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APPENDICES

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1 NON TECHNICAL SUMMARY

1.1 Preamble

Cork County Council propose to extend the existing wastewater treatment works to treat wastewaters from both domestic and industrial sources in Carrigtohill and its environs. The existing wastewater treatment works is operating above its design capacity and the proposed extension is required to provide additional capacity to cater for the existing loads and for the future loads expected to arise as the town continues to expand.

The existing wastewater treatment plant is located at a site at Tullagreen to the south of Carrigtohill and has a nominal design capacity to treat flows from a population equivalent of 8,500 PE. Wastewater treatment capacity is usually defined in terms of Population Equivalent (PE) where one PE represents the pollutant load associated with a single person. Estimates of the load currently arriving at the works suggest that the average daily load corresponds to 12,000 PE. The population of Carrigtohill has doubled in the last four years with substantial residential development ongoing. There is also a steady increase in the level of industry in the town and a step increase is anticipated when the Amgen plant becomes operational. It is now clear however that, with further increases in both the domestic population and non domestic discharges as provided for in the development plans for the town and its environs, the plant capacity will need to be increased to 45,000 PE as Phase 1 and to 62,000 PE as Phase 2 to cater for the longer term development of the town.

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 the requirements imposed by the designation of the receiving waters as a sensitive intermediate water in the EPA Report. The treated effluent is to be discharged via an outfall pipe at North Point, approximately 800 metres west of the existing outfall point.

An environmental impact assessment has been completed for the proposed expansion to the wastewater treatment works at Carrigtohill. In this study, the likely impacts of the proposed development on the environment have been systematically and comprehensively examined and suitable measures to limit, to an acceptable level, the effects of any negative impacts have been identified.

This report presents the findings of the Environmental Impact Assessment process. The non-technical summary presents the results of the study in a condensed form. It will be made available to the public, for a period of six weeks, so that any person, if they so wish, may make submissions and observations in relation to the effects of the proposed development on the environment.

1.2 The Need for Additional Wastewater Treatment Capacity

The Urban Wastewater Treatment Directive, enacted under Irish law, requires that wastewater from all towns with populations greater than 10,000 discharging to specified waters, including Cork Harbour, must be subject to secondary treatment or a similar level of treatment by the 31st of December, 2005. These regulations additionally require that the total phosphorus concentration in the treated effluent should not exceed 2 parts per million by weight (2 mg/l). These regulations continue to have legislative effect so that anticipated increased loading of the works associated with the expansion of the town must be treated to the same standard. The existing plant with a design capacity of 8,500 PE is already overloaded and this situation will be exacerbated as more developments are connected to the wastewater collection system in Carrigtohill. A study of the wastewater needs of the town based on a complete take up of zoned lands both within and outside the town council boundary suggests a medium term requirement for a plant of 45,000 PE and a longer term requirement for a plant of 62,000 PE and upgrading of the existing plant to this capacity is the subject of this Environmental Impact Statement (E.I.S.).

1.3 The Proposal

It is proposed to construct an extension to the existing wastewater treatment works at the Tullagreen to cater for an ultimate PE of 62,000 with an initial phase of 45,000 PE. This includes for pollution loads from both domestic and non-domestic sources, such as shops, hotels, restaurants and local industries as well as the proposed Amgen site. In accordance with the regulations, the WWTW will continue to treat flows arising to a tertiary standard, including Phosphorus removal. However, a much higher effluent standard will be required as part of the upgrading process.

Figure 1.1A shows the location of the treatment works in Carrigtohill and Figure 1.1B shows the layout of the existing plant. The plant includes a screen to remove objects suspended in the flow that cannot be broken down in the treatment works. Removal of grit from the flow is also included to reduce the wear on moving parts such as scrapers and sludge pumps in the remainder of the WWTW. The macerated wastewater is pumped from

Figure 1.1A: Location of Existing Carrigtohill WWTP

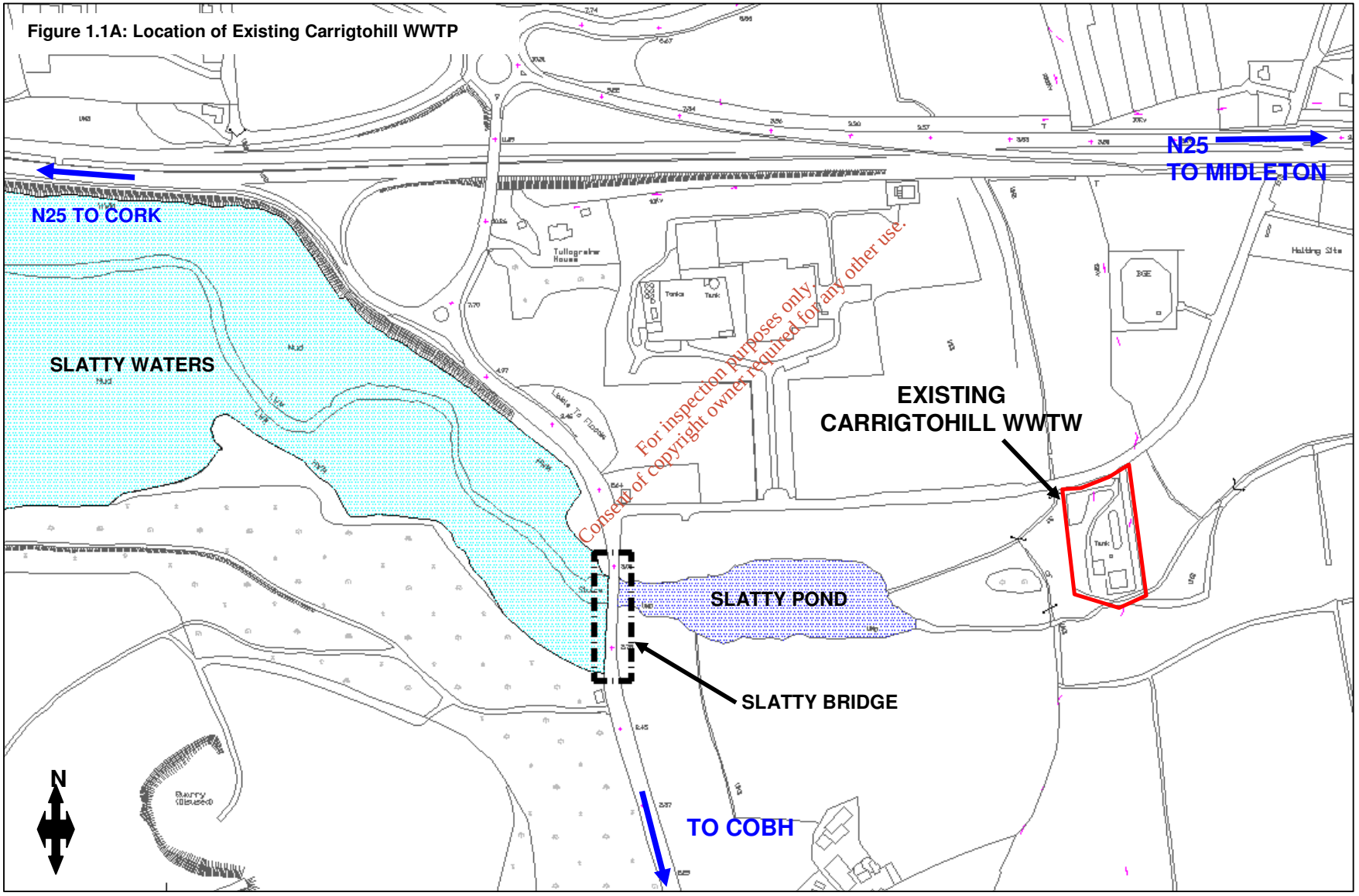
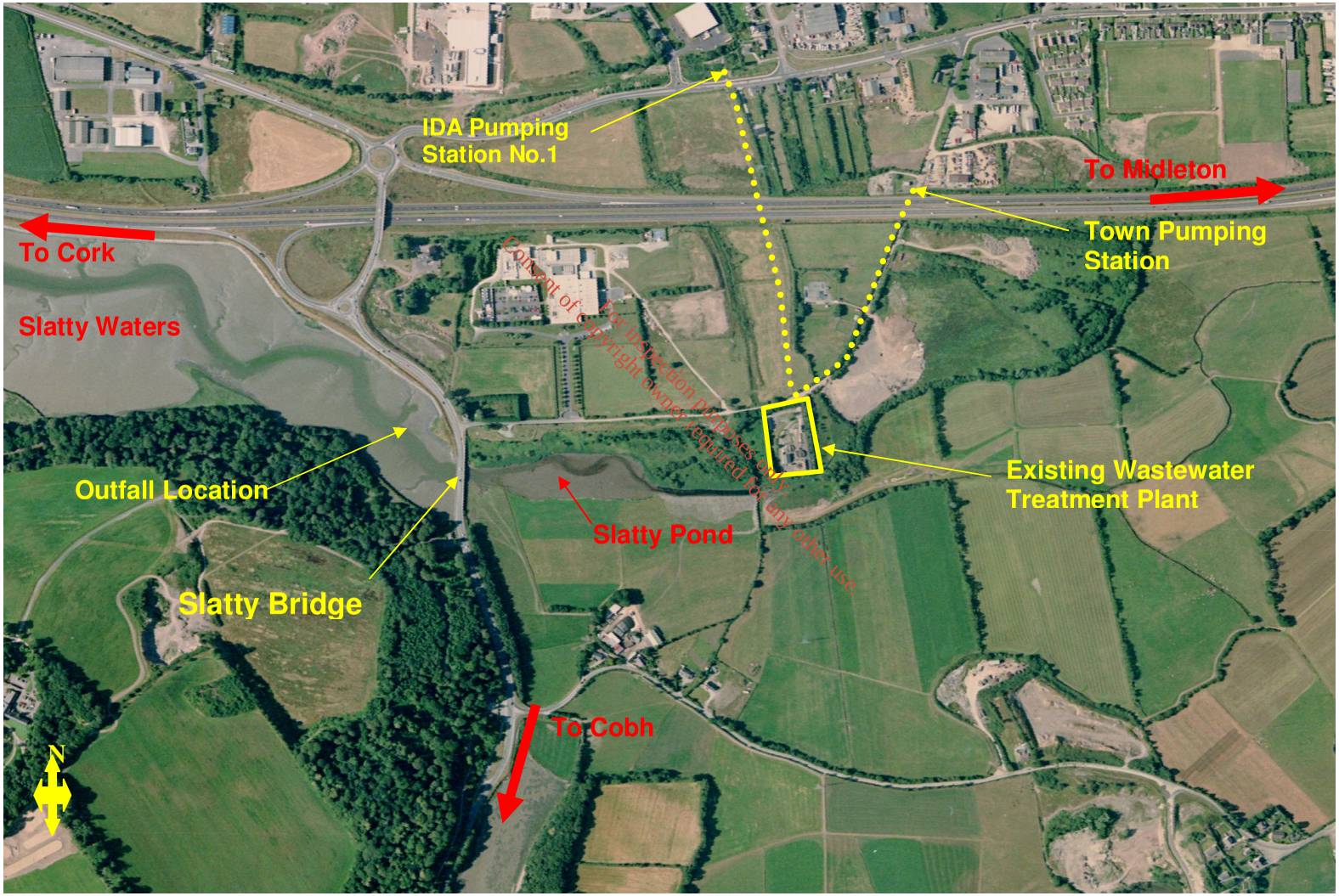
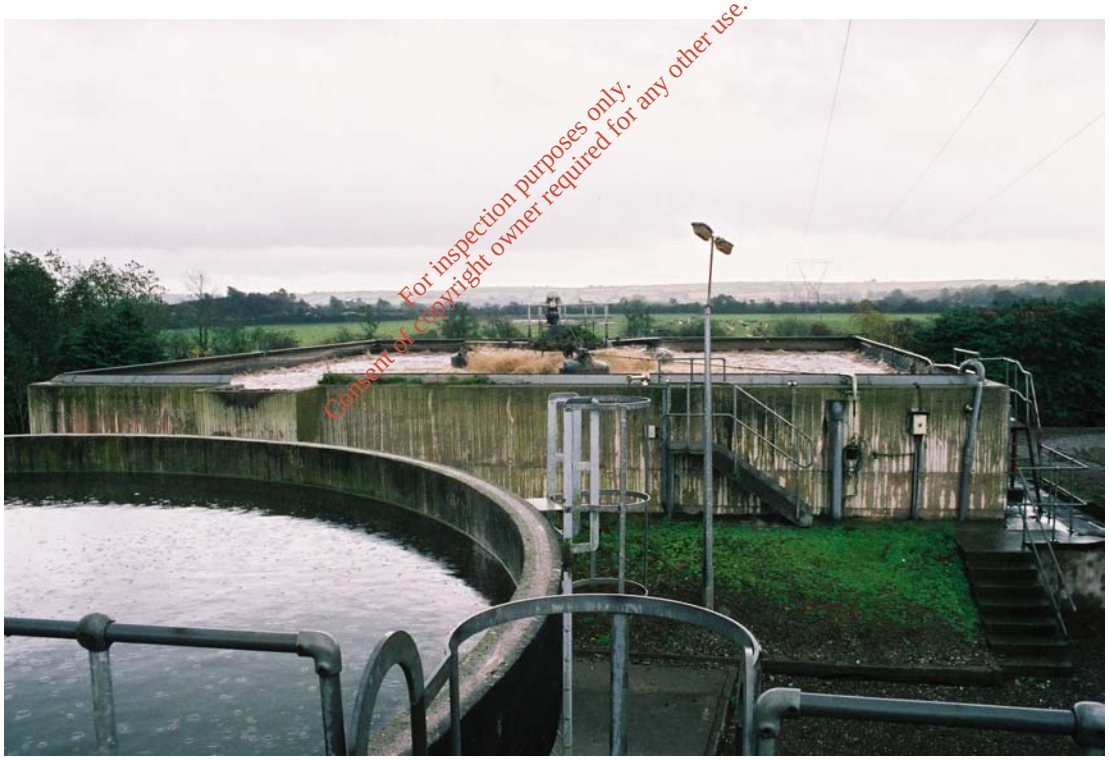


Figure 1.1B: Aerial Photograph of Area around Carrigtohill WWTP



the two pumping stations to the square aeration tank. Here, it is aerated by means of a floating surface aerator. The water flows to the secondary clarifier via an overflow weir. Leachate from the landfill is tankered to the site and pumped into the oxidation ditch. The oxygen input is by means of two horizontal brush aerators. From the ditch the activated sludge flows into the secondary clarifier, in which the sludge settles. The final effluent of both secondary clarifiers flows over into the outlet flow measurement chamber, from which it flows to the discharge location at the Slatty Waters.

The waste activated sludge from both clarifiers is pumped via the sludge collection chamber into the picket fence thickener. The sludge is thickened to a dry solids concentration of about 1-5%. The supernatant is returned to the oxidation ditch. The thickened sludge is pumped to the dewatering building, where it is dewatered by means of a belt press. The dewatered sludge is removed by a conveyor belt to an uncovered skip outside the building. The final destination is the Rossmore Landfill. The filtrate off the belt press is pumped to the square aeration tank.



Photograph 1.1 – Balancing tank at the Carrigtohill works

Procurement of the expansion to the works will be by means of a design, build and operate contract. This will allow tenderers to put forward their own design for meeting the specified discharge standards. Selection of a preferred design will be on the basis of a

number of criteria including cost, compliance with relevant standards etc. and will be in accordance with the Department of the Environment, Heritage and Local Government (DEHLG) Water Services guidelines for the evaluation of tenders. Only those tenders which can meet specified requirements in terms of final effluent discharge standards and other specified environmental standards (eg odour, noise) can be considered for acceptance.

Photograph 1.2 Floating Surface aerator in Balancing Tank

A typical design based on the above is shown in Figures 1.2 and is described in more detail in Section 3 of the main body of the report. However tenderers will be free to offer their own designs which may differ from that shown and described below. The typical design shown may therefore be taken as indicative only of the type of plant layout that may ultimately be constructed. Tenderers are free to offer alternative designs/layouts provided the plant offered can meet the required final effluent standards, is consistent with this environmental impact statement and complies with any additional requirements set out by the local authority in the tender documents.

Photograph 1.3 Oxidation Ditch at Carrigtohill Works

Figure 1.2 shows an indicative design prepared for this EIS. The indicative layout of the WWTP in Carrigtohill consists of:

1) Preliminary Treatment

Preliminary Treatment of the incoming sewage is carried out at the inlet works, comprising both screening of the sewage to remove plastic and non-biodegradable matter, and grit removal. On removal, the screenings are washed and compacted for ease of disposal either to landfill or by burial. Oil, fat and grease removal may also be required.

The grit is washed during the removal process to ensure that any organic material is removed thereby leaving a clean material for disposal to landfill.

The Inlet Works are envisaged in a building approximately 17m x 10m in plan and 12 metres high and air treatment equipment will be provided for odour control. The preliminary treatment will be designed to cater for Phase 2 flows.

2) Secondary Treatment

This stage comprises biological oxidation of the sewage by an activated sludge process followed by a settling stage. For Carrigtohill, the construction of SBRs is proposed due to the fact that the available site is limited and the footprint of SBRs is substantially smaller than that of a conventional activated sludge system comprising of an activated sludge tank and a final settling tank. The Phase 1 dimensions of the aeration basins are an approximately 20m by 40m and 4.7m (liquid) deep. Provision is made in the layout of the plant for increasing the number of aeration basins in Phase 2.

3) Tertiary Treatment

Nitrogen removal is envisaged in the SBRs. Phosphorous will be chemically removed in 12 No. rapid sand filters (8 for Phase 1 and another 4 for Phase 2). The dimensions of these filters are 4 m diameter with a filter bed height of 2 m.

4) Sludge Treatment

The sludge removed from the SBRs would be directed to the sludge storage facilities to await de-watering. The sludge is pressed and de-watered to reduce its volume so that it is suitable for transportation to the regional sludge hub centre for stabilisation and reuse. This de-watering operation would be carried out within a closed building, which would also be fitted with air treatment equipment for odour control.

The approximate dimensions envisaged for the various units described above are as follows:

a) Sludge De-watering Building : 15 x 30m;

b) Sludge Holding Tanks : 500 m3 storage capacity;

c) Buffer Tank : 500 m3 storage capacity;

As the final works layout cannot be specified at this stage the layout drawings shown should be taken as indicative only of the type of wastewater treatment plant to be constructed. The main elements of the indicative designs shown are as follows:-

- The present inlet works will be replaced by a new covered inlet works housing the inlet channels, storm overflow and preliminary treatment units.
- Additional stormwater holding tankage will be constructed.
- The existing No 1 aeration tank will be demolished and replaced with four Sequence Batch Reactors for Phase 1 with an additional two added for Phase 2
- Sludge thickening would be provided using either centrifuges or belt presses fully enclosed in a building.
- Air extraction and treatment systems will be provided to limit odours from the plant
- Tertiary treatment by polishing in pressure filters would be provided.

The main parameters used to measure the efficiency of the treatment processes in removing the pollutant load from the wastewaters are:

The Biochemical Oxygen Demand (BOD), which is a measure of the amount of oxygen required to degrade or stabilize the organic pollutants in the wastewater, and

The Suspended Solids (SS) content, which is a measure of the amount of solid matter in the wastewaters.

The Total Phosphorous (TP) content, which is a measure of the amount of phosphorous in the wastewaters. For inland waterways and particularly lakes, phosphorous is associated with eutrophication in which aquatic organisms grow to an extent that they deplete the oxygen level and cause distress or death to fish and other aquatic organisms.

Typically, domestic sewage has a BOD of around 300mg/l, a SS of around 250mg/l and a TP of around 10 mg/l. Preliminary, secondary and tertiary treatment will achieve at least a 85-90% reduction in these levels, thereby complying with relevant EU legislation with regard to the treatment of urban wastewaters.

The various stages of a typical wastewater treatment process may be described as follows:

1. The preliminary treatment process is essentially a physical process involving the removal of grit and screening of the wastewater to remove rags and coarse solids. These would cause mechanical damage and inhibit biological activity if allowed to progress to the primary and secondary treatment processes. The accumulated grit and screenings would be washed to limit the generation of malodours and then compacted for ease of disposal, generally to landfill. These units would normally be covered or housed in a building equipped with an odour control system. The sewage flow into the plant would be continuously monitored.

2. The secondary treatment stage incorporates biological and chemical treatment methods in different tanks. The biological treatment occurs in anaerobic and aeration basins where the primary effluent is retained in a micro-organism enriched environment. The dissolved and colloidal solid particles in the effluent are then converted to harmless substances (water, carbon dioxide, methane, *etc.*) through natural biological degradation or converted into cell matter. The aeration basin effluent is then passed to a clarifier where, possibly using chemical assistance, much of the remaining suspended solids including the cell matter referred to above, are settled out. The clarifier effluent represents a 90% reduction in the BOD, SS and pathogen levels when compared to the untreated wastewater.

3. The tertiary treatment stage is used as a polishing stage which further reduces the concentrations of BOD, SS, nutrients and pathogens. There is a wide variety of tertiary treatment processes such as sand filtration, membrane installations, reed beds and disinfection units.

There are two effluent streams from most wastewater treatment plants - *i.e.* the clarified water and the so-called “sludge” stream. It is intended that the Carrigtohill works will continue to dewater its own excess sludge and will also dewater the sludge from smaller wastewater treatment plants which are close to Carrigtohill. These imported sludges will be taken to the Carrigtohill works in tankers. This dewatered sludge will be transported off site for further treatment in accordance with the County Cork Sludge Management Plan.

Safety measures at the wastewater treatment works are designed to provide a safe working environment for the plant's operatives and to limit access to the site by unauthorized personnel. Generally all external equipment with moving parts would be capable of being shut down locally by means of emergency stop switches. A security fence and intruder alarm system will be installed as required.

Under the proposed indicative design, the treated wastewater would be discharged to Slatty Waters via an 800 metre long outfall pipe.

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. The nearest dwellings are approximately 230 - 250 metres from the site boundary. A rigorous assessment of the predicted odour and noise levels following the proposed expansion of the plant was carried out. All necessary mitigation measures recommended as a result of the assessment will be incorporated into the proposed works in order to limit any adverse impact on the closest residence to an acceptable level.

The layout of the treatment works on which this E.I.S. is based may be taken as indicative only. Contractors competing for the contract for the construction of the Carrigtohill works will be free to put forward any design capable of providing the required level of performance. It is expected that such alternatives will be based on variations in the secondary or tertiary treatment process.

The E.I.S. is concerned primarily with the impact of the development on the environment and, while the layouts shown are indicative only, the specifications for the project will clearly set out the performance criteria which the finally constructed treatment works must achieve in terms of: -

- Final effluent standards (see 1.6 below)
- Odour levels.
- Noise Levels.
- Heights of buildings and structures on the site.
- Proximity of buildings and structures to site boundaries.
- Screening at site boundaries.

- Sludge handling and disposal.
- Proven technology.
- Reliability of Plant and Equipment.
- Other impacts such as traffic movements, visual impacts of site lighting etc.

Accordingly an alternative design and layout will only be considered if:-

1. The impacts are equal to the impacts outlined in this E.I.S.

and/or

2. The positive impacts are of greater significance than those outlined in this E.I.S.

and/or

3. The negative impacts are of lesser significance than those outlined in this E.I.S.

1.4 Alternatives Considered

Because of the scale and cost of this development, a number of alternative treatment processes and alternative locations were examined.

1.4.1 Alternative Treatment Processes

In terms of process many alternatives would be available for the secondary treatment stage based on variations of the activated sludge process described earlier. However only a limited number of processes would be capable of producing an effluent of the required standard. Amongst these would be the activated sludge processes, attached media processes (including trickling filters, biologically active filters and rotating biological contactors) and constructed wetlands (reed beds). The latter process would not generally be considered as reliable as activated sludge treatment. It also has a very high space requirement which could not be accommodated within the boundaries of the existing site. The very high space requirements for reed beds means that this process can be discounted as an alternative to the indicative design described.

1.4.2 Alternative Locations

The existing WWTW has sufficient land available in the ownership of Cork County Council to allow construction of the new treatment plant without interference with the operation of the existing plant. There are also a lack of suitable alternative locations along the coastline due to the route of the N25 and the proximity of the N25 to the coast line. As a result the existing WWTW site was considered the optimum location for a treatment plant in the

Carrigtohill area. It was proposed to construct the new plant on the western side of the existing plant due to the presence of the main gas line on the eastern side and the presence of the high voltage ESB line over the existing plant.

The alternative considered for the treatment of the sewage arising from Carrigtohill was to transfer the sewage to Carrigrenan and treat at that location.

The Cork Main Drainage Scheme includes major sewer works in the city of Cork as well as interceptor sewers along the banks of the River Lee, a Pumping Station at the Atlantic Pond, two rising mains from the Atlantic Pond to the Header Chamber at Mahon, a twin siphon across Lough Mahon and a treatment plant at Carrigrenan.

The design capacity of the wastewater treatment plant in Carrigrenan is 413,000 PE and it is designed to accommodate flows from Cork City, Tramore Valley, Glounthane, Glanmire and Little Island areas. The plant is in operation and is treating a load of approximately 313,000 PE but is overloaded hydraulically.

The Carrigrenan WWTW has capacity for a predefined catchment in the environs of Cork City. The areas to be served by Carrigrenan have no alternative treatment route and the capacity designated to these areas must be retained. In general the areas to the north and west of Cork City have no alternative other than Carrigrenan.

We have considered two different sub-options:

1a) Treatment of the wastewater arising from Carrigtohill in the existing WWTP in Carrigrenan. This can only be achieved by significantly reducing the infiltration rate into the city collection network.

1b) Construction of a new phase at Carrigrenan to cater for the wastewater from Carrigtohill.

Different routes from Carrigtohill to Carrigrenan have been investigated. These are:

1) Along the N25 Motorway;

2) Along the old Youghal Road to Glounthane;

3) Through Fota Island.

Route 1: Along the N25 E1 Motorway

A suitable route for the rising main from Carrigtohill to Carrigrenan would most likely be along the southern edge of the N25. The NRA have indicated that this route would not be available due to plans to upgrade the N25 to motorway status in the future.

Route 2: Along the Old Youghal Road to Glounthane

The section of the old Glounthane road from Glounthane to where the Cobh railway veers away from the main road is designated a "Scenic Route" under the County Development Plan 2003. However the route is along the main road and is not expected to negatively impact upon any of the scenic elements of the route. Traffic numbers are reduced on this road since the opening of the N25 dual carriageway. This route does not involve any crossings of the estuary.

Route 3: Through Fota Island

If the pipe is laid in a straight line from the Carrigtohill Pumping Station to the wastewater treatment plant at Carrigrenan, the route may be only 5,000 m long. The Cork Main Drainage Preliminary Report estimated that the length of rising main would be approx 5 km, and would need to be 450 mm in diameter. This length assumes a route across Fota Island. This route is potentially the shortest route, however there are a substantial number of problems to be overcome:

- Getting a wayleave for a pipeline across the island, which may include crossing Fota Golf course, would be difficult.
- The entire island is designated "Scenic Landscape" under the 2002 County Development Plan.
- The Cobh road is heavily loaded with traffic (count of 12,000 vehicles/day according to the Area Engineer).
- There are large stonewalls on either side of the road associated with the Fota House demesne.
- After crossing Fota Island, there is still the difficulty of crossing the channel between Fota Island and Little Island. It appears that the route through Fota Island is not a suitable route for the pipeline.

The preferred route is the route via Glounthane. The route is the longest but causes the least impact en-route. It is separate from the N25, so that it does not affect the upgrading of the road to motorway status.

Cost estimates were produced to compare the option of upgrading the WWTW at Carrigtohill to the option of treating at Carrigrenan. Based on whole life costs for both alternatives the option to construct the WWTW at Carrigtohill offered better value for money.

1.5 Environmental Considerations

The proposal for the wastewater treatment works has been assessed in terms of its impacts on the natural and man-made environment and on the people who live and work in Carrigtohill and its environs.

The impacts are discussed in detail in Chapters 5 to 12 of this E.I.S. where each impact is addressed under the following sub-headings:

- Receiving Environment;
- Characteristics of the Proposal;
- Potential Impact of the Proposal;
- Mitigation Measures;
- Predicted Impact of the Proposal;
- Monitoring
- Reinstatement.

They are summarised here in the same sequence as they appear in the main statement.

1.6 Water

1.6.1 Slatty Waters

The existing treatment works discharges into Slatty Waters downstream of Slatty Bridge. Slatty Waters is the name given to the estuary at the eastern end of the upper Cork Harbour. The water body forms the divide between Fota Island and the mainland to the west of Carrigtohill.

The water body is approx. 150 – 250 m wide and 2,950 m long from Slatty Bridge to the railway bridge near Harpers Island. There is a low level of freshwater discharge into Slatty Waters. The main body of water is saline and tidal. The only exit/entry point for the saline water is at the west end of Slatty waters adjacent to Harpers Island. The dilution and mixing of the water is provided entirely by the ebb and flow of the tides.

A model of Cork harbour has been constructed and used in conjunction with current legislation to derive appropriate standards for the treated effluent from the upgraded works. The legislation considered included the following:

- The Urban Waste Water Treatment Regulations
- The Phosphorus Regulations
- EPA "Assessment of the Trophic Status of Estuaries and Bays in Ireland" report.

The final effluent discharge standards proposed taking account of the above requirements are shown in table 1.1 below. The derivation of these standards is described in detail in Section 5 of the main body of the E.I.S.

Parameter	Phase 1	Phase 2	Unit
BOD	25	20	mg/l
Suspended Solids	35	35	mg/l
Total Phosphorus	1	1	mg/l
Nitrogen	15	10	Mg/l

Table 1.1 - Proposed Treated Effluent Discharge Standards

The application of these final effluent standards to the upgraded plant represents a substantial improvement on the quality of the existing effluent discharge. The benefits will include:

- 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 EPA "Assessment of the Trophic Status of Estuaries and Bays in Ireland" report.
- The upgraded works will satisfy all of Cork County Council's obligations under the UWWT Regulations and the Phosphorus Regulations.

The predicted impact of the discharge on the aquatic flora and fauna was studied in detail by Dixon-Brosnan Environmental Consultants as part of this EIS. Their report is reproduced in full in Appendix C to the EIS. It concluded that the increase in population equivalent discharging to Slatty Water will increase the total nutrient loading over time despite the improved treatment standard. However the location of the new discharge point

will result in increased dispersion of the effluent as outlined in Chapter 5 of this report and the nutrient levels should remain within the parameters set by the EPA for sensitive estuarine and coastal waters. There will be a positive impact on the upstream end of Slatty Waters due to the removal of the existing outfall.

1.7 Air

The boundary of the WWTW site is approximately 230 metres from the nearest residential unit. It was considered essential to assess the main airborne parameters (noise and odour) for the upgraded works to specify the allowable levels of odour and noise to ensure that any potential impacts on the local community are mitigated to an acceptable level.

1.7.1 Noise

Bord na Mona conducted a noise survey at the WWTW site. The results of this survey are detailed in Section 6.2 and attached in full in Appendix A. The study identified that the dominant noise in the area is from the N25 and R624 roads.

The analysis carried out by Bord na Mona has led to the recommendation of maximum acceptable noise level criteria at the nearest house or any house, varying from 50dB(A) in daytime to 35dB(A) at night-time, in order to ensure that there is no noise disturbance to the community arising from the operation of the works.

A number of mitigation measures have been recommended to help achieve the recommended limits. These are detailed in Section 6.2 along with additional mitigation measures for the construction phase and include:

- Careful selection of plant;
- Construction of an earthen berm along the southern and western boundaries;
- Acoustic insulation on buildings where appropriate, especially the blower building and the inlet works building;
- Construction of pumping stations, using submersible pumps, to achieve the noise limits;
- Positioning of noisier plant to optimise screening;
- Sound attenuation on any fan or opening likely to emit excess noise.

These mitigation measures apply during the operation of the plant. Table 1.2 shows typical sound levels in terms of dBA units.

Levels in dB(A) (Decibels)	Source of Situation
140	Fireworks, Jet Takeoff at c.100m
130	Threshold of Pain
120	Night Clubs, Noisy Toys, Chainsaws, Stereos
110	Personal Stereo at high sound level
100	Video Arcades, Classical Music
90	Lawnmower, Motorbike, Crying Child
80	City or Town Traffic, Nearby Ringing Phone
70	Outside Busy Roadside House
60	Normal Conversation at c.1 metre
50-55	Normally acceptable by day, outdoors
40	Refrigerator, Quiet Living Room, Library
35-40	Normally acceptable at night, outside houses
25-30	Inside Bedrooms
20	Whisper
10	Very Quiet Countryside
0	Threshold of Hearing

Table 1.2 – Typical Noise Levels from Common Activities and Sources

With these mitigation measures in place, Bord na Mona advise that the noise level contribution from the WWTW outside the nearest house will be less than the maximum permissible levels of 35dB(A) at night and 50dB(A) by day, thereby ensuring an acceptably low noise impact on the residents.

1.7.2 Odour

Odours are often perceived to be the principal potential negative impact of wastewater treatment works. Mr. Michael Bailey of Envirocon has assessed the probable impacts of odour generation from locating the works at the proposed site. The results of this survey are detailed in Section 6.3 and attached in full in Appendix B to the main body of the report. Mr. Bailey's brief was to assess the adequacy of the odour control measures in the indicative design of the works and to make further recommendations as required.

An assessment of the odour producing potential associated with the indicative design at the proposed site concluded that odour levels at the nearest residences (230 metres to the

west and 250 metres to the south-west) and beyond could be kept below the barely perceptible level (0.25 odour units) on a 98 percentile basis, provided certain mitigation measures are put in place.

The measures initially proposed in the indicative design included the following:

- The inlet works channels and screening/grit removal equipment would be housed in a purpose designed building
- Screened material and grit from the grit trap would be washed and transferred into covered skips located within the inlet works building.
- Diffused aeration in the activated sludge aeration tanks would be used to reduce the turbulence and hence the potential for generating malodours and aerosols from the tank surface. In addition, the level of oxygen present in the tank liquor would be continuously monitored to ensure an adequate level is present to prevent anaerobic conditions forming.
- Desludging chambers would be covered and the foul air passed through an odour control unit before being vented to atmosphere.
- The sludge thickening tanks would be covered and the headspace ducted to a high efficiency odour control unit.
- Emissions from the sludge treatment plant would be passed through an extraction system connected to an odour control unit to extract any foul odours.
- The installed odour control units would operate with removal efficiencies of over 95%. Single or dual stage units may be required to achieve the necessary reduction in odour levels in the exhaust gases. It is planned that one odour control unit would treat foul air from the inlet works, with a second unit for treating headspace air from the sludge tanks and dewatering building. These units may be stand-alone systems installed at ground level or emission vents located on the buildings. The location and design of the exhaust stacks to these units would ensure that adequate mixing of emissions is achieved. The odour control systems to be installed would ensure that no significant malodours occur beyond the site boundary.

The aim of the above measures is to prevent an odour nuisance arising beyond the site boundary. The complete elimination of odour would be practically impossible and would entail enormous cost. The anticipated level of odour of 0.5 odour units (99.5 percentile at Phase 2 loading) at the nearest residence is barely perceptible and is well below the established nuisance threshold of 5 odour units. The installation of odour abatement

measures consistent with the levels outlined above will be a condition for award of the contract. Accordingly, only those designs that can meet these requirements will be considered. Specific penalty clauses will be applied under the Contract with respect to the odour standards with breaches resulting in a reduction in payments to the contractor.

1.7.3 Aerosols

Aerosols are produced in the activated sludge process at the aeration tanks when mechanical surface aerators are used to transfer oxygen to the mixed liquor or due to the effect of wind on the surface of the liquor. They can also be produced locally when final effluent is used as wash water for activities such as pressure washing. The design prepared for the E.I.S. envisages the decommissioning of the existing rotors.

The Employer's Requirements will dictate that the aeration must be by either fine bubble diffused air systems, which have a negligible hazard or by surface aerators, which have additional measures to prevent the production of aerosols.

If wash water is to be reused then it would normally be disinfected before use. It is generally accepted that aerosols do not constitute a health hazard beyond 20m from the source. Even within this distance the risk is limited. There are no documented cases of infection being transmitted via aerosols. The concentration of bacteria and viruses in sewage aerosols can be high but the droplets evaporate quickly and the bacteria and viruses, being dependant on moisture for survival, are killed.

1.7.4 Light

The development of the treatment works site will increase the generation of artificial lighting in the area. Flood lighting will be required for safety and security but will only be fully operated at night if the treatment plant is manned or if the intruder alarm system is activated.

Careful positioning of the lighting columns and screening with trees and shrubs will minimize over-spill of light outside the site boundary.

1.7.5 Climate

The climate in Carrigtohill in general is typical of Ireland. There will be no effects on the climate resulting from the new works nor are there any particular climatic issues that need to be addressed in this E.I.S..

1.8 Soils

1.8.1 Type/Characteristics

Carrigtohill town lies on relatively low-lying coastal land with a typical elevation of 5mOD to 15mOD (Malin) level. Much of the local land is silty and typical of coastal areas. The catchment to the north of the town rises steeply to approximately 90m OD.

Some site investigations have been carried out near to the proposed site. Groundwater observations were limited but generally were about 0.2m to 2.8m below ground level and were probably tidal in this area.

The ground investigation indicates that the ground comprises variable deposits of medium dense sands and gravels which are sometimes clayey or silty, with layers of silts and clays which would be expected to be firm but from experience of these soils may have soft layers.

It would be reasonable to assume that the ground conditions at the proposed site are similar and a detailed site investigation will be carried out.

1.8.2 Foundations

Piled foundations may be required to support certain units. Anchors may be required to hold down the tanks against flotation when empty.

1.9 Ecological Impacts

1.9.1 Land Based Habitats

A study of the flora and fauna was undertaken as part of the E.I.S. by Dixon-Brosnan Environmental Consultants. The results of this survey are detailed in Section 8 and attached in full in Appendix C. The report notes that although there is evidence of numerous species of birds using the site, the temporary disruption caused to their activities during the construction phase could be offset by sensitive landscaping and that re-colonization should quickly occur. The development would have no significant medium or long-term impacts on the plant populations.

1.9.2 Aquatic Habitats

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 this area as

important for salmon or sea trout. The only species noted in the absence of dedicated fish surveys were mullet, which utilise the creek at low tide.

1.10 Socio-Economic Impacts

The existing site is adjacent to the existing WWTW so there is already an established wastewater treatment use in the area.

The Cork Area Strategic Plan (CASP) designates Carrigtohill as an area with significant growth potential for both residential and industrial/enterprise developments. CASP envisages that the Metropolitan Cork area (inclusive of Carrigtohill) would act as a single housing and jobs market. It is expected that Carrigtohill will have a rapid population growth over the next 20 years

The upgrading of the works will be a major part of this infrastructure and will be an essential driver of growth in the region. It will allow the development of industry and residential areas to proceed unhindered.

There are existing power and water supplies to the site that may require upgrading.

1.10.1 Transport and Communications

The level of traffic entering the site will naturally increase during the construction phase. The overall level of traffic during the operational phase will be slightly higher than the current level (average anticipated level would be 1 tanker per day). Given the level of traffic in the area and the proximity to the N25 and R624 this will not have a significant effect.

1.10.2 Sludge, Screenings and Grit Disposal

The dewatering of sludge at Carrigtohill prior to delivery to the sludge hub at Carrigrenan will substantially reduce the number of lorry movements between the greater Carrigtohill area and Carrigrenan. Provision will be also be made for accepting and dewatering imported liquid sludges from a number of smaller wastewater treatment plants near Carrigtohill to minimise transportation costs to the hub centre in Carrigrennan.

Under the indicative design prepared for the E.I.S., compacted screenings and grit are to be sent to landfill. The comparatively small volumes (perhaps 1 No. skip per week) arising and the low organic content, makes landfill the most suitable means of disposal.

1.11 Material Assets

The site is already owned by Cork County Council. It is anticipated that the upgraded works will allow sustainable growth in the area and prove to be a valuable asset for both the County Council and the Carrigtohill area in the future.

1.12 Visual Impact

1.12.1 Topography

The treatment plant is located outside the village of Carrigtohill to the south side of the N25. The northern boundary is a local road with a manufacturing facility located on the opposite side of the road. The southern boundary is formed by Slatty Pond. Slatty waters are to the west of the site and open agricultural land to the east. The existing plant is screened by existing hedging on all sides. It is anticipated that some of this hedging will act as a screen for the east side of the new works.

The general character of the area is mixed with industrial and commercial developments to the north and east of the site agricultural and open water to the south and Slatty Waters and the N25 to the west.

1.12.2 Landscape and Buildings

The proposals described in the indicative design provide for the construction of new process tanks and buildings as required to meet the final effluent discharge standards proposed. The tanks may be expected to be no more than 5.0m above existing ground levels while new buildings will be significantly higher. Landscaping in the form of gently sloping mounds planted with shrubbery will soften the impact. Under the indicative design a new preliminary treatment works building is to be constructed which may be up to 15m in height. Landscaping and planting will form an integral part of the proposed work with the contractor required to develop specific landscaping proposals to suit the requirements of his particular design. These proposals may be expected to include the construction of perimeter bunds to the southern and western boundaries, softly contoured screening embankments and tree/shrub planting. Tree planting may be expected to soften the impact of the taller buildings. However it is expected that the taller buildings will remain visible because of the general topography of the area. The type and choice of planting will reflect the indigenous landscape of the area. In time, and with proper care and maintenance, plants, shrubs and trees will become more established and mature, and enhance the visual appearance of the area generally.

The different treatment units comprising a typical works are identified in Figure 1.2. Photo montages illustrating the impact of the development are given in Section 11 of the main body of the report.

1.13 Cultural Heritage

The existing wastewater treatment plant is located South-West of Carrigtohill in the townland of Tullagreen, Carrigtohill, County Cork. The town of Carrigtohill is reportedly named from the Irish *Thuahill*, meaning left handed or North. It is so called because, whereas most of the rocks in that part of the country run east-west, the rocks at Carrigtohill run north-south. The town itself is synonymous with the Earls of Barrymore from the thirteenth to the eighteenth centuries but much earlier settlement activity in the area is also evident.

The existing WWTW and the proposed area of the development was originally a boggy greenfield site. The existing treatment plant has since disturbed most of this ground. That which has not been built on has been landscaped, covered with concrete or stone gravel and used as a storage area.

The impact of the proposed outfall pipeline on the archaeological landscape of the area was assessed using all of the available documentary and cartographic sources. There are three recorded monuments surrounding the proposed development area. It is also possible that previously unrecorded monuments may be uncovered during disturbance of the mud-flats and construction of the outfall pipe. Mitigation measures have been recommended in chapter 12 of this report to prevent any potential loss to the archaeological record.

1.14 Recommendations

The upgrading of the sewage treatment works at Carrigtohill will improve the standard of treatment and allow greater dispersion of the treated wastewater. It is an integral part of the infrastructure to enable growth in the region and is essential to the future development of the town and the greater Cork area. Failure to provide a suitable treatment facility will restrict growth in the town and in the county as a whole.

Mitigation measures will be provided at the site at Tullagreen in order to minimise any potential negative impacts. It is therefore recommended that the proposed sewage treatment works be located there.

In summary, it is recommended that:

- Cork County Council proceed with their proposal to upgrade the wastewater treatment works as outlined in this document;
- This treatment works be sited on council owned land adjacent to the existing WWTW;
- The measures as outlined in this document be provided for the mitigation of any negative impacts on the environment resulting from this development.

2 INTRODUCTION

2.1 Preamble

Throughout the world there is increasing awareness of the immediate and long-term detrimental effects on the natural environment brought about by man's activities. With the growing recognition that all natural resources are finite there is now much greater acceptance of the principle of balancing the needs of man and nature and conserving resources - *i.e.* the principle of sustainability.

Therefore, where significant developments are proposed, it is essential that a systematic examination be carried out to assess the likely effects such developments may have on the environment. This is desirable so as, firstly, to ensure that the development is environmentally sustainable and, secondly, to maximize the positive aspects while, at the same time, mitigating any negative effects of the project on the environment.

The proposed upgrading of the Carrigtohill Wastewater Treatment Works is a necessary step in the development of the area and the provision of the infrastructure required to achieve growth on a sustainable basis.

2.2 Environmental Impact Assessment

The Environmental Impact Assessment is an established procedure for examining the impact of new developments, which because of their size or nature have the potential to have a significant impact on the environment.

