Licensing Notice - Unsolicited Correspondence - 1 for Carrigtwohill and Environs Licence (D0044-01)

Licence: Carrigtwohill and Environs (D0044-01)

Status Reason: Closed

Issued On: 22/05/2014

Action Type: Licensing Notice

Status History Action: Unsolicited Correspondence

Sean, Please find attached additional information (IW-ER-LTOO26 and 5 attachments) from Irish Water in response to the Agency Reg 18(3)(b) notice dtaed 3 October 2014 and subsequent Cork County Council. Yours sincerely, Ken Conroy

Associated Documents

- IW-ER-LT0026 - Carrigtwohill (D0044-01).pdf
- IW-ER-LT0026 attachment 2617-Fig 2 Indicative layout of
- IW-ER-LT0026 attachment 2617-Fig 3 Extent of SAC-
- IW-ER-LT0026 attachment 2617-Fig 4 DESIGNATED
- IW-ER-LT0026 attachment Carrigtohill WWTW Appropriate
- IW-ET-LT0026 attachment 2617-Fig 1 WWTP Location

CORK COUNTY COUNCIL

CARRIGTOHILL WWTW UPGRADE

APPROPRIATE ASSESSMENT

NATURA IMPACT STATEMENT

MAY 2014

In partnership with

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS

DixonBrosnan
environmental consultants

Rev	Date	Revision Description	Prepared	Checked	Approved
A	May 2014	First Draft	CD	SS	EF

CONTENTS

1.0 INTRODUCTION

1.1 Project details

The project is for the upgrading of the existing WWTW at Carrigtohill, County Cork. The existing plant was designed for a population equivalent of 7,500 pe. It is currently overloaded and there are plans for further industrial and residential development in the area. It is proposed to construct a new WWTW on the land immediately to the east of the existing WWTW site. There is insufficient space on the existing site for the construction works and the existing infrastructure is not adequate for the increased loading.

An Environmental Impact Statement (Carrigtohill Sewerage Scheme EIS, T.J O' Connor, 2008) was prepared during the planning process. A summary of the project details, as detailed in this document, is provided below. The EIS provides a more comprehensive description of the project. It is noted that the design parameters have changed since the EIS was produced; the current design proposal is for a wastewater treatment plant with a capacity of 30,000; this is reduction from the 45,000 p.e. specified for Phase 1 in the EIS. As Phase 1 will see a net reduction in the population equivalent the conclusions of the EIS remain valid.

The EIS was based on the proposal to construct an extension to the existing wastewater treatment works at Tullagreen to cater for an ultimate PE of 62,000 with an initial phase of 45,000 p.e. (now reduced to 30,000 p.e.). In accordance with the relevant regulations, the WWTW will continue to treat flows arising to a tertiary standard, including Phosphorus removal.

The proposed expansion of the plant is to be constructed immediately to the west of the existing plant. The site is bounded to the north by a local road and the Millipore industrial facility, to the west by the R624 and Slatty Waters, to the east by the existing treatment plant and agricultural land and to the south by Slatty pond and agricultural land. An overview of the site is shown in **Figure 1.**

The wastewater will be treated to a high standard to meet the requirements of the Urban Wastewater Treatment Directive, the Phosphorus Regulations (SI 254 of 1998) and environmental sensitivity of the receiving environment. The treated effluent is to be discharged via an outfall pipe at North Point, approximately 800 metres west of the existing outfall point.

A number of options were considered as part of the planning process. However it was concluded, following a comprehensive assessment of the financial and environment implications, that the

extension of the existing plant and the new location of the proposed discharge point were the preferred options.

The layout of the treatment works on which the E.I.S. was based was indicative only. Contractors competing for the contract for the construction of the Carrigtohill works were free to put forward any design capable of providing the required level of performance.

The reasons for constructing the new treatment plant adjacent to the existing plant include the following:

- There is an existing WWTW at the site and use can be made of some of the assets present on site
- Wastewater treatment is already an established land use for the site
- There are strong strategic reasons for developing a separate wastewater treatment plant at Carrigtohill to allow the retention of any available capacity at Carrigrenan for Cork City and the areas to the north and west of the city where there is no alternative treatment route.
- The sewage is already routed to the site.
- The Carrigtohill WWTW will be used as a sludge satellite centre for a number of smaller plants in the area reducing the need to transport liquid sludge to Middleton.
- The Carrigtohill WWTW would be the treatment centre for leachate from the Rossmore landfill site reducing the requirements for transportation to Midleton.
- Factors mitigating against a move to an alternative site include the construction of lengthy rising mains.
- Based on the results of the model utilised during the EIS, the following is the proposed discharge standard:

Parameter	Phase 1 Value	Phase 2 Value	Unit
BOD	25	20	mg/l
SS	35	35	mg/l
P	1	1	mg/l
N	15	10	mg/l
T. Coliforms	No specific limit	No specific limit	MPN/100 mls
F. Coliforms	No specific limit	No specific limit	MPN/100 mls

Table 1 Summary of Proposed Effluent Standards

These discharge limits were designed to meet the following standards

1. UWWT standard treatment (25:35 BOD:SS)
2. The Phosphorus Regulations (subsequently repealed by SI No 272 of 2009 - European Communities Environmental Objectives (Surface Water) Regulations)

Satisfactory dispersion qualities have been demonstrated at North Point by the hydrodynamic model. The North Point is a suitable discharge location for the Carrigtohill Sewerage Scheme because of the level of dispersion available and the short periods of retention.

The nutrient concentrations (N, P) will be reduced below the recommended level (EPA Report "An assessment of the Trophic Status of Estuaries and Bays in Ireland", 2001.) prior to discharge into Lough Mahon and the Lee estuary. The discharge standards recommended will provide adequate treatment for the Carrigtohill WWTW for both phases of the development while complying in principle with all of the relevant standards.

1.2 Planning history

The wastewater arising in the town of Carrigtohill is treated in a wastewater treatment plant, which is located approximately one kilometre southwest of the town centre and half a kilometre to the east of Slatty Bridge. The design biological capacity of the existing plant is approximately 7,500 PE. The existing plant is currently overloaded.

Carrigtohill has been identified in the Cork Development Plan and the Cork Area Strategic Plan as an area of potential high growth and a substantial increase in the capacity of the foul and surface water networks and treatment plant will be required to cater for the existing and increased hydraulic and biological loads. This in combination with more stringent discharge standards necessitates the construction of new wastewater treatment facilities at Carrigtohill. The construction of the wastewater treatment facilities at Carrigtohill is being procured under a design/build/operate (DBO) form of contract.

This contract, "Carrigtohill WWTP Design Build Operate" provides for the design, construction, operation and maintenance of Wastewater Treatment Plant (WWTP) and associated works including pumping stations, intake works, pipelines and ancillary works as described more fully in these Tender Documents. The design capacity of Phase 1 of the new WWTP is 30,000 PE with provision for a future extension to 45,000 and 60,000 PE in Phases 2 &3.

The scope of Works comprises the design, build and operation and maintenance of the wastewater treatment plant and includes inter alia, the following:

1. Design of the treatment plant to cater for the Phase 3 population equivalent of 60,000.

2. Construction of that portion of the treatment plant necessary to cater for the Phase 1 population equivalent of 30,000 including raising the ground levels on the site to the minimum level specified in the Employer's Requirements.

3. Design and construction of an outfall pipeline to convey the treated effluent from the Carrigtohill WWTW to the north point at Slatty Waters (approx 1.14km in length for an effluent flow of 6 DWF for a population equivalent of 60,000 p.e.

4. Operation and maintenance of the new wastewater treatment plant for the 20 years or a lesser period as required by the Contract, including delivery of the sludge cake to recycling/reuse facilities to be determined by the Employer.

5. Operation and maintenance of the existing wastewater treatment plant and associated pumping stations during the design and build period, in accordance with the Employer's Requirements.

The Preliminary Report for the project was adjusted on several occasions as the design parameters changed due to a number of factors, including increasing the estimates of population growth, the request for additional capacity from Amgen, the withdrawal of Amgen and a reduction in the population growth estimates after the downturn in the economy. The current design proposal is for a wastewater treatment plant with a capacity of 30,000 p.e. in Phase 1. An Environmental Impact statement was issued to An Bord Pleanala in July 2008. Copies were circulated to the following bodies:

- Development Applications Unit (DAU) of the DoEHLG.
- Department of Transport.
- Department of Agriculture, Fisheries and Food (DAFF).
- South-Western Regional Fisheries Board.
- HSE.
- Failte Ireland.

- Environmental Protection Agency.
- Minister for Communications, Energy and Natural Resources.
- The Arts Council.
- National Trust for Ireland.
- Heritage Council.

The following bodies issued comments to An Bord Pleanala

- The Development Applications Unit of the DoEHLG
- The South Western Regional Fisheries Board
- The Environmental Protection Agency

An Bord Pleanala granted permission (subject to conditions) on 13th August 2010 for the construction of a treatment plant up to a design capacity of 45,000 pe and stated that a new application with a new Environmental Impact Statement would be required in the future should there be a need to take the capacity to 60,000 pe.

1.3 Background

1.3.1 Habitats Directive and Natura 2000 sites

According to the EU Birds Directive (2009/147/EC) and Habitats Directive (92/43/EEC), member states are required to designate areas in order to protect priority habitats and species. These designated sites are known as Natura 2000 sites. In Ireland, the Natura 2000 network of European sites comprises Special Areas of Conservation (SAC), including candidate Special Areas of Conservation (cSAC), and Special Protection Areas (SPA), including proposed Special Protection Areas (pSPA).

Under Article 6(3) of the EU Habitats Directive (92/43/EEC) and Article 30 of Statutory Instrument No 94/1997 – European Communities (Natural Habitats) Regulations, 1997 as amended, any plan or project, which is not directly connected with or necessary to the management of a Natura 2000 site and has the potential to significantly impact thereon, must be subject to an Appropriate Assessment.

Article 6(3) of the Habitats Directive states:

Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's

conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

Article 6(4) states:

If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted. Where the site concerned hosts a priority natural habitat type and/or a priority species the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

1.3.2 Appropriate Assessment

It is the responsibility of the proponent of the plan or project to provide the relevant information (ecological surveys, research, analysis etc) for submission to the "competent national authority". Having satisfied itself that the information is complete and objective, the competent authority will use this information to screen the project, to determine if an AA is required and to carry out the AA, if one is deemed necessary. The competent authority shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned.

The appropriate assessment process consists of a four-stage process. Each stage determines whether a further stage in the process is required. If, for example, the conclusions at the end of Stage One are that there will be no significant impacts on the Natura 2000 site, there is no requirement to proceed further. The four stages are:

- Screening to determine if an appropriate assessment is required
- Appropriate assessment
- Consideration of alternative solutions
- Imperative Reasons of Overriding Public Interest/Derogation

Stage 1. Screening to determine if an appropriate assessment is required

Screening is the technique applied to determine whether a particular plan would be likely to have significant effects on a Natura 2000 site and would thus warrant an Appropriate Assessment. The key indicator that will determine if an Appropriate Assessment is required is the determination of whether the development is likely to have *significant environmental effects* on a Natura 2000 site or not.

Stage 2. Appropriate Assessment

This step is required if the screening report indicates that the development is likely to have a significant impact on a Natura 2000 site. Stage 2 assesses the impact of the plan or project on the integrity on the Natura 2000 site, either alone or in combination with other plans or projects, with respect to the site's structure, function and conservation objectives. Where there are adverse impacts, an assessment of the potential mitigation of these impacts in also required.

Stage 3 – Assessment of Alternative Solutions.

If it is concluded that, subsequent to the implementation of measures, a plan or project will have an adverse impact upon the integrity of a Natura 2000 site, it must be objectively concluded that no alternative solutions exist before the plan or project can proceed.

Stage 4 – Imperative Reasons of Overriding Public Interest/Derogation

Where no alternative solutions exist and where adverse impacts remain but imperative reasons of overriding public interest (IROPI) exist for the implementation of a plan or project, an assessment of compensatory measures that will effectively offset the damage to the Natura site 2000 will be necessary.

2 METHODOLOGY AND ASSESSMENT

2.1 Methodology for appropriate assessment

This assessment follows the methodology guidelines outlined in *"Assessment of plans and projects significantly affecting Natura 2000 sites, methodological guidance on the provisions of Articles 6(3) and 6(4) of the Habitats Directive 92/43/EEC" (2001*), Department of Environment, Heritage and Local Government (2009, revised February 2010), *Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities.* (Department of Environment, Heritage and Local Government, 2010 revision) and National Parks and Wildlife Services (2010) Circular NPW 1/10 & PSSP 2/10 *Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities.* These assessment guidelines provide for a step by step process as outlined above.

Planning permission for this development was granted by An Bord Pleanala in 2010. Subsequent to the application for a discharge licence, the Environmental Protection Agency (EPA) noted in late 2013 that "*due to the likelihood of a significant effect on a European Site, an Appropriate Assessment is required and notice of that determination is hereby given in accordance with Regulation 42(8)(a) of the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011). You are thereby required to submit a Natura Impact Statement, as defined in Regulation 2(1) of the aforesaid Regulations."* This Natura Impact Statement was prepared by Carl Dixon MSc of DixonBrosnan Environmental Consultants who also carried the ecological assessment at the EIS stage.

2.2 Receiving Environment

2.2.1 Site of WWTP

The existing treatment plant will be extended to the east and primarily to the west. To the west of the existing treatment plant the land consists of mixture of wet woodland with reed beds associated with the watercourse/lake along the southern boundary of the site. This area is located within a proposed Natural Heritage Area and candidate Special Area of Conservation (cSAC) (Great Island Channel site 001058) and is part of the Special Protected Area (SPA) (Cork Harbour 004030). A minor road runs along the northern boundary of the site.

2.2.2 Proposed pipeline route and discharge point.

The pipeline route and discharge area is characterised by uniform mudflats, which are exposed at low tide. The creek is formed by a small watercourse, which discharges at Slatty Bridge via a small brackish lake. There are sluice gates at Slatty Bridge, which controls the influx of salt water into the lake. The mudflats are bounded to the north by the N25 and roundabouts at Tullagreen, as well as roadside grassy verges and rock armour associated with the road. The southern boundary of this area of mudflats is formed by Fota Island. Due to the presence of the N25 along the northern boundary and the R624 road to Cobh along the eastern boundary, current traffic noise levels are considerable.

2.3 Designated sites

A list of protected Natura 2000 sites within 10km of the proposed development site is given in **Table 1**. Site synopses for relevant SPA and SAC are included in Appendix **1** of this report. The relevant Natura 2000 sites for the purposes of this report are the Cork Harbour SPA and Great Island Channel SAC. These are shown on **Figure 2**. Qualifying habitats/species and conservation objectives for these sites are listed in Table 3 and Table 4 below.

Site	Code	Distance
Cork Harbour SPA	004030	Within
Great Island Channel SAC	1058	Within

Table 2. Protected sites within 10km.

2.3.1 NPWS site designation qualifying interests

The NPWS lists the following habitats as qualifying interests for the Great Island Channel (001058) **(Table 3)** and the following birds species as qualifying interests for the Cork Harbour SPA 004030. (**Table 4**).

Name	Habitat Code	Habitat	% cover Approx.
Great Island Channel	1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	2
Great Island Channel	1140	Mudflats and sandflats not covered by seawater at low tide	62
Great Island Channel	1320	Spartina swards (Spartinion maritimae)	10
Great Island Channel	1130	Estuaries	20

Table 3 Qualifying habitats for the Great Island Channel SAC 1058

Annex of EU Birds Directive	Common Name	Scientific name
N/A	Cormorant	*Phalacrocorax carbo*
N/A	Shelduck	*Tadorna tadorna*
N/A	Oystercatcher	*Haematopus ostralegus*
Annex 1	Golden Plover	*Pliuvialis apricaria*
N/A	Lapwing	*Vanellus vanellus*
N/A	Dunlin	*Calidris alpina*
N/A	Black tailed godwit	*Limosa limosa*
Annex 1	Bar tailed godwit	*Limosa lapponica*
N/A	Curlew	*Numenius arquata*
N/A	Redshank	*Tringa totanus*
Annex 1	Common tern	*Sterna hirundo*
N/A	Little grebe	*Tachybaptus ruficollis*
N/A	Great crested grebe	*Podiceps cirstatus*
N/A	Grey heron	*Ardea cinerea*
N/A	Wigeon	*Anas penelope*
N/A	Teal	*Anas crecca*
N/A	Pintail	*Anas acuta*
N/A	Shoveler	*Anas clypeata*
N/A	Red-breasted merganser	*Mergus serrator*
N/A	Grey plover	*Pliuvialis sqyuatarola*
N/A	Black headed gull	*Larus ribundus*
N/A	Common gull	*Larus canus*

Source: European Communities (Conservation of Wild Birds (Cork Harbour Special Protection Area 004030)) Regulations 2010

Table 4 Birds listed as Special Conservation Interests under the EU Birds Directive for SPA 004030

2.3.2 Conservation objectives for Natura 2000 sites.

The overall aim of the Habitats Directive is to maintain or restore the favourable conservation status of habitats and species of community interest. Favourable conservation status of a habitat is achieved when: its natural range, and area it covers within that range, are stable or increasing, and the specific structure and functions which are necessary for its long-term maintenance exist and

are likely to continue to exist for the foreseeable future, and the conservation status of its typical species is favourable.

The favourable conservation status of a species is achieved when: population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Generic conservation objectives for these sites can be stated as follows:

Objective: To maintain or restore the favourable conservation condition of the Annex I habitats for which the Great Island SAC has been selected.

Objective: To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for the Cork Harbour SPA.

2.3 Ecological Assessment – EIS

The ecological report which was prepared for the EIS is included as **Appendix 2** of this report and relevant findings are summarised below:

2.3.1 Marine Habitat

- The classification of marine habitat follows the scheme outlined in the Heritage Council publication A *Guide to Habitats in Ireland* (Fossit, 2000). The area of estuarine habitat affected by the proposed development is classified as Estuaries MW4 / Littoral (Intertidal) Mud shores LS4. Estuaries are linked with the Annex I habitat 'estuaries (1130)' and Littoral (Intertidal) Mud shores LS4 corresponds to the Annex 1 habitat 'Mudflats and sandflats not covered by seawater at low tide (1140)'. As is typical in the upper reaches of estuaries, the mudflats are dominated by fine silt and clay (>95%). Algae is largely absent.
- Core samples were taken at low tide. Observations on the samples indicate that the surface of the mud was brown, however a black anoxic layer was recorded close to the surface. The results of invertebrate analysis indicate that diversity and biomass is low within the mud samples taken at and adjacent to the proposed discharge point.

2.3.2 Birds

- Slatty Waters is considered of high value as a habitat for wintering birds. It is therefore proposed that the pipeline will be constructed outside the wintering period (October to March). To ascertain bird usage outside the wintering period, a survey of birds in the area of mudflats to be affected by the development was carried out in April 2007. This survey concluded the following:

- The observations made in April 2007 showed that the Slatty's Bridge mudflat is used as a feeding area and a high tide roost site by several species of wildfowl and waders. The main roost areas were at the north western end of the study site and along the southern bank. Species observed roosting in these areas included oystercatcher, black-tailed godwit, redshank, teal, shelduck and little egret.

- At low tide, most feeding activity was focused on the area of exposed mudflats and the central channel that dissected the study area. Species utilising the mudflats and central channel for food included black-tailed godwit, oystercatcher, shelduck, redshank, greenshank, cormorant and curlew.

- Although only one species was recorded in nationally important numbers (i.e. Black-tailed Godwit: >80 birds) during the April visits, the Slatty's Bridge mudflat may support greater numbers of birds at other times of year, such as the autumn passage, winter and the breeding season (i.e. May to July).

2.3.3 Terrestrial and Freshwater Habitats

Habitats directly affected by the proposed works at the WWTP and along the terrestrial sections of the pipeline route lie within the boundaries of designated sites as shown in **Figure 3.** These areas were surveyed during the preparation of the EIS in 2007. It is noted that any impact on a designated cSAC/SPA under the NRA classification scheme, regardless of size, is classed as severe and negative under the classification scheme utilised for the 2007 EIS. The relevant details are included below in **Table 5.**

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
Riparian woodland WN5	Part of the Special Area of Conservation and Natural Heritage Area (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be **Internationally Important (Category A)**	The designated areas include the wooded area to the west of the existing WWTP. Although this area is designated, it is a small part of a much larger site. This habitat though of local interest is of considerably less value than the estuarine habitats which form the bulk of the designated sites.	No rare species were detected in this habitat however it is part of a mosaic of habitats including reedbeds, brackish lake and watercourse. The total area to be affected is approximately 2.33 ha and in this area vegetation will be completely removed. Overall despite its designation the site is considered to be of moderate, local value and is not of particular value in the context of the cSAC/SPA.
Marsh CM1/Immature woodland WS2	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be **Internationally Important (Category A)**	Moderate range of species noted although none were rare or uncommon. This habitat is evolving into woodland. Part of a mosaic of habitats with riparian woodland and reedbeds.	This area will be removed by the development of the WWTP. Overall this habitat is of local value and the impact of its removal is not considered to be of high significance.
Reed and large sedge swamp FS1.	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be **Internationally Important (Category A)**	Relatively uniform with a low diversity of plant species. However this fringe of reedbed does form a buffer zone at the edge of the lake and may be used by nesting birds and otters.	The extension of the WWTP site will result in the removal of a small proportion of this habitat which is considered of moderate, local value. Overall this habitat is of local value and the impact of its removal is not considered to be of high significance.
Drainage ditch FW4	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be **Internationally Important (Category A)**	Small and with no significant fisheries value.	This habitat is of moderate local value and is not an important component of the cSAC.
Amenity grassland GA2	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to	Low value habitat with some planted trees and small areas of scrub.	The pipeline route will pass through this habitat which is of low local value despite its inclusion within the designated site boundary.

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
	be **Internationally Important (Category A)**		

Table 5 details of NRA Classification

2.3.4 Ecological information subsequent to completion of the EIS.

Following discussions with the NPWS it was considered necessary to carry out chemical analysis on sediments from the estuarine mudflats through which the pipeline will pass. The purpose of this study was to assess the potential ecological impacts from tidal re-suspension of potentially toxic heavy metal or organic compounds associated with excavation and backfilling of the pipeline. This report (*Assessment of the potential impacts generated from tidal re-suspension of potentially toxic heavy metal or organic compounds associated with excavation and backfilling of a pipeline associated with Carrigtohill WWTP, DixonBrosnan 2008*) is attached as **Appendix 3** of this report and its conclusions are summarised below:

The literature review notes that re-suspension of contaminated sediments may pose an ecological threat to organisms exposed to the water-column and on this basis extensive chemical tests were carried out to determine the level of contamination of sediments by heavy metals and other compounds. The guidelines for the assessment of dredge material for disposal in Irish water notes the following:

- The lower level guidance values correspond to contaminant concentrations below which the sediment, if disposed of at sea, is assumed to have a physical impact only. The upper level guidance values are set at concentrations above which adverse effects might be expected.

- Lower level guidance values represent concentrations that are either a) at the upper end of the no-effect range or b) at background concentrations. Upper level guidance values are set at the lower end of the known range of effective concentrations i.e. lowest concentrations shown to have adverse effects on marine organisms.

- The guidelines also note that management of sediments with chemical concentrations that place them in Class 2 may be extremely complex. The type and level of contamination will be

considered. All decisions regarding class 2 sediment (i.e. sediments with concentrations between levels 1 and 2) will be based on best professional judgement.

Based on the above and given that chemical levels were either recorded below the detection limit or were well below the upper limits (with the exception of zinc at S2), the pipeline works don't appear to constitute a significant ecological threat via re-suspension of compounds. This assumes that the construction method effectively minimises disturbance of sediment.

It is also noted that the sediment will be backfilled and thus will not be impacting on new areas which may support macro-invertebrate communities which are not adapted to this type of sediment type and chemical composition. It is also noted that silt may settle at low tides. Overall there is no significant evidence to indicate the works will have a noticeable impact on the ecology or bird populations of the designated area.

As a precautionary measure and given that some heavy metal concentrations come within class 2, a detailed method statement should be produced prior to the commencement of construction which sets out the construction method and measures proposed to minimise disturbance of estuarine sediments and re-suspension of compounds. It is particularly important to minimise disturbance in the upper part of the pipeline route where concentrations of heavy metals are highest. Such a method statement should also specify the mitigation measures required to prevent negative impacts on bird populations and the provisions of the method statement should be agreed with the NPWS prior to commencement of works.

2.3.6 Site surveys 2014

A resurvey of habitats at the site in May 2014 did not note any significant differences with reference to the habitats recorded in 2007. No otter holts were recorded although signs of their presence were noted. The most obvious change since 2007 is the growth of the invasive species Japanese knotweed in proximity to the pipeline route.

2.3.7 Modelling of potential impact of wastewater discharge on Cork Harbour

A study was carried out to provide numerical modelling of the hydrodynamic and water quality conditions that are prevalent in Cork Harbour and as a result of proposed discharges from the Carrigtohill and Carrigrenan outfalls. The purpose of the model was also to decide on an appropriate

discharge location, standards and discharge period in relation to the tidal regimes. This report is included as **Appendix 4** of this report and its conclusions are summarised below.

Based on the results of the model, the following was the recommended discharge standard:

Parameter	Phase 1 Value	Phase 2 Value	Unit
BOD	25	20	mg/l
SS	35	35	mg/l
P	1	1	mg/l
N	15	10	mg/l
T. Coliforms	No specific limit	No specific limit	MPN/100 mls
F. Coliforms	No specific limit	No specific limit	MPN/100 mls

Table 6 Proposed Discharge Standards

The limits specified above in Table 6 were designed to meet the following legislative requirements:

- UWWT standard treatment (25:35 BOD:SS)
- Shellfish Regulations (100:1000), (with dispersal, at specific locations only)
- Bathing Regulations (1000:5000) (with dispersal, at specific locations only)
- National Shellfish Sanitary System (at Weir Island Shellfish Farms).These discharge limits are also in accordance with the recent status of Cork Harbour, as of 2007, as a designated sensitive area.
- Satisfactory dispersion qualities have been demonstrated at North Point by the hydrodynamic model.
- The North Point is a suitable discharge location for the Carrigtohill Sewerage Scheme because of the level of dispersion available and the short periods of retention.
- The nutrient concentrations (N, P) will be reduced below the recommended level (EPA Report) prior to discharge into Lough Mahon and the Lee estuary.
- The discharge standards recommended will provide adequate treatment for the Carrigtohill WWTW for both phases of the development while complying in principle with all of the relevant standards.

2.4 Other environmental information contained in the EIS

Other environmental information relevant to potential impacts on designated sites relate to flooding risk (WWTP site), traffic and construction noise and dust**.** This information is summarised below:

- Based on the Lidar survey and calculations on the maximum sea level when taking into account a rise due to global warming, it can be concluded that the treatment plant site will be within the floodplain. Measures to protect the site from flooding will be required.

Increase of the ground level and construction of an embankment around the site including enclosing one of the streams flowing through the site in a culvert are possible options.

- There will be an increased volume of traffic on the access roads to the site. Given the proximity of the site to the N25, the increased level of traffic will not represent a substantial increase on the existing level. The increased level of traffic will be for a limited period only and will reduce dramatically as the civil and building elements of the works draw to a close. Any noise, which will arise during the construction of the works, will be mainly due to construction traffic and the operation of machinery and plant. Plant noise will be controlled in accordance with BS5228: 1984 or similar control criteria, which will be specified in the contract documents for the construction of the works. Noise limits will be set in the specification for the construction works in accordance with Department of the Environment Regulations S.I. No. 320 of 1988.

- The use of water tankers to hose down the work areas may be necessary to keep dust levels down in dry, windy periods. A wheel washing facility will be in place to ensure that no material is dragged on to the local roads.

3. MITIGATION MEASURES TO BE IMPLEMENTED AS PART OF THE PROJECT DESIGN.

The following mitigation measures were specified by the EIS:

3.1 General

- Measures to protect the site from flooding will be required. Increase of the ground level and construction of an embankment around the site including enclosing one of the streams flowing through the site in a culvert are possible options.

3.2 Ecology

- Any works which impact on estuarine habitats during the wintering period (approximately October to March) will have a negative impact on the local bird community and therefore will be avoided. Works will therefore proceed outside this period.

- Due to the difficulties associated with predicting the effect of increased nutrient loadings on the nutrient status of estuarine mudflats it is recommended that detailed monitoring of nutrient levels, macro-invertebrates and wintering birds be carried out. The results of these surveys should be considered in tandem with available I-WeBS data to accurately determine if changes detrimental to the ecology of the area are occurring. Initially accurate baseline winter data should be obtained with surveys repeated every two years until 4 years after the plant reaches its full capacity.

- If feasible, scope should be provided within the design of the treatment plant to upgrade the treatment standard and/or move the discharge point should survey results indicate that important bird populations are being adversely affected.

- Removal of natural vegetation and in particular reedbeds which fringe the brackish lake should be kept to a minimum. To prevent incidental damage by machinery or by the deposition of spoil, it is recommended that habitats earmarked for retention be securely fenced early in the development process. The fencing should be clearly visible to machine operators. No work should take place outside the lands made available for construction, and all materials and liquids associated with the work should be stored in a manner that will not result in pollution or habitat deterioration. Particular care should be taken at the boundary

between the development site and the cSAC, SPA and pNHA so that construction activities do not cause damage to habitats in this area. Consultation should be undertaken with National Parks & Wildlife Service with regard to the nature of proposed works along this boundary. During construction, siltation of water bodies must be minimized by the appropriate use of settlement ponds, silt traps and bunds particularly during any diversion of the drainage ditches currently running through the site. Grit interceptors will also be put in place, as appropriate, to control pollution and run off.

- The cSAC and SPA bordering the development area are, by definition, nationally important for their habitats and the species they support. It is essential that all construction staff, including all sub-contracted workers, be notified of the boundaries of the cSAC and SPA and be made aware that no construction waste of any kind (rubble, soil, etc.) is to be deposited in these protected areas outside the landtake area and that care must be taken with liquids or other materials to avoid spillage. A Construction and Demolition Waste Management Plan will be developed for the site, with particular emphasis placed on preventing any materials being placed in the pNHA, cSAC and SPA.

3.3 Noise

- Adoption of noise limits of 50 $Laeq_{1hour}$ by day, and 35 $Laeq_{15minute}$ at night during operation of the proposed plant, at the nearest house and any house is the overriding control measure. Appropriate attenuation measures will be used to achieve these limits. All plant within the proposed new plant will be designed to meet the noise limits outlined above. Similarly, all plant will be monitored to detect and rectify, as soon as possible, any other excessively noisy plant which develops in the course of use.

- An earthen berm of suitable height is recommended along the Southern and Western site boundary in order to assist in containing noise emissions effectively.

- Construction plant and equipment for use on the proposed works should comply with Statutory Instrument No.632 of 2001 “European Communities (Noise Emission by Equipment for Use Outdoors) Regulations 2001”, and that silencers and engine covers be kept in good and effective working order.

- The methodology of British Standard B.S.5228:1997 “Noise and vibration control on Construction and open sites” Part 1, is available for use, if need be, during the construction work if required to minimise emission of any noise to any residence. Construction work is not expected to occur at night.

3.4 An Bord Pleanala Planning Conditions

- Phase two of the proposed works shall be excluded from this approval in order to allow for further assessment of the environmental impacts when phase one (45,000 population equivalent plant capacity) is in operation.

- Storm tanks with a minimum capacity to ensure compliance with the requirements of the DEHLG publication “Procedures and Criteria in relation to Storm Water Overflows” (1995) shall be installed.

- The treatment of any watercourses running through the development site shall be agreed with Inland Fisheries Ireland prior to the commencement of construction.

- A comprehensive Construction Environmental Management Plan shall be prepared prior to commencement of construction in consultation with the Department of Environment, Heritage and Local Government (National Parks and Wildlife Service). This shall include the detailed method statement for the laying of the outfall pipeline as referred to in the last paragraph of the conclusions in the report by the Environmental Consultants submitted to An Bord Pleanála on the 25th day of February, 2010.

3.5 Mitigation 2014

The Construction Environmental Plan which will be prepared prior to commencement of construction will specify a range of mitigation measures to be implemented during site works. The plan will be drawn up with input from the supervising ecologist and will be agreed with NPWS and Inland Fisheries prior to commencement of site works.

The works area should be surveyed for Japanese Knotweed prior to construction of works. Where invasive species such as Japanese knotweed are recorded an Invasive Species Management Plan will be required.

Mitigation measures to be implemented may include restrictions on timing of works, fencing to protect habitats within designated sites, silt traps and curtains, hydrocarbons interceptors, bunding of stored chemicals, use of adequately maintained machinery, protection of existing vegetation, reseeding of bare earth, restoration of damaged vegetation, separation of non-construction related runoff (clean water) and construction runoff (soiled water) to avoid cross contamination, protection of fisheries and minimisation of noise and disturbance.

It is recommended that a baseline survey of birds be carried out prior to construction and within 12 months of completion of construction.

3.6 Implementation of mitigation measures

Evidence of how these will be secured and implemented and by whom and evidence of how measures will be monitored and should mitigation failure be identified how that failure will be rectified.

A comprehensive Construction Environmental Management Plan shall be prepared prior to commencement of construction in consultation with the Department of Environment, Heritage and Local Government (National Parks and Wildlife Service) and Inland Fisheries Ireland.

The implementation of the mitigation measures will also be provided for in an Environmental Management Plan Audit Report, which effectively lists all mitigation measures prescribed in any of the planning documentation, all conditions attached to the grant of planning permission and any further mitigation measures proposed during the detailed design stage, and allows them to be audited on a regular basis. The first assessment is a simply Yes/No, has the mitigation measure been employed on-site or not. Following confirmation that the mitigation measure has been implemented, the effectiveness of the mitigation measures will be the subject of regular review and audit during the full construction stage of the project. If some remedial actions are needed to improve the effectiveness of the mitigation measure, then these are notified to the site staff immediately during the audit site visit, and in writing by way of the circulation of the audit report. Depending on the importance and urgency of rectifying the issue, the site staff are given a timeframe by when the

remedial works need to be completed. The on-site construction staff are responsible for implementing the mitigation measures specified in the EIS and compiled in the Audit Report. Their implementation will be overseen by the ecologist and/or engineers and other specialists depending on who is best placed to advise on the implementation. The system of auditing referred to above ensures that the mitigation measures are maintained for the duration of the construction phase, and into the operational phase where necessary.

3.7 Implementation of mitigation measures

Evidence of degree of confidence in their likely success.

The likely success of the proposed mitigation measures is high, either in their current form or as they will be adapted on-site to achieve the desired result. The mitigation measures to be implemented are relatively standard and have been drawn up in line with current best practice and include an avoidance of sensitive habitats at the design stage. It is clear in what the mitigation measures are designed to achieve in lowering or reducing the risk of impact to acceptable levels. Whilst the proposed methods of mitigation may be amended and supplemented the risk that the mitigation measures will not function effectively in preventing significant impacts on designated sites is low.

3.8 Implementation of mitigation measures

Timescale, relative to plan or project for their implementation or completion.

The timescale for implementation of the mitigation measures will be dependent on the construction programme of the proposed project. However, based on evidence from other projects, the mitigation measures can only commence in tandem with other site operations as staff, machinery and other resources are necessary to implement the measures. Certain mitigation measures will have to be undertaken in advance of certain construction works, while others can proceed in parallel and others will only be necessary following completion of the main site works. It is recommended that bird monitoring work should commence prior to the commencement of construction work.

4. POTENTIAL IMPACTS

Potential impacts could arise with respect to the following;

- Water and habitat quality within the upper reaches of the Slatty Waters is expected to improve due to the relocation of the discharge point to an area with greater dilution and where dispersal will be more effective.
- Increases in nutrient levels reaching Cork Harbour may cause a deterioration in water quality overall. This may impact on the Great Harbour SAC qualifying habitats (Mudflats and sandflats not covered by seawater at low tide and Atlantic salt meadows (Glauco-Puccinellietalia maritimae).
- There may be a net potential impact on birds (negative or positive) resulting from the relocation of the existing outfall to an area of Cork Harbour where more dilution is available.
- Two habitats listed as qualifying interests for the Great Island Channel SAC namely Mudflats and sandflats not covered by seawater at low tide (which equates to Littoral (Intertidal) Mud shores LS4 under the Fossit 2000 classification scheme) and Estuaries (equates to Estuaries MW4 under Fossit, 2000) will be directly affected by the development of the pipeline.
- During construction of the pipeline there will be direct disturbance/displacement of feeding and/or roosting birds due to construction of the pipeline.
- Changes in nutrient levels and the location of the discharge point may impact on invertebrate populations due to increased or reduced nutrient levels in estuarine mudflats. This may have a knock on effect on the feeding behaviour or feeding success of important bird populations.
- Similarly the direct impact on invertebrate populations during construction of the pipeline may impact on bird populations.
- Increased noise and traffic disturbance during construction works on the WWTP will occur.
- A range of other habitats (Riparian woodland WN5, Marsh CM1/Immature woodland WS2, Reed and large sedge swamp FS1, Drainage ditch FW4 and Amenity grassland GA2) which are located within the Cork Harbour SPA and Great Island Channel SAC will be directly affected. It is noted that these habitats are not qualifying habitats for Natura 2000 sites.
- High levels of siltation in surface water run-off and accidental spillages of chemicals such as hydrocarbons may impact on freshwater and marine water quality within the relevant Natura 2000 sites.
- Flooding of the WWTP site could result in the run-off of deleterious substances such as hydrocarbons, stored chemicals etc and could result in high levels of nutrients reaching aquatic and marine habitats.

5. POTENTIAL IN-COMBINATION IMPACTS

Within the overall Cork Harbour area there are a range of possible impacts on water quality including construction works, industrial discharges, large scale treatment plants and run-off from roads. As noted in the EIS:

"Cork Harbour meets several of the criteria for a eutrophic system. Cork Harbour, particularly the area around Lough Mahon appears to be eutrophic. The estuarine circulation in the harbour acts as a focus for the eutrophication-related effects. Increased residence times in the subsurface layer allow more time for algal growth and simultaneously increase the scope for de-oxygenation of the water column. Direct nutrient inputs to the surface layers may increase the size of the toxic algal blooms when conditions are appropriate for growth of PSP-causing species."

In estuarine waterways the EPA rates water quality as Unpolluted, Intermediate, Potentially Eutrophic and Eutrophic. The former two are considered to be acceptable estuarine water quality, while the latter two water quality ratings are considered as unsatisfactory. **Table 7** displays the current results for Cork Harbour.

Area	Water quality status
Lough Mahon	Estuarine & coastal water quality – Intermediate Water Framework Status - Good Status. At risk of not achieving good status

Source: EPA Envision map system

Table 5. EPA Q values for the waterways in relation to the proposed pipeline route

The discharge from the Carrigrenan WWTP is the most significant of the large scale discharges to Cork Harbour. The scheme was developed in response to the EU Wastewater Treatment Directive of 1991, which demanded that all discharges of untreated effluent be collected and brought to a new WWTP, which was constructed as part of the scheme. The plant services a population of 324,000 people and the system involves primary and secondary treatment and sludge drying. This plant discharge waste treated to 25:35 BOD:SS standard at Marino Point.

