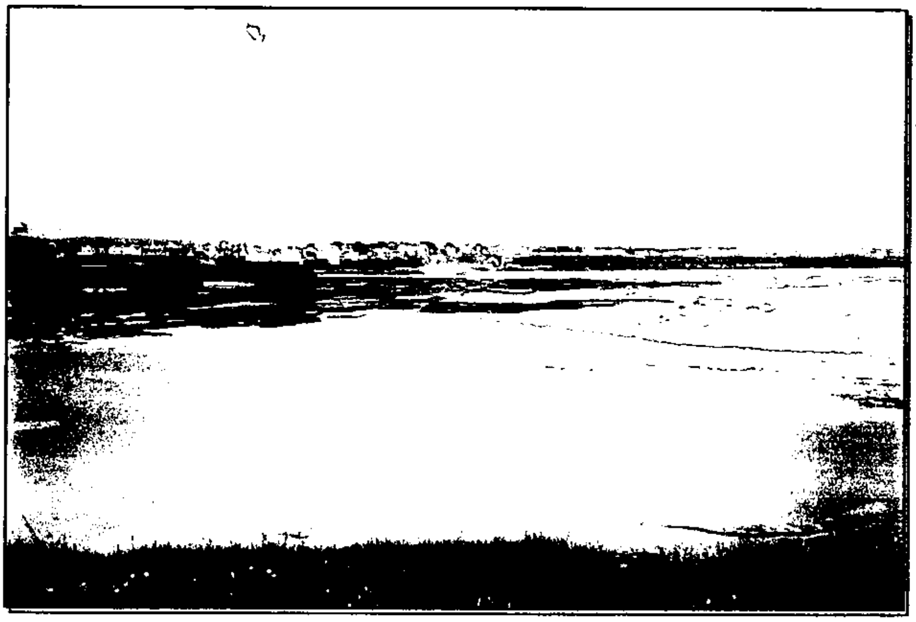
Comhairle Chontae Dhún na nGall 1348
Donegal County Council

BUNDORAN
WASTEWATER TREATMENT WORKS



ENVIRONMENTAL IMPACT STATEMENT
Volume 1 of 3

Non-Technical Summary

PH McCarthy & Partners
CONSULTING ENGINEERS
Civil • Environmental • Structural

February 2001

EIS No	1348	
Devment 1	Wastewater Treatment Works	Description of development in up to 3 line
Devment 2		
Devment 3		
P_Reg_No	X	Planning application registration number. Blank otherwise
Annex_97_1	2	Category of development under Annex I or II of Directive 97/11/EC
Annex_97_2	11	Sub division of Annex
Annex_97_3	©	further sub division of Anne
Locate 1	Bundoran	Address of development in up to 3 lines
Locate 2		
Locate 3	Co. Donegal	
Co_CoBor	Donegal C. C.	Council or City Council (one of 34 areas)
PlanAuth	Donegal C. C.	Planning Authority often the Competent Authority
CompAuth	Donegal C. C.	Competent Authority under the Directive. Add an * if there is a 2nd. Competent Authority
CompAuth 2		The EPA is a 2nd Competent Authority for some projects
CACode		CC - County Co., CB - City Co., OP - other Pl, GD - Gov. Dep., OS - Other
Devlpr 1	Donegal C. C.	The name of the Developer in up to 2 Lines
Devlpr 2		
Consult 1	P. H. McCarthy & Partners	The name of the Consultant in up to 2 Lines
Consult 2		
SubmDate	X	Date of submission of EIS to planning Auth. if more than 1 Comp Auth is involved.
SubmDate 2		Date of submission of EIS to any 2nd. Comp. Auth.
Pages	305	Equivalent number of A4 Pages in EIS. An A3 page counts as 2
Hardcopy	Yes	Whether a hard copy of EIS has been obtained. Ordered,Yes, No, NA
Notes		
MF_Stat		Whether the Micro-Fiche has been obtained. Ob=obtained, No, O=on orde
Fiche	0	No. of separate fiches for this EIS
Status		X= to be excluded in reports/indices, FUP= Follow up action needed

DONEGAL COUNTY COUNCIL

BUNDORAN WASTEWATER TREATMENT WORKS

ENVIRONMENTAL IMPACT STATEMENT

NON TECHNICAL SUMMARY
Volume 1 of 3

Document Title :	Bundoran Wastewater Treatment Works Environmental Impact Statement **Non Technical Summary - Volume 1 of 3**
Document Ref(s). :	**6690010/EIS/17d**

Date	Edition/Rev	Status	Originator	Checked	Approved
09/10/2000	First	Draft	L. Dwyer	S. Ó Ruairc	M.J. Edger
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07/02/2001	Third	Final	L. Dwyer		

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NON TECHNICAL SUMMARY

NON TECHNICAL SUMMARY

1.0 FOREWORD

Donegal County Council plan to construct a Wastewater Treatment Works (WWTW) for the town of Bundoran with sufficient capacity to cater for a future design population equivalent of 30,000. In accordance with the European Community (Environmental Impact Assessment) Regulations, SI No. 349 of 1989 an Environmental Impact Statement is required for any wastewater treatment works with a design capacity greater than 10,000 population equivalent. These regulations define an environmental impact statement as "a statement of the effects, if any, which the proposed development, if carried out would have on the environment".

2.0 INTRODUCTION

Bundoran is a popular tourist destination on the south west coast of County Donegal. It supports a number of tourist related activities including golf, waters sports, walking and the Waterworld Leisure Centre. While the current resident population is around 2,000, the population during the summer months and at peak holiday weekends can rise to an estimated 15,000 persons. Long term demographic projections estimate that this could increase to 40,000.

In order to comply with the Environmental Protection Agency Act 1992 (Urban Waste Water Treatment) Regulations 1994 (SI 149 of 1994) a wastewater treatment works is required for the town. These regulations require that towns with a population equivalent over 10,000 discharging to coastal waters must have secondary treatment facilities by 31st December 2005.

The existing sewerage system for the town discharges untreated sewage directly into Donegal Bay at a sea outfall located at Pollbrean to the west of the town. Under current legislation this practice must now be terminated and all sewage must be subjected to secondary treatment prior to discharge. In addition the existing pumping station and the sewer system in the centre of town are unable to adequately deal with flows during periods of heavy rainfall and require rehabilitation and upgrading.

The Department of the Environment and Local Government Circular Letter L3/99 "Procurement through the Use of Design/Build (DB) and Design/Build/Operate (DBO) Contracts Interim Arrangements" dated 26th January 1999 sets out revised procedures for the carrying out of certain elements of water services capital projects by means of Design/Build and Design/Build/Operate contracts. In accordance with this circular Donegal County Council intend to proceed with procurement of the project using the Design/Build/Operate approach. As this method of procurement encourages alternative design options this Environmental Impact Statement has been prepared to reflect prescribed performance values rather than detailed designs.

3.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The principal element of the development is to eliminate raw sewage discharges to Donegal Bay from the Bundoran sewerage system and provide a treatment plant that treats all waste waters to a standard that complies with National and EU legislation including:

- Environmental Protection Agency Act 1992 (Urban Waste Water Treatment) Regulations 1994 (SI 419 of 1994).

- Quality of Bathing Water Regulations 1992 (SI 155 of 19092).

In addition to the construction of the treatment works other main elements include rehabilitation and upgrading the existing sewer network, the construction of a new main pumping station and storage tank at the centre of the town, the construction of a pumping station and storage tank to service the west end and the extension of the existing sea outfall to discharge at a point 400 metres off-shore.

The waste water treatment works will incorporate preliminary, primary, secondary, tertiary and sludge treatment.

Pre-treatment will include screening and settlement to remove plastics, rags and grit from the sewage.

Primary treatment will provide for the removal of suspended matter as sludge and settled sewage will be forwarded for secondary treatment.

Secondary treatment provides for the biological treatment of the sewage in conjunction with a secondary settlement or other process.

Tertiary treatment will be provided to reduce ammonia levels in the sewage to levels that are non-toxic to fish.

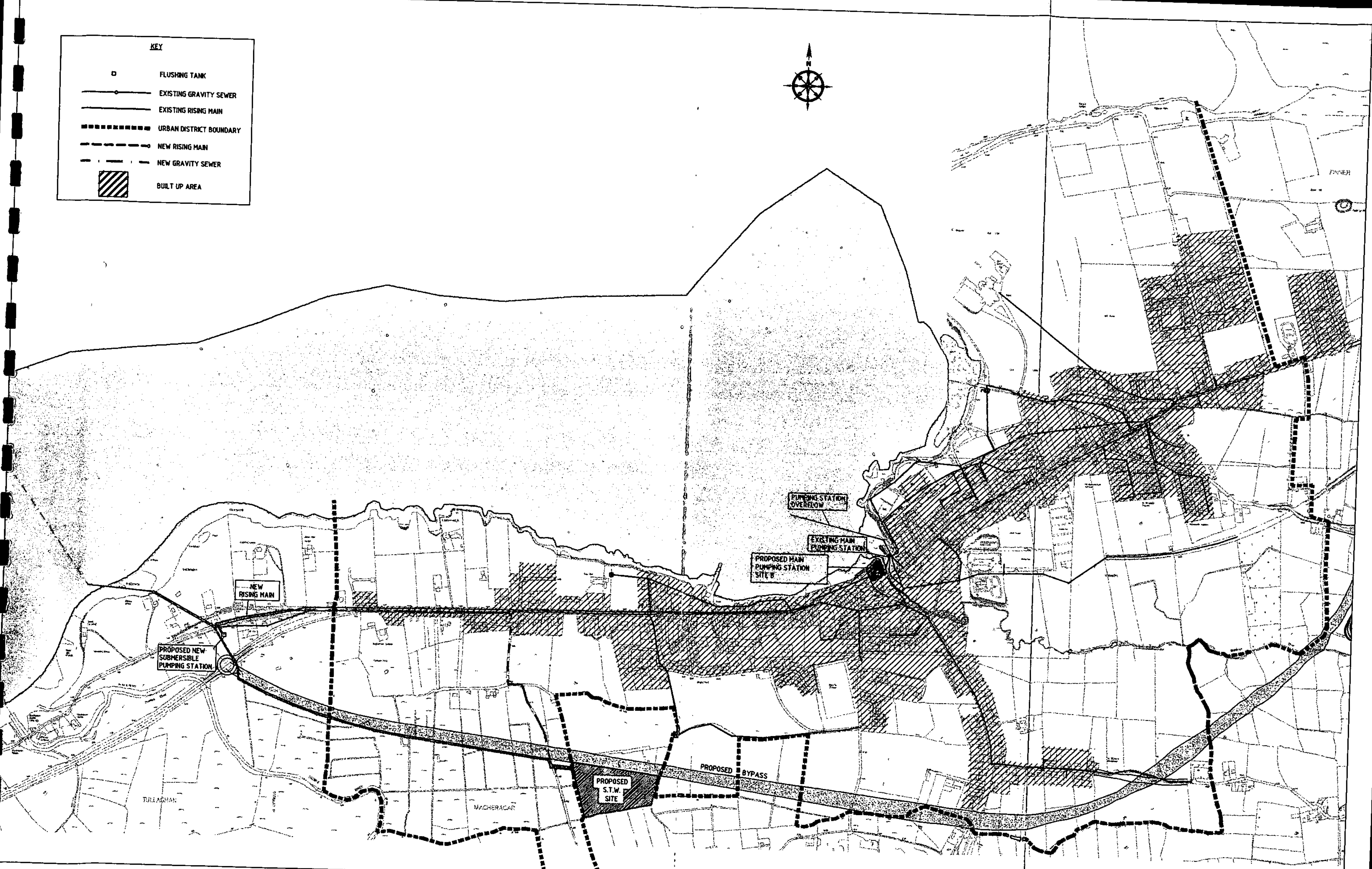
While this EIS has been prepared for a treatment works with a 30,000 pe the work will be constructed in two stages. The initial construction for Stage 1 of the works will not exceed 20,000 pe.

Sludge produced by the process will be reduced in volume by thickening and dewatering prior to transportation off-site for treatment and disposal in accordance with County Donegal's Sludge Management Plan.

All flows up to six times dry weather flow (6 DWF) will be forwarded for preliminary treatment. Three dry weather flow (3 DWF) will pass for full treatment while flows in excess of 3 DWF will be stored at the works prior to treatment. The choice of the treatment process and its operation to meet both winter low flows and summer peaks will be decided during the evaluation of the winning tender for the design, build and operation of the works.

Storage will be provided at the main pumping station in the town and at the pumping station at the west end to control the frequency of storm overflows to levels that are known not to have a detrimental effect on the environment or compromise the Bathing Water Standards.

The treated effluent will be discharged to Donegal Bay via a sea outfall at Pollbrean to the west of the town. The outfall, an extension of the existing outfall by some 400m, will terminate in a diffuser section to optimise initial dilution and dispersion of the effluent. The proposed development is shown on Fig. 3.1.



PROPOSED W.W.T.W., MAIN PUMPING STATION & UPGRADED SEWER NETWORK

FIG. 3.1

4.0 ALTERNATIVES

The "Do Nothing" scenario cannot be considered, Donegal County Council are required under Irish and EU Legislation to construct a wastewater treatment works and upgrade the sewerage system. The European Directive 91/271/EEC concerned with the treatment of urban waste water was transposed into Irish Law by the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulation 1994 (SI 419 of 1994). These regulations state that towns with a population equivalent over 10,000 discharging to coastal waters must put in place secondary treatment facilities by 31st December, 2005.

Initial consideration was given to the centralised wastewater treatment works to serve both Bundoran and Ballyshannon. This option was not favoured on environmental or economic grounds. Given the slack currents in this area of Donegal Bay there was a real risk that one large point discharge could compromise water quality in the area. Outline economic analysis showed no cost benefits for a centralised treatment works. Consequently Donegal County Council decided to proceed with a separate scheme for Bundoran.

Eight sites were identified as possible locations for the treatment works. Four of these were discounted as initial analysis indicated that they were in Special Areas of Conservation (SAC) or were designated, by Dúchas, as a site of national archaeological importance. The four remaining sites were evaluated in a framework analysis, which ranked the sites in order of suitability. The two most suitable sites were then subjected to further economic and environmental analysis. Site 6 was selected as the preferred option. It is located to the south of the proposed by-pass, some 0.5km from the N15 and 155m from the nearest dwelling (see Fig. 4.1).

The moving of the main pumping station from its location adjacent to the Bradoge River in the centre of town would require a major reconfiguration of the town drainage system and was discounted on environmental and technical grounds. Three alternative sites in the centre of the town adjacent to and including the site of the existing station, were evaluated. The preferred site on technical, environmental and economic grounds was Site B located on the opposite side of the Bradoge River to the existing pumping station (see Fig. 4.2).

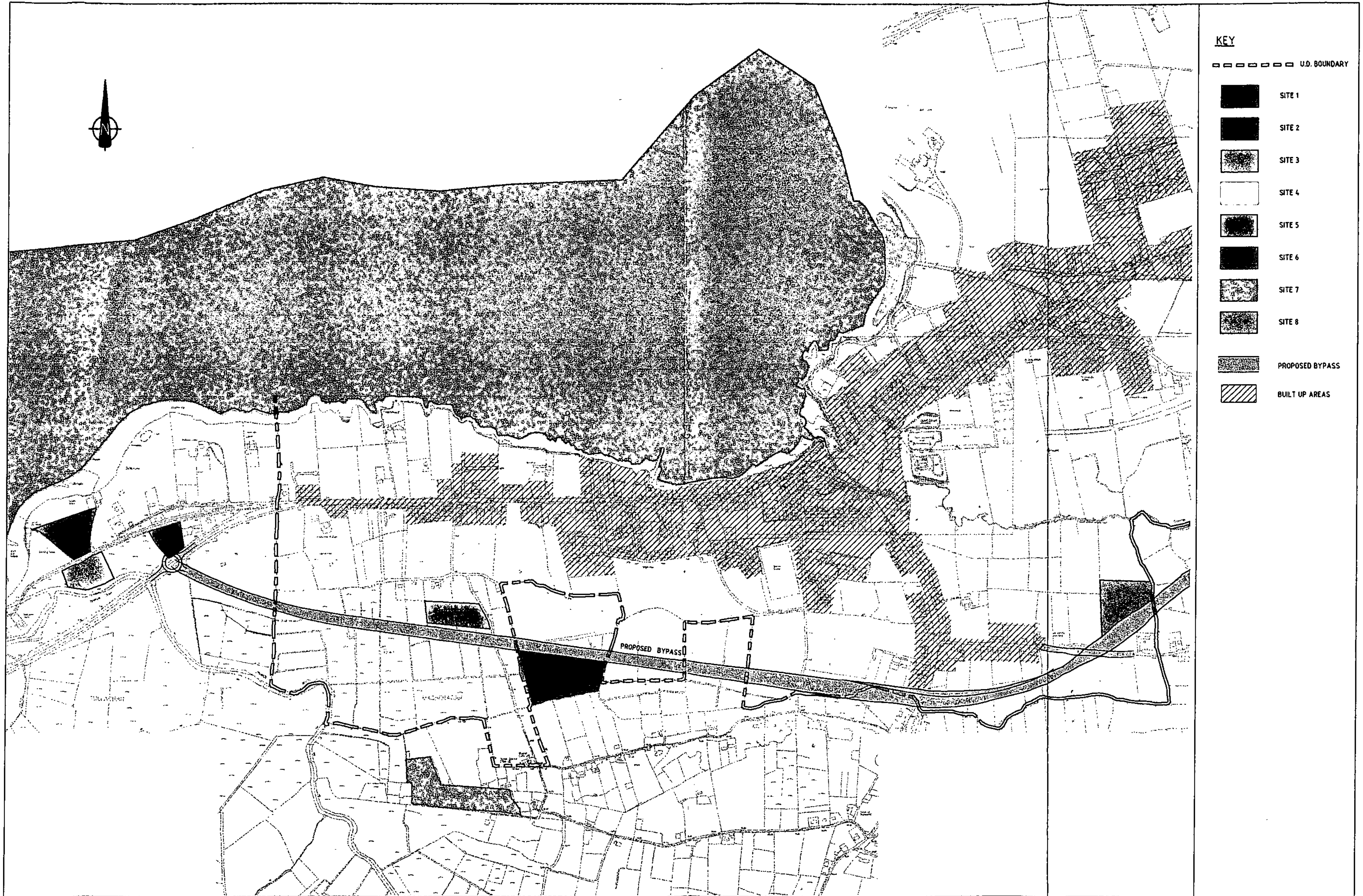
5.0 DIFFICULTIES ENCOUNTERED

No undue difficulties were encountered that significantly affected the production of this EIS.

6.0 WATER QUALITY

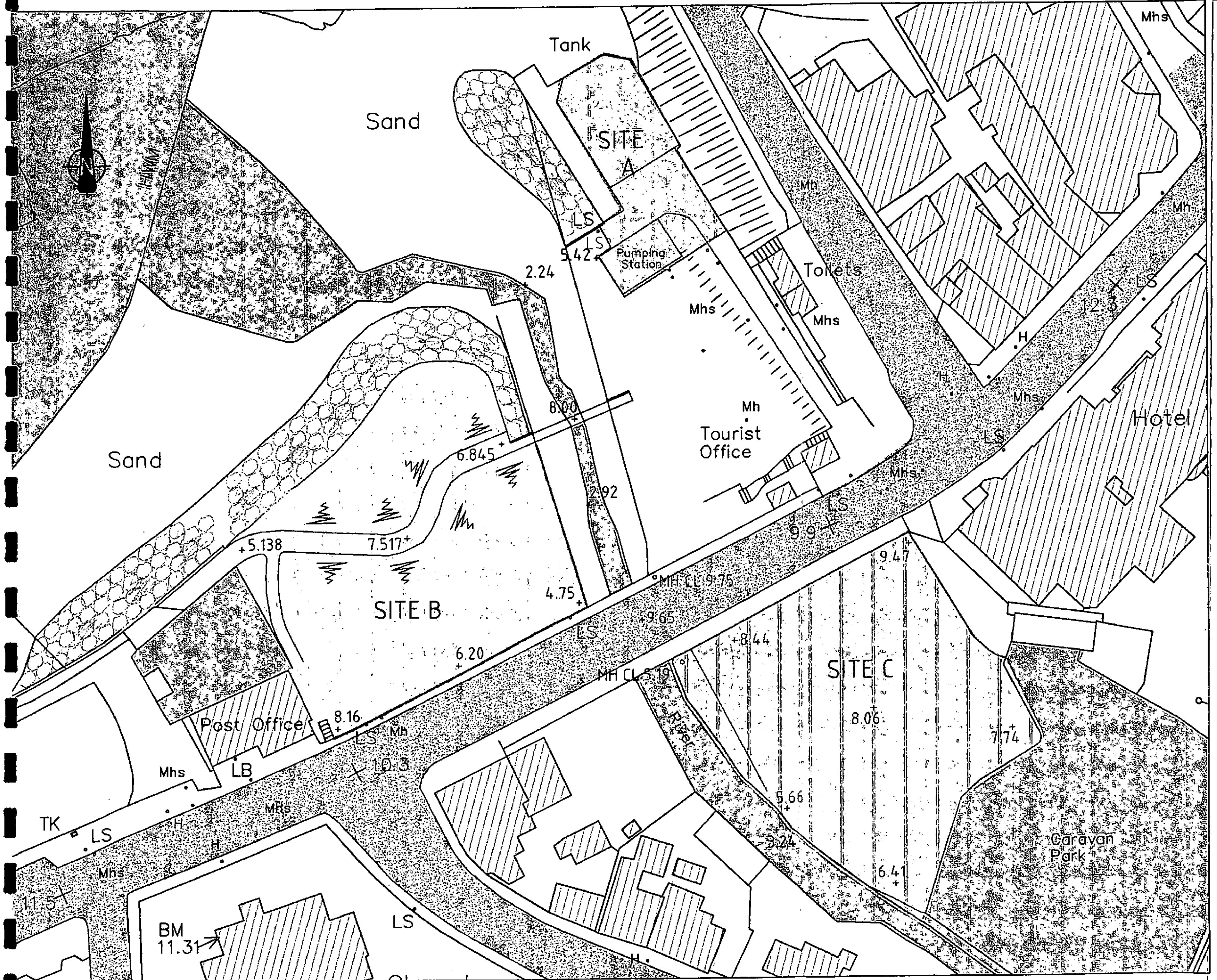
Unscreened and untreated sewage from the Bundoran catchment currently discharges to the sea through an existing outfall at Pollbrean. The outfall is exposed under low tides. The existing pumping station in the centre of the town is not operating efficiently. The pumping/storage regime is inadequate to deal with current flows in the system leading to frequent overflow occasions and surcharging of sewers in the centre of the town.

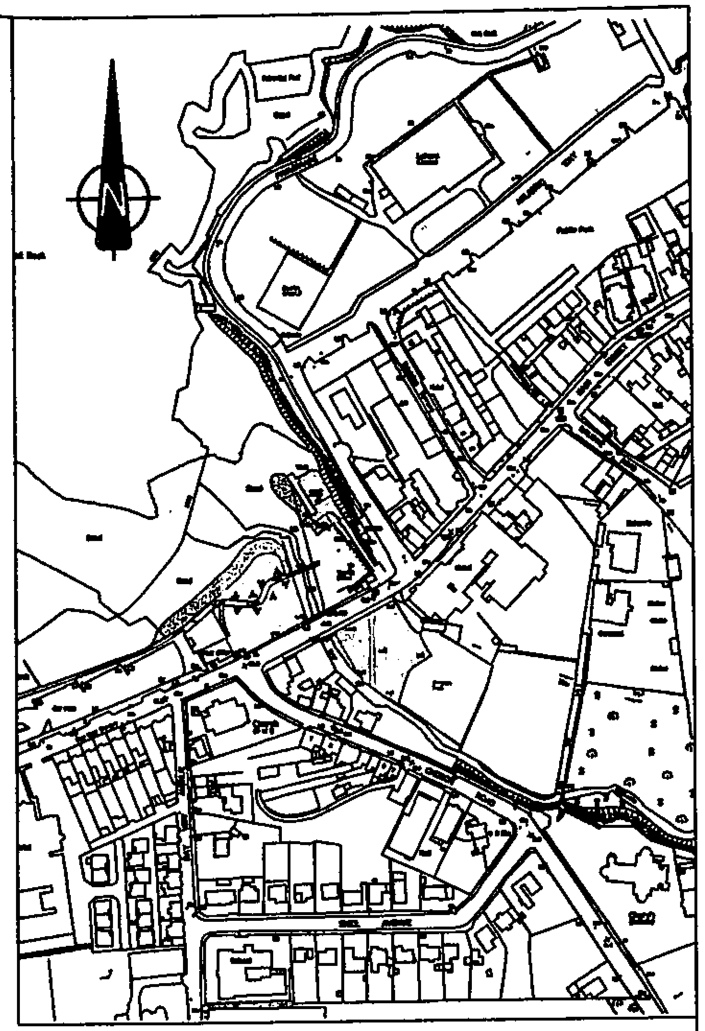
The new treatment works will treat effluent to standards set out in EU and national legislation before it is discharged into Donegal Bay through an upgraded and extended outfall. Water quality modelling undertaken during the EIA has confirmed that water quality in the area will not be compromised and shows that the EC guideline limit for faecal coliforms will be achieved at the beach during the bathing season, thus the receiving



ALTERNATIVE SITES CONSIDERED FOR THE TREATMENT WORKS

FIG. 4.1





ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM

ALTERNATIVE SITES CONSIDERED
FOR THE MAIN PUMPING STATION

FIG. 4.2

water at the Bundoran beach should satisfy the water quality requirements for a Blue Flag Beach.

Tertiary treatment will be provided to reduce ammonia levels in the effluent and prevent the risk of toxicity to fish at the mouth of the Drowes River. The water quality modelling confirms that discharges will not impact negatively on the quality of the water nor will ammonia levels at the mouth of the Drowes River impact on the salmonoid fishery.

Pumping and storage regimes will be upgraded to ensure that the frequency of storm overflows will not exceed those set out in national guidelines. The overflow frequencies adopted have been selected based on the classification of the receiving waters as a Bathing Water.

The development will have a positive impact on water quality in the Bundoran area of Donegal Bay.

7. FLORA AND FAUNA

7.1 Terrestrial Flora and Fauna

The site of the proposed treatment works occupies part of a uniform floodplain-mire habitat. The site has an extensive network of open drains, many of which are choked with vegetation causing impeded drainage. The loss of part of this habitat will cause a slight, adverse impact on flora and fauna.

The proposed pipeline route is also classified as floodplain-mire habitat and has a similar fauna and flora species composition to that at the treatment works.

The proposed pumping station site has vegetation dominated by fescue and sea plantain, development of this site will not cause a significant impact to terrestrial flora and fauna.

7.2 Marine Flora and Fauna

The treated effluent will discharge into Donegal Bay through the existing outfall which is to be extended further out into the Bay. The flora and fauna of the inter-tidal zone are comprised of species typical of exposed sites on a bedrock substrate with full salinity sea water.

The construction of the outfall will result in a temporary localised adverse impact on marine life, however the long-term benefits associated with the discharge of a treated effluent will positively impact on marine flora and fauna.

7.3 Freshwater Flora and Fauna

The Drowes exits Lough Melvin at Lareen Bay, flows in a westerly direction for a distance of approximately 5km and enters Donegal Bay near Bundoran. The Drowes is one of Irelands premier salmon fishing rivers and the future of this fishery is dependent on the maintenance of free access between the freshwater and marine environment and good quality water. There will be no direct discharge from the treatment works into the Drowes. The proposed development to improve the water quality in Donegal Bay will positively impact on the flora and fauna in the Drowes.

8.0 HUMAN BEINGS

8.1 Socio Economic

It is predicted that the winter resident population of Bundoran will rise from a present level of 2000 to 4000 by the year 2030. It is further predicted that the summer population including resident tourists and day trippers will swell to 30,000.

Construction work on the proposed development is estimated to provide 50 man-years of direct and 20 man-years of indirect employment. Once operational it is estimated that three persons will be permanently employed.

Overall the construction programme will bring a moderate benefit to the local economy. On completion the scheme will have a positive impact on the development of the area.

8.2 Public Health

The present method of sewage disposal does not comply with National and EU legislation and if allowed to continue could compromise public health as the town continues to expand. The proposed development will have a positive impact on public health.

8.3 Amenity

The construction stage will have some short term negative impacts in relation to noise, traffic, dust and dirt on the roads. Measures such as traffic control, noise abatement, dust suppression and mechanical road cleaning will mitigate the impact on local amenities.

The operation of the treatment works site is not expected to have a negative impact on amenities in the area. The construction of a new pumping station and the demolition of the existing station with new landscaping will have a positive impact on the amenities in the centre of the town.

The improved water quality in the Bay will enhance the amenity value of the area.

9.0 AIR

9.1 Noise

The proposed treatment works site is in a rural area 0.5km from the N15. Currently there is no intensive noise source in the area of the proposed development. The main noise source comes from traffic on the N15.

The predicted noise levels from the works have been modelled and show that with current noise abatement technology the EPA guideline figure of 45dBA at the site perimeter can be achieved.

The noise levels from the proposed main pumping station have been modelled to show that during operation and with current noise abatement technology the EPA guideline figure of 45dBA can be achieved.

The prescribed mitigation measures will limit noise levels at the boundary of the sites to ensure the impact of the development is minimal.

During construction a short-term adverse noise impact is expected. However, noise and vibration control measures will be observed to reduce the sound levels from the construction site.

9.2 Odour

Odour in the area of the treatment works is currently characteristic of a rural setting with no persistent mal odours. The new pumping station will be adjacent to the existing station which has no odour control.

Neither Ireland nor the EU have produced standards relating to odour from wastewater treatment works. The Netherlands adopt a policy of reducing environmental odour to a level as low as is reasonably achievable. For new wastewater treatment works surrounded by residential areas, ribbon development or other odour-sensitive receptors a level of IOU/m^3 at 98% non exceedence level is adopted. Odours at the perimeter of the site and outside the main pumping station will be limited to this level. Modelling carried out as part of the EIS shows that this level can be achieved using available technologies.

During the construction phase some transient odours may be associated with machinery being used in the sites.

10.0 VISUAL

10.1 Wastewater Treatment Works

The site is located on the southern side of Bundoran town on fields presently set in rough pasture. The nearest dwellings to the north and south are some 155m from the site.

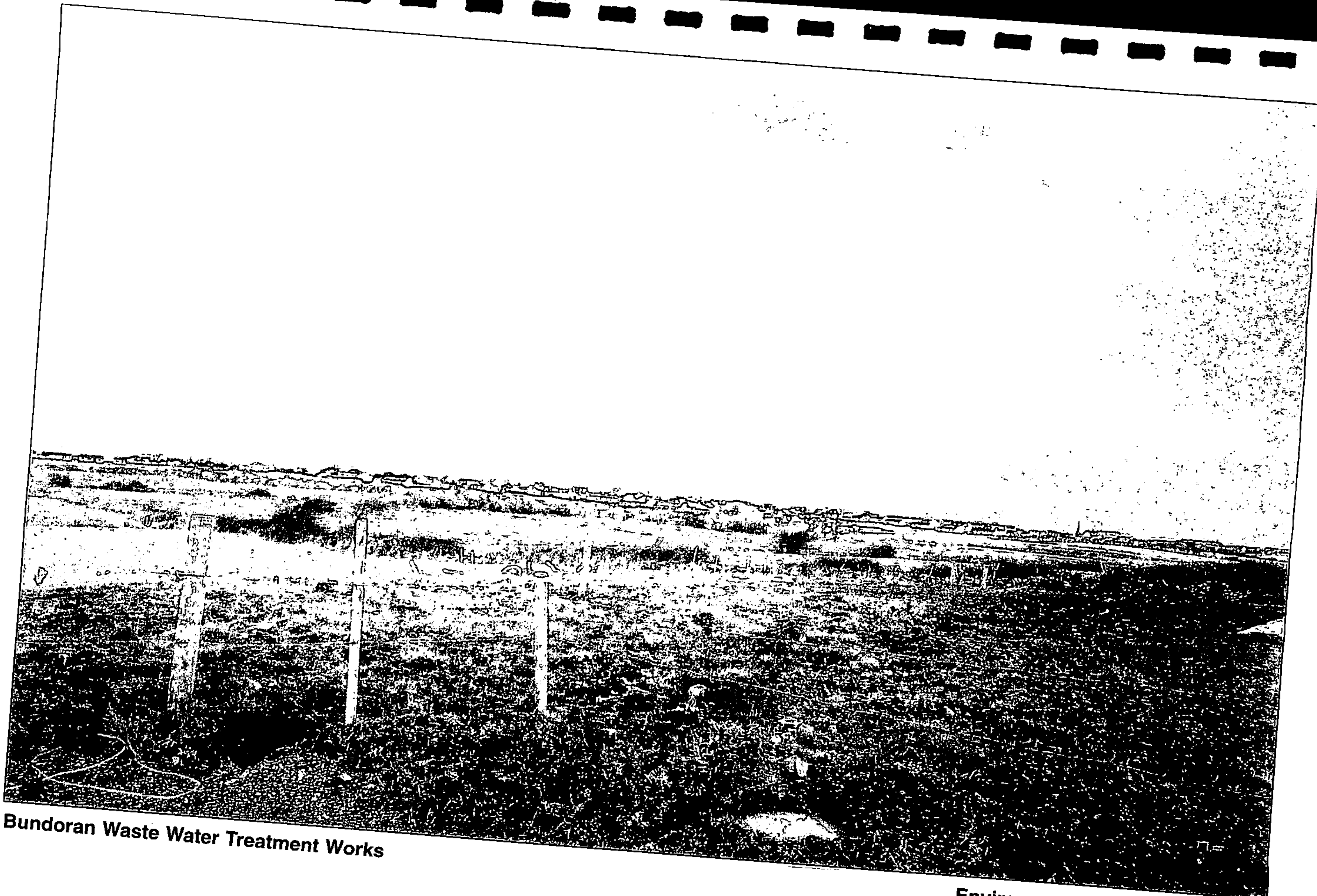
Existing views of the site have been photographed from four view points. A photograph of the site from the closest dwelling to the south of the site is shown on Fig. 10.8.

Based on outline designs of two possible treatment process options, four photomontages of the proposed works have been prepared for each process option. The photomontages of one of the works options viewed from the south of the site is shown on Fig. 10.9. The processes adopted in the EIS and the photomontages prepared represent the outer permissible parameters and general locations of the built elements.

During construction there will be evidence of building activity with cranes, excavators and scaffolding having a short-term negative impact on views from the surrounding areas.

During operation the new works will have a slight adverse impact on the landscape and visual character of the area due to changes to ground levels, buildings, associated access roads, screen planting and site lighting.

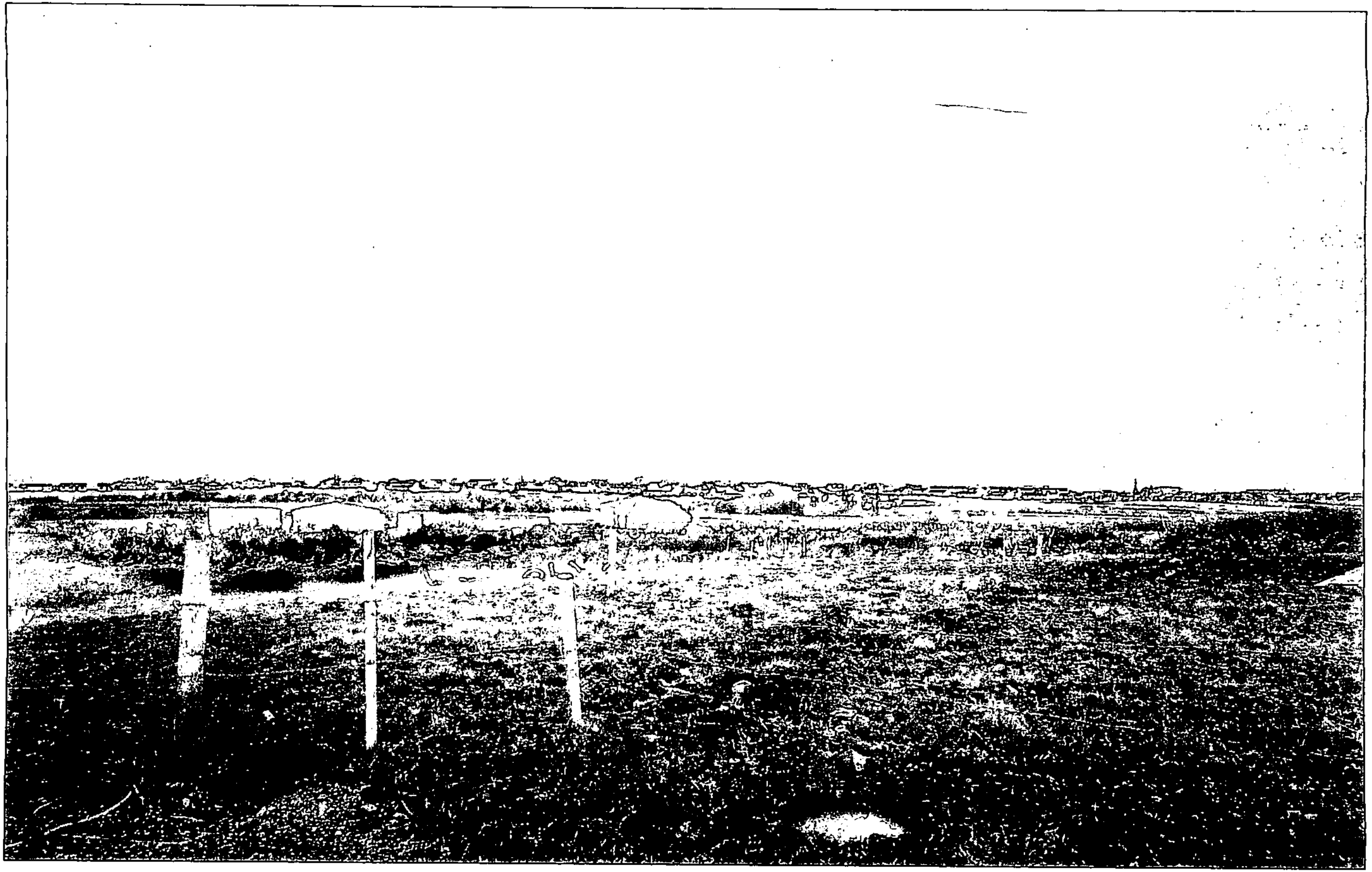
Mitigating measures will include the location of buildings along the lower northern boundary of the site, adoption of building design criteria to avoid radial or random scattered planning, ensure good structural plan shapes, place emphasis on horizontal forms, and reduce building mass. Materials, colours and textures will be selected to ensure longevity and to blend with the environment. Landscaping and planting using integrated hard and soft concepts will compliment the building concept and provide some screening through the planting of a berm on the site boundary.



Bundoran Waste Water Treatment Works

Fig. 10.8

Environmental Impact Statement
View C as existing



Bundoran Waste Water Treatment Works

Environmental Impact Statement

Fig. 10.9

View C, Option 1

10.2 Main Pumping Station

The proposed main pumping station will be located on the sea side of Bundoran Bridge. The site is currently set in rough grass and the UDC have a proposal to create a linear park in the area. From the sea and from the esplanade to the east, the site is dominated by established structures including the Church of Ireland and the Post Office. A photograph of the site from this viewpoint is shown on Fig. 10.20.