2.3 Definition of Scope

This present Study has been prepared for Cork County Council in accordance with the provisions of the following documents, namely:

1) Statutory Instrument No. 349 of 1989 - European Communities (Environment Impact Assessment) Regulations 1989 and (Amendment) Regulations 1994 (SI No. 84 of 1994)
2) Statutory Instrument No. 101 of 1996 - Environment Impact Assessment Regulations (Amendments)
3) Statutory Instrument No. 351 of 1998 - Environment Impact Assessment Regulations (Amendments)
4) Statutory Instrument No. 93 of 1999 - Environment Impact Assessment Regulations (Amendments)

5) Statutory Instrument No. 450 of 2000 - Environment Impact Assessment Regulations (Amendments)
6) Statutory Instrument No. 600 of 2001 - The Planning and Development Regulations 2001
7) Statutory Instrument No. 436 of 2004 - The Planning and Development Regulations 2004

The provisions of the above regulations identify project types that must be subjected to an Environmental Impact Assessment prior to the granting of the necessary approval for the project to proceed to construction stage.

The particular provisions of the Regulations applicable to this study are those pertaining to development by or on behalf of Local Authorities. The subject of this proposal, an extension to a sewage treatment works with associated disposal facilities, falls within the scope of paragraphs 11 and 13 of Part II of the First Schedule of S.I. No. 93 of 1999 - i.e. an extension (>25%) to a wastewater treatment plant with a capacity greater than 10,000 PE.

In summary, the study in the following sections of this document addresses the following issues:

1) The necessity for providing an increase in the capacity of the sewage treatment works at Carrigtohill;
2) The information required in an Environmental Impact Statement as specified in Article 25 of S.I. No. 349 of 1989;
3) Compliance of the scheme with the relevant Plans and Directives including:
    a) The Carrigtohill Town Development Plan (Carrigtohill Town Council, 1999);
    b) Draft Discussion Report (Messrs. Cunnane Stratton Reynolds for Cork County Council, 2003);
    c) SI 254 of 2001, concerning urban wastewater treatment.

This E.I.S. has been prepared by T.J.O'Connor and Associates in conjunction with DHV Water (BV) and input from specialist consultants where appropriate.

The specialist consultants who contributed to this E.I.S. were:

Bord na Mona	Noise study
Envirocon Ltd	Odour study
Dixon-Brosnan Environmental Consultants	Flora and fauna studies

Archaeological Services Unit UCC Archaeological Study

3 DESCRIPTION OF THE PROPOSED WORKS

3.1 Preamble

Carrigtohill is located approximately 10km to the east of Cork city and 6km to the west of Midleton. It is to the north of the N25 (E30) dual carriageway section known as the East Cork [or Eastern] Parkway, which provides a first class road corridor between Cork City and Midleton. The village of Carrigtohill was constructed in the early 13th century, around the same time as Barryscourt Castle. Phillip de Barra built Barryscourt Castle between 1206 and 1234. Originally the village consisted of one long irregular street of 98 small houses and fairs were held there every quarter in the year. In recent years the village has developed into a reasonably large commercial and industrial centre.

The current resident population in Carrigtohill according to the most recent census is given as 2,782 people; this figure is increasing rapidly due to the high level of residential development as Carrigtohill becomes a satellite town for Cork City.

The latest development plan for the area has been prepared on the basis that a firm commitment by the appropriate agencies has been made to re-open the Cork to Midleton rail service. In the 2003 Development Plan the general area to be considered in the SLAP was indicated by a large rectangle with an overall area in the region of 90 hectares, 60 hectares of which is outside the current development boundary. Additional zoned land was added by the SLAP increasing the Carrigtohill catchment serviced area by 112 hectares bringing the total area to 545 hectares. Changes made in September 2005 version brings the total area covered in Cork County development plans for Carrigtohill to 584.1 hectares. The September 2005 SLAP was amended in December 2006 to zone an additional 54 hectares to accommodate the Amgen development. The development boundary is shown on figure 3.2.

In 1976 a Preliminary Report was prepared on the Carrigtohill Sewerage Scheme. In the early 1980's construction work on the sewage collection system and the sewage treatment works near Slatty Bridge was carried out. This existing activated sludge treatment works has a design capacity of approximately 8,500PE. The treated effluent from the works is discharged to Cork Harbour at a location immediately west of Slatty Bridge.

Carrigtohill village and the surrounding area are at a low elevation relative to sea level, and as a result the municipal and industrial sewage has to be pumped to the treatment works. The existing collection network in Carrigtohill is a partially combined system and

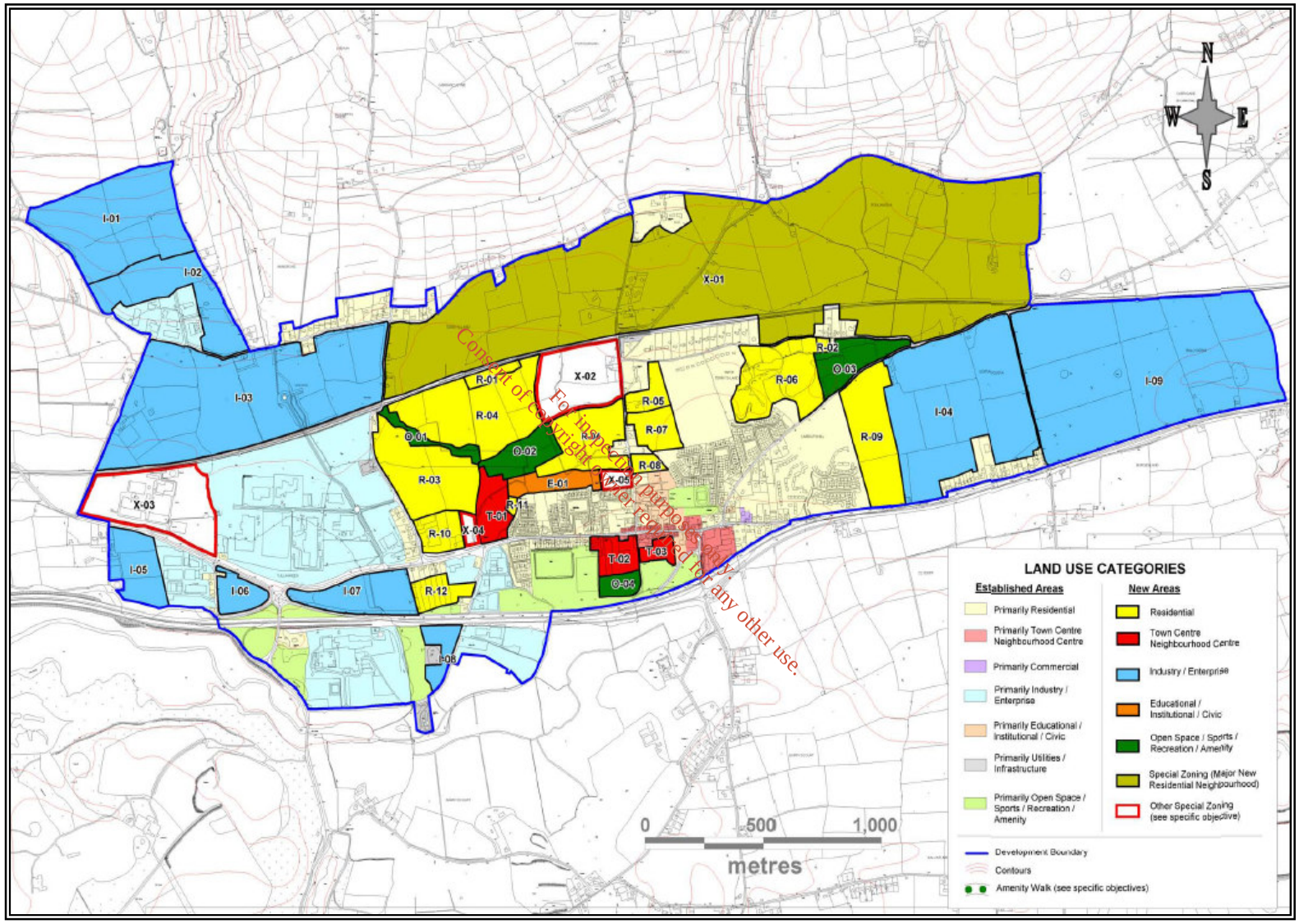


Figure 3.2: Carrigtohill Special Local Area Plan [SLAP] as amended in April 2006.

during extended periods of heavy rain the increased flow to the works causes operational problems at the works.

The present and future needs of institutions and commercial holdings within the catchment also need to be catered for. Using the information currently available regarding land zoning within the catchment boundary it is estimated that the population of the fully developed Carrigtohill catchment will be in the region of 18,433 persons. The population equivalent for the Special Local Area Plan area is estimated to be just under 45,000PE.

A multinational pharmaceutical company, Amgen, have proposed to construct a facility at Carrigtohill with a potential for 2,000 new jobs. The proposed Amgen site is expected to have a final foul and process effluent discharge of 4,000m^3/day once fully operational in the third quarter of 2010. The flow will be balanced to be no greater than 200m^3/hr. This will bring the population equivalent for the combined domestic and non-domestic flows in Carrigtohill to around 62,000 by 2030.

Accordingly there is a need to increase the capacity of the treatment works to cater for the development of the town. The location of the existing works is shown in Figure 3.1.

There were two options considered for the treatment of the additional waste water emanating from Carrigtohill. The first option was to pump the waste water to the Carrigrenan WWTP in Little Island which has a capacity of 413,000 PE and is currently treating a load of approximately 313,000 PE. Currently the Carrigrenan plant has spare capacity of 100,000 PE but is overloaded hydraulically. However this capacity is allocated for growth for areas within Cork City that have no alternative for treatment. The treatment of all or part of the Carrigtohill wastewater will require an extension to the existing plant to maintain the capacity allocated for Cork City.

The second option is the construction of a complete new WWTP at Carrigtohill with a capacity of 62,000 PE. The available site is the existing site plus some adjacent fields, which are already in the ownership of Cork County Council. As such land availability is not a problem. The WWTP will comprise of inlet works (screens and grit traps), activated sludge tanks and final polishing filters. The sludge stream is envisaged to consist of thickening and dewatering. The consideration of these options is discussed in further detail in Section 4 of this Report.

It is proposed to construct a new upgraded treatment plant adjacent to the location of the existing treatment plant to provide treatment capacity for up to 45,000 PE in the first phase and a final capacity of 62,000 PE.

3.2 Carrigtohill Main Drainage Scheme

The Carrigtohill foul /combined system can be divided up, primarily, into two separate areas. The two main pumping stations servicing the catchment define the division within the collection system. The main pumping stations are the town pumping station, which is located on the Old Cobh Road [cul-de-sac], and the IDA pumping station [Nr.1] located to the east of the main entrance into the IDA development.

The town [Old Cobh Road] pumping station takes flows from the town of Carrigtohill. The land serviced by the collection system feeding into the town pumping station is that served by the existing collection system to the east of the pumping station, for about 2.5km to 3.0km between the N25 dual carriageway and the railway line. Foul flows from the Millipore plant site are also transferred to this pumping station.

The IDA pumping station [Nr.1] takes flows primarily from the existing industrial units present in the development south of the railway line. A new IDA pumping station [Nr. 2] has been put in place on the northern side of the IDA's new bridge over the rail line. It is intended that this will transfer the foul wastewater from the new industrial units proposed for this section of the IDA development across the railway line cutting and discharge to a manhole on the southern side of the bridge. The wastewater will then flow by gravity to the main IDA pumping Station [Nr. 1]. A third pumping station [Nr. 3] was constructed in 2004 to collect effluent from the IDA lands north of the railway at the western side of the development. This pumping station transfers to IDA pumping station [Nr. 2]. The IDA pumping station [Nr. 1] also takes some domestic wastewater from seven dwellings on the eastern boundary of the IDA development.

Areas not connected to the existing foul system include the following:

- The business park located across the road and to the south of the Old Youghal Carpet site – soon to be connected to the IDA PS (Nr 1)
- All the area north of the railway line [except for the IDA lands recently connected]
- The houses to the south of the junction between the Main Street and the road north to Wise's Bridge.
- The commercial units to the east of the junction between the Main Street and the

road north to Wise's Bridge.

These areas use septic tanks to treat their effluent.

The existing foul/combined sewers are generally in good condition except for the old vitreous clay pipeline that services the Main Street. It is proposed that this pipeline shall be replaced as part of any proposed wastewater collection system construction contract. There are other sections of the existing collection system within the catchment that require rehabilitation. The layout of the existing sewers and proposed extensions are shown in Figures 3.2 and 3.3.

3.3 Existing WWTW

The original wastewater treatment plant was built in 1978, on a raised site south of the town of Carrigtohill. Access to the site is gained via the "Old Cobh road" (from Slatty bridge to Carrigtohill Village).

The plant was originally designed to cater for a population equivalent of 5,000 PE and consisted of the following:

- Balancing Tank;
- Acid dosing tank;
- Oxidation ditch;
- Settling Tank;
- Outlet Flow Measuring Chamber;
- Sludge Thickening Tank;
- Control House;
- Acid Storage Tank;
- Lime Silo.

A layout of the original plant is given in Figure 3.5

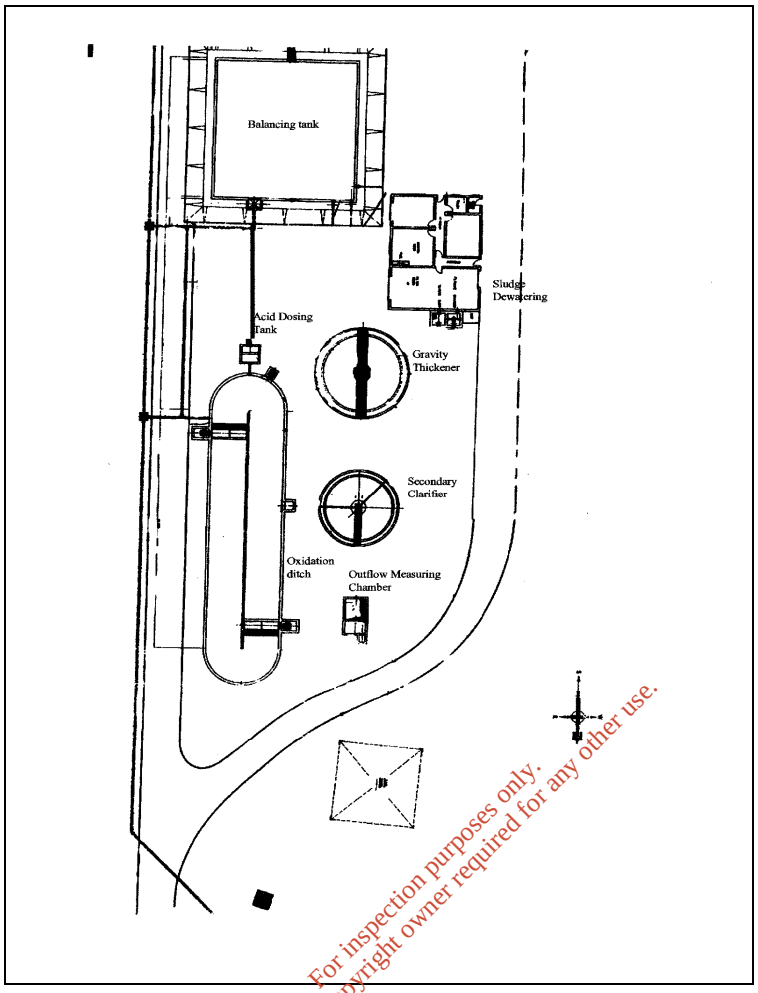


Figure 3.5 Layout of original WWTP (1978)

In 1990, the plant was extended to a capacity of 8,500 PE. The following alterations were made:

- A secondary settlement tank was added. This tank was located between the balancing tank and the oxidation ditch. An excess sludge pumping station was added;
- The balancing tank was converted to an aeration tank via the addition of a floating surface aerator. It was also necessary to install splash plates on the sides of the tank, as the freeboard was not sufficient to contain the spray. As a result the plant was converted into two separate liquid treatment streams;
- Storage tanks were added on the western side of the site to store leachate from Rossmore Landfill;

- The acid dosing chamber downstream of the primary settlement tank was converted to an overflow weir;
- A second aerator (Kessner brush rotor) was added to the oxidation ditch. Walkways were provided to the two rotor locations;
- Various pipework was extended and upgraded to facilitate the increased flows.

A layout plan of the existing treatment plant is given in Figure 3.6 below.

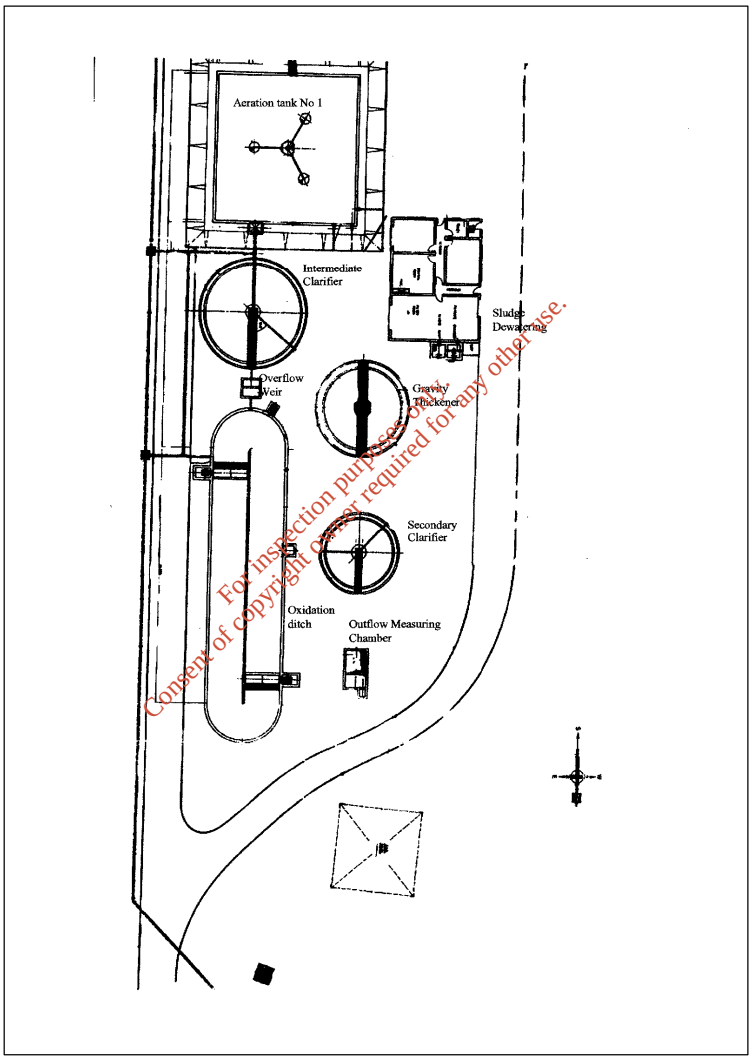


Figure 3.6: Layout of existing WWTP

3.3.1 Liquid Stream

The macerated wastewater is pumped from the two pumping stations to the square aeration tank. Here, it is aerated by means of a floating surface aerator. The water flows to the secondary clarifier via an overflow weir. Leachate from the landfill is tankered to the site and pumped into the oxidation ditch. The oxygen input is by means of two horizontal brush aerators. From the ditch the activated sludge flows into the secondary clarifier, in which the sludge settles. The final effluent of both secondary clarifiers flows over into the outlet flow measurement chamber, from which it flows to the discharge location at the Slatty Waters.

Photograph 3.1: View at Oxidation Ditch and Secondary Clarifier

Photograph 3.2: Acid Dosing Chamber between PST and Oxidation Ditch

Leachate from the Rossmore landfill site is tankered in and discharged into the leachate storage tanks. From there it is pumped into the oxidation ditch. Recent practice is that the leachate is discharged directly into the oxidation ditch. Waste from the Wexport Company was also pumped into a tank beside the oxidation ditch prior to being discharged into the system. However this waste is no longer delivered to the wastewater treatment plant.

Photograph 3.3 Primary settling Tank at Carrigtohill works

3.3.2 Sludge Stream

The waste activated sludge from both clarifiers is pumped via the sludge collection chamber into the picket fence thickener. The sludge is thickened to a dry solids concentration of about 1-5%. The supernatant is returned to the oxidation ditch. The thickened sludge is pumped to the dewatering building, where it is dewatered by means of a belt press. The dewatered sludge is removed by a conveyor belt to an uncovered skip outside the building. The final destination is the Rossmore Landfill. The filtrate off the belt press is pumped to the square aeration tank.

3.3.3 Odour Treatment

Odours from wastewater treatment works are due mainly to the presence of organic matter which decomposes under anaerobic conditions. This can result in the formation of hydrogen sulphide, organic sulphides, mercaptans and organic amines, which result in the characteristic odour associated with sewage. A previous odour and air quality study, found that a low level odour was present at the inlet works and the sludge dewatering building. Odour control modelling of the proposed upgraded plant has been carried out and this is discussed in detail in Chapter 6.

Photograph 3.4 Secondary Clarifier with Flow Measurement Chamber in Background

3.4 Existing Flows and Loads

As outlined above, the wastewater is pumped from two pumping stations to the treatment plant, the Carrigtohill and the IDA Industrial Estate Pumping Stations. Dry Weather Flow (DWF) from the Carrigtohill pumping station appears to be of the order 725 m^3/day. Storm flow rates of up to 2,700 m^3/day have been recorded, and up to 4,400 m^3/day have been reported. The large storm flows are due in part to surface water draining from an older section of the Carrigtohill Bypass (N25).

Typical flow rates from the IDA industrial estate are 330m^3/day. Storm flows are not such a problem for this catchment area, as the foul and surface water drainage is relatively well separated.

Typical outflows from the wastewater treatment plant are 837m^3/day, and typical overflows are 53m^3/day.

The fact that the sum of the inflows and outflows over the month do not equate would indicate some inaccurate recording of flow or else some flows that are not recorded at all. It appears that the overflow is operating continuously, even during dry weather conditions.

Loads

Taking samples of the influent is difficult because of the pumped nature of the influent. There are few samples taken due to the lack of a suitable sampling location.

Photograph 3.5 Sludge Thickening Tank

Table 3.1: Influent Concentrations

Parameter	Concentration mg/l	
Date	22/1/2003	5/2/2003
Unit	mg/l	mg/l
B.O.D.	180	195
C.O.D.	353	590
Suspended Solids.	140	130
Tot. – P	-	2.4
NH_4 – N	15	11.1
pH	7.4	7.3
Sampling Method	24 h comp.	24 h comp.

Other data shows that the approximate load to the square aeration tank is 3,700 PE and that the approximate load to the oxidation ditch is 550 – 750 PE.

There are four major industries discharging to the wastewater treatment plant. Their hydraulic contribution is about 30% of the total flow to the treatment plant, while their biological load accounts for approximately 75-80% of the incoming loads.

Photograph 3.6 Storage Tanks for Leachate from Landfill

3.4.1 Historical Population Trends

The 2002 census Volume 1 was published by the CSO in July 2003. It provides a breakdown of the population figures for the Counties, District Electoral Divisions (DED) and towns. Carrigtohill town is the main town within the boundaries of the Carrigtohill

DED. The remainder of the DED is generally rural apart from a section of Glounthane village, as well as Killahora village, which are within the DED's western boundary.

The census data used in this section was taken from data collected by the Central Statistics Office [CSO] over a period of 31 years, from 1971 to 2002.

Table 3.2 shows the population figures for Carrigtohill town and DED and the overall population of Cork County, Cork City and the State.

Figure 3.6 gives a graphical representation of the data on Carrigtohill shown in Table 3.7.

The census results show the following:

- The line graph showing the DED and town population figures indicates that growth patterns are similar.
- A sharp rise in population figures for both the DED and town between 1970 and 1979.
- There was a levelling off of the population for both DED and town between 1979 and 1996.
- The 2002 figures indicate that there is an increased growth for the DED population
- The 2006 figures show a 100% increase in the population in the town from 2002

Due to the large demand for serviced land within easy commuting distance of Cork City, the population in this area has, even since the 2006 census, already increased significantly and this is expected to continue over the coming years.

If the historical population figures for the Carrigtohill DED and town are used to produce a linear trend line it can be seen that the population of the region is expected to continue growing to a figure of around 4,400 persons in the DED and around 1,800 for the town by the year 2020. However, the 2006 figures show a break with the earlier pattern and it is believed that historical trends currently available for the Carrigtohill environs do not provide a realistic picture of the future population figures in the area under consideration for the following reasons:

- The recent expansion in economic activity continues to put pressure on housing availability in population centres like Cork City. The close proximity of Carrigtohill to the city makes it an ideal location for suitably serviced lands to help cater with Cork

City's housing needs.

- The new planning permissions granted within the catchment for developments that are currently under construction. These include a development by Gable Holdings Ltd, which will have in the region of 1,600 dwellings.

- The current requirements of planning authorities are that lands being developed be suitably serviced for sewage collection and treatment. Therefore, if a suitable wastewater collection system and treatment facility is put in place, it is very likely that development of Carrigtohill will continue until the design population of the scheme is reached. A factor inhibiting further housing development in Carrigtohill has been the inability of the existing collection system and treatment works to cater for any further large increases in either domestic or non-domestic effluent.

- With the improvements in the transport infrastructure i.e. the improved N25 bypassing the town along with easy access to the Jack Lynch Tunnel and the proposed reopening of the railway connection to Cork city, it is expected that Carrigtohill will have a rapid population growth over the next 20 years.

- The Cork Area Strategic Plan [CASP] considers the Carrigtohill area to be an area with significant growth potential for both residential and industrial/enterprise developments. CASP will be discussed in more detail later in this chapter.

Table 3.2: Population of Carrigtohill village & DED, Cork County & the State 1971 – 2002

	Census Results							
Area	**1971**	**1979**	**1981**	**1986**	**1991**	**1996**	**2002**	**2006**
Carrigtohill Town	622	1,170 *[88.1%]*	1,198 *[2.4%]*	1,272 *[6.2%]*	1,212 *[-4.7%]*	1,232 *[1.7%]*	1,411 *[14.5%]*	2782 *[97.2%]*
Carrigtohill DED	1,785	2,781 *[55.8%]*	2,831 *[1.8%]*	3,017 *[6.6%]*	3,035 *[0.6%]*	3,115 *[2.6%]*	3,507 *[12.6%]*	4875 *[39.0%]*
Midleton Rural Area	13,315	16,629 *[24.9%]*	17,248 *[3.7%]*	18,045 *[4.6%]*	17,877 *[-0.9%]*	18,558 *[3.8%]*	21,054 *[13.4%]*	*26,633* *[26.5%]*
Cork County	224,238	257,851 *[15.0%]*	266,121 *[3.2%]*	279,464 *[5.0%]*	283,116 *[1.3%]*	293,323 *[3.6%]*	324,843 *[10.7]*	361,877 *[11.4%]*
Cork City	128,645	138,267 *[7.5%]*	136,344 *[-1.4%]*	133,271 *[-2.3%]*	127,253 *[-4.5%]*	127,187 *[-0.05%]*	123,338 *[-3.0%]*	119,418 *[-3.0%]*
CORK City & County Total	352,883	396,118 *[12.3%]*	402,465 *[1.6%]*	412,735 *[2.6%]*	410,369 *[-0.6%]*	420,510 *[2.5%]*	448,181 *[6.6%]*	481,295 *[7.4%]*
State	2,978,248	3,368,217 *[13.09%]*	3,443,405 *[2.23%]*	3,540,643 *[2.82%]*	3,525,719 *[-0.42%]*	3,626,087 *[2.85%]*	3,917,336 *[8.03%]*	4,239,848 *[8.23%]*

Note: Figures given in brackets equal the percentage change between census result and the previous result.

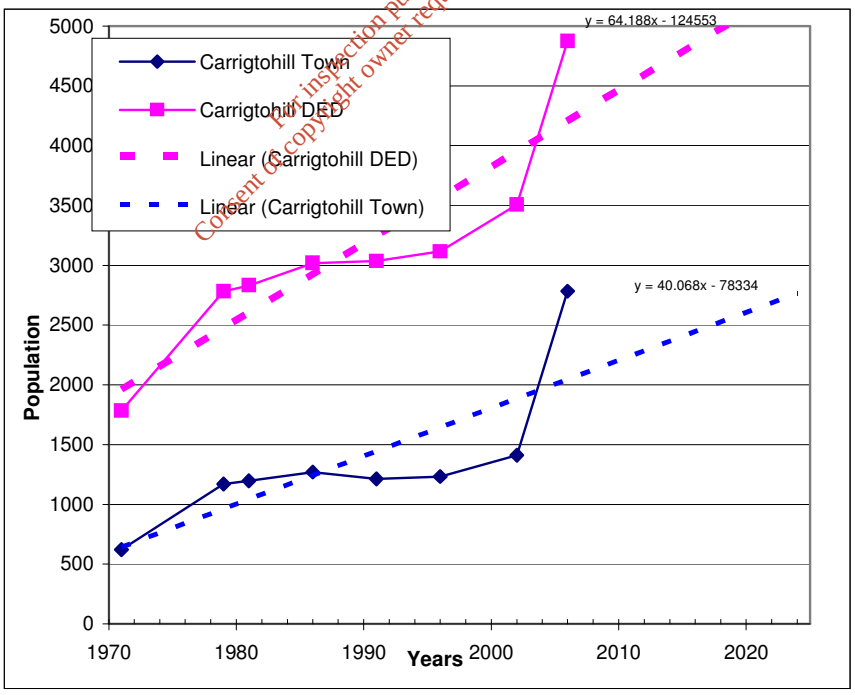
It should be noted there was an 8-year inter-census period between 1971 & 1979 and a 2-year period between 1979 & 1981.
Source: CSO Census of Population, 1971 to 2002

Table 3.3: Population / Households

	Total	Permanent Private	Temporary Private	Non-private
Carrigtohill DED				
No of Households	900	889	6	5
Number of persons in Households	3,115	3,072	21	22
Persons / Household	3.46	3.46	3.50	4.40
Carrigtohill Town				
No of Households	366	365	-	1
Number of persons in Households	1,232	1,225	-	7
Persons / Household	3.37	3.36	-	7.00

Source: Census 1996.
Note: CSO Quarterly National Household Survey = 2.97 persons / household in 2002

Figure 3. 7 Census Population figures 1971 to 2006 for Carrigtohill village & DED with a linear trend line applied.



3.4.2 Current Domestic Population

The latest census figures available (2006) showed a total population of 2,782 in Carrigtohill town. This represents an increase of 97% since the 2002 Census. The population has already increased above this figure since the Census due to the scale of development.

Based on the existing domestic population equivalent of approximately 2,782, the resulting average daily flow to the plant is 646m^3/d and the average daily BOD load is 167 kg/d.

3.4.3 Current Commercial Discharges

Based on the areas set aside in the development plans for Carrigtohill, it is estimated that in a fully developed Carrigtohill catchment, the commercial/institutional portion of the wastewater discharges in the catchment will account for 4.3% of the total volume. This is much lower than the typical figure of between 10% and 20%; this is due primarily to the very large area set aside for industrial development in Carrigtohill. When the commercial/institutional discharges are compared to the domestic discharges they are equivalent to 13.3%.

Table 3.4: Commercial Wastewater

Description	Objective No	Objective Area	Total Area	Water Usage	
Specific Zoning Objectives			*(Ha)*	*l/ha/day*	*m^3/day*
• Industry, Enterprise or commercial (non town centre) uses.	X-01 (CTWL 5.1)	9.68 (Assumed 20% area non-domestic)	1.936	10,000	19.36
• Industry Enterprise & Commercial	X-02	13.32			
• Retail Supermarket selling convenience goods & associated car parking	X-03	0.97	14.29	10,000	142.97
Town / Neighbourhood Centre					
• Existing – Primarily Town / Neighbourhood Centres	-	3.98			
• Proposed Town / Neighbourhood Centres.	T01, T02, T03 & pt. of SLAP 7.2	7.23	11.21	10,000	112.10
Commercial					
• Petrol Station (existing)	-	0.22		10,000	2.22
				TOTAL	**276.65**

3.4.4 Current Institutional Discharges

In general as the population of any catchment increases, there will be a concurrent increase in the volume of discharges from new or extended commercial and institutional establishments. That is to say, as the population grows, new or extended facilities, such as schools, shops, public houses, restaurants, garages etc will be required to satisfy demand.

According to water meter readings, provided by Cork County Council for the secondary school, a total annual water usage of 17 m^3 per annum is used, which would imply a daily water usage of less than 100 litres. As the figures provided would appear to be inaccurate an approximation of the current and future wastewater flows has been estimated in the calculations for institutional flows.

Table 3.5: Institutional Wastewater

Description	Objective No	Objective Area	Pupils /staff	Water Usage	
Educational, Institutional & Civic			*Nr.*	*l/hd/day*	*m^3/day*
• Current School Population		3.6	974	45	43.83
• Increase in school population (18,432 – 1,411)*0.3		9.6	5,107	45	229.80
				TOTAL	**273.63**

3.4.5 Current Industrial Discharges

The September 2005 SLAP proposes that any future industrial development requirements for Carrigtohill will occur in land to the west and east of the village centre. A total of 638 hectares has been given specific zoning allocations in the plan. The existing industrial lands cover an area of 73.5 hectares (12.6%) and these are not yet fully developed. The proposed industrial lands cover an area of 124.5 hectares (21.3%). Therefore, over 33.9% (198.0 hectares) of the entire Carrigtohill development area has been zoned as Industrial.

The largest industrial estate in Carrigtohill is the Irish Development Authority [IDA] industrial estate. The main pumping station in the IDA estate transfers all the foul wastewater to the existing wastewater treatment plant and is located in the southeast corner of the IDA lands. This station also takes some domestic wastewater (~7 connections).

The other areas within the catchment that cater currently for industrial units are either connected to the collection system that flows to the Cobh Road [or town] pumping station or have their own septic tank/ treatment facility on site.

Photograph 3.7 Main IDA Pumping Station

Photograph 3.8 IDA Pumping Station to North of railway Line

Table 3.6: Industrial Wastewater

Description	Objective No	Objective Area	Area	Water Usage	
Industrial & Enterprise Areas			*(Ha)*	*l/ha/day*	*m^3/day*
• Existing Industrial lands (Not fully developed)	-	73.5	73.5	28,000	2,058.4
• Industry &/or warehousing & distribution.	I-01 I-02 I-03	20.3 10.6 43.7	74.6	28,000	2,090.7
• Large Stand alone Industry	I-04	32.3	32.3	28,000	903.3
• Office Based Industry	I-05 I-06	2.7 6.8	9.5	10,000	95.3
• Industrial estate development of small to medium light industrial units.	I-07	2.3	2.3	28,000	63.3
• New industry at Cobh Cross	CTWL SLAP 9.4	5.8	5.8	10,000	57.6
Additional Industry outside Development Lands					**5,268.6**
• Amgen Site	currently not zoned	54.0	54.0	52,778	4,000.0
				TOTAL	**9,268.8**

In addition to the future flows from industrial zoned lands covered in the SLAP, provision has been made to receive an additional 4,000m^3/day of foul and process effluent from the proposed Amgen facility on an IDA site not currently zoned to the east of the development boundary. Flows from the site will be balanced and the predicted maximum hours flows from the site is given as 200m^3/hr.

Application of this additional 4,000m^3/day from the Amgen facility would increase the total projected Industrial Flow to 9,270 m^3/day. This is a significant increase and in terms of hydraulic loading would add an extra 17,778PE (hydraulic load) to the population equivalent based on the SLAP alone.

3.4.6 WWTW Records

The treatment works for Carrigtohill was originally designed to produce an effluent, which would comply with the Royal Commission Report of 1912 with a permitted sewage discharge to rivers containing a BOD of 20 mg/L and a SS of 30 mg/L.

Sampling of the works effluent over the past two years, as indicated in Table 3.7, suggests that the standard achieved is not always below the original 20/30 target. Sampling to date does not take into account any possible discharge of overflows from the oxidation ditch.

The relatively high average concentrations are due to a number of overflows during storm conditions. Appendix M includes the monthly effluent data for the years 2006 and 2007 (January to June).

Table 3.7: Effluent Concentrations

Parameter	Average Concentration mg/l		Maximum Concentrations mg/l	
Year	2006	2007	2006	2007
Unit	mg/l	mg/l	mg/l	mg/l
B.O.D.	16	31	31	129
C.O.D.	172	267	207	314
Suspended Solids.	48	187	68	72
Tot. – P	1.9	7.4	3.78	10.23
PH	8.0	7.5	112	79

3.4.7 Summary

The figures shown above, though derived from different sources show a reasonable level of consistency in terms of the flows and biological loads generated and the proportion of

the domestic, non-domestic and infiltration elements of the total. Table 3.8 below provides a summary of the figures that have been calculated as being the existing loads on the treatment works.

Table 3.8 Summary of Current Loadings

	Volumes m^3/day	**PE**	**COD** Kg/day	**BOD_5** Kg/day	**S.S.** Kg/day	**N_{ki}** Kg/day	**P** Kg/day
Current	2,087	9,276	1,391	557	696	106	16

Effluent characteristics assumed for domestic, commercial and institutional effluents are as follows:

Table 3.9 Typical Effluent Characteristics

COD	150 g/hd/day
BOD_5	60 g/hd/day (240 mg/l)
SS	75 g/hd/day (300 mg/l)
N_{ki}	11.4 g/hd/day
P	1.7 g/hd/day

3.5 Future Flows and Loads

3.5.1 Background

The 2006 population figure for people resident in the Carrigtohill area is 2,782 persons in 887 households and, along with the industries and commercial premises and the estimated 1,300 people plus employed in the catchment, it brings the current population equivalent up to around 6,500. The current collection system and wastewater treatment plant provides for the existing village but neither provide sufficient capacity to allow the village to expand to the potential envisaged in the current development plans set out by Cork County Council.

As planning authorities all over Ireland are discouraging ribbon developments in the countryside and encouraging residential construction to occur in the more controlled and better serviced urban centres, an increase in the Carrigtohill catchment population is to be expected. The Development Plan for Carrigtohill, prepared by Cork County Council in 2002, designates a significant area of land for future development. The draft Plan permits extensive residential and non-residential development, within the Carrigtohill area. Servicing of the lands to accommodate the proposed developments is therefore of some importance.

To establish a future population figure, the 2003 Cork County Development Plan, the amended Special Local Area Plan (September 2005), the Cork Area Strategic Plan, the National Spatial Strategy Report and the two reports commissioned by Iarnród Éireann on the rail infrastructure in Cork, were studied and taken into account.

3.5.2 Future Domestic Populations

The current County Development Plan sets out as concisely as possible Cork County Council's thinking on planning policy until the year 2011. The Council adopted the final Development Plan in mid January 2003.

Carrigtohill has been designated as a satellite town within the Metropolitan Cork area. The concept of 'Metropolitan Cork' was put forward as part of the Cork Area Strategic Plan [CASP] as discussed in the previous section. The objectives as set out in the County Cork Development Plan for Carrigtohill and the general Metropolitan area are as follows:

(a) To promote the city, its suburbs, satellite towns, strategic industrial areas and villages as a single unified entity with a single jobs and property market

(b) To develop and support an integrated transport system and the level of social, cultural and educational facilities required by a modern European city.

(c) To establish 'Metropolitan Cork' as a prominent element in the network of settlements and as the key economic hub of the region.

(d) To promote the satellite towns as important residential, service and employment centres with strong distinctive individual identities.

(e) To promote high levels of community facilities and amenities within the satellite towns and to enhance their clearly defined greenbelt setting with good public transport connections to the city.

The Cork County Development Plan (January 2003) gives a population figure for Carrigtohill village for the year 2000 of 1,680 persons approximately and 540 households. It estimates that by 2011 Carrigtohill will have a population within the town of approximately 8,140 people living in a total of 2,960 households. This is the largest figure for any of the 31 main settlements listed in the Development Plan for the whole of County Cork.

The design residential figure could be based on one of two documents, the CASP recommendations or the 2003 Cork County Development Plan as amended by the Special

Local Area Plan for Carrigtohill (September 2005).

The recommendation of CASP and the subsequent recommendations of the Policy Planning Unit, regarding the proposed rail connection, give an estimated residential population for Carrigtohill in the year 2020 of 15,100 persons with an additional 4,277 dwellings (~ 13,473 persons) coming post 2020 and CASP, giving a total of 28,573 persons. These documents give numbers of new dwellings and a general indication that the higher density housing should be based close to the proposed train station, but do not give specific details.

The calculated residential population figures based on a fully developed Development Plan (including the changes set out in SLAP) would give rise to a residential population of 18,433. Most of the proposed residential lands zoned in the 2003 Development Plan, is currently being developed (in phases), so a large percentage of this population figure could be reached in the short to medium term.

As the Development Plan has allotted specific areas and housing numbers for these areas of land, and CASP was taken into account as part of its preparation, the proposed final design residential population figure to be used as part of this document is 18,433.

3.5.3 Future Non-Domestic Loads

3.5.3.1 Future Commercial Loads

In an effort to estimate the future commercial loads it is assumed that the commercial loads would increase in proportion to the domestic flows, as per a typical ratio calculated at 1 PE commercial to 5 PE domestic. This ratio assumes that 20% of the existing commercial load results from domestic populations which reside outside the collection network area and so will not be subject to the same level of increase.

Taking the maximum growth scenario, with domestic populations increasing to 4,147 PE, the resulting commercial population equivalent increase would be 1,229 PE Assuming as previously that the BOD concentration of commercial wastewaters is comparable to domestic wastewater (300mg/l BOD) this would produce an additional daily commercial load of 74 kg of BOD or 277m^3.

3.5.3.2 Future Institutional Loads

Since it is only necessary to consider discharges from pupils who do not reside within the Carrigtohill collection network area and since the populations in the rural areas surrounding Carrigtohill are not expected to increase due to the government's policy regarding one-off housing, etc. then it is assumed that there will be no significant increase in institutional loads.

3.5.3.3 Future Industrial Loads

Following an announcement in February 2006 it is proposed that an additional 54 hectares of land to the east of the SLAP boundary north of the N25 will be developed as part of the Amgen complex. This development envisages that there will be a workforce of approximately 2,000, employed directly by the company, but that this will also lead to many more jobs in firms used to service Amgen in the Carrigtohill area. It is envisaged that this site will eventually discharge 4,000 m^3/day once fully operational. There may be a requirement to cater for additional loads at the existing WWTW resulting from the construction workforce at the Amgen site (estimated to peak at 1,500 pe) prior to the completion of the new WWTW. In this event an interim upgrade of the existing works may be required.

Some of the flow details that are currently available are as follows:

1. Surface water run off for Q2/Q3 2007 is based on 19,000m^2 of roof installed, with no on-site attenuation in place (and 50mm/hour design rainfall)
2. Surface water run off from Q4 2007 onwards is based on 2l/s/ha over the total site area (54 hectares) with full attenuation in place
3. It is presently assumed that foul and process effluent will be treated on site to a standard comparable to domestic sewage
4. It is presently assumed that foul and process effluent will be balanced on site to provide an average hourly volume not greater than 200 m^3/hr

This development brings the total of land proposed for industrial development up to 265 hectares in Carrigtohill, and the area to be served by the Sewerage Scheme to 638 hectares.

In the calculation of the existing and projected effluent volumes, the following unit rates have been adopted:

Table 3.10 Wastewater Flow Rates

Wastewater Flow Rates	
Domestic:	225 l/hd/day
[Includes for infiltration into the collection system]	
Industry	
Industrial – Light	28,000 l/ha/day
Industrial – Medium	56,000 l/ha/day
Industrial – Heavy	112,000 l/ha/day
Institutional:	
National School (183 school days)	45 l/hd/day
Secondary School	45 l/hd/day
Crèche	45 l/hd/day
Non-domestic:	
Shops & Offices	10,000 l/ha/day

Conclusions

Significant domestic and associated non-domestic development is to be expected in Carrigtohill over the coming years and a substantial increase in the capacity of the treatment works will be required to cater for the increased hydraulic and biological loads. Table 3.11 below provides an estimate of these increased loads and the capacity required to fulfil the planning objectives of the current development strategy.

Table 3.11: Proposed Design Loadings

Sector	Volumes m^3/day	PE	COD Kg/day	BOD_5 Kg/day	S.S. Kg/day	N_{ki} Kg/day	P Kg/day
Domestic	4,147.60	18,434	2,765	1,106	1,383	210	31
Commercial	276.65	1,229	184	74	92	14	2
Institutional	273.63	1,216	182	73	91	14	2
Industrial	5,268.60	23,416	3,512	1,405	1,756	267	40
Other	4,000.00	17,778	3,000	1,200	1,334	240	48
	13,966.48	62,073	9,643	3,858	4,656	745	123

The estimated final design population for the Carrigtohill catchment is as follows:

- A design residential population of 18,433 achievable, based on the SLAP September 2005.
- The design institutional and commercial population equivalent for Carrigtohill is 2,787.
- The design industrial wastewater population equivalent is 24,008.
- The proposed Amgen site will add an additional 54 hectares of industrial lands to that already set aside in Carrigtohill SLAP. It is estimated that the foul and process effluent

from the site which is to be treated on site to a standard comparable to domestic sewage will reach a maximum of 4,000 m^3/day when the plant is fully operational. This is equivalent to a population equivalent of 17,778.

