

WITNESS STATEMENT FOR
GALWAY HARBOUR EXTENSION
ORAL HEARING
Dr. Brendan O'Connor.

January 2015

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1. Introduction

1.1. Name and qualifications

I am Brendan O'Connor, Managing Director of AQUAFAC International Services Ltd. My academic qualifications include a BSc Honours in Zoology and a PhD in the sea bed (benthic) ecology of Galway Bay. I have 5 year's post-doctoral work experience (1981 – 1986) in monitoring benthic sea bed invertebrate communities in inner Galway Bay and have worked as a private consultant in the field of marine biology for 28 years since founding AQUAFAC in 1986. I have published approximately 70 scientific papers on marine science, I have presented papers at several scientific symposia and I have been a technical advisor to the Irish delegation at conferences of the International Commission for the Exploration of the Sea (ICES).

AQUAFAC has provided specialist marine ecological services to Galway Harbour Company for the Galway Harbour Extension project and I was lead marine ecologist for this work. I also was lead author for the Natura Impact Statement.

1.2. Experience

I have been studying the ecology and oceanography of Galway Bay since I undertook field work for my BSc thesis in 1972. This involved the collection and examination of plankton samples and a desk top survey of physical oceanography of the study area including an understanding of how the River Corrib interacts with the sea.

Between the years 1973 – 1976 I undertook field work for my PhD thesis which involved a sea bed mapping survey of the animals and the sediments in which they live throughout Galway Bay from areas around the navigation channel into the docks out to areas west of the Aran Islands. Another aspect of my PhD was to study the dynamics of a benthic community southwest of the Margareta Buoy over the period 1974 – 1976. I became Associate Director of the UCG Benthos Group in 1978 and worked in that capacity till 1986. This group completed several large scale surveys including a joint survey with the Marine Biology Lab., Roscoff, Brittany of the Celtic Sea and surveys at Carnsore Point, Kinsale Harbour and an area from the Aran Islands south to Dunmanus Bay off the Kerry Coast. My post-doctoral work involved a continuation of the longer term monitoring of sea bed communities, but this time as part of an integrated EU COST 647 programme and also an assessment of Sediment Profile Imagery (SPI) which was a joint Irish-French EU funded project.

During the above surveys, I became involved in applying mathematical models to the field of benthic ecology in order to predict where different faunal assemblages may occur and since then I have worked closely with modellers in setting up data collection programmes, the analysis of the data and in the examination of modelled out-put to determine likely impacts as well as in the validation of those models.

My experience includes broad scale benthic surveys all around the Irish coast and further afield, taxonomic expertise in selected macrofaunal taxa, plankton surveys, oceanographic data collection campaigns, interrogation of output from oceanographic mathematical models, Sediment Profile Image analysis, bird surveys (I have been a bird watcher since my early teens), Strategic Environmental Assessments (SEA), Environmental Impact Statements (EIS) and Natura Impact Statements (NIS).

1.3. Purpose of this witness statement

AQUAFAC^T's surveys included a description of the sea floor habitats (both intertidal and subtidal) of the general area, a radio tracking survey of salmon smolts, an assessment of predation rates on smolts by cormorants and seals and a water quality assessment. I also assessed the possible effects of the harbour extension on crustacean fisheries in the area and the issue of invasive species. This Brief of Evidence begins with a description of the salient features of Galway Bay. It then outlines the approach used for the Galway Harbour Extension EIS, presents some of the key findings and assesses their significance.

2. Marine survey approach

2.1. Description of Galway Bay

Galway Bay is a large west facing bay and is bounded by County Galway to the north and by County Clare to the south. At its widest, it measures some 60 km and extends westwards over some 70 km. The proposed development site lies in the north eastern part of Inner Galway Bay.

There are three small islands in the inner bay area and these are Mutton (now joined to the mainland by a causeway), Hare Island and Rabbit Island. Water depths in this inner part of Galway Bay range down to 10 m south of Mutton Island and sea bed sediments are characterised by muddy sands. At low water, the intertidal substrates are a complex of algal-and mussel-covered rocks and muddy sands. Lough Atalia and its small offshoot, Renmore Lough, both of which are lagoons, are separated from the open sea by a land mass on which the railway embankment was built in the 1850s.

As part of the Water Framework Directive, the EPA has defined the marine environment where the development is to take place as Transitional *i.e.* with variable salinity or estuarine, in character. Water quality is defined as good by the EPA.