The pumping station will act as a viewing platform. Access will be provided to the roof and hard landscaping of the area will be provided at lower level. A perspective view of the station is shown on Fig. 10.19 and a photomontage from the esplanade to the east is shown on Fig. 10.21.

There will be a requirement for a crane and scaffolding on the site during construction which will have some short-term adverse impact.

The most appreciable effect of the development will be the intensification of built forms on the riverside landscape. However, given the urban characteristics of the area this intensification will not have a significant impact on the character of the area.

Mitigating measures include building the structure adjacent to the existing bridge so as not to impose on the existing wall height, the use of stonework on battered and curved wall to reflect designs and materials elsewhere in the location and through the use of hard landscaping and public terracing around the structure.

11.0 CULTURAL HERITAGE

There is no record of archaeological activity on or in the immediate vicinity of the treatment works site or on the pipeline route. There are four archaeological sites a short distance south west of the existing outfall and a small circular earthwork was identified south of the pipeline route.

The possibility exists that damage may occur to known monuments and now buried architectural features or artefacts may be uncovered during construction excavations.

To mitigate the impact on cultural heritage all excavation works will be notified to and carried out under the supervision of Dúchas the Heritage Service or their agents.

The operation of the development will have no impact on the natural heritage.

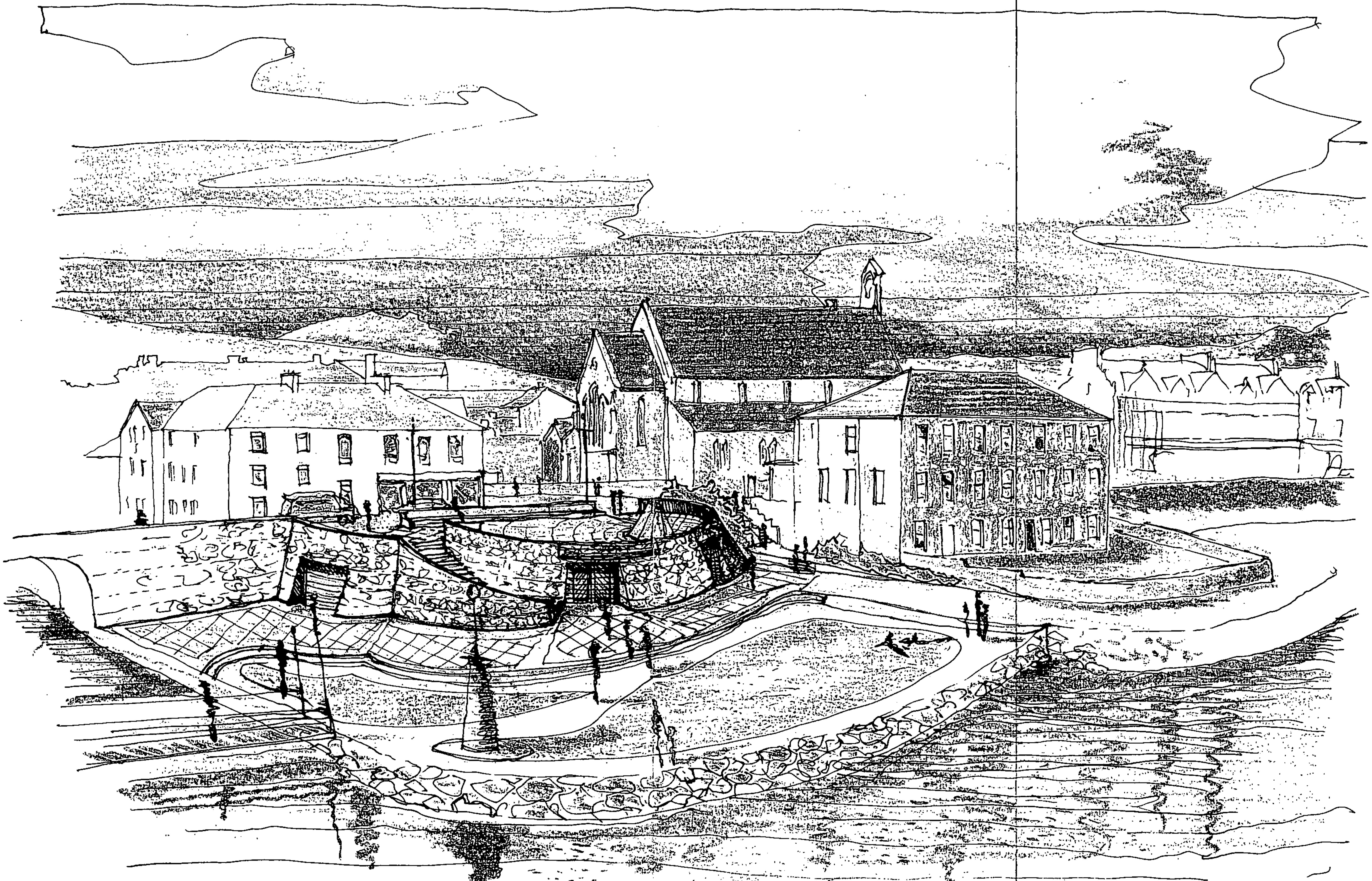
12.0 SOIL

The soils at the treatment works site consist of very soft dark brown/black fibrous peat overlying a soft to firm bluish grey slightly sandy silty clay. These soils will be permanently disturbed either by excavation of compaction depending on the method of construction chosen.

The soils at the pumping station will similarly be disturbed during the construction phase.

The soils on pipeline routes as part of the development will be reinstated.

The operation of the development will have no impact on the soil.



VIEW FROM FORESHORE TO EAST OF SITE

Fig. 10.19

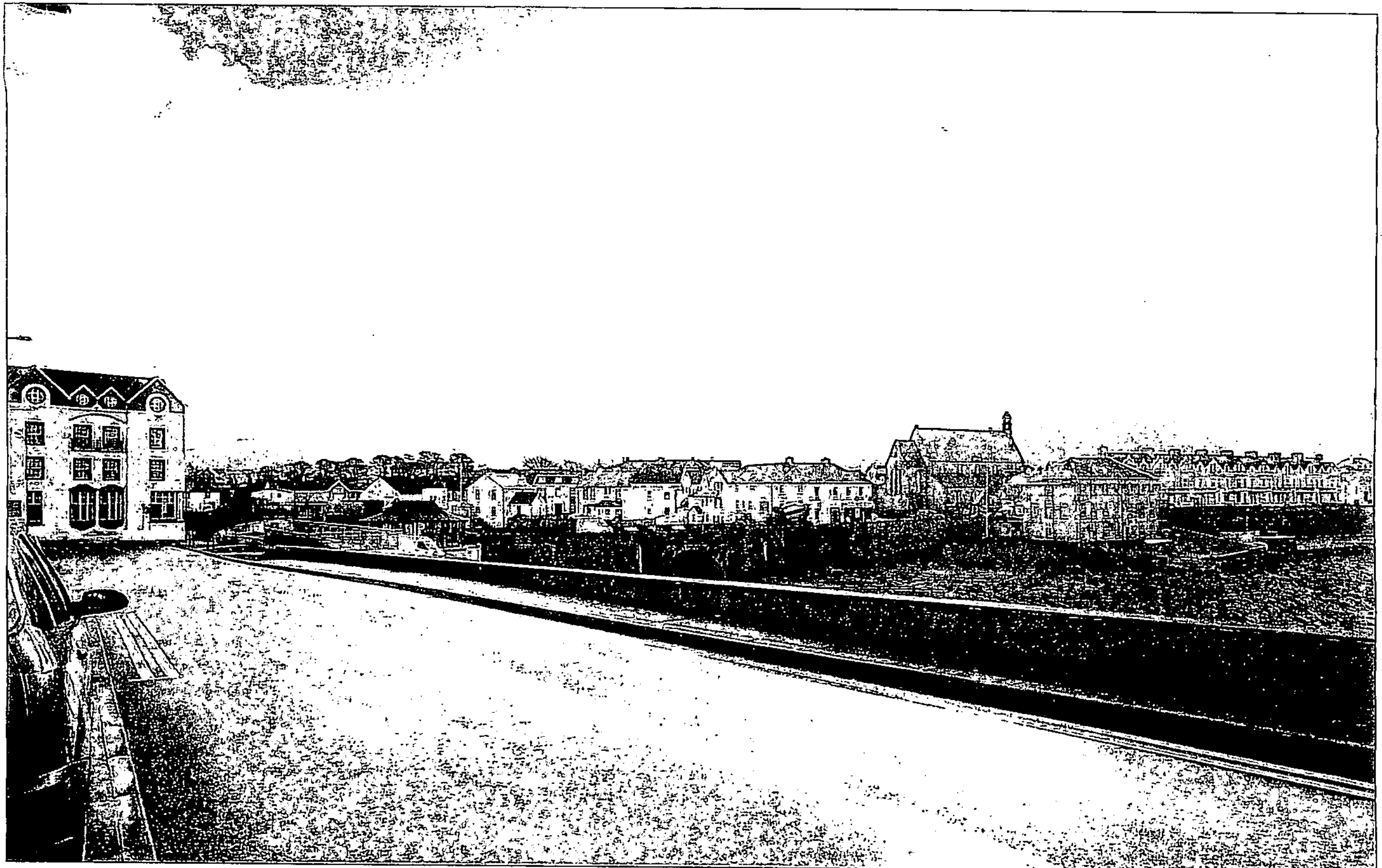


Fig. 10.20
View E as existing

Bundoran Waste Water Treatment Works

Fig. 10.21

Environmental Impact Statement
View E as proposed

13.0 TRAFFIC

Presently the treatment works site can be accessed from either the Bundoran Sligo Road N15 or the Bundoran Kinlough road R280, along a single county road joining the two. On construction of the proposed by-pass the access from the N15 will be severed and the only remaining access route will be via the county road from the R280. The distance of the site from the N15 and R280 is 0.5km and 1.7km respectively.

The greatest impact caused by traffic will be during the construction phase of the development with two way truck and car movements on the routes from the N15 and R280. An increase of 10 vehicles/hour on the preferred access road over current base flow is predicted. On operation of the proposed development this will reduce to 2 vehicles/hour.

The junction of the county road with the R280 will be modified to improve sight line geometry. In order to facilitate vehicles passing on the county road, widening will be undertaken including the construction of overtaking bays at some 100m intervals to allow safe passage of vehicles travelling in opposite directions.

The main pumping station will be accessed via the entrance to the car park in the town centre. Traffic volumes during construction and operation will be low in traffic terms and can easily be assimilated on to the existing road network.

14.0 CLIMATE

The climate of Bundoran is temperate and typical of its position on the north west coast of Ireland. This will not be affected by the proposed development.

15.0 INTERACTION OF ENVIRONMENTAL PARAMETERS

In this section the interaction between all the environmental parameters have been assessed.

Comhairle Chontae Dhún na nGall
Donegal County Council

BUNDORAN
WASTEWATER TREATMENT WORKS

ENVIRONMENTAL IMPACT STATEMENT
Volume 2 of 3

Main Report

PH McCarthy & Partners
CONSULTING ENGINEERS
Civil • Environmental • Structural

February 2001

DONEGAL COUNTY COUNCIL

BUNDORAN WASTEWATER TREATMENT WORKS

ENVIRONMENTAL IMPACT STATEMENT

MAIN REPORT – Volume 2 of 3

Document Title :	Bundoran Wastewater Treatment Works Environmental Impact Statement **Main Report - Volume 2 of 3**
Document Ref(s). :	**6690010/EIS/17d**

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09/10/2000	First	Draft	L. Dwyer	S. Ó Ruairc	M.J. Edger
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1.0 FOREWORD

1.1 Procedural Context

It is proposed to construct a wastewater treatment plant in Bundoran of sufficient capacity to cater for an equivalent design population of 30,000. Such a project is required to undergo an Environmental Impact Assessment (EIA) under the provisions of Council Directive 85/337/EEC and the European Communities (Environmental Impact Assessment) Regulations, 1989 to 2000. The directive requires an EIA for wastewater treatment plants and the regulations, through which the directive is implemented in Ireland, refine this to "Waste water treatment plants with a capacity greater than 10,000 population equivalent".

The development will include the construction of a new pumping station in the centre of the town, an extension to the existing outfall at Pollbrean and the rehabilitation and upgrading of the existing sewerage system. While these activities do not individually require an EIS, the second schedule of the European Communities (Environmental Impact Assessment) (Amendment) Regulations 1999 (SI 93 of 1999) calls for "a description of the physical characteristics of the whole proposed development and the land-use requirements during the construction and operational phases." The EIS, therefore, will include descriptions of the pumping station, outfall extension and upgrading of the sewer system.

According to the European Communities (Environmental Impact Assessment) Regulations, SI No. 349 of 1989, an Environmental Impact Statement (EIS) is "a statement of the effects, if any, which the proposed development, if carried out, would have on the environment".

In addition to works within Donegal County Councils functional area the proposed development includes works within the Bundoran Urban District Council's functional area, and works on the foreshore at Pollbrean.

Accordingly for these elements of the development Donegal County Council is making the following submissions:

- Planning Application to Bundoran UDC under Part IX of the Local Government (Planning and Development) Regulations, 1994. SI No. 86 of 1994.

- Application for a Foreshore Licence in accordance with the Foreshore Acts 1933 to 1998.

1.2 Terms of Reference

In September 1999, P.H. McCarthy & Partners were appointed by Donegal County Council to prepare the Preliminary Report and the Environmental Impact Assessment for Bundoran Wastewater Treatment Works. The consultants were advised to review the applicability of Design Build/Design Build Operate Contracts for the proposed project. This is discussed in detail in Section 2.6.

1.3 Purpose and Scope of the Environmental Impact Statement

Environmental Impact Assessment (EIA) is a systematic integrated evaluation of the positive and negative impacts of a project on the natural environment; on beneficial uses of the environment, including man-made structures, amenities and facilities; and on the socio-cultural environment.

The aim of the approach is to identify and predict any impacts of consequence; to describe the means and extent by which they can be reduced or ameliorated; to interpret and communicate information about the impacts; and to provide an input into the decision making and planning process. It is the intention of P.H. McCarthy & Partners, Consulting Engineers, to ascertain the potential impact that this proposal will inflict upon the study area, and to explore mitigating circumstances, so as to protect and enhance the environment to its fullest potential.

The Environmental Impact Statement is an essential element of the EIA process required under the provisions of Council Directive 85/337/EEC and the European Communities (Environmental Impact Assessment) Regulations, SI No 349 of 198, SI no. 93 of 1999 and SI No. 450 of 2000. It should be noted that it is just one of three constituent parts of the process, the three being as follows:

- The Environmental Impact Statement.
- The Comments of the Public, Local or State Authorities or EC Member States.
- The Assessment by the Competent Authority.

Under the European Communities (Environmental Impact Assessment) (Amendment) Regulations, 2000 SI No. 450 of 2000 and Local Government (Planning and Development) (No. 2) Regulations, 2000, SI No. 458 of 2000 provision is made to transfer to An Bord Pleanála the functions currently performed by the Minister for the Environment and Local Government in relation to the certification of local authority developments requiring Environmental Impact Assessment.

The European Communities (Environmental Impact Assessment) (Amendment) Regulations, S.I. No. 93, 1999 has laid down a standard list of areas of the environment, which must be addressed in any EIS. These areas comprise:

- Human Beings; Flora; Fauna;
- Soil; Water; Air; Climate; Landscape;
- Material Assets, including the Architectural and Archaeological Heritage, and the Cultural Heritage
- Archaeological Heritage;
- The inter-relationship between the above factors.

It is necessary to scope each of these areas of the environment with respect to the impacts that the proposed development will have on these areas. The purpose of this exercise is to shape the EIS so as not to dismiss any impacts, which may in fact be significant, and to focus on issues that need to be resolved.

With respect to the headings described in paragraph 2(b) of the Second Schedule of the European Communities (Environmental Impact Assessment) Regulations, 1999, the likely and significant impacts of the project on each are described in the following sections.

HEADINGS IN S.I. 93 OF 1999	RELEVANT SECTIONS IN EIS
Human Beings	4.0, 6.0, 8.0, 9.0, 10.0, 11.0, 13.0
Flora	7.0
Fauna	7.0
Soil	13.0
Water	6.0
Air	9.0
Climate	14.0
The Landscape	10.0
Material Assets	8.0
The Cultural Heritage	11.0
The Interaction between the Foregoing	15.0

1.4 Format of the Environmental Impact Statement

Environmental Impact Statements require the assimilation, co-ordination and presentation of a wide range of relevant information in order to allow for the overall assessment of a proposed development. The document is presented in a 'Grouped Format' structure, as recommended in the draft guidelines produced by the Environmental Protection Agency, to provide a consistent and coherent discussion of the various elements.

1.4.1 Receiving Environment

In describing the receiving environment, an assessment is made of the context into which the proposed development will fit.

1.4.2 Characteristics of the Proposal

Consideration of the "Characteristics of the Proposal" allows for a projection of the 'Level of Impact' on any particular aspect of the environment which could arise.

1.4.3 Potential Impact of the Proposed Development

This section allows for a description of the specific, direct and indirect, impacts which the proposed development may have. This is done with reference to the receiving environment, while also referring to the magnitude, duration, consequences and significance of the impacts.

1.4.4 Mitigation Measures

This includes a description of any remedial or mitigation measures that are considered necessary and practicable or reasonable having regard to the potential impacts.

1.4.5 Predicted Impact of the Proposal

This section allows for a description of the specific, direct and indirect, impacts which the proposed development may have, if all mitigation measures are applied. This is done with reference to both Section 1.4.3 Potential Impact of the Proposal and Section 1.4.4 Mitigation Measures, producing a definitive and concise statement of impact for the development based on the nature and significance of the predicted impacts.

1.4.6 Monitoring

This involves an explanation of the monitoring of any effects on the environment that may be required in the development and post development phase. This section addresses the effects which require monitoring, along with the methods and the agencies who are responsible for such implementation.

1.4.7 Reinstatement

In the event of the proposal being discontinued, certain measures will be required to ensure a negligible effect on the environment. A description of the reinstatement method proposed and the agencies responsible for its' implementation has been included where necessary.

1.5 EIS Team

This EIS has been prepared for Donegal County Council by P.H. McCarthy and Partners with contributions from the following specialist sub-consultants:

Patrick O' Donovan, Archaeologist	Cultural Heritage
Natural Environment Consultants Ltd.	Flora and Fauna
Aquens	Limnology
Aquavarra Research Ltd.	Odour
Biospheric Engineering Ltd.	Noise
Paul O' Toole Architects	Visual
Arc Photographic Ltd.	Visual
Kirk McClure Morton	Water Quality
Aquafact	Water Quality

2.0 INTRODUCTION

2.1 Description of Town

Bundoran is a coastal town in South County Donegal with a high reliance on tourism. The town has grown substantially in recent years. The current resident population is estimated at 2,000. This swells to some 15,000 during peak holiday periods due to the influx of resident tourists and day trippers. To provide for its future development a wastewater treatment works is required in order to comply with the Environmental Protection Agency Act 1992 (Urban Waste Water Treatment) Regulations 1994 (SI 419 of 1994). These regulations state that towns with a population equivalent over 10,000 discharging to coastal waters must put in place secondary treatment facilities by 31st December 2005.

2.2 Existing Sewerage System

The existing sewerage system is predominantly combined, with both foul and surface water carried in the same system. The system may be divided into three main catchments, east, west and middle Bundoran as is illustrated in Fig 2.1. East and middle Bundoran drain to the main pumping station in the centre of the town. This pumps the collected flows to a point where it joins with the west Bundoran catchment. Overall the three catchments discharge to a sea outfall at Pollbrean.

2.3 Relevant Legislation and Policy

Both European and National legislation concerning the control of pollutants and the quality of the aquatic environment contain requirements which have implications for the development of a wastewater treatment works in Bundoran.

The relevant EU Directives and National regulations pertain to:

- Treatment Standards
- Bathing Water Quality
- Waste Management

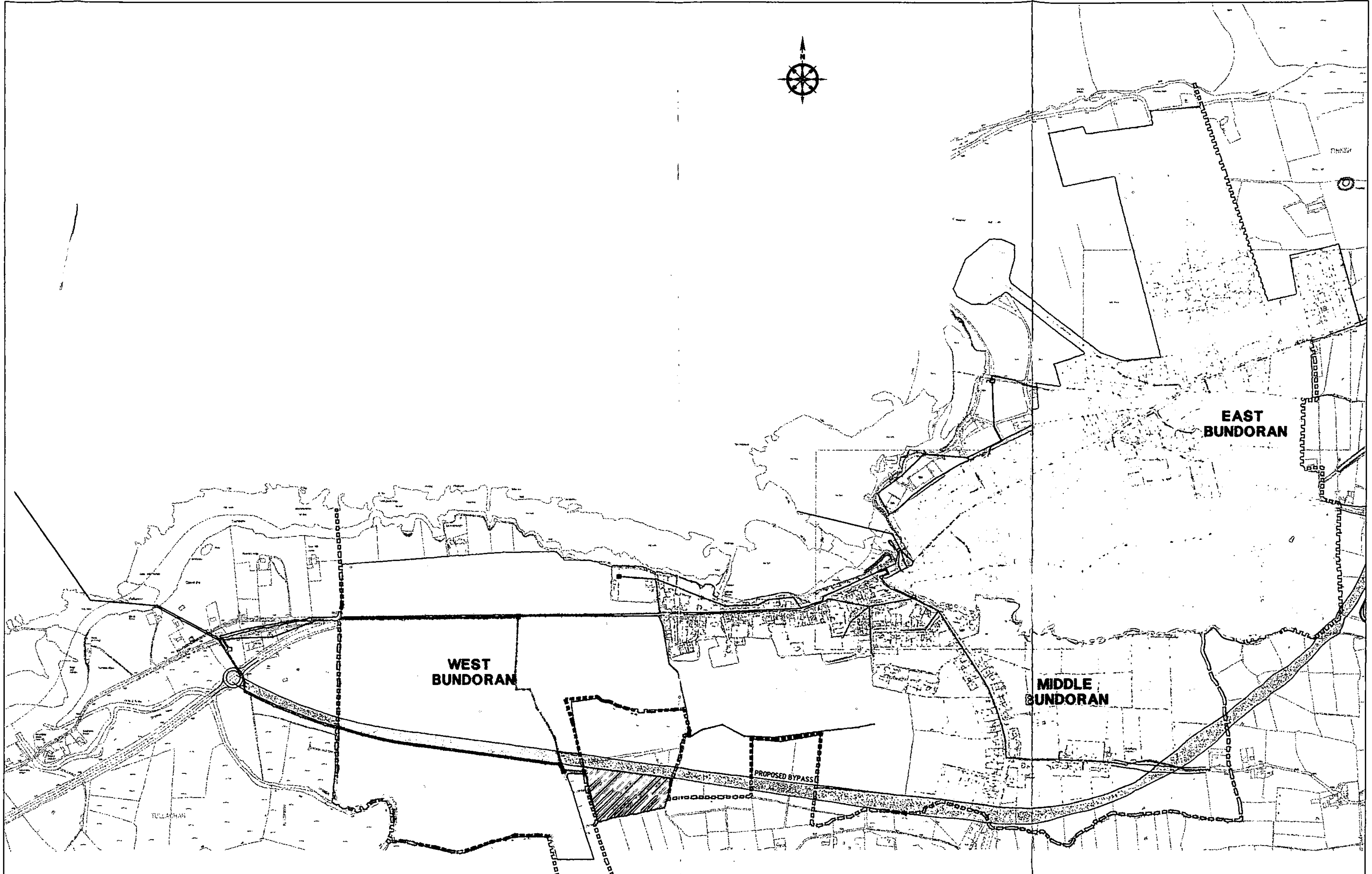
2.3.1 Treatment Standards

These are controlled by the Urban Waste Water Treatment (UWWT) Directive 91/271/EEC, which is concerned with the collection, treatment and disposal of urban waste waters and the treatment and discharge of industrial waste waters. The UWWT Directive was transposed into Irish Law by the Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations 1994 (SI 419 of 1994).

According to Annex I of the UWWT Directive and to relevant Irish legislation, a plant shall be capable of producing an effluent with a BOD not exceeding 25mg/L, suspended solids not exceeding 35mg/L and COD not exceeding 125mg/L (Table 1 – 91/271/EEC).

2.3.2 Bathing Water Quality

This is regulated under Council Directive 76/160/EEC concerning the Quality of Bathing Waters and by the European Communities Regulations entitled Quality of Bathing Water Regulations, 1992 (SI No. 155 of 1992) and Quality of Bathing Waters (Amendment) Regulations, 1994 and 1996 (SI No. 145 of 1994 and SI No. 203 of 1996).



CATCHMENT AREAS EAST, MIDDLE & WEST BUNDORAN

FIG. 2.1

The Bathing Water Directive (76/160/EEC) outlines chemical, physical and microbiological parameters for the quality of bathing waters and establishes a system for the monitoring of bathing water quality by member states. The Directive requires that faecal coliform counts must be within 2000/100ml for 95% of samples at bathing beaches while the Bathing Water Regulations (SI No. 155 of 1992) require, in addition, that 80% of samples shall be within the Irish National Limit value of 1000/100ml for faecal coliforms.

2.3.3 Waste Management Plan

Under Section 22 of the Waste Management Act 1996, local authorities are required to prepare Waste Management Plans for their functional areas. Non-hazardous sludges including sludge arising from the treatment of wastewater form part of the waste stream to be managed. This waste stream is considered in Sludge Management Plans prepared for the functional area of each local authority.

Future management strategies for wastewater sludge arising in Bundoran must adhere to the County Donegal Sludge Management Plan.

2.4 Bundoran Town Development Plan

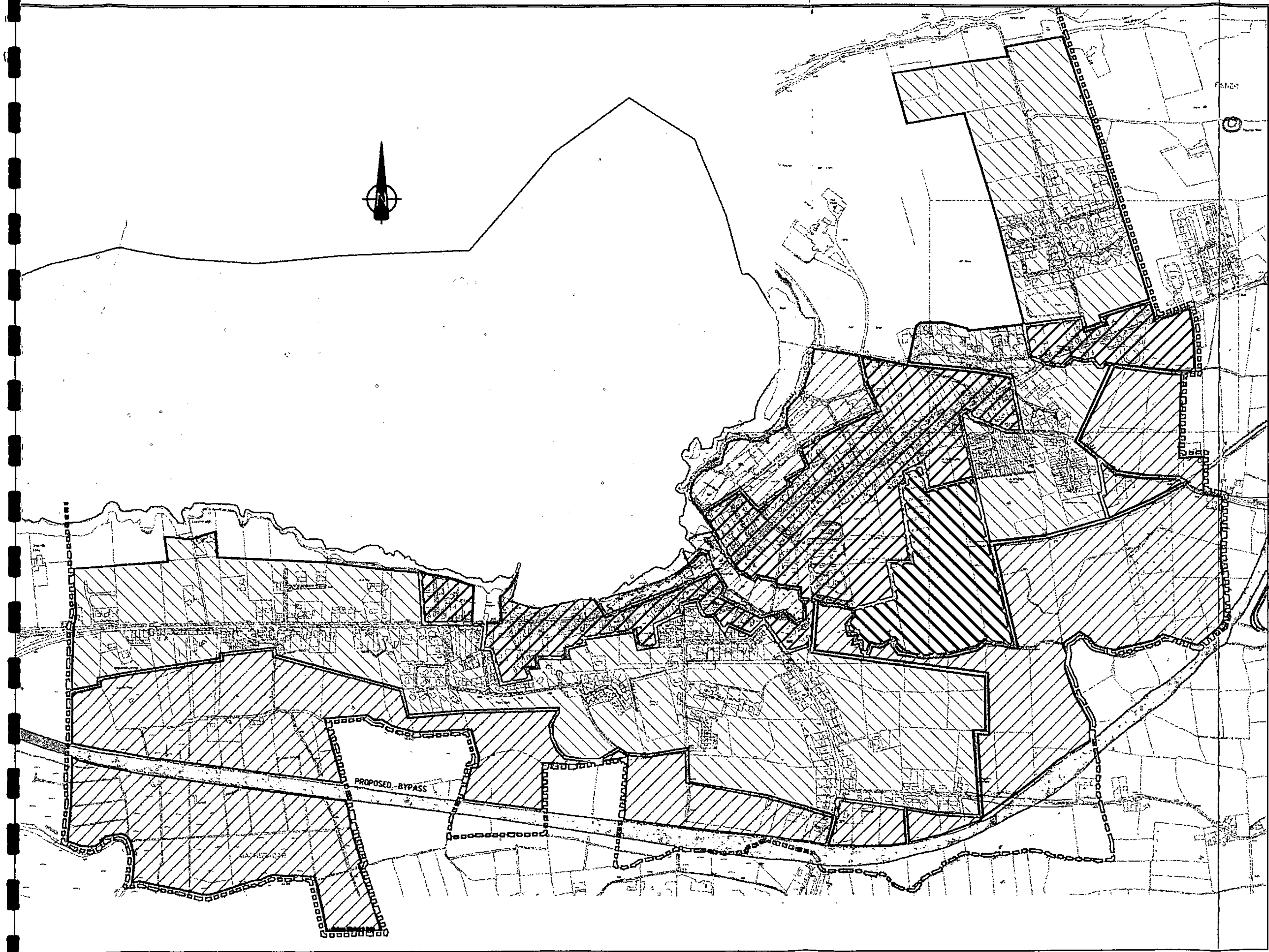
The 1998 Bundoran Town Development Plan has a number of broad Planning Policy aims, which are outlined below, and illustrated in Fig. 2.2.

- To identify the use solely or primarily of areas for particular purposes whether residential, commercial, industrial, agricultural or otherwise.
- To encourage the development and diversification of the local economy to provide additional income and employment opportunities.
- To protect and enhance the built and natural environment.
- To ensure the continued development of Bundoran as a leading year round tourist destination.
- To secure the greater convenience and safety of road users and pedestrians.
- To define the urban area and so reduce the potential for ribbon development and urban sprawl.
- To improve the quality of life in Bundoran as a place to live, work, shop and visit.

2.5 Public Consultation.

In the spring of 2000 P. H. McCarthy & Partners undertook an extensive Public Consultation and Information process on behalf of Donegal County Council with a view to informing the public of their intention to construct a wastewater treatment works, upgrade the existing sewer network and construct a new main pumping station in Bundoran. The principal elements of the process were:

- A presentation to elected representatives of Bundoran UDC.
- The preparation of a consultation document which was forwarded to all elected representatives of Bundoran UDC and Donegal County Council and to 48 No.



KEY

PURPOSE OF ZONE

- R1 — TO PROVIDE FOR RESIDENTIAL DEVELOPMENT TO PRESERVE, PROTECT & IMPROVE RESIDENTIAL AMENITY.
- R2 — TO PROVIDE FOR DEVELOPMENT OF A RESIDENTIAL COMMUNITY ON LAND OUTSIDE THE SEWER CATCHMENT AREA
- G — TO PROVIDE FOR GENERAL BUSINESS INCLUDING SHOPPING, OFFICE & COMMERCIAL DEVELOPMENT & TO PROVIDE COMMUNITY FACILITIES
- C — TO PROVIDE FOR DEVELOPMENT OF CARAVAN PARKS
- S1 — TO PROVIDE FOR DEVELOPMENT OF OUTDOOR TOURIST RECREATIONAL FACILITIES. CLUSTERS OF PUBLIC CAR PARKS ASSOCIATED WITH USE OF LANDS WITHIN THIS S1 ZONE TO BE PERMITTED IN ADDITION TO THE USES WHICH ARE ALREADY PERMITTED WITHIN THIS ZONE.
- I — TO PROVIDE FOR INDUSTRIAL DEVELOPMENT
- URBAN DISTRICT BOUNDARY
- PROPOSED BYPASS

BUNDORAN URBAN DISTRICT
DEVELOPMENT PLAN 1998

FIG. 2.2

regional, national and state bodies including those bodies stipulated in the Local Government (Planning & Development) Regulations SI 86 of 1994.

- To ensure the widest distribution of information on the scheme a public notice was placed in the local newspaper.

- A letter detailing elements of the proposed scheme was distributed to residents in the location of the proposed Wastewater Treatment Works Site.

All parties were encouraged to make written submissions and to attend meetings with representatives of the Council and the Consultants to discuss the proposal.

From this consultation the issues raised included water quality, visual impact, odour, noise, ecology and traffic pertaining to the wastewater treatment works, the pumping station and the outfall extension. These issues are addressed in the respective sections of this EIS.

2.6 Procurement

The Department of the Environment and Local Government Circular Letter L3/99 "Procurement through the Use of Design/Build (DB) and Design/Build/Operate (DBO) Contracts Interim Arrangements" dated 26th January 1999 sets out revised procedures for the carrying out of certain elements of water services capital projects by means of Design/Build and Design/Build/Operate (DBO) contracts.

Donegal County Council intend to proceed with procurement of the project using the Design/Build/Operate approach. As this method of procurement encourages alternative design options in accordance with *Best Available Technology Not Entailing Excessive Cost* **(BATNEEC)** this Environmental Impact Statement has been prepared to reflect performance values rather than detailed design.

3.0 PROJECT DESCRIPTION

3.1 Objectives

The objective of the development is to provide a level of treatment to waste waters collected at the treatment works consistent with the requirements of:

* The Environmental Protection Agency Act, 1992 (Urban Waste Water Treatment) Regulations, 1994 (SI 419 of 1994) giving effect to Council Directive concerning Urban Waste Water Treatment (UWWT) 91/271/EEC.

* Quality of Bathing Waters Regulations 1992 (SI 155 of 1992) giving effect to Council Directive concerning the quality of bathing waters 76/160/EEC.

Consistent with these objectives is the adoption of the principles of BATNEEC (Best Available Technology Not Entailing Excessive Cost) with a view to providing Donegal County Council with the Best Practicable Environmental Option.

3.2 Overview

The principal elements of the development will consist of:

- Upgrading/rehabilitation of the existing collection system where required.
- Construction of a new main pumping station.
- Construction of a wastewater treatment works.
- Extension of the existing outfall

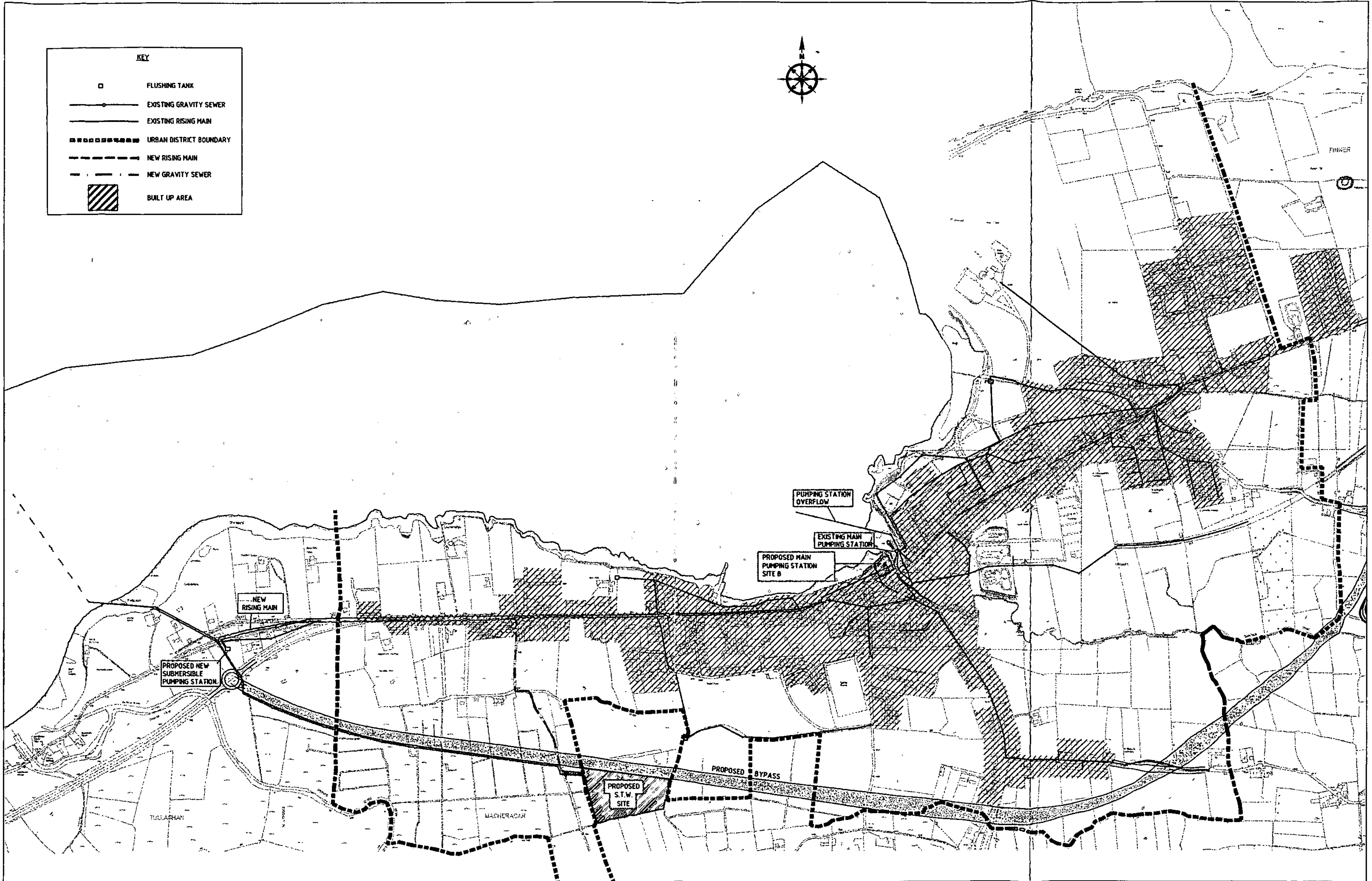
These elements are described in outline below and in detail in Sections 3.5 – 3.11

3.2.1 Collection System

The existing sewer system in Bundoran will be upgraded to facilitate the collection and treatment of all wastewater in the town. It will include new sewers in the centre of the town to prevent existing surcharging, new pumping mains and gravity main to transfer flows to the proposed treatment works site and new sewers to transfer treated effluent to the new outfall at Pollbrean. Manholes to provide safe access for maintenance will be constructed on all new sewer lines and a submersible (below ground) pumping station will be constructed to transfer flows for the west end catchment to the new treatment works. The extent of these new sewers are shown in Fig. 3.1.

3.2.2 The New Main Pumping Station

The existing drainage system terminates at a main pumping station in the centre of the town adjacent to Bundoran Bridge. This pumping station and its associated storage tank are not operating satisfactorily which results in frequent overflow occasions and surcharging of sewers in the town centre. It is proposed to construct a new main pumping station and storage tank on the opposite side of the Bradoge River adjacent to the existing pumping station and to decommission and demolish the existing pumping station on completion of the new scheme. The site of the demolished pumping station will be reinstated in a manner consistent with the environmental improvement works recently completed by Bundoran UDC in this area. The location of the existing and proposed main pumping station is shown in Fig. 3.1.



PROPOSED W.W.T.W., MAIN PUMPING STATION & UPGRADED SEWER NETWORK

FIG. 3.1

3.2.3 Treatment Works Site

The proposed site consists of 2.8ha of land in the townland of Magheracar townland south of the N15 and proposed Bundoran to Ballyshannon by-pass. The nearest residence is approximately 155m on the southern side of the site. Bundoran town lies to the north and to the west, the land is currently set in pasture lying fallow. The site location is shown in Fig. 3.1.

3.2.4 Stages of Treatment at the Treatment Works

The treatment of wastewater will include preliminary, primary, secondary and tertiary treatment.