- The design population equivalent for the scheme will be 62,000PE, over an area of 638 hectares

3.6 Site for the Proposed Works

The existing wastewater treatment plant almost covers the whole of the existing site. Three high tension power cables pass over the western side of the existing site at an elevation of about 25 m overhead. A gas main passes adjacent to the eastern boundary of the existing site There is a wayleave of 7 m at each side of the main which make the land to the east of the existing works sterile and unavailable for construction work.

However, the local authority owns lands immediately adjacent to the western boundary of the existing site, which can be used for the extension. A number of streams crossing this site will need to be diverted or culverted and the general ground level will need to be raised to the level of the existing site. It is proposed to locate the new treatment plant in the additional area provided to the west of the existing treatment plant to avoid any conflict with the existing treatment plant, the overhead power lines and the gas main.

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.

It is proposed to construct a plant with a capacity of 45,000 PE on this land adjacent to the existing wastewater treatment plant. The preliminary treatment, sludge treatment and buildings will be designed for the phase 2 capacity of 62,000 PE. When the first phase is commissioned, any of the old existing structures that are not incorporated into the new works will be demolished. The additional SBR capacity for phase 2 will be constructed adjacent to the phase 1 tanks and the necessary pipe connections etc for phase 2 will be allowed for in phase 1.

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 hub centre for a number of smaller plants in the area reducing the need to transport liquid sludge to Carrigrenan.
- The Carrigtohill WWTW would be the treatment centre for leachate from the Rossmore landfill site reducing the requirements for transportation to Carrigrenan.
- Factors mitigating against a move to an alternative site include the construction of lengthy rising mains. These are discussed in more detail in Section 4 of this report

3.7 Effluent Discharge Standards

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

Table 3.12: Proposed Discharge Standards for 45,000 pe and 62,000 pe

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

These standards meet the following regulations:

1. UWWT standard treatment (25:35 BOD:SS)
2. The Phosphorus Regulations

These discharge limits are also in accordance with the recent status of Cork Harbour as a designated sensitive area by the EPA Report “An assessment of the Trophic Status of Estuaries and Bays in Ireland”.

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.

3.7.1 The Urban Wastewater Treatment Regulations (UWWT)

These regulations have been in force in Ireland since 1994 and define minimum levels of treatment for wastewaters to be achieved by specified dates, depending on the population served and on the receiving water body. For Carrigtohill the requirements are stipulated in terms of maximum concentrations (95% of samples) of BOD (25mg/l), Suspended Solids (35mg/l), COD (125mg/l), and Total Phosphorus (2mg/l). The existing Carrigtohill plant is currently operating under the regulations and in general has regularly exceeded the requirements.

The design capacity for phase 1 of the proposed treatment plant at Carrigtohill is 45,000 pe rising to 62,000 pe for phase 2. The model was run based on both of these design capacities.

For nutrients the standard removal efficiency of an activated sludge system was taken as a starting point. The output of the model should determine whether more stringent removal should be necessary for both organic substances (COD, BOD) and nutrients (N, P).
Significantly lower concentrations of certain parameters are proposed for the effluent in connection with other water quality objectives as described below.

3.7.2 The Phosphorus Regulations

These regulations (SI 258 of 1998) known as the Local Government (Water Quality Standards for Phosphorus) Regulations 1998, were brought into force to tackle a significant deterioration in water quality standards in Irish surface waters in the recent past and principally the problem of eutrophication. The regulations call for the maintenance or improvement of the standard of water quality in Irish rivers.

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 UWWTD 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. This was considered for both the neap tide and the spring tide.

At 45,000 pe and a discharge standard of 1 mg/l P the resulting average concentration of phosphorus in the receiving water during the spring tide is 0.031 mg/l (inclusive of the contribution from Carrigrenan). During the neap tide the average concentration at the outfall point is 0.078 mg/l P. This reduces to 0.072 mg/l if Carrigrenan is excluded. While this is slightly higher than the recommended value (0.06 mg/l P) the concentration will reduce to 0.029 mg/l P, as a result of the dispersion, before the water reaches Harpers Island, approximately 900 metres downstream of the outfall point.

At 62,000 pe, the resulting average concentration in the receiving water during the neap tide would be 0.101 mg/l P. The dispersion would result in the recommended concentration being reached before the water reaches Harpers Island, approximately 900 metres downstream of the outfall point. The average concentration at harpers Island would be 0.038 mg/l P.

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.

3.7.3 BOD Levels

As described above, the Urban Wastewater Treatment Regulations sets the discharge standards for BOD at 25 mg/l for plants with a population equivalent of more than 10,000.

In order to determine the discharge standard appropriate to the receiving waters, it is necessary to consider the impact of the discharge, particularly in low water conditions. To do this it is first necessary to establish the background BOD levels in the estuary upstream of the outfall and to estimate the low water expressed as an exceedance probability (percentile).

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 1.55 mg/l during a neap tide with the effect of Carrigrenan included (worst case). During a spring tide the average concentration drops to 0.73 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 (62,000 pe) a discharge standard of 20 mg/l BOD will result in a concentration of 2.03 mg/l in the receiving water. Therefore a discharge of 25 mg/l (in accordance with the UWTD) is appropriate for phase 1 of the development and will be reduced to 20 mg/l BOD for phase 2.

3.7.4 Summary

Considering the Urban Waste Water Treatment Regulations, the various directives and associated regulations outlined above and the existing treated effluent discharge standards, Table 3.12 above summarises the proposed treated effluent standards of the upgraded treatment works.

3.8 Proposed Treatment Process and Operation

As is the nature of DBO contracts, the Contractor may specify which plant he chooses to meet the performance specification. Only those processes capable of meeting the effluent discharge standards and the other requirements identified in this E.I.S. will be accepted. For the purposes of this E.I.S. however, indicative designs have been prepared for the Carrigtohill works. It is anticipated that the successful design would have some or all of the following stages of treatment.

Waste sludge would be pumped to the sludge thickening tank. Thickened sludge would be dewatered on site prior to removal off site for further treatment and / or beneficial re-use. Sludges brought on site from other works would be received at the Sludge Acceptance plant.

The indicative layout of the WWTP in Carrigtohill consists of:

1) Preliminary Treatment

Preliminary Treatment of the incoming sewage is carried out at the inlet works, comprising both screening of the sewage to remove plastic and non-biodegradable matter, and grit removal. On removal, the screenings are washed and compacted for ease of disposal either to landfill or by burial. Oil, fat and grease removal may also be required.

The grit is washed during the removal process to ensure that any organic material is removed thereby leaving a clean material for disposal to landfill.

The Inlet Works are envisaged in a building approximately 17m x 10m in plan and 12 metres high and air treatment equipment will be provided for odour control.

2) Secondary Treatment

This stage comprises biological oxidation of the sewage by an activated sludge process followed by a settling stage. For Carrigtohill, the construction of SBRs is proposed due to the fact that the available site is limited and the footprint of SBRs is substantially smaller than that of a conventional activated sludge system comprising of an activated sludge tank and a final settling tank (The successful tenderer will be free to propose a traditional aeration process as an alternative). The Phase 1 dimensions of the aeration basins are an approximately 20m by 40m and 4.7m (liquid) deep. Provision is made in the layout of the plant for increasing the size of the aeration tank in Phase 2.

3) Tertiary Treatment

Nitrogen removal is envisaged in the SBRs. Phosphorous will be chemically removed in 12 No. rapid sand filters (8 for Phase 1 and another 4 for Phase 2). The dimensions of these filters are 4 m diameter with a filter bed height of 2 m.

4) Sludge Treatment

The sludge removed from the SBRs would be directed to the sludge storage facilities to await de-watering. The sludge is pressed and de-watered to reduce its volume so that it is suitable for transportation to the regional sludge hub centre for stabilisation and reuse. This de-watering operation would be carried out within a closed building, which would also be fitted with air treatment equipment for odour control.

The approximate dimensions envisaged for the various units described above are as follows:

a) Sludge De-watering Building : 15 x 30m;
b) Sludge Holding Tanks : 500 m3 storage capacity;
d) Buffer Tank : 500 m3 storage capacity;

In the event of any inordinate delay to the construction of the treatment plant it may be necessary to implement interim measures to cater for the discharges from the Amgen site. These measures would be required to upgrade the existing plant to treat the increased load and would probably consist of an additional sequenced batch reactor system housed in steel tanks located either within the existing site or, more likely, within the proposed new site. These tanks would be located above ground level (up to 5 metres high) and will have ancillary items such as inlet/outlet chambers, power/aeration building, control room etc. An indicative detail is shown on Figure 3.5A.

3.8.1 Buildings

In addition to the buildings/superstructures to be provided at the Inlet Works and Sludge De-watering Plant, the following buildings will probably be provided:

a) Administration Building incorporating an office/control room, canteen, laboratory, store, toilets etc;
b) A building to house the air compression units (blowers) for the activated sludge process
c) Stores building for the storage of consumables and maintenance equipment.

3.8.2 Safety and Security

Safety measures at the wastewater treatment works will provide for the requirements of those persons who will be working on the site itself and will limit access to the site by unauthorized personnel.

Handrails are provided to all units which are not roofed or otherwise protected, such as the section of the inlet works which is not housed; the aeration tanks; the final clarifiers; the picket fence thickener, together with safety chains to units as necessary. Cages shall be provided to the access ladders on elevated units. All exposed ducts and channels shall have safety grid flooring. Warning and information signs shall be provided, particularly where machinery with moving parts are located. Local knock-off buttons shall be provided on all machines. Life-buoys are placed at strategic locations around water units.

A perimeter security fence is provided with an intruder alarm system linked up to a centralised control station. Floodlighting will be installed. These measures will help deter intruders from entering the works.

3.8.3 Outfall

The final effluent will be discharged by gravity through an outfall pipeline to North Point, where it will enter the Slatty Water estuary. The diameter of the outfall pipe will be between 1200mm and 1500mm in diameter. The route of the outfall pipe will be along the Old Cobh Road and cross the R624 regional road just to the North of Slatty Bridge. The pipeline will then follow a direct route out along the mudflats of the Slatty estuary to a discharge point at the low water mark adjacent to North Point. See Figure 3.10 for details.

3.9 Effluents, Emissions and Residues

Sewage arising from both domestic and non-domestic sources will be treated at the wastewater treatment works at Carrigtohill. The initial and future design pollutant loads are set out in Tables 3.8 and 3.11.

3.9.1 Effluent Standard

The treatment works for Carrigtohill was originally designed to produce an effluent, which would comply with the Royal Commission Report of 1912 with a permitted sewage discharge to rivers containing a BOD of 20 mg/L and a SS of 30 mg/L.

As stated in Section 3.7 the proposed final effluent discharge standard for the Carrigtohill WWTW will take into account the statutory requirements of the Urban Wastewater Treatment Regulations and the Phosphorus Regulations. As a result discharge standards will be set at a higher level than would be required if the statutory requirements were considered in isolation. The resulting discharge standards are shown in Table 3.13 below.

Table 3.13 - Proposed Treated Effluent Discharge Standards

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

In accordance with the urban wastewater treatment regulations, the values for BOD and suspended solids are 95 percentile values while the value for phosphorous is a mean value.

3.9.2 Estimated Quantities of Expected Residues and Emissions

Efficient operation of a wastewater treatment works will significantly reduce, but will not completely eliminate, the various pollutants and a considerable volume of sludge would remain to be disposed of in a safe and environmentally acceptable manner.

The design discharge parameters for the proposed works have been derived from an analysis of the existing estuary water quality and consideration of the potential impact of the discharge from the proposed works. This is discussed in detail in Section 5 of this report.

The expected discharges from the proposed works are as follows:

To waters via outfall pipe at the Phase I (45,000 PE) load based on 225lts per P.E.

- BOD load – 253.1 kg/d
- SS load – 354.4 kg/d
- Total Phosphorus load – 10.1 kg/d

To waters via outfall pipe at the Phase I (62,000 PE) load based on 225lts per P.E.

- BOD load – 279 kg/d
- SS load – 488.3 kg/d
- Total Phosphorus load – 13.9 kg/d

To atmosphere:

- Odour – Air extraction and odour treatment units will be provided to ensure that the odour levels at the boundary of the site do not exceed 1.5 odour units on a 98 percentile basis.
- Noise – No greater than 35dB(A) outside nearest residence at night;

De-watered Sludge for further treatment

- c. 5,749 m^3/annum @ 20% DS; Phase I (45,000 P.E.)
- c. 7,920 m^3/annum @ 20% DS; Phase II (62,000 P.E.)

Screenings and grit removal

- variable but small quantities (typically 1 to 2 domestic wheelie bins per week each).

The pollutant load of the effluent following treatment has been assessed in terms of the waste assimilative capacity of the river in Section 5 of this report. It was found that, if the specified final effluent parameters are achieved, the proposed works will lead to an improvement in the quality of the water in the river. It should be noted that this improvement may be masked by the ongoing agricultural practices in the upstream river catchment.

3.10 Construction

The main construction activities will be excavation and filling, reinforced concrete construction, pipe laying, building works, mechanical and electrical fit out and commissioning of the works. Furthermore, the existing WWTP will be demolished when Phase 1 of the new works is completed and in operation. The main impact on the local environment will be a short term increase in the levels of traffic, noise and dust.

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 traffic can be managed to ensure that deliveries do not unduly affect the local residents. 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. A wheel washing facility will be in place to ensure that no material is dragged on to the local roads.

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.

The impact of the traffic generated in the construction phase of the works is described and assessed at Section 9.3.

3.11 Conclusions

The existing treatment plant in Carrigtohill is severely overloaded and the current effluent discharge standards can only be maintained by the use of temporary Venturii aerators and a high level of supervision and operator intervention. 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 significantly in the short term. An increase in treatment capacity is therefore required to provide for the sustainable development of the town. As part of this EIS and as detailed in section 4 below, 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 to 45,000PE for Phase I and 62,000PE at the end of Phase II as well as any possible interim upgrade of the treatment plant. It is also recognised that the low levels of dilution available in the receiving waters at this location call for a very high standard of final effluent. 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 proposed discharge standards are summarised in Tale 3.16 below

Table 3.16: Proposed Discharge Standards for 45,000 pe and 62,000 pe

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

In the event that an interim upgrade of the existing WWTW is required to cater for the construction loading from the Amgen site as outlined in section 3.5.3.3, this will be provided by installation of a package plant at the existing treatment plant.

For the particular form of procurement (DBO) that will be used to tender works to expand the capacity of the plant, it is not possible to set out the precise layout of the plant that will be constructed. This is because the tenderers will be free to offer their own designs that will meet the requirements specified in the tender documents regarding plant performance, and environmental impact. The typical design described earlier in this section, is indicative only of the general layout of the plant that may ultimately be constructed. However the final design must comply with this EIS in terms of the effluent discharge standards, odour

and noise impacts, visual impacts etc. and only those tenders which meet these requirements can be considered for advancement to construction and operation.

4 ALTERNATIVES CONSIDERED

4.1 Treatment

The standard of effluent required for the new WWTW at Carrigtohill as outlined in the previous sections means that several stages of treatment will be necessary. Alternatives to the indicative design can be considered provided these are capable of meeting the final effluent discharge standards. Some of these alternative treatment methods are described below.

For the indicative design described in Section 3, primary treatment has not been included in the liquid stream option outlined. However primary treatment could be included with other stages provided the final effluent discharge standards can be achieved. Although it is not incorporated in the existing WWTW, it might be considered as an option on the basis that it would reduce the variation in loading to subsequent treatment stages currently experienced at Carrigtohill WWTW. The purpose of primary treatment is to reduce the solids and BOD load by settlement of some of the solid material in the incoming sewage. This provides a balanced flow to the main works.

Secondary and Tertiary Treatment – there are various forms of secondary treatment available all of which rely on bacterial action to remove suspended and dissolved matter from the wastewater. The main methods used would fall into two broad categories; these being the activated sludge process and attached media systems. The activated sludge process involves aeration of a mixture of wastewater and a population of bacteria (sludge) which consume nutrients and dissolved oxygen in the wastewater. These processes include sequencing batch reactors in which the wastewater is batched and treated in a single tank, and conventional activated sludge treatment followed by final settlement. There are many other variations of the activated sludge process involving varying levels of tankage which may offer advantages in particular situations (eg plug flow, deep shaft, stepped aeration, extended aeration, etc). Attached media processes include trickling filters, biologically active filters, and rotating biological contactors. The indicative design is based on the use of sequenced batch reactors. Under the DBO contract proposed for the procurement of the works, tenderers for the Carrigtohill WWTW would be free to offer such processes.

The main alternative to the filtration with coagulation proposed in the indicative design described would be membrane treatment or via constructed wetlands. These methods can produce very high quality effluents. Owing to limitations with respect to the size of the site,

constructed wetlands could not be considered as this would typically require 1m^2 per PE for effluent polishing. Secondary treatment processes of the type described above cannot produce an effluent of the required quality and a tertiary treatment stage will be needed.

4.2 Sludge Dewatering Processes

The County Cork Sludge Management Plan designated the WWTW at Carrigrenan as the hub centre for the treatment of wastewater sludges in the county. All wastewater treatment sludges arising in Carrigtohill are to be dewatered prior to onward transportation to Carrigrenan for treatment. Provision will also be made for accepting and dewatering imported liquid sludges from a number of smaller wastewater treatment plants near Carrigtohill to minimise transportation costs to the hub centre in Carrigrenan.

The indicative design provides for dewatering of sludges using new belt presses. Any alternative to belt presses which is capable of producing a sludge cake of the required dry solids content could be considered. This would include centrifuges with or without pre-thickening using gravity belt thickeners. A proposal to use centrifuges and/or gravity belt thickeners would not have any impacts beyond those associated with the belt presses described in the indicative design. Air from the sludge dewatering building will be extracted and treated regardless of the technology chosen.

4.3 Alternative Treatment Plant Locations

The existing site for the WWTW has a number of advantages over any proposal to relocate the plant elsewhere. These would include:-

- The existing collection system is designed to deliver the raw sewage to the existing site
- There is an established land use at the existing site.
- There is sufficient space available at the existing site to allow construction of the new plant without interfering with the operation of the old plant
- It is in reasonable proximity to the source of the wastewater at Carrigtohill
- No new land has to be acquired

The disadvantages of locating the plant at the existing site include

- The available dilution at the existing outfall point is low – an outfall pipe is required to discharge the final effluent at North point to get improved dilution/dispersal

The following sections examine the alternatives considered and compare the advantages and disadvantages of these alternatives with the proposed development at the existing site.

4.3.1 Alternatives Considered

The existing WWTW has sufficient land available in the ownership of Cork County Council to allow construction of the new treatment plant without interference with the operation of the existing plant. There are also a lack of suitable alternative locations along the coastline due to the route of the N25 and the proximity of the N25 to the coast line. As a result the existing WWTW site was considered the optimum location for a treatment plant in the Carrigtohill area. It was proposed to construct the new plant on the western side of the existing plant due to the presence of the main gas line on the eastern side and the presence of the high voltage ESB line over the existing plant.

The alternative considered for the treatment of the sewage arising from Carrigtohill was to transfer the sewage to Carrigrenan and treat at that location.

4.3.1.1 Carrigrenan WWTW

The Cork Main Drainage Scheme includes major sewer works in the city of Cork as well as interceptor sewers along the banks of the River Lee, a Pumping Station at the Atlantic Pond, two rising mains from the Atlantic Pond to the Header Chamber at Mahon, a twin siphon across Lough Mahon and a treatment plant at Carrigrenan.

1. The design capacity of the wastewater treatment plant in Carrigrenan is 413,000 PE and it is designed to accommodate flows from Cork City, Tramore Valley, Glounthane, Glanmire and Little Island areas. The plant is in operation and is treating a load of approximately 313,000 PE but is overloaded hydraulically.

The liquid stream comprises screening, grit removal, primary sedimentation, sequenced batch reactors (SBRs) and final sedimentation. Sludge will be reduced to a pasteurised, dry granular material. Very strict measures are taken for odour emission prevention (coverage of main sedimentation tanks, housing of primary treatment and sludge treatment combined with extensive air treatment).

The final effluent is designed to be in accordance with the Urban Wastewater Treatment Directive, i.e. 25 mg/l BOD and 35 mg/l Suspended Solids. Final effluent is discharged at Marino Point, where the good depth of water facilitates dispersion of the effluent.

The complete capacity of the plant is reserved for the domestic and industrial loads within the catchment of the plant. At the time of drafting this Preliminary Report, the hydraulic capacity of Carrigrenan has already been reached, while the biological load is less than the design capacity. This is expected to be caused by significant infiltration into the collection network.

Space has been retained for the expansion of the plant and also for the addition of nutrient removal facilities.

The Carrigrenan WWTW has capacity for a predefined catchment in the environs of Cork City. The areas to be served by Carrigrenan have no alternative treatment route and the capacity designated to these areas must be retained. Cork County Council may also need to provide a treatment solution for additional areas such as Killeens, Whitechurch and perhaps, Waterfall in the future. Transfer of the wastewater to Carrigrenan would provide an attractive solution for these areas. The River Basin Management Plan, which is currently being drafted, may place limits on any expansion to the WWTWs at Ballincollig and Blarney. In this event the only alternative would be to transfer part or all of the wastewater from these areas to Carrigrenan. There is also a proposed new town to the north of the city at Monard (approximately 15,000 PE) and any wastewater arising from this development will have to be transferred to Carrigrenan.

In general the areas to the north and west of Cork City have no alternative other than Carrigrenan.

We have considered two different sub-options:

1a) Treatment of the wastewater arising from Carrigtohill in the existing WWTP in Carrigrenan. This can only be achieved by significantly reducing the infiltration rate into the city collection network.

1b) Construction of a new phase at Carrigrenan to cater for the wastewater from Carrigtohill.

4.3.1.2 Pipeline Routes Considered

Different routes from Carrigtohill to Carrigrenan have been investigated. These are:

1. Along the N25 E1 Motorway;
2. Along the old Youghal Road to Glounthane;
3. Through Fota Island.

Route 1: Along the N25 E1 Motorway

A suitable route for the rising main from Carrigtohill to Carrigrenan would most likely be along the southern edge of the N25. The estimated length would be approx. 6 km, and the rising main would be approx. 525 mm in diameter. This rising main is sized on the basis that the storm flows would be stored at Carrigtohill, and only 3DWF would be pumped to Carrigrenan. A foreshore licence may be required from the Department of the Marine for this pipeline route, if the rising main has to be located in the foreshore. Such a foreshore licence may require an EIS.

Archaeological sites along this route should not be significant if the route taken by the N25 is followed. The site investigation undertaken for the N25 roadway may be of benefit. The NRA have indicated that this route would not be available due to plans to upgrade the N25 to motorway status in the future.

Route 2: Along the Old Youghal Road to Glounthane

The section of the old Glounthane road from Glounthane to where the Cobh railway veers away from the main road is designated a "Scenic Route" under the County Development Plan 2003. However the route is along the main road and is not expected to negatively impact upon any of the scenic elements of the route. Traffic numbers are reduced on this road since the opening of the N25 dual carriageway. This route does not involve any crossings of the estuary. The Glounthane scheme has been designed to pump wastewater from beside Glounthane Church to the plant at Carrigrenan. The proposed pumping route is via the Little Island Interchange through Flaxfort and onto Carrigrenan. There is a crossing of the Midleton Railway line.

Route 3: Through Fota Island

If the pipe is laid in a straight line from the Carrigtohill Pumping Station to the wastewater treatment plant at Carrigrenan, the route may be only 5,000 m long. The Cork Main Drainage Preliminary Report estimated that the length of rising main would be approx 5 km, and would need to be 450 mm in diameter. This length assumes a route across Fota Island. This route is potentially the shortest route, however there are a substantial number of problems to be overcome:

- Getting a wayleave for a pipeline across the island, which may include crossing Fota Golf course, would be difficult.
- The entire island is designated "Scenic Landscape" under the 2002 County Development Plan. It may be difficult to find a suitable route outside of the new

Fota Development. The area has a high amenity value (Fota House and Gardens, Fota Wildlife Park, Fota Golf Club).

- The Cobh road is heavily loaded with traffic (count of 12,000 vehicles/day according to the Area Engineer). This road consists of a series of bends and has short lines of sight. There is no hard shoulder, so that one-way traffic controls would be required during pipelaying.
- There are large stonewalls on either side of the road associated with the Fota House demesne. There are two old watermains, which would have to be avoided (a 12" AC and a 8" CI) as they could be damaged by pipelaying adjacent to them.
- There is no grass margin, so the traffic would have to be reduced to 1 way. This could cause significant disruptions.
- Here are substantial road upgrading works to be carried out over the next few years. Belvelly Bridge is not due to be upgraded. If the pipelaying works were to proceed at a separate time to the roadworks, the disruption to road users could be excessive.
- After crossing Fota Island, there is still the difficulty of crossing the channel between Fota Island and Little Island. It appears that the route through Fota Island is not a suitable route for the pipeline.
- A Foreshore Licence would be required for the pipeline crossing the channel between Fota Island and Little Island

The preferred route is the route via Glounthane. The route is the longest but causes the least impact en-route. It is separate from the N25, so that it does not affect the upgrading of the road to motorway status.

4.3.1.3 Conclusions

The available capacity at Carrigrenan is required for the needs of Cork City and the areas to the west of Carrigtohill.

Cost estimates were produced to compare the option of upgrading the WWTW at Carrigtohill to the option of treating at Carrigrenan. Based on whole life costs for both alternatives the option to construct the WWTW at Carrigtohill offered better value for money.

4.3.2 Alternative Outfall Locations

Instead of relocating the wastewater treatment works, the option of relocating the outfall to a point further downstream was also considered. The harbour model was used to identify the optimum location of the outfall point for the effluent based on dispersal within the receiving waters. It was established that relocation of the outfall location to North Point would offer substantially improved dispersion than the existing location. Relocating the outfall beyond North Point would not result in an increase in dispersion of significance to justify the additional cost.

Photograph 4.1 Existing Outfall to Slatty Waters

4.3.3 Conclusion

There are strong strategic reasons for developing a separate wastewater treatment plant at Carrigtohill. This will 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 development of a wastewater treatment plant at Carrigtohill is the most economically advantageous option.

It is also proposed to use the wastewater treatment plant for Carrigtohill as a sludge hub centre for a number of smaller plants in the area. In the absence of the sludge hub in

Carrigtohill all sludge would need to be transferred by road to Carrigrenan with increases in cost, traffic and pollution.

The Carrigtohill WWTW would also be the treatment centre for leachate from the Rossmore landfill resulting in lower transportation costs than if the leachate were to be transferred to Carrigrenan.

The alternative of transferring the raw sewage to Carrigrenan offers no significant environmental benefit over the proposed expansion of the plant at the existing site. The associated loss of capacity for Cork City and the areas to the north and west of Cork would create a need for additional inland treatment plants in these areas with associated environmental disadvantages.

Relocating the final effluent outfall to the north point offers better dispersal than the existing outfall location. Extending the outfall beyond this point offers limited additional environmental benefit when compared to the costs involved. It is concluded that the expansion of the existing plant with the outfall relocated to North Point has the least environmental impact of all the alternatives considered and that such an expansion can be accommodated at this site without causing undue negative environmental impacts.

5 WATER

5.1 Slatty Waters

The existing treatment works discharges into Slatty Waters downstream of Slatty Bridge. Slatty Waters is the name given to the estuary at the eastern end of the upper Cork Harbour. The water body forms the divide between Fota Island and the mainland to the west of Carrigtohill. The following bound the water body:

- To the east are the sluice gates at Slatty Bridge
- To the north is the mainland
- To the south and south east is Fota Island which is connected to the mainland
- To the west is the northern channel (the railway line may be taken as the boundary.)
- West of the northern channel is Little Island and Lough Mahon.
- Harper's Island and Brown Island are located at the western end of the water body.

The water body is approx. 150 – 250 m wide and 2950 m long from Slatty Bridge to the railway bridge near Harpers Island. There is a low level of freshwater discharge into Slatty Waters. The main body of water is saline and tidal. The only exit/entry point for the saline water is at the west end of Slatty waters adjacent to Harpers Island. The dilution and mixing of the water is provided entirely by the ebb and flow of the tides.

The Slatty Water Estuary forms part of Special Area of Conservation (SAC) no. 1058 known as the Great Island Channel. This SAC contains an important variety of birdlife. A description of this SAC is included in Appendix N.

There is (also) shellfish farming in the North Channel (east of Belvelly Channel), close to Midleton. The North Channel is separated from Slatty Waters by Fota Island.

This section of the EIS examines the available water quality data for the Slatty Waters and sets out final effluent discharge standards appropriate to the background pollution levels and the available dilution. A separate assessment of the impact of the discharge on the aquatic flora and fauna is presented in chapter 8.

5.1.1 Receiving Environment

5.1.1.1 Receiving Water Quality

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 loading on the existing plant exceeds the design capacity and the effluent regularly exceeds the specified standard. The location of the outfall is immediately to the west of Slatty Bridge with minimal dispersion. The existing plant is contributing to the current level of nutrients in Slatty Waters.

A new treatment plant to treat the waste from Cork City has been constructed at Carrigrenan (on Little Island). This plant discharges waste treated to 25:35 BOD:SS standard at Marino Point.

5.1.1.2 Previous Water Quality Studies in Cork Harbour

A number of studies on the water quality in Cork Harbour have been carried out previously by local authorities, statutory 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) has been recorded in Cork Harbour, namely Alexandrium Tamarense in 1996 and 1997 (Marine Institute 1999).

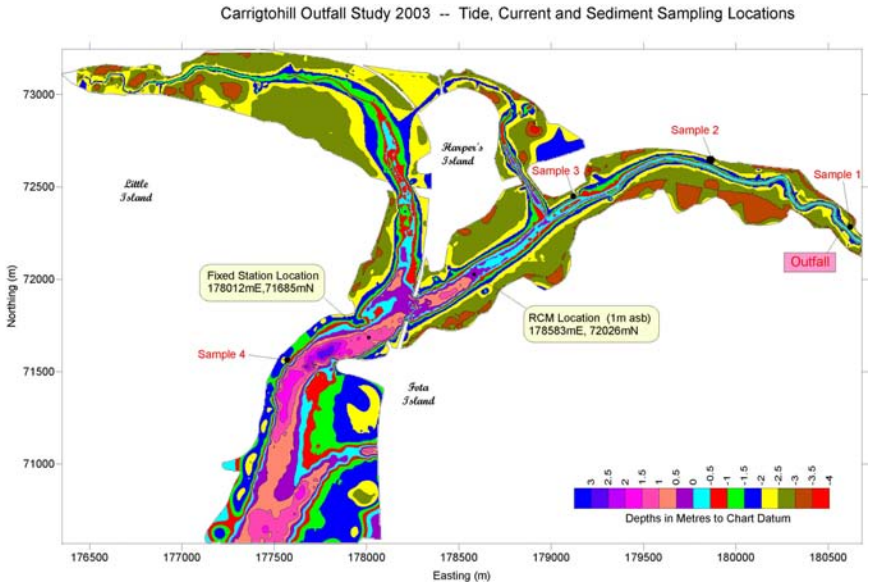
5.1.1.3 Modelling of the Harbour

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 MIKE 21 and was developed by the Danish Hydraulic Institute (DHI). The two modules of the MIKE 21 software used in the study were MIKE 21 HD (Hydrodynamic Module) and MIKE 21 WQ (Water Quality Module).

The approach adopted 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 impacts of various discharge scenarios from the Carrigtohill outfall for both Spring and Neap tidal conditions.

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 runs successfully and gives reliable results it is necessary to include a large area extending beyond the area of interest. Therefore, for this study, even though the Slatty Water Estuary and Upper Harbour 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 lengthened the simulation time.

Figure 5.2 Model showing Bathymetry (Plot units: m Chart datum)



The model was calibrated by running the same simulation until through adjustment of the model parameters the model satisfactorily reproduces the field conditions. Once the model was calibrated using one set of field conditions (spring tide) it is then validated using a different set of conditions (neap tide). In the case of the cork Harbour model, good agreement was achieved relatively quickly. The dispersion characteristics of the Slatty Water Estuary were determined by simulating one of the dye releases that was carried out. The dispersion characteristics produced y 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. 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.

In the Cork Main Drainage Preliminary Report, 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 currently available.

The effects of overflows from the Carrigtohill plant or collection network have not been modelled. A full description of the model including the bathymetric study is included in Appendix N.

The design capacity for phase 1 of the proposed treatment plant at Carrigtohill is 45,000 pe rising to 62,000 pe for phase 2. The model was run based on both of these design capacities.

Furthermore, it was assumed that the treatment plant should meet the discharge standards as described in the Urban Wastewater Treatment Directive as tabled below.

Table 5.1: Urban Wastewater Treatment Directive (UWTD) Discharge Standards

Parameters	Concentration (mg/l)	Minimum Percentage Reduction
BOD	*25 mg O2/l	90
Suspended Solids	*35 mg/l	90
COD	*125 mg O2/l	75

* Standard to be achieved by 95% of samples or more

For nutrients the standard removal efficiency of an activated sludge system was taken as a starting point.

The output of the model should determine whether more stringent removal should be necessary for both organic substances (COD, BOD) and nutrients (N, P).

5.1.2 Characteristics of the Proposal

The discharge standards for the treated effluent from the upgraded Carrigtohill plant need to take account of both statutory requirements under the various enactments referred to above and other non statutory objectives relating to the improvement of the water course. The following as discussed in the previous sections will therefore need to be considered in defining the standard to be achieved.

1) The Urban Waste Water Treatment Regulations (SI 254 of 2001)
2) Quality of Bathing Water Regulations (SI 155 of 1992 and subsequent amendments)
3) Dangerous Substances Directive

Each of the above is discussed separately below before a final standard consistent with the requirements of each is proposed.

5.1.2.1 Urban Waste Water Treatment Regulations

As detailed in the Urban Waste Water Treatment Regulations, the effluent discharge standards for wastewater treatment plants with a population equivalent of greater than 10,000 are shown in Table 5.2 below.

Parameter	Concentration	Minimum Reduction (%)
BOD	25 mg/l	70-90
SS	35 mg/l	75
COD	125 mg/l	90

Table 5.2 – UWWT Regulations effluent discharge standards for plants with a population equivalent of more than 10,000.

Furthermore, Slatty Waters has been designated a sensitive water and the directive additionally requires that discharges to sensitive waters for agglomerations (towns) above 10,000 PE incorporate nutrient reduction facilities. Table 5.3 lists the requirements for discharges from urban wastewater treatment plants to sensitive waters.

Parameter	Concentration	Minimum Reduction (%)
Total Phosphorus	2 mg/l	80
Total Nitrogen	15 mg/l	70-80

Table 5.3 – Additional UWWT Regulations effluent discharge standards for plants discharging to sensitive waters.

In addition to the standards outlined above, the UWWT Regulations also state that 'more stringent provisions than those specified shall be applied to discharges from a treatment plant where this is required to ensure that the receiving waters satisfy any other relevant Community Directives.

5.1.2.2 Quality of Bathing Waters Regulations

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.

5.1.2.3 Quality of Shellfish Waters Regulations

There are no designated shellfish waters within the area of the Slatty waters as specified in the First and Second Schedules of the Quality of Shellfish Waters Regulations (SI 200 of 1994) and subsequent amendments. There are, however, shellfish farms in the North Channel (east of Belvelly Channel), close to Midleton. The North Channel is separated from Slatty Waters by Fota Island. The Department of Marine requested that the model consider the impact of the discharge with respect to the Shellfish Regulations at the regions shellfish farms.

In considering the effect of the proposed Carrigtohill WWTW the main issue of concern is the concentration of faecal coliforms in the area of the shellfish farms. Modelling of the Faecal Coliform count with the existing outfall retained shows that the expected peak at Belvelly bridge is only 11 MPN/100 mls. for the combined discharges. The corresponding figure for Weir island (between the shellfish beds and Belvelly) is zero MPN/100 mls. When Carrigtohill discharge only is run, the count at Belvelly is 1 MPN/100 mls. The simulation with the peak wind conditions showed better rather than worse dispersion. Based on these figures it is considered that shellfish farmers operating to the east of Belvelly Channel should have no grounds for concern about discharges from Carrigtohill.

5.1.2.4 Local Government Water Pollution Act 1977

This directive is very wide-ranging in scope. For the purpose of this report, only the Phosphorus Regulations (S.I. No. 258 of 1998) are relevant, as these give effect to requirements arising under the directive, concerning the setting of water quality objectives as part of overall pollution reduction programmes. With respect to Carrigtohill and Cork Harbour in general there is no baseline set by the Phosphorus Regulations as the Regulations refer only to river and lake waters. The EPA have published a document "An Assessment of the Trophic Status of Estuaries and Bays in Ireland" which has been used as a reference when considering the discharge standards for phosphorus and nitrogen from the Carrigtohill WWTW. This is discussed in detail below.

5.1.2.5 The Water Framework Directive

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

5.1.2.6 Effects of Discharge

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.

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 3.13 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 (62,000 pe) a discharge standard of 25 mg/l BOD will result in a concentration of 4.46 mg/l in the receiving water. Therefore a discharge of 25 mg/l (in accordance with the UWTD) is appropriate for phase 1 of the development but will need to be reduced to 20 mg/l BOD for phase 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 recommended in the EPA report. At 45,000 PE and a discharge standard of 15 mg/l N the resulting concentration in the receiving water would be 1.02 mg/l N. At 62,000 PE and a discharge standard of 15 mg/l the resulting concentration in the receiving water would be 1.32 mg/l N with peaks rising to 2.33 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.

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 0.078 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 62,000 pe, the resulting concentration in the receiving water would be 0.101 mg/l P. gain, the dispersion would result in the recommended concentration being reached just before Harpers Island, approximately 900 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. This is substantially better than the discharge concentration recommended under the UWWT directive of 2 mg/l.

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 with the existing outfall retained shows that the expected peak at Belvelly bridge is only 11 MPN/100 mls, for the combined discharges. The corresponding figure for Weir island is 1 MPN/100 mls. When Carrigtohill discharge only is run, the count at Belvelly is zero MPN/100 mls. The simulation with the peak wind conditions showed better rather than worse dispersion. Based on these figures it is considered that shellfish farmers operating to the east of Belvelly Channel should have no grounds for concern about discharges from Carrigtohill.

5.1.2.7 Proposed Final Effluent Parameters

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

Table 5.4: Proposed Discharge Standards for 45,000 pe and 62,000 pe

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

These standards meet the requirements of the UWWT standard treatment Directive (25:35 BOD:SS). The Bathing Water Quality Standards and the Shellfish Water Quality Standards are not applicable within Slatty Waters and the greater area affected by the discharge. The level of dispersion of the coliforms are such that there should be no cause for concern for the shellfish farms operating to the east of Belvelly.

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.

5.1.3 Potential Impact of the Proposal

The potential impact of the proposal is an improvement to the dispersal within Slatty Waters. 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 EPA "Assessment of the Trophic Status of Estuaries and Bays in Ireland" report.
- The upgraded works will satisfy all of Cork County Council's obligations under the UWWT Regulations and the Phosphorus Regulations.

It is clear that the potential impact of the proposed works on the area is wholly positive.

5.1.4 Mitigation Measures

No further mitigation measures will be required.

5.1.5 Predicted Impact of the Proposal

The predicted impact of the proposal is the same as the potential impact in that 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" report.
- The upgraded works will satisfy all of Cork County Council's obligations under the UWWT Regulations and the Phosphorus Regulations.

It is clear that the potential impact of the proposed works on the area is wholly positive.

5.1.6 Monitoring

Ongoing monitoring will be carried out in accordance with the requirements of the UWWT Regulations to ensure that the target final effluent parameters are achieved. The UWWT Regulations requires a minimum of 12 samples per year for a plant of this size. However, even more frequent daily monitoring during the proposed DBO contract will be required to demonstrate compliance with effluent discharge standards.

5.1.7 Reinstatement

Not applicable

5.2 Groundwater

5.2.1 Receiving Environment

Carrigtohill town lies on relatively low-lying coastal land with a typical elevation of 5mOD to 15mOD (Malin) level. Much of the local land is silty and typical of coastal areas. The catchment to the north of the town rises steeply to approximately 90m OD. Generally the bedrock for Carrigtohill town is Limestone while the catchment to the north has a variable geology. The Carrigtohill town area is underlain by Waulsortion Limestone (WA - described as massive unbedded lime mudstone). To the north of the town the bedrock changes with narrow bands of Ballysteen Formation (BA - fossiliferous dark-grey muddy limestone) and Kinsale Formation-Cuskinney member (Kncu - flaser-bedded sandstone and mudstone). The limestone around Carrigtohill is karstified and a gravel layer that acts as an aquifer underlies parts of the area. This is shown on Figure 7.1 – GSI Survey Aquifer Map. The karstified nature of the local geology is evident in the large underground fissures and caves that exist, particularly to the east of the town and on towards Midleton. These give rise to a free draining subsoil and a number of underground streams and springs. Given the karstified nature of the ground it is important that sewage does not enter the groundwater.

5.2.2 Characteristics of the Proposal

The treatment works will treat wastewater imported to the site through existing watertight pipelines. The treated final effluent will be discharge through an outfall to the North Point. There will be no discharges of treated or untreated wastewater to the surrounding land from the WWTW and hence, no impact on the groundwater.

5.2.3 Potential Impact of the Proposal

Proper construction and water-tightness of the pipes and water-retaining structures in the upgraded works will ensure no negative impact on the water quality of groundwater. Spillages from chemical storage tanks could enter the groundwater system.

5.2.4 Mitigation Measures

For process tanks good design to the appropriate water retaining standards will ensure

that no egress of water or wastewater can take place. Commissioning tests using clean water will ensure that the tanks are water tight. Pipework including gravity and pressure pipes will be tested in accordance with the codes of practise to ensure that they are fully watertight. Bunds to all chemical storage tanks will be provided to ensure that any leaks or spillages of chemical are contained and do not enter the groundwater system.

5.2.5 Predicted Impact of the Proposal

The predicted impact will be insignificant.

5.2.6 Monitoring

The DBO contractor will be required to ensure that all chemical storage bunds are periodically relieved of any accumulated rainwater. Influent and final effluent flow monitoring will be provided to ensure that any significant leaks are quickly detected and repaired

5.2.7 Reinstatement

No specific measures are proposed.

5.3 Surface Water Abstraction

Not applicable

6 AIR

6.1 Preamble

There are a number of aspects in relation to air quality, which must be considered when assessing the potential impacts of a sewage treatment works. These include the following:

- Noise;
- Odour;
- Aerosols;
- Light.

A noise and odour impact assessment was commissioned for the proposed site at Carrigtohill in order to predict probable noise and odour levels during operation of the proposed plant. These were considered to be the two most important parameters that would affect adjoining areas.

6.2 Noise

6.2.1 Receiving Environment

The Tullagreen site is an established Wastewater Treatment Works. It is surrounded by fields with some one off rural houses nearby. There are no significant residential developments in close proximity to the site. To the north of the site is an industrial development. Further to the north is the N25 cork to Waterford Road. To the west of the site is the R624 Cobh road. Road noise dominates the noise environment in this area. The proposed treatment works will be located adjacent to the site of the existing works.

The nearest residences, to the proposed Treatment Works, are two residences one of which is located 230m to the west of the facility and a second which is located 250m south west of the plant. Of the points monitored these two had the highest ambient noise levels due to the proximity to the traffic on the R624.

Noise can be a nuisance and excessive levels of noise can cause deafness to employees, stress and varying community responses. A sewage treatment works operates on a 24hr basis and, hence, it is a source of some noise at all times. At night, in particular, when background noise levels are low, noise can travel a long way, although the level diminishes with distance. Pumps, motors, compressors and aerators will all generate noise. The tolerance of noise levels can vary depending on noise source, duration, time of day and frequency.

Bord na Mona have carried out measurements of source noise levels at the boundary of

the proposed site and at the two nearest houses for a daytime assessment (7th March 2007) and nighttime assessment (15th March 2007). These readings are shown in full in the report contained in Appendix A and demonstrate the relatively steady nature of the noise levels at the existing works.

Measurements were made in accordance with International Standard ISO 1996 (1982, 1987) "Acoustics - Description and Measurement of Environmental Noise". This standard specifies that the average level L_{eq} is to be used for measurement and assessment of environmental noise. Basic acoustical data are equivalent continuous A-weighted sound pressure levels, denoted $L(A)_{eq}$., averaged over a given period.

The quieter areas adjacent to the proposed treatment works site have a noise climate characterised by the levels shown in Tables 6.1 and 6.2.