Current flow studies on the west coast of Ireland show that the tidal pulse along the west coast is from the south to the north on the flooding tide. Maximum tidal differences between low water and high water Spring tides is approximately 5.6 m. Water enters the bay from the south, primarily through the South Sound with the Foul (between Inisheer and Inishmaan) and Gregory (between Inishmaan and Inishmore) Sounds being less important in this respect. Circulation is anticlockwise with water leaving the bay chiefly through the North Sound. This overall south to north net flow directs fresh (largely Corrib) water outflow largely Westward along the North Shore with suspended materials being deposited over this area. The deflection of the Corrib water westwards along the north shore of Galway Bay is driven largely by the Coriolis effect. While predominantly inshore and "estuarine" in nature, the bay is subject to periodic intrusions of oceanic water masses in late Summer/early Autumn. Both Lusitanian and North Atlantic Drift indicator species have been taken in the plankton of the Mid Bay.

Transport of nutrients and bacteria in inner Galway Bay depends on a number of variables including current speed and direction, wind speed and direction, river flow and tidal conditions. Surface water movement in Galway Bay is strongly influenced by wind. Current directions are mainly between northeast and east during flood tide and between southwest and northwest during the ebb tide.

There is some salinity stratification at the mouth of the River Corrib under different stages of the tidal cycle. The vertical mixing of the water column in terms of salinity and temperature is weaker during Neap tides than during Spring tides.

The River Corrib flows into Galway Bay through Galway City and when in flood (*ca* 300m³/sec) plays a significant role in water structure in Inner Galway Bay. There are other small rivers at the eastern end of the bay but their flows are far less significant than the Corrib. The Corrib has a strong effect in structuring the water column in the northeastern section of the inner bay, especially during spate periods. Although this

freshwater may follow the anticlockwise flow of the Atlantic seawater within the bay, it is strongly influenced by wind velocity and direction. In calm conditions, the river water flows in a westerly direction along the north shore but, when westerly gales are blowing, this water can be backed up into the eastern parts of Inner Galway Bay. The flow of the River Corrib affects surface salinities in the area, *i.e.* northeast of Mutton and Hare Islands. From there, the freshwater tends to flow seawards in a west/southwest direction. Low salinity at the surface also extends to Oranmore Bay, New Harbour and Mweeloon Bay.

On the turn of the tide after low water, the water fills from the southwest as it makes its way eastwards towards Oranmore Bay. Due to the presence of the Mutton Island causeway, the flooding tide is directed around the island and enters the mouth of the River Corrib and also spills into Lough Atalia. The movement of the ebbing tide water is essentially the reverse of this.

Data collected by the EPA at a number of locations in Inner Galway Bay show that levels of suspended sediments are generally lower than 10 mg/l with the Corrib itself being lower than 5 mg/l. However, a sample of sea water collected at low water during an extreme storm period and analysed for suspended sediments returned a level of 56,000 mg/l.

Winds coming from the west to the southwest sector are the strongest winds in inner Galway Bay. These winds can modify surface water current speeds causing water to be forced either to the north during southerly wind flows or easterly if the wind comes from the west. These prevailing wind conditions generate an easterly moving longshore drift in inner Galway Bay. The Mutton Island causeway intercepts any sediment mobilised by this long shore drift and thereby has reduced the extent of material being carried onto Ballyloughaun Beach and into the area of the proposed Galway Harbour extension.

In terms of river flow, there is a strong seasonality regarding to volume between Winter and Spring months with Winter having the largest flows. Open water tidal velocities in the area are low and do not exceed 30 cm/sec. However, when the Corrib River is in spate, ebb tide velocities can reach *ca* 60 cm/sec. In the access channel into Lough Atalia, velocities can be significantly higher.

Inner Galway Bay is designated as a candidate Special Area of Conservation (cSAC) for selected habitats and non-avian species and a Special Protection Area (SPA) for birds. One of the habitats of the cSAC *i.e.* Lough Atalia (including Renmore Lough) is a lagoon and lagoons are classified as a Priority Habitat under the EU Habitats Directive which confers an additional level of protection to it as the term "priority" in the Directive refers to habitats or species in danger of disappearing.

2.2. Intertidal habitats

The intertidal area can be described as a sheltered shore with much of the area being covered by typical brown and green algae and common marine invertebrates such as limpets, dog whelks, winkles, barnacles, mussels and sand hoppers. This habitat is a qualifying interest for Galway Bay cSAC. (A qualifying interest is a habitat or species which is specifically mentioned in a description of any particular cSAC by the National Parks and Wildlife).

The intertidal area consists of a mosaic of typical intertidal plants and animals, mussel reefs and exposed muddy shores. The intertidal area is classified as a 'mixed substrata shore'. Further to this, NPWS describes the intertidal habitat as a 'furoid dominated intertidal reef complex' and this represents a combination of both 'mudflats and sandflats not covered by seawater at low tide' and 'reefs' as described in the EU Habitats Directive. Both are listed in Annex I Habitats of this Directive. (Annex I of the EU Habitats Directive lists natural habitat types of Community interest whose conservation requires the designation of Special Areas of Conservation).