Modelling of the impacts on the discharge was carried out as part of the EIS process (Appendix N – EIS). The purpose of the model was to estimate the potential impact on Cork Harbour and to decide on an appropriate discharge location and on standards and the appropriate discharge period.

This study involved the numerical modelling of the hydrodynamic and water quality conditions that were prevalent in Cork Harbour and to predict impacts arising as a result of proposed discharges from the Carrigtohill and Carrigrenan outfalls. The overall aim was to reduce the impact of the combined discharges (from both Carrigtohill and Carrigrenan) rather than the impact of the Carrigtohill discharge alone. Thus the conclusions of the EIS are based on the impact arising from both treatment plants.

6. CONCLUSIONS OF EIS

The following conclusions from the original EIS are considered relevant to this report:

6.1 Conclusions water quality

The existing treatment plant in Carrigtohill is overloaded. With predicted growth in the domestic and non-domestic loads as provided for in the development plans for Carrigtohill and its environs, over-loading of the plant may be expected to worsen in the short term. An increase in treatment capacity is therefore required to provide for the proper treatment of the existing load and for the sustainable development of the town. A number of alternative sites were considered before it was concluded that an expansion of the existing plant was the most appropriate means of providing the necessary increase in treatment capacity. It is also recognised that the low levels of dilution available at the existing outfall location call for a very high standard of final effluent and an extended outfall to increase the dispersion. The proposal and the subject of this EIS is the construction and operation of a plant to provide for the treatment of wastewaters arising in Carrigtohill to such a standard.

The upgraded works will have a number of benefits for Slatty Waters and the Carrigtohill area in general.

- The standard of treatment of the wastewater will be substantially improved;
- The relocation of the outfall will improve the dispersion of the discharged final effluent in Slatty Waters;
- The elimination of storm water overflows from the WWTW except during exceptionally adverse weather conditions;
- The water quality of the receiving water will meet the requirements of the EPS "Assessment of the Trophic Status of Estuaries and Bays in Ireland", 2001 report.
- The upgraded works will satisfy all of Cork County Council's obligations under the UWWT Regulations and the Phosphorus Regulations (subsequently repealed by SI No 272 of 2009 - European Communities Environmental Objectives (Surface Water) Regulations).

Satisfactory dispersion qualities have been demonstrated at North Point by the hydrodynamic model. The North Point is a suitable discharge location for the Carrigtohill Sewerage Scheme because of the level of dispersion available and the short periods of retention.

The nutrient concentrations (N, P) will be reduced below the recommended level (EPA Report “An assessment of the Trophic Status of Estuaries and Bays in Ireland”.) prior to discharge into Lough Mahon and the Lee estuary.

The discharge standards recommended will provide adequate treatment for the Carrigtohill WWTW for both phases of the development while complying in principle with all of the relevant standards.

6.2 Conclusions ecology

Overall there will be a net loss of designated terrestrial habitats. No long-term significant impact on otters and bats is likely to occur. After construction, benthic communities should recolonise disturbed estuarine areas, with an accompanying re-establishment of fish in these areas. The increased nutrient levels could impact on the distribution of macro-invertebrate populations which in turn could impact on populations of birds and fish. However it is expected that effective dispersal of nutrients will occur.

7. PREDICTED IMPACTS 2014

7.1 Predicted direct impacts on terrestrial habitats (not listed as qualifying interests).

Some habitats (Riparian woodland WN5, Marsh CM1/Immature woodland WS2, Reed and large sedge swamp FS1, Drainage ditch FW4 and Amenity grassland GA2) which are located within the Cork Harbour SPA and Great Island Channel SAC will be directly affected. It is noted that these habitats are not qualifying habitats for Natura 2000 sites. Whilst these habitats support a range of relatively common species of flora and fauna they are not considered of high value for the birds listed as qualifying interests for the Cork Harbour SPA. Whilst there will be an impact at a local level, no significant impact on the qualifying interests for Natura 2000 sites is envisaged.

The lake and reedbed fringe and the agricultural land at the edge of the lake are utilised by a number of species including black-tailed godwits, curlews, wigeon, mute swans, shelduck, little grebe and teal. Green sandpipers and wood sandpipers occur periodically and American wigeon has been observed here in the past. There is likely to be some short-term, indirect disturbance of these species however the impact is not expected to be significant in the context of background noise from existing road traffic. Landscaping of the WWTP will minimise visual impacts post construction. Whilst there will be an impact at a local level, no significant impact on the qualifying interests for Natura 2000 sites is envisaged.

7.2 Direct impacts on estuarine habitats

The discharge pipeline will impact on approximately 800m of estuarine habitat. Two habitats listed as qualifying interests for the Great Island Channel SAC namely Mudflats and sandflats not covered by seawater at low tide (which equates to Littoral (Intertidal) Mud shores LS4 under the Fossit 2000 classification scheme) and Estuaries (equates to Estuaries MW4 under Fossit, 2000) will be directly affected by the development of the pipeline. The habitat to be affected consists of uniform mudflats with little vegetation and the works will take approximately 90 days to complete. Following completion of works it is expected that the disturbed mud habitat will rapidly return to its pre-construction structure. There will be an impact on mud-dwelling invertebrates due to disturbance of the substratum. However impact is expected to localised and short-term and no long-term impact on invertebrate populations is envisaged as the species present would be expected to rapidly re-colonise the affected habitats. Thus the only long-term impact will be the loss of mud shore habitat equal to

the volume of the proposed pipeline. In the context of Cork Harbour in general, and more specifically Slatty Waters, this impact is considered long-term and minor negative.

7.3 Impacts on marine water quality from proposed discharge and predicted impacts on the Cork Harbour SAC

The proposed treatment plant will provide a higher level of treatment and storm water overflows will be largely prevented. The treatment standards were designed to meet the relevant legislative standards and the cumulative impacts of this discharge and the discharge from Carrigrenan was taken into account in the design process. The WWTP will be managed under licence from the EPA. The decrease in nutrients reaching the confined inner reaches of Slatty Waters is expected to lead to a significant improvement in habitat quality.

Although there will be net decrease in nutrients discharging into the upper reaches of Slatty Waters there will be a net increase in nutrients reaching Cork Harbour as a whole over time. Potential ecological impacts could arise due to increased algal growth, increased turbidity impacting on feeding success for birds and mammals and if particularly severe direct toxic impacts. The treatment standards and discharge location, based on modelling of potential concentrations within the harbour, are designed to prevent background levels within the harbour from reaching a level at which significant ecological impacts are likely to occur. On this basis no significant impact on the qualifying interests and the conservation objectives for the Great Island Channel SAC is envisaged. It is also noted that the removal of the discharge from Slatty Waters will allow a more natural ecology to develop within this relatively enclosed area with increased diversity of invertebrates expected to develop.

7.4 Impacts on marine water quality from proposed discharge and predicted impacts on the Cork Harbour SPA

As noted above there will be a net increase in nutrients reaching Cork Harbour over time, although there will be a net reduction in nutrients reaching the relatively enclosed upper section of Slatty Waters. The impact from the reduction or increase of nutrients on birds within the estuarine environment is difficult to predict. In a review of the impact of nutrients on birds Macdonald (2006) notes that the indirect effects of eutrophication can be complex and highly localised in aquatic

systems, and local changes in bird populations may be affected by changes at larger scales. Increased nutrient loading may be beneficial to birds up to a point at which radical changes to habitat occur.

In estuarine and coastal areas, where sewage outfalls are removed, or where treatment is implemented, invertebrate biomass usually falls, although species richness increases and species composition more closely approximates natural conditions. Species with specific prey requirements or foraging habits, such as shelduck, may not benefit from nutrient inputs.

In conditions of extreme eutrophication, where extensive macro-algal mats form, the anoxic conditions may force the mud-dwelling fauna to the surface, providing a short-term flush of food. If the mats persist, the food supply will be reduced in the long term. Diving ducks in coastal waters also benefited from the increased food supplies around sewage outfalls, and their numbers have declined where outfalls have been removed.

Birds may generally benefit from nutrient inputs into tidal areas provided there is no extensive development of algal mats and thus it is possible that the net reduction of nutrients reaching Slatty Water will lead to a slight, localised decline in bird numbers. However although theoretically the removal of sewage discharges or improvement to sewage treatment is expected to reduce shorebird populations, this has not been observed everywhere (Eaton 2000b; Burton et al., 2004). This may be due to the complexity of nutrient dynamics in estuarine environments, however it may also be due to difficulties in determining changes at an appropriate scale, or because insufficient time had elapsed to discern changes (Burton et al., 2004). Notwithstanding a possible net localised reduction in bird usage of the upper sections of Slatty Waters, it is noted that macro-invertebrate diversity was found to be low in sediment samples taken as part of the EIS process. This may be indicative of significant localised impacts due to the limited exchange of water within this relatively enclosed area. In these circumstances movement of the discharge point may have a positive impact.

Whilst a slight, localised reduction in bird numbers using Slatty Waters cannot be entirely precluded, it is noted that the Cork Harbour SPA consists of large areas of suitable wintering habitat scattered throughout the harbour with birds moving between different feeding areas. In this context the potential net reduction in nutrients reaching the upper reaches of Slatty Waters, which may impact on bird populations, is likely to be offset by increased nutrient levels elsewhere within Cork Harbour. Overall it is not envisaged that the development as proposed will have a significant impact on important bird population with the the Cork Harbour SPA as a whole.

7.5 Disturbance impacts during construction and predicted impacts on Cork Harbour SPA.

The potential effects and impacts of disturbance have been widely recognised in wildlife conservation legislation, as has the need to develop conservation measures for birds whilst taking human activities into account. Article 4.4 of the Bird's Directive (79/409/EEC) requires member states to "take appropriate steps to avoid… any disturbances affecting birds, in so far as these would be significant having regard to the objectives of this Article". This specifically relates to conservation measures concerning Annex I species.

The development of the pipeline will lead to disturbance and possible displacement of feeding birds within the Slatty Waters area which is considered of value for waders and other species. Some additional noise and disturbance will arise during construction of the WWTP which could impact on birds using the lake, although any risk to birds using the estuary during works onshore is considered low. During operation noise and disturbance levels will be low and regular and birds would be expected to effectively habitualise to such impacts.

More significant impacts could occur during pipeline construction within estuarine habitats. Cayford (1993) points out that optimal foraging theory is a useful basis from which to understand likely effects of disturbance on feeding. Many studies have shown that birds concentrate where feeding is best. If birds are forced temporarily or permanently to leave these places then there is an increased risk that their foraging ability will suffer. However the severity of this type of situation and the way is which birds respond, vary in a very complex way. The multiplicity of variables underlying the observed interactions between waterfowl and people makes it difficult to assess the cause and implications of a particular instance of disturbance. The magnitude of disturbance to waterfowl may arise from synergistic effects of more than one activity. For example the results of Townshend & O'Connor (1993) on a study of a UK estuary, suggest that waterfowl numbers were affected by hunting activity, but mainly when the presence of bait-diggers in just one part of the estuary prevented birds from using an area established as a non-shooting refuge.

Burger and Gochfeld (1991) examined the impact of human disturbance on the foraging behaviour of sanderlings. During the four year survey period the numbers of people using the area within 100m of the sanderling's foraging grounds increased significantly. The result was that foraging time reduced significantly during daylight (when people were present) and increased significantly after dusk (when people were absent).

Scott (1989) studied the disturbance to waders from walkers, bait-diggers and fishermen on an estuary in north-east Scotland. On this estuary waders took flight from advancing disturbance at short distances: about 10 m in oystercatchers and dunlins, 10-15 m in redshank and 7 m in turnstones. Several species kept a considerable distance away from a fisherman: average distances were over 50 m in oystercatchers, 40 m in redshank, and 35 m in curlews. It should be noted that disturbance in itself does not always imply a serious problem for birds, at least in the short term. Some bird species have been shown to accelerate food intake to compensate for time lost foraging during disturbance periods (Swennen *et. al,* 1989).

The size of the area available to birds may also affect the levels of disturbance. On small estuaries there may be few alternative locations available to birds moving away from disturbance and it takes only a few activities in different places to make much of an area unsuitable to birds of some species (Davidson & Rothwell, 1993). The type and scale of response of different waterfowl to disturbance is very variable. Redshanks, for example, feeding in a narrow tidal creek with frequent passers-by on the shore will tolerate people within 20m, yet redshanks on some large estuaries fly off when a person is still over 100m away. Factors implicated in such variability are time of year, time of tide, weather conditions, flock size, feeding success, type of disturbance and past history of disturbance.

It should be noted that some studies have shown that birds have the ability to habituate to human disturbance (Schreiber 1979; Fitzpatrick and Bouchez' 1998). However a number of studies suggest that this may require predictable patterns of human activity which birds can learn pose no threat to them (Burger 1989; Burger and Gochfeld 1991).

In this instance it is noted that the pipeline works will take place outside the main wintering season which runs from October to March inclusive and will take place in close proximity to a busy road. Thus some degree of habituation to traffic noise and activity is likely to have occurred. Works will only take place during the day with no impacts predicted to occur at night. The pipeline works will be relatively short in duration 90 days approx.

A comprehensive Construction Environmental Management Plan shall be prepared prior to commencement of construction in consultation with the Department of Environment, Heritage and Local Government (National Parks and Wildlife Service). Ongoing monitoring of birds during the construction period and beyond will be put in place to allow for an ongoing assessment of impacts on birds. It is also noted that although Slatty Water is a relatively small area there are large areas of suitable feeding habitat within Cork Harbour overall. Although other areas within Cork Harbour may

be at full carrying capacity with respect to birds or may not provide optimal foraging conditions, given the limited duration of works the long-term impact on important estuarine birds is likely to be negligible. Overall therefore a minor, short-term localised impact on SPA bird populations is likely to occur and no significant long-term impact on qualifying interests, conservation objectives or the integrity of Natura 2000 sites is predicted to occur.

7.6 Predicted impacts on freshwater habitats located within the Cork Harbour SPA and Great Island Channel SAC (not listed as qualifying interests).

The brackish lake that adjoins the site and the drainage channel/watercourse within the site could be negatively affected by high levels of silt in surface water run-off or inadvertent spillages of hydrocarbons or other chemicals. During construction and following further consultation with Inland Fisheries Ireland, a detailed construction environmental management plan will be produced by the contractor prior to commencing work and used in conjunction with an Environmental Management Plan Audit Report. The mitigation measures to be implemented during a construction project are standard and are expected to effectively protect aquatic habitats within and outside the site boundary. During operation of the site standard operating protocols and procedures will be implemented under EPA licence. No significant impacts on freshwater/brackish habitats within the relevant Natura 2000 sites are envisaged.

7.7 Predicted impacts from potential flooding of the WWTP site.

Measures to protect the site from flooding will be required. Increase of the ground level and construction of an embankment around the site including enclosing of the drain/stream flowing through the site in a culvert are possible options. The final design of flood protection measures will be agreed with Inland Fisheries Ireland and NPWS. However the risk of flooding will be minimised to negligible levels.

8. CONCLUSIONS

The movement of the discharge point is expected to improve habitat quality within Slatty Waters due to increased dilution and better dispersal. The increase in nutrient levels reaching Cork Harbour may over time have a slight, localised impact (negative or positive) on important bird populations.

Overall there is no evidence to indicate that works will cause significant deterioration of qualifying habitats, the habitats of the qualifying species and species of special conservation interest or significant disturbance to these species thus ensuring the integrity of the site is not adversely affected. No indirect or cumulative impacts are predicted.

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APPENDIX 1

SITE SYNOPSIS FOR THE RELEVANT SPA AND SAC

Site synopsis for Great island channel SAC site code: 001058

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton, provide the main source of freshwater to the North Channel.

The main habitats of conservation interest are the sheltered tidal sand and mudflats and Atlantic salt meadows, both habitats listed on Annex I of the EU Habitats Directive. Owing to the sheltered conditions, the intertidal flats are composed mainly of soft muds. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algal species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially at Rossleague and Belvelly. The salt marshes are scattered through the site and are all of the estuarine type on mud substrate. Species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Greater Sea-spurry (*Spergularia media*), Sea Lavender (*Limonium humile*), Sea Arrowgrass (*Triglochin maritimum*), Mayweed (*Matricaria maritima*) and Red Fescue (*Festuca rubra*).

The site is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Shelduck are the most frequent duck species with 800-1000 birds centred on the Fota/Marino Point area. There are also large flocks of Teal and Wigeon, especially at the eastern end. Waders occur in the greatest density north of Rosslare, with Dunlin, Godwit, Curlew and Golden Plover the commonest species. A population of about 80 Grey Plover is a notable feature of the area. All the mudflats support feeding birds; the main roost sites are at Weir Island and Brown Island and to the north of Fota at Killacloyne and Harper’s Island. Ahanesk supports a roost also but is subject to disturbance. The numbers of Grey Plover and Shelduck, as given above, are of national importance.

The site is an integral part of Cork Harbour which is a wetland of international importance for the birds it supports. Overall, Cork Harbour regularly holds over 20,000 waterfowl and contains Internationally important numbers of Black-tailed Godwit (1,181) and Redshank (1,896) along with Nationally important numbers of nineteen other species. Furthermore, it contains the large Dunlin (12,019) and Lapwing (12,528) flocks. All counts are average peaks, 1994/95 – 1996/97. Much of the site forms part of Cork Harbour Special Protection Area, an important bird area designated under the EU Birds Directive. While the main land use within the site is aquaculture (Oyster farming), the greatest threats to its conservation significance come from road works, infilling, sewage outflows and possible marina developments.

The site is of major importance for the two habitats listed on the EU Habitats Directive that it contains, as well as for its important numbers of wintering waders and wildfowl. It also supports a good invertebrate fauna.

Site synopsis Cork harbour SPA site code: 004030

Cork Harbour is a large, sheltered bay system, with several river estuaries – principally those of the Rivers Lee, Douglas and Owenacurra. The SPA site comprises most of the main intertidal areas of Cork Harbour, including all of the North Channel, the Douglas Estuary, inner Lough Mahon, Lough Beg, Whitegate Bay and the Rostellan inlet.

Owing to the sheltered conditions, the intertidal flats are often muddy in character. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algae species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially where good shelter exists, such as at Rossleague and Belvelly in the North Channel. Salt marshes are scattered through the site and these provide high tide roosts for the birds. Salt marsh species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Laxflowered Sea-lavender (*Limonium humile*) and Sea Arrowgrass (*Triglochin maritima*).

Some shallow bay water is included in the site. Cork Harbour is adjacent to a major urban centre and a major industrial centre. Rostellan lake is a small brackish lake that is used by swans throughout the winter. The site also includes some marginal wet grassland areas used by feeding and roosting birds.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. The five-year average annual core count for the entire harbour complex was 34,661 for the period 1996/97-2000/01. Of particular note is that the site supports an internationally important population of Redshank (1,614) – all figures given are average winter means for the 5 winters 1995/96-1999/00. A further 15 species have populations of national importance, as follows: Great Crested Grebe (218), Cormorant (620), Shelduck (1,426), Wigeon (1,750), Gadwall (15), Teal (807), Pintail (84), Shoveler (135), Red-breasted Merganser (90), Oystercatcher (791), Lapwing (3,614), Dunlin (4,936), Black-tailed Godwit (412), Curlew (1,345) and Greenshank (36). The Shelduck population is the largest in the country (9.6% of national total), while those of Shoveler (4.5% of total) and Pintail (4.2% of total) are also very substantial. The site has regionally or locally important populations of a range of other species, including Whooper Swan (10), Pochard (145), Golden Plover (805), Grey Plover (66) and Turnstone (99). Other species using the site include Bat-tailed Godwit (45), Mallard (456), Tufted Duck (97), Goldeneye (15), Coot (77), Mute Swan (39), Ringed Plover (51), Knot (31), Little Grebe (68) and Grey Heron (47). Cork Harbour is an important site for gulls in winter and autumn, especially Common Gull (2,630) and Lesser Black-backed Gull (261); Black-headed Gull (948) also occurs.

A range of passage waders occur regularly in autumn, including Ruff (5-10), Spotted Redshank (1-5) and Green Sandpiper (1-5). Numbers vary between years and usually a few of each of these species over-winter.
The wintering birds in Cork Harbour have been monitored since the 1970s and are counted annually as part of the I-WeBS scheme. Cork Harbour has a nationally important breeding colony of Common Tern (3-year mean of 69 pairs for the period 1998-2000, with a maximum of 102 pairs in 1995).he birds have nested in Cork Harbour since about 1970, and since 1983 on various artificial structures, notably derelict steel barges and the roof of a Martello Tower. The birds are monitored annually and the chicks are ringed.

Extensive areas of estuarine habitat have been reclaimed since about the 1950s for industrial, port-related and road projects, and further reclamation remains a threat.

As Cork Harbour is adjacent to a major urban centre and a major industrial centre, water quality is variable, with the estuary of the River Lee and parts of the Inner Harbour being somewhat eutrophic. However, the polluted conditions may not be having significant impacts on the bird populations. Oil pollution from shipping in Cork Harbour is a general threat. Recreational activities are high in some areas of harbour, including jet skiing which causes disturbance to roosting birds.

Cork Harbour has is of major ornithological significance, being of international importance both for the total numbers of wintering birds (i.e. > 20,000) and also for its population of Redshank. In addition, there are at least 15 wintering species that have populations of national importance, as well as a nationally important breeding colony of Common Tern. Several of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover, Bar-tailed Godwit, Ruff and Common Tern. The site provides both feeding and roosting sites for the various bird species that use it.

APPENDIX 2

ECOLOGICAL REPORT FROM THE EIS

DixonBrosnan

Project	Assessment of the ecological impacts of discharging treated wastewater from Carrigtwohill, Co. Cork		
Client	T.J. O' Connor & Associates		
Project ref	Report no	Client ref	Pages
Carrigtwohill	07085		30

Dixon.Brosnan, 7 The Cedars, Bridewood, Ovens, Co. Cork
Tel/Fax: 086 8511437 | Email: carl@dixonbrosnan.com | www.dixonbrosnan.com

Date	Rev	Status	Prepared by	Issued
16/5/08	0	Issue to client	Carl Dixon	Carl Dixon

1. Introduction

DixonBrosnan environmental consultants were commissioned by T.J. O'Connor & Associates to assess the possible ecological impacts of constructing a new wastewater treatment plant and associated pipeline to discharge treated wastewater to Cork Harbour. This report will form part of an environmental impact statement (EIS). The treated wastewater will be discharged into a narrow estuarine creek (Slatty Water), which is adjoined by extensive estuarine mudflats. The existing wastewater treatment plant

(WWTP) services a population equivalent of 8,500 p.e. however the load often exceeds the capacity. This treatment plant discharges at Slatty Bridge. It is proposed to build a new WWTP which will have a final design capacity of 67,000 p.e. A tertiary level of treatment will be provided by the new plant.

This assessment follows the structure and protocols detailed in *Advice notes on current practice in the preparation of Environmental Impact Statements* (EPA, 2003) and *Guidelines on the information to be contained in Environmental Impact Statements* (EPA, 2002). The local representative of the National Parks and Wildlife Service (NPWS) and South Western Regional Fisheries Board were contacted during this process.

2. Site designation

The area of Cork Harbour into which the treated wastewater will be discharged is a candidate Special Area of Conservation (cSAC) (Great Island Channel site 001058) and is part of the Special Protected Area (SAC) (Cork Harbour 004030). A site description of these protected areas in included in Appendix 1.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. There are a number of important and interconnected areas of importance for birds within the overall harbour area. The harbour supports internationally important numbers of redshank and nationally important numbers of a further fifteen species (great crested grebe, cormorant, shelduck, wigeon, gadwall, teal, pintail, shoveler, red breasted merganser, oystercatcher, lapwing, dunlin, black tailed godwit, curlew and greenshank). There are also important numbers of shelduck, shoveler, pintail, whooper, pochard, golden plover, grey plover, turnstone, common gull, lesser black backed gull and black-headed gull. A nationally important population of common tern in also located within the harbour.

The Great Island Channel is an important ecological component of Cork Harbour and stretches from Little Island to Midleton. It forms the eastern section of a limestone basin and is relatively undisturbed. Habitats of high value found within the site include sheltered tidal sand and mudflats and Atlantic salt meadows both of which are included in Annex 1 of the Habitats Directive. The mud flats support a variety of invertebrate species, which in turn are an important food source for birds. Within the salt marsh habitats a variety of typical plant species occur.

The Great Island Channel is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Important species in this area include shelduck, teal, wigeon, dunlin, godwit, curlew, golden plover, gray plover, black-tailed godwit, redshank and lapwing. There are important roosting sites at Weir Island, Brown Island, Killacloyne and Harpers Island.

3. Surrounding landscape

3.1 Site of WWTP

It is proposed that the existing treatment plant will be extended to the east and primarily to the west of the existing site of the wastewater treatment plant. The area to the east has been stripped of its vegetation and is of minimal ecological value at the present time. The site of the current treatment plant is surrounded by planted hedges, which include non-native species. To the west of the existing treatment plant the land consists of mixture of wet woodland with reed beds associated with the watercourse/lake along the southern boundary of the site. This area is located within the proposed Natural Heritage Area and candidate Special Area of Conservation (cSAC) (Great Island Channel site 001058) and is part of the Special Protected Area (SAC) (Cork Harbour 004030). A minor road runs along the northern boundary of the site.

3.2. Proposed pipeline route

It is proposed that the pipeline will discharge to a small creek at the low water mark to the west of Slatty Bridge. This area is characterised by uniform mudflats, which are exposed at low tide. The creek is formed by a small watercourse, which discharges at Slatty Bridge via a small brackish lake. There are sluice gates at the Slatty Bridge, which controls the influx of salt water into the lake. The mudflats are bounded to the north by the N25 and roundabouts at Tullagreen, as well as roadside grassy verges and rock armour associated with the road. The southern boundary of this area of mudflats is formed by Fota Island. Due to the presence of the N25 along the northern boundary and the R624 road to Cobh along the eastern boundary, current traffic noise levels are considerable. Direct disturbance of the site by walkers etc is low for the same reason. The area of Fota Island which adjoins the mudflats is also relatively undisturbed as there is a band of mixed woodland which separates the rest of the island from the shoreline.

4. Marine ecology

4.1 Cork Harbour

Cork harbour is a large natural harbour which receives treated effluent from a number of small and large, scattered settlements including Cork city and Midleton. Studies on the water quality of Cork Harbour have been carried out previously and deteriorations in water quality have been recorded in the past. Following completion of the Cork Main Drainage scheme, wastewater from Cork City is treated to a high standard and discharged at Carrigrenan, Little Island. This new facility is expected to significantly improve water quality within Cork Harbour.

Slatty Water into which the treated wastewater will be discharged is 150-250m wide and 2950m long pipeline from Slatty Bridge to the railway bridge near Harpers Island. This relatively small inlet is predominantly saline and tidal with only a limited freshwater influence.

4.2 Habitat classification

The classification of marine habitat follows the scheme outlined in the Heritage Council publication A *Guide to Habitats in Ireland* (Fossit, 2000). The area of estuarine habitat affected by the proposed development is classified as *Estuaries MW4 / Littoral (Intertidal) Mud shores LS4*.

The treated wastewater will be discharged to a small brackish creek which runs entirely through mudflats downstream of Slatty Bridge. Thus it discharges into an estuarine environment despite the relatively small size of the freshwater input from this small stream. Estuaries differ from other coastal inlets in that sea water is measurably diluted by inputs of freshwater and this, combined with tidal movement, means that salinity is permanently variable. The mixing of two very different water masses gives rise to complex sedimentological and biological processes and patterns. Estuaries are loosely linked with the Annex I habitat *'estuaries (1130)*'. This small brackish creek is only accessible at low tide as this area is flooded in its entirety at high tide. The creek lacks flora as it runs through mudflats with no rocky substratum. On the upper shore this is small amounts of algae i.e. bladder wrack.

The primary habitat type within this estuarine environment is Mud Shores LS4. Mudflats which on a macro-scale are relatively uniform are the dominant habitat within the shallow bay though which the creek runs. Small rivulets of freshwater discharge to the creek and form shallow channels within the mudflats. As is typical in the upper reaches of estuaries the mudflats are dominated by fine silt and clay

(>95%). Algae is largely absent. The surface of the mud is brown in colour with a black to grey anoxic zone approximately 2 cm below the surface.

4.3 Sediment survey – macroinvertebrates

Sediment samples were taken from mudflats adjoining the discharge point to assess macroinvertebrate populations. The mudflats in this area provide a relatively uniform habitat and there is virtually no natural rocky shore habitat along the upper shore. However there will be a greater freshwater influence close to the creek which may reduce macroinvertebrate diversity. Due to the absence of significant variation in habitat type, transects from upper to lower shore were not considered necessary. Therefore samples were taken from upstream/east of the discharge point (sample 1), at the approximate discharge point (sample 2) and downstream/west of the discharge point (sample 3). These samples are considered representative of habitats in the vicinity of the proposed discharge.

Core samples were taken at low tide using a standard corer. Sediment samples were taken for analysis of benthos and a sub- sample was then taken for particle size analysis (PSA). Samples were kept cool in a cooler box to prevent decomposition from affecting grain size. Sediments were sieved through a full set of sand sieves and fractionated to gather fauna using a sprinkler. Samples were sorted using a white squared tray. Sediments were classified according to the Wentworth scale (Wentworth, 1922). Identification was carried out using a binocular viewer (x100) and identified using Hayward and Ryland (1998). Specimens were not fixed but identified live.

4.4 Results

Mudflats are typically productive environments, which are characterised by high biomass but relatively low species diversity. Rare species of macro-invertebrates are generally not present. Observations on the samples indicate that the surface of the mud was brown, however a black anoxic layer was recorded close to the surface. The results of invertebrate analysis indicate that diversity and biomass is low within the mud samples taken at and adjacent to the proposed discharge point. The only species recorded was king ragworm (*Nereis virens*). This is a large species which can survive in brackish conditions. The low diversity of species may reflect toxic impacts in the past or high levels of nutrient enrichment. The results of this survey are difficult to interpret as they were taken close the existing creek where freshwater may be impacting on species distribution. However the low diversity may be indicative of habitat deterioration.

4.5 Fish

Cork Harbour is an important spawning area for marine fish species and both commercial and recreational fishing are carried out within the harbour. Larger species found within the greater harbour area include dogfish, codling, conger, pollack, turbot, plaice, blond ray, thornback ray, ballan wrasse, cuckoo wrasse, rockling, blue shark, ling, whiting, bass and grey mullet. Smaller species include flounder, goby species, fifteen spined stickleback, pipefish, blenny species and butterfish. The harbour waters also provide important spawning and nursery areas for sea fish species such as herring and salmon. Sea trout migrate through the harbour from rivers such as the Lee, Glashaboy, Owenboy and Owennacurra.

It is noted that Slatty Water is a small tidal inlet and it therefore does not have significant value in terms of the larger and more commercial fish species. However it does have the potential to support a variety of fish species including mullet, bass, flounder, common eel, gobies and blenny species. The presence of sluice gates may preclude salmon or sea trout from the area. The only species noted in the absence of dedicated fish surveys were mullet, which utilise the creek at low tide.

5. Terrestrial ecology

5.1 Methodology

Site visits were conducted in February and April 2007. All habitats were classified to level 3 of the classification scheme outlined in A Guide to Habitats in Ireland (Fossitt, 2000) and a list of the species on which the habitat classifications are based is included in Appendix 4. These habitats are also outlined on Figure 1 in broad terms the habitat map is based on the methodology outlined in the British JNCC publication (1993) on Phase 1 habitat surveys. It should be noted that some of the habitats are transitional and where this occurs they are placed in the category they most resemble.

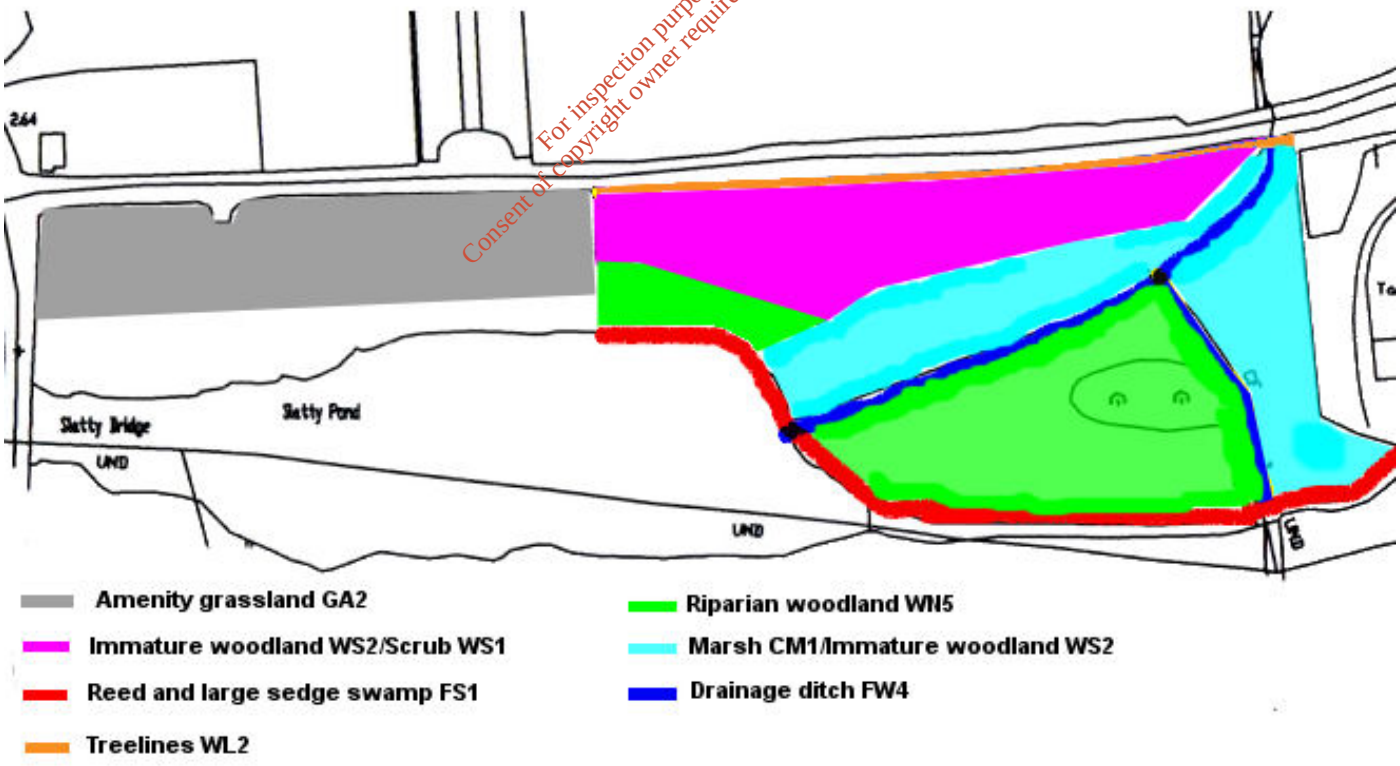
The areas to the west and east of the existing WWTP, the section of the discharge pipe located between the WWTP and Slatty Bridge are included in the candidate Special Area of Conservation (Great Island Channel site 001058) which is part of the Special Protected Area (Cork Harbour 004030).

5.2 Terrestrial Habitat types

The habitats listed below are shown on Figure 1 and a list of the species detected is given in Appendix.x. The survey area was divided into the following habitat types:

- Riparian woodland WN5
- Marsh CM1/Immature woodland WS2
- Reed and large sedge swamp FS1.
- Amenity grassland GA2
- Drainage ditch FW4
- Treeline WL2

Fig.1 Habitat Map. Areas overlap and are approximate. Not to scale.



5.2.1 Riparian woodland WN5

Within the vegetated area to the west of the existing treatment plant there is a low-lying area/island which is subject to frequent flooding. The dominant trees are willow and alder. It appears to be former grazing land which has been abandoned and trees are either immature or semi-mature. The diversity of plant species is generally high and includes typical species of wetland habitats including hemlock water dropwort, remote sedge, valerian, meadowsweet and early purple orchid.

5.2.2 Marsh CM1/Immature woodland WS2

These two habitat types form a mosaic within an area to the west of the existing WWTP. Generally the immature woodland occurs on drier areas where oak and ash are becoming established. These drier areas have an understorey of coarse and tussocky grasses such as cocksfoot and meadow foxtail. Areas of marsh support a mixture of common wetland species including meadowsweet and yellow flag. Wetter marsh areas adjacent to drainage ditches are gradually being colonised by riparian woodland species such as willow.

5.2.3 Immature woodland WS2/Scrub WS1 and Treelines WL2

To the west of the existing treatment plant there is a strip of land between the roadside treeline and the wetter marsh area/riparian woodland. Ground levels along much of this strip have been raised by imported spoil/infill. This area is now overgrown and scrub is developing. Within this are there a number of planted trees (i.e. white poplar) and exotic species such as Cotoneaster species and red currant.

5.2.4 Reed and large sedge swamp FS1.

This occurs on the southern and western boundaries proposed WWTP site. The reed beds fringe a small lake which discharges via sluice to Cork harbour. The dominant species is common reed although other typical species such as water mint and meadowsweet were also recorded.

5.2.5 Drainage ditch FW4

Two drainage ditches cross through the area west of the existing treatment plant. They are both small and support limited amounts of typical wetland species such as hemlock water dropwort. However the

ditches are of insufficient size to be of value for fisheries although they could conceivably support eels or stickleback. Due to the operation of the sluice gates at Slatty Bridge it is expected that both of these drains will back up and contribute to water-logging within the adjacent habitats.

5.2.6 Amenity grassland GA2

The pipeline route will pass through an area of grassland between the extended treatment plant and Slatty Bridge. This area is dominated by common agricultural species with a car park area and planted trees.

6. Mammals

6.1 Otters

Otters are found around the Irish coast and utilise both freshwater and marine habitats. The following are considered to be indicators of otter activity:

1. Spraints and anal glands
2. Footprints and sign heaps
3. Runs or paths
4. Feeding sites and prey item remains
5. Couches (resting areas) and holts (tunnel systems).

No evidence of the presence of otters was found in the area to be directly affected. However signs of their presence were noted on the edge of the Slatty Water at Fota Island and otters will almost certainly use the lake upstream of the bridge. Otters can be found throughout Cork Harbour and previously the author has observed signs of otter on the upstream side of Slatty Bridge and to the east of the existing treatment plant.

6.2 Seals and cetaceans

Although individual grey and common seals have been recorded in Cork Harbour, the area outlined for development is not of value for seals. Cetaceans, such a pilot whales and killer whales, have been recorded in Cork Harbour and species such as bottlenose dolphin, common dolphin and harbour porpoise may also occur. However no cetacean species will habitually utilise this area.