Location	Period (Mins)	Leq	L10	L90	L_{FMAX}
N1	15	61	60	49	82
N2	15	66	71	57	78
N3	15	57	58	57	66
NSL1	15	80	83	62	94
NSL2	15	64	59	45	85
Leq : Average noise level for the period L90 : the level exceeded for 90% of the period (the "floor level") L10, the level exceeded for 10% of the period					

Table 6.1 - Noise Levels (dB) near WWTW Site, 7th March 2007 - Daytime

N1 –north-western boundary of the proposed site
N2 – Entrance to the existing site
N3 – Inside the WWTP
NSL 1 – House to the west of the proposed site
NSL 2 – House to south-west of the proposed site

Location	Period (Mins)	Leq	L10	L90	L_{FMAX}

N1	15	50	52	48	61
N2	15	54	55	52	62
N3	15	Not Accessible			
NSL1	15	72	77	53	82
NSL2	15	47	48	46	53
Leq : Average noise level for the period L90 : the level exceeded for 90% of the period (the "floor level") L10, the level exceeded for 10% of the period					

Table 6.2 - Noise Levels (dB) near WWTW Site, 15th March 2007 - Nightime

6.2.2 Characteristics of the Proposal

The proposed Works sources likely to emit noise include:

(a) Blower Building (Enclosed)
(b) Preliminary Treatment Plant (removal of grit, rags and coarse solids-housed in a building)
(c) Sludge Dewatering Building (enclosed)
(d) Tertiary Filters
(e) Pumping Stations

The existing layout drawings are taken as indicative only as the proposal is to be a design and build contract which allows tenderers to put forward their own design for meeting the specified emission and discharge standards.

The proposed treatment works would operate 24 hours/day and 7 days per week.

The daytime activities will include transport of sludge in and out of the site, along with the continuously running plant items. An estimated average c.1 tanker/day, and c.10-12 cars, could enter and exit the site. The noise from these sources is unlikely to cause nuisance at any house. The recommended criterion for traffic at any residence is 55 $LAeq_{1hour}$.

At night only quiet (or enclosed) plant will be running, suitably attenuated to meet the given noise limit of 35 LAeq. This would not be expected to cause any complaints.

Site preparation and construction will take place over a number of months. This phase will generate some moderately high noise levels for short periods. Initially, it is expected that a

bank or berm for noise containment will be constructed. There will be no construction work at night.

6.2.3 Potential Impact of the Proposal

A noise is liable to disturb people and provoke complaints when its level exceeds the pre-existing ambient level by a certain margin, or when the level attains a particular absolute value. People's reactions to noise may be influenced by a number of factors such as:

- **Noise level;**
- **Noise character;**
- **Habituation;**
- **Degree of control over the source;**
- **Personal sensitivity to noise;**
- **Attitude to the source;**
- **Activity engaged in;**
- **Time of day or night;**
- **Character of area;**
- **Visibility or otherwise of the noise source, and**
- **Seasonality of the operation.**

The night-time environment in the area of this site is dominated by the noise from the traffic on the N25 and the R624. Therefore, since the proposed works would operate continuously, a potential impact might arise if the noise emissions were to exceed 35 LAeq, and could adversely affect, at night, some local residents by causing sleep disturbance. However, if noise levels are maintained at or below this level at night, no adverse impact is likely to arise. It is unlikely that adverse daytime intrusion of works noise would occur.

The estimated traffic is c.1 tanker/day, and c.10-12 employee/visitor cars, entering and exiting the site. The noise from these sources is unlikely to cause a nuisance at any house. The recommended criterion for WWTW traffic at any residence is 55 $LAeq_{1hour}$.

At night there will be no traffic to or from the site. Only quiet (or enclosed) plant will be running, suitably attenuated to meet the given limit of 35 LAeq. This would not be expected to cause any complaints (noise-related).

The operations of the proposed WWTW are expected to be generally in the range up to 35 (at night), and up to 45 $LAeq_{1hour}$ (daytime) at any house.

External noise levels of 35 $LAeq_{15min}$ at night and 50 $LAeq_{1hour}$ by day are unlikely to disturb anybody. Therefore no interference with normal family or domestic activities is likely and, consequently, no noise-related complaints are considered likely.

6.2.4 Mitigation Measures

Adoption of noise limits of 50 $Laeq_{1hour}$ by day, and 35 $Laeq_{15minute}$ at night, 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. This facility could be part of the proposed supervisory control and data acquisition (SCADA) system.

The contractor, in his design, will be required to select plant that can be attenuated, to avoid any significant noise intrusion or disturbance at local residences. Plant will also be chosen to avoid significant low-frequency noise emission at night, which increases nuisance potential.

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

The proposed blower house, standby generator and the inlet works building, will each have an acoustic insulation standard sufficient to achieve the overall recommended noise limits stated above.

Any new pumps may be of the submersible type and any new blowers may be sound insulated in such a manner that the overall noise limits mentioned above are achieved.

Noisier plant should be positioned to optimise screening by other plant.

Sound attenuation will be fitted to any fan or opening likely to emit excess noise. The internal walls of buildings will, if necessary, be fitted with sound-absorbing material to minimise any noise emissions. This could be of rockwool or glass-wool or equivalent

sound absorbent. It would be protected mechanically by a suitable frame or fixtures and wire grill or netting.

Construction Phase

The temporary nature of construction activities accords the associated noise a higher level of acceptance by people than noise sources of a more permanent nature.

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.

A daytime limit of 65-70 $LAeq_{12hr}$ is often considered reasonable for construction work. This proposal is not expected to generate levels in excess of 70 $LAeq_{12hr}$, at any house, for any phase of the construction process. Furthermore construction work is only expected to take place during daytime hours.

6.2.5 Predicted Impact of the Proposal

The external noise level criteria considered appropriate are as follows :

Operations 0700-1900 hours : Daytime 50 $LAeq_{1hr}$; **Traffic** - 55 $LAeq_{1hour}$

1900-2200 hours : Evening 45 $LAeq_{1hour}$

2200-0700 hours : Night-time 35 $LAeq_{15mins}$, with no tones or impulses.

Note - Definition of day-night times is intended as a guide. These times can vary. Table 6.3 gives a guide to the likely community response to different noise levels.

dB(A) Excess Of Rating Sound	Estimated Community Response	
Level Over noise Criterion	**Category**	**Description**
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very Strong	Vigorous community action

Table 6.3 - Estimated Community Response to Noise (ISO-1996)

If the mitigation measures outlined in section 6.2.4 above are implemented to achieve the recommended noise limits, it is predicted that there will be no adverse impact on the local environment.

6.2.6 Monitoring

Monitoring of noise emissions will be undertaken at the nearest residence or any other location requested by the regulating authority, should any complaints relating to noise arise.

6.2.7 Reinstatement

No reinstatement will be required.

6.3 Odour

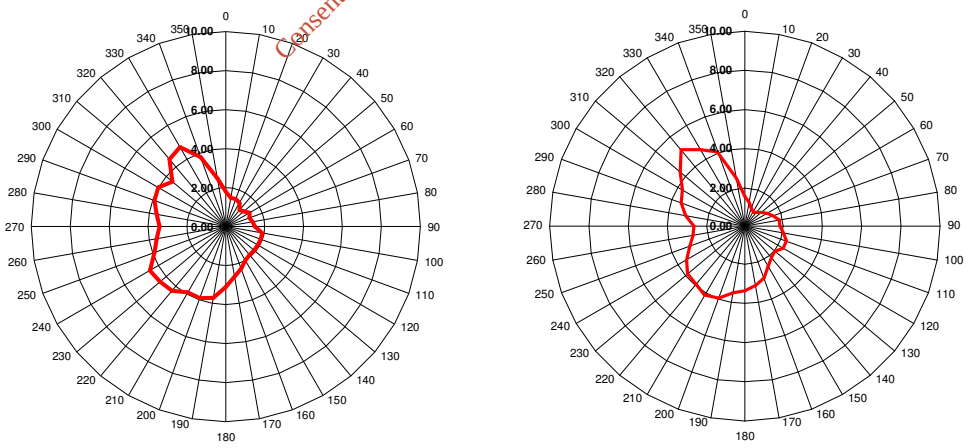
6.3.1 Receiving Environment

The wastewater treatment plant site is located approximately 0.75 km to the south east of the Carrigtohill village with the site accessed from a minor public road running eastwards from the R624. It is located on low-lying ground at about 10m O.D. The Carrigtohill Bypass (N25) runs east-west about 300m to the north of the treatment plant site and is on a raised embankment. There is a pharmaceutical production plant (Millipore) located about 300m from the existing treatment plant and 100m from the Eastern boundary of the extension site. However, there are no significant industrial emissions within the locality of the treatment plant site. The nearest house is located near the junction with the R624, about 225m from the Western boundary of the extension site. There are also a small number of houses about 250m to the SW of the site.

Overall, the air quality in the locality is good with levels of air pollutants in the area substantially below the National Air Quality Standards (NAQS) specified in the Air Quality Standards Regulations 2002 (SI No 271 of 2002). Daily concentrations of sulphur dioxide would be less than 20% of the limit value of 125 µg/m^3 specified in the 2002 Regulations. Ambient concentrations of nitrogen dioxide would be less than 40% of the future NAQS annual limit of 40 µg/m^3, which is to be met by 2010. Corresponding hourly concentrations would also well below the current NAQS hourly limit value of 200 µg/m^3. Carbon monoxide and benzene levels, which are important components of motor vehicle exhausts, would be very low in the area and typically less than 10% of the NAQS limit values.

Dust and airborne particulates, in particular those referred to, as PM_{10} (particulate material with a mean aerodynamic diameter of less than 10 µm) would be below the National Air Quality Standards. The limit values specified in the Regulations 2002, which entered into force in January 2005, give a daily level of 50 µg/m^3 (as a 90.4 percentile of daily average values) and an annual average value of 40 µg/m^3. Annual concentrations would be typically in the region of 10-15 µg/m^3 close to the northern site boundary, with vehicle exhaust emissions and roadside dust along the access road being the principal sources.

No malodours could be detected during the site visit undertaken in February 2007 near the site boundary of the existing treatment plant. The weather conditions were dry during the site visit with winds of about 5m/s from the SW.



Cork Airport **Roches Point**

Figure 6.1 – Hourly Wind Direction Frequency at Cork Airport and Roches Point

There are two meteorological stations within 17km of the Carrigtohill site, one at Cork Airport (17km to the West) and the other at Roches Point (12km to the South). Long-term observations at both meteorological stations indicate that the prevailing wind direction is from a southwesterly direction with a secondary maximum for north-westerly winds. The long-term wind roses indicating the incidence of winds at 10-degree intervals around the compass for the two locations are shown in Figure 6.1 for Cork Airport and Roches Point respectively. The meteorological station at Cork Airport is at about 154m O.D., compared to the one at Roches Point, which is located near the mouth of Cork Harbour. However, the station at Roches Point is very exposed to coastal breezes and nocturnal air flows out through the mouth of Cork Harbour during light wind conditions in the area. The site at Carrigtohill is north of Great Island and is less likely to be affected by the coastal sea breeze experienced around Cork harbour, in particular at the mouth at Roches Point. Prevailing conditions would tend to be comparable to the general wind field over the region in the Cork area and so climatological data for Cork Airport was used in the odour modelling study.

The long-term incidence of winds of 5m/s or less at Cork Airport is about 52% of the year with speeds of <2 m/s (including calms) occurring about 7% of the time. The lowest frequency is for winds from a north-easterly direction, which account for about 8% of the year. The mean annual wind speed is 5.5 m/s with an incidence of 0.5 % of hours for speeds below 1m/s. Climatological data from Roches Point indicate a lower incidence of wind speeds below 5 m/s, with about 45% below this value. The mean annual wind speed at Roches Point is about 6.3 m/s, as a result of the exposed coastal location of this meteorological station. The wind roses for Cork Airport for the modelled years 2005 and 2006 are given in Figure 6.1, which show the high frequency of winds from a SW and NW direction, compared to the incidence of winds from an easterly direction.

The greatest potential for odorous emissions is normally during the summer months when warm dry weather conditions can increase the rate of evaporation from exposed tank surfaces within the treatment plant. During the winter months with damp cool windy conditions prevailing, the potential for odours being detected more than a few metres from the side of the open tanks and odour exhaust vents would be substantially lower.

The annual mean air temperature for the Carrigtohill area is about 9.5C, with a range in daily averages for most of the year of about 2-18.5 C. During warm dry spells in the summer, temperatures may rise to over 25C, as experienced during 2005 and 2006. The

greatest potential for odorous emissions is during the summer months when warm dry weather conditions can increase the rate of evaporation from exposed treatment tank surfaces. These weather conditions may also be associated with low-flow sewage conditions from the surrounding area.

6.3.2 Characteristics of the Proposal

Fresh sewage arriving at a wastewater treatment plant via a properly constructed sewer system has a slight smell, normally described as musty in character. As long as a certain level of dissolved oxygen is maintained in the sewage, anaerobic conditions will not take place. However, if the oxygen content of the sewage is used up, then gases such as hydrogen sulphide, nitrogen and sulphur based organic compounds (mercaptans, ketones, amines, indoles and skatoles) are quickly produced and a general septic condition occurs with typical pungent odours being emitted. These conditions may arise where the incoming sewage becomes septic as it is pumped along the rising main and result in strong malodours at the inlet works.

The proposed extension of the existing treatment works at Carrigtohill is designed to provide treatment capacity for a Biological Oxygen Demand (BOD) load for Phase 1 of 45,000 p.e. (person equivalent), compared to the current design capacity of 8,500 p.e. The final design capacity (Phase 2) will be 62,000 p.e. This will require a new inlet works, storm water tank, secondary treatment and sludge treatment facilities.

The construction contract is design/build/operate (DBO). This means that the Contractor will carry out the design of the plant. The DBO contract will contain performance specifications, including odour control. The Contractor will also be required to monitor odorous emissions to ensure compliance with emission limits during the normal routine operation of the plant.

It will be a requirement of the design of the new treatment plant that the following components will be included: -

- The present sewage treatment works will be replaced.
- A new inlet works building housing the inlet sump/flumes and preliminary treatment screening equipment will be constructed.
- A storm-water holding tank will be installed.

- Secondary treatment will be provided by Secondary Batch Reactor Tanks (a type of activated sludge process)
- A new sludge treatment building will be constructed.
- Odours from the inlet works building and the sludge treatment building will be treated with high efficiency odour control units.

The Envirocon assessment of odour potential due to air emissions was carried out by examining local climatic conditions, reviewing specialist literature to obtain baseline data and assessing this data using air dispersion modelling techniques. Odour control measures are proposed for the inlet works (which will be covered or housed), the sludge draw-off chambers and the sludge de-watering building.

The indicative design for the Carrigtohill works include an inlet works with screening and grit removal. Fine screening filters out material greater than 6mm from the liquid and washes and compresses them to lower moisture content. Biodegradable material will be washed out and returned with the wash water to the treatment stream, hence the screenings for disposal will be relatively dry and, therefore, less offensive with respect to odour production. These compacted screenings will be disposed of to landfill. The inlet works will be covered or housed and provided with odour control equipment, which could take the form of air scrubbing through peat filter bed or similar type of odour removal equipment.

The storm water tanks are unlikely to be a significant source of odour due to the infrequent nature of their use. Quick and efficient cleaning of the tanks after use will ensure that any odours generated would be short-term only.

Under normal operating conditions the aeration tanks should not be a significant source of odour. The aeration plant will maintain aerobic conditions in the tanks.

Odours from secondary settlement tanks are not normally detectable beyond a few metres from the tank.

The sludge treatment system will be designed to prevent the escape of malodours to the atmosphere. The various sludge processes outlined earlier will be carried out within enclosed containers/covered buildings. There will be a separate odour treatment unit dedicated to the sludge stream. The exhaust air from the buildings and any covered odour

source will be treated. Sludge will be stored within enclosed units or within covered tanks/silos.

The Environcon brief was to assess the adequacy of these measures and recommend further measures if required. It is accepted that odour cannot be totally eliminated within the site without enormous cost implications. The aim, therefore, is to prevent an odour nuisance, which could be detected beyond the site boundary.
High efficiency single or two stage odour control units will be installed to treat odorous air from the inlet works building and the sludge treatment plant. Each unit will have a very high removal efficiency rate, with odour reduction levels in excess of 95%. Acceptable methods of odour control include charcoal scrubbers, bio filtration and ozone scrubber systems.

6.3.3 Potential Impact of the Proposal

Short-term ground level odour concentrations downwind of the wastewater treatment plant were computed using the ADMS3 (Version 3.3, July 2005) advanced air quality dispersion model developed in the U.K. by CERC (Cambridge Environmental Research Consultants). This prediction model is used by Regulatory Authorities and the Environment Agency in the United Kingdom and has been approved by the Environmental Protection Agency for modelling studies supporting IPCL applications. It has been widely used in Ireland for evaluating the impact of odours from wastewater treatment plants.

Hourly climatological data from Cork Airport, for the years 2005 and 2006 were used to predict the 99.5 and 98 percentile hourly odour concentration values. These percentile calculations give the odour concentration at each receptor location that is predicted to be exceeded for 2% of the year or 175 hours in the case of the 98 percentile. The 99.5 percentile value is the concentration predicted to be exceeded for 0.5% of the time, or 45 hours. The pattern of predicted odour concentration around the plant reflects the annual incidence of certain wind speeds and directions coupled with the different types of atmospheric stability close to the ground

An odour concentration of 1 o.u./m^3 is defined as the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At odour levels below 1 o.u./m^3, the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the gas is still present in the air no odour may be detected. Sensitivity to an odour also

depends on the location; for example, an odour from agricultural related activities is likely to be tolerated by the community longer in a rural setting than in an urban area.

The results of the odour impact modelling study based on the Phase 1 extension of the wastewater treatment plant are presented as odour concentration contour plots in Figures 6.2 and 6.3. These plots show the pattern of the 99.5 percentile and 98 percentile odour concentrations in the locality of the plant and are based on the maximum value predicted at each receptor location over the two years that were modelled.

The predicted 99.5 percentile odour concentrations that are predicted for the planned extension are shown in Figure 6.2 and the pattern of odour levels indicates that the maximum level at the nearest house to the West of the site boundary will be between 0.25-0.5 o.u./m^3. At the houses to the NE of the site boundary, on the outskirts of Carrigtohill, the predicted 99.5 percentile odour concentration is less than 0.25 o.u./m^3 and to the south the predicted level will also be below 0.25 o.u./m^3. In other words, the odour prediction model predicts that odour levels will generally be below the odour detection level for 99.5 percent of the time at the nearest houses to the site. The predicted 99.5 percentile odour concentrations at the Millipore plant boundary to the NW of the site are predicted to be about 0.5-1 o.u./m^3 near the entrance and 0.25-0.5 o.u./m^3 in the vicinity of the production buildings. At the site boundary adjacent to the public road, the predicted 99.5 percentile odour concentration is predicted to be about 3-4 o.u./m^3. This is due to the proximity of the indicative location of the SBR tanks near to the northern site boundary.

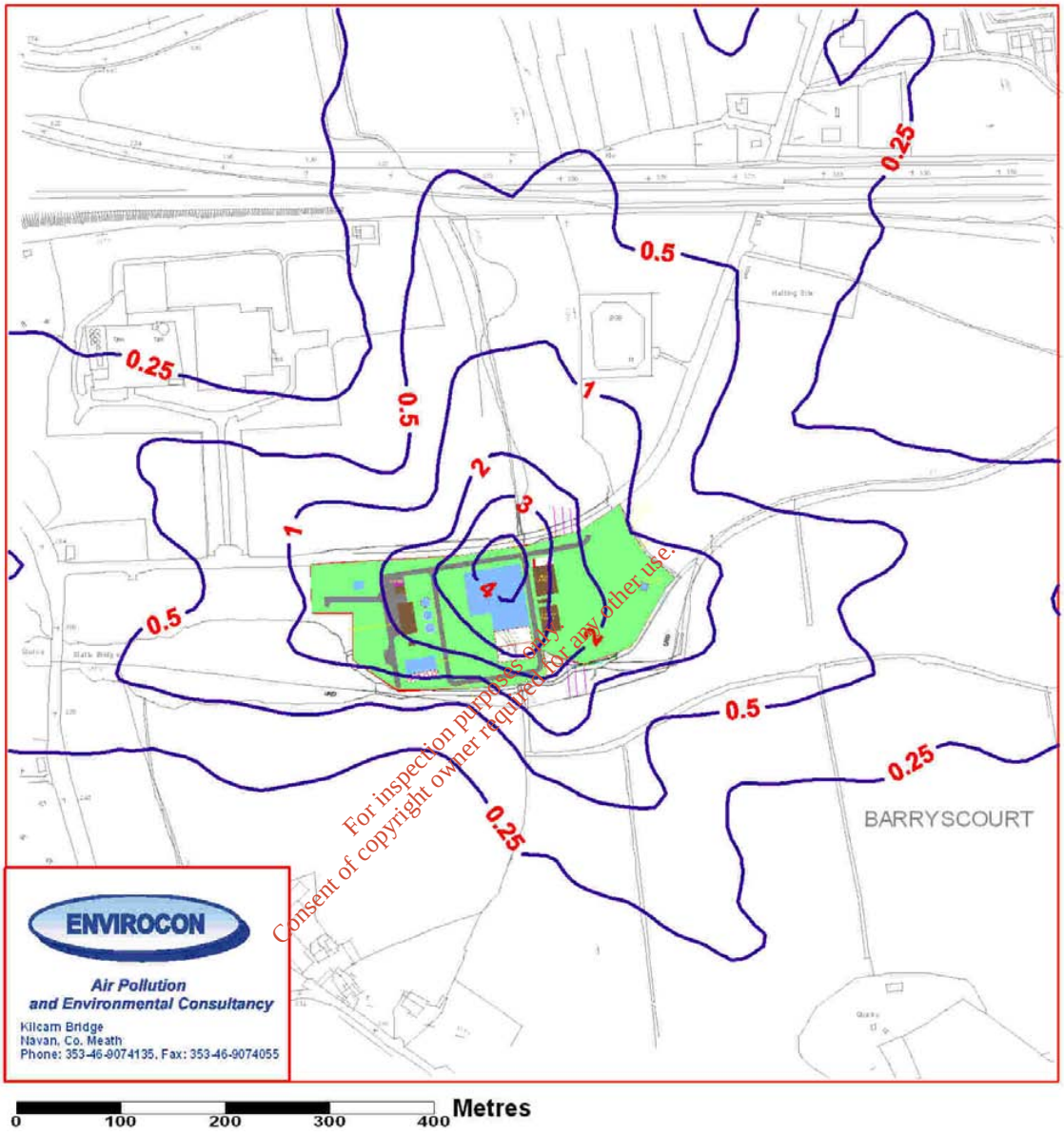


FIGURE 6.2: PREDICTED MAXIMUM 99.5 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 1) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

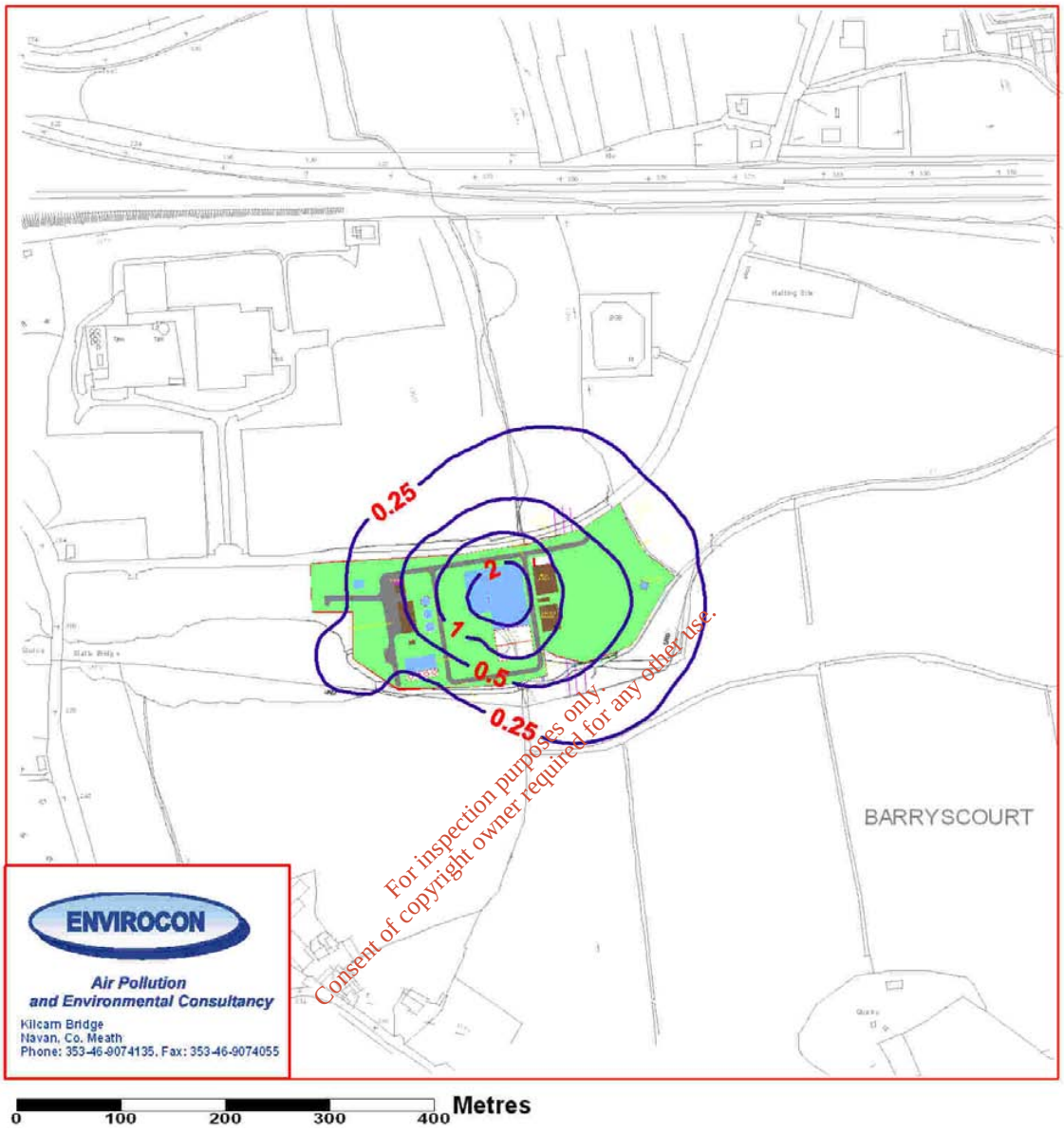


FIGURE6.3: PREDICTED MAXIMUM 98.0 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 1) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

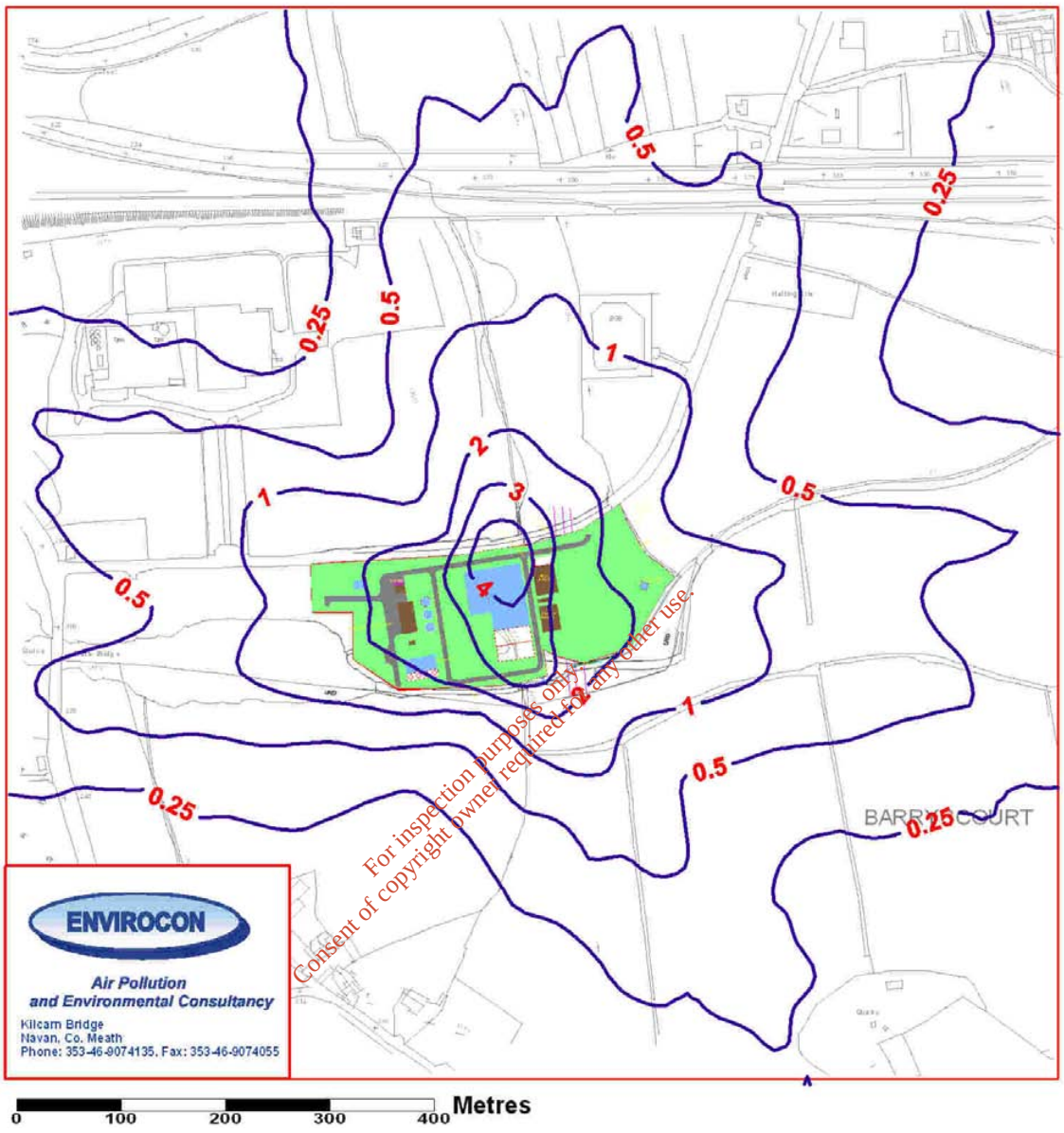


FIGURE 6.4: PREDICTED MAXIMUM 99.5 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 2) OF WASTEWATER TREATMENT PLANT(O.U./M^3)

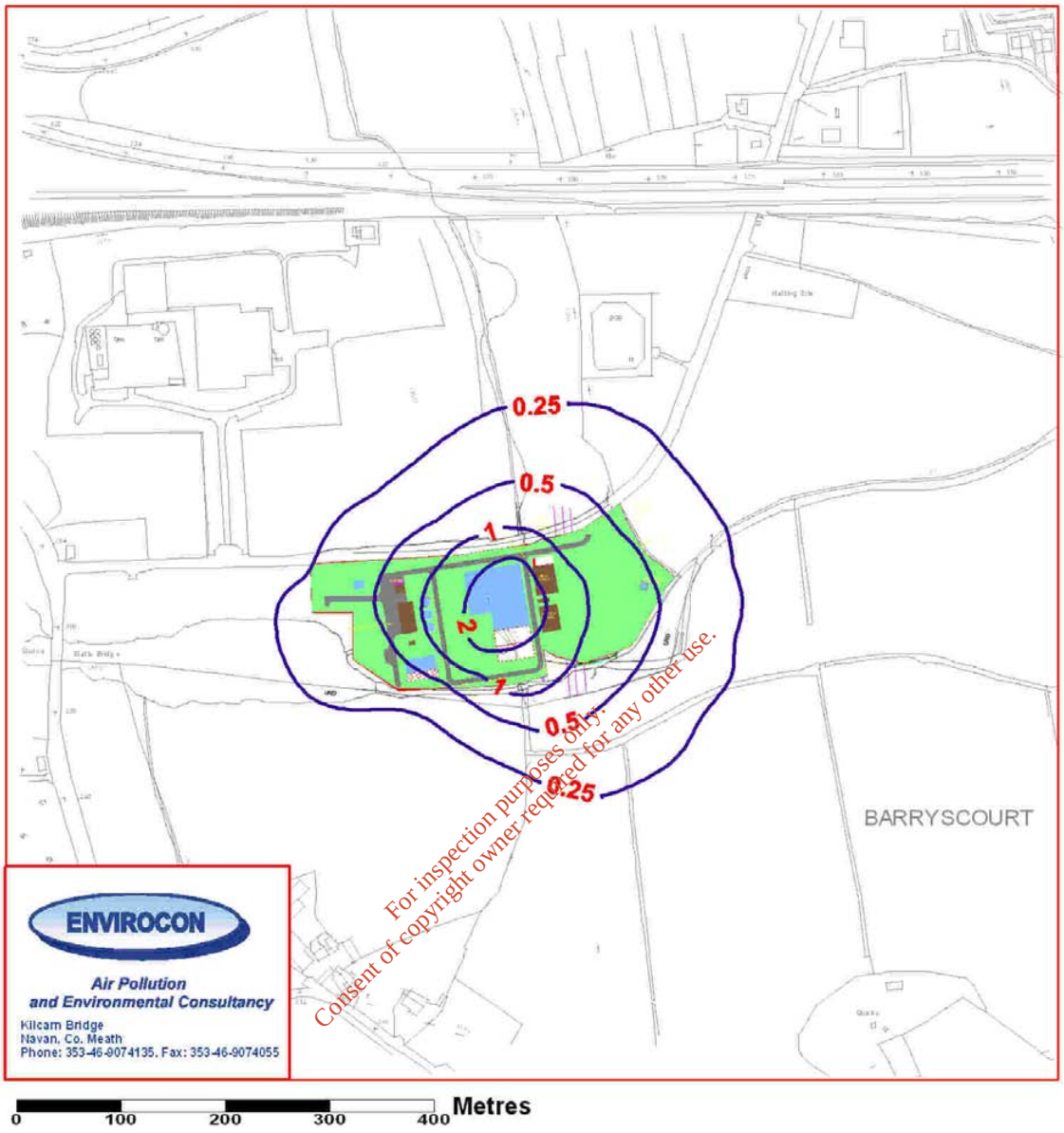


FIGURE 6.5: PREDICTED MAXIMUM 98.0 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 2) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

The predicted 99.5 odour concentrations at the nearest private properties are very low and although there are no National Standards the predicted odour concentrations would meet the Standards required in other European Countries such as the Netherlands. In the Netherlands a maximum concentration of 1 o.u./m^3, which should be met for 99.5% of the year, has been used as a limit value downwind of new plants.

The odour concentrations in the locality of the wastewater treatment plant that are predicted to be exceeded for 2% of the year, or 175 hours during the year, referred to as the 98 percentile, are shown in Figure 6.3. At the nearest houses the site, the predicted 98 percentile odour concentration are predicted to be well below 0.1o.u/m^3. The 98 percentile concentration is also predicted to be well below 0.2 o.u./m^3 at the Millipore premises. The odour levels are predicted to be less than 1.5 o.u./m^3 along all boundaries around the planned extension site.

An odour concentration of greater than 5 o.u./m^3 has been widely used as a criteria for determining possible nuisance complaints, typically as a predicted hourly average 98 percentile limit value. This predicted odour concentration has been adopted in the past as an acceptable approach in Ireland and the U.K. to demonstrate that no odour nuisance would occur beyond the site boundary of planned wastewater treatment plants.

Ambient odour limits proposed by the EPA in a report (Odour Impacts and Odour Emissions Control Measures for Intensive Agriculture, EPA 2002) regarding odorous emissions from pig production units propose a more stringent condition in relation to a limit value around new pig production units of 3 o.u./m^3 as a 98 percentile of predicted hourly concentrations. A target value of 1.5 o.u./m^3 also as a 98 percentile has also been proposed to provide a general level of protection against odour nuisance for the general public. A predicted odour concentration of 1.5 o.u./m^3, expressed as a 98 percentile of hourly values, is recommended by the Environment Agency in the U.K. (IPPC H4 Horizontal Guidance for Odour Part 1, 2003) for sources with a potential for offensive odours, including wastewater treatment plants.

For the Phase 2 design scenario, the predicted 99.5 percentile of short-term odour concentrations is predicted to be 0.25-0.6 o.u./m^3 at the nearest houses to the site, as shown in Figure 6.4. Predicted odour concentrations are shown to be less than 1 o.u./m^3 in the vicinity of the production building at the Millipore site. The corresponding 98 percentile odour concentrations presented in Figure 6.5 are less than 0.25 o.u./m^3 at the nearest private properties and near the Millipore plant.

It is evident from the analysis of the modelled odour impact due to emissions from the proposed treatment plant that the potential for significant malodours to be detected beyond the boundary to the plant will be very low. No significant impact, likely to result in an odour nuisance in the locality of the nearest private properties is predicted as a result of the planned expansion to the wastewater treatment plant. It is considered that based on the

foregoing that the predicted 98 percentile odour value should not exceed 1.5 o.u./m^3 at the site boundary and 0.25 o.u./m^3 at the nearest sensitive receptor to the boundary such as a house.

6.3.4 Mitigation Measures

The following measures to control and reduce potential sources of malodours are proposed for the extension of the wastewater treatment plant at Carrigtohill:-

- The inlet works channels and screening equipment will be housed in an enclosed building.

- Screened coarse material and grit from the grit trap will be washed and transferred into covered skips located within the inlet works building.

- Odorous emissions from inlet works building will be vented to atmosphere via a high efficiency odour control unit.

- Odorous emissions from the sludge treatment building will be vented to atmosphere via a high efficiency odour control unit.

- The odour control units will operate with removal efficiencies of over 95%. The location and design of the exhaust stacks to these units will ensure that adequate vertical release of emissions is achieved to ensure that there will be no malodours occurring beyond the site boundary from the exhaust stacks.

- The secondary sludge thickening tank will be covered and the headspace air in the tank ducted to the sludge treatment building odour control unit.

The odour control units shall be designed to operate with removal efficiencies of over 95%. It is planned that one odour control unit will treat foul air from the inlet works, with a second unit for treating headspace air from the sludge treatment plant. These units may be stand-alone systems installed at ground level or emission vents located on the buildings. The location and design of the exhaust stacks to these units should ensure that adequate vertical release of emissions is achieved. The odour control systems to be installed should ensure that no malodours occur beyond the site boundary.

Under the form of procurement proposed, tenderers will be required to provide performance guarantees with respect to odours from their particular design. These will require the tenderers to guarantee that their designs will not generate odours of greater than 1.5 odour units at the boundary on a 98-percentile basis and to substantiate their proposal by odour modelling.

The predictive odour maps demonstrate that it is possible to mitigate the odour impact of the WWTW to within acceptable limits by incorporating the measures referred to earlier, including covering or housing of the inlet works in a building, covering of other odour sources where required, and provision of separate odour treatment units dedicated to the sludge and liquid streams.

6.3.5 Predicted Impact of the Proposal

The predicted 99.5 percentile odour concentrations for Phase 1 of the scheme are predicted to be less than 0.5 o.u./m^3 at the nearest housing and so would be unlikely to result in a short-term nuisance odour. Predicted levels are within the range of 3-4 o.u./m^3 near the northern site boundary, adjacent to the access road. The corresponding 98 percentile odour concentrations are less than 0.5 o.u./m^3 beyond about 100m from the site boundary. For the Phase 2 final design stage, with all 6 SBR units in operation, the predicted short-term 99.5 percentile odour levels are also predicted to be less than 0.5 o.u./m^3 at the nearest housing. The corresponding 98 percentile odour concentrations are also well below 0.5 o.u./m^3 at the nearest housing.

The design and operation of the proposed upgrading and extension of the wastewater treatment plant at Carrigtohill minimises the potential for malodours to be detected beyond the site boundary. Based on the results of the odour dispersion modelling study carried out, no significant impact on the ambient air quality of the area is predicted due to odour emissions from the wastewater treatment plant.

6.3.6 Monitoring

Under the form of procurement proposed for the treatment works the contractor appointed to operate the works will be required to ensure that detectable odours from the plant do not occur outside the works boundary based on the units discussed above. Failure on his part to control the odour from the plant to this level will result in liquidated damages being invoked so that the contractor will have a financial incentive to control the odours at the works. Routine monitoring of odour will be undertaken on a twice-yearly basis or more frequently in response to any complaint from the public relating to odours near the

treatment works. There should be no odour nuisance under normal operating conditions within a well maintained plant.

6.3.7 Reinstatement

No reinstatement will be required.

6.4 Aerosol

6.4.1 Receiving Environment

The fine mist of droplets above an aerated liquid is referred to as an aerosol. Aerosols can be produced by a number of methods. The areas of concern at Carrigtohill are the potential use of surface aerators and the use of effluent as wash water for cleaning within the works. Each of these situations have the potential to lead to the production of aerosols.

6.4.2 Characteristics of the Proposal

Aerosols are introduced into the air at aeration tanks in the activated sludge process due to the turbulent nature of the process, *i.e.* the injection of air into the liquid. They are produced in pressure cleaning by use of effluent as wash water and by the discharge of effluent. In the case of Carrigtohill the discharge point will be under water so no aerosols will be possible. Aerosols take the form of a fine mist of tiny droplets (smaller than 5µm). Aerosols produced in a WWTW will contain an element of bacteria. However, because of the very small size of the fine mist droplets, they evaporate very quickly. Hence the micro-organisms will be subjected to rapid dehydration and generally do not survive. There are no known recorded cases of infection from aerosols derived from WWTWs.

6.4.3 Potential Impact of the Environment

Aerosols introduced into the air at the aeration tanks or through use of effluent as wash water should only present a potential public health hazard to anyone within 20m of these operations. Even then the risk is very small as there is little evidence that aerosols affect the plant operatives at existing treatment works. At distances greater than 20m the risk of contamination falls away rapidly. The risk is described as negligible beyond 20m by Dr. N. Gray of Trinity College Dublin in his publication “Biology of Wastewater Treatment” (Gray, 1989).

In the case of certain food processing and dairy industries only a zero risk of contamination is considered acceptable. It is normal practice for such industries to install purification systems on any air intakes and in sensitive production areas of their plants.

6.4.4 Mitigation Measures

Aerosols are really only of concern within the treatment works. Any proposal to use the effluent as site wash water should include ultraviolet treatment of the wash water at source or an alternative disinfection process. Operatives will also need to take precautions, such as the wearing of facemasks during certain operations such as the use of high pressure washing equipment, to prevent the inhalation of the aerosols.

The use of mechanical surface aerators will be permitted under the DBO contract under the provision of sufficient cover near the aerator to prevent aerosol production. If the aeration units employ diffusers for the transfer of oxygen, aerosol production and its inherent risks are dramatically reduced such that the aerosol production is negligible.

6.4.5 Predicted Impact of the Environment

The predicted impact of aerosols at the proposed treatment works is deemed to be minimal due to their rapid evaporation and consequently the inability of the micro-organisms to survive. Also, there is no known recorded evidence of a health hazard to those living near and being exposed to such aerosols.

6.4.6 Monitoring

Aerosol generation and distribution profile can be monitored by microbiological air sampling. Another important point for monitoring disposition of microbes from the plant would be sampling leaves from the surrounding trees for faecal indicator bacteria such as *E. coli.* However such monitoring is not considered necessary at this stage but could be implemented by the Council at a later stage if deemed necessary.

6.4.7 Reinstatement

No reinstatement will be required.

6.5 Light

6.5.1 Receiving Environment

The site of the plant is between Slatty Pond and the N25 to the south of Carrigtohill. There are industrial developments and agricultural land in the immediate vicinity of the site. Street lighting and external lighting are included within the perimeter of the Millipore industrial site immediately across the road from the treatment plant site. There is no street lighting to the west south or east of the site.

6.5.2 Characteristics of the Proposal

The wastewater treatment works will be in operation for twenty four hours per day for 365

days per year but it will not be manned at all times. Lighting will be provided as a safety and security measure and will only be used as required.

It is proposed to provide lighting to illuminate all of the treatment units and access roads. This will consist of a combination of high masts and low level lighting where appropriate. The masts should be positioned so as to illuminate the individual treatment units and the roadways.

6.5.3 Potential Impact of the Proposal

The development of the treatment works site will increase the artificial light generated in this area. Excessive light levels can be a source of nuisance and could cause the treatment works to become a prominent feature in the landscape at night. This could have the potential to affect the surrounding residential and rural population.

6.5.4 Mitigation Measures

- The lighting fixtures should be directed inwards so as to minimize any over-spill of light at the boundaries.
- The design of the lighting and the selection of the types of lighting to be used will minimise the spillage of lighting outside the site boundary towards the local area.
- At night, the full lighting will only be in operation if the plant is manned or if the alarm system is activated. Screening of the works boundary with trees and shrubs as well as an embankment will also help shield the light spread outside the site.