Preliminary treatment will be provided by mechanical and settlement processes to remove screenings, such as rags and plastics, and grit from effluent.

Primary settlement will allow for the settlement of suspended solids from the raw sewage and provide for its removal as sludge.

Secondary treatment will consist of a biological process which will cause organic matter to be broken down and/or be incorporated into biological cells and then removed as sludge.

Tertiary treatment will be provided to reduce ammonia levels in the final effluent to levels that based on results of water quality modelling will not prove toxic to fish.

3.2.5 Sludge Treatment

Sludge is to be conditioned. The sludge will be thickened and dewatered and transported off site for treatment as is outlined in the County Donegal Sludge Management Plan.

3.2.6 Storm Water

Flows up to 6DWF will be forwarded to the treatment works and will receive preliminary treatment. 3DWF will be transferred for further treatment and flows in excess of 3 DWF will be retained in storm tanks at the works. The tanks will have a two hour retention. Screened and settled flows greater than this volume will be discharged to the outfall. Effluent remaining in the storm tanks on abatement of the storm event will be forwarded for full treatment.

Storage will be provided at the pumping stations in the centre of the town and west end to control spills to the Bay to levels that are known not to impact on water quality in the area. All flows will be screened prior to discharge to the receiving water.

3.2.7 Development Works

Development works will include:

- Temporary construction structures such as offices, stores, cranes, scaffolding and other supports.
- Tanks and buildings associated with treatment processes and pumping facilities.
- Roads and paving works.
- Landscaping works.

3.2.8 Outfall

The existing outfall discharges raw sewage into Donegal Bay at Pollbrean. Following the analysis of water quality modelling carried out in this area it is proposed to extend the existing outfall a further 400 metres into the sea. The location of the new outfall is shown in Fig. 3.2.

3.3 Design Population

3.3.1 Introduction

In order to determine the population contributing to the proposed wastewater treatment works and plan for its phased development, the future population figures for Bundoran have been estimated for the period 2000 to 2030.

In making the population projections reference has been made to:

- Preliminary Report on the 1996 Census (Central Statistics Office).
- Review of Population and Labour Force Projections 1996 – 2026 (Central Statistics Office).
- Bundoran Tourism Development Action Plan – July 1996.
- Bundoran Urban District Council's Water Records
- Flow and Load Surveys on the Existing Sewerage System

Bundoran's location on the south-west coast of Donegal has made it a popular holiday resort. In 1996 the registered and unregistered tourist accommodation in the town was estimated at 12,292 beds.

Since 1996 there has been major construction activity in the town as reflected by the number of new planning applications to Bundoran UDC. Most of this development has been driven by the Government's Section 48 Incentive Scheme for seaside resorts.

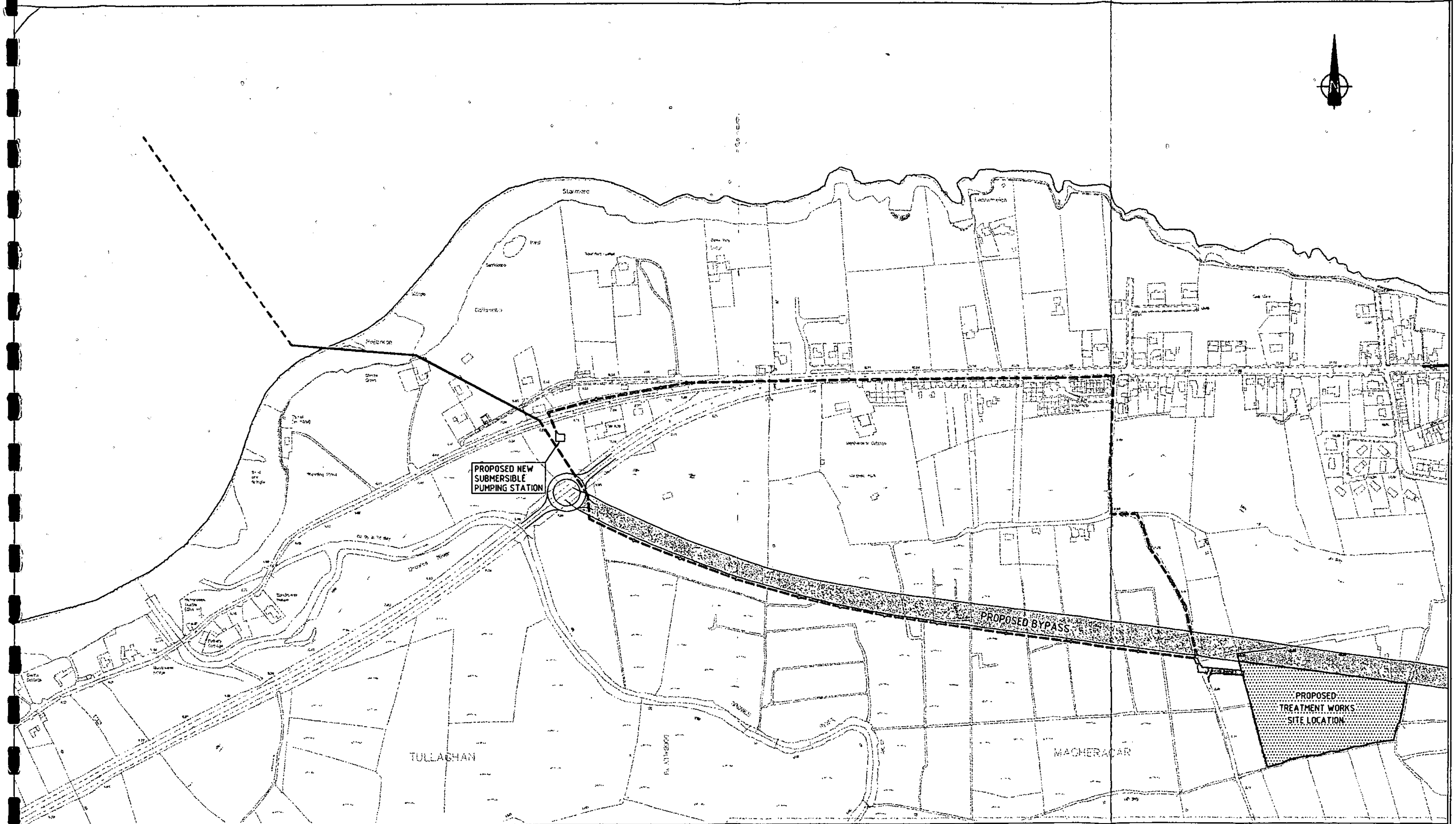
An analysis of planning permissions 1996 to 1999, from the records of UDC statistics, indicates that an additional 4,137 beds are available in Bundoran mainly for tourism accommodation. This assessment excludes planning permissions granted but not built and outline planning permissions.

It is estimated that the total beds available in Bundoran for tourist accommodation was circa 16,429 at the end of 1999.

3.3.2 Existing Resident Population

The population within the UDC boundary increased from 1,463 in 1991 to 1,704 in 1996 (source CSO). This indicates a net growth of 16.5% over the five year period or an annual growth of 3.1% per annum.

Since 1996 there has been unprecedented growth in the Irish economy. Emigration has declined and immigration increased to an extent that there is currently net immigration into the country. The effect of the peace initiatives in Northern Ireland has had a noticeable effect in stabilising the political situation and stimulating growth in the border areas. With this background it is considered that the current annual growth rate in Bundoran exceeds the historical growth rates between 1991 – 1996.



KEY
- NEW GRAVITY SEWER
- NEW RISING MAIN
- EXISTING SEWER

PROPOSED ROUTE FROM
W.W.T.W. SITE TO OUTFALL

FIG. 3.2

In order to estimate the current 1999 resident population recourse was made to the UDC water records. Average winter daily demands were calculated from the records. A survey of night flows was carried out on 4th November 1999 to establish unaccounted for water (UFW). An assessment of the current resident population was made by dividing the daily water consumption by a typical per capita consumption figure. The result of this analysis indicates a year 1999 resident population of 1918 persons. This equates to a 12.6% increase over three years or 4% per annum.

Given the factors contributing to enhanced growth in the area since the 1996 census, a estimated year 2000 base population of 2000 persons is considered to be to well founded.

3.3.3 Existing Peak Summer Population

The population in Bundoran during the summer months is made up of four distinct groups as follows:

- Local Residents;
- Tourist Residents;
- Seasonal Temporary Staff;
- Seasonal Day Trippers.

The population of these groups is discussed in the following sub-paragraphs.

Local Residents

It is assumed that the local resident population in Bundoran will be the same as the winter months.

Tourist Residents

The number of tourists resident in Bundoran varies throughout the year. The Bundoran Tourism Development Action Plan indicates that 22% of annual visitors time their arrival in July and 20% in August. The average length of stay is roughly 5 nights and 45% of total visitors are resident and 55% day trippers. The peak periods for visitors occur on five weekends throughout the year, including the July 12th and August Bank Holiday weekends. High occupancy rates are experienced on these weekends.

During the months of July and August the tourists resident in Bundoran on a weekday are less than those on a weekend.

Seasonal Temporary Staff

There is a large requirement for staff to support the tourism industry in Bundoran. While some staff will be resident outside the catchment the remainder will be resident in the town for the duration of the holiday season. It is also considered likely that a proportion of these employees would come from families resident in Bundoran.

Day Trippers

There are a large number of tourist related attractions in Bundoran including the Waterworld activity centre, watersports, amusement arcades, golf, cliff walks, bars and restaurants.

While day trippers stay for periods up to 8 hours their individual contribution to the wastewater treatment works would be limited. In terms of population equivalent their impact equates typically to only 20-30% of total resident domestic contribution.

Summary of Existing Population

A flow and load survey was implemented in the winter of 1999 and the peak summer period of July and August 2000, to establish the existing flows and organic loads in the system. Existing summer populations have been estimated by assessing the total organic load in the system and dividing this by a per capita contribution of 60g/c/d. Winter populations have been established using the UDC's water records.

The existing population equivalent contributing to the sewerage system is summarised in Table 3.1. The definition of population equivalent as used in this evaluation is as stated in paragraph 3.3.4.

Table 3.1 - Summary of Existing Population Equivalent

Description	Population Equivalent
Winter	2,000
Summer Peak Weekday	7,500
Summer Peak Weekend	9,000

A breakdown of the existing summer populations by category is estimated as follows:

Table 3.2 - Summary of Existing Summer Population by Category

Category	Peak Weekday	Peak Weekend
Local Residents	2,000	2,000
Seasonal Workforce	1,000	1,000
Resident Tourists	4,000	5,500
Day Trippers	4,500	6,500
TOTAL	**11,500**	**15,000**

3.3.4 Future Population Projections

Population Equivalents

Based on the above assessment of existing populations projections have been carried out using high and low growth scenarios for winter and summer periods up to a design horizon of 2030. For the purposes of wastewater treatment plant design and comparison, sewage flows are considered in terms of population equivalent (pe). Effectively this gives a means of relating tourist, day tripper and other flows to domestic flows. The basis of this relationship is this assessment is that a Biological Oxygen Demand (BOD) of 60g per day represents 1 pe.

Future Resident Population

The growth in the resident population in Bundoran was some 3% per annum between the 1991 and 1996 census. There is evidence that this rate has increased since 1996 and based on water consumption figures the current 2000 resident population is estimated to be 2000. This equates to a current growth rate of some 4% per annum. This high level of growth has been due to the upturn in the economy and the peace process in Northern Ireland giving political stability to the border region. This in turn has led to investment in and net migration to the area. Bundoran has a major role to play in the future development of South Donegal. The Government's future strategy for regional development is based on Sligo as the main centre for development in the North West. Bundoran, with its proximity to Sligo, is well suited to develop as a satellite town. In assessing the future resident population the high growth scenario has assumed that the 4% growth rate will continue for a 5 year period to 2005 slowing down to a national average growth of 1% over the following 25 years, ie. year 2030. The low growth scenario assumes a 4% growth rate continues to 2005 and slows down proportionately to a national average of 1% by the year 2025. The high growth scenario indicates a year 2030 population of 4,200 and the low growth scenario a population of 3,800.

Future Tourist Residents

It is estimated that on completion of current developments in Bundoran there will be some 16,500 beds available for tourist accommodation. Most of the growth is accounted for by developments covered under the Government's tax incentive scheme for seaside resorts and the future resident tourist population will be very sensitive to the rate of uptake of this additional accommodation.

In assessing the future resident population in the high growth scenario it has been assumed that during peak weekend holiday periods all the 16,500-bed accommodation will be fully occupied by the year 2015.

In assessing the low growth rate scenario it has been assumed that during peak weekend holiday periods all the 16,500-bed accommodation will be fully occupied by the year 2020.

Under both scenarios growth would continue at the same rate up to the design horizon year of 2030.

The high growth scenario indicates a year 2030 peak weekend resident tourist population of 22,500 and a peak weekday population of 16,875.

The low growth scenario indicates a year 2030 peak weekend resident tourist population of 20,500 and a peak weekday population of 14,350.

Future Seasonal Temporary Staff

To service the projected growth in the tourist industry the resident seasonal temporary staff will increase accordingly. In the case of the high growth scenario it has been assumed that levels would increase from the current 2,000 to 4,200 over a 30 year period. In the low growth scenario it has been assumed that the current level would increase from 2,000 to 3,800 over the 30 year design horizon. In establishing the contribution to the existing population (reference section 3.3.3) it was assumed that 50% of all seasonal temporary staff would come from the resident families.

Future Day Trippers

It is estimated that some 6,500 day trippers currently visit Bundoran on peak holiday weekends and some 4,500 during the weekdays in the July and August holiday period.

The growth in day trip tourism will be directly related to the developments of tourist related activities in the town. In assessing day trips it has been assumed that in the high growth scenario the number of day trippers would increase from a peak of 6,500 in 2000 to 14,500 in 2030. Large temporary fluctuations in the number of day-trippers will have a minimal impact on the overall projected future population equivalent and consequently a minimal impact on the operation and the proposed phasing of the wastewater treatment works.

In the low growth scenario the day trippers increase is estimated to increase from a current peak of 6,500 to 11,200 over the 30 year design horizon.

The high growth scenario indicates a year 2,030 peak weekend day tripper population of 14,300 and a peak weekday population of 10,000.

The low growth scenario indicates a year 2030 peak weekend day tripper population of 11,200 and a peak weekday population of 7,800.

In terms of contribution to the wastewater treatment works it is assumed based on the results of the recent flow and load survey that day trippers contribute in the order of 15-20 g/c/d or 25-33% of a pe.

Industrial

Some 3.2 ha of land is zoned for industrial development in the Bundoran Development Plan. While there is currently no industry in Bundoran at present and the existing commercial figures are included in the measure of resident population it is considered prudent to make provision for future industrial and commercial growth.

In the high growth scenario a figure of 1,000 pe has been allocated for future industrial and commercial contributions.

In the low growth scenario a figure of 750 pe has been adopted.

It has been assumed that this industry would operate 5 days per week and would only contribute to future winter and summer weekday loadings.

Design Population Summary

The future design population contributing to the wastewater treatment plant is summarised in Table 3.3.

Table 3.3 - Future Design Population Equivalents

Category	Year 2000	Year 2030	
		High Growth	Low Growth
Resident Winter	2,000	5,200	4,550
Peak Weekend	9,000	32,400	29,000
Peak Weekday	7,500	26,700	22,800

In terms of planning it is essential that the proposed wastewater treatment works can provide for the long-term development of the town. A design figure of 30,000 pe has therefore been adopted when preparing this EIS.

While this EIS has been prepared to support the development of a wastewater treatment plant for a population equivalent of 30,000pe, the development will be constructed in two stages. The initial stage of development will be for works to cater for a population equivalent that does not exceed 20,000pe.

3.4 Wastewater Characteristics

The wastewater characteristics vary from the summer to the winter with the peaks in concentration occurring in the summer months. Large fluctuations in load result from the large changes in the contributing population throughout the year. Typical average loads for summer and winter periods have been assessed and are summarised in Table 3.4.

Table 3.4 - Bundoran Wastewater Characteristics

	2000		2030	
	Winter	**Summer**	**Winter**	**Summer**
Dry Weather Flow (DWF) (l/s)	11	22	24	58
Average Flow (l/s)	14	27	30	73
Max. Flow to Treatment(3DWF) (l/s)	* N/A	* N/A		175
BOD (kg/d)	120	540	312	1800
SS (kg/d)	250	675	390	2250

* Not Applicable.

3.5 Sewage Treatment

3.5.1 General

As outlined in Section 3.2 sewage treatment in Bundoran will comprise of three principal elements:

- Preliminary Treatment
- Primary Settlement
- Secondary Treatment

The extents and elements of each of these in the context of this development are described in the following sub-sections.

3.5.2 Preliminary Treatment

Crude sewage contains gross organic and inorganic solids, which can damage equipment, create blockages in subsequent treatment plant and interfere in the subsequent treatment processes. The essential elements of Preliminary Treatment are the removal of:

- Plastics and rags
- Grit, silt and sand

The main processes utilised to achieve this are screening and grit removal. This will result in a residues that will have to be disposed of off site.

Screening

Screening of sewage is generally considered under three headings, coarse, medium and fine.

Coarse screens have apertures greater than 50mm in size and their purpose is to protect equipment from large objects such as logs of wood etc. Medium screens have an aperture in the range of 15 to 50mm but mostly in the range 15 to 25mm. In general the screens will comprise curved bars, vertical straight bars or inclined straight bars and will incorporate a raking mechanism.

Fine screening, less than 15mm and more generally 6mm in aperture may be further sub-divided into Rotary, Moving Belt, Static and Sac. This sub-division has generally evolved from the research and development of individual manufacturers. However, solids removal equivalent to screening to 6mm aperture or better will be incorporated on all incoming streams to Bundoran WWTW.

Screenings Conditioning

Screenings can be objectionable because of the presence of faecal matter and sanitary items. In order to render screenings less objectionable a number of devices are employed. These devices essentially wash screenings, thereby returning the faecal and other treatable matter to the treatment stream. Thereafter the screenings are squeezed or compacted to remove water and reduce volume prior to removal off site for disposal with municipal solid waste.

General Maintenance

General maintenance of the screening and screenings conditioning plant is likely to involve the installation of high pressure and/or high temperature water cleaning devices to maintain the plant in peak operating condition. In particular high temperature water is particularly effective in dealing with fats, oils and grease accumulations.

Grit Removal

Grit may be defined as the heavy mineral material such as sand gravel silt or fragments of metal or glass present in sewage. It is abrasive and if not removed causes wear of pumps and other equipment and blockages in tanks and pipes. However since grit tends to have a density greater than other solids in sewage it has a tendency to settle at low flow velocities. In summary the principle applied in grit removal is based upon Stokes Law and relates to adopting a flow velocity which will permit the settlement of grit but which will retain less dense organic material in suspension.

This velocity is regulated by a number of methods many of which are patented. These may be summarised under a number of headings:

- Constant Velocity Channels
- Spiral Flow Channels
- Cross Flow Detritors
- Vortex Separators

Any or all of these methods could be utilised.

Grit once collected requires to be washed to remove any organic matter which may have adhered to the grit particles and thereafter sieved and collected for disposal. The actual

quantity will depend on the nature of the sewage and in particular the extent to which storm flows are included in the discharge to the works. On the basis of an average removal of 0.025kg/m³ it can be estimated that the a grit removal rates will be of the order of 0.15 tonnes per day for the summer period rising to 0.19 tonnes per day at occasional peaks. In the context of Bundoran WWTW with high levels of combined sewer discharges to the works it can be expected that at times, particularly following prolonged dry spells, that a larger quantity than outlined above will be obtained.

This grit will be removed to municipal landfill.

3.5.3 Primary Settlement

Sewage having passed through preliminary treatment to remove gross solid materials and insoluble inorganic matter nonetheless contain high concentrations of suspended matter which is mainly organic and highly polluting. The purpose of primary settlement is to separate this sewage into two main components: sludge and settled sewage. This is achieved by the reduction of the flow velocity of the sewage to a point below which it can transport the suspended matter and as a consequence the materials settle and can be removed as sludge. In summary the purpose of Primary Settlement is to remove the maximum amount of polluting matter from sewage as quickly and as economically as possible. In addition to this a number of physical and biological side effects occur in the settled sewage which are beneficial in later treatment phases.

A number of Primary Settlement configurations exist to achieve the desired end result including:

- Horizontal Flow Tanks
- Radial Flow Tanks
- Upward Flow Tanks

The tanks generally utilise mechanical scraping mechanisms for the collection of settled sludge from tank bottoms to central locations for further treatment.

The progression from horizontal flow to upward flow through radial flow is in general consistent with a decreasing works size.

Processes are available to reduce the area required to achieve the desired primary settlement. These include lamella separators, chemical precipitation or a combination of both. Lamella separators consist of multiple inclined parallel plates or tubes inserted inside a tank. Settlement of solids occurs in the liquid between surfaces and the height for settlement is a small fraction of that required in a standard tank. For a given area of tank the settlement rate is considerably higher in the lamella separators than in the conventional horizontal flow tank.

Similarly precipitants which attach themselves to the suspended solids in the sewage will enhance the settlement characteristics of the solids and ensure a faster settlement rate. This process can be allied to the lamella separators to provide the required settlement rate.

In the Bundoran Plant during winter months when flows to the treatment works are low it is unlikely that primary settlement will be required.

3.5.4 Secondary Treatment.

Secondary treatment is defined in the Urban Waste Water Treatment Directive 91/271/EEC as the "treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process ".

Secondary treatment processes may generally be sub-divided under two headings:

- Suspended Growth (or completely mixed processes)
- Attached Growth (or fixed film processes)

Suspended Growth Processes are biological treatment processes in which the micro-organisms responsible for the conversion of the organic matter or other constituents in the sewage stream to gases and cell tissues are maintained in suspension within the liquid. Activated sludge is the general name given to a large number of processes which are suspended growth processes.

These include:

- Conventional Activated Sludge (AS)
- Extended Aeration Oxidation Ditch (EA)
- A-B Process
- Sequencing Batch Reactor (SBR)
- UNOX
- Deep Shaft

Attached Growth Processes are biological treatment processes in which the micro-organisms responsible for the conversion of the organic matter or other constituents in the sewage stream to gases and cell tissues are attached to some inert material such as rock, slag or ceramic or plastic material.

Processes which may be classified under this heading include:

- Trickling Filters
- Rotating Biological Contactors (RBC)
- Biological Aerated Filters (BAF)

3.5.5 Tertiary Treatment

Tertiary treatment can be defined as the additional treatment needed to remove suspended or dissolved substances which remain after conventional secondary treatment. These substances include a variety of organic or suspended substances as well as inorganic ions. The results of water quality modelling carried out as part of this assessment (Reference Section 6 of the EIS) indicate that nitrogen removal will be required in the treatment process to reduce ammonia levels in the final effluent and ensure water quality at the mouth of the Drowes River is not toxic to fish.
The two principal mechanisms for the removal of nitrogen are assimilation and nitrification – denitrification. Nitrogen removal is normally carried out in the same basin used for the treatment of carbonaceous organic matter in the secondary growth treatment process. However, separate basins can be provided. Nitrification can also be achieved in attached growth systems using the same or separate treatment units.

3.5.6 Final Process Selection

Full details on the nature and characteristics of the viable processes for Bundoran WWTW is given in Appendix A. However, given the design capacity of Bundoran WWTW not all these processes will be appropriate. The final choice of treatment process for Bundoran WWTW will be made in the context of the selection of the winning tender for the Bundoran WWTW and may include the above, variations of the above or alternative technologies.

Among the primary criteria in the selection of the final process will be:

- Process suitability for treatment objectives
- Satisfactory demonstration on a comparable scale
- Operational complexity
- Ease of uprating for increased throughput
- Ease of uprating for stricter effluent standards
- Sludge production and characteristics
- Process reliability, flexibility of operation and standby requirement
- Land requirement
- Hydraulic head requirement
- Construction aspects

Fig. 3.3 and Fig. 3.4 show typical layout configurations for two secondary treatment options based on conventional activated sludge and sequencing batch reactor processes.

From Chapter 6 the primary requirement for the wastewater treatment process will be the achievement of the consent standards of BOD 25mg/l, SS 35mg/l, COD 125mg/l and NH_4 5mg/l on a 95 percentile basis.

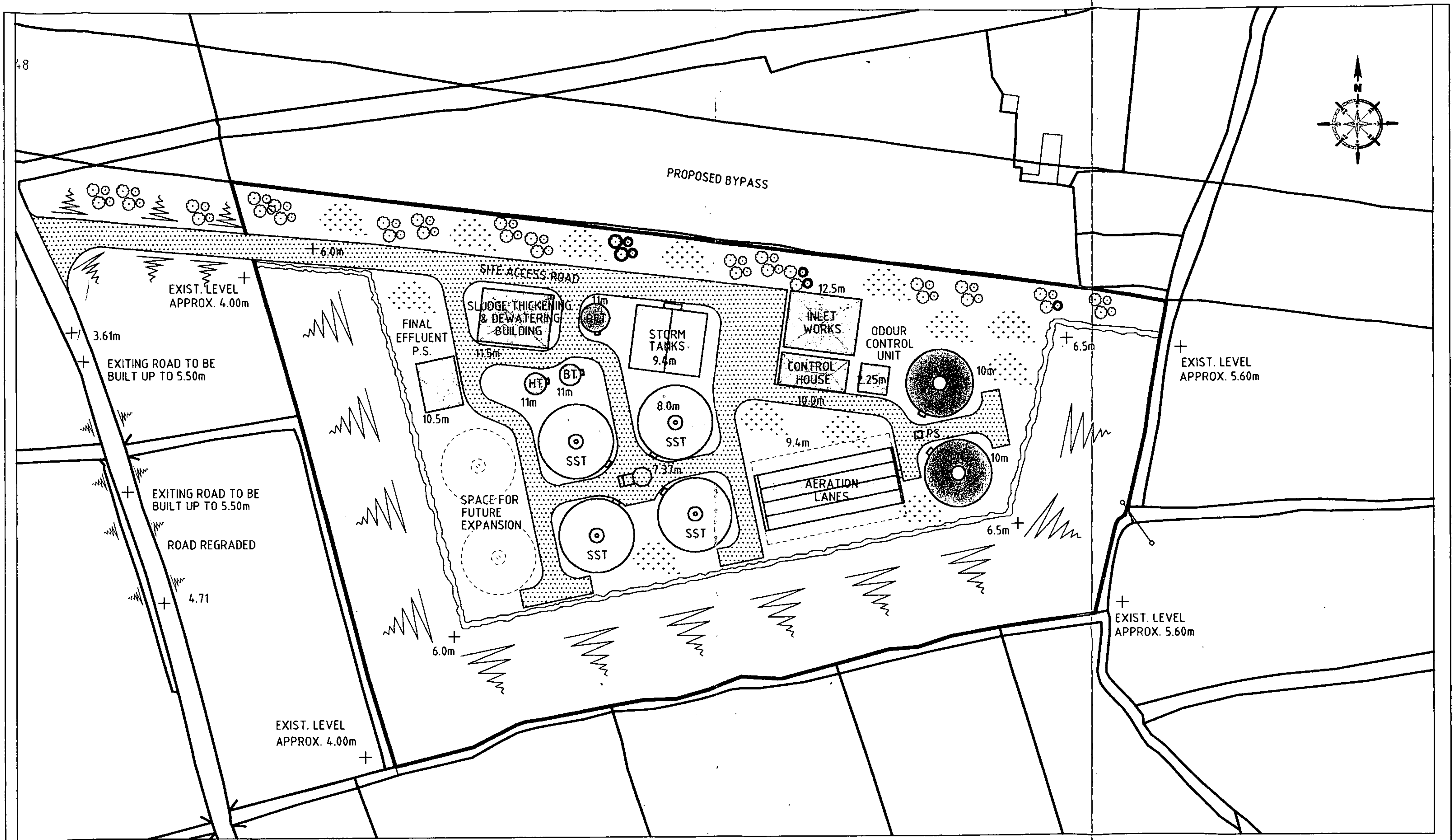
3.6 Sludge Quantities and Characteristics

3.6.1 Sludge Quantities

One possible method of operation of the treatment process during the winter months when flows are low would be to reduce the amount of primary sludges during the winter months would be to by-pass the primary settlement tanks and carry out extended aeration in the secondary treatment process. The method of operation will be largely determined by the sludge treatment requirements in Donegal Town.

Using the above-mentioned operational mode the expected current and future sludge quantities have been estimated. When the Bundoran treatment plant is commissioned it is estimated that the annual sludge production will be 156 tonnes dry solids (tds) (126 tds summer, 30 tds winter). This equates to 61 tds of primary sludge and 65tds of secondary sludge for the summer, with no primary sludge and 30 tds secondary sludge for the winter.

Estimation of the sludge production for the year 2030 depends upon the sewage treatment processes adopted in the final design. For medium performance parameters, an annual sludge production of 340 tds (280 tds summer, 60 tds winter) is estimated. This equates to 136 tds of primary sludge and 144 tds of secondary sludge for the summer and no primary sludge and 60 tds of secondary sludge for the winter.



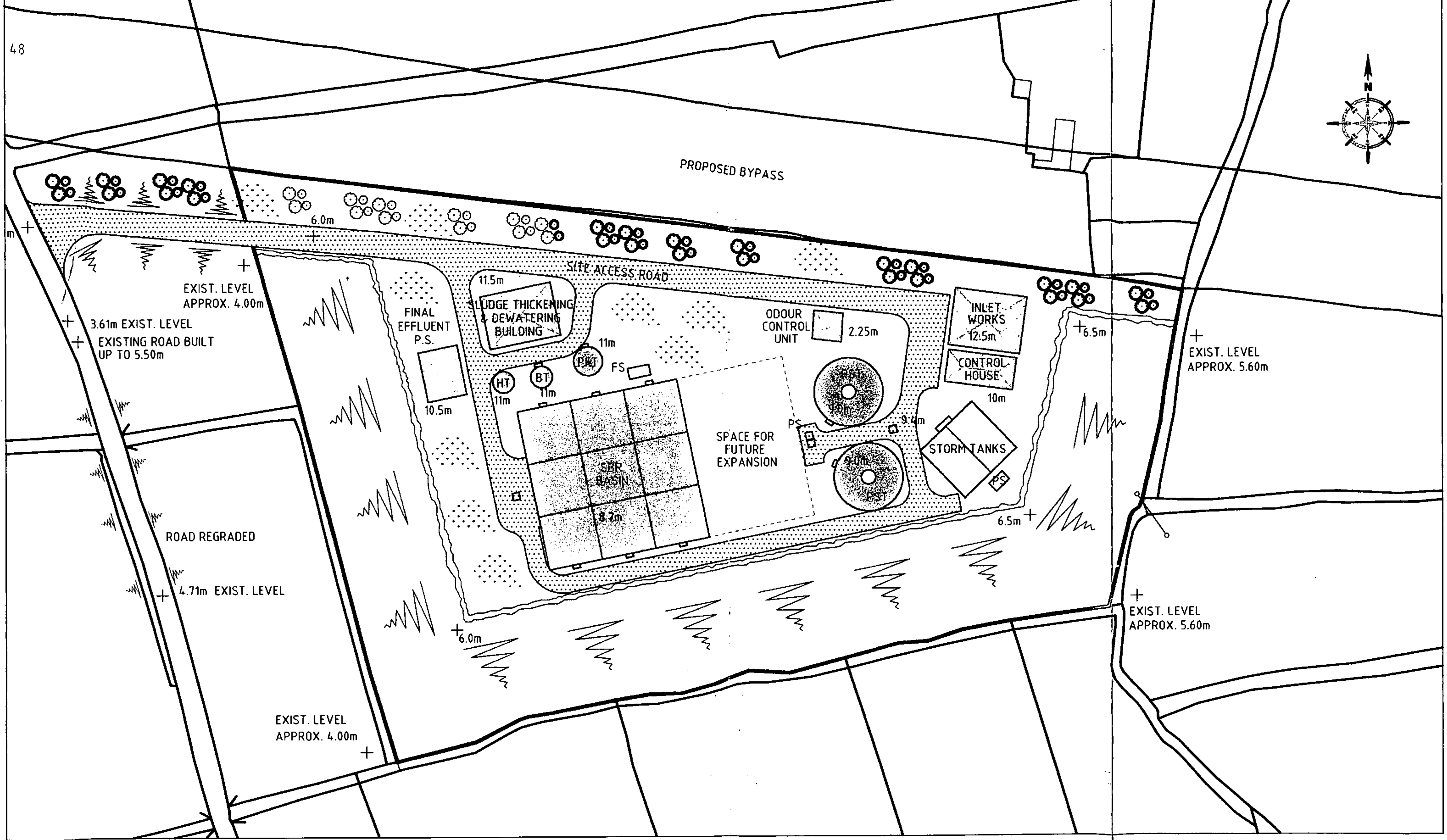
ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM

LEGEND

PST	PRIMARY SETTLING TANK
SST	SECONDARY SETTLING TANK
PFT	PICKET FENCE THICKENER
HT	SLUDGE HOLDING TANK
BT	SLUDGE BALANCING TANK
PS	PUMPING STATION

TYPICAL SITE LAYOUT
ACTIVATED SLUDGE

FIG. 3.3



ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM

LEGEND

PST	PRIMARY SETTLING TANK
SBR	SEQUENTIAL BATCH REACTOR
PFT	PICKET FENCE THICKENER
HT	SLUDGE HOLDING TANK
BT	SLUDGE BALANCING TANK
PS	PUMPING STATION

TYPICAL SITE LAYOUT
SEQUENCING BATCH REACTOR SYSTEM

FIG. 3.4

3.6.2 Sludge Characteristics

Presently no sludge is produced in Bundoran and as a result there are no sludge samples or analysis. However it is expected that the nature of the sludge following the commissioning of the plant will be typical of a catchment dominated by domestic contributions and that the sludge will not contain elevated levels of contaminants such as heavy metals. Under the current development plan some land is zoned for industrial use. Any future industrial discharges will be licensed by the Council to ensure that they will not result in the sludge from the treatment plant failing to meet the requirements for re-use under the County's Sludge Management Plan.

3.7 Sludge Treatment Options Considered

3.7.1 General

Sludge produced from sewage treatment contains a large proportion of water. To reduce transport costs volume reduction by the removal of water by thickening and dewatering will be required at the Works.

Sludge reuse options require an appropriately treated 'clean' sludge relatively free of contaminants acceptable for the disposal routes available. Mixed sludges during the summer months will be thickened and dewatered to between 20-28% and if only secondary sludges are produced they will be thickened and dewatered to 18-20%, and subsequently transported to Donegal WWTW for full treatment prior to disposal. Both treatment and disposal will be accordance with County Donegal's Sludge Management Plan.

3.7.2 Sludge Thickening

Thickening is used to reduce the water content (by separating water from solids) in sludge thereby significantly reducing sludge volume. For primary sludge, a dry solids content of 6 to 9% can be achieved by thickening from feed sludge containing 3 to 5% dry solids. Secondary sludge thickens less readily, a value in the range 3 to 6% would be typical.

Sewage sludge may be thickened by gravity or by mechanical means.

At Bundoran, mechanical thickening of secondary sludge is likely to be the favoured option given the design throughput. Gravity and mechanical thickening are considered options for primary sludge.

Gravity Thickening

Gravity thickening is a simple process whereby sewage sludge particles agglomerate to form flocs which settle under gravity. Interstitial water is displaced from pores within and between the flocs.

In modern practice, gravity thickening is designed as a continuous process, with sludge pumped to the thickeners at a low flow rate throughout the day. In order to ensure that effective solids separation is achieved in the thickener the upward flow velocity is kept low.

Supernatant liquor is removed from the thickener clarification zone by means of a peripheral weir located at the top of the tank. Thickened sludge is removed intermittently from the tank base by means of a desludging pump.

Thickening is assisted by a picket fence comprising an array of vertical bars or angles supported on cross members fixed to a central rotating shaft driven by an electrically powered drive arrangement.

Operation is automatic and requires very little attendance. Energy costs are low and no chemicals are necessary.

Mechanical and Belt Thickening

Two types of mechanical equipment are commonly employed for the purpose of thickening sewage sludges. These are centrifuges and belt thickeners. Conditioning with polyelectrolyte is usually required for this method of thickening.

Centrifuges are essentially thickeners that rotate at high speed around a central axis. Solids separation is produced by centrifugal force which is many times greater than that due to gravitational force alone. The centrifuge consists essentially of a rotating drum or bowl, a central inlet feed tube which delivers sludge to the rotating drum, a screw conveyor or scroll which transports the thickened sludge to the discharge end of the drum and a weir and/or decanting channel arrangement for discharging the centrate.

Belt thickener operation is a continuous process for removing water from sludge. The device comprises a continuous porous belt which runs over rollers to provide a horizontal or inclined surface through which the filtrate discharges by gravity to collector trays and the thickened sludge is removed by means of a knife-edge scraper. Belt widths are available in a range of sizes from 1m to 3m giving good flexibility on plant sizing. Sludge is quickly thickened after withdrawal from the settlement tanks and the holding time in the thickening process is reduced considerably.

3.7.3 Dewatering

Sludge dewatering is employed to reduce the volume of sludge by removing water so that the resultant sludge contains a minimum of 15% dry solids and in some cases up to 40%.

Mechanical devices used for sludge dewatering include centrifuges, belt presses and filter presses (plate and membrane configurations). In each case, sludge conditioning usually with polyelectrolytes prior to dewatering, is essential.

The configuration and operation of centrifuges for dewatering is similar in principle to that for thickening. Achievement of constant high performance relies on a constant feed of sludge with consistent solids content and characteristics.

A belt press consists of a pair of filter belts moving in the same direction over a system of rollers. The conditioned sludge is applied across the full width of the lower belt as it moves in a horizontal direction and some gravity dewatering takes place. The upper belt converges with the lower belt compressing the sludge between them. The belts then pass between a series of rollers progressively squeezing water from the sludge. The dewatered cake is removed by means of knife-edge scraper and discharges to a skip, conveyor or hopper for onward treatment or disposal. A sparge pipe washing arrangement continuously washes the belt before further application of sludge.

Filter presses may be of two types, the solid recessed plate type and the membrane plate press. Both types are similar in arrangement, each having a series of 30 to 100 plates compressed together by means of hydraulic rams. When in this closed position, the plates form a continuous series of chambers connected together by a central feed port through which the conditioned sludge is fed. Each plate is covered by a filter cloth. Solids are

retained on the cloths while filtrate passes through to be returned to the sewage treatment plant. Sludge is fed to the presses by means of positive displacement pumps. Membrane filter presses are capable of achieving the highest cake dryness of all the dewatering machines. Filtrate produced from dewatering is returned to the sewage works inlet.

Centrifuge and belt press operation is continuous, whereas filter presses operate in a batchwise manner. Machine size and hence building size for centrifuge and belt presses is smaller than that required by filter presses. Belt presses produce cake with dry solids content 3-5% ds less than centrifuge, though the latter tends to require more polyelectrolyte. Generally, the washwater requirement for belt presses is greatest and that for centrifuges is lowest. Centrifuge and belt presses are commonly used at large and small works and either option would be applicable at Bundoran. Filter presses are normally used at only the largest works and where high cake dryness is required.

3.8 Pumping Station Requirements

3.8.1 The Existing Situation

The existing drainage system in Bundoran divides into three catchments. The two covering the east of the town and Town Centre discharge to the existing pumping station at the Bradoge Bridge. Flows are then pumped to a high point to the west of the town and discharge by gravity to the existing outfall at Pollbrean. The third catchment covers the west of the town and flows to the outfall by gravity.