6.3 Bats

Bats will feed along the woodland at the Fota side of the estuary and in proximity to the brackish lake habitat and the species most likely to occur are soprano and common pipistrelle, Leislers and brown long eared. The habitats to be removed are unlikely to be of significant value for bats although they may feed along woodland edge and along treelines. There are no large trees which would be of sufficient size to support significant bat roosts in the area to be affected. Thus no significant impact on bat roosts is expected to occur.

6.4 Badgers

Evidence of badger activity was noted on the Fota side of Slatty Waters in woodland. However this area will not be affected. The woodland directly affected by this development is wet and is therefore unsuitable for badger setts. No impact on this species is therefore expected to occur.

6.5 Other Mammals

Some rodent species are ubiquitous in the Irish countryside and both brown rat and field mouse are almost certainly present within hedges and scrub. The area directly to be affected in waterlogged and not of high value for other mammal species although fox may occur periodically.

7. Birds

7.1 Terrestrial/brackish lake habitat

The wet/woodland area which will be affected by the provision of the new WWTP is unlikely to support rare or uncommon species. However this habitat supports a variety of relatively common countryside birds including blackbird, wren, moorhen, great tit and rook all of which were noted. The lagoon and reedbed fringe and the agricultural land at the edge of the lake are utilised by a number of species including black-tailed godwits, curlews, wigeon, mute swans, shelduck, little grebe and teal. Green sandpipers and wood sandpipers occur periodically and American wigeon has been observed here in the past.

7.2 Slatty Waters

Parts of Cork Harbour including this area are extremely important for birds particularly during the winter period. A survey of birds in the area of mudflats to be affected by the development was carried out in April 2007 to determine usage of the site during the spring period. The full report is detailed in Appendix 2. The report makes the following conclusions:

7.2.1 The observations made in April 2007 showed that the Slatty's Bridge mudflat is used as a feeding area and a high tide roost site by several species of wildfowl and waders. The main roost areas were at the north western end of the study site and along the southern bank. Species observed roosting in these areas included oystercatcher, black-tailed godwit, redshank, teal, shelduck and little egret.

7.2.2 At low tide, most feeding activity was focused on the area of exposed mudflats and the central channel that dissected the study area. Species utilising the mudflats and central channel for food included black-tailed godwit, oystercatcher, shelduck, redshank, greenshank, cormorant and curlew.

7.2.3 Although only one species was recorded in nationally important numbers (i.e. Black-tailed Godwit: >80 birds) during the April visits, the Slatty's Bridge mudflat may support greater numbers of birds at other times of year, such as the autumn passage, winter and the breeding season (i.e. May to July).

7.2.4 Most terrestrial species were recorded in small numbers along the northern and southern perimeters of the study site or in transit flying across the mudflat. The Hooded Crow was the only terrestrial bird species actively using the mudflat as a feeding site. All terrestrial species seen were typical of the habitats found on site.

8. Impact of proposed development on flora and fauna

8.1 Proposed development

The extension of the site of the WWTP will result in the complete removal of the habitat located to the west of the existing site. There will be no direct impact on the brackish lake. The pipeline route will affect

low value habitats east of the Slatty Bridge and will run entirely through mudflats on the western side of the same bridge.

8.2 Ecological succession in the absence of development

It is expected that willow, alder woodland will continue to colonise the area to the west of the existing site. No significant changes in the status of the mud flats are expected to occur in the absence of this development.

8.3 Habitat values

The relative value of each habitat type is detailed in Table 1. It should be noted that the value of a habitat is site specific, and will be partially related to the amount of that habitat in the surrounding landscape. The classification scheme used in Table 1 for the value of habitats and the impacts on them is detailed in the NRA publication *Guidelines for assessment of ecological impacts of National Road Schemes* (NRA, 2006). This classification scheme is outlined in Appendix 3.

Table 10.1. Habitat and species values

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
Estuaries MW4 / Littoral (Intertidal) Mud shores LS4	Part of the Special Area of Conservation and Natural Heritage Area (Great Island Channel site 001058) and is part of the Special Protected Area (Cork	Slatty Water is an important part of the network of bird habitats in Cork Harbour.	This habitat is of primary value for birds which feed on macroinvertebrates within the mudflats. Initial surveys indicate that macroinvertebrate diversity and density is relatively low close to the discharge point which may be due to the influence of freshwater and/or nutrient enrichment or toxic impacts in the past. The increase in population equivalent discharging to Slatty Water will increase the total nutrient loading over time despite the improved treatment standard. It is difficult to predict how this may impact on mudflat habitats given there may be significant nutrients already bound up in the sediments, the available dilution, the movement of the discharge point and large scale changes to nutrient levels in the harbour due to the main drainage scheme for Cork City and improvements to treatment standards

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
	Harbour 004030). This site is considered to be International ly Important (Category A)		at Midleton in recent years. It is also probable that the movement of the discharge point will allow much greater dispersal of nutrients and in a report prepared by HMRC for this EIS it was noted that "*The effect of any local nutrient enrichment within the confines of the Slatty Waters inlet is greatly ameliorated by the tidal exchange with Lough Mahon, which reduces the average water residence time in the Slatty Waters inlet. The tidal nature of the channel results in frequent changes of the water mass indicating that the receiving water in the channel is refreshed on a regular basis. As a result the concentrations of the dispersed effluent parameters are removed from the channel frequently.* It is noted that that bird usage of the area is relatively high at present despite the existing discharge from Carrigtwohill. Overall it is expected that effective dispersal of treated wastewater from Carrigtwohill will prevent any significant changes in macroinvertebrate composition which would impact significantly on bird populations. However due to the difficulties associated with accurately predicting impacts on macroinvertebrate populations an ongoing monitoring programme is required. The provision of a discharge pipe will require the disturbance of the intertidal mudflats along the pipeline route. The discharge pipe can impact on intertidal mudflats via removal of mud from the site and direct impacts on fauna living within the sediment. Loss of habitat will be reduced by maintaining

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
			the dredged sediment and using it to cover the discharge pipe. Therefore the loss of habitat will be limited to the volume occupied by the pipe. This is a small proportion of the overall habitat within the site. Fauna within dredged sediments will be killed if the sediment dries out. Some of the more mobile species such as polychaete worms will escape in such circumstances. Once work complete it is expected that the affected area will be recolonised relatively quickly.
Riparian woodland WN5	Part of the Special Area of Conservation and Natural Heritage Area (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be Internationally Important (Category A)	The designated areas include the wooded area to the west of the existing WWTP. Although this area is designated, it is a small part of a much larger site. This habitat though of local interest is of considerably less value than the estuarine habitats which form the bulk of the designated site.	No rare species were detected in this habitat however it is part of a mosaic of habitats including reedbeds, brackish lake and watercourse. The total area to be affected is approximately 2.33 ha and in this area vegetation will be completely removed. Overall despite it designation the site is considered to be of moderate, local value and is not of particular value in the context of the cSAC/SPA. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative.
Marsh CM1/Immature	Part of the Special Area	Moderate range of species noted although none were rare or uncommon. This habitat	This area will be removed by the development of the WWTP. Overall this habitat is of local value and the impact of its

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
woodland WS2	of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be International ly Important (Category A)	is evolving into woodland. Part of a mosaic of habitats with riparian woodland and reedbeds	removal is not considered to be of high significance. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative.
Reed and large sedge swamp FS1.	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the	Relatively uniform with a low diversity of plant species. However this fringe of reedbed does form a buffer zone at the edge of the lake and may be	The extension of the WWTP site will result in the removal of a small proportion of this habitat which is considered of moderate, local value. Overall this habitat is of local value and the impact of its removal is not considered to be of high significance. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative.

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
	Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be Internationally Important (Category A)	used by nesting birds and otters.	
Drainage ditch FW4	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to	Small and with no significant fisheries value.	This habitat is of moderate local value and is not an important component of the cSAC. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative.

Habitat Type/Species	Relative Habitat Value	Comments	Impacts
	be International ly Important (Category A)		
Amenity grassland GA2	Part of the Special Area of Conservation (Great Island Channel site 001058) and is part of the Special Protected Area (Cork Harbour 004030). Overall this part of Cork Harbour is considered to be International ly Important (Category A)	Low value habitat with some planted trees and small areas of scrub.	The pipeline route will pass through this habitat which is of low local value despite its inclusion within the designated site boundary. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative.

8.4 Impacts on Mammals

Noise impacts are likely to be significant during the construction phase, which will involve the dredging of a trench. However it is noted that due to the presence of existing roads this is already a high noise

environment. There is no evidence to suggest that otters breed within the area to be affected, although they do occur within this area. Due to the current high levels of traffic noise some habituation to increased noise levels is likely for resident species. In this context the increase in noise levels is unlikely to have a significant impact. Otters are highly mobile and can move quickly away from external disturbance. It is not expected that the discharge will have a significant impact on this species.

Evidence of badgers was noted in woodland at the Fota side of Slatty Water. However given the distance between this area and the works any significant impact is considered highly unlikely.

8.5 Direct impacts on birds

The removal of vegetation will result in a net loss of habitat within the woodland/scrub/marsh habitat located to the west of the site. It is not expected that the development will significantly impact on reedbed habitats.

As detailed in this report and in the site synopsis the area into which the pipe will discharge is of extremely high value for birds and in particular for wintering populations of waterfowl. Any works during the wintering period (approximately October to March) will have a negative impact on birds and therefore will be avoided.

8.6 Indirect impacts on birds

The birds, which feed on the mudflats, are reliant on populations of macroinvertebrates as a food source. Any changes to the density and distribution of macroinvertebrates could potentially impact on bird populations. The low diversity of macro-invertebrates within at least part of the habitat to be affected and the anoxic appearance of mud samples may be indicative of habitat deterioration. Due to the complexity of the estuarine environment and changes in discharges elsewhere in the harbour the impact of an increased discharge is hard to determine. It is also noted that the use of the marine macroinvertebrates as indicators of eutrophication/toxic impacts can be unreliable.

Although I-WeBS bird counts do cover this area of Cork Harbour the counts at Slatty Water have been included in the overall counts for Slatty Water/ Glounthane since 2003. Thus it is not possible to determine if localised changes in bird distribution have occurred in recent years.

Based on the comments outlined above an accurate prediction of possible impacts on birds is difficult. Therefore it is recommended therefore that detailed monitoring be carried out on an ongoing basis.

8.7 Fish

Although some fish such as mullet utilise the creek at low tide, most fish species utilising this area are likely to be present at high tide. Due to the presence of sluice gates the creek is not an important migratory route for sensitive salmonids such as sea-trout and salmon. Significant dilution at this stage of the tide should prevent any direct impact on fish from high nutrient loadings. Indirect effects on macroinvertebrates could conceivably impact on fish by reducing prey availability. Although it is difficult to accurately predict this impact it is not expected to be significant.

9. Mitigation measures

Any works which impact on estuarine habitats during the wintering period (approximately October to March) will have a negative impact on the local bird community and therefore will be avoided. Works should be confined to the period from June to August.

Due to the difficulties associated with predicting the effect of increased nutrient loadings on the nutrient status of estuarine mudflats it is recommended that detailed monitoring of nutrient levels, macroinvertebrates and wintering birds be carried out. The results of these surveys should be considered in tandem with available I-WeBS data to accurately determine if changes detrimental to the ecology of the area are occurring. Initially accurate baseline winter data should be obtained with surveys repeated every two years until 4 years after the plant reaches its full capacity.

If feasible, scope should be provided within the design of the treatment plant to upgrade the treatment standard and/or move the discharge point should survey results indicate that important bird populations are being adversely affected.

Removal of natural vegetation and in particular reedbeds which fringe the brackish lake should be kept to a minimum. To prevent incidental damage by machinery or by the deposition of spoil, it is recommended that habitats earmarked for retention be securely fenced early in the development process. The fencing should be clearly visible to machine operators. No work should take place outside the lands made available for construction, and all materials and liquids associated with the work should be stored in a manner that will not result in pollution or habitat deterioration. Particular care should be taken at the boundary between the development site and the cSAC, SPA and pNHA and so that construction activities do not cause damage to habitats in this area. Consultation should be undertaken with National Parks & Wildlife Service with regard to the nature of proposed works along this boundary.

During construction, siltation of water bodies must be minimized by the appropriate use of settlement ponds, silt traps and bunds particularly during any diversion of the drainage ditches currently running through the site. Grit interceptors will also be put in place, as appropriate, to control pollution and run off.

The cSAC and SPA bordering the development area are, by definition, nationally important for their habitats and the species they support. ***It is essential*** that all construction staff, including all sub-contracted workers, be notified of the boundaries of the cSAC and SPA and be made aware that no construction waste of any kind (rubble, soil, etc.) is to be deposited in these protected areas outside the landtake area and that care must be taken with liquids or other materials to avoid spillage. A Construction and Demolition Waste Management Plan will be developed for the site, with particular emphasis placed on preventing any materials being palced in the pNHA, cSAC and SPA.

The Wildlife Amendment Act 2000 (S.46.1) provides that it is an offence to cut, grub, burn or destroy any vegetation on uncultivated land or such growing in any hedge or ditch from the 1st of March to the 31st of August. Exemptions include the

clearance of vegetation in the course of road or other construction works or in the development or preparation of sites on which any building or other structure is intended to be provided. None the less it is recommended that vegetation be removed outside of the breeding season where possible. In particular, removal during the peak-breeding season (March-June) should be avoided. If possible, boundary hedges should be retained and enhanced. Any trees or hedgerows scheduled for retention should be protected from damaging construction activities by the erection of appropriate fencing. NRA guidelines on the protection of trees and hedges prior to and during construction should be followed (NRA, 2006).

Where feasible, within the scope of the development, landscaping should replace some of the native species, which have been removed. Landscaping proposals are detailed in Chapter 11 of the EIS. It is recommended that new hedgerows be planted as soon as possible to connect with existing hedgerows in the wider environment. Where practicable, the boundary landscape planting should be predominantly of Irish native species that reflect the existing vegetation of the area. It is recommended that the final landscape plans are designed in consultation with a qualified ecologist.

9. Residual impacts

Overall there will be a net loss of designated terrestrial habitats. No long-term significant impact on otters and bats is likely to occur. After construction, benthic communities should recolonise disturbed estuarine areas, with an accompanying re-establishment of fish in these areas. The increased nutrient levels could impact on the distribution of macroinvertebrate populations which in turn could impact on populations of birds and fish. However it is expected that effective dispersal of nutrients will occur.

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Appendix 1: Description of Designated Areas

SITE NAME: CORK HARBOUR SPA SITE CODE: 004030

Cork Harbour is a large, sheltered bay system, with several river estuaries - principally those of the Rivers Lee, Douglas and Owenacurra. The SPA site comprises most of the main intertidal areas of Cork Harbour, including all of the North Channel, the Douglas Estuary, inner Lough Mahon, Lough Beg, Whitegate Bay and the Rostellan inlet.

Owing to the sheltered conditions, the intertidal flats are often muddy in character. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algae species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially where good shelter exists, such as at Rossleague and Belvelly in the North Channel. Salt marshes are scattered through the site and these provide high tide roosts for the birds. Salt marsh species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Lax- flowered Sea-lavender (*Limonium humile*) and Sea Arrowgrass (*Triglochin maritima*). Some shallow bay water is included in the site. Cork Harbour is adjacent to a major urban centre and a major industrial centre. Rostellan lake is a small brackish lake that is used by swans throughout the winter. The site also includes some marginal wet grassland areas used by feeding and roosting birds.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. The five-year average annual core count for the entire harbour complex was 34,661 for the period 1996/97-2000/01. Of particular note is that the site supports an internationally important population of Redshank (1,614) – all figures given are average winter means for the 5 winters 1995/96-1999/00. A further 15 species have populations of national importance, as follows: Great Crested Grebe (218), Cormorant (620), Shelduck (1,426), Wigeon (1,750), Gadwall (15), Teal (807), Pintail (84), Shoveler (135), Red-breasted Merganser (90), Oystercatcher (791), Lapwing (3,614), Dunlin (4,936), Black-tailed Godwit(412), Curlew (1,345) and Greenshank (36). The Shelduck population is the largest in the country (9.6% of national total), while those of Shoveler (4.5% of total) and Pintail (4.2% of total) are also very substantial. The site has regionally or locally important populations of a range of other species, including WhooperSwan (10),

Pochard (145), Golden Plover (805), Grey Plover (66) and Turnstone (99). Other species using the site include Bat-tailed Godwit (45), Mallard (456), Tufted Duck (97), Goldeneye (15), Coot (77), Mute Swan (39), Ringed Plover (51), Knot (31), Little Grebe (68) and Grey Heron (47). Cork Harbour is an important site for gulls in winter and autumn, especially Common Gull (2,630) and LesserBlack-backed Gull (261); Black-headed Gull (948) also occurs.

A range of passage waders occur regularly in autumn, including Ruff (5-10), Spotted Redshank (1-5) and Green Sandpiper (1-5). Numbers vary between years and usually a few of each of these species over-winter. The wintering birds in Cork Harbour have been monitored since the 1970s and are counted annually as part of the I-WeBS scheme.

Cork Harbour has a nationally important breeding colony of Common Tern (3-year mean of 69 pairs for the period 1998-2000, with a maximum of 102 pairs in 1995). The birds have nested in Cork Harbour since about 1970, and since 1983 on various artificial structures, notably derelict steel barges and the roof of a Martello Tower. The birds are monitored annually and the chicks are ringed.

Extensive areas of estuarine habitat have been reclaimed since about the 1950s for industrial, port-related and road projects, and further reclamation remains a threat. As Cork Harbour is adjacent to a major urban centre and a major industrial centre, water quality is variable, with the estuary of the River Lee and parts of the Inner Harbour being somewhat eutrophic. However, the polluted conditions may not be having significant impacts on the bird populations. Oil pollution from shipping in Cork Harbour is a general threat. Recreational activities are high in some areas of the harbour, including jet skiing which causes disturbance to roosting birds.

Cork Harbour has is of major ornithological significance, being of international importance both for the total numbers of wintering birds (i.e. > 20,000) and also for its population of Redshank. In addition, there are at least 15 wintering species that have populations of national importance, as well as a nationally important breeding colony of Common Tern. Several of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover, Bar-tailed Godwit, Ruff and Common Tern. The site provides both feeding and roosting sites for the various bird species that use it.

SITE NAME: GREAT ISLAND CHANNEL SITE CODE: 001058

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton, provide the main source of freshwater to the North Channel.

The main habitats of conservation interest are the sheltered tidal sand and mudflats and Atlantic salt meadows, both habitats listed on Annex I of the EU Habitats Directive. Owing to the sheltered conditions, the intertidal flats are composed mainly of soft muds. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algal species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially at Rossleague and Belvelly. The salt marshes are scattered through the site and are all of the estuarine type on mud substrate. Species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Greater Sea-spurry (*Spergularia media*), Sea Lavender (*Limonium humile*), Sea Arrowgrass (*Triglochin maritimum*), Mayweed (*Matricaria maritima*) and Red Fescue (*Festuca rubra*). The site is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Shelduck are the most frequent duck species with 800-1000 birds centred on the Fota/Marino Point area. There are also large flocks of Teal and Wigeon, especially at the eastern end. Waders occur in the greatest density north of Rosslare, with Dunlin, Godwit, Curlew and Golden Plover the commonest species. A population of about 80 Grey Plover is a notable feature of the area. All the mudflats support feeding birds; the main roost sites are at Weir Island and Brown Island and to the north of Fota at Killacloyne and Harper's Island. Ahanesk supports a roost also but is subject to disturbance. The numbers of Grey Plover and Shelduck, as given above, are of national importance. The site is an integral part of Cork Harbour which is a wetland of international importance for the birds it supports.

Overall, Cork Harbour regularly holds over 20,000 waterfowl and contains Internationally important numbers of Black-tailed Godwit (1,181) and Redshank (1,896) along with Nationally important numbers of nineteen other species. Furthermore, it contains the large Dunlin (12,019) and Lapwing (12,528)

flocks. All counts are average peaks, 1994/95 – 1996/97. Much of the site forms part of Cork Harbour Special Protection Area, an important bird area designated under the EU Birds Directive.

While the main land use within the site is aquaculture (Oyster farming), the greatest threats to its conservation significance come from road works, infilling, sewage outflows and possible marina developments.

The site is of major importance for the two habitats listed on the EU Habitats Directive that it contains, as well as for its important numbers of wintering waders and wildfowl. It also supports a good invertebrate fauna.

Appendix 2: Carrigtwohill Bird Survey

Baseline Spring Bird Surveys at Slatty's Bridge mudflat, Co. Cork

Mick Mackey

Carrigroan, Minane Bridge, Co. Cork
Telephone: +353 21 488 7985 or +353 21 490 4295
E-mail: m.mackey@ucc.ie

1 INTRODUCTION

A baseline spring bird assessment of a mudflat site that lies to the west of Slatty's Bridge, Co. Cork was carried out by Mick Mackey at the request of DixonBrosnan Environmental Consultants.

The aim of the survey was to assess the bird species likely to occur in the area during the early spring period. The bird survey forms part of an ecological assessment of the mudflat as a proposed site for the instalment of a wastewater outfall pipeline, as part of the Carrigtwohill Sewerage Scheme.

1.1.1 Location

The study site is a tidal mudflat located to the west of Slatty's Bridge, along the northern bank of Fota Island, Co. Cork. The eastern limit of the study area is marked by Slatty's Bridge, the northern edge abuts the Midleton Road and the western boundary lies north of the Nursery Wood. The location of the proposed outfall pipeline lies in the central channel, which actively flows at low tide. The total study site area is approximately 4 ha.

1.1.2

1.1.3 Methodology

All species were counted using the "look-see" method employed by the Irish Wetland Bird Survey (I-WeBS) (Bibby *et al.*, 1992; Colhoun, 2001). Observers using this method count the number of individuals of each species present in a predetermined study area.

Site visits were made on 1st, 2nd, 13th and 14th April 2007. The visits on 1st, 13th and 14th April were made at low tide to assess what areas around the site were used as feeding areas for waders and wildfowl. The visit on 2nd April was made at high tide to establish what areas of the site are used by roosting waders and wildfowl. On each visit, counts of wildfowl, waders and gulls were made at a series of points along the northern boundary of the tidal mudflat using a combination of binocular (*Leica* 10x42) and telescope (*Swarovski* HD, fitted with a 20x - 60x eyepiece) scans.

In addition, a list of terrestrial species of birds encountered on all four visits was also recorded. All parts of the site were walked and all species seen or heard were recorded. Bird identification follows Mullarney *et al* (1999).

1.1.4 Weather

The weather encountered during the first three site visits was sunny and clear with good visibility and light, variable winds, force 1 to 2. The weather on the final site survey was overcast and dull with light variable wind, force 1 to 2.

Figure 1. Study site for the proposed Carrigtohill Sewerage Scheme outfall pipeline.

2 RESULTS

2.1 Survey of tidal area around site

Fifteen species of wildfowl, waders and gulls were noted during the four counts over the tidal mudflat survey site (Table 2.1). Highest species diversity was recorded during the first low tide visit, when 14 species were recorded, compared to 10 species and 9 species over the remaining respective low tide counts. Seven wader and wildfowl species were encountered during the solitary high tide visit. The Little Egret was the only Annex I species of the EU Birds Directive (79/409/EEC) encountered. The Little Egret was observed during each site visit, with the highest number of four being recorded during the second low tide count. The Black-tailed Godwit was the only species recorded in nationally important numbers (i.e. >80 birds). This level was surpassed during each of the low tide surveys and was almost breached during the high tide count. No species were recorded in internationally important numbers in April 2007 (Colhoun, 2001).

Table 2.1 Total numbers of wildfowl, waders and gulls recorded at the study site, April 2007.

Cormorant	2	1	1	0
Little Egret	3	1	4	1
Grey Heron	1	0	0	0
Shelduck	18	10	8	8
Mallard	2	0	0	2
Wigeon	5	0	0	0
Teal	52	70	21	11
Oystercatcher	9	35	15	30
Redshank	42	31	4	6
Greenshank	3	0	1	0
Black-tailed Godwit	121	75	129	153
Curlew	3	0	0	0
Black-headed Gull	2	0	0	1
Common Gull	7	0	4	0
Great black-backed Gull	0	0	2	2

2.1.1 Species accounts

Cormorant *Phalacrocorax carbo*
The cormorant is a widespread, commonly encountered seabird that prefers shallow inshore waters. This fishing-eating species was recorded in low numbers during the first three site surveys. At low tides, the cormorant was observed feeding in the central channel towards the eastern end and the centre of the study site. One individual was also observed collecting nesting material during a low tide.

Little Egret *Egretta garzetta*
The Little Egret is a species that has shown a marked increase in local breeding numbers since 1997 (Smiddy, 2002). A total of nine birds were recorded during the study period. At low tides, the Little Egret was observed feeding in close association with the central channel in the eastern half of the study area. At high tide, a single bird was noted roosting along the southern bank of the mudflat.

Grey Heron *Ardea cinerea*
The Grey Heron is a very distinctive species that inhabit estuaries and sea loughs. A single bird was observed feeding in the central channel towards the eastern boundary on the first low tide site assessment.

Shelduck *Tadorna tadorna*
Shelduck are commonly encountered on mudflats where they feed on mud snails and worms (Batten *et al.*, 1990). This large, brightly coloured duck displays day-to-day fluctuations in numbers due to continued immigration and emigration of birds from moulting areas to wintering regions (Murphy *et al.*, 2006). Shelduck were in encountered in low to moderate numbers on all four site visits. During the high tide, ten birds were noted roosting along the southern bank, in the eastern half of the mudflat. During the low tides Shelduck were distributed evenly through the study site feeding over the open are of the mudflat. A few birds were also observed sleeping along the central channel in close association with Teal and Black-tailed Godwits.

Mallard *Anas platyrhynchos*
Mallard are one of the most familiar and widespread duck species of the northern hemisphere. Two male-female pairs were observed during two separate low tide site visits. Both pairs were swimming along the central channel close to Slatty's Bridge.

Wigeon *Anas Penelope*
Wigeon are a highly migratory species that winter in Ireland and Britain from their Russian breeding grounds (Murphy *et al.*, 2006). A group of five birds were observed flying west across the mudflat during the first site visit.

Teal *Anas crecca*
Teal frequent areas of shallow water on estuaries and mudflats where they feed on seeds of aquatic plants and small invertebrates such as chironomid larvae and snails (Batten *et al.*, 1990). Teal that winter in Ireland are known to breed in Iceland (Prater, 1981). The largest concentrations of Teal were observed during the low and high tide site visits of the first week (Table 2.1). The majority of the initial low tide birds were located along the central channel at the eastern end of the mudflat. The behaviour included feeding, sleeping, preening and bathing. The 70 birds observed during the high tide were initially observed roosting along the southern bank before they flew as two separate flocks to the waters of the study site's central region. The lower numbers recorded during the final two low tide visits may be due to emigration of birds to their Icelandic breeding grounds.

Oystercatcher *Haemotopus ostralegus*

Oystercatchers are ubiquitous coastal birds that feed on molluscs and ragworms (Batten et al., 1990). Oystercatchers were observed in varying numbers on all four site visits (Table 2.1), with the highest numbers being recorded roosting with Black-tailed Godwits on the northern bank at the western end of the mudflat. Low tide observations were largely made in the western half of the study site, where feeding birds were sparsely distributed across the mudflat, in the company of Black-tailed Godwits.

Redshank *Tringa totanus*
Redshanks are relatively short-distance migrants, whose feeding range extends higher up the shore than most other waders. The majority of Redshank observed during the first low tide site visit were recorded feeding along the northern bank of the mudflat down to the central channel. The high tide assessment reported Redshank roosting along the southern perimeter, towards the eastern half of the mudflat. The sudden reduction in Redshank numbers observed during the final two site visits may be due to the emigration of birds to northern breeding grounds.

Greenshank *Tringa nebularia*
Greenshanks are passage migrants and winter visitors that feed chiefly on small invertebrates and small fish (Batten *et al.*, 1990; Irish Rare Birds Committee, 1998). Four Greenshanks were observed during low tide visits, feeding along the central channel towards the eastern half of the mudflat.

Black-tailed Godwit *Limosa limosa*
Cork Harbour holds the largest flocks of wintering Black-tailed Godwits in Ireland (Hutchinson & O'Halloran, 1984). Black-tailed Godwits (Plate 1) were the most numerous species encountered during the April site visits, with figures exceeding nationally important levels (>80 birds) during each of the three low tide assessments (Table 2.1). Prater (1981) suggests that the April peak in Black-tailed Godwit numbers may be due to passage migrants from England, France and Iberia stopping over in Ireland before moving on to their Icelandic breeding grounds. Low tide assessments saw large numbers of Black-tailed Godwit feeding over the exposed mudflat throughout the study area. Other birds were also recorded sleeping and preening at low tide along the central channel towards the eastern half of the mudflat. Similar behaviour patterns were observed by Hutchinson & O'Halloran (1994). The high tide survey reported 75 birds roosting in the company of Oystercatchers on a rocky bank at the north western end of the site. The lower number noted during high tide indicates that the Black-tailed Godwit are using roosting sites outside of the study area (Hutchinson & O'Halloran, 1984).

Plate 1. Black-tailed Godwits were the most numerous species observed during the April site assessments (© Mick Mackey, 2007).

Curlew *Numenius arquata*

Curlew are a resident species regularly found in intertidal habitats, river valleys, damp pasture, heaths and in fields of arable crops where they feed on a wide range of medium to large invertebrates (Prater, 1981; Batten *et al.*, 1990). Three Curlew were observed during the first site assessment feeding on the mudflat region of the study site and subsequently flying southeast.

Black-headed Gull *Larus ridibundus*
Black-headed Gulls are the most commonly encountered gull species in central Cork, along the River Lee. Three birds were observed scanning the mudflat area during low tide.

Common Gull *Larus canus*
Common Gulls (also known as Mew Gulls) are characteristic birds of inland pastures (Prater, 1981). This medium sized gull has spread in Ireland both as breeding bird and winter visitor since 1900 (Whilde, 1984). Eleven birds were observed roosting on a vegetative bank at the north western end of the study site during the first two low tide assessments.

Great Black-backed Gull *Larus marinus*
Great Black-backed Gulls are the largest and most aggressive gull species in Ireland. Two adult-juvenile pairs were observed on separate occasions during the final two low tide assessments standing a grassy bank of the mudflat's north western edge.

Main areas of bird activity at Slatty's Bridge mudflat

Exposed mudflats
The exposed mudflats were used at low tides as feeding areas for Black-tailed Godwits, Oystercatcher, Shelduck, Curlew, Redshank and Greenshank. The western half of the study site appeared to support higher levels of feeding activity over the mudflats. Nationally important numbers of Black-tailed Godwit were observed utilising the mudflats as a feeding site during all three low tide assessments.

Central Channel
The central channel that dissects the study site was used by several species as a feeding site, as well as a site for preening, bathing and resting activities. The eastern end of the central channel supported the lion's share of activity. At low tide this area was used by Teal, Little Egret, Grey Heron, Cormorant, Shelduck, Mallard, Black-tailed Godwit and Oystercatcher.

Southern Bank
At high tide, the southern bank was used as a roosting site for Teal, Shelduck, Little Egret and Redshank.

North Western Bank
At high tide the north western bank was used as a roosting site for Black-tailed Godwit and Oystercatcher. This area was also used at low tide as a resting site by the three gull species observed during the study.

2.2

2.3 Terrestrial species within the site

Eight terrestrial bird species were recorded within the survey site (Table 2.2), with the majority of the birds being recorded in association with the vegetation along the northern and southern edges of the study site. The Hooded Crow was the only terrestrial bird species observed in direct contact with the mudflat region of the study site, where they were observed feeding during low tide site visits.

Table 2.2. Terrestrial bird species recorded within the study site

Wood Pigeon	*Columba palumbus*	1
Pied Wagtail	*Motacilla alba*	4
Wren	*Troglodytes troglodytes*	1
Blue tit	*Parus caeruleus*	2
Blackbird	*Turdus merula*	5
Magpie	*Pica pica*	2
Rook	*Corvus frugilegus*	28
Hooded Crow	*Corvus corone*	7

3

4 CONCLUSIONS

5 WADERS & WATERFOWL IN TIDAL AREAS

The observations made in April 2007 showed that the Slatty's Bridge mudflat is used as a feeding area and a high tide roost site by several species of wildfowl and waders. The main roost areas were at the north western end of the study site and along the southern bank. Species observed roosting in these areas included Oystercatcher, Black-tailed Godwit, Redshank, Teal, Shelduck and Little Egret.

At low tide, most feeding activity was focused on the area of exposed mudflats and the central channel that dissected the study area. Species utilising the mudflats and central channel for food included Black-tailed Godwit, Oystercatcher, Shelduck, Redshank, Greenshank, Cormorant and Curlew.

Although only one species was recorded in nationally important numbers (i.e. Black-tailed Godwit: >80 birds) during the April visits, the Slatty's Bridge mudflat may support greater numbers of birds at other times of year, such as the autumn passage, winter and the breeding season (i.e. May to July).

5.1 Terrestrial birds

Most terrestrial species were recorded in small numbers along the northern and southern perimeters of the study site or in transit flying across the mudflat. The Hooded Crow was the only terrestrial bird species actively using the mudflat as a feeding site. All terrestrial species seen were typical of the habitats found on site.

5.2 Summary of impacts

The detrimental impacts of human activities on estuaries, such pollution, enrichment, reclamation, disturbance, fisheries, leisure activities, have been well documented (Prater, 1981; Batten *et al.*, 1990; Nairn *et al.*, 1995; Smiddy *et al.*, 1995; Boelens *et al.*, 1999). The main potential impacts resulting from the instalment of a wastewater outflow pipeline at the site would be reclamation, disturbance and subsequent pollution and enrichment.

6

7 RECLAMATION & DISTURBANCE

Lewis *et al.* (2002) and Lewis *et al.* (2003) looked at the impacts of a pipeline construction on estuarine benthic invertebrate communities and the associated response of estuarine birds in Clonakilty Bay, West Cork. They concluded that although the pipeline construction did impact on the invertebrate community at the time of disturbance, a gradual recolonisation of some species in the study was observed after 6 months (Lewis *et al.*, 2002). The recolonization of an important prey species for waders, *Scrobicularia plana*, showed a recovery after 1 year attributable mainly to settlement of juveniles, but with some evidence of passive or active dispersal by adults. While lower numbers of foraging birds were recorded in the winter following construction, numbers of diurnally roosting birds in the same area increased (Lewis *et al.*, 2003). They go on to suggest that if habitat displacement is coupled with other sources of disturbance, during times of stress (e.g. during late summer when birds are in the process of moulting) the cumulative effect may impact more strongly.

8

9 POLLUTION & SEDIMENT ENRICHMENT

Increased nutrient concentrations due to discharge loadings will result in increased primary productivity and subsequent secondary productivity (i.e. algal and invertebrate production respectively). Overloading a system with nutrients may encourage the growth of *Enteromorpha* to such an extent that when the plants decay in winter the mud becomes deoxygenated and significantly reduces the diversity or abundance of other plants and invertebrate foods for birds (Prater, 1981). Acute or chronic poisoning of a system can occur when pesticides, heavy metals and other industrial pollutants are introduced via wastewater discharges (Batten *et al.*, 1990).

9.1 Recommendations

Cork Harbour is considered to be an Important Bird Area (IBA) that regularly supports over 20,000 waders and waterfowl (Heath & Evans, 2000). Slatty's Bridge mudflat appears to be of great importance during April as a feeding and roosting site for migratory wader and waterfowl species such as Teal, and spring passage migrants such as Black-tailed Godwit. However, the mudflat appears to be of minimal importance to gulls and terrestrial bird species during April. To gain a true idea of the real importance of the Slatty's Bridge mudflat for autumn passage migrants and wintering populations of waders and waterfowl, a comprehensive series of surveys should be conducted between September and January. It would appear that the study area is of lower importance during the spring-summer period. However, it would be useful to conduct a breeding bird survey prior to any development between May and July to determine what species are breeding within the site.

If the area is found to be of significant importance to wintering populations and passage migrants, then any impacts resulting from reclamation and disturbance could be reduced by concentrating development of the site during between June and July.

The negative effects from pollution and sediment enrichment from the subsequent outflow can be minimised by adequate water treatment prior to discharge. Discharging during high tide will also minimise the effects attributable to nutrient-rich effluents.

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Appendix 3. Site evaluation scheme

Rating	Qualifying criteria
A	Internationally important Sites designated (or qualifying for designation) as SAC* or SPA* under the EU Habitats or Birds Directives. Undesignated sites containing good examples of Annex I priority habitats under the EU Habitats Directive.
B	Nationally important Sites or waters designated or proposed as an NHA* or statutory Nature Reserves. Undesignated sites containing good examples of Annex I habitats (under EU Habitats Directive). Undesignated sites containing significant numbers of resident or regularly occurring populations of Annex II species under the EU Habitats Directive or Annex I
C	High value, locally important Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or significant populations of locally rare species. Small water bodies with known salmonid populations or with good potential salmonid habitat. Sites containing any resident or regularly occurring populations of
D	Moderate value, locally important Sites containing some semi-natural habitat or locally important for wildlife. Small water bodies with some coarse fisheries value or some potential salmonid habitat.
E	Low value, locally important Artificial or highly modified habitats with low species diversity and low wildlife value.

*SAC = Special Area of Conservation
SPA= Special Protection Area
NHA= Natural Heritage Area

Criteria for assessing impact significance

(a) Terrestrial habitats

Impact level	Site category* A sites Internationally important	B sites Nationally important	C Sites High value, locally important	D sites Moderate value, locally important	E sites Low value, locally important
Severe negative	Any permanent impacts	Permanent impacts on a large part of a site			
Major negative	Temporary impacts on a large part of a site	Permanent impacts on a small part of a site	Permanent impacts on a large part of a site		
Moderate negative	Temporary impacts on a small part of a site	Temporary impacts on a large part of a site	Permanent impacts on a small part of a site	Permanent impacts on a large part of a site	
Minor negative		Temporary impacts on a small part of a site	Temporary impacts on a large part of a site	Permanent impacts on a small part of a site	Permanent impacts on a large part of a site
Neutral	No impacts	No impacts	No impacts	No impacts	Permanent impacts on a small part of a site
Minor positive				Permanent beneficial impacts on a small part of a	Permanent beneficial impacts on a large part of a site
Moderate positive			Permanent beneficial impacts on a small part of a site	Permanent beneficial impacts on a large part of a	
Major positive		Permanent beneficial impacts on a small part of a	Permanent beneficial impacts on a large part of a site		

Criteria for assessing impact significance

(b) Aquatic habitats

A Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Severe	Severe	Severe

Localised	Major	Major	Severe	Severe

B Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Major	Severe	Severe
Localised	Moderate	Moderate	Major	Major

C Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Moderate	Moderate	Major	Major
Localised	Minor	Moderate	Moderate	Moderate

D Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Minor	Minor	Moderate	Moderate
Localised	Not significant	Minor	Minor	Minor

E Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	Not significant	Not significant	Minor	Minor
Localised	Not significant	Not significant	Not significant	Not significant

In line with the EPA Guidelines (EPA 2002), the following terms are defined when quantifying duration:

Temporary: up to 1 year,
Short-term: from 1-7 years,
Medium-term: 7-15 years,
Long-term: 15-60 years,
Permanent: over 60 years.