Adult mussels form feeding resources for invertebrate species such as carnivorous sea snails and star fish and bird species such as Oystercatcher and Hooded Crow while post larvae and juveniles are a food resource for a wide range of sea floor invertebrates.

The construction of the Galway Harbour extension will permanently remove 5.6 ha of this habitat and its species from the cSAC. The use of specially designed rock known as "bioblock" will accelerate settlement of plants and animals on the face of the new structure.

2.3. Subtidal habitats

A survey of marine habitats below low water was carried out. Sediments in the proposed development area are predominately fine sands and silt-clay. The sea floor in the area is relatively poorly oxygenated with low successional stage values (from Sediment Profile Image analysis) indicating that the area of Galway Bay where it is proposed to build the Galway Harbour extension is of low to medium quality. Organic carbon content (between 2 – 5.2%) in this region is not considered to be excessively high or uncommon for Galway Bay. Heavy metal concentrations and hydrocarbon and PAH (polycyclic aromatic hydrocarbons) levels in the area are below the lower guidance National Guideline level as set by the Irish Marine Institute.

The dominating macrofaunal subtidal species are all well-known shallow mud dwelling species that are found throughout the Irish coast line in similar habitats. The 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 or rare species were observed during the present study nor have any ever been recorded since the general area began to be surveyed in the mid-1970s.

The construction of the Galway Harbour Extension will permanently remove this habitat and its species from the area within the construction foot print. This habitat is described as "Transitional" or "Estuary" by the EPA but this habitat is not listed as a qualifying interest from the Galway Bay cSAC by the National Parks and Wildlife in its description of the area. Where dredging is required for vessels to access the new structure, these areas will re-colonise within 1 year with species that were present there before. This statement is based on my experience and on the findings of very many published papers throughout the World of how quickly marine invertebrates can migrate into areas that have been dredged.

The historic development of the site (infilling for the Galway Enterprise Park) had an effect on the Galway Bay cSAC and Inner Galway Bay SPA. While it is considered unlikely that the effects had an impact on the ecological functioning of either Natura site, adopting the precautionary principle and on the basis that it cannot be said without reasonable scientific doubt that the impacts would not be significant, for the purpose of this assessment, such habitat loss is being treated as significant. The loss of this area for feeding and foraging purposes also affected Otter and the Harbour seal which are qualifying interest cSAC species.

A detailed assessment of Lough Atalia was carried out. Numbers of species and numbers of individuals in Lough Atalia were found to be low and sediment quality was poor. Lough Atalia and its small off-shoot, Renmore Lough comprise an area of *ca* 40 ha of Inner Galway Bay. 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 over the tidal cycle, 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 which under EU legislation are habitats requiring protection as they are vulnerable.

Lough Atalia has a narrow channel to the south-west connecting it with Inner Galway Bay. There is a shallow sill at the entrance to the lagoon which restricts full tidal flow into and out of it. This is a characteristic feature

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. The intertidal, muddy area in the northern part of Lough Atalia is relatively small in comparison to the large area of water retained.

Renmore Lough 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 in 1851 and a new channel was opened *ca* 100m to the west of the original access point. This goes under the railway line to join the main body of Lough Atalia. The water level in Renmore Lough is *ca* 1 m higher than the top of the culvert under the railway line. Sea water can only access Renmore Lough from Lough Atalia at high water on astronomically high Spring tides.

Water depths in Lough Atalia are mostly shallow (less than 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. Depths of Renmore Lough range between 0.15-0.85m.

Current velocities around the mouth at the mouth of Lough Atalia vary from 0.15 - + 2m/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.

Salinities within Lough Atalia range 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. Salinity in Renmore Lough ranges from 2.2 to 23.9 psu with the higher values at its northern end. The extensive range of salinities recorded both in Lough Atalia and Renmore Lough classifies them as poikilohaline systems (poikilohaline = high variability in salinities). Lagoonal species are typically tolerant of a wide salinity range.

Of the 50 species known to occur in Lough Atalia and Renmore Lough, 3 (*Chaetomorpha linum*, *Jaera nordmanni* and *Palaemonetes varians*) are considered to be lagoonal specialist species.

A review of species and where they occur in Lough Atalia clearly showed that the bed of the lough is very species-poor. The more biologically diverse area is the intertidal zone and the deeper pool at the mouth of the lagoon. Given the poor sediment quality and low faunal densities and numbers of species, it is my opinion that Lough Atalia is of no conservation value. This opinion is validated by the National Parks and Wildlife supporting document 2013 on lagoons in the Galway Bay cSAC which states that Lough Atalia is of no conservation value.

An assessment of the potential impact on significantly changing salinity levels in Lough Atalia and Renmore Lough was based on a detailed modelling study of the physical and chemical characteristics of these water bodies under maximum River Corrib flows and different Spring and Neap tidal flows. The output of the model showed that the present range of salinities which vary from *ca* 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 that the median salinity will reduce by 1.29 psu from the present value. These potential variations will not, in my opinion, have any ecological impact on these water bodies.

