	
			Abra alba	1	8.02	n/a	23.17	100.00	
III	4	n/a	*Scoloplos armiger*	n/a	n/a	n/a	37.6	37.63	Slightly Gravelly Sandy Mud
			Thyasira flexuosa	n/a	n/a	n/a	32.3	69.89	
			Kurtiella bidentata	n/a	n/a	n/a	15.1	84.95	
			Nephtys sp. (juv)	n/a	n/a	n/a	7.5	92.47	
			Terebellides stroemii	n/a	n/a	n/a	4.3	96.77	
IV	7	n/a	*Mediomastus fragilis*	n/a	n/a	n/a	14.3	14.33	Muddy Sand
			Pholoe inornata	n/a	n/a	n/a	13.7	28.01	
			Pomatoceros sp.	n/a	n/a	n/a	7.5	35.50	
			Pomatoceros triqueter	n/a	n/a	n/a	7.2	42.67	
			Tanaopsis graciloides	n/a	n/a	n/a	4.2	46.91	

Table 7.5.9 Characterising/dominant species and community classification for the 6 faunal groups identified from the 2010 survey data

Characterising/dominant species for each faunal group									
Group	**Stations**	**Avg. Group Similarity**	**Species**	**Av. Abund**	**Av. Sim**	**Sim/SD***	**Contrib %**	**Cum %**	**Sediment Type#**
V	1, 2, 3	61.23	*Thyasira flexuosa*	2.44	2.62	3.67	4.29	4.29	Slightly Gravelly Sandy Mud & Sandy Mud
			Pholoe inornata	2.26	2.6	25.1	4.25	8.54	
			Melinna palmata	1.92	2.4	13.67	3.92	12.46	
			Amphiura filiformis	1.85	2.33	24.75	3.8	16.26	
			Kurtiella bidentata	2.08	2.27	9.08	3.7	19.96	
VI	8, 9, 10, 12	38.25	*Tellina* sp.	1.85	4.24	3.95	11.08	11.08	Slightly Gravelly Sand, Sandy Mud & Muddy Sand
			Nephtys hombergii	1.4	3.75	4.23	9.8	20.89	
			Spiophanes bombyx	1.27	3.37	5.61	8.81	29.69	
			Scoloplos armiger	1.23	3.12	6.51	8.15	37.84	
			Tubificoides pseudogaster agg.	1.36	2.17	0.85	5.67	43.51	

* Cannot be calculated as the group only have 2 stations
n/a = Similarity percentages cannot be calculated on groups with only one station
According to Folk (1954) Classification

Table 7.5.9 contd/. Characterising/dominant species and community classification for the 6 faunal groups identified from the 2010 survey data

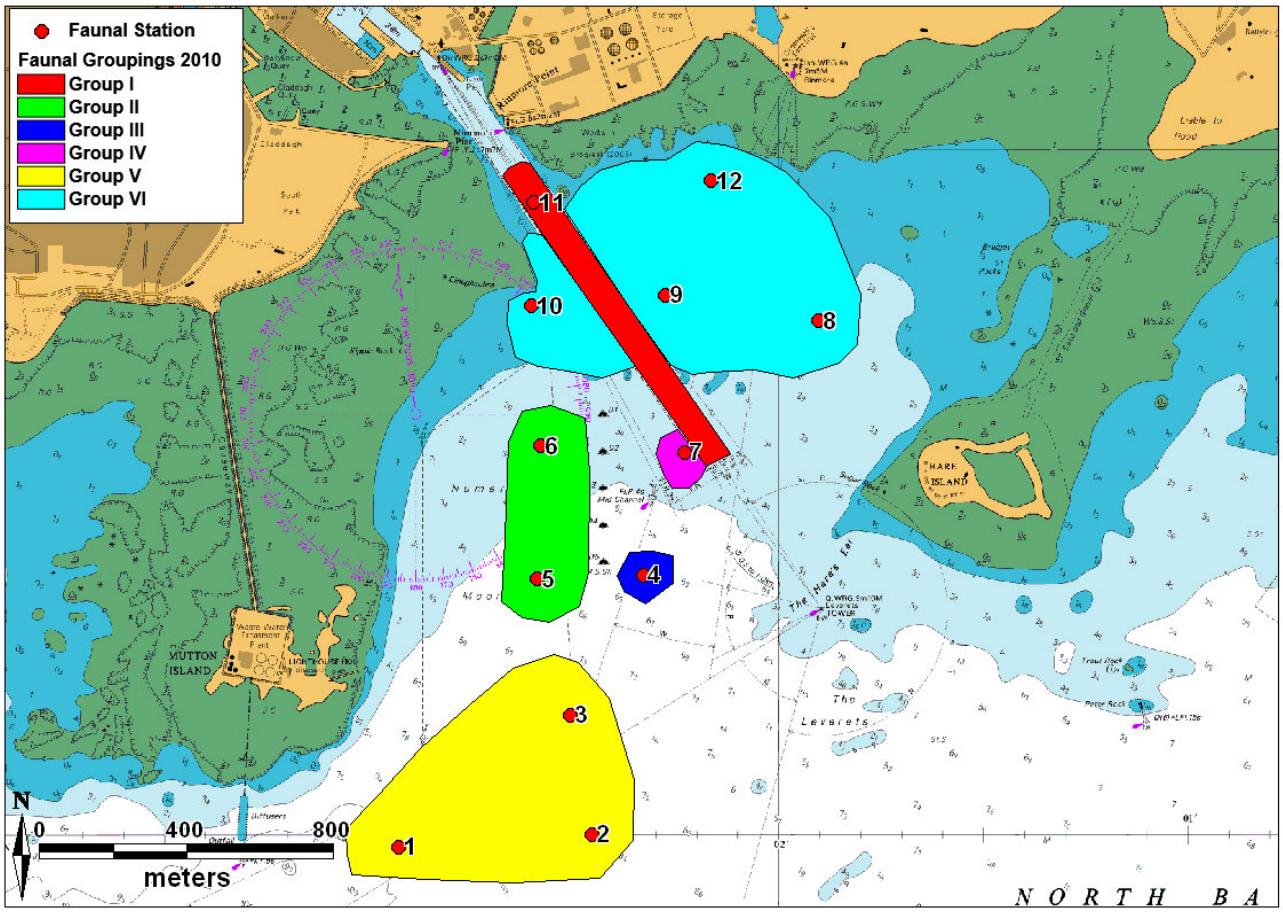


Figure 7.5.12 - Faunal groupings identified from the survey area in 2010

7.5.3.4 Sediment Profile Imagery (SPI)

The results of the analyses on the images collected at the 22 sites in 2004 (see Figure 7.5.3) are presented in Table 7.5.10.

7.5.3.4.1 Major mode

Fine sediments dominate the area surveyed. Of the 22 stations samples, 15 (Stations 1, 4, 7, 9, 11 – 20 and 22 had their major modes represented by the 3 –2 phi fraction which is muddy sand. 1 site, Station 10 had its mode at 4 phi . The remaining stations had modes that included the phi range of 2 - 1 which is fine sand.

Mean values for SPI analyses							
Station	Major Mode (phi)	Mean Penetration (cm)	S.B.R. (cm)	Mean Redox (cm)	S.S.[1]	OSI[2]	BHQ[3]
1	3 – 2	6.245	0.97	4.88	II	2	5
2	2 – 1	3.65	1.07	2	II	-1	4
3	2 – 1	4.05	1.32	>4.05	II	4.3	6
4	3 – 2	13.61	0.77	4.45	I	-0.3	2.3
5	2	5.97	9.42	1.57	I-II	-2	1.3
6	2 – 1	3.14	0.89	2.8	II	-0.5	2.5
7	4-3/3-2	>21 (op)	-	2	I	-1	2
8	2 – 1	14.16	1.23	4.37	II	4.3	6.7
9	3-2/2-1	12.23	1.02	5.07	II	2	5
10	4/4-3	17.96	1.9	2.5	I	-1	2.5
11	3 - 2	>21 (op)	-	1.5	I	-2	4.7
12	3 – 2	20.72	0.60	3.6	II	5	4
13	3 – 2	16.71	0.84	3.88	II-III	3.7	4
14	3 – 2	18.5	1.09	1.01	II	6	6
15	3 – 2	11.73	0.91	4.17	II	1.3	3
16	2-3/3-2	8.67	0.70	4.85	II	4	5
17	2-1/3-2	10.07	0.69	4.875	II	4.3	5.3
18	3 – 2	12.63	3.65	2	Azoic – II	- 6	2
19	3 – 2	18.09	1.46	4.9	I-II	-1.3	2
20	1-0/3-2	16.04	0.68	3.45	I on III	1	2
21	2 - 1	2.62	2.09	>2.62	II	0	3
22	3 - 2	17.13	0.92	3.24	I-II	1.3	3

Table 7.5.10 - Mean values for SPI analyses on samples collected in inner Galway Bay

[1] Ranges from 0 to III, [2] Ranges from -6 to +11, [3] Ranges from 0 to +15
- indicates that analysis was not possible, op = over penetration

7.5.3.4.2 Mean penetration

Mean penetration ranges from 2.62 at Station 21 to a maximum of 20.72 at Station 12. Over penetration occurred at 2 stations (Stations 7 and 11). Fifteen stations (Stations 4, 7, 8 – 15, 17 – 20 and 22) returned mean penetrations of greater than 10cm.

7.5.3.4.3 Surface boundary roughness

Surface boundary roughness (SBR) was lowest at Station 17 (0.69) and greatest at Station 5 (9.42). Most values were lower than 2.

7.5.3.4.4 Mean Redox discontinuity

The redox discontinuity was shallowest at Station 14 (1.01cm) and deepest at Station 9 (5.09). Fourteen stations (Station 1, 3, 4, 8, 9, 12, 13, 15 – 20 and 22) had redox discontinuities of 3 cm or deeper.

7.5.3.4.5 Successional Stage

The successional stage ranged from Azoic to Stage II-III,

7.5.3.4.6 Organism Sediment Index

The Organism Sediment Index varied from -2 at Stations 5 and 11 19 to 6 at Station 14.

7.5.3.4.7 Benthic Habitat Quality

Benthic Habitat Quality varied from 1.3 at Station 5 to 6.7 at Station 8.

7.5.4 Discussion

7.5.4.1 Sedimentology

7.5.4.1.1 Granulometry

Sediments in the layby were dominated by silt-clay (81.8%) and sediments within the docks ranged from sandy mud to muddy sand to muddy and sandy gravel.

The sediments returned from the proposed development area were predominately fine sands and silt-clay. The navigation channel is periodically dredged (*ca* every 10 years), due to the accumulation of sand, silt and clay through the natural process of sedimentation. It is to be expected that these sites would be dominated by sand and silt. The findings of sand and silt in this area are consistent with those from previous workers (Shin, 1981; Shin et al., 1982; O'Connor *et al*., 1993; Roche, 2004).

With regard to sedimentation rates and build up of material, as there will be at most only the same amount of sediment coming in from the river/sea, the rate will be at most the same as it is at present. In fact with the Mutton Island causeway in place, the expected increase in current velocities anticipated due to the new structure (See Chapter 8 of EIS) and the decommissioning of the sewage pipes in the Corrib River and off South Park, the sediment loadings will be somewhat less than in previous years. This in turn suggests a slower build-up of material within the proposed development area over time than is the case at present.

Information from the Harbour Master indicates that maintenance dredging occurs *ca* every 10 years *i.e.* when the channel has filled in to *ca* +50 cm over the last dredging episode. As suspended sediment loadings will be lower and current velocities will be higher, it is predicted that maintenance dredging may only be required every 15 years.

7.5.4.1.2 Sediment Chemistry

Organic carbon contents of inshore and estuarine sediments, as estimated by loss on ignition, are generally highly correlated with the fine silt-clay fraction (Marine Institute, 1999). This correlation can be clearly seen in the results of the present survey. Organic carbon values greater than 20 g/kg (2%) (Stations 2, 4, 7, 10, 11, 20 and the layby station) corresponded with those stations that were predominately composed of silt-clay sediments. The maximum organic carbon content value recorded was 52 g/kg (5.2%) at Station 7. Values in this region are not considered to be excessively high or uncommon for this area.

The mercury levels recorded in this area were consistent with previously recorded values of <1 mg/kg (ppm) (Roche, 2004) and are all below the lower guidance level of 0.2 mg/kg (Cronin e*t al.,* 2006).

Cadmium, arsenic and nickel were consistent with previous findings and were not found in elevated concentrations (>1 mg/kg, >10 mg/kg and >25 mg/kg respectively) at any station. Cadmium levels exceed the upper guidance level within the dock area only. All other Cadmium levels throughout the study area were all below the lower guidance level of Cronin *et al.* (2006) with one exception. Lead, zinc and copper were within their expected ranges (>50 mg/kg, >80 mg/kg and >20 mg/kg respectively) at all stations with the exception of Stations 2 and 7. Values were slightly elevated at these stations. It is thought that elevated concentrations of lead and zinc in this area are the result of the bulk shipping of these metals [powered oxide] from the docks in past times. Zinc, lead and copper exceed the upper guidance level within the dock area and zinc levels exceeded the upper guidance level in the layby. All were below the lower guidance level in the wider study area. Iron and manganese levels were consistent with previously recorded values (Roche, 2004) for this area. Aluminium values were within the expected range of 5.7% (57,000 mg/kg) obtained from the Irish Sea (CEFAS, 2000) (No data from Galway Bay was available for comparison)

Regarding levels of PAH's, all were significantly lower than the lower guidance level of 4000 µg/kg (for all 16 PAHs). Regarding chlorinated pesticides, very little references material can be found from Irish marine sediments, with the exception of dieldrin. The Marine Institute (1999) reported levels of greater than 0.5 µg/kg as being measurable. Results in this survey ranged from <4.2 to <7.6 µg/kg. It is possible that the analytical procedure used in this analysis could not attain a lower detection limit to reveal more precise concentrations. All PCB's had levels <10 µg/kg, these levels are well below the upper guidance levl of 180 µg/kg of Cronin *et al.* (2006). TBT values recorded from the Galway Bay area were below the expected value recorded by the Marine Institute (1999) >800 µg/kg (0.8 mg/kg). Levels were well below the lower guidance level of 0.1 mg/kg {100 µg/kg}.

In order to look at the effects of the remobilisation of contaminants from deeper sediments, results of bore hole surveys carried out by Causeway Geotech Ltd. (see Appendix 6.2) were examined. The following results were recorded (see Appendix 7.6). The levels of arsenic ranged from a minimum concentration of 3.9 mg/kg in BH03 (depth 0.5-1.5 m) to a maximum of 18 mg/kg in BH02 (depth 2.0-2.5 m). These levels were within the guidance levels of Cronin *et al.* (2006). The levels of cadmium ranged from a minimum value of <0.10 mg/kg in BH01, BH02 (1.5-2.0 and 2.0-2.5 m), BH03, BH05 (5.5-6 m), BH06 (0.5-1.0 m), BH07 and BH08 to a maximum of 0.35 mg/kg in BH05 (depth 0.5-1 m). These levels were below the lower guidance level of Cronin *et al.* (2006). Chromium ranged from a minimum of <5.0 mg/kg in BH03 (depth 0.5-1.5 m) to a maximum of 38 mg/kg in BH06 (depth 6.5-7.0 m). These levels were below the lower guidance level of Cronin *et al.* (2006). Copper ranged from a minimum of <5.0 mg/kg in BH03 (0.5-1.5 m and 3.5-4.0 m), BH04 (0.5-1.0 m), BH05 (0.5-1.0 m) and BH06 (0.5-1.0 m and 1.5-2.0 m) to a maximum of 32 mg/kg in BH06 (6.5-7.0 m). These levels were below the lower guidance level of Cronin *et al.* (2006). Lead ranged from a minimum of <5.0 mg/kg in BH03 (0.5-1.5 m and 3.5-4.0 m), BH04 (0.5-1.0 m), BH05 (0.5-1.0 m) and BH06 (0.5-1.0 m) to a maximum of 31 mg/kg in BH06 (6.5-7.0 m). These levels were below the lower guidance level of Cronin *et al.* (2006). The levels of mercury were recorded at <0.10 mg/kg in all samples. These levels were below the lower guidance level of Cronin *et al.* (2006). The levels of nickel ranged from <5.0 mg/kg in BH03 (0.5-1.5 m and 3.5-4.0 m) and BH06 (0.5-1.0 m) to a maximum of 37 mg/kg in BH06 (6.5-7.0 m). These levels were within the guidance levels of Cronin *et al.* (2006). Selenium levels ranged from <0.2 mg/kg in BH02 (2.0-2.5 m), BH03 (7.5-8.0 m) and BH07 (1.5-2.0 m) to 0.74 mg/kg in BH04 (4.5-5.0 m). Zinc ranged from a minimum of 10.0 mg/kg in BH06 (0.5-1.0 m) to a maximum of 83 mg/kg in BH01 (1.5-2.0 m). These levels were below the lower guidance level of Cronin *et al.* (2006).

Boron levels ranged from 1 to 6.9 mg/kg in BH05 (5.5-6.0 m) and BH03 (0.5-1.5 m) respectively. Total and free cyanide was <0.50 mg/kg in all samples. Sulphur levels ranged from 0.11 to 0.96 mg/kg in BH02 at depths of 2.0-2.5 m and 0.5-1.0 m respectively. Sulfide levels ranged from 3.9 to 10 mg/kg in BH07 (0.5-1.0 m) and BH03 (7.5-8.0 m) respectively. Sulfate as SO_4 ranged from 3500 to 24000 mg/kg in samples BH02 (2.0-2.5 m) and BH05 (8.5-9.0 m) respectively. Thiocyanate levels were <5.0 mg/kg in all samples except in BH02 (2.0-2.5 m) and BH03 (7.5-

8.0 m) in which they were 15 and 18 mg/kg respectively. Hexavalent chromium was <0.5 mg/kg in all samples.

Acenaphthene, acenapthylene, anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(g,h,)perylene, dibenzo(a,h)anthracene, fluorine, indeno(1,2,3-cd)pyrene and naphthalene values were < 0.1 mg/kg at all stations. Phenanthrene and fluoranthene values were <0.1 mg/kg in all samples except BH01 (0-0.5m) at which it was 0.2 mg/kg. Benzo(a)anthracene, chrysene and pyrene levels were <0.1 mg/kg in all samples except BH01 (0-0.5 m) in which it was 0.1 mg/kg. Levels of total PAHs (polycyclic aromatic hydrocarbons) was <2 mg/kg in all samples. All PAH levels were below the lower guidance level of Cronin *et al.* (2006).

The level of total petroleum hydrocarbons (TPH) was <10 mg/kg in all samples. TPH aliphatic >C5-C6, TPH aliphatic >C6-C8, TPH aliphatic >C8-C10, TPH aromatic >C5-C7, TPH aromatic >C7-C8 and TPH aromatic >C8-C10 levels were <0.1 mg/kg in all samples. The level of TPH aliphatic >C10-C12, TPH aliphatic >C12-C16, TPH aliphatic >C16-C21, TPH aliphatic >C21-C35, TPH aliphatic >C35-C44, TPH aromatic >C10-C12, TPH aromatic >C12-C16 and TPH aromatic >C35-C44 was <1 mg/kg in all samples. TPH aromatic >C16-C21 and TPH aromatic >C21-C35 levels were <1 in all samples except BH01 (1.5-2 m) in which they were 2.0 and 1.8 mg/kg respectively. All hydrocarbons were below the lower guidance level of Cronin *et al.* (2006).

The level of catechols, phenol, cresols, xylenols, nephthols and trimethyl phenols was <0.05 mg/kg in all samples. Total phenols level was <0.3 mg/kg in all samples.

Boelens, 1999 (Fig. 4.2.11, Ireland's Marine and Coastal Areas and Adjacent Seas and associated text) was used as establishing background levels for heavy metals. Arsenic levels ranged from 3.9 mg/kg to a maximum concentration of 18 mg/kg in the Causeway Geotech Ltd. survey. Seven of the 21 samples have a value above >10 mg/kg which is considered an elevated level, but all have levels below the maximum concentration of 20 mg/kg. Cadmium levels were found to reach a maximum value 0.35 mg/kg, and lie below accepted levels of >1.0 mg/kg . Levels of chromium found are below the estimated background level of 30 mg/kg in all samples except in one which has a value of 38 mg/kg. However, this value is below the maximum level of 40 mg/kg. Copper levels are considered elevated above 20 mg/kg, and four samples from the Causeway Geotech Ltd. survey have a concentration above these with a maximum of 32 mg/kg. These values are less than the maximum concentrations of >100 mg/kg found by Boelens (1999). Lead levels were detected to a maximum of 31 mg/kg which is below what is considered elevated levels of >50 mg/kg. Mercury concentrations of <.0.1 mg/kg found in all samples are below the detectable limit, and these are lower an elevated concentration of 0.1 -0.9 mg/kg. All except three of the samples show a nickel concentration in line with that found by Boelens (1999) of <25 mg/kg. The maximum level of nickel detected was 37 mg/kg which is below the maximum concentration of 40 mg/kg found by the same author. Zinc levels detected in the sediment samples were all below the concentration of >80 mg/kg which is considered to be elevated, except one sample in which a level of 83 mg/kg was detected. However, this is much lower than the high concentrations of zinc of >250 mg/kg.

These results indicate that there are no reasons to suggest that mobilisation of deep sediments will impact on water or sediment quality during the dredging operations.

All traces of metals in the samples taken at South Park were found to be extremely low. Arsenic levels were found to be very low, at 1.1 mg/kg or less, and far below what is considered to be an elevated degree of >10 mg/kg (Boelens, 1999) and well below Cronin *et al.* (2006) lower guidance levels. Cadmium concentrations were recorded at <0.20 mg/kg in both samples, and well below an elevated threshold of >1 mg/kg and well below Cronin *et al.* (2006) lower guidance levels. Levels of chromium were recorded at a maximum value of 2.8 mg/kg and much lower than the estimated background level of >30 mg/kg and well below Cronin *et al.* (2006) lower guidance levels. Copper was detected at a concentration of 5.1 mg/kg in both samples, well below elevated levels of >20 mg/kg and well below Cronin *et al.* (2006) lower guidance levels.

Lead levels were recorded at a minimum of 2.1 mg/kg and a maximum of 5.3 mg/kg, and were very low when compared to potential elevated concentrations of >50 mg/kg and well below Cronin *et al.* (2006) lower guidance levels. Mercury was detected at levels <0.35 mg/kg, and according to Boelens 1999 (Fig. 4.2.11, Ireland's Marine and Coastal Areas and Adjacent Seas), this may indicate a medium concentration but still below elevated levels of >1.0 mg/kg and within Cronin *et al.* (2006) guidance levels. Nickel was barely detectable, with concentrations recorded at <1.0 mg/kg (values of >25 mg/kg are considered elevated) and well below Cronin *et al.* (2006) lower guidance levels. Zinc concentrations ranged between 16 and 18 mg/kg and were also very low when compared to elevated levels of >80 mg/kg and well below Cronin *et al.* (2006) lower guidance levels.

Extractable HC/DRO (C8-C40) (diesel hydrocarbons) tests found concentrations of <50 mg/kg, while PRO (C5-C12) (petroleum hydrocarbons) tests returned levels of <5 mg/kg in both samples, which are considered low (Complete Lab Solutions, *pers. comm.*). Extractable hydrocarbon levels are well below Cronin *et al.* (2006) lower guidance levels. Fats, oils and greases were recorded at values of <5 mg/l and these are considered to be low concentrations.

In general, the analyses indicate that there is nothing unexpected in the sediment having regard to its location at the mouth of a river / harbour and that any disturbance of those sediments will not impact on the water quality and hence aquatic life in the location.

These results do not indicate any long term or residual contaminant leakage or seepage from the historical municipal dump at Southpark.

7.5.4.2 Macrofauna

The construction of the proposed harbour extension will involve the infilling of *ca* 27ha including breakwaters and dredging of *ca* 46.5 ha of intertidal and subtidal habitat which include Annex 1 habitats as listed in the EU Habitats Directive and include biogenic reefs (mussels beds). The only annexed habitat is the intertidal area which covers an area of *ca* 5.9 ha. In the present study the dominating macrofaunal subtidal species were the bivalve *Kurtiella bidentata,* the tube-dwelling polychaete *Melinna palmata,* the amphipod *Ampelisca brevicornis* and the bivalve mollusc *Thracia phaseolina*. Other dominants included the polychaete *Phyllochaetopterus anglicus*, the amphipod *Crassicorophium crassicorne*, the polychaetes *Nephtys* spp. and *Euclymene oerstedii*, the bivalves *Angulus fabula, Venus casina* and *Thyasira flexuosa*, the gastropod *Turitella communis* and the ophiuroid *Amphiura filiformis*. These species are quite common for this area and are typical of species that inhabit muddy sand areas. Their characteristics identify them with previously recorded communities in the area: the *Melinna palmata* association reported by Keegan *et al.* (1976), Groups A and C recorded by Shin *et al*. (1982) and is an equivalent to the *Telinna fabula* sub-community described by Spärck (1935).

The groupings identified by the CLUSTER analysis represented slight variations of the above community between stations, but overall the faunal assemblage of the area is homogenous. *Kurtiella bidentata* is a common species in this area and *Melinna palmata* is tolerant to organic enrichment. These species are typical of the study area, which is a shallow, moderately exposed site and the species inhabiting it are adapted to on-going natural stresses and disturbances (*i.e.* fluctuations in salinity, strong waves, tides and storms, periodic high turbidity). No unusual species were observed during the present study.

Adult mussels form feeding resources for invertebrate species such as carnivorous gastropods and star fish and bird species such as Oystercatcher and Hooded Crow while postlarvae and juveniles are a food resource for a wide range of benthic invertebrates. However, as the mussel beds that will be lost due to the construction of the harbour extension represent < 0.1% of the total area of this habitat in the bay, its loss is regarded as being insignificant.

7.5.4.3 Sediment Profile Imagery

The most important SPI parameters that describe the status of the sea floor are the mean redox depth, the successional stage and the organism sediment index (OSI). Typically, redox values of 0.5 cm or less are characteristic of heavily organically enriched sediments. No such low values were recorded and as noted above, 13 of the 22 stations had redox depths of 3 cm or greater. This indicates that the sea floor in the general area is relatively well oxygenated. With regard to the successional stage, the lowest value of “Azoic”was recorded from one image recovered from Station 18. The next lowest, Stage I, was recorded at three sites (Stations 7, 10 and 11), Stage I-II at three sites (Stations 5, 13 and 22) while the majority of stations (12) had values of I – II. Station 13 returned a value of II-III while Station 20 returned I in III. These are plotted in Figure 7.5.13 below. OSI can range from -6 to +11 and Table 7.17 above shows that this value ranges from - 6 at Station 18 to a maximum of +6 at Station 14. BHQ values can range from 0 - +15 and again, Table 7.17 above shows values range from 1.3 at Station 5 to 6.7 at Station 8. All these values indicate that the area of Galway Bay where it is proposed to build the harbour extension is of low to medium quality.

Figure 7.5.13 shows the successional sere determined for each station.

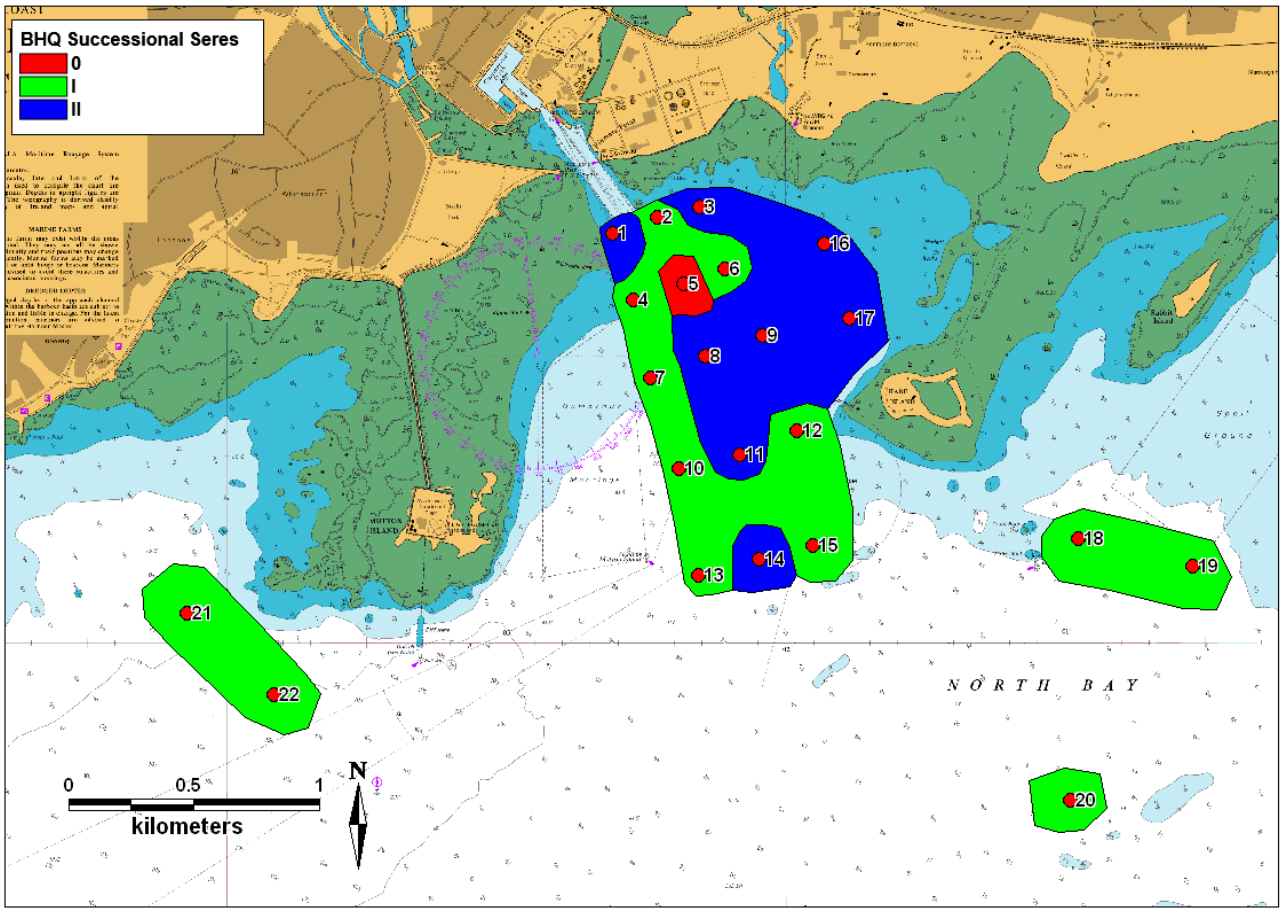


Figure 7.5.13 - Successional seres in the vicinity of the proposed development site

7.5.5 Fish in the Existing Environment

7.5.5.1 Methodology and Limitations

Sources of information for this section included data collected from direct surveys in addition to a compilation of information on commercial fish species based on landing data obtained from local fish merchants, the DoCMNR, Inland Fisheries Ireland (IFI) and the Marine Institute. Commercial fish data was used to give an indication of the species of fish present within the Galway Bay area. A discussion of the likely impacts on the fishery is included within the Human Beings Chapter 5 of this EIS. A salmon smolt tagging exercise was also completed, in addition to specific survey for Eel. Details are provided below.

7.5.5.2 Desk Study

7.5.5.2.1 Available Information concerning Fish and Shellfish

There is a relatively large body of data about Atlantic Salmon, Trout and Eel in the Inner Galway Bay area (discussed in Section 7.5.5.2.2 below). Although there is less published information about other types of fish, available information is summarised below:

Fish merchants McDonagh Redsail Ltd. (located in the Enterprise Park, Galway Harbour Park Phase I) used to purchase the majority of the locally-landed crustaceans and shelled molluscs, but ceased to trade several years ago. Data provided by MacDonagh Redsail for these landings in the year 2003 are included as Appendix 7.8 to this report.

DoCMNR Shrimp landing data were made available by Dr. Edward Fahy of the Marine Institute and are included as Appendix 7.9 to this report. Very little data was available for the 2003 Shrimp season.

Catch data for the Galway and High Bank Salmon angling fisheries, the Galway commercial Salmon netting fishery and the Galway Eel fishery were provided by the IFI and the Marine Institute, while catch data for the Salmon drift net fishery in Galway bay were made available via the Marine Institute. This data is either presented in the main body of the text, or is included in Appendices 7.10 – 7.12.

Other sources of information were published papers and reports (including the Marine Institute's Fishery Leaflets and Irish Fisheries Investigations publications) and unpublished theses from NUI Galway.

In some recent years Sea Lamprey (*Petromyzon marinus*) have travelled up the River Corrib to spawn sporadically below the Galway Salmon Weir. This species is listed in the official National Parks and Wildlife Service (NPWS) site synopsis for the Lough Corrib cSAC, which includes the River Corrib and is a qualifying interest of the Lough Corrib cSAC.

Thick-lipped Grey Mullet (*Chelon labrosus*) are often seen by Nimmo's Pier and in Lough Atalia by members of the public who sometimes mistake them for Salmon (Dr. Greg Forde, IFI, *pers comm.*).

Dietary analysis of seal scats carried out at NUI Galway indicates that Whiting (*Merlangius merlangus*) are present in Galway Bay and are a common prey item for seals (Jane Gilleran, NUI Galway, *pers comm.*).

According to Mulligan (1980), Herring (*Clupea herangus*) and Mackerel (*Scombrus scomber*) have been commercially fished in the outer bay until recently at least. Herring were fished from late Autumn to early Spring (when they come inshore to spawn) at Black Head and in Cashla Bay. Formerly Herring used to come as far into the bay as the markers for the harbour channel

and were fished, but this has not happened in recent years. Mackerel can be caught from late Summer to early Winter, when they come inshore to feed. Mackerel are regularly caught by sport anglers in the Inner Galway Bay area. The same author also lists Spotted Ray (*Raja montagui*), Thornback Ray (*Raja clavata*), Blonde Ray (*Raja brachyura*), Pollack (*Pollachius pollachius*), Saithe (*Pollachius virens*), Dab (*Limanda limanda*), Flounder (*Platichthys flessus*), Plaice (*Pleuronectes platessa*), Megrin (*Lepidorhombus whiffiagonis*), Common Sole (*Solea vulgaris*) and Lemon Sole (*Microstomus kitt*) as having been fished in Galway Bay. Further, the small fish species Sprat (*Sprattus sprattus*) and Norway Pout (*Trisopterus esmarkii*) are mentioned as being important prey items for Haddock.

Other literature mentions Ray's Bream (*Brama brama* syn. *Brama raii*), Five-bearded Rockling (*Ciliata mustela*), Butterfish (*Pholis gunellus*), Yarrell's Blenny (*Chirolophis ascii*), Lesser-spotted Dogfish (*Scyliorhinus canicula*), Rabbit Fish (*Chimaera monstrosa*), Great Silver Smelt (*Argentina silus*), Long-spined Sea Scorpion (*Taurulus bubalis*), Short-spined Sea Scorpion (*Myoxocephalus scorpius scorpius*), Thick Back Sole (*Microchirus variegatus*), Solenette or Yellow Sole *(Buglossidium luteum*), Dragonet (*Callionymus lyra*), Lesser Sand-eel (*Ammodytes tobianus*), Corkwing Wrasse (*Crenilabrus melops*) and Ballan Wrasse (*Labrus bergylta*) as living or having been taken in Galway Bay (Gibson, 1964; Boyd, 1973; Cheetham, 1985; Cheetham & Fives, 1990; Dunne & Cooper, 1980; Henderson & Dunne, 1999; O'Ceidigh, 1959a, 1959b; King & Fives, 1983, 1990; King *et al.*, 1983, 1986, 1994; O'Connell & Fives, 1995; Deady, 1995; Deady & Fives, 1995).

The IFI, in the information they make available on sea angling in the Inner Galway Bay area, list Mackerel, Pollack, Flounder, Dab, Thick-lipped Grey Mullet, rays, Tope, dogfish, Bull Huss (*Scyliorhinus stellaris*), Conger Eel (*Conger conger*) and Sea Bass (*Dicentrarchus labrax*) as being regularly caught by rod and line.

Sunfish (*Mola mola*) are quite often recorded from the west coasts of both Ireland and Britain, usually in Summer or Autumn. It is sometimes stated that this species is occurring more frequently in Ireland because of ocean warming. One was sighted on the 2nd of August 1992 near to the Aran Islands (per Irish Whale and Dolphin Group, IWDG), but the only recent records for the Inner Galway Bay area are of one near Silver Strand, Barna on the 27th May 2003 and one at Baile na hAbhann near Inveran on the 27th of August 2005 (per Galway Branch, BirdWatch Ireland).

Basking Shark (*Cetorhinus maximus*) is another species that is recorded off the west coast of Ireland during the Summer months. This is the largest fish in the region. A search of the IWDG's sightings database revealed that all recent records are from the Outer Bay in the vicinity of the Aran Islands: 1 on 29th of August 1992, 1 on 18th August 1995, 1 on 12th September 1995, 2 on 24th July 2003 and 1 on 24th May 2004.

Shellfish in the Inner Galway Bay area include: Shrimp (*Palaemon serratus*), Lobster (*Homarus gammarus*), Velvet Crab (*Necora puber*) and cultivated oysters (*Ostrea edulis* and *Crassostrea gigas*).

There are smaller-scale fisheries for Spider Crab (*Maja brachydactyla*), Scallop (*Pecten maximus*), Mussel (*Mytilus edulis*), Whelk (*Buccinum undatum*) and Winkle (*Littorina littorea*). A fishery involving the native Carpet Clam (*Tapes decussata*) existed in the past (Wilkins, 2004) and Mulligan (1980) also mentions Queen Scallop (*Chlamys opercularis*), Dublin Bay Prawn or Scampi (*Nephrops norvegicus*), Spiny Lobster (*Palinurus vulgaris*), Edible Crab (*Cancer pagurus*) and the collection of Purple Sea Urchin (*Paracentrotus lividus*) by SCUBA divers.

As well as oysters, the cultivation of Scallops, Mussels and Manila Clams (*Ruditapes phillipinarum*, syn. *Tapes phillipinarum*, syn. *Tapes semidecussata*) also occurs in Galway Bay (Marine Institute, 1999).

7.5.5.2.2 Species of Conservation Importance that use the Site and Surrounding Area

Atlantic Salmon (Salmo salar)

Atlantic Salmon is listed in Annexes II (when in fresh water) and V of the EU Habitats Directive. Atlantic Salmon is a qualifying interest of the Lough Corrib cSAC.

Salmon are anadromous fish (*i.e.* they hatch in freshwater, migrate to the sea, where they mature before returning to their natal areas to breed), they are from 2 to 4 years old when the fully-silvered juveniles, known as smolts, migrate to the sea. Adult Salmon that have spent a Winter at sea are known as grilse. Grilse are the most numerous type of Salmon that are found migrating back into rivers from the sea. Some individuals spend more than one Winter at sea before breeding and are referred to as Multi-Sea-Winter (MSW) fish. MSW fish are usually larger than grilse and are known as 'Spring' fish when they migrate back into rivers during the Spring. Between the months of April and July inclusive, *ca* 60% of returning Salmon pass though the Corrib (Tom McDermott, *pers. comm.*). During the period from 1989 to 2003, the proportion of Spring fish in the total annual angling catch from the Galway Fishery ranged between 3.7% and 41.3% (data courtesy of Mr. Tom McDermott, Marine Institute). Adult Salmon lose 40% of their body weight during migration and spawning and mortality is high. Some adults, known as kelts, survive the spawning season and live to run back downriver and return to sea. A few (3 – 6%) kelts survive to return to their natal rivers again as previous spawners (Hendry & Cragg-Hine, 2003).

Salmon are present in the River Corrib in Galway from January to October: Spring fish come into the river from January to May, whilst returning grilse run upriver from May to August. Between the months of April to July inclusive approximately 60% of the Spring fish pass through the mouth of the Corrib. There is also a smaller Autumn grilse run in September and October. Smolts migrate downriver to the sea from March to May.

Investigations into the population densities of juvenile Salmon in the Corrib system began in 1979 (Browne & Gallagher 1980a,b) and it was considered in 1987 that *"the majority of the Corrib tributaries appear adequately stocked with Salmon."* (Browne & Gallagher, 1987).

There has been much academic interest in the possible impact of mammal and bird predation on Salmon populations. Based on observations from the River Dee in Scotland, Carter *et al.* (2001) suggested that migrating adult Atlantic Salmon tend to move into rivers at night and during the ebb tide during Summer and when water levels are low, while at other times of year and during higher river flows Salmon migrate into rivers during the day. The same authors reported that predation by seals on salmonids was observed most often during the day and further suggested that seals may find salmonids easier to catch during daylight. Fish-eating birds such as Gannet (*Morus bassanus*), Cormorant (*Phalacrocorax carbo*), Shag (*Phalacrocorax aristotelis*), Red-breasted Merganser (*Mergus serrator*) and gull species are known to predate on Salmon and, with the exception of Gannet, all of these birds are common in the Inner Galway Bay area. It is likely that divers (also found in small numbers in the area from Autumn to Spring) will prey on Salmon too. The species mentioned generally search for food by sight and so feed during the day. Greenstreet *et al.* (1993) postulated that Salmon smolts migrate at night in order to avoid such predators.

Adult Salmon may often be seen during the day, in Spring and early Summer, below the Salmon Weir in Galway City. These fish are lying up before attempting the weir, but it may be that the majority of them would have passed through the area at night had there been no weir to delay their progress. Salmon smolts running down the River Corrib do not show any preference for night migration (Tom McDermott, Marine Institute, *pers comm.*), but migrate during either day or night in groups of perhaps 50, 70 or 90. Their migration down the Corrib seems to be more dependent on river conditions than time of day. It may be that predation pressure from diurnal predators is not a significant factor for the Corrib catchment Salmon population.

Sea Lamprey (Petromyzon marinus)

Sea Lamprey is listed in Annex II of the EU Habitats Directive. Adults enter the River Corrib in May and early June to spawn. These fish have been photographed getting up through the fishpass at the Salmon Weir by Inland Fisheries Ireland (Forde, pers. comm.). The years 2003 and 2004 appear to have been good spawning years for Sea Lamprey and their spawning areas (or redds) were clearly visible just upstream of the Salmon Weir Bridge in 2004 (Forde, pers comm.). Prior to the year 2003 Sea Lamprey had not been detected travelling upstream in significant numbers into Galway for some years (Hartigan, pers comm.).

The NPWS have records of this species for Lough Corrib and it is thought that the lake may hold a non-migratory population (Dr. Ferdia Marnell, NPWS, pers. comm.).

7.5.5.2.3 Other Fish Species

Trout (Salmo trutta)

Freshwater Brown Trout are found in the River Corrib and throughout the Lough Corrib and Lough Mask system and they would not be impacted by the proposed development. Although there are now not many Sea Trout coming further up the River Corrib than the Salmon Weir, there are a certain number of 'slob trout' that live permanently near to the river mouth (Forde, *pers comm.*).

European Eel (Anguilla anguilla)

The European Eel spawns at sea and the spawning grounds are believed to be in the Sargasso Sea, although no adult Eel has ever been located in the area. The larvae are transparent when they hatch and they migrate across the Atlantic in less than one year. These glass eels can be found just offshore or on the foreshore in Galway Bay in late Winter and Spring. They metamorphose into small pigmented Eels called elvers. These elvers migrate up the River Corrib from the sea from the end of April to May.

Elvers migrating through Galway Harbour often travel through the canals in Galway City, taking indirect routes upriver in the direction of Lough Corrib. They can be seen on Spring nights out of water climbing up the canal lock gates. The IFI have expressed concerns that elvers may not be able to migrate upstream if the proposed development were to alter the water flow at the river mouth to an extent that the flow rate became too great. This will not arise as shown in Chapter 8 of the EIS which presents Hydrodynamic and Sediment Modelling.

Eels can remain in fresh water for up to 57 years (Poole & Reynolds, 1998) before preparing for migration back to sea for spawning. Eels in freshwater are known as yellow eels, but these change head shape and colour (from yellow to silver) prior to migration. These adult migratory Eels are known as silver eels and they run down the River Corrib from October to January.

The numbers of European Eel recorded in the Galway Fishery have declined in recent years, although the fishery has been very important in the past. The Galway Eel fishery, using a weir with 14 coghill nets located just downstream of the Salmon Weir Bridge, relied on Silver Eels. Table 7.5.11 shows the annual catch figures for the Corrib commercial Eel fishery from 1994 to 2009 (courtesy of Seamus Hartigan, IFI). Due to the decline in Eel numbers and in accordance with the national Eel Management Plan, only fishing for research was allowed in 2009. Due to health and safety issues with the Galway Fishery eel weir structure, this site was not fished in 2010 or 2011.

Commercial Eel Fishery, River Corrib 1994-2009	
Year	Catch (Tonnes)
1994	8.32
1995	8.16
1996	4.07
1997	7.29
1998	4.62
1999	6.01
2000	7.95
2001	6.84
2002	5.81
2003	6.30
2004	5.80
2005	7.15
2006	9.16
2007	9.32
2008	5.20
2009	12.60 #

= Research catch (eels released)

Table 7.5.11 Commercial Eel fishery, River Corrib, 1994 – 2009

There has been a global decline- noted for European Eel, Japanese Eel (*Anguilla japonica*), American Eel (*Anguilla rostrata*) and for anguillid species from the southern hemisphere- in juvenile Eel stocks since 1960. The causes of the decline are not precisely known. The total juvenile stock of European Eel has declined by 99%, although the picture is much better in Ireland and stocks are still reasonably strong. In response to this trend, the international academic community and other interested parties signed the Québec Declaration of Concern (Casselman and Cairns, 2003), detailing the world decline in Eel stocks and warning that precautionary action should be taken to maintain them.