Localised impacts on rivers are loosely defined as impacts measurable no more than 250m from the impact source. Extensive impacts on rivers are defined as impacts measurable more than 250m from the impact source. Any impact on salmonid spawning habitat, or nursery habitat where it is in short supply, would be regarded as an extensive impact as it is likely to have an impact on the salmonid population beyond the immediate vicinity of the impact source.

Appendix 4 – Terrestrial ecology species list

9.2.1		Riparian woodland WN5	Immature woodland WS2/Scrub WS1/Treelines WL2	Marsh GM1/ Immature woodland WS2	Reed and large sedge swamps FS1
Alder	*Alnus glutinosa*	X			
Angelica	*Angelica archangelica*	X			
Ash	*Fraxinus excelsior*	X	X		
Bindweed	*Calystegia spium*		X	X	
Blackthorn	*Prunus spinosa*	X	X		
Bramble	*Rubus fructicosus*		X	X	
Broad leaved Dock	*Rumex obtusifolius*		X		
Cleavers	*Galium aparine*		X		
Cocksfoot	*Dactylis glomerate*		X		
Common reed	*Phragmites communis*			X	X
Cotoneaster.	*Cotoneaster sp.*		X		
Crack willow	*Salix fragilis*	X			
Creeping bent	*Agrostis stolonifera*			X	
Creeping buttercup	*Ranunculus repens*	X		X	
Creeping cinquefoil	*Potentilla reptans*				
Creeping thistle	*Cirsium arvenesis*		X	X	
Dog rose	*Rosa canina*	X	X		
Elm	*Ulmus sp.*		X		
Early purple orchid	*Orchis mascula*	X			
False oat grass	*Arrhenatherum elatius*	X			
Fools watercress	*Apium nodiflorum*			X	
Gorse	*Ulex europeaus*		X		
Hairy brome	*Bormopsis ramosa*		X		
Hartstongue Fern	*Asplenium scolopedrium*	X			
Hawthorn	*Crataegus monogyna*	X	X		
Hemlock water dropwort	*Ocenanthe crocata*			X	
Hogweed	*Heracleum sphondylium*		X		
Horsetail	*Equisetum arvense*			X	
Ivy	*Hedera helix*	X	X		
Lesser celendine	*Ranunculus ficaria*	X			
Ladies Fern	*Athyrium filix-femina*	X		X	
Lesser sea rush	*Juncus maritimus*			X	
Lord and Ladies	*Avum maculatum*		X		
Marsh Foxtail	*Alopecurus geniculatus*			X	
Mayflower	*Cardamine pratensis*			X	
Meadow buttercup	*Ranunculus acris*	X			
Meadow foxtail	*Alopecurus pratensis*		X		
Meadow sweet	*Filiendula ulmaria*	X	X	X	X
Nettle	*Urtica dioica*	X	X	X	
Penduculate oak	*Quercus robor*			X	
Red current	*Ribes rubrum*	X			
Reed canary grass	*Phalaris arundinacea*	X			
Remote sedge	*Carex remota*	X		X	
Rough meadow grass	*Poa trivialis*			X	
Rowan	*Sorbus acuparia*				
Silver weed	*Potentilla anserina*			X	
Sycamore	*Acer psuedoplatanus*	X	X		

Tufted vetch	*Vicia cracca*			X	
Valerian	*Caleriana officinalis*	X			
Water mint	*Mentha aquatica*			X	X
White poplar	*Populus alba*		X		
Wild privet	*Ligustrium vulgare*		X		
Willow	*Salix sp.*	X	X	X	
Willowherb	Epilobium hirsutum			X	
9.2.1.1.1 Winter heliotrope	*Petasites fragans*		X		
Wood avens	*Guem urbanum*	X			
Wood dock	*Rumex saguineus*	X			
Wood sedge	*Carex sylvatica*	X			
Woody nightshade	*Solanum dulcamara*	X			
Yellow Flag	*Iris psuedocorus*	X		X	

APPENDIX 3

REPORT ON ASSESSMENT FROM RESUSPENSION OF HEAVY METALS AND OTHER TOXIC COMPOUNDS

DixonBrosnan
environmental consultants

Project	Assessment of the potential impacts generated from tidal re-suspension of potentially toxic heavy metal or organic compounds associated with excavation and backfilling of a pipeline associated with Carrigtwohill WWTP		
Client	T.J. O' Connor & Associates		
Project ref	Report no	Client ref	
Carrigtwohill	1009		

Dixon.Brosnan, 7 The Cedars, Bridewood, Ovens, Co. Cork
Tel/Fax: 086 8511437 | Email: carl@dixonbrosnan.com | www.dixonbrosnan.com

Date	Rev	Status	Prepared by	Issued
19/2/08	1	1st draft	Carl Dixon Sorcha Sheehy	Carl Dixon

1. Introduction

It is proposed that treated wastewater from an upgraded treatment plant at Carrigtwohill will be discharged into a narrow estuarine creek (Slatty Water), which is adjoined by extensive estuarine mudflats. The existing wastewater treatment plant services a population equivalent of 8,500 p.e. however the load often exceeds the treatment capacity. This treatment plant discharges at Slatty

Bridge. It is proposed to build a new WWTP which will have a final design capacity of 67,000 p.e.. A tertiary level of treatment will be provided by the new plant.

It is proposed that the pipeline will discharge to a small creek at the low water mark to the west of Slatty Bridge. This area is characterised by uniform mudflats, which are exposed at low tide. The creek is formed by a small watercourse, which discharges at Slatty Bridge via a small brackish lake. There are sluice gates at the Slatty Bridge, which controls the influx of salt water into the lake.

Previous ecological assessments carried out for the proposed works determined that macroinvertebrate diversity was low within the mud sediments affected by the pipeline route. The Slatty water mudflats are considered of high value for birds and this area has conservation designations as detailed below.

Following completion of initial ecological assessments Dixon.Brosnan Environmental Consultants were commissioned to assess the potential impacts generated from tidal re-suspension of potentially toxic heavy metal or organic compounds associated with excavation and backfilling of the pipeline as based on an analysis of the mudflat samples. This report was prepared by Carl Dixon M.Sc. and Dr. Sorcha Sheehy Ph.D.

2. SITE DESIGNATION

The area of Cork Harbour into which the treated wastewater will be discharged is a candidate Special Area of Conservation (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030).

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. There are a number of important and interrelated areas of importance for birds within the overall harbour area. The harbour supports internationally important numbers of redshank and nationally important numbers of a further 15 species also occur (great crested grebe, cormorant, shelduck, wigeon, gadwall, teal, pintail, shoveler, red breasted merganser, oystercatcher, lapwing, dunlin, black tailed godwit, curlew and greenshank. There are also important numbers of shelduck, shoveler, pintail, whooper, pochard, golden plover, grey plover, turnstone, common gull, lesser black backed gull and black-headed gull. There is also a nationally important population of common tern.

The Great Island Channel is an important ecological component of Cork Harbour and stretches from Little Island to Midleton. It forms the eastern section of a limestone basin and is relatively undisturbed. Habitats of high value found within the site include sheltered tidal sand and mudflats

and Atlantic salt meadows both of which are included in Annex 1 of the Habitats Directive. The mud flats support a variety of invertebrate species, which in turn are an important food source for birds. Within salt marsh habitats a variety of typical plant species occur.

The Great Island Channel is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Important species in this area include shelduck, teal, wigeon, dunlin, godwit, curlew, golden plover, grey plover, blacktailed godwit, redshank and lapwing. There are important roosting sites at Weir Island, Brown Island, Killacloyne and Harpers Island.

3. Assessment methodology

Five sediment core samples were taken along the pipeline route as shown on **Fig. 1.** The samples were stored in a cool box and sent to Environmental Laboratory Services (ELS) in Cork for analysis. This lab is accredited and an accreditation certificate is attached to this report as **Appendix 1.** The suite of tests was extensive and largely based on the parameters specified in the publication Guidelines for the assessment of dredge material for disposal in Irish Waters (*Marine and Environmental Health Series No. 244, 2006*). *The approach proposed in this document aims to provide an improved, and more integrated, assessment of the ecological risks associated with individual sediment dredging and disposal activities.* Although the material affected by the provision of the pipeline will not strictly speaking be dumped at sea, the limits specified in this document were created specifically to protect the marine environment. The analysis results are included in **Appendix 2** of this report. A desktop review was also undertaken to determine the potential impacts of re-suspended compounds on ecology.

It is noted that sediment samples do not directly indicate the level of re-suspension that would occur during construction works on the pipeline. It was intended that further modelling would be carried out

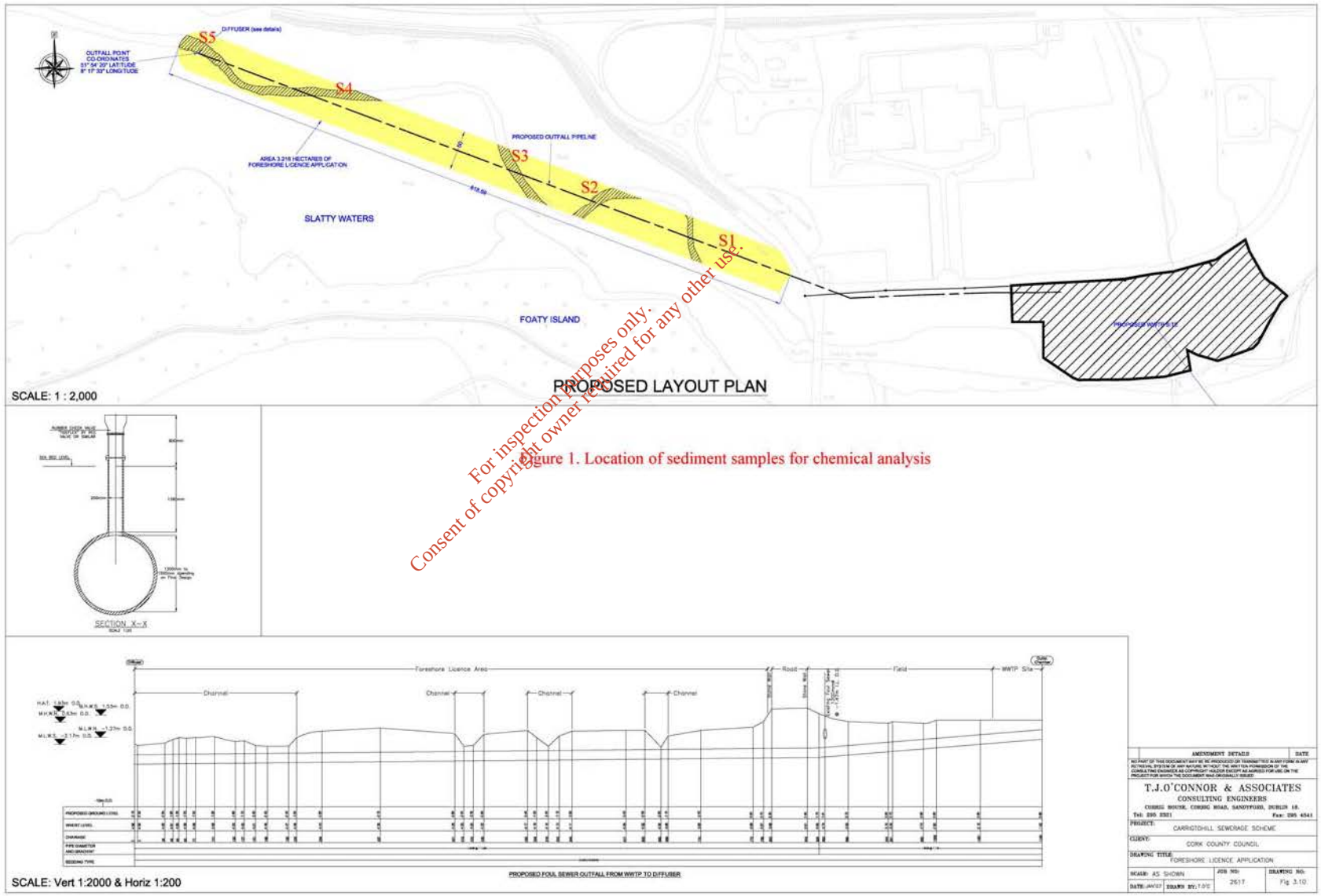

Figure 1. Location of sediment samples for chemical analysis

where the results were indicative of serious pollution and where the literature review determined that there could potentially be negative impacts on ecology within the designated site. Further work if it had been required would have considered sediment/water equilibrium partitioning which would give a concentration expected in the water column relative to concentrations present in the sediment. However this method would take into account only toxicity caused by ingestion or absorbtion of contaminants in interstitial water and not through ingestion of food by deposit feeders. As chemical results did not indicate that the sediments were grossly polluted such modelling was not considered necessary.

3. Assessment criteria

The substances which are considered most problematical are those with combined properties of toxicity, persistence and liability to persist. Such compounds include oranotin compounds, heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and oils (OSPAR, 2004).

The *Guidelines for the assessment of dredge material for disposal in Irish Waters* provides a holistic and integrated assessment methodology for determining the ecological risk associated with dredged material disposal operations. The impact resulting from the construction of a pipeline will in essence have the same affect as disposal of dredge material, in that sediment will be disturbed in both cases and thus re-suspension could potentially occur. However during construction of the pipeline, sediment will be backfilled and thus there will be no large scale movement of material off site or the other areas of the seabed. Given the similarities between the two processes i.e. dredging and pipeline construction and in the absence of any other standard limits, the limits specified by this document are considered viable for the purposes of this report.

The guidelines propose two action levels which cover an extended list of parameters. The guidelines may also consider other factors such as bioavailability and available volatile suphides (AVS). The two tier method of assessment proposed by the document specifies two levels; lower (level 1) and upper (level 2). In effect the system works as a classification system where sediments with concentrations less than level 1 fall within class 1, sediments with concentrations between levels 1 and 2 fall within class 2 while those above level 2 will fall within class 3. These classes are described in **Table 1.**

Table 1. Classes

Class 1	Contaminant concentrations less than level 1. Uncontaminated; no biological affect likely
Class 2	- Contaminant concentrations between Level 1and Level 2.

	- Marginally contaminated; - Further sampling & analysis necessary todelineate problem area, if possible.
Class 3	Heavily contaminated; - Very likely to cause biological effects / toxicity to marine organisms. - Alternative management options to be considered.

The guidelines suggest a three stage assessment with the following characteristics.

Phase 1: initial screening

Phase 2: further chemical testing

Phase 3: aims to delineate the problem area

To avoid unnecessary delay and due to the sensitivity of the receiving environment a more extensive range of tests than that specified by phases 1 and 2 was carried out. Some of these tests would not normally be used unless a level 3 assessment was being carried out.

4. Results

The results of chemical analysis on the five samples is included in **Appendix 2.** Results show that no volatile organic compounds (VOCs) were detected. Similarly organochlorine pesticides, polychlorinated biphenyls (PCBs) or polycyclic aromatic hydrocarbons (PAHs) were not detected above the limit of detection for the relevant compounds. TBT was not detected above the detection limit of 0.02 mg/kg. The moisture content was relatively consistent across the compounds and ranged from 46.9% to 50.4%. Total organic carbon ranged in concentration from 40556 mg/kg to 77778 mg/kg.

A range of heavy metals were tested and they are compared with the guidance values for Lower Level 1 and Upper Level 2 as specified by the guidance document. Levels that breach the level 1 limit are in bold.

Parameter mg/kg	**S1**	**S2**	**S3**	**S4**	**S5**	**Level 1 limit**	**Level 2 limit**
Arsenic	**15.9**	**15.3**	**13.6**	**10.9**	8.9	9	70
Cadmium	**1**	**1.4**	**1.1**	**1**	0.6	0.7	4.2
Chromium	28.2	36.6	35.4	30.2	21	120	370
Copper	9.5	9.4	9.3	8.9	6.7	40	110
Lead	**62.2**	**79.5**	**80.6**	**63.5**	47.5	60	218
Mercury*	<0.5	<0.5	<0.5	<0.5	<0.5	0.2	0.7
Nickel	**28.2**	**30.2**	**30.3**	**28.1**	20.2	21	60
Zinc	**192.7**	**302.1**	**276.5**	**220.8**	**172.7**	160	410

* levels of mercury do not exceed the level 1 limit; however the detection limit is quite high and exceeds 0.2 mg/kg

4.1 Results discussion

Although some results were elevated above the Level limit 1 generally there were only slightly elevated and the results were all considerably lower than the upper level 2 limit. However zinc levels were more than 50% above the level 1 limit for one sample (S2).The main pattern discernible in the results was a decrease in a number of parameters for sample 5 which is furthest from the existing discharge point. Levels for site 4 were also slightly lower. It is not possible to ascertain whether the higher results in the upper part of Slatty Water, is due to the existing discharge or due to other factors. No exceedances of the detection limits for the remaining compounds were noted and levels of TBT were found to be low.

5. Literature review on impacts of sediment resuspension.

A literature review on the potential impacts of sediment biota was carried out by Dr. Sorcha Sheehy Ph.D

5.1 Marine sediments and resuspension

The accidental or regulated release of pollution from industry and urbanisation has severely affected the diversity and abundance of plants and animals in harbours and estuaries (Luoma and Philips 1988, Morrisey *et al*. 2003, Johnston and Roberts 2009). Heavy metals, many of which are highly toxic to marine organisms (McLusky *et al*. 1986), are amongst the most common contaminants in estuarine environments (Birch and Taylor 1999). A large proportion of these metals bind within sediments and through time accumulate to extremely high concentrations (Long 2000, Birch and Taylor 1999, Cundy *et al*. 2003).

Contaminated sediments clearly affect the diversity and abundance of organisms living within them (e.g. Clements 2004, Millward *et al*. 2004), but their threat goes well beyond this – potentially affecting mammals, fish, invertebrates and algae living in the water-column or on nearby hard surfaces e.g. rocky shore. Anthropogenic activities such as shipping and dredging can cause the resuspension of contaminated sediments and may release significant quantities of heavy metals into the water-column (Simpson *et al*. 1998, Saulnier and Mucci 2000). Resuspension of sediments releases sulfides and exposes anoxic sediments to the water-column which may cause the dissociation of heavy metal ions from bonds with organic material (Apte and Batley 1995). The free ionic forms of heavy metals are considered most toxic or biologically available (Campbell 1995). Resuspension of contaminants may also make sediment-bound metals available to suspension-feeding organisms. Furthermore, the suspension of sediments, on its own, can cause serious effects through mechanical damage or clogging of the breathing or respiring organs of invertebrates and fish (Airoldi 2003) or smothering of photosynthetic surfaces of algae. These effects may also leave marine organisms more susceptible to contaminants, such as heavy metals.

Despite such potentially significant impacts, few studies have examined the impacts of resuspended contaminated sediment. The majority of studies which have examined the impacts of resuspension on marine organisms have been ecotoxicological laboratory studies and have usually used sediments spiked with contaminants and mechanical agitation, vigorous airlift, recirculating pumps or serial diluters to maintain suspension of sediments.

Cope *et al* (1996), for example, exposed fish to resuspended sediments and associated contaminants. Test sediments were resuspended by revolving test chambers on rotating shafts driven by an electric motor. This illustrated the performance of this system with results from a 28-day test in which juvenile bluegills *Lepomis macrochirus* were exposed to resuspended, riverine sediments differing in texture and cadmium content. At the end of the test, an average of 50% of the introduced cadmium was associated with the suspended sediment compartment, whereas the filtered (0.45 μm) water contained 0.4% and bluegills 1.8% of the cadmium.

Fichet, *et al.* (1998) examined the larvae of three marine species reared within the suspended particulate phases of contaminated harbour sediments to assess the effects of four metals (Cd, Cu, Pb, Zn). The results showed that resuspension processes of dredged harbour sediments could induce both a release of Cd, Cu and Pb which are bioavailable for larvae (levels of bioaccumulation depending on the species) and biological perturbations, i.e. abnormal development in *C. gigas* and *P. lividus* larvae for the more contaminated sediments and growth inhibition in all three larvae for slightly contaminated sediments.

Herbrandson *et al* (2003) explored the effects on *Daphnia magna* from exposure to the pesticide carbofuran in combination with stress from suspended solids exposure. When *D. magna* were exposed to a constant carbofuran concentration, the numbers of affected organisms increased with increasing suspended solids concentrations. At a suspended solids concentration of 1000 mg/l, the EC_{50} for carbofuran was reduced by half to 45 μg/l.

Maddock *et al* (2006) used polluted, anoxic estuarine sediments which were suspended in oxygenated estuarine water, in laboratory experiments. This was intended to simulate their dispersion by flood flow or dredging operations, in order to measure any release into solution of heavy metals originally present as sulphides that might suffer oxidation. Oxidation of sulphides to sulphate acidified the waters, but only after at least 5 h of suspension. Furthermore, the oxidation of acid volatile sulphide (AVS) to sulphate was more rapid and only proceeded to completion within 5 days, when large quantities of sulphide forming metals other than Fe were not present. In sediment heavily polluted with zinc, oxidation of AVS was slower and incomplete, resulting in soluble release of a much smaller

fraction of the Zn present in the sediment and a maximum dissolved zinc concentration that was much lower than that resulting from less contaminated sediment. The maximum percentages of sulphide-bound metals appearing in solution at any time during re-suspension were low, less than 46% in all cases and typically less than 10%. These maxima were manifested only after acidification by sulphate formation. Appreciable metal dissolution would not occur in an estuary if dilution and dispersion separated the sediment from acid generated or if dredged material settled before acidification occurred.

While each of the aforementioned studies found severe effects of resuspended contaminated sediments upon marine organisms, laboratory experiments have been criticised for being too simplistic and inadequate in predicting the effects of toxicants in the real world (Kimball and Levin 1985, Underwood 1995, Johnston and Keough 2003). Field experiments are thought to be a more realistic way to assess ecological threats as they incorporate the physical, chemical and biological complexity of the real world (Underwood 1995). However, there appears to be a paucity of research on the ecological effects of the resuspension of contaminated sediments on organisms living above the sediment.

Nayar *et al*. (2004) experimentally determined that phytoplankton and bacteria can be affected by the small-scale resuspension of contaminated sediments.

Knott *et al*. (2009) demonstrated that the large-scale resuspension of contaminated sediments dramatically reduced the recruitment of sessile invertebrate such as barnacles and polychaete tube worms, which were the major space-occupiers in these assemblages. Dredging activities resulted in the large-scale resuspension of contaminated sediments. Concurrently, the recruitment of the dominant filter-feeders (e.g. barnacles and polychaete worms) was virtually extinguished for 4 months, despite being abundant prior to dredging. This pattern contrasted with the recruitment of the same invertebrates in the reference estuaries, which showed little change over the same period.

Hedge *et al.* (2009) used oysters *Saccostrea glomerata* to assess short term changes in metal availability caused by the resuspension of contaminated sediments. *S. glomerata* experienced large increases in accumulation of zinc, copper and tin during dredging in the study area relative to oysters deployed in reference estuaries. Lead and tin were found to be permanently elevated.

Knott and Johnston (2009) assessed whether repeated short-term resuspension of contaminated sediments would affect the diverse assemblages of rocky reef sessile invertebrates in Sydney Harbour. The study used the sessile invertebrates as “mine canaries” as they are sensitive filter-feeders and cannot move away from water-borne sediment plumes. Despite being exposed to resuspensions of some of the most contaminated sediments in the world, a diverse range of Sydney Harbour sessile

invertebrates clearly showed no short-term ecological effects. The abundances and area that the invertebrates covered did not differ among the assemblages exposed to the resuspension and control treatments indicating that there were no immediate impacts of the resuspension of contaminated sediments. The high levels of relatively clean sediments did not affect the invertebrates. This result was unexpected, as suspended sediments at the level used in this experiment are generally thought to have substantial negative effects. The lack of an effect from relatively short-term resuspension of contaminated sediments is surprising considering the dramatic effects caused by the large-scale resuspension of contaminated sediments associated with dredging (Knott *et al*. 2009).

It is noted that the examples noted in many cases involved much higher levels of contaminants than were recorded in Slatty Water. It is also noted that previous macroinvertebrate sampling indicated that communities were not diverse and were dominated by tolerant species which may be less susceptible to some of the problems noted above.

5.2 Cork Harbour

Cork Harbour is home to the only oil refinery in Ireland, located at Whitegate as well as one of the county's largest electricity-generating plants at Aghada. Large scale pharmaceutical activities occur throughout the harbour as well as residential developments, industrial and shipping activities. The resulting release of heavy metals, polycyclic aromatic hydrocarbons (PAH) and other persistent organic pollutants (POP) into the harbour has led to a proliferation of studies on the impacts of such activities. While the majority of these studies have focused on pollutants within the water column and plant or animal samples (e.g. Berrow *et al*. 1982; Boelens *et al.* 1990;Casey, 2001), a small number have examined sediment contamination within Cork Harbour.

Heavy metal levels in mussels (*Mytilus edulis*) and sediments were studied in samples from Cork Harbour, Ireland (Berrow,1991). Copper levels in sediments and mussels were greatest in the inner harbour but were within the range recorded from the east coast of Ireland; however levels in mussels were higher than typical values for the east coast of Ireland. Lead levels in sediments and mussels were elevated inside the harbour and demonstrated a west-east cline in sediments. Levels of zinc and chromium in sediments were elevated in the inner harbour. Chromium and nickel levels in mussels were generally greater than those reported from the east coast of Ireland. Mercury levels in sediments from inside Cork Harbour were elevated, especially in the inner harbour, while levels in mussels were elevated relative to sites in the southern North Sea. Cadmium and silver levels were below detection limits in sediments but cadmium was significantly elevated in mussels.

Kilemade *et al.* (2003) examined the potential of sediment originating from Cork Harbour to induce DNA instability in juvenile turbot *Scophthalmus maximus*, a fish whose predominantly benthic

lifestyle made it the ideal species for studying sediment-water-organism interactions. Sediment was sampled from two sites within Cork Harbour; Whitegate and Aghada which were previously shown to have elevated levels of chlorinated organic compounds and from a relatively unpolluted reference site, Ballymacoda, Co. Cork. Results indicated that turbot exposed to sediments from the Cork Harbour sites displayed an increase in DNA damage in comparison to those exposed to sediment from Ballymacoda, the reference site.

Kilemade *et al.* (2004) employed the alkaline single cell gel electrophoresis (SCGE) or Comet assay to test the potential of surficial sediment collected from Cork Harbour, Ireland, to induce DNA damage in turbot (*Scophthalmus maximus L.*) in a laboratory exposure experiment. Turbot were exposed for 21 days to field-collected sediment from Cork Harbour and from a relatively clean reference site at Ballymacoda and sampled at 0, 7, 14, and 21 days. As a positive control for the sediment exposure experiment, a sub-sample of the turbot was exposed to cadmium chloride-spiked seawater. DNA damage analysis was performed on epidermal, gill, spleen, liver, and whole blood cell preparations. Liver, gill, and blood were the most sensitive tissues while a lower level of damage was detected in the epidermis and spleen. Chemical analysis of the sediment indicated that PAH's formed the bulk of the contaminants, with the harbour sites having almost double the levels of those from the reference site. The data indicated that turbot exposed to sediments from Cork Harbour elicited a significant increase in DNA damage in comparison with those exposed to sediment from the reference site and that exposure to the contaminated sediments caused a multi-organ genotoxic response.

Kilmade *et al* (2004) examined surface sediment from three polluted sites within Cork Harbour, Ireland, and from a relatively clean reference site. Samples were analysed for polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), brominated flame retardants (BFRs), organotins (OTs), and heavy metals. PAHs were determined to be the most abundant class of contaminant. A similar pattern was observed with the other contaminants however, these compounds, with the exception of the heavy metals, all tended to be detected at concentrations on or below detection limits.

Hartyl *et al.* (2007) exposed hatchery-reared turbot (*Scophthalmus maximus L.*) under laboratory conditions, to sediment collected from polluted sites in Cork Harbour and a reference site at Ballymacoda, Co. Cork, Ireland for a period of three weeks. The purpose of this study was to assess the effect of sediment exposure in hatchery reared *S. maximus* under controlled laboratory conditions by means of two complimentary biomarkers on two levels of biological organisation, biochemical (cytochrome P450 induction) and genetic (DNA instability), and to evaluate the potential of this species as a model organism for the detection of sediment-associated pollutants in the environment. The potential of surficial sediment for inducing hepatic biomarkers was assessed. The induction of

cytochrome P450 activity (EROD, MROD and PROD) in animals following a 7-day exposure to contaminated sediments was significantly higher than those exposed to reference site sediment and remained elevated thereafter; BROD was not induced. DNA single-strand breaks were also significantly higher following exposure to contaminated sediments throughout the experiment.

Kilmade *et al*. (2008) exposed juvenile turbot to inter-tidal sediments collected from areas around Cork Harbour. Chemical analysis of the sediment samples revealed that these were mainly contaimtated with PAH's. Following three weeks of exposure to the sediments, fish showed a strong immunogenic response.

As part of the EIS for the Irish Steel plant at Cork Harbour, sediment samples from a number of locations around the harbour were analysed (White Young Green, 2008). Results were compared to guideline/screening values as well as trends within other Irish industrial ports. Levels of copper, zinc and nickel were marginally elevated above guideline values. Chromium and chromium VI levels were below guideline values. PCB's were detected at levels marginally above guideline values. The report concluded that there was no gross contamination in the marine sediment samples analysed, however marginal contamination was detected in most samples.

Available research indicates that the resuspension of contaminated sediments may pose an ecological threat to organisms exposed to the water-column. The proposed dredging works could potentially cause the resuspension of contaminated sediments. However although elevated levels of PAH's and heavy metals have been detected in sediments at a number of locations within Cork Harbour, in this instance levels of both were relatively low. However as a precautionary measure active management methods may need to be employed in order to confine contaminated sediments and mitigate against any potential impacts during dredging activities.

6. Conclusions

The literature review notes that re-suspension of contaminated sediments may pose an ecological threat to organisms exposed to the water-column and on this basis extensive chemical tests were carried out to determine the level of contamination of sediments by heavy metals and other compounds. The guidelines for the assessment of dredge material for disposal in Irish water notes the following in Section 1.10.

The lower level guidance values correspond to contaminant concentrations below which the sediment, if disposed of at sea, is assumed to have a physical impact only. The upper level guidance values are set at concentrations above which adverse effects might be expected.

Lower level guidance values represent concentrations that are either a) at the upper end of the no-effect range or b) at background concentrations. Upper level guidance values are set at the lower end of the known range of effective concentrations i.e. lowest concentrations shown to have adverse effects on marine organisms.

The guidelines also notes (section 1.10.3) that; *Management of sediments with chemical concentrations that place them in Class 2 may be extremely complex...The type and level of contamination will be considered. All decisions regarding class 2 sediment s(i.e. sediments with concentrations between levels 1 and 2) will be based on best professional judgement.*

Based on the above and given that chemical levels were either recorded below the detection limit or were well below the upper limits (with the exception of zinc at S2) the pipeline works don't appear to constitute a significant ecological threat via resuspension of compounds. This assumes that the construction method effectively minimised disturbance of sediment.

It is also noted that the sediment will be backfilled and thus will not be impacting on new areas which may support macroinvertebrate communities which are not adapted to this type of sediment type and chemical composition. It is also noted that silt may settle at low tides. Overall there is no significant evidence to indicate the works will significantly impact on the ecology or bird populations of the designated area.

As a precautionary measure and given that some heavy metal concentrations come within class 2, a detailed method statement should be produced prior to the commencement of construction which details the construction method and measures proposed to minimise disturbance of estuarine sediments and resuspension of compounds. It is particularly important to minimise disturbance in the upper part of the pipeline route where concentrations of heavy metals are highest. Such a method statement should also specify the mitigation measures required to prevent negative impacts on bird populations and the provisions of the method statement should be agreed with the NPWS prior to commencement of works.

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APPENDIX 4

MODELLING OF HARBOUR REPORT

APPENDIX N:
Details of Harbour Modelling

Contents:

SAC GREAT ISLAND CHANNEL

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour that contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed.

The main habitats of conservation interest are the sheltered tidal mudflats and Atlantic salt meadows, both habitats listed on Annex I of the EU Habitats Directive. These habitats, along with brackish pools and open water, support a rich invertebrate fauna. Cord-grass (Spartina sp.) has colonised the mudflats in places, especially around Rossleague and Belvelly.

The site is also extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North channel, Harper's Island and Belvelly-Marino Point. An Foras Forbartha provided the following description in 1986: waders and wildfowl occur in large numbers during the winter. Shelduck are the most frequent duck species with 800-1000 birds centred on the Fota/Marino Point area. There are also large flocks of Teal and Wigeon, especially at the eastern end. Waders occur in the greatest density north of Rosslare with Dunlin, Godwit, Curlew and Golden Plover the commonest species. A population of about 80 Grey Plover is a notable feature of the area. All the mudflats support feeding birds; the main roost sites are at Weir Island and Brown Island and to the north of Fota at Killacloyne and Harpers Island. Ahanesk supports a roost also but is subject to disturbance. The numbers of Grey Plover and Shelduck, as given above, are of national importance.

The site is an integral part of Cork Harbour which is a wetland of international importance for the birds it supports. Overall, Cork Harbour regularly holds over 20,000 waterfowl and contains Internationally important numbers of Black-tailed Godwit (1,779) and Redshank (2,382) along with Nationally important numbers of nineteen other species. Furthermore, it contains the largest Dunlin (10,912) and Lapwing (14,713) flocks in the country. All counts are average peaks, 1984/85 - 1986/87. Much of the site forms part of Cork Harbour Special Protection Area, an important bird area designated under the Birds Directive.

While the main land use within the site is aquaculture (Oyster farming), the greatest threats to its conservation significance come from road works, infilling, sewage outflows and possible marina developments.

The site is of major importance for the three habitats listed on the EU Habitats Directive that it contains, as well as for its important numbers of wintering waders and wildfowl. It also supports a good invertebrate fauna.

PREVIOUS HARBOUR STUDIES

The report by the EPA entitled *Measurement and Modelling of Nutrient dynamics of Two estuaries in Ireland – Wexford and Cork Harbours (Synthesis Report)* provides information of interest. An extract of the report is below:

"Many studies have been undertaken on Cork Harbour by local authorities, statuary bodies, third level institutions, state and semi-state laboratories, environmental organisations and private companies. The Cork Harbour Report (ERU 1989) was the first report to collate all available data on Cork Harbour and the report by Forbairt and ARUP (1996) built on this. The two former reports and that by Pettit (1992) , documented most of the data on Cork Harbour with the exception of recent studies, notably the unpublished monitoring by the EPA (1994 – 1996). Many of the studies concentrated on a few areas within the estuary and harbour or only analysed a limited number of parameters and were short-term. The reports concluded that the water quality particularly in the upper reaches of the harbour has deteriorated over time. Generally the areas which suffered the most from low dissolved oxygen , high biological oxygen demand, phosphorus, ammonia, and nitrate were the inner estuary (north and south channels of River Lee) and the Lough Mahon area. Phytoplankton causing Paralytic shellfish Poisoning (PSP) have been recorded in Cork Harbour, namely Alexandrium tamarense in 1996 and 1997 (Marine Institute 1999).

The study found that point sources (outfalls) of nutrients are contributing to phytoplankton blooms in both estuaries. Measures to reduce such waste inputs into the inner brackish water part of the estuaries are thus required to reduce the occurrence of harmful algal blooms , especially in Cork Harbour where toxic blooms have occurred and are likely to continue to occur.

Cork Harbour meets several of the criteria for a eutrophic system. Cork Harbour, particularly the area around Lough Mahon appears to be eutrophic. The estuarine circulation in the harbour acts as a focus for the eutrophication-related effects. Increased residence times in the subsurface layer allow more time for algal growth and simultaneously increase the scope for de-oxygenation of the water column Direct nutrient inputs to the surface layers may increase the size of the toxic algal blooms when conditions are appropriate for growth of PSP-causing species.

Within estuaries, eutrophication is better characterised by apparent problems than simple chlorophyll levels. On this basis the deoxygenation in Cork Harbour estuary and toxicity from dinoflagellates, indicate that the estuary is eutrophic."

Cork Harbour Water Quality, 1989, by the ERU had the following findings:

Many of the environmental parameters measured in the harbour show a gradient extending from the upper harbour and estuarine areas, through the lower Harbour to the Harbour mouth. Thus going in this direction, BOD loadings, phosphate, nitrate, and ammonia levels, bacteria levels, and levels of contaminants in the water, sediments and biota all show a general decrease in values as the Harbour mouth is reached. Dissolved oxygen levels, on the other hand, show an increase along the same gradient.

The very steep rise in the levels of nutrients, especially nitrogen, in Cork Harbour is the most outstanding feature of the data collected in the harbour over the last 15 years. This rise is most prominent in the upper harbour reaches particularly in Lough Mahon and the West Passage but it is also marked in the lower harbour. While an increase in phosphate levels relative to 1975 values has occurred, some spurious results mean that the pattern is not clear cut.

Contamination levels measured in the water column, under the priviso of unproven accuracy and precision of the analytical procedures indicate that, in general, metal levels in Cork Harbour are moderate, i.e. they are not low, relative to other, uncontaminated, locations. In particular high levels of zinc and to a lesser extent, nickel have been highlighted. A zinc gradient was shown for the harbour in the late 1970s and was attributed to the disposal of metal wastes at that time. This waste disposal has not taken place for some years now and it has been suggested that this zinc gradient has now dissipated. However this suggestion needs present day confirmation.

"*A synthesis of Existing Information on the Environment of Cork Harbour*" by Ove Arup, 1996, states the following:

The BOD levels in the lower and outer harbour normally range between 1 to 3 mg/l. There has been a general rise in BOD in the harbour between early-mid 1970 and the mid 1980s. BOD levels tend to be highest in Autumn/Summer.

Regarding phosphorus levels, the stage of the tide appears to make a large difference, ranges between 0.03 to 0.14 mg/l are normal.

Orthophosphate levels are normally much lower than phosphorus levels, as the phytoplankton readily use the Orthophosphate.

Ammonia levels were recorded are at their highest when salinity in the harbour is low. The IFI fertiliser manufacturing plant (no longer in operation) was seen to be a major contributor of Ammonia, but when the dispersal effects were modelled, it was found that it only caused a very minor increase in the Ammonia concentration in the surrounding areas. Nitrogen levels were found to be higher in winter; this was put down to runoff from farmland.