Predictions on movement of sediments suspended during capital dredging operations along the navigation channel into the existing harbour showed that finer sediments can enter Lough Atalia. In order to minimise this, capital dredging in this new channel to the docks, the boundary of which is shown in Drawing numbers 2139 – 2217, will be restricted to the ebbing/outflowing tides.

There is an area of cobble along the high water mark between Renmore Lough and the open sea which is definable as "Perennial vegetation of stony banks (1220)" under the EU Habitats Directive. This habitat is a Qualifying Interest for Galway Bay cSAC. The environment in which this habitat exists is dynamic as it is affected by extreme weather events such as occurred in December 2013 and January 2014 when a storm surge of 3.59m over Malin Ordnance. This affected the entire bay and caused over topping of the bank at the southern end of Renmore Lough. However, if the harbour extension is constructed, this location will be more sheltered and it is considered that this plant community will change to species such as willow, bramble and nettle. However, as overtopping of this bank will still occur under extreme weather conditions, it is unlikely that plants such a trees will ever successfully permanently colonise this area.

2.4. Smolt tracking study

Inland Fisheries Ireland had concerns that the proposed new structure might affect the outward migration of salmon smolts from the River Corrib to the sea. In order to provide information on the route taken and the length of time that fish take to get from the Corrib out to sea, sound emitting tags were used along with 10 listening devices placed in the sea. 94 individually identifiable acoustic tags were surgically placed in the abdominal cavity of salmon smolts. The listening devices were deployed at the flowing locations: one at the mouth of the Corrib River, one in Lough Atalia and one at Blackrock Reef, off Gentian Hill and seven were placed in an arc shape from the eastern part of Mutton Island to Renmore Beach. Of the 94 tagged fish released, 80 were detected post-release by acoustic receivers deployed in the study area. Tag detections were picked up by nine out of the ten receivers deployed. No detections were made at the Black Rock area.

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

- 1) Fish (58) that remain in the Corrib/Claddagh Basin for a variable length of time following release, are detected at the mouth of the Corrib, proceed to swim to one or more of the outer stations in the Mutton Island to Renmore Beach arc and then are not detected again during the study period.
- 2) Fish (10) 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 fast transit behaviour. This group may include fish that have been eaten by predators (seals, porpoises, dolphins, birds).

The proposed structure would lie in the southeastern/southern path taken by fish that exit the estuary and descending smolts would be restricted into the area of sea water between the new structure and Mutton Island causeway.

2.5. Predation studies

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 and in April 2010, the colony was estimated at 110 occupied nests.

Cormorants have been identified as significant predators on Salmon smolts in certain fisheries (e.g. the River Bann in Northern Ireland) 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 raised 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 and involved making 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, cetaceans and otters present at the same time in the same area.

Numbers of Cormorants and Seals at the site

Cormorants were regularly recorded in the vicinity of the proposed development site. Birds overflying the area were also noted. 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 calm weather. Maximum numbers (+50) were recorded between October 2010 to mid-January 2011 when there was a shoal of Sprat in the area while no birds were recorded on a number of dates throughout the survey period. Salmon smolts annually migrate out of the Corrib system during the months of March and April. 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.

Maximum salmon smolt numbers in 2010 peaked at 1250 on 8 May. 1301 smolts was the highest number recorded in 2011 on 19th April. In order to minimise impacts on migrating smolts, no work will be carried out in the water during the period of April 1st to July 31st in any year.

The same field methodology as for Cormorants described above was used to assess seal numbers in the area. 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 observer also checked for otters and cetaceans. Porpoises were seen on one occasion and a single dolphin was noted several times in the area between Hare Island and Mutton Island. A single otter was seen several times in the area off the head of Nimmo's Pier and one individual was seen swimming in the open sea off Nimmo's Pier in the direction of Mutton Island. As for Cormorants, maximum numbers of seals coincided with the presence of shoaling Sprat between the period October 2010 to January 2011. Outside this period, seal numbers were low at the site and no seals were recorded 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.

2.6. Water quality

Water Framework Directive monitoring results from 1994 to 2011 collected by the EPA were reviewed. In the Corrib Estuary transitional waters, annual median ammonia (NH₃) values ranged from 0.01 to 0.3 mg/l, annual median total organic Nitrogen (TON) values ranged from 0.01 to 0.92 mg/l. In the Inner Galway Bay North coastal water body, annual median NH₃ values ranged from 0.01 to 0.3 mg/l, annual median TON values ranged from 0.01 to 0.3 mg/l and annual median PO₄ values ranged from 4.99 to 24 µg/l from 1994 to 2011.

Heavy metal levels measured over the past in water samples taken in inner Galway Bay were always very low and results from surveys carried out during the preparation of the NIS showed that all levels remained low.