6.5.5 Predicted Impact of the Proposal

The lighting at the treatment plant is not predicted to have any impact on the village of Carrigtohill. It is not predicted to have any significant negative impact on the area in the immediate vicinity of the Carrigtohill WWTW as it will not be fully in use at night time or outside normal working hours and will be used only when the need arises. The external lights will generally only be in operation if lighting conditions demand during normal working hours, when the plant is manned or if the alarm system has been activated. Any negative impact will be minimised by mitigation in accordance with 6.5.4 above.

6.5.6 Monitoring

Monitoring will be required to ensure that there is no excessive or overuse of artificial site lighting.

6.5.7 Reinstatement

No reinstatement will be required.

6.6 Climate

Carrigtohill is located on the south coast of Ireland. The average rainfall varies between 990mm and 1244 mm with higher proportion of precipitation during the winter months The area has a humid, mesothermal climate that is typical of the country. There are no aspects of the WWTW project that will impact on the local climate. There are no climatic effects in the region that will require any special measures to be taken during the design, construction and operation of this project.

7 SOILS

7.1 Soil Type/Characteristics

7.1.1 Receiving Environment

Carrigtohill town lies on relatively low-lying coastal land with a typical elevation of 5mOD to 15mOD (Malin) level. Much of the local land is silty and typical of coastal areas. The catchment to the north of the town rises steeply to approximately 90m OD.

The Geological Survey of Ireland (GSI) has published "The Geology of East Cork – Waterford", 1995. This document describes the geology of the area in some detail and is the source of the synopsis below.

Generally the bedrock for Carrigtohill town is Limestone while the catchment to the north has a variable geology. The Carrigtohill town area is underlain by Waulsortion Limestone (WA - described as massive unbedded lime mudstone). There are a number of limestone quarries in the Carrigtohill area from which Waulsortian limestone is currently being extracted. The existence of caves demonstrates the karstified nature of the ground in an abandoned quarry to the north of The Rockland and Castleview Estates. To the north of the town the bedrock changes with narrow bands of Ballysteen Formation (BA - fossiliferous dark-grey muddy limestone) and Kinsale Formation-Cuskinney member (Kncu - flaser-bedded sandstone and mudstone). Further north is a wide band of Gyleen Formation (GY - sandstone with mudstone and silt). These details are shown on Figure 7.1.

The ground water level at the proposed treatment plant site is at the existing ground level during the winter months and slightly lower during the summer months.

A site investigation was carried out to the east of the existing WWTW in January 2007 as shown on Figure 7.2. The ground conditions are summarised in Table 7.1 below.

Stratum	Description	Zone	Comment
Soft peats & silts	Topsoil, soft peaty lays and Silts; sometimes gravelly	Ground level between 1.2m and 2.5m	
Sands and gravels with layers of clays and silts	Sands and Gravels, sometimes clayey or silty with layers or pockets of stiff gravely lay, firm clay and silts	To bottom of the boreholes which were 10m to 14m	Noparticle size distribution analyaes to assist in identification Soil descriptions varied from silty Sands clayey Sands, Sand silty or clayey Gravel Fine grain soils ecountered in BHs 1 and 5 (adjacent were stiff gravely Clay layer from 3.8m to 5.5m and silt layer from 8.6m to 9.8m (BH1) and firm and stiff sandy clay in H5 from 5.8m to 8.5m and from 11m to btm of BH at 14m

Table 7.1 Summary of Ground Conditions

Groundwater observations were limited but generally were about 0.2m to 2.8m below ground level and were probably tidal in this area.

The boreholes indicate that this is a very variable deposit of Sands and Gravels with layers of clays and silts. The variability is particularly indicated by BHs 1 and 5 which are the most westerly and closest to the site of the proposed upgraded treatment plant. Given the general nature of the deposits in this area, it is possible that this stratification represents marine estuarine deposits which have layers of sand and silts and gravel

The ground investigation indicates that the ground comprises variable deposits of medium dense sands and gravels which are sometimes clayey or silty, with layers of silts and clays which would be expected to be firm but from experience of these soils may have soft layers.

It would be reasonable to assume that the ground conditions at the proposed site are similar and a detailed site investigation will be carried out.

7.1.2 Characteristics of the Proposal

The main impact in respect of soils will be the construction of process tanks and foundations for new buildings. For the indicative design prepared for the E.I.S., several new tanks are shown. These new tanks are assumed to be based around top water levels to permit a gravity flow of the influent through the works from the preliminary treatment building. It is anticipated that the ground levels at the treatment plant site will be raised

prior to construction due to the high water table. Under the proposed DBO contract, tenderers will be free to offer alternative designs including those entailing inter-stage pumping which may be proposed to avoid excavation below the water table. Where excavation below the water table is proposed, it is expected that the contractor will establish temporary sumps and pumping to lower the water table locally. Any tanks placed within or below the water table will be required to have an adequate factor of safety against flotation when empty. All surplus excavated material will be exported off site to licensed (non hazardous) landfill sites.

7.1.3 Potential Impact of the Proposal

The construction will have very little impact on the soils if the ground level is raised and the tanks are above ground level. If the tanks are buried then some dewatering will take place and certain tanks may need to be both anchored to prevent flotation and to be piled to prevent settlement due to the underlying soft silty layers. This excavation will be isolated in the areas of the tanks and the impact on the soils will be minimal.

7.1.4 Mitigation Measures

No mitigation measures are required.

7.1.5 Predicted Impact of the Proposal

The predicted impact of the proposal will be minimal.

7.1.6 Monitoring

No monitoring of the soil on site will be required.

7.1.7 Reinstatement

Reinstatement of the topsoil on the site will be carried out as part of the landscaping of the site.

7.2 Foundations

7.2.1 Receiving Environment

Piled foundations may be required to support certain units. Anchors may be required to hold down the tanks against flotation when empty.

7.2.2 Characteristics of the Proposal

The foundation works will be limited to normal excavation, piling and dewatering and, possibly, some ground anchors.

7.2.3 Potential Impact of the Proposal

The impact of the foundation works will be standard for similar type construction activities.

7.2.4 Mitigation Measures

No mitigation measures are required.

7.2.5 Predicted Impact of the Proposal

The impact of the foundation works will be standard for similar type construction activities.

7.2.6 Monitoring

No monitoring will be required.

7.2.7 Reinstatement

No reinstatement will be required.

8 ECOLOGICAL IMPACTS

A study of the ecology of the proposed treatment works site and of Slatty Waters downstream of the WWTW was carried out by Dixon-Brosnan Environmental Consultants, a UCD based company, between February and April 2007. A report summarizing the findings of this study and describing possible impacts of the proposed development on the ecology is reproduced in full in Appendix C. The flora and habitats of the WWTW site and the impact of the proposed wastewater treatment plant are described below in the form of a summary of the main findings from the Dixon-Brosnan report.

8.1 Land Based Habitats

8.1.1 Receiving Environment

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. A minor road runs along the northern boundary of the site.

The habitats listed below are shown on Figure 8.1. 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**

A detailed description of these habitats is given in the Dixon-Brosnan report in Appendix D. In general terms the flora in the area is typical of the type of habitat. There was no evidence of otters, seals, cetaceans, bats or badgers on the site though it may be used by small rodent species and foxes.

The wet/woodland area which will be affected by the provision of the new WWTP is unlikely to support rare or uncommon species however it will potentially support 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.

8.1.2 Characteristics of the Proposal

The existing WWTW extension is confined to the proposed site. Significant construction will be undertaken in this area disrupting the existing habitat. These construction works include clearing of vegetation, stripping of topsoil, excavations, construction of concrete tanks, construction of temporary and permanent roads and fences and associated works. Construction of the treatment works buildings and landscaping and re-planting will be as described in earlier sections of this report.

8.1.3 Potential Impact of the Environment

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. It is expected that willow, alder woodland will continue to colonise the area to the west of the existing site. In general terms the designation of the site is of local value (mostly low to moderate) and the impact of its removal is not considered to be of high significance.

Noise impacts are likely to be significant during the construction phase however it is noted that due to the presence of existing roads this is a high noise environment. There is no evidence to suggest that otters breed within the area to be affected although this species do occur within this area. Some adaptation to increased noise levels is likely for any species, which habitually occur in this area, due to high levels of traffic noise and 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 note in woodland at the Fota side of Slatty Water. However given the distance between this area and the works and significant impact is considered highly unlikely.

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.

8.1.4 Mitigation Measures

A number of mitigation measures are required to ensure that there will be no long-term negative impact on the environment. The mitigation measures recommended in the Report on Flora and Fauna have been reproduced below as follows:

- Removal of natural vegetation and in particular reed beds 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.
- 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 and that care must be taken with liquids or other materials to avoid spillage.
- A Construction and Demolition Waste Management Plan should be developed for the site, with particular emphasis placed on preventing any materials being dumped in the cSAC and SPA.
- 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.
- Where feasible, within the scope of the development, landscaping should replace some of the native species, which have been removed. It is recommended that

new hedgerows be planted as soon as possible to connect with existing hedgerows in the wider environment.

- It is recommended that the final landscape plans are designed in consultation with a qualified ecologist.

8.1.5 Predicted Impact of the Proposal

The comprehensive measures proposed above to conserve or replace the existing habitats will form part of the design brief for the contractor for the design, construction and operation of the works. With such measures in place, the long-term impact of the proposal is negligible. Any other nominal existing habitats within the site which are disturbed by construction activities will be expected to regenerate elsewhere on or near the site so there will be no-long term adverse effects on the environment.

8.1.6 Monitoring

Monitoring of the regenerated hedgerows and vegetation areas should be performed to ensure that they are adequate and conducive to the return of the original wildlife.

8.1.7 Reinstatement

Where practicable the boundary landscape planting should be predominantly of Irish native species that reflect the existing vegetation of the area. Planting of hedgerows with broad-leaved trees and shrubs, especially berry-producing species will maintain the bird density in the area and will enhance the visual aspect of the development and also improve its value as a site for wildlife.

8.2 Aquatic Habitats

8.2.1 Receiving Environment

A detailed description of the various flora and communities of species inhabiting Slatty Waters is given in the Dixon-Brosnan Report in Appendix C and is summarised briefly below.

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.

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 northern boundary of the mudflats is formed 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 there is a considerable volume of traffic noise however the levels of direct disturbance by walkers etc are 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.

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. A number of studies have been previously carried out on water quality in Cork Harbour 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 and this new facility is expected to significantly improve water quality.

Slatty water into which the treated wastewater will be discharged is 150-250m wide and 2950m long 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.

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.

Mudflats are typically productive environments, which are characterised by high biomass but relatively low species diversity. Rare species of macroinvertebrates 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. The nutrient levels may be elevated due to the discharge of effluent from the existing outfall that does not meet the required standard for nitrogen and phosphorus and is discharged at a point of comparatively low dispersal.

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 this area as important for salmon or sea trout. The only species noted in the absence of dedicated fish surveys were mullet, which utilise the creek at low tide.

8.2.2 Characteristics of the Proposal

The treated effluent will be discharged through an outfall pipe directly into a small creek at the low water mark to the west of Slatty Bridge. No construction work is planned for the banks of Slatty Waters.

8.2.3 Potential Impact of the Proposal

The increase in population equivalent discharging to Slatty Water will increase the total nutrient loading over time despite the improved treatment standard. However the location of the new discharge point will result in increased dispersion of the effluent as outlined in Chapter 5 of this report and the nutrient levels should remain within the parameters set by the EPA for sensitive estuarine and coastal waters. There will be a positive impact on the upstream end of Slatty Waters due to the removal of the existing outfall.

There will be no negative impact as long as the targeted final effluent standards are achieved. It will be important to monitor the discharge during construction and

commissioning.

If the proposed extension to the WWTW does not take place, then the quality of the final effluent will deteriorate as the region grows. This would have a substantial negative effect on the river.

8.2.4 Mitigation Measures

There should be a minimal requirement for mitigation measures as the discharge standards proposed may be expected to assist in the attainment of a substantial improvement in the water quality in the river. The measures recommended in the Dixon-Brosnan report are as follows.

- The installation of the outfall pipeline in the mudflats should not take place during the wintering period (approximately October to March).
- The dredged sediment should be reused within Slatty Waters to prevent drying out and subsequent death of the fauna within the sediment.
- Silt arising from the treatment plant during the development of the site should be contained.
- Effluent being discharged from the upgraded plant needs to adhere strictly to the standards set out in the aforementioned regulations.
- The discharge should be monitored.
- Monitoring of nutrient levels, macro invertebrates and wintering birds should be carried out.

8.2.5 Predicted Impact of the Proposal

The measures proposed above will form part of the design brief for the contractor for the design, construction and operation of the works. There will be localised disturbance in the mudflats during construction but the affected area should recolonise relatively quickly.

8.2.6 Monitoring

Monitoring of the effluent quality from the WWTW will be undertaken as part of the DBO contract, as provided for under the Urban Wastewater Treatment Regulations. Additional monitoring of the nutrient levels, macro invertebrates and wintering birds should be carried out every two years until four years after the plant reaches its maximum capacity.

8.2.7 Reinstatement

The dredged sediment should be returned to Slatty waters without having time to dry out.

9 SOCIO-ECONOMIC IMPACTS

9.1 Industrial and Residential Development

The 2006 census suggests that the population of Carrigtohill grew at a rate of approximately 20% per annum since 2002. It is anticipated that the future growth will be substantially in excess of this rate for a number of reasons:

- The recent expansion in economic activity continues to put pressure on housing availability in population centres like Cork City. The close proximity of Carrigtohill to the city makes it an ideal location for suitably serviced lands to help cater with Cork City's housing needs.

- The new planning permissions granted within the catchment for developments that are currently under construction. These include a development by Gable Holdings Ltd, which will have in the region of 1,600 dwellings.

- The current requirements of planning authorities are that lands being developed be suitably serviced for sewage collection and treatment. Therefore, if a suitable wastewater collection system and treatment facility is put in place, it is very likely that development of Carrigtohill will continue until the design population of the scheme is reached. A factor inhibiting further housing development in Carrigtohill has been the inability of the existing collection system and treatment works to cater for any further large increases in either domestic or non-domestic effluent.

- With the improvements in the transport infrastructure i.e. the improved N25 bypassing the town along with easy access to the Jack Lynch Tunnel and the proposed reopening of the railway connection to Cork City, it is expected that Carrigtohill will have a rapid population growth over the next 20 years.

  - The Cork Area Strategic Plan [CASP] considers the Carrigtohill area to be an area with significant growth potential for both residential and industrial/enterprise developments. CASP envisages that the Metropolitan Cork area (inclusive of Carrigtohill) would act as a single housing and jobs market.

  - As a result of the Special Local Area Plan (SLAP) for Carrigtohill the total zoned area for Carrigtohill has been increased to 584.1 hectares.

  - Amgen have commenced work on a new pharmaceutical facility in Carrigtohill which

will eventually employ approximately 2,000 people. This site is additional to the 584.1 hectares already zoned for development.

The estimated final design population for the Carrigtohill catchment is as follows:

- A design residential population of 18,433 is achievable, based on the SLAP September 2005.

- The design institutional and commercial population equivalent for Carrigtohill is 2,787.

- The design industrial wastewater population equivalent is 24,008.

- The proposed Amgen site will add an additional 54 hectares of industrial lands to that already set aside in Carrigtohill SLAP. It is estimated that the foul and process effluent from the site which is to be treated on site to a standard comparable to domestic sewage will reach a maximum of 4,000m3/day by the third quarter (Q3) in 2010. This is equivalent to a population equivalent of 17,777.

- The design population equivalent for the scheme will be 62,000PE, over an area of 638hectares

9.1.1 Potential Impact of the Proposal

The proposed extension of the treatment plant is designed to cater for the future needs of Carrigtohill town and its environs until the year 2030. The increased capacity of the plant will allow for the sustainable socio-economic development of the town and its environs over this period.

The region has good infrastructure in terms of transport with connections to Cork City via the N25 and will have a new rail link to the city centre. These are essential for the sustainable development of the area, particularly with regard to industrial and commercial transport issues.

The existing plant is currently overloaded and will not be able to cope with any additional loads resulting from future growth. Sustainable growth as outlined above is dependant on the increased wastewater capacity that will result from the new extension.

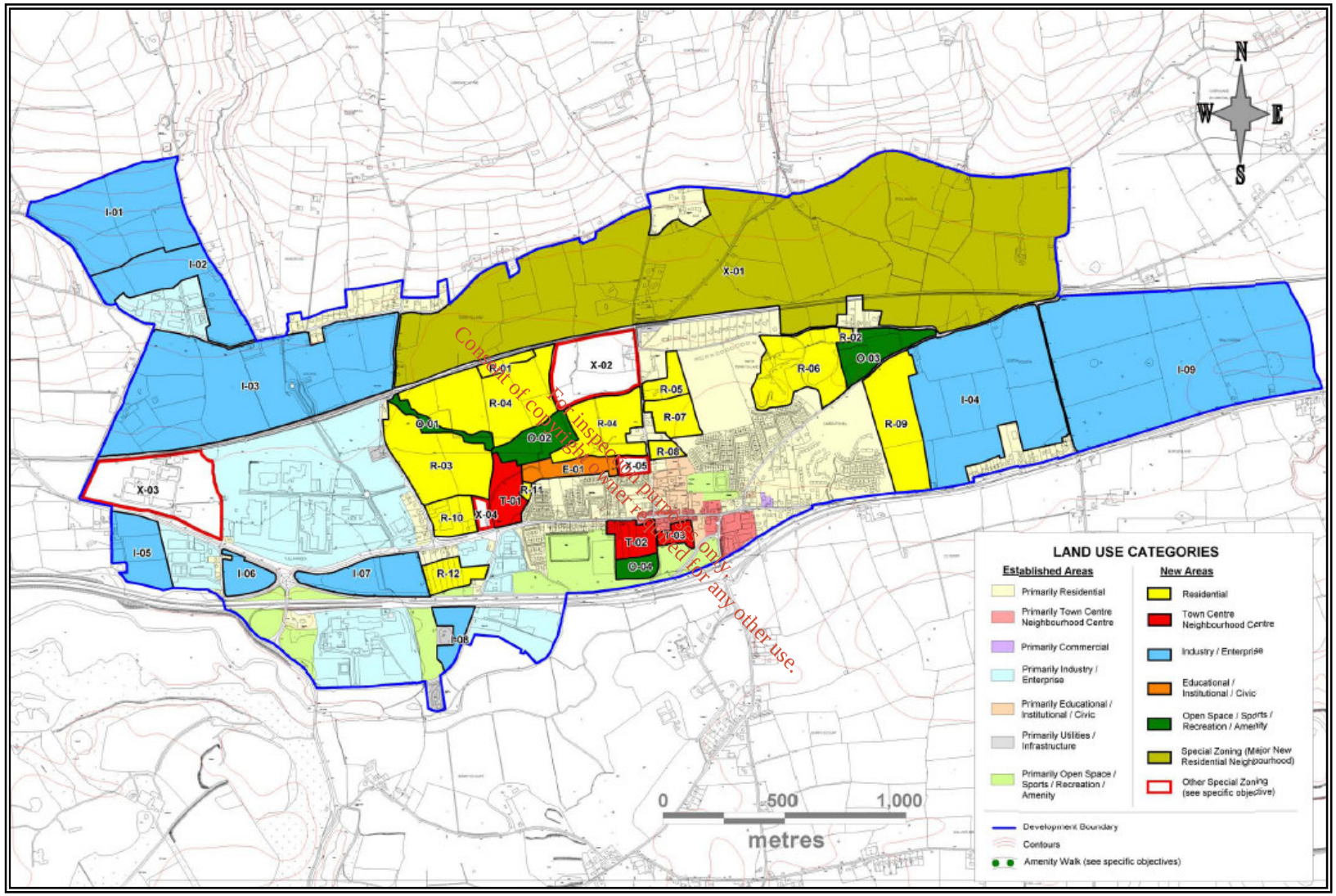


Figure 9.4: Carrigtohill Special Local Area Plan [SLAP] as amended in April 2006.

In summary, a number of developments have recently taken place which facilitate a substantial and growth in the population of the Carrigtohill area. The proposed extension of the wastewater treatment plant is essential for this development to take place on a sustainable basis. It will enable increased populations in the local area, provide for further commercial and industrial investment and assist in the attainment of higher levels of employment and sustained prosperity for the region.

9.1.2 Mitigation Measures

There are no mitigation measures required with respect to the socio-economic impact of the new extension to the treatment works.

9.1.3 Predicted Impact of the Proposal

The upgrading of the wastewater treatment plant in Carrigtohill will enable the sustainable development of Carrigtohill town and its environs.

9.1.4 Monitoring

No monitoring will be required.

9.1.5 Reinstatement

No reinstatement will be required.

9.2 Power and Water Supply

9.2.1 Receiving Environment

The wastewater treatment plant is located on the edge of the town. There is a 3-phase high-tension overhead cable serving the existing works. At the WWTW a transformer is installed. An existing watermain serves the site.

9.2.2 Characteristics of the Proposal

Normally, high-tension electricity is only required where the maximum demand is greater than 500kW. Both the existing and proposed works will have a lower power requirement less than 500kW, and for this reason a low-tension transformer station is installed to facilitate the electricity supply to the works. This transformer is located within the existing site and no new power lines are envisaged. A stand-by generator is to be provided in case of power failure.

The existing water main will cater for the potable water requirements of the new site. Additional water for polymer make-up and washing may be obtained from the re-use of

final effluent. No new water mains will be required.

9.2.3 Potential Impact of the Proposal

As no new power lines or water mains will be required there will be no impact on the environment around the site.

9.2.4 Mitigation Measures

In the case of a power failure a standby generator will come into operation to provide electricity for the operation of the works and maintain the quality of the final effluent.

9.2.5 Predicted Impact of the Proposal

There will be no impact on the local environment.

9.2.6 Monitoring

No monitoring will be required.

9.2.7 Reinstatement

No reinstatement will be required.

9.3 Transport and Communications

9.3.1 Receiving Environment

The Carrigtohill WWTW is located adjacent to the N25 road. The entrance to the site has been improved during the previous upgrade of the WWTW to increase the sight distance at the access point.

9.3.2 Characteristics of the Proposal

Construction and operation of the works will involve two distinct classes of vehicle and products. The main construction traffic will be associated with the delivery of construction materials to the site and the transport of machinery and plant items to and from the site. The latter traffic will mainly be confined to the start-up and finish of the project. The construction traffic will be the cause of some inconvenience in the short term and should be managed in order to minimize the disruption. It is anticipated that any material arising from the excavations will be reused as fill or landscaping.

During the operations phase, the dewatered sludge will be transported off site for treatment/reuse while the screenings and grit will sent to landfill. Table 9.1 details the materials and residues to be of imported to and exported from the WWTW during the

operational phase of the plant as well as the associated truck movements.
There will be further traffic arising from staff and services such as the collection of rubbish. The level of annual heavy traffic movements anticipated by 2012 is shown in Table 9.1.

	Number of visits to and from the WWTW
Removal of dewatered sludge	**160**
Rubbish and screenings collection	**90**
Delivery of materials	**24**
Total	**274**

Table 9.1 - Total annual number of anticipated lorry movements for the new works

The total number of heavy transport movements to and from the site is calculated at approximately 548 per year, which will average 2 one-way trips per working day.

9.3.3 Potential Impact of the Proposal

During the construction phase there will be an increase in the level of traffic associated with the transport of material and construction personnel to the site. As is normal on construction projects the level of activity will vary, commencing slowly and building to a peak during the project before reducing toward the end. With the close proximity of the site to the N25 (without passing through Carrigtohill itself) the temporary increase in traffic levels should have a very low impact on traffic levels in Carrigtohill generally. There will nevertheless be an increase in local traffic though this should only be significant on the access road to the site.

During the operation of the works the heavy transport entering the site will be approximately 2 one-way trips per working day. The area of the site is to the south of the N25 and is mainly industrial and agricultural. This level of traffic is considered to be negligible in the context of the traffic currently using the road and the low level of residential development in the area. Given that the site is located adjacent to the N25 the effect of this traffic will be limited to the access road.

9.3.4 Mitigation Measures

A temporary wheel wash or washing facilities will be required to ensure that the lorries leaving the site during construction are clean and do not contaminate the local roads.

Permanent wheel washing facilities will be installed for the permanent works.

Construction traffic will be scheduled to minimise disruption and will generally only operate during normal working hours on a five and a half day week.

9.3.5 Predicted Impact of the Proposal

The long-term impact of the proposal on the local traffic will be low. All vehicles used to transport the generated sludge will be monitored to ensure that they are maintained in a clean and sanitary condition.

9.3.6 Monitoring

No monitoring will be required.

9.3.7 Reinstatement

No reinstatement will be required.

10 MATERIAL ASSETS

10.1 Assimilative Capacity of Slatty Waters

The existing receiving water quality has been assessed in Section 5 of this E.I.S. The assimilative capacity and anticipated dispersion of effluent within Slatty Waters has been considered in conjunction with other regulations to establish acceptable discharge levels for the treatment plant.

The calculations shown in Section 5 demonstrate that the chosen final effluent standards of 25 mg/l BOD, 35 mg/l SS, 1 mg/l P and 15 mg/l N are consistent with the dual targets of complying with the regulations and operating within the assimilative capacity of Slatty Waters.

10.2 Land Ownership and Access

The proposed site is already owned by Cork County Council.

10.3 Development Potential and Expansion

The first phase of the treatment works at Carrigtohill will have the capacity, once commissioned, to treat wastewater arising from 45,000 persons equivalent (PE). However, the preliminary treatment and stormwater facilities will be designed for the final capacity of 62,000 PE. The layout of the treatment works will be planned to accommodate this future expansion.

10.4 Existing Structures

Most of the existing structures and buildings are expected to be demolished after completion of the new works.

11 VISUAL IMPACT

11.1 Topography and Location

The treatment plant is located outside the village of Carrigtohill to the south side of the N25. The northern boundary is a local road with a manufacturing facility located on the opposite side of the road. The southern boundary is formed by Slatty Pond. Slatty Waters are to the west of the site and open agricultural land to the east. The existing plant is screened by existing hedging on all sides. It is anticipated that some of this hedging will act as a screen for the east side of the new works.

The ground level in the area of the proposed new works will be raised at least to the level of the existing works.

The general character of the area is mixed with industrial and commercial developments to the north and east of the site, agricultural and open water to the south and Slatty Waters and the N25 to the west.

11.2 Landscape and Buildings

The layout of the site is dictated to a large extent by the functional requirements of the treatment works. However, earthworks, landscaping and appropriate architectural forms are proposed to soften the impact of the works. The buildings will have external finishes of a high quality. It is anticipated that the most likely external finish will be a combination of high quality cladding and plastered blockwork. These finishes would generally be in character with the commercial and industrial character of the area.

Sections through the site illustrating the relative heights of the various building and process units are shown in Figure 11.1.

In the following figures, perspective views from different locations are presented without and with the proposed extension of the WWTW. The indicative views show the impact of proposed trees and shrubbery which may be expected to further soften the impact of the larger buildings over the longer term, particularly the preliminary treatment works building.

Existing View

Indicative View of Proposed Extension

Figure 11.1- Perspective View from Aherns farm to South of Slatty Pond

Existing View

Indicative View of Proposed Extension

Figure 11.2- Perspective View from Slatty Bridge

Existing View

Indicative View with proposed extension

Figure 11.3- Perspective View from Slatty Bridge North

11.3 Mitigation Measures

Landscaping will be required at the north, west and southern boundaries of the site to minimise any impact of the new buildings and tanks. Embankments will be provided intermittently along the full length of boundary as shown on Figure 11.2. These embankments will vary between 2 metres and six metres in width and will be between 1.5 metres and 2 metres in height (above the raised ground level). The embankments will be planted using the species listed in Table 11.1.

Some internal embankments and landscaping will be required to soften the impact of the proposed tanks and buildings on the vista. The final ground profile should be a rolling landscape rising around the tanks and buildings to offer a landscaping shield in close proximity to the structures. In this way the structures will be shielded without interfering with the existing profile of the site.

Species to be included in planting	
Ash	Fraxinus Excelsior
Oak	Quercus Petraea
Hawthorn	Cretaegus monogyna
Wild rose	Rosa sp
Elder	Sambucus nigra
Blackthorn	Prunus spinosa

Table 11.1 - Species to be included in planting on landscaping embankments

11.4 Predicted Impact of the Proposal

The mitigation measures above will ensure that there will be a minimal impact on the environment at Carrigtohill. Given the topography of the site the impact of the embankment in combination with screening will reduce the visibility of the site from all sides. However the taller buildings will remain visible from surrounding areas

11.5 Monitoring

No monitoring will be required.

11.6 Reinstatement

No reinstatement will be required.

12 CULTURAL HERITAGE

The archaeological and cultural heritage and the impact on these of the proposed extension to the WWTW were studied by the Archaeological Services Unit of University College Cork. Their report, included in Appendix D, forms the basis of this section of the E.I.S..

12.1 Receiving Environment

The existing wastewater treatment plant is located South-west of Carrigtohill in the townland of Tullagreen, Carrigtohill, County Cork. The town of Carrigtohill is reportedly named from the Irish *Thuahill*, meaning left handed or North. It is so called because, whereas most of the rocks in that part of the country run east-west, the rocks at Carrigtohill run north-south. The town itself is synonymous with the Earls of Barrymore from the thirteenth to the eighteenth centuries but much earlier settlement activity in the area is also evident.

The existing WWTW and the proposed area of the development was originally a boggy greenfield site. The existing treatment plant has since disturbed most of this ground. That which has not been built on has been landscaped, covered with concrete or stone gravel and used as a storage area.

12.2 Characteristics of the Proposal

The proposed development shall include the existing treatment works site, the proposed site to the west and shall extend approximately 800m to the west into Slatty Waters.

12.3 Potential Impact of the Proposal

Visual impact

The proposed development will not have any visual impact on the known archaeological sites in the environs of the townland of Tullagreen, Carrigtohill, Co. Cork.

Archaeological Impact

The proposed outfall pipeline route is not located within the zone of any recorded archaeological sites, however, there are three known sites in the environs, including evidence for prehistoric settlement (Fig 2; Appendix 1). The proposed outfall pipeline is within the Slatty Water estuary. This waterway is tidal with substantial mud-flats exposed

at low tide. It is possible, therefore that formerly unrecorded sites including archaeological material in the inter-tidal zone could be uncovered during disturbance of the environs of the pipeline. Buried archaeological sites may range from small-scale sites such as isolated burials to extensive evidence for habitation. These sites may be detected by an archaeological walkover at low tide or it may be necessary to conduct a dive survey. This area should also be subject to metal detection survey.

Impact Summary

The impact of the proposed outfall pipeline on the archaeological landscape of the area was assessed using all of the available documentary and cartographic sources. There are three recorded monuments surrounding the proposed development area. It is also possible that previously unrecorded monuments may be uncovered during disturbance of the mud-flats and construction of the outfall pipe. This area is therefore subject to an archaeological walkover and metal detection survey at low tide or a dive survey if required.

12.4 Mitigation Measures

In order to prevent any potential loss to the archaeological record a series of mitigation strategies are recommended.

1. The Slatty Water estuary is tidal with substantial mud-flats exposed at low tide, these may be walked across at low tide and a non-intrusive inspection should be carried out of the inter-tidal zone and riverbed affected by the proposed development. Depending on the depth of water, a dive survey may be required.

2. A metal detection survey of the area must be undertaken. It will record the location of all ferrous and non-ferrous materials on and beneath the inter-tidal zone and riverbed. Each contact will be plotted, facilitating the development of a metal detector contact distribution pattern.

3. The archaeologist will require a licence for this work and this licence will be issued by the Department of the Environment, Heritage and Local Government. Fifteen working days advance notice is required to apply for and obtain the necessary licence.

4. The archaeologist should be empowered to halt the development if buried archaeological features or finds are uncovered.
5. Provision, including financial and time should made be at the outset of the project to facilitate any excavation or recording of archaeological material that may be uncovered during the developmental works.

12.5 Predicted Impact of the Proposal

Subject to the mitigation strategies proposed above the proposed development will not have any impact on the archaeology of the area.

12.6 Monitoring

Monitoring of the construction works for the outfall pipeline will be required where the bed is disturbed. No monitoring of the proposed treatment plant site is required.

12.7 Reinstatement

No reinstatement will be required.

13 SUMMARY OF LONG TERM IMPACTS AND INTERACTIONS

13.1 Summary of Impacts

The previous eight sections have described the environmental impacts that are likely to arise as a result of the decision to upgrade the sewage treatment facilities at Carrigtohill. These impacts have been considered in detail in respect of the proposed site for the treatment works. The following provides a brief summary of the overall impact of the proposal.

The provision of a wastewater treatment works for Carrigtohill is a statutory requirement under Irish Law. The construction of the works at the existing site near Slatty Pond will enable the County Council to discharge their obligations in this respect. A brief summary of the impacts of the proposal is presented below.

- Movement of the outfall point resulting in significantly improved dispersion of the polluting matter entering Slatty Waters leading to
  - Enhanced water quality
  - A reduced public health risk

- The town will be provided with a facility which will significantly enhance its ability to attract and cater for industrial, residential and other developments in the town and its environs.

- The works will be designed to modern standards in respect of air treatment and no discernable odours are expected to be detectable beyond the works boundary during normal operation. Mitigation measures to reduce noise and light levels will ensure that the plant will not impact on the nearest residence or businesses in the locality.

- The landscaping and other measures proposed will minimise the visual impact of the works on the local environment.

- Any disruption of the natural habitat during the construction phase will be temporary in nature and any affected species are expected to become quickly re-established.

- Increased traffic to and from the completed works during the operational phase is

limited. Given the proximity of the N25 and the connection road to the bypass this will have a minimal impact on the surrounding roads network.

13.2 Inter-Actions

The statement has demonstrated that the wastewater treatment works will have a positive impact on the environment and will substantially enhance the attractiveness of the Carrigtohill area for residential, commercial and industrial development. In these terms the interactions of the impacts of the proposal combine to produce an enhanced environment with positive benefits for the Carrigtohill area generally.

Some intensification of traffic in the area during the construction stage is unavoidable as is a short-term deterioration in the visual impact of the site. These impacts will, however, be confined to the construction period.

The mitigation measures identified for potentially negative impacts following construction such as odour and noise confine these impacts to within accepted limits. When considered together, there are no foreseeable circumstances in which the mitigated impacts can combine to produce a cumulative impact of any greater significance.

13.3 Recommendations

The upgrading of the sewage treatment works at Carrigtohill will improve the environment of Slatty Waters and enhance the amenity value of the coastline to the town. It is an integral part of the infrastructure to enable growth in the region and is essential to the future development of the town. Failure to provide an adequate level of treatment will restrict growth in the town and in the county as a whole.

Mitigation measures will be provided at the site at the proposed site in order to minimise any potential negative impacts. It is therefore recommended that the proposed sewage treatment works be located there.

In summary, it is recommended that:

- Cork County Council proceed with their proposal to upgrade the wastewater treatment works as outlined in this document;
- This treatment works be sited at the existing site at Tullagreen;
- The associated mains/sewers be upgraded to convey wastewater to the works;
- The measures as outlined in this document be provided for the mitigation of any negative impacts on the environment resulting from this development.

APPENDIX A – REPORT ON POTENTIAL NOISE IMPACT

APPENDIX B – STUDY ON AIR QUALITY IMPACT

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Noise Impact Study for the Proposed WWTP Upgrade at Carrigtohill, Co. Cork.

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1.0 INTRODUCTION

The Carrigtohill wastewater treatment plant (WWTP) was originally built in 1976, with an upgrade occurring during the 1980's. The current capacity of the WWTP is 8,500 PE. However recent significant population growth and industrial development in the area means that this capacity is regularly exceeded, hence the requirement for an upgrade to this WWTP.

It is proposed to construct a new WWTP plant on the site of the currently operational plant, with a design capacity of approximately 67,000 PE. This development will comprise of two phases, with phase 1 of the project being constructed adjacent to the currently operational plant. The old plant will then be decommissioned and demolished, with phase 2 of the development occurring at this location.

The plant will be designed to meet the requirements of the Urban Wastewater Directive (91/271/EC), comprising of primary treatment, secondary treatment and tertiary treatment (nutrient removal).

1.1 Noise Sources

The specifications for the proposed plant are not available at this time because the proposed project will operate as a design and build contract which will allow tenderers to put forward their own design for meeting the specified emission and discharge standards. However the proposed works is likely to comprise of the following:

- Inlet Works: Preliminary treatment of the influent will be undertaken primarily by screening to remove plastic, non-biodegradable material and grit. This equipment will be enclosed in a building, thus minimising the noise impact.

- Settlement Tanks: Primary treatment will be undertaken here, whereby solids are removed by way of settlement. The resultant sludge would be pumped to sludge storage facilities (for removal via tanker). Noise from this process is mainly due to the occasional operation of pumps and the removal of sludge by "tankers".

- A number of processes will be considered for the secondary treatment at the plant. These are the activated sludge process, the extended aeration

process (unlikely), percolating filters and fluidised or fixed bed filters. The main noise emanating from these processes will result from the operation of pumps and the aeration process.

- Tertiary treatment: Further various treatment methods are introduced in order to remove phosphorus and nitrogen from the wastewater.

The proposed treatment plant will operate 24 hours/day and 7 days a week. Activities during the day which may generate noise include the arrival and departure of employees by car and the transport and removal of sludge by tanker from the site (c. 1 tanker per day). It is unlikely that these occasional noise sources will result in nuisance at any nearby sensitive receptors.

During the night time the only noise arising from the plant will be the running of the plant machinery (many of which are enclosed). All plant will be suitably attenuated to ensure noise they meet the given noise limit of 35LAeq.

There will be a short period of increased noise generation during the construction of the proposed plant. Construction will occur during the daytime only.

1.2 Noise Environment

The site for the proposed WWTP is located on the site of the existing plant. It is in an area on the edge of the small town of Carrigtohill. It is surrounded by fields on three sides, with some one off rural houses in close proximity. There are no significant residential developments in close proximity to the site. To the north of the site is an industrial development. Further north is the N25 Cork to Waterford road. To the west of the site is the R624 Cobh road. Road noise dominates the noise environment in this area.

The closest sensitive receptors to the proposed WWTP (and the currently operational plant), are two residences, one of which is located 230m to the west of the facility and a second which is located 250m south west of the plant.

This report discusses the existing noise levels at the proposed site, the potential impacts of the proposed development on the existing noise levels and the abatement measures that may be employed to reduce or eliminate the impact.

2.0 METHODOLOGY

2.1 Baseline Noise Survey

A survey of the baseline noise levels at the site of the proposed development was carried out by Bord na Móna Environmental Consultancy Services, to determine current noise levels in the area resulting from the currently operational site and other local noise sources. Both a day time and night time acoustic assessment was undertaken at dates in March 2007 at the locations given in Table 2.1/1.

All measurements were taken at 1.5 m height above local ground level and 1-2 m away from reflective surfaces at each of the locations on the following days:

- Daytime Assessment: 7th March - Wind speed was less than 5 m/s; the weather was cold, dry with slight breeze at the time of the assessment.

- Night time Assessment: 15h March - Wind speed was less than 5 m/s; the weather was cold, dry with slight breeze at the time of the assessment.

TABLE 2.1/1 : LOCATION OF NOISE MONITORING MEASUREMENTS

Map Reference No.	Location Type	Location
N1	Boundary	North-Western Boundary (Next to Millipore Entrance)
N2	Boundary	North-Eastern Boundary (Entrance to Existing WWTP)
N3	Boundary	South-Eastern Boundary
NSL 1	Noise Sensitive Location	Residence (230m to West of Site)
NSL 2	Noise Sensitive Location	Residence (250m to South-West of Site)

Established acoustics methodologies as outlined below were applied for this assessment and subsequent interpretation of the resultant data.

Standards and Guidance

The acoustic assessment and subsequent reporting are in accordance with International Standard Organisation (ISO) 1996 Acoustics – Description and Measurement of Environmental Noise Part 1, 2, and 3 in addition to relevant sections of the Environmental Protection Agency – Environmental Noise Survey Guidance Document.

Measurement Parameters

Leq Values

L_{eq} (t) values represent the continuous equivalent sound level over a specified time (t). This value expresses the average levels over time and is a linear integral.

L_{Max} Values

The maximum RMS, A-Weighted sound pressure level occurring within a specified time period.

L_{90} and L_{10} Values

The L_{90} and L_{10} values represent the sound levels exceeded for a percentage of the instrument measuring time. L_{10} indicates that for 10% of the monitoring period, the sound levels were greater than the quoted value. L_{10} is a good statistical parameter for expressing event noise such as passing traffic. The L_{90} represents post event sound levels and is a good indicator of background noise levels.

Tonal and Impulsive Characteristics

For the purpose of this report, tonal noise is characterised in accordance with ISO 1996-2, which indicates that a noise source being tonal at a particular frequency is either clearly audible or exceeds the level of the adjacent bands by 5dB or more. A subjective assessment of tonal noise was carried out during this monitoring event.

An impulsive noise is of short duration (typically less than one second), it is brief and abrupt, its' startling effect causes greater annoyance than would be expected from a simple measurement of sound pressure level. For example an instantaneous bang/thud that maybe associated with pile driving, hammering etc.

Instrumentation Equipment Used

The following equipment was employed during the acoustic assessments.

Bruel & Kjaer Real-Time Noise Analyzer Type 2260 Observer with Sound Analysis Software BZ 7210:

Model No: 2260…….. Serial No. 2418359
Date of Certificate and Calibration…….. 7th January 2007
Microphone Type: B&K 4936 ……..Serial No: 2417709
Tripod

- Certified current annual calibration certificates are available for the meter upon request.

On Site Calibration

The instrument was calibrated immediately before and after the measurement periods with no drift in calibration level noted.

3.0 NOISE IMPACTS

3.1 Results of the Baseline Noise Survey

TABLE 3.1/2: CARRIGTWOHILL SITE NOISE MEASUREMENTS DAYTIME					
Location	**Period (mins)**	**L_{eq} dB(A)**	**L_{10} dB(A)**	**L_{90} dB(A)**	**L_{FMax} dB(A)**
N1	15	61	60	49	82
N2	15	66	71	57	78
N3	15	57	58	57	66
NSL 1	15	80	83	62	94
NSL 2	15	64	59	45	85

TABLE 3.1/2: CARRIGTWOHILL SITE NOISE MEASUREMENTS NIGHTIME					
Location	**Period (mins)**	**L_{eq} dB(A)**	**L_{10} dB(A)**	**L_{90} dB(A)**	**L_{FMax} dB(A)**
N1	15	50	52	48	61
N2	15	54	55	52	62
N3	15	Not Accessible			
NSL 1	15	72	77	53	82
NSL 2	15	47	48	46	53

3.2 Discussion of Results:

N1

The measurement taken at the north-western corner of the boundary of the proposed WWTP was denoted as location N1. The resulting daytime LAeq result of 61 dB was influenced by road traffic both on the local road which runs adjacent to the existing WWTP and the N25. Site activities from the Millipore site were also audible. The LAFMax of 82 dB was caused by a passing JCB.

The same noise sources (N25 traffic, Millipore site) audible during the day were audible at night. However, as no cars passed by the monitoring location on the local road the LAeq of 50 dB was significantly less than the recorded day time LAeq. The LA90 of 48 dB is almost identical to the daytime LA90 of 49dB which show that the noise from the N25 is relatively constant throughout the day.

N2

This location is at the entrance to the existing WWTP. The daytime results were significantly influenced by construction work to the east of the site and as such are not considered to be representative of the baseline noise environment for the area. However the on site notes detailed that the road traffic on the local road and more significantly, the traffic on the N25 were the main contributors to the noise environment in the absence of the construction works which are only temporary.

The night time results for N2 are considered to be more representative of the existing baseline noise environment. The LAeq of 54 dB, the LA10 of 55 dB and the LA90 of 52 dB are all quite similar and indicate that the main noise source dominates the local noise environment, as per location N1 this is the N25 main road. Aside from this noise source, a continuous hum was also audible from the existing WWTP.

N3

Only daytime measurements were undertaken at this location as the WWTP was locked during night time hours. This measurement was carried out to assess the existing noise levels at the WWTP. The LAeq, LA10 and LA90 were all very similar as the only noise source at this location was from the existing WWTP which is a fairly constant source. The LAFMax of 66 dB was caused by the adjacent construction work.

NSL1

This monitoring location was situated adjacent to the house located at the junction of the local road which runs parallel to the existing WWTP and the R624. As can be seen from both the daytime LAeq of 80 dB and the night time LAeq of 72 dB this Nearest Sensitive Location (NSL) is significantly impacted by road traffic noise with no other sources of noise audible. The LA90 results of 62 dB and 53 dB respectively for day and night time were influenced by traffic on the R624, it is predicted from the results for N1 and N2 which are equidistant from the N25 that in the absence of traffic on the R624 the L90 would be similar to that recorded at N1 and N2.