Nitrate concentrations have increased significantly since the mid 1970s. Agricultural inputs upstream are seen to be most significant.

HARBOUR MODELLING

1) INTRODUCTION

Cork Harbour is the second largest natural harbour in the world. Its vast size brings it in contact with many users. Sailing and boating is a popular sport, based in Crosshaven, Cobh, East Ferry and other smaller marinas. Fishing vessels use the harbour as their base. Liners stop at the main port terminal in Cobh. The Harbour is classified as a deep multi-modal port. The movement of the larger vessels is controlled by the Port of Cork Company (formerly known as the Cork Harbour Commissioners). The tidal rise at Cork ranges from 3.4m (11 feet) on neap tides to

4.4m (14.5 feet) on spring tides. There are no recognised bathing areas within the harbour.

The Slatty Estuary forms part of the proposed Special Area of Conservation (SAC) no. 1058 known as the Great Island Channel. This SAC contains an important variety of birdlife. Also there is shellfish farming in the channel east of Belvelly Channel, close to Midleton. It is necessary to consider if the discharges allow the Shellfish Regulations to be met at the regions licensed for the shellfish farming.

Since its construction in 1985, the Carrigtohill Wastewater Treatment Plant has been discharging treated effluent to the head of the Slatty Water Estuary via the existing outfall. The adequacy of this form of discharge and treatment for the present and future loadings is to be investigated. Proposed improvements to the discharge regime are to be examined.

For this reason, a hydraulic and water quality model of the relevant parts of Cork Harbour was developed by the Hydraulic and Maritime Research centre, University College of Cork. Bathymetric and coastline data were supplied in digital format by Irish Hydrodata Ltd.

The Department of Marine requested that the model consider if the discharges allow the Shellfish Regulations to be met at the regions licensed for the shellfish farming.

A new treatment plant to treat the waste from Cork City has been constructed at Carrigrenan (on Little Island). This plant shall discharge waste treated to 25:35 BOD:SS standard at Marino Point. The model was set up to deal with both the discharges of Carrigrenan and Carrigtohill to investigate the impact of the combined discharges.

2) PURPOSE OF THE MODEL

The purpose of the model is to estimate the effect on Cork Harbour as a result the existing discharge, and to decide on appropriate discharge location and standards and discharge period in relation to the tidal regimes for the proposed scheme (design population of 45,000 for Phase 1) Our overall aim is to reduce the impact of the combined discharges (from both Carrigtohill and Carrigrenan) rather than the impact of the Carrigtohill discharge alone.

3) MODEL DESCRIPTION

3.1 Introduction

This study involved the numerical modelling of the hydrodynamic and water quality conditions that are prevalent in Cork Harbour and in particular as a result of proposed discharges from the Carrigtohill and Carrigrenan outfalls. The software used to undertake the modelling work is called MIKE21 and was developed by the Danish Hydraulic Institute (DHI). The following two models of the MIKE software were used in the study.

MIKE21 HD (Hydrodynamic module): This software simulates the water level variations and flows due to different forcing functions. A rectangular grid of the relevant area has to be specified and information on such items as bathymetry, bed resistance coefficients, wind field, and the hydrographic boundary conditions need to be provided. The model includes such influences as convective and cross momentum, bottom shear stress, wind shear stress, evaporation, flooding and drying, sources and sinks, Coriolis forces, momentum dispersion and wave induced currents.

MIKE21 WQ (Water Quality Model): This model which runs simultaneously with the hydrodynamic model examines the impact of a pollution source to a water body. The pollution source may be an outfall containing industrial or domestic wastewater, riverine discharges or agricultural run-off. Through the solution of a system of equations involving the various physical, chemical and iological interactions associated with the survival of bacteria the resulting water quality can be determined. Many variables can be modelled, including but not limited to BOD, Ammonia, NH3, Nitrate, NO3, Dissolved Oxygen, DO, Phosphorus, PO4, Faecal coliforms, Total Coliforms.

3.2 Methodology

The approach adopted in this study involved first setting up the model grid and then calibrating/validating the hydrodynamic model, using field measurements to verify the output. Once validated the model input parameters were then varied to examine the effects and implications of various discharge scenarios from the Carrigtohill outfall for both Spring and Neap tidal conditions.

The following sections will outline the methodology in more detail.

3.3 Model set-up/Grid layout

The first major step for the setting up of the numerical model is the input of the bathymetry and the land boundaries. To ensure that the model would run successfully and give reliable results it was necessary to include a very large area extending beyond the area of interest. Therefore, for this study, even though the Slatty water and upper harbour region was the area of interest all of Cork Harbour was included in the model set-up. This approach helped to improve the stability and reliability of the model even though it considerably lengthens the simulation time.

Bathymetric and land data was supplied in digital format by Irish Hydrodata Ltd (see Section 4) which was then imported into MIKE 21 where the discrete randomly located data points were transformed into a regular grid. A grid size of 30 x 30m grid was chosen as it gave sufficient resolution of the relevant processes and gave an acceptable model run time. A complete 15 x 15m grid as well as a nested 15 x 15m section of grid were also set up but it was found that these set ups had a run time in excess of two days, which was considered too long. It was considered that a 30m x 30m grid was sufficiently fine to accurately model the various processes (the model used in the Cork Main Drainage Study had a 100m x 100m grid size).

The interpolated grid was then carefully checked and adjustments were made, by editing the grid, when the data was interpreted incorrectly. This was particularly the case for the land boundaries and relatively small structures such as the piers and islands. Figure 3.1 below shows the extent of the model as well as the bathymetry. Figure 3.2 shows in more detail the most relevant area of the harbour with the locations where data was extracted for analysis.

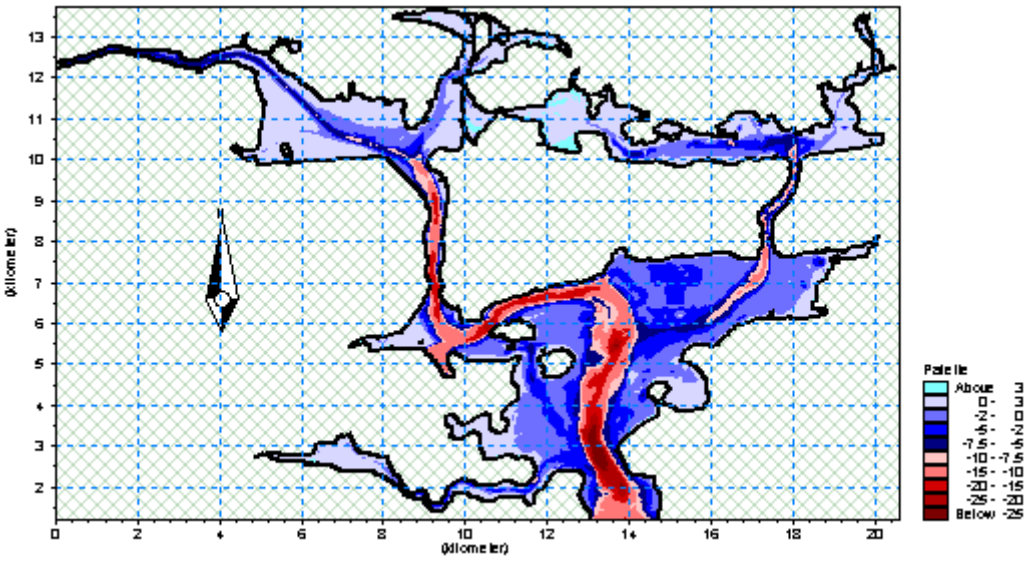


Figure 3.1 Model Area with Bathymetry (Plot Units: m Chart Datum)

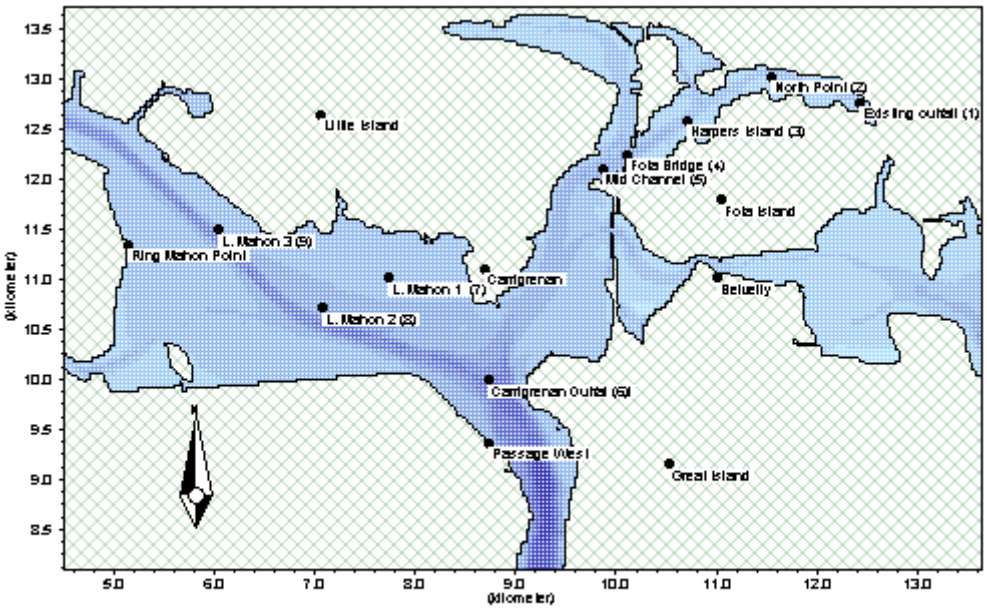


Figure 3.2 Locations of Data Extraction Points (In the simulations where the proposed Outfall is located in the Slatty Estuary)

3.4 Model Calibration/Validation

Before undertaking any design work using the output of numerical models it is imperative that the model is properly calibrated/validated against field measurements. In the case of this study calibration/validation work was carried out in relation to the both the hydrodynamic and water quality models such that the correct flow and dispersion characteristics were substantially reproduced.

3.4.1 Hydrodynamic Model

The calibration process involves running the same simulation until, through adjustment of model parameters, the model satisfactorily reproduces the field conditions. The field measurements used for the calibration/validation of the model included the current speeds and directions as recorded by the recording current meter and fixed station plus the water surface elevations recorded at Fota and Roches Point (see field measurement report for more details). Once the model has been calibrated for one set of input conditions it must be then validated for a different set of field conditions to ensure that it still gives satisfactory results. In the case of this study the model was calibrated for a spring tidal condition and validated on a neap tide. It should be noted that the calibration/validation of a model is a non-trivial task and it often takes considerable time to achieve satisfactory results. In the case of the hydrodynamic model for Cork Harbour good agreement was achieved relatively

quickly and this was attributed to the good selection of field measurement points. The methodology followed in the process is described below.

The model grid contained one boundary, located at the southern extremity of the interpolated grid (see Figure 3.1). At this boundary the input condition (driving force) was a water level fluctuation corresponding to the tidal elevations as obtained from the Roches Point field data. For the calibration the simulation lasted for two tidal cycles - the first cycle allowed the model to stabilise whilst data was collected for the remaining cycle. Once the model run was complete comparisons were then made between the measured and simulated data in terms of water surface elevations and current speeds and direction. It required a number of simulations, with adjustments being made to the physical set-up of the model and parameters such as eddy viscosity and bed resistance before satisfactory agreement was achieved. The output plots for the calibration show that the model gives a good representation of the flow at the two measurement points (see figures 3.3 to 3.5).

For the validation of the model a slightly different approach was taken in that the model was run for a total of 9 tidal cycles. Model runs of this length are not normal for validation but given that the field data was available it was considered that the longer run would be a better test of the model. Figures 3.6 to 3.8 show comparisons between the simulated and measured results and in general they agree quite well. It should be noted that both the calibration and validation runs did not include for wind effects and this is partly responsible for observed differences between the measured and simulated results. However these differences are not considered to be significant in terms of influencing the nature of the flow regime in the Slatty Water Estuary.

The completion of the above work ensured that the model could properly reproduce the flow characteristics in the Upper Harbour and thus be used to determine the impact of the proposed outfall from the Carrigtohill treatment plant.

3.4.2 Dispersion Characteristics

The dispersion characteristics of the Slatty Water Estuary were determined by simulating one of the dye releases that was carried out. The model was set up such that a non-decaying substance was introduced at the same location and time as the dye and its subsequent movements were tracked in a similar manner to what was done in the field. The dispersion characteristics as produced by the model were then compared to the field measurements and if they differed then the model was re-run with a different set of dispersion parameters. Figures 3.9 to 3.11 show two comparisons between the model and field data at 3 and 4 hours after the dye release. Note that the dye release was made at high tide.

The completion of the above work ensured that the model could properly reproduce the flow characteristics in the Upper Harbour and thus be used to determine the impact of the proposed outfall from the Carrigtohill treatment plant.

3.5Flow Regime Upper Harbour

Since the discussion of the results will be concerned mainly with water quality it is considered relevant to include a section on the Upper Harbour flow regime at this point. Figures 3.13 and 3.14 show the mid ebb and mid flood flows for a neap tide condition. The plots show that the highest velocities are confined to the main channel (compare with Bathymetry plot – Figure 3.1) and also at the location of constrictions (Belvelly, Fota Bridge etc). It is also relevant to note that there is very little flow interaction between the Upper Harbour and the area north of Great Island, via Belvelly Channel. The shallow depths at Belvelly as well as severe flow constriction at this point ensures that the area north of Great Island floods and ebbs by means of the East Ferry Channel. This is important to note as discharges from both Carrigrenan and Carrigtohill will be shown to have a minimal impact on water quality in this area.

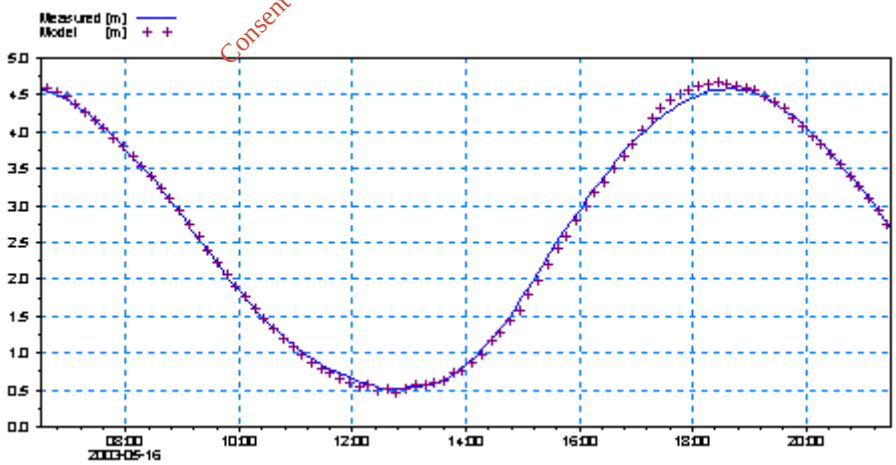


Figure 3.3 Water Surface Elevations (Fota)

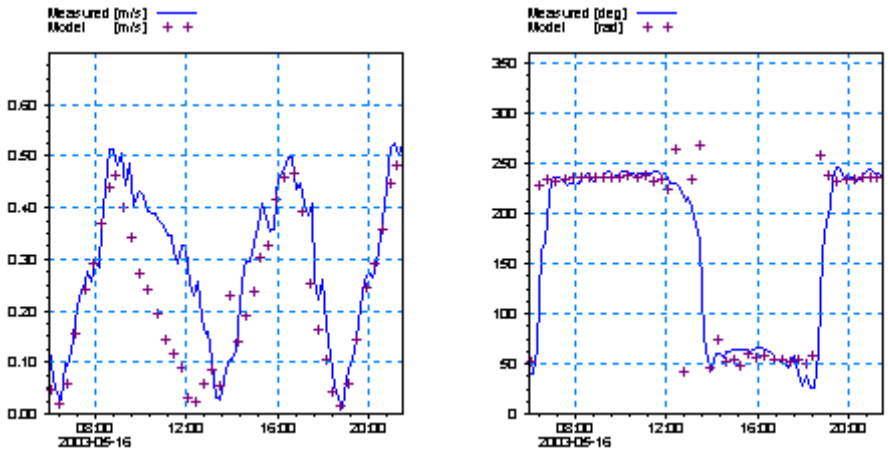


Figure 3.4 ((a) & (b)) Current Speed and Direction (RCM)

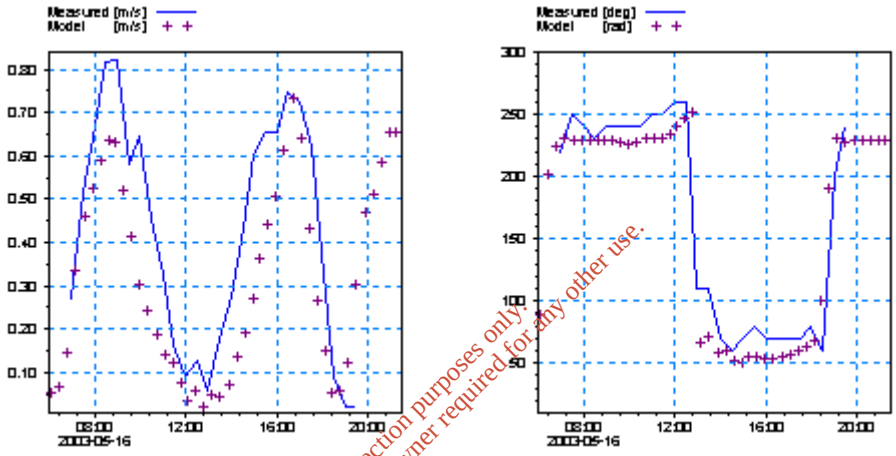


Figure 3.5 ((a) & (b)) Current Speed and Direction (Fixed Station)

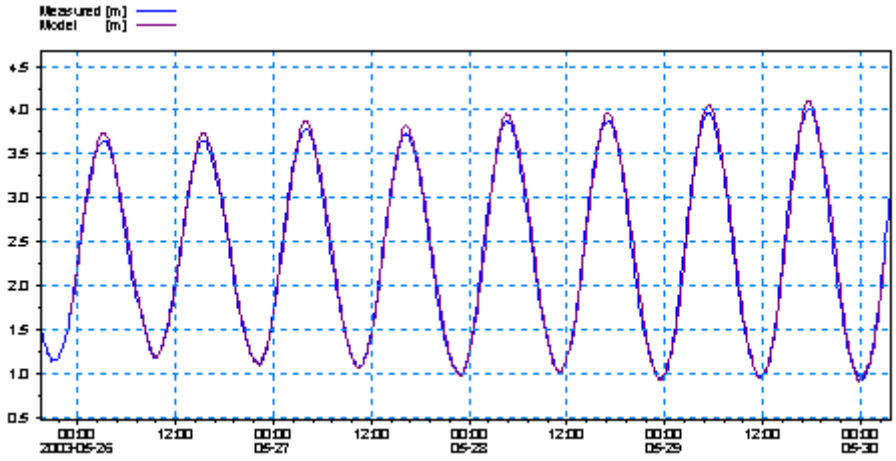


Figure 3.6 Water Surface Elevations (Fota)

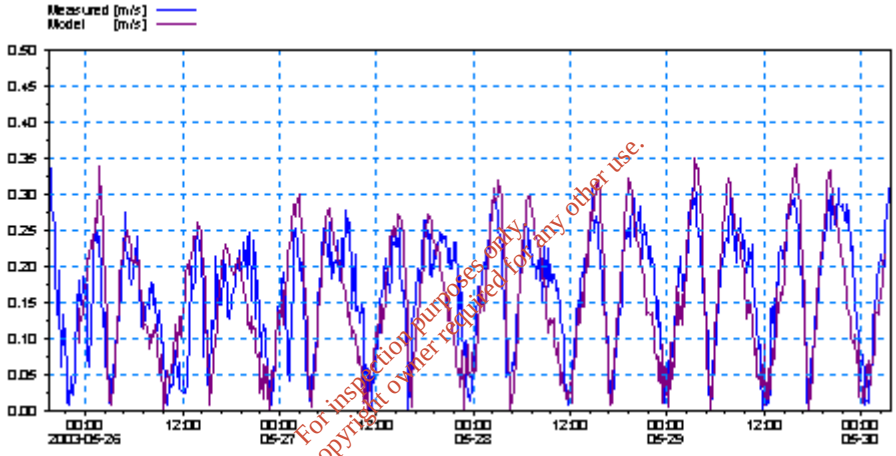


Figure 3.7 Current Speed (RCM)

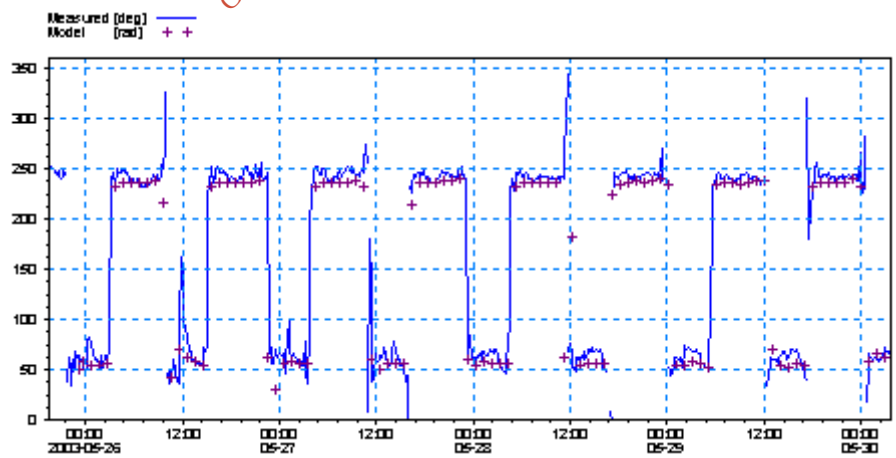


Figure 3.8 Current Direction (RCM)

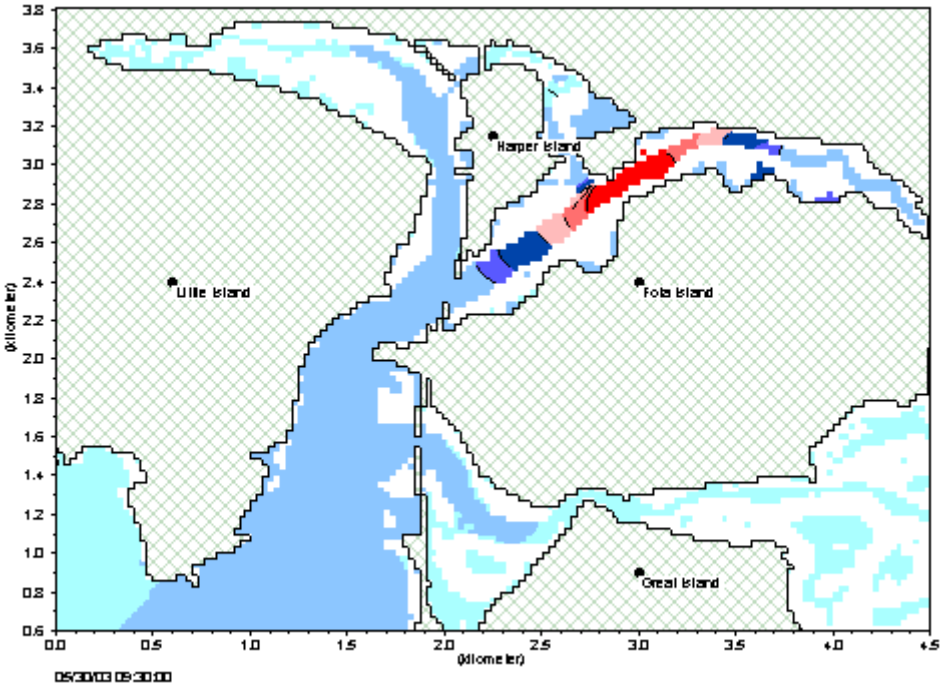


Figure 3.9 Dispersion Model Output HW +3h

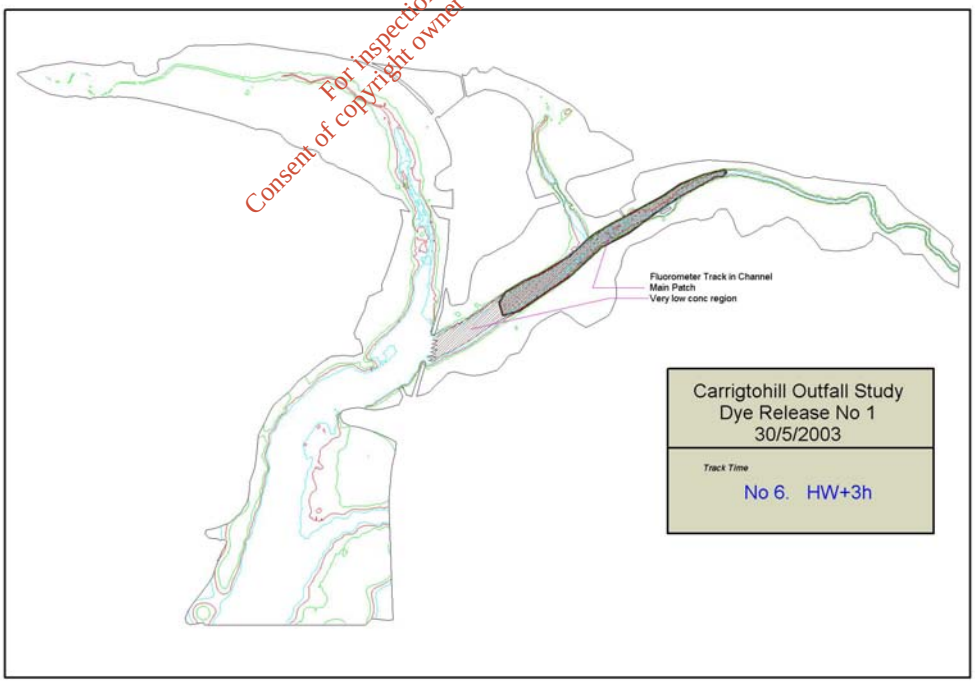


Figure 3.10 Field Measurements HW +3h

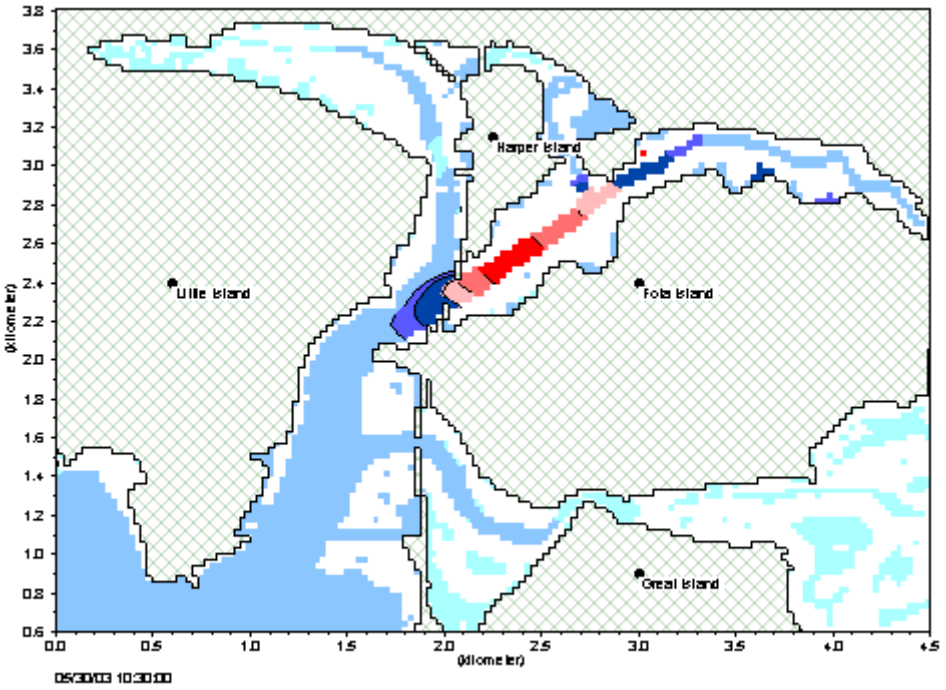


Figure 3.11 Dispersion Model Output HW +3h

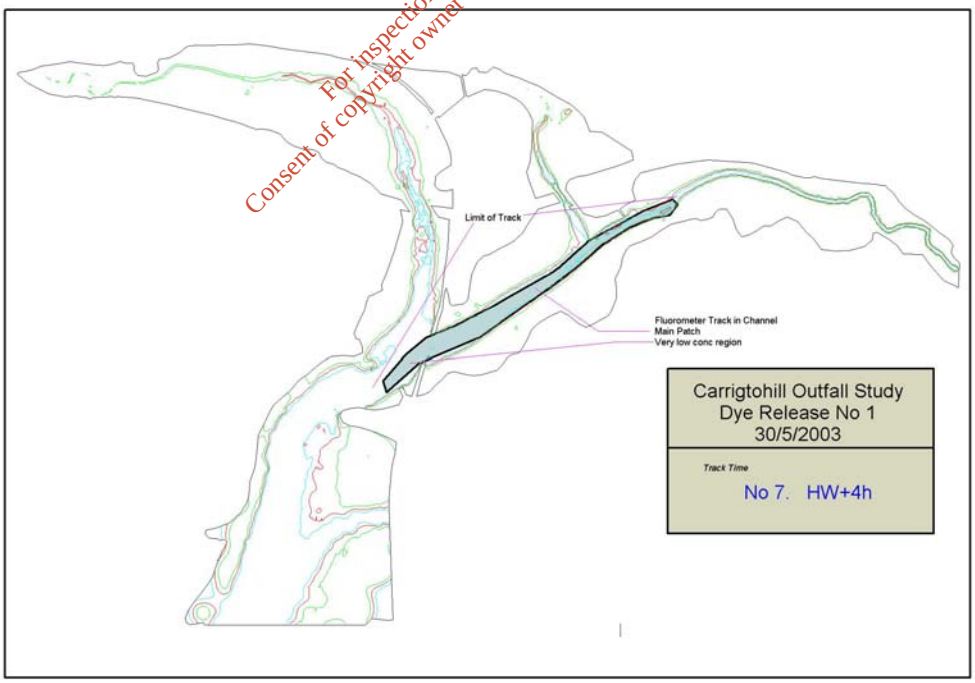


Figure 3.12 Field Measurements HW +3h

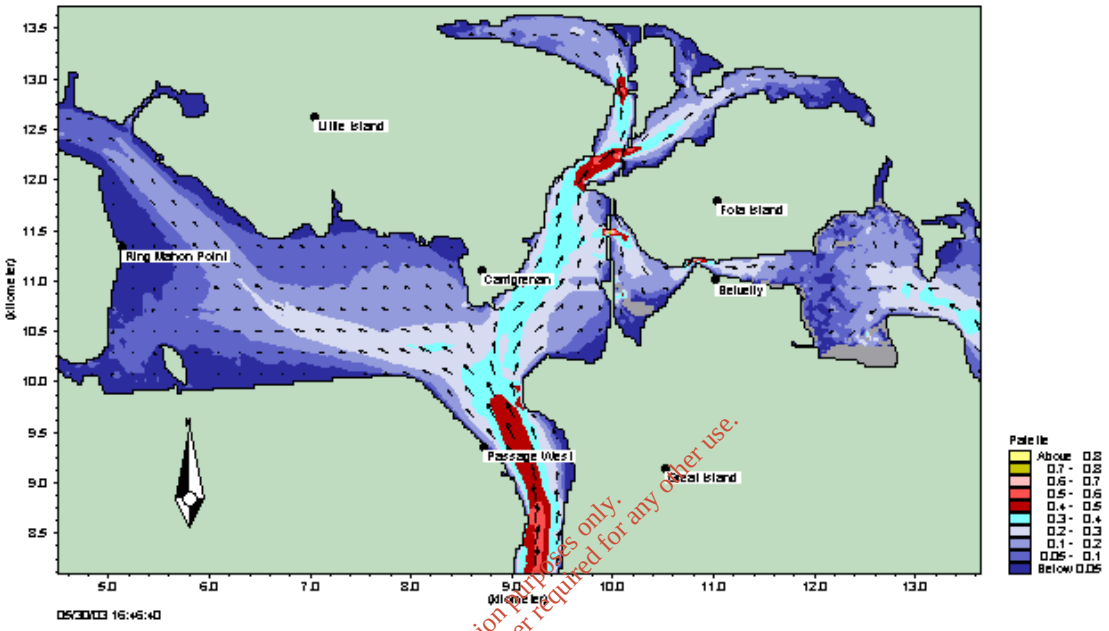


Figure 3.13 Flow Regime, mid ebb tide

(Plot units m/s)

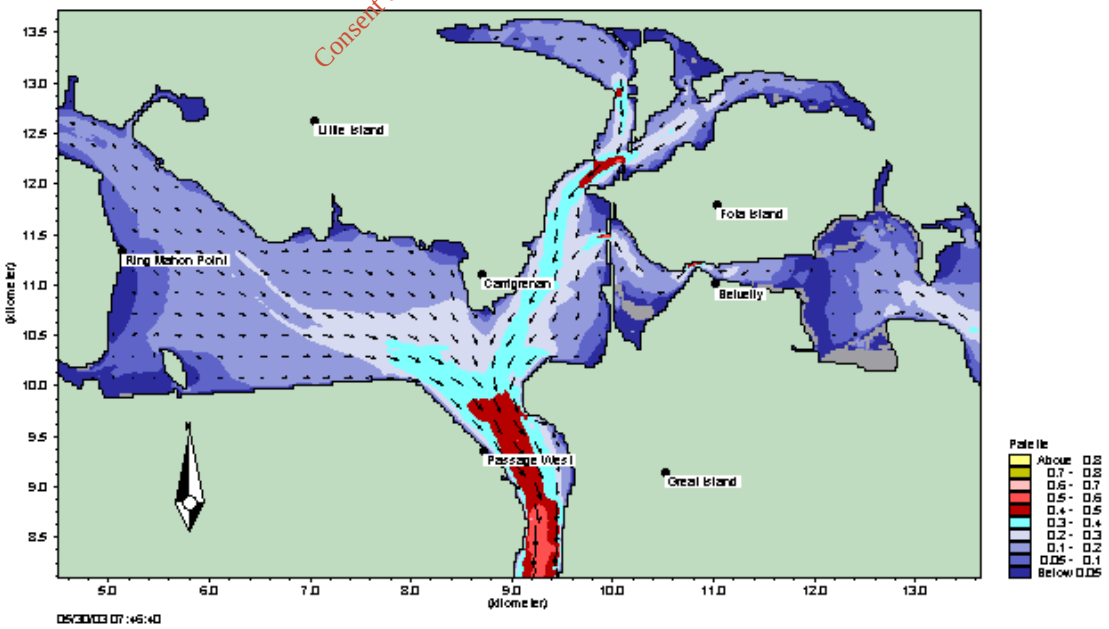


Figure 3.14 Flow Regime, mid flood tide

(Plot units m/s)

3.6 Description of Simulations

The numerical model simulations set out to determine the water quality in the Upper Harbour region as a consequence of the discharges from outfalls from the Carrigtohill and Carrigrenan treatment plants. The Carrigrenan outfall has already been extensively studied (Cork Main Drainage Study) but its impact on the water quality in the Slatty Estuary needed to be included for reference purposes. With regard to the Carrigtohill outfall the objective was to determine the optimal discharge criteria, in terms of both cost and water quality standards, in relation to the following parameters,

- Treatment standard required – impact of various discharge values of coliforms, BOD and nutrients on water quality
- Location of Outfall – consider impact of discharging at different locations in the Slatty Water Estuary
- Discharge type – continuous or tidal

The following sub-sections indicate the variables used in the simulations that were run as part of this study. .

3.6.1 Water levels

Two tidal levels were simulated corresponding to the mean neap and spring tide situations as indicated in the Admiralty tide tables. The high water levels and range for each of these tidal conditions are given below,

Description	High Water Level (Chart Datum)	Range (m)
Neap	3.2	1.9
Spring	4.4	4

Table 3.1 Tidal Conditions

3.6.2 Wind Conditions

Wind can have an impact on the flow conditions within the estuary and to examine this one simulation was run with a wind speed of 15m/s and a wind direction of 225 degrees. It was regarded that winds from a general south westerly direction would most influence the flows in the Slatty Estuary and the Cork Main Drainage Study had shown that this is the most prevalent direction. The input wind conditions would be regarded as being severe with only a bout a 1% frequency of occurrence.

3.6.3 Outfall Discharge Rates

For all simulations the dry weather flow (DWF) was used for the discharge from each of the outfalls. The Carrigrenan outfall had a DWF value of 103,950m^3/day. For Carrigtohill this corresponded to a flow rate of 1050m^3/day for the current situation and 10,125m^3/day for the proposed future condition (45,000 PE). In additional simulation runs, the following flow rates were used for Carrigtohill:

- 55,000 PE : 12,375 m^3/d
- 62,000 PE : 13,950 m^3/d
- 82,500 PE : 18,560 m^3/d
- 100,000 PE : 22,500 m^3/d

3.6.4 River Discharges

The model included fresh water discharges from the Slatty Pond and the River Lee. The Slatty Pond flow rate was 0.4m^3/s whilst for the River Lee a value of 51m^3/s was used.

3.6.5 Decay Rates

The decay rate for both coliforms and BOD was chosen based on the discussion in Volume 3 of the Cork Main Drainage Report (pg 19). For coliforms the decay rate is specified as a T_{90} (time taken for 90% of the micro-organisms to die) and a value of 6 hours was used. This value is considered to be conservative. For BOD a value of 0.2/day was chosen and this is regarded as being typical of dry summer conditions.

3.6.6 Simulation Length

In general most simulations were run for ten tidal cycles, which corresponded to more that 5 days. This length of simulation was required to allow the coliform and BOD values to stabilise. Two simulations with a 28 day length were also run to examine the build up of nutrients over a longer time period.

3.6.7 Background Values

Background values of coliforms BOD and nutrients (ammonia, nitrate and phosphorous) were set to zero such that the model only predicted the impact of the two outfalls on the water quality in the harbour. Measured values of these parameters should be added to model output to determine the true values.

3.6.8 Preliminary Model Runs

A number of preliminary model runs were carried out to determine the optimum discharge type and location. These simulations are not listed in Table 3.2 below but were useful in showing that the water quality particularly south of Fota Bridge was not that sensitive to either of these factors. Three different discharge locations were simulated corresponding to the existing outfall, a point 300m east of it and the north point of the Slatty Estuary (see Figure 2.1). Water Quality in the vicinity of the outfall was affected but the differences became marginal as the distance from the outfall increased. Similarly with the discharge type, as continuous and various 2, 3 and 4 hour discharges (about high tide) were modelled. It was found that there was less variation in water quality for the continuous discharge condition and peak values occurred around low tide (as opposed to after high tide for the tidal discharge).