3.8.2 Bradoge Bridge Pumping Station

Under the proposed scheme the flows from the east and centre of the town will still be pumped to a high point to the west of the town from this point it can flow by gravity to the treatment works site.

A new pumping station, to be constructed on the opposite side of the Bradoge River from the existing station will be required to pump 6 DWF from this catchment. This station will consist of a wet well and a dry well to house the pumping plant. Coarse bar screens will be provided at the pumping station to prevent damage to the pumps. All other solids will be passed for removal at the treatment works site. The station will incorporate a ventilation and odour treatment system. Duty and standby plant will be provided and the operation of the plant will be monitored by the scheme telemetry system.

3.8.3 West End Pumping Station

Under the proposed scheme flows from the east of the existing west end catchment can flow to the treatment works by gravity. The remainder of the catchment will have to be pumped from the west end to a high point on the N15. From this position sewage can flow by gravity to the treatment plant.

The flows to be pumped from the west end west catchment will be much less than those from the proposed Bradoge Bridge Pumping Station. This station would be a submersible pumping station with duty standby pumps capable of pumping 6 DWF from this catchment onward for treatment. The structure housing the pumps would be below ground with only a kiosk holding the pump controls and electrics in an above ground kiosk. No forced ventilation or odour treatment systems are required at these submersible locations. The pump operation will be monitored by the scheme telemetry system.

3.9 Storm Water Management

3.9.1 Introduction

In addition to foul wastes many of the sewers contributing to the flows to the Bundoran WWTW carry storm water run-off and are classified as "combined" sewers. Consequently when it rains on the catchment the flow in the sewers is augmented by the rainwater run-off. The following stormwater management strategy has been adopted in the design of the scheme:

- Maximum flow to treatment 6 DWF.
- All flows up to 6 DWF will receive preliminary treatment at the works.
- 2 hours storage at 3 DWF will be provided at the treatment works site.
- On-line and off-line storage would be used to control overflow frequency to the receiving waters at combined sewage overflows at Bradoge Bridge and at the West End. The spill frequency depending on the sensitivity of the receiving waters.

3.9.2 Treatment Works Site

Following rainfall events maximum flow to treatment will be 6 DWF. This flow will receive treatment by screening (6mm aperture) and grit removal and 3 DWF will be forwarded for full secondary and tertiary treatment. Stormwater retention tanks will be provided at the plant with two hours storage capacity. Stormwater will settle in these tanks and on occasions when they overflow flows will be decanted from the top of the tanks and transferred to the plant outfall.

3.9.3 Main Pumping Station

Once the flows to the works have receded the water retained in the stormwater tank will be forwarded for full treatment.

The existing overflow at the Bradoge River would be incorporated into the overall scheme. Additional off-line storage would be provided as part of the new pumping station construction to limit overflow occasions.

The Department of the Environment and Local Government has published a paper "Procedures and Criteria in relation to Storm Overflows". The paper sets out criteria for limited pollution from stormwater overflows to the receiving waters by controlling overflow frequency and volume discharged depending on the classification of the receiving waters.

The existing outfall discharges close to bathing waters. In accordance with the above criteria storage will be provided so that overflows will be limited on average three occasions per bathing season. This would ensure that the water quality standards as set out in the Bathing Water Regulations will be achieved for at least 98.2% of occasions and the water quality standards in relation to Blue Flag status will not be compromised by overflows from the outfall.

All flows to the existing outfall will be screened to 6mm prior to discharge and all flows up to 1 in 10 year design storm will be screened.

The existing outfall discharges below Mean Low Water Spring Tide (MLWST).

All waters remaining in the retention tank at the end of the storm event will be pumped forward for full treatment at the works.

3.9.4 West End Overflow

It is proposed that overflows from the West End Pumping Station would pass to the Pollbrean outfall for discharge some 400m off shore.

This outfall discharges some distance from the bathing beaches and using the DOELG guidelines for water contact recreational use a overflow frequency of 7 occasions on average per bathing season have been adopted. Below ground storage would be provided at the West End Pumping Station to limit overflows to seven per bathing season.

All flows would be screened to 6mm and screening returned to main flow for transfer to the treatment works. Water remaining in the storm event would be pumped forward for full treatment at the works.

3.10 Outfall

The treated effluent from the wastewater treatment plant will discharge via a sea outfall at Pollbrean to the west of the town. This outfall will be an extension and upgrade of the existing outfall and will discharge 400m off shore. The new outfall will terminate in a diffuser section incorporating "Tideflex" diffuser valves to optimise diffusion into the water column and maximise initial dilution. In the interest of marine safety the end of the outfall will be marked with a marker buoy.

3.11 Development Works

The works on the Bundoran site will comprise the buildings and structures to accommodate the processes described in 3.5 to 3.9 above, the roads to provide access to the process buildings, the pumps and pipework delivering sewage from one process to the next and the general landscaping associated with the development.

Fig. 3.4 and Fig. 3.5 shows in plan two possible treatment process that may be employed using DBO procurement. The treatment processes and dimension of buildings that may be employed are not limited to those detailed on these plans. The visual impact and related conditions of what might be employed are detailed in Chapter 10.

4.0 ALTERNATIVES

This section examines the alternatives considered for the location of the treatment works and main pumping station to serve the town of Bundoran.

4.1 Outline

Initially consideration was given to the possibility of a central wastewater treatment works to service the towns of Bundoran and Ballyshannon. On early evaluation this alternative was eliminated on environmental grounds. There is a weak tidal flow regime in the Bundoran area and effluent will be slow to disperse. Similar conditions exist at Ballyshannon where flow in the estuary is restricted. It was therefore considered that one large point source could compromise water quality in the area. In addition outline economic analysis showed no added cost benefits in relation to a centralised treatment facility and in fact favoured separate treatment plants when annual running costs were discounted over a 25 year period. Donegal County Council decided to proceed with separate treatment works for the two towns and focus centred on selecting a suitable site to treat the wastewater from Bundoran.

A variety of sites have been examined and are illustrated in Fig. 4.1.

The sites were screened for suitability against a variety of criteria including:

- area of land available
- proximity to existing or planned developments
- ease of access
- environmental constraints
- economics of development
- economics of operation

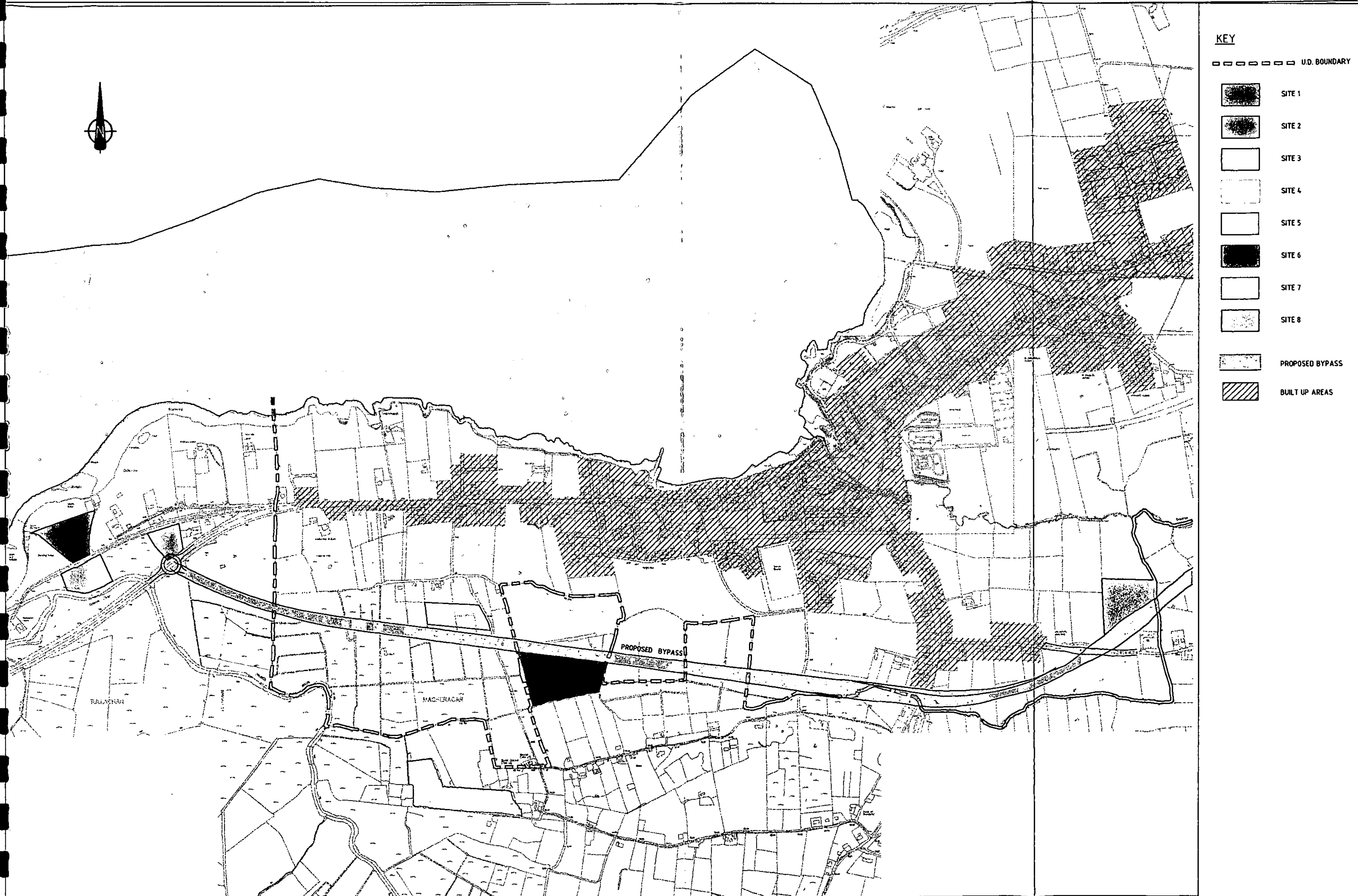
Those options considered unsuitable have been eliminated from further consideration. The remaining sites have been ranked in order of preference and the preferred options subjected to further analysis.

4.2 Alternative Sites for Treatment Works

4.2.1 Initial Site Screening

Consideration was given to the option of locating the treatment works in the centre of the town. This was immediately eliminated on environmental and economic grounds. The treatment works would need to be located adjacent to the existing pumping station in the centre of Bundoran. This is a high amenity area and the UDC plans to landscape this area are ongoing. There is a limited amount of land available and additional land would have to be reclaimed from the sea. This in turn would require a foreshore licence from the Department of the Marine and Natural Resources. To mitigate visual impact the plant would have to be built underground and the process designed to the highest environmental standards. Such a plant would prove extremely expensive to construct and operate.

A proposed National Heritage Area takes in the area of the coastline between Tullaghan and Ballyshannon. Sites immediately to the east of the town were not considered as encroachment into this area to construct a treatment works site would be in conflict with Donegal County Council's Draft Development Plan 1999. The current drainage system has developed with the natural fall to the West of the town, making this a favourable location for the works.



ALTERNATIVE SITES CONSIDERED FOR THE TREATMENT WORKS

FIG. 4.1

An outfall investigation at the location of the Pollbrean outfall was carried out by An Foras Forbartha in May 1983. It indicated that under the most adverse conditions coliform counts from untreated effluent would be less than the limits set out in national and EU standards for bathing waters in Bundoran and Mullaghmore, the nearest bathing beaches and that the effluent would not interfere with the passage of migratory fish on the nearby Drowes river. These conclusions have been confirmed in practice by the fact that Bundoran is able to maintain Blue Flag Status and that the Drowes River is a premier salmon fishery. As the current system drains to the West of the town and the existing outfall offers the opportunity to provide the dispersion and dilution necessary to meet the requirements of the environmental legislation, a variety of sites were considered in the proximity of the existing outfall.

4.2.2 Site Identification and Assessment

Eight possible sites were identified. Seven are to the west of the town and within a 2km distance of the existing Pollbrean outfall. One site is on high ground 1.3km by road to the south of the town some 3.6km from the existing outfall. The sites are shown on Figure 4.1 and relative merits of the sites are discussed in the following paragraphs.

Site No. 1

The site is within Donegal County Council's planning jurisdiction. It is located on high ground between the old Bundoran road and the coastline. Some 1.5ha is available. It is immediately adjacent to the existing Pollbrean outfall. Effluent pumped to the site could gravitate through the works. The works would have to be built into the hillside to mitigate visual impact. Access to the site would be via the Old Bundoran Road. The site would border on two existing dwellings, and other properties are in very close proximity to the site. The remains of a castle are evident close to the site, and there are possible heritage and archaeological impacts. Dúchas have confirmed that this is a site of national archaeological importance and therefore, it could not be considered further.

Site No. 2

This site within Donegal County Council's planning jurisdiction is located between the old and new Bundoran roads. Some 0.7ha of land is currently available. The available land could reduce depending on the land take in the area required for the proposed Bundoran by-pass and, as such, there is unlikely to be sufficient land to site a works. Effluent pumped through the works could gravitate to the outfall. It would be difficult to screen the works at this location and visual intrusion would be high. This site borders on a number of existing dwellings including a Chinese restaurant, and a new housing development is within 250m of the site. Access to the works would be via the old Bundoran Road. The site is also located within a recently designated Special Area of Conservation (SAC) and therefore was not considered further.

Site No. 3

This site within Donegal County Council's planning jurisdiction is West of Site No. 2. It is located in low-lying lands between the Old Bundoran Road and the Drowes River. Some 1.1ha of land is available. The site would have to be protected from flooding of the Drowes River. There are a number of dwellings within 200m of the site. The site could be screened to reduce visual impact. Again this site is located in the recently designated SAC and was not considered further.

Site No. 4

This site, within Donegal County Council's planning jurisdiction, is located south of the Bundoran Road and adjacent to the Drowes River. The site would also be south of the proposed bypass route. In excess of 2.9ha of land is available. The land is low-lying and the works would be required to protect the site from flooding of the Drowes River. The site is approximately 750m from the existing outfall location. Access would be via a new road off the existing Bundoran Road and, on completion of the bypass, via an additional spur from the proposed roundabout on the western side of the bypass. The site is some 250m from existing dwellings and 200 metres from a site for which there is an existing planning permission for a caravan park. The site is visible from the road and would require screening to reduce visual impact. Again this site falls within the recently designated SAC and was not considered further.

Site No. 5

This site is located within Bundoran UDC's planning jurisdiction. It is located to the south west and on the town side of the proposed bypass. The land available is 1.3ha. It is low-lying and subject to flooding. The nearest property is less than 50m away and a residential housing development is within 100m of the site. Access to the site would be via existing residential roads that would require upgrading to take both construction traffic and, on completion of the works, operational vehicles. The site is some 1.4km from the proposed outfall location. Flows from the west end catchment of the town would have to be collected in an additional pumping station to be located close to the Drowes River and pumped to the proposed treatment works.

Site No. 6

Site 6 site is close to Site No. 5 but lies within Donegal County Council's planning jurisdiction. All flows would have to be pumped to the works. Some 2.8ha of low-lying land are available for the development of the wastewater treatment works. Filling would be required to raise the site above flood level. The site is located adjacent to the south side of the proposed bypass. The nearest existing and planned dwellings are within 150m of the site. The site is visible but natural screening would be used to minimise the visual impact on the environment. Access to the site would be via existing roads that would require upgrading to take both construction traffic and, on completion of the works, operational vehicles. The site is some 1.6km from the existing sea outfall at Pollbrean. A pumping station would be required east of the Drowes Bridge to pump effluent form the west end catchment to the site.

Site No. 7

This site is located within Donegal County Council's planning jurisdiction. It is located on a ridge of high land to the south west of Site No. 6. The nearest property is some 50m from the site. This is a single dwelling and there are no other dwellings in the area. The site is some 1.3km from the proposed outfall. While some 2.9ha of land is available it is made up of a long narrow strip and is not ideally suited to a treatment plant layout. Access to the site would be via the existing roadway which would have to be upgraded over a length of 1km. The site would be screened naturally and visual impact would be low. The ordnance survey maps indicate a burial ground in the vicinity and there is evidence of stone buildings and an old agricultural settlement that may have archaeological and heritage value. A pumping station would have to be constructed at the location of the Drowes Bridge to pump all effluent to the inlet of the treatment works.

Site No. 8

Site No. 8 is located on high ground to the south of the town. It is on lands within Bundoran UDC's planning jurisdiction, adjacent to the proposed by-pass and beside to an existing ESB transformer station. The land available is 1.7ha and it is 100m distance from adjacent housing. Access to the site would be via the existing road network. The adoption of this site would require major reconfiguration of the town drainage scheme. A pumping station would be required at the location of the bridge over the Drowes River to pump effluent from the west end catchment to the existing main pumping station at Bundoran Bridge in the centre of town. The pumps within the main pumping station would be reconfigured to pump to the treatment works site. Treated effluent would then discharge via gravity to a new sea outfall to be constructed at the location of the outfall of the stream which currently discharges on to Bundoran Beach. The stream could be culverted and discharged via the same outfall. This option would be costly in relation to construction, operational and maintenance costs.

4.2.3 Framework Criteria and Rating

The four available site options Sites 5, 6, 7 and 8 have been evaluated in a framework analysis under the following criteria:

- area of land available
- use of marginal lands
- distance from the nearest dwelling
- distance from high density housing
- low visual impact
- low pollution risk
- ease of access
- economics of construction
- economics of operations

The following suitability ratings were adopted - high, moderately high, moderate, moderately low, low. The results of the analysis are shown on Table 4.1. Based on the framework, the sites are ranked in order of preference.

The framework analysis indicates that the preferred site is Site No. 6 followed by Site No. 7. Both these sites were subjected to further technical, economic and environmental selection criteria in the following sections.

4.2.4 Technical Evaluation

Site No. 6

A works located on Site No. 6 could not be fed by gravity by a simple diversion of the existing drainage system. While flows from the majority of the catchment can be diverted to the site by gravity a submersible below ground pumping station would have to be constructed at the location of the existing outfall to collect flows from the West End of Bundoran and pump these to Site No. 6 treatment works. This would require some 1.4km of rising main.

The works site is low lying and site levels would have to be raised to ensure the works are above flood levels.

The works would be some 1.6km from the proposed outfall location across low lying ground which is understood to be soft silty clays.

Table 4.1 Bundoran Wastewater Treatment Works
Site Options
Framework Analysis

	Area Available	Use of marginal lands	Distance to nearest dwelling	Distance from high density housing	Low visual impact	Low polluting risks	Ease of access	Economics of development	Economics of operation	Ranking
Site 5	**	*****	**	**	*	***	***	***	***	3
Site 6	*****	*****	***	****	***	***	**	****	****	1
Site 7	***	***	*	*****	****	****	*	**	**	2
Site 8	***	**	**	**	***	****	****	*	*	4

Suitability

High	*****	Moderately low	**
Moderately high	****	Low	*
Moderate	***		

Table 4.2 Bundoran Pumping Station
Site Options
Framework Analysis

	Area Available	Low visual impact	Low polluting risks	Loss of Amenity	Ease of Access	Economics of Development	Ranking	
Site A	*	****	*	****	***	*	3	14
Site B	*****	***	****	***	***	****	1	22
Site C	*****	*	****	*	****	**	2	17

Suitability

High	*****	Moderately low	**
Moderately high	****	Low	*
Moderate	***		

Access to the site, in advance of the proposed by-pass construction, would be from the N15 via an existing rural road that would require upgrading over a length of some 400m. The National Roads Authority will not permit direct access off the new by-pass. On construction of the by-pass access to the site from the N15 will be severed and new access will be required from the Kinlough Road (R280).

Site No. 7

A works located on Site No. 7 could not be fed by gravity by simple diversion of the existing drainage scheme. All flows would have to be pumped to the works. It would be necessary to construct a major pumping station to pump all flows to the treatment works on Site No. 7. In addition to the main pumping station in the centre of the town an additional above ground pumping station would be required close to the existing outfall at Pollbrean.

The topography of the site is steeply sloping and major earthworks would be required to form terraces on the site to facilitate the works.

The outfall would be some 1.4km from the proposed outfall location across low lying ground which includes soft silty clays.

Access to site will be required from the Kinlough Road and would require upgrading of the existing rural road network and construction of a new access road to the site over a length of 400m. The topography is steep and not ideally suited to road construction.

Summary

From the technical evaluation Site No. 6 has the following technical benefits over Site No. 7.

- Does not require an additional pumping station.
- Easier access to the site.
- Minimum amount of siteworks.

4.2.5 Economic Evaluation

The cost of construction of the wastewater treatment plant units and outfall would be similar on both Site No. 6 and Site No. 7. However, the cost of pumping station construction, siteworks and access road construction will be greater should Site No. 7 be adopted.

Because of its higher elevation additional pumping costs would be incurred by Donegal County Council should Site No. 7 be adopted. These running costs, if capitalised, would show further economic benefits for Site No. 6 selection.

4.2.6 Environmental Evaluation

An initial environmental screening was carried out on both Site No. 6 and Site No. 7.

Site No. 6

Site No. 6 is located on the southern side of the proposed by-pass road, some 250m distance from the nearest high density housing developments and approximately 155m from the nearest dwelling.

The site will have to be raised above flood plain development. The site would be visible from dwellings to the north and south of the site. However, on construction of the proposed by-pass the works would be partially screened from the north. A high level of architectural treatment to the building finishes and selected landscaping will be required to mitigate visual impact. Given the distance of the development to the nearest dwelling issues such as noise and odours can be mitigated using current technologies.

In ecological terms there are no species of significant importance identified on the site.

No items of archaeological or heritage interest were identified on the site.

Site No. 7

The site will be a considerable distance from high density housing development and is within 50m of the nearest dwelling.

While the site is screened naturally much of this screening would have to be removed to facilitate site access and replanting would be required to mitigate visual impact.

Given the proximity of the nearest dwelling noise and odour would require major mitigating measures using current technologies.

In ecological terms badger tracks were abundant throughout the site. While no sett was located it is probable that it is located in the scrub to the east of the site.

The O.S. maps of the area indicate a burial ground in the location of Site No. 7 and there is evidence of stone buildings and an old agricultural settlement.

Summary

In environmental terms Site No. 6 has the following benefits over Site No. 7:

- A greater distance from the nearest dwelling.
- Less risk of noise and odour impact.
- Less ecological impact.
- Less archaeological/heritage impact

4.2.7 Preferred Site Option

Based on technical, economical and environmental criteria Site No. 6 is the preferred site option for the location of the wastewater treatment works.

4.3 Alternative Site for Main Pumping Station

4.3.1 Initial Site Screening

The existing drainage system for the east and middle of the town terminates at a pumping station in the centre of the town adjacent to Bundoran Bridge. From this station screened and macerated raw sewage is transferred to the sea outfall at Pollbrean to the west of the town. The existing pumping station and its associated storage tank are not operating satisfactorily and uncontrolled and frequent overflows are occurring into Donegal Bay. A new or upgraded pumping station and storage tank are required.

The relocation of the main pumping station away from the centre of the town would require major reconfiguration of the town's drainage scheme with the installation of numerous submersible below ground pumping stations and the relaying of a majority of the towns sewerage system. This alternative was immediately eliminated on both environmental and economic grounds.

4.3.2 Site Identification and Assessment

Three possible sites were identified all in the centre of the town adjacent to Bundoran Bridge. The sites are shown on Figure 4.2 and the relative merits discussed in the following paragraphs.

Site A

This site covers the location of the existing pumping station and storage tank. It is limited in area, 0.14 ha and this would provide insufficient land for the new development without reclamation of land from the foreshore or encroaching on the area to the south of the site which has been recently developed by the UDC as an amenity area.

Access to the site would be via the existing access to the pumping station.

Technical difficulties would be experienced in constructing the new station on this site and keeping the pumping station operating. There is a real risk that water quality could be compromised during the construction period.

Given the proximity of the station to public areas odour and noise mitigating measures would be required.

The site is low lying and while screened from the road a high level of architectural treatment would be required to mitigate visual impact given its central location and adjoining amenity area.

Site B

This site is located on the opposite side of the Bradoge River to Site A. The area available is 0.53 ha, sufficient for the new development without reclamation of lands from the foreshore.

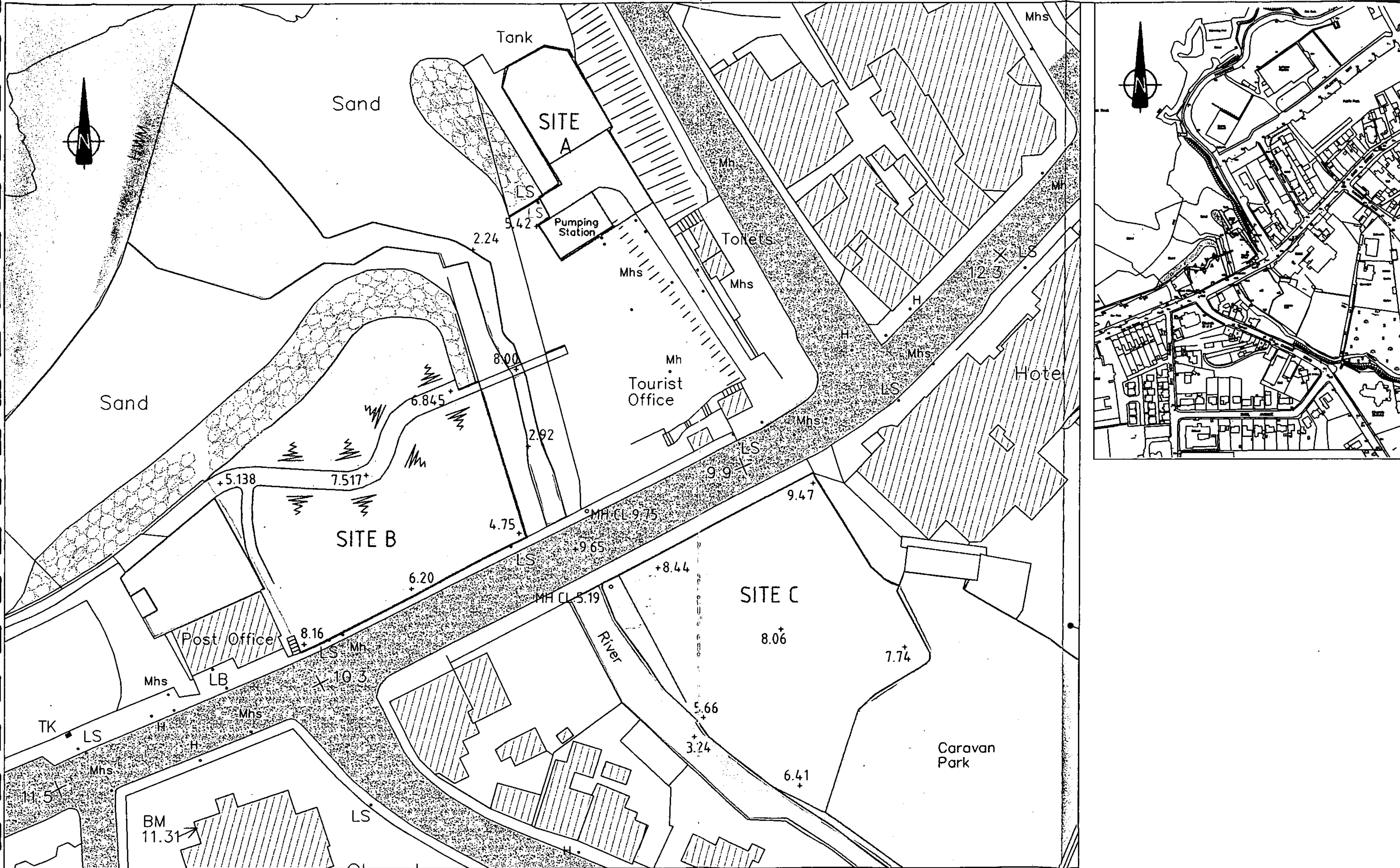
Access to the site would be via the existing public car park to the west of the site.

The construction of the station on this site could be carried out with the minimum of disruption to the operation of the existing system.

While this site is currently undeveloped the UDC have plans to enhance the amenity value of this location. As the majority of the work on this site would be below ground level the situation could be readily integrated into their overall plans for development in this area.

Given the proximity of the station to public areas odour and noise mitigating measures would be required.

While the site is low lying and below road level a high level of architectural treatment would be required given its central location and there is a need to integrate the development into the amenity plans for the site.



ALL LEVELS RELATE TO MALIN HEAD ORDNANCE DATUM

ALTERNATIVE SITES CONSIDERED
FOR THE MAIN PUMPING STATION

FIG. 4.2

Site C

Site C is located on the southern side of the Main Street. The area available is 0.52 ha and is sufficient for the new development.

Access to the site would require a new access onto the Main Street. The site is adjacent to hotels and a caravan site.

Unlike Site A and Site B this site is not low lying, more extensive groundworks would be required to construct the pumping station at this location. As for Site B the station could be constructed on this site with the minimum disruption to the operation of the existing pumping station.

Given the proximity of the station to public areas and adjacent buildings high levels of odour control and noise mitigation will be required.

The site would be extremely visible from the Main Street and would need a high level of architectural treatment and present a considerable challenge to integrate it into the existing streetscape.

4.3.3 Preferred Site Selection

The three available site options have been evaluated under the following criteria:

- area of land available
- low visual impact
- low pollution risk
- loss of amenity area
- ease of access
- economics of construction

The following suitability ratings were adopted high, moderately high, moderate, moderately low and low. The results of the analysis are shown on Table 4.2. Based on the framework analysis the sites are ranked in order of preference.

The analysis indicates that the preferred site is Site B.

4.4 Do Nothing Scenario

The Do Nothing Scenario cannot be considered, Donegal County Council are required under Irish and EU legislation to construct a wastewater treatment works and upgrade the sewerage system.

Failure to do so within an agreed timeframe would incur penalties and water quality in Donegal Bay would deteriorate. Public health could be put at risk by the inability of the existing system to cater for future development.

5.0 DIFFICULTIES ENCOUNTERED

In consideration of paragraph 2(d), Schedule II of the European Communities (Environmental Impact Assessment) Regulations, 1999 (S.I.93 of 1999), which allows for the inclusion of a description of difficulties encountered in compiling the EIS, it is concluded that adequate technical knowledge and information has been available in the production of this statement.

6.0 WATER QUALITY

6.1 Introduction

This section prepared by P.H. McCarthy & Partners, Aquafact and Kirk McClure Morton examines the quality of water in the Bundoran area and the impacts the proposed development will have on the water quality.

As part of the study bathymetric surveys, dye/dispersion monitoring and current metering were carried out and a water quality model of Donegal Bay calibrated. The report on this water quality modelling is included in Appendix B.

The model was used to predict the impact of the proposed development on water quality in the bay.

Kirk McClure Morton carried out a Beach Study Report 1996 the findings of which recommended the culverting of the Bundoran stream thus diverting discharge from the bathing beach to below the Mean Low Water Spring Tide Level. During the recent resort initiative and the construction of Stage 2 of the Bundoran Drainage scheme, raw sewage discharges to the stream have been eliminated.

In the water quality modelling carried out as part of the EIS it is being assumed that the recommendation to culvert the stream is being implemented.

6.2 Receiving Environment

Unscreened and untreated flows from the Bundoran catchment currently discharge through the existing marine outfall at Pollbrean. From the flow and load survey it is estimated that during the peak summer period some 540 Kg/d BOD_5 and 675 Kg/d SS are discharged at this location. The outfall is short and is exposed under low tide conditions. Dye dispersion monitoring indicates that under certain conditions of wind, wave and tide effluent is driven back to the shore in the proximity of the outfall.

There is an existing main pumping station in the centre of town which is not operating efficiently. The pumping/storage regime is inadequate for the current flows in the system leading to more frequent overflow occasions and reports from local surfers of deterioration in water quality near the overflow outfall during periods of discharge.

Notwithstanding the above, Bundoran Beach has in recent years maintained it's Blue Flag status.

6.3 Characteristics of the Proposal

There are a number of key elements of the proposal which will have an impact on water quality:

- Construction of a wastewater treatment plant to treat effluent to the following standards on a 95 percentile basis:

BOD_5	25 mg/l
SS	35 mg/l
COD	125 mg/l
NH_4	5 mg/l

- Construction of a new sea outfall discharging some 400m off-shore from the existing Pollbrean outfall terminating in a diffuser section.
- Construction of a new pumping station in the centre of the town beside the Bradoge River with associated balancing storage and screens to limit overflows to an average three occasions per bathing season.
- Construction of a new submersible pumping station at the West End with associated balancing storage to limit overflow to the new Pollbrean outfall to an average seven occasions per bathing season.
- Provision of 6mm aperture screens on all overflows up to a 1:10 year design flow.

The treated effluent will be discharged by an extended sea outfall terminating in a diffuser section. The outfall will be designed to ensure the maximum level of dilution at the discharge point. Water quality modelling indicated that dilution and dispersion will be such that it will not compromise migrating fisheries on the Drowes in terms of ammonia or current bathing water quality standards at Bundoran's Blue Flag beach. The location of the outfall is shown on Fig. 3.2.

The new pumping station and storage tank to be constructed at Bundoran Bridge will be designed to ensure that stormwater discharges will be limited to an average three spills per bathing season. This is in keeping with the Department of the Environment and Local Government's paper "Procedures and Criteria in Relation to Storm Water Overflows" for discharge to Bathing Waters. In addition the overflows will be to the existing outfall and discharge will be below MLWST.

The new pumping station and storage tank at the west end will be designed to ensure that stormwater discharges from this overflow to the new sea outfall at Pollbrean will be limited to seven spills per bathing season. This is in keeping with the DOELG Guidelines for discharge to waters classified as water contact and recreational which is appropriate to the water use in this area.

The provision of screens on all overflows will eliminate the discharge of gross solids at the overflows and their visual impact at the outfall points.

6.4 Potential Impact of Proposal

Construction

The proposed wastewater treatment plant is some distance from the Drowes River. A series of agricultural drainage ditches in the area connect to the Drowes River. The drains are overgrown and silted up and flows are low. The risk of impact on water quality in the Drowes River is considered extremely low.

The sea outfall will be laid in a trench excavated in the sea bed. Some local silting of the water in this area will occur. In addition explosives may be required to excavate in rock. This material, where practical, will be placed on the sea bed as pipe protection and supplemented with imported bedding material.

A new pumping station and storage tank will be constructed in the centre of the town on the seafront. On commissioning of the new station the existing station will be demolished. Both construction and demolition may cause some local silting problems.

Operation

Treated effluent (BOD_5, 25 mg/l, SS 35 mg/l, COD 125 mg/l and NH_4 5 mg/l) will be discharged via a new outfall at Pollbrean. It is estimated that at average flows through the works some 84 Kg/d BOD_5, 116 Kg/d BOD_5 and 13 Kg/d of NH_4 will be discharged to the bay in 2030 based on the future estimated peak PE values.

The water quality model demonstrated that the above discharges will in terms of BOD_5, SS and NH_4 not have a detrimental effect on the water quality at the mouth of the Drowes River. NH_4 is an important parameter at elevated concentrations as it is toxic to aquatic life. The model further shows that the coliform levels will not have a detrimental effect on bathing water quality at the beaches in Bundoran.

The overflow frequency from the main pumping station will be limited to an average three occasions per bathing season and at the west end pumping station to an average of seven occasions per bathing season. All flows up to a 1 in 10 year design storm overflow will be screened to 6mm aperture size.

Do Nothing Scenario

In a do nothing scenario increased volumes of untreated and unscreened effluent will continue to discharge to the sea at the existing Pollbrean outfall. Storm overflows from the pumping station in the town centre will increase in volume and frequency. The option not to treat the effluent and control stormwater discharges would be a contravention of the EU Council Directive (91/271/EEC) concerning urban waste water treatment incorporated into Irish Law under SI 419 of 1994.

6.5 Mitigation Measures

Mitigating measures that will be put in place during the construction period will include:

- Inclusion of a stilling pond and silt traps on all gravity and pumped flows during construction excavations to prevent pollution from groundwater and surface run-off.

- Carrying out construction work on the outfall during periods when construction will not impact on fish migration.

6.6 Predicted Impact of Proposal

The proposed treatment works will treat the wastewater to the standards set out in the Urban Wastewater Treatment Directive. This will reduce BOD_5 and SS discharges at the outfall from present peak values of 450 Kg/d and 675 Kg/d to future estimated peak values of 84 Kg/d and 116 Kg/d respectively in 2030

In addition the treatment plant will provide for nitrogen removal to reduce NH_4 in the final effluent to 5 mg/l. Modelling has shown that if nitrogen removal is not provided NH_4 levels at the mouth of the Drowes River could exceed levels that are known to be toxic to fish lift. NH_4 discharge will reduce from a current 43 Kg/d to 13 Kg/d under future conditions in 2030.

The water quality model predicted that the treated effluent discharging from the outfall would have no detrimental impact on the salmonoid river or on the blue flag beach in Bundoran. The overall pollution load in terms of BOD_5, SS and NH_4 in will be reduced having a significant positive impact on water.

The new pumping stations will result in a reduction in the frequency of the overflow occasions thus resulting in a positive impact on water quality.

6.7 Monitoring

Following the construction of the proposed treatment works on-going monitoring will be carried out to record the quality and quantity of the discharging effluent.

The Council will also monitor water quality at the bathing beaches.

6.8 Reinstatement

No reinstatement is considered necessary.

7.0 FLORA AND FAUNA

7.1 Introduction

This chapter examines the terrestrial, marine and freshwater flora and fauna in the Bundoran area and the impact the proposed development will have on said.

7.2 Terrestrial Flora and Fauna

7.2.1 Introduction

Natural Environment Consultants Ltd. was commissioned to conduct a baseline survey of flora and fauna of the proposed sites of the treatment works, pumping station and outfall.

Methods

The possible sites for the proposed treatment works and pumping stations were visited in March 2000 and a Phase I Habitat Survey (Anon. 1993) was carried out. The pipeline running from the proposed treatment works site to the proposed outfall location was surveyed in August 2000. A comprehensive listing of plant and bird species was not conducted on each site due to the season during which the fieldwork was conducted. While this may preclude the identification of rare or threatened species, the character of the habitat type was adequately ascertained from the assessment conducted.

7.2.2 Receiving Environment

The site for the proposed treatment works is located approximately 1km south-west of Bundoran town adjacent to a tertiary road connecting the N15 with the R280 road. The site is situated in a poorly drained valley floodplain of a minor tributary of the Drowes River.

The proposed pumping station site is located in the centre of Bundoran town adjacent to the existing pumping station.

The proposed pipeline route to the outfall site runs adjacent to the proposed Bundoran bypass route on the south of the town across wet to marshy grassland. It crosses the N15 Bundoran to Tullaghan road immediately east of the Drowes River bridge.

Designated Area

The Drowes River valley is part of a proposed Special Area of Conservation (pcSAC) that covers the Drowes River valley and Lough Melvin (pcSAC 00428). A list of all designated areas within a 5km radius of Bundoran is given in Table 7.1.

Table 7.1 - Designated conservation sites within 5km of Bundoran.

Status	Site Name	Reference No.
PcSAC	Drowes River valley / Lough Melvin	00428
PNHA	Finner Dunes and Erne Estuary	00139

Proposed candidate Special Area of Conservation (pcSAC)
Proposed National Heritage Area (pNHA)

This is a statutory designation that has legal basis in the EU Habitats Directive (92/43/EEC) as transposed into Irish law through the European Communities (Natural Habitats) Regulations, 1997 (S.I. 94 of 1997). The main implication of this designation is that any project likely to have a significant adverse impact on the integrity of the pcSAC may only be carried out for "imperative reasons of overriding public interest, including those of a social or economic nature".