NSL2

This NSL is a house located approximately 250 meters to the south west of the proposed WWTP. A road runs adjacent to the house which services the houses, a quarry and waste facility. During the day time monitoring event road traffic on this local road was a significant source however during the night time monitoring period it was traffic on the R624 and N25 that were the main noise sources.

3.3 Potential Noise Impacts

The site of the proposed WWTP is located on the outskirts of the town with little residential development surrounding the site. However there are a number of residences (one-off rural housing) in close proximity to the proposed facility.

Construction Phase

During the construction of the proposed plant there will be extra noise generated, however these activities will be restricted to daytime hours (08:00 – 18:00). The construction phase will also be temporary in nature. This will mean that the noise impacts will be limited and it is considered that the noise impact during the construction period will be slight.

Operational Phase

During the operation of the WWTP, noise levels will mainly result from the following sources:

- Traffic Movements onto and off the site
- Treatment Works

The traffic movements onto the site will be limited. They will consist primarily of employees arriving in the morning and leaving in the evening and the removal of sludge from the site by tanker, on average once a day. All traffic movements will occur during the daytime and hence the impact will be minimal with no night-time traffic noise resulting.

The operations of the proposed WWTP are not expected to be in excess of 35 LAeq at night and 45 LAeq during the day.

These operational noise levels are not expected to cause any impact on nearby sensitive receptors and the overall impact is expected to be minimal.

4.0 MITIGATION MEASURES

Construction Phase

The construction phase of the proposed development will occur over short term period and will be restricted to daylight hours. The most significant noise impacts will occur during the initial site preparation phase. Furthermore, all construction plant and equipment will comply with the European Communities (Construction Plant and Equipment) (Permissible Noise Levels) Regulations 1988, (Statutory Instrument No. 320 of 1988).

There are several mitigation measures that can be put in place to further reduce noise levels impacting on the receiving environment. These include:

- Proper training of operators in equipment use to minimise noise generation, excessive revving of engines, ensuring that vehicles are operated with noise control hoods closed.
- Proper maintenance of vehicles and equipment, checking the efficiency of silencers, lubrication of bearings.
- The control of on-site activities through the implementation of good management practices will combine to ensure that the noise generated at the site will not have any undesirable effects on the existing neighbouring environment.
- Selection of plant with low inherent potential for generation of noise and / or vibration.
- Erection of barriers as necessary around noisy items

It is therefore contended that due to the relatively short duration of the construction phase of the proposed development, the noise impact on the nearest sensitive receptors are not likely to be of significance.

Operation Phase

There are several mitigation measures that can be put in place to further reduce noise levels impacting on the receiving environment. These include:

- Speed Limit of 25 kmph at site entrance.

- Maintenance of trucks to prevent excessive noise from faulty parts e.g. screeching brakes.

Other practical measures will include:

- Proper training of operators in equipment use to minimise noise generation, prevention of excessive revving of engines.

- Proper maintenance of vehicles and equipment, checking the efficiency of silencers, lubrication of bearings

- Monitoring of site noise levels to ensure compliance.

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AIR QUALITY IMPACT OF PROPOSED EXTENSION OF CARRIGTOHILL WASTEWATER TREATMENT PLANT CO. CORK

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Date: 11 April 2007 (DRAFT) **Report By: Michael L. Bailey**

1.0 INTRODUCTION

An upgrading and extension of the wastewater treatment plant at Carrigtohill, Cork is proposed, to provide sufficient capacity for the projected increase in municipal and industrial sewage from Carrigtohill and the surrounding area. As part of the evaluation of the likely environmental impact of the planned treatment plant, an assessment of the potential impact of odours from was undertaken by Envirocon Ltd. As part of this assessment a site visit was made to the existing sewage treatment plant in February 2007.

2.0 EXISTING ENVIRONMENT

2.1 Air Quality

The wastewater treatment plant site is located approximately 0.75 km to the south east of the Carrigtohill village with the site accessed from a minor public road running eastwards from the R624. It is located on low-lying ground at about 10m O.D. The Carrigtohill Bypass (N25) runs east-west about 300m to the north of the treatment plant site and is on a raised embankment. There is a pharmaceutical production plant (Millipore) located about 300m from the existing treatment plant and 100m from the Eastern boundary of the extension site. However, there are no significant industrial emissions within the locality of the treatment plant site. The nearest house is located near the junction with the R624, about 225m from the Western boundary of the extension site. There are also a small number of houses about 400m to the SW of the site.

Overall, the air quality in the locality is good with levels of air pollutants in the area substantially below the National Air Quality Standards (NAQS) specified in the Air Quality Standards Regulations 2002 (SI No 271 of 2002). Daily concentrations of sulphur dioxide would be less than 20% of the limit value of 125 µg/m^3 specified in the 2002 Regulations. Ambient concentrations of nitrogen dioxide would be less than 40% of the future NAQS annual limit of 40 µg/m^3, which is to be met by 2010. Corresponding hourly concentrations would also well below the current NAQS hourly limit value of 200 µg/m^3. Carbon monoxide and benzene levels, which are important components of motor vehicle exhausts, would be very low in the area and typically less than 10% of the NAQS limit values.

Dust and airborne particulates, in particular those referred to, as PM_{10} (particulate material with a mean aerodynamic diameter of less than 10 µm) would be below the National Air Quality Standards. The limit values specified in the Regulations 2002, which entered into force in January 2005, give a daily level of 50 µg/m^3 (as a 90.4 percentile of daily average values) and an annual average value of 40 µg/m^3. Annual concentrations would be typically in the region of 10-15 µg/m^3 close to the northern site boundary, with vehicle exhaust emissions and roadside dust along the access road being the principal sources.

No malodours could be detected during the site visit undertaken in February 2007 near the site boundary of the existing treatment plant. The weather conditions were dry during the site visit with winds of about 5m/s from the SW.

2.2 Climate

2.2.1 General Climatology

The climate of the Cork Region is characterised by the passage of Atlantic low pressure weather systems and associated frontal rain belts from the west during much of the winter period. Over the summer months, the influence of anticyclonic weather conditions will result in drier continental air over this part of Ireland, in particular when winds are from the east, interspersed by the passage of Atlantic frontal systems. Occasionally, the establishment of a high pressure area over Ireland will result in calm conditions and during the winter months these are characterised by clear skies and the formation of low level temperature inversions with slack wind conditions at night-time. During the summer months, if anticyclonic conditions become established, then high day-time temperatures may be recorded; as experienced during 2005 and 2006.

2.2.2 Wind

The characteristics of the wind field in terms of wind speed and direction will affect the magnitude of the odour impact at ground level in the surrounding area due to emissions from the tanks and other emission sources within the treatment plant.

There are two meteorological stations within 17km of the Carrigtohill site, one at Cork Airport (17km to the West) and the other at Roches Point (12km to the South). Long-term observations at both meteorological stations indicate that the prevailing wind direction is from a southwesterly direction with a secondary maximum for north-westerly winds. The long-term wind roses indicating the incidence of winds at 10-degree intervals around the compass for the two locations are shown in Figures 1 and 2 for Cork Airport and Roches Point respectively. The meteorological station at Cork Airport is at about 154m O.D., compared to the one at Roches Point, which is located near the mouth of Cork Harbour. However, the station at Roches Point is very exposed to coastal breezes and nocturnal air flows out through the mouth of Cork Harbour during light wind conditions in the area. The site at Carrigtohill is north of Great Island and is less likely to be affected by the coastal sea breeze experienced around the Cork harbour, in particular at the mouth at Roches Point. Prevailing conditions would tend to be comparable to the general wind field over the region in the Cork area and so climatological data for Cork Airport was used in the odour modelling study.

The long-term incidence of winds of 5m/s or less at Cork Airport is about 52% of the year with speeds of <2 m/s (including calms) occurring about 7% of the time. The lowest frequency is for winds from a north-easterly direction, which account for about 8% of the

year. The mean annual wind speed is 5.5 m/s with an incidence of 0.5 % of hours for speeds below 1m/s. Climatological data from Roches Point indicate a lower incidence of wind speeds below 5 m/s, with about 45% below this value. The mean annual wind speed at Roches Point is about 6.3 m/s, as a result of the exposed coastal location of this meteorological station. The wind roses for Cork Airport for the modelled years 2005 and 2006 are given in Figure 3, which show the high frequency of winds from a SW and NW direction, compared to the incidence of winds from an easterly direction.

2.2.3 Air Temperature

The annual mean air temperature for the Carrigtohill area is about 9.5C, with a range in daily averages for most of the year of about 2-18.5 C. During warm dry spells in the summer, temperatures may rise to over 25C, as experienced during 2005 and 2006. The greatest potential for odorous emissions is during the summer months when warm dry weather conditions can increase the rate of evaporation from exposed treatment tank surfaces. These weather conditions may also be associated with low-flow sewage conditions from the surrounding area.

3.0 THE PROPOSED DEVELOPMENT

3.1 Odour Emissions from Wastewater Treatment Plants

Fresh sewage arriving at a wastewater treatment plant via a properly constructed sewer system has a slight smell, normally described as musty in character. As long as a certain level of dissolved oxygen is maintained in the sewage anaerobic conditions will not take place. However, if the oxygen content of the sewage is used up then gases such as hydrogen sulphide, nitrogen and sulphur based organic compounds (mercaptans, ketones, amines, indoles and skatoles) are quickly produced and a general septic condition occurs with typical pungent odours being emitted. These conditions may arise where the incoming sewage becomes septic as it is pumped along the rising main and result in strong malodours at the inlet works.

The rate of emissions of malodorous compounds from within a treatment plant depend on the freshness of the incoming sewage, exposed surface areas of treatment tanks, sludge handling procedures and presence and type of odour control measures installed. In most cases, odour nuisance problems are due to the age of the plant, septicity of sewage and overloading conditions during primary or secondary treatment. Modern technology at treatment plants such as enclosing inlet works, high efficiency odour control systems, constant monitoring of flow conditions, diffused aeration for secondary treatment and sludge treatment within enclosed buildings can result in odours being greatly reduced.

Sulphide compounds, especially hydrogen sulphide and mercaptans, have very low levels of odour detection and these gases are a major component of the malodours generated

from treatment of sewage. The most common component is hydrogen sulphide, which has a detection threshold of about 0.5-2 µg/m^3. Its characteristic smell of rotten eggs occurs at concentrations about 3-4 times higher with odour nuisance complaints likely at higher levels.

The perception of odour at some point downwind of an emission source depends on the type of odour compound and the air concentrations of the odorous gas. The measure used to quantify odour nuisance potential is the odour concentration (odour unit per cubic metre, o.u./m^3). An odour concentration of 1 o.u./m^3 is the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At levels below 1 o.u./m^3 the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the odorous gas is still present in the air no odour will occur.

The intensity of an odour ranges from 1 o.u./m^3 = odour detection, 2= faint odour with the intensity increasing up to 5 o.u./m^3 where the odour is easily identifiable, with higher levels likely to result in nuisance complaints by the local community. The length of time the odour can be detected is an important factor in the likelihood of the odour causing a nuisance. If the odour is recognisable but very infrequent over the year, then again complaints are unlikely. This is especially the case in rural environments where the community has a higher tolerance of odours associated with agricultural activities than those living in an urban area.

3.2 Proposed Extension of WWTP

3.2.1 Introduction

The proposed extension of the existing treatment works at Carrigtohill is designed to provide treatment capacity for a Biological Oxygen Demand (BOD) load for Phase 1 of 45,000 p.e. (person equivalent), compared to the current design capacity of 8,500 p.e. The final design capacity (Phase 2) will be 67,000 p.e. This will require a new inlet works, storm water tank, secondary treatment and sludge treatment facilities.

The construction contract is design/build/operate (DBO). This means that the Contractor will carry out the design of the plant. The DBO contract will contain performance specifications, including odour control. The Contractor will also be required to monitor odorous emissions to ensure compliance with emission limits during the normal routine operation of the plant.

It will be a requirement of the design of the new treatment plant that the following components will be included: -

- The present sewage treatment works will be replaced.
- A new inlet works building housing the inlet sump/flumes and preliminary treatment screening equipment will be constructed.

- A storm-water holding tank will be installed.
- Secondary treatment will be provided by Secondary Batch Reactor Tanks
- A new sludge treatment building will be constructed.
- Odours from the inlet works building and the sludge treatment building will be treated with high efficiency odour control units.

3.2.2 Inlet Works

The inlet works will be housed in a single building and will be designed to operate to a high level of efficiency. This building will be located near in the NE part of the extension area and will be approximately 17m x 10m in dimension. There will be a high degree of control of odorous emissions from the various stages of the preliminary sewage treatment process. All the inlet channels, along with the inlet chamber will be completely covered and the foul air ducted to an odour control unit. The sewage will pass through the mechanical coarse and fine screens housed in this building. Screened material will be washed and classified into covered skips housed within the inlet works building.

The influent will pass to a covered grit trap within the building to remove grit and finer particulates from the influent. This material will be piped into a classification system to remove organic material and excess liquid and then it will be washed and discharged into a covered skip that will be located within the building.

3.2.3 Storm-water Holding Tank

Incoming flows in excess of 3DWF will be stored in an open rectangular storm-water holding tank located adjacent to the Secondary treatment tanks within the eastern part of the extension site. Once high flow conditions have abated, the storm-water liquor will be pumped into the inlet works and the bottom and side-walls of the tank will be manually hosed down to remove debris adhering to the sides. Prompt cleaning of the sidewalls after the storm-water holding tank is emptied will reduce the potential for malodours to be generated from the tank.

3.2.4 Secondary Treatment

Secondary treatment will be provided by four rectangular Secondary Batch Reactor (SBR) tanks, each with estimated dimensions of 14 x 34m. These tanks operate as batch reactors, with a self-contained secondary treatment of equalisation, aeration and clarification in one basin. The typical flow process is that the wastewater enters a partially filled reactor, containing biomass. Once it is full the aeration process commences and mixing takes place with diffused sub-surface aeration. On completion of the aeration process the biomass settles and the treated supernatant is drawn-off. The quantity of sludge produced using this treatment process is substantially less than from

conventional treatment systems as no primary sludge is generated. The treatment process within the SBR tank removes the need for separate secondary clarifier tanks.

The batch reaction process within the SBR tank involves both periods of aeration and no aeration (anoxic) and so the aeration equipment supplies air into the tank over a shorter period compared to tank basin by sub-surface cyclonic aeration which reduces the release of large quantities of aerosols and malodours into the air compared to emissions from surface shaft propeller systems observed from secondary treatment plants in older sewage treatment plants around the country.

3.2.5 Sludge Treatment

Sludge removed from the SBR treatment tanks will be transferred to a holding tank before being thickened and dewatered within the dewatering building. The holding and thickening tanks will be enclosed and the sludge dewatering belt presses covered within the dewatering building. Odorous emissions from the sludge treatment building will be treated in a high efficiency odour control unit. The building will be located within the western sector of the site and will have dimensions of approximately 15 x 10m.

3.2.6 Odour Control Units

Two high efficiency odour control units, one for the inlet works and another for the sludge treatment building, are planned to treat contaminated foul air from the various sources within the buildings. The ventilation within both buildings will provide for 5 air changes per hour. These odour emission point sources will be located close to the inlet works building and the sludge treatment buildings respectively.

Each unit will have a very high removal efficiency rate, with odour reduction levels in excess of 95%. Acceptable methods of odour control include biofiltration, charcoal and ozone scrubber systems. It is likely that the odour control units will be sited on the ground with the scrubbed outlet air from the unit ducted to a vertical stack.

4.0 ODOUR IMPACT OF WWTP EXTENSION

4.1 Odour Model Overview

Short-term ground level odour ground level concentrations downwind of the wastewater treatment plant were computed using the ADMS3 (Version 3.3, July 2005) advanced air quality dispersion model developed in the U.K. by CERC (Cambridge Environmental Research Consultants). This prediction model is used by Regulatory Authorities and the Environment Agency in the United Kingdom and has been approved by the Environmental Protection Agency for modelling studies supporting IPCL applications. It

has been widely used in Ireland for evaluating the impact of odours from wastewater treatment plants.

The ADMS3 model takes account of the substantially improved understanding of the plume dispersion within the atmospheric boundary layer by the use of more complex parameterisation, than used in previous generation prediction models. It uses boundary layer theory based on the Monin-Obukhov length and boundary layer height instead of the categories of atmospheric stability used in the older U.S. EPA dispersion models including the ISC3. The model is suitable for modelling odour impacts from area emission sources near the ground, such as wastewater treatment tanks that have emission heights of 2-3m above ground level.

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4.2 Input parameters

4.2.1 Odour emission estimates

4.2.1.1 Overview

Unlike emission rates for industrial sources such as boiler stacks or process vents, where specific information for a range of emission characteristics is generally available, estimation of emissions from wastewater treatment plants is much harder to quantify. Although measurement of emissions from wastewater plants has been extensively carried out and models to predict emission rates from the various sources produced in the U.S. these relate to volatile organic compounds (e.g. toluene, benzene, and trichloroethylene). These types of pollutants tend to be more inert in the treatment plant process and so a mass balance approach may be used.

For estimating emissions of odours due to inorganic compounds and organic compounds (e.g. mercaptans and other sulphides) that are produced as a result of anaerobic activity during the sewage treatment process, a mass balance approach is unsuitable. Many of the studies citing odour concentrations from existing treatment plants tend to be based on situations where problems exist in old overloaded plants. Hence selection of suitable emission rates needs to be made with due consideration of the type of treatment conditions, such as tank design and method of sludge handling, at the wastewater treatment plant.

The emission rates used in the odour prediction model were expressed in terms of odour release per second. For the secondary treatment tanks, the emission rates were expressed in terms of the odour emission rate per unit area per second (o.u./m^2.s). In the case of emissions from the exhaust stacks of the odour control units the odour emission rate was calculated in terms of o.u/s.

4.2.1.2 Secondary Treatment

A tank surface height of 3m for the rectangular SBR's and an emission plume temperature near to ambient conditions was used in the odour dispersion model. The vertical exit velocities from the surface of the tanks are very low with rates typically below 0.01 m/s reported in the literature and so emission rates from tanks are due primarily to the rate of evaporation from the water surfaces.

The surface area of each of the proposed rectangular tanks is approximately 475 m^2, resulting in an emission rate per tank of 190 o.u./s, based on an emission rate per m^2 of 0.4 o.u./s.

4.2.1.3 Odour control units

The emission rates for proposed odour control exhaust stacks for the inlet works and sludge treatment buildings were set equivalent to 500 o.u./s in the odour impact model. These stacks will be a minimum height of 5m with a typical stack exit diameter of 0.5m. An exhaust flow rate of 8 m/s and exit temperature of 15^oC were used in the odour prediction model for both the inlet works and sludge treatment building odour control units.

4.2.2 Climatological Data

Sequential hourly climatological data from Cork Airport was used in predicting the odour concentrations near the site. The ADMS3 model was run using hourly observations for 2 discrete annual data sets (2005 and 2006) to allow for annual variations in the wind field. Input parameters for wind speed, direction, cloud cover and air temperature provided values to enable the degree of atmospheric turbulence, or stability to be calculated. The wind roses that show the distribution of wind direction/speed for 2005 and 2006 are given in Figure 3. Atmospheric instability occurs due to heating of the ground by solar radiation and this is related to the amount of cloud cover, coupled with the solar inclination, which is a function of the time of year.

4.2.3 Surface Roughness

The vertical wind profile above the ground is an important parameter in determining the structure of the atmospheric boundary layer near the ground. The Monin-Obukhov length provides a measure of the relative importance of buoyancy generated by heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. This frictional effect is related both to the surface roughness length and wind speed. The former parameter is supplied as input to the ADMS3 dispersion model and it can vary from 0.001m over open sea to 1.5m in urban areas. It is used in calculating the boundary layer structure, which determines the rate of dispersion of an emission plume both in the horizontal and vertical plane as the plume travels downwind from the stack. A surface roughness length value of 0.3m, which approximates to general agricultural areas, was used in the ADMS3 to represent conditions around Carrigtohill.

4.2.4 Receptor Grid

A receptor grid was used in the ADMS3 model to predict ground level odour concentrations within 1km of the wastewater treatment plant site. The grid covered an area around the site with a grid reference of 180600E, 71800N at the SW corner. Preliminary modelling to assess the extent of the area of the likely maximum hourly and daily ground level impact from the exhaust stack emissions indicated that the highest levels occurred within 0.5km.

4.3 Results of odour dispersion model

Hourly climatological data from Cork Airport, for the years 2005 and 2006 were used to predict the 99.5 and 98 percentile hourly odour concentration values. These percentile calculations give the odour concentration at each receptor location that is predicted to be exceeded for 2% of the year or 175 hours in the case of the 98 percentile. The 99.5 percentile value is the concentration predicted to be exceeded for 0.5% of the time, or 45 hours. The pattern of predicted odour concentration around the plant reflects the annual incidence of certain wind speeds and directions coupled with the different types of atmospheric stability close to the ground

An odour concentration of 1 o.u./m^3 is defined as the level at which there is a 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At odour levels below 1 o.u./m^3, the concentration of the gaseous compound causing the odour in the air will be less than the detection level and so although the gas is still present in the air no odour may be detected. Sensitivity to an odour also depends on the location; for example, an odour from agricultural related activities is likely to be tolerated by the community longer in a rural setting than in an urban area.

The results of the odour impact modelling study based on the Phase 1 extension of the wastewater treatment plant are presented as odour concentration contour plots in Figures 1 and 2. These plots show the pattern of the 99.5 percentile and 98 percentile odour concentrations in the locality of the plant and are based on the maximum value predicted at each receptor location over the two years that were modelled.

The predicted 99.5 percentile odour concentrations that are predicted for the planned extension are shown in Figure 4 and the pattern of odour levels indicates that the maximum level at the nearest house to the West of the site boundary will be between 0.25-0.5 o.u./m^3. At the houses to the NE of the site boundary, on the outskirts of Carrigtohill, the predicted 99.5 percentile odour concentration is less than 0.25 o.u./m^3 and to the south the predicted level will also be below 0.25 o.u./m^3. In other words, the odour prediction model predicts that odour levels will generally be below the odour detection level for 99.5 percent of the time at the nearest houses to the site. The predicted 99.5 percentile odour concentrations at the Millipore plant boundary to the NW of the site

are predicted to be about 0.5-1 o.u./m^3 near the entrance and 0.25-0.5 o.u./m^3 in the vicinity of the production buildings. At the site boundary adjacent to the public road, the predicted 99.5 percentile odour concentration is predicted to be about 3-4 o.u./m^3. This is due to the proximity of the planned location of the SBR tanks near to the northern site boundary.

The predicted 99.5 odour concentrations at the nearest private properties are very low and although there are no National Standards the predicted odour concentrations would meet the Standards required in other European Countries such as the Netherlands. In the Netherlands a maximum concentration of 1 o.u./m^3, which should be met for 99.5% of the year, has been used as a limit value downwind of new plants.

The odour concentrations in the locality of the wastewater treatment plant that are predicted to be exceeded for 2% of the year, or 175 hours during the year, referred to as the 98 percentile, are shown in Figure 5. At the nearest houses the site, the predicted 98 percentile odour concentration are predicted to be well below 0.1o.u/m^3. The 98 percentile concentration is also predicted to be well below 0.2 o.u./m^3 at the Millipore premises. The odour levels are predicted to be less than 1.5 o.u./m^3 along all boundaries around the planned extension site.

An odour concentration of greater than 5 o.u./m^3 has been widely used as a criteria for determining possible nuisance complaints, typically as a predicted hourly average 98 percentile limit value. This predicted odour concentration has been adopted in the past as an acceptable approach in Ireland and the U.K. to demonstrate that no odour nuisance would occur beyond the site boundary of planned wastewater treatment plants.

Ambient odour limits proposed by the EPA in a report (Odour Impacts and Odour Emissions Control Measures for Intensive Agriculture, EPA 2002) regarding odorous emissions from pig production units propose a more stringent condition in relation to a limit value around new pig production units of 3 o.u./m^3 as a 98 percentile of predicted hourly concentrations. A target value of 1.5 o.u./m^3 also as a 98 percentile has also been proposed to provide a general level of protection against odour nuisance for the general public. A predicted odour concentration of 1.5 o.u./m^3, expressed as a 98 percentile of hourly values, is recommended by the Environment Agency in the U.K. (IPPC H4 Horizontal Guidance for Odour Part 1, 2003) for sources with a potential for offensive odours, including wastewater treatment plants.

For the Phase 2 design scenario, the predicted 99.5 percentile of short-term odour concentrations is predicted to be 0.25-0.6 o.u./m^3 at the nearest houses to the site, as shown in Figure 6. Predicted odour concentrations are shown to be less than 1 o.u./m^3 in the vicinity of the production building at the Millipore site. The corresponding 98 percentile odour concentrations presented in Figure 7 are less than 0.25 o.u./m^3 at the nearest private properties and near the Millipore plant.

5.0 ODOUR CONTROL MEASURES

The following measures to control and reduce potential sources of malodours are proposed for the extension of the wastewater treatment plant at Carrigtohill:-

- The inlet works channels and screening equipment will be housed in an enclosed building.
- Screened coarse material and grit from the grit trap will be washed and transferred into covered skips located within the inlet works building.
- Odorous emissions from inlet works building will be vented to atmosphere via a high efficiency odour control unit.
- Odorous emissions from the sludge treatment building will be vented to atmosphere via a high efficiency odour control unit.
- The odour control units will operate with removal efficiencies of over 95%. The location and design of the exhaust stacks to these units will ensure that adequate vertical release of emissions is achieved to ensure that there will be no malodours occuring beyond the site boundary from the exhaust stacks.
- The secondary sludge thickening tank will be covered and the headspace air in the tank ducted to the sludge treatment building odour control unit.

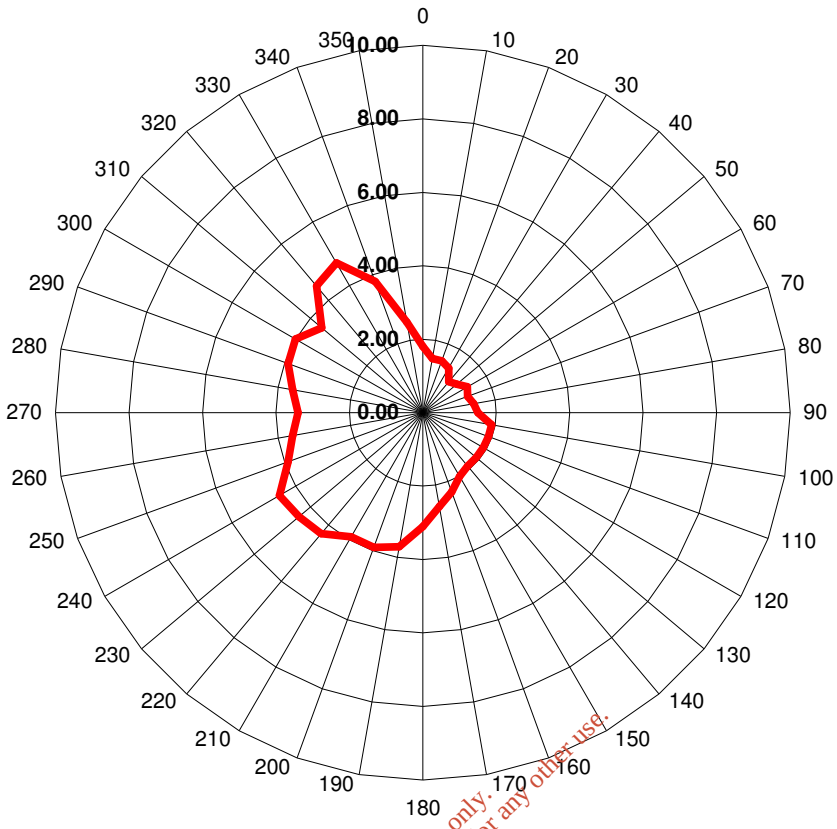
6.0 CONCLUSION

The predicted 99.5 percentile odour concentrations for Phase 1 of the scheme are predicted to be less than 0.5 o.u./m^3 at the nearest housing and so would be unlikely to result in a short-term nuisance odour. Predicted levels are within the range of 3-4 o.u./m^3 near the northern site boundary, adjacent to the access road. The corresponding 98 percentile odour concentrations are less than 0.5 o.u./m^3 beyond about 100m from the site boundary. For the Phase 2 final design stage, with all 6 SBR units in operation, the predicted short-term 99.5 percentile odour levels are also predicted to be less than 0.5 o.u./m^3 at the nearest housing. The corresponding 98 percentile odour concentrations are also well below 0.5 o.u./m^3 at the nearest housing.

The design and operation of the proposed upgrading and extension of the wastewater treatment plant at Carrigtohill minimises the potential for malodours to be detected beyond the site boundary. Based on the results of the odour dispersion modelling study carried out, no significant impact on the ambient air quality of the area is predicted due to odour emissions from the wastewater treatment plant.

FIGS 1-7

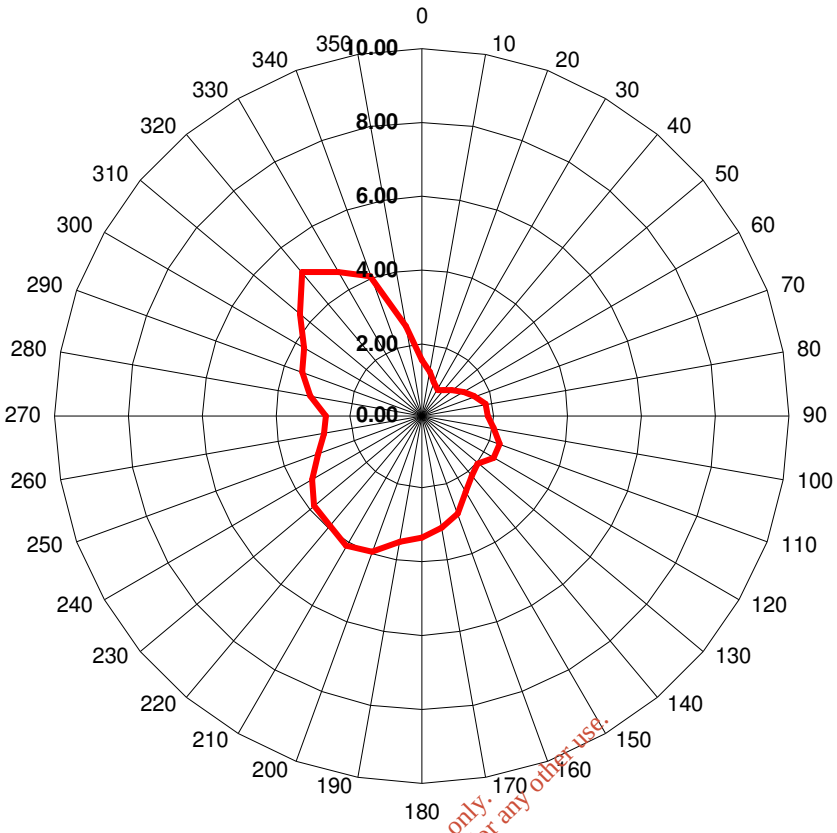
WIND ROSES AND AIR QUALITY DISPERSION MODELLING RESULTS



HOURLY WIND DIRECTION FREQUENCY - ALL WIND SPEEDS

Direction	Percentage Occurrence of Wind Speeds (m/s)						
	<2	2-3	3-5	6-8	9-11	>11	All
350-10	0.6	1.2	1.9	1.6	0.4	0.0	5.7
20-40	0.6	1.1	1.3	1.0	0.2	0.0	4.0
50-70	0.3	0.8	1.4	1.1	0.3	0.0	3.9
80-100	0.3	0.6	1.3	1.6	0.5	0.5	4.8
110-130	0.5	0.9	1.5	1.7	0.7	0.3	5.6
140-160	0.6	0.9	1.3	1.9	0.8	0.7	6.2
170-190	0.7	1.4	2.2	2.9	1.3	0.8	9.3
200-220	0.6	1.4	2.7	3.9	1.8	1.7	12.1
230-250	0.6	1.7	3.4	4.4	1.7	0.9	12.8
260-280	0.7	2.1	3.3	3.1	0.9	0.5	10.6
290-310	0.8	2.3	3.5	3.3	1.1	0.4	11.4
320-340	0.7	2.3	4.8	3.9	1.0	0.3	13.0
Calms	0.5						0.5
Total	**7.3**	**16.8**	**28.5**	**30.3**	**10.8**	**6.3**	**100.0**

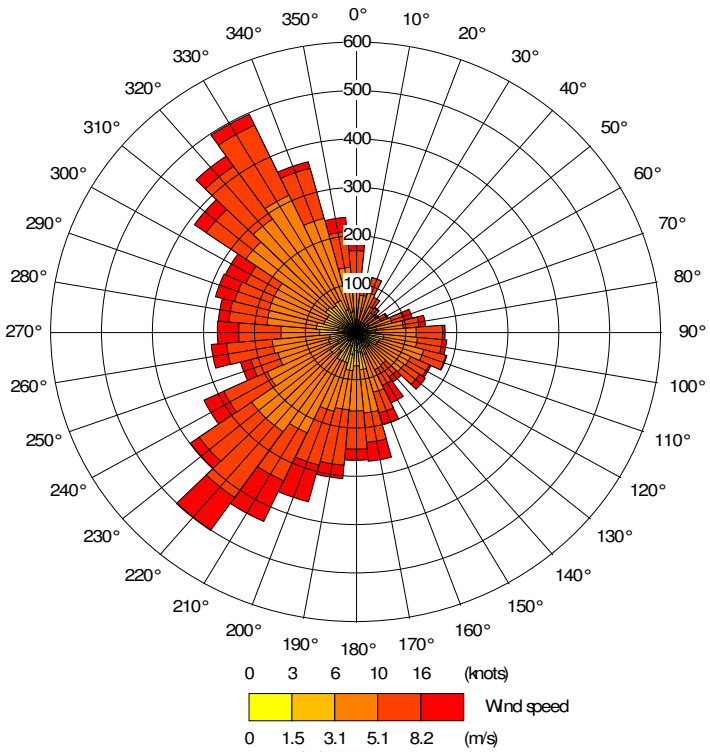
FIGURE 1: FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR HOURLY OBSERVATIONS AT CORK AIRPORT, CO. CORK (1962-91)



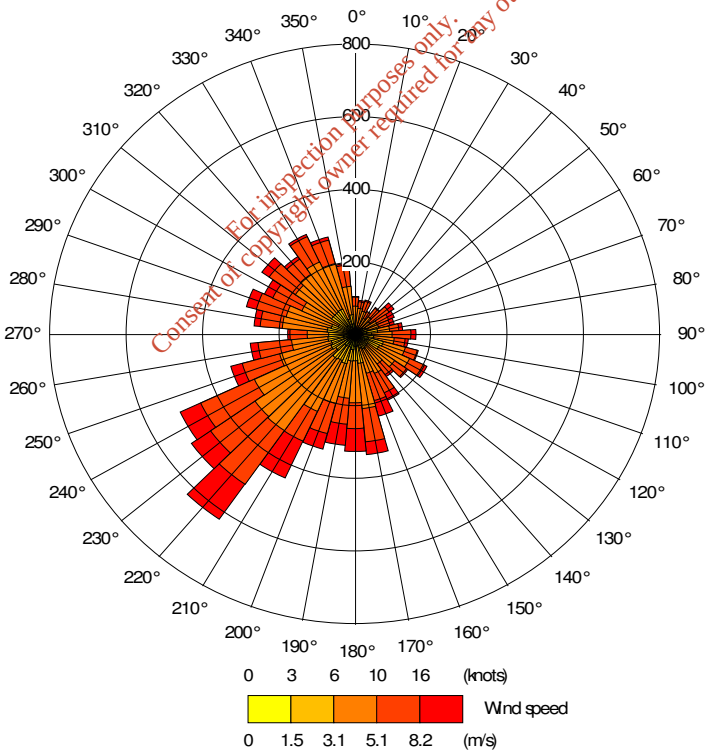
HOURLY WIND DIRECTION FREQUENCY - ALL WIND SPEEDS

Direction	Percentage Occurrence of Wind Speeds (m/s)						
	<2	2-3	3-5	6-8	9-11	>11	All
350-10	0.7	1.0	1.5	1.4	0.4	0.3	5.3
20-40	0.3	0.6	1.1	0.8	0.1	0.0	2.9
50-70	0.3	0.6	1.2	1.2	0.4	0.2	3.9
80-100	0.3	0.6	1.5	2.0	0.8	0.2	5.4
110-130	0.6	1.0	1.9	2.1	0.7	0.3	6.6
140-160	0.6	1.0	1.6	2.0	1.1	0.8	7.1
170-190	0.7	1.1	2.1	2.8	1.5	1.7	9.9
200-220	0.6	1.1	2.3	3.8	2.1	2.1	12.0
230-250	0.4	0.7	2.2	3.8	1.7	1.5	10.3
260-280	0.3	0.7	2.1	3.2	1.3	0.8	8.4
290-310	0.7	1.1	2.4	3.8	1.9	1.8	11.7
320-340	1.7	2.0	2.8	4.1	1.7	1.4	13.7
Calms	2.8						2.8
Total	10.0	11.5	22.7	31.0	13.7	11.1	100.0

FIGURE 2: FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR HOURLY OBSERVATIONS AT ROCHES POINT (1962-91)



2005



2006

FIGURE 3: WIND ROSES OF HOURLY OBSERVATIONS AT CORK AIRPORT, DURING MODELLED YEARS 2005 AND 2006

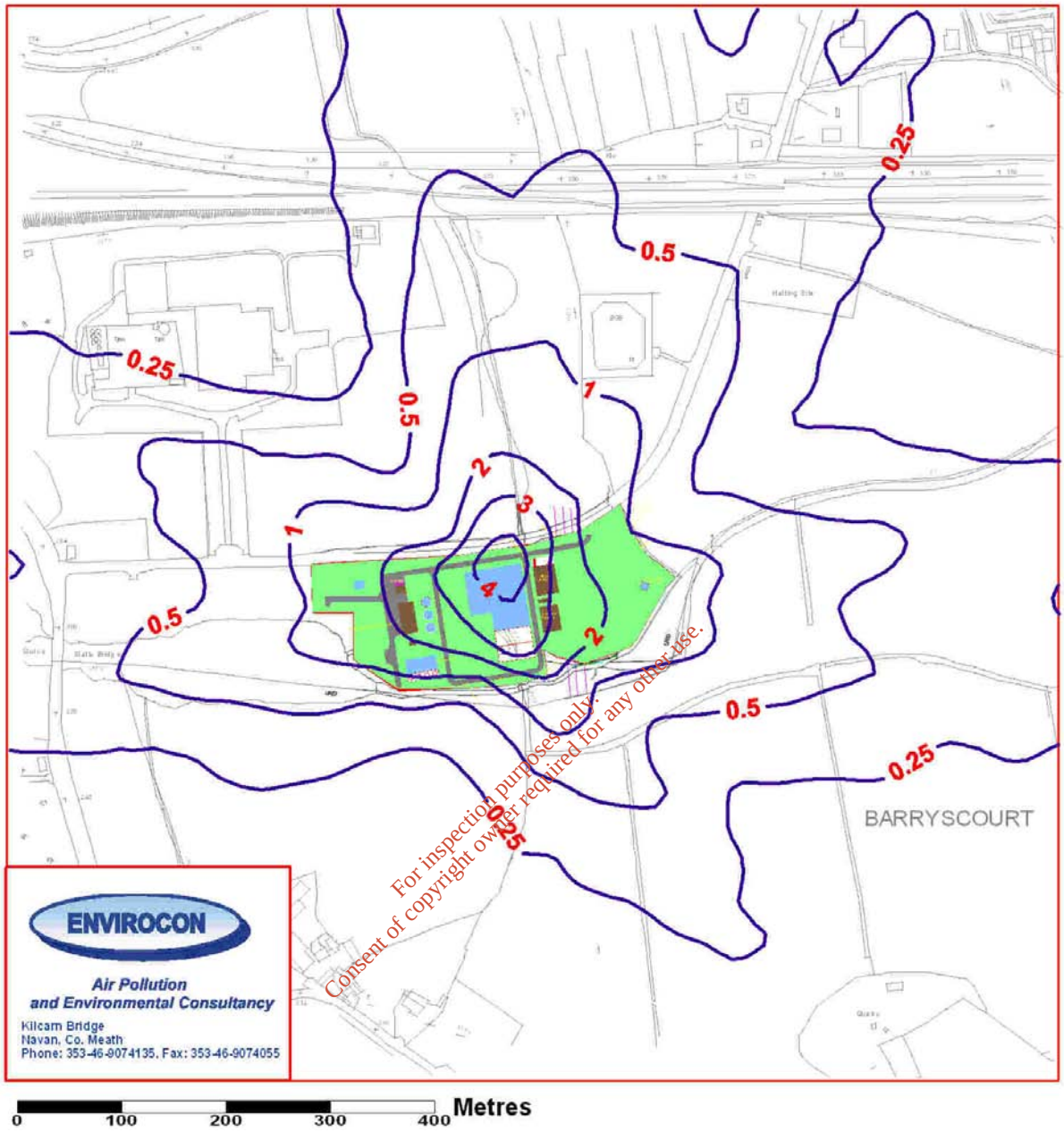


FIGURE 4: PREDICTED MAXIMUM 99.5 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 1) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

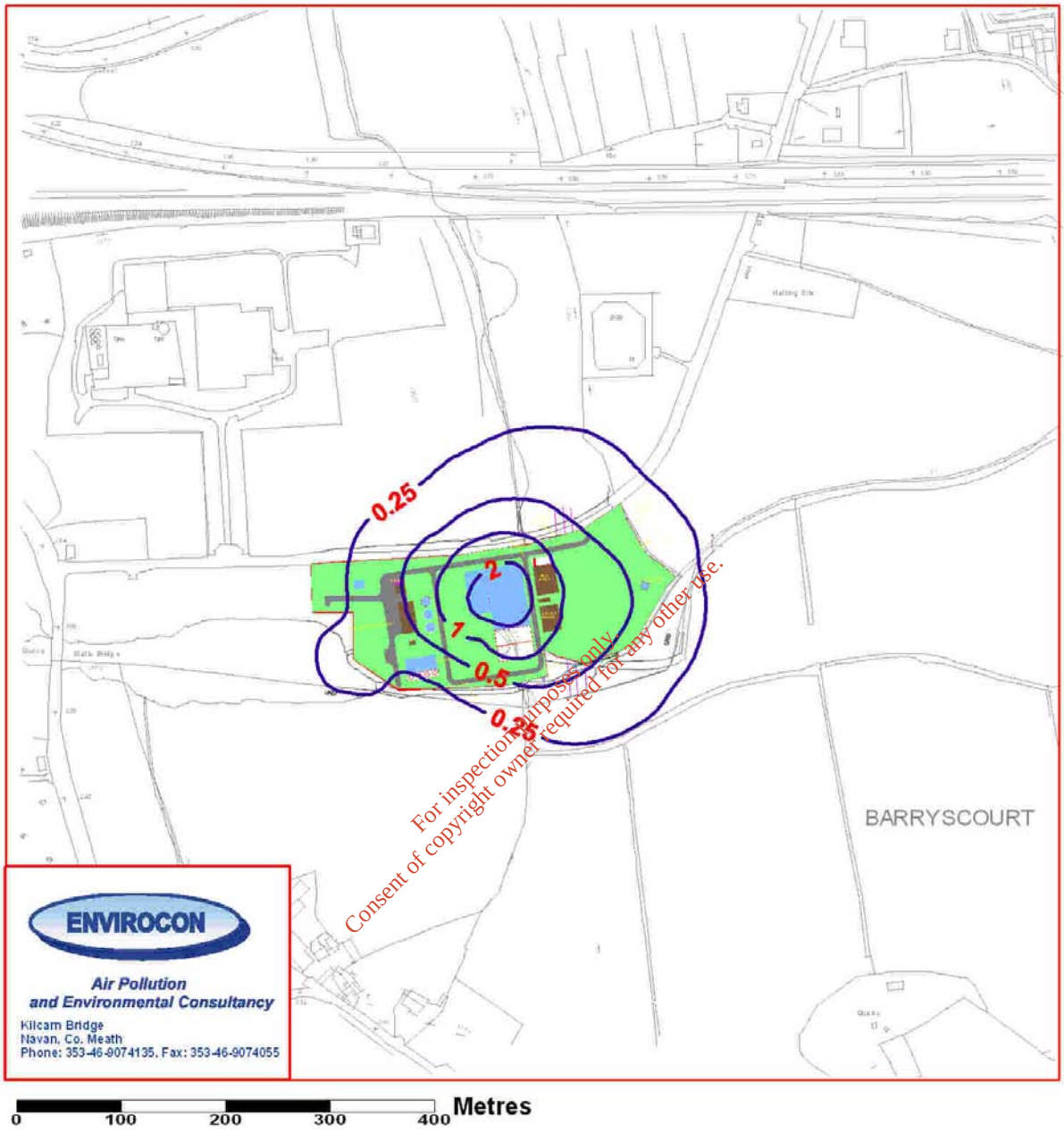


FIGURE 5: PREDICTED MAXIMUM 98.0 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 1) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