The EU brought forward Council Regulation 1100/2007, establishing measures for the recovery of the stock of European Eel. This regulation stipulated that an Eel Management Plan (EMP) must be prepared by all Member States for implementation from the 1st of July 2009. A Joint Working Group was established in 2008 to prepare Ireland's national eel management plan and to develop an eel management plan, on a river basin district basis, as required by the regulation. The Eel Management Plan for Ireland (DoCENR, 2008) contained four main Management Actions aimed at reducing Eel mortality and increasing silver eel escapement in Irish waters are recommended in the draft Eel Management Plan. These were: an immediate cessation of the commercial Eel fishery and closure of the market; mitigation of the impact of hydropower, including a comprehensive silver eel trap and transport plan; ensuring upstream migration of juvenile Eel at barriers and the improvement of water quality in Eel habitats.

Silver eels migrate in the faster-flowing reaches of rivers. The fastest flowing reach of the River Corrib at its mouth is in the main dredged channel between Nimmos Pier and the existing Galway Harbour Enterprise Park. Since the channel would run alongside the proposed new pier, the possibility of impacts of the proposed development on migrating silver eels must be considered in addition to possible impacts on elvers. Cullen & McCarthy (2000) found that catches of silver eel from traps adjacent to artificial lights on the Killaloe Eel weir suffered reduced catches when the lights were in use. Proposed mitigation measures in relation to lighting are addressed in Section 7.7.6.15.

Dr. T.K. McCarthy (Department of Zoology, NUI Galway), who has worked on the biology of the Eel for some years, is of the opinion that the proposed development would have little impact on the migration of Eel in the area, at least in the operational phase. Since elvers come into the harbour area on the high tide and do not commence active swimming until they reach the mouth

of the River Corrib, Dr. McCarthy was of the opinion that changes in water flow rate are unlikely to halt upstream elver migration. Similarly, although Dr. McCarthy thought it quite possible that the migratory path of silver eels could be deflected by powerful artificial lights mounted on the proposed new development, he did not think it likely that migration would be halted, or even delayed, by them. Proposed mitigation measures in relation to lighting are addressed in Section 7.7.6.15.

7.5.5.2.4 Crustaceans and Shelled Molluscs

Shrimp (Palaemon serratus)

Shrimp move inshore in late Summer and move back offshore in Winter. This seasonal movement is thought to be attributable to the fact that Shrimp are susceptible to cold conditions. Spawning dates around the Irish coast vary, but Shrimp are said to spawn in April in Galway Bay. The eggs remain attached to the female Shrimp for some months after spawning (females with attached eggs are said to be 'berried'). The Inner Galway Bay area is a significant nursery area for Shrimp, but there are no quantitative data (Oliver Tully, *pers comm.*).

Lobster (Homarus gammarus)

Galway Lobster Fishermen's Association, which represents the interests of Inner Galway Bay fishermen, runs a 50% grant aided conservation program for Lobster, known as the V-notch program. The minimum catch size for Lobster is 87 mm for the carapace. The V-notch scheme involves the marking of Lobster with a V-notch on the telson (tail). Most of the individuals marked are hens (females) and those that are borderline for size. Most of the Lobster taken are males or unberried hens (*i.e.* those not carrying eggs). Individuals marked with a V-notch, or with a damaged telson, cannot be legally sold. The Association have also participated in a Lobster tagging program in 2002 and 2003.

The proposed development is unlikely to have any significant negative impacts on the local Lobster populations as long as dumped spoil will not apply (Dr. Edward Fahy, then Team Leader, Inshore Fisheries, Marine Institute, *pers comm.*). The dredging methods for capital and maintenance dredging are addressed in Chapter 4 of the EIS.

Other Species

Velvet crab (*Necora puber*) and Whelk (*Buccinum undatum*) are also fished and found in Galway Bay, in addition to European Flat Oyster (*Ostrea edulis*) and Pacific Oyster (*Crassostrea gigas*) and Mussel (*Mytilus edulus*) which are commercially farmed and Winkles (*Littorina littorea*) which are common around the coast and traditionally handpicked from intertidal areas.

7.5.5.3 Field Surveys – Elver Survey

During the period February – April 2010, March-April 2011 and 2012, low tide hand searches for glass eels and elvers were made beneath seaweed and rocks at three sites in inner Galway Bay. These sites were the shore at the southern end of the existing reclaimed phase 1 of the Galway Harbour Park, at Ballyloughane beach (east of the site of the proposed development) and at the shore adjacent to the eastern side of the Mutton Island causeway (west of the site of the proposed development). At each site, two people searched for glass eels and elvers for one hour. A number of small eels (larger and more mature than elvers and which live on the sea shore) were recorded along with glass eels and elvers. Table 7.5.12 shows the results of this work.

Glass eels and elvers collected in harbour area			
Date	**Mutton Island**	**Harbour Park**	**Ballyloughane**
18/02/2010	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver = 0 Small Eel = 0
26/02/2010	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver = 1 Small Eel = 0	Glass Eel/Elver = 0 Small Eel = 0
04/03/2010	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver =0 Small Eel = 0	Glass Eel/Elver = 0 Small Eel = 0
12/03/2010	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver = 3 Small Eel = 8	Glass Eel/Elver = 1 Small Eel = 0
18/03/2010	Glass Eel/Elver = 1 Small Eel = 11	Glass Eel/Elver = 1 Small Eel = 7	Glass Eel/Elver = 7 Small Eel = 0
23/03/2010	Glass Eel/Elver = 0 Small Eel = 0	Glass Eel/Elver = 1 Small Eel = 0	Glass Eel/Elver = 0 Small Eel = 0
29/03/2010	Glass Eel/Elver = 0 Small Eel = 8	Glass Eel/Elver = 0 Small Eel = 27	Glass Eel/Elver = 8 Small Eel = 2
09/04/2010	Glass Eel/Elver = 2 Small Eel = 3	Glass Eel/Elver = 1 Small Eel = 1	Glass Eel/Elver = 0 Small Eel = 2
13/04/2010	Glass Eel/Elver = 2 Small Eel = 11	Glass Eel/Elver = 1 Small Eel = 18	Glass Eel/Elver = 2 Small Eel = 8
19/04/2010	Glass Eel/Elver = 0 Small Eel = 11	Glass Eel/Elver = 2 Small Eel = 2	Glass Eel/Elver = 3 Small Eel = 9
26/04/2010	Glass Eel/Elver = 2 Small Eel = 16	Glass Eel/Elver = 5 Small Eel = 16	Glass Eel/Elver = 5 Small Eel = 21
Totals	Glass Eel/Elver = 7 Small Eel = 60	Glass Eel/Elver = 15 Small Eel = 79	Glass Eel/Elver = 26 Small Eel = 42
15/03/2011	Glass Eel/Elver = 3 Small Eel = 6	Glass Eel/Elver = 4 Small Eel = 10	Glass Eel/Elver = 1 Small Eel = 5
24/03/2011	Glass Eel/Elver = 2 Small Eel = 9	Glass Eel/Elver = 0 Small Eel = 4	Glass Eel/Elver = 0 Small Eel = 11
06/04/2011	Glass Eel/Elver = 2 Small Eel = 8	Glass Eel/Elver = 3 Small Eel = 14	Glass Eel/Elver = 1 Small Eel = 7
Totals	Glass Eel/Elver = 7 Small Eel = 23	Glass Eel/Elver = 7 Small Eel = 28	Glass Eel/Elver = 2 Small Eel = 23
20/03/2013	Glass Eel/Elver = 0 Small Eel = 4	Glass Eel/Elver = 0 Small Eel = 2	Glass Eel/Elver = 0 Small Eel = 3
11/04/2013	Glass Eel/Elver = 2 Small Eel = 12	Glass Eel/Elver = 1 Small Eel = 14	Glass Eel/Elver = 9 Small Eel = 2
Totals	Glass Eel/Elver = 2 Small Eel = 16	Glass Eel/Elver = 1 Small Eel = 16	Glass Eel/Elver = 9 Small Eel = 5

Table 7.5.12 Glass Eels and Elvers collected at three sites in the harbour area February/April 2010, March-April 2011 and March/April 2013

During the years 1981 and 1982, McGovern & McCarthy (1992) regularly collected glass eels and elvers from the same site and times of year as that collected from on the shore in the Galway Harbour Park during 2010 (see Table 7.5.12, above). During the 1981 and 1982 study, two workers would collect 100 glass eels/elvers in a maximum of one hour. During 2010, a total of only 48 glass eels and elvers were collected from the three sites during 11 weekly visits and only 15 were collected at McGovern and McCarthy's old site in the same number of visits (*i.e.* where 1,100 glass eels and elvers might have been expected in the early 1980s). Three searches of the same three sites were made in March and April of 2011 and two searches (one in March and one in April) were also made at the same sites in 2013. In 2011, 16 glass eels and elvers were recorded (seven at McGovern and McCarthy's old site). In 2013, 12 glass eels and

elvers were recorded (only one at McGovern and McCarthy's old site). These figures demonstrate the extent of the decline of elvers in inner Galway bay in the last 30 years.

7.5.5.4 Field Surveys - Salmon Smolt Tracking

Salmon smolt tracking was carried out in 2010 to determine the routes or patterns of descending Atlantic Salmon smolts (*Salmo salar)* running to the sea from Lough Corrib and to assist in the assessment of the potential effects of the proposed development.

7.5.5.4.1 Materials and Methods

For the purposes of the smolt tagging study, 10 single-channel acoustic receivers and 100 acoustic tags were procured. Key stages in the proposed work were as follows:

- Tag ranging – test range for the transmitter receiver combination in the environmental conditions specific to the study area.
- Receiver deployments – plot out locations for the 10 receivers based on the results of the range tests. Deploy receivers at these locations
- Fish capture & tagging – surgically implant acoustic tags into wild Atlantic Salmon smolts captured at the Inland Fisheries smolt trap downstream of the Corrib Weir.
- Fish releases – release fish in batches to continue downstream to Galway Bay over a range of lighting and tidal conditions
- Data retrieval & analysis – recover data from the acoustic receivers to allow analysis and interpretation of results.

Tag Ranging

Range testing of the acoustic tags to be used during the study was carried out from a rigid inflatable boat (RIB) in the proposed study area in Galway Bay on 09th April 2010. Weather was clear and dry with a light southeasterly breeze blowing. The sea had a slight surface chop. The tags used for the study were Thelma Biotel 7.3 mm ID transmitters, the receivers were Vemco VR2W single channel receivers. The dates and times on:

- a laptop used for receiver downloads,
- the Vemco VR2W receiver and
- a GPS unit

were checked for synchronicity.

For the purpose of range testing, a single receiver was deployed on the seafloor using SCUBA equipment. A perforated metal rod was hammered vertically into the seabed leaving 0.75 to 1.5 m of bar protruding. The Vemco VR2W receiver was then attached to this protruding section of bar using cable ties and rope.

The location of the receiver's position was logged using GPS. A Thelma Biotel 7.3 mm tag was activated and inserted into a dead fish that was secured to a weighted line. This set up allowed the tagged fish to be suspended in the water column at a particular depth while varying its distance from the receiver. Seafloor depth in the survey area varied between approximately 3 m and 11 m – range tests were carried out with the tagged fish suspended at 2 m and a second run of range tests were conducted with the tagged fish suspended at 5 m depth. The tagged fish was lowered to the required test depth and notes made of the distance from the receivers' location and the time. On downloading the receiver log for the duration of the test, the approximate maximum range at which the tag was detected at each depth run was noted by matching up the hand-written time/range log with tag detections on the receiver log. Maximum detection ranges recorded were 235 m and 243 m at 8 m and 5 m depth, respectively.

Receiver Deployments – Listening Stations

Ten Vemco VR2W receivers (see Figure 7.5.14) were deployed on the seabed as described in the previous section at ten stations in the study area. Based on the results of range tests in the field, listening stations were plotted (using MapInfo Professional) with a 220 m reception radius on each receiver (see Figure 7.5.15). One receiver (#1) was placed in Lough Atalia, in the deeper portion of the Lough, upstream of the railway bridge. A second receiver (#2) was placed just outside the harbour entrance covering the gap between Rinmore Point and Nimmo's Pier, and the area immediately beyond this. This receiver (#2) was placed to allow the detection of each tagged smolt as it exited the Claddagh basin area, and also to determine if it remained in this area, or returned to this area after its first transit through this receiver's range. A cordon of receivers (#s 3-8) was deployed in an arc stretching between the head just south of Renmore Barracks and Mutton Island in order to detect tagged smolts exiting and entering this area during the course of the study period. A small overlap in receiver range was included to ensure that no 'deaf' areas existed between adjoining listening stations that might allow smolts to exit this area without being detected.

Two receivers (#s 9 and 10) were deployed in the North Channel area, between Black Rock and Grey Rock.

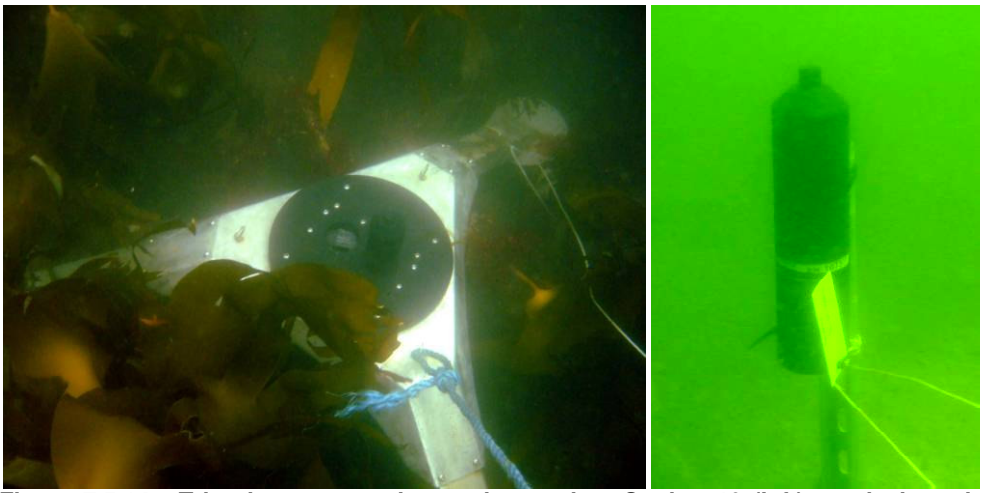


Figure 7.5.14 - Tripod mount used at rocky receiver Station 10 (left), vertical steel rod mount used at sandy/muddy receiver Stations 1-9 (right)

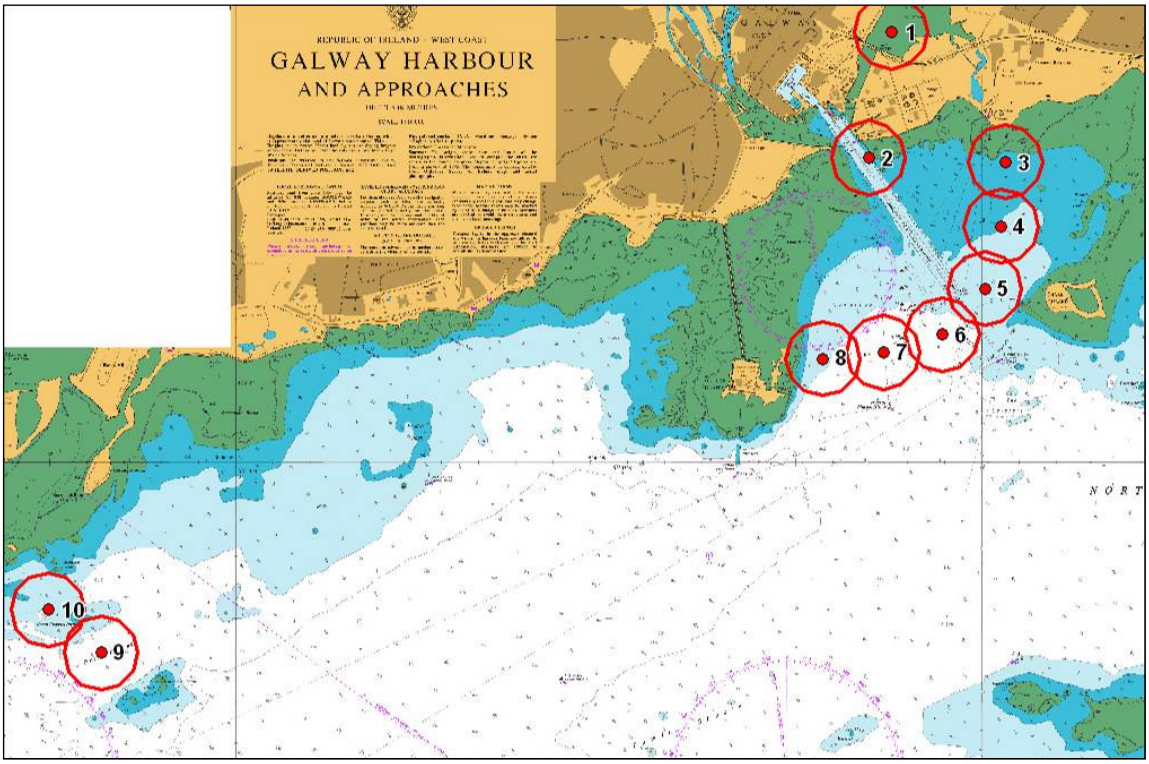


Figure 7.5.15 - Locations of 10 acoustic receivers deployed in Galway Bay, April 21st & April 22nd 2010

Fish tagging – surgical insertion

Prior to tagging, all tags were magnetically activated (27th April, 2010) and checked for proper functioning. Two tags out of a batch of 100 were found to be non-functional. Acoustic ID transmitter tags were sequentially numbered from 201-300. Fish were captured at the Inland Fisheries Ireland smolt trap (see 7.28) and transferred to a laboratory at Inland Fisheries Ireland, Kings Island, Galway for surgical implantation of Thelma Biotel 7.3 mm acoustic ID transmitters. Where possible, larger fish were chosen for tag implantation due to the greater ease of handling larger fish during surgery.

Figure 7.5.16 - Location of the Inland Fisheries Ireland smolt trap, downstream of the main weir on the River Corrib, Galway. Inset shows detail of the trap viewed from the eastern bank

After anaesthetisation, each fish was weighed and its fork length measured. Tags were sterilised before insertion. A latero-ventral incision was made behind the pectoral fins and a tag was inserted into the peritoneal cavity. Two interrupted sutures were then tied to prevent tag extrusion (see Figures 7.5.17 and 7.5.18). Fish were returned to small tanks of oxygenated water for revival from the anaesthetic. Once revived they were transferred to large holding tanks at Inland Fisheries Irelands Nun's Island facility for recovery from surgery.

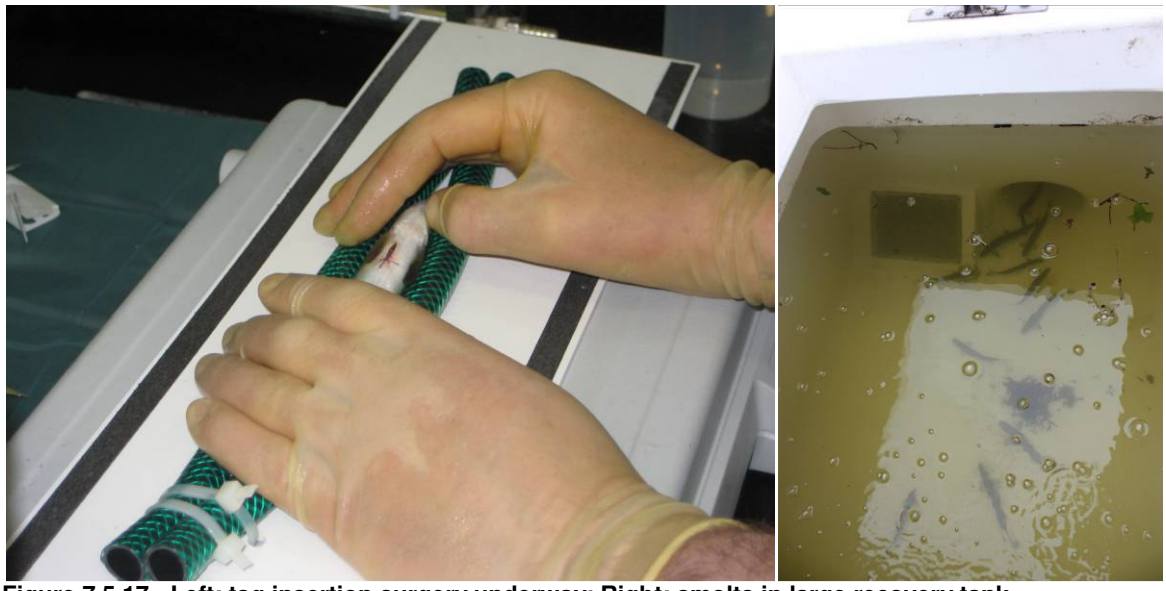


Figure 7.5.17 - Left: tag insertion surgery underway; Right: smolts in large recovery tank

Figure 7.5.18 - Post-surgery view of Salmon smolt with sutured tag insertion wound

Fish were handled as gently as possible during all procedures to minimise stress, skin damage and scale loss. Three holding tanks were used to keep tagged fish in post-surgery recovery. These tanks were filled with fresh river water on the morning of tagging. Tanks were flushed out, rinsed and re-filled with fresh river water before both sets of releases. The water in each tank was oxygenated (O_2 was supplied to each tank from an Oxygen tank via diffuser attached to an O_2 cylinder). Moribund fish and mortalities were removed as soon as they were identified to reduce stress to other fish in the tanks. Acoustic tags were recovered from any dead fish for re-use. Fish were tagged on two separate days – 27th April, 2010 and 07th May, 2010. In all, 94 tagged smolts were released.

Due to the relatively large number of tags used in a relatively small study area, it was decided to release tagged fish in small batches over a number of days in an attempt to reduce the number of transmission “collisions”. “Collisions" happen when two or more tags transmit all or part of their pulse train at the same time. When this happens, the pings overlap and neither transmission can be detected by the receiver. Although collisions are inevitable, tags are designed to transmit in such a way as to eliminate the possibility of any two tags *continuously* colliding with each other.

Fish Tagged on 27th April – Released during daylight hours

A total of 51 fish were tagged on 27th April 2010. These were released into the lower river Corrib at Nun’s Island in three batches during hours of daylight as detailed in Table 7.5.13.

Batch release of smolts 28th/29th April 2010			
Release Details	**Tank 1**	**Tank 2**	**Tank 3**
Release date	28th April, 2010	28th April 2010	29th April 2010
Release time	16:45-16:54	11:07-11:17	09:11-09:24
Number released	19 fish	18 fish	14 fish
Non Detections	2	6	2

Table 7.5.13 - Batch release of smolts 28th/29th April 2010

Fish were removed from the large holding tanks as gently as possible using a fine mesh pond net. As fish were removed from the large holding tanks, they were transferred to a 10 litre bucket containing fresh river water. This was gently lowered into the river once 3-5 smolts had been captured and allowed to submerge. The bucket was recovered once all of the fish had swam free.

Fish Tagged on 07th May – Released during daylight hours

A total of 43 fish were tagged on 07th May 2010. These were released into the lower river Corrib at Nun’s Island in three batches during hours of darkness as detailed in Table 7.5.14.

Batch release of smolts 7th/8th/9th May 2010			
Release Details	**Tank 1**	**Tank 2**	**Tank 3**
Release date	07th May, 2010	09th May 2010	08th May 2010
Release time	23:25-23:30	23:30-23:35	23:25-23:31
Number released	14 fish	15 fish	14 fish
Non Detections	1	1	2

Table 7.5.14 Batch release of smolts on 7th/8th/9th May 2010

Data Retrieval – Receiver Recovery

Data were downloaded from all receivers on 04th May 2010. On this date all receivers were recovered using SCUBA equipment and data were downloaded on site to a ruggedised laptop computer. Meters 2-10 were immediately re-deployed after data download. Meter 1 was recovered from the water and brought back to the office. It was redeployed on 09th May 2010. The final recovery of all receivers was carried out on the 27th May 2010. All ten receivers were returned to the lab and the final data downloads made.

7.5.5.4.2 Salmon Smolt Tracking Results

Tag Detections

Of the 94 tagged fish released, 80 were detected post-release by the ten acoustic receivers deployed in the study area while 14 No. i.e. 204, 219, 220, 229, 230, 232, 260, 265, 266, 281, 282, 287, 288 and 289 were not detected following release. Tag detections were picked up by nine out of the ten receivers deployed. No detections were made at Station 10 (in the North Channel/Black Rock area). Table 7.5.15 gives an overview of the number of tagged fish detected at each station during the current study.

Number of tags detected at each station	
Station	**Number of tags detected**
1	3
2	77
3	12
4	19
5	24
6	23
7	25
8	15
9	2
10	0

Table 7.5.15 Total number of tags detected at each station after fish releases.

Of the 80 tagged fish detected following release, 77 were detected at Station 2 (the receiver located outside the harbour mouth). Tag 214 was only detected at Station 1 (the Lough Atalia receiver). A total of 3 tags were detected at stations other than Station 2 but not at Station 2 (Tags 214, 224 & 225) – *i.e.* these fish exited the Claddagh Basin without being picked up by the receiver whose range spanned the harbour mouth.

The tagged fish can be divided into two main groups for which behaviour can be deduced following release:

Fish that remain in the Corrib/Claddagh Basin for a variable length of time following release, are detected at Station 2, proceed to swim from Station 2 to one or more of the outer stations and then are not detected again during the study period. This may be best visualised in the plot below (Figure 7.5.19).

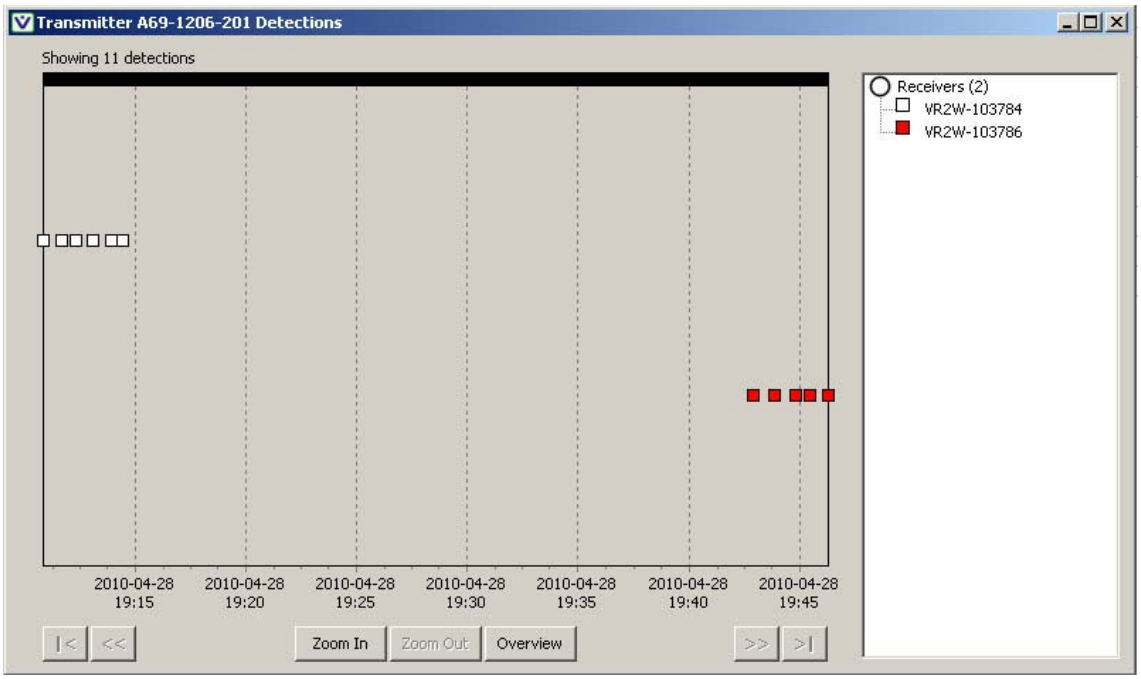


Figure 7.5.19 - Detection pattern of fish exhibiting 'transit' behaviour as represented in the Vemco VUE (software) plotted detections window for Tag 201. The x-axis is time, the y-axis splits detections between various receivers by which the tag was picked up

These fish spent a short amount of time at Station 2 (detections shown by white boxes) and made the transit to Station 4 within about 27 minutes. The fish spent approximately five minutes within range of Station 4 and were not detected again during the study period. A total of 58 out of the 80 tags detected (73%) showed this pattern of detections.

- Fish whose behaviour does not follow the above pattern. These fish are generally detected at the listening stations over a much longer period (weeks) of time than those exhibiting the simple transit behaviour. This group may include fish that have been eaten by predators (seals, porpoises, dolphins, birds). The Vemco VUE plot below (Figure 7.5.20) shows an example of the pattern of detections seen for this type of tag.

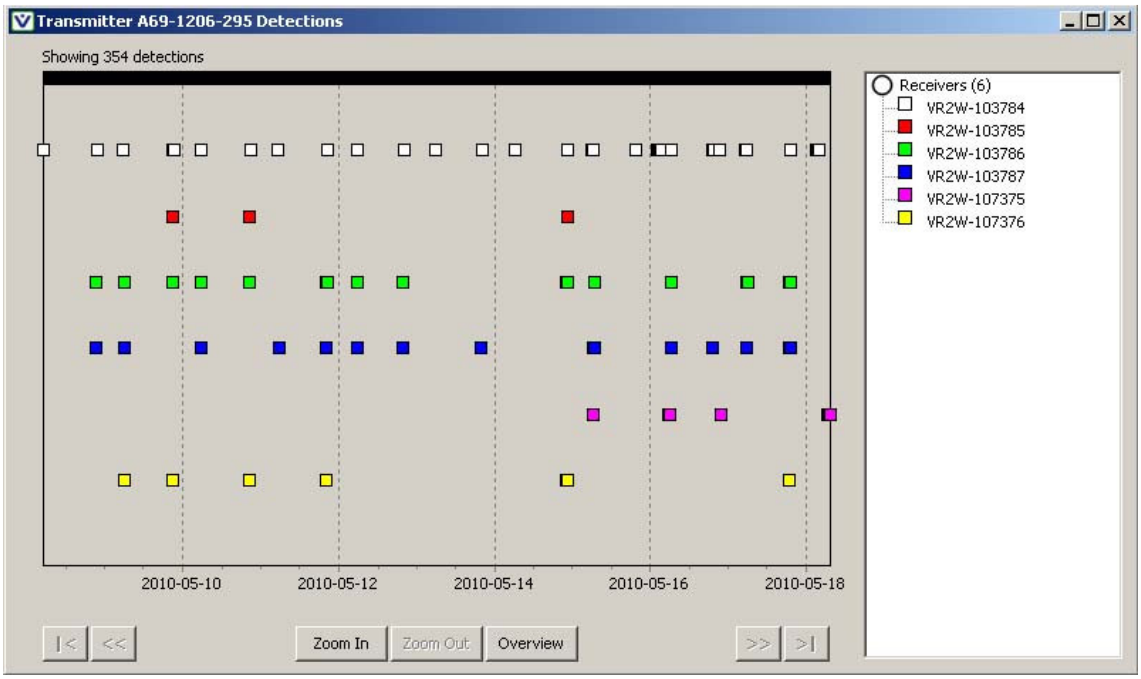


Figure 7.5.20 - Detection pattern of fish exhibiting 'aberrant' behaviour as represented in the Vemco VUE (software) plotted detections window for Tag 295. The x-axis is time, the y-axis splits detections between various receivers by which the tag was picked up

This plot covers a time period of approximately ten days (as opposed to approximately 35 minutes for the previous plot). The tag (# 295) was detected at Station 2 just outside the Harbour mouth (white boxes) fairly continuously over the ten day period covered by the plot. It was detected at Station 1 (in Lough Atalia) over the final three days during which detections were recorded for this tag. It was also detected at intervals at stations 3, 4, 5 and 6 during this time. A total of 10 out of the 80 tags detected (approximately 13%) showed this type of pattern of detections.

7.5.5.4.3 Tag detections

Figure 7.5.21 shows the time taken by the 77 fish detected at Station 2 to reach that station following their release at Nun's Island (*i.e.* their residence time in the River Corrib/ Claddagh Basin following release). The yellow horizontal lines mark intervals of 24 hours – five days. A total of 52 fish (67.5%) made the journey in 24 hours or less. A further 10 fish (cumulative 80.5%) were detected at Station 2 within 48 hours (1-2 days), a further 5 (87% cumulative) within 72 hours (2-3 days), an additional 5 (93.5% cumulative) within 96 hours (4-5 days) and the remaining 5 fish were detected in range of station 2 more than 4 days after their release time.

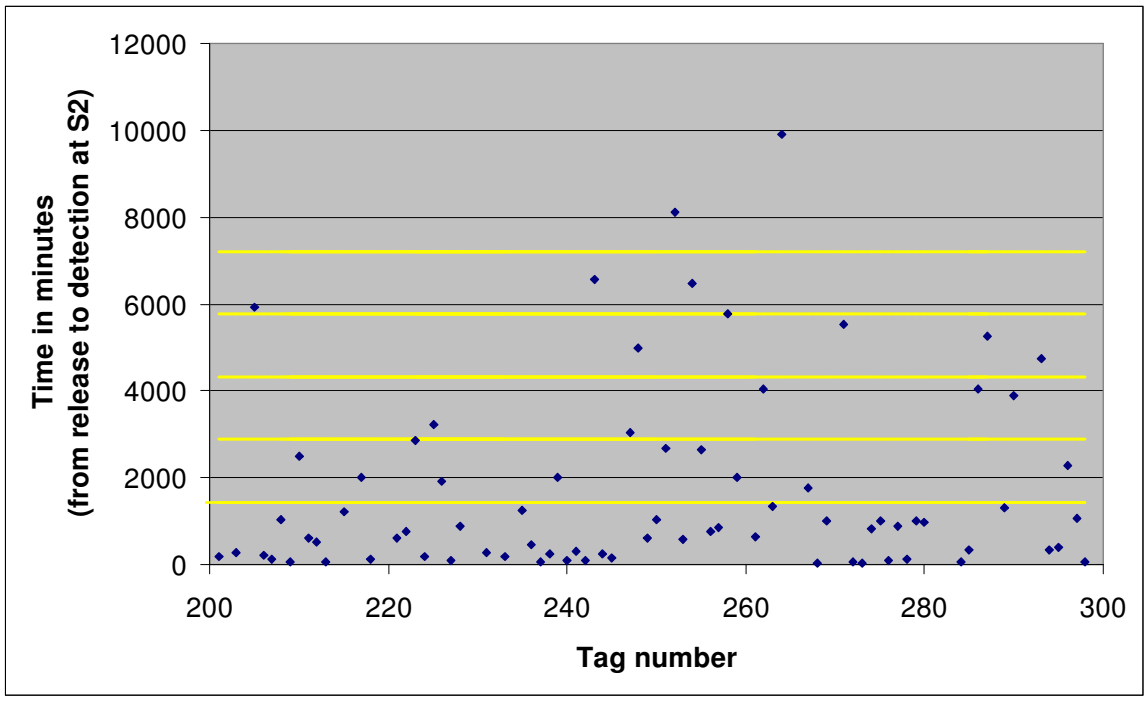


Figure 7.5.21 - Time taken by fish released at Nun's Island to reach Station 2 (77 tags detected). Yellow horizontal lines mark successive intervals of 24 hours following tag release – a total of five days are marked

Corrib/Claddagh Basins – Tag Detection Patterns

Tags detected post-release fell into two main categories (see Figure 7.5.22) in terms of tag detection patterns:

- Fish that were detected at Station 2, subsequently detected at one or more of the outer stations, generally within a reasonably short time frame (minutes to hours), and then not detected again during the study period (58 tags – 72.5% of detected tags)
- Fish that did not conform to the above pattern and were detected at many stations or at a single station only over a period of several days during the study period (10 tags – 12.5% of detected tags).

Two further groups of tags (Figure 7.5.22) were noted:

- Tags that were detected only at Station 2 (approximately 15% of detected tags)
- A single tag that was detected only at Station 7

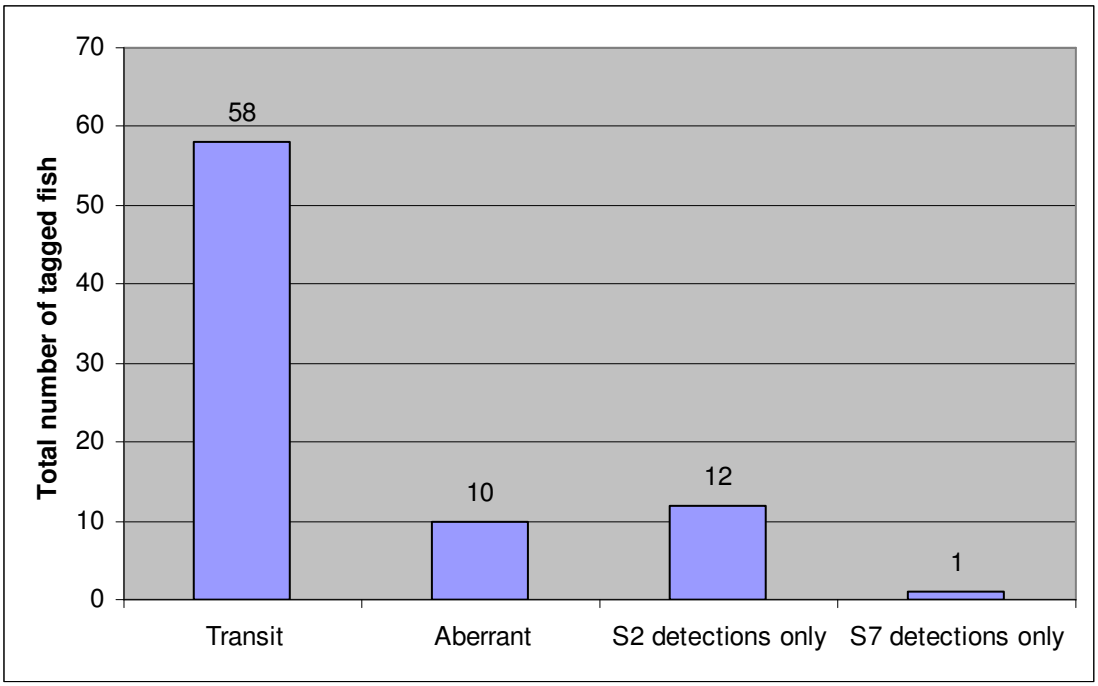


Figure 7.5.22 - Number of fish falling into various tag detection pattern categories

Galway Harbour Outer Receivers – Tag Transit Times

Figure 7.5.23 shows a plot of the time taken for fish to swim between Station 2 and the cordon of outer Stations (Stations 3-8). This represents a distance of approximately 1.25 – 1.75 km. Times were calculated by calculating the difference in minutes between the time of first detection of each tag at Station 2 and the time of final detection of the tag at the outer receiver stations (the lower yellow horizontal line in Figure 7.5.23 represents 1 hour, whilst the upper yellow horizontal line represents 1 day). The majority of transit times for tagged fish are clustered either side of the 1 hour mark, with a relatively much smaller number of fish taking substantially longer than this.

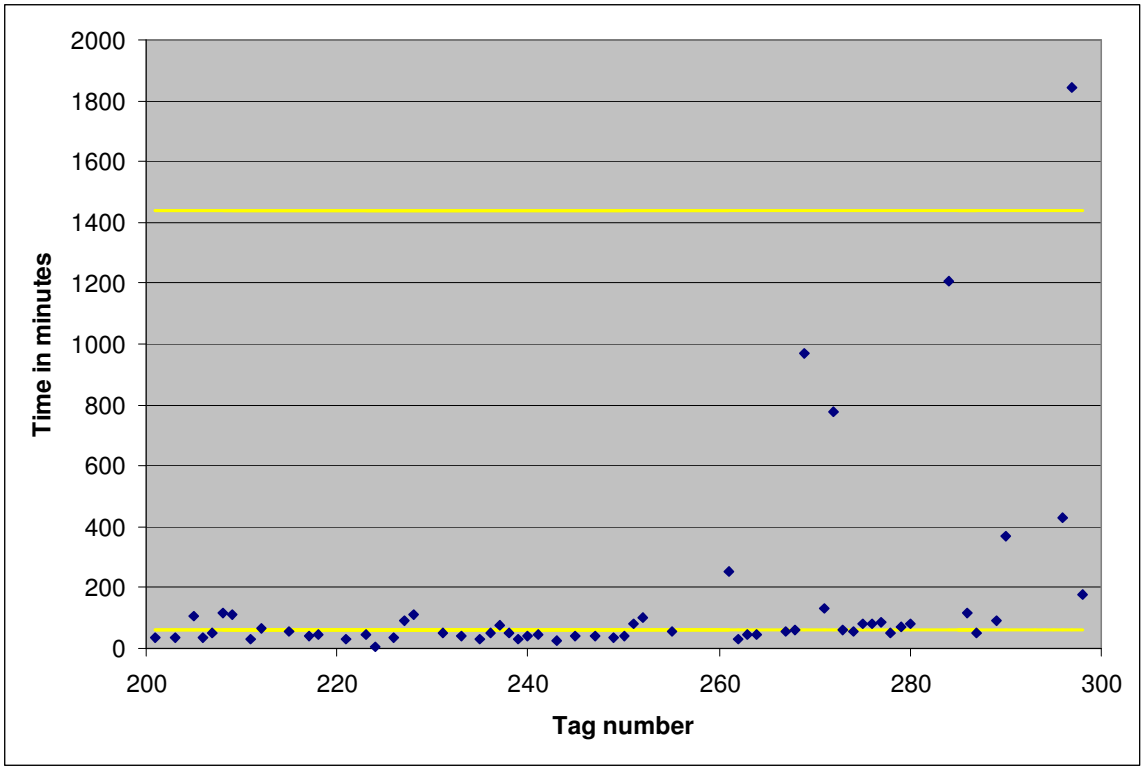


Figure 7.5.23 - Time taken for fish to swim between Station 2 and the outer stations. Time of first detection at Station 2 was taken as the start point and time of final detection at the outer station as the end of the duration of this transit time (the lower yellow)

ExistingTag Detections

Figure 7.5.24 shows the total number of tag detections at each receiver located along the outer cordon of stations in Galway Bay (Stations 3-8) during the smolt tracking period, and at Station 9 in the outer bay for tags displaying the more common 'transit type' behaviour recorded during the current study. Some tags were detected at more than one station on their exit of the harbour area – for example a fish may have swam between Station 7 and 8 and, due to the range overlap of the receivers, been detected simultaneously at both. This accounts for the total of transiting tag detections being greater than the total number of post release tags detected during the study.

Figure 7.5.24 gives a good indication of the areas most used by descending tagged salmon smolts in exiting the harbour during the current study. A total of 35 tags were detected between Stations 3, 4 and 5. A total of 54 tags were detected between stations 6, 7 and 8. A total of 2 tags were detected at Station 9 – one of the outer bay receiver stations between Black Rock and Grey Rock in the North Channel area.