Water quality in inner Galway Bay has improved since the waste water treatment plant located on Mutton Island became operative in September 2003. The microbiological analyses carried out by AQUAFAC over the 2003 and 2004 period revealed that coliform levels had dropped and that bathing areas such as Salthill and Silver Strand complied with the EU Directive on Bathing Waters. Water quality at Ballyloughane has been compromised in recent years due to a storm water over flow at Michael Collins Road and swimming is no longer permitted there.

2.7. Crustacean fishery

There is an active pot-based fishery for shrimp in Inner Galway Bay where the proposed harbour extension is planned. Lobster and velvet crab area also fished in Inner Galway Bay but there is no fishery for these species within the foot print of the proposed harbour.

The Galway Bay Inshore Fishermen's Association (IGBFA) commissioned the Marine Institute and BIM to prepare a report on the fishery. This report estimated the size of the area fished for shrimp in Inner Galway Bay to be 108 km². The proposed harbour extension will cover an area of 26.93 ha.

Concerns are raised in the letter of objection from GBIFA to the proposed Galway Harbour extension in relation to the impact of sediments suspended during the dredging operations in the construction and maintenance phases of the proposed plan. As part of the EIS, computer simulations were carried out to assess the area that would be impacted (see also Chapter 8 of the EIS). Four locations within the area modelled were selected to provide information on where the sediments would disperse to and what the concentrations would be. The sediment plume modelling for the construction period showed sediment deposition to be generally localised close to the dredging point. The simulations demonstrated that even when modelling a 100% fine silt (a conservative approach), the suspended sediment concentrations are only significantly elevated above background in the vicinity of the dredging point with the plume achieving considerable dispersal thereafter. The measured sediment characteristics classify the sediment as a fine sand with a fine silt/clay content varying between 4 and 40%. The coarse to fine sand fraction will deposit close to the dredge point whereas the silt will disperse with the inflowing and outflowing tides. The model predicts a maximum spread of 2000m away from the dredger in mean tides and low Corrib River flow periods. Generally, concentrations remote (\pm 1km) from the dredging point are 1 mg/l or less. At a concentration of 1 mg/l of silt, the depositional rate based on a settling velocity of .0001 m/s is 8.64 g/m² per day which is considered insignificant and particularly so, given the temporary nature of the construction dredging activity in any one year. Also, as noted above, there will be no construction activities in the sea during the period April 1st – July 31st in any year.

Under larger river fluvial flows, the sediment plume would encounter greater dispersion out to sea resulting in lower sediment plume concentrations.

There will be two periods during which the sedimentary conditions in the mouth of the River Corrib will change and these relate to the dredging/construction period and for a period of a number of weeks post-completion. Dealing firstly with the dredging/construction period, sediment will be brought into suspension by the dredging activities and the model has been used to predict concentrations at the selected sites within the works area. As sediments can only travel northwards on a flooding tide and as maximum flow occurs on Spring tides, only these conditions were modelled. The predicted deposition levels at all four observation sites mentioned above indicate that the majority of suspended sediments will fall out within short distances of the dredging activity. In order to establish naturally occurring levels of suspended solids at Ballyloughan Beach, a water sample was taken on May 24th, 2011 during a period of extreme wind conditions. This site was chosen as it is facing into the prevailing wind direction which is from the southwest. The sea water at the beach was very turbid and suspended solid values were recorded at 65,000 mg/l, which is 4 orders of magnitude above the values predicted by the model *i.e.* less than 1 mg/l.

Since the model predicts increased velocities in the deeper water between the new structure and the causeway, there will be a period of erosion post-completion of Phase 1 in which fine surface sediments will be transported southwards. The model predicts that the material will deposit eastwards of Mutton Island. Sedimentary conditions in this area are characterized by muddy sands and the eroded material that will deposit in this location are fine muds of less than 63 μ m. Given the low predicted volumes and the fact sediments in the area of fall out already comprise of such sediments, it is considered that the addition of these fines will not have a significant impact on the biological communities in the area.

The previous simulations of the four reference locations modelling fine and coarse dredge suspended sediment was carried out for the existing bay hydrodynamics (*i.e.* without the harbour development in place) and demonstrated that the critical tides were Spring tides under Summer low Corrib Flow conditions.

Maintenance dredge suspended sediment analysis

Following on from the construction dredge impact assessment presented above, a series of dredge plume simulations for similar hydrodynamic conditions were carried out with the proposed port and dredged channel in place. These simulations were performed to further assess the potential impact from future maintenance dredge operations on water quality at sensitive receptors such as the shrimp fishery in the area, Lough Atalia and Renmore Beach.