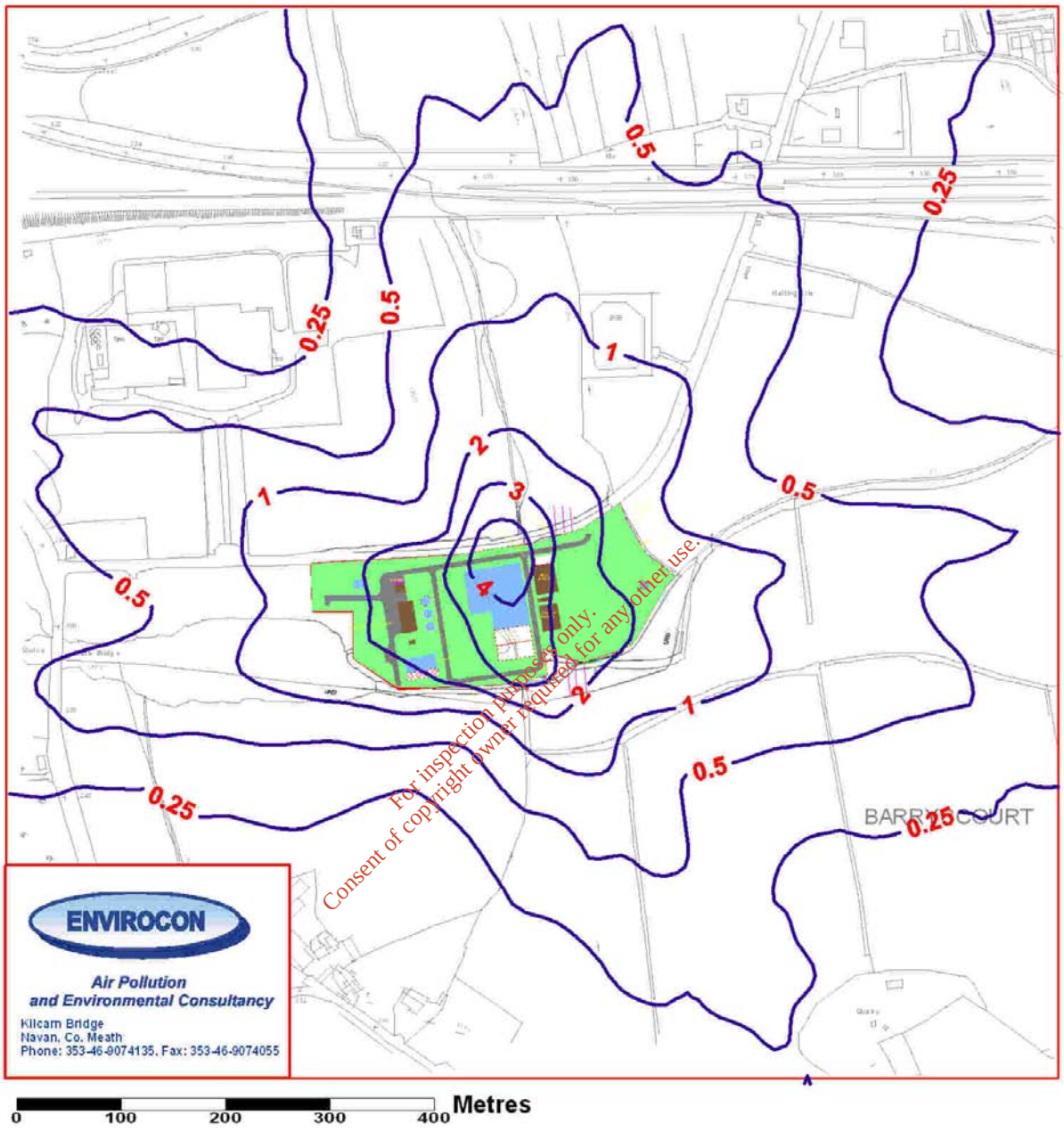


FIGURE 6: PREDICTED MAXIMUM 99.5 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 2) OF WASTEWATER TREATMENT PLANT(O.U./M^3)

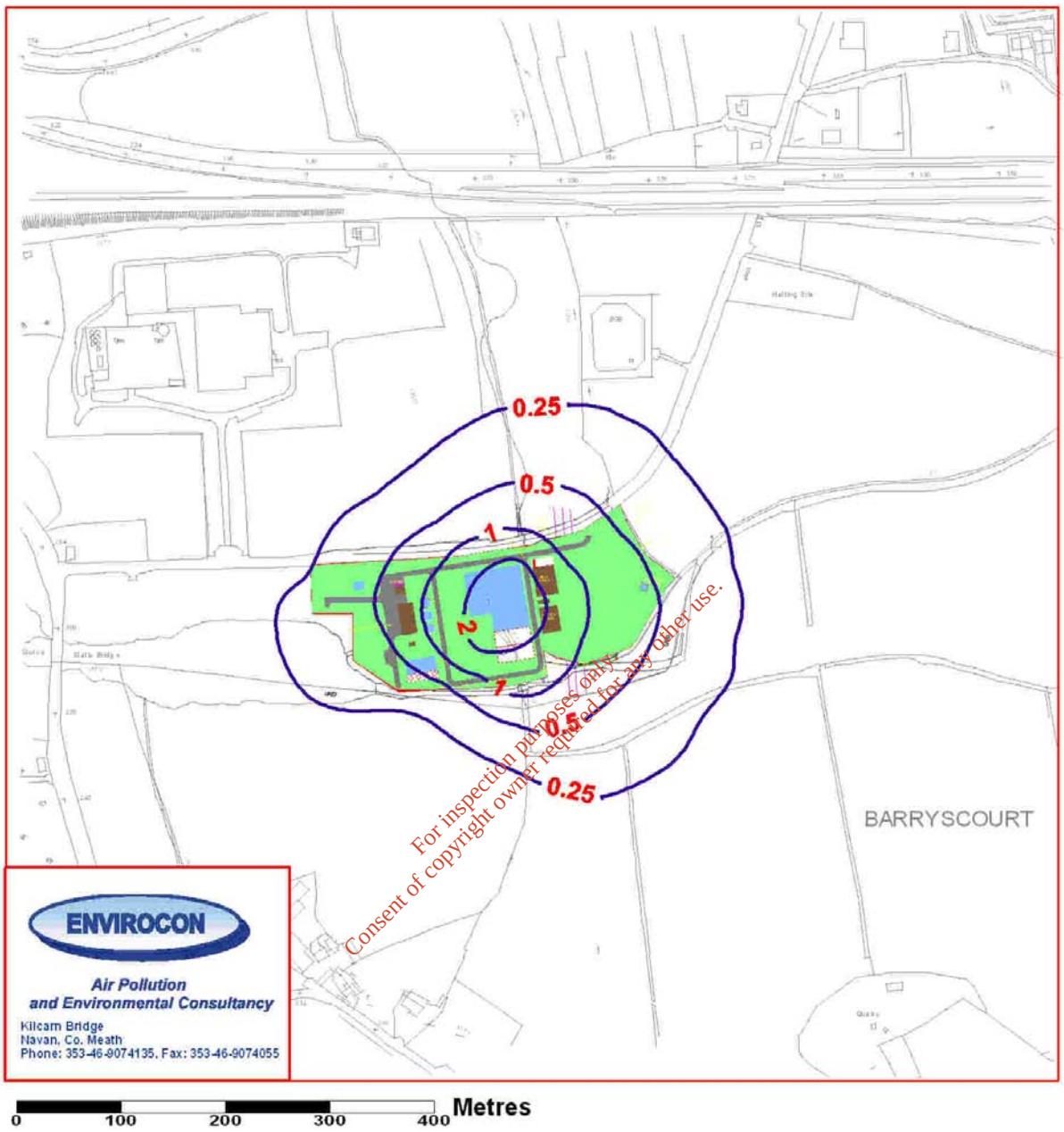


FIGURE 7: PREDICTED MAXIMUM 98.0 PERCENTILE OF SHORT-TERM ODOUR CONCENTRATIONS DUE TO EMISSIONS FROM PROPOSED EXTENSION (PHASE 2) OF WASTEWATER TREATMENT PLANT (O.U./M^3)

Dixon.Brosnan environmental consultants	
Project title	Assessment of the ecological impacts of discharging treated wastewater from Carrigtwohill, Co. Cork
Client	T.J. O' Connor & Associates
Client ref.	
D.B ref.	
Revision	1 – 1st draft
Date	
approved by	Carl Dixon B. Sc. (Applied Ecology)
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1. Introduction

Dixon.Brosnan environmental consultants were asked 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 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 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 (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, gray plover, black-tailed godwit, redshank and lapwing. There are important roosting sites at Weir Island, Brown Island, Killacloyne and Harpers Island.

Fig 1 showing proposed pipeline route and discharge point.

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. 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 northern boundary of the mudflats is formed 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 there is a considerable volume of traffic noise however the levels of direct disturbance by walkers etc are 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. A number of studies have been previously carried out on water quality in Cork Harbour 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 and this new facility is expected to significantly improve water quality.

Slatty water into which the treated wastewater will be discharged is 150-250m wide and 2950m long 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 using a corer at low tide. 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 effecting 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 (Cooper et al, 2002). 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 macroinvertebrates 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 is a cause for concern.

5.5 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 habour 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, 15 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 and 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 this area as important for salmon or sea trout. 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 1. 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 WWWTP and Slatty Bridge are included in the candidate Special Area of Conservation (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030).

5.2 Terrestrial Habitat types

The habitats listed below are shown on Figure 10.1 and a list of the species detected is given in Appendix 10.1. The proposed development is shown in Figure 10.2 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**

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 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 a strip of land between the roadside treeline and the 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 sp. and red currant.

5.2.4 Reed and large sedge swamp FS1.

The occurs on the southern and western boundaries proposed area of the extended WTP. 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 they 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 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.

6.2 Seals and cetaceans

Although individual grey and common seals have been recorded in Cork Harbour this area is not of value for seals. Cetaceans such a pilot whales and killer whales have been recorded from 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

Although bats may feed along the woodland at the Fota side of the estuary and in proximity to the brackish lake habitat there is 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 Birds 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 it will potentially support 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 Bird Survey 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:

- 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).

- 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. Evaluation of Flora and Fauna Impacts

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 is expected to occur in the absence of this development.

Habitat values

The relative values of each habitat type are 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.* This classification scheme is outlined in Appendix 2.

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 (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030). This site is considered to be Internationally Important (Category A) Check ramsar convention and pNHA status	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 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 XXXX 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 maintaining 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 (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030). Overall this part of Cork Harbour is considered to be Internationally Important (Category A)	The designated areas includes 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 XXX 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 woodland WS2	Part of the Special Area of Conservation (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030). 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 changing to woodland in the absence of 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. 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 1058) and is part of the Special Protected Area (Cork Harbour 4030). Overall this part of Cork Harbour is considered to be Internationally Important	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. Any impact on a designated cSAC/SPA

	(Category A)		under the NRA classification scheme is classed as severe and negative.
Drainage ditch FW4	Part of the Special Area of Conservation (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030). 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.. Any impact on a designated cSAC/SPA under the NRA classification scheme is classed as severe and negative
Amenity grassland GA2	Part of the Special Area of Conservation (Great Island Channel site 1058) and is part of the Special Protected Area (Cork Harbour 4030). Overall this part of Cork Harbour is considered to be Internationally 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. Impacts on fauna

8.2 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 a high noise environment. There is no evidence to suggest that otters breed within the area to be affected although this species do occur within this area. Some adaptation to increased noise levels is likely for any species, which habitually occur in this area, due to high levels of traffic noise and 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 note in woodland at the Fota side of Slatty Water. However given the distance between this area and the works and significant impact is considered highly unlikely.

8.3 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.

8.4 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 macroinvertebrates within as least part of the habitat to be affected and the anoxic appearance of mud samples is a cause for concern. 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-web bird counts do cover this area of Cork harbour the counts at Slatty water have been included in the overall counts for Slatty Water/ Glountane 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 sampling be carried out on an ongoing basis.

8.5 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 it is not that the creek is 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 during the wintering period (approximately October to March) will have a negative impact on birds and therefore will be avoided. Works should be confined to the period from June to August.

Due to the difficulties associated with predicting the affect 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. These results of these surveys should be considered in tandem with available I-web 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 reed beds 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 etc and by avoiding operating in watercourses/drains where feasible. Grit interceptors will also be put in place, as appropriate, to control pollution and run off. – ABOVE TO BE CONFIRMED

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 and that care must be taken with liquids or other materials to avoid spillage.

A Construction and Demolition Waste Management Plan should be developed for the site, with particular emphasis placed on preventing any materials being dumped in the 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 first 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, 2006b).

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 XXXX. 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

After construction, benthic communities should recolonise disturbed 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.

APPENDIX 1: SITE SYNOPSIS
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 (45). 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.

4.7.2004

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.

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

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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 Dixon Brosnan 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 Carrigtohill Sewerage Scheme.

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 XX ha.

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). Appendix A contains a list of all species recorded.

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.

Results

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.

Species	01/04/07 Low tide	02/04/07 High tide	13/04/07 Low tide	14/04/07 Low tide
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	53	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

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.

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

Species	Latin Name	Number recorded
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

Conclusions

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).

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.

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.

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.

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).

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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Table of Contents

1. Introduction

This report assesses the impact of a proposed waste water treatment plant outfall pipeline on the archaeological and historical landscape of the townland of Tullagreen, Carrigtohill, County Cork. The proposed development area is south-west of Carrigtohill town (Fig. 1), extending for a length of *c*. 800m, along the northern edge of Slatty Water, west and south of Tullagreen House. The chosen route for the outfall pipeline does not directly incorporate any known archaeological sites but is within the environs of three recorded monuments (Fig 2; Appendix 1). The development will involve disturbance of the mud-flats during the site preparation works and the construction phases of the proposed outfall pipeline.

2. Study Methodology

A desktop study of the proposed development area was carried out in order to assess the developments impact on the archaeological potential of Tullagreen townland, Carrigtohill, Co. Cork and the surrounding area. The desktop study included a review of the first and second editions of the six inch scale Ordnance Survey (OS) maps, the Sites and Monuments Record (SMR) and the Record of Monuments and Places (RMP) for County Cork. All of the available archaeological and historical literature for the area was also consulted. All local historical and archaeological journals were checked to establish if any new information on the area was published in the recent past.

3. The Receiving Environment

The proposed outfall pipeline route is located *c*.1mile south-west of Carrigtohill town, in the barony of Barrymore and is directly west of Barryscourt Castle. The pipeline is located within Slatty Water, part of the estuary of the River Lee and directly north-east of Lough Mahon. Cork Harbour is one of the largest natural harbours in the world and several towns and suburbs of Cork City are located around its shores. Cork harbour also houses a large number of islands, notably Foaty Island to the south of the development area and Brown Island and Harpers Island to the west. The Youghal Branch of the Great Southern and Western Railway is to the north.

. 4. Development Proposal

This project consists of the construction of an outfall pipeline for a sewerage scheme. The pipeline will extend along the northern edge of Slatty Water, west and south of Tullagreen House and the outfall point is located at the western end (Fig. 3).

5. Archaeological and Historical Background

The proposed outfall pipeline is centered on the townland of Tullagreen, *c*.1 mile south-west of Carrigtohill in the barony of Barrymore. The proposed development does not incorporate any recorded archaeological sites but there are at least three known sites in the environs (Fig. 2; Appendix 1).

The town of Carrigtohill is reportedly named from the Irish *Thuahill*, meaning left handed or North. It is so called because, whereas most of the rocks in that part of the country run east-west, the rocks at Carrigtohill run north-south. The town itself is synonymous with the Earls of Barrymore from the thirteenth to the eighteenth centuries but much earlier settlement activity in the area is also evident. A flint scatter, for example, is recorded from the townland of Clyduff to the east. This may suggest quite early occupation in this part of Cork, with the lithics possibly dating from the Mesolithic right through the Neolithic and Bronze Age (*c*.7000-500 BC). Flint and similar stone would have been used to manufacture sharp tools, like arrowheads, scrapers and knives. Residual scatters of discarded stone tools and the debris from their manufacture, usually found in ploughed fields, may indicate the location of settlements *in situ* beneath the topsoil. A cave in the townland of Terry's-Land to the north-east was explored in 1934 and subsequently excavated to reveal wolf skull and more recent domestic fauna. Despite the modern finds it is possible that the site was used as a refuge for humans and animals from the earliest times.

Many *fulachta fiadh* are also within the environs of Carrigtohill These archaeological features are most commonly interpreted as ancient cooking-sites, which usually survive as small horseshoe-shaped mounds of charcoal-enriched soil packed with fragments of heat-shattered stones. They are usually located close to a water source, such as these examples,

which are adjacent to streams, some of which have been drained and in marshy ground. The cooking would have taken place in a rectangular pit, lined with wooden planks or stone slabs to form a trough. The water in the trough was probably boiled using hot stones taken from a nearby fire, which resulted in the heat-shattered stones being discarded to one side when the cooking was complete. The majority of available radiocarbon dates place these monuments in the Bronze Age (Power *et al*. 1994, 24).

Of particular interest is the prehistoric occupation site (RMP[1] CO075-077) uncovered during the development of the Fota Golf Course. This site is located directly south of the proposed development area, focused on Fuchsia Hill on Foaty Island. Several areas of archaeological potential were excavated, ranging from prehistoric to post-medieval in date. Of note was a Bronze Age structure with an external hearth, 50m north-east of this was a spread of fire-shattered stones and 10m from the settlement evidence was a large clay-lined pit, three fire-pits with shallow 'flues', a pit containing Late Neolithic or Early Bronze Age pottery and another pit with a similar dated mortuary vessel and flint blade probably represented a re-interred cremation burial (Power *et al*. 1994, 365; Rutter and O'Connell 1992). On the lower slopes of the hill were another three fire-pits, while early post-medieval activity was represented by a late medieval jug in a pit, field enclosures, drains and numerous pits/post-holes (*ibid*.). It is notable that only 5% of the total area under development was properly investigated, suggesting that this location, within Cork harbour was extensively occupied from the prehistoric period onwards.

North of the proposed development area, in the townland of Kilacloyne, is the site of an enclosure (RMP CO075-014). This is an enigmatic category as earthen monuments are often particularly difficult to classify due to poor preservation, deliberate destruction, trampling by livestock, etc. Many are therefore only categorised by shape, size and/or degree of preservation (Power *et al*. 1994, 182). The majority of enclosures may simply be levelled or poorly preserved ringforts, although the possibility is always there that they belong to other classifications such as prehistoric barrows or henges, medieval ringworks or modern landscape features (*ibid*). This particular example is shown on the 1st edition (1842) and 2nd edition (1904) O.S. maps as a sub-rectangular enclosure cut across by an east-west field fence (Fig. 4). The site was subsequently levelled and no visible surface trace remains today (*ibid*., 185).

[1] Record of Monuments and Places

Barryscourt castle (RMP CO075-018/01) is located *c*. 0.5 miles to the east of the proposed development area and represents the remains of a medieval tower house and bawn, the seat of the Barry family from the twelfth to the seventeenth centuries. The earliest building at the site was in 1206 by Philip de Barry. The surviving castle is a fine example of a fifteenth century tower house with sixteenth century additions and alterations. The bawn wall with three corner towers is also largely intact. Related to this demesne and located directly east of the proposed development area in the townland of Tullagreen is a significant post-medieval private dwelling or country house (RMP CO075-019). This structure is known as 'Barry's Lodge' and is late eighteenth or early nineteenth century in date. The country house and its demesne were dominant features of the rural Irish landscape throughout the eighteenth and nineteenth centuries, particularly in the areas of richer quality land such as this. Lewis (1837, 87) mentions this residence, stating that it was the elegant residence of D. Barry, Esq.This house was originally a two-storey L-shaped building with a hipped roof but was demolished in the early 1990s. According to local information farm buildings to SSE are the remains of a larger complex that included a mill from which two millstones survive (Power *et al*. 1994, 329).

Fota House and associated gardens to the south are also evidence for important post-medieval activity in the area. The house dates to the eighteenth century and was altered in various stages until the end of the nineteenth century. The Fota gardens contain many rare and exotic shrubs and trees, including an extensive rose garden.

It is notable that many archaeological sites are low visibility monuments, which include ancient (prehistoric) settlements, souterrains, ceremonial and burial sites. Remains of these types of sites may lie buried under the surface. Sites have also been leveled in the past and the sub-surface evidence for these may still remain below the modern surface. Stray finds, dropped or lost in the past can also be recovered when the ground is disturbed. The present inventories of sites and monuments (SMR and RMP) indicates only sites that are now visible above the ground and there remains the possibility that other buried sites exist below the surface.

6. Impact of Proposed Development on the Archaeological Landscape

Visual impact

The proposed development will not have any visual impact on the known archaeological sites in the environs of the townland of Tullagreen, Carrigtohill, Co. Cork.

Archaeological Impact

The proposed outfall pipeline route is not located within the zone any recorded archaeological sites, however there are three known sites in the environs, including evidence for prehistoric settlement (Fig 2; Appendix 1). The proposed outfall pipeline runs along the northern side of the Slatty Water estuary. This waterway is tidal with substantial mud-flats exposed at low tide. It is possible, therefore that formerly unrecorded sites could be uncovered during disturbance of the environs of the pipeline. Buried archaeological sites may range from small-scale sites such as isolated burials to extensive evidence for habitation. These sites will only be detected by an archaeological walkover at low tide. This area will be subject to metal detection survey.

Impact Summary

The impact of the proposed outfall pipeline on the archaeological landscape of the area was assessed using all of the available documentary and cartographic sources. There are three recorded monuments surrounding the proposed development area. It is also possible that previously unrecorded monuments may be uncovered during disturbance of the mud-flats and construction of the outfall pipe. This area is therefore subject to an archaeological walkover and metal detection survey at low tide.

7. Mitigation Strategies

In order to prevent any potential loss to the archaeological record a series of mitigation strategies are recommended.

1. The Slatty Water estuary is tidal with substantial mud-flats exposed at low tide, these may be walked across at low tide and a non-intrusive inspection should be carried out of the inter-tidal zone and riverbed affected by the proposed development.

2. A metal detection survey of the area must be undertaken. It will record the location of all ferrous and non-ferrous materials on and beneath the inter-tidal zone and riverbed. Each contact will be plotted, facilitating the development of a metal detector contact distribution pattern.

3. The archaeologist will require a licence for this work and this licence will be issued by the Department of the Environment, Heritage and Local Government. Fifteen working days advance notice is required to apply for and obtain the necessary licence.

4. The archaeologist should be empowered to halt the development if buried archaeological features or finds are uncovered.

5. Provision, including financial and time should made be at the outset of the project to facilitate any excavation or recording of archaeological material that may be uncovered during the developmental works.

8. Non-Technical Summary

A number of sources were consulted in order to assess the archaeological and historical potential of the proposed development area. While there is no direct impact on the recorded archaeological monuments within the vicinity of the development area as yet unknown archaeological monuments in the development zone may be impacted upon. A number of mitigating strategies are recommended in order to protect these monuments and to prevent accidental loss or damage to archaeological finds or features that lie below the present surface and have no visible surface remains.

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Appendix 1

Extracts from the *Archaeological Inventory of County Cork, Vol. 2: East and South* (Power *et al* 1994).

Killacloyne **RMP CO075-014**

Enclosure Indicated on 1842 OS map as sub-rectangular enclosure (L *c*.40m N-S; *c*.20m E-W) cut across by E-W field fence. Levelled; no visible surface trace.

Tullagreen **RMP CO075-019**

Country house Late 18th/early 19th-century 2-storey L-shaped house; recently demolished. Hipped roof, gabled at rear. Entrance front (E) of 5 bays, central door. Brick-larched windows; brick cornice. Central 2-storey hipped projection to rear. According to local information farm buildings to SSE are remains of larger complex which included mill from which two millstones survive.

Foaty **RMP CO075-077**

Occupation site On Fota Island, in former parkland. Extensive area of archaeological remains partially excavated (1992) under salvage conditions in advance of golf-course development. Around 5% of total area properly investigated, centred on Fuchsia Hill; analysis of finds, C14 samples, in progress.

Area 1: *c*.100m W of power station. Ovid structure (8m E-W; 5.5m N-S), with 1 central post-hole; entrance to E, with probable porch. Hearth (L c.1m) just NE of structure. Comparable to Bronze Age mortuary house at Ballyveelish (Doody 1987, 8-21).

Area 2: *c*. 50m NE of (1): enigmatic spread of lightly fire cracked stones, 80 m sq, in slight hollow.

Area 3: On lower W slopes Fuchsia Hill, 3 small firepits: two pits *c*.3m apart; one, re-cut, 25m to NE. Unable to investigate surrounding area.

Area 4: 90m to W of power station. Large pit (L 6.4m; W 3.75m; D 0.86m) with 2 successive clay linings. Just to NE were 3 small firepits (diams. *c*. 1.25m; D *c*. 0.4m) with shallow 'flues' radial to large pit to SW, containing late Neolithic/early Bronze Age (LNEBA) pottery. Three shallow pits SW of larger pit, one containing LNEBA mortuary vessel, flint blade; possibly re-interred cremation. Four small pits in square *c*. 6m S of large pit, each containing 1 water-rolled quartz pebble.

Area 5: *c*. 110m S of (4), *c*. 60m S of (1), under destroyed bank, hearth and 3 post-holes; land between (1) and (5) now listed by OPW.

Area 9: 150m W of (6), early post Medieval pit containing late Medieval fug, cutting possible butt end shallow ditch; medieval wall remnant 32m to NE terminates at re-cut post-hole, presumably for gate; these and other features suggest presence field enclosures pre-emparkment for Fota House. Complex to N includes shallow linear cut feature, underlying post-holes belonging to an area 6m x 6m to NE, comprising 40 stake-holes and 20 pits/post-holes, some re-cut; one contained prehistoric pottery. Overlain by drystone revetted bank (Wth *c*.2.5m) on approx. same line as early cut feature; two post medieval drains then cut to either side of bank. Bank subsequently leveled; material pushed over top of side ditches contains prehistoric pottery (Rutter and O'Connell, 1992).

Figure 1: Site location.

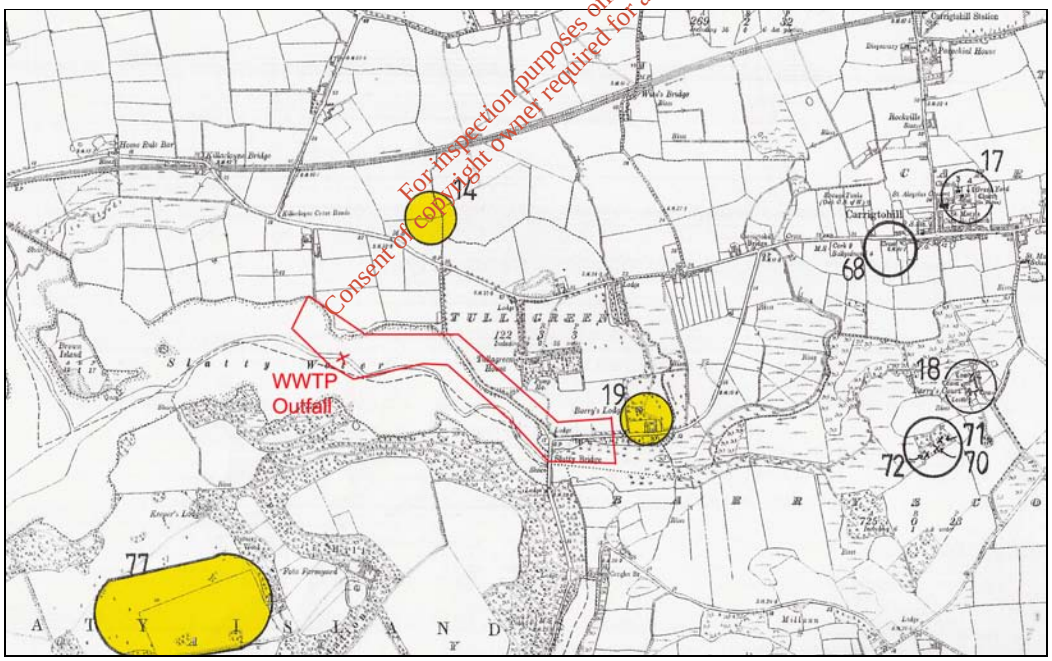


Figure 2: Extract from RMP CO075 showing proposed development area and known archaeology in the environs.

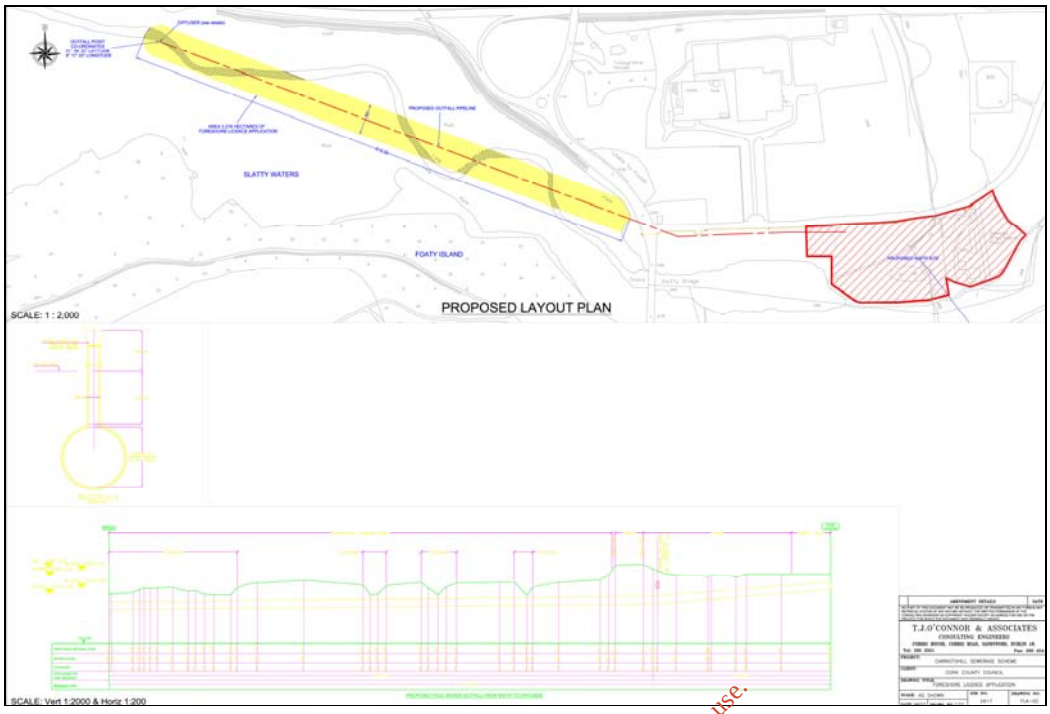


Figure 3: Proposed development area of outfall pipeline.

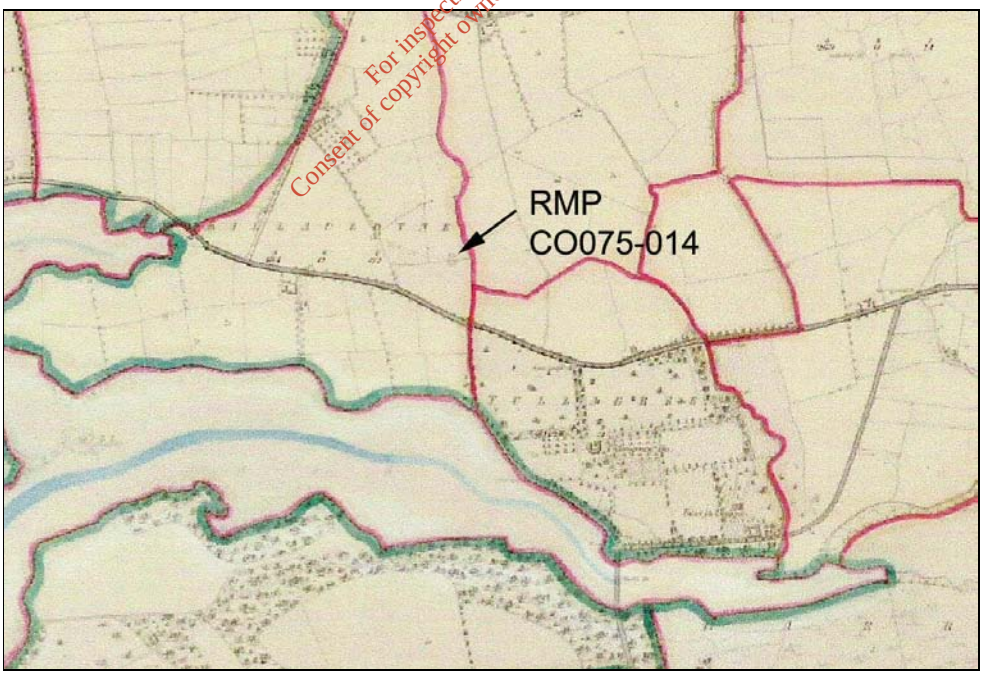


Figure 4: Sub-rectangular enclosure (RMP CO075-014) marked on 1st edition 6" O.S. Map.

		Existing	North Point	Harpers	Fota Br.	Mid Chann	C.grenin O	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	62	373	30	192	481	1750	770	572	125	0	0
	17:40	44	344	13	148	295	1072	690	538	93	0	0
	18:40	22	301	4	35	59	628	245	470	26	0	0
Flow Rate 10125	19:40	9	371	50	6	8	659	131	334	2	0	0
F Coli 10000	20:40	3	388	175	16	3	543	109	48	0	0	0
T Coli 100000	21:40	1	417	243	95	16	448	45	2	0	0	0
BOD 25	22:40	1	532	268	147	38	684	32	1	0	0	0
SS 35	23:40	0	999	253	75	29	2163	42	2	0	0	0
DO 1	00:40	1	640	204	16	9	1624	68	11	0	0	0
Ammonia 3	01:40	2	423	74	3	4	995	96	41	0	0	0
Nitrate 15	02:40	8	329	9	5	27	824	678	543	4	0	0
Phos. 1	03:40	23	283	3	56	302	775	927	680	23	0	0
Input : North Point	04:40	52	277	19	195	510	1101	780	598	90	0	0
Neap Tide	16:40	39	369	0	0	0	0	0	0	0	0	0
Carrigrenan excluded	17:40	29	347	1	0	0	0	0	0	0	0	0
	18:40	14	308	3	0	0	0	0	0	0	0	0
Flow Rate 10125	19:40	5	372	54	1	0	0	0	0	0	0	0
F Coli 10000	20:40	2	378	180	18	2	0	0	0	0	0	0
T Coli 100000	21:40	1	392	245	101	18	0	0	0	0	0	0
BOD 25	22:40	0	492	263	153	40	0	0	0	0	0	0
SS 35	23:40	0	992	249	80	32	0	0	0	0	0	0
DO 1	00:40	0	623	208	17	10	0	0	0	0	0	0
Ammonia 3	01:40	1	413	79	3	1	0	0	0	0	0	0
Nitrate 15	02:40	3	339	10	0	0	0	0	0	0	0	0
Phos. 1	03:40	16	287	1	0	0	0	0	0	0	0	0
Input : North Point	04:40	42	295	0	0	0	0	0	0	0	0	0
Spring Tide	16:40	102	283	56	35	81	826	178	157	276	3	0
	17:40	59	234	59	43	47	389	192	170	250	6	0
	18:40	27	114	53	46	39	246	336	127	251	7	0
Flow Rate 10125	19:40	9	95	51	53	41	284	192	226	198	4	0
F Coli 10000	20:40	2	142	48	38	28	318	140	191	6	2	0
T Coli 100000	21:40	1	220	83	51	23	303	84	17	0	2	0
BOD 25	22:40	0	383	122	79	29	435		8	0	2	0
SS 35	23:40	0	607	163	77	28	2143		30	0	2	0
DO 1	00:40	0	1237	163	14	20	1171	82	28	1	1	0
Ammonia 3	01:40	0	306	21	7	14	524	352	550	16	1	0
Nitrate 15	02:40	109	78	21	221	492	336	421	333	415	1	0
Phos. 1	03:40	207	73	141	78	149	294	225	190	365	11	0
Input : North Point	04:40	131	221	63	45	88	418	185	158	306	5	0

Neap Tide	16:40	62	521	0	0	0	0	0	0	0	0	0
	17:40	42	473	1	0	0	0	0	0	0	0	0
	18:40	20	418	4	1	0	0	0	0	0	0	0
Flow Rate 13950	19:40	8	508	76	2	1	0	0	0	0	0	0
F Coli 10000	20:40	2	512	249	25	3	0	0	0	0	0	0
T Coli 100000	21:40	1	532	337	140	25	0	0	0	0	0	0
BOD 20	22:40	0	671	358	211	56	0	0	0	0	0	0
SS 35	23:40	0	1360	339	111	44	0	0	0	0	0	0
DO 1	00:40	0	866	286	25	14	0	0	0	0	0	0
Ammonia 3	01:40	1	573	110	4	2	0	0	0	0	0	0
Nitrate 10	02:40	5	458	15	0	0	0	0	0	0	0	0
Phos. 1	03:40	21	398	1	0	0	0	0	0	0	0	0
Input : North Point	04:40	48	402	0	0	0	0	0	0	0	0	0

Neap Tide	16:40	44	403	0	0	0	0	0	0	0	0	0
Wind 6.5m/s 250deg	17:40	45	281	1	0	0	0	0	0	0	0	0
Carrigrenan Excluded	18:40	28	289	4	0	0	0	0	0	0	0	0
Flow Rate 10125	19:40	11	335	65	2	0	0	0	0	0	0	0
F Coli 10000	20:40	4	342	167	24	3	0	0	0	0	0	0
T Coli 100000	21:40	1	361	226	96	20	0	0	0	0	0	0
BOD 20	22:40	0	469	236	141	39	0	0	0	0	0	0
SS 35	23:40	0	1063	224	64	32	0	0	0	0	0	0
DO 1	00:40	0	620	190	20	12	0	0	0	0	0	0
Ammonia 3	01:40	1	411	71	4	2	0	0	0	0	0	0
Nitrate 10	02:40	4	334	12	0	0	0	0	0	0	0	0
Phos. 1	03:40	13	292	1	0	0	0	0	0	0	0	0
Input : North Point	04:40	39	323	0	0	0	0	0	0	0	0	0

Neap Tide	16:40	40	405	23	108	335	1593	427	521	604	1	0
Wind 6.5m/s 250deg	17:40	43	281	13	64	156	1309	253	438	391	1	0
	18:40	26	287	6	21	35	635	373	364	462	1	0
Flow Rate 10125	19:40	11	332	65	8	9	543	400	365	216	1	0
F Coli 10000	20:40	4	339	166	26	6	525	248	362	18	1	0
T Coli 100000	21:40	1	358	224	96	20	559	200	162	0	1	0
BOD 20	22:40	0	466	234	141	40	1212	150	47	0	1	0
SS 35	23:40	0	1058	222	65	33	2268	100	68	0	1	0
DO 1	00:40	1	613	189	20	13	1681	69	174	1	0	0
Ammonia 3	01:40	1	406	72	5	7	956	102	286	22	0	0
Nitrate 10	02:40	4	336	12	9	43	775	195	777	150	0	0
Phos. 1	03:40	13	289	6	37	128	749	548	663	382	0	0
Input : North Point	04:40	40	307	20	95	321	1057	556	562	608	1	0

		Existing	North Point	Harpers	Fota Br.	Mid Chann	C.grenin Ol	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	625	3729	152	962	2405	8749	3849	2862	627	1	0
	17:40	445	3444	68	739	1473	5358	3451	2690	466	1	0
	18:40	221	3008	32	177	294	3142	1223	2350	131	0	0
Flow Rate 10125	19:40	89	3712	495	34	43	3293	657	1668	8	0	0
F Coli 10000	20:40	31	3883	1750	159	27	2715	547	239	0	0	0
T Coli 100000	21:40	15	4174	2433	954	161	2240	223	12	0	0	0
BOD 25	22:40	6	5319	2679	1470	376	3421	159	3	0	0	0
SS 35	23:40	5	9993	2526	751	291	10815	209	11	0	0	0
DO 1	00:40	11	6398	2042	164	91	8118	338	57	0	0	0
Ammonia 3	01:40	20	4234	739	25	25	4977	480	203	2	0	0
Nitrate 15	02:40	77	3286	93	27	137	4118	3391	2715	22	0	0
Phos. 1	03:40	233	2827	21	279	1509	3875	4637	3398	115	0	0
Input : North Point	04:40	519	2768	95	974	2548	5503	3902	2988	448	1	0
Neap Tide	16:40	390	3686	1	0	0	0	0	0	0	0	0
Carrigrenan excluded	17:40	293	3466	6	0	0	0	0	0	0	0	0
	18:40	139	3080	28	4	1	0	0	0	0	0	0
Flow Rate 10125	19:40	52	3720	542	14	4	0	0	0	0	0	0
F Coli 10000	20:40	16	3784	1803	178	23	0	0	0	0	0	0
T Coli 100000	21:40	6	3919	2454	1009	176	0	0	0	0	0	0
BOD 25	22:40	2	4924	2629	1528	401	0	0	0	0	0	0
SS 35	23:40	1	9923	2490	802	315	0	0	0	0	0	0
DO 1	00:40	3	6230	2080	174	99	0	0	0	0	0	0
Ammonia 3	01:40	7	4133	787	27	14	0	0	0	0	0	0
Nitrate 15	02:40	31	3385	105	2	2	0	0	0	0	0	0
Phos. 1	03:40	156	2869	9	0	0	0	0	0	0	0	0
Input : North Point	04:40	416	2950	2	0	0	0	0	0	0	0	0
Spring Tide	16:40	1016	2266	280	176	407	4130	890	783	1379	14	0
	17:40	592	1897	293	214	235	1947	962	848	1249	32	0
	18:40	269	999	269	229	196	1228	1681	635	1257	36	0
Flow Rate 10125	19:40	89	930	381	333	220	1421	959	1131	989	19	1
F Coli 10000	20:40	20	1412	455	305	181	1591	699	956	28	9	1
T Coli 100000	21:40	5	2195	818	496	201	1518	420	83	2	9	2
BOD 25	22:40	1	3829	1219	781	279	2173		38	0	9	2
SS 35	23:40	0	6070	1626	767	269	10715		150	0	8	2
DO 1	00:40	0	12371	1628	137	177	5858	412	142	6	7	2
Ammonia 3	01:40	1	3054	204	54	95	2623	1764	2753	78	6	1
Nitrate 15	02:40	1095	774	118	1106	2461	1678	2104	1667	2078	3	0
Phos. 1	03:40	2073	589	707	389	743	1471	1128	952	1825	57	0
Input : North Point	04:40	1310	1588	315	227	440	2089	924	789	1533	25	0

Neap Tide		16:40	623	5211	1	0	0	0	0	0	0	0	0
		17:40	424	4735	7	0	0	0	0	0	0	0	0
		18:40	204	4181	41	6	1	0	0	0	0	0	0
Flow Rate	13950	19:40	75	5081	757	19	6	0	0	0	0	0	0
F Coli	10000	20:40	23	5121	2488	252	33	0	0	0	0	0	0
T Coli	100000	21:40	9	5324	3368	1401	246	0	0	0	0	0	0
BOD	20	22:40	3	6705	3581	2110	558	0	0	0	0	0	0
SS	35	23:40	2	13598	3393	1115	440	0	0	0	0	0	0
DO	1	00:40	4	8661	2858	247	141	0	0	0	0	0	0
Ammonia	3	01:40	9	5733	1099	38	20	0	0	0	0	0	0
Nitrate	10	02:40	45	4579	149	3	2	0	0	0	0	0	0
Phos.	1	03:40	214	3983	13	0	0	0	0	0	0	0	0
Input : North Point		04:40	483	4017	2	0	0	0	0	0	0	0	0