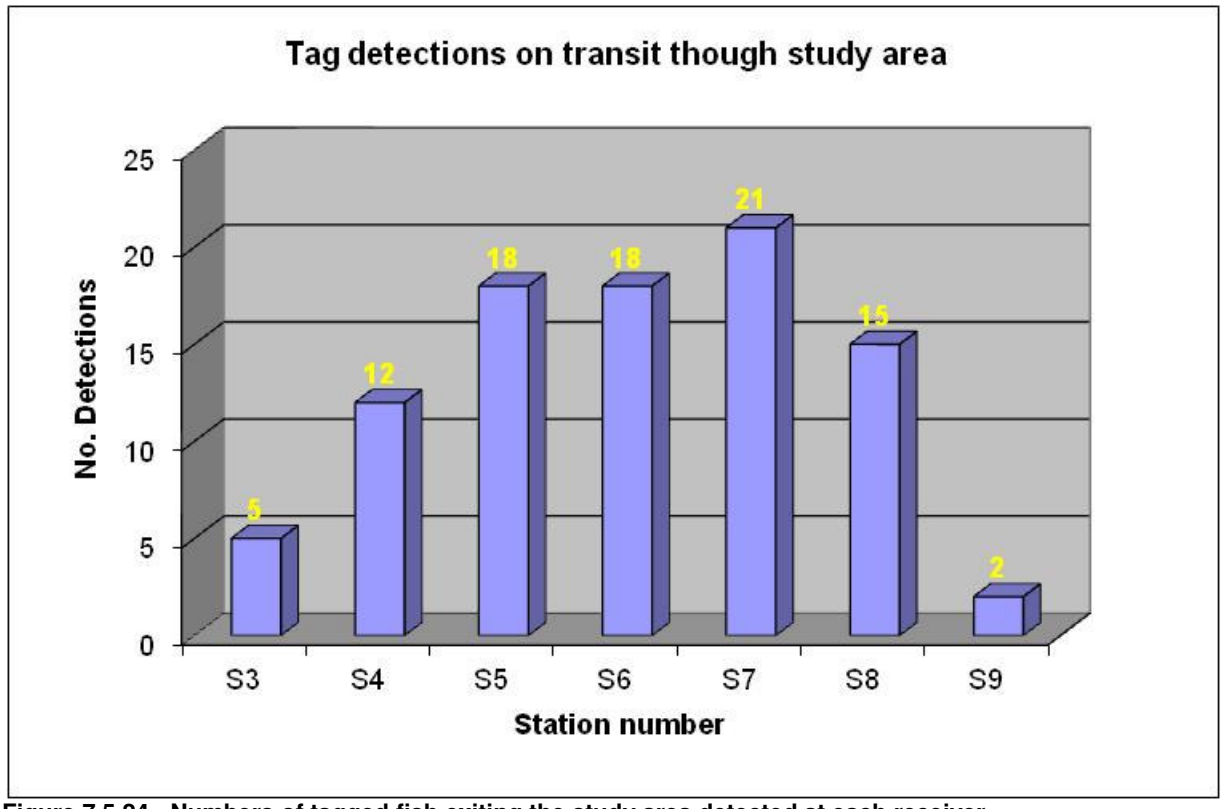


Figure 7.5.24 - Numbers of tagged fish exiting the study area detected at each receiver

7.5.5.4.4 Discussion

Tag Detections

A total of 80 tags out of the 94 released were detected during the study period. The fact that 14 tags were *not* detected may be attributed to a number of potential causes:

- Malfunction of 14 tags.
- Extended residence time - the tagged fish may have remained in the Corrib/Claddagh Basin throughout the duration of the study period and not come into range of the Station 2 receiver.
- Predation - the tagged fish may have been eaten by a predator and been removed from the study area before reaching the Station 2 receiver.
- Tag extrusion – the tag may have been extruded through the insertion wound and deposited on the river bed or bed of the Claddagh Basin before the fish reached the ranged of the Station 2 receiver.
- Tag collisions - "Collisions" happen when two or more tags transmit all or part of their pulse train at the same time. With such a large number of tags in such a small area, some collisions are almost inevitable. In an attempt to reduce this problem during the current study, tagged fish were released in batches over a number of days (instead of releasing all fish in a tagged group simultaneously).

The 3 tags that were detected at stations other than Station 2 but not at Station 2 are likely to be attributable to tag collisions. Tag 214 was detected only at Station 1 (the Lough Atalia receiver) over a period of approximately four days.

First Detection – Corrib/Claddagh Basin Residence Times

The longest residence time for a tagged fish in the Corrib/Claddagh Basin was approximately one week following its release. However, most of the tagged fish released into the river proceeded to move towards the sea in a shorter time than this. Just over two thirds of tagged fish

released into the river began their seaward movement in 24 hours or less. A total of 80.5% of released fish had been detected at Station 2 within 48 hours.

Note: All of these fish had undergone surgery, post surgery recovery and had been subjected to handling. In addition, each fish was carrying a relatively large, actively pinging foreign body (an acoustic tag) in its peritoneal cavity upon release. The effect of this treatment on fish behaviour is unknown. We can only assume that tagged fish behaviour roughly approximates to untagged fish behaviour.

Corrib/Claddagh Basin – Tag Detection Patterns

Of the two main categories identified in terms of tag detection patterns, it is assumed that the behaviour exhibited by those fish undertaking a relatively fast transit from Station 2 to one or more of the outer stations (72.5% of detected tags) represents 'normal' behaviour for descending Atlantic salmon smolts in the Corrib system. The pattern of tag detections seen in the 10 fish assigned to the 'Aberrant' group is assumed not to be representative of 'normal' migratory behaviour for Atlantic salmon. Some of these detection patterns may be attributable to a tagged fish having been eaten by a predator (with the tag continuing to transmit from inside the predators digestive tract) or to the effects of the tagging process and the presence of the tag on behaviour of the fish. It is also possible that the behaviour of these fish may represent the true behaviour of a small proportion of the migrating population.

Galway Harbour Outer Receivers – Tag Transit Times

Of those fish exhibiting 'normal' behaviour, the majority (approximately 87%) made the journey between Station 2 (the inner harbour mouth station) and the outer cordon of harbour receivers within, or around, one hour. A relatively much smaller number (approximately 13% of the total) of fish took substantially longer than this with only one fish taking longer than 24 hours.

Smolt Exit Paths – Proposed Development Footprint

The number of individual tags detected at each receiver in the outer cordon of receivers in the current study are shown in Figure 7.5.24. This gives a good indication of the paths taken by fish exiting the harbour area. Figure 7.5.25 below shows the approximate footprint of the proposed harbour development in relation to the locations of the inner bay cordon of acoustic receivers. The proposed structure would lie in the path taken by fish that, during the current study, exited the inner harbour area using the corridor covered by receivers S3, S4, S5, S6 and part of S7. This represents between approximately 60% and 83% of exiting individual tag detections. In effect, with the new pier structure in place, all descending smolts would now be concentrated into an area through which, prior to its construction, somewhere between 40% and 60% of descending individual tag detections were recorded. All fish will now pass between the area where S6, S7 and S8 were located.

Salmon smolt migration behaviour, once they reach the sea, is thought to be regulated by the track of the river plume in which they swim (Ford, Gargan and Rogers, Western Regional Fisheries Board, *pers. comm.*) and it is thought that swimming depths are in the top *ca* 2 m of sea (O'Farrell, *pers. comm.*). Thorstad *et al.,* (2004) reported that fish swam in directions that were independent of current flow. Based on the information presented (see Chapter 8 of the EIS for salinity modelling) on the track of the River Corrib plume and how variable it can be based on flow rate and prevailing wind and tidal conditions, smolts may swim out into the open sea in any direction between a line defined by the Mutton Island causeway to the west and the new pier to the east. Once the fish pass Mutton Island they can then swim westwards along the north shore of Galway Bay and swim out northwestwards to their feeding grounds in the North East Atlantic.

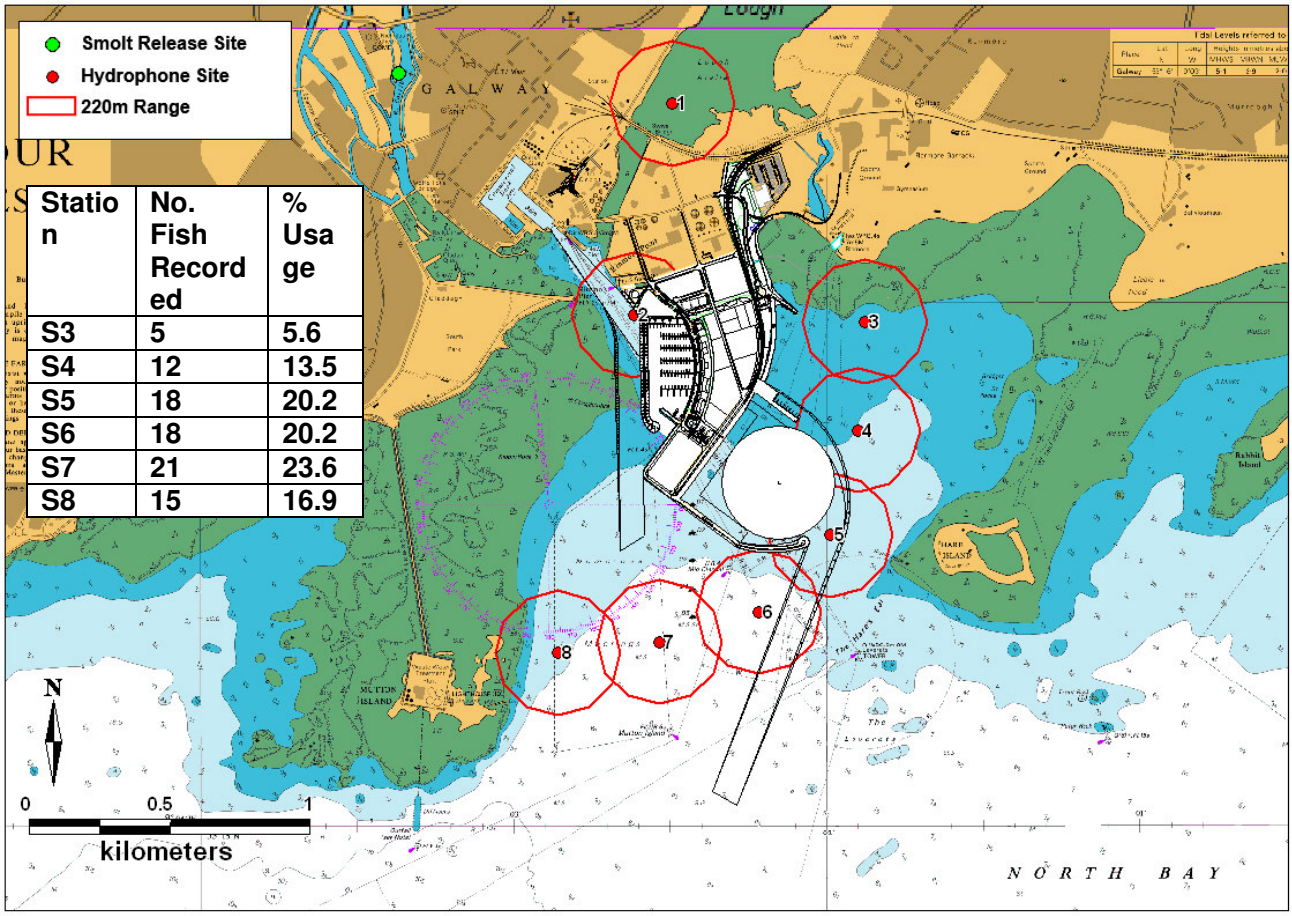


Figure 7.5.25 - Approximate footprint of the proposed harbour development at Galway in relation to the locations of the inner bay receiver stations

7.5.5.5 Timetable of important fisheries events

Based on the data collated regarding various significant fish and fishery species, the following calendar (Table 7.5.16) has been drawn up to show the annual timing of the various fish migratory movements in to and out of the River Corrib and of the spawning season for Shrimp.

Timing of important fishing events												
Event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Downstream Salmon smolt run			•	•	•							
Upstream Spring salmon run	•	•	•	•	•							
Upstream grilse run					•	•	•	•	•	•		
Upstream Sea Lamprey run					•	•						
Upstream elver run				•	•							
Downstream silver eel run	•									•	•	•
Shrimp spawning				•								

Table 7.5.16 Timing of Important Fisheries Events, River Corrib/Inner Galway Bay.

7.5.5.6 Fish Predation Surveys

7.5.5.6.1 Introduction

Cormorants (*Phalacrocorax carbo*) are common fish predators and occur in both marine and freshwater habitats. There is a breeding colony on Deer Island in Inner Galway Bay off the Clare coast (see Figure 7.5.26) and in April 2010, the colony was estimated at 110 occupied nests.

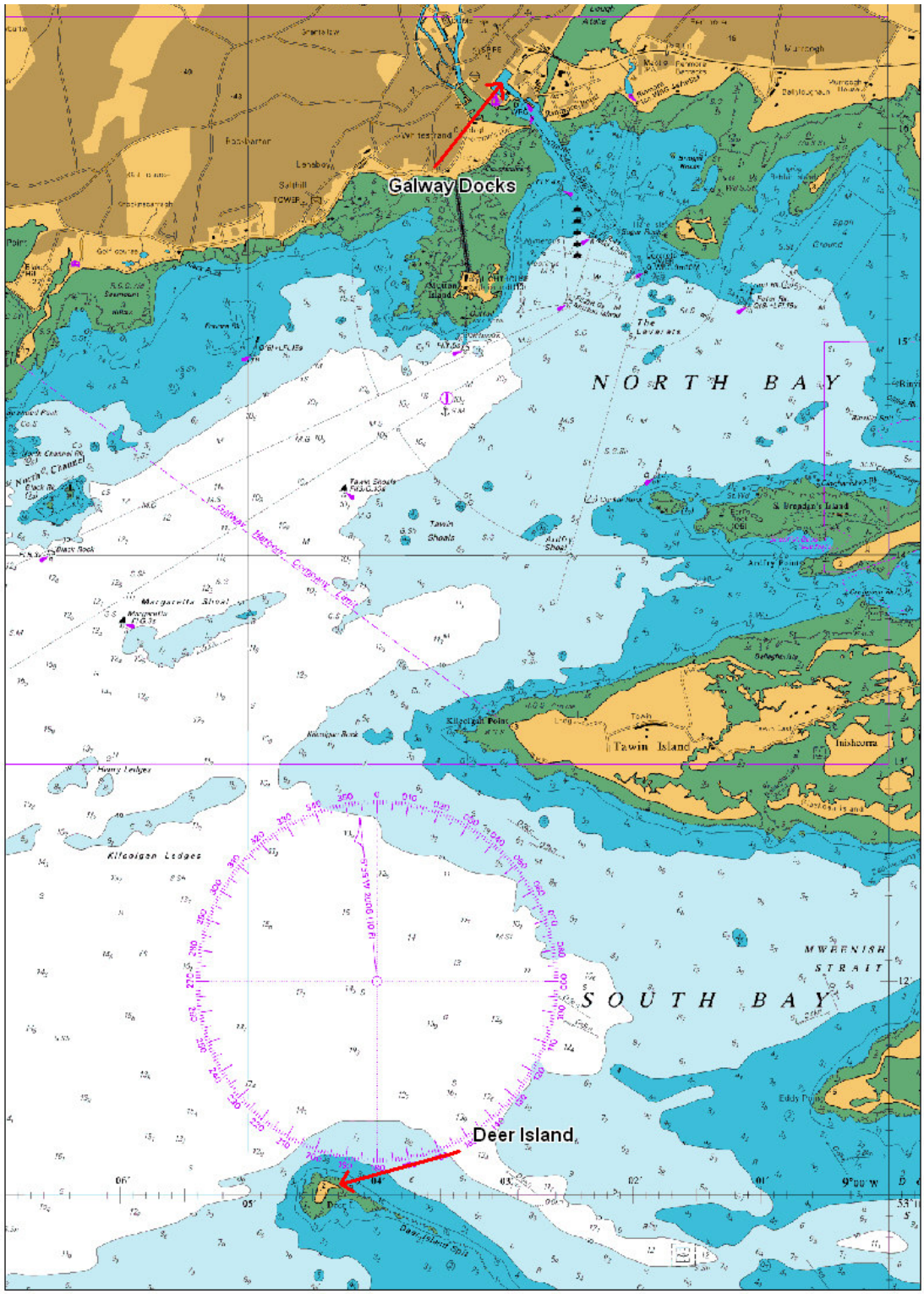


Figure 7.5.26 - Location of Deer Island in relation to Galway Docks

Cormorants have been identified as significant predators on Salmon smolts in certain fisheries (*e.g.* the River Bann) as the fish depart their mother rivers and head for marine feeding grounds. The migration period for Salmon smolts on the Corrib is well established and data on numbers of smolts running down the River Corrib for a number of years were reviewed.

Inland Fisheries Ireland (IFI) had concerns that the proposed development could impact smolt numbers by restricting the fish to a smaller area of sea water than they have access to at present and thereby increase likely contact with predators such as Cormorants and seals. A study was under taken to address this issue.

7.5.5.6.2 Methodology

The study took the form of the following elements:

1. Make regular observations in the vicinity of the proposed development area to record numbers of Cormorants and to observe birds to try to determine what they were feeding on. The opportunity was taken to make observations on numbers of seals present at the same time in the same area.
2. Visit the colony at Deer Island to estimate numbers of birds/nests.

7.5.5.6.3 Results

Numbers of Cormorants and Seals at the site

Figure 7.5.27 show the numbers of Cormorants recorded in the vicinity of the proposed development site during the period February '09 – May '13. Observations were made with x10 binoculars from the end on Nimmo's Pier and the duration of each observation period was 15 minutes. Observations were made between the layby and the new slipway within the Galway Enterprise Park and broad scale sweeps were made between the slip, Hare Island and Mutton Island in calmer weather. Maximum numbers (+50) were recorded between October 2010 to mid-January 2011 when there was a shoal of Spratt in the area while no birds were recorded on a number of dates throughout the survey period. Salmon smolts migrate out of the Corrib system during the months of March and April and Figure 7. 5.28 is a graph of smolt numbers that went to sea during the Spring months of 2010 and 2011. Comparison of the cormorant and the smolt numbers shows no correlation with periods of smolt migration through the area and indicate that in the Corrib Estuary, cormorants are not a significant predator on salmon smolts. From the observations made of birds overflying the area, it appears that Cormorants have a greater preference for feeding within Lough Corrib than in the estuary.

The length of each cormorant dive into water was *ca* 45 seconds and positive identification of prey items proved difficult with the only definite identification being Eel.

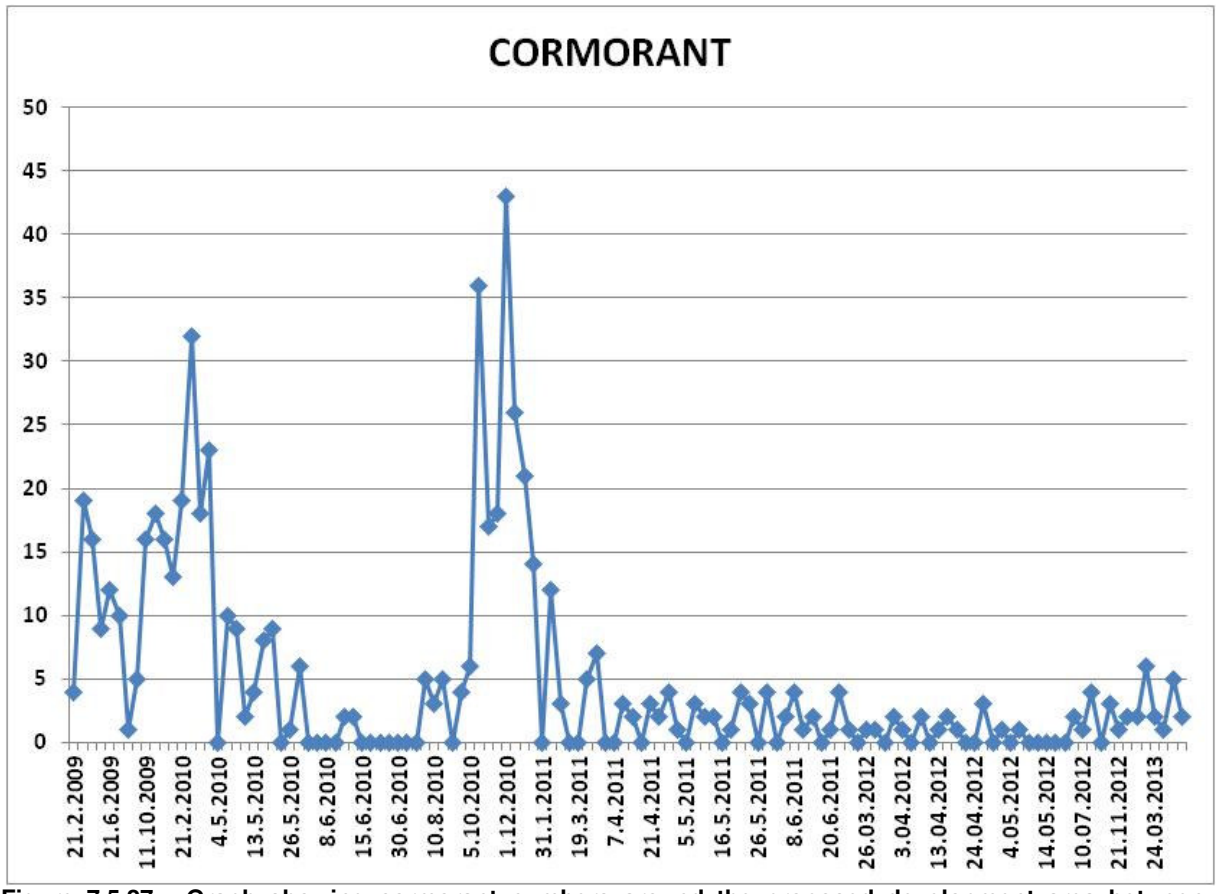


Figure 7.5.27 - Graph showing cormorant numbers around the proposed development area between February 2009 and May 2013

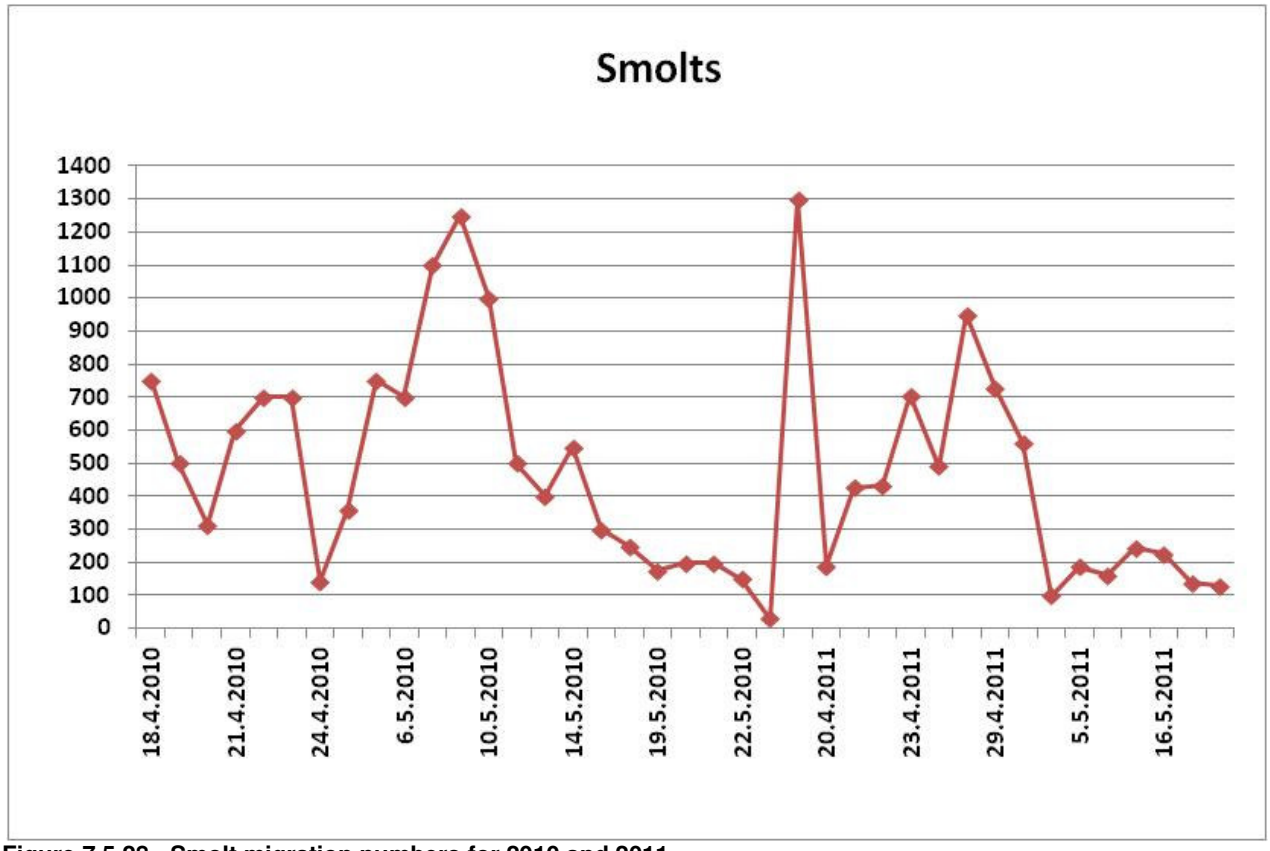


Figure 7.5.28 - Smolt migration numbers for 2010 and 2011

Salmon smolt migration numbers, recorded during April and May 2010/2011, can be seen in Figure 7.5.28. In 2010 the peak number of 1250 smolts was recorded on 8 May. 1301 smolts was the highest number recorded in 2011, being recorded earlier in the year on 19th April.

Figure 7.5.29 is a graphical representation of Seal numbers observed off Nimmo's Pier. The same field methodology as for sea Cormorants described above was used. When making the observations both at the mouth of the Corrib and during the sweeps between the Galway Enterprise Park, Hare and Mutton Islands, the observers also checked for cetaceans. A single dolphin was occasionally observed to the west of Hare Island. A picture of numerous seals photographed on December 1st 2010 is shown in Photo 5 of Appendix 7.14. As for Cormorants, maximum numbers coincided with the presence of shoaling Spratt between the period October 2010 to January 2011.Outside this period, seal numbers were low at the site and no seals were observed on several occasions. Comparison of the seal and the smolt numbers shows no correlation with periods of smolt migration through the area and indicates that in the Corrib Estuary, seals are not a significant predator on Salmon smolts.

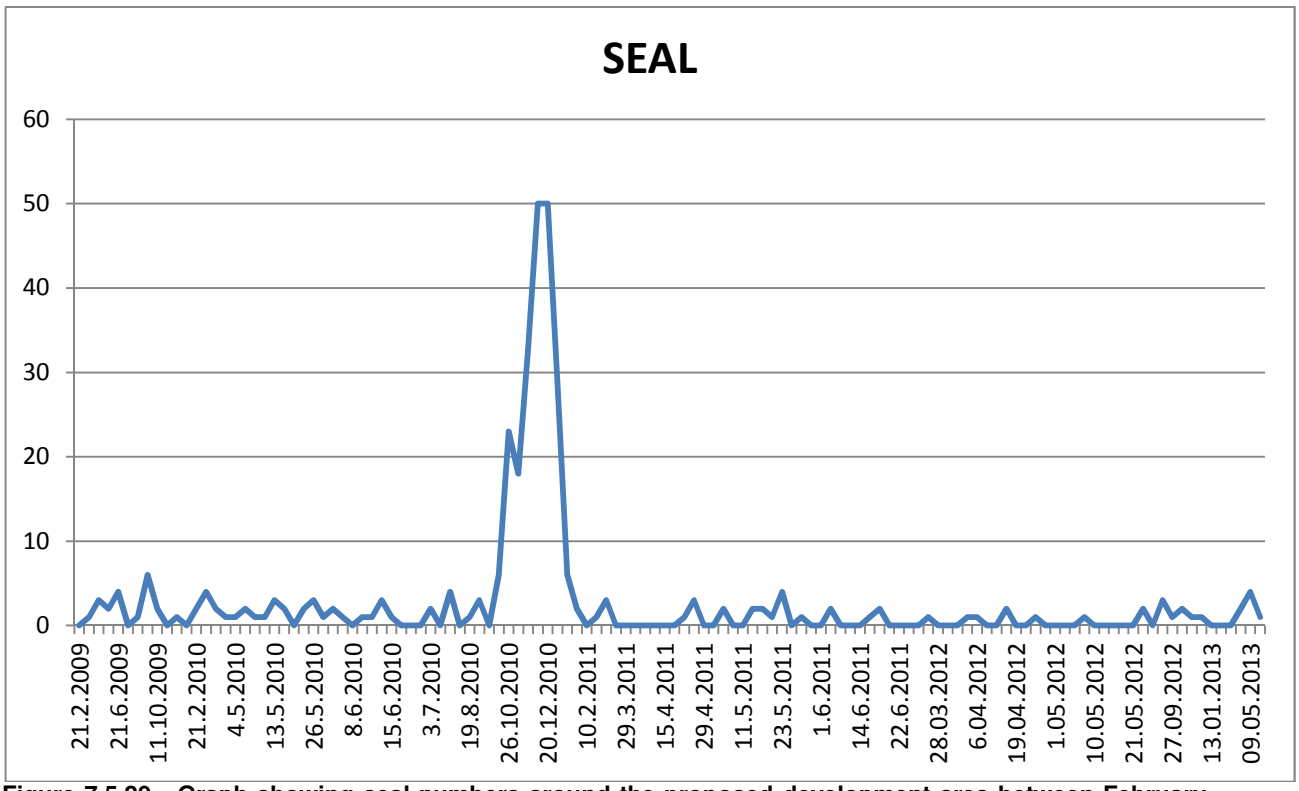


Figure 7.5.29 - Graph showing seal numbers around the proposed development area between February 2009 and May 2013

Visit to Deer Island

Deer Island was visited in June 2010 when the weather was sunny and calm. The colony occupies the western section of the island and the nests occur from the upper splash zone to the highest part of the island (see photos in Appendix 7.13). The population was estimated at *ca* 300 birds and 100 nests.

Cormorants retain hard parts of prey items in their stomachs: items such as fish bones, decapods carapaces and nereid jaws do not pass into the gut; this is to prevent damage to the intestine. These hard parts are regurgitated by the adult around the nest as a small, mucous enwrapped package. Regurgitates were present throughout the colony as rainfall levels during the preceding week had been extremely low (regurgitates are known to break up when exposed to rainfall). No microscopic analyses of the regurgitates was attempted but eel, perch and swimming crab were identified during examination by eye.

7.5.6 Birds

7.5.6.1 Desk Study

7.5.6.1.1 Designated Areas

The whole of the site of the proposed development is within the Inner Galway Bay Special Protection Area (SPA) for Birds. Drawing No. 2139-2105 shows the SPA area. This designated site includes the coastal areas from a point just to the west of Rusheen Bay, Barna, Co. Galway in an easterly direction around the bay to a point just to the west of Ballyvaughan Bay, Co. Clare. The marine boundary of the SPA can be said to be roughly equivalent to the five fathom (9.2 m) depth mark in the bay. The whole area is also designated under the Ramsar Convention on Wetlands of International Importance (Wetlands International Site No. 3IE030).

7.5.6.1.2 Bird Atlases

The principal sources of information regarding the distribution of breeding birds in Ireland are '*The Atlas of Breeding Birds in Britain and Ireland*' (Sharrock, 1976) and '*The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991*' (Gibbons *et al.*, 1993). Similarly, *'The Atlas of Wintering Birds in Britain and Ireland'* (Lack, 1986) is the most comprehensive work on wintering birds in Ireland.

These atlases show data for breeding and wintering birds in individual 10 km by 10 km squares. The site of the proposed development is very close to the boundary of two of these squares, M22 and M32. Accordingly, the atlases were searched for data from both squares. For breeding birds, data are included for species that could conceivably breed in the area, given that the site of the proposed development is located in the centre of Galway City. In the case of wintering birds, data are included for species of conservation importance mentioned in the NPWS synopsis for the Inner Galway Bay Complex cSAC and for those regularly recorded in the area during the Inner Galway Bay I-WeBS Count (see 5.4.3.3 below). The results for the breeding atlases are shown in Table 7.5.17 and the data for the wintering atlas is shown in Table 7.5.18.

Common Name	Scientific Name	Breeding Atlas 68-72	Breeding Atlas 88-91
Lapwing	*Vanellus vanellus*	Confirmed breeding	Evidence of breeding
Ringed Plover	*Charadrius hiaticula*	Confirmed breeding	Evidence of breeding
Snipe	*Gallinago gallinago*	Confirmed breeding	Evidence of breeding
Curlew	*Numenius arquata*	Probable breeding	Present in breeding season
Redshank	*Tringa totanus*	Confirmed breeding	Present in breeding season
Common Tern	*Sterna hirundo*	Confirmed breeding	Evidence of breeding
Arctic Tern	*Sterna paradisea*	Confirmed breeding	Evidence of breeding
Little Tern	*Sterna albifrons*	Possible breeding	-
Sandwich Tern	*Sterna sandvicensis*	Possible breeding	-

Table 7.5.17 Breeding Bird Atlas data.

Common Name	Scientific Name	Wintering Atlas 1981/82–1983/84 †
Red-throated Diver	*Gavia stellata*	8+
Black-throated Diver	*Gavia arctica*	1
Great Northern Diver	*Gavia immer*	6+
Pale-bellied Brent Goose	*Branta bernicla hrota*	16-330
Greenland White-fronted Goose	*Anser albifrons flavirostris*	13-64
Peregrine	*Falco peregrinus*	-
Golden Plover	*Pluvialis apricaria*	496+
Bar-tailed Godwit	*Limosa lapponica*	176+
Little Gull	*Larus minutus*	5+
† The numbers given in third column of Table 7.20		

† represent the number ranges of birds recorded in a day (defined as 6 hours) in the 10 km square M32 during the three Winters of the survey.

Table 7.5.18 Wintering Bird Atlas data.

The figure of 13-64 Wintering Greenland White-fronted Goose most likely refers to the traditional flock at Creganna, 7.4 km east-south-east of the site of the proposed development. This site falls just within square M32. Since the site is an inland one and the Inner Galway Bay I-W*e*BS count covers coastal sites (and a few areas very close to the coast), Greenland White-fronted Goose is not regularly recorded during these counts. Similarly, another species listed in Annex I of the EU Birds Directive and a widespread Winter visitor to Ireland, Whooper Swan (*Cygnus cygnus*), uses freshwater areas and is rarely recorded by Inner Galway Bay counts. A single Whooper Swan (probably sick or injured) was present with the Mute Swan herd at Nimmo's Pier from the 4th July 1999 to the 19th February 2000 (ten Cate & Peppiatt, 2004) and three were seen at the same place on the 23rd of October 2004 (per Galway Branch, BirdWatch Ireland).

7.5.6.1.3 Irish Wetland Bird Survey (I-WeBS)

The wintering bird populations of Inner Galway Bay have been comprehensively summarised by Whilde (1983) and Nairn *et al.* (2000). The area has been regularly counted since 1976 by the Galway Branch of BirdWatch Ireland. Originally, counts were carried out in January and March, but since 1980 a third count has also been carried out in November. The count area is divided into four sectors: from Barna to Oranmore Bay, from Oranmore to Clarinbridge, from Clarinbridge to Aughinish, Co. Clare and from Aughinish to the Rinn (a shingle spit on the western side of Ballyvaughan Bay, Co. Clare). This area is roughly equivalent to that of the SPA and the site was designated as such in the light of this accumulated count data. Count data for the site as a whole were incorporated into the all-Ireland Winter Wetlands Survey, which ran for three Winters from 1984/85 to 1986/87 (Sheppard, 1993). Since 1994/95 count data have been incorporated into the Irish Wetland Bird Survey (I-W*e*BS) and from January 2003 onwards the four count sectors were further subdivided in order to provide more detailed site count data. The site of the proposed development lies within the Barna to Oranmore Bay section of the count area and (for counts since January 2003) the counts from the Nimmo's Pier, Lough Atalia and Ballyloughaun sub-sections cover its immediate vicinity. This historic count information in addition to observational data from BirdWatch Galway Branch (as summarized in Appendix 7.13) were considered during the impact assessment process.

7.5.6.2 Birds in the Existing Environment

7.5.6.2.1 Resident and Summer Populations

The vast majority of the site of the proposed development currently lies below the high tide mark in Galway Harbour, the landward boundary being the rock wall established as part of the existing Galway Harbour Enterprise Park. As such, the birds that may be impacted by the proposed development will mainly be those associated with the intertidal zone or the waters of the Harbour itself (*i.e.* waders, gulls, terns, grebes, divers and wildfowl). Of the terrestrial bird species found in Ireland, only the Rock Pipit (*Anthus petrosus*) might be expected to breed in or close to a rock wall close to the high tide mark and this species does commonly breed in gaps in the masonry of both Nimmo's Pier and Galway Docks.

Sandwich Tern (*Sterna sandvicensis),* Common Tern (*Sterna hirundo*), Arctic Tern (*Sterna paradisea*) and Little Tern (*Sterna albifrons*) have all been known to breed in Galway Bay in the past. These four species are all listed in Annex I of the EU Birds Directive.

Common and Arctic Terns breed on islands in Lough Corrib and other lakes, or on those off the coast of Connemara and in the Aran Islands. Little Tern are known to breed in the Aran Islands, although there is a strong probability that there may also be a few pairs breeding on the Connemara coast west of Galway City. The nearest Sandwich Tern breeding colony (shared with Common Tern and Black-headed Gull) is at Gull Island in Corranroo bay, 13.6 km to the south-southeast of the site of the proposed development. The species is a common sight in the area during Summer and perhaps 5 to 10 individuals overwinter in Inner Galway Bay. The Common Tern breeding colony that was once to be found on the eastern side of Mutton Island was abandoned in 2003 and 2004. It is impossible to say whether or not this was due to the construction of the water treatment facility; it is claimed that terns can be fickle in their choice of breeding sites. Since the Summer of 2005, a Common Tern breeding colony of approximately 50-100 pairs (with perhaps a few pairs of Arctic Tern) has become established on nearby Rabbit Island, approximately 2 km to the east of the site of the proposed development.

Up to the 1970s, there used to be a Herring Gull (*Larus argentatus*) colony numbering several hundred birds on Rabbit Island, but a visit during that decade found large numbers of dead and dying birds (Neil Sharkey, pers comm.). It has been conjectured that these deaths may have been due to outbreaks of avian botulism. A survey during Summer 2004 revealed no definite records of breeding gulls on Rabbit Island or Hare Island. There is a small colony of Herring Gull that breeds on the tops of the higher buildings in Galway City and, in Summer 2009, Lesser Black-backed Gulls (*Larus fuscus*) were also recorded breeding in the same place.

There is a large Cormorant (*Phalacrocorax carbo*) breeding colony on Deer Island, approximately 9.7 km to the south-southwest of the site of the proposed development. This colony has remained comparatively stable at 200 – 300 nests (Whilde, 1990; Mitchell *et al.*, 2004). The most recent available count gave an estimate of 100 occupied nests (AQUAFACT, June 2010). It is highly unlikely that this colony would be affected by the proposed development, as long as anti-pollution and spill measures are strongly enforced.

Finally, the Claddagh area and Nimmo's Pier in Galway City are famous for their herd of Mute Swan (*Cygnus olor*). These birds keep mainly to the area close to the slipway at Nimmo's Pier, where people regularly feed them. Mute Swan are present in the area throughout the year, but there is no breeding in the immediate vicinity. Numbers build up during late July and August, when the adults undergo their post-breeding moult, may be more than 100 birds present at this time. Although Mute Swan are not considered to be of high conservation importance and most of the herd is usually found on the opposite side of the River Corrib mouth to the site of the proposed development, they are held in high esteem by many people and are strongly associated with this area of the city.

7.5.6.2.2 Wintering Populations

Although there are some breeding seabirds and waders in Galway Bay, both the species diversity and individual numbers of birds are much greater during the Winter months. There is a high tide roost of waders on the eastern end of Mutton Island. This was surveyed in 1991/92 and from 1998/99 to 2002/03, before during and after construction of a sewage treatment facility (Nairn, 2005). The mean peak counts of wader species recorded at this roost during the period from 1998 to 2003 were: Oystercatcher, 320; Ringed Plover, 243: Grey Plover, 5; Knot, 2; Sanderling, 1: Turnstone, 64; Dunlin, 465; Redshank, 75; Greenshank, 1; Bar-tailed Godwit, 324; Curlew, 221 and Snipe, 7.

Inner Galway Bay was ranked twenty-fourth in a list of 56 Internationally Important sites for wintering waterfowl in Ireland by Sheppard (1993). Forty species of birds are regularly noted during Winter counts, with perhaps twenty others being recorded less frequently. The SPA is considered to hold internationally important wintering numbers of Great Northern Diver (*Gavia immer*) and Light-bellied Brent Goose (*Branta bernicla hrota*), in addition to numbers of Cormorant (*Phalacrocorax carbo*), Shelduck (*Tadorna tadorna*), Wigeon (*Anas penelope*), Teal (*Anas crecca*), Shoveler (*Anas clypeata*), Red-breasted Merganser (*Mergus serrator*), Ringed Plover (*Charadrius hiaticula*), Golden Plover (*Pluvialis apricaria*), Lapwing (*Vanellus vanellus*), Dunlin (*Calidris alpina*), Bar-tailed Godwit (*Limosa lapponica*), Curlew (*Numenius arquata*), Redshank (*Tringa totanus*), Greenshank (*Tringa nebularia*) and Turnstone (*Arenaria interpres*) that are of national importance (Colhoun, 2001; Crowe, 2005).

7.5.6.2.3 Bird Migration in the Area

During both Autumn and Spring migration periods large numbers of birds pass through the area. In Autumn the waders and wildfowl that Winter in the bay arrive, but there is also passage of birds that will Winter elsewhere (*e.g.* waders that will Winter in countries further south, or in other parts of Ireland). In Spring, the reverse occurs, with waders and geese travelling northwards to Iceland, Greenland, Scandinavia and eastern Europe to breed and wintering gulls dispersing, while terns arrive from the south to breed in the area. There are often good passages of birds that are not present during the rest of the year, *e.g.* Whimbrel (*Numenius phaeopus*) and Pomarine Skua (*Stercorarius pomarinus*) in Spring.

7.5.6.2.4 Bird Survey Work at the Site of the Proposed Development

Most recent bird survey work data (designed to cover both the foreshore area and the marine area of the bay that will be directly affected by the construction of the proposed development) are presented in Appendix 7.13. This work consisted of watches from a vantage point above the foreshore of the current harbour park (*i.e.* from the area from which the reclamation of land out into the current harbour area is proposed) at E130500 N24595. The survey area consisted of the shoreline of the current harbour park (*i.e.* from Rinmore Point to just to the West of Renmore Beach), including all of the intertidal area that is exposed at low tide, and the marine area from this shoreline out as far as the end of Mutton Island and bounded by Mutton Island in the West and Hare Island in the East. This marine area is approximately 2.5 km^2 in extent at high tide.

Watches were carried out over the thirteen month period from March 2011 to March 2012. Initially, watches lasted three hours, but these were later extended to eight hours (effectively covering the whole day). In all, 18 watches were carried out, totalling 84 hours of observer effort. All states of the tide were covered. Watches were carried out in acceptable visibility conditions (minimum 2 km) and when the sea conditions were no worse than Sea State 4 (in most cases Sea State 2 or better). The optical equipment used was 8.5 X magnification Swarovski (Absam, Austria) binoculars and a tripod-mounted Swarovski telescope with a 20-60 X zoom lens.

In addition, six watches were made from a site at Traught Beach (Grid Ref.: E134130 N213900; West of Kinvara), 10 km SSE of the site of the proposed development. A marine area of equivalent size to that surveyed at the site of the proposed development was surveyed from

November 2011 to March 2012, with a total of 33 hours of observer effort. The purpose of these watches was to compare the numbers of divers using the marine area with those at the site of the proposed development.

A total of 31 bird species were recorded using the shoreline and marine area in the site of the proposed development. This included birds that were feeding or resting along the rock wall boundary of the existing harbour park and areas that were exposed at lower tides. Birds recorded as using the marine area were those that were either on or in the water (resting, roosting or feeding) or that were feeding from flight (*e.g.* plunge feeding Gannet and terns, shearwaters), but not birds that were merely flying through the area.

The list of bird species recorded comprises: Black-headed Gull, Brent Goose, Common Gull, Common Tern, Cormorant, Curlew, Forster's Tern, Gannet, Great Black-backed Gull, Great Northern Diver, Great-crested Grebe, Greenshank, Grey Heron, Guillemot, Herring Gull, Hooded Crow, Iceland Gull, Kittiwake, Little Egret, Mallard, Manx Shearwater, Mute Swan, Oystercatcher, Razorbill, Red-breasted Merganser, Redshank, Red-throated Diver, Sandwich Tern, Shag, Turnstone and Wigeon.

This list includes 13 of the 21 birds listed as Special Conservation Interests of the Inner Galway Bay SPA. In addition, five of the species recorded (Common Tern, Great Northern Diver, Little Egret, Red-throated Diver and Sandwich Tern) are listed in Annex I of the EU Birds Directive.

Four of the species recorded (Black-headed Gull, Curlew, Herring Gull and Redshank) are placed in the Birds of Conservation Concern in Ireland (BoCCI; Lynas *et al*., 2007) Red List as being of high conservation concern. However, all four species are placed in the Red List in respect of the conservation concern for Irish breeding (not wintering) populations. There is no suitable breeding habitat for any of these four species within the footprint of the site of the proposed development. There are no known breeding sites for Black-headed Gull, Curlew or Redshank in the vicinity of the site, while the nearest breeding colony of Herring Gull is on the tops of the higher buildings in the centre of Galway City (approximately 1 km North-west of the site of the proposed development).

The following thirteen species (that were not recorded at the site) - Goldfinch, House Martin, Jackdaw, Kestrel, Linnet, Magpie, Meadow Pipit, Pied Wagtail, Ringed Plover, Rock Pipit, Rook, Swallow and Twite - were recorded within the existing harbour park close to the site of the proposed development.

One or two Ringed Plover were occasionally recorded in the harbour park over the Summer months. One favoured breeding habitat for this species is gravel areas (on beaches or at the sides of rivers) and it is possible that a pair or two may breed in the gravel areas of the harbour park. Ringed Plover is a Special Conservation Interest for the Inner Galway Bay SPA, but as a wintering species, rather than as a breeding one.

A single Twite was recorded for eight minutes feeding on weed seeds in the existing harbour park close to the survey watch point on the 13th of January 2012. This species is part of the BoCCI Red List. Twite have been declining steadily in Ireland in recent years. Recent population studies have estimated a breeding population of only 54-110 pairs (McLoughlin & Cotton, 2008). The majority of these birds are found in Co. Mayo and in West Donegal, with smaller numbers in Counties Antrim, Galway and Kerry. Twite prefer upland heather-dominated areas and coastal areas, while they are usually coastal in winter. There is no confirmed breeding population of Twite in Co. Galway, although there may be a few pairs in the Clifden area. Twite have been recorded during Winter in the Harbour Park/Nimmo's Pier/Mutton Island area on 22 occasions since 2001, although some of these records certainly refer to multiple sightings of the same flock or group. The numbers are usually few (less than ten), although 22 were recorded at Nimmo's Pier on the 2nd of January 2003 and 21 were recorded at the same place on the 5th of November 2008. Further afield, there are occasional Winter records from Salthill, Rusheen Bay, near Kinvara, Connemara, the Aran Islands and Inishbofin.