The findings from these simulations clearly show that dredging activities in the new approach channel to the old docks and marina will result in an increase of suspended solids concentration in excess of 1 mg/l in this area. However, as this area is never used to deploy pots to catch shrimp, there can be no impact on the fishery. The simulation results in the port and approach predict low levels of suspended sediments arising from the maintenance dredging and that the spatial extent of the plume is restricted to within a short distance of the dredging activity. This area is not used by shrimp fishermen as an important fishing ground but is used as an area for keep pots. As shrimp are an estuarine species and therefore tolerant of increased suspended sediment loadings, the predicted temporal increases in such loadings will have no significant impact on this species.

Concerns are raised by the Galway Bay Inshore Fishermen's Association in relation to the proposed provision of facilities for inshore commercial boats in the north eastern section of the Galway Harbour extension where it is stated that this area would be totally open to south easterly winds as there is no evidence of a breakwater being provided. Examination of the drawings however clearly shows that two breakwaters are designed in to the planned harbour extension along its north eastern section. These follow the same compass angle as the existing quay wall in the layby where some shrimp boats currently tie up.

Concerns are also raised by the Galway Bay Inshore Fishermen's Association in relation to potential heavy metal contamination of the material to be dredged and the impact of this on the shrimp fishery. An assessment of the sediment chemistry (including heavy metals) was carried out on both surface samples (22 in all) and bore hole samples that were taken for geophysical purposes and this showed that values for a wide range of analyses on all but one sample were within National Guidelines recommended by the Irish Marine Institute indicating that the sediments that will be mobilised during the dredging activity are not heavily polluted. Impacts on the shrimp fishery are therefore considered negligible.

2.8. Migratory fish species

A number of fish species pass in and out through the area where the proposed Galway Harbour Extension is to be built and these include sea lamprey, salmon, sea trout and eel. Even though there is some activity of arriving or departing fish throughout the year, there are main periods of peak migrations for specific species. The main period for silver eel is from November – January during hours of darkness; for elvers, it is March – April, for lamprey May June July while the main period for adult salmon is April – July. Salmon smolts leave the Corrib system in the April - May period.

Discussions with Inland Fisheries Ireland during the course of the preparation of the EIS included an agreement that no construction activity would take place in the sea between April 1st and July 31st in any year during the construction period. This will minimise the potential impacts of these activities of the various fish species.

2.9. Birds

I have read Dr. Gittings' report on birds and I agree with his conclusions which are:

It can be stated beyond reasonable scientific doubt that none of the potential impacts arising from the proposed development will be likely to cause population-level consequences to any of the species of conservation interest (SCI) populations of the Inner Galway Bay SPA.

His assessment has not identified any potential cumulative impacts from habitat loss due to the GHE development in combination with the historical habitat loss from the development of the Galway Harbour Enterprise Park that are likely to cause population-level consequences to any of the SCI populations of the Inner Galway Bay SPA.

He stated as a result of his assessment that, beyond reasonable scientific doubt, there will be no potential cumulative impacts from habitat loss due to the GHE development in combination with the historical habitat loss from the development of the Galway Harbour Enterprise Park which could cause population-level consequences to any of the SCI populations of the Inner Galway Bay SPA.

His assessment also showed that there will not be any significant impact from bottom mussel culture on benthic prey resources for terns. Therefore, no potential cumulative impacts from the GHE development in combination with impacts from mussel bottom culture arise.

2.10. Terrestrial habitats, mammals and birds.

I have read Dr. Pepiatt's brief of evidence and specifically in relation to Section 10, I agree with the predicted impacts and proposed mitigation measures on terrestrial habitats, mammals and birds he outlines. In summary, his conclusions are:

Loss of terrestrial habitats on the site will be mitigated through the proposed native species planting plan and landscaping scheme and the residual associated impact is therefore considered a permanent slight positive impact.

In relation to terrestrial habitats around Lough Atalia and Renmore Lough, as there will be no 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 both water bodies, terrestrial habitats outside of the site red line area will not be impacted negatively as a result of the proposed development.

With regard to the effects of bore hole drilling, blasting and pile driving on marine mammals, these activities will be carried out during daylight hours. This 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. Blasting will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site or for a period of 30 minutes after one has been spotted; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day's blasting begins. 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.

Research from the U.K. suggests that there is the potential for seals to be killed by ducted propellers if vessels 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). If vessels with ducted propellers are used during the construction stage and these are likely to be making the types of manoeuvres mentioned above, they will be fitted with mesh screens at the ends of the ducts to prevent seal entry to the ducts.

The NPWS considers that Otter in the marine environment do the majority of their foraging within 80 metres of the shoreline. There will be an initial loss of 4.64 hectares of such habitat. After 2-5 years (the time taken for the newly constructed coastline to be fully colonised by algae, invertebrates and fish), 16.08 hectares of new shoreline habitat will suitable foraging habitat for Otter. Thus, the initial loss of 4.64 hectares of main foraging habitat will be short-term, followed by a permanent gain of 11.14 hectares of prime Otter foraging habitat.