3.6.9 Simulation runs

Tables 3.2 and 3.3 below show the input parameters for the model simulations. There are 20 in total and include a variety of different input conditions. They intend to initially show the existing water quality in the Slatty Estuary and follow on to examine the individual impacts of both the Carrigrenan and Carrigtohill outfalls. Even though it is proposed to have a continuous discharge at Carrigrenan one simulation with a tidal discharge was carried out. Following simulations consider the impacts of applying different treatment standards to the effluent. Of note is simulation 14, which considers an alternative discharge location in the Belvelly channel.

In a further stage, additional simulation runs were carried out, again focusing on the discharge locations, but also on the maximum allowable capacity and the discharge standards. Descriptions of these simulation runs are shown in Table 3.4.

The tabled output of the simulation runs is included in Annex 3 (Initial Runs) and Annex 4 (additional Runs). The graphic results of the initial runs are included in annex 5.

Sim. No.	Location	F. Coliforms /100ml	T. Coliforms /100ml	BOD mg/l	S. Solids mg/l	DO mg/l	Amm. mg/l	Nit. mg/l	Phos. mg/l	Discharge Type	Discharge m^3/day	Location	Sim Length days
1	Carrigtohill	1000000	5000000	20	30	1	5	30	8	LW-2 - LW+2	1050	Existing	5
	Carrigrenan	0	0	0	0	0	0	0	0	0	0	Marino Pt.	
2	Carrigtohill	0	0	0	0	0	0	0	0	0	0		5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
3	Carrigtohill	0	0	0	0	0	0	0	0	0	0		5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	HW+.5 - HW+3.5	104198	Marino Pt	
4	Carrigtohill	200000	1000000	10	20	1	5	25	8	Continuous	11145	Existing	5
	Carrigrenan	0	0	0	0	0	0	0	0	Continuous	104198	Marino Pt	
5	Carrigtohill	200000	1000000	20	30	1	2	15	3	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
6	Carrigtohill	200000	1000000	20	30	1	2	15	3	Continuous	11145	North Pt.	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
7	Carrigtohill	1000	5000	10	10	1	3	10	1	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	20	30	1	3	10	1	Continuous	104198	Marino Pt	
8	Carrigtohill	1000	5000	10	10	1	2	15	3	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
9	Carrigtohill	200000	1000000	10	20	1	5	25	8	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
10	Carrigtohill	200000	1000000	10	20	1	5	25	8	Continuous	11145	Existing	28 (all neap)
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
11	Carrigtohill	200000	1000000	10	20	1	5	25	8	Continuous	11145	Existing	28(real tidal cycle)
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
12	Carrigtohill	1000	5000	10	10	1	2	15	3	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
13	Carrigtohill	1000	5000	10	10	1	5	25	8	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
14	Carrigtohill	1000	5000	10	10	1	5	25	8	Continuous	11145	Belvelly	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
15	Carrigtohill	1000	5000	10	10	1	3	10	1	Continuous	11145	North pt	5
	Carrigrenan	200000	1000000	20	30	1	3	10	1	Continuous	104198	Marino Pt	
16	Carrigtohill	1000	5000	10	10	1	2	15	3	HW - HW+3	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	

Table 3.2 Input for Neap Tide Simulations

Sim. No.	Location	F. Coliforms /100ml	T. Coliforms /100ml	BOD mg/l	S. Solids mg/l	DO mg/l	Amm. mg/l	Nit. mg/l	Phos. mg/l	Discharge Type	Discharge m^3/day	Location	Sim Length days
17	Carrigtoohill	1000	5000	10	10	1	5	25	8	Continuous	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
18	Carrigtoohill	1000	5000	10	10	1	5	25	8	HW - HW+3	11145	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
19	Carrigtoohill	1000	5000	10	10	1	2	15	3	HW - HW+3	11145	North Pt	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
20	Carrigtoohill	1000	5000	10	10	1	5	25	8	Continuous	11145	North Pt	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	

Table 3.3 Input for Spring Tide Simulations

Sim. No.	Location	F. Coliforms /100ml	T. Coliforms /100ml	BOD mg/l	S. Solids mg/l	DO mg/l	Amm. mg/l	Nit. mg/l	Phos. mg/l	Discharge Type	Discharge m^3/day	Location	Sim Length days
21	Carrigtohill	1000	5000	10	20	1	5	25	8	Continuous	18560	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
22	Carrigtohill	1000	5000	10	20	1	5	25	8	Continuous	22500	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
23	Carrigtohill	200000	1000000	10	20	1	2	8	0.4	Continuous	18560	North Pt	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
24	Carrigtohill	200000	1000000	10	20	1	2	8	0.4	Continuous	18560	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
25	Carrigtohill	200000	1000000	10	20	1	2	8	0.5	Continuous	12375	Existing	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	
26	Carrigtohill	200000	1000000	10	20	1	2	8	0.5	Continuous	12375	North Pt	5
	Carrigrenan	200000	1000000	25	35	1	5	25	8	Continuous	104198	Marino Pt	

Table 3.4 Input for Additional Simulation Runs (Neap Tide)

4) FIELD REPORT

4.1 Introduction

In June 2003 Irish Hydrodata Limited (IHD) were commissioned by the Hydraulic and Maritime Research Centre (HMRC) to conduct a marine survey of the Foaty Channel and adjacent waters in Cork Harbour. The study forms part of a wider investigation into the dispersion of treated wastewaters from the Carrigtohill sewer outfall.

The study methodology was agreed between IHD and HMRC. The various aspects of the study were to include bathymetry, tide level, current profiling, dye tracking and sediment and water sampling. Data and results were to be presented in a format that would facilitate preparation of a numerical dispersion model.

This report documents the study works and includes relevant figures and plots.

All survey position data is to Irish National Grid and vertical control is to Cork Harbour Chart Datum which is 2.57m below Malin Head datum.

4.2 Bathymetric Survey

A bathymetric survey of the Foaty Channel and adjacent waters was conducted over the area shown in Figure 4.1. The survey was completed from a 7m long shallow draft launch equipped with a Knudsen 320m dual frequency echosounder and a Trimble NT300D positioning system. Data was logged on a computer running HYPACK survey software. Tidal levels were recorded manually at Slatty Bridge and bathymetric data subsequently reduced to Cork Harbour chart datum (-2.57m OD Malin).

The shallow waters presented a particular challenge as survey work could only proceed for approximately 1 hour on either side of high water. The survey was completed over a period of four days. Survey lines were chosen to delineate the channels in so far as possible. Limited data was obtained on the shallow mudflats. The tidally reduced survey data was input to a terrain model. Suitable breaklines were manually added to define the channels and xyz data generated on a 5m x 5m rectangular grid. Figure 4.2 shows a colour coded contour plot of this data.

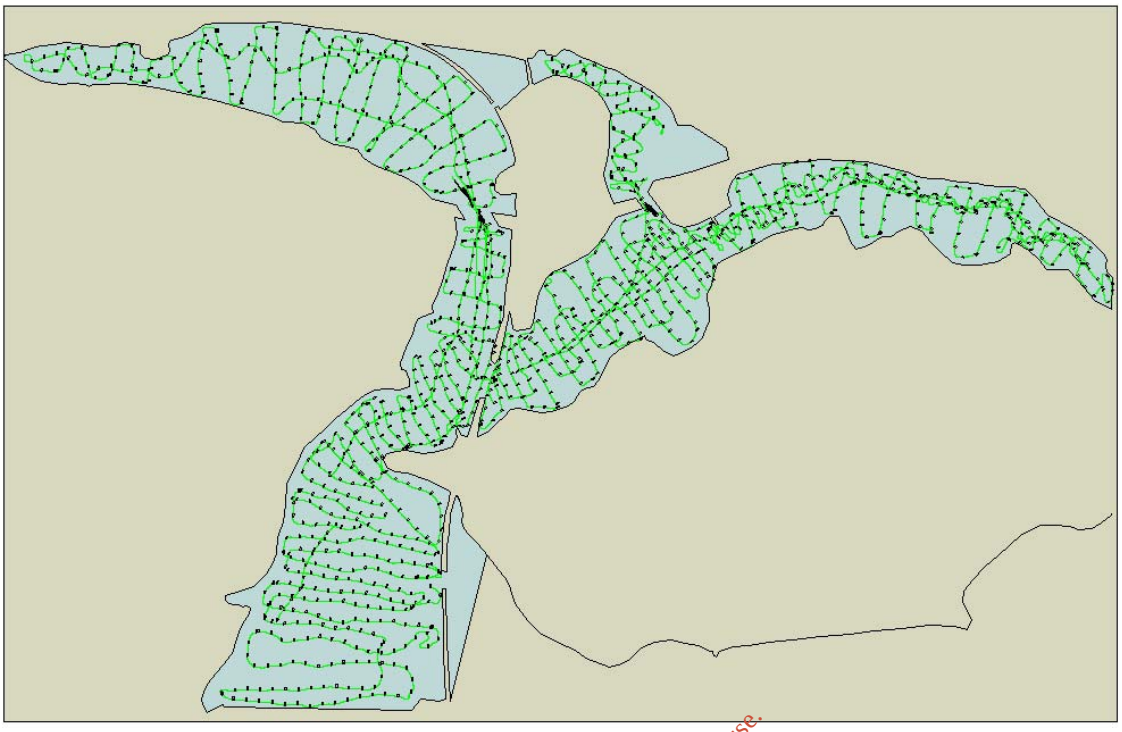


Figure 4.1 – Bathymetric Survey Tracklines

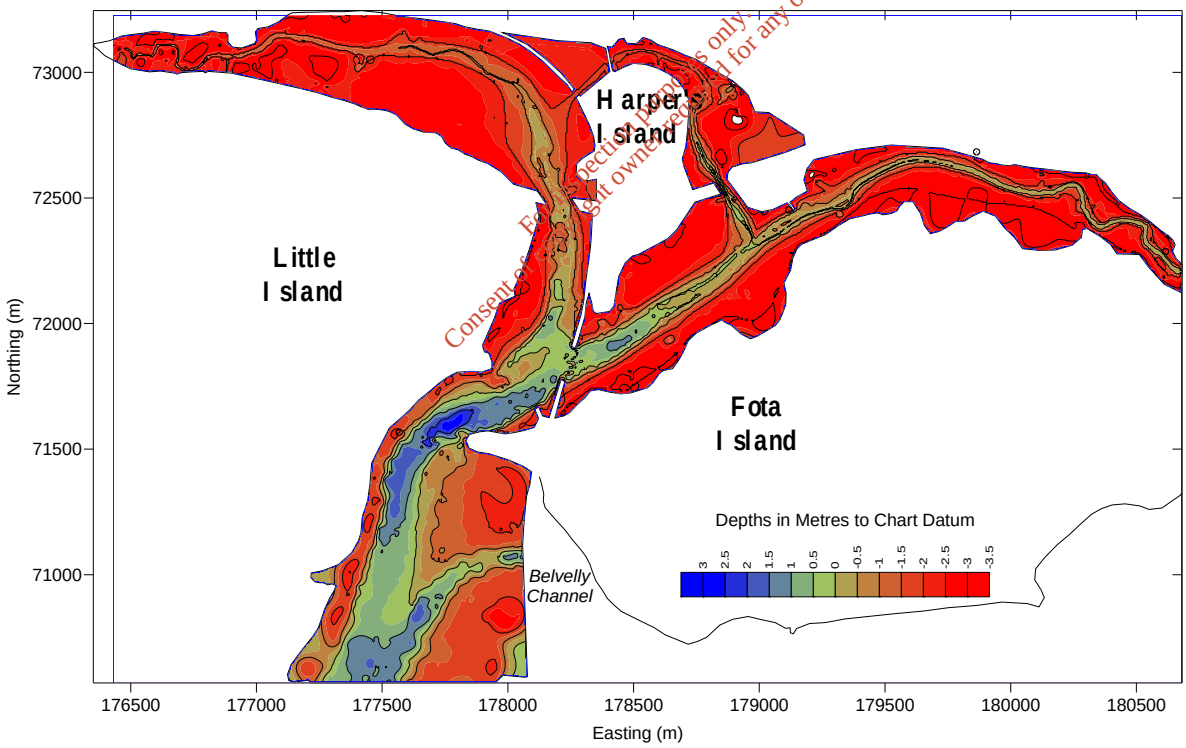


Figure 4.2 –Bathymetry and contours from terrain model

4.3 Tidal level Recording

Two digital tide gauges were deployed for this study; one at the entrance to the harbour near Roches Point and the other within the survey area near Harpers Island. (Figure 4.3). Both were seabed mounted Coastal Leasing Minitide units that recorded absolute pressure (i.e. atmospheric and water) data at 10-minute intervals. Data from the Met Eireann weather station at Roches Point was used to correct for atmospheric pressure variations at the end of the deployment period which lasted for 20 days from 14th May to 5th June. The gauges were levelled into chart datum.

Time series plots for both data sets are presented in Figure 4.4.

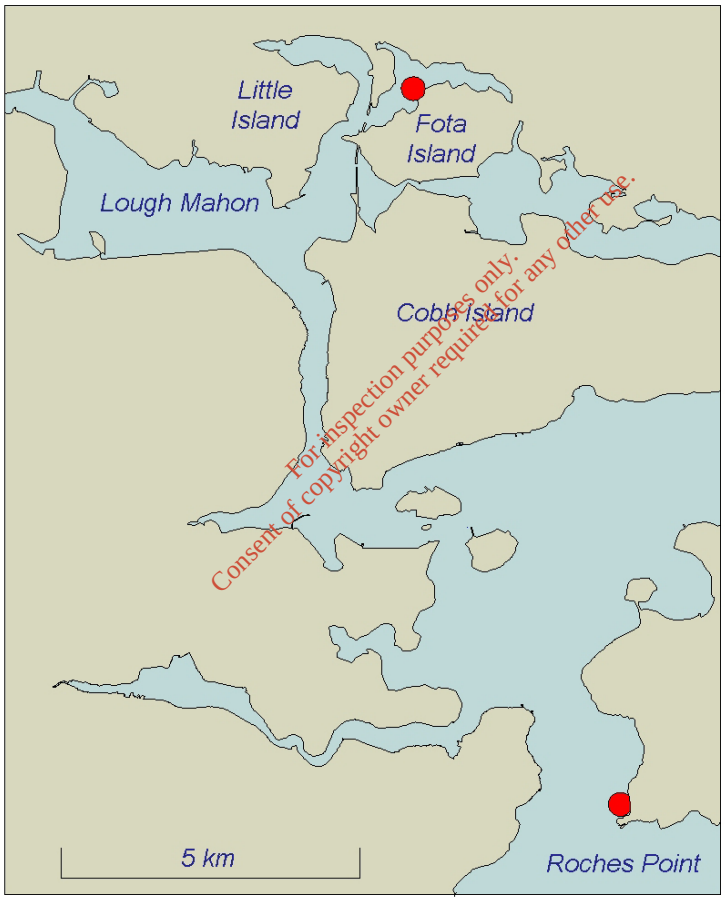


Figure 4.3 – Tide Gauge Locations

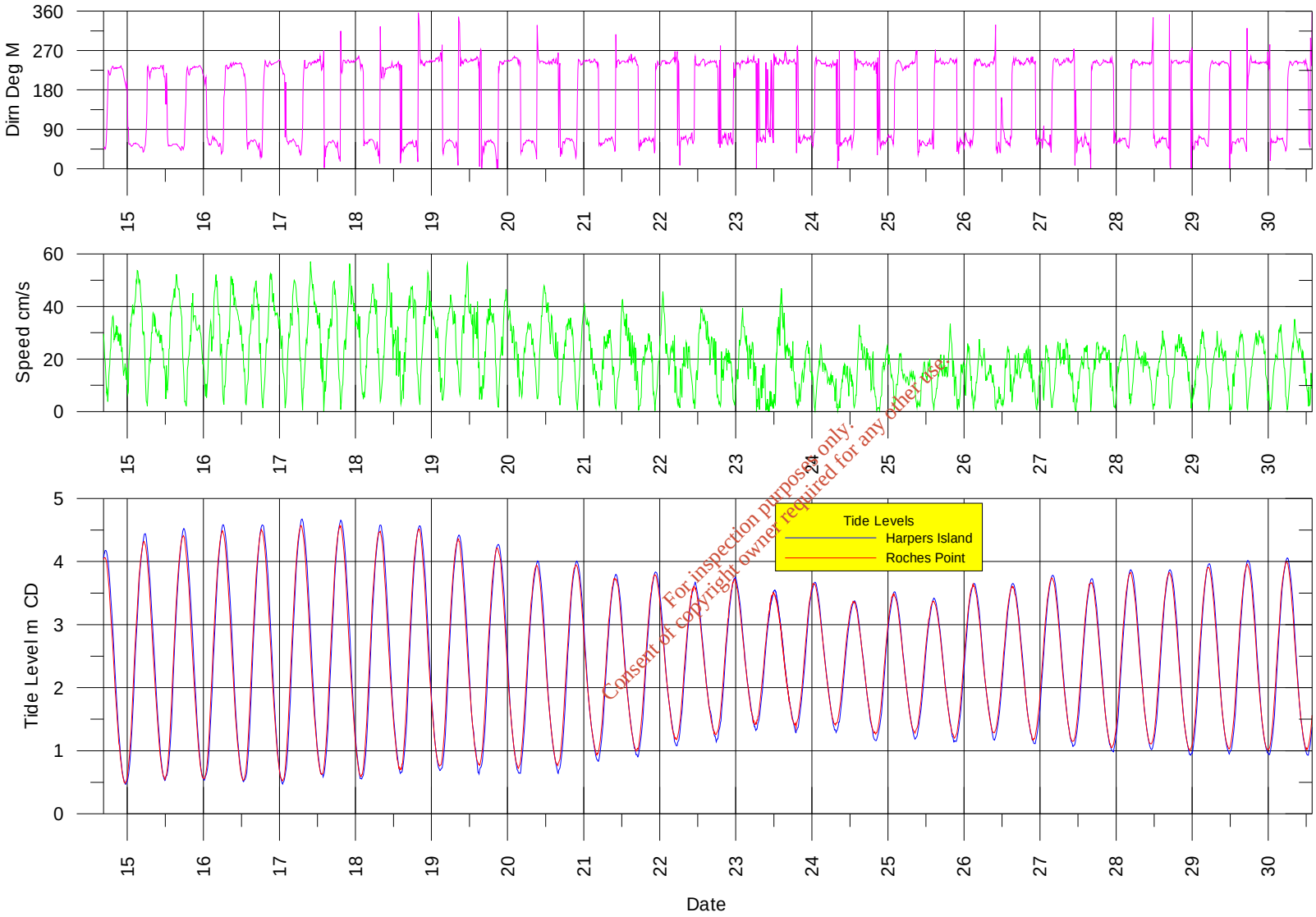


Figure 4.4 – Current Meter and Tidal Data

4.4 Current Metering

Current metering was conducted at the two locations shown in Figure 4.5.

A recording meter was deployed at the north-eastern site for a period of 16 days. This was an Interocean S4 unit which recorded speed and direction data at 10-minute intervals. Fixed station measurements from a moored vessel were made at the western site on two dates. Current data was recorded at ½ hour intervals over a 12½-hour tidal cycle on a spring (16th May) and neap tide (23rd May). Data was recorded at three depths over the water column using a Valeport BFM 008 meter.

The long-term time series plots for the recording current meter are shown with the tidal data in Figure 4.4. Fixed station data for the spring and neap measurements are presented in Figures 4.6 and 4.7. These plots also include RCM and tidal data for the same period.

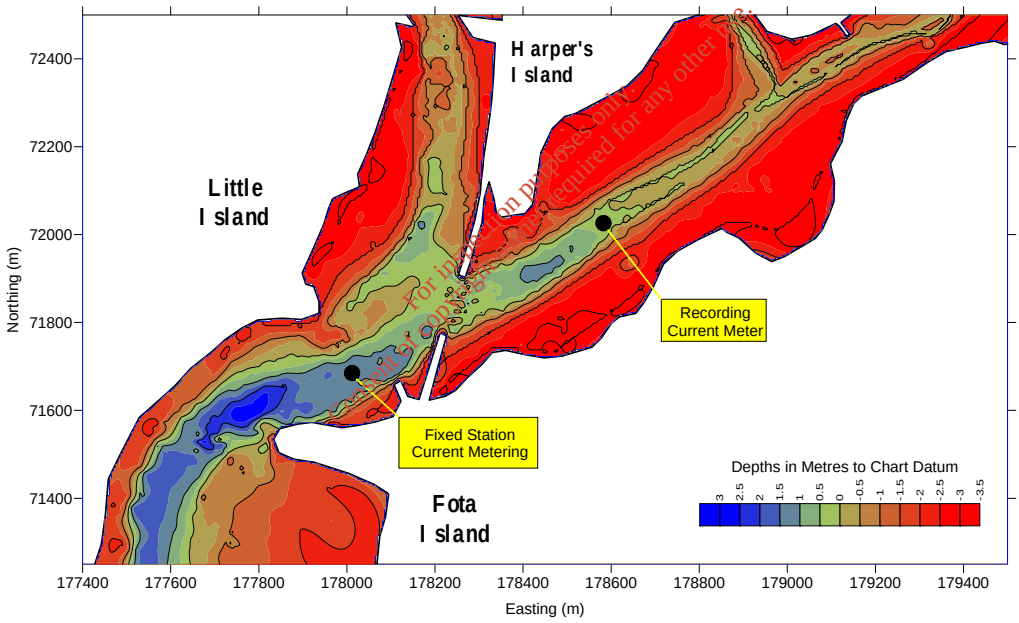


Figure 4.5 – Current Metering Locations

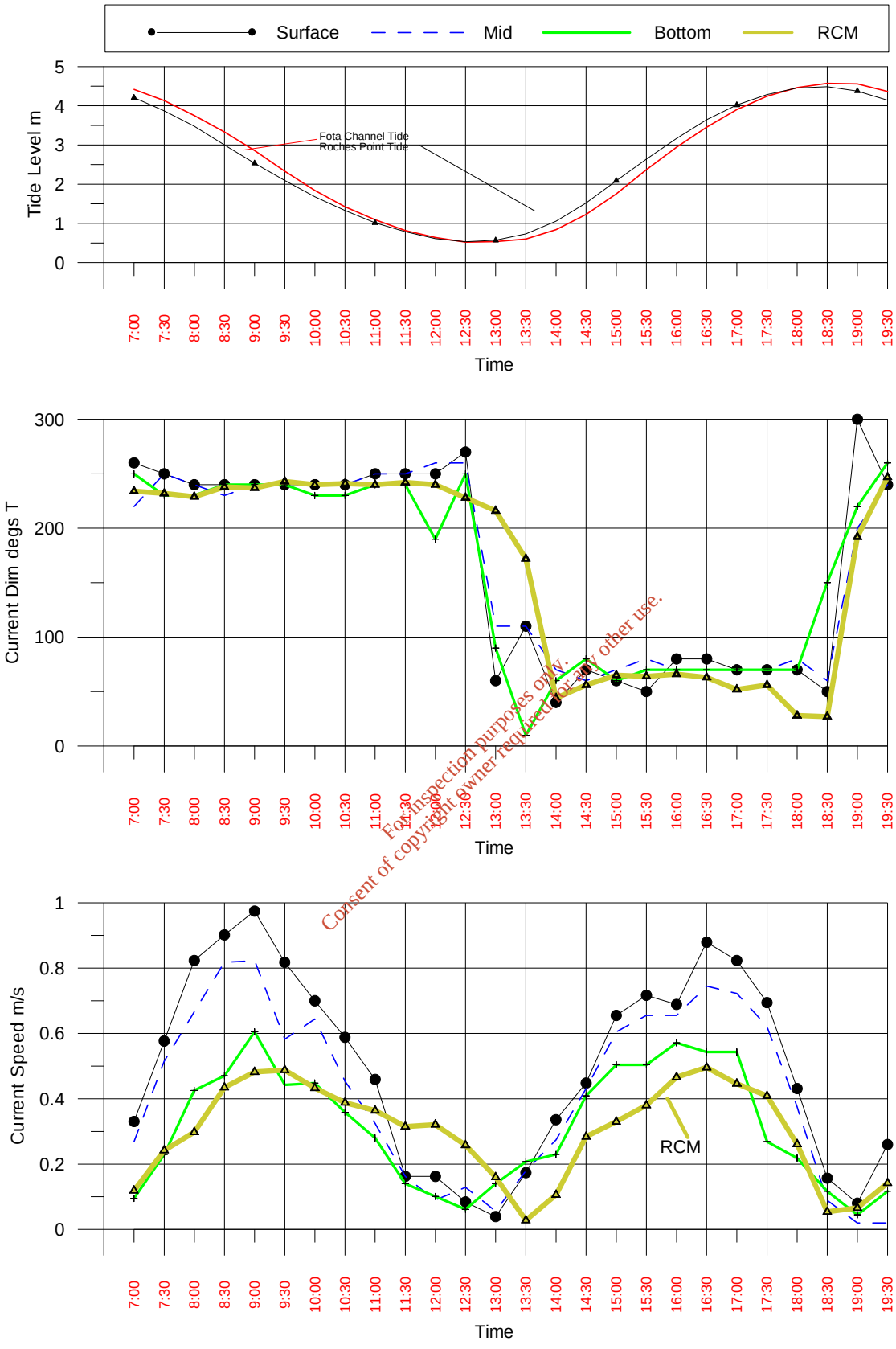


Figure 4.6 – Fixed Station, Spring Tide 16th May 2003

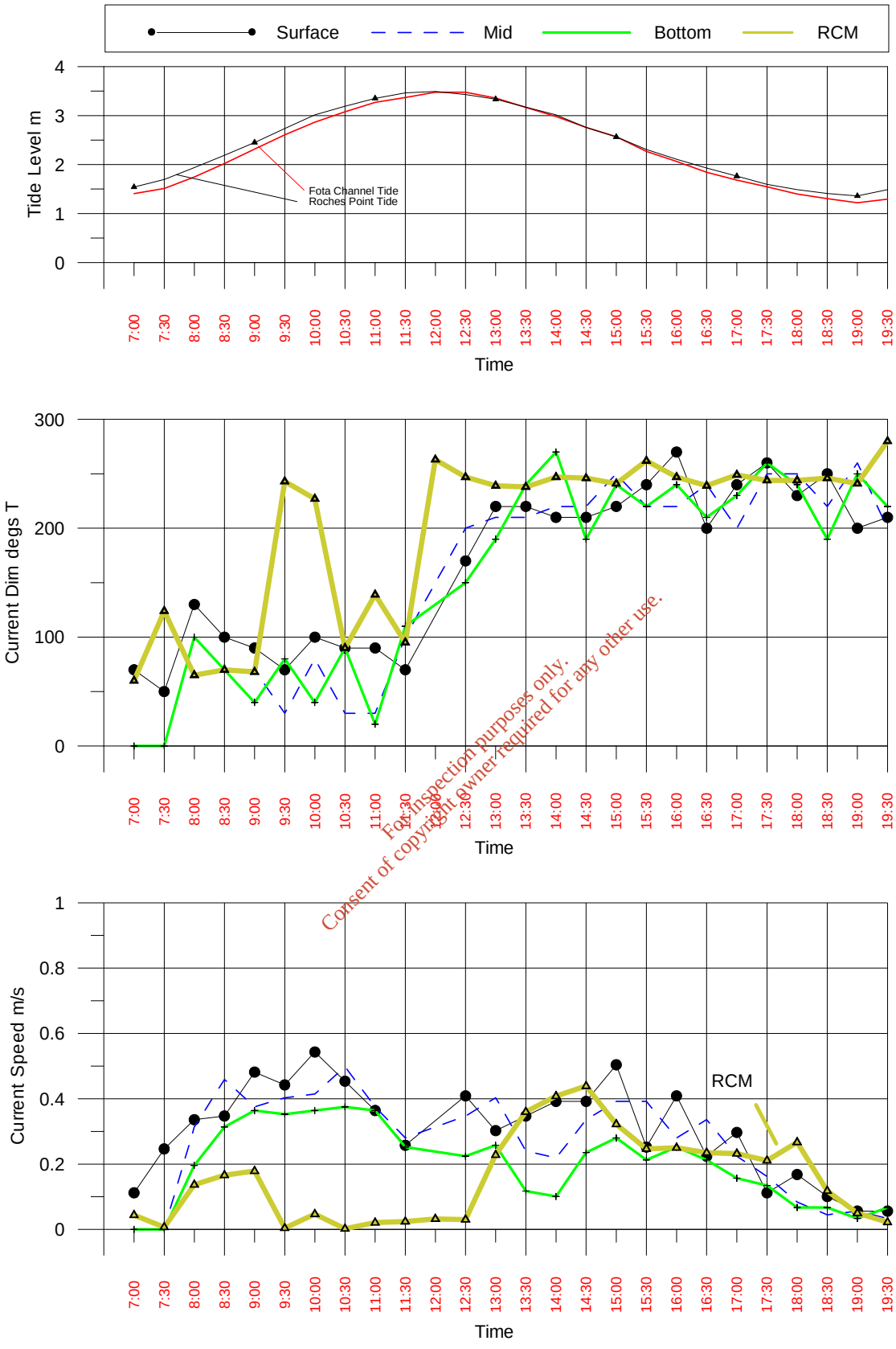


Figure 4.7 – Fixed Station, Neap 23rd May 2003

4.5 Water and Sediment Sampling

Ten water samples were collected at various times during the survey. Three of these were taken from the survey vessel during echo sounding works and the remainder from the northern shore at high and low waters. The sampling locations are indicated in Figure 4.8. Samples were analyzed for salinity and biochemical oxygen demand (BOD) and results are presented in Table 4.1.

Four sediment samples were taken from the intertidal zone at the low water neap contour. The locations were adjacent to the water sampling sites shown in Figure 4.8. Replicate samples were taken with a 50mm core barrel at each site. These were then analysed for sediment oxygen demand (SOD) by the Aquatic Services Unit at UCC. Analysis results are presented in Table 4.2.

	Location	Tide State	Salinity	BOD mg/l
1	Fixed Station Site	HW	27.7	1.97
2	Fixed Station Site	HW+2h	27.6	1.58
3	Fixed Station Site	HW+3h	24.7	1.83
4	Sample Site - S2	LW	11.1	4.28
5	Sample Site - S3	LW	21.8	3.21
6	Sample Site - S4	LW	24.1	1.96
7	Sample Site - S1	HW+1h	18.5	>7.1
8	Sample Site - S2	HW+1h	16.4	3.85
9	Sample Site - S3	HW+1h	20.0	2.25
10	Sample Site - S4	HW+1h	24.7	3.56

Table 4.1 – Water Sample Analysis Results

	Location	Time	SOD $gO_2/m^2/d$
1	1	LW	2.2
2	2	LW	1.7
3	3	LW	2.1
4	4	LW	1.7

Table 2 – Sediment Sample Analysis Results

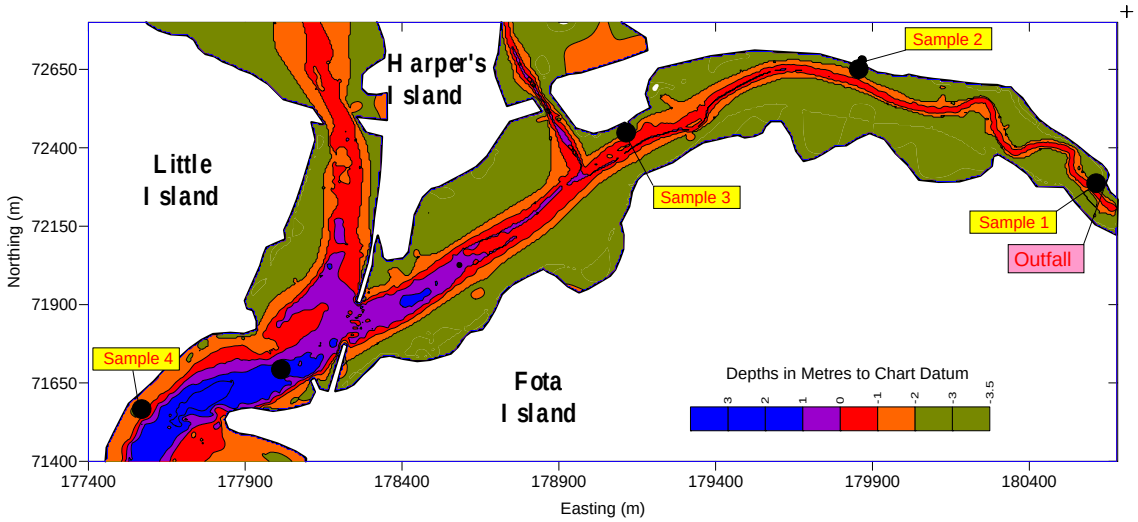


Figure 4.8 – Water & Sediment Sampling Locations

4.6 Dye Tracking

Dye tracking exercises were conducted on two dates, 30th May and 3rd June. On each occasion a slug (250ml) of Rhodamine WT tracer dye was released on the water surface at the outfall location soon after high water. The spreading patch was then tracked as it travelled westwards along the channel. Initially, tracking was visual but as soon as concentrations permitted, tracking commenced with a continuous flow-through fluorometer fitted to the survey vessel.

Plots showing the progress of the patch for Day 1, 30th May and Day 2, 3rd June are presented in Annex 1 and Annex 2.

The tracking was hindered by the shallow waters, which prevented the patch extents and concentrations from being reliably mapped. Subsequent analysis of the data allowed limited descriptive parameters to be established. Details of the patch spreading rates and changing peak concentration are outlined in Figures 4.9 and 4.10. These are similar in feature to typical data observed in other coastal sites.

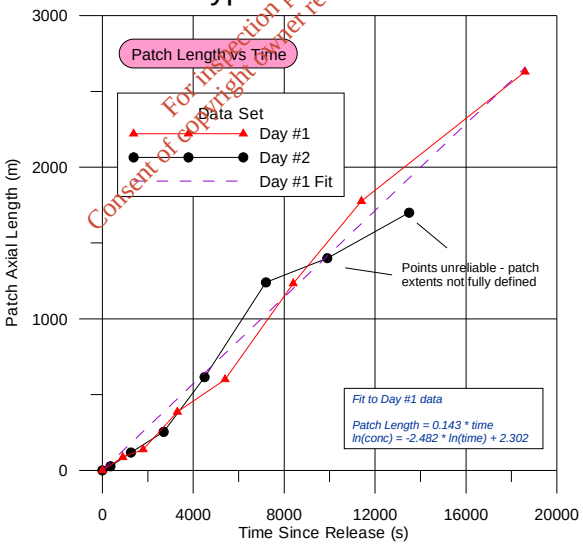


Figure 4.9 – Dye Tracking, Change in Patch Length vs Time

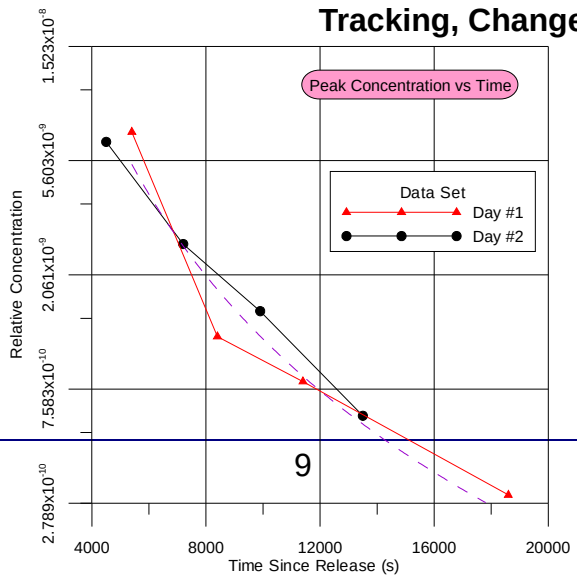


Figure 4.10 – Dye Tracking, Change in Peak Concentration vs Time

5) DISCUSSION OF RESULTS

5.1 Model Calibration and Validation

The model can be stated to be well calibrated. In the CMD PR, it was stated that the peak BOD predicted at the outfall as a result of the discharges from the treatment plant at Carrigrenan would be 0.33 mg/l. We found in our model that the peak BOD at the same outfall would be 0.41 mg/l. Thus we conclude that the models are essentially in agreement, the slight difference may be put down to the sizes of the grids and the improved computing power.

The model assumed the Slatty Water Estuary channel bed to be horizontal so that the depth of the water in the channel to be constant at any specific time in the tide.

The effects of overflows from the treatment work or collection have not been modelled.

5.2 Background values

The following parameter measurements were taken in the Slatty Water Estuary. The estimated BOD values from the model resulting from the existing Carrigtohill discharges are also stated.

Sample No.	Location	Salinity	BOD	Tide	Model Estimated BOD values	True background values
		%	mg/l		mg/l	mg/l
1	Fixed Station	27.7	1.97	HW	0.07	1.90
2	Fixed Station	27.6	1.58	HW + 2	0.06	1.52
3	Fixed Station	24.7	1.83	HW + 3	0.03	1.80
4	S2	11.1	4.28	LW	0.37	3.91
5	S3	21.8	3.21	LW	0.21	3.00
6	S4	24.1	1.96	LW	0.03	1.93
7	S1	18.5	>7.10	HW + 1	0.50	0.00
8	S2	16.4	3.85	HW + 1	0.06	3.79
9	S3	20.0	2.25	HW + 1	0.01	2.24
10	S4	24.7	3.56	HW + 1	0.01	3.55

Table 5.1 Background Values

The large differences between the measured BOD values and the model estimated values can be explained by the effects of additional untreated discharges to Cork Harbour including the City, Little Island and Belvelly sources.

5.3 Input Parameters

The existing discharge from the Carrigtohill Sewerage treatment works was input (a DWF of 1,050 m3/day was assumed, and the discharge standard of 25:35 was assumed. Note that this standard is not always met). The proposed discharge from Carrigrenan was input along with that from Carrigtohill. It was endeavoured to ensure that the input parameters for the Carrigrenan discharge were as similar as possible to the input parameters used in the Cork Main Drainage Preliminary Report model, for comparison purposes.

Other discharges including those from the City directly into the River Lee and those from the Belvelly into Belvelly Channel were not included in the model. These were excluded on the grounds that the discharges to River Lee will cease when the Carrigrenan plant is operational. The discharges from Belvelly are expected to cease when appropriate treatment is provided at that location. The Belvelly discharges are from a relatively small population equivalent. The Cork Main Drainage Project Office has monitored the Coliforms counts along the Belvelly Channel for several months because of the existence of the shellfish farms.

The flow from the two plants was input at DWF.

The flow from Slatty pond is taken as a discharge over the low tide only as currently occurs.
The flow from the river Lee was input as a constant flow rate of 50 m3/s.

The definition of the North Point is the most northerly location in the Slatty Waters Estuary.

5.4 Receiving Water Quality

The implementation of the EU Water Framework Directive (2000/60/EC) has stimulated intense reviews of practices in relation to the management of all waters in Ireland. As part of this process, the EPA has carried out extensive research on Irish estuarine and coastal waters resulting in the publication of a report entitled “An Assessment of the Trophic Status of Estuaries and Bays in Ireland”.