The following nine species (that were not recorded using the site) - Arctic Skua, Bar-tailed Godwit, Dunlin, Leach's Petrel, Lesser Black-backed Gull, Merlin, Shelduck, Whooper Swan and Whimbrel - were recorded overflying the area. Leach's Petrel, Merlin and Whooper Swan are listed in Annex I of the EU Birds Directive.

A female Merlin was observed to fly south-eastwards out over Galway Bay from Mutton Island on the 19th of October 2011. On the same day, seven Whooper Swan were observed close to Mutton Island flying at height towards the South. A single Leach's Petrel was observed over the sea close to Mutton Island on the 22nd of September 2011. These observations were made during cetacean watches. Merlin are widely (though thinly) distributed around the coast during the Winter. There are a number of breeding pairs on the Connemara bogs West of Spiddal. Whooper Swan are widely-distributed in Co. Galway's wetlands during Winter; 783 birds were recorded in the county during the national census of January 2010. The only known breeding site in Ireland for Leach's Petrel is on the Stags of Broadhaven off the North coast of Co. Mayo. The birds spend most of their time in deep waters out of sight of land. They are rarely seen in Galway Bay, almost always after spells of strong westerly gales, which had indeed occurred in the days before the watch during which the bird was observed.

Birds using the site shoreline and intertidal area

Table 7.5.19 (below) shows the maximum recorded numbers of the bird species that were observed using the shoreline and intertidal area within the site of the proposed development during the watches that were held during the March 2011 to March 2012 period. The birds included are those that are listed as Special Conservation Interests of the Inner Galway Bay SPA, plus Little Egret (Birds Directive Annex I species) and the two wader species Greenshank and Oystercatcher. The maximum number of each species recorded using the site is shown alongside the maximum number for that species recorded during I-W*e*BS counts in the area corresponding to the Inner Galway Bay SPA over the Winter of 2011 – 2012 and the percentage of the I-W*e*BS maxima represented by the site counts is also shown.

Species	Max. count at site	I-W*e*BS max 2011-2012	% SPA total (from I-W*e*BS)
Black-headed Gull *	4	2115	0.2
Brent Goose *	16	1936	0.8
Common Gull *	2	1717	0.1
Cormorant *	2	194	1.0
Curlew *	2	672	0.3
Greenshank	1	55	1.8
Grey Heron *	2	136	1.5
Little Egret †	1	26	3.8
Oystercatcher	7	684	1.0
Redshank *	1	902	0.1
Turnstone *	19	393	4.8
Wigeon *	2	3564	<0.1

* = Special Conservation Interest of Inner Galway Bay SPA
† = EU Birds Directive Annex I

Table 7.5.19 Birds recorded using the site shoreline and intertidal, 2011 – 2012, compared with I-WeBS counts 2011-2012.

Table 7.5.20 (below) shows the same species and site maxima alongside the figure for one percent of the international population of the species (also known as the threshold for international significance, *i.e.* a site is of international importance for a species if 1% of the international population is present) after Wetlands International (2006).

Species	Max. count at site	1% International Population	% International Threshold
Black-headed Gull	4	20,000	<0.1
Brent Goose	16	260	6
Common Gull	2	16,000	<0.1
Cormorant	2	1,200	0.2
Curlew	2	8,500	<0.1
Greenshank	1	2,300	<0.1
Grey Heron	2	2,700	<0.1
Little Egret	1	1,300	<0.1
Oystercatcher	7	10,200	<0.1
Redshank	1	3,900	<0.1
Turnstone	19	1,500	1.3
Wigeon	2	15,000	<0.1

Table 7.5.20 Birds recorded using the site shoreline and intertidal, 2011 – 2012, compared with international thresholds.

Inspection of the results of the survey work for the shoreline and intertidal area at the site reveal that it is used by small numbers of waterfowl and waders. None of the species' maximum count numbers constitutes as much as 5% of the maximum recorded number for the 2011 – 2012 Winter season I-W*e*BS counts for the Inner Galway Bay SPA as a whole and none is more than a few percent of the relevant 1% international population threshold.

The maximum count for Turnstone (19) is equal to 4.8% of the maximum 2011 – 2012 season I-W*e*BS count for the SPA as a whole. However, the figure of 19 birds was the maximum obtained after 84 hours of survey (spread over 18 days) at one small site, whereas the I-W*e*BS count figures were obtained by the summation of counts made by groups of observers, each of which have to cover a number of sub-sites during a day's counting. The Inner Galway Bay SPA is counted on three occasions per Winter (in November, January and March). Since Turnstone is a species that is often found on rocky shores and that is often very difficult to count (birds may be behind rocks and boulders and may thus not be visible), it is likely that the numbers obtained from counts are an underestimate. Since this problem is more acute where particular sites are counted relatively quickly (*i.e.* due to the need to cover a number of sites in one day) on a small number of occasions, it is likely that the maximum figure of 19 birds recorded at the site of the proposed development is not, in fact, equal to as much as 4.8% of the number of Turnstone Wintering in the SPA as a whole. This is likely to be the case (although perhaps not to such an extent) when counts of most or all of the bird species that were recorded in the intertidal zone and in the marine area are compared with I-W*e*BS results.

The intertidal zone at the site of the proposed development is covered by boulders with attached brown algae (seaweeds), interspersed with muddy sand and shell shingle. In many ways this area is equivalent as bird habitat to rocky shore and it is used by small numbers of the wader species that would be expected in such habitat (*i.e.* Turnstone, Oystercatcher, Curlew, Redshank). Wader species that feed on exposed areas of mud, muddy sand or sand did not use the intertidal zone at the site for feeding, even though they are present in the immediate area. For example, numbers of Bar-tailed Godwit and Dunlin (sometimes with small numbers of Knot) feed on exposed sediment at Nimmo's Pier (on the other side of the River Corrib to the site and only approximately 300 m away) at low tide. None of these three species were recorded feeding at the intertidal zone at the survey site.

It is reasonable to state, therefore, that (by virtue of the relatively small size of the area and lack of significant numbers of birds using it) the intertidal zone at the site of the proposed development is not of significance as a feeding or resting area for birds within the Inner Galway Bay SPA.

Birds using the site marine area

The maximum numbers of bird species that were observed using the site marine area are shown in Table 7.5.21, below.

Species	Max. count at site	I-WeBS max 2011-2012	% SPA total (from I-WeBS)
Black-headed Gull *	69	2115	3.3
Brent Goose *	5	1936	0.3
Common Gull *	7	1717	0.4
Common Tern * †	4		
Cormorant *	6	194	3.1
Great-crested Grebe	8	84	9.5
Great Northern Diver * †	8	146	5.5
Red-breasted Merganser *	3	248	1.2
Red-throated Diver * †	2	19	10.5
Sandwich Tern * †	13		
Wigeon *	12	3564	0.3

* = Special Conservation Interest of Inner Galway Bay SPA
† = EU Birds Directive Annex I

Table 7.5.21 Birds recorded using the site marine area, 2011 – 2012, compared with I-WeBS counts 2011-2012.

Table 7.5.22 (below) shows the same species and site maxima alongside the figure for the 1% international threshold.

Species	Max. count at site	1% International Population	% International Threshold
Black-headed Gull	69	20,000	0.3
Brent Goose	5	260	1.9
Common Gull	7	16,000	<0.1
Common Tern	4	1,900	0.2
Cormorant	6	1,200	0.5
Great-crested Grebe	8	3,600	0.2
Great Northern Diver	8	50	16
Red-breasted Merganser	3	1,700	0.2
Red-throated Diver	2	3,000	<0.1
Sandwich Tern	13	1,700	0.8
Wigeon	12	15,000	<0.1

Table 7.5.22 Birds recorded using the site marine area, 2011 – 2012, compared with international thresholds.

The figures for the maximum numbers of birds recorded in the marine area at the site reveal that most species are not present at the site in numbers that are significant in terms of the SPA as a whole. While the maximum recorded numbers of Red-throated Diver, Great-crested Grebe and Great Northern Diver do equal a greater proportion of 2011 – 2012 SPA I-WeBS maxima (10.5, 9.5 and 5.5%, respectively); there is a strong possibility that this has been skewed to some extent by the differing degrees of observer effort when the site survey is compared with the

I-W*e*BS counts. No recent figures are available for the Summering populations of Common Tern and Sandwich Tern in inner Galway Bay. However, if 50 – 100 pairs of Common Tern are present at the Rabbit Island colony and perhaps 100 pairs of Sandwich Tern at the colony in Corranroo Bay, then minimum populations must be 100 – 200 Common and 200 Sandwich Tern.

Divers at the site and at the comparison site
Table 7.5.23 (below) shows the 2011 – 2012 I-WeBS count maxima for the three diver species, along with the maximum counts at the site of the proposed development and at the comparison site at Traught, with these figures also expressed (in parentheses) as percentages of the I-WeBS count maxima for the Inner Galway Bay SPA in the 2011 – 2012 Winter season.

Species	I-W*e*BS max 2011-2012	Max. count at site	Max. count at Traught
Black-throated Diver	8	0 (0%)	2 (25%)
Great Northern Diver	146	8 (5.5%)	25 (17.1%)
Red-throated Diver	19	2 (10.5%)	19 (100%)

Table 7.5.23 Divers recorded using the site marine area and the comparison site at Traught, 2011 – 2012, compared with I-WeBS maxima for the 2011 – 2012 Winter season

Both Great Northern and Red-throated Diver were recorded feeding in the site marine area, but Black-throated Diver was not recorded. As can be seen from Table 7.5.23, the maximum diver counts recorded at Traught were much higher than those recorded at the site marine area. This is in agreement with I-WeBS data from both the 2011 – 2012 I-W*e*BS season and from earlier winters, where the numbers of divers recorded on the southern side of Galway Bay have always been larger than those recorded on the northern side of the bay. No particular pattern or variation in the numbers of divers present at either site (*i.e.* with respect to state of the tide or time of day) was noted.

7.5.6.3 Species of Conservation Importance that use the Site and Surrounding Area

The following species that are listed in Annex I of the EU Birds Directive have been regularly recorded during the Winter Inner Galway Bay I-W*e*BS Count: Red-throated Diver (*Gavia stellata*), Black-throated Diver (*Gavia arctica*), Great Northern Diver (*Gavia immer*), Little Egret (*Egretta garzetta*), Peregrine (*Falco peregrinus*), Merlin (*Falco columbarius*), Golden Plover (*Pluvialis apricaria*), Bar-tailed Godwit (*Limosa lapponica*) and Little Gull (*Larus minutus*).

Red-throated Diver (*Gavia stellata*)
This species is a mainly Winter visitor to Ireland, although there is a small breeding population in Co. Donegal. From October to March it is not unusual for a few individuals to be recorded in the vicinity of Nimmo's Pier, Galway Docks, Lough Atalia and Ballyloughane beach.

Black-throated Diver (*Gavia arctica*)
Inner Galway Bay is the best place in Ireland to see this scarce Winter visitor. However, almost all records have come from the southern side of the bay, in the Clarinbridge to Aughinish and Aughinish to the Rinn stretches of the SPA.

Great Northern Diver (*Gavia immer*)
Inner Galway Bay plays host to the greatest numbers of this species present during Winter (Crowe, 2005). Ones and two can regularly be seen from South Park, Nimmo's Pier or Galway Docks. A few birds linger until April or May, by which time they have attained their breeding plumage. I-W*e*BS counts show that by far the highest numbers are found on the south side of Inner Galway Bay, in the Aughinish to Rinn count sector.

Little Egret (*Egretta garzetta*)
This species has been undergoing a range expansion within Europe in recent years. Since this species has only recently colonised Britain and Ireland, it did not feature in the last breeding and wintering bird atlases. The first recorded instance of breeding in Ireland was in 1997 and numbers have increased regularly since then (Hillis, 2003). Breeding has occurred in counties Cork, Waterford, Wexford and Wicklow; breeding was proven in Co. Galway at two sites outside the city in 2009, with a third being discovered in 2011. The maximum single count for a Co. Galway site is in excess of 50 birds and they are most commonly encountered at Roscam, the Rinville-Ardfry area, Rusheen Bay, Kilcaimin, Traught and Rossaveal (3.3, 4.7, 5, 7, 12.5, and 35 km respectively from the site of the proposed development). This species often breeds in company with Grey Heron (*Ardea cinerea*). There are no heronries that are likely to be impacted by the proposed development, the nearest large one being at Rusheen Bay, nor are any known Little Egret breeding sites likely to be impacted by the proposed development.

Peregrine (*Falco peregrinus*)
This species has increased in numbers in Ireland over recent decades, having largely recovered from declines caused by persecution and infertility related to pesticides like DDT. There are still risks from racing pigeon fanciers, egg thieves and from those who would try to steal eggs and young birds for sale to falconers, however.

Peregrines are seen quite regularly all around Galway Bay and they breed at coastal and mountain sites in north Co. Clare and in Connemara. The nearest known breeding site is probably that at a quarry more than 5 km to the north of the site of the proposed development.

Merlin (*Falco columbarius*)
This species is quite regularly seen around Galway Bay in Winter, when birds move from their breeding grounds to the coast, often preying on waders. There are a number of breeding pairs on the Connemara bogs west of Spiddal.

Golden Plover (*Pluvialis apricaria*)
This species is a Winter visitor to Inner Galway Bay, although small numbers nest on peatlands in Connemara west of Spiddal. The highest Inner Galway Bay I-W*e*BS counts are recorded from November to January. The average count in the Barna to Oranmore section for these months in the years 2000 to 2009 was 732 birds. This species is not found in the vicinity of the site of the proposed development. All of the birds recorded during 2003-2009 I-W*e*BS season counts in the Barna to Oranmore region were from Oranmore Bay and Rosshill, approximately 6.5 km to the east of the site of the proposed development.

Bar-tailed Godwit (*Limosa lapponica*)
This species breeds in Siberia and Alaska and is a common Winter visitor to the area. Notwithstanding this, a few non-breeding birds can be seen in any month of the year. The average count figure for the Barna to Oranmore section of the Inner Galway Bay I-W*e*BS count in the years 2000 to 2009 was 173, while the combined average for the Nimmo's Pier, Lough Atalia and Ballyloughane sub-sections was 44. These birds will have been counted from areas adjacent to Nimmo's Pier, Salthill, Lough Rusheen and Ballyloughane, rather than from the site of the proposed development where there is little suitable feeding habitat for wading birds.

Little Gull (*Larus minutus*)
Little Gull is a non-breeding visitor to Ireland. Madden & Ruttledge (1993) summarised the occurrence of this species in Galway from 1970 to 1991. Most records came from the Inner Galway Bay area. Traditionally the majority of birds have been recorded between December and March after westerly or south-westerly winds. The sewage outfall at Dun Aengus in the docks was once a favoured feeding site, but there have been fewer records since the Mutton Island sewage treatment plant came on line.

Common Tern (*Sterna hirundo*)
As mentioned above, there has been a breeding colony of approximately 100 pairs of Common Tern (with possibly a few pairs of Arctic Tern, *S. paradisaea*) breeding on Rabbit Island since the Summer of 2005, with approximately 50 pairs being present in 2010 and 35-50 pairs in 2011. The all-Ireland breeding population of Common Tern numbered just over 3,000 pairs during the last survey in 1995 (Hannon *et al*., 1997). Following increases in the numbers of pairs at East coast sites, the population is now estimated to be approximately 5,000 pairs (S. Newton, BirdWatch Ireland, *pers comm*.). Thus the breeding colony on Rabbit Island is significant, standing as it does at approximately 1-2% of the all-Ireland breeding population.

Sandwich Tern (*Sterna sandvicensis*)
There is a breeding colony of approximately 100 pairs on Gull Island in Corranroo Bay and this species can be seen commonly over much of the inner bay. Numbers (up to 100) sometimes rest at Rusheen Bay in late Summer. There is a small wintering population of perhaps 5-10 birds in the inner bay.

7.5.7 Mammals

7.5.7.1 Desk Study

7.5.7.1.1 Otter Records

Although not strictly a marine mammal, Otter (*Lutra lutra*) are often found on the coast as well as in lakes and rivers. Otter is listed in Annexes II and IV of the EU Habitats Directive and is a qualifying interest of the Galway Bay Complex cSAC. The species is shy and mainly nocturnal, but there have been many records of Otter in even the most densely-populated towns and cities of Ireland (Chapman & Chapman, 1982; Hayden & Harrington, 2000; Sleeman & Moore, 2005). Otter have been recorded relatively frequently in Lough Atalia and in the general area bounded by Mutton Island, the River Corrib mouth and the mouth of the Lough Atalia channel.

There have been a number of recorded sightings in the Galway Harbour area in recent years (per Galway Branch, BirdWatch Ireland and records available via the National Biodiversity Data Centre, NBDC) as outlined in Table 7.5.24, below.

Number	Site	Date
2	Lough Atalia	23rd of November 2003
1	Lough Atalia	29th of September 2004
1	Nimmo's Pier	30th of October 2004
1	Mutton Island	17th of December 2004
1	Nimmo's Pier	9th of November 2005
1	Mutton Island	10th of January 2008
1	Nimmo's Pier	20th of December 2011
1	Mutton Island Causeway	15th of June 2012 *
1	Nimmo's Pier	10th of September 2012
1	Rinmore Point	29th of September 2012 *
1	Mutton Island Causeway	19th of July 2013 *

Table 7.5.24 Records of Otter from Inner Galway Bay.
*** per NBDC**

7.5.7.1.2 Seal Records

Available records from seal sites in the Inner Bay based on various sources are compiled in Table 7.5.25, below.

Site	Observation	Source
Oranmore Bay	27 adult and 10 pup Common, 29th Jun 1989	Lyons, 2004
	67 Common, 15th Aug 2003	Cronin *et al*., 2004
	105 Common, 9th Sept 2009	NPWS, 2012
	22 Common, 23rd Oct 2009	C. Peppiatt
	21 Common, 9th Feb 2010	C. Peppiatt
	122 Common, 11th Aug 2010	NPWS, 2012
	159 Common, 18th Aug 2011	NPWS, 2012
Tawin Island	97 Common, 30th Nov 1988	Lyons, 2004
	170 Common, 12th Jan 2004	J. Gilleran, NUI Galway
Deer Island	4 adult and 6 pup Grey, 5th Oct 1983	Lyons, 2004
	125 adult and 10 pup Common, 28th Sept 1991	Lyons, 2004
	6 pup Grey, Sept/Oct 2005	Ó Cadhla, 2007
Kinvara Bay	63 adult and 39 pup Common, 8th June 1989	Lyons, 2004
	143 Common, 28th Sept 1991	Lyons, 2004
	100 Common, 16th Aug 2003	Cronin *et al*., 2004
	109 Common, 25th Aug 2009	NPWS, 2012
	113 Common, 27th Aug 2010	NPWS, 2012
	130 Common, 18th Aug 2011	NPWS, 2012
Rabbit Island	1 Common, 11th July 1979	Lyons, 2004
	11 Common, 23rd Oct 2009	C. Peppiatt
	5 Common, 17th April 2011	C. Peppiatt
	1 Common, 17th May 2011	C. Peppiatt
Point 900 m E Rinmore Point	5 Common, 17th April 2011	C. Peppiatt
Claddagh Beach, South Park	2 Common, 7th Nov 2009	C. Peppiatt
Tarrea Pier	40 Common, 8th Aug 1988	Lyons, 2004

Table 7.5.25 Historical counts from seal haul out sites in Inner Galway Bay

Harbour Seal is listed in Annexes II and V of the EU Habitats Directive and is a Qualifying Interest of the Galway Bay Complex cSAC.

7.5.7.1.3 Cetacean Records

A search of the IWDG's sightings database yielded some historical sightings of cetacean species in the Inner Galway Bay area. These are displayed in Table 7.5.26 below. The most commonly-recorded cetaceans in the harbour and inner bay area are Bottle-nosed Dolphin and Harbour Porpoise, although Short-beaked Common Dolphin (*Delphinus delphis*), Killer Whale (*Orcinus orca*), Minke Whale (*Balaenoptera acutorostrata*) and Long-finned Pilot Whale (*Globicephala melas*) have also been recorded. The number of sightings recorded by IWDG has increased in recent years; it is likely that is more an effect of increased interest and recording effort rather than of an increased local cetacean populations.

Date	No.	Common Name	Scientific Name	Site
15th Jul 1992	9	Long-finned Pilot Whale	*Globicephala melas*	Barna
2nd May 1997	12	Bottle-nosed Dolphin	*Tursiops truncatus*	Barna
13th Apr 2002	25	Bottle-nosed Dolphin	*Tursiops truncatus*	Salthill
24th Sept 2002	20	Bottle-nosed Dolphin	*Tursiops truncatus*	Silver Strand, Barna
29th Mar 2004	7	Bottle-nosed Dolphin	*Tursiops truncatus*	Spiddal
23rd Jan 2005	1	Harbour Porpoise	*Phocaena phocaena*	Galway Docks
31st May 2005	8	Bottle-nosed Dolphin	*Tursiops truncatus*	Salthill
29th June 2005	12 (2 calves)	Bottle-nosed Dolphin	*Tursiops truncatus*	Galway Bay
24th July 2005	7	Bottle-nosed Dolphin	*Tursiops truncatus*	Furbo
24th July 2005	3	Poss. Harbour Porpoise	*Phocaena phocaena*	White Strand, Galway
27th July 2005	2	Harbour Porpoise	*Phocaena phocaena*	Spiddal
31st Aug 2005	6	Harbour Porpoise	*Phocaena phocaena*	Spiddal
15th Nov 2005	2	Harbour Porpoise	*Phocaena phocaena*	Spiddal
25th Nov 2005	2	Harbour Porpoise	*Phocaena phocaena*	Spiddal
6th Mar 2006	11	Bottle-nosed Dolphin	*Tursiops truncatus*	Spiddal
12th Mar 2006	1	Bottle-nosed Dolphin	*Tursiops truncatus*	Tawin
9th May 2006		Common Dolphin	*Delphinus delphis*	Barna
13th May 2006	1	Harbour Porpoise	*Phocaena phocaena*	Spiddal
13th May 2006	1	Minke Whale	*Balaenoptera acutorostrata*	Spiddal
16th May 2006	3	Bottle-nosed Dolphin	*Tursiops truncatus*	Galway Docks
4th June 2006	5	Bottle-nosed Dolphin	*Tursiops truncatus*	Nr. Spiddal
8th June 2006	8	Bottle-nosed Dolphin	*Tursiops truncatus*	Spiddal
12th July 2006	20	Bottle-nosed Dolphin	*Tursiops truncatus*	Mutton Island
13th July 2006	8	Bottle-nosed Dolphin	*Tursiops truncatus*	Galway Docks
14th July 2006	20	Bottle-nosed Dolphin	*Tursiops truncatus*	Furbo
16th July 2006	9	Bottle-nosed Dolphin	*Tursiops truncatus*	Galway Docks
12th Sept 2006	4	Harbour Porpoise	*Phocaena phocaena*	Spiddal
3rd Nov 2006	3	Harbour Porpoise	*Phocaena phocaena*	Spiddal
17th Feb 2007	2	Harbour Porpoise	*Phocaena phocaena*	Spiddal
5th April 2007	4	Killer Whale	*Orcinus orca*	Spiddal
3rd April 2008	3	Bottle-nosed Dolphin	*Tursiops truncatus*	Blackrock, Salthill
26th April 2008	2	Bottle-nosed Dolphin	*Tursiops truncatus*	Salthill
1st May 2008	2	Bottle-nosed Dolphin	*Tursiops truncatus*	Island Eddy
9th May 2008	1	Harbour Porpoise	*Phocaena phocaena*	New Harbour, Galway Bay
23rd June 2008	1	Harbour Porpoise	*Phocaena phocaena*	Renville
3rd July 2008	1	Killer Whale	*Orcinus orca*	Nr. Tawin

Table 7.5.26 Recent sightings of cetaceans in the Inner Galway Bay area (per IWDG)

Date	No.	Common Name	Scientific Name	Site
25th July 2008	1	Killer Whale	*Orcinus orca*	Inner Galway Bay
7th Aug 2008	1	Poss. Harbour Porpoise	*Phocaena phocaena*	Salthill
29th Aug 2008	1	Bottle-nosed Dolphin	*Tursiops truncatus*	Salthill
28th May 2009	3	Harbour Porpoise	*Phocaena phocaena*	Tawin
31st May 2009	1	Poss. Harbour Porpoise	*Phocaena phocaena*	Kinvara Bay
22nd June 2009	3	Poss. Minke Whale	*Balaenoptera acutorostrata*	Tawin
1st Aug 2009	3	Bottle-nosed Dolphin	*Tursiops truncatus*	Nr. Barna
12th Aug 2009	2	Harbour Porpoise	*Phocaena phocaena*	Spiddal
1st Oct 2009	7	Bottle-nosed Dolphin	*Tursiops truncatus*	Spiddal
16th Oct 2009	3	Harbour Porpoise	*Phocaena phocaena*	Blackrock, Salthill
18th April 2010	1	Harbour Porpoise	*Phocaena phocaena*	Tawin
16th June 2010	2	Dolphin sp.		Oranmore
25th June 2010	1	Minke Whale	*Balaenoptera acutorostrata*	Tawin
9th Aug 2010	2	Whale sp.		Furbo
29th Aug 2010	4	Harbour Porpoise	*Phocaena phocaena*	Tawin
10th Oct 2010	2	Harbour Porpoise	*Phocaena phocaena*	Ballyloughane
16th Oct 2010	4	Harbour Porpoise	*Phocaena phocaena*	Tawin
5th Dec 2010	3	Harbour Porpoise	*Phocaena phocaena*	Tawin
21st April 2011	1	Dolphin sp.		Nr. Hare Island
25th Mar 2012	1	Poss. Harbour Porpoise	*Phocaena phocaena*	SE Rabbit Island
28th Mar 2012	1	Poss. Harbour Porpoise	*Phocaena phocaena*	Mutton Island
24th May 2012	3	Common Dolphin	*Delphinus delphis*	Nr. Island Eddy
7th of Aug 2012	2	Harbour Porpoise	*Phocaena phocaena*	Tawin
6th Oct 2012	2	Bottle-nosed Dolphin	*Tursiops truncatus*	Galway Docks
11th Nov 2012	4	Harbour Porpoise	*Phocaena phocaena*	Tawin
3rd June 2013	2	Harbour Porpoise	*Phocaena phocaena*	Tawin
10th July 2013	1	Harbour Porpoise	*Phocaena phocaena*	Furbo
10th July 2013	1	Harbour Porpoise	*Phocaena phocaena*	Mutton Island
All records are validated and available on www.iwdg.ie				

Table 7.5.26 contd/ Recent sightings of cetaceans in the Inner Galway Bay area (per IWDG)

Since March 2009, a lone Bottle-nosed Dolphin (christened 'Salty') has been regularly seen close inshore off Salthill (although the number of sightings have declined recently). The same animal is probably responsible for the large number of single animal sightings that have been recorded, not only in Salthill, but around Mutton and Hare Islands and as far east as Renville and south to Tawin, since it appeared (reported sightings of what is presumed to be this animal in these areas are numerous and they have not been listed in Table 7.5.26).

There are no records of recent live cetacean strandings in the area, but a search of the IWDG's strandings database showed that there have been 42 incidents (usually involving single individuals; on one occasion two) in the Inner Galway Bay area since 1970. It should be remembered that beached cetaceans may have drifted some distance since their death. The records are displayed in Table 7.5.27, below.

Date	No.	Common Name	Scientific Name	Site
19th Jun 1971	1 female	Harbour Porpoise	*Phocaena phocaena*	Barna
14th Aug 1972	1 female	Harbour Porpoise	*Phocaena phocaena*	Barna
23rd Sept 1974	1 male	Harbour Porpoise	*Phocaena phocaena*	Galway Harbour
20th Nov 1978	1	Long-finned Pilot Whale	*Globicephala melas*	Barna
15th Jun 1981	1 female	Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Galway City
6th Oct 1985	1 male	Pygmy Sperm Whale	*Kogia breviceps*	Silver Strand, Barna
Mar 1989	1	Short-beaked Common Dolphin	*Delphinus delphis*	Spiddal
15th Mar 1990	1 male	Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Spiddal
18th Mar 1992	1	Short-beaked Common Dolphin	*Delphinus delphis*	Clarinbridge
21st Sept 1997	1 male	Sperm Whale	*Physeter macrocephalus*	Loughaunrone, Oranmore
Jun 1998	1	Minke Whale	*Balaenoptera acutorostrata*	Salthill
25th Jun 2000	1	Pygmy Sperm Whale	*Kogia breviceps*	Eddy Point, Kinvarra
21st May 2001	2	Short-beaked Common Dolphin	*Delphinus delphis*	Silver Strand, Barna
1st Jan 2004	1 male	Short-beaked Common Dolphin	*Delphinus delphis*	Salthill
23rd Jan 2004	1 male	Long-finned Pilot Whale	*Globicephala melas*	Oranmore
5th May 2004	1	Long-finned Pilot Whale	*Globicephala melas*	Spiddal Pier
6th July 2004	1	'cetacean sp.'		Spiddal
9th Jan 2005	1	'Whale sp.'		Spiddal
8th Sept 2006	1	Bottlenosed Dolphin	*Tursiops truncatus*	Maree
13th Dec 2006	1	Short-beaked Common Dolphin	*Delphinus delphis*	Barna
7th Jan 2007	1	Short-beaked Common Dolphin	*Delphinus delphis*	Grattan Rd. beach, Salthill
13th April 2007	1	Short-beaked Common Dolphin	*Delphinus delphis*	Rinville, Salthill
5th Sept 2007	1	Harbour Porpoise	*Phocaena phocaena*	Renville Bay
6th Sept 2007	1	Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Kinvara Bay
22nd Sept 2007	1	Poss. Harbour Porpoise	*Phocaena phocaena*	Island Eddy
5th Dec 2007	1	Striped Dolphin	*Stenella coeruleoalba*	The Claddagh, Galway
24th Feb 2008	1	Harbour Porpoise	*Phocaena phocaena*	Rinville
14th July 2008	1	Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Clarinbridge
27th Feb 2009	1	Striped Dolphin	*Stenella coeruleoalba*	Ballyloughane, Renmore
1st March 2009	1	Poss. Harbour Porpoise	*Phocaena phocaena*	Kinvara Bay
3rd June 2009	1	'Dolphin sp.'		Island Eddy
2nd July 2010	1	Harbour Porpoise	*Phocaena phocaena*	Barna
7th March 2011	1	Harbour Porpoise	*Phocaena phocaena*	Barna

Table 7.5.27 Cetacean strandings in the Inner Galway Bay area since 1970 (per IWDG)

Date	No.	Common Name	*Scientific Name*	Site
9th Dec 2011	1	Harbour Porpoise	*Phocaena phocaena*	Salthill
29th Dec 2011	1	Short-beaked Common Dolphin	*Delphinus delphis*	Silver Strand, Galway city
27th Jan 2012	1	Bottlenosed Dolphin	*Tursiops truncatus*	Furbo
1st Feb 2012	1	Harbour Porpoise	*Phocaena phocaena*	Silver Strand, Galway city
17th Mar 2012	1	Cuvier's Beaked Whale	*Ziphius cavirostris*	Barna
31st Dec 2012	1	Short-beaked Common Dolphin	*Delphinus delphis*	Kinvara Bay
16th May 2013	1	Long-finned Pilot Whale	*Globicephala melas*	Silver Strand, Galway city
4th Sep 2013	1	Harbour Porpoise	*Phocaena phocaena*	Salthill
All records are validated and available on www.iwdg.ie				

Table 7.5.27 contd/. Cetacean strandings in the Inner Galway Bay area since 1970 (per IWDG)

Other species that have either been sighted or which have stranded in Galway Bay, but not in the Inner Galway Bay area are: Risso's Dolphin (*Grampus griseus*), Sowerby's Beaked Whale (*Mesoplodon bidens*) and True's Beaked Whale (*Mesoplodon mirus*). The greatest number of cetacean sightings in Galway Bay have been in the vicinity of the Aran Islands, although it is not possible to say if this is because the area represents the best cetacean habitat, or because of the number of boats that visit it.

7.5.7.2 Mammal Surveys

7.5.7.2.1 Otter Site Survey Results

The foreshore at the current Galway Harbour Park was surveyed for Otter at low tide on the 22nd of May 2011. There is a small amount of open shore at low tide that is a mixture of rocks, shell shingle and mud. On the landward side is the rock walling of the harbour park. Figure 7.5.30 (below) shows the character of this area.

Figure 7.5.30 - Foreshore at the Galway Harbour Park at low tide, 22.05.2011

No Otter were recorded during the site visit. The search of the foreshore did not reveal any signs of Otter (*e.g.* spraints, fish remains, couches or holts). The rock walling in this area varies between four and five m high and tide marks show that approximately the lower 3 m of same is inundated at high tide.

Otter often rest among rocks or seaweed at the coast and there is potential for individuals to do so in the area around the site of the proposed development (indeed they have been known to rest on the causeway to Mutton Island). The rock walling at the current harbour park foreshore consists of large boulders and there are large gaps and spaces between them. The nature of this rock walling (*i.e.* with open, draughty spaces unfilled by soil or sediment) and the fact that most of it is inundated by the sea at high tide means that its potential as a site for a regularly used holt (particularly a natal holt) is low.

Otter were recorded four times during survey work in the area of the site. One (probably an adult male) was recorded (for 12 minutes) during a cetacean watch on the 15th of December, feeding on Mutton Island. Another sighting was made (during surveys for seals in Lough Atalia) of one individual in the outflow channel of Lough Atalia on the 2nd of February 2012. Four Otter were observed (over a period of four hours and 32 minutes) on the 5th of February 2012 in the area of water from in front of Renmore Beach, along the front of the existing harbour park at Rinmore Point to the mouth of the River Corrib. This observation was made during one of the bird survey vantage point watches from near Rinmore point. The observer interpreted the observation to involve an adult male and female (possibly courting) and two younger animals (possibly the female's cubs from the year before). The area around Renmore Lough (*i.e.* behind the boulder ridge at the top of Renmore beach and around the lough) was investigated for signs of an Otter holt on the 7th of February 2012. A number of animal tracks were found close to the lough and Otter spraint was observed at multiple locations in the area. However, no signs of a holt were discovered and it seems likely that the Otter recorded in the area on the 5th of February were holting elsewhere. Finally, Otter were recorded by AQUAFACT staff in the port area on several dates in 2012 and 2013 up to time of going to print.

7.5.7.2.2 Seal Survey Results

Twelve monthly surveys of known seal haul-out sites in the area around the site of the proposed development were conducted in 2011-2012. Haul-out site surveys were conducted over the four-hour period lasting from two hours before low tide until two hours after low tide. The optical equipment used was 8.5 X magnification Swarovski binoculars and a tripod-mounted Swarovski telescope with a 20-60 X zoom lens. The haul out sites covered during this survey work were situated along the coastline of inner Galway Bay from the vicinity of the site of the proposed development eastwards and then South as far as known haul-out sites in Kinvara Bay and at Deer Island. Some sites were observed from the shoreline, while for others (*e.g.* Deer Island, Earl's Rock/St. Brendan's Island and the seaward side of Hare Island) observations were made from a rigid inflatable boat.

In addition, specific surveys (25 visits at all states of the tide) of Lough Atalia were conducted to survey for seals between November 2011 and May 2012.

Seal data are presented in Appendix 7.14; seal haul-out survey results, results from the Lough Atalia survey visits and observations made during bird and cetacean surveys are also included.

The haul-out survey work gave counts of between 31 and 169 Harbour Seal at or close to the eleven haul-out sites between Renmore and Deer Island. There was some variation, although the numbers were higher in the months before and after the birth of pups (June/July), with the lowest counts being made in the December – March period. On the 14th of July 2011, pups were recorded at the breeding sites in Oranmore Bay (8), Kinvara Bay (17) and Deer Island (6). Observations made during the vantage point watches for birds and cetaceans indicated that Harbour Seal are regular in the bird survey sea area (*i.e.* that around the site of the proposed development), although the maximum number recorded here was only two.

During the twelve haul-out surveys and 25 visits to Lough Atalia, Harbour Seals were recorded eight times, although they were also recorded incidentally on two occasions during I-W*e*BS counts. On most occasions single seals were recorded at Lough Atalia, although two were recorded on two occasions. The observations made indicate that Harbour Seal regularly visit Lough Atalia in small numbers (maximum two recorded) and can be seen at any state of tide, although they are unlikely to enter or leave Lough Atalia at low tide because of the rock sill at the mouth of the inlet. A small rock at the south-eastern end of Lough Atalia, close to the railway bridge, is used as a haul-out.

Grey Seal were recorded during three of the twelve monthly haul-out surveys, with the maximum number of individuals recorded being six. These Grey Seals were recorded at Goormeen Island in Kinvara Bay (12 km south-east of the site of the proposed development) and at Deer Island (8 km south of the site) only, they were not recorded in the harbour area.

During fish predation survey work from 2009 to 2012, AQUAFACT staff made counts of seals from the Galway Enterprise Park out as far as Hare Island and Mutton Island when sea conditions allowed (see Appendix 7.14). Large numbers (up to a maximum of 50 individuals) of Harbour Seal were recorded during the time when a spratt shoal was present in the area between October 2010 and January 2011. At other times, the counts were in single figures. This illustrates that seals are opportunistic feeders that can gather in unusual numbers to take advantage of events that provide large aggregations of prey, only to disperse when such an event finishes.

7.5.7.2.3 Cetacean Survey Results

From June 2011 until May 2012, twelve monthly 100-minute cetacean watches were carried out over the site of the proposed development. The IWDG standard protocol for monitoring inshore sites for cetaceans was followed. The vantage point used was the top of the Mutton Island lighthouse (Grid Ref. E129750 N223120, approximately 5 metres elevation). The optical equipment used was 8.5 X magnification Swarovski binoculars with 42 mm objective lenses and a tripod-mounted Swarovski telescope with a 20-60 X zoom eypepiece lens and an 80 mm objective lens.

The only occasions during the twelve watches on which cetaceans were recorded was during the watch of the 19th of October 2011. On this occasion two Harbour Porpoise were seen twice briefly travelling together in a south-easterly direction. The porpoises were first seen at a point approximately 800-900 m south-east of Hare Island and 800-900 m south of Rabbit Island (*i.e.* outside of the footprint of the proposed development).

Details of the cetacean watches are shown in Appendix 7.16.

Static acoustic monitoring for cetaceans was carried out under contract by IWDG. The final report of the IWDG on this work (authored by Dr. Joanne O'Brien and Dr. Simon Berrow) is included as Appendix 7.15 to this report.

The monitoring was carried out using a single underwater recording device called a C-POD (Chelonia Ltd., Mousehole, UK), moored close to the southern shore of Mutton Island (Grid Ref. 53° 15.022N, 9° 03.145W or E129920 N222695). The C-POD operates in a passive mode and records tonal clicks within a frequency range of 20kHz to 160kHz. Detection distance trials have suggested detection distances of approximately 400 m for harbour porpoise and 800 m for bottle-nosed dolphin. The positioning of the mooring was governed by water depth (the device does not work well in water depths less than 10 m, due to reflection of sound between the seabed and water surface) and the position of the harbour shipping channel. As a result, the vast majority of the proposed development site lies outside the area in which small cetaceans can be detected by the C-POD, but the results give an indication of the activity in the wider area surrounding the development site.

The C-POD data have been retrieved on eight occasions. These deployments have given 27 months (804 days) of data between the 28th June 2011 and the 4th of October 2013. Recording was continuous throughout this period, except for approximately 30 days that were lost in January-February 2012 due to the C-POD coming loose from its mooring.

The majority (over 90%) of the detections to date have been of harbour porpoise, while the remaining detections were of dolphin *spp.* (probably bottle-nosed and/or short-beaked common). Porpoises were recorded at the site on 84% of days monitored and dolphins on 32% of days monitored. Data recorded at the site showed that most porpoise detections were recorded during night time. This indicates that they are more active at the site during hours of darkness. An understanding of this activity could not have been determined if monitoring relied solely on visual means.

The dataset was explored for significant factors effecting presence such as season, diel, tidal phase and tidal cycle. Season was found to be a significant factor in porpoise presence with more detections recorded during the Autumn and Winter. There was a sharp decrease in detections between February-May 2012 and March-May 2013; this is consistent with previous results collected at Spiddal, where significantly more detections were recorded during the Autumn and Winter months, with detections dropping off during the Spring and rising again during the Summer (PReCAST Final Report, O'Brien *et al.*, 2012). Dolphin detections also showed a seasonal effect with more detections recorded during the summer and winter months.
Cetacean detections were recorded on from 67% to 91% of the deployment days, depending on the time of year of the deployment. The mean recorded Detection Positive Minutes (DPM) for harbour porpoise varied between 3.9 and 18.3 and the mean DPM for dolphins varied between 0.6 and 2.2, depending on the deployment and thus the time of year.

During marine investigation work at the site of the proposed development, a marine mammal observer (MMO) made approximately 82.5 hours of observations from a barge on eight days between the 10th and 22nd of March 2012. No cetaceans were recorded during this time. This lack of visual cetacean registrations corresponds with the C-POD detection data which has been cross-referenced with the times and dates of the MMO's observations.

The study showed that the wider area around the site of the proposed development is of some importance for small cetaceans, with almost daily presence having been recorded. The EU Habitats Directive Annex II species harbour porpoise is present in the area throughout the year.

7.5.7.2.4 Bat Survey Results

An ultrasound bat detector survey was carried out at the site over the night of the 13th and 14th of June 2011. A handheld Pettersson Elektronik AB (Uppsala, Sweden) D240x dual heterodyne/time expansion bat detector (with broadband coverage from 20 kHz to 120 kHz) was used. Sunset on the 13th of June was at 22:05 and sunrise the next morning was at 05:12. The dusk survey was carried out between 21:30 and 02:00 and a dawn survey was carried out between 03:30 and 05:45 the next morning.

The weather conditions were favourable for bat activity during the whole of dusk/dawn survey period, as there were only very light westerly breezes, no rain and the minimum recorded temperature was 7.6 ℃. There was no cloud cover at the beginning of the survey and it was not more than 10.5 ℃ at dawn and was therefore within the recommended Bat Conservation Ireland guidelines. The moon was at the waxing gibbous stage (*i.e.* about two days short of full) on the night of the survey. Low tide was at 22:11 (*i.e.* it was low tide at the beginning of the survey). The survey route was along the rock walling at the current Harbour Enterprise Park between Rinmore Point and Renmore beach.

During the course of the night's survey only six registrations of bats were recorded, three each of Soprano Pipistrelle (*Pipistrellus pygmaeus*) and Common Pipistrelle (*Pipistrellus pipistrellus*). The first registration was not made until more than 40 minutes after sunset and the last was more than four hours before sunrise. The behaviour observed was short periods of foraging, either by the lighting associated with the harbour enterprise park buildings, or (in one case) over seaweed at low tide on the shoreline. There was no indication of any roosting behaviour in the vicinity of the harbour enterprise park site investigated.

The two species of bats recorded are the two most numerous and frequently recorded in Ireland. They will forage at street lights where most other Irish bat species will avoid them and also feed along the tidelines of beaches in still conditions (presumably on winged insects associated with washed-up seaweed). However, bats will avoid exposed coastal areas on occasions when the winds are anything more than moderate.

Given the small number of registrations of bats made, the behaviour observed and the species involved, indications are that the site is not of significance for bats, only for small-scale foraging during calm weather. There was no indication that the proposed development will be likely to have any negative impacts on local bat populations and there was nothing to suggest that any further survey work would be necessary.

7.5.7.3 Species of Conservation Importance within the Site and Surrounding Area

Otter (*Lutra lutra*)
Otter is listed in Annexes II and IV of the EU Habitats Directive and is a qualifying interest of the Galway Bay Complex cSAC. The species is shy and mainly nocturnal, but there have been many records of Otter in even the most densely populated town and cities of Ireland (Chapman & Chapman, 1982; Hayden & Harrington, 2000; Sleeman & Moore, 2005). Otter have been recorded relatively frequently in Lough Atalia and in the general area bounded by Mutton Island, the River Corrib mouth and the mouth of the Lough Atalia channel.

Harbour Seal (*Phoca vitulina*)
Harbour Seal is listed in Annexes II and V of the EU Habitats Directive and is a Qualifying Interest of the Galway Bay Complex cSAC. These animals are often seen at the mouth of the River Corrib, close to Nimmo's Pier and they often come right into the dock area. Some individuals will even take fish scraps from fishermen. Harbour Seal can be generally said to be a common sight all around Galway Bay. There are no colonies of seals within the harbour itself. There are a number of seal haul-outs in the Inner Galway Bay area, however. There is a large colony on Tawin Island; this is not a breeding colony and the seals disperse in the Summer. There was a maximum count of 170 on the 12th of January 2004 (Jane Gilleran, *pers comm.*). The closest important site to that of the proposed development is at Oranmore Bay, a breeding colony of approx. 30-40 seals. There was a maximum count of 67 in Oranmore Bay on the 15th of August 2003 (Cronin *et al.*, 2004). However, Harbour Seal occasionally haul out on Rabbit Island (approximately 2 km from the development site) and on the Claddagh Beach by South Park (this site is within a few hundred metres of the development site, but seals are not often seen ashore here and the area is subject to disturbance caused by walkers and their dogs). A survey in August 2003 (co-ordinated by the NPWS) recorded 227 Harbour Seal and 7 Grey Seal in the Inner Galway Bay area (Cronin *et al.*, 2004).