The construction of the new infilled area and the new deep water pier will constitute a minor barrier to connectivity between areas immediately to the east of the harbour extension (e.g. in the Renmore Beach area) and areas to the west of it, although no complete barriers will be formed.

A wildlife pass will be included in the harbour extension design at the junction of the 400m quay with the 260m quay. This will shorten the route from the east to the west (or *vice versa*) of the extension by a distance of one kilometre. This pass will be used by fish species including elvers, otter and seals (in the latter case at least in the periods outside low tide).

2.11. Invasive species

Invasive species, either algae or invertebrates, can be brought into Irish coastal seas in a number of ways: larvae in ballast or bilge water can be released into the water column, if the vessel pumps this liquid within a short distance of the shoreline. This can be prevented if vessels are required to pump bilges etc in off shore water. A Harbour bye law will be added to the existing bye laws to require that "vessels are required to exchange ballast waters outside of the 12 mile limit".

The other way that invasive species can enter Irish territorial waters is if adults are present on the vessel's hull. It is possible that these adults could release larvae in Irish coastal waters and that these then could settle as adults on suitable substrates. This is a universal issue and there is no method to prevent this happening. However, the area around and within the existing Galway Docks site has been the subject of many surveys carried out by AQUAFACt staff as early as 1975 when they were active researchers in NUI, Galway. No non-native invertebrate species have been recorded within the area to date.

Another way that non-native species can be brought into Irish territorial waters is via import of shellfish spat from waters outside the State: a non-native species, *Didemnum vexillum* (an ascidian or sea squirt) was recorded in 2007 at Parknahallagh near Ballindereen, County Galway. It is believed that aquaculture stock transmissions of oysters were the cause of its introduction. It was recorded there again in 2014 and was found to have extended its range since 2007. It was first recorded in Ireland in 2005 in Malahide marina. *D. vexillum* was the subject of species alerts issued by the National Biodiversity Data Centre (NBDC) in 2007, and by the all-Ireland forum on invasive species under the aegis of The Department of Arts, Heritage and the Gaeltacht.

2.12. Possible Alternative Locations

As part of the EIS and NIS studies, a number of possible alternative locations in Galway Bay and further afield were examined. In Galway Bay, Mutton Island, Tawin headland and Rossaveal were examined but in relation to the first two, both were found to have greater impacts on the cSAC and SPA in addition to the requirement of building a road and railway into the sites. Rossaveal has some existing on-shore infrastructure but the lack of road and rail access and the presence of both cSAC and SPA along any potential route from Galway to Rossaveal presented significant ecological impacts. Further afield, like Rossaveal, Killybegs has some on-shore infrastructure but again the lack of road and rail to the harbour were serious negative attributes for this location. Access to Sligo Harbour is through both a cSAC and an SPA and would require significant dredging to allow access to larger vessels. For this reason, it was discounted. Shannon/Foynes, while determined not to be a viable alternative, has a significant level of on-shore infrastructure but also contains a number of Natura sites along its length. Bottle nosed dolphin is one qualifying interest for the Shannon cSAC. Current maintenance dredge disposal takes place within a cSAC. Any required port expansion may require the destruction of qualifying interest habitats. Adopting the precautionary principal on the basis that it cannot be said without reasonable scientific doubt that impacts would not be significant, such habitat loss and impact on species must be treated as significant. The Shannon/Foynes option was therefore rejected. Cork, Waterford and Dublin were considered to be too removed geographically to be considered as serious candidate alternative locations.

2.13. Mitigation

An extensive range of mitigation measures, monitoring programmes and an Environmental Management Framework have been devised and have been incorporated into the EIS (see Chapter 10 and Chapter 15) and NIS. Mitigation based on aspects of the design of the structure and engineering solutions regarding water runoff and the use of most environmentally acceptable materials *e.g.* geotextiles and textured blocks called "bioblocks" are incorporated into the development. Construction methods and timing of specific activities such as blasting and pile driving to minimise impacts on migrating fish such as salmon and on breeding periods of tern species and seals have also been included. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting will be carried out before blasting works begin as part of the marine mammal monitoring programme. Other monitoring programmes include the examination of suspended solids when dredging is on-going, monitoring of numbers of relevant bird species, otters and seals within and outside the construction area, sea shore and sea bed sampling before, during and after construction to monitor and changes in flora, fauna and sediment type and salinity and current direction and velocity studies.

2.14. Natura Impact Statement

I was lead author of the Natura Impact Statement for the proposed Harbour Extension. As a result of the findings of the NIS, the proposed Galway Harbour Extension was found to have the potential to either directly or indirectly impact two Natura sites *i.e.* Galway Bay cSAC and SPA. For some of the qualifying interests of the Galway Bay Complex cSAC and special conservation interests of the Inner Galway Bay SPA, adopting the precautionary principal and on the basis that it cannot be said without reasonable scientific doubt that the impacts would not be significant, these impacts are considered as significant.