Habitats, Flora and Fauna

Treatment Works Site

The site occupies an area of approximately 2.8ha which is comprised of a uniform floodplain-mire habitat type. The land is waterlogged and floods extensively in winter. The site lies in a shallow valley that was formed by a tributary of the Drowes River. The site has an extensive network of open drains, many of which are choked with vegetation causing impeded drainage.

The site is bordered to the north by an old track-way running to the east from the road and which is fringed for most of its length by shrubby willow (*Salix* spp.) and occasional hawthorn (*Crataegus monogyna*). A line of willow also fringes the western boundary of the site along an old drainage ditch. The remainder of the site is covered by a tussocky sward which has a high proportion of plants associated with fen habitat. Rushes (*Juncus* spp.) are abundant along with water horsetail (*Equisetum fluviatale*), marsh bedstraw (*Galium palustre*) and creeping bent grass (*Agrostis stolonifera*). There is a high proportion of moss within the sward. Other species present include sorrel (*Rumex acetosa*), daisy (*Bellis perrenis*), marsh thistle (*Cirsium palustre*), bog pondweed (*Potamogeton polygonifolius*), water mint (*Mentha aquatica*) and meadow sweet (*Filipendula ulmaria*). Marsh marigold (*Caltha palustris*), water figwort (*Scrophularia auriculata*) and crested dog's-tail (*Cynosurus cristatus*) are occasional. Within the choked drainage ditches common reed (*Phragmites australis*), sweet-grass (*Glyceria* sp.), flag iris (*Iris pseudacorus*), water-cress (*Nasturtium officinale*), starwort (*Callitriche* sp.) and occasional branched bur-reed (*Sparganium erectum*) occur.

Snipe were abundant within the site and may utilize the area for breeding given the suitability of the habitat. Skylark and reed bunting were also present and were evidently occupying breeding territories.

Badger tracks were abundant on the track-way forming the northern boundary of the site but there was no evidence of a sett located within the site. The tracks led towards some higher ground approximately 60m to the east of the site around a derelict dwelling, which provides suitable foraging as well as a potential sett site.

Otter spraints were present on the bridge over the Drowes tributary located approximately 60m south-west of the site. Otters may occasionally utilize the site foraging for frogs and eels along the ditches, though there are no suitable sites for a breeding holt present.

Pumping Station

The pumping station site is located north of the N15 road and on the west bank of the Bradoge River. It is flanked by the Post Office to the west and the river bank to the east. The site is currently separated from a sandy shoreline by a shingle berm deposited as part of the construction works taking place adjacent to the tourist office. The site has a vegetation dominated by fescue (*Festuca* spp.) and sea plantain (*Plantago maritima*). There has been some disturbance to the site as part of the recent shore protection works.

Proposed Pipeline Route from Treatment Works to Outfall Site

The pipeline route follows the southern edge of the proposed Bundoran bypass. The pipeline swings north approximately 90m east of the Drowes River before crossing the old Tullaghan Road and heading north-west towards the outfall at Pollbrean. Throughout the length of the pipeline between the proposed treatment works and the point at where it crosses the Sligo Road (a distance of approximately 1km), the route crosses an area of wet grassland which grades into floodplain-mire habitat. The land slopes gently to the south towards the Drowes River from the Sligo Road with the western section of the route passing through rank grassland. There is an extensive network of open drains in the lower land, many of which are choked with vegetation causing impeded drainage. The vegetation of the area is classified as floodplain-mire and has a similar fauna and flora species composition to that recorded at the treatment works site.

7.2.3 Characteristics of Proposal

The proposal is for the construction of a wastewater treatment works on a green field site and the construction of a pumping station in the centre of Bundoran adjacent to the existing pumping station, the upgrading of the sewer network and the extension of the existing outfall.

7.2.4 Potential Impact of the Proposal

Construction

The construction of the sewage treatment works may cause the loss of an area of floodplain-mire vegetation. There may also be a loss of habitat for a number of breeding and wintering bird species. Construction of the pipeline between the treatment works and the outfall site will also cause the short term loss of floodplain-mire vegetation. The construction of the pumping station will cause the loss of a minor area of neglected grassland.

Operation

The operation of the treatment works, pumping station and pipeline will have no significant impact on the terrestrial habitats in their vicinity. In the event of a malfunction at the wastewater treatment works all flows to the main lift pumping station will cease and these flows will be diverted to storage tanks provided under the main lift pumping station. Overflows from which will be screened before discharge.

Do Nothing Scenario

Should the proposed sewage treatment works not proceed, there will be no impact on the floodplain-mire habitat at the site of the proposed treatment works and pipeline route from the proposed development. However, there will be a continued deterioration of water quality in the inshore waters around Bundoran and within Donegal Bay.

7.2.5 Mitigation Measures

The loss of floodplain-mire vegetation at the site of the proposed treatment works can be mitigated against by appropriate landscape planting around the site. This should focus on the use of native species, which would serve to enhance both the aesthetics of the finished site as well as facilitating re-colonization by wildlife. The landscaping of the works and pumping station will be carried out under expert technical guidance.

The pipeline route should be constructed using a minimum operation width. Due to the high water table and the sensitivity of the vegetation to compaction, the laying of the pipeline should be carried from an artificial mattress laid along the route. Sods of vegetation should be removed form the trench line using appropriate machinery, stored in appropriate conditions and subsequently re-laid. This operation will carried out under the guidance of technical experts.

7.2.6 Predicted Impact of the Proposal

Following the incorporation of the prescribed mitigation measures, the predicted impact of the proposal will be minor and any loss of habitat will be compensated for by the improved water quality in the vicinity of Bundoran and throughout Donegal Bay.

The development of the treatment works will see the permanent loss of a minor habitat.

The pumping station site has already been disturbed for the purpose of developing the area resulting in no significant loss of habitat following the proposed construction of the pumping station.

7.2.7 Monitoring

The re-laying of the vegetation sods along the proposed pipeline route should be monitored immediately post-works by technical experts to ensure satisfactory compliance with the prescribed methodology. A follow up assessment of the re-establishment of the vegetation should be made at a six month interval following the completion of this operation.

7.2.8 Reinstatement

No reinstatement is required as a result of the proposed development.

7.2.9 Reference

Anon. (1993) Phase I Habitat Survey: *A technique for environmental audit.* Joint Nature Conservation Committee. Peterborough.

7.3 Marine Flora and Fauna

7.3.1 Introduction

Natural Environment Consultants Ltd. was commissioned to conduct a baseline survey of the marine flora and fauna at the outfall for the proposed Bundoran Sewage Scheme.

Methods

The site of the existing outfall pipe (inter-tidal) was visited in April 2000. The biota was assessed and classified according to the Joint Nature Conservation Committee (JNCC) system of classification (Connor *et al.*, 1997) and The Heritage Council (Fossit, 2000). The proposed 400m sub-tidal extension for the outfall was surveyed in August 2000 using scuba and the biota was assessed for the inter-tidal communities.

7.3.2 Receiving Environment

General Site Description

The location of the proposed outfall is situated approximately 2km west of Bundoran town on a low headland. The shore is north-facing at this point and has a moderate to high exposure. The headland is formed from a thin band of glacial over-burden overlying gently dipping limestone bedrock. The inter-tidal zone is comprised of a shelf of limestone through which the existing outfall pipe extends for a distance of approximately 200m in a west to north-west direction. The pipeline is currently bedded into the limestone and covered with concrete. The sub-tidal area is gentle shelving with some areas of boulder, gravel and sands overlying the limestone bedrock.

Habitats, Flora and Fauna

Proposed Outfall Site

The proposed outfall is located approximately 2km to the west of the town centre at the site of the existing outfall. The existing pipeline is buried into the bedrock of the inter-tidal zone which is formed by gently dipping limestone pavement. The outfall is located approximately 80m from the upper shoreline and discharges at approximately 200mm above mean low water spring level. The shore, which has a northerly aspect at this point, has a moderate to high exposure. The upper shore is backed by a low cliff with a thin band of glacial over-burden on limestone bedrock. Immediately west of where the existing outfall pipe meets the shoreline at Pollbrean, there is a storm beach formed of rounded cobbles at the upper end of the Pollbrean gully. The limestone pavement extends to the lower inter-tidal where it steps down approximately 3m to a boulder, cobble and gravel substrate which overlies the limestone bedrock.

Inter-tidal Zone

The major habitat type present on the shore within the vicinity of the outfall is high to moderate energy, wave-exposed rock with full salinity. The littoral or inter-tidal zone is comprised of limestone pavement which dips gently to the south in shallow steps forming a series of pools. The vertical faces of the steps, along with the joints and fissures in the rock, form a secondary niche providing some shelter and a firmer anchor point for a variety of organisms than the horizontal pavement. The upper shore and splash-zone are formed from shattered bedrock and have abundant nooks and crannies to provide shelter to organisms from desiccation by the sun. The shore type is classified as moderately exposed rock with barnacles and limpets (*Patella* spp.) (ELRBpat_ir) according to the JNCC classification (Connor *et al.*, 1997).

Lichens are abundant in the splash zone with extensive coverage by the black *Verrucaria maura* lower down and abundant *Xanthoria parietina* and *Ramalina* spp. higher up. Within the upper shore, winkles (*Littorina littorea*) and barnacles (*Semibalanus balanoides*) are frequent, with limpets (*Patella vulgata*) and mussels (*Mytillus edulis*) occurring in small numbers. The green seaweed (*Enteromorpha* sp.) is abundant, with occasional patches of channeled wrack (*Fucus canaliculata)*. The honeycomb worm (*Sabellaria alveolata)* is also present in small quantities under overhangs and larger boulders. Two prominent *Sabellaria* reefs are located in close proximity to the outfall; the more extensive is situated at Pollbrean and the second lies approximately 50m south-west of the outfall. The brown seaweed *Fucus cerranoides* forms a light sward over much of the reef.

Within the mid to lower shore the green seaweed (*Cladophora cf. rupestris)* is dominant with extensive amounts of the crustose red seaweeds *Lithothamnion* and *Lithophyllum* occuring on the lower shore and in the pools higher up. Dabberlocks (*Alaria esculenta)* and *Porphyra umbilicaris* are also frequent on the lower shore along with the brown seaweed *Scytosiphon lomentaria.* The red seaweeds *Gigartina stellata* and *Furcellaria fastigiata* are both occasional in the pools and below the mean low water spring level. Mussels and barnacles are abundant with limpets occurring frequently on vertical rock faces and in rock pools. Mussels are most frequent along the crack lines and in nooks in the mid and lower shore where their byssus threads can gain a firm holding. They are primarily less than 1cm in length. Barnacles reach very high densities extending from the lower shore to the mean high water neap mark. Beadlet anemones (*Actinia equina*) occur occasionally within the pools and in some of the more sheltered recesses of the rock.

Sub-tidal Zone

The sub-tidal substrate is comprised primarily of exposed limestone bedrock with varying amounts of boulder, cobble, gravel and sand occurring in patches. The limestone slopes gently to the north, varying in depth from approximately 2.5m (below chart datum) at the base of the low cliff defining the littoral zone to approximately 13.5m at a distance of 400m. The rock is fractured primarily on an east-west orientation forming frequent shallow channels. There are two prominent rock faces along the proposed outfall route, the first occurring adjacent to the existing outfall pipe and the second located approximately 100m offshore from this point. The seaward 100m of the proposed outfall route was comprised of poorly fractured limestone with occasional blocky boulders.

The shallow sub-tidal zone was dominated by a loose canopy of kelp (*Laminaria digitata* and *L.hyperborea*), with an understorey of red seaweeds (*Pophyra umbilicalis, Palmaria palmate* and *Delesseria sanguinea*). Crustose red seaweeds (*Lithothamnion* spp. and *Lithophyllum i.*) were abundant on larger rocks and exposed bedrock. The brown seaweeds *Fucus serratus, Alaria esculenta* and *Pelvetia caniculata* were occasional. Limpets (*Patella vulgata*) and winkles (*Littorina littorea*) were occasional to frequent with tufts of the green algae *Cladophora* occurring on many of the limpet shells. The abundance of kelp varied with the substrate and in places was absent entirely due to the presence of sand or an un-fractured shelf of limestone.

Sea urchins (*Echinus esculentus*), sea cucumber (*Holothuria forskali*) and starfish (*Asteria rubens*) were occasional throughout. The fish were dominated by ballan wrasse (*Labrus bergylta*), corkwing wrasse (*Creilabrus melops*) and rockcook (*Centrolabrus exoletus*). Leopard-spot goby (*Thorogobius ephippiatus*) and bib (*Trispoterus luscus*) were occasional. Common prawns (*Leander serratus*) and squat lobsters (*Galathea* sp.) were frequent in suitable crevices in vertical rock faces.

Evaluation

The flora and fauna of the inter-tidal zone are comprised of species typical of exposed sites on a bedrock substrate with full salinity sea water. The limestone nature of the bedrock provides additional niches due to its fracturing and eroding properties. The communities present in this zone are typical of these conditions and are widespread along the western seaboard of Ireland.

The flora and fauna of the sub-tidal section of the outfall route are typical of exposed infralittoral rocky communities and are also found abundantly along the western Irish seaboard.

7.3.3 Characteristics of the Proposal

The development proposes to extend the existing outfall further out to sea along the existing path.

7.3.4 Potential Impact of the Proposal

Construction

Standard rock-breaking equipment will be employed in the inter-tidal section of the pipe-laying operation that will follow the existing pipeline route. This will result in a temporary minor localized impact. However, there is likely to be a significant temporary impact in the sub-tidal section due to the use of explosives for trench excavation.

The nature of these impacts on marine life from underwater explosions is presented which has been derived from Rasmussen (1967). Explosive charges used underwater generate a shock wave, which is propagated at a speed of about 1,500m/sec. At the point of explosion a gas bubble is also formed which expands and contracts owing to the water pressure. This phenomenon gives rise to a secondary shock wave that is less powerful than the first. Gunpowder produces a comparatively mild sound and shock wave compared to dynamite and has markedly less impact on fish. The mortality of fish varies with the quantity of fish in the area and their position in the water column. The shock wave from a seabed explosion will travel in a well-defined conical path owing to bottom contours producing a shadow zone around the explosion crater. Fish within the shadow zone apparently are not killed by the explosion. Bottom-dwelling fish are less affected than pelagic species due to their lack of swim bladders making them more resistant to pressure change. Molluscs and crustaceans appear to be quite resistant to the pressure waves from underwater explosions. Impacts of underwater explosions on fish fry and zooplankton appear to be poorly understood. The impact on seals and cetaceans from underwater explosions is potentially high, but is proportional to the size and type of explosion and the distance of the animals from the source.

In conclusion, there will be a temporary significant localised adverse impact on marine life from the constructional phase of the outfall pipe-laying operation.

Operation

The impact of the sewage treatment works and in particular the outfall during the operation phase will be positive following the re-colonization of disturbed substrate by fauna and flora. Additionally, the reduced nutrient load and BOD levels emanating from the existing outfall will result in better water quality in the immediate area as well as throughout Donegal Bay.

Do Nothing Scenario

Water quality in the Bundoran area and throughout Donegal Bay will be negatively impacted by the continued release of inadequately treated sewage at the current outfall site. While only very localized impacts on the marine biota are apparent from the current outfall, their impact on nutrient levels and the links with algal blooms within Donegal Bay are likely to be at least moderately negative.

7.3.5 Mitigation Measures

The trenching and operational width in the inter-tidal zone should be kept to a minimum during the construction phase. The existing pipeline route should be utilized where possible.

Within the sub-tidal zone, the use of explosives for trench excavation should be kept to a minimum. The depth and width of the trench should be kept to an absolute minimum. Underwater detonations should be conducted during low water to minimize the depth of water over the explosion and thus the radius of the shock wave cone. Sonic seal-scarers should be set at 50m intervals at a radius of 300m around the explosion points to prevent seals being affected by sound or shock waves. The impact on benthic dwelling flora and fauna can be minimized by removing trench debris onto a barge as opposed to setting it to one side of the trench. Backfilling should be completed by capping with large stones or slabs of limestone.

7.3.6 Predicted Impact of the Proposal

The proposed outfall pipe as part of the wastewater treatment plant for Bundoran will have a positive impact on water quality within the Bundoran area and throughout Donegal Bay.

The construction phase of the inter-tidal section of the outfall pipe will have a temporary minor negative impact on the associated flora and fauna. The construction phase of the sub-tidal section of the outfall pipe will have a temporary significant adverse impact on the associated flora and fauna. In both the inter- and sub-tidal sections, re-colonization by flora and fauna will commence rapidly following completion of construction works.

7.3.7 Monitoring

The sub-tidal trenching operation will be monitored by technical experts to determine the extent of the impact on the biota from the use of underwater explosives. The recovery of the biota in the damaged area should be monitored on completion of the pipe-laying, after a six month and twelve month period to assess re-colonization and recovery.

7.3.8 Reinstatement

Reinstatement of the substrate along the trenched section of land for the laying of the outfall pipe should be carried out with a view to providing a continuity of existing substrate type and character. This can be achieved by utilizing limestone as trench capping in the sub-tidal section, and plastering with a lime-rich aggregate over the inter-tidal section.

7.3.9 References

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7.4 Freshwater Fauna

7.4.1 Introduction

Aquens Ltd. were engaged to carry out a desk study of the salmonids in the Drowes River. The effluent from the plant is to be discharged into Donegal Bay. However, given the proximity of the Drowes estuary to the proposed effluent outfall it was deemed essential to include a review of the Drowes fishery in the assessment. A perusal of the available literature demonstrated the existence of two major scientific works for the lake and its catchment. The first by Kennedy and Fitzmaurice (1971) dealt with age and growth studies of brown trout in rivers and lakes throughout the twenty-six counties and included Lough Melvin. The second work by Ferguson (1986) concentrated on the unique fish community found in Lough Melvin and its tributaries. Other references were directed more towards helping visiting anglers. In 1987 and 1991 O'Reilly produced two excellent guides for visiting anglers. The first volume dealt with the trout and salmon Loughs of Ireland while the second volume concentrated on salmonids in the rivers

7.4.2 Receiving Environment

The Drowes is the only effluent tributary to exit Lough Melvin at Lareen Bay, flowing in a westerly direction for a distance of circa 5 km to enter Donegal Bay near Bundoran. The lower reaches of the Drowes are estuarine and under tidal influence. Melvin is bordered by the Counties of Leitrim and Fermanagh. It, therefore, straddles the border with the north-eastern corner of the lake lying in Northern Ireland. The lake possesses six inflowing tributaries, the Tullymore, Roogagh, County, Ballagh and Glenaniff.

Melvin is, by Irish standards, a lake of moderate size. It has a grid reference of G9052 and its main axis lies in NW-SE direction. The area of the lake is 2,125 hectares, surface area 22.5 km^2, catchment area 223.6 km^2, maximum length 12.5 km, maximum width 2.4 km, maximum depth 45 metres, altitude 21.3 metres, conductivity 145-161 µS/cm, alkalinity range 0.91-1.06 mEq/l, hardness range 58-64 mg/l $CaCO_3$. The depth range in Lough Melvin is generally 10-20 metres, with a deep trench traversing east-west from Rossinver Bay towards the outlet into the Drowes.

Fishery Resource

The following eight species are known to occur in Melvin and its tributaries;

Atlantic salmon (*Salmo salar* L.)
Brown trout (*Salmo trutta* L.)
Arctic char (*Salvelinus alpinus* L.)
Eel (*Anguilla anguilla* L.)
Three-spined stickleback (*Gasterosteus aculeatus* L.)
Nine-spined stickleback (*Pungitius pungitius* L.)
Perch (*Perca fluviatilis* L.)
Minnow (*Phoxinus phoxinus* L.)

The salmonid species, particularly Atlantic salmon, are of most concern. Salmon are a migratory species depending on free access between the marine and freshwater environments. They also require good water quality. O'Reilly (1991) refers to the Drowes River as being one of the premier spring and summer salmon fisheries in Ireland. He further states that sea trout rarely enter the system but the river carries a good stock of indigenous, non-migratory brown trout. Atlantic salmon also occur in Melvin together with four genetically distinct races of trout. These are brown trout, ferox trout, sonahen trout and gillaroo trout.

Mr Thomas Gallagher, Kinlough, Co. Leitrim, is the present owner of the Drowes. All of the left bank of the river from Lough Melvin to Bundrowes Bridge and most of the right bank are in his possession. Commercial traps located at the mouth of the river have not been in operation since 1979 and are now considered derelict. Mr Gallagher manages the fishery and currently hires out the fishery to tourist anglers and caters, in particular, for continental clientele. The beat system is not operated on the Drowes. This system has sometimes been a feature of other Irish salmon rivers. The number of rods fishing at any one time is also unlimited. O'Reilly gives further valuable information on the Drowes by stating that there is a profusion of salmon pools (55 named pools) in a relatively short stretch of river water.

Rod Caught Salmon Numbers from the Drowes River

O'Reilly (1991) includes annual salmon figures for the Drowes for the period 1984-1989; these are supplemented by a more recent set of figures provided by Mr Gallagher, the present owner (Table 7.3.1).

Table 7.3.1 - Salmon Catches Over Two Separate Periods for the Drowes

Year	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**Average of 6 Years Data**
Salmon	910	747	821	728	650	1,240	847

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**Average of 5 Years Data**
Salmon	1,192	1,295	1,517	1,001	1,419	1,285

According to Mr Gallagher in earlier years the onus lay with individual anglers to make proper catch returns but not all anglers had co-operated. In fact he contends that there have been many anomalies found in the earlier catch returns rendering them unreliable. Since he became involved he has striven to improve this important aspect of the fishery. His efforts have been vindicated when the catches for the 1995-1999 period are examined.

To improve casting facilities for rod fishing a series of walkways have been installed on either bank from Lareen Bay, the exit point of the Drowes from Melvin, to the Four Masters Bridge. This upper section of the river has a moderate gradient with reasonable flow rates passing through many pools intermingled with a series of streams. The middle section of the river, however, tends to be more torrential downstream as far as Lennox's Bridge. Again, water levels determine when this reach fishes best. Experience has shown that salmon catches tend to improve when water levels are medium to low in depth. Towards the estuarine portion of the system the flow rate decreases markedly as water depth increases.

The Drowes River forms an integral part of a magnificent natural facility. Migrating salmon arrive in the estuary from 1st January onwards each year. The fish move rapidly upstream. The first rod caught salmon of the season in Ireland is generally taken on the Drowes. The spring run of salmon reaches its peak during the March/April period. The main grilse run does not commence until the latter part of May. It continues during June and July. By August and September anglers are fishing over mainly resident salmon. It is difficult to believe that the excellent brown trout fishing which exists in the Drowes is largely ignored. This may be linked with the fact that many of the trout in the lower reaches of the system tend to be young and of a small size. The Drowes estuary comprises three pools downstream of Bundrowes Bridge in Tullaghan, Co Leitrim. These pools are always worth fishing at high tide.

From a scientific viewpoint Melvin possesses a unique salmonid fish community which originates from the Last Ice Age. In many respects Melvin is still unique in that its water quality has remained relatively unaffected by nutrient enrichment or over-exploitation. The now classical work of Ferguson (1986) which outlined the salmonid story for Melvin and its tributaries is still creating interest among international scientists in other countries. Unlike most other Irish lakes Melvin is known to hold four species of brown trout. In order of abundance they include sonaghen (*Salmo nigripinnis*), gillaroo (*Salmo stomachius*) and ferox trout (*Salmo ferox*), any trout that did not clearly fit into one of the other categories was called a brown trout. The three first mentioned species are distinct and have been separated on the basis of morphological features, meristic character differences or by genetic character variation. There are also clear feeding differences between sonaghen and gillaroo. The former species feed mainly on *Cladocera* spp. (water fleas), chironomids (non-biting midges) and *Chaoborus* spp. (phantom larvae), while the latter feed mainly on bottom living macroinvertebrates. These aquatic organisms include snail, caddis-fly and shrimp. The third species (ferox) is known to switch to a fish diet early in its life cycle. Fish living on a fish diet tend to grow faster. In the case of the ferox trout they also tend to be cannibalistic feeding on other trout. Ferox trout are generally found in the larger Irish lakes where they live for long periods of time (some fish have been 12-13 years old).

The sonaghen is known to spawn in the smaller tributaries especially the Ballagh, Tullymore and County streams. The gillaroo, however, breeds in the upper reaches of the Drowes, also in Lareen Bay and possibly in other shallow bays of Melvin. The genetic differences found for the sonaghen and gillaroo species has been confirmed by hatchery population studies. Growth in gillaroo is accepted as being slightly faster than in the sonaghen. Most trout in the Melvin system reach 25 cm in length within three years. Neither species is long-lived and few survive beyond four to five years. This is a normal feature of Irish brown trout.

One other species of fish occurs in Melvin at the present time the arctic char (*Salvelinus alpinus*). Arctic char are known to be extant in Loughs Mask and Melvin. According to Toivonen (1972) these fish are characteristic of large oligotrophic European lakes. Much has been written by Went (1945, 1971) on the distribution and subspecies of char in Irish waters. Champ (1977) highlights the fact that char have become biological indicators. Over the past twenty years there are numerous cases recording the gradual disappearance of the char from many Irish lakes including Loughs Ennell, Owel, Conn Corrib and Leane. The disappearance has been inextricably linked to eutrophication.

7.4.3 Potential Impact of the Proposal

The future of the Drowes and Melvin salmon fishery depends on the maintenance of free access between the freshwater and marine environments and good water quality. The proposed introduction of the waste-water treatment plant is a most welcome move in regard to ensuring the future water quality of Donegal Bay.

Construction Phase

Silt and run-off during the construction of the access road to the treatment works and the works itself could discharge into the Drowes.

Operation

The treated discharge at the outfall may impact upon migrating salmon. Problems may also arise for fish if backwash of effluent enters the river estuary.

Do Nothing Scenario

If the development does not proceed there would be no change in the existing river environment.

7.4.4 Mitigating Measures

In order to mitigate against the runoff of silt and oil to the Drowes during the construction phase all surface water should be intercepted to ensure polluting substances are removed before discharging surface water to any water course.

The discharged effluent should be monitored regularly to ensure the required standards are being met and that treated effluent discharges meet the parameters set out in Section 6. These parameters have been selected to ensure that they have a positive impact on migrating fish at the mouth of the Drowes River.

7.4.5 Predicted Impacts of the Proposal

As was discussed in Section 6 above a mathematical modelling exercise of Donegal Bay was undertaken in order to ascertain the impacts of discharging a treated effluent at the proposed outfall location. The model illustrates that the discharged effluent does not reach the river estuary, that the treated effluent will improve the quality of the water in the Bay, ensuring the safe passage of migratory fish from marine to fresh waters.

The provision of the proposed scheme will have a significant beneficial impact on the receiving water quality and is a welcome development, as the existing drainage system is the primary source of waste discharges to the estuary and bay.

7.4.6 Monitoring

No monitoring is required other than the water quality monitoring at the outlet from the treatment works.

7.4.7 Reinstatement

No reinstatement is envisaged as a result of this development.

7.4.8 Acknowledgements

The author wishes to acknowledge the courteous and warm welcome afforded to him by Mr Tom Gallagher, Kinlough, Co. Leitrim, owner of the Drowes fishery, and for the invaluable assistance received from him during a recent visit to the Drowes and Melvin fishery. Also a word of thanks for his help and courtesy to Ms Caitriona Ni Choclain BSc.,M.Appl. Sci.(Env. Sci.) Research Assistant, Zoology Department, University College Dublin. A special word of thanks to Mr Trevor Champ BSc., MSc. Central Fishery Board, Glasnevin, Dublin for relevant papers received in relation to the Melvin fishery. Finally, my sincere thanks to Mr Lindsay Clarke, Angling Officer, Northern Regional Fisheries Board, Ballyshannon, Co Donegal, for all his trouble in providing information on the salmon landings and redd counts for the Drowes river.

7.4.9 Bibliography

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8.0 HUMAN BEINGS

8.1 Introduction

This section prepared by P.H. McCarthy & Partners, describes the human environment of Bundoran and its environs and the impact the proposed development will have in terms of socio-economics, public health and amenity uses.

8.2 Socio Economics

8.2.1 Receiving Environment

Bundoran's location on the south-west coast of Donegal has made it a popular holiday resort. This results in an influx of tourists during the summer months giving rise to a significant increase in the loading on the sewerage system during this period. Thus winter and summer populations must be addressed individually, this is discussed in detail in Section 3.3.

Existing and Future Population

The existing population and estimated high and low growth future populations derived in Section 3 are summarised below in Table 8.1.

Table 8.1 Existing Population Equivalent

Description	Population 2000	Year 2030	
		High Growth	Low Growth
Winter	2,000	5,200	4,550
Summer Peak Weekday	7,500	32,400	29,000
Summer Peak Weekend	9,000	26,700	22,800

8.2.2 Characteristics of Proposal

The proposed development is for a wastewater treatment works, a new main pumping station, upgrading of the existing sewerage system and an extension to the existing outfall.

8.2.3 Potential Impact of the Development

Construction Phase

The construction phase of the proposed development is expected to have a moderate impact on the population and employment in the area. The proposed development will make possible the creation of both direct and indirect employment during the construction phase with direct employment equivalent to approximately 50 man years and indirect employment equivalent to approximately 20 man years. Overall, the construction programme will bring a moderate benefit to the local economy due to the income that will result.

Operational Phase

In terms of direct employment it is likely that there will be approximately three staff permanently employed on the operation of the Works. The construction of the works will greatly increase the potential for the town to develop both commercially and industrially and will have a positive impact on the social and economic development of the area.

Do Nothing Scenario

If the development does not proceed European and National requirements for the treatment of urban waste water will not be adhered to.

8.2.4 Mitigating Measures

No mitigation measures are deemed necessary from the point of view of population and employment as a result of this development.

8.2.5 Predicted Impact of the Development

As for potential impacts of the development.

8.2.6 Monitoring

No monitoring is considered necessary.

8.2.7 Reinstatement

No reinstatement is required in relation to population as a result of this proposed development.

8.3 Public Health

8.3.1 Receiving Environment

Presently wastewater in Bundoran is flows through a network of sewers and is discharged untreated through an outfall at Pollbrean into Donegal Bay. The European Directive 91/271/EEC concerning Urban Waste Water Treatment requires that Member States ensure that discharges of sewage be at least subject to secondary treatment by 2005 for towns with population equivalents of between 10,000-15,000 p.e.

8.3.2 Characteristics of Proposal

The proposed development is for a wastewater treatment works, a new main pumping station, upgrading of the existing sewerage system and an extension to the existing outfall.

8.3.3 Potential Impacts of the Development

Construction Phase

During the construction phase increased traffic movements in the area of Bundoran may pose a risk to public safety. However Bundoran is on a national primary route and residents in the area are not unaccustomed to large volumes of traffic passing through the town especially during the summer season.

Operational Phase

On operation of the proposed treatment works residents can expect positive impacts arising from the discharge of a treated effluent at the outfall. Concerns regarding the safety of the Bay for recreational and sporting activities should be lessened.

Do Nothing Scenario

If the development does not take place legislation will not be adhered to. With an increasing population the absence of a treatment works would pose a real risk to public health.

8.3.4 Mitigating Measures

Impacts relating to traffic in the area will be dealt with in Section 13.0. All other impacts addressed above are associated with positive impacts on public health with the completion of the proposed development.

8.3.5 Predicted Impact of Proposal

It is envisaged that the positive impacts on the health and safety of the residents will outweigh any negative issues arising as a result of this development.

8.3.6 Monitoring

Measures will be put in place to regularly sample and analyse the discharge from the treatment works and also the water quality at the bathing beaches.

8.3.7 Reinstatement

No reinstatement is required as a result of this development.

8.4 Amenity

8.4.1 Receiving Environment

Bundoran is a popular destination for day-trippers and tourists. Situated approximately 32km north of Sligo town overlooking the Atlantic, Bundoran offers a variety of sports and leisure activities. The major amenities in the area include a sandy beach, which has achieved the blue flag status, a golf course and pitch and putt course. Sailing, surfing and windsurfing are popular activities along the coast while the River Drowes is noted as being one of the premier spring and summer salmon fisheries in Ireland. Bundoran also supports a large indoor Waterworld centre, horse riding and mountain climbing facilities.

8.4.2 Characteristics of Proposal

The proposed development is for a wastewater treatment works, a new main pumping station, upgrading of the existing sewerage system and an extension to the existing outfall.

8.4.3 Potential Impacts of the Development

Construction Phase

The potential impacts on amenities in the area are envisaged during the construction phase are traffic, noise, dust and dirt on the roads.

Operational Phase

The operation of the treatment works and the pumping station is not expected to have any negative impacts on amenities in the area, in fact the discharge of a treated effluent into Donegal Bay is likely to increase the potential for water amenities in the area.

The discharge of a treated effluent can only improve the quality of the water thus helping to maintain the blue flag status that the beach currently holds.

The UDC have ongoing plans to develop the area around the pumping station in the centre of the town as a public amenity area. During the construction of the pumping station this aspect of development may also be addressed.

Do Nothing Scenario

If the development is not realised legislative requirements pertaining to urban wastewater will not be met.

8.4.4 Mitigation Measures

Mitigating measures pertaining to traffic control during construction are addressed in Section 13 and noise in Section 9. A water doser will be used to suppress dust and mechanical road cleaning equipment will remove dirt from the road during construction.

8.4.5 Predicted Impacts of the Development

The overall predicted impacts from the proposal are positive and favour the development.

8.4.6 Monitoring

No monitoring is considered necessary in this instance.

8.4.7 Reinstatement

No reinstatement is envisaged as a result of this development.

9.0 AIR

9.1 Introduction

This section will examine the sub-topics of noise and odour.

9.2 Noise

9.2.1 Introduction

This section has been undertaken by P.H. McCarthy & Partners in association with Biospheric Engineering Ltd. An assessment of the potential noise impacts at the proposed wastewater treatment works site and the main pumping station in the centre of Bundoran town is discussed.

The proposed site for the works is close to the River Drowes - to the south of the Bundoran Road and proposed bypass route. See Fig. 3.1.

The works will be procured on a design-build operate basis so exact details of the actual equipment to be used or even the type of treatment process is not as yet confirmed. In order to cater for the different alternative technologies two possible treatment options were examined; an Activated Sludge process and a Sequencing Batch Reactor (SBR) process. Potential equipment suppliers of the equipment were contacted and noise data on the items of equipment were collected. This information was compiled with existing monitoring data from measurements taken by Biospheric Engineering Ltd. on existing wastewater treatment works to provide the basis for noise prediction maps for both technical options.

Results from a background noise survey were combined with the noise prediction maps produced by Biospheric Engineering Ltd. to assess the possible impacts of the proposed works.

The study shows the level of reduction that can be achieved by modern noise abatement methods and sets levels for noise emission from the proposed works.

9.2.2 Receiving Environment

Two types of noise measurement were required to assess the situation; (a) background noise, (b) noise generated by the proposed works.

Background Noise Measurement

Background noise measurements were carried out on 8th and 9th of June 2000, using a Bruel & Kjaer model 2260 Noise Analyser. The ISO standard cites the factors to take into consideration in establishing suitable monitoring locations for assessing noise emissions as:

- Proximity of the source to sensitive receptors (residential developments, public buildings, roads, recreational areas).
- Existing background levels.
- The topography of the surrounding area.
- The prevailing wind direction.

The following monitoring locations were chosen and are illustrated on Fig. 9.1.

Site	Location
N1	Proposed New Main Pumping Station Site
N2	New house South of proposed WWTW Site
N3	Housing Estate East of Proposed WWTW Site
N4	House North of Proposed WWTW Site
N5	Proposed WWTW Site

Table 9.1 - Measurement of Noise Emissions (Site Survey)

Site	Total time	L_{Aeq}		L_{AF95}	
		Day	Night	Day	Night
N1	3 hours	47		40	
N2	1 Hour	41		37	
N3	1 Hour		40		36
N4	1 Hour		41		37
N5	1 Hour		40		36

The site is located in a valley to the South of Bundoran town at an approximate Ordinance Datum of 5.6 metres. The site is overlooked to the South by a series of newly constructed and older dwellings at an approximate O.D. of 12 metres. The valley is approximately 400 metres wide in the location of the site and extends East-West for a considerable distance (beyond the scope of influence of the noise emissions from the proposed works).

The area is essentially rural in character with farm buildings and older farmhouses forming the older building stock with new dwellings being developed in "ribbon development" on the road network in the area.

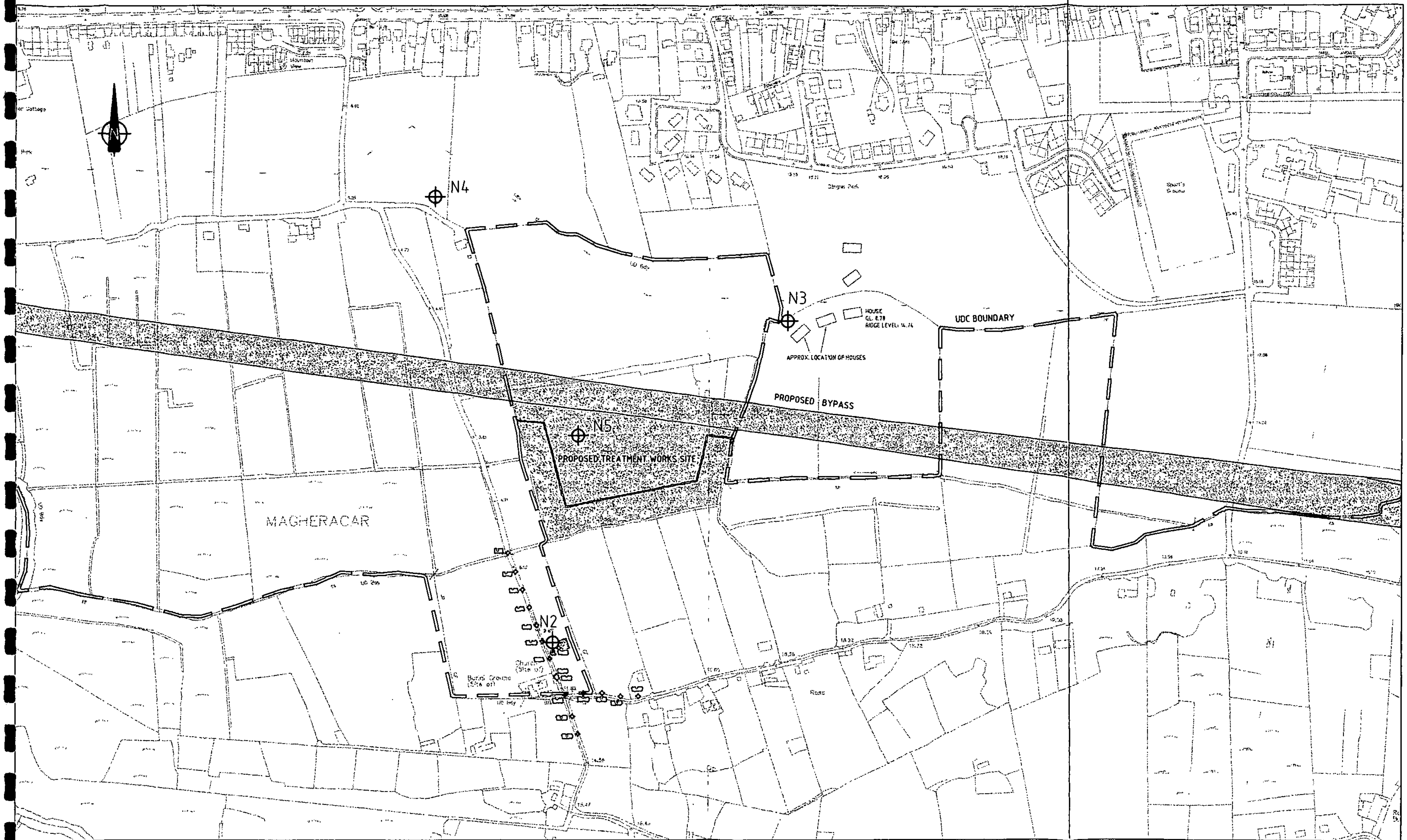
There are no intensive noise sources in the area at present. The main noise source comes from traffic on the N15 located 500 metres to the North and extends to a point about 700 metres west of the proposed works.