Individual seals developed the habit of stealing Salmon from drift nets in both Galway and Sligo bays (McCarthy, 1985). There is considerable debate over the significance of the impact of predation by seals on Atlantic Salmon stocks. Carter *et al.* (2001) found that seal predation on large salmonids in estuaries in Scotland is apparently an order of magnitude less important than mortality caused by angling within the rivers.

The following additional species are considered of conservation importance, but are not qualifying interests of the Galway Bay Complex cSAC:

Grey Seal (*Halichoerus gryphus*)
Most of the sightings of Grey Seal in Co. Galway are from sites in west Connemara like the north-west Galway Islands, Slyne Head and Inishbofin. However, the following sightings have been recorded in the Inner Galway Bay area: 4 adults Illaunloo (Grid Ref. E122200 N211600), 15th July 1978; 1 adult Kilcolgan Point, 15th of July 1978; 4 adults and 6 pups Deer Island, 5th of October 1983 (Lyons, 2004); 6 pups Deer Island, September/October 2005. Grey Seal is listed in Annexes II and V of the EU Habitats Directive.

Short-beaked Common Dolphin (*Delphinus delphis*)
Short-beaked Common Dolphin is listed in Annex IV of the EU Habitats Directive. This species was to be seen regularly in small pods off Salthill, occasionally coming in quite close to Nimmo's Pier. These observations are not recorded in the IWDG sightings database and have apparently ceased in the last 5-10 years. Most recent records in the Galway Bay area have been west of Spiddal or around the Aran Islands, where pods of up to 65 in number have been recorded and large 'super-pods' have been recorded in Irish waters (including one of approximately 700 animals recorded in Clifden Bay, Co. Galway).

Bottle-nosed Dolphin (*Tursiops truncatus*)
This species is listed in Annexes II and IV of the EU Habitats Directive. Bottle-nosed Dolphins have been recorded near Galway Docks, near Mutton Island, Salthill and Barna. Normally single animals or pods of less than ten are seen, although the maximum recorded was a pod of 25. Since Spring 2009 a lone individual has repeatedly been sighted off Salthill and it is likely that this is the individual involved in frequent recent sightings near Mutton Island, Hare Island and Renville. This animal has been christened 'Salty' and there are fears that it could become habituated to humans.

Harbour Porpoise (*Phoceana phoceana*)
Harbour Porpoise is listed in Annexes II and IV of the EU Habitats Directive. This is a small species (maximum 1.9 m in length) that is visible at the water surface only briefly when it breathes. It generally avoids humans, does not follow boats/ships and so can be difficult to see. In recent years 1-3 individuals have occasionally been recorded at Renville, Galway Docks, Tawin and in the Salthill area.

7.6 SIGNIFICANCE OF HABITATS AND SPECIES

7.6.1 Significance of Habitats

Annexed Habitats within the site of the proposed development are described below:

Mudflats and sandflats not covered by seawater at low tide (1140) – It is an Annex I habitat located within the footprint of the development but its occurrence there is not exclusive to that area. The area represents ca 0.1% of the total Galway Bay cSAC.

Reefs (1170) – It is an Annex I habitat located within the footprint of the development but is present throughout the SAC. The reef habitat lies within the area of mud flat listed above.

NPWS describes the intertidal community at the proposed development site as "fucoid-dominated intertidal reef complex", these two habitats are considered together.

Lough Atalia and Renmore Lough are designated in the Conservation Objectives for Galway Bay cSAC by NPWS (2013 see appendix 7.1) as a lagoon. Lagoons are priority habitats as defined in the EU Habitats Directive, described as being in danger of disappearing and therefore requiring protection. In 2007 the conservation status of Lough Atalia was assessed as 'Unfavourable- Bad' with problems of eutrophication and pollution, the threat of urbanisation, dumping and silting up. A major problem is the water quality at the site (Oliver, 2007).

The diversity of terrestrial habitats within the site is poor and much of the area has been or is still subject to human disturbance. None of the plants that are found in this area of particular conservation significance, some of them being introduced or escaped alien species. There are no annexed terrestrial habitats within the site of the proposed development.

7.6.2 Significance of Flora

All marine flora recorded at the proposed development site are common species throughout Ireland and NW Europe. None are regarded as rare or sensitive. None are listed in the EU Habitats Directive.

None of the terrestrial plants that are found in this area are of particular conservation significance, some of them being introduced or escaped alien species.

7.6.3 Significance of Fauna

All marine benthic faunal species recorded at the proposed development site are common throughout Ireland and NW European intertidal habitats. None are regarded as rare or sensitive. None are listed in the EU Habitats Directive.

Due to the naturally high physical and salinity variations in the area where the proposed development is to take place, there are no sensitive invertebrate species present and the habitat type can be found through Irish inshore waters.

Otter is listed in Annexes II and IV of the EU Habitats Directive and is a qualifying interest of the Galway Bay Complex cSAC. No sign of an Otter holt was recorded during a dedicated survey of the area and it is considered that the conditions on-site mean that its potential as a site for a regularly used holt (particularly a natal holt) is low.

Harbour Seal is listed in Annexes II and V of the EU Habitats Directive and is a Qualifying Interest of the Galway Bay Complex cSAC. There are no colonies of seals within the harbour itself. There are a number of seal haul outs within the Inner Galway Bay, most notably at Tawin Island and Oranmore Bay.

7.7 POTENTIAL IMPACTS AND MITIGATION

7.7.1 'Do Nothing' Impact

Long Term Slight Positive Impact
The 'do nothing' impact of the proposed development in the short term will be that the current nature and commercial activities of the existing Galway Harbour will remain at the same level as at present. In the longer term, it is possible that the number of ships using the port will decline because of difficulties for large ships in docking at certain states of the tide and because of a lack of facilities. From an ecological point of view this may have a positive impact in that the amount of ship disturbance could decline and the potential for spillages/pollution from ships in the bay may decrease. However, any such impact would be slight or imperceptible in that there are no visible problems from disturbance, and pollution incidents have not been significant.

7.7.2 Impacts on Designated Sites

Impacts on designated Natura 2000 sites have been dealt with in greater detail within the Natura Impact Statement which is an attendant document of this EIS. A summary is provided below:

While there is potential for minor short-term disturbance impacts on fish, birds and aquatic mammals during the construction phase, best practice and specific mitigation measures will avoid permanent significant negative impacts of migratory fish, seal and bird colonies and also minimise any impact on the local populations of the same biota. The avoidance of significant

disruption to fish migration through the vicinity of the site will mean that any disturbance effects will be insignificant for the sites as a whole, since disturbance will be limited to the site and to a relatively small area around it. Known seal and bird breeding colonies are outside the area that will be affected by construction or operating disturbance.

There is potential for some injury or disturbance to Atlantic Salmon, Sea Lamprey, Harbour Seal, Otter and small cetaceans during construction, but this will be mitigated by the timing of the works and by precautionary monitoring before and during works (*e.g.* blasting works will be suspended if porpoises or dolphins are seem in the vicinity) and these impacts are not considered significant. No significant impacts on fish and mammals are predicted during the operational phase. No impacts on Annex I bird species are predicted.

Modelling exercises carried out as part of the EIS indicate that there will be minor increases in velocities west of the new structure. These will cause fine seabed sediments to move south on a line between Mutton Island and Deer Island, an area that already consists of similar sediments. This change is considered as insignificant. The model also predicts changes in current direction and these changes are also considered as insignificant. The model also predicts that salinity levels will rise east of the new structure. This is considered as a positive impact as species that are intolerant to depressed salinities may colonise the seabed. There will be short term increases in suspended solids loading that will arise from dredging operations but predicted levels are at least two orders of magnitude lower than natural storm levels. The model predicts that these will be localised to around the dredger. Benthic fauna will recover within one year of completion of dredging.

Galway Bay Complex cSAC: As the proposed construction site is at the mouth of the River Corrib, it experiences significant daily and seasonal salinity, temperature, flow and suspended solids variations. Due to the shallow nature of the water in the area, the seabed naturally re-suspends during storms increasing the suspended solids loading. The shipping channel has been in existence for the last *ca* 150 years and regular maintenance dredging activities have not significantly impacted the functioning of the inner parts of Galway Bay. Furthermore, the area has been historically receiving organically enriched Corrib water for tens of decades and this has affected sediment chemistry characteristics and therefore also in fauna characteristics. The impact of the development as indicated by model output will only affect the area in the immediate vicinity of the new structure, an area that is already significantly impacted. It is therefore considered that the project as proposed will not significantly affect the functioning of the overall cSAC.

The total area taken up by the proposed development will be 26.93 ha, in the marine environment, where the change will be irrevocable. An annexed habitat within the marine footprint of the development correspond to only *ca* 0.16% of the overall area of the cSAC and would not be considered of high quality relative to other areas within the bay. The area to be taken up by the proposed development and the area disturbed by dredging will total 78.71 ha, corresponding with 0.56% of the cSAC. No annexed terrestrial habitats will be redeveloped within the cSAC. There is some potential for disturbance to Otter and Harbour Seal during construction. Mitigation by safety procedures regarding the occurrence of blasting, possible seal deterrent devices and (to some extent) the timing of blasting will avoid a significant impact. The removal 26.93 ha of feeding and foraging marine habitat for 2 qualifying interest special of the cSAC *i.e.* Otter and Seal is permanent and indeterminate; applying the precautionary principle, this is regarded as significant.

Inner Galway Bay SPA: The total land area taken up by the proposed development will be approximately 26.93 ha, in the marine environment, where the change will be irrevocable. The loss of this area of SPA is permanent and indeterminate; applying the precautionary principle, this is regarded as significant.

Lough Corrib cSAC: There will be no land take and no emissions within the cSAC. There is some potential for disturbance to Atlantic Salmon and Sea Lamprey migrating past the site of the

proposed development during construction, but this will be mitigated by the timing of the relevant works (*i.e.* blasting and dredging).

7.7.3 Impacts on Terrestrial Communities

7.7.3.1 Impacts on Terrestrial Communities during the Construction Phase – Habitat Loss Permanent Slight Positive Impact

The terrestrial part of the site of the proposed development is small (less than 10%) in comparison to the development area as a whole. Most of the redevelopment of the harbour enterprise park will involve works on existing roads, or will affect areas covered by habitats that are not of importance (*e.g.* spoil and bare ground or recolonising bare ground). An area of 0.29 ha of scrub (not an annexed habitat) will be lost on the existing railway embankment in the making of the proposed rail connection.

Mitigation: Loss of terrestrial habitats will be mitigated through the proposed planting plan and landscaping scheme which incorporates a planting of native planting of 5.44 ha. The residual associated impact is therefore considered a permanent slight positive impact.

7.7.4 Impacts on Marine Communities

7.7.4.1 Impacts on Marine Communities during the Construction Phase – Habitat Loss Permanent Significant Negative Impact

Approximately 0.16% of the cSAC/SPA marine habitat will be lost through the construction of the harbour extension. It is comprised of mud/sandflats and reef habitat described by the NPWS as a "fucoid-dominated reef community complex." The quality of these habitats in that section of Galway Bay are poor due to a long history of organic enrichment, fluctuating salinities, resuspension due to storms and maintenance dredging. Reclamation of land as part of the construction of the proposed development constitutes a direct and irreplaceable loss of 29.79 ha of habitat for marine plants and invertebrates of which 5.93 ha is represented by the fucoid-dominated reef community complex which is a qualifying interest habitat for the cSAC.

Mitigation: It is not possible to mitigate for the loss of subtidal habitat. Loss of intertidal habitat will be mitigated for by the construction of new quay wall and rock armouring (see below).

7.7.4.2 Impacts on Marine Communities during the Construction Phase – Habitat Creation *Permanent Moderate Positive Impact*

Approximately 76,000 m^2 quay wall and break water will be created as part of this project. Recent research (Firth *et al.,* 2010) on textured and engineered *e.g.* the introduction of pits, crevasses, holes *etc*, cement blocks for use in coastal protection in the U.K. has shown that this gives rise to greatly increased rates of settlement of both flora and fauna. This will more than compensate for the 550 m of current man-made rock wall coastline that will be covered.

Mitigation: None required.

7.7.4.3 Impacts on Marine Communities during the Construction Phase – Habitat Loss of Dredge Area

Short-term Moderate Negative Impact
Initial dredging of the approach channel and turning areas will cause the loss of bottom-dwelling in fauna, making them temporarily unsuitable for bottom feeding fish. The proposed dredge area is 46.48 ha. This is a temporary impact as recolonisation will commence immediately post-dredge. The original community and biomass will re-establish after *ca 2 years*. Dredged areas

will experience sediment import from the River Corrib flow and will require periodic *(ca* every 10 years) maintenance dredging.

Mitigation: None possible.

7.7.4.4 Impacts on Marine Communities during the Construction Phase – Physical Damage of Destruction Caused by Underwater Blasting

Temporary Potentially Moderate Negative Impact
The detonation of explosives under the sea generates a percussive shock wave that passes through the water, often travelling for great distances. The thermal and explosive effects of a sub-surface detonation are limited to the immediate vicinity of the explosion and the shock wave is the primary cause of damage to aquatic life. When blasting is carried out to remove rock, the explosives are detonated in boreholes within (and not at the surface of) the rock. The potential impacts on marine animals include direct physical damage (*e.g.* internal injury auditory damage/deafness in fish and marine mammals), indirect physical damage (*e.g.* sound-induced formation of bubbles that could cause 'the bends' in deep-diving species), perceptual impacts (*e.g.* the interference of the blasting sound with echolocation or intra-species communication), behavioural impacts (*e.g.* avoidance of the blast area), stress (*e.g.* induction of physiological effects such as increased heart and respiratory rates) and indirect effects *(e.g.* the reduction of prey availability) (Gordon *et al*., 1998).

Mitigation: None possible.

7.7.4.5 Impacts on Marine Communities during the Construction Phase – Physical Damage of Destruction Caused by Pile Driving

Permanent /Moderate Negative Impact
Fish are sensitive to noise and vibration and construction activities could cause avoidance reactions and possibly delay fish migration. Nedwell (cited in Solomon, 2001, p. 32) suggested that an avoidance reaction may be induced at distances of up to 2 km from pile driving works. Driven sheet piles are a component of the construction of the proposed development. The piles would be secured into bedrock that had previously been drilled and blasted. Investigations into the noise produced by oil drilling platforms has shown that drilling can produce infrasound at approximately 5 Hz at levels in the range 119-127 dB at distances from 9 to 61 metres from the drilling rig (Vella *et al*., 2001), within the range of the sound sensitivity of salmon (Hawkins and Johnstone, 1978), so there may be some localised effect on migrating Salmon. It should also be stated that the drilling and blasting required for the placing of sheet piles for the proposed development would be a short-term operation and that any environmental impacts caused by drilling noise would also be short-term, therefore.

Mitigation: None possible.

7.7.4.6 Impacts on Marine Communities during the Construction Phase – Physical Damage of Destruction Caused by the Noise of Dredging

Temporary Slight Negative Impact
Dredging can be characterized as a continuous, tonal, low frequency noise source. Richardson *et al*. (1995) recorded peak noise levels of 178 dB at 160 Hz, with an overall source level of 185 dB during dredging operations. There are various types of equipment used for marine dredging. Capital dredging is often carried out using back hoe rock dredgers. Dredging of sediments can be achieved with grab or clamshell dredges (these lift bucketfuls of silt onto waiting barges), with hopper dredges (these ships pass over the dredge site sucking sediments into an internal hopper via trailing dragheads), or with transfer dredges (moored or anchored ships which transfer sediments onshore or into barges via a suction pipe). It is proposed that 1,815,000 cubic metres

of soft sediment will be dredged-up using a cutter suction dredger as part of the proposed development. It is estimated that this work will take 18 weeks to complete. In some of the areas where a greater depth is required some rock will have to be removed. This will be achieved by blasting, followed by the removal of the blasted rock with a back hoe dredger.

Richardson *et al*. (1995) noted that two different vessels operating as transfer dredges produced different sound levels, but that the noisiest of these was at most only as noisy as the quietest of the hopper dredger whose noise levels were also checked. Westerberg (1982), while acoustically tracking adult salmon moving through coastal waters in the Baltic, found that they passed within 100-150 m of working dredgers without hesitation. At ranges of less than 100 metres form the dredging, contact with the ultrasonic transmitter was lost due to the intense background dredge noise, but the Salmon passed without any appreciable delay and "seemed essentially unaffected by the dredging at even closer range". A number of Dutch bucket-dredgers were working sand and gravel in the area; no measurements were made of the dredging sound (Dr. Håkan Westerberg, Fiskeriversket, National Board of Fisheries, Sweden, pers comm.).

Using available information and current suggested best practice (Southall *et al*., 2007) it has been calculated that the impact threshold distances for physical damage caused by dredging (worst case scenario for backhoe dredging) at the site are up to 128 metres for fish (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up to 32 metres for fish (based on a 5 minute exposure at that distance).

Mitigation: None possible.

7.7.4.7 Impacts on Marine Communities during the Construction Phase – Adverse Impacts caused by Shipping

Permanent Neutral or Imperceptible Negative Impact

The hearing of salmon is restricted to frequencies below approximately 380 Hz and hearing sensitivity drops off steeply above 150 Hz (Hawkins and Johnstone, 1978). Knudsen *et al*. (1992, 1994) observed strong avoidance reactions from salmon smolts in response to underwater noise. These reactions were to low frequency noises at 10 kHz, while minimal reactions were shown to higher frequency noises at 150 kHz. These workers conducted experiments using pure sine waves, rather than more complex noises like boat noise.

However, Nedwell (cited in Solomon, 2001, p. 31) presented data showing that the noises produced by ships are low frequency (below 50 kHz), in the range with greatest behavioural impact for salmon. Moore and Ives (cited in Solomon, 2001, p. 31) detailed evidence of salmon smolts swimming away from boat sound in Southampton Water, UK. No dredging was taking place when the observations were made. These observations contradict those made by Westerberg on adult salmon (see above) and it is possible that adults are less affected by noise than are smolts. Assuming that the development of a deep water dock would lead to the increased usage of Galway Harbour by shipping, any current impact on migrating smolts could be increased as a result. However, the range over which such responses can be caused would have a bearing on the possible impacts of shipping noise; the new deep water dock would have the effect of moving large ships further from the mouth of the River Corrib.

Given that there is currently low frequency noise from large ships entering the harbour, that these are relatively localized to the vicinity of the actual individual vessel and that their duration in any particular area is short, coupled with the fact that large vessels will be moved further from the area of the river mouth as a result of the proposed development, significant negative impacts are not envisaged.

Mitigation: None possible.

7.7.4.8 Impacts on Marine Communities during the Construction Phase – Adverse Impacts caused by Suspended Solids/Sediment

Temporary Moderate Negative Impact

Dredging and water-based construction activity will cause an increase of suspended solids in the operation area. The suction head of the Trailer Suction Hopper Dredger will be immersed in the sediments which will minimise silt suspension. The softer materials will not be dredged using a backhoe as this would result in a greater loss of fines. The stiffer materials will be lifted in a closed backhoe bucket to minimise the loss of finer material. Placing the dredged materials in custom-built lagoons will result in water being displaced from the lagoons and from the saturated soils. The sediments are not contaminated and the discharged water will be filtered by a membrane lining of the lagoon walls. Chapter 4 of the EIS details this proposed lagoon wall.

The reduction in quality of water through increased suspended solids poses a risk to fish and mammals and infaunal communities within the zone of influence, which have the potential for secondary impact of reduced food availability for birds, mammals and other fish species.

The turbidity caused by suspended solids can affect primary production by shading and increased sedimentation can disturb benthic communities. Newcombe and MacDonald (1991) state that high levels of suspended solids (typically of the order of 20,000 mg/L or more for exposure periods of 24 to 96 hours for smolts of several species) can be lethal for salmonoids. The same authors also detail sub-lethal responses (including cellular damage and physiological stress) and behavioural responses (*e.g.* avoidance behaviour and alarm responses) to suspended solids.

The concentrations of suspended solids causing these responses were variable (from 6 to 650 mg/l for behavioural responses and from 14 to 1547 mg/l for sub-lethal responses) and are probably dependent on the duration of exposure of the fish to the suspended solids. Whitman *et al.* (1992) observed the effects on Pacific Chinook Salmon (*Oncorhynchus tshawytscha*) that were caused when volcanic ash was added to water under experimental conditions.

When ash was added to a concentration of 350 mg/l the preference of the fish for home water (*i.e.* water from their natal river) was significantly reduced. This was apparently due to avoidance of the ash, rather than an inability to identify home water. The proposed limit recommended is 50 mg/l above background levels measured 100m distance down current of the dredge vessel.

The adverse impacts of suspended solids on fish that have been recorded experimentally are generally at concentrations greater than 10 mg/l and often several orders of magnitude more than this. Results from the capital dredge sediment analysis (see Chapter 8 of EIS) predict that concentrations of suspended material in the dredge plume will fall to concentrations of 5 mg/l or less within several hundred metres of the dredge site. It should be realized that negative impacts on fish from experimental data often followed prolonged periods of exposure, whereas fish in the vicinity of the site of the proposed development will have the opportunity to move away from areas affected by the dredge plume.

In addition, the material that will be removed after dredging and blasting (*i.e.* 1,815,000 cubic metres of wet silt and muddy material and 24,000 cubic metres of rock) will all be used as fill material for the land reclamation portion of the proposed development, so there will be no impact from the disposal at sea of construction dredge spoil.

Dredging and other construction activity will cause the level of suspended solids in the area to be temporarily increased. There is also a possibility that the placement of the wet dredged sediment that will be used to partially fill the reclaimed land section of the development will give rise to a runoff of seawater. This runoff will be controlled to ensure that the carry back of fine sediment will be less than the limits.

The turbidity caused by suspended solids will locally affect primary production by shading and smothering of benthic communities. In Chapter 8 of the EIS, the model predications indicate that this smothering will be localised to around *ca* 50 m of the dredging operations. The model predicts that at sites close to the mouth of Lough Atalia, sediments suspended by the dredging operation will enter the lough

Mitigation: It is not possible to mitigate against smothering of benthic communities around the dredger. In order to prevent suspended sediments entering Lough Atalia, dredging activity will be restricted to periods of ebb tide in the vicinity of the entrance to the lough.

The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will reduce or remove the possibility of silt escaping back into the marine environment from the development. The geotextile mesh will be sized to retain suspended solids in the land reclamation lagoons.

7.7.4.9 Impacts on Marine Communities as a Result of Potential for Spillages during Construction

Short-term Potentially Significant Impact
Pollution from accidental spillages of fuel or oil from construction machinery may occur if the environmental management plan is not adhered to.

Mitigation: All machinery used in the construction of the proposed development will be checked to ensure that it is well maintained and not likely to leak fuel, lubricating oils, greases etc. into the aquatic environment. Any onsite refueling or maintenance will be carried out on a securely-bunded temporary hard stand areas. All oily wastes generated will be stored in leak-proofs tanks for removal by a licensed operator holding a valid Waste Collection Permit. Detailed construction and waste management plans will be agreed and put in place prior to the start of works. Dredgers will be re-fuelled in the existing docks using best available practice to ensure no spillages into the designated sites.

7.7.4.10 Impacts on Marine Communities as a Result of Use of Concrete during Construction

Short-term Potentially Significant Negative Impact (localised)

Uncured (wet) concrete will only be used to grout mass pre-cast concrete blocks. Uncured concrete in direct contact with water is toxic to aquatic life.

Mitigation: Normal best construction practice with regard to the use of concrete will be adhered to. Pre-cast concrete elements will be used wherever possible. Any wash water contaminated with concrete will not be allowed to enter the marine environment and will be disposed of elsewhere. Contaminated equipment (e.g. concrete delivery trucks, pumping equipment and tools) will be cleaned where there is no possibility of the drainage of wash water to the marine environment. The design by using sheet pile and rock armour has ensured a minimal underwater concrete requirement. There will be concrete quay etc. and these will be above tide level. Chapter 4 of the EIS details the proposed construction methods.

7.7.4.11 Impacts on Marine Communities during Operation Phase caused by Changed River Flow and Sediment Export

Short-term Slightly Negative Impact (localised)

The narrowing of the river mouth that will result from the construction of the proposed development means that the flow rate of the river will increase in this area. The predicted impact on flow is the deflection of the Corrib outflow more southwards towards Mutton Island resulting in a concentration of flow along the proposed dredged channel past the marina breakwater (see Chapter 8). Simulations indicate higher velocities *i.e.* increasing from 0.1–0.15 m/s to 0.2 - .25 m/s will occur. This in turn will cause short-term remobilisation of sediment form this area to the south

The results of modelling indicate that the proposed development restricts the erosive flow to the proposed dredge channel immediately to its west. This may have the beneficial effect of reducing the dredging maintenance requirement (currently approximately 50 centimetres of silt is removed at roughly ten year intervals). The overall conclusion from the modelling is that the proposed port configuration will confine the high flows and critical bed shear to the approach channels and will not result in any erosive impact elsewhere.

Simulation of the fine sediment from the River Corrib showed the proposed development extending the river plume (and thus suspended sediment) southwards out to sea past Mutton Island on the ebbing tide and away from the Renmore area. On the flooding tide the plume is much more diluted.

The simulation results indicate a reduction of between 40 and 60% in fine sediment load east of the proposed development

Mitigation: None possible

7.7.4.12 Impacts on Marine Communities during Operation Phase due to Changes in Salinity Regime

Permanent Slight Positive Impact

The impact of the proposed new structure will increase salinities immediately to the east of it under average River Corrib flows. This impact will be reflected under Corrib flood flow conditions and to a lesser extent under low flow conditions. Reductions in salinity are predicted to the west of the structure and very minor changes are predicted for Lough Atalia and the waters beyond Mutton Island.

As a consequence of the proposed development, the Corrib plume will flow directly southwards and south southwest towards Mutton Island and thus more out to sea than at present, with no opportunity for the freshwater plume to directly disperse into the Renmore Bay area. On neap tides, the predicted changes will be east of the new port, with average increases in salinity of 2.2 to 4.8 psu (practical salinity units) and very minor changes elsewhere, including Lough Atalia. To the west of the structure, salinities will be depressed on neap tides and spate river conditions at low water. On spring tides, salinities will increase in the Renmore shoreline area, with increased salinities to 7.2 psu and 8.5 psu respectively. In Lough Atalia, a slight reduction in median salinity concentrations is predicted. Further south along the new approach channel reductions in salinity are also predicted.

Since migrating salmon are attracted by scent to their natal waters, given that there will be more freshwater flowing between the causeway and the new structure salmon will more easily find the mouth of the Corrib. It is known that presently some salmon initially enter Lough Atalia before swimming upstream to Lough Corrib. This will continue to occur.

Mitigation: None possible

7.7.4.13 Impacts on Marine Communities during Operation Phase due to Pollution associated with Wastewater from Operations

No impact
Since all foul sewage generated within the area of the proposed development will be piped to the existing pumping station (which has sufficient capacity for both the existing and the proposed developments) and then pumped into the Galway City main drainage network for treatment, the wastewater produced as a result of the proposed development will not have an impact.

Mitigation: None required

7.7.4.14 Impacts on Marine Communities during Operation Phase due to Suspended Solids from Reclaimed Land

Potential Serial Short-term Moderate Negative Impact Events
Fill material used to create the reclaimed land creates the potential for increased suspended solids to runoff and affect water quality.

Mitigation: The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will reduce or remove the possibility of silt escaping back into the marine environment from the development.

7.7.4.15 Impacts on Marine Communities during Operation Phase due to Regular Maintenance Dredging

Short-term Serial Localised Moderate Negative Impacts (similar to those that already occur)
Maintenance dredging, which takes place along the existing dock every ten years or so, would also be a periodic necessity for the proposed development. Maintenance dredging brings with it the impacts that would come from dredging and spoil disposal (*i.e.* temporary loss of infaunal communities and fish feeding areas, increased suspended solids loads, decreased dissolved oxygen levels, mobilisation of any toxic compounds in the silt).

Before the harbour channel was last dredged (in August 2001), it was calculated that 80,000 m^3 of dredging spoil would be disposed of. Modelling work suggested that, after dumping, the thickness of settled material would drop to less than 1 mm within a radius of 450 metres from the edge of the dumping site. The same modelling work predicted that “resuspension rates were of a very low order and, therefore, the volume of material being resuspended is small enough to be deemed insignificant” (Aquafact report, 2001). The effects of the settling and possible resuspension of dredging spoil dumped as part of the maintenance works for the proposed development would be dependent on the amount of material dumped.

Mitigation: Spoil from maintenance dredging will be disposed of to a permitted site located outside Natura 2000 sites.

7.7.4.16 Impacts on Marine Communities during Operation Phase due to Potential for Increased Suspension of Bottom Sediment caused by Increased Ship Traffic

Permanent Slight Positive Impact
Vessels approaching the docks may cause the local suspension/re-suspension of some sediment from the sea bed. However, the greater depth (8 to 10 metres, compared with 3.4

metres in the current dredged channel) of water at the proposed new berths indicates that this effect will reduce rather than increase.

Mitigation: None required.

7.7.4.17 Impacts on Marine Communities during Operation Phase due to Increased Potential for Increased Pollution from Shipping

Potential Serial Short-term and Long-term Significant Negative Impacts
There is a potential risk of hydrocarbon pollution from accidental spillages/ bilge flushing *etc.* from shipping. These compounds tend to accumulate in receiving environments because of their very persistent nature. The Sea Pollution (Miscellaneous Provisions) Bill, in enacting the International Convention on the Control of Harmful Antifouling Systems for Ships, made the reapplication of TBT paints to ships illegal at the beginning of the year 2003. The effect of this should be a gradual reduction in TBT levels in the environment. Galway Harbour Company's Environmental Management Plan deals with the requirements on shipping to ensure no spillages to the water (See Appendix 4.2).

Mitigation: A detailed spill response plan has been prepared (Oil Spill Contingency Plan Appendix 4.3). This will limit the negative effects of any spills. GHC have an Environmental Management policy to ensure that there are no spillages to the sea.

7.7.4.18 Impacts on Marine Species during Operational Phase due to Increased Potential for Risk of Introduction of Invasive Alien Species by Shipping

Potential Permanent Significant Negative Impact
Transnational shipping leads to an increased risk of the introduction of potentially harmful alien species into Galway Bay.

Mitigation: Harbour Company will implement the Environmental Management Plan and policy regarding handling of invasive alien species.

7.7.5 Impacts on Lough Atalia/Zone of Potential Influence

By adopting the recommended mitigation measures and adopting the environmental management plan, no additional suspended sediments will enter Lough Atalia and Renmore Lagoon and their sedimentary characteristics will not alter. The model predicts a possible decrease in salinity of 1.8 psu within Lough Atalia. Given the measured range of 1 – 29 S_P, it is not considered that such a potential increase will have any effect on the ecological functioning of this water body. The model predicts that salinities to the east of the new structure may increase.

Since there will be no perceptible change in tidal range or erosion/deposition regimes as a result of the construction of the proposed development and no significant change to the salinity regime in Lough Atalia, terrestrial habitats outside of the site red line area will not be impacted negatively as a result of the proposed development.

7.7.6 Impacts on Fish

7.7.6.1 Impacts on Fish during the Construction Phase – Subtidal Habitat Loss

Permanent Moderate Negative Impact
Reclamation of land as part of the construction of the proposed development constitutes the direct and irreplaceable loss of 26.93 ha of potential feeding habitat for fish, sea birds and sea mammals. This removal of marine habitat also constitutes a small part of the fishing grounds for

Shrimp. Since the reclaimed land is intended for industrial use, it is likely that the terrestrial area created will have little, if any, ecological value.

Mitigation: None possible.

7.7.6.2 Impacts on Fish during the Construction Phase – Intertidal Habitat Loss

Permanent Slight Negative Impact
Approximately 5.93 ha of foreshore between Rinmore Point and Renmore beach will be lost when the development is constructed. This is an area with boulders interspersed with muddy sand and shell fragments, with patches of brown algae. This constitutes an area of potential shelter for small fish and a feeding area at high tide. In the context of the Galway Bay complex cSAC, this constitutes 0.2% of the total available foreshore (calculated at 2,555 ha).

Mitigation: None possible.

7.7.6.3 Impacts on Fish during the Construction Phase - Habitat Creation

Permanent Moderate Positive Impact
Approximately 1,400 m of rocky (rock wall) coastline (equivalent to one hectare of intertidal zone) will be created on the eastern side of the land reclamation site. This will more than compensate for the 550 m of current man-made rock wall coastline that will be destroyed during the land reclamation procedure. These rock walls constitute habitat for the epifauna and flora typical of sheltered rocky shores. In addition there will be approximately 1,000 m of quay wall (consisting of concrete and concrete piles) and approximately 1,700 m of dock and causeway built. Recent research (Firth *et al.,* 2010) on textured and engineered *e.g.* the introduction of pits, crevasses, holes *etc*, cement blocks for use in coastal protection in the U.K. has shown that this gives rise to greatly increased rates of settlement of both flora and fauna. These structures will quickly become covered with the same type of community and will also form extra cover and feeding areas for associated fish species.

Mitigation: None necessary.

7.7.6.4 Impacts on Fish during Construction Phase - Habitat Loss of Dredge Area

Short-term Moderate Negative Impact
Initial dredging will cause the loss of bottom-dwelling infauna from the dredged areas, making them unsuitable for bottom-feeding fish. The proposed dredge area is 46.5 ha. This is a temporary impact: it would take several months for recolonisation to occur and several years for the original community and biomass to be re-established. Dredged areas would, of course, be subject to sediment export caused by the River Corrib flow and to periodic maintenance dredging.

Mitigation: None possible.

7.7.6.5 Impacts on Fish during Construction Phase - Physical Damage or Disturbance caused by Underwater Drilling and Blasting

Temporary Potentially Moderate Negative Impact
The detonation of explosives under the sea generates a percussive shock wave that passes through the water, often travelling for great distances. The thermal and explosive effects of a sub-surface detonation are limited to the immediate vicinity of the explosion and the shock wave is the primary cause of damage to aquatic life. When blasting is carried out to remove rock, the explosives are detonated in boreholes within (and not at the surface of) the rock. The potential impacts on marine animals include direct physical damage (*e.g.* internal injury auditory damage/deafness in fish and marine mammals), indirect physical damage (*e.g.* sound-induced

formation of bubbles that could cause 'the bends' in deep-diving species), perceptual impacts (*e.g.* the interference of the blasting sound with echolocation or intra-species communication), behavioural impacts (*e.g.* avoidance of the blast area), stress (*e.g.* induction of physiological effects such as increased heart and respiratory rates) and indirect effects (*e.g.* the reduction of prey availability) (Gordon *et al.*, 1998).

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon and other anadromous species, blasting and piling will be limited to periods when juvenile stage salmonids are not passing in the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to eliminate the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by blasting.

Explosion weight will be limited to a maximum of 10kg.

Blasting and drilling work will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area *i.e.* they will be able to migrate undisturbed during non-blasting hours.

Underwater noise levels will be monitored prior to commencement of development, with particular emphasis on the presence of seals and during the smolt and eel migration period.

7.7.6.6 Impacts on Fish during Construction Phase - Physical Damage or Disturbance caused by Pile Driving

Temporary Slight Negative Impact

Fish are sensitive to noise and vibration and construction activities could cause avoidance reactions and possibly delay fish migration. Nedwell (cited in Solomon, 2001, p. 32) suggested that an avoidance reaction may be induced at distances of up to 2 km from pile driving works. Driven sheet piles are a component of the construction of the proposed development. The piles would be secured into bedrock that had previously been drilled and blasted. Investigations into the noise produced by oil drilling platforms has shown that drilling can produce infrasound at approximately 5 Hz at levels in the range 119-127 dB at distances from 9 to 61 m from the drilling rig (Vella *et al.*, 2001), within the range of the sound sensitivity of Salmon (Hawkins and Johnstone, 1978), so there may be some localised effect on migrating Salmon. Avoidance to infrasounds at 11.8 Hz has been demonstrated in migrating silver Eel (Sand *et al.*, cited in Vella *et al.*, 2001, p. 52), although this would not be significant if there were no works during the night when Eel are migrating. It should also be stated that the drilling and blasting required for the placing of sheet piles for the proposed development would be a short-term operation and that any environmental impacts caused by drilling noise would also be short-term, therefore.

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, piling will be limited to periods when juvenile stage salmonids are not passing in the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to eliminate the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by pile driving.

Pile driving will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area *i.e.* they will be able to migrate undisturbed for a minimum of 8 hours during night-time hours.

Underwater noise levels will be monitored prior to commencement of development, with particular emphasis on the presence of seals and during the smolt and eel migration period.

7.7.6.7 Impacts on Fish during Construction Phase - Physical Damage or Disturbance caused by Dredging

Temporary Slight Negative Impact

Dredging can be characterized as a continuous, tonal, low frequency noise source. Richardson *et al*. (1995) recorded peak noise levels of 178 dB at 160 Hz, with an overall source level of 185 dB during dredging operations. There are various types of equipment used for marine dredging. Capital dredging is often carried out using back hoe rock dredgers. Dredging of sediments can be achieved with backhoe (these lift bucketfuls of silt onto waiting barges), with hopper dredges (these ships pass over the dredge site sucking sediments into an internal hopper via trailing dragheads), or with transfer dredges (moored or anchored ships which transfer sediments onshore or into barges via a suction pipe). It is proposed that 1.815 million cubic metres of soft sediment will be dredged-up using (i) a Trailer suction hopper dredger dredging the upper softer layers into a floating pipeline and (ii) a backhoe excavator on a raft dredging the stiffer lower layers into a barge. It is estimated that this work will be broken into more than one season each of approx 36 weeks. In part of the main berthing area where a greater depth is required some rock will have to be removed. This will be achieved by blasting, followed by the removal of the blasted rock with a back hoe dredger.

Likewise some rock will be required to be removed to key in sheet piles. Total rock removal is estimated as 24000 cubic metres or 1.3% of the dredging. 98.7 % of the dredging will be of the lower noise generating sediment dredging.

Richardson *et al*. (1995) noted that two different vessels operating as transfer dredgers produced different sound levels, but that the noisiest of these was at most only as noisy as the quietest of the hopper dredgers whose noise levels were also checked. Westerberg (1982), while acoustically tracking adult salmon moving through coastal waters in the Baltic, found that they passed within 100-150 m of working dredgers without hesitation. At ranges of less than 100 metres from the dredging, contact with the ultrasonic transmitter was lost due to the intense background dredge noise, but the Salmon passed without any appreciable delay and “seemed essentially unaffected by the dredging at even closer range”.

Using available information and current suggested best practice (Southall *et al*., 2007) it has been calculated (see Chapter 10, Noise and Vibration) that the impact threshold distances for physical damage caused by dredging (worst case scenario for backhoe dredging) at the site are up to 128 metres for fish (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up to 32 metres for fish (based on a 5 minute exposure at that distance).

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, dredging will be limited to periods when juvenile stage salmonids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to remove the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction. This material has been assessed following site investigations and is suitable for use in the land reclamation. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by dredging.

7.7.6.8 Impacts on Fish during Construction Phase - Adverse Impacts caused by Suspended Solids/Sediment

Temporary Moderate Negative Impact

Local fishing interests have been concerned that the dumping of dredged spoil could negatively impact Shrimp or Lobster, although the disposal of dredge spoil in Inner Galway Bay in the past has not caused long-term adverse effects on the infaunal communities in the area (Roche, 2004). However, the material that will be removed after dredging and blasting (*i.e.* 1.815 million cubic metres of silt and sand material and 24,000 cubic metres of rock) will all be used as fill material for the land reclamation portion of the proposed development, so there will be no impact from the disposal at sea of construction dredge spoil.

Dredging and other construction activity will cause the level of suspended solids in the area to be temporarily increased. The geotextile mesh will be sized to retrain suspended solids in the land reclamation lagoons. The suction head of the Trailer Suction Hopper Dredger will be immersed in the softer soils to be dredged minimising silt suspension. The softer materials will not be dredged using a backhoe as this would result in a greater loss of fines. The stiffer materials will be lifted in a closing backhoe bucket to ensure the minimum loss of fines. The placing of dredged materials in lagoons will result in seawater being displaced from the lagoons and from the saturated soils. The soils are not contaminated and the discharged water will be filtered by a membrane lining of the lagoon walls and by the build up of soils on the membrane.

The turbidity caused by suspended solids can affect primary production by shading and increased sedimentation can disturb benthic communities. There is also the possibility of negative impact on Shrimp, particularly if solids are suspended during the breeding season. Newcombe and MacDonald (1991) state that high levels of suspended solids (typically of the order of 20,000 mg/L or more for exposure periods of 24 to 96 hours for smolts of several species) can be lethal for salmonids. The same authors also detail sub-lethal responses (including cellular damage and physiological stress) and behavioural responses (*e.g.* avoidance behaviour and alarm responses) to suspended solids.

The concentrations of suspended solids causing these responses were variable (from 6 to 650 mg/L for behavioural responses and from 14 to 1547 mg/L for sub-lethal responses) and are probably dependent on the duration of exposure of the fish to the suspended solids. Whitman *et al.* (1992) observed the effects on Pacific Chinook Salmon (*Oncorhynchus tshawytscha*) that were caused when volcanic ash was added to water under experimental conditions. When ash was added to a concentration of 350 mg/L the preference of the fish for home water (*i.e.* water from their natal river) was significantly reduced. This was apparently due to avoidance of the ash, rather than an inability to identify home water.

The avoidance behaviour of Cod and Herring to dredging-induced turbidity and the effects of sediment plumes on the buoyancy and mortality of Cod eggs and larvae have been studied as part of the Environmental Impact Assessment for the Öresund Link bridge-tunnel project between Denmark and Sweden (Westerberg *et al.*, 1996). The avoidance threshold to suspended sediments of glacial clay of limestone origin was studied in an experimental saltwater flume and was found to be approximately 3 mg/l for both species. Adhering particles from sediment suspensions were shown to cause a loss of buoyancy for Cod eggs, while larvae showed increased mortality on exposure to sediment concentrations of 10 mg/l.

The adverse impacts of suspended solids of fish that have been recorded experimentally are generally at concentrations greater than 10 mg/l and often several orders of magnitude more than this. Results from the capital dredge sediment analysis (see Chapter 8) predict that concentrations of suspended material in the dredge plume will fall to concentration of 1mg/l or less within several hundred metres of the dredge site. It should be realized that negative impacts on fish from experimental data often followed prolonged periods of exposure, whereas fish in the vicinity of the site of the proposed development will have the opportunity to move away from areas affected by the dredge plume.

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, events that could cause the suspensions of solids (i.e. blasting, drilling, dredging and infilling) will be limited to periods when juvenile stage salmonids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to remove the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction. This material has been assessed following site investigations and is suitable for use in the land reclamation. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by dredging.

Dredging of sediments within 800m of the mouth of Lough Atalia will not occur during ebb tides. This measure is intended to avoid the possibility of suspended sediments entering Lough Atalia

The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will minimise the possibility of silt escaping back into the marine environment from the development. The geotextile mesh will be sized to retain suspended solids in the land reclamation lagoons. These lagoons are shown in Drgs 2139-2142 & 2139-2143 which outlines the various construction elements and shows the proposed areas where the lagoons will be formed as the land is reclaimed and Plates 21-24 of the Visuals includes images of the stages of development.

Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan. The position and distance of the sampling points will be agreed after consultation with the appropriate authorities and will be such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment plume model analysis.

7.7.6.9 Impacts on Fish during Construction Phase - Adverse Impacts caused by Suspended Solids/Sediment – Salmonids

Short-term Potentially Significant Negative Impact
Salmonids are particularly sensitive to reduced levels of dissolved oxygen. Reduced dissolved oxygen levels are likely where dredging and other construction works mobilise sediments that consume oxygen. Solution of oxygen in water depends on water temperature and salinity. Oxygen saturation is 13 mg/L in fresh water at 4 ℃ and 7.4 mg/L in full strength seawater (*i.e.* 30 S_P) at 21 ℃. Salmonids and other fish will have the opportunity to move away from areas of low oxygen concentration, but migration into and out of the River Corrib could be affected.

Mobilisation of toxic chemicals (*e.g.* try-butyl tin TBT, Polychlorinated Byphenyls PCBs), from sediment raised as a result of dredging and other construction activities, is a possibility. Raised levels of lead and zinc were found in some samples, which "*would be consistent with export of base metal ores*" (Mercury Analytical Ltd. report, 2000). Both PCBs and TBT accumulate in the environment, in sediments, fish and especially shellfish. Apart from the direct effects on the organisms themselves, fish or shellfish products with too great a level of this type of contaminant would be unfit for human consumption. In the year 2000, the sediments in the harbour channel were analysed for some heavy metals, TBT, di-butyl tin (DBT), hydrocarbons, pesticides and PCBs prior dredging works (in 2001). Since there will be no dumping of dredged silt or rock from the capital dredging operations, there will be no need for an application to the EPA for a dumping at sea permit and no need to determine the levels of lead and PCB congeners for that purpose.