The primary purpose was to identify waterbodies in which eutrophication is occurring or may potentially occur. The Cork Harbour area was one of the waterbodies

investigated. A waterbody is classified as eutrophic, when each of the following criteria are breached:

Criteria for nutrient enrichment (N,P);
Criteria for accelerated growth (chlorophyll);
Criteria for 'undesirable disturbance' (DO).

The Slatty Waters and the waters at North Point are determined as intermediate waters (between tidal fresh waters and full-salinity waters). The criteria for eutrophication are set for intermediate waters at:

Dissolved Inorganic Nitrogen	:	1.4	mg/l
Ortho-phosphate (MRP)	:	0.06	mg/l as P

These concentrations are recommended as the maximum concentrations in the receiving water when the impact of the discharge of effluent is considered.

This report contributed to the designation of certain areas as sensitive waters as part of the Urban Wastewater Regulations 2001 (SI No. 254 of 2001). The Lee estuary/Lough Mahon area was designated as a sensitive water and any discharged effluent must meet the standards set in these regulations. The standards set for a treatment plant with a loading between 10,000 PE and 100,000 PE are:

Total Phosphorus	2 mg/l
Total Nitrogen	15 mg/l

The achievement of bathing water quality in the Slatty Water Estuary is not considered an issue, as there are no designated bathing areas in the estuary. Sailing is the predominant water sport within the harbour. Any experienced sailors would be wary of sailing up along the estuary for fear of running aground on the mud flats when the tide goes out. There are no beaches within the estuary and there are no known swimming locations. It is proposed that the Bathing Water Regulations be met only where there is sufficient water over the course of the full tidal cycle for the safe passage of small sailing boats. The first location where there appears to be sufficient water through the course of the tide for such boats is at the channel between Little Island and Foaty Island. This location was titled "Main Channel" in the output tables.

5.5 Model output

The results stated below are for the parameters excluding the background values. The background values are discussed separately above. The figures may thus be compared 'like for like' with the results stated in the Cork Main Drainage Preliminary Report.

Spring tide runs were also run. The full effects of the spring and neap tides are experienced every two weeks. For the spring tide runs, the peaks are expected to be

higher and averages are expected to be lower, though this was not the case as shown in the results below for the existing outfall location.

Parameter	Input Value	Output Value	Unit
Design Capacity	**8,000**	**-------**	**p.e.**
BOD	**20**	**1.76**	**mg/l**
SS	**30**	**Not simulated**	**mg/l**
P	**8**	**0.71**	**mg/l**
N	**30**	**2.67**	**mg/l**
DO	**10**	**8.3**	
T. Coliforms	**5,000,000**	**363,946**	**MPN/100mls**
F. Coliforms	**1,000,000**	**83,980**	**MPN/100mls**
DWF	**1,050**	**------**	**m^3/day**

Table 5.3 Discharge Parameters for Existing Carrigtohill WWTW

The existing water quality conditions are considered quite reasonable.

The BOD values remain well below 4mg/l. The BOD standard of 20 mg/l is not always met by the existing treatment works, particularly during period of heavy rainfall, when the dispersion is higher than normal. The oxygen level is at its lowest at 8.3 mg/l. this level of oxygen is not expected to affect the flora or fauna locally.

The nutrient levels drop off rapidly such that at the Mid Channel, phosphorus levels are expected to be 0.01 mg/l and nitrogen levels are expected to be 0.05 mg/l. There is no trace of these nutrients at Marino Point or Lough Mahon. The short retention period of 6 hours on average prevents eutrophication from occurring.

The high coliform counts do not have any noticeable effects, due to the lack of shellfish, bathing or water sports within the estuary. The total coliform counts fall to 1,845 at the Mid Channel.

However the outfall pipe is visible at low tide as is the effluent. The visible nature of the discharge is probably the largest impact.

5.7 Discharge Locations

The first goal of the model was to investigate the most appropriate location of the discharge of the Carrigtohill WWTP. Three locations were considered, namely (i) the existing outfall location near Slatty Bridge; (ii) discharge at North Point (see Figure 5.1) and (iii) discharge east of Belvelly Channel were investigated. This was done with a design population of 45,000 PE.

The goal of minimising the impact of the combined loads from the two plants (Carrigtohill and Carrigrenan), requires that the outfalls are located as far away from each other as possible. However, the dispersion near the existing outfall location is less than would occur further along the Slatty Water Estuary. Discharging at the existing location might hence result in relatively high concentration locally.

An alternative discharge location was examined at the North Point. It was found that the dispersion locally at this point was better. Depending on the final effluent quality, the North Point location can be more favourable than the current location at Slatty Waters. The most critical parameter herein is phosphate. Given the lower levels of dispersion at the existing outfall location the water quality standards as set for intermediate waters may not be achievable.

The option of discharging to the east of Belvelly Channel was examined. This option was only considered with a total coliform discharge standard of 5,000 MPN/100 mls. The peak Total Coliform level is seen to fall rapidly from 469 to 10 at Brick Island and to 1 MPN/100 mls at Brown Island. Thus, there is a reasonable degree of dispersion available in this part of Cork Harbour. However, due to the presence of shellfish farms within the estuary, discharges to this part of the estuary would most likely be unacceptable to the Department of Communications, Marine and Natural Resources.

Thus it is proposed that the optimum discharge location is at North Point.

5.8 Tidal Discharges

Three different tidal discharges were modelled. The first one was a continuous discharge. The second one was form high tide for three hours. The third one was for three hours, beginning one hour before the high tide. In general this was found to be the best locally at the outfall point. The parameters are slightly elevated within the Slatty Waters Estuary as a result of a continuous discharge; this can be seen in the output tables. However it was found that the effect of the tidal discharge was not noticeable by the time the effluent was carried down to the Mid Channel. As the water quality at Lough Mahon and east of Belvelly is under consideration here, thus it appears to be difficult to justify the storage of treated effluent for tidal discharge. It is proposed to discharge continuously.

5.9 Effects of Discharges

The Slatty Waters channel to which the effluent from Carrigtohill WWTW is discharged is an inlet from Lough Mahon. It has a negligible freshwater inflow, hence the water quality entering the channel is effectively that of Lough Mahon. (The channel between Slatty Bridge and Harpers Point feeds into a much larger water mass, Lough Mahon, which discharges to the sea.) The water quality in Lough Mahon has improved substantially in recent years. The proposed enhanced removal of N and P in the Carrigtohill WWTW will ensure that its contribution to the overall nutrient input to Lough Mahon will be insignificant. The effect of any local nutrient enrichment within the confines of the Slatty Waters inlet is greatly ameliorated by the tidal exchange with Lough Mahon, which reduces the average water residence time in the Slatty Waters inlet. The volume of water discharging from the channel is miniscule compared to the volume within Lough Mahon and the impact on the existing Lough Mahon concentrations will be very small. There is a very low level of freshwater discharge into Slatty waters and the dilution and mixing is provided entirely by the ebb and flow of the tides. The tidal nature of the channel results in frequent changes of the water mass indicating that the receiving water in the channel is refreshed on a regular basis. As a result the concentrations of the dispersed effluent parameters are removed from the channel frequently. This “cleansing” of the channel has been taken into account when determining the recommended effluent parameters to strike a balance between the need to minimise the phosphate and nitrogen concentrations within the receiving waters and the need to provide a level of treatment that maximises the efficient use of energy and other valuable resources.

5.9.1 BOD

The model runs with a design capacity of 45,000 PE show that a discharge standard of 25 mg/l is possible when the effluent is discharged at North Point. This results in an average concentration in the receiving water at the outfall point of 2.75 mg/l. If it were discharged at the existing outfall location, the water quality standard of 4 mg/l would be exceeded. At the final design capacity (60,000 pe) a discharge standard of 25 mg/l BOD will result in a concentration of 3.72 mg/l in the receiving water. Therefore a discharge of 25 mg/l (in accordance with the UWTD) is appropriate for both phases of the development.

5.9.2 Nitrogen

From the initial model runs, with a design capacity of 45,000 PE, it became clear that nitrogen removal is necessary to meet the water quality standard. At 45,000 PE and a discharge standard of 15 mg/l N the resulting concentration in the receiving water

would be 1.29 mg/l N. At 60,000 PE and a discharge standard of 15 mg/l the resulting concentration in the receiving water would be 1.74 mg/l N. This is above the recommended concentration of 1.4 mg/l N contained in the EPA report so a reduced discharge standard of 10mg/l N would be required for phase 2

The mass of Nitrogen to be discharged from the proposed Carrigtohill WWTW is miniscule when compared to the mass of water in Lough Mahon and would contribute less than 1% of the total nitrogen in Lough Mahon.

Therefore a discharge standard of 15mg/l N (in accordance with the UWTD) is recommended for phase 1 and 10 mg/l N for phase 2 of the development.

5.9.3 Phosphate

Analogous to the model runs on nitrogen, we have investigated the necessary level of phosphorous removal. Discharging at the existing location is not possible without extreme treatment. Although the UWTD sets a standard of 2 mg/l P for the final effluent, this concentration would be excessive in terms of the resulting concentration within the receiving water. As a result, a concentration of 1 mg/l was considered. At 45,000 pe and a discharge standard of 1 mg/l P the resulting concentration of ortho-phosphate in the receiving water would be 0.1 mg/l P at the outfall location. While this is slightly higher than the recommended value (0.06 mg/l P) the concentration will reduce to the recommended value, as a result of the dispersion, before the water reaches Harpers Island, approximately 900 metres downstream of the outfall point. At 60,000 pe, the resulting concentration in the receiving water would be 0.14 mg/l P. The dispersion would result in the recommended concentration being reached at Mid-Channel, approximately 2,000 metres downstream of the outfall point.
The mass of phosphorus to be discharged from the proposed Carrigtohill WWTW is miniscule when compared to the mass of water in Lough Mahon and would contribute less than 3% of the total phosphorus in Lough Mahon.
The cost of providing phosphorus removal below 1mg/l rises disproportionately when compared to the benefits in terms of the usage of resources such as energy, finance and manpower. Given the large body of water into which the channel feeds, the regular refreshing of the receiving water within the channel, the localised peak at the outfall point and the rapid reduction of the concentration due to dispersion a discharge concentration of 1 mg/l is recommended for both phases of the development.

5.9.4 Coliforms

The model estimates peak coliform counts at Blackrock at 10 MPN/ 100 mls, assuming that there are no sources at the River Lee, and that the nearest source is

at Carrigrenan. The corresponding figure stated in the Cork Main Drainage Preliminary Report was 0 MPN/ 100 mls.
Fortunately, with the outfall point chosen above, the discharges from Carrigtohill and Carrigrenan are not accumulative to a significant extent at any location at any time. They do both affect the water quality at the Fota Bridge region, but at different stages of the tide. Thus the effects of either one is dominant at a time, depending on the stage of the tide. When the tide is rising the effluent from Carrigrenan is dominant, when the tide is falling the effluent from Carrigtohill is dominant.
As the Port of Cork do not recognise the Slatty Water Estuary for boating of any significance and as there are no licensed shellfish areas within the Slatty Water Estuary it appears to be unnecessary to treat the effluent to either the Shellfish or Bathing Water standards.

Modelling of the Faecal Coliform count for the 45,000 pe WWTP with discharge from the proposed outfall at north Point shows that the expected peak at Weir Island (including the dominant effect of Carrigrenan) is only 9 MPN/100 ml. This equates to a maximum daily average of 3 MPN/100 ml. The simulation with the peak wind conditions showed better rather than worse dispersion. It should be noted that the maximum average daily concentration at mid-Channel is 145 MPN/100 ml. This increases by 395% to 573 MPN/100 ml at Carrigrenan as a result of the discharge from the Carrigrenan outfall before reducing to 3MPN/100 ml at Weir Island. The impact of the Carrigtohill WWTW discharge on the faecal coliform levels at Weir Island reduces to zero based on the model results.

Based on these figures it is considered that shellfish farmers operating to the east of Weir Island should have no grounds for concern about discharges from Carrigtohill.

5.10 Sensitivity analysis

A sensitivity analysis was undertaken by changing the grid spacing from 30m to 15m, to show that the results are the same. The size of the model grid is not influential, at this spacing, to the accuracy of the results, though the input parameters are likely to be influential. When the grid size is 30m, the time step associated with that grid size of 30 secs. A simulation with a grid of 15m and 15 secs is to be run, and to be compared with an otherwise identical run, to show that the grid is sufficiently accurate.

Further sensitivity analysis was undertaken with a 28-day simulation. This 28-day run had 56 tidal cycles. It was found that the parameters showed very minor increases except for the nutrients. The nutrient increases found were described above. The expected peak BOD level rose from 2.96 mg/l too 3.03 mg/l. The expected peak Total Coliform levels rose from 276,246 to 291,414 MPN/100mls.

5.11 Wind Effects

The effects of the wind were also modelled. From the wind records at Cork airport over the period 1998 to 2003, it was found that the prevailing wind direction was SSW (225 degrees to the north). Extreme wind conditions were also modelled using wind speed of 15 m/s. This wind speed was exceeded only 1% of the time over the period. The effects of the wind are somewhat exaggerated due to the assumption that the land around the waters is flat. The effect in the Slatty Water Estuary was to decrease the coliforms counts significantly. The BOD vales fell only slightly (from 2.93 mg/l to 2.75 mg/l). The other parameters were no worse at any location as a result of the extreme wind conditions. The coliform count at Belvelly was lower as a result of the wind.

5.12 Proposed Discharge Standard

Based on the results of the model, the following is the proposed discharge standard:

Parameter	Phase 1 Value	Phase 2 Value	Unit
BOD	25	20	mg/l
SS	35	35	mg/l
P	1	1	mg/l
N	15	10	mg/l
T. Coliforms	No specific limit	No specific limit	MPN/100 mls
F. Coliforms	No specific limit	No specific limit	MPN/100 mls

Table 5.1: Proposed Discharge Standards for 45,000 pe and 67,000 pe

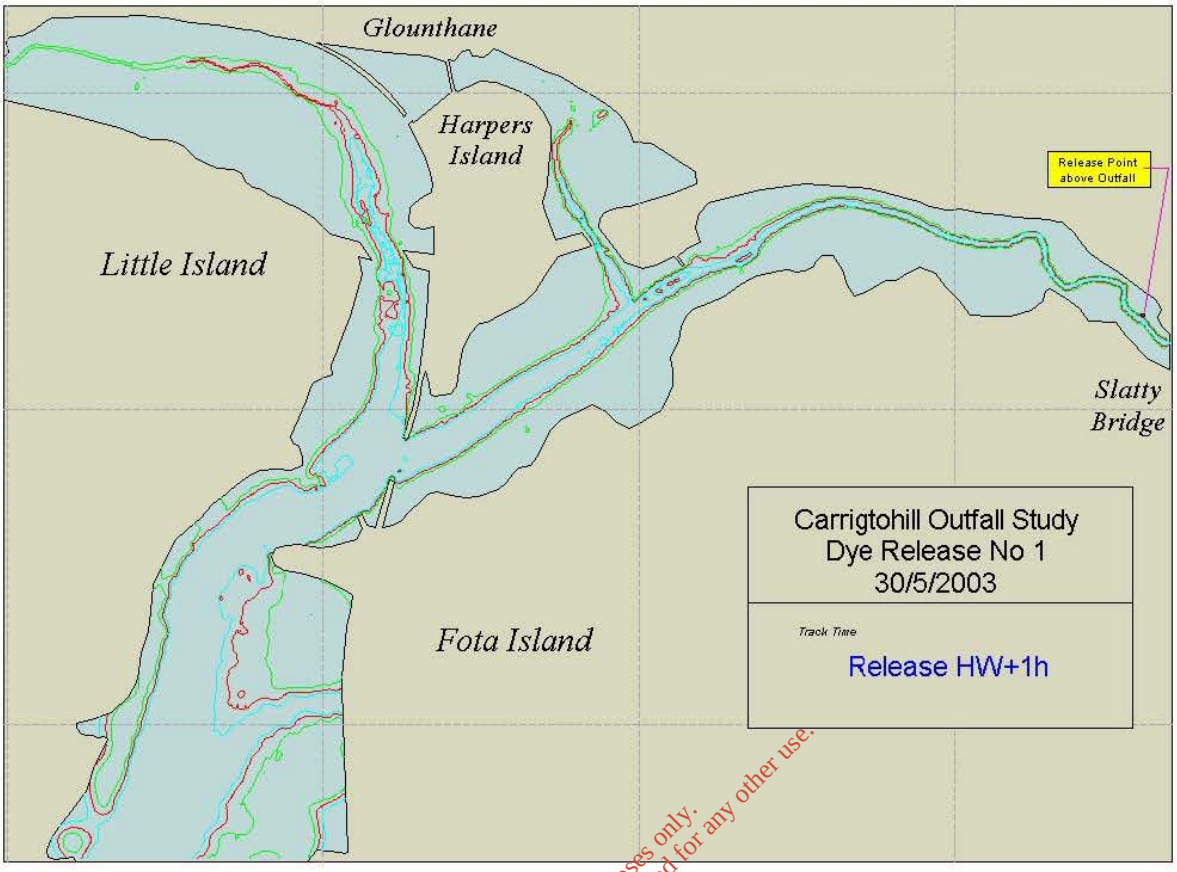
These standards meet the following regulations:

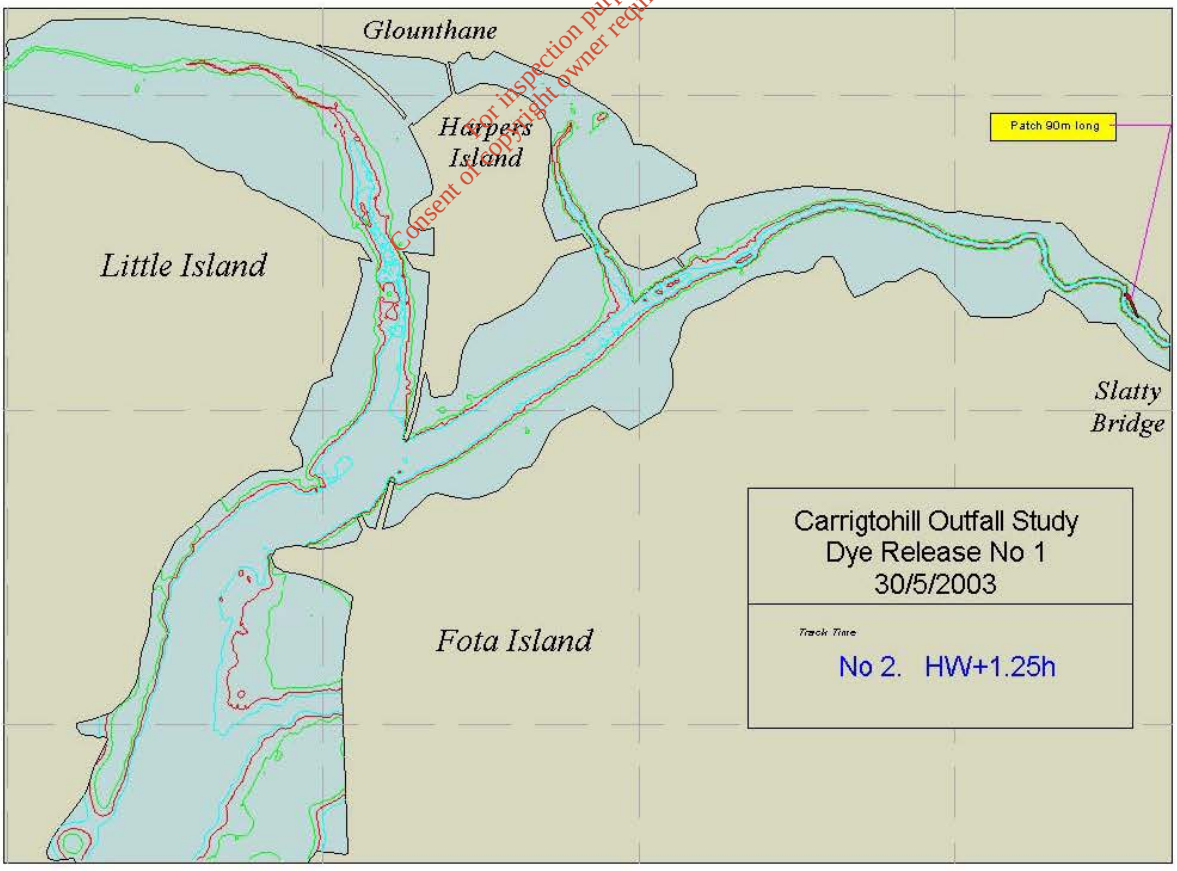
UWWT standard treatment (25:35 BOD:SS)
Shellfish Regulations (100:1000), (with dispersal, at specific locations only)
Bathing Regulations (1000:5000) (with dispersal, at specific locations only)
National Shellfish Sanitary System (at Weir Island Shellfish Farms)

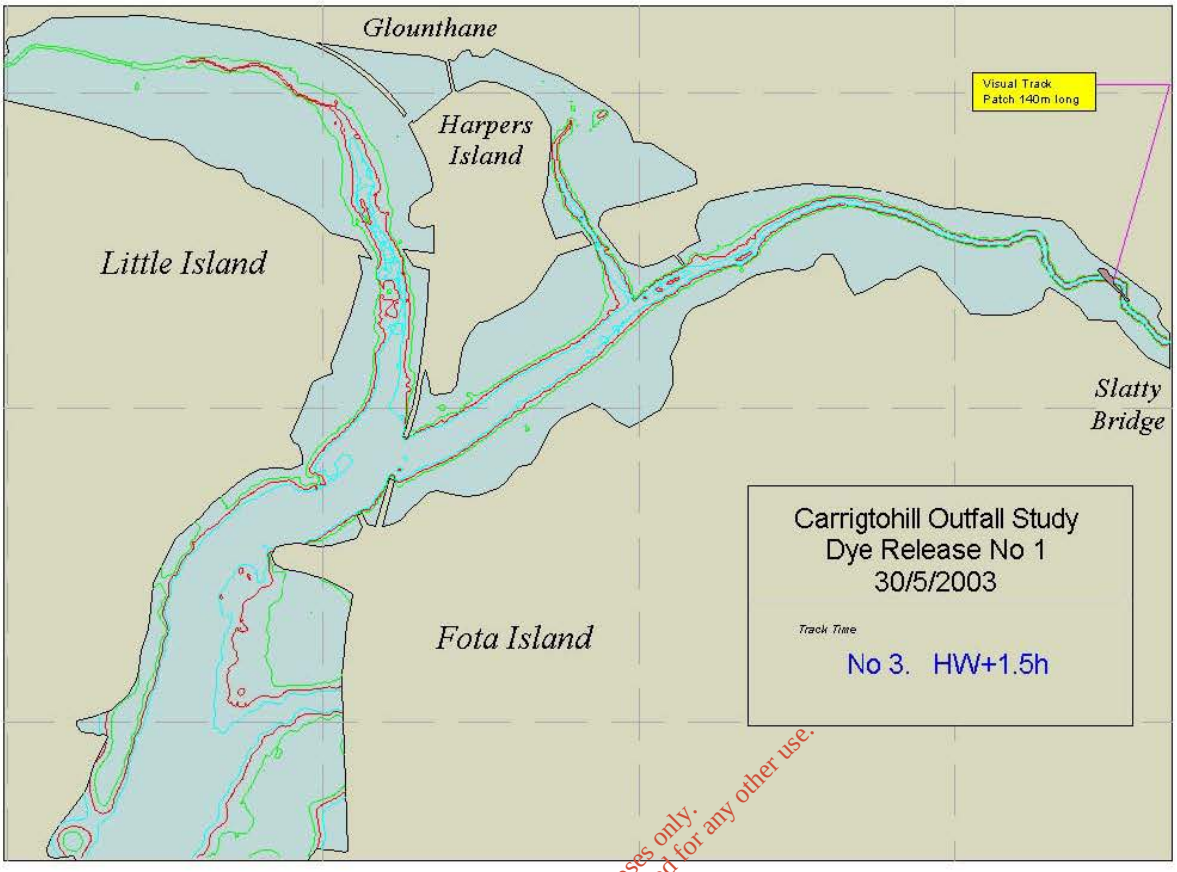
These discharge limits are also in accordance with the recent status of Cork Harbour as a designated sensitive area.
Satisfactory dispersion qualities have been demonstrated at North Point by the hydrodynamic model. The North Point is a suitable discharge location for the Carrigtohill Sewerage Scheme because of the level of dispersion available and the short periods of retention.

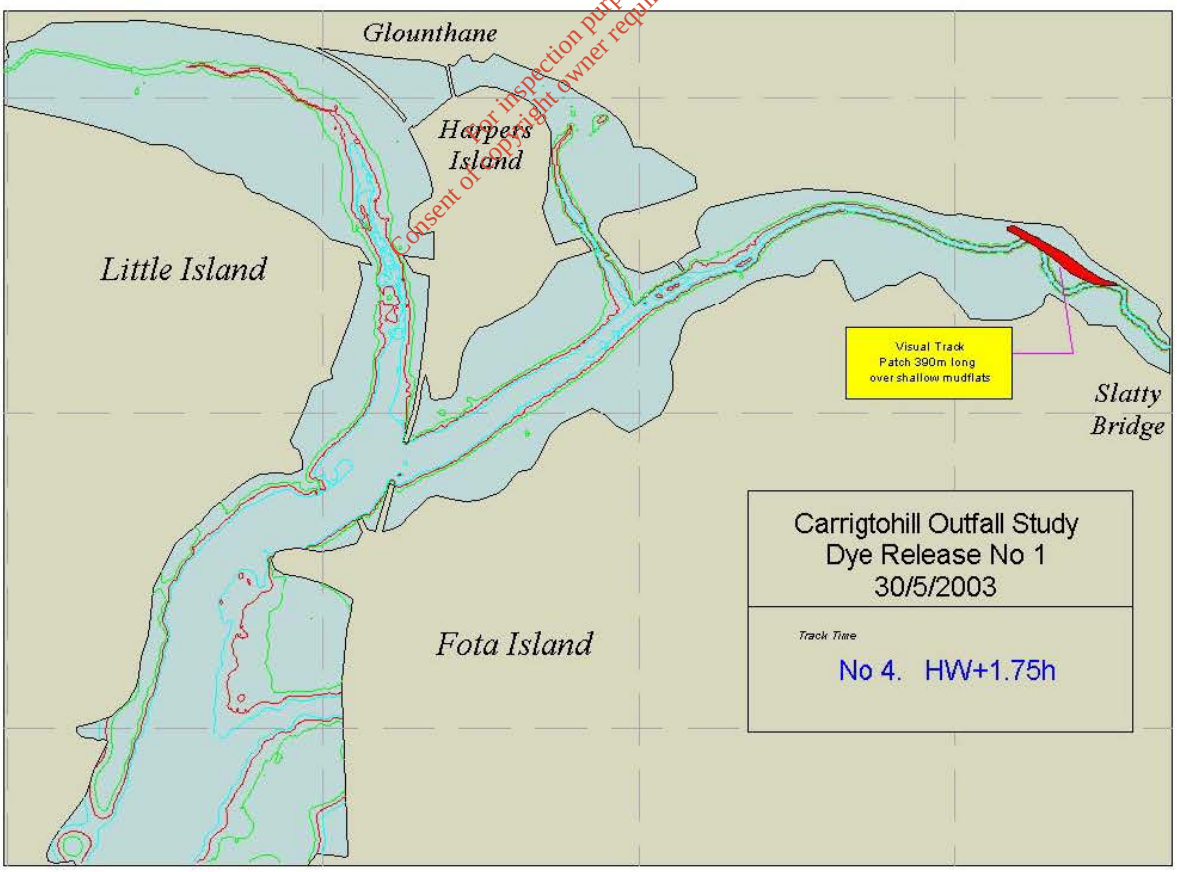
The nutrient concentrations (N, P) will be reduced below the recommended level (EPA Report) prior to discharge into Lough Mahon and the Lee estuary.
The discharge standards recommended will provide adequate treatment for the Carrigtohill WWTW for both phases of the development while complying in principle with all of the relevant standards.