One of the proposed routes for the N15 Bundoran bypass is located immediately to the North of the proposed works and if the proposed bypass is constructed on this route it is estimated that the peak (L_{A10}) noise levels in the rural area will increase to 60 dBA during the day as a result of traffic on the bypass.

The receiving environment at the proposed pumping station comprises an area to the North of the N15 which fronts onto the beach and lies below the level of the N15 and the adjoining properties. The roof of the proposed pumping station will be approximately level with the N15 and a viewing platform for the public will be provided on the roof of the pumping station. Due to the shape of the proposed location noise will be directed towards the beach. If the public have access to the roof of the building consideration must be given to equipment vibration isolation for the pumping station.

9.2.3 Characteristics of Proposal

The proposed development consists of the construction of a new pumping station in the centre of Bundoran town, a wastewater treatment works on a greenfield site, upgrading of the existing sewer system and an extension to the existing outfall at Pollbrean.



N2 NOISE MONOTORING SITE

NOISE MONITORING LOCATIONS

FIG. 9.1

9.2.4 Potential Impact of the Proposal

Construction

Noise levels in the area will increase during the construction phase of the project. During the construction of the treatment works noise will be generated from the use of excavators, concrete equipment, cranes and increased traffic movements, in particular the movement of soil and concrete to and from the site. The driving of piles on site will also add to noise levels. Noise generated by the construction phase cannot be quantified at this point as the detailed design and method of construction are not known. The noise generating potential of commonly used construction equipment is outlined in Table 9.2.

Table 9.2 – Noise Generating Potential of Construction Equipment

Equipment Item	Noise Level dB(A) @ 15m
Trucks	82-94
Tractors	76-96
Front Loaders	72-84
Scrapers/Graders	80-93
Concrete Mixers	75-88
Concrete Pumps	80-84
Concrete Vibrators	70-82
Mobile Cranes	75-88
Derrick Cranes	86-88
Pumps	68-72
Generators	72-82
Compressors	75-88
Jackhammers	82-98
Rockdrills	85-100
Impact Pile Drivers	95-115
Saws	73-82

During construction of the pumping station, excavators and rock breakers will be operating on the site. The movement and placement of concrete and equipment will also increase noise levels.

Noise and vibration from construction activity can be the cause of serious disturbance and inconvenience to anyone exposed to it. The potential disturbance from the construction phase of the project is significant in terms of potential noise levels generated. The construction phase will however be of limited duration and noise levels will be controlled by the mitigation measures outlined later in this report.

The combination of short duration and implementation of mitigation measures during the construction phase will mitigate against any short-term inconvenience.

During the construction of the extension to the outfall pipe the construction noise may potentially impact on fish migrating from the marine environment to the freshwater environment.

Operation

Due to the requirement for a design build and operate project it was necessary to provide two separate assessments for two possible treatment options; the Activated Sludge and the SBR option. As no equipment supplier has been selected both possible options were pursued and the following companies were contacted for information on equipment and possible noise emissions.

- ABS Pumps Ireland Ltd.,
- Aerzen Machines, UK
- Hick Hargreaves, UK
- Jones Environmental, Dublin
- Seepex, UK
- USF Bowen, Kilkenny
- Westfalia, Denmark

Biospheric Engineering Ltd. have carried out several previous studies of noise emissions in connection with licence applications to the Environmental Protection Agency and have data on file for similar equipment in operation on other sites.

This data was combined to generate a list of equipment for each option and the associated sound power levels of the equipment. The equipment used in each model is outlined in the following Tables 9.3 and 9.4.

A similar methodology was used to generate data for the new main pumping station model Table 9.5.

It should be emphasised that the calculations are based on best available information and do not outline the actual equipment to be used for the works. The models provide information on the potential impacts of the different options available and illustrate how with corrective measures noise can be kept within the required levels.

Table 9.3 - Summary of Noise Emissions Activated Sludge Option

Source	Octave bands (Hz) Sound Power Levels dB (A-weighted) per band									Impulsive or tonal qualities	Periods of Emission	Number of items included in calculations and Other Comments
	31.5	63	125	250	500	1K	2K	4K	8K			
Aerator / Blowers	85	89	85	89	94	89	88	87	83	Tonal	24 Hrs	3 No.
Aeration lanes	78	76	81	77	78	79	77	76	71		24 Hrs	1 No.
Primary Settlement tank	77	76	72	74	75	72	70	66	60		24 Hrs	2 No.
Odour control fans	78	76	88	87	82	78	74	68	61	Tonal	24 Hrs	5 No.
Intake Sewage pumps	71	72	70	74	76	81	73	71	58		24 Hrs	3 No.
Effluent sewage pumps	71	72	70	74	76	81	73	71	58		24 Hrs	2 No.
Storm tank	85	89	85	89	94	89	88	87	83		24 Hrs	2 No.
Transfer sewage pumps	71	72	70	74	76	81	73	71	58		24 Hrs	2 No.
Dewatering Press Building	66	66	67	65	65	65	61	61	54		24 Hrs	1 No.
Secondary Settlement Tank	77	76	72	74	75	72	70	66	60		24 Hrs	4 No.

Levels may in fact be higher, depending on the equipment used, e.g. centrifuge is noisier than other options. Any equipment used will however be specified to be acoustically treated to ensure that noise emissions are within the limits outlined in this report.

Table 9.4 - Summary of Noise Emissions SBR Option

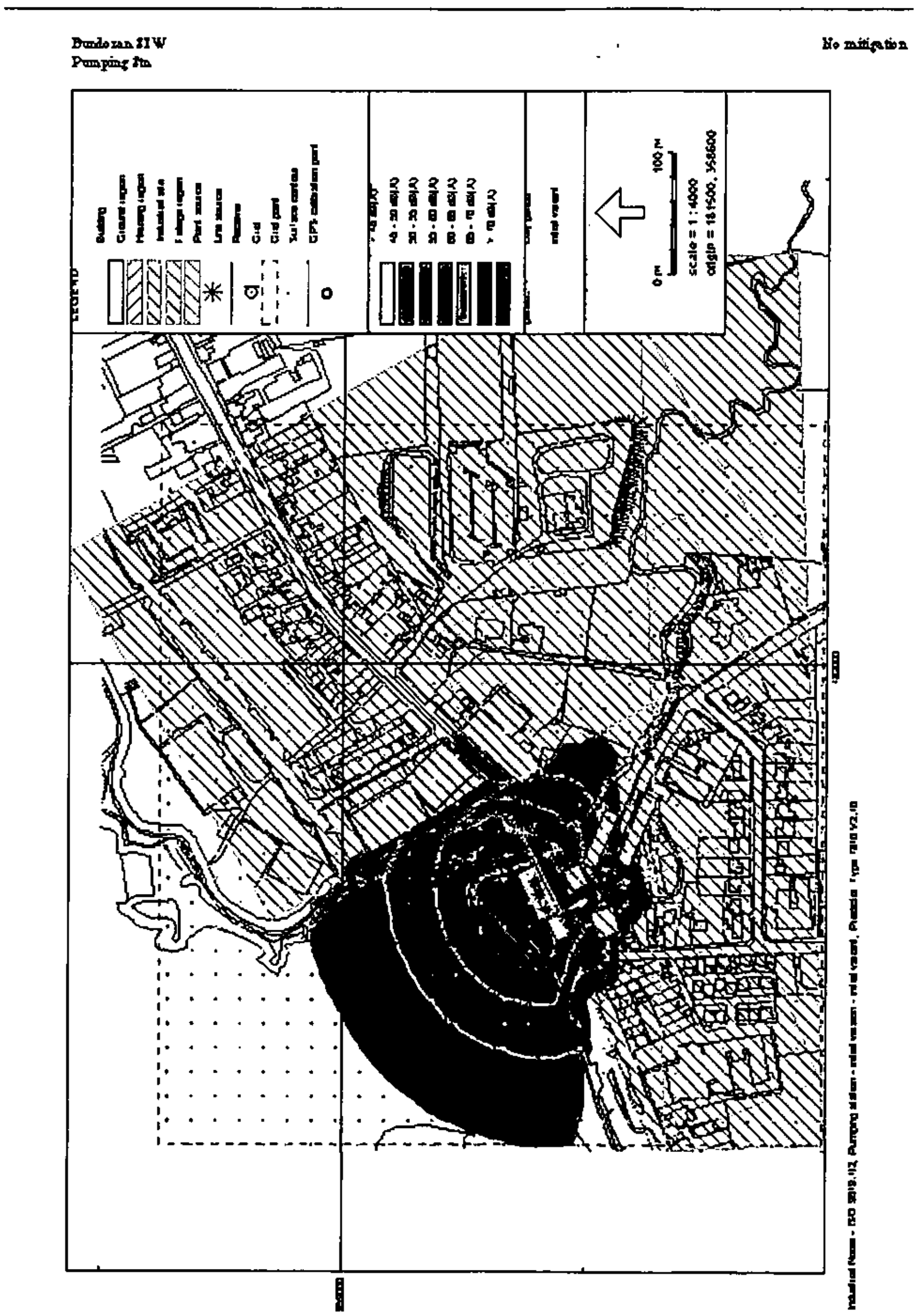
Source	Octave bands (Hz) Sound Power Levels dB (A-weighted) per band									Impulsive or tonal qualities	Periods of Emission	Number of items included in calculations and Other Comments
	31.5	63	125	250	500	1K	2K	4K	8K			
Blowers	89	87	89	98	93	89	85	79	72		24 Hrs	3 No.
Inlet Sewage pumps	71	72	70	74	76	81	73	71	58		24 Hrs	3 No.
SBR Basin	82	86	84	93	98	95	91	90	89		24 Hrs	6 No.
PST	85	89	85	89	94	89	88	87	83		24 Hrs	2 No.
Odour Control Fans	78	76	88	87	82	78	74	68	61	Tonal	24 Hrs	5 No.
Final Sewage pumps	71	72	70	74	76	81	73	71	58		24 Hrs	2 No.
Dewatering Press Building	66	66	67	65	65	65	61	61	54		24 Hrs	1 No.

Table 9.5 – Summary of Noise Emissions at Main Pumping Station

Source	Octave bands (Hz) Sound Power Levels dB (A-weighted) per band									Impulsive or tonal qualities	Periods of Emission	Number of items included in calculations and Other Comments
	31.5	63	125	250	500	1K	2K	4K	8K			
Pumps	96	95	94	98	101	100	98	96	81		24 Hrs	3 No.

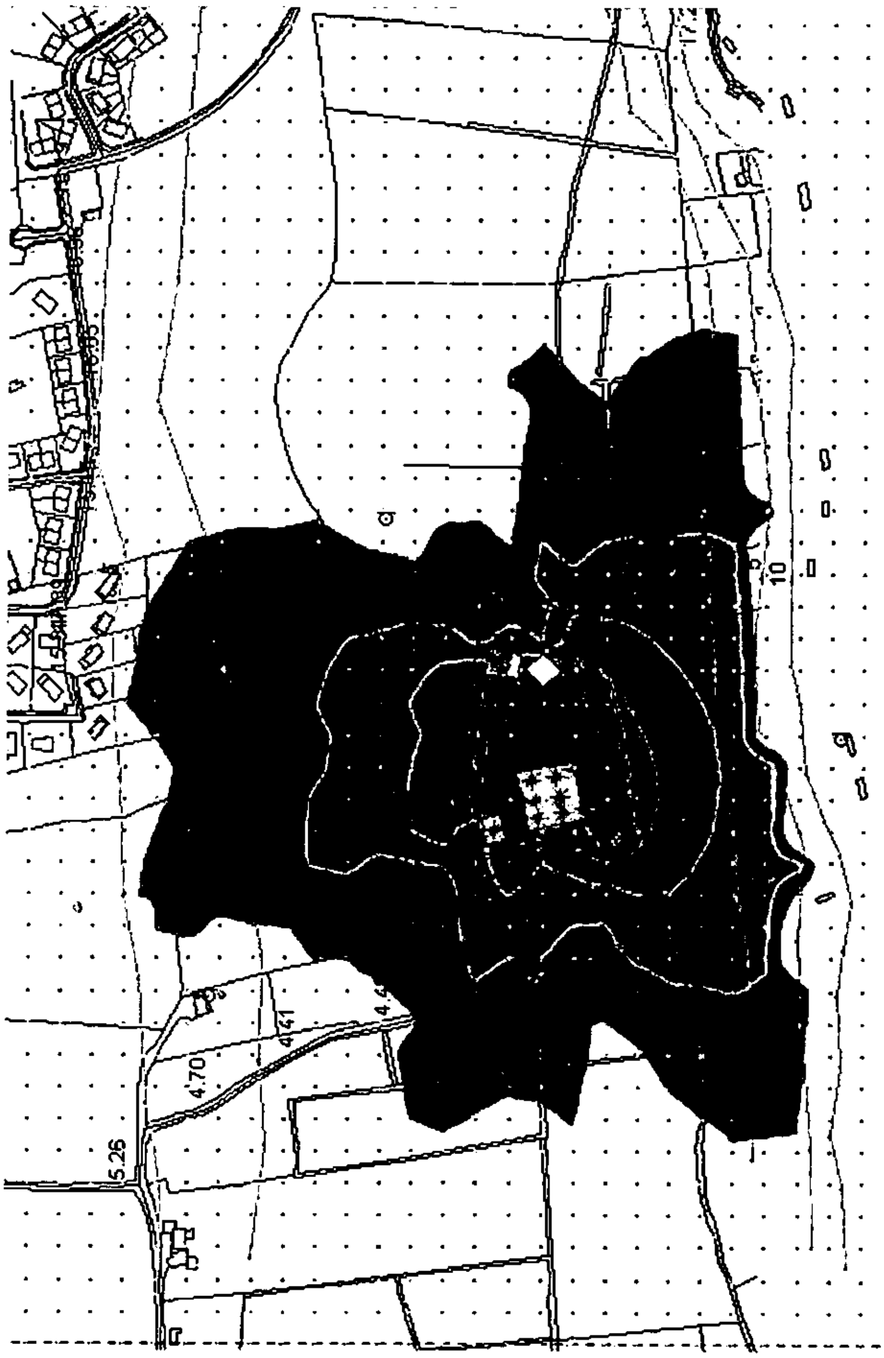
The data outlined above was then input to a software model to calculate the noise levels in the vicinity of the proposed works. The resulting noise contour maps are reproduced below.

Fig. 9.2 - Modelling of Potential Noise Emissions from the Pumping Station without Noise Abatement Technology



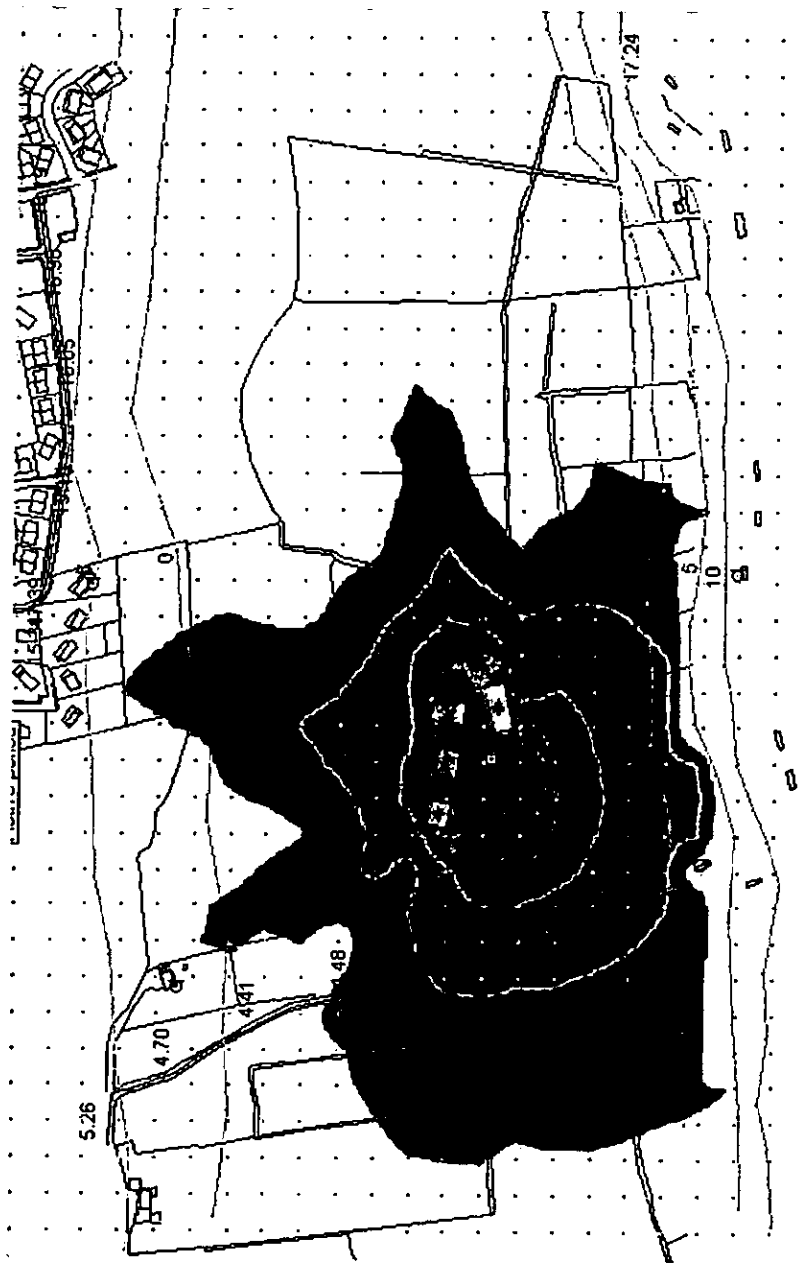
The contours represent the average noise level on a 24-hour basis of the equipment indicated in the appropriate table. The objective should be 45-50 dBA outside the site boundary (i.e. a yellow colour external to the site). Again we can see a significant impact on the area to the Northwest of the proposed site along the beach area. There is also an impact in the area above the pumping station and along the main street. In addition to the noise impact there is a suggestion that the roof of the pumping station be utilised as a viewing platform.

Fig. 9.3 - Modelling of Potential Noise Levels from the Sequencing Batch Reactor without Noise Abatement Technology



As can be seen from the contours there is a significant impact outside the site boundary from this option so significant mitigation measures will be required to ensure that equipment is silenced if this option is to be utilised.

Fig. 9.4 - Modelling of Potential Noise Levels from the Activated Sludge Plant without Noise Abatement Technology



As we can see the Activated sludge option does not indicate a significant impact at any of the nearby residences but does exceed the target value outside the site perimeter.

Do Nothing Scenario

This situation is not applicable as the development must proceed in order to comply with National and EU legislation pertaining to the treatment of urban wastewater.

9.2.5 Mitigation Measures

Construction

The duration of the construction phase is limited and noise during the construction phase can be controlled by:

- Construction contractor to provide a detailed schedule of works indicating likely periods when noisy activity will be required on site.
- Limiting the hours of construction activity from 8am to 8pm Monday – Friday and from 9am to 1pm on Saturdays, with no heavy machinery to operate on Sundays or Public holidays.
- Guidelines on techniques to be used to minimise noise from construction activities (as set out in BS 5228) to be imposed on the construction works.

Operation

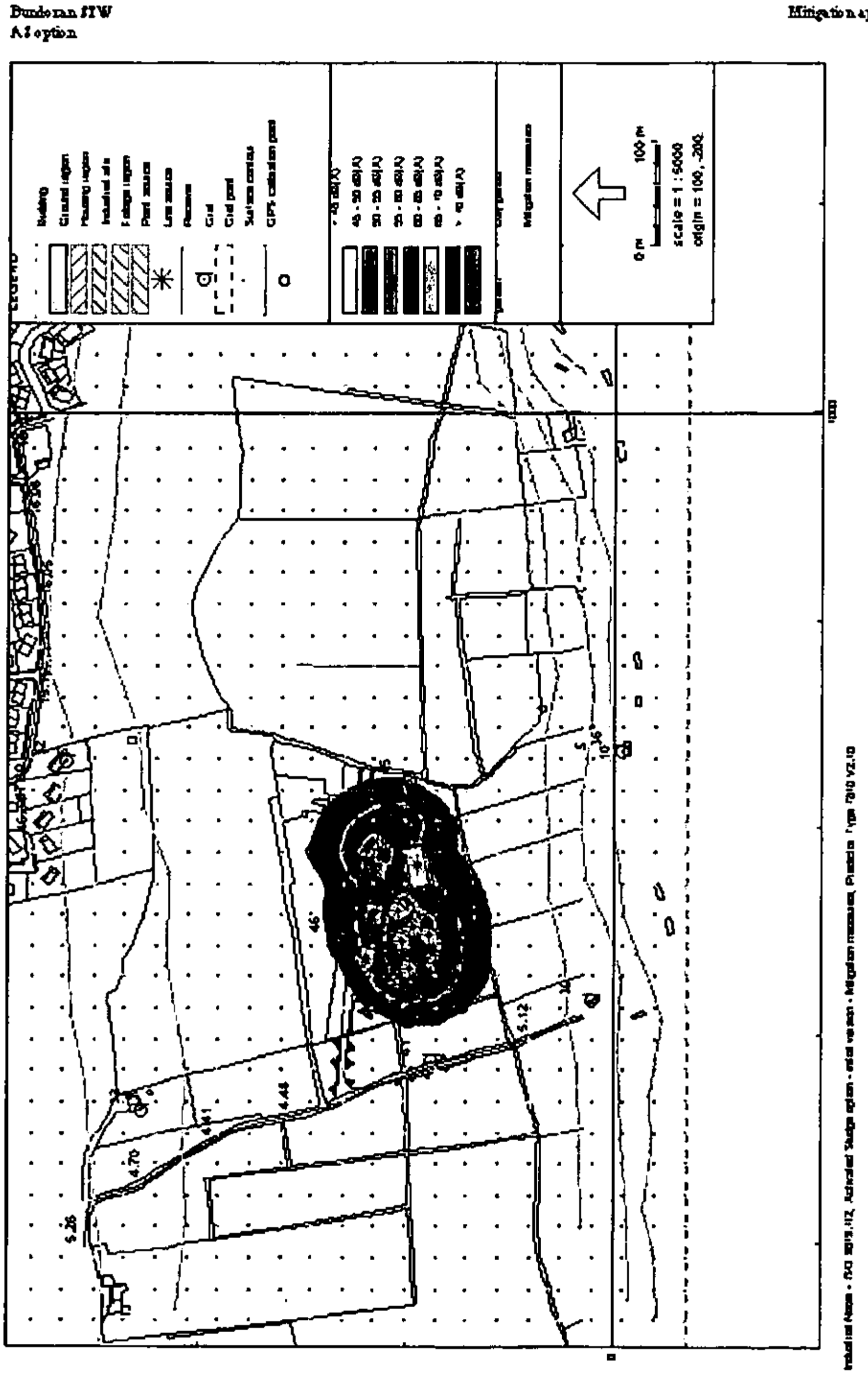
The proposed remedial measures are extensive and include significant acoustic attenuation measures to be applied to each item of equipment as outlined in Table 9.6.

Table 9.6 – Noise Attenuation Measures

Source	Remedial measures proposed
SBR Blowers	Use low noise model Fit acoustic hood with minimum 25 dB attenuation Locate inside services building with acoustic louvres on doors All blowers to be mechanically isolated from supporting structure and pipe work.
Odour Control Fans	Use Radial flow fans where possible Orient Axial flow fans vertically where possible All fans to be fitted with exhaust attenuators All fans to be mechanically isolated from supporting structure and ductwork.
Pumps	Use low noise model where possible Use submersible pumps where possible All pumps to be mechanically isolated from supporting structure and pipe work.
Aeration Basins/ SBR Basins	Locate motors inside rim of basin where possible Use low noise motors and gearboxes where possible All motors to be mechanically isolated from supporting structure.
Access Points/ Doorways	Orientation of plant-room doorways to direct noise into site. Utilise acoustic louvres on all doors
Pumping Station	Use low noise model where possible All pumps to be mechanically isolated from supporting structure and pipe work. Orientation of plant-room doorways to direct noise into site. Utilise acoustic louvres on all doors

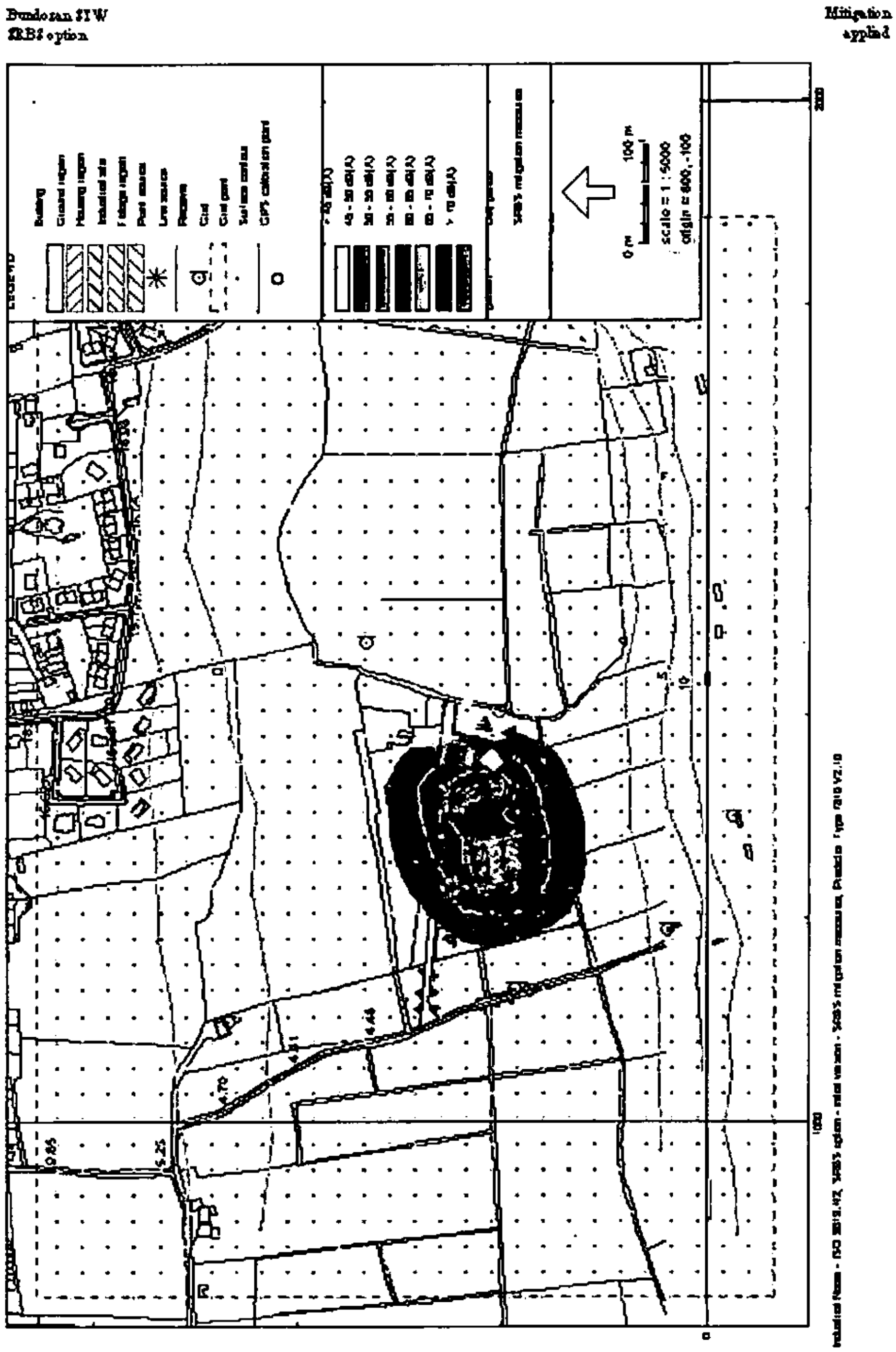
Utilising the measures proposed above the noise contour maps for the various options were re-calculated and are reproduced in Fig. 9.5, Fig. 9.6 and Fig. 9.7.

Fig 9.5 - Modelling of Predicted Noise Emissions from the Activated Sludge Option having considered available Noise Abatement Technology



The noise levels at the perimeter are now within Environmental Protection Agency Guidelines of 45 dBA.

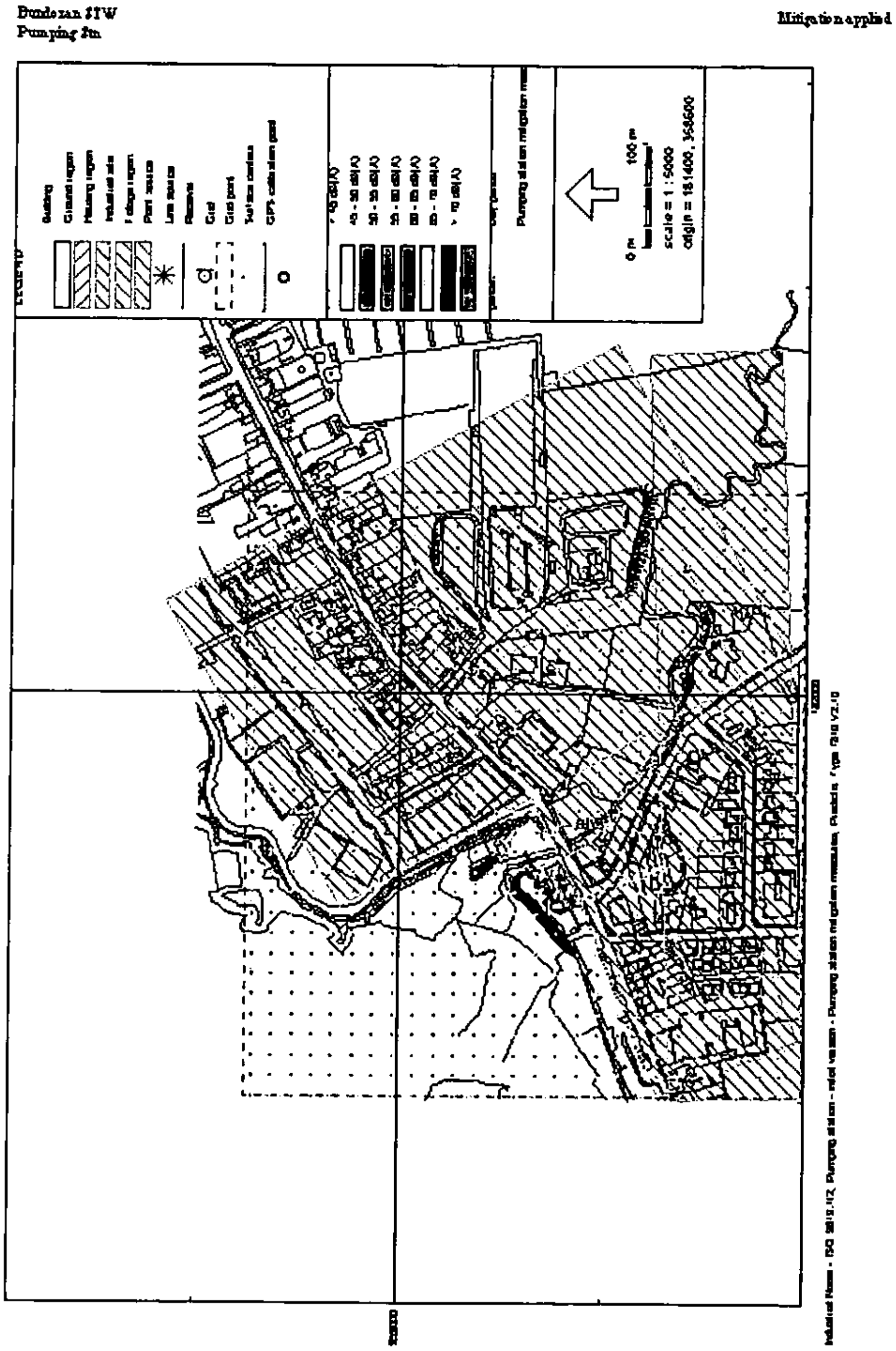
Fig 9.6 - Modelling of Predicted Noise Emissions from the SBR Option having considered available Noise Abatement Technology



We can see that the noise level at the site perimeter is reduced to 45 dBA by applying the measures outlined above.

Fig 9.7 - Modelling of Predicted Noise Emission Levels from the Pumping Station having considered Noise Abatement Technology

The Outfall pumping station noise contour map is as follows:



As we can see the affected area is reduced to a minimum with proper acoustic treatment.

9.2.6 Predicted Impact of Proposal

In order to ascertain if the mitigation measures proposed are sufficient to ensure minimal impact from the proposed works it is necessary to examine what is an acceptable level of noise in the affected area.

The proposed works will operate on a 24-hour basis as the plant provides an essential service to the community and operates efficiently on a continuous basis. This means that all the equipment could be running through the night. All calculations have been made on the basis of 24-hour operation so the calculated values are the noise levels expected at night due to the works alone.

The Environmental Protection Agency generally impose a limit of 55 dBA during the day and 45 dBA during the night measured over a fifteen minute period at the site perimeter. The measurement period is usually extended to one hour during the day. Night-time is defined as the hours between 10 p.m. and 8 a.m.

The World Health Organisation guideline for restorative sleep is 30 dBA over an 8-hour period. If we wish to obtain this level in a bedroom at night with a window slightly ajar then the noise level external to the window must be about 45 dBA or less (average attenuation through an open window is 15 dB). This correlates with the EPA guideline figure of 45 dBA at night.

As can be seen from the noise contour maps including the mitigation measures the noise levels outside the site perimeter can be reduced to 45 dBA and thus the impact will be negligible with regard to sleep disturbance.

From the noise contour maps, using acoustic treatments it is possible to reduce noise levels below 45 dBA as set by the Environmental Protection Agency. No noise levels in excess of Environmental Protection Agency guidelines have been predicted for either the pumping station or the wastewater treatment works site.

9.2.7 Monitoring

Construction

During construction the guideline measures outlined in B.S. 5228 Noise and Vibration Control on Construction and open sites will be observed with particular regard to Table B 1 Methods of reducing sound levels from construction plant.

Operation

During operation of both the pumping station and the works monitoring of noise levels will be carried out to ensure compliance with Environmental Protection Agency requirements.

9.2.8 Reinstatement

No reinstatement is considered necessary.

9.2.9 Definitions

A-weighted sound pressure, in Pascals: The root mean square sound pressure determined by use of frequency network "A" (see IEC Publication 651).

Sound pressure level in decibels: The sound pressure level is given by the formula

$L_p = 10 \text{ Log } (p/p_o)^2$ where,
P is the root mean square sound pressure in Pascals
p_o is the reference sound pressure (20 uPa)

Percentile level: The A-weighted sound pressure level obtained by using time-weighting "F" (see IEC Publication 651) that is exceeded for N% of the time interval considered. e.g. $L_{A90,1 \text{ hour}}$ is the A-weighted level exceeded for 90% of 1 hour.

Equivalent continuous A-weighted sound pressure level in decibels: Value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval T, has the same mean square sound pressure as a sound under consideration whose level varies with time.

Rating level: The equivalent continuous A-weighted sound pressure level during a specified time interval, plus specified adjustments for tonal character and impulsiveness of the sound.

Symbols for Sound Levels:

Quantity	Symbol	Unit	Remarks
Sound Pressure Level	L_p	dB	
A-weighted sound pressure level	L_{pA}	dB	
Percentile level	$L_{AN,T}$	dB	Level exceeded for N% of time T
Equivalent continuous A-weighted Sound pressure level	$L_{Aeq,T}$	dB	1 hour unless otherwise specified
Rating level	$L_{Ar,T}$	dB	1 hour unless otherwise specified

Approximate Sound Pressure Levels in dB:

Location	Level (dB)	Comment
	140	Threshold of pain
Airport	125	Jet take-off
	120	Uncomfortably loud, conversation impossible
Construction site	115	Pneumatic drill
Disco or Rock concert	100	
Motorway	90	Heavy truck passing
Very busy pub	85	Voice has to be raised to be heard
Busy restaurant	70	Conversation difficult
Business office	65	Normal conversation possible
0.5 km from busy roadway	55	Daytime
Library	35	Whispering
	35	Quiet countryside, no wind
	0	Threshold of hearing

9.3 Odour

9.3.1 Introduction

This section of the report was prepared by Aquavarra Research Ltd. to examine the impacts on odour resulting from the proposed development. This assessment states the odour limits that will be imposed at the perimeter to the sites and determines if the odour limits set can be achieved with available odour abatement technology.

Odour is the sensation transmitted to the brain by the olfactory receptors in the nasal cavity when exposed to so called odorous substances in the inhaled air. If these substances are of a malodorous nature and are present in air above a certain threshold concentration they may cause annoyance and constitute an environmental nuisance. The science of odour response measurement is known as olfactometry. Standard olfactometric methods for odour strength measurement by dilution techniques, using a panel of people operating according to standard procedures, have been developed (Frechen, 1994).

The concentration of odorants in air is expressed in odour units per cubic metre (OU/m^3). Its numerical value is quantified as the number of dilutions with clean air required to reach the odour perception threshold. The odour perception threshold is the lowest odour concentration which is detectable by half the members of a test panel (half the members do not detect any smell while the other half still smells something). At a concentration of 2 OU/m^3 an odour is faintly perceivable, at 3 OU/m^3 it is clearly perceivable while at 5 OU/m^3 is strongly perceivable and, if unpleasant, is likely to give rise to environmental nuisance. The duration of an odour is also significant. Dispersion calculations are normally based on meteorological data using mean 1-hour wind speeds, producing hourly means of odour concentration. A concentration of 5 OU/m^3 lasting 15 to 30 minutes is commonly used as the nuisance threshold. If the mean hourly odour concentration is less than 1 OU/m^3, it is unlikely that shorter duration odour concentrations will exceed 5 OU/m^3.

9.3.2 Receiving Environment

The proposed treatment works site is located in a rural setting. Odour in this area is characteristic of a rural setting with no persistent mal-odours.

The proposed location of the new pumping station is adjacent to the existing pumping station, which does not include odour control.

9.3.3 Characteristics of Proposed Development

The proposed development will be a wastewater treatment works constructed on a green field site. The development also proposes the construction of a new pumping station in the centre of the town adjacent to the existing pumping station.

9.3.4 Potential Impact of the Proposed Development

Construction Phase

During the construction of both the wastewater treatment works and the pumping station odours may result from the excavation works. A transient odour may be associated with the machinery being used on the sites.

Operation Phase

Wastewater odours arise either through the discharge of odorous substances of industrial origin to the sewer system or from the anaerobic decomposition of biodegradable matter in the wastewater. Anaerobic biodegradation produces volatile fatty acids and a variety of reduced sulphur compounds most of which have a very low odour threshold concentration as indicated in Table 9.7.