Sediment chemical analysis (see above) in the proposed development area has shown that aluminium, mercury, cadmium, arsenic, nickel, iron and manganese levels were in line with

previous findings and were not found in concentrations that were particularly elevated or of concern. Levels of polyaromatic hydrocarbons (PAHs) were less than are recorded in the Celtic Sea and the concentration of TBT was below that expected from values previously recorded by the Marine Institute. Recorded levels of PCBs were consistent with values recorded by the Marine Institute in the south-east Irish Sea and in Cork Harbour. Given that the more highly concentrated suspended solids concentrations predicted for the dredge plume are restricted to areas close to the dredge site and that these will fall rapidly due to deposition, the likelihood of a significant impact is low.

Mitigation: Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan. The position and distance of the sampling points will be agreed after consultation with the appropriate authorities and will be such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment plume model analysis.

7.7.6.10 Impacts on Fish as a Result of Potential for Spillages during Construction

Short-term Potentially Significant Impact
Pollution from accidental spillages of fuel or oily wastes from construction machinery may occur if a construction management plan has not been put in place.

Mitigation: All machinery used in the construction of the proposed development will be checked to ensure that it is well maintained and not likely to leak fuel, lubricating oils, greases etc. into the aquatic environment. Any onsite refueling or maintenance will be carried out on securely bunded temporary hard standing areas. All oily wastes generated will be stored in leak-proofs tanks for removal by a licensed operative holding a valid Waste Collection Permit. Dredgers will be re-fuelled at sea using best available practice to ensure no spillages into the designated sites.

7.7.6.11 Impacts on Fish as a Result of Use of Concrete during Construction

Short-term Potentially Significant Negative Impact (localized)
Uncured (wet) concrete will be used on site and in the event of accidental spillage into the bay, would act as a caustic pollutant, raising the pH in water. Uncured concrete in direct contact with water is toxic to aquatic life and dust liberated during the grinding of concrete can also create a pH problem.

Mitigation: Normal best construction practice with regard to the use and pouring of concrete will be adhered to. If concrete cannot be poured in dry protected areas away from water until full curing has taken place, particular attention will be paid to the quality and security of the shuttering used for pouring. Pre-cast concrete elements will be used wherever possible and these will be designed to allow for enhanced settlement of Flora and Fauna as reported in recent scientific papers (Firth 2013, Chapman and Brown 2011, Martins and Thompson, 2009). Any wash water contaminated with concrete will not be allowed to enter the marine environment and will be disposed of elsewhere. Contaminated equipment (*e.g.* concrete delivery trucks, pumping equipment and tools) will be cleaned where there is no possibility of the drainage of wash water to the marine environment. The design by using sheet pile and rock armour has ensured a minimal underwater concrete requirement. While the main quays will be concrete, these will be above tide level.

7.7.6.12 Impacts on Fish during the Operation Phase due to Increased Shipping Noise

Permanent Neutral or Imperceptible Negative Impact
The hearing of salmon is restricted to frequencies below approximately 380 Hz and hearing sensitivity drops off steeply above 150 Hz (Hawkins and Johnstone, 1978). Knudsen *et al*. (1992, 1994) observed strong avoidance reactions from salmon smolts in response to underwater noise.

These reactions were to low frequency noises at 10 kHz, while minimal reactions were shown to higher frequency noises at 150 kHz. These workers conducted experiments using pure sine waves, rather than more complex noises like boat noise.

However, Nedwell (cited in Solomon, 2001, p. 31) presented data showing that the noises produced by ships are low frequency (below 50 kHz), in the range with greatest behavioural impact for salmon. Moore and Ives (cited in Solomon, 2001, p. 31) detailed evidence of salmon smolts swimming away from boat sound in Southampton Water, UK. No dredging was taking place when the observations were made. These observations contradict those made by Westerberg on adult salmon (see above) and it is possible that adults are less affected by noise than are smolts. Assuming that the development of a deepwater dock would lead to the increased usage of Galway Harbour by shipping, any current impact on migrating smolts could be increased as a result. However, the range over which such responses can be caused would have a bearing on the possible impacts of shipping noise; the new deepwater dock would have the effect of moving large ships further from the mouth of the River Corrib.

Given that there is currently low frequency noise from large ships entering the existing harbour, that these are relatively localized to the vicinity of the actual individual vessel and that their duration in any particular area is short, coupled with the fact that the lesser number of larger vessels will be moved further from the area of the river mouth and the path of the anadromous fish as a result of the proposed development, significant negative impacts are not envisaged. The smaller marina vessels will not generate a significant level of noise.

Mitigation: Vessels approaching the Galway Harbour Extension area will be limited in their approach speeds thereby reducing the level of noise.

7.7.6.13 Impacts on Fish during Operation Phase caused by Changed River Flow and Sediment Export

Permanent Neutral or Slight Positive Impact
The slight narrowing of the river mouth that would be one of the results of the construction of the proposed development means that the flow rate of the river as it enters the sea would be increased. The principal predicted impact on flow is the deflection of the Corrib outflow more southwards towards Mutton Island resulting in a concentration of flow along the proposed dredged channel past the marina breakwater and southwards (see Chapter 8, Water). Simulations indicate higher velocities in this channel than predicted for the existing dredge channel (*i.e.* as at present). Another impact on the flow regime is an increase in tidal velocity past the head of the breakwater, with velocities increasing from 0.1–0.15 m/s to 0.2 - .25 m/s.

The results of modelling indicate that the proposed development restricts the erosive flow to the proposed dredge channel immediately to its west. This may have the beneficial effect of reducing the dredging maintenance requirement (currently approximately 50 centimetres of silt is removed at roughly ten year intervals). The overall conclusion from the modelling is that the proposed port configuration will confine the high flows and critical bed shear to the approach channels and will not result in any erosive impact elsewhere.

To quote Chapter 8: "*Simulation of the fine sediment from the River Corrib showed the proposed development pushing the river plume and thus suspended sediment southwards out to sea past Mutton Island on the ebbing tide and away from the Renmore area only returning in a much more dilute plume on the flooding tide. The simulation results indicate a reduction of between 40 and 60% in fine sediment load east of the proposed development*."

Mitigation: None possible

7.7.6.14 Impacts on Fish during Operation Phase due to Changes in Salinity Regime

Permanent Slight Positive Impact
The impact of the proposed new structure will increase salinities immediately to the east of it under average River Corrib flows. This impact will be reflected under Corrib flood flow conditions and to a lesser extent under low flow conditions. Less significant changes (reduction in salinity) are predicted to take place in salinities levels (slight reduction) to the west of the structure and very minor changes are predicted for Lough Atalia or the waters beyond Mutton Island.

As a consequence of the proposed development, the Corrib plume will flow directly southwards and south southwest towards Mutton Island and thus more out to sea than at present, with no opportunity for the freshwater plume to directly disperse into the Renmore Bay area. On Neap tides the predicted changes will be significant east of the harbouir extension, with average increases in salinity of 2.2 to 4.8 psu and very minor changes elsewhere, including Lough Atalia. On Spring tides very significant changes in salinity will occur in the Renmore shoreline area, with increased salinities to 7.2 psu and 8.5 psu respectively. In Lough Atalia and the approaches off Nimmo's pier a slight reduction in median salinity concentrations of 1.29 psu is predicted. Further south along the new approach channel reductions in salinity of 5 psu are predicted.

Since migrating salmon are attracted by scent to the their natal waters, there may be a positive impact in that this will help returning fish to find the river mouth, rather than failing to do so and entering areas like Lough Atalia, as some are known to currently do. It will also help smolt reach the wider, safer salt waters.

Mitigation: None needed.

7.7.6.15 Impacts on Fish during Operation Phase due to Lighting

Permanent Moderate Negative Impact
There is potential for lighting in the newly reclaimed land and along the new breakwater to negatively impact migrating fish (which prefer to migrate under cover of darkness and are somewhat deterred from passing through brightly illuminated areas) entering or leaving the River Corrib.

Mitigation: There will be mitigation through the use of energy efficient lighting in a configuration designed to provide the minimum lighting level required for safety. The lights used will be of a design that casts light downwards and landwards only and the lamp standards will be positioned in such a way that only the newly reclaimed land or new breakwater will be illuminated, not any areas of water.

7.7.6.16 Impacts on Fish during Operation Phase due to Potential for Increased Predation of Migratory Fish by Seals

Permanent Potentially Significant Negative Impact
The IFI have expressed some concerns that the new harbour construction may provide additional haul-out sites for seals and that this could lead to additional predation on salmon and sea trout in the vicinity of the river mouth, where the fish have to migrate through a relatively confined area and may be especially vulnerable.

Mitigation: The design of the proposed with steel sheet pile to act as a toe for the rock armour will create a steep drop into the water and thus mitigate against the possibility of seal haul out areas being created in this area (mitigation by design).

7.7.6.17 Impacts on Fish during Operation Phase due to Increased Potential for Pollution

Potential Serial Short-term Significant Negative Impact Events
Storm water from both the proposed development and the existing Phase 1 of the Galway Harbour Park might form a route whereby silt, spilled petrol and other oily wastes from the industries within the area and from parking places might enter the waters of Galway Harbour.

Mitigation: The stormwater from the existing Phase I of the Galway Harbour Enterprise Park currently discharges from three discharge points. It is proposed that these three discharge points will be linked up, as part of the Phase 2 development, so that only one discharge point for all the existing Harbour Enterprise Park will discharge storm water to the sea. This new system will divert storm water to a petrol interceptor fitted with a silt trap prior to its discharge to sea. In the event of an oil spill entering the storm water system, the use of one discharge point for all the existing harbour enterprise park will allow the contaminated water to be controlled more efficiently as the discharge of water to sea will be prevented by the use of a control valve. The discharge from the new lands will be as detailed in Drawing 2139-2214 all of which will have oil, grit interceptors and control valves to prevent contaminated water discharging to sea.

7.7.6.18 Impacts on Fish during Operation Phase due to Pollution associated with Wastewater from Operations

No Impact
Since all foul sewage generated within the area of the proposed development will be piped to the existing pumping station (which has sufficient capacity for both the existing and the proposed developments) and then pumped into the Galway City main drainage network for treatment, the wastewater produced as a result of the proposed development will not have an impact. In the new development all shipping *etc*. will discharge to a direct system of foul drainage via pumps thus ensuring no spillages. Harbour bye-laws currently provide for effluent disposal in a safe manner.

Mitigation: None needed.

7.7.6.19 Impacts on Fish during Operation Phase due to Regular Maintenance Dredging

Short-term Serial Localised Moderate Negative Impacts (similar to those that already occur)
Maintenance dredging, which takes place along the existing approach channel every ten years or so, would also be a periodic necessity for the proposed development. Maintenance dredging brings with it the impacts that would come from dredging and spoil disposal (*i.e.* temporary loss of infaunal communities and fish feeding areas, increased suspended solids loads, decreased dissolved oxygen levels, possible mobilisation of toxic compounds in the silt).

Before the harbour channel was last dredged (in August 2001), it was calculated that 80,000 m^3 of dredging spoil would be disposed of. Modelling work suggested that, after dumping, the thickness of settled material would drop to less than 1 mm within a radius of 450 metres from the edge of the dumping site. The same modelling work predicted that “resuspension rates were of a very low order and, therefore, the volume of material being resuspended is small enough to be deemed insignificant” (AQUAFACT report, 2001). The effects of the settling and possible resuspension of dredging spoil dumped as part of the maintenance works for the proposed development would be dependent on the amount of material dumped.

When maintenance dredging is required, it will be subject to licencing by the EPA. Spoil from maintenance dredging will be disposed of to an EPA permitted site located outside Natura 2000 sites.

Mitigation: None possible

7.7.6.20 Impacts on Fish during Operation Phase due to Potential for Increased Suspension of Bottom Sediment caused by Increased Ship Traffic

Permanent Slight Positive Impact
As the manoeuvres of large ships approaching the docks may cause the local suspension/re-suspension of some sediment from the bottom of the harbour, increased levels of shipping in the area might increase this effect. However, the greater depth (8 to 10 metres, compared with 3.4 metres in the current dredged channel) of water at the proposed new berths means that this effect would be reduced rather than increased.

Mitigation: Vessels approaching the Galway Harbour Extension area will be limited in their approach speeds thereby minimizing the resuspension of bottom sediments. Furthermore, due to water depth in the area the possibility of propellers resuspending sediments is minimal.

7.7.6.21 Impacts on Fish during Operation Phase due to Increased Potential for Increased Pollution from Shipping

Potential Serial Short-term and Long-term Significant Negative Impacts
One of the purposes of the proposed development is to increase the amount of shipping using Galway Harbour. This would lead to an increased risk of hydrocarbon pollution from accidental spillages/ bilge flushing *etc*. Increased local shipping use might also increase the levels of antifouling compounds (*e.g.* tributyl tin or copper thiocyanates) in the local environment. These compounds tend to accumulate in receiving environments because of their very persistent nature. The Marine Institute do not have any data for TBT levels in sediments in Galway Bay (Dr. Margo Cronin, Marine Institute, pers comm.). The Sea Pollution (Miscellaneous Provisions) Bill, in enacting the International Convention on the Control of Harmful Antifouling Systems for Ships, made the reapplication of TBT paints to ships illegal at the beginning of the year 2003. The effect of this should be a gradual reduction in TBT levels in the environment. Galway Harbour Company's Environmental Management Plan deals with the requirements on shipping to ensure no spillages to the water (See Appendix 4.2).

Mitigation: A detailed spill response plan has been prepared (Oil Spill Contingency Plan Appendix 4.3). This will limit the negative effects of any spills. GHC has an Environmental Management policy to ensure that there are no spillages to the sea. All vessels will have a boom

7.7.6.22 Impacts on Fish during Operational Phase due to Increased Potential for Risk of Introduction of Invasive Non-native Species by Shipping

Potential Permanent Significant Negative Impact
Shipping and leisure craft from other ports increases the risk of the introduction of potentially harmful non-native species into Galway Bay. Plants and animals can settle on the hulls of vessels and be passively carried from port to port as the ships make their passages. No such species have been recorded to date.

Mitigation:

The area around the docks will be monitored on an on-going basis to record the occurrence of such species. If noted, possible remedial measures will be put in place to control the spread of such species.

7.7.7 Impacts on Birds

7.7.7.1 Impacts on Birds associated with increased disturbance during Construction and Operational Phases

Imperceptible Impact
There is potential for the large ship traffic that will occur as a consequence of the operation of the proposed development to cause disturbance to the tern colony on Rabbit Island. A colony of Common Terns has nested on a mooring dolphin in the River Liffey in Dublin Port since 1995 at least (Merne, 2004). This colony has increased from 238 pairs in 2002 to 400 pairs in 2009 (S. Newton, BirdWatch Ireland, *pers comm.*), so it can be concluded that the busy port traffic there has no negative impact on the colony. A study on breeding Common Tern in the U.S.A. (Burger, 1998) showed that speed boats and small private craft could cause the birds to take flight if they came close to the colony. The author recommended that craft should not come within 100 metres of the colony and that their speed should be limited whilst in the vicinity of it. It is to be expected that larger boats entering or leaving the harbour would be moving slowly down the dredged harbour channel and would not approach Rabbit Island closely, since the water around the island is too shallow for them. During the construction phase, Galway Harbour Company will direct that no small craft approach Rabbit Island closer than 100 metres during the bird breeding season (March – August). The April – July closed season on blasting, drilling, pile driving and infilling protects the Rabbit Island Common Tern colony from disturbance during these works.

Mitigation: None possible.

7.7.7.2 Impacts on Birds associated with the possibility of physical damage caused by blasting and pile driving during the construction phase

Potential Short-term slight negative impact on bird populations
In order to ensure that diving bird species are not present during blasting activities, a RIB will be used to deter species from the area.

7.7.7.3 Impacts on Birds associated with Loss of Feeding Habitat

Permanent Slight Negative Impact
The loss of 5.6 hectares of muddy sand foreshore constitutes a loss of potential feeding areas for birds (particularly waders). However, the area of foreshore concerned is not a roosting site for wading birds and both available information for the area and bird survey results indicate that this area is not of significance for feeding or resting birds within the SPA. The loss of 23.89 hectares of marine habitat constitutes a loss of feeding area for divers, grebes, terns *etc.*, although the concentrations of Wintering divers found at the site are not as high as those in other areas of inner Galway Bay. The loss of feeding habitat for marine birds is small in relation to the total area of marine habitat available within the SPA. Wintering divers are also well distributed along areas of the coast of Galway Bay to the West of the Inner Galway Bay SPA.

Mitigation: None possible.

7.7.7.4 Impacts on Birds associated with increased possibility of Pollution Incidents during Construction and Operational Phases

Potential Short-term Significant Negative Impact Events
A possible indirect negative impact of the proposed development on waterbirds is the increased possibility of harmful pollution incidents that the expected increase in marine traffic will bring with it.

In the past there used to be many small spillages in Galway Harbour docks. Recently, large fines have been imposed on vessels that spill oil and the occurrence of spills has decreased. There was one recorded spill in 2004– 550 litres of gas oil and one recorded spill of 100 litres of oil in 2003 (Captain Brian Sheridan, Galway Harbour Master, pers comm.).

Mitigation: Detailed Spill Response and Construction Waste Management Plans have been prepared (Appendix 4.3). This will limit the negative effects of any spills.

7.7.8 Impacts on Mammals

7.7.8.1 Impacts on Marine Mammals due to Disturbance during the Construction and Operational Phases of the Development

Temporary Slight Negative Impact
The major source of potential negative impacts on local aquatic and marine mammals will come from underwater blasting, drilling and pile driving. Noise and vibration will also be generated by the general construction activity (dumping of fill material, use of heavy goods vehicles *etc.*) at the site. Sound waves are propagated over long distances through water and there is evidence to suggest that sea mammals are likely to be very sensitive to loud noises. Most of the noise caused by shipping, dredging and drilling is of low frequency (approximately 5 to 160 Hz).

Possible indirect negative impacts of the operational phase of the proposed development on marine mammals are: increased disturbance from shipping noise, the increased possibility of injury caused by impact of ships and their propellers with marine mammals and the increased possibility of harmful pollution incidents that the expected increase in marine traffic will bring with it.

The sea is an environment that is naturally a relatively high noise environment. Cetaceans in particular have evolved ears that function well within this high natural background or ambient noise and which may be more resistant to hearing damage than land mammals (Ketten, 2004). Crum and Mao (1996) calculated that the exposure of marine mammals to 500 Hz sounds at sound pressure levels of 210 dB re. 1 µPa could cause bubble growth that could theoretically cause 'the bends'. Finneran *et al*. (2000) measured the hearing thresholds of Bottlenose Dolphins and Belugas (*Delphinapterus leucas*) that had been exposed to noises that were designed to mimic those produced by distant explosions. No threshold shifts (*i.e.* deafness) were observed in these experiments, but disruption of trained behaviour was noted at distances of several kilometres from the theoretical explosion points.

While mysticete (*i.e.* baleen, or non-toothed) whales may be affected by low frequency noise due to their use of low frequency infrasounds for communication, this type of cetacean is not at all common in the area (one known record of a stranded Minke Whale since 1970, see Table 7.29, above). Odontocete (toothed) cetaceans, a group that includes Short-beaked Common Dolphin, Harbour Porpoise and Bottle-nosed Dolphin, are most sensitive to sounds in the frequency range 10 kHz to 60 kHz (Vella *et al*., 2001). As far as disturbance by shipping goes, the group of Short-beaked Common Dolphin that are regularly found in the area often follow ships entering and leaving Galway Harbour. In addition, Harbour Porpoise (a species that is considered shy) are often observed in areas of intense shipping activity (Hoffman *et al*., cited in Vella *et al*., 2001, p.46).

Both Harbour Seal and Grey Seal are members of the phocinid or true seal group. The lowest limit of hearing sensitivity measured for Harbour Seal was 100 Hz, but a noise level of 96 dB was necessary for this to be possible (Kastak and Schusterman, cited in Vella *et al*., 2001, p. 48). The same workers found that there was intraspecific variation in the hearing ability of this species (*i.e.* different individuals had varying hearing abilities). It has been claimed that, if phocinid seals can perceive noise in the frequency range below 1000 Hz (1 kHz), they are probably not able to hear it above general ambient noise levels (Vella *et al*., 2001). It seems, therefore, that seals are

unlikely to be significantly affected by the low frequency noises that would be produced by drilling, dredging or by boat noise.

Acoustic Deterrent Devices (ADDs) are used by some fish farms and fisheries to deter seals that might otherwise prey on stocked fish. These devices typically produce strong pulse noises in the range 8 to 17 kHz (much higher frequencies than boat or construction noise) at levels of 175 to 210 dB (Vella *et al*., 2001; Gordon and Northridge, 2002). Some individual seals become habituated to even this loud, high frequency noise.

All of the mammal species found in the local marine environment are particularly mobile. Although there may be some temporary disturbance during the construction phase of the proposed development, there are large areas of adjoining suitable habitats into which seals, dolphins and Otter can move. Since these mammals are accustomed to ambient water noise and the noise generated by the current harbour and its activities, no direct long-term negative impacts of the proposed development on mammal populations in the area is anticipated.

However, the blasting phase of the development construction has the potential to cause serious negative impacts (*e.g.* including injury and possible death) on local cetaceans and seals. The design of the drill holes, their depths and the amount of explosives used has minimised the numbers of blasts, the number of blasting days and the total period over which the blasts would be staged during the construction period.

Using available information and current suggested best practice (Southall *et al*., 2007), it has been calculated (see Chapter 10, Noise and Vibration) that the impact threshold distances for physical damage caused by dredging (worst case scenario is for backhoe dredging of rock in particular of which there is less than 1.3% of the total dredging quantity i.e. 24,000 m^3) at the site are up to 64 metres for seals and 16 metres for Harbour Porpoise (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up 128 metres for seals and one kilometre for Harbour Porpoise (all based on a 5 minute exposure at that distance). There are no significant seal haul outs within this distance of the dredging site. There will be a constant mammal watch and there will be a gradual build up of noise to allow time for mammals not in view but within earshot, to move out of range i.e. a “soft start” to the work.

Mitigation: Blasting will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day’s blasting begins. They will be equipped with binoculars, telescopes and tripods with which to watch for the animals, and two-way radios with which to communicate with each other and the explosives engineers. Blasting will not occur if a seal or cetacean is sighted within one kilometre of the blast site, or for a period of 30 minutes after one has been sighted within the ‘exclusion area’. Observers will use Mutton Island and Hare Island as watch points. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting watches will be carried out before blasting works begin.

The IWDG runs a national strandings scheme that covers Galway Bay. It is anticipated that the project team will arrange with IWDG to receive news of any strandings that occur in the area during the construction period, but it is further proposed that:

i. after episodes of blasting a search party will be sent out in a RIB to search the area around the blast site for dead or injured seals or cetaceans.
ii. a public awareness campaign will be launched in which members of the public are encouraged to report dead or injured seals in the inner Galway Bay via a designated phone line.

7.7.8.2 Impacts on Marine Mammals due to Disturbance from Pile Driving during the Construction Phase of the Development

Temporary Potentially Moderate Negative Impact
Impact threshold distances for physical damage caused by pile driving at the site are up to 4 metres for both seals and Harbour Porpoise. The impact threshold distances for disturbance caused by pile driving at the site are up to 64 metres for both seals and Harbour Porpoise.

Impact threshold distances for physical damage caused by blasting at the site are up to 500 metres for seals and 128 metres for Harbour Porpoise. The impact threshold distances for disturbance caused by blasting at the site are up to one kilometre for seals and 256 metres for Harbour Porpoise.

Mitigation: Pile driving will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day's pile driving begins. They will be equipped with binoculars, telescopes and tripods with which to watch for the animals, and two-way radios with which to communicate with each other and the explosives engineers. Pile driving will not occur if a seal or cetacean is sighted within one kilometre of the blast site, or for a period of 30 minutes after one has been sighted within the 'exclusion area'. Observers will use Mutton Island and Hare Island as watch points. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting watches will be carried out before pile driving works begin.

7.7.9 Additional monitoring

7.7.9.1 Biological

7.7.9.1.1 Intertidal benthos
Intertidal annual seasonal sampling should commence pre-construction and for one year post-construction at the following locations: Ballyloughan, Lough Atalia, Renmore Lough, east and west of the causeway and at an agreed control site to record macrofaunal assemblages and sediment granulometry at High, Mid and Low water. Sampling should incorporate quadrates, cores and photography (including Sediment Profile Imagery). Post-completion, the additional 1 year's data can be reviewed to see if seasonal sampling is still required or if it can be reduced to once a year.

7.7.9.1.2 Subtidal benthos
Annual benthic sampling should be commenced pre-construction at the following sites: south of Ballyloughan Beach, Lough Atalia, Renmore Lough, west of the causeway, south of Mutton Island and at an agreed control southwest of the Margaretta using a 0.1 sqm grab and a 1 mm sieve. 3 faunal samples a 1 sediment sample should be collected and analysed using the same techniques as were used in the EIS. Sediment Profile Imagery should also be incorporated into the monitoring methodologies. The sampling should continue for at least 5 years post-completion.

7.7.9.1.3 Salmon smolts
The acoustic tagging study that was carried out as part of the EIS should be re-done during and post the construction period to document changes in patterns of migration routes that the smolts undertake.

7.7.9.1.4 Marine Mammals
A Marine Mammal Watch Plan including marine observers will be employed, during the construction phase, prior to and during blasting. The use of acoustic deterrent devices will be employed if required.

Monitoring of Harbour Seal populations prior to, during and for at least two years post construction will be completed as part of ecological monitoring of the development. This will follow a similar methodology to that employed as part of the baseline surveying, using similar techniques and haul out locations to allow for comparative analysis with baseline information.

Survey for otter holt sites will be completed immediately prior to construction phase and on two occasions post construction phase, following a similar methodology to that employed as part of baseline surveys. During the construction phase, observation surveys for otter activity will be made and notes from marine observers and bird surveyors will also be included as part of the dataset.

7.7.9.1.5 Birds

Monitoring of bird populations prior to, during and for at least two years post construction will be completed as part of ecological monitoring of the development. This will follow a similar methodology to that employed as part of the baseline surveying, using similar techniques and point count locations to allow for comparative analysis with baseline information.

Marine chemistry

As the proposed development has the potential to alter salinity regimes in the area, *in situ* monitoring of salinity should commence prior to construction at the following sites: at the mouth and within Lough Atalia, Renmore Lough, off Ballyloughan, south of Mutton Island and southwest of the Margaretta. This monitoring should continue for at least two years post-construction.

Marine physics

As the proposed development has the potential to alter current velocities and wave heights in the area, appropriate measuring devices should be deployed pre-construction to measure current speeds and wave heights at the following sites: south of Ballyloughan, east of the existing shipping channel, south of Mutton Island and southwest of the Outer Margaretta Buoy.

7.7.10 In Combination Effects of the Project

As part of the EIS process, it is necessary to assess the possible in combination effects which may arise as a result of the proposed development in addition to other plans (local, regional, national), Directives and projects (current activities and proposals within the planning process).

7.7.10.1 Plans, Directives and Regional/National Projects

The assessment of in combination effects considered the impacts which may arise as a result of proposed regional/national projects within the planning process (*e.g.* road schemes, wastewater treatment plants) and land use and other development plans and Directives. A summary of the projects and plans considered possible to have in combination effects are listed below. Except for possible interactions between outfall plumes from Mutton Island and a proposed new outfall west of Oranmore Bay, the potential interaction effects were assessed qualitatively.

The following National, Regional strategy plans, Local area plans, conservation and management plans and road schemes and their potential impact were assessed:

- National Development Plan 2007 – 2013
- National Spatial Strategy 2002 – 2020
- West Regional Planning Guidelines 2010 – 2022
- Galway County Development Plan 2009 – 2015
- Galway City Development Plan 2011 – 2017
- Clare County Development Plan 2011 – 2017
- Galway County Biodiversity Action Plan
- North Clare Local Area Plan 2011 – 2017
- Barna Local Area Plan 2007 – 2013
- Moycullen Local Area Plan 2005 – 2011
- Oranmore Local Area Plan 2006 – 2012

- Headford Local Area Plan 2005 – 2011
- Tuam Local Area Plan 2011 – 2017
- Kinvara Local Area Plan 2005 – 2011
- Claregalway Local Area Plan 2005 - 2011
- Oughterard Local Area Plan 2006 – 2012
- Clarinbridge Local Area Plan 2007 – 2013
- NPWS Conservation Management Plans
- Western River Basin Management Plan 2009 – 2015
- Inland Fisheries Ireland (IFI) Corporate Plan 2011 – 2015
- N59 Moycullen Bypass
- Galway City Outer Bypass (GCOB)

The national and regional strategy plans would be addressed at local level and except for Moycullen Bypass and the GCOB, which were a potential negative impact; all others were assessed as either neutral or positive.

A number of wastewater treatment plants are currently discharging into the Natura 2000 sites subject to this assessment, or have proposed upgrades which will involve discharge to the relevant Natura 2000 sites. In the case of existing treatment plants which operate within the conditions of discharge licences, no potential for cumulative effects is anticipated, if plants work within their discharge licence conditions. In the case of Kinvara, Claregalway and Milltown, funding for some new plants has been approved; the installation of which will result in better water quality within the associated designated sites and therefore within the timescale of the proposed development will not have the potential to result in negative in combination effects.

- Galway Eastern Environs WWTP
- Kinvara WWTP
- Clarinbridge WWTP
- Claregalway WWTP
- Milltown WWTP
- Tuam WWTP
- Headford WWTP
- Oughterard WWTP
- Moycullen WWTP
- Dunkellin Drainage Scheme (flood Relief scheme)
- Lough Corrib Arterial Drainage Maintenance

The following directives were assessed:

7.7.10.2 Water Frame Work Directive

The proposed Galway Harbour extension will alter the classification of that part of Galway Bay from Transitional to Modified.

7.7.10.3 Marine Strategy Framework Directive (MSFD)

As the area where the proposed Galway Harbour extension is to occur is covered by the Water Frame Work Directive, MSFD does not apply to this project.

Proposed/Existing Local Projects and Activities
In addition to the above, private development and coastal activities within the Study Area with the potential for in-combination effects on the Natura 2000 sites have been considered in more detail below.

7.7.10.3.1 Aquaculture

Several parts of Inner Galway Bay including areas within the Galway Bay Complex cSAC and Inner Galway Bay SPA have been designated by the Government as aquaculture sites and these include the following production areas and species that are grown in each:

- Mweeloon Bay mussels and oysters.
- Carraghduff oysters.
- Killeenaran mussels and oysters.
- Clarinbridge mussels and oysters
- Kinvarra Bay mussels and oysters
- Doorus Point oysters.
- Aughinish oysters.
- Poulnaclough mussels and oysters
- Ballyvaughan oysters and clams.

The cultured oyster in Inner Galway Bay is *Crassostrea gigas* also known as the Pacific Oyster. The cultivation method is based on the species being placed in bags and put on steel trestles at low water. The trestles are made of 16 mm steel tubing and are usually approximately 300 mm high and are 2.5-3.0 m long by 1 m wide. Each trestle can hold 5-6 oyster bags, which are held on by rubber bands and/or hooks. The bags vary in mesh size depending on the size of oyster being held. The bags and trestles are re-usable and remain on the shore all year round. These bags are checked on a regular basis *i.e.* low water Spring tides and sorted into different sizes depending on the individuals' growth rates. Bags are also cleaned of any algal growth. The sites are accessed by farmers at low tide using a tractor and trailer. The growing sites are positioned between Mean Low Water Spring and Mean Low Water Neap, allowing 2.5-3.5 hrs exposure per day, depending on weather and tidal conditions.

In Inner Galway Bay, mussels are cultivated by suspended mussel culture systems which involves the collection and wrapping of seed mussels on ropes or similar material, which are hung from rafts or floats. The mussels are typically collected *in situ* by settlement from the plankton and grown on the collecting ropes. As the mussels develop, they are stripped from the ropes, graded for size, tubed (mesh) and re-suspended in the water column. Harvesting usually occurs 18-30 months from settlement.

Clams (*Spisula* sp.) are not cultured in Inner Galway Bay but are fished in the southern part of the bay.

The nearest licensed area for oysters to the proposed new structure is Mweeloon Bay at a distance of *ca* 4 km. Given the low intensity level of activity arising from aquaculture activities and the distance from the proposed development site, no interaction between aquaculture and the development is foreseen.

7.7.10.3.2 Harbour Flights

Planning permission has been given by Galway City Council for sea planes to take off and land in an area to the southwest of Hare Island to take people to and from the Aran Islands and other destinations. This proposal underwent an appropriate assessment and this concluded that as there would be no impact on the Natura sites, an NIS was not required. There is the possibility of in combination effects arising from noise of air craft and air-born noise during the construction and operation periods of the Harbour Extension project.

7.7.10.3.3 Changed Galway Coastline

For a variety of reasons *e.g.* coastal protection works, enhancement projects, the construction of the Mutton Island causeway, the infilling of the area seaward of the Galway Enterprise Park *etc.,* the coastline in the vicinity of Galway City has changed.

Figure 7.7.1 is a part of the 1843 British Admiralty chart showing the coastline from Black Rock to the west, east to Renmore Point including the channel into Lough Atalia. Nimmo's Pier (completed in 1827) can be seen to the west of Renmore Point and the eastern bank of the entrance into Lough Atalia and the southern side of Renmore Point are drawn as uneven shorelines. The area between Fair Hill and Black Rock is also drawn as an uneven shore line. The area at White Strand used to flood at High Spring tides.

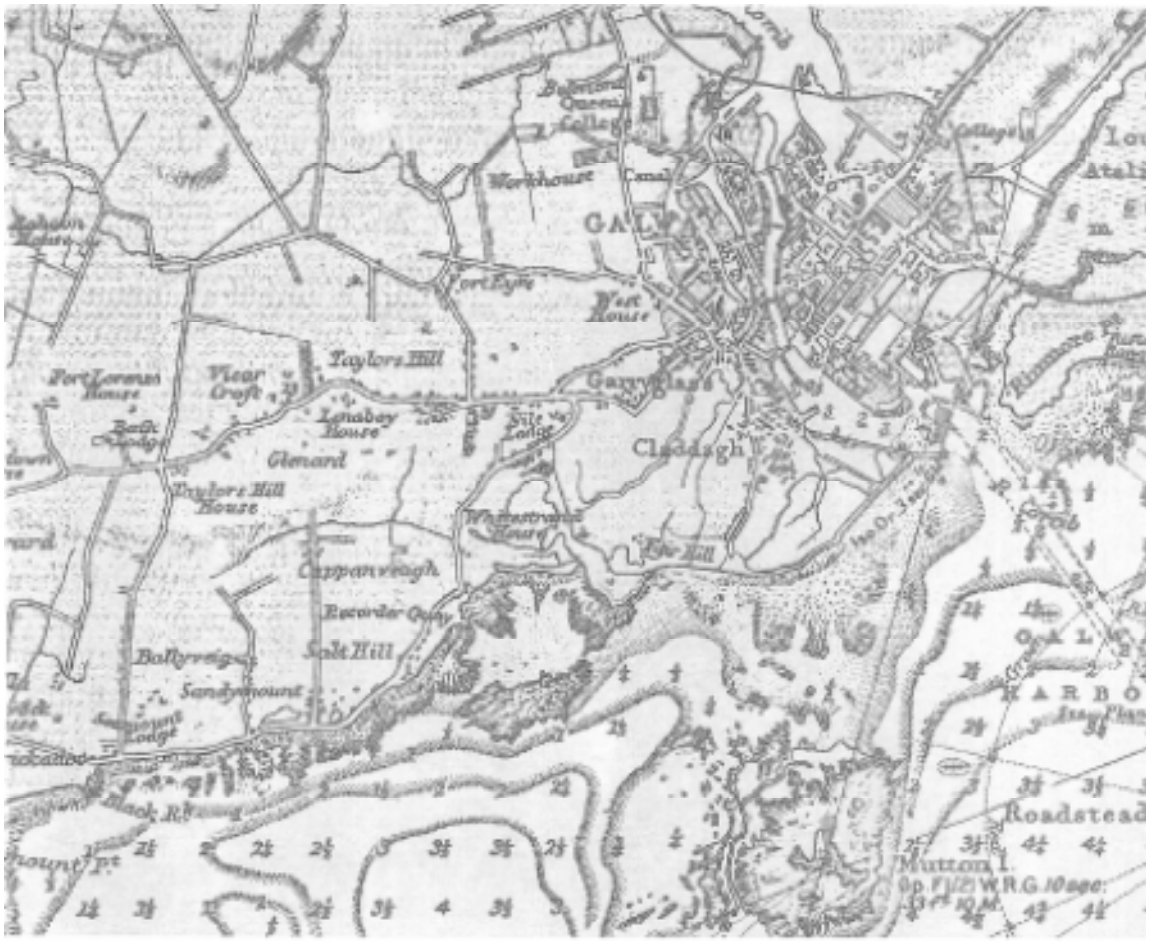


Figure 7.7.1 - Section of Admiralty Chart number 1984 showing the area from Renmore Point to Black Rock ca 1843

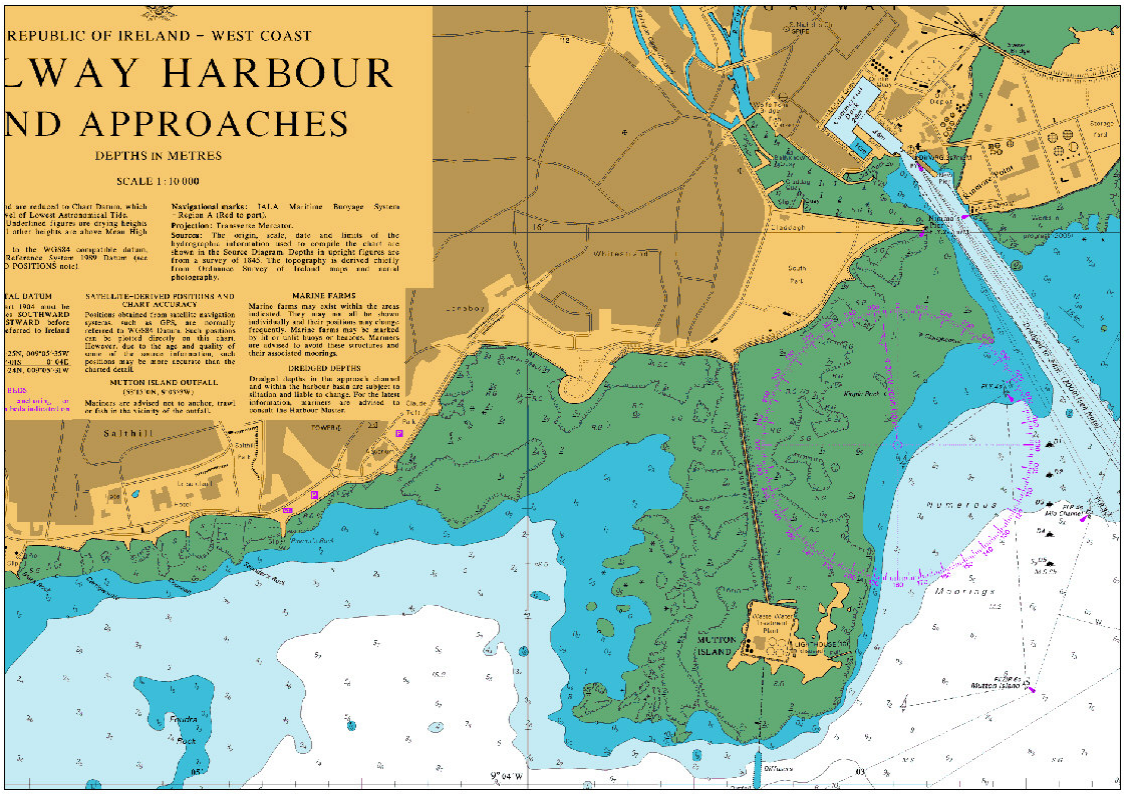


Figure 7.7.2 - Section of Admiralty Chart number 1904 showing approximately the same area in ca 2012

Figure 7.7.2 is a section of Admiralty Chart number 1904 of the same general area and the shore line in the area of the entrance to Lough Atalia and the Galway Enterprise Park can be seen as straight lines. A number of groynes are present to the east of the causeway (not all shown in Figure 7.7.2) and along the coastline at Salt Hill Road upper and the diving board at Black Rock. The coastline between Fair Hill and the Salt Hill Promenade is now straightened and sea access to the area at White Strand has been blocked. The Grattan Park amenity area has been contoured into a regular shape. None of these alterations/structures are considered large enough to have had a significant impact on local oceanography and no in-combination effects are considered likely.

However, the most significant change to the coastline in the vicinity of Galway City was the construction of the Mutton Island Causeway in the early 2000's. This blocked the passage between Mutton Island and the mainland forcing both ebbing and flooding tides around the island. It also diverted the long shore drift southwards around Mutton Island. This is a flow of suspended solids that is generated by wave action and directed by currents steered by prevailing winds which in Galway Bay is predominantly from the west/southwest. The long shore drift is therefore generally clockwise albeit that the general tidal flows are anticlockwise due to the geography of the Bay and the Coriolis effect. The construction of the Mutton Island causeway cut off this long shore drift to the area to east of it. It should be noted that as natural levels of suspended solids in Galway Bay are typically low, rates of accretion due to the long shore drift are also low. Due to the prevailing wind direction, the causeway has also reduced wave action/inshore swell conditions in the same area. The causeway was designed to be overtopped by extremely high tides to curtail shelter induced accretion which is also somewhat curtailed by south easterly storm waves and storm events.

An in combination consequence of the causeway and the harbour extension construction will be to "canalise" the River Corrib, increase current velocities and alter salinity patterns. Migratory fish species will be restricted to this "canal" with the potential for some increased predation by cormorants and seals. However, long term studies have not indicated that either of these potential predators are selective of migratory species. The increases in velocities are predicted to

alter sediment and sedimentation patterns in the area with mobilisation occurring to the west of the harbour extension and deposition happening further to the south of where it currently takes place. The impact of this on benthic fauna is regarded as short term as they will recolonise sediments once the system returns to equilibrium. The changes in salinity in the "canal" are considered too small to have any impact on benthic fauna in that area; however, to the east of the new structure where higher salinity patterns are predicted to occur, some species that are less tolerant to low salinities *e.g.* echinoderms, may colonise the benthos.

Overall, the in combination effects of the causeway and the new structure are not regarded as having any effect on the functioning of the cSAC.

7.7.10.3.4 Ocean Energy Test Site, east of Spiddal.

This site was used to test a wave energy device known as the Ocean Energy Buoy from 2006 to 2011. AQUAFACT carried out a benthic survey during the trial period and after the buoy had been removed. The site had been surveyed as part of a broader benthic survey of Galway Bay in 1975 as part of a Ph. D. programme and these data were used to establish background benthic faunal conditions. The surveys found that mussels which had not been recorded in the 1975 survey, had settled on the buoy and had been sloughed off and had settled to the sea bed.

As the buoy has now been removed, there can be no in combination effects. Due to the distance between the test site and the Galway Harbour Extension location, there will be no in combination effects in the future use of the test site.

7.7.10.3.5 Tarrea pontoon

A local marine engineering firm is planning to construct a small floating structure as a new pier close to Tarrea Pier, Kinvara Bay. AQUAFACT was commissioned to carry out an appropriate assessment of the development. The size of the area that will be partly (floating not equal to land take) lost from the cSAC was determined 1,400 m^2. The appropriate assessment identified no issues of concerns for the integrity of the cSAC nor the SPA and their associated habitats, flora and fauna and no significant negative impacts on these sites. Tarrea is *ca.* 13 km from the proposed development site at Galway City and no in combination effects are predicted if the pontoon is constructed.

7.7.10.3.6 Conclusion of In Combination Effects

Having considered other plans and projects within the vicinity of the relevant Natura 2000 sites, it is regarded that the proposed project and implementation of effective mitigation measures to avoid impacts does not have the potential for further in combination impacts arising in combination with any other plans or projects. This will not result in significant negative impacts on the conservation objectives or integrity of such Natura 2000 sites.

7.7.10.3.7 Assessment of Residual Impacts

An assessment of the residual impacts arising following the implementation of proposed mitigation measures are considered below. These are presented in the context of the residual impacts on the qualifying interests, special conservation interests and conservation objectives of the Lough Corrib cSAC, Lough Corrib SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA.

7.7.11 Attributes and Targets to provide for Favourable Conservation Condition of Relevant Annex I Habitats and Annex II Species

Conservation Objectives are available on the NPWS web site for Galway Bay Complex cSAC and Inner Galway Bay SPA (see Appendix 7.1 for the full documents). NPWS has not yet prepared detailed conservation objectives for Lough Corrib cSAC and Lough Corrib SPA. Indicative conservation objectives and targets for many of the qualifying interests of Lough Corrib cSAC and SPA can be anticipated based on conservation objective documents for Galway Bay cSAC and SPA and these have been considered in the context of the proposed development in the following sections.

Attributes and Targets which are considered to be required to maintain or restore the favourable conservation condition of the screened Annexed Habitats and Species as listed above are outlined below in Table 7.7.1 – Table 7.7.10 for Galway Bay Complex cSAC and Inner Galway Bay SPA.

Areas noted in Tables 7.7.1 – 7.7.11 are to be read in conjunction with the impact areas and asscociated cell references presented in Summary of Impacts Table 7.7.12.