Neap Tide		16:40	435	4030	1	0	0	0	0	0	0	0	0
Wind 6.5m/s 250deg		17:40	449	2808	8	0	0	0	0	0	0	0	0
Carrigrenan Excluded		18:40	279	2891	40	2	0	0	0	0	0	0	0
Flow Rate	10125	19:40	113	3348	647	20	5	0	0	0	0	0	0
F Coli	10000	20:40	38	3418	1673	244	32	0	0	0	0	0	0
T Coli	100000	21:40	15	3612	2255	960	196	0	0	0	0	0	0
BOD	20	22:40	5	4689	2363	1414	392	0	0	0	0	0	0
SS	35	23:40	3	10626	2236	645	318	0	0	0	0	0	0
DO	1	00:40	5	6204	1900	197	117	0	0	0	0	0	0
Ammonia	3	01:40	11	4109	714	35	23	0	0	0	0	0	0
Nitrate	10	02:40	41	3343	115	3	2	0	0	0	0	0	0
Phos.	1	03:40	127	2923	13	0	0	0	0	0	0	0	0
Input : North Point		04:40	387	3228	2	0	0	0	0	0	0	0	0

Neap Tide		16:40	396	4050	114	538	1677	7965	2134	2604	3020	4	0
Wind 6.5m/s 250deg		17:40	433	2809	67	322	778	6546	1265	2189	1955	5	0
		18:40	260	2872	53	107	174	3175	1866	1818	2310	5	1
Flow Rate	10125	19:40	105	3324	652	51	45	2717	2001	1827	1080	4	1
F Coli	10000	20:40	36	3394	1663	250	44	2627	1240	1809	92	4	1
T Coli	100000	21:40	14	3578	2240	961	200	2793	999	811	2	3	1
BOD	20	22:40	5	4664	2344	1408	394	6059	748	236	0	3	1
SS	35	23:40	3	10577	2219	644	322	11342	501	342	0	3	1
DO	1	00:40	6	6133	1891	197	123	8407	344	868	4	2	1
Ammonia	3	01:40	13	4061	723	40	47	4779	512	1429	112	2	1
Nitrate	10	02:40	39	3363	118	47	215	3876	975	3884	748	1	0
Phos.	1	03:40	133	2893	35	183	643	3745	2742	3316	1910	1	0
Input : North Point		04:40	404	3065	99	474	1605	5286	2779	2808	3039	3	0

		Existing	North Point	Harpers	Fota Br.	Mid Channel	C.grenin Out	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	0.30	1.12	0.01	0.04	0.10	0.25	0.16	0.14	0.03	0.00	0.00
	17:40	0.22	1.12	0.01	0.03	0.06	0.17	0.14	0.14	0.03	0.00	0.00
	18:40	0.11	1.18	0.02	0.01	0.01	0.14	0.06	0.13	0.01	0.00	0.00
Flow Rate 10125	19:40	0.05	1.58	0.21	0.01	0.01	0.15	0.04	0.09	0.00	0.00	0.00
F Coli 10000	20:40	0.02	1.62	0.75	0.08	0.01	0.12	0.03	0.02	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.55	1.20	0.42	0.08	0.09	0.01	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	1.70	1.33	0.70	0.17	0.11	0.01	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	2.89	1.31	0.37	0.14	0.29	0.01	0.00	0.00	0.00	0.00
DO 1	00:40	0.01	2.14	1.12	0.08	0.05	0.24	0.02	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	1.72	0.40	0.01	0.01	0.19	0.03	0.01	0.00	0.00	0.00
Nitrate 15	02:40	0.05	1.44	0.05	0.00	0.01	0.17	0.12	0.10	0.00	0.00	0.00
Phos. 1	03:40	0.14	1.11	0.01	0.01	0.06	0.14	0.17	0.14	0.01	0.00	0.00
Input : North Point	04:40	0.26	0.91	0.01	0.04	0.11	0.17	0.16	0.14	0.03	0.00	0.00
			1.55									
Neap Tide	16:40	0.18	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan excluded	17:40	0.14	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.07	1.21	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.03	1.54	0.24	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	1.51	0.78	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	1.37	1.17	0.45	0.08	0.00	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	1.49	1.25	0.73	0.19	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	2.77	1.23	0.40	0.15	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	1.98	1.11	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	1.60	0.43	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.02	1.44	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.08	1.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.19	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.48									
Spring Tide	16:40	0.33	0.45	0.01	0.01	0.02	0.11	0.03	0.03	0.06	0.00	0.00
	17:40	0.20	0.39	0.01	0.01	0.01	0.05	0.04	0.04	0.06	0.00	0.00
	18:40	0.09	0.23	0.01	0.01	0.01	0.04	0.07	0.03	0.06	0.00	0.00
Flow Rate 10125	19:40	0.03	0.25	0.08	0.05	0.02	0.05	0.05	0.05	0.05	0.00	0.00
F Coli 10000	20:40	0.01	0.40	0.13	0.07	0.03	0.06	0.03	0.05	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.59	0.25	0.15	0.06	0.06	0.02	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.99	0.37	0.25	0.09	0.06		0.00	0.00	0.00	0.00
SS 35	23:40	0.00	1.54	0.47	0.25	0.09	0.28		0.01	0.00	0.00	0.00
DO 1	00:40	0.00	3.13	0.49	0.05	0.06	0.17	0.02	0.01	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.86	0.07	0.02	0.02	0.09	0.06	0.09	0.00	0.00	0.00
Nitrate 15	02:40	0.31	0.21	0.01	0.04	0.08	0.05	0.08	0.07	0.07	0.00	0.00
Phos. 1	03:40	0.62	0.12	0.03	0.02	0.03	0.04	0.04	0.04	0.07	0.00	0.00
Input : North Point	04:40	0.42	0.27	0.01	0.01	0.02	0.06	0.03	0.03	0.06	0.00	0.00
			0.73									

Neap Tide	16:40	0.28	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:40	0.19	1.56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.10	1.64	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 13950	19:40	0.04	2.09	0.33	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	2.03	1.07	0.13	0.02	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.85	1.60	0.62	0.12	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	2.03	1.68	1.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	3.77	1.66	0.55	0.22	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	2.72	1.52	0.13	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	2.19	0.59	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.03	1.95	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.11	1.57	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.22	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			2.03									

Neap Tide	16:40	0.19	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.19	0.93	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan Excluded	18:40	0.13	1.11	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.05	1.32	0.26	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.02	1.29	0.70	0.11	0.02	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.20	1.02	0.41	0.09	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	1.37	1.06	0.65	0.18	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	2.88	1.05	0.31	0.15	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	1.89	0.96	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	1.48	0.37	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.03	1.33	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.07	1.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.17	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.39									

Neap Tide	16:40	0.17	1.21	0.01	0.03	0.08	0.23	0.11	0.13	0.14	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.19	0.93	0.01	0.02	0.04	0.20	0.08	0.12	0.10	0.00	0.00
	18:40	0.12	1.09	0.03	0.01	0.01	0.13	0.11	0.11	0.12	0.00	0.00
Flow Rate 10125	19:40	0.05	1.30	0.26	0.02	0.01	0.13	0.12	0.11	0.07	0.00	0.00
F Coli 10000	20:40	0.02	1.27	0.70	0.11	0.02	0.13	0.08	0.11	0.01	0.00	0.00
T Coli 100000	21:40	0.01	1.17	1.01	0.41	0.09	0.13	0.06	0.06	0.00	0.00	0.00
BOD 20	22:40	0.00	1.35	1.04	0.64	0.18	0.21	0.05	0.02	0.00	0.00	0.00
SS 35	23:40	0.00	2.86	1.03	0.31	0.15	0.34	0.04	0.03	0.00	0.00	0.00
DO 1	00:40	0.00	1.85	0.95	0.10	0.06	0.27	0.03	0.07	0.00	0.00	0.00
Ammonia 3	01:40	0.01	1.46	0.37	0.02	0.02	0.18	0.04	0.09	0.01	0.00	0.00
Nitrate 10	02:40	0.02	1.33	0.06	0.01	0.02	0.15	0.07	0.16	0.06	0.00	0.00
Phos. 1	03:40	0.07	1.08	0.01	0.01	0.04	0.13	0.12	0.15	0.11	0.00	0.00
Input : North Point	04:40	0.17	0.97	0.01	0.03	0.08	0.16	0.13	0.14	0.14	0.00	0.00
			1.37									

		Existing	North Point	Harpers	Fota Br.	Mid Chann	C.grenin O	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	0.44	1.62	0.01	0.05	0.14	0.32	0.22	0.20	0.05	0.00	0.00
	17:40	0.32	1.63	0.01	0.04	0.09	0.23	0.19	0.19	0.04	0.00	0.00
	18:40	0.17	1.75	0.03	0.02	0.02	0.20	0.08	0.18	0.01	0.00	0.00
Flow Rate 10125	19:40	0.07	2.34	0.32	0.02	0.01	0.21	0.06	0.12	0.00	0.00	0.00
F Coli 10000	20:40	0.03	2.38	1.12	0.12	0.02	0.17	0.05	0.02	0.00	0.00	0.00
T Coli 100000	21:40	0.01	2.24	1.80	0.63	0.12	0.12	0.02	0.00	0.00	0.00	0.00
BOD 25	22:40	0.01	2.44	2.00	1.06	0.26	0.14	0.02	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	4.10	1.97	0.56	0.22	0.36	0.02	0.00	0.00	0.00	0.00
DO 1	00:40	0.01	3.08	1.71	0.13	0.07	0.30	0.03	0.01	0.00	0.00	0.00
Ammonia 3	01:40	0.02	2.55	0.61	0.02	0.02	0.25	0.05	0.02	0.00	0.00	0.00
Nitrate 15	02:40	0.08	2.17	0.08	0.01	0.02	0.23	0.16	0.14	0.00	0.00	0.00
Phos. 1	03:40	0.20	1.66	0.01	0.02	0.08	0.19	0.23	0.20	0.01	0.00	0.00
Input : North Point	04:40	0.38	1.33	0.01	0.05	0.14	0.22	0.22	0.20	0.04	0.00	0.00
Neap Tide	16:40	0.26	1.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan excluded	17:40	0.20	1.66	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.10	1.78	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.04	2.27	0.36	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	2.20	1.17	0.14	0.02	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.98	1.76	0.68	0.13	0.00	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	2.13	1.86	1.10	0.29	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	3.91	1.84	0.60	0.24	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	2.83	1.68	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	2.36	0.65	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.03	2.16	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.12	1.69	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.27	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring Tide	16:40	0.48	0.63	0.02	0.01	0.02	0.13	0.04	0.04	0.08	0.00	0.00
	17:40	0.29	0.54	0.02	0.01	0.01	0.07	0.05	0.05	0.08	0.00	0.00
	18:40	0.14	0.33	0.02	0.02	0.01	0.05	0.10	0.04	0.08	0.00	0.00
Flow Rate 10125	19:40	0.05	0.36	0.11	0.07	0.02	0.07	0.06	0.08	0.06	0.00	0.00
F Coli 10000	20:40	0.01	0.57	0.19	0.11	0.04	0.09	0.05	0.06	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.84	0.37	0.22	0.08	0.08	0.03	0.01	0.00	0.00	0.00
BOD 25	22:40	0.00	1.39	0.53	0.37	0.13	0.08		0.00	0.00	0.00	0.00
SS 35	23:40	0.00	2.16	0.68	0.37	0.13	0.34		0.01	0.00	0.00	0.00
DO 1	00:40	0.00	4.38	0.70	0.07	0.09	0.21	0.03	0.01	0.00	0.00	0.00
Ammonia 3	01:40	0.00	1.22	0.10	0.02	0.03	0.12	0.08	0.11	0.01	0.00	0.00
Nitrate 15	02:40	0.44	0.30	0.02	0.05	0.11	0.07	0.11	0.09	0.10	0.00	0.00
Phos. 1	03:40	0.89	0.17	0.04	0.02	0.04	0.05	0.06	0.05	0.10	0.00	0.00
Input : North Point	04:40	0.61	0.37	0.02	0.01	0.02	0.07	0.04	0.04	0.09	0.00	0.00

Neap Tide	16:40	0.40	2.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:40	0.28	2.27	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.14	2.41	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 13950	19:40	0.05	3.08	0.50	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.02	2.96	1.60	0.20	0.03	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	2.67	2.40	0.94	0.18	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	2.89	2.52	1.51	0.40	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	5.33	2.49	0.84	0.33	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	3.89	2.30	0.19	0.12	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	3.22	0.91	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.04	2.92	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.16	2.33	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.32	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neap Tide	16:40	0.27	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.28	1.35	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan Excluded	18:40	0.18	1.62	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.08	1.93	0.39	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.03	1.87	1.05	0.17	0.03	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.72	1.52	0.62	0.13	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	1.94	1.57	0.98	0.27	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	4.06	1.56	0.47	0.23	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	2.68	1.45	0.15	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.01	2.16	0.57	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.04	1.97	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.10	1.62	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.25	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neap Tide	16:40	0.25	1.73	0.02	0.04	0.12	0.29	0.15	0.19	0.21	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.27	1.35	0.02	0.03	0.06	0.25	0.12	0.17	0.15	0.00	0.00
	18:40	0.17	1.60	0.04	0.02	0.02	0.18	0.16	0.16	0.18	0.00	0.00
Flow Rate 10125	19:40	0.07	1.91	0.39	0.03	0.01	0.18	0.18	0.16	0.11	0.00	0.00
F Coli 10000	20:40	0.03	1.85	1.04	0.17	0.03	0.19	0.11	0.16	0.02	0.00	0.00
T Coli 100000	21:40	0.01	1.68	1.50	0.62	0.13	0.19	0.10	0.09	0.00	0.00	0.00
BOD 20	22:40	0.00	1.91	1.55	0.97	0.27	0.28	0.08	0.04	0.00	0.00	0.00
SS 35	23:40	0.00	4.02	1.54	0.46	0.23	0.43	0.06	0.05	0.00	0.00	0.00
DO 1	00:40	0.01	2.64	1.43	0.15	0.09	0.35	0.05	0.10	0.00	0.00	0.00
Ammonia 3	01:40	0.01	2.12	0.57	0.03	0.03	0.25	0.07	0.14	0.02	0.00	0.00
Nitrate 10	02:40	0.04	1.97	0.09	0.01	0.03	0.21	0.10	0.22	0.10	0.00	0.00
Phos. 1	03:40	0.10	1.60	0.02	0.02	0.07	0.17	0.17	0.21	0.16	0.00	0.00
Input : North Point	04:40	0.25	1.41	0.02	0.04	0.11	0.21	0.18	0.20	0.21	0.00	0.00

		Existing	North Point	Harpers	Fota Br.	Mid Channel	C.grenin Out	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	10.0	9.6	10.0	10.0	9.9	9.9	9.9	9.9	10.0	10.0	10.0
	17:40	10.0	9.6	10.0	10.0	10.0	9.9	9.9	9.9	10.0	10.0	10.0
	18:40	10.0	9.5	10.0	10.0	10.0	9.9	10.0	9.9	10.0	10.0	10.0
Flow Rate 10125	19:40	10.0	9.3	9.9	10.0	10.0	9.9	10.0	9.9	10.0	10.0	10.0
F Coli 10000	20:40	10.0	9.2	9.6	10.0	10.0	9.9	10.0	10.0	10.0	9.9	10.0
T Coli 100000	21:40	10.0	9.3	9.4	9.8	9.9	9.9	9.9	10.0	10.0	9.9	10.0
BOD 25	22:40	10.0	9.3	9.3	9.6	9.9	9.9	9.9	10.0	10.0	9.9	9.9
SS 35	23:40	10.0	8.8	9.3	9.8	9.9	9.9	9.9	10.0	10.0	9.9	9.9
DO 1	00:40	9.9	9.0	9.3	9.9	9.9	9.9	9.9	10.0	10.0	9.9	9.9
Ammonia 3	01:40	9.9	9.1	9.7	10.0	9.9	9.9	9.9	10.0	10.0	9.9	9.9
Nitrate 15	02:40	9.9	9.2	9.9	10.0	9.9	9.9	9.9	9.9	10.0	9.9	9.9
Phos. 1	03:40	9.8	9.4	9.9	10.0	9.9	9.9	9.9	9.9	10.0	10.0	9.9
Input : North Point	04:40	9.8	9.5	9.9	9.9	9.9	9.9	9.8	9.9	9.9	10.0	9.9
Neap Tide	16:40	10.0	9.6	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Carrigrenan excluded	17:40	10.0	9.6	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	18:40	10.0	9.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Flow Rate 10125	19:40	10.0	9.3	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
F Coli 10000	20:40	10.0	9.3	9.6	9.9	10.0	10.0	10.0	10.0	10.0	9.9	10.0
T Coli 100000	21:40	10.0	9.4	9.4	9.8	9.9	10.0	10.0	10.0	10.0	9.9	10.0
BOD 25	22:40	10.0	9.4	9.4	9.6	9.9	10.0	9.9	10.0	10.0	9.9	9.9
SS 35	23:40	10.0	8.9	9.3	9.8	9.9	10.0	9.9	10.0	10.0	9.9	9.9
DO 1	00:40	9.9	9.1	9.4	9.9	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Ammonia 3	01:40	9.9	9.2	9.7	10.0	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Nitrate 15	02:40	9.9	9.2	9.9	10.0	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Phos. 1	03:40	9.9	9.4	9.9	10.0	9.9	10.0	10.0	10.0	10.0	10.0	9.9
Input : North Point	04:40	9.8	9.5	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.9
Spring Tide	16:40	10.0	9.8	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	17:40	10.0	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	18:40	10.0	9.9	10.0	10.0	10.0	10.0	10.0	10.0	9.9	10.0	10.0
Flow Rate 10125	19:40	10.0	9.9	10.0	10.0	10.0	10.0	10.0	9.9	10.0	10.0	10.0
F Coli 10000	20:40	10.0	9.8	9.9	9.9	10.0	9.9	9.9	9.9	10.0	9.9	9.9
T Coli 100000	21:40	10.0	9.7	9.8	9.9	9.9	9.9	9.9	10.0	10.0	9.9	9.9
BOD 25	22:40	10.0	9.6	9.8	9.8	9.9	9.9		9.9	10.0	9.9	9.9
SS 35	23:40	10.0	9.3	9.7	9.8	9.9	9.9		9.9	10.0	9.9	9.8
DO 1	00:40	9.9	8.7	9.6	9.9	9.9	9.9	9.8	9.9	10.0	9.9	9.8
Ammonia 3	01:40	9.9	9.5	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.8
Nitrate 15	02:40	9.7	9.8	9.9	9.9	9.9	10.0	9.9	9.9	9.9	9.9	9.9
Phos. 1	03:40	9.6	9.9	9.9	10.0	9.9	10.0	9.9	9.9	9.9	10.0	9.9
Input : North Point	04:40	9.7	9.8	10.0	10.0	10.0	10.0	10.0	10.0	9.9	10.0	9.9

Neap Tide	16:40	10.0	9.4	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	17:40	10.0	9.4	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	18:40	10.0	9.3	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Flow Rate 13950	19:40	10.0	9.0	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
F Coli 10000	20:40	10.0	9.1	9.5	9.9	10.0	10.0	10.0	10.0	10.0	9.9	10.0
T Coli 100000	21:40	10.0	9.2	9.2	9.7	9.9	10.0	10.0	10.0	10.0	9.9	10.0
BOD 20	22:40	10.0	9.2	9.2	9.5	9.8	10.0	9.9	10.0	10.0	9.9	9.9
SS 35	23:40	10.0	8.5	9.1	9.7	9.8	10.0	9.9	10.0	10.0	9.9	9.9
DO 1	00:40	9.9	8.8	9.2	9.9	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Ammonia 3	01:40	9.9	8.9	9.6	10.0	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Nitrate 10	02:40	9.9	9.0	9.9	10.0	9.9	10.0	9.9	10.0	10.0	9.9	9.9
Phos. 1	03:40	9.8	9.2	9.9	10.0	9.9	10.0	10.0	10.0	10.0	10.0	9.9
Input : North Point	04:40	9.8	9.3	9.9	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.9
Neap Tide	16:40	9.9	9.5	10.0	10.0	9.9	9.9	9.9	9.8	9.8	10.0	9.8
Wind 6.5m/s 250deg	17:40	9.9	9.6	9.9	10.0	9.9	9.9	9.9	9.8	9.8	10.0	9.8
Carrigrenan Excluded	18:40	9.9	9.5	9.9	9.9	10.0	9.9	9.8	9.8	9.8	10.0	9.8
Flow Rate 10125	19:40	9.9	9.4	9.8	9.9	9.9	9.9	9.8	9.8	9.8	9.9	9.8
F Coli 10000	20:40	9.9	9.4	9.6	9.8	9.9	9.8	9.8	9.8	9.9	9.8	9.8
T Coli 100000	21:40	9.9	9.4	9.4	9.7	9.9	9.8	9.8	9.8	9.9	9.8	9.7
BOD 20	22:40	9.9	9.3	9.4	9.6	9.8	9.8	9.8	9.8	9.9	9.8	9.7
SS 35	23:40	9.9	8.8	9.4	9.7	9.8	9.8	9.7	9.8	9.9	9.8	9.7
DO 1	00:40	9.9	9.1	9.4	9.9	9.8	9.8	9.7	9.8	9.9	9.7	9.7
Ammonia 3	01:40	9.9	9.2	9.7	9.9	9.8	9.8	9.7	9.8	9.8	9.7	9.6
Nitrate 10	02:40	9.8	9.2	9.8	9.9	9.8	9.9	9.7	9.8	9.8	9.8	9.7
Phos. 1	03:40	9.8	9.3	9.9	9.9	9.8	9.9	9.7	9.8	9.8	10.0	9.7
Input : North Point	04:40	9.7	9.4	9.9	9.9	9.8	9.9	9.7	9.8	9.8	10.0	9.7
Neap Tide	16:40	9.9	9.5	10.0	9.9	9.9	9.8	9.8	9.8	9.7	10.0	9.8
Wind 6.5m/s 250deg	17:40	9.9	9.6	9.9	9.9	9.9	9.8	9.8	9.8	9.8	10.0	9.8
	18:40	9.9	9.5	9.9	9.9	9.9	9.8	9.8	9.8	9.7	10.0	9.8
Flow Rate 10125	19:40	9.9	9.4	9.8	9.9	9.9	9.8	9.7	9.7	9.8	9.9	9.8
F Coli 10000	20:40	9.9	9.4	9.6	9.8	9.9	9.7	9.8	9.7	9.9	9.8	9.8
T Coli 100000	21:40	9.9	9.4	9.5	9.7	9.9	9.7	9.8	9.8	9.9	9.8	9.7
BOD 20	22:40	9.9	9.3	9.4	9.6	9.8	9.7	9.7	9.8	9.9	9.8	9.7
SS 35	23:40	9.9	8.8	9.4	9.7	9.8	9.7	9.7	9.8	9.9	9.8	9.7
DO 1	00:40	9.9	9.1	9.4	9.9	9.8	9.7	9.7	9.7	9.9	9.7	9.7
Ammonia 3	01:40	9.9	9.2	9.7	9.9	9.8	9.7	9.7	9.7	9.8	9.7	9.6
Nitrate 10	02:40	9.8	9.2	9.8	9.9	9.8	9.8	9.7	9.7	9.7	9.8	9.7
Phos. 1	03:40	9.8	9.3	9.9	9.9	9.8	9.8	9.7	9.7	9.7	10.0	9.7
Input : North Point	04:40	9.7	9.4	9.9	9.9	9.8	9.8	9.7	9.7	9.7	10.0	9.7

		Existing	North Point	Harpers	Fota Br.	Mid Channel	C.grenin Out	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	0.05	0.15	0.00	0.01	0.02	0.06	0.04	0.04	0.01	0.00	0.00
	17:40	0.03	0.16	0.00	0.01	0.01	0.04	0.03	0.04	0.01	0.00	0.00
	18:40	0.02	0.18	0.00	0.00	0.00	0.04	0.01	0.03	0.00	0.00	0.00
Flow Rate 10125	19:40	0.01	0.25	0.03	0.00	0.00	0.04	0.01	0.02	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.26	0.12	0.01	0.00	0.03	0.01	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.23	0.20	0.06	0.01	0.02	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.24	0.22	0.11	0.03	0.02	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.38	0.22	0.06	0.02	0.06	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.31	0.19	0.01	0.01	0.05	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.27	0.07	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.01	0.23	0.01	0.00	0.00	0.04	0.03	0.02	0.00	0.00	0.00
Phos. 1	03:40	0.02	0.17	0.00	0.00	0.01	0.04	0.04	0.04	0.00	0.00	0.00
Input : North Point	04:40	0.04	0.13	0.00	0.01	0.03	0.04	0.04	0.04	0.01	0.00	0.00
Neap Tide	16:40	0.03	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan excluded	17:40	0.02	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.01	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.00	0.24	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.23	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.20	0.19	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.20	0.20	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.35	0.20	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.27	0.18	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.24	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.00	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.01	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.03	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring Tide	16:40	0.04	0.06	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.00	0.00
	17:40	0.02	0.05	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
	18:40	0.01	0.03	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.00	0.00
Flow Rate 10125	19:40	0.00	0.03	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00
F Coli 10000	20:40	0.00	0.05	0.02	0.01	0.00	0.02	0.01	0.01	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.07	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.12	0.04	0.03	0.01	0.01		0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.18	0.05	0.03	0.01	0.06		0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.37	0.05	0.01	0.01	0.04	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.10	0.01	0.00	0.00	0.02	0.01	0.02	0.00	0.00	0.00
Nitrate 15	02:40	0.04	0.02	0.00	0.01	0.02	0.01	0.02	0.02	0.02	0.00	0.00
Phos. 1	03:40	0.08	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.00	0.00
Input : North Point	04:40	0.05	0.03	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.00

Neap Tide	16:40	0.04	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:40	0.03	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.02	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 13950	19:40	0.01	0.34	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.32	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.27	0.27	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	0.28	0.28	0.17	0.04	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.49	0.28	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.38	0.27	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.34	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.00	0.32	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.02	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.03	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neap Tide	16:40	0.03	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.03	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan Excluded	18:40	0.02	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.01	0.19	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.19	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.16	0.16	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	0.18	0.16	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.36	0.16	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.25	0.15	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.21	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.00	0.20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.01	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.02	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Neap Tide	16:40	0.02	0.16	0.00	0.01	0.02	0.05	0.02	0.03	0.04	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.03	0.13	0.00	0.01	0.01	0.05	0.02	0.03	0.03	0.00	0.00
	18:40	0.02	0.16	0.00	0.00	0.00	0.03	0.03	0.03	0.03	0.00	0.00
Flow Rate 10125	19:40	0.01	0.19	0.04	0.00	0.00	0.03	0.03	0.03	0.02	0.00	0.00
F Coli 10000	20:40	0.00	0.18	0.10	0.02	0.00	0.03	0.02	0.03	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.16	0.15	0.06	0.01	0.03	0.02	0.02	0.00	0.00	0.00
BOD 20	22:40	0.00	0.17	0.16	0.10	0.03	0.05	0.01	0.01	0.00	0.00	0.00
SS 35	23:40	0.00	0.35	0.16	0.05	0.02	0.07	0.01	0.01	0.00	0.00	0.00
DO 1	00:40	0.00	0.24	0.15	0.01	0.01	0.06	0.01	0.02	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.20	0.06	0.00	0.00	0.04	0.01	0.02	0.00	0.00	0.00
Nitrate 10	02:40	0.00	0.19	0.01	0.00	0.00	0.04	0.02	0.04	0.02	0.00	0.00
Phos. 1	03:40	0.01	0.16	0.00	0.00	0.01	0.03	0.03	0.04	0.03	0.00	0.00
Input : North Point	04:40	0.02	0.13	0.00	0.01	0.02	0.04	0.03	0.04	0.04	0.00	0.00

		Existing	North Point	Harpers	Fota Br.	Mid Channel	C.grenin Out	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	0.21	0.72	0.01	0.05	0.12	0.27	0.19	0.17	0.04	0.00	0.00
	17:40	0.15	0.73	0.01	0.04	0.07	0.19	0.16	0.16	0.03	0.00	0.00
	18:40	0.08	0.80	0.01	0.01	0.02	0.16	0.07	0.15	0.01	0.00	0.00
Flow Rate 10125	19:40	0.03	1.09	0.15	0.01	0.01	0.18	0.05	0.10	0.00	0.00	0.00
F Coli 10000	20:40	0.01	1.11	0.52	0.06	0.01	0.14	0.04	0.02	0.00	0.00	0.00
T Coli 100000	21:40	0.01	1.03	0.84	0.29	0.05	0.10	0.02	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	1.10	0.94	0.49	0.12	0.11	0.01	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	1.82	0.93	0.26	0.10	0.30	0.02	0.00	0.00	0.00	0.00
DO 1	00:40	0.01	1.40	0.80	0.06	0.03	0.25	0.03	0.01	0.00	0.00	0.00
Ammonia 3	01:40	0.01	1.17	0.29	0.01	0.01	0.21	0.04	0.02	0.00	0.00	0.00
Nitrate 15	02:40	0.04	1.00	0.04	0.00	0.01	0.19	0.13	0.11	0.00	0.00	0.00
Phos. 1	03:40	0.10	0.76	0.01	0.02	0.07	0.16	0.19	0.17	0.01	0.00	0.00
Input : North Point	04:40	0.18	0.60	0.01	0.04	0.12	0.19	0.19	0.17	0.03	0.00	0.00
			1.02									
Neap Tide	16:40	0.12	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan excluded	17:40	0.09	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.05	0.82	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.02	1.05	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	1.02	0.53	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.90	0.82	0.31	0.06	0.00	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.95	0.87	0.51	0.13	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	1.71	0.86	0.28	0.11	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	1.27	0.79	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	1.08	0.30	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.01	0.99	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.06	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.13	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.97									
Spring Tide	16:40	0.21	0.28	0.01	0.01	0.02	0.11	0.04	0.04	0.07	0.00	0.00
	17:40	0.13	0.24	0.02	0.01	0.01	0.06	0.04	0.04	0.06	0.00	0.00
	18:40	0.06	0.14	0.01	0.01	0.01	0.04	0.08	0.03	0.07	0.00	0.00
Flow Rate 10125	19:40	0.02	0.16	0.05	0.03	0.01	0.06	0.05	0.06	0.05	0.00	0.00
F Coli 10000	20:40	0.00	0.25	0.08	0.05	0.02	0.07	0.04	0.05	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.36	0.16	0.10	0.04	0.06	0.02	0.01	0.00	0.00	0.00
BOD 25	22:40	0.00	0.60	0.23	0.16	0.06	0.07		0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.93	0.29	0.16	0.06	0.28		0.01	0.00	0.00	0.00
DO 1	00:40	0.00	1.88	0.30	0.03	0.04	0.17	0.03	0.01	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.53	0.05	0.01	0.01	0.10	0.06	0.09	0.01	0.00	0.00
Nitrate 15	02:40	0.19	0.13	0.01	0.04	0.09	0.06	0.09	0.07	0.08	0.00	0.00
Phos. 1	03:40	0.39	0.08	0.03	0.02	0.04	0.04	0.05	0.04	0.08	0.00	0.00
Input : North Point	04:40	0.26	0.17	0.02	0.01	0.02	0.06	0.04	0.04	0.07	0.00	0.00

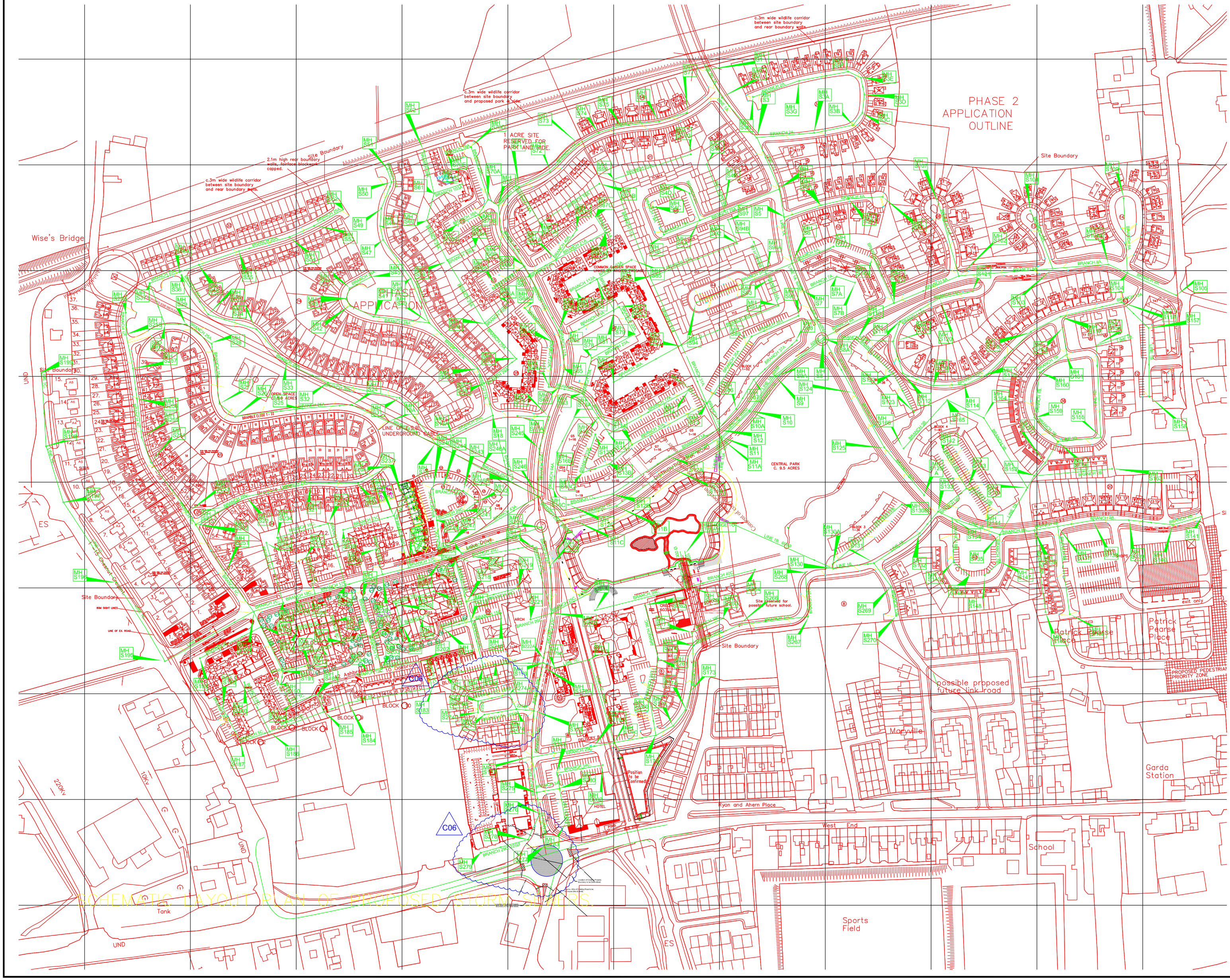
			0.44									
Neap Tide	16:40	0.19	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:40	0.13	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.07	1.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 13950	19:40	0.03	1.42	0.23	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	1.36	0.73	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	1.21	1.12	0.43	0.08	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	1.29	1.17	0.70	0.18	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	2.33	1.16	0.39	0.15	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	1.74	1.08	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	1.47	0.42	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.02	1.34	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.08	1.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.15	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.32									
Neap Tide	16:40	0.13	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.13	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan Excluded	18:40	0.09	0.74	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.04	0.89	0.18	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.01	0.85	0.48	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.01	0.77	0.70	0.28	0.06	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	0.86	0.72	0.45	0.12	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	1.77	0.72	0.22	0.10	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	1.19	0.67	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.98	0.26	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.02	0.90	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.05	0.73	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.11	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.90									
Neap Tide	16:40	0.11	0.76	0.01	0.03	0.10	0.24	0.13	0.16	0.17	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.13	0.60	0.01	0.03	0.05	0.21	0.10	0.14	0.12	0.00	0.00
	18:40	0.08	0.73	0.02	0.01	0.02	0.15	0.13	0.13	0.15	0.00	0.00
Flow Rate 10125	19:40	0.03	0.87	0.18	0.01	0.01	0.15	0.14	0.14	0.09	0.00	0.00
F Coli 10000	20:40	0.01	0.84	0.47	0.08	0.01	0.15	0.09	0.13	0.01	0.00	0.00
T Coli 100000	21:40	0.00	0.76	0.69	0.28	0.06	0.15	0.08	0.08	0.00	0.00	0.00
BOD 20	22:40	0.00	0.84	0.71	0.44	0.12	0.23	0.06	0.03	0.00	0.00	0.00
SS 35	23:40	0.00	1.75	0.71	0.21	0.10	0.36	0.05	0.04	0.00	0.00	0.00
DO 1	00:40	0.00	1.17	0.66	0.07	0.04	0.29	0.04	0.09	0.00	0.00	0.00
Ammonia 3	01:40	0.01	0.96	0.26	0.01	0.01	0.21	0.06	0.12	0.02	0.00	0.00
Nitrate 10	02:40	0.02	0.89	0.04	0.01	0.02	0.17	0.08	0.19	0.08	0.00	0.00
Phos. 1	03:40	0.05	0.72	0.01	0.02	0.06	0.14	0.14	0.18	0.13	0.00	0.00
Input : North Point	04:40	0.12	0.63	0.01	0.03	0.09	0.17	0.15	0.16	0.17	0.00	0.00
			0.89									

		Existing	North Point	Harpers	Fota Br.	Mid Channel	C.grenin Out	L. Mahon1	L. Mahon2	L. Mahon3	Belvelly	Weir Island
Neap Tide	16:40	0.02	0.051	0.00	0.01	0.04	0.09	0.06	0.06	0.01	0.00	0.00
	17:40	0.01	0.053	0.00	0.01	0.02	0.06	0.05	0.05	0.01	0.00	0.00
	18:40	0.01	0.063	0.00	0.00	0.00	0.06	0.02	0.05	0.00	0.00	0.00
Flow Rate 10125	19:40	0.00	0.088	0.01	0.00	0.00	0.06	0.01	0.03	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.088	0.04	0.00	0.00	0.05	0.01	0.01	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.080	0.07	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.081	0.08	0.04	0.01	0.04	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.129	0.08	0.02	0.01	0.10	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.104	0.07	0.00	0.00	0.08	0.01	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.093	0.02	0.00	0.00	0.07	0.01	0.01	0.00	0.00	0.00
Nitrate 15	02:40	0.00	0.081	0.00	0.00	0.00	0.07	0.04	0.04	0.00	0.00	0.00
Phos. 1	03:40	0.01	0.059	0.00	0.00	0.02	0.05	0.06	0.06	0.00	0.00	0.00
Input : North Point	04:40	0.01	0.044	0.00	0.01	0.04	0.06	0.06	0.06	0.01	0.00	0.00
			0.078	0.029								
Neap Tide	16:40	0.01	0.051	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan excluded	17:40	0.01	0.054	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.00	0.063	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.00	0.083	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.079	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.067	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.067	0.07	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.118	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.092	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.083	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 15	02:40	0.00	0.079	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.00	0.060	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.01	0.046	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.072									
Spring Tide	16:40	0.01	0.024	0.00	0.00	0.01	0.03	0.01	0.01	0.02	0.00	0.00
	17:40	0.01	0.021	0.00	0.00	0.00	0.02	0.01	0.01	0.02	0.00	0.00
	18:40	0.00	0.011	0.00	0.00	0.00	0.01	0.03	0.01	0.02	0.00	0.00
Flow Rate 10125	19:40	0.00	0.010	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.00	0.00
F Coli 10000	20:40	0.00	0.016	0.01	0.00	0.00	0.02	0.01	0.02	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.024	0.01	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.00
BOD 25	22:40	0.00	0.039	0.01	0.01	0.00	0.02		0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.061	0.02	0.01	0.00	0.09		0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.125	0.02	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.034	0.00	0.00	0.00	0.03	0.02	0.03	0.00	0.00	0.00
Nitrate 15	02:40	0.01	0.008	0.00	0.01	0.03	0.02	0.03	0.02	0.02	0.00	0.00
Phos. 1	03:40	0.03	0.006	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.00
Input : North Point	04:40	0.02	0.017	0.01	0.00	0.01	0.02	0.01	0.01	0.02	0.00	0.00
			0.031									

Neap Tide	16:40	0.01	0.073	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	17:40	0.01	0.076	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	18:40	0.01	0.088	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 13950	19:40	0.00	0.115	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.109	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.093	0.09	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	0.093	0.10	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.163	0.10	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.128	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.116	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.00	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.01	0.085	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.01	0.065	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.101	0.038	0.011							

Neap Tide	16:40	0.01	0.053	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.01	0.043	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carrigrenan Excluded	18:40	0.01	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flow Rate 10125	19:40	0.00	0.067	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F Coli 10000	20:40	0.00	0.064	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.055	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD 20	22:40	0.00	0.059	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
SS 35	23:40	0.00	0.120	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
DO 1	00:40	0.00	0.084	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.072	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrate 10	02:40	0.00	0.068	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Phos. 1	03:40	0.00	0.054	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Input : North Point	04:40	0.01	0.047	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			0.065									

Neap Tide	16:40	0.01	0.053	0.00	0.01	0.03	0.08	0.04	0.05	0.06	0.00	0.00
Wind 6.5m/s 250deg	17:40	0.01	0.043	0.00	0.01	0.02	0.07	0.03	0.05	0.04	0.00	0.00
	18:40	0.01	0.054	0.00	0.00	0.00	0.05	0.05	0.04	0.05	0.00	0.00
Flow Rate 10125	19:40	0.00	0.066	0.01	0.00	0.00	0.05	0.05	0.05	0.03	0.00	0.00
F Coli 10000	20:40	0.00	0.063	0.04	0.01	0.00	0.05	0.03	0.05	0.00	0.00	0.00
T Coli 100000	21:40	0.00	0.054	0.05	0.02	0.00	0.05	0.03	0.03	0.00	0.00	0.00
BOD 20	22:40	0.00	0.058	0.05	0.03	0.01	0.08	0.02	0.01	0.00	0.00	0.00
SS 35	23:40	0.00	0.119	0.05	0.02	0.01	0.12	0.02	0.01	0.00	0.00	0.00
DO 1	00:40	0.00	0.082	0.05	0.00	0.00	0.10	0.01	0.03	0.00	0.00	0.00
Ammonia 3	01:40	0.00	0.070	0.02	0.00	0.00	0.07	0.02	0.04	0.01	0.00	0.00
Nitrate 10	02:40	0.00	0.067	0.00	0.00	0.01	0.06	0.03	0.06	0.03	0.00	0.00
Phos. 1	03:40	0.00	0.054	0.00	0.01	0.02	0.05	0.05	0.06	0.04	0.00	0.00
Input : North Point	04:40	0.01	0.044	0.00	0.01	0.03	0.06	0.05	0.06	0.06	0.00	0.00
			0.064									



NOTES

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2. All Levels refer to Ordnance Survey Datum, Malin Head.
3. DO NOT SCALE, use figured dimensions only, if in doubt ask.

No.	Date	Check	Amendment / Issue	App.
C06	JULY '06	RH VC	SEWER LAYOUT REVISED	VC
C05	MAY. '05	RH VC	SEWER LAYOUT REVISED	DL
C04	MAR. '05	RH VC	SEWER LAYOUT REVISED	DL
C03	Nov. '04	RH DL	LAGOONS REVISED	DL
C02	OCT. '04	RH DL	ISSUE FOR CONSTRUCTION	DL
C01	24.02.04	RH DL	ISSUE FOR CONSTRUCTION	DL

Client:

GABLE HOLDINGS LIMITED

RPS-MCOS Ltd., Innishmore, Ballincollig, Co. Cork, Ireland.
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Project:

Development at Castle Lake
Carrigtohill, Co. Cork.

Title:

OVERALL LAYOUT
PLAN SHOWING
PROPOSED STORM
SEWERS

Drawn by:	R.H.	Job No:	MCW0267
Checked by:		File No:	MCW0267DG0003
Approved by:		Drg. No:	GH/P 02
Scale:	NTS	Rev:	C06
Date:	24.02.04		

NOTES

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2. All Levels refer to Ordnance Survey Datum, Malin Head.
3. DO NOT SCALE, use figured dimensions only, if in doubt ask.

No.	Date	Chkd	Amendment / Issue	App.
C05	JULY. '06	VC	SEWER SIZE & LAYOUT REVISED	VC
C04	JUNE. '06	VC	SEWER LAYOUT REVISED	VC
C03	MAY. '05	VC	SEWER LAYOUT REVISED	DL
C02	OCT. '04	VC	ISSUE FOR CONSTRUCTION	DL
C01	24.02.04	DL	ISSUE FOR CONSTRUCTION	DL

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Project:

Development at Castle Lake
Carrigtohill, Co. Cork.

Title:

OVERALL LAYOUT PLAN
SHOWING FOUL SEWERS

Drawn by:	R.H.	Job No:	MCW0267
Checked by:		File No:	MCW0267DG0004
Approved by:		Drg. No:	GH/P 03
Scale:	NTS	Rev:	C05
Date:	24.02.04		