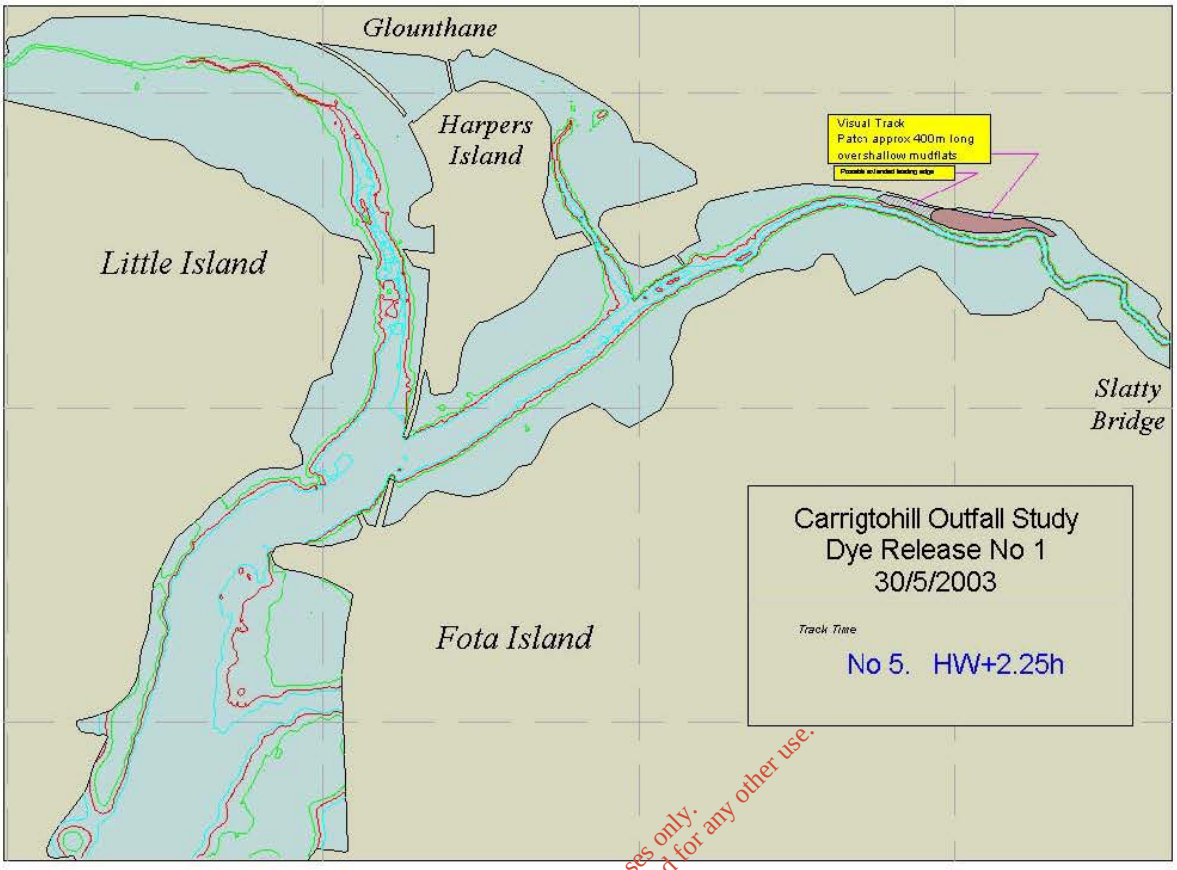
ANNEX 1 DYE TRACK NO 1 30TH MAY 2003

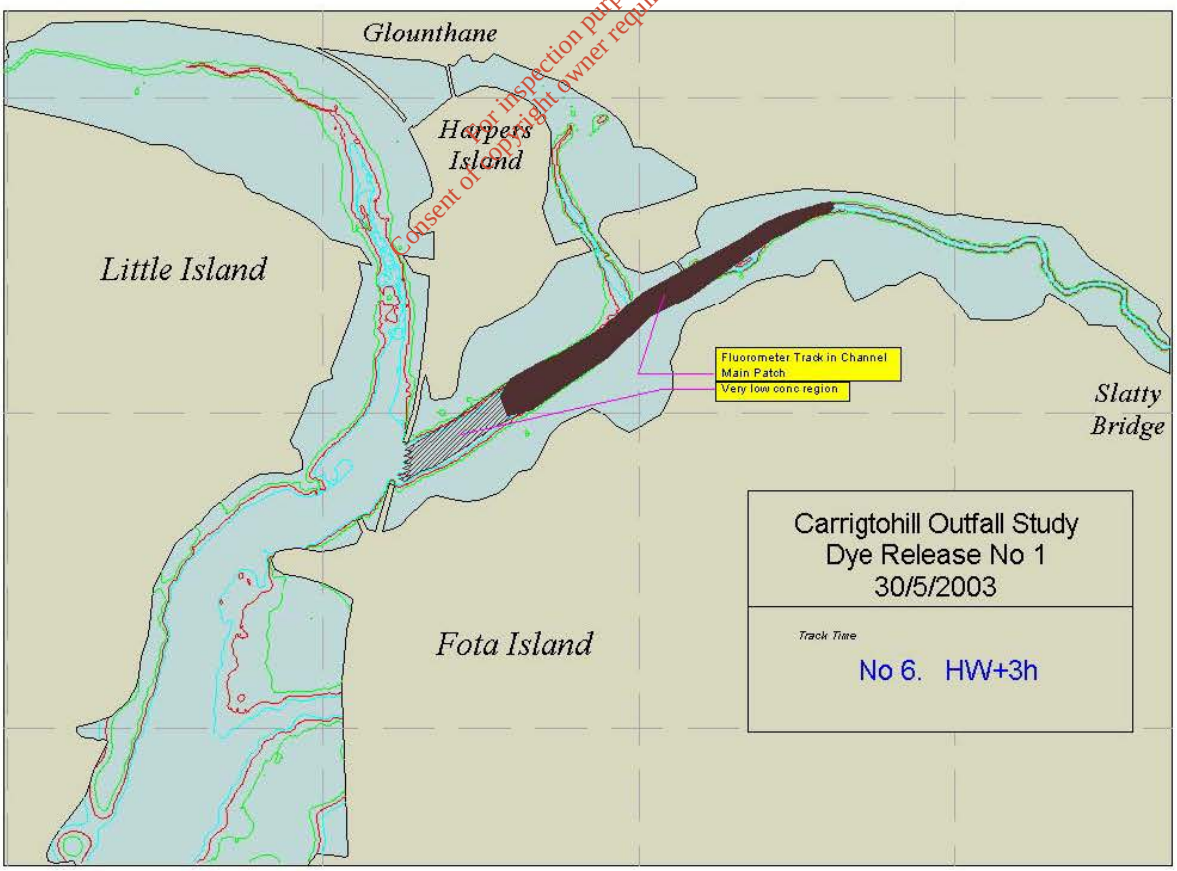


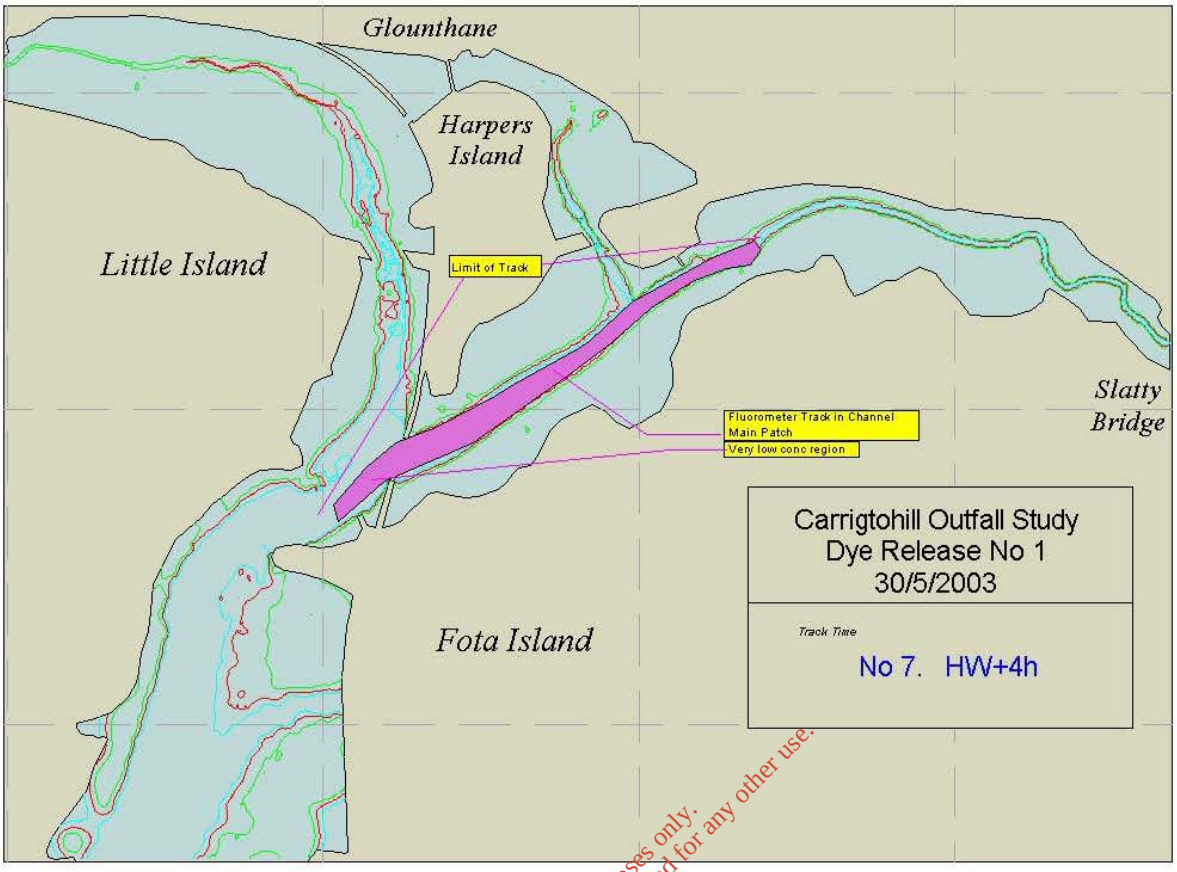


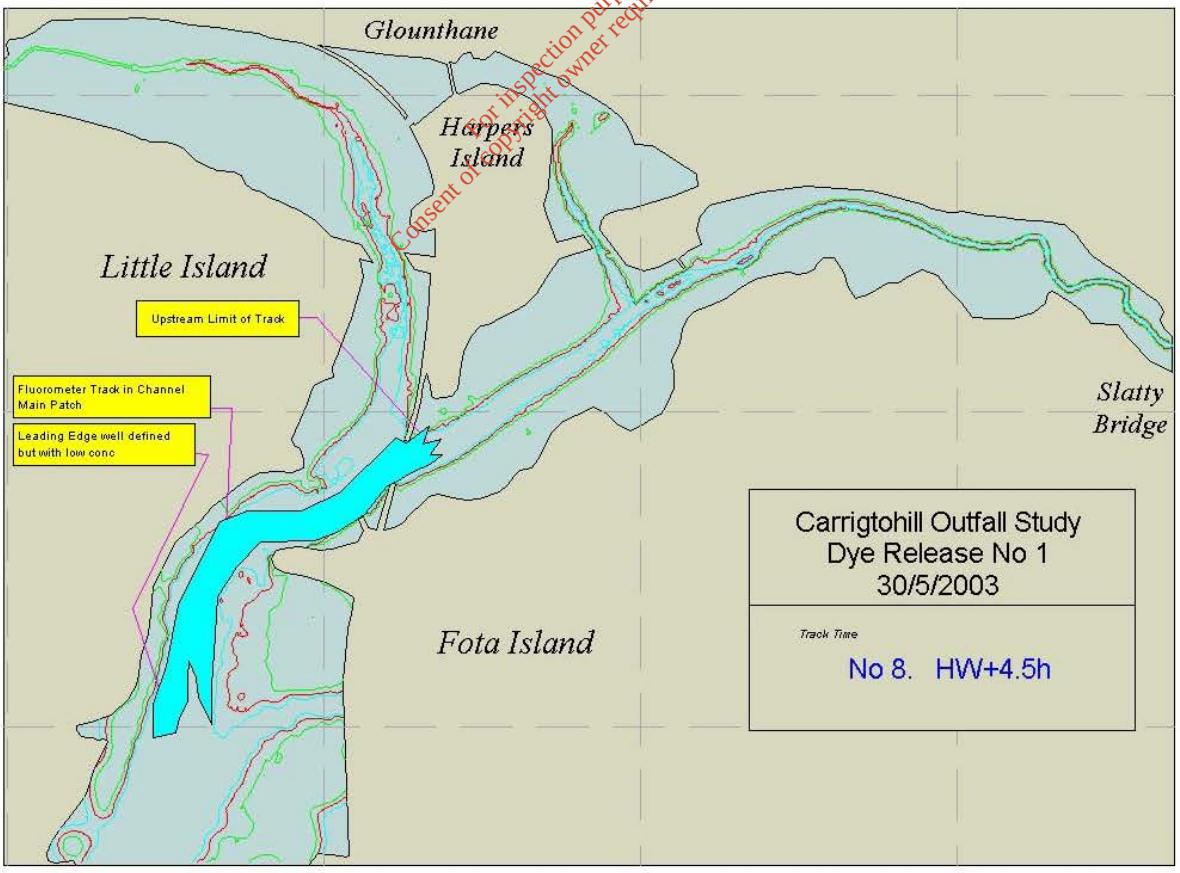




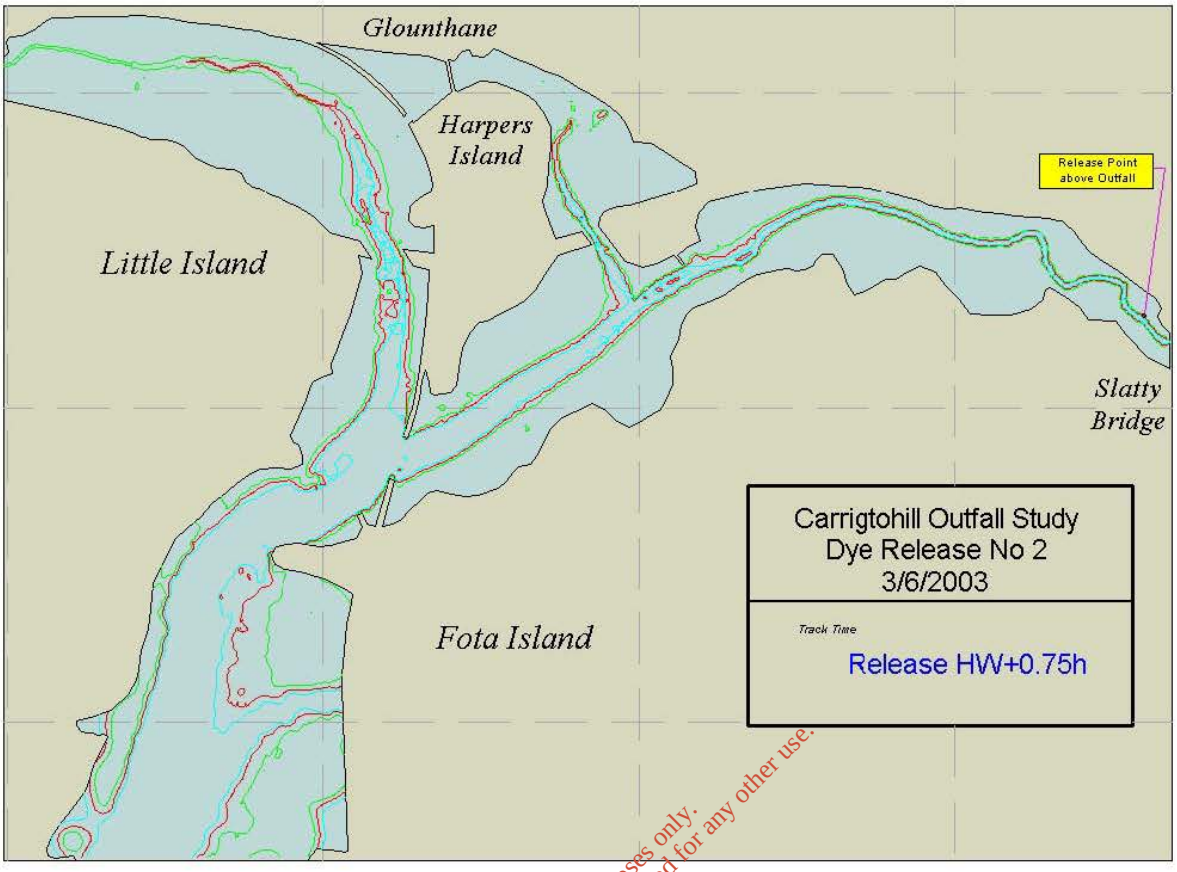


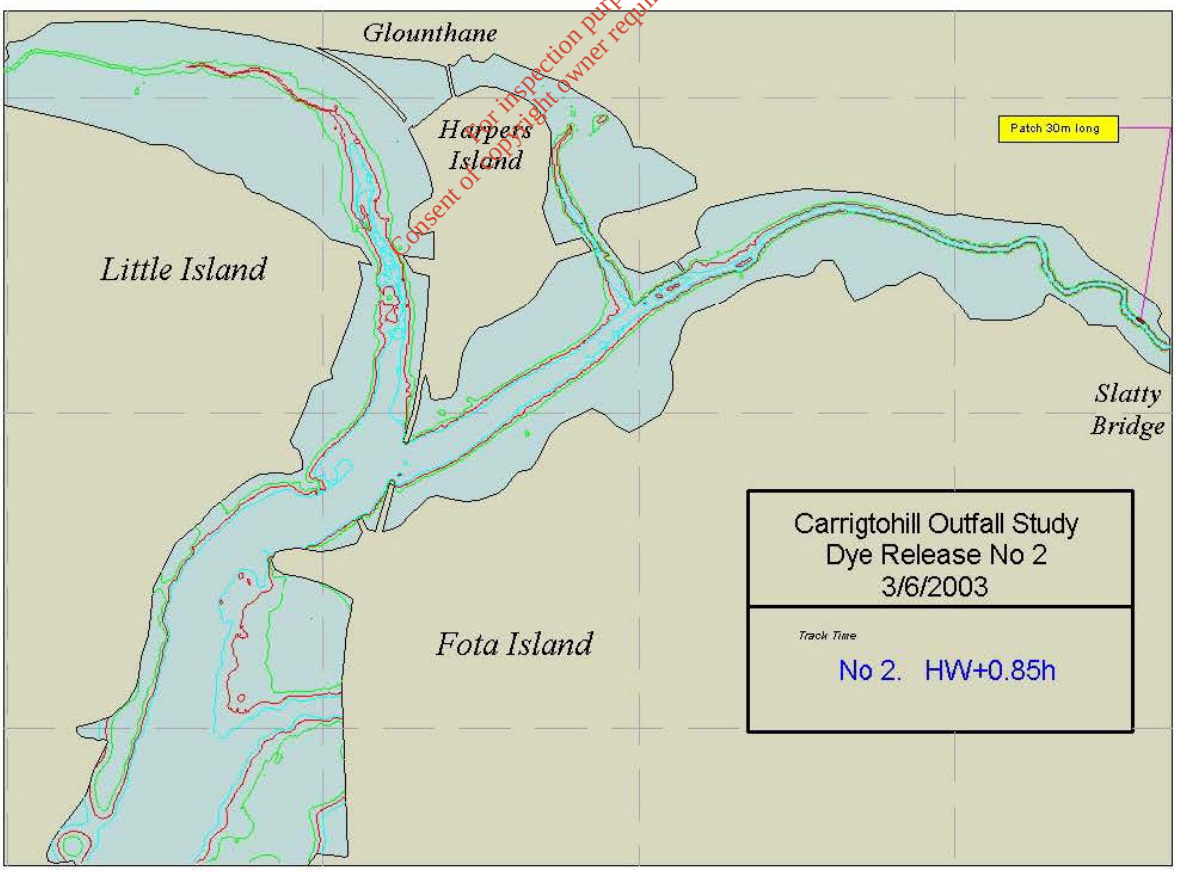


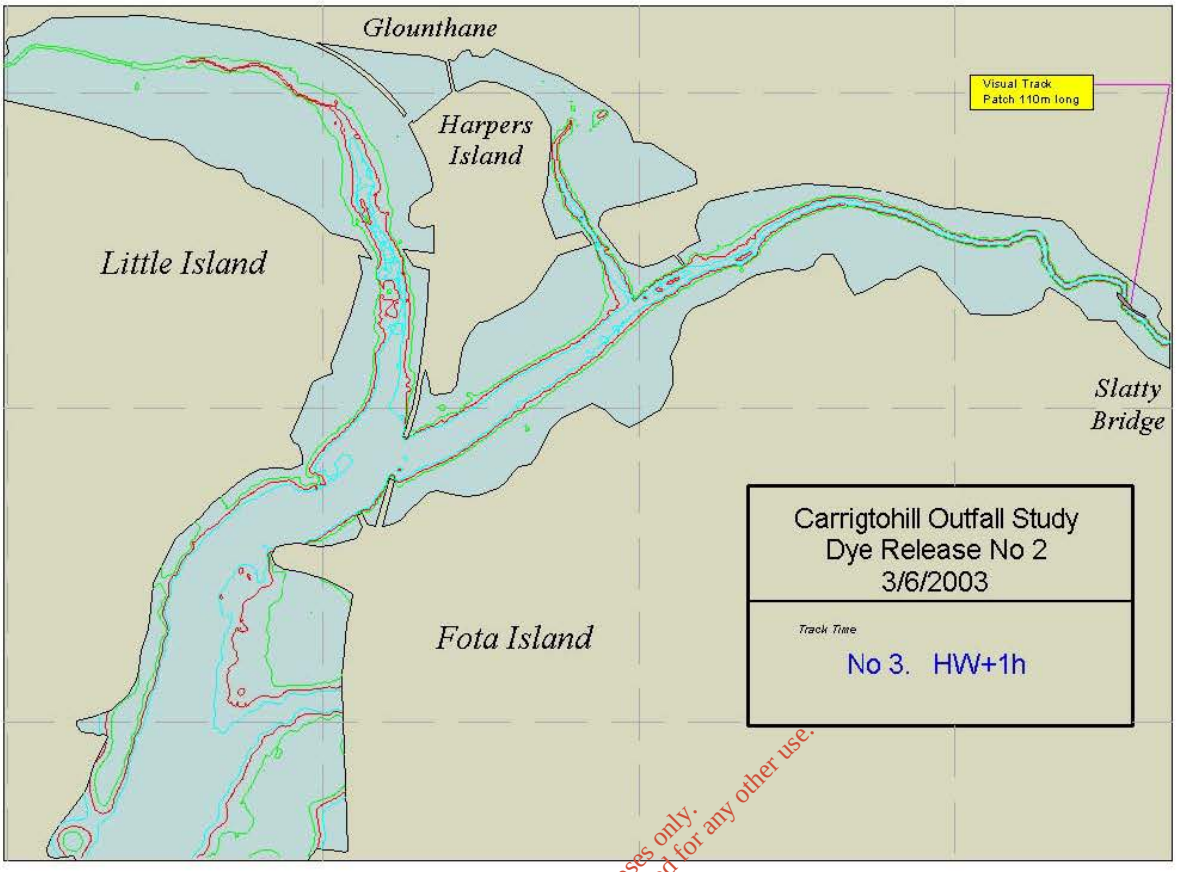


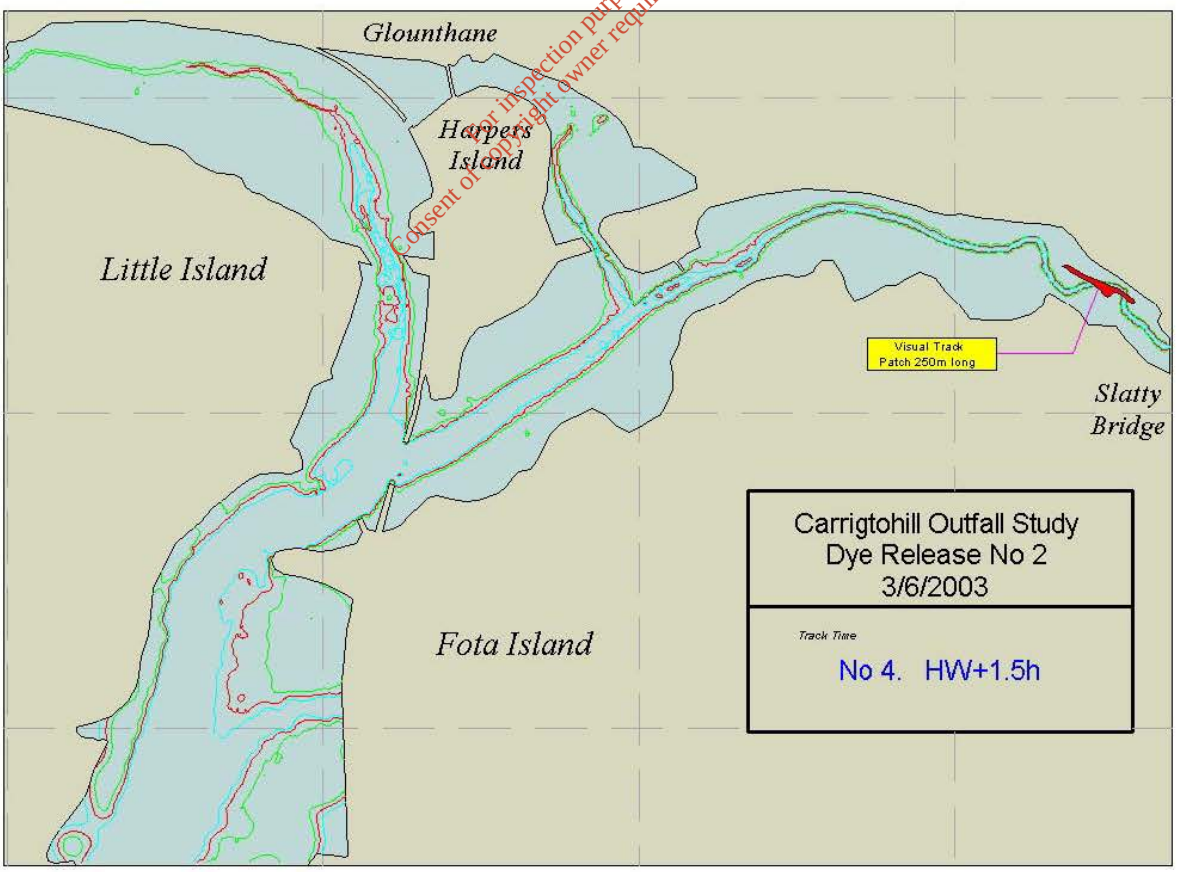


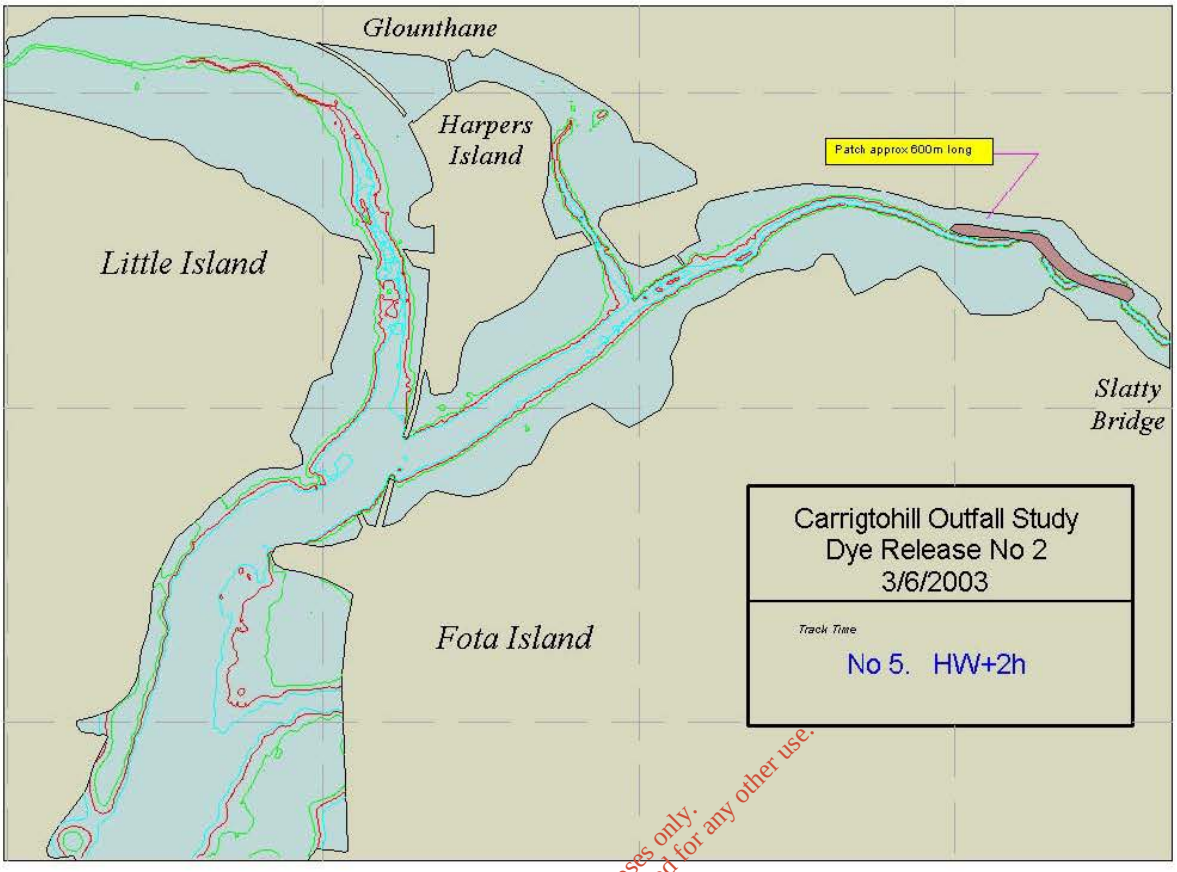
ANNEX 2 DYE TRACK NO 2 3RD JUNE 2003

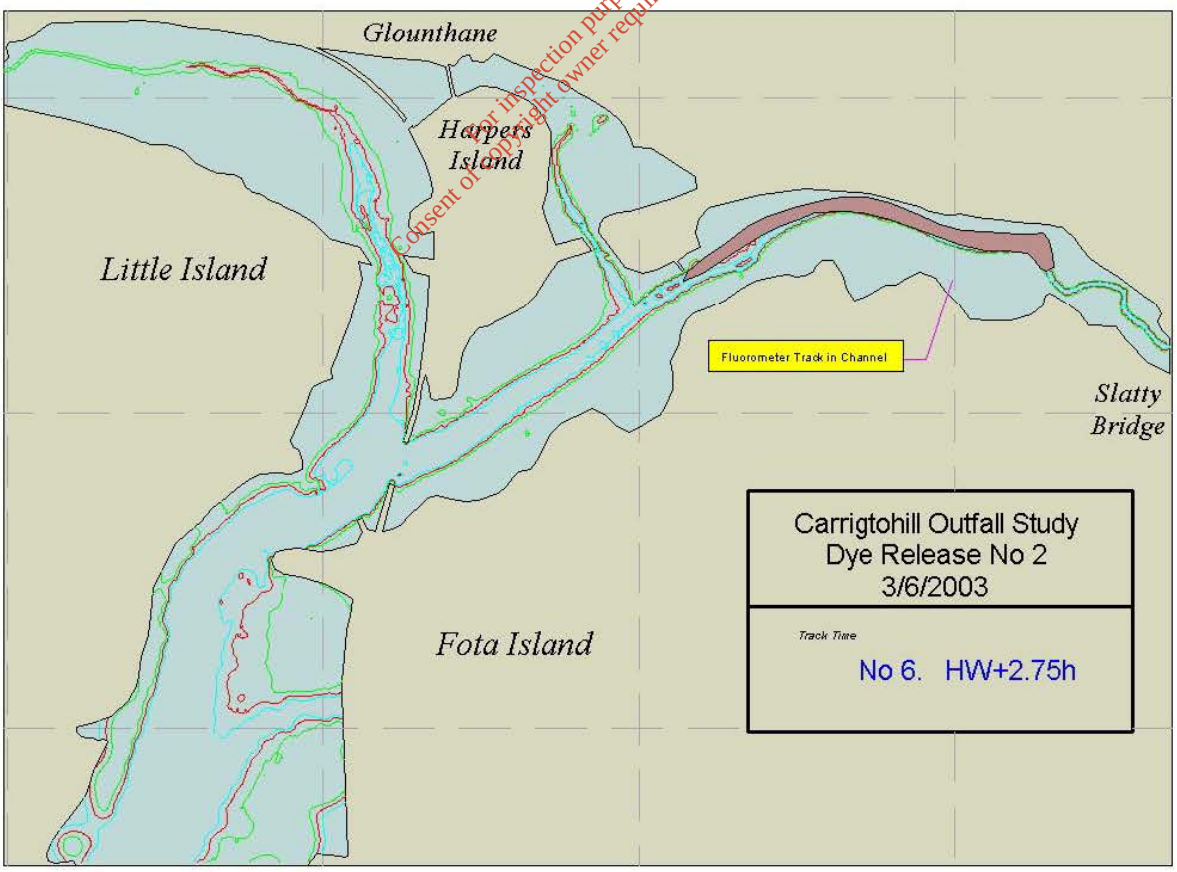


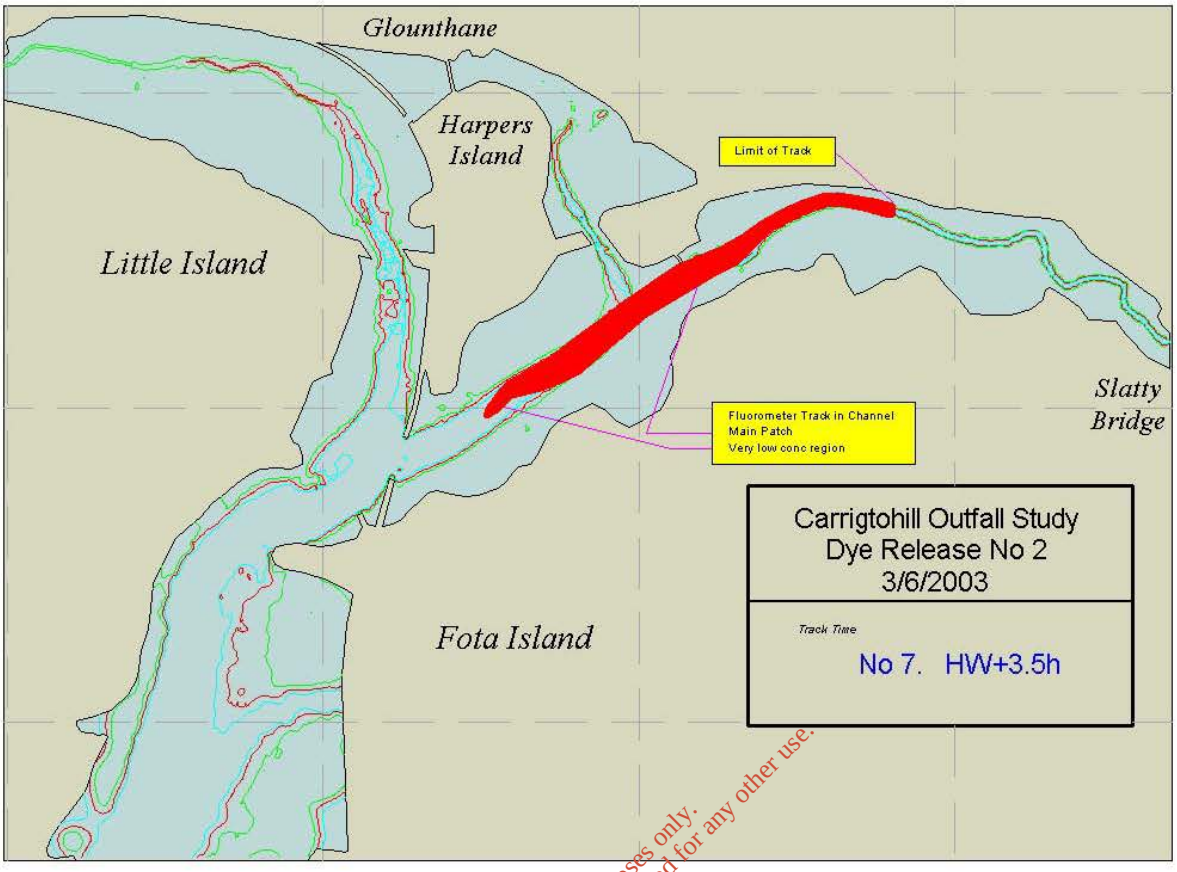


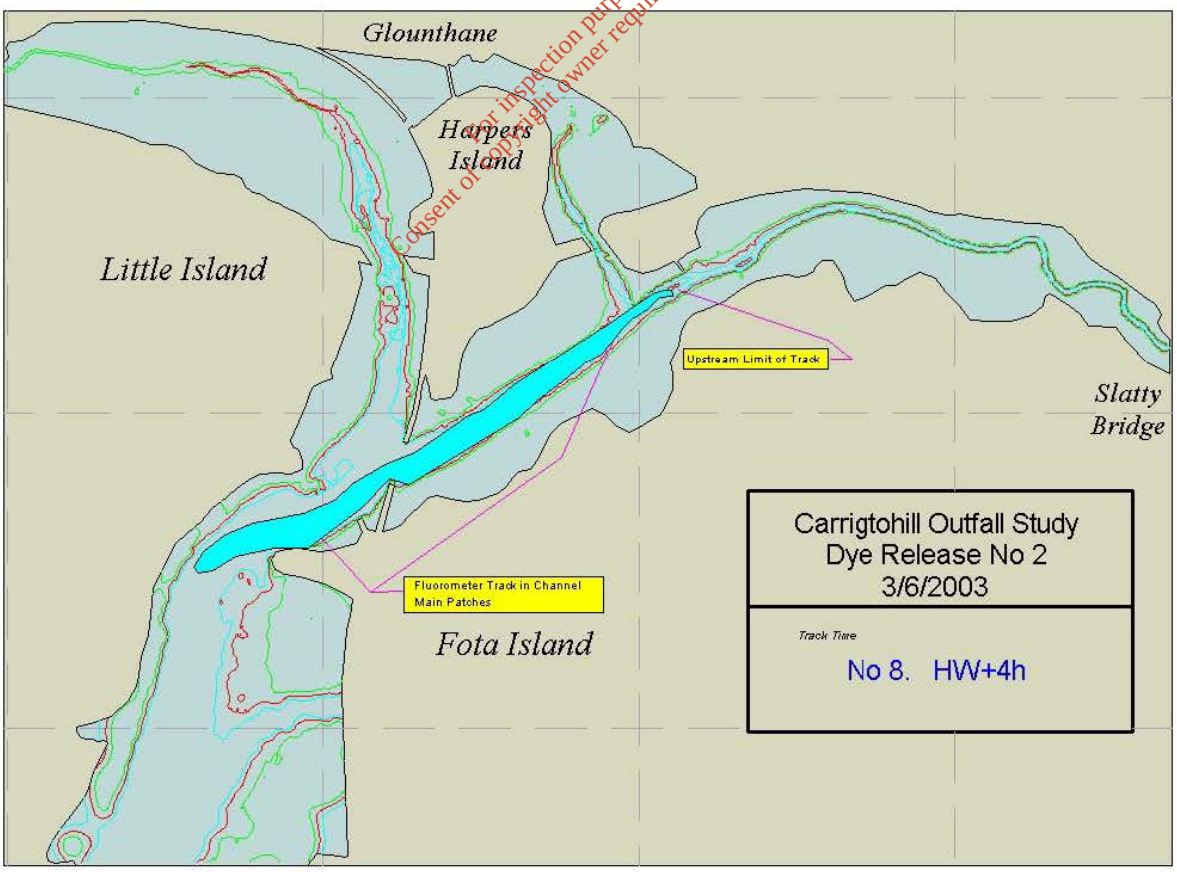












Annex 3 Simulation Results

N

EXTENT OF WAYLEAVE FOR EXISTING ESB CABLES

EXTENT OF WAYLEAVE FOR EXISTING GAS MAIN

SITE BOUNDARY

EXISTING STREAM TO BE DIVERTED

STANDBY GENERATOR

NEW PUMPING STATION

FINAL EFFLUENT CHAMBER

CONTROL BUILDING

SAS TANK

SBR Nr.1 PHASE 1

STORM WATER TANK

SBR Nr.2 PHASE 1

INLET WORKS

POWER

SBR Nr.3 PHASE 1

AERATION BUILDING

EXISTING TREATMENT PLANT TO BE DECOMMISSIONED AFTER CONSTRUCTION OF PROPOSED TREATENT PLANT

SBR Nr.5 PHASE 2

SBR Nr.4 PHASE 1

SLUDGE BUILDING

3Nr SLUDGE TANKS

HARD STANDING AREA

ACCESS ROAD

ODOUR CONTROL

DIVERTED STREAM

ACCESS ROAD

8 No. RAPID GRAVITY FILTERS (4mØ)

4 No. RAPID GRAVITY FILTERS (4mØ) PHASE 2 ONLY

BOUNDARY OF PROPOSED SITE FOR NEW TREATMENT PLANT

UND

NOTE
THE LAYOUT OF THE PROPOSED WASTEWATER TREATMENT WORKS SHOWN ON THIS DRAWING SHOULD BE TAKEN AS INDICATIVE OF THE TYPE OF TREATMENT PLANT THAT SHOULD BE CONSTRUCTED.

REV	DESCRIPTION	DRN	CHKD	APPR	DATE

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@iol.ie Web: www.tjoc.ie

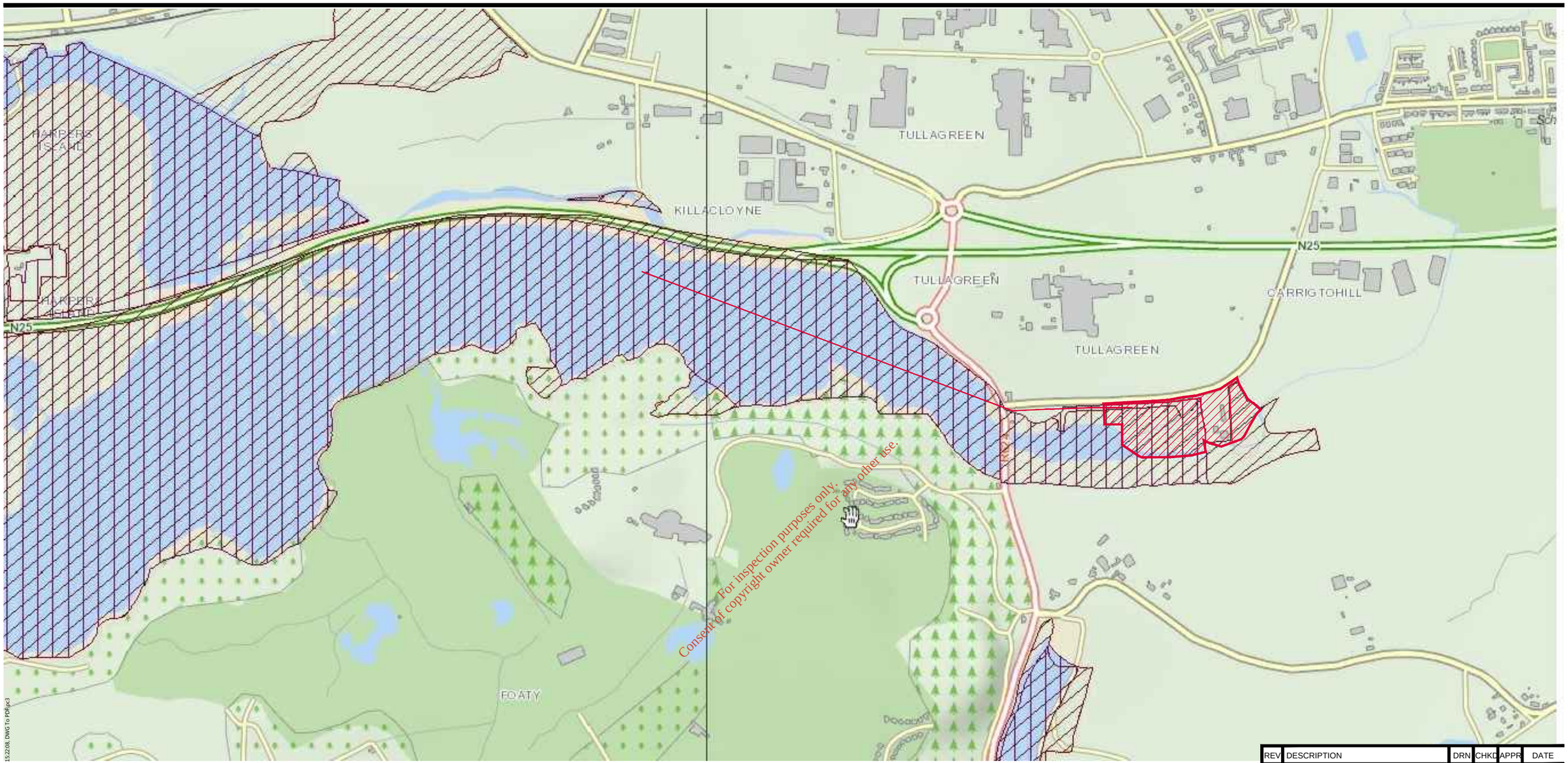
PROJECT: CARRIGTOHILL WASTEWATER TREATMENT WORKS

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: INDICATIVE LAYOUT OF PROPOSED PLANT

SCALE:		DRAWN:
1:1000	(A3)	GJD

DATE:	JOB NO:	DRAWING NO:	REV:
MAY2014	2617	Figure 2	



REV	DESCRIPTION	DRN	CHKD	APPR	DATE

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@iol.ie Web: www.tjoc.ie

PROJECT:
CARRIGTOHILL WASTEWATER TREATMENT WORKS

CLIENT:
CORK COUNTY COUNCIL

DRAWING TITLE:
EXTENT OF SAC/SPA

SCALE:	NTS	(A3)	DRAWN:	GJD

DATE:	JOB NO:	DRAWING NO:	REV:
MAY2014	2617	Figure 3	

\\PC3-N026\projects\Carrigtohill WWTP- BS - 2617\Appropriate Assessment May2014\2617-Fig 3 Extent of SAC-SPA.dwg, A3L, 14/05/2014 15:22:08, DWG To PDF.pc3

N

NOTE
THE LAYOUT OF THE PROPOSED WASTEWATER TREATMENT WORKS SHOWN ON THIS DRAWING SHOULD BE TAKEN AS INDICATIVE OF THE TYPE OF TREATMENT PLANT THAT SHOULD BE CONSTRUCTED.

EXTENT OF WAYLEAVE FOR EXISTING ESB CABLES

EXISTING STREAM TO BE DIVERTED

EXTENT OF WAYLEAVE FOR EXISTING GAS MAIN

SITE BOUNDARY

ACCESS ROAD

FINAL EFFLUENT CHAMBER

ACCESS ROAD

PARKING

ADMIN/CONTROL BUILDING

STORM/BALANCING TANKS

INLET WORKS

NEW PUMPING STATION

STANDBY GENERATOR

ACCESS ROAD

SBR Nr.4 PHASE 2&3

SBR Nr.1 PHASE 2

POWER

Tank

SLUDGE DEWATERING BUILDING

SBR Nr.2 PHASE 1

AERATION BUILDING

SBR Nr.5 PHASE 2&3

HARD STANDING AREA

SLUDGE TANKS

ACCESS ROAD

SBR Nr.6 PHASE 2&3

SBR Nr.3 PHASE 1

DIVERTED STREAM

ACCESS ROAD

RAPID GRAVITY FILTERS

TERTIARY TREATMENT RAPID GRAVITY FILTERS

BOUNDARY OF PROPOSED SITE FOR NEW TREATMENT PLANT

UND

UND

UND

0 5 10 15 20 30 40 50m
1:500

REV	DESCRIPTION	DRN	CHKD	APPR	DATE

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@iol.ie Web: www.tjoc.ie

PROJECT: CARRIGTOHILL WASTEWATER TREATMENT WORKS

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: INDICATIVE LAYOUT OF PROPOSED WORKS SHOWING DESIGNATED CONSERVATION AREA

SCALE:	NTS	(A1)	DRAWN:	GD
DATE:	JOB NO:	DRAWING NO:	REV:	
MAY 2014	2617	Figure 4		

N

Carrigtohill Town Centre

W.W.T.P. Site

BARRYSCOURT

REV	DESCRIPTION	DRN	CHKD	APPR	DATE

TJ O'CONNOR & ASSOCIATES
CONSULTING ENGINEERS
CORRIG HOUSE, CORRIG ROAD, SANDYFORD, DUBLIN 18.
Tel: 01-295 2321 Fax: 01-295 4541 Email: tjoc@iol.ie Web: www.tjoc.ie

PROJECT: CARRIGTOHILL WASTEWATER TREATMENT WORKS

CLIENT: CORK COUNTY COUNCIL

DRAWING TITLE: WWTP LOCATION MAP

SCALE: 1:5000 (A3) DRAWN: GJD

DATE: MAY2014 JOB NO: 2617 DRAWING NO: Figure 1 REV

\\PC3-WD\Projects\Carrigtohill WWTP BS - 2617\Appropriate Assessment May2014\2617 Fig 1 WWTP Location Map.dwg, WWTP Site location 19/05/2014 11:07:44, DWG To PDF.pc3