Anaerobic biodegradation is inhibited in the presence of dissolved oxygen and thus does not occur while wastewaters remain aerobic. However, where there is a long residence time in the sewer system or where sewer gradients are small, resulting in low velocities and solids deposition, wastewaters are likely to become septic and malodorous. Biodegradation rates are also strongly influenced by temperature, hence odour problems are likely to be accentuated during warm weather or where industrial discharges raise the wastewater temperature.

Odour Emission from Wastewater Treatment Processes

The rate of release of odorous compounds into the atmosphere at wastewater treatment works (WWTWs) is influenced by:

(a) The concentration of odorous substances in the liquid phase exposed to air.
(b) Total air/wastewater interface area.
(c) Conditions at air/wastewater interface.

Table 9.7 - Odour Threshold Concentrations (Vincent & Hobson, 1998)

Substance	Threshold conc. ($\mu g/m^3$ air)
Ammonia	100-11000
Methylamine	1.2-65
Dimethylamine	47-160
Indole	7.1
Scatole	0.012-0.35
Ethylmercapton	0.043
Diethyl sulphide	1.4
Hydrogen sulphide	0.76
Methylmercapton	0.003-38
Methyl sulphide	0.34-1.1
Acetic acid	43
Butyric acid	0.35-86
Acetaldehyde	0.01-4
Butyraldehyde	15
Isobutyraldehyde	15-22
Valeraldehyde	2.5-34

Raw wastewaters and sludges generally have high concentrations of odorous substances. Processes that generate surface turbulence and high rates of interface renewal, such as open channel flow, weir overflows, biofilter flow distribution systems etc., have much higher rates of volatilisation of odorous compounds than quiescent processes such as sedimentation.

The specific odour emission rate from a water or sludge surface can be measured experimentally in a standardised way using a floating collector hood into which is discharged a measured flow of odour-free air. The odour concentration is then measured in the emergent air stream. The specific odour emission rate ($OU/m^2.h$) is quantified as the product of the emitted odour concentration (OU/m) and the specific air flow rate ($m^3/m^2.h$). A sample set of wastewater process odour emission rates, measured in this way, is presented in Table 9.8.

Table 9.8 - Odour Emission Measurement Results (Frechen, 1992)

Odour Source	Odour Concentration (OU/m^3)	Specific Air Flow Rate ($m^3/m^2.h$)	Specific Emission Rate ($OU/m^2.h$)
Aerated grit chamber	1021.00	7.0	7147
Grit container	6923.00	7.0	48461
Storm tank, dirty	71.00	6.3	447
Primary sedimentation surface	96.50	7.35	709
Primary sedimentation overflow	128.00	6.8	870
Aeration tank	80.00	7.6	608
Secondary sedimentation tank	39.50	6.7	265
Secondary sedimentation overflow	52.00	5.5	286

Wastewater screening, grit separation, primary treatment processes, biofiltration processes and sludge handling processes are the major foul odour sources at WWTWs. With the exception of aerobically stabilised sludges, sludge residues are the primary sources of very high odour concentration at WWTWs. This is because of their potentially high concentrations of reduced volatile substances including hydrogen sulphide (H_2S). It should be noted that anaerobically digested sludge, though biologically stable, can be a significant source of malodour, particularly if it contains H_2S - 1 ppm by volume of H_2S in air is approximately equivalent to an odour concentration of 200 OU/m^3. Aerobically stabilised sludges, on the otherhand, have a relatively low odour emission rate. Surplus activated sludges from medium or high rate processes also have low odour emission rates while maintained in an aerobic condition.

During the operation of the pumping station odour may potentially arise from the wet well if an odour treatment unit is not installed.

Do Nothing Scenario

This situation is not applicable, as the development must proceed in order to comply with EU and national legislation pertaining to the treatment of urban wastewater.

9.3.5 Mitigation Measures

Odour Standards for Wastewater Treatment Plants

The European Community has not as yet developed environmental directives relating to the control of odour nuisance nor are there any mandatory national standards in force in Ireland. The Irish EPA, in its general approach to environmental protection, promotes the use of so-called BATNEEC solutions (use of the best available technology not entailing excessive cost). It is well established that odour nuisance in the vicinity of wastewater treatment facilities can be avoided by the application of this principle to the design new wastewater treatment facilities.

It is also useful to look to the example of the approach used in other countries. The Netherlands, for example, has adopted a policy aimed at the reduction of environmental odour to an as low as reasonably achievable level (ALARA principle). For wastewater treatment plants this translates into the following maximum environmental concentration levels.

At locations surrounded by residential areas, ribbon-development or other odour-sensitive receptors:

- 1 OU/m^3 at 98% non-exceedence level for new WWTWs
- 3 OU/m^3 at 98% non-exceedence level for existing situations

At locations with scattered houses or industrial estates:

- 2 OU/m^3 at 98% non-exceedence level for new WWTWs
- 7 OU/m^3 at 98% non-exceedence level for existing plants

It is proposed that an odour level of 1 OU/m^3 at a 98% non-exceedence level at the site boundary is taken as the environmental odour standard for the Bundoran WWTW.

Odour Abatement at Wastewater Treatment Plants

The emission of foul odours from wastewater treatment facilities can be controlled by covering/housing the primary odour sources and by providing forced ventilation of the enclosed air spaces to appropriate air treatment facilities. The required rate of ventilation should, at minimum, maintain a slight negative pressure within the enclosed air space, thus preventing air escape other than to the forced ventilation system. Higher rates of ventilation are required for accessible enclosures while low rates are adequate for enclosures that are not accessible. Ventilation rates are typically expressed in terms of a ventilation factor or frequency of air change (ventilation factor x enclosed air volume = ventilation rate). Ventilation factors may vary from 2 h^{-1} for non-accessible enclosures to 20 h^{-1} for frequently used rooms with high odour-emission potential.

Treatment technologies for odorous air streams, such as generated at wastewater treatment plants, include:

- Biofiltration and bioscrubbing
- Activated carbon
- Wet chemical scrubbing
- Thermal oxidation

In biological treatment processes such as biofiltration and bioscrubbing the odour contaminants are adsorbed on to a moist contact medium, where they are decomposed by selected bacteria that are capable of using the contaminants as a growth substrate. Peat or heather is used as the contact medium in biofilters while a variety of packing materials is used in biotower scrubbers.

Biofiltration will probably be the most suitable method of treatment for the Bundoran WWTW application. A well-designed enclosed biofilter, equipped with a wetting system for the filter bed, should be capable of achieving an odour reduction efficiency of in the range 90%-95%.

It is recommended that an environmental odour standard of 1 OU/m^3 with a 98% non-exceedence level at the WWTW site boundary be set as the target odour control goal.

To meet the recommended odour standard, it will be necessary to provide odour control and treatment facilities for all process units that are potential sources of foul odours, including:

- Inlet works/preliminary treatment, including influent pumping, screening, grit separation, treatment and disposal of screenings and grit.
- primary sedimentation tanks (if used), including sludge removal
- sludge processing including thickening/pasteurisation/stabilisation/dewatering and offsite transport.

The ventilated air should be de-odourised in odour treatment facilities designed to reduce the environmental odour concentration at the site boundary to a level not exceeding 1 OU/m^3 on a 98%ile basis.

Odour from the pumping station is from a fixed point source, namely the wet well. The wet well should be enclosed and provided with forced ventilation which is directed to an odour treatment unit to eliminate any odour nuisance to the surrounding enviorns.

The odours emitted from WWTWs are carried downwind and are diluted through atmospheric dispersion by mixing and transport mechanisms. Wind speed and atmospheric turbulence are primary agents in odour dispersion. In general terms, the lower the wind speed and the more stable the atmospheric conditions, the poorer will be the atmospheric dilution of odour and the greater the environmental odour concentration.

Atmospheric stability is a measure of the atmosphere's ability to disperse emitted air contaminants. A stable atmosphere will dampen the movement of an air parcel, whereas an unstable atmosphere will enhance the movement of a displaced air parcel. A standard stability classification scheme, known as the Gifford-Turner classification is typically used in air quality modelling. This scheme categorises atmospheric stability into 6 classes ranging from A (very unstable) to F (very stable), based on such factors as wind speed, isolation (exposure to the sun), and cloudiness.

The atmospheric odour dilution process can be mathematically modelled as a Gaussian plume (Pasquill, 1974), taking wind speed, wind direction and atmospheric stability conditions into account (USEPA, 1987). Thus, using the local meteorological data and the estimated odour emission rates from the individual treatment processes, it is possible to compute the odour concentration fluctuation at sensitive receptor locations in the vicinity of a WWTW.

Meteorological Data

The required meteorological data consists of the mean hourly values for wind speed, wind direction and the stability classification for the WWTW location for at least one year's duration. The prevailing stability category has a strong influence on the rate odour dilution with distance from source. Unfavourable dispersion conditions arise when there is a combination of low wind velocity and reduced solar radiation such as occurs at night-time or in overcast conditions during the daytime.

The nearest weather station, which may reasonably be regarded as having similar climatic conditions to Bundoran, is located at Belmullet. The results of a statistical analysis of wind speed/wind direction and stability class for the 30-year period 1969-99 for the Belmullet station are plotted on Figs 9.8 and 9.9 respectively.

As can be seen in Fig. 9.8, the predominant wind condition is a south westerly wind with a speed of 6m/s or higher. During conditions of lower wind speed which are conducive to poor odour dispersion, the wind direction is relatively evenly distributed in all directions, with a small south-south easterly bias at speeds of 0.5 – 3.0 m/s, and a small westerly bias at the higher 3-6m/s range.

Fig. 9.9 shows that the predominant stability class is D. Class D indicates a stable atmospheric condition, which is conducive to poor odour dispersion.

For the purposes of odour dispersion analysis in this case, the 30-year average wind speed/direction data were used in conjunction with a fixed stability class D. This synthetic meteorological data combination is likely to provide a conservative estimate of the extent of odour spread.

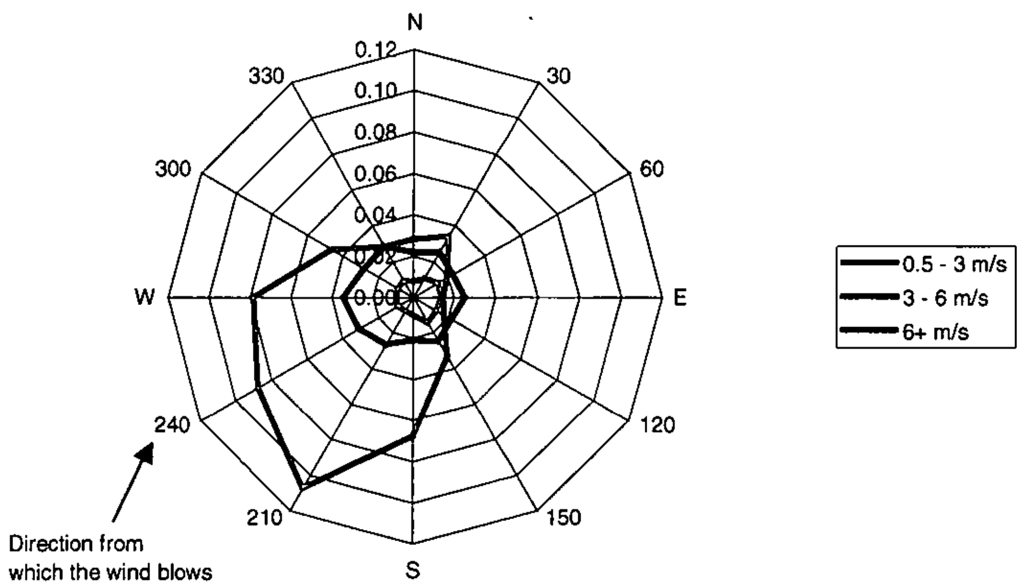


Fig 9.8- 30 year (1960-1990) Frequency Distribution of Wind Direction and Speed for Belmullet Met. Station

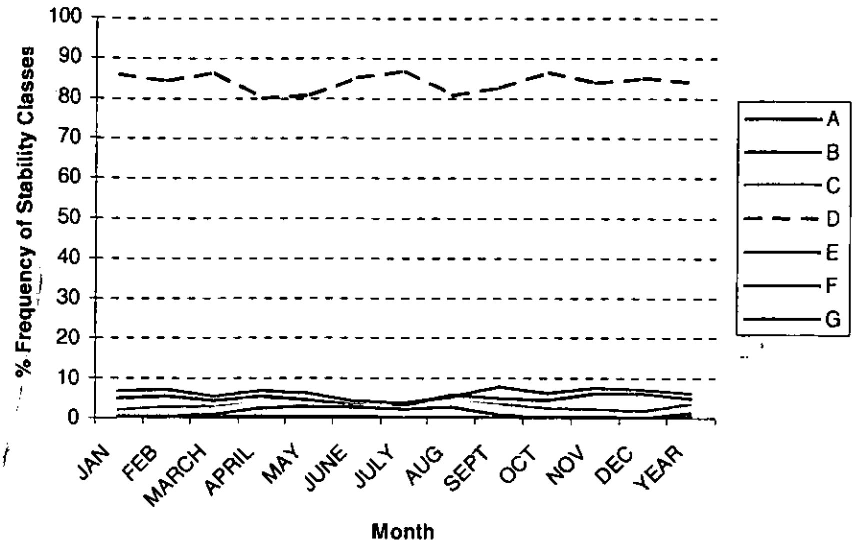


Fig 9.9 - Wind Stability Class Frequency Distribution for Belmullet Met. Station (1960-1990)

Odour Dispersion Analysis

In order to determine the predicted impact of the proposed development two levels of odour emission were examined.

Level (1): Relates to the situation, which would prevail in the absence of odour abatement measures. The estimated odour emission rates are given in Table 9.8.

Level (2): Relates to the estimated reduced level of odour emission required to meet the target environmental standard of 98% non-exceedence of 1 OU/m^3 at the site boundary. Odour abatement measures are applied to all potential sources of unpleasant odour viz. the inlet works, stormwater tank, primary sedimentation tanks and sludge processes; the estimated reduced odour emission rates are given in Table 4. With this level of odour control in place, the residual odour emission is estimated at 725 OU/s, some 58% of which is derived from aerobic secondary treatment processes. While there is a perceptible odour associated with the latter, it is normally described as an "earthy" odour and does not cause odour nuisance.

The odour emission estimates are based on the specific odour emission rates presented in Table 9.8, modified by a peaking factor of two.

Table 9.9 - Estimated odour emission rates from Bundoran WWTP (Level 1 No Odour Emission)

Source	Open surface Gross area (m^2)	Specific Odour Emission ($OU/m^2.s$)	Process Emission (OU/s)
Inlet works (1)	n/a	n/a	474
Storm tanks	360	0.3000	108
Primary sed. tanks	628	0.4436	279
Aeration tanks	640	0.3398	217
Secondary clarifiers	1256	0.1636	205
Picket Fence Thickener	50	7.5708	379
Sludge Holding Tank	28	7.5708	212
Sludge Buffering Tank	28	7.5708	212
Sludge Dewatering	150	3.1350	470
		Total	**2082**

Footnotes to Table 9.9

(1) Inlet works consisting of: Aerated Grit Chamber (96 OU/s)
Screening (294 OU/s)
Grit Container (86 OU/s)

Table 9.10 - Estimated odour emission rates from Bundoran WWTP with odour abatement measures applied to inlet works, stormwater tank, primary sedimentation tanks, sludge processes (Level 2 odour emission)

Source	Open surface Gross area (m^2)	Specific Odour Emission ($OU/m^2.s$)	Process Emission (OU/s)
Odour treatment unit 1(1)	n/a	n/a	86
Odour treatment unit 2(2)	n/a	n/a	216
Aeration	640	0.3398	217
Secondary clarifiers	1256	0.1636	206
		Total	**725**

Footnotes to Table 9.10

(1) Discharge from odour treatment unit 1, serving inlet works, storm tank and primary sed. Tanks
(2) Discharge form odour treatment unit 2, serving the sludge building, the sludge holding tank, the buffer tank and the picket fence thickener

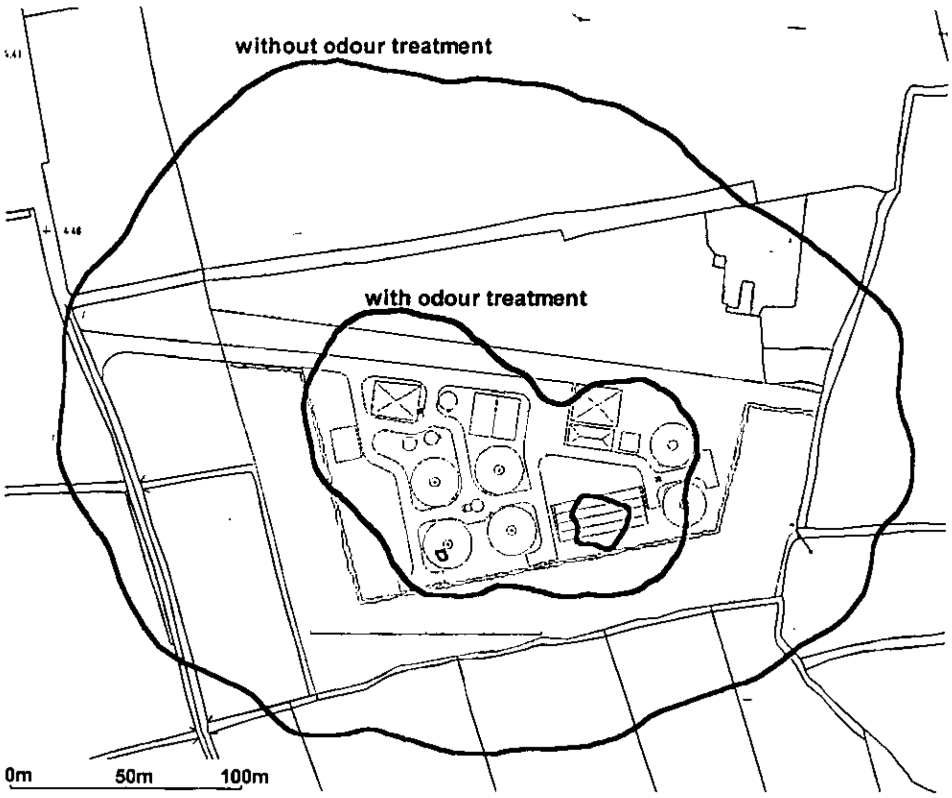
9.3.6 Predicted Impact of Proposal

Results of Dispersion Analysis

A series of computer analyses of odour dispersion from the Bundoran WWTW, using the 30-year average Belmullet hourly wind data at a fixed stability class D and the odour emission rates set out in Tables 9.9 and 9.10, was carried out. The output data was analysed to define the 1 OU/m^3/98% isolines for the treatment plant environs.

The resultant odour isolines are plotted on Fig. 9.10. The dispersion analysis indicates that, in the absence of odour control measures, the 98% isoline extends well outside the site boundary. However, if the odour emission rates are reduced to the values given in Table 9.10, the 98% isoline spread is effectively reduced to fit within the site boundary, thus meeting the proposed environmental odour standard for the WWTW.

Fig 9.10 - Computed Extent of Odour Spread (1 OU/m³) at the 98% Non-Exceedance Level



Treated: relates to odour spread with control measures limiting odour emission to the level indicated in Table 9.9.

Untreated: relates to odour spread in the absence of control measures.

An environmental odour standard of 1 OU/m³ at a 98% non-exceedence level at the WWTW site boundary is considered appropriate to this development. It has been shown by odour dispersion analysis that this standard is achievable by the application of appropriate odour control measures to those processes that generate foul odours. The control measures required are feasible within the economic confines of the BATNEEC principle.

Odour from the pumping station being from a point source can be removed by a treatment unit, thus no odour above 1 OU/m³ is predicted from the pumping station.

9.3.7 Monitoring

Monitoring at both the treatment works site and the pumping station will be carried out on operation of both plants to ensure recommended odour levels are being achieved.

9.3.8 Reinstatement

No reinstatement is considered necessary.

9.3.9 References

Vincent, A and Hobson, J (1998) Odour Control, CIWEM Monograph on Best Practice No. 2, Terence Dalton Publishing Ltd., 47 Water St., Lavenham, Suffolk, CO10 9RN, UK.

Frechen, F B (1994) Odour emission of wastewater treatment plants - recent German experiences, Wat. Sci. Tech., Vol 30, No. 4, pp. 35-46.

Frechen, F B (1992) Odour emission of large WWTPs: source strength measurement, atmospheric dispersion calculation, emission prognosis, counter measures - case studies, Wat. Sci. Tech., Vol 25, No. 4-5, pp. 375-382.

Pasquill, F (1974) Atmospheric Diffusion, 2nd. ed., John Wiley & Sons, Inc., New York.

USEPA (1987) Industrial Source Complex (ISC) Dispersion Model User's Guide - Second Edition (Revised), Vols 1 and 2, EPA/450/4-88/002A and B, Office of Air Quality Planning and Standards, Research Triangle Park, NC. (NTIS Accession numbers: Vol. 1, PB88-171 475; Vol. 2, PB88-171 483).

10.0 VISUAL IMPACT

10.1 Introduction

Paul O'Toole Architects and Arc Digital Photographic Ltd have undertaken this section examining the visual impact of the proposed development. The wastewater treatment works site and the pumping station sites are discussed separately.

The final decision for the choice of treatment plant will be subject to a design, build and operate tender. In assessing visual impacts two different treatment processes have been evaluated:

- Conventional Activated Sludge Process with Sludge Thickening and Dewatering (AS)

- Sequencing Batch Reactor (SBR) with Sludge Thickening and Dewatering

The processes assessed in this EIS represent the outer permissible parameters and the general location of the build elements of the development. The assessment makes a reasonable assumption as to the "worst case scenario" for each of the options in terms of visual and landscape impacts.

The structure for assessing the landscape impact of any development is based on draft guidelines prepared by the Environmental Protection Agency (EPA).

10.2 Wastewater Treatment Works

10.2.1 Introduction

This section examines the visual impact the proposed wastewater treatment works will have on the surrounding environment.

10.2.2 Receiving Environment

Context

The general area is part of the flat coastal plain stretching northwards from Sligo to Donegal town with the Dartry Mountains forming a dramatic and varying backdrop to the south and Donegal bay forming a northern edge. The site is visible from the western outskirts of Bundoran town and from the surrounding fields. The site is currently used as rough pasture.

Site Location and Description

The site with an approximate area of 2.8 ha is located on the southern side of the proposed Bundoran-Ballyshannon bypass approximately 1.1km east of its proposed connection with the existing N15. There are no discernible manmade features visible. It is bound by a combination of low (1m) walls made of loose rounded granite stones and a briar hedgerow. It is presently set in rough pasture. The prevailing winds are from the south west. The nearest dwellings to the north are approximately 200 metres away and a new house under construction to the south are approximately 155 metres distance from the site. To the east and west the land is currently set in pasture or lying fallow.

Landscape Character

The landscape character of the area is an essentially gently sloping, loose boulder bordered field set either in poor pasture or lying fallow. The most prominent feature on the landscape is the impressive backdrop of the Dartry Mountains with a combination of tabletop plateaux and eroded escarpments. A moderate amount of deciduous and evergreen trees line some field borders together with stunted and windswept hedgerows. The proposed route of the Bundoran by-pass runs along the northern boundary of the site.

Surrounding Built Elements

There are groups of houses surrounding the site – at various relative distances to its boundaries. These may be summarised as follows:

To the north – the southern edge of Bundoran town itself, at an average distance of 230 metres. These buildings consist of clustered, low lying, slate roofed, light coloured, painted gable walled homes.

To the south – at an average distance of 230 metres. These homes are aligned along the existing road, are less densely positioned than those to the north but share the same materials and built forms.

The fields to the east and west of the site are open and undeveloped.

Site Visibility

Existing views of the site have been photographed from a number of viewpoints in order to build photomontages illustrating potential views of the proposed treatment works site.

The viewpoints from which photographs have been taken are discussed and illustrated below.

Viewpoint A (VA on Site Plan) - From the field to the east

Viewpoint B (VB) – From the N15 overlooking the field to the north of the proposed site

Viewpoint C (VC) - From the house under construction to the south

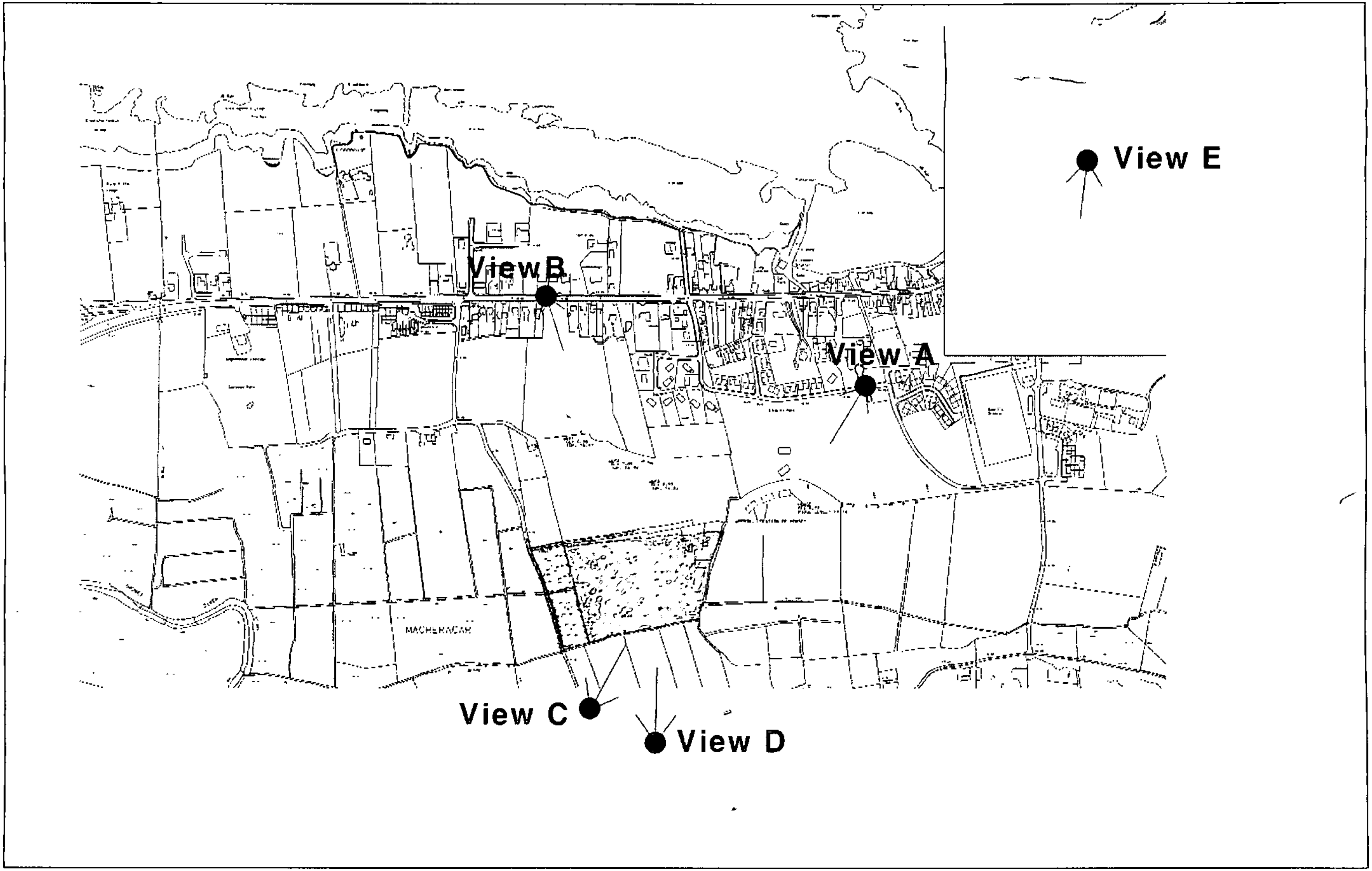
Viewpoint D (VD) - From the road to the south

The viewpoints are shown on Fig. 10.1.

10.2.3 Characteristics of Proposal

The proposed development includes the construction of a wastewater treatment works on a green field site in the town land of Magheracar. The development also includes for the upgrading of access roads to the proposed wastewater treatment works site.

Photomontages from the viewpoints listed above have been prepared for the two alternatives under valuation. These are shown on the following pages Fig. 10.2 – 10.13.



Bundoran Waste Water Treatment Works

Environmental Impact Statement
View Location Map (not to scale)

Fig. 10.1

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View A as existing

Fig. 10.2

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View A, Option 1

Fig. 10.3

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View A, Option 2

Fig. 10.4

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View B as existing

Fig. 10.5

Bundoran Waste Water Treatment Works

Environmental Impact Statement

Fig. 10.6

View B, Option 1

Fig. 10.7

View B, Option 2

Fig. 10.8

View C as existing

Bundoran Waste Water Treatment Works

Fig. 10.9

Environmental Impact Statement
View C, Option 1

Bundoran Waste Water Treatment Works

Fig. 10.10

Environmental Impact Statement
View C, Option 2

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View D as existing

Fig. 10.11

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View D, Option 1

Fig. 10.12

Bundoran Waste Water Treatment Works

Environmental Impact Statement
View D, Option 2

Fig. 10.13

10.2.4 Potential Impact

Construction

During the construction of the WWTW much building activity will be ongoing with the presence of cranes, excavators, scaffolding etc. This may cause short-term negative impact on views from the surrounding areas. Security lighting and a site hut may contribute to lighting pollution in this rural setting.

Operation

The proposal to provide this new facility will inevitably have some degree of impact on the landscape and visual character of the surrounding areas. These impacts will arise from changes such as:

- **Alterations to Ground Levels**

  Currently the ground levels within this flat site vary from a low of 4.00 O.D. in the south west portion of the site to a high point of 5.6 O.D. in the north eastern portion of the site. It is proposed to create a planted berm along the west, south and eastern perimeters of the site with an average finished height of 6.2 O.D.

- **Building Development**

  A number of built elements will feature in the development. These are listed in Table 10.1 for each of the alternatives under consideration. These include buildings and tanks.

Description	Activated Sludge AS		Sequencing Batch Reactor SBR	
	Area m^2	Height (m OD) *	Area m^2	Height (m OD) *
Buildings				
Inlet Works	300	15.5	300	15.5
Sludge Thickening & Dewatering	300	13.5	300	13.5
Control House	200	14.0	200	14.0
Final Effluent Pumping Station	150	12.5	150	12.5
Tanks				
Primary Settlement Tanks	1260	10.0	1260	0.0
Sequencing Batch Reactors	N/Ap	N/Ap	2500	9.0
Aeration Basin	2500	9.0	N/Ap	N/Ap
Secondary Settlement Tanks	1260	8.0	N/Ap	N/Ap
Sludge Holding Tanks	150	11.0	150	11.0
Storm Tanks	400	10.0	400	10.0

* Building height reflects ridge levels to Malin O.D.

A number of the elements are common to both alternative processes. In general the tanks are low level structures covering larger areas. The buildings have low floor areas and higher building heights to facilitate the plant and equipment housed in the structure.

- **Associated Developments (eg. Access Roads, Car Parking etc.)**

  An access road will run from the existing lane, into the site and there will be a small area for car parking adjacent to the administration building.

- **Proposed Screen Planting**

  As part of the overall development of the site, it is proposed to plant some hardy vegetation that will withstand the harsh conditions that prevail on the site. It is proposed that these plantings shall be along the site boundaries at a similar spacing/density as the surrounding lines of vegetation and throughout the site where the building layout allows.

- **Site Lighting**

  The proposed development includes for the provision of lighting along and around the proposed new access roads and buildings. Floodlights will be required adjacent to and within sumps and tanks in the case of emergencies and for on-site monitoring periods. These lighting proposals will result in some light pollution due to the site's location within a low-density rural area.

Do Nothing Scenario

In any assessment of possible impacts upon the environment, it is accepted practice to assess the impact of the proposed developments against a "baseline". The "baseline" represents a "do-nothing scenario". In the case of landscape elements, this is not fixed but is a dynamic one. All landscapes are in a process of continuing change due to natural processes, changes in the type and intensity of land use and alterations in social norms and values concerning the landscape. The Bundoran site is likely to either remain as undeveloped land or at some point in the future be developed for housing.

Presence/Absence of Proposed By Pass

There is a proposal to build a bypass parallel to the northern boundary of the site. It will have a finished level of approximately 7.6m OD and be edged with a sloping bank running down to the base of the proposed planted berm surrounding the proposed treatment works site.

The potential impact of the proposed by-pass may be summarised as follows:

Views from North (VA VB) towards site	**with Bypass**	**without Bypass**
	Site partially obstructed	Site view unobstructed

Views from south (VC VD) towards site	**with Bypass**	**without Bypass**
	will mitigate impact of site buildings	will provide no relieving backdrop

Views from the east and west towards the site will be slightly mitigated by the presence of the bypass which will reduce the impact of the buildings against the surrounding landscape.

10.2.5 Mitigation Measures

Mitigating measures, which will be employed on the scheme, are as follows:

Site Layout
Structure Design & Materials
Planting

Site Layout

The site layouts for both options under consideration are shown on Fig. 10.14 and Fig. 10.15.

The siting of the buildings in both Option 1 Sequencing Batch Reactor and Option 2 Activated Sludge Option and will be generally along the lower, northern part of the site, which will minimise their visual impact.

The houses – both existing and those under construction – south of the site, will see the treatment works buildings with the slope of the proposed bypass behind them. This will mitigate their impact on the immediate landscape.

Their position on the relatively lower part of the site will maximise the house occupiers' vision lines towards Bundoran.

Views into the site from the proposed bypass will be from a significantly higher vantage point than the same area has at the moment. This will be due to the raised level over the existing landscape that is proposed for the road. Proposed planting will minimise the impact of the buildings in the medium to long term.

Furthermore, views into the site from further north – on the southern outskirts of Bundoran will be minimised by the bypass's embankments. The backdrop of the mountains will also reduce the scheme's impact. Portions of the taller structures will be visible.

Structure Design – Materials

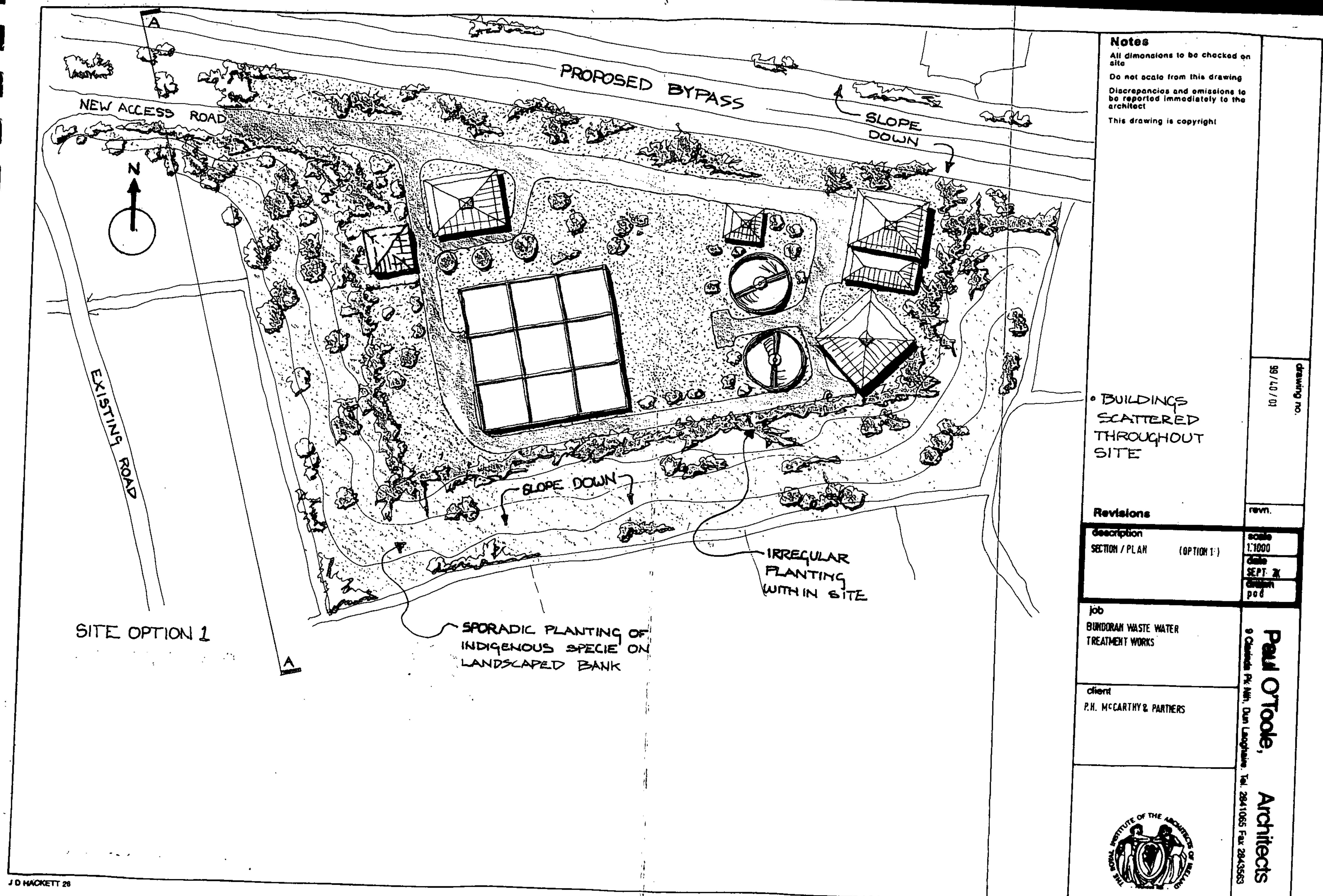
Building Design Criteria

Introduction

The purpose of this section is to define the limits to be imposed on the final designer of the buildings without actually designing the building themselves.

It is proposed to deal with this section under a number of headings which when taken as a whole will give the designer flexibility to express his or her own design philosophy within a clear and unambiguous set of parameters.

Site Zoning	Cluster versus Linear versus Radial.
Plan Shapes	Geometric rectilinear versus Free shape circulinear Economic wall to floor ratio Integration with landscaping
Structure	Load Bearings Masonry versus Frame and Panel Steel Frame versus Concrete Frame.