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mudflats and sandflats not covered by seawater at low tide [1140]** and reefs [1170]**** **NPWS describes the intertidal community at the proposed development site as "fucoid-dominated intertidal reef complex", these two habitats are considered together.	
	Attribute: Distribution **Target:** The distribution of reefs is stable or increasing, subject to natural processes.	Permanent loss of *ca* 5.93 ha (see 6B of table 7.7.12) of this habitat.
	Attribute: Habitat Area **Target:** The permanent habitat area is stable or increasing, subject to natural processes. The mud/sandflat habitat area was estimated using OSI data as 744ha. The reef habitat area was estimated as 2,773ha using survey data.	Permanent loss of *ca 5.93* ha of this habitat.
	Attribute: Community Distribution **Target:** Conserve the following community types in a natural condition: intertidal sandy mud community complex and intertidal sand community complex	Permanent loss of *ca* 5.93 ha of this habitat.
	Attribute: Community Extent **Target:** Maintain the extent of the *Mytilus*-dominated reef community, subject to natural processes.	*Permanent loss of ca 5.93 ha of this habitat.*
	Attribute: Community Structure: *Mytilus* density **Target:** Conserve the high quality of the *Mytilus*-dominated community, subject to natural processes.	Permanent loss of *ca* 5.93 ha of this habitat.
	Attribute: Community Structure **Target:** Conserve the following community types in a natural condition: fucoid-dominated community complex, *Laminaria*-dominated community complex, and shallow sponge-dominated community complex.	Permanent loss of *ca* 5.93 ha of this habitat.

Table 7.7.1 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs.

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mudflats and sandflats not covered by seawater at low tide [1140]** and reefs [1170]**** **NPWS describes the intertidal community at the proposed development site as "fucoid-dominated intertidal reef complex", these two habitats are considered together.	
Impacts during Construction Phase	Permanent loss of intertidal plant and animal communities due to infilling in the construction site. Suspended sediment levels will temporarily increase around the construction site; this will have a minimal impact on the neighboring intertidal communities. There is the potential for contamination of the nearby intertidal area if spillages occur during the construction phase; however, strict adherence to the Environmental Management Plan will minimise the impact. (Refer Figure 7.7.3 overleaf).	
Impacts during Operational Phase	The changes to the physical oceanography of the area will result in a change in grain size distribution and therefore faunal communities present; however, model predictions show these changes will only occur in the dredge site and approach channel and these are too far from the intertidal areas to have an impact. The predicted increase in traffic levels will have no impact on the intertidal areas. The intertidal communities to the east of the proposed development will experience increases in salinity and as a result euryhaline species will dominate in these areas. There will be no discharges from the development into the marine environment and therefore there will be no impact from this activity.	
In Combination Effects	Permanent loss of 14.51 ha (6A+6B of table 7.7.12)	
Proposed Mitigation	There are no specific mitigation measures available to reduce the loss of habitat.	
Level of Residual Impact	The permanent loss of 5.93 ha (6A of table 7.7.12) of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality; however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.1 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs.

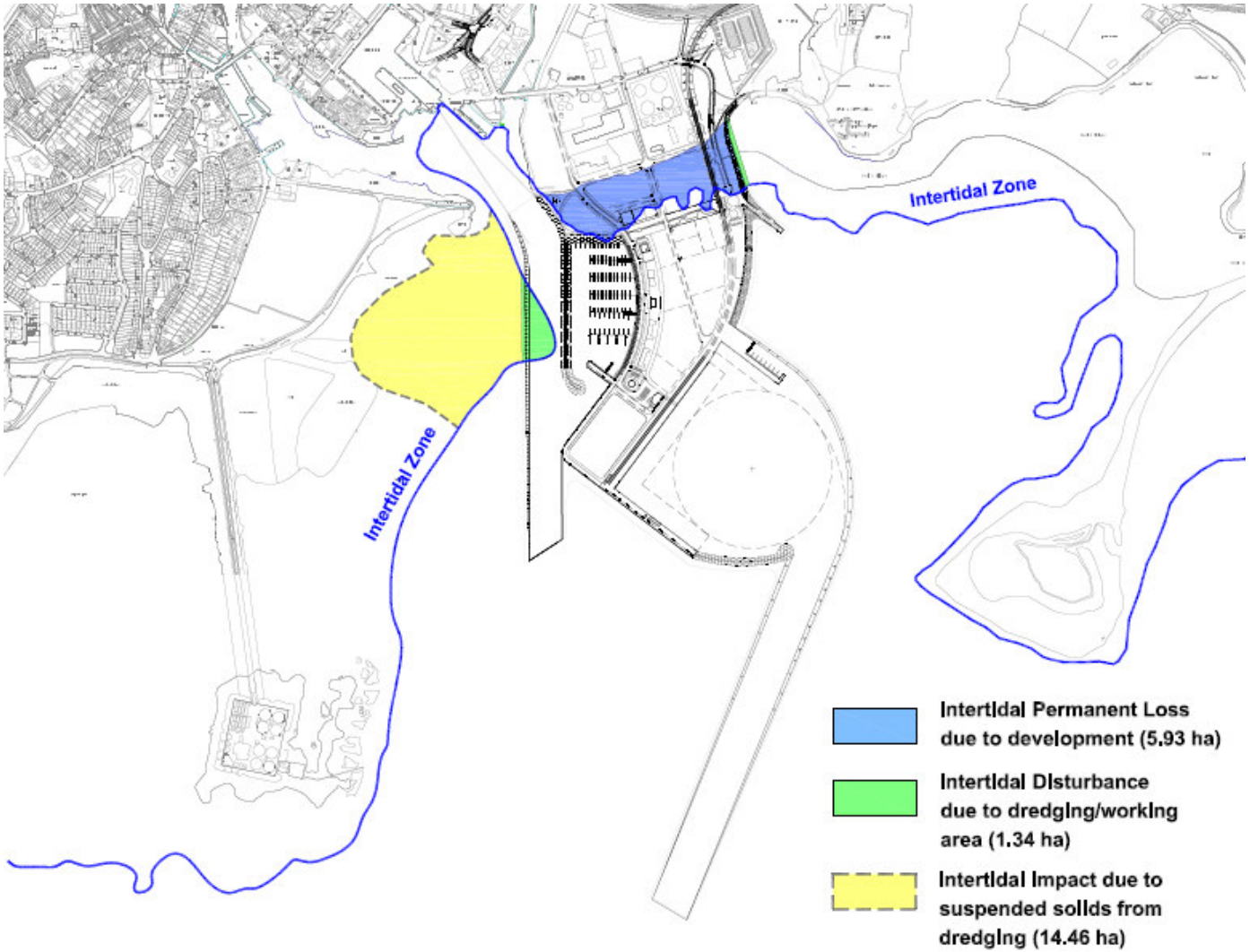


Figure 7.7.3 - Map showing Intertidal Areas

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	. **Coastal lagoons* [1150]**	
	Attribute: Habitat Area **Target:** Area stable subject to slight natural variation.	There will be no impact on the area of Lough Atalia and Renmore Lough.
	Attribute: Habitat distribution **Target:** No decline subject to natural processes.	There will be no impact on the area of Lough Atalia and Renmore Lough.
	Attribute: Salinity regime **Target:** Median annual salinity and temporal variation within natural ranges. The lagoons in the site vary from oligohaline to euhaline. Lough Atalia and Renmore Lough are poikilohaline systems	Fluctuations on the existing variability possible though deemed not to have any impact on the functioning of the ecosystem.
	Attribute: Hydrological regime **Target:** Annual water level fluctuations and minima within natural ranges. Most of the lagoons listed for the site are considered to be shallow; however, Aughinish and Lough Atalia do have deeper (at least 3m) parts.	Water levels will be maintained and will not be altered by the development.
	Attribute: Barrier **Target:** Permeability of barrier maintained. Appropriate hydrological connections between lagoons and sea, including where necessary, appropriate management. The lagoons within this site exhibit a variety of barrier types including cobble/shingle, karst and artificial embankment/causeway. Several are recorded as having sluices.	There will be no impact on the barrier/silll.

Table 7.7.2 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	. **Coastal lagoons* [1150]**	
	Attribute: Water Quality (Chlorophyll a) **Target:** Annual median chlorophyll a reduced within natural ranges and less than 5µg/L. Target based on Roden and Oliver (2010).	There will be no impact on chlorophyll a.
	Attribute: Water Quality (MRP) **Target:** Annual median MRP within natural ranges 0.1mg/L. Target based on Roden and Oliver (2010).	The development will not alter MRP level.
	Attribute: Water Quality (DIN) **Target:** Annual median DIN within natural ranges and less than 0.15mg/L. Target based on Roden and Oliver (2010).	The development will not alter DIN level.
	Attribute: Depth of Macrophyte Colonisation **Target:** Macrophyte colonisation at least 2m depth.	Development will not alter macrophyte communities.
	Attribute: Typical Plant Species **Target:** Maintain number and extent of listed lagoonal specialists, subject to natural variation. Species listed in Oliver (2007).	The development will not alter floral lagoonal specialists.
	Attribute: Typical Animal Invertebrate Species **Target:** Maintain listed lagoon specialists, subject to natural variation. Species listed in Oliver (2007).	The development will not alter faunal lagoonal specialists.

Table 7.7.2 contd/ Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	. **Coastal lagoons* [1150]**	
	Attribute: Negative Indicator Species **Target:** Negative indicator species absent or under control. Low salinity, shallow water and elevated nutrient levels increase the threat of accelerated encroachment by reedbeds.	The development will not alter negative indicator species.
Impacts during Construction Phase	Sediments suspended during the dredging operations have the potential to enter the lagoon. As a result of the oceanographic conditions within the lagoon, this sediment will not be remobilised and will be retained within the lagoon system. The result will be the loss of water depth *(ca* 10mm) in the northeastern portion of the lagoon. This will be controlled by allowing dredging under ebb tides.	
Impacts during Operational Phase	The present range of salinities which vary from 0 to 30 psu, within Lough Atalia will not change, the cumulative annual frequency of zero salinity at the southern part of Lough Atalia will increase from 7 to 18 hours over an average year and the median salinity will reduce by 1.29 psu from the present value. The impact of the additional temporary, seasonal and spatially restricted decreases in salinity to 0 psu within parts of the ecosystems will not affect their status or their ecological functioning.	
In Combination Effects	None identified.	
Mitigation	Impacts from dredging operations will be controlled by only allowing dredging under ebb tides.	
Level of Residual Impact	Fluctuations on the existing variability possible though deemed not to have any impact on the functioning of the ecosystem.	

Table 7.7.2 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

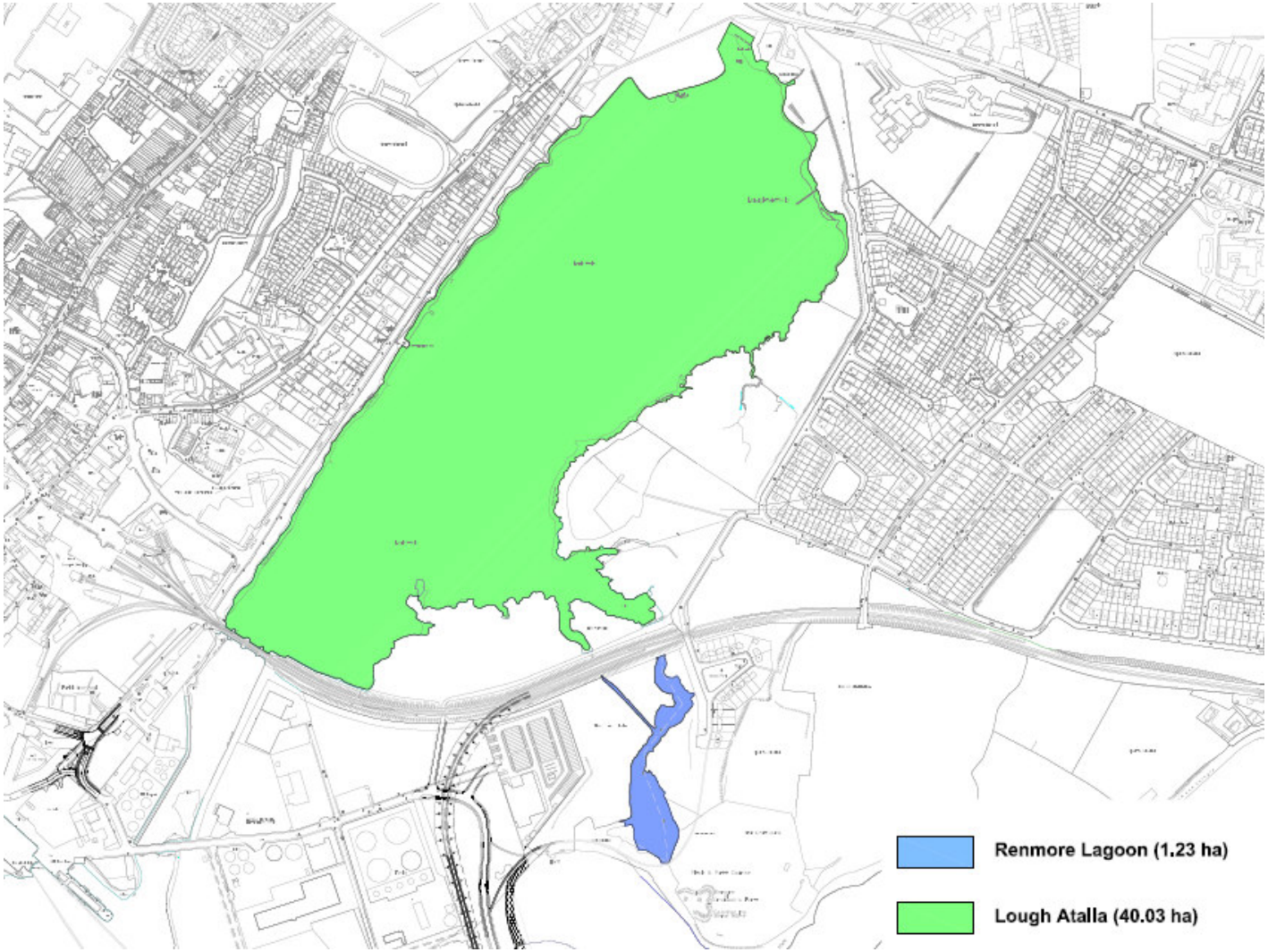


Figure 7.7.4 - Map showing Coastal Lagoons [Priority Habitat]

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Perennial vegetation of stony banks [1220] and Annual vegetation of drift lines (Natura 2000 Code 1210)**	
	Attribute: Habitat Area **Target:** Area stable or increasing, subject to natural processes, including erosion and succession.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Habitat Distribution **Target:** No decline or change in habitat distribution subject to natural processes.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Physical Structure: functionality and sediment supply **Target:** Maintain the natural circulation of sediment and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Vegetation structure: zonation **Target:** Maintain range of coastal habitats including transitional zone, subject to natural processes.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Vegetation composition: typical species and sub communities **Target:** Maintain the typical vegetated shingle flora including range of subcommunities within the different zones.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.
	Attribute: Vegetation composition: negative indicator species **Target:** Negative indicator species (including non-natives) to represent less than 5% cover.	Potential slight impact associated with increased shelter of area. Cannot predict exact level of change.

Table 7.7.3 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs.

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Perennial vegetation of stony banks [1220] and Annual vegetation of drift lines (Natura 2000 Code 1210)**	
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	Potential for slight impact associated with possible increased exposure shelter of habitat following construction of proposed development.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of this habitat, of a total extent of *ca 0.28* ha (1A of table 7.7.12)	
Proposed Mitigation	Further to mitigation by design, no additional suitable mitigation is considered available.	
Level of Residual Impact	Potential for residual negative impact on the targets and attributes of this habitat, a qualifying interest of the Galway Bay Complex cSAC exist. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered likely to be significant as the extent and quality of habitat present is limited, however a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.3 contd./ Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]**	
	Attribute: Habitat Area **Target:** Area increasing, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Habitat Distribution **Target:** No decline or change in habitat distribution, subject to natural processes.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: creeks and pans **Target:** Maintain creek and pan structure subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Physical Structure: flooding regime **Target:** Maintain natural tidal regime.	No impact anticipated.
	Attribute: Vegetation Structure: zonation **Target:** Maintain range of coastal habitat zonations including transitional zones, subject to natural processes, including erosion and succession.	No impact anticipated.

Table 7.7.4 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]**	
	Attribute: Vegetation structure: vegetation height **Target:** Maintain structural variation within sward.	No impact anticipated.
	Attribute: Vegetation structure: vegetation cover. **Target:** Maintain more than 90% area outside creeks vegetated.	No impact anticipated.
	Attribute: Vegetation composition: typical species and sub-communities. **Target:** Maintain range of sub-communities with typical species listed in Saltmarsh Monitoring Project.	No impact anticipated.
	Attribute: Vegetation composition: negative indicator species – *Spartina anglica* **Target:** There is currently no spartina in this cSAC.	No impact anticipated.
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	No impacts are expected during the operational phase.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park have identified loss of Salt Marsh habitat, of a total extent of *ca* 7.69 ha (2A+3A of table 7.7.12) - mosaic of Atlantic and Mediterranean Salt Meadows habitats.	
Proposed Mitigation	Further to mitigation by design, no additional suitable mitigation is considered available.	
Level of Residual Impact	The permanent historic loss of *ca* 7.69 ha (2A+3A of table 7.7.12) of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.4 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mediterranean salt meadows (*Juncetalia maritimi*) [1410]**	
	Attribute: Habitat Area **Target:** Area stable or increasing, subject to natural processes including erosion and succession.	No impact anticipated.
	Attribute: Habitat Distribution **Target:** No decline, subject to natural processes.	No impact anticipated.
	Attribute: Physical Structure: sediment supply **Target:** Maintain/restore natural circulation of sediments and organic matter, without any physical obstructions.	No impact anticipated.
	Attribute: Physical Structure: Creeks and Pans **Target:** Maintain creek and pan structure, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Physical Structure: flooding regime **Target:** Maintain natural tidal regime.	No impact anticipated.
	Attribute: Vegetation Structure: zonation **Target:** Maintain range of coastal habitat zonations including transitional zones, subject to natural processes, including erosion and succession.	No impact anticipated.
	Attribute: Vegetation structure: vegetation height **Target:** Maintain structural variation in the sward.	No impact anticipated.

Table 7.7.5 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annex I Habitat	**Mediterranean salt meadows (*Juncetalia maritimi*) [1410]**	
	Attribute: Vegetation structure: vegetation cover. **Target:** Maintain more than 90% of area outside creeks vegetated.	No impact anticipated.
	Attribute: Vegetation composition: typical species and sub-communities. **Target:** Maintain range of sub-communities with typical species listed in Saltmarsh Monitoring Project.	No impact anticipated.
	Attribute: Vegetation composition: negative indicator species – *Spartina anglica* **Target:** No *Spartina* in the SAC at present.	No impact anticipated.
Impacts during Construction Phase	No loss of, or impact on this habitat is expected during the construction phase.	
Impacts during Operational Phase	No impacts are expected during the operational phase.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of Salt Marsh habitat, of a total extent of *ca* 7.69ha (2A+3A of table 7.7.12) - mosaic of Atlantic and Mediterranean Salt Meadows habitats).	
Proposed Mitigation	Further to mitigation by design, no additional suitable mitigation is considered available.	
Level of Residual Impact	The permanent historic loss of *ca* 7.69 ha (2A+3A of table 7.7.12) of this Annex I habitat equates to a residual negative impact on one of the targets and attributes of the qualifying interest of the Galway Bay Complex cSAC. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are of poor quality, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.5 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Annex II Species Table

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Otter (*Lutra lutra*) [1355]**	
	Attribute: Distribution **Target:** No significant decline	Standard Otter survey technique normally applied to riverine rather than purely marine sites. Current range in Western RBD estimated at 70% (Bailey and Rochford 2006). No decline in overall distribution expected.
	Attribute: Extent of terrestrial habitat **Target:** No significant decline	Area mapped to include 10 metre buffer above HWM on shoreline. HWM on shoreline is against the rock wall of the existing harbour park. Since the land above this rock wall is open dry spoil and bare ground (ED2), this terrestrial habitat is of low potential for Otter. 0.58 ha will be lost (see Fig 7.7.5). A further 0.67 ha will be created (see Fig 7.7.5) by the new land reclamation area. Thus, the development will result in an increase in the total area of the type of terrestrial habitat that is currently available to Otter in the harbour park phase I.
	Attribute: Extent of marine habitat **Target:** No significant decline	Area mapped based on evidence that Otter tend to forage within 80 m of shoreline (HWM). 4.21 ha will be lost (Figure 7.7.6 & 7B of table 7.7.12). A further 16.04 hectares (Fig. 7.7.7 & 7D of table 7.7.12) will be created adjacent to new land reclamation area. Thus, the development will result in an increase in the total area of the type of marine habitat (*i.e.* within 80 m of shoreline) that is currently available to Otter in the harbour park area.
	Attribute: Extent of freshwater (river) habitat **Target:** No significant decline	Proposed development will not affect extent of freshwater habitat.

Table 7.7.6 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Otter (*Lutra lutra*) [1355]**	
	Attribute: Extent of freshwater (lake/lagoon) habitat **Target:** No significant decline	Proposed development will not affect extent of freshwater habitat.
	Attribute: Couching sites and holts **Target:** No significant decline	No known sites/holts will be affected.
	Attribute: Fish biomass available **Target:** No significant decline	Resident freshwater fish, anadromous and catadromous fish are not expected to be affected. No significant effects expected on coastal fish prey species (*e.g.* rockling and wrasse), except loss of 21.00 ha (5B of table 7.7.12) of shallow subtidal habitat at development site (excluding 5.93 ha of intertidal). This is 0.25% of the total designated subtidal area. Probable minor but indeterminate negative impact.
	Attribute: Barriers to connectivity **Target:** No significant increase	Otter will regularly commute across stretches of open water up to 500m wide. The development will lengthen some potential commuting routes (*e.g.* from river mouth to Renmore Lough) but no complete barriers will be formed. No significant loss of connectivity.
Impacts during Construction Phase	There will be direct disturbance within 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat (excluding 5.93 ha of intertidal) as a result of the proposed development and disturbance in the wider area around this, although the available area of terrestrial habitat and subtidal foraging area within 80 metres of the shoreline will be increased. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during the construction works. There is also potential for negative impacts due to pollution from work areas during construction.	

Table 7.7.6 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Otter (*Lutra lutra*) [1355]**	
Impacts during Operational Phase	There will be the loss of 21.00 ha (5B of table 7.7.12) of shallow subtidal habitat at development site (excluding 5.93 ha of intertidal), although the available area of terrestrial habitat and subtidal foraging area within 80 metres of the shoreline will be increased. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during regular maintenance dredging. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during regular maintenance dredging.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of suitable habitat for Otter of a total extent of 5.52ha (5A of table 7.7.12)	
Proposed Mitigation	Exclusion of drilling, blasting and pile driving during the hours of darkness. Limiting individual sizes of blasting charges. Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off. Environmental Management Plan including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.	
Level of Residual Impact	The permanent loss of 21.00 ha (5B of table 7.7.12) of shallow subtidal habitat at development site (excluding 5.93 ha of intertidal), and disturbance within an area of a further 50.44 ha (5C of table 7.7.12) of subtidal habitat equates to a residual negative impact on one of the targets and attributes of otter, a qualifying interest of the Galway Bay Complex cSAC and Lough Corrib cSAC. Similarly, a previous historic loss of *ca* 16 ha associated with previous development within the Galway Harbour Enterprise Park has resulted in cumulative impacts associated with the development (see Fig. 7.7.10 & Drg. 2139-2118 for Habitat Map of Lands pre 1990). This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are extensive in the surrounding area and usage of the site by otter was recorded but not extensive, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.6 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

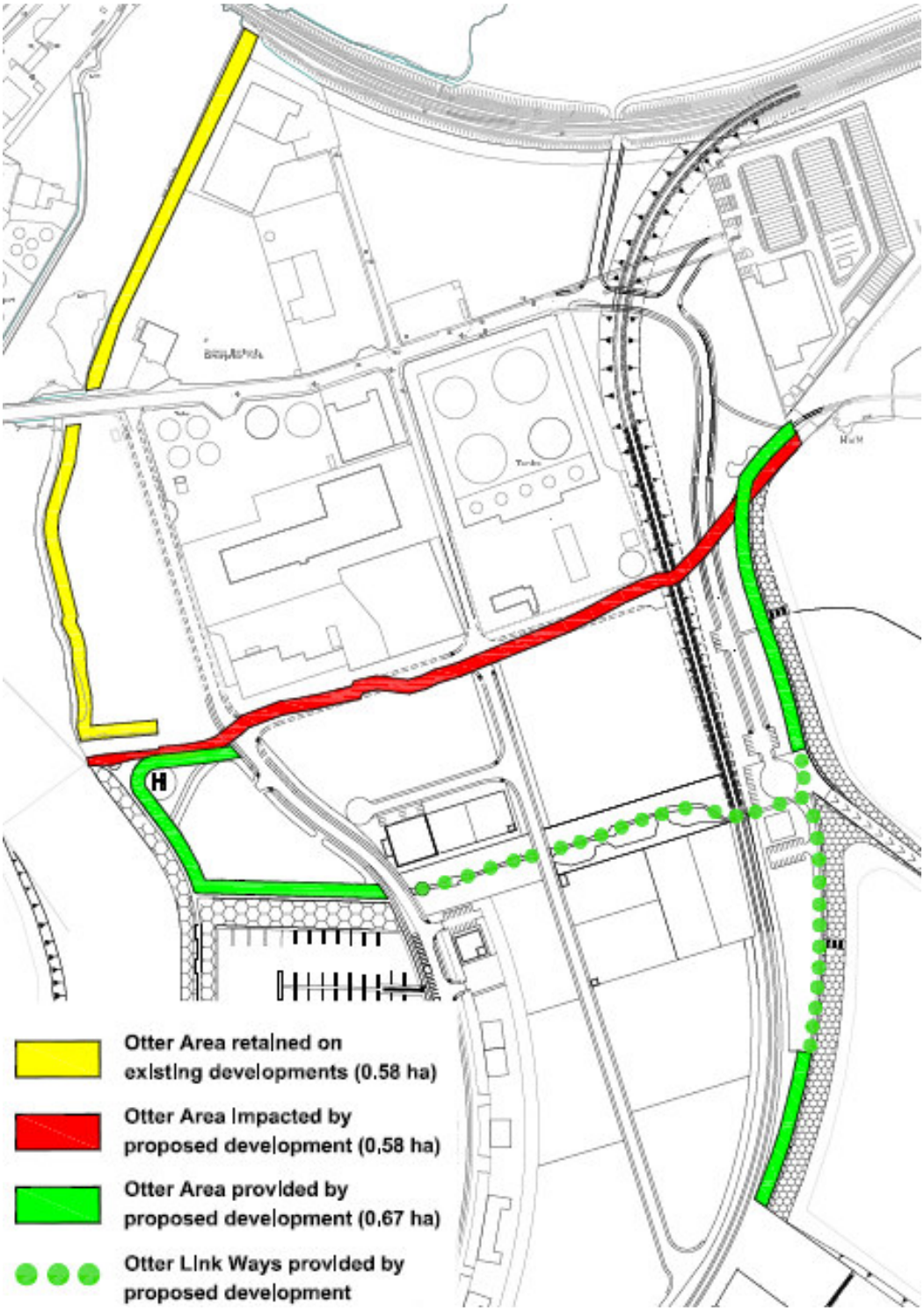
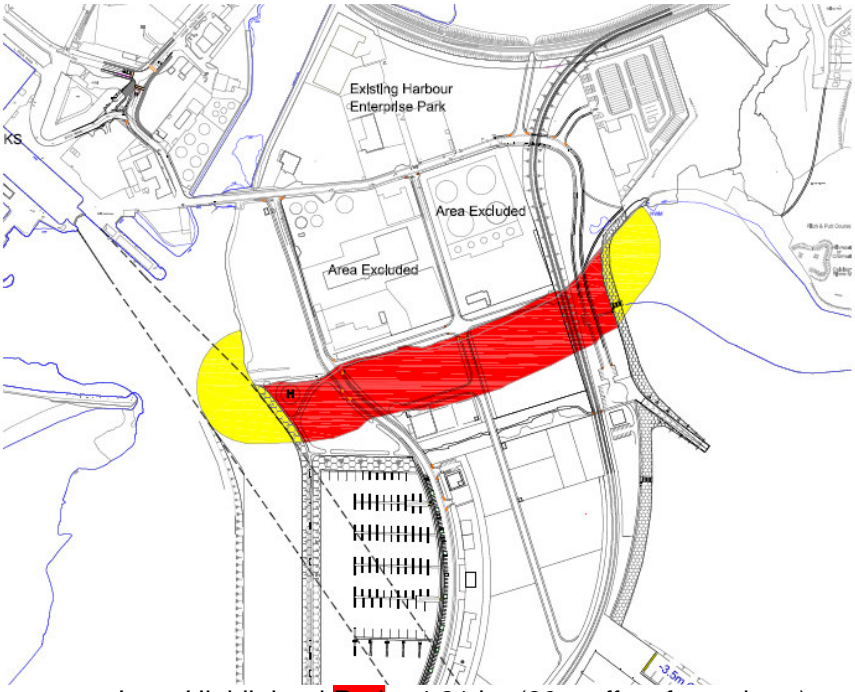
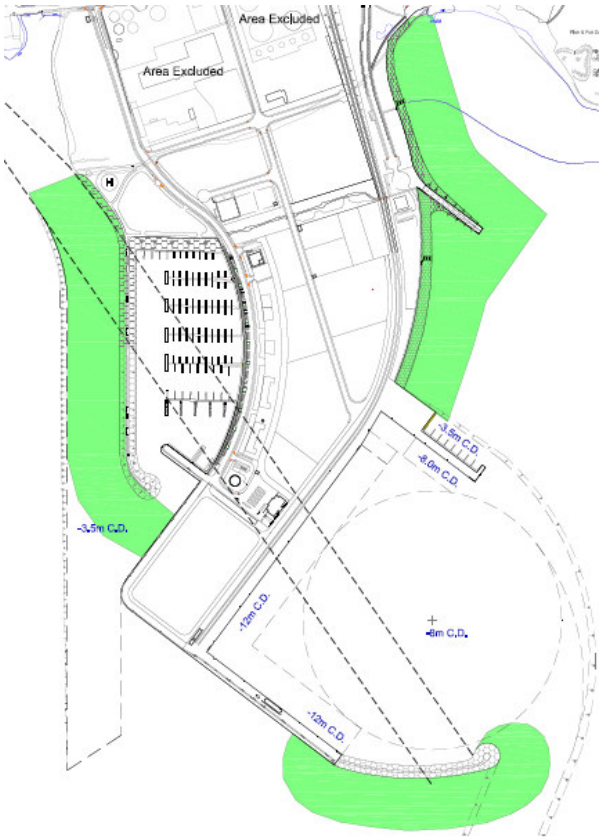


Figure 7.7.5 - Map showing Otter terrestrial areas



Permanent Loss Highlighted Red = 4.21 ha (80m offset from shore)
Temporary Loss Highlighted Yellow 2.04 ha

Figure 7.7.6 - Map showing Otter Marine Habitat Loss



Area of Gain Highlighted Green = 16.04 ha (80m offset from shore)

Figure 7.7.7 - Map showing Otter Marine Habitat Gain

The above maps show the marine area gain relevant to the Otter.

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365]**	
	Attribute: Access to suitable habitat **Target:** Species range within the site should not be restricted by artificial barriers to site use.	The proposed development will alter potential commuting routes for this species in the river mouth area, but the proposed development will not constitute an effective barrier to the movement of this species.
	Attribute: Breeding behaviour **Target:** Conserve breeding sites in a natural condition.	Haul out sites where pups are born will not be affected. Mating occurs in water with male visual and vocal displays (probably lekking) occurring near to haul out sites. These areas will not be affected by the proposed development.
	Attribute: Moulting behaviour **Target:** Conserve moult haul-out sites in a natural condition.	Moult haul-out sites will not be affected by proposed development.
	Attribute: Resting behavior **Target:** Conserve resting haul-out sites in a natural condition.	Resting haul-out sites will not be affected by proposed development.
	Attribute: Disturbance **Target:** Human activities should occur at levels that do not adversely affect the harbour seal population at the site.	Important breeding sites will not be affected by the development. Smaller non-breeding haul-outs are at distance from development footprint. No significant disturbance effects expected post-construction.
	Attribute: Loss of foraging habitat **Target:** No decline, subject to natural processes.	Loss of 26.93 ha (8B of table 7.7.12) of shallow subtidal habitat and intertidal at development site. This is 0.25% of the total designated subtidal area. Probable minor but indeterminate negative impact.

Table 7.7.7 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365]**	
Impacts during Construction Phase	There will be direct disturbance within 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat (excluding 5.93 ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction. Research from the U.K. suggests that there is the potential for seals to be killed by ducted propellers if barges etc. with this propeller type are used in the construction works and perform manoeuvres while either static or moving slowly (*i.e.* while still operating the propeller/propellers). Examination of seal corpses found in the U.K. (eastern Scotland, north Norfolk and Strangford Lough) has led researchers (Thompson *et al*., 2010) to believe that the seal had been killed by being drawn through ducted or cowled ship propellers, such as fixed Kort or Rice nozzles, or ducted azimuth thrusters. Indications are that these accidents are unlikely to have happened as a result of casual collisions. The workers have theorised that the seals were killed after being attracted to the vicinity of the propellers, either as a result of concentrations of prey fish close to vessels, or as an inappropriate response to the acoustic output of the propellers. This type of propeller is common in tugs, construction vessels and construction barges and is used when such vessels are either manoeuvring slowly, or trying to maintain position. This situation could occur for long periods during the construction phase. It should be possible to specify that vessels used by contractors are fitted with grilles or guards to prevent seals being pulled through the ducts. However, there is no way of stopping vessels fitted with such propellers from using the port of Galway and (if the mechanism is as the Sea Mammal Research Unit have posited) speed limits would not have any effect on the impact. It is worth stating that: (1) no dead seals with similar injuries have been found in Galway Bay (2) the impact, as suggested by the report, is theoretical in nature and may not actually exist, (3) it is not possible knowing if the port development will lead to an increase in the use of these types of propeller, or if the use of these types of propeller will change over time even if the development does not go ahead. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during the construction works. There is also potential for negative impacts due to pollution from work areas during construction.	

Table 7.7.7 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365] contd/..**	
Impacts during Operational Phase	There will be a loss of 26.93 ha (8B of table 7.7.12) of potential sub-tidal and intertidal foraging habitat. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during regular maintenance dredging. There is potential for disturbance to feeding by individuals as a result of suspended solids generated during regular maintenance dredging. Research from the U.K. suggests that there is the potential for seals to be killed by ducted propellers if the volume of shipping traffic with this propeller type that is either static or moving slowly while still operating propellers is increased as a consequence of the development.	
In Combination Effects	An assessment of previous works completed at the Galway Harbour Enterprise Park has identified loss of suitable habitat for Harbour Seal of a total extent of 35.51 ha (8A+8B of table 7.7.12)	
Proposed Mitigation	Drilling, blasting and pile driving will be carried out during daylight hours and at low tide. This blasting schedule will coincide with the time when the maximum number of seals are hauled out of the water and will thus be less at risk from blasting activities. The individual sizes of blasting charges will be limited to minimize the size of the area of the zone of potential effect from any individual blast event. If barges with ducted propellers are used during the construction stage and these are likely to be making the types of manoeuvres mentioned above, the fitting of acoustic deterrent devices (ADDs) to them will be considered or vessels will be fitted with mesh screens at the ends of the ducts to prevent seal entry to ducts.	

Table 7.7.7 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Harbour seal (*Phoca vitulina*) [1365]**	
	Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off. Environmental Management Plan including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.	
Level of Residual Impact	The permanent loss of 26.93ha (8B of table 7.7.12) of subtidal and intertidal habitat and disturbance within an area of 71.44 ha of subtidal habitat (excluding intertidal) equates to a residual negative impact on one of the targets and attributes of Harbour Seal, a qualifying interest of the Galway Bay Complex cSAC. Similarly, a previous historic loss of 8ha associated with previous development within the Galway Harbour Enterprise Park has resulted in combination effects associated with the development. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as the habitats present are extensive in the surrounding area and usage of the site by Harbour Seal was recorded but not extensive, however, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.7 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Salmon (*Salmo salar*) [1106]**	
	Attribute: Distribution and extent of anadromy **Target:** Accessibility of river channels from estuary	The proposed development will not affect the accessibility of river channels from the bay.
	Attribute: Adult spawning fish **Target:** Conservation Limit for each system consistently exceeded.	Current Conservation Limit for the Corrib system (1SW & MSW) is being exceeded. It is not expected that this will be affected by the proposed development.
	Attribute: Salmon fry abundance **Target:** Maintain or exceed 0+ fry mean catchment-wide abundance threshold value.	Fry abundance will not be directly affected by proposed development.
	Attribute: Out migrating smolt abundance **Target:** No significant decline.	The proposed development will not affect migrating smolt abundance.
	Attribute: Number and distribution of redds. **Target:** No decline in number and distribution of spawning redds due to anthropogenic causes.	Salmon spawn in freshwater gravels. Redds/red sites will therefore not be affected.
	Attribute: Water quality **Target:** At least Q4 at all sites sampled by EPA.	River/lake quality will not be affected by proposed development.
Impacts during Construction Phase	There will be direct disturbance within 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat (excluding 5.93 ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals during blasting, dredging and pile driving operations during construction.	

Table 7.7.8 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Salmon (*Salmo salar*) [1106]**	
	There is potential for disturbance and/or physical damage to individuals as a result of suspended solids generated during the construction works. However, as salmon regularly swim through estuaries they are conditioned to tolerate increased suspended solids loadings. There is also potential for negative impacts due to pollution from work areas during construction. As no toxic sediments have been discovered in the site investigations, there is no potential of impact of such chemicals during construction.	
Impacts during Operational Phase	There will be a permanent loss of 26.93 ha (9B of table 7.7.12) of subtidal and intertidal habitat. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration during dredging operations. There is potential for disturbance and/or physical damage to individuals as a result of suspended solids generated during regular maintenance dredging.	
In Combination Effects	None identified.	
Proposed Mitigation	Drilling, blasting and pile driving will not be carried out during the hours of darkness. Blasting works will be carried out between 1st August and 31st of March inclusive. The individual sizes of blasting charges will be limited to minimize the size of the area of the zone of potential effect from any individual blast event. Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off. Environmental Management Plan including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.	
Level of Residual Impact	No significant residual impact is predicted.	

Table 7.7.8 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Sea lamprey (*Petromyzon marinus*) [1095]**	
	Attribute: Extent of anadromy **Target:** % of river accessible.	Changes to the vicinity of the eastern side of the mouth of the River Corrib should not affect river accessibility for this species.
	Attribute: Population structure of juveniles **Target:** At least three age/size groups present.	Sites where juveniles likely or possibly found will not be affected.
	Attribute: Juvenile density in fine sediment **Target:** Mean catchment juvenile density at least 1/m^3	Juvenile sites and thus juvenile density will not be directly affected.
	Attribute: Extent and distribution of spawning habitat. **Target:** No decline in extent and distribution of spawning beds.	Spawning bed sites will not be affected.
	Attribute: Availability of juvenile habitat **Target:** More than 50% of sample sites positive	Juvenile habitat will not be affected by proposed development.
Impacts during Construction Phase	There will be direct disturbance within 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat (excluding 5.93 ha of intertidal habitat) (and disturbance in the wider area around this) as a result of the proposed development. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration/shock waves during blasting, dredging and pile driving operations during construction. There is potential for disturbance and/or physical damage to individuals as a result of suspended solids generated during the construction works. However, as sea lamprey regularly swim through estuaries they are conditioned to tolerate increased suspended solids loadings. There is also potential for negative impacts due to pollution from work areas during construction. As no toxic sediments have been discovered in the site investigations, there is no potential of impact of such chemicals during construction.	

Table 7.7.9 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

Attributes and Targets to Provide for Favourable conservation Condition of Relevant Qualifying Interests of cSACs		
Attributes	**Targets**	**Comment on Potential Impact on Attribute/Target**
Annexed Species		
Annex II Species	**Sea lamprey (*Petromyzon marinus*) [1095]**	
Impacts during Operational Phase	There will be a permanent loss of 26.93 ha (10B of table 7.7.12) of subtidal and intertidal habitat. There is potential for physical damage and/or disturbance to be caused to individuals by noise/vibration during operations during regular maintenance dredging. There is potential for disturbance and/or physical damage to individuals as a result of suspended solids generated during regular maintenance dredging.	
In Combination Effects	None identified.	
Proposed Mitigation	Drilling, blasting and pile driving will not be carried out during the hours of darkness. Blasting works will be carried out between 1st August and 31st of March inclusive. The individual sizes of blasting charges will be limited to minimize the size of the area of the zone of potential effect from any individual blast event. Infill/reclamation area lined with geotextile membrane to minimize impacts from suspended solid run off. Environmental Management Plan including measures on the storage and disposal of oily wastes, maintenance procedures for machinery etc, monitoring of levels of suspended solids and best practice with respect to the pouring of concrete.	
Level of Residual Impact	No significant residual impact is predicted.	