2.15. Legacy Issues

The historic development of the site and surrounding area has had an effect on the Natura 2000 sites – Galway Bay Complex cSAC and Inner Galway Bay SPA. This resulted in the permanent loss of Annex I cSAC habitats *i.e.* the loss of 0.28 ha of stony banks and annual vegetation of drift lines, 8.58 ha of fucoid-dominated intertidal reef complex and 7.39 ha of Atlantic and Mediterranean Salt Meadows. Adopting the precautionary principal and on the basis that it cannot be said without reasonable scientific doubt that the impacts would not be significant, these impacts are considered as significant. The loss of these areas for feeding and foraging purposes also affected Otter and the Harbour seal which are Qualifying Interest cSAC species.

2.16. Galway Bay cSAC and SPA

During the violent storms of December 2013 and January 2014, stones and cobbles were thrown into the southern part of Renmore Lough over the stony bank that separates the Lough from the sea. The increased protection afforded to this stony bank by the proposed new structure will prevent future ingress of stones and cobbles into Renmore Lough which is a priority habitat. With regard to the impact of the proposed development on this cSAC, it will reduce the perennial vegetation of stony banks and annual vegetation of drift lines by 0.18 ha, fucoid-dominated intertidal reef complex habitat by 5.93 ha and subtidal habitat by 24.8 ha. This gives a total of 27.23 ha of marine feeding habitat lost for Otter and Harbour Seal foraging (Annex Habitat and Qualifying Interests of the cSAC). This loss is not considered significant on Otter due to the proposed mitigation. However, significant impacts cannot be ruled out on the Harbour seal.

Considering the SPA, it is predicted that no bird species will be negatively impacted by the proposed development and that the loss of 36.70 ha which is based on 5.93 ha of intertidal, 24.8 ha of subtidal and 15.97 ha of legacy loss wetland habitat is not considered as significant.

Habitat Type/ Species	Existing Galway Harbour Enterprise Park	New Development	
		Construction Stage	Operations

		Permanent Loss	Totals	Temporary Loss	Permanent Gain	Temporary Loss	Permanent Gain
	A	B		C	D	E	F
1	Stony Banks	0.28 ha	0.18 ha*	0.46 ha	None	None	None
2	Salt Marsh (incl. Transitional)	7.39 ha	None	7.39 ha	None	None	None
3	Intertidal (including wetland for birds)	8.58 ha	5.93 ha	14.51 ha	0 ha**	1.69 ha	1.34 ha***
4	Otter	8.58 ha	5.22 ha	13.80 ha	None	18.18 ha	None
5	Seal	8.58 ha	26.93 ha	35.51 ha	51.78 ha**	None	51.78 ha***
6	Salmon	8.58 ha	26.93 ha	35.51 ha	51.78 ha**	None	51.78 ha***
7	Lamprey	8.58 ha	26.93 ha	35.51 ha	51.78 ha**	None	51.78 ha***
8	All SCI species	8.58 ha	26.93 ha	35.51 ha	51.78 ha**	None	51.78 ha***
9	Wetland for birds	16.27ha	26.93 ha	43.2 ha	51.78 ha**	None	51.78 ha***

Notes:

* Even though there is no direct loss of area of this habitat, adopting the precautionary principal and on the basis that it cannot be said without reasonable scientific doubt that potential impacts would not be significant, for the purpose of this assessment, such habitat loss and impact on species is being treated as significant.

** 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).

2.17. Analysis of in combination effects

The following projects and activities were examined and assessed in terms of possible interaction between them and the proposed Galway Harbour Extension: aquaculture, proposed boat plane flights from the mouth of the Corrib, man-made changes to the coastline around the City such as the causeway out to Mutton Island, an ocean energy test site off Spiddal and the construction of a pontoon at Tarrea in Kinvarra Bay. The conclusion of these analyses was that the proposed project and implementation of effective mitigation measures to avoid impacts did not have the potential for further 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.

As noted above with regard to the assessment on birds by Dr. Gittings, any potential cumulative impacts from habitat loss due to the Galway Harbour Extension (GHE) development in combination with any other development is not predicted.

2.17 Conclusion

To conclude, the proposed Galway Harbour Extension was found to have the potential to directly impact two Natura sites *i.e.* Galway Bay cSAC and SPA. The impacts are the permanent loss of qualifying interest habitats and the potential impact on certain species arising from this loss but the effects are not considered to be significant on either of the NATURA sites. However, adopting the precautionary principal and on the basis that it cannot be said without reasonable scientific doubt that the impacts would not be significant, for the purpose of this assessment, such habitat loss and impact on species is being treated as significant.