Table 7.7.9 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of cSACs

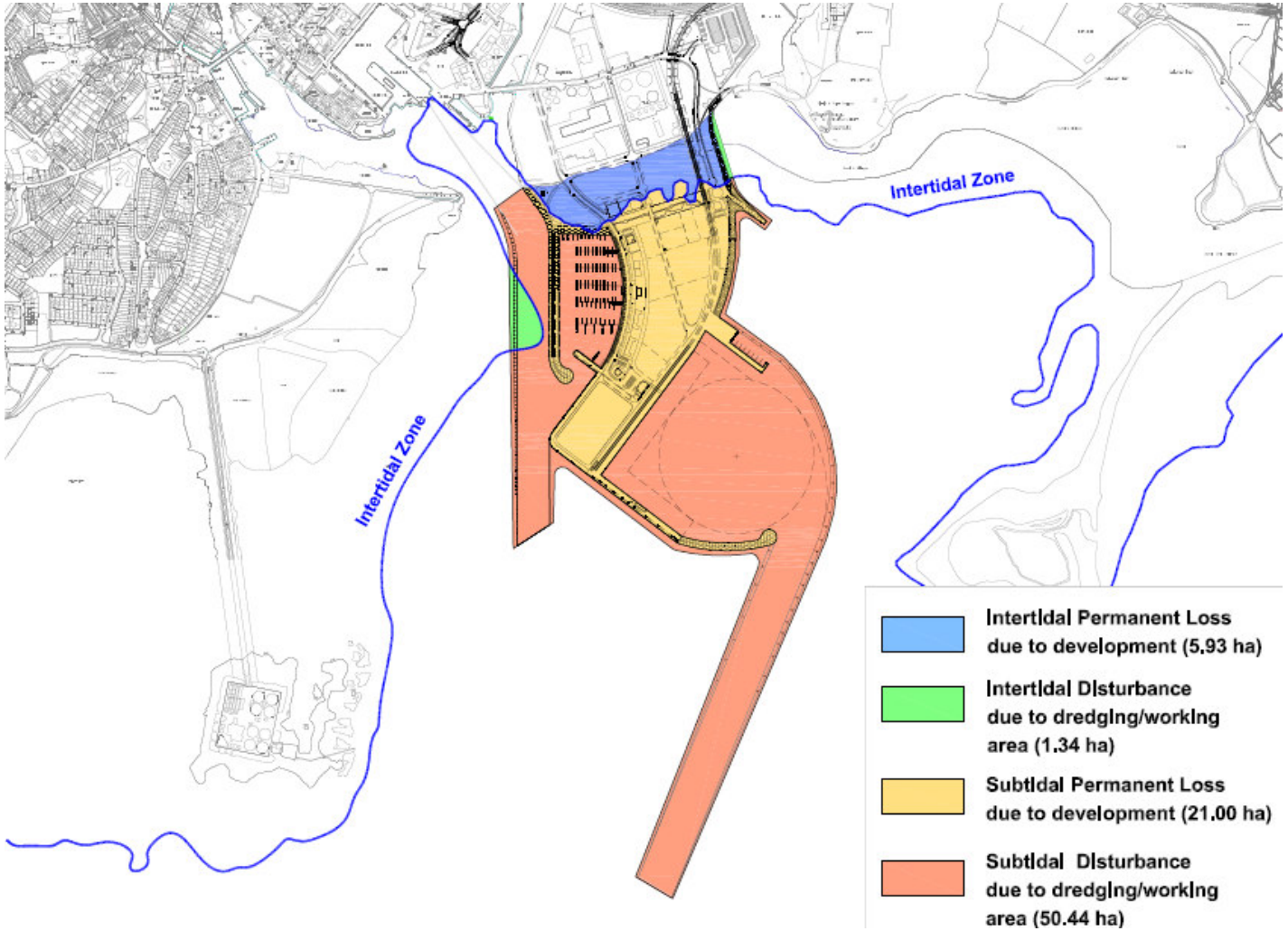


Figure 7.7.8 - Birds, intertidal and subtidal losses

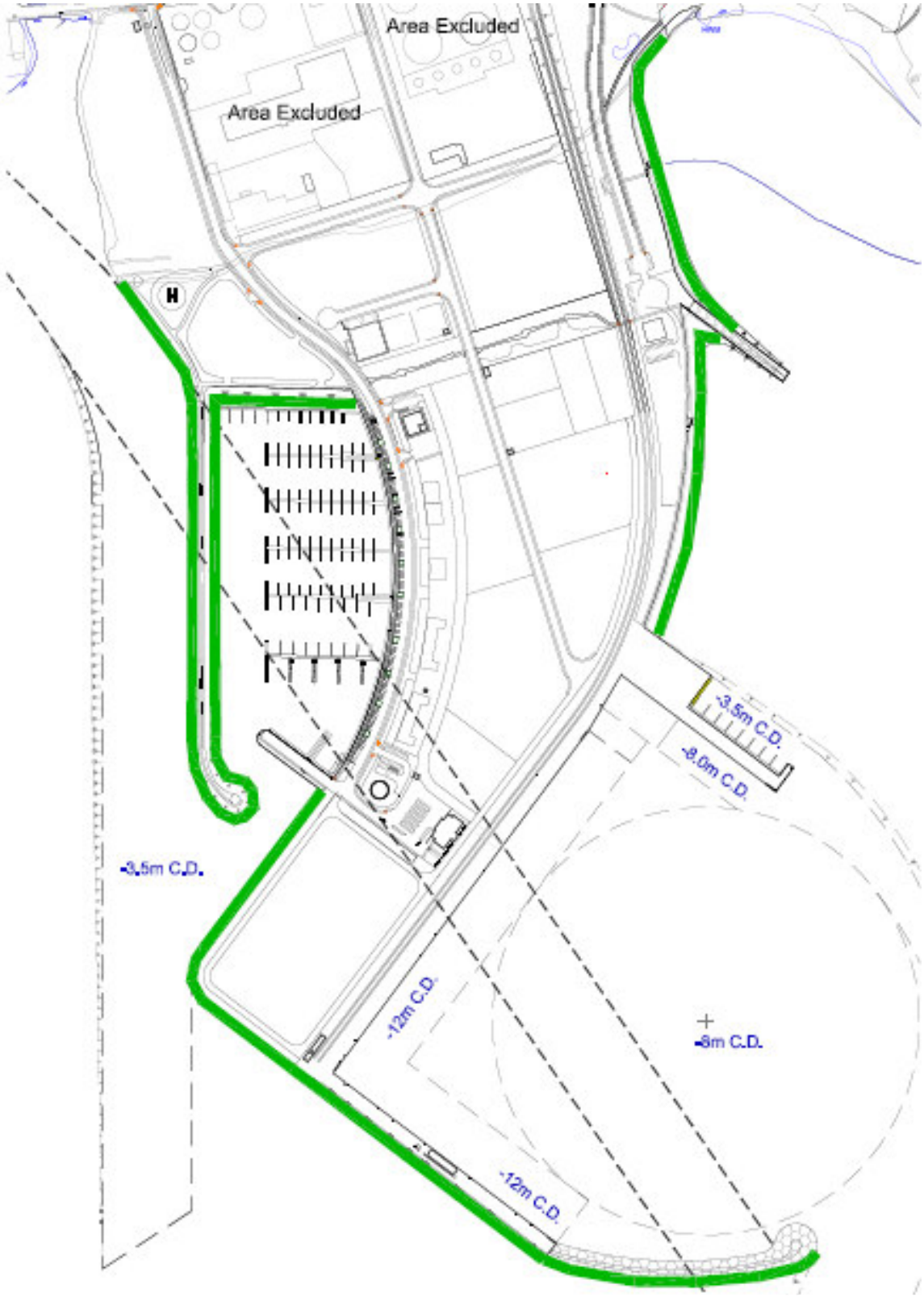


Figure 7.7.9 - Map Showing Intertidal Gain

Intertidal Gain shown highlighted Green = 1.69 ha

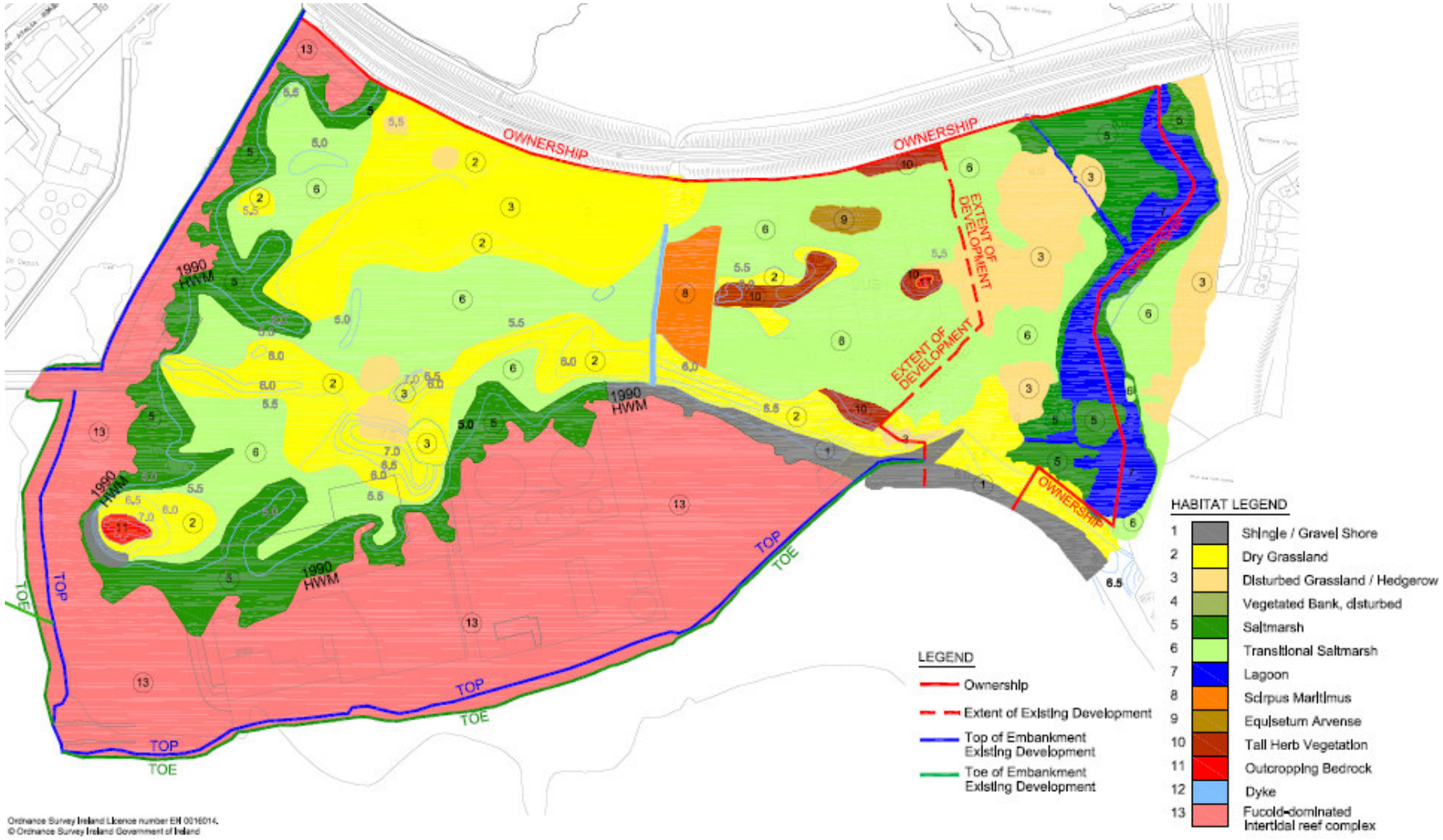


Figure 7.7.10 - Map Showing GHEP Lands Pre 1990 – (Extract from Drg 2139-2118)

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
Annex I species	**Great Northern Diver (*Gavia immer*) [A003]**	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 26.93 ha (11B of table 7.7.12) of foraging and roosting habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Great Northern Diver, other than that occurring from natural patterns of variation	Loss of *ca* 26.93 ha (11B of table 7.7.12) of marine subtidal and intertidal habitat will constitute a potential range decrease of approximately 0.2% of the 12,912 hectares of marine subtidal habitat (as per NPWS SPA polygons) in the SPA. The potential significance of this loss in the wider Galway Bay area (*i.e.* including areas not designated, but where the species does winter) will be less.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species (e.g. due to noise and inaudible vibrations and potentially due to suspension of solids during construction work). These impacts would be short-term and, since the area affected (potentially the marine area of the development footprint, 78.71 ha (11B+11C of table 7.7.12)) is small in relation to the overall available marine area, they are not likely to be significant, but are indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Temporary loss of 51.78 ha subtidal habitat(11C of table 7.7.12)	
Impacts during Operational Phase	There will be the permanent loss of 26.93 ha (11B of table 7.7.12) of marine habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available marine area, this impact is not likely to be significant, but is indeterminate.	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 26.93 ha (11B of table 7.7.12)of subtidal and intertidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Cormorant (*Phalacrocorax carbo*) [A017]	
	Attribute: Breeding population abundance: apparently occupied nests (AONs) **Target:** No significant decline	No significant decline is predicted as a result of the proposed development.
	Attribute: Productivity rate **Target:** No significant decline	No significant decline is predicted.
	Attribute: Distribution: breeding colonies **Target:** No significant decline	No negative effect on the current breeding colony on Deer Island is expected.
	Attribute: Prey biomass available **Target:** No significant decline	No significant decline is predicted.
	Attribute: Barriers to connectivity **Target:** No significant increase	This species regularly flies over land, built areas in port sites and over urban areas. The proposed port development will not constitute a barrier between remaining marine areas of the SPA for the species.
	Attribute: Disturbance at breeding site **Target:** Human activities should occur at levels that do not adversely affect the breeding cormorant population	Activities connected with the construction and operation of the proposed development are not expected to cause disturbance at the known current breeding site.
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 26.93 (11B of table 7.7.12) ha of foraging including *ca* 5.93 ha of roosting habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the numbers or range of areas used by Cormorant, other than that occurring from natural patterns of variation	Loss of *ca* 26.93 ha (11B of table 7.7.12) of marine subtidal habitat will constitute a potential range decrease of approximately 0.2% of the 12,912 hectares of marine subtidal habitat (as per NPWS SPA polygons) in the SPA. The loss of *ca* 5.93 ha (6B of table 7.7.12) of potential roosting habitat rocky shore is also minor, since there is a large amount of such habitat in the SPA. The decrease in range within the within the SPA will probably be insignificant, but this is indeterminate. The potential significance of this loss in the wider Galway Bay area (i.e. including areas not designated, but where the species does winter) will be negligible.

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Cormorant (*Phalacrocorax carbo*) [A017] contd/.	
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species (*e.g.* due to noise and inaudible vibrations and potentially due to suspension of solids during construction work). These impacts would be short-term and, since the area affected (potentially the marine area of the development footprint, 51.78 ha) is small in relation to the overall available marine area, they are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 26.93 ha (11B of table 7.7.12) of marine habitat (foraging and roosting) including 5.93 ha (6B of table 7.7.12) of inter-tidal habitat (roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available marine area, this impact is not likely to be significant, but is indeterminate. No direct impacts are expected on the breeding colony on Deer Island.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Temporary loss of 51.78 ha (11C of table 7.7.12) subtidal habitat	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 26.93 ha (11B of table 7.7.12) of subtidal and intertidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Grey Heron (*Ardea cinerea*) [A028]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal foraging and roosting habitat are unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Grey Heron, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal foraging and roosting habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species (*e.g.* due to noise and inaudible vibrations and potentially due to suspension of solids during construction work). These impacts would be short-term and, since the area affected (potentially the intertidal area of the development footprint, 5.93 ha) is small in relation to the overall available marine area, they are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of intertidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available marine area, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 5.93 ha intertidal habitat (6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat and disturbance within an area of 51.78 ha of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Light-bellied Brent Goose (*Branta bernicla hrota*) [A046]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal and *ca* 21.00 ha (5B of table 7.7.12) of subtidal habitat are unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Brent Goose, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal and *ca* 21.00 ha of subtidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to food sources. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 5.93 ha of inter-tidal habitat and 21.00 ha of subtidal habitat. The supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available intertidal area of this type (which is virtually ubiquitous within the SPA, as is the Brent Goose itself), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of inter-tidal habitat and 21.00 ha of subtidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available intertidal area of this type and the number of birds using the site of the proposed development is relatively few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha (6B of table 7.7.12) of intertidal habitat, 21.00 ha (5B of table 7.7.12) of subtidal habitat and disturbance within an area of 51.78 ha of subtidal and intertidal habitat (11C of table 7.7.12) equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Wigeon (*Anas penelope*) [A050]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal and *ca* 21.00 ha (5B of table 7.7.12) of subtidal habitat are unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Wigeon, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal and *ca* 21.00 ha of subtidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to food sources. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 5.93 ha of inter-tidal habitat and 21.00 ha of subtidal habitat. The supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available intertidal area of this type (which is virtually ubiquitous within the SPA, as is Wigeon itself), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93ha of inter-tidal habitat and 21.00 ha of subtidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available intertidal area of this type and the number of birds using the site of the proposed development is relatively few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha (6B of table 7.7.12) of intertidal habitat, 21.00 ha (5B of table 7.7.12) of subtidal habitat and disturbance within an area of 51.78 ha of subtidal and intertidal habitat (11C of table 7.7.12) equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Teal (*Anas crecca*) [A052]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend (especially since Teal was not recorded at the site of the proposed development), although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Teal, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be zero/insignificant, but this is indeterminate.
Impacts during Construction Phase	Due to the fact that this species has not been recorded using the site during one year of survey work in 2011/2012, potential disturbance impacts during the construction phase are not considered significant.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of intertidal habitat (potential for foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since survey work has indicated that this area is not significant for Teal within the SPA and the species has not been recorded at the site, this impact is not adjudged to be significant.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Shoveler (*Anas clypeata*) [A056]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend (especially since Shoveler was not recorded at the site of the proposed development), although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Shoveler, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be zero/insignificant, but this is indeterminate.
Impacts during Construction Phase	Due to the fact that this species has not been recorded using the site during one year of survey work in 2011/2012, potential disturbance impacts during the construction phase are not considered significant.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of intertidal habitat (potential for foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since survey work has indicated that this area is not significant for Shoveler within the SPA and the species has not been recorded at the site, this impact is not adjudged to be significant.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Red-breasted Merganser (*Mergus serrator*) [A069]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 26.93 ha (11B of table 7.7.12) of foraging habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Red-breasted Merganser, other than that occurring from natural patterns of variation	Loss of *ca* 26.93 ha of marine subtidal and intertidal habitat will constitute a potential range decrease of approximately 0.2% of the 12,912 ha of marine subtidal habitat (as per NPWS SPA polygons) in the SPA, the significance of which is debatable. The potential significance of this loss in the wider Galway Bay area (i.e. including areas not designated, but where the species does winter) will be less.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to food sources. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 51.78 ha (11C of table 7.7.12) of subtidal and intertidal marine habitat within the construction footprint. Since the area that will be lost is small in relation to the overall available marine area of this type (which is common within the SPA close to shoreline), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of approximately 21.00 ha (5B of table 7.7.12) of subtidal habitat (foraging) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available subtidal area of this type and the number of birds using the site of the proposed development is relatively few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Temporary loss of 51.78 ha subtidal and intertidal habitat (11C of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 21.00 ha (5B of table 7.7.12) of subtidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Ringed Plover (*Charadrius hiaticula*) [A137]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat that will be lost has been assessed as unsuitable for this species (apparently too muddy a substrate to be suitable). The species was not recorded in the intertidal area during survey work.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Ringed Plover, other than that occurring from natural patterns of variation	It is considered that the range of this species within the SPA will not be affected.
Impacts during Construction Phase	This species was not recorded using the intertidal zone of the site during one year of survey work (in 2011/2012), a fact that is all the more significant given its known high site fidelity at non-breeding sites. Thus, the potential for disturbance impacts during the construction phase is not considered significant.	
Impacts during Operational Phase	Survey work at the site of the proposed development, coupled with habitat type and the known high site fidelity of Ringed Plover, indicate that this site is not of significance for this species within the SPA. Therefore, no significant impacts are anticipated. Flocks of Ringed Plover were observed flying over water through the study area during the bird surveys. Birds were also observed feeding on sediment near Nimmo's Pier and small numbers feed at Ballyloughaun beach. The possibility that Ringed Plover might be deterred from commuting between these areas, or might have to fly further to do so because of an unwillingness to overfly the new harbour construction was considered. Ringed Plover in inner Galway Bay quickly habituated to the Mutton Island causeway after its construction and can be seen readily overflying it. Ringed Plover also readily overfly large piers at both high and low tides. The probability of a negative impact on Ringed Plover due to habitat fragmentation or increased commuting distances is considered to be very low (and likely to be short-term before habituation occurs), but it cannot be completely ruled out.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
Annex I species	**Golden Plover (*Pluvialis apricaria*) [A140]**	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend (especially since Golden Plover was not recorded at the site of the proposed development), although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Golden Plover, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be zero/insignificant, but this is indeterminate.
Impacts during Construction Phase	This species was not recorded using the intertidal zone of the site during one year of survey work (in 2011/2012). Thus, the potential for disturbance impacts during the construction phase is not considered significant.	
Impacts during Operational Phase	Survey work at the site of the proposed development, coupled with habitat type, indicate that this site is not of significance for this species within the SPA. Therefore, no significant impacts are anticipated.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Lapwing (*Vanellus vanellus*) [A142]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend (especially since Lapwing was not recorded at the site of the proposed development), although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Lapwing, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be zero/insignificant, but this is indeterminate.
Impacts during Construction Phase	This species was not recorded using the intertidal zone of the site during one year of survey work (in 2011/2012). Thus, the potential for disturbance impacts during the construction phase is not considered significant.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of intertidal habitat (some potential for roosting) caused by the construction of the proposed harbour and land reclamation area. Survey work at the site of the proposed development, coupled with habitat type, indicate that this site is not of significance for this species within the SPA. Consequently, this impact is not adjudged to be likely or significant.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Dunlin (*Calidris alpina alpina*) [A149]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca 5*.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend (especially since Dunlin was not recorded at the site of the proposed development), although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Dunlin, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be zero/insignificant, but this is indeterminate.
Impacts during Construction Phase	This species was not recorded using the intertidal zone of the site during one year of survey work (in 2011/2012). Thus, the potential for disturbance impacts during the construction phase is not considered significant.	
Impacts during Operational Phase	Survey work at the site of the proposed development, coupled with habitat type, indicate that this site is not of significance for this species within the SPA. Therefore, no significant impacts are anticipated.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
Annex I species	**Bar-tailed Godwit (*Limosa lapponica*) [A157]**	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat that will be lost has been assessed as unsuitable for this species (apparently too muddy a substrate to be suitable). The species was not recorded in the intertidal area during survey work.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Bar-tailed Godwit, other than that occurring from natural patterns of variation	It is considered that the range of this species within the SPA will not be affected.
Impacts during Construction Phase	This species was not recorded using the intertidal zone of the site during one year of survey work (in 2011/2012). Thus, the potential for disturbance impacts during the construction phase is not considered significant.	
Impacts during Operational Phase	Survey work at the site of the proposed development, coupled with habitat type (the correct type of feeding substrate for this species is not available, even at low tide), indicates that this site is not of significance for this species within the SPA. Flocks of Bar-tailed Godwit were observed flying over water through the study area during the bird surveys. Birds were also observed feeding on sediment near Nimmo's Pier and small numbers feed at both Renmore Beach and Ballyloughaun beach. The possibility that Bar-tailed Godwit might be deterred from commuting between these areas, or might have to fly further to do so because of an unwillingness to overfly the new harbour construction was considered. Bar-tailed Godwit in inner Galway Bay quickly habituated to the Mutton Island causeway after its construction and can be seen readily overflying it. Godwits also readily overfly large piers at both high and low tides. The probability of a negative impact on Bar-tailed Godwit due to habitat fragmentation or increased commuting distances is considered to be very low (and likely to be short-term before habituation occurs), but it cannot be completely ruled out.	
In Combination Effects	Permanent loss of 14.51 ha intertidal habitat (6A+6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	None proposed.	
Level of Residual Impact	No significant residual impact is expected.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Curlew (*Numenius arquata*) [A160]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Curlew, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 5.93 ha of inter-tidal habitat, the supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available intertidal area of this type (which is virtually ubiquitous within the SPA, as is the Curlew itself), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of inter-tidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available intertidal area and the number of birds using the site of the proposed development is few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 5.93 ha intertidal habitat5.93 ha (6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat5.93 ha (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Redshank (*Tringa totanus*) [A162]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Redshank, other than that occurring from natural patterns of variation	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 5.93 ha of inter-tidal habitat, the supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available intertidal area of this type (which is virtually ubiquitous within the SPA, as is the Redshank itself), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of inter-tidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available intertidal area and the number of birds using the site of the proposed development is few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 5.93 ha intertidal habitat5.93 ha (6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat5.93 ha (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Turnstone (*Arenaria interpres*) [A169]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal habitat is unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Turnstone, other than that occurring from natural patterns of variation.	The range decrease caused by the loss of *ca* 5.93 ha of intertidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The area affected is 5.93 ha of inter-tidal habitat, the supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available intertidal area of this type (which is virtually ubiquitous within the SPA, as is the Turnstone itself), these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 5.93 ha of inter-tidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available intertidal area of this type and the number of birds using the site of the proposed development is relatively few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 5.93 ha intertidal habitat (6B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat and disturbance within an area of 51.78 ha (11C of table 7.7.12) of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Black-headed Gull (*Chroicocephalus ridibundus*) [A179]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal and *ca* 21.00 ha (5B of table 7.7.12) of subtidal habitat are unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Black-headed Gull, other than that occurring from natural patterns of variation.	The range decrease caused by the loss of *ca* 5.93 ha of intertidal and *ca* 21.00 ha of subtidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The areas affected are 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat and 5.93 ha of inter-tidal habitat, the supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available area of these habitat types and given the wide range of habitats that can be utilised by this species, these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 21.00 ha of subtidal habitat and 5.93 ha of intertidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available areas of these habitat types and the number of birds using the site of the proposed development is relatively few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat, 21.00 ha of subtidal habitat and disturbance within an area of 51.78 ha of subtidal and intertidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
	Common Gull (*Larus canus*) [A182]	
	Attribute: Population trend **Target:** Long term population trend stable or increasing	The loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal and *ca* 21.00 ha (5B of table 7.7.12) of subtidal habitat are unlikely to influence the population trend, although this impact is indeterminate.
	Attribute: Distribution **Target:** No significant decrease in the range, timing or intensity of use of areas by Common Gull, other than that occurring from natural patterns of variation.	The range decrease caused by the loss of *ca* 5.93 ha (6B of table 7.7.12) of intertidal and *ca* 21.00 ha (5B of table 7.7.12) of subtidal habitat will probably be insignificant, but this is indeterminate.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging and roosting birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The areas affected are 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat and 5.93 ha of inter-tidal habitat, the supra-tidal habitat that will be lost being unsuitable for this species. Since the area that will be lost is small in relation to the overall available area of these habitat types, these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 21.00 ha (5B of table 7.7.12) of subtidal habitat and 5.93 ha of inter-tidal habitat (foraging and roosting) caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available areas of these habitat types and the number of birds using the site of the proposed development is few, this impact is not likely to be significant, but is indeterminate.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging and roosting habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 5.93 ha of intertidal habitat, 26.93 ha (11B of table 7.7.12) of subtidal habitat and disturbance within an area of 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
Annex I species	**Sandwich Tern (*Sterna sandvicensis*) [A191]**	
	Attribute: Breeding population abundance: apparently occupied nests (AONs) **Target:** No significant decline	No significant decline is predicted as a result of the proposed development.
	Attribute: Productivity rate **Target:** No significant decline	No significant decline is predicted.
	Attribute: Distribution: breeding colonies **Target:** No significant decline	No negative effects on the current breeding colony in Corranroo Bay are expected.
	Attribute: Prey biomass available **Target:** No significant decline	No significant decline is predicted.
	Attribute: Barriers to connectivity **Target:** No significant increase	This species regularly flies over land and over built areas in port sites. The proposed port development will not constitute a barrier between remaining marine areas of the SPA for the species.
	Attribute: Disturbance at breeding site **Target:** Human activities should occur at levels that do not adversely affect the breeding Sandwich Tern population.	Activities connected with the construction and operation of the proposed development are not expected to cause disturbance at the known current breeding sites.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The areas affected are 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat within the construction footprint. Since the area that will be lost is small in relation to the overall available area of shallow subtidal habitat in the SPA, these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 21.00 ha (5B of table 7.7.12) of subtidal foraging habitat caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available areas of this habitat type and the numbers of birds using the site of the proposed development are relatively few, this impact is not likely to be significant, but is indeterminate. No direct negative impacts on the breeding colony in Corranroo Bay are expected.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 21.00 ha (5B of table 7.7.12) of subtidal habitat and disturbance within an area of 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
SCI Species		
Annex I species	**Common Tern (*Sterna hirundo*) [A193]**	
	Attribute: Breeding population abundance: apparently occupied nests (AONs) **Target:** No significant decline	No significant decline is predicted as a result of the proposed development.
	Attribute: Productivity rate **Target:** No significant decline	No significant decline is predicted.
	Attribute: Distribution: breeding colonies **Target:** No significant decline	No negative effects on the current breeding colonies on Rabbit Island and in Corranroo Bay are expected.
	Attribute: Prey biomass available **Target:** No significant decline	No significant decline is predicted.
	Attribute: Barriers to connectivity **Target:** No significant increase	This species regularly flies over land and over built areas in port sites. The proposed port development will not constitute a barrier between remaining marine areas of the SPA for the species.
	Attribute: Disturbance at breeding site **Target:** Human activities should occur at levels that do not adversely affect the breeding Common Tern population.	Activities connected with the construction and operation of the proposed development are not expected to cause disturbance at the known current breeding sites.
Impacts during Construction Phase	Expected impacts during the construction phase include various forms of disturbance. These include direct disturbance to foraging birds and disturbance to prey species. These impacts would be short-term, but would be followed by a permanent loss of habitat. The areas affected are 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat within the construction footprint. Since the area that will be lost is small in relation to the overall available area of shallow subtidal habitat in the SPA, these impacts are not likely to be significant, but are indeterminate.	
Impacts during Operational Phase	There will be the permanent loss of 21.00 ha (5B of table 7.7.12) of subtidal foraging habitat caused by the construction of the proposed harbour and land reclamation area. Since the area affected is small in relation to the overall available areas of this habitat type and the numbers of birds using the site of the proposed development are relatively few, this impact is not likely to be significant, but is indeterminate. No direct negative impacts on the breeding colonies on Rabbit Island and in Corranroo Bay are expected.	
In Combination Effects	Permanent loss of 35.51 ha marine habitat (11A+11B of table 7.7.12) Permanent loss of 7.97 ha terrestrial habitat (4A of table 7.7.12)	
Proposed Mitigation	No mitigation for loss of foraging habitat within the current SPA boundary is possible.	
Level of Residual Impact	The permanent loss of 21.00 ha of subtidal habitat and disturbance within an area of 71.44 ha (5B+5C of table 7.7.12) of subtidal habitat equates to a residual negative impact on one of the targets and attributes of this special conservation interest of the Inner Galway Bay SPA. This is considered to be a negative impact on one of the conservation objectives of the Natura 2000 site. The level of residual impact is not considered to be significant as similar suitable habitat is present in the surrounding area and usage of the site by the species was recorded but not extensive. However, a measure of the level of impact is difficult to assess in the context of the overall Natura 2000 site and is therefore considered indeterminate.	

Table 7.7.10 contd/. Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interests of SPA

Attributes and targets to provide for favourable conservation condition of relevant Special Conservation Interests of SPA		
	Attributes and targets	**Comment on Potential Impact on Attribute/Target**
Qualifying Interest Habitat	**Wetlands [A999]**	
	Attribute: Habitat Area **Target:** The permanent area occupied by the wetland habitat should be stable or not significantly less than the area of 13,267 ha, other than that occurring from natural patterns of variation.	Comment: Loss of 5.93 (6B of table 7.7.12) of wetland (intertidal) habitat i.e. 0.05% which is not significant.

Table 7.7.11 - Attributes and Targets to provide for Favourable Conservation Condition of Relevant Qualifying Interest Habitat of SPA

This assessment was carried out taking consideration of the information contained in "*Conservation Objectives: Inner Galway Bay SPA 004031*" (Version 1, NPWS, 01 May 2013).

A summary of the impact areas of the new development and the Galway Harbour Enterprise Park on Annex II Habitats, cSACs, QIs and SCI Species is presented in Table 7.7.12.

Summary Table of Impacts on Annex II Habitats, cSAC QIs and SCI Species							
Habitat Type		Galway Harbour Enterprise Park	New Development				
			Construction Stage			Operations	
			Permanent Loss	Temporary Loss	Permanent Gain	Temporary Loss	Permanent Gain
****		A	B	C	D	E	F
1	Stony Banks	0.28 ha	0.35ha *	None	None	None	None
2	Salt Marsh (incl Transitional)	7.39 ha	None*	None	None	None	None
3	Scirpus Maritimus	0.30 ha	None	None	None	None	None
4	Terrestrial	7.97 ha	None	None	None	None	None
5	Subtidal	None	21.0 ha	50.44 ha**	None	50.44 ha***	None
6	Intertidal	8.58 ha	5.93 ha	1.34 ha**	1.69 ha	1.34 ha***	None
7	Otter	5.52 ha	4.21 ha	2.04 ha	16.04 ha	None	None
8	Seal	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
9	Salmon	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
10	Lamprey	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	None
11	All SCI species	8.58 ha	26.93 ha	51.78 ha**	None	51.78 ha***	Possible

Table 7.7.12 - Summary Table of Impacts on Annex II Habitats, cSACs, QIs & SCI Species

Notes:
** Even though there is no direct loss of area of these 2 habitats, it is uncertain as to what the long term effect of the development will be on them. For this reason, the impact is considered indeterminate.*
*** This denotes temporary loss of seabed during capital dredging of approach channels and turning circle*
**** This denotes temporary loss of seabed during maintenance dredging of approach channels and turning circle (which is estimated to be every 10 years).*
*****Cell references applied to identify source of areas of impact noted in tables 7.7.6 – 7.7.11*

7.8 MONITORING

7.8.1 Fish and Fisheries

Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan and this includes limit values. The position and distance of fixed and mobile sampling points have also been identified such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment model analysis. Operations will be suspended in the event that an exceedance occurs.

As the most important migratory fish occurring in the vicinity of the site of the proposed development, Atlantic Salmon will be monitored during both the construction and subsequent operation phases. It may be possible to co-ordinate with existing studies being completed by the Marine Institute and the IFI on salmon tagging. A tracking programme involving individual fish marked with telemetry tags is an option that would allow the migratory behaviour of the Salmon passing through the area to be directly monitored.

In relation to salmon smolts, the acoustic tagging study that was carried out as part of the EIS will be re-done during and post the construction period to document changes in patterns of migration routes that the smolts undertake.

Survey of elvers will be undertaken at appropriate locations and times during the construction and operational phases of the development, as part of an overall ecological monitoring programme.

7.8.2 Birds

It is anticipated that the current long-term monitoring of the birds populations in Inner Galway Bay (*i.e.* the I-W*e*BS counts carried out by BirdWatch Ireland) will continue. These data will make possible the monitoring of the Wintering populations of birds in the area, compared with the baseline data that has already been collected.

Monitoring of bird populations prior to, during and for at least two years post construction will be completed as part of ecological monitoring of the development. This will follow a similar methodology to that employed as part of the baseline surveying, using similar techniques and point count locations to allow for comparative analysis with baseline information.

7.8.3 Marine Mammals

Should the fresh corpse of any marine mammal be washed ashore during, or shortly after, periods of blasting work, the corpse will be the subject of an autopsy performed by a veterinary surgeon. Of particular interest would be any injury that may have been caused by underwater blasting (*e.g.* damage to the ear drums). Details of stranded cetaceans will be passed on to the IWDG strandings network in case they have not already come to the attention of that project. In the event that an autopsy reveals damage to ear drums, the working methodology will be reviewed and revised to include additional cetacean mitigation including possible increase in exclusion area for blasting or real time acoustic monitoring for marine mammals at blasting times.

A Marine Mammal Watch Plan including marine observers will be employed, during the construction phase, prior to and during blasting. The use of acoustic deterrent devices will be employed if required.

Monitoring of Harbour Seal populations prior to, during and for at least two years post construction will be completed as part of ecological monitoring of the development. This will

follow a similar methodology to that employed as part of the baseline surveying, using similar techniques and haul out locations to allow for comparative analysis with baseline information.

Survey for otter holt sites will be completed immediately prior to construction phase and on two occasions post construction phase, following a similar methodology to that employed as part of baseline surveys. During the construction phase, observation surveys for otter activity will be made and notes from marine observers and bird surveyors will also be included as part of the dataset.

7.8.4 Marine Invertebrates

7.8.4.1 Intertidal benthos

Intertidal annual seasonal sampling will commence pre-construction and for one year post-construction at the following locations: Ballyloughan, Lough Atalia, Renmore Lough, east and west of the causeway and at an agreed control site to record macrofaunal assemblages and sediment granulometry at High, Mid and Low water. Sampling should incorporate quadrates, cores and photography (including Sediment Profile Imagery). Post-completion, the additional 1 year's data can be reviewed to see if seasonal sampling is still required or if it can be reduced to once a year.

7.8.4.2 Subtidal benthos

Annual benthic sampling will be commenced pre-construction at the following sites: south of Ballyloughan Beach, Lough Atalia, Renmore Lough, west of the causeway, south of Mutton Island and at an agreed control southwest of the Margaretta using a 0.1 sqm grab and a 1 mm sieve. 3 faunal samples a 1 sediment sample should be collected and analysed using the same techniques as were used in the EIS. Sediment Profile Imagery should also be incorporated into the monitoring methodologies. The sampling will continue for at least 5 years post-completion.

7.8.5 Marine chemistry

As the proposed development has the potential to alter salinity regimes in the area, *in situ* monitoring of salinity will commence prior to construction at the following sites: at the mouth and within Lough Atalia, Renmore Lough, off Ballyloughan, south of Mutton Island and southwest of the Margaretta. This monitoring will continue for at least two years post-construction.

7.8.6 Marine physics

As the proposed development has the potential to alter current velocities and wave heights in the area, appropriate measuring devices will be deployed pre-construction to measure current speeds and wave heights at the following sites: south of Ballyloughan, east of the existing shipping channel, south of Mutton Island and southwest of the Outer Margaretta buoy.

7.8.7 Mitigation measures

The potential negative impacts of the proposed development and their relative significance are outlined in Table 7.8.1.

Potential negative impacts of the proposed development			
No.	**Potential Impact**	**Resulting From**	**Potential Severity**
1	Release of suspended solids into Galway Bay, with associated siltation on seabed, resulting in damage to habitats surrounding the proposed development and inner Galway Bay. Duration: During the construction period.	Runoff from construction site and resuspension of sediments during excavations.	Potentially high impact severity. Vulnerability of existing flora & fauna to such a release is not considered severe; however, the area of Galway Bay and the length of time that the impacts occur are considered insignificant.
2	Alteration of salinity levels in the vicinity of the Corrib River outflow. Resulting in impacts to salinity sensitive species. Duration: Permanent.	As a result of increased current velocities or changes in current direction due to the construction of the proposed development.	Potential impact severity is considered low, as the freshwater current regime from the Corrib River will not be significantly altered.
3	Alteration to current directions at the proposed development site will impact the sedimentary environment resulting in a shift of existing erosion and deposition sites and a subsequent alteration of benthic habitat types. Duration: Permanent	Construction of proposed development in the intertidal and subtidal zone in proximity to the Corrib outflow.	Moderate potential impact severity. Existing current velocities are predicted to be increased along west side of the solid structure of the development.
4	Alteration to current directions at the proposed development site will impact the sedimentary environment resulting in a shift of existing erosion and deposition sites and a subsequent alteration of benthic habitat types. Duration: Permanent	Construction of proposed development in the intertidal and subtidal zone in proximity to the Corrib outflow.	Low potential impact severity. Current direction is not expected to be significantly altered.
5	Release of cement into the surrounding waters, resulting in considerable damage to habitat and organisms present. Duration: During construction only.	Pouring of in situ concrete. Accidental puncturing of cement bags. Cement mixer washout operations.	High potential impact severity. Cement material is very aggressive with a high pH. In high concentrations it could damage flora & fauna. The potential occurrence is considered to be magnified by the quantity of material required for the proposed development.

Table 7.8.1- Potential negative impacts of the proposed development and their relative significance.

Potential negative impacts of the proposed development			
No.	**Potential Impact**	**Resulting From**	**Potential Severity**
6	Physical damage to marine and terrestrial habitats. Duration: During construction only.	Removal of land, intertidal and subtidal habitats. Machines tracking over shore.	High impact severity. The proposed development will result in the removal of *ca* 23.89 ha. The habitats within the development footprint will be totally destroyed.
7	Reduction in habitat area on foreshore, with reduction in the relevant populations. Duration: Permanent.	Footprint of new development occupying an area of the foreshore.	Moderate impact severity. The area to be occupied by the new development is large however the habitat quality within the development site is poor and has been altered. The potential impacts are considered not significant.
8	Release of grey water, bilge water, sewage, diesel *etc*. from the construction site. Duration: Construction only	Leakages of diesel or sanitary facilities, spillages of fuels, chemicals or other contaminants.	High potential impact severity. Given the size of the proposed development, there will be a significant quantity of harmful materials in storage on the construction site.
9	Oil spills, disposal of ballast water and other accidental release of fluids/solids during loading/off loading of vessels. Duration: During port operation	Leakages of fuels or ballast water, spillages of other fluids or any material being imported or exported.	High potential impact severity. The severity depends on what kind of fluid leaks *e.g.* oil. Ballast waters can introduce non-native species that have the potential to out-compete native species.
10	Noise Duration: Construction & Operational phases	Construction vessels, dredging operations, blasting, operational phase	No impact due to the fact that invertebrates are too primitive to have hearing systems
11	Light Duration: Construction & Operational phases	Construction and operational traffic	No impact on invertebrates

Table 7.8.1 contd/ Potential negative impacts of the proposed development and their relative significance

Potential negative impacts of the proposed development			
No.	**Potential Impact**	**Resulting From**	**Potential Severity**
12	Sediment suspension due to propeller wash Duration: Operational phase	Vessel movements	The increase in leisure craft during the operational phase will have no impact on the functioning of the ecosystem as the great majority of these vessels are less than 20m and interaction sediment resuspension will be minimal. The larger commercial vessels will be operating in deeper water than they currently do as they will not have to enter the port and for this reason, it is considered that the propeller wash will not re-suspend the sea floor sediments as much as presently happens. For this reason the operational phase of the port is not seen as having any additional impact on the benthic ecology

Table 7.8.1 contd/ Potential negative impacts of the proposed development and their relative significance

The mitigation measures, as presented below, will be adopted in respect of the above impacts, resulting in the described residual impacts.

7.9 MITIGATION MEASURES PROPOSED

7.9.1 Summary of Mitigation Measures

A summary of the proposed mitigation measures is outlined below.

Mitigation by Design

- The layout and footprint of the proposed development has evolved over the course of the design processes with a view to minimising the impact on Natura 2000 sites and their qualifying interests.
- Semi-vertical breakwaters have been proposed to mitigate seal predation on salmonoids.
- Native species to be used as part of landscaping plan.
- Storm water treated using valved outfall lines with petrol interceptor and silt traps.
- Sensitive lighting plan to avoid lighting of water body.
- Rock built sea walls on the eastern side will more than replace existing rock walls to be lost.
- The use of textured construction material to enhance settlement by algae and invertebrates.

Construction Methods and Timing

- The proposed use of geotextiles to minimize escape of silt during construction of lagoons will ensure minimized impact on water quality and associated impacts on qualifying interests of Natura 2000 sites.
- Limit timing of works in line with sensitive months for salmon avoiding April – July inclusive.
- Monitoring of suspended solids and dissolved oxygen as part of Environmental Management Plan.
- Implementation of Best Practice construction methods and Environmental Management Plan (See Appendix 4.2).
- Implementation of Emergency Spill Contingency Plan in the form of Galway Harbour Company's Oil Spill Contingency Plan (See Appendix 4.3).

Monitoring Programmes

- Marine Mammal Watch Plan including marine observers prior to blasting and use of acoustic deterrent devices if required.
- Monitoring of birds and Harbour Seal populations prior to, during and after construction as part of the environmental management plan.

Mitigation for the construction and operational phase of the development were considered and proposed as part of the Environmental Impact Assessment process and have been taken into consideration in the preparation of this Natura Impact Statement and Appropriate Assessment. A more detailed summary of mitigation measures is outlined below.

7.10 CONSTRUCTION MITIGATION

7.10.1 Underwater Blasting, Pile Driving and Dredging

In order to minimise the effects of the construction phase on migrating Atlantic salmon, dredging, blasting and piling will be limited to periods when juvenile stage salmonoids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to eliminate the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of the Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction.

Blasting work will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area (*i.e.* they will be able to migrate undisturbed during non-blasting hours).

Pile driving will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area (*i.e.* they will be able to migrate undisturbed for a minimum of 8 hours during night-time hours).

Underwater noise levels will be monitored prior to commencement of development, with particular emphasis on the presence of seals and during the smolt and eel migration period.

In order to ensure that diving bird species are not present during blasting activities, a RIB will be used to deter species from the area.

7.10.2 Impact of Blasting/Pile driving on Mammals

Blasting will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day's blasting begins. They will be equipped with binoculars, telescopes and tripods with which to watch for the animals, and two-way radios with which to communicate with each other and the explosives engineers. Blasting will not occur if a seal or cetacean is sighted within one kilometre of the blast site, or for a period of 30 minutes after one has been sighted within the 'exclusion area'. Observers will use Mutton Island and Hare Island as watch points. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting watches will be carried out before blasting works begin.

The use of acoustic deterrent devices (ADDs) to deter seals from entering blast areas will be considered if seals are often present in these areas and significant disruption to blasting activities occurs.

7.10.3 Suspended Solids and Construction/Operational Dredging

In order to minimise the effects of the construction phase on migrating Atlantic Salmon, dredging will be limited to periods when juvenile stage salmonoids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to remove the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction. This material has been assessed following site investigations and is suitable for use in the land reclamation.

The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will minimise the possibility of silt escaping back into the marine environment from the development. The geotextile mesh will be sized to retain suspended solids in the land reclamation lagoons.

These lagoons are shown in Drawing 2139-2142 & 2139-2143 which outlines the various construction elements and shows the proposed areas where the lagoons will be formed as the land is reclaimed and Plates 21-24 of the Visuals includes images of the stages of development.

Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan. The position and distance of the sampling points will be agreed after consultation with the appropriate authorities and will be such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment plume model analysis.

7.10.4 Potential Spillages

All machinery used in the construction of the proposed development will be checked to ensure that it is well maintained and not likely to leak fuel, lubricating oils, greases etc. into the aquatic environment. Any onsite refueling or maintenance will be carried out on securely bunded temporary hard standing areas. All oily wastes generated will be stored in leak-proofs tanks for removal by a licensed operative holding a valid Waste Collection Permit. Dredgers will be re-fuelled at sea using best available practice to ensure no spillages into the designated sites.

7.10.5 Use of Concrete

Normal best construction practice with regard to the use and pouring of concrete will be adhered to. If concrete cannot be poured in dry protected areas away from water until full curing has taken place, particular attention will be paid to the quality and security of the shuttering used for pouring. Pre-cast concrete elements will be used wherever possible and these will be designed to allow for enhanced settlement of Flora and Fauna as reported in recent scientific papers (Firth 2013, Chapman and Brown 2011, Martins and Thompson, 2009). Any wash water contaminated with concrete will not be allowed to enter the marine environment and will be disposed of elsewhere. Contaminated equipment (*e.g.* concrete delivery trucks, pumping equipment and tools) will be cleaned where there is no possibility of the drainage of wash water to the marine environment. The design by using sheet pile and rock armour has ensured a minimal underwater concrete requirement. While the main quays will be concrete, these will be above tide level.

7.11 OPERATION MITIGATION

7.11.1 Lighting

Mitigation for impacts of lighting during the operational phase has been provided through the use of energy efficient lighting in a configuration designed to provide the minimum lighting level required for safety. The lights used will be of a design that casts light downwards only and the lamp standards will be positioned in such a way that only the newly reclaimed land or new breakwater will be illuminated, not any areas of water.

7.11.2 Predation of Fish by Seals

The design of the proposal with steel sheet pile to act as a toe for the rock armour will create a steep drop into the water and thus mitigate against the possibility of seal haul out areas being created in this area (mitigation by design).

7.11.3 Water Pollution and Increased Risk of Spillage when Operational

The storm water from the existing Phase I of the Galway Harbour Park currently discharges from three discharge points. It is proposed that these three discharge points will be linked up, as part of the Phase 2 development, so that there will be only one discharge point from the existing GHEP. This new system will divert storm water to petrol interceptors fitted with silt traps prior to

its discharge to sea. In the event of an oil or other spill entering the storm water system, the discharge of contaminated water will be prevented by the use of control valves.

A detailed spill response plan has been prepared. This will limit the negative effects of any spills. In addition, Galway Harbour Company GHC has an Environmental Management policy to ensure that there are no spillages to the sea.

7.11.4 Depositing Maintenance Dredge Material

Spoil from maintenance dredging will be disposed of to an EPA permitted site located outside Natura 2000 sites.

7.11.5 Contingency plans

The main source of significant damage could occur if the construction area was flooded during construction, when wet cement was still soluble or in the event of a diesel spillage. If this occurred during concrete pouring, the wet material could be washed out into the marine environment. This cannot be allowed to happen.

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