PROPOSED BYPASS
NEW ACCESS ROAD
SLOPE DOWN
N
EXISTING ROAD
SLOPE DOWN
• BUILDINGS SCATTERED THROUGHOUT SITE
IRREGULAR PLANTING WITHIN SITE
SPORADIC PLANTING OF INDIGENOUS SPECIE ON LANDSCAPED BANK
SITE OPTION 1
A
A
J D HACKETT 28
Notes
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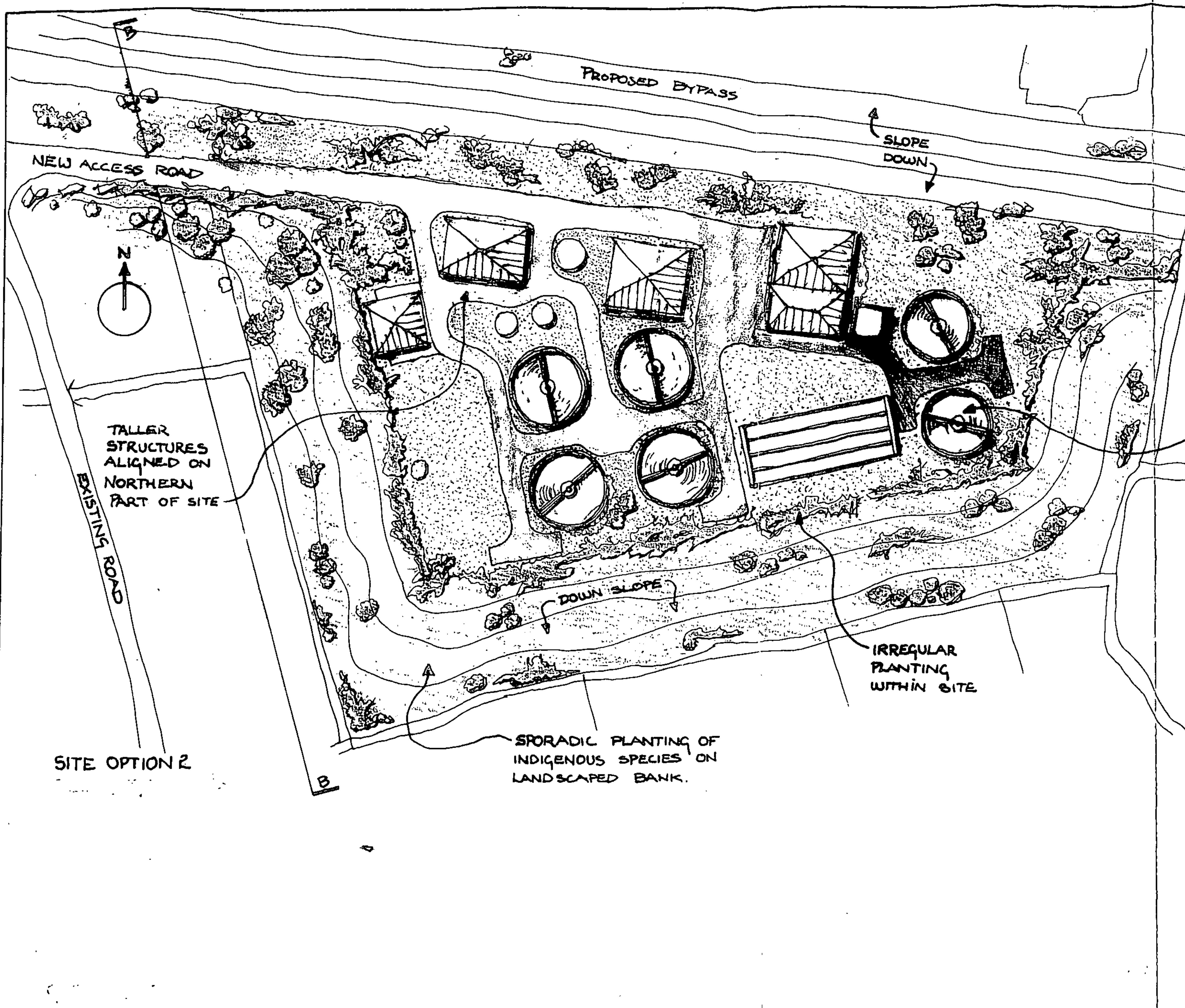
job
BUNDORAN WASTE WATER TREATMENT WORKS
client
P.H. McCARTHY & PARTNERS
Paul O'Toole, Architects
9 Clarinda Pk Nth, Dun Laoghaire. Tel. 2841065 Fax 2843563

Fig. 10.14



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Revisions

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scale: 1:1000

date: SEPT. '2K

job: BUNDORAN WASTE WATER TREATMENT WORKS

client: P.H. McCARTHY & PARTNERS

Paul O'Toole, Architects

Tel. 2841065 Fax 2843583

J D HACKETT 28

Fig. 10.15

Buildings Form	Horizontal versus Vertical Heap - Mound - Floating Box
Building Mass	Mass reduction - Form articulation Roof design Articulation by separation Height restrictions Visual transfer from horizontal to vertical Meeting the ground Lack of scaling devices i.e fenestration
Materials	Longevity - indigenous - maintenance free Natural - Stone - Slate - Stainless Steel Detailing/Staining/Waterproof
Colour	Neutral - Non Primary Colours
Texture	Rough - Smooth - Natural - Synthetic
Roof Configuration	Pitch - Scale - Reflectivity
Scale	Scaling Devices - Human Relationship
Services	Inlet/exhaust - integration with external envelope
Landscaping	Hard and Soft

Site Zoning (Refer to Fig. 10.6 and 10.7)

The preferred disposition of building structure location is included on the site map.

Cluster planning is acceptable as a mass reducing technique but excessive density will be avoided. Spaces between buildings will relate to a 360 degree viewing potential.

Linear planning is acceptable. Care will be taken in considering the rhythm of varying heights when viewed from:

- the town
- the hills to the south, and
- the potential new road

Radial or random scattered planning will be avoided.

Plan Shapes

The design of the individual building and structure plan shapes will be considered in the context of the overall site planning.

The chosen solution will have an economical wall to floor ratio.

In choosing plan forms, structural complexity will be avoided, and overall buildability will be considered.

Experimental structural solutions to unconventional plan shape concepts will be avoided.

Structure

In lower, short span buildings, load bearing masonry or equivalent structures will be acceptable.

In larger, taller buildings steel or concrete frames will be considered provided the chosen weather skin is completely external to the frame with proper detailing to permit the differential movement between structure and skin.

Building Form

The building forms selected will be mitigated by the initial concept response to all the above. However on a wide flat rural terrain a horizontal emphasis is preferred.

It will be acceptable to introduce elements of verticality into any concept to act as a visual connector or link between horizontal planes.

Buildings will be ground hugging to accentuate their horizontal nature and the connection and articulation of planes should be clearly defined by detail, material, and colour.

Building Mass

The overall height of the structures is shown on Table 10.1 and on the photomontages.

The proportion of the height to plan size of all buildings will be carefully considered in order to ensure that the desired overall built form articulated in the Building Form described above is to be achieved.

Normal de-massing techniques will be adopted. This will apply to the taller buildings such as the inlet works and control house.

Materials

The treatment works is located at the gateway to County Donegal and the choice of building materials to embellish the chosen building forms will be chosen to give the works a civic importance.

In principle all materials will be chosen with maintenance free longevity in mind.

There will be a strong preference for natural material in all external envelope cladding to all structures. Stone, slate, stainless steel, cast aluminium will be considered as acceptable.

Synthetic material such as exposed concrete, man-made fibrous cement cladding systems, coloured renders, all plastics, galvanised steel, will be avoided.

All detailing will be carried out with great care to prevent against staining both on vertical, horizontal and sloped surfaces.

Tanks will be constructed in fair faced concrete.

Colours

All synthetic finishes will have a neutral monochromatic tone varying from light to dark.

No primary colours will be used with the exception of necessary notices for health and safety reasons.

Texture

Generally contrasting textures from rough to smooth to accentuate different chosen forms or material will be adopted.

Materials will be chosen for their natural texture where weathering will enhance their appearance over a long period of time such as slate, copper, lead, stone.

Roof Configurations

The buildings are always viewed from a higher surrounding landscape. Thus the roof design is to be considered as a vital element in the design concept. The shape, form, pitch, materials chosen, and their relative reflectivity will be considered against the various back drops of bright grey/blue sky and green/grey mountain scape.

The form, texture, reflectivity should reflect the forms and colours, of a seasonally changing background. The buildings should mould with their backgrounds and not impose themselves on them.

Scale

As the majority of buildings have an absence of fenestration to act as a normal scaling device, alternative methods of design will be considered to maintain the all important human scale.

Services

All grills, flues etc. will be carefully designed to integrate them with the overall design and form of the buildings.

The designer must ascertain all mechanical and electrical and civil engineering requirements prior to finalising any building designs. The critical integration of these elements with the chosen forms and external materials will be considered as vital to the success of the chosen design concept.

Landscaping

The integration of both hard and soft landscape concepts will be chosen to compliment the building concepts.

All chosen hard landscaping treatment will be of natural indigenous materials which will be maintenance free.
All chosen soft landscaping and planting will be designed by a qualified Landscape Architect and will reflect the indigenous surrounding vegetation.

Planting

It is proposed that all species of plants for the proposal will be indigenous to the area. Semi-mature shrubs will be planted in sporadic groups both on the planted slopes on the site's perimeter and within the site itself. This lack of any formal design will be in keeping with the natural dispersal of plants seen in the immediate area around the site.

Views into the site from east and west will be mitigated by the proposed planted berm.

10.2.6 Night-time Lighting Mitigation

General site illumination will be restricted to low level lamps adjacent to access roads, therefore minimising their Impact.

10.2.7 Predicted Impact

The changes in the site from fallow grassland to treatment works will impact primarily upon:

- The upland area to the south
- Adjoining properties
- Nearby public vehicular and pedestrian access routes
- Properties to the north, closer to Bundoran
- Long range views the mountain tops

The proposed tanks, buildings etc. will lead to some increase in the sense of intensification in the area. These visual impacts will be heightened during the construction phase of the development due to increased activity and unfamiliarity.

The proposal will have a number of associated developments of which the most significant will be:

- Access to the site from the proposed road to provide necessary circulation.
- Car parking/service vehicle turning points in association with the new buildings.

Any change in a landscape has a corresponding impact on the character of a particular area. However, the extent of any impact depends on the associations with, uniqueness of and degree of change in a particular landscape.

The most appreciable effect of the proposal will be the intensification of built forms on this rural landscape. This intensification will result from increases in the nature, scale and site coverage of the building units. Given the rural character of the area, this intensification will have a significant impact on its character. The proposed architectural language that will be employed however will mitigate against this impact.

10.2.8 Monitoring

It is the intention that all aspects of the design, construction and landscaping will be monitored at every stage, to ensure that the overall aims stated in this document are being interpreted and implemented to the satisfaction of the consultants.

10.2.9 Reinstatement

Given the nature of the development, it is unlikely that a return to the sites existing condition will occur.

10.3 The Pumping Station

10.3.1 Introduction

The visual impact of constructing a pumping station adjacent to the existing pumping station is examined in this section. The pumping station as described in this section will be subject to a separate planning application to Bundoran UDC under Part IX of the Local Government (Planning and Development) Regulations, 1994.

10.3.2 The Receiving Environment

Context

The site of the proposed pumping station is located on the sea side of Bundoran bridge, adjacent to the existing pumping station but on the opposite side of the River Bradoge, see Fig. 10.16. The ground is currently set in rough grass and slopes down towards the river bank and the sea. There is a proposal to create a linear park with associated landscaping between the new building and the seafront. As seen from the sea, the site is surrounded by established structures - some of considerable height and mass e.g. Christ Church and the Post Office.

Site Location

The approximate 0.53 hectare site is located on the sea side (north) of the western approach to Bundoran Bridge. It is bound to the north by the sea shore, to the west by the Post Office, to the east by the mouth of the river Bradoge.

Landscape Character

The landscape is essentially a gently sloping river mouth field running down towards the sea. The strongest feature being the random rubble stone wall of the bridge and its approach road along the site's southern edge. The backdrop of the Dartry mountains is a distant but a significant geographical element.

Site Description

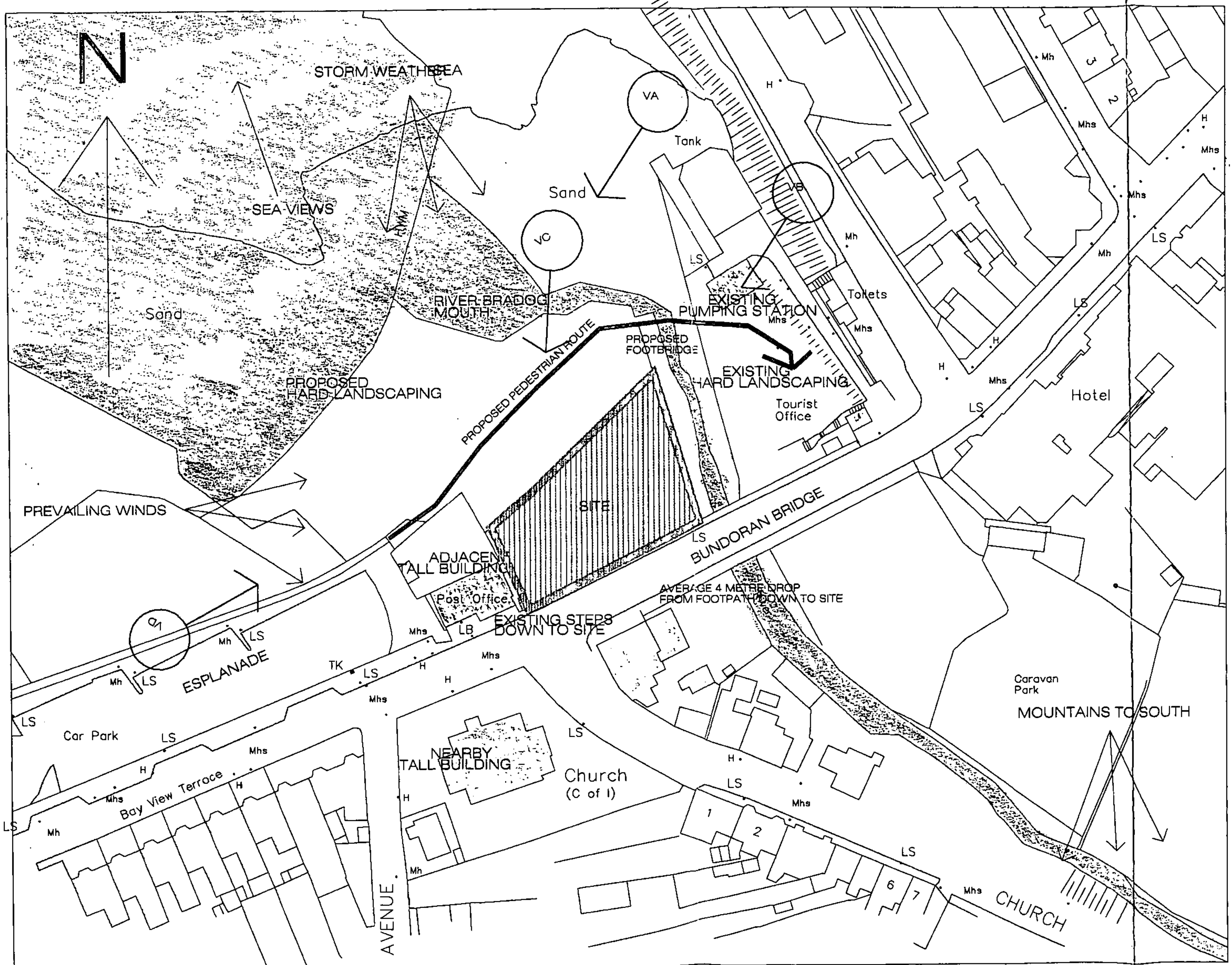
The site has a fall of approximately 1 metre from the bridge wall to the northern boundary. The nearest building is the three storey, hipped slated roof Post Office. The site is currently accessed by a flight of concrete steps from the bridge end overhead. The road level is approximately 2 metres over the ground level at the site's highest point (next to existing steps) increasing to a 4.8 metre difference at the eastern corner (adjacent to the river bank and bridge arch).

Significance

It is the stated aim of the 1998 Development Plan to enhance the awareness of the town's proximity to the sea with its views and opportunities for 'bracing sea walks'. It notes the importance of this asset in generating capital from the tourism industry. The proposed site for the pumping station and associated landscaping will further encourage this development.

Site Visibility

The location of the pumping station is shown in plan on Fig. 10.17.



Notes
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Revisions	date	inls

description: PUMPING STATION SITE PLAN ANALYSIS
drawing no.: 99/40/10
revision no.:

job: WASTE WATER TREATMENT WORKS & PUMPING STATION WORKS, BUNDORAN
scale: 1:1000
date: 15.9.00
drawn: SOT
checked:

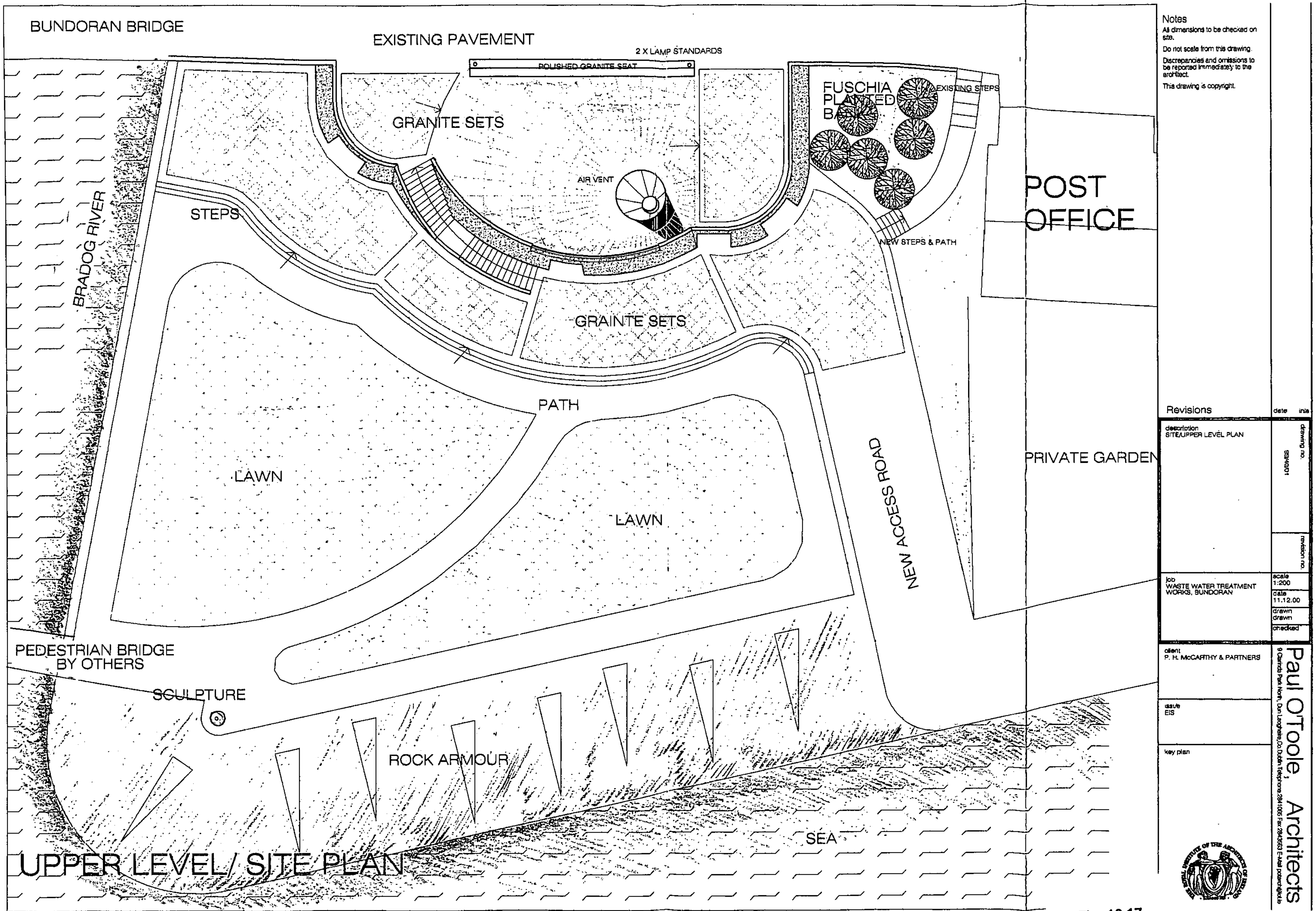
client: P. H. McCARTHY & PARTNERS

issue: EIS

key plan

Paul O'Toole, Architects
9 Clarinda Park North, Dun Laoghaire, Co. Dublin Telephone 2841065 Fax 2843563

Fig. 10.16



BUNDORAN BRIDGE
EXISTING PAVEMENT
2 X LAMP STANDARDS
POLISHED GRANITE SEAT
GRANITE SETS
FUSCHIA PLANTED BANK
EXISTING STEPS
AIR VENT
STEPS
NEW STEPS & PATH
POST OFFICE
BRADOG RIVER
GRAINTE SETS
PATH
LAWN
LAWN
NEW ACCESS ROAD
PRIVATE GARDEN
PEDESTRIAN BRIDGE BY OTHERS
SCULPTURE
ROCK ARMOUR
SEA
UPPER LEVEL/ SITE PLAN
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SITE/UPPER LEVEL PLAN
drawing no.
revision no.
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WASTE WATER TREATMENT WORKS, BUNDORAN
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client
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EIS
key plan
Paul O'Toole, Architects

Fig. 10.17

Surrounding Built Elements

Nearby built elements include: adjacent Post office; church to west and on opposite side of road; existing Pumping Station to the east on other side of river; Bundoran bridge itself.

10.3.3 Characteristics of Proposed Development

The characteristics of the proposed development are the building of a pumping station and providing hard landscaping around it at the lower level. Access to the roof of the new station (which will act as a public viewing platform) from the road is also planned. New openings in the existing bridge wall therefore are planned. A new access route via the end of the existing esplanade car park is planned. This access will be used for traffic movements during the construction phase but will predominantly be a pedestrian route with occasional vehicle access on commencement of operation of the new main pumping station. This new access will run in front of the adjoining Post Office and be integrated with the rock armour currently placed in the area.

The proposed building will be 310 square metres in area and have a flat roof which will be level with and accessible from the main road (10.53 O.D.).

In order to service the pumping station, a new linking road between it and the existing esplanade car park, which runs parallel to the shore to the west of the sites will be necessary.

10.3.4 Potential Impact

The proposal to build a new pumping station on the site will have an impact on the landscape and visual character of the surrounding area during both construction and operation.

Construction

There will be a requirement for a crane and scaffolding on site during construction. The visual impact will be short-term and will be removed at the end of the construction contract.

Operation

There will be alterations to existing ground levels. The site will be levelled off and stepped down towards the sea.

The building structure will have an impact on the area especially when viewed from the location of the esplanade to the east of the site.

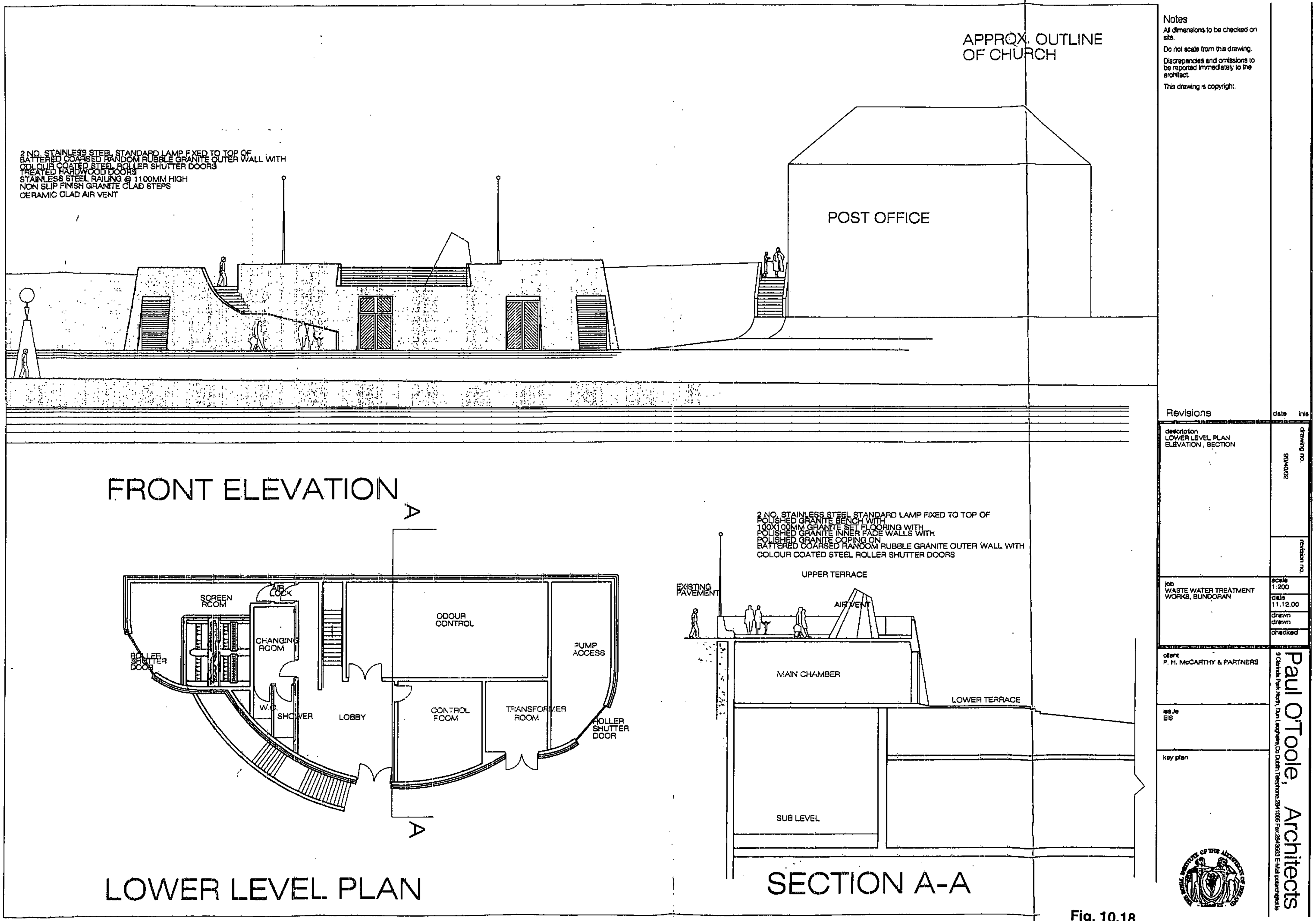
A number of lighting points will be located at both the top level and base of the building.

A front elevation and perspective drawing of the proposed development is shown on Fig. 10.18 and Fig. 10.19 respectively.

A number of lighting points will be located at both the top level and base of the building.

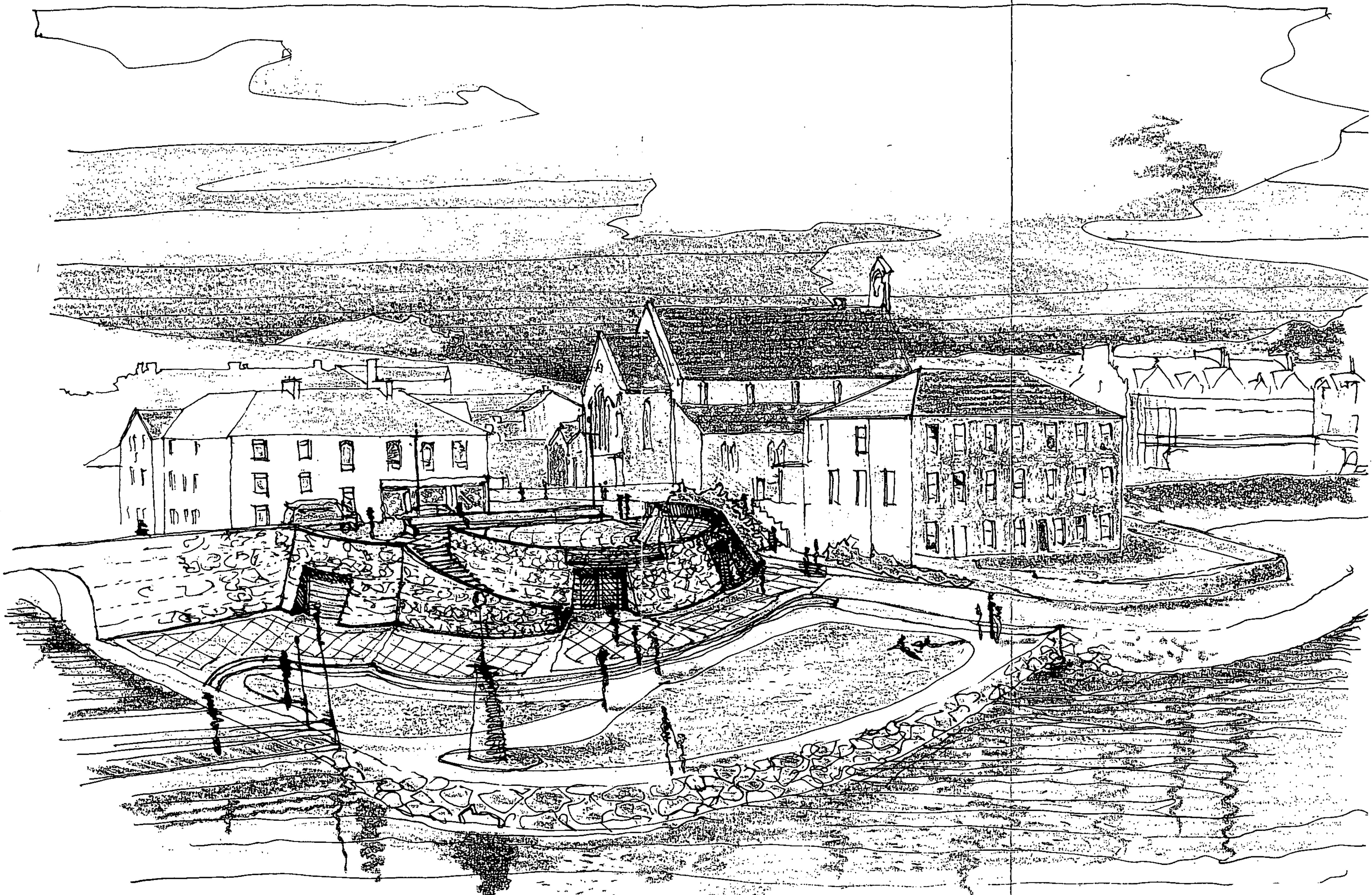
Do Nothing Scenario

If the new pumping station does not go ahead, an adequate sewerage system for the town will not be realised. The site itself will be developed as is proposed, with or without the presence of the proposed pumping station.



APPROX. OUTLINE OF CHURCH
POST OFFICE
2 NO. STAINLESS STEEL STANDARD LAMP FIXED TO TOP OF
BATTERED COARSED RANDOM RUBBLE GRANITE OUTER WALL WITH
COLOUR COATED STEEL ROLLER SHUTTER DOORS
TREATED HARDWOOD DOORS
STAINLESS STEEL RAILING @ 1100MM HIGH
NON SLIP FINISH GRANITE CLAD STEPS
CERAMIC CLAD AIR VENT
FRONT ELEVATION
A
SCREEN ROOM
AIR LOCK
ODOUR CONTROL
CHANGING ROOM
PUMP ACCESS
ROLLER SHUTTER DOOR
W.C.
SHOWER
LOBBY
CONTROL ROOM
TRANSFORMER ROOM
ROLLER SHUTTER DOOR
A
LOWER LEVEL PLAN
2 NO. STAINLESS STEEL STANDARD LAMP FIXED TO TOP OF
POLISHED GRANITE BENCH WITH
100X100MM GRANITE SET FLOORING WITH
POLISHED GRANITE INNER FACE WALLS WITH
POLISHED GRANITE COPING ON
BATTERED COARSED RANDOM RUBBLE GRANITE OUTER WALL WITH
COLOUR COATED STEEL ROLLER SHUTTER DOORS
UPPER TERRACE
EXISTING PAVEMENT
AIR VENT
MAIN CHAMBER
LOWER TERRACE
SUB LEVEL
SECTION A-A
Notes
All dimensions to be checked on site.
Do not scale from this drawing.
Discrepancies and omissions to be reported immediately to the architect.
This drawing is copyright.
Revisions
date
inls
description
LOWER LEVEL PLAN
ELEVATION , SECTION
drawing no.
99/40/02
revision no.
job
WASTE WATER TREATMENT WORKS, BUNDORAN
scale
1:200
date
11.12.00
drawn
checked
client
P. H. McCARTHY & PARTNERS
issue
EIS
key plan
Paul O'Toole, Architects

Fig. 10.18



VIEW FROM FORESHORE TO EAST OF SITE

Fig. 10.19

10.3.5 Mitigation Measures

Mitigating elements, which will be employed on the scheme, are as follows:

Structure Location
Structure Design & Materials
Landscaping

Structure Location

In order to minimise the physical impact of this building on the site, it will be located directly adjacent to the existing bridge wall. It will not impose itself above the existing wall height.

Structure Design & Materials

The proposed Pumping Station will consist of a curved, battered wall with a flat roof, projecting from the existing bridge wall. Its roof will form a viewing platform, accessible from the road. A flight of steps will descend from the platform down to the terrace below and provide public access to the new seafront esplanade proposed by others.

The building will be constructed of low/non reflective materials – to minimise impact on surrounding environment. In so far as is possible, natural materials will be used. The materials will reflect, where possible, those that are used locally as building products.

Landscaping

The impact and appearance of the development will also be ameliorated and enhanced through landscape proposals consisting of hard landscaped areas of public terracing.

10.3.6 Predicted Impact

The changes in the site from empty field to finished building and landscaping will impact on:

- The site itself
- The approach to the Bridge
- Views from foreshore
- Views from sea
- Views from esplanade

The Site

The most appreciable effect of the proposal will be the intensification of built forms on this river side landscape. This intensification will result from increases in the nature, scale and site coverage of the building. Given the urban character of the area, this intensification will not have a significant impact on its character. In fact the removal of the existing main pumping station and sensitive integration of the proposed new main pumping station will positively impact of the visual character of the area.

During the construction of the proposal, there will be significant negative impact on the surrounding area due to the presence of machinery, for example excavators and cranes.

The Bridge

At the moment, views from the bridge and its approaches overlook the site and allow direct views of the river mouth and the sea beyond. Due to the low lying nature of the proposed building, views will not be interrupted unduly. The proposed provision of a viewing platform on the roof of the building will provide an opportunity to view the surrounding environment.

The Foreshore and the Sea

At present, views towards the site from the foreshore show the sloping field and the bridge wall. The proposed building will decrease the amount of bridge wall that is visible but because the buildings materials will be similar to those of the bridge, the visual impact will by ameliorated. The buildings height – which will not appear over the existing wall, further mitigates its impact.

The Esplanade

Because of the position of the proposed building relative to the Post Office, there will be little visual intrusion by the new pumping station from this viewpoint. The existing view of the location of the pumping station is shown on Fig. 10.20 with the photomontage of the proposed pumping station illustrated on Fig. 10.21.

10.3.7 Monitoring

It is the intention that all aspects of the design, construction and landscaping will be monitored at every stage, to ensure that the overall aims stated in this document are being interpreted and implemented to the satisfaction of the consultants.

10.3.8 Reinstatement

Reinstatement of this site is not envisaged.

Bundoran Waste Water Treatment Works

Fig. 10.20

:nvironmental Impact Statement
View E as existing

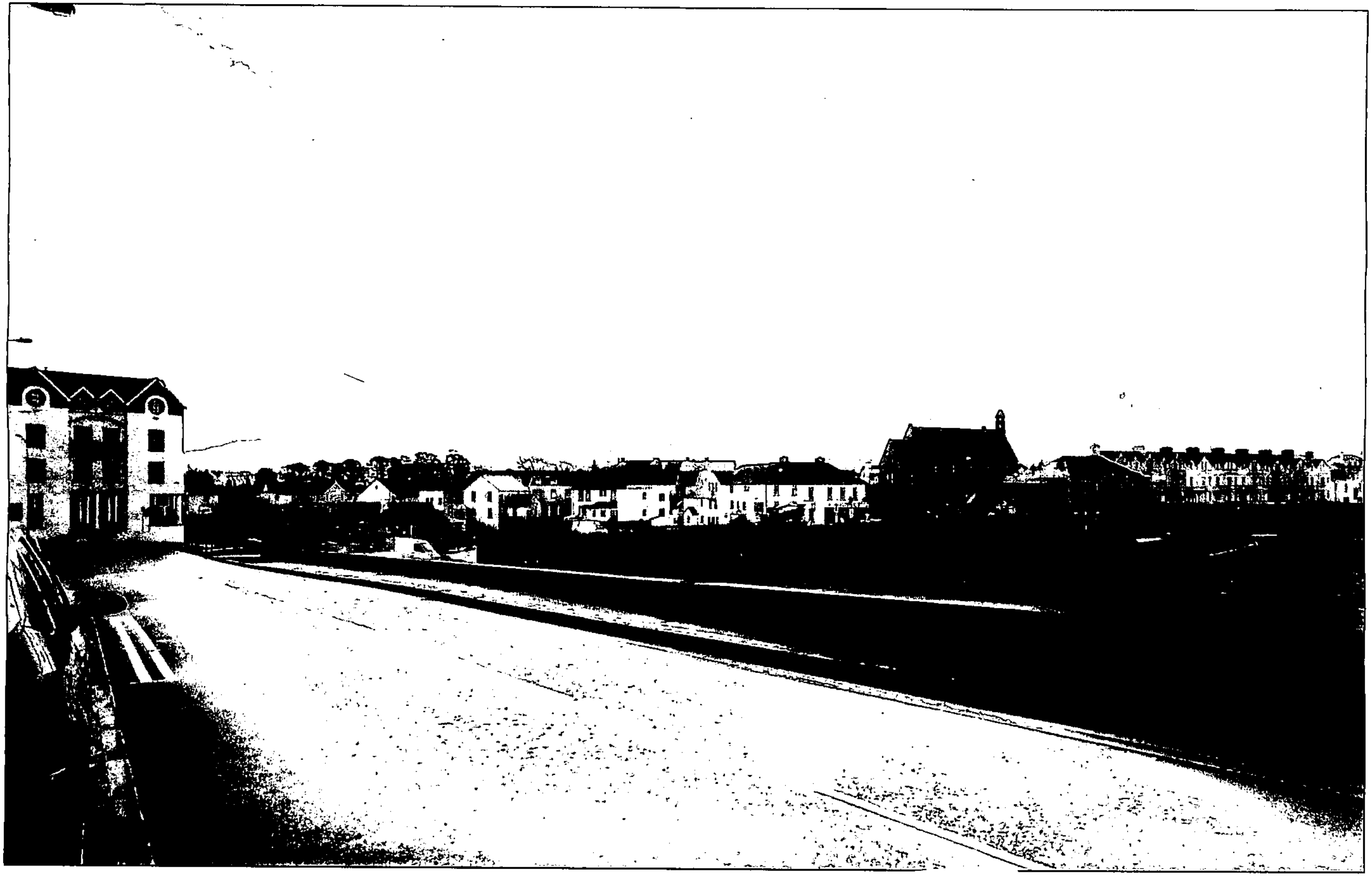


Fig. 10.21

View E as proposed

11.0 CULTURAL HERITAGE

11.1 Introduction

The purpose of this archaeological assessment is to ensure that the impact of the proposed development on the archaeological heritage of the area is kept to a minimum. This assessment is based on a desktop study and a field survey. This section of the report has been prepared by Patrick O' Donavan.

The desktop study is based on an examination of cartographic and selected archaeological and historical journals & books. However the principal sources are the *Record of Monuments and Places for County Donegal* that was issued in 1995 by The Commissioners of Public Works in Ireland (National Monuments and Historic Properties Service) and the *Archaeological Survey of County Donegal,* compiled by Brian Lacy, and published in 1983 by Donegal County Council. The field survey was undertaken on Tuesday, April 4th. 2000.

11.2 Receiving Environment:

There is no record of archaeological activity at or within the immediate vicinity of the proposed wastewater treatment works site. No archaeological features/artifacts were identified during the field survey. However the terrain is low-lying and waterlogged - a typical setting for a fulachta fiadh (see Section 11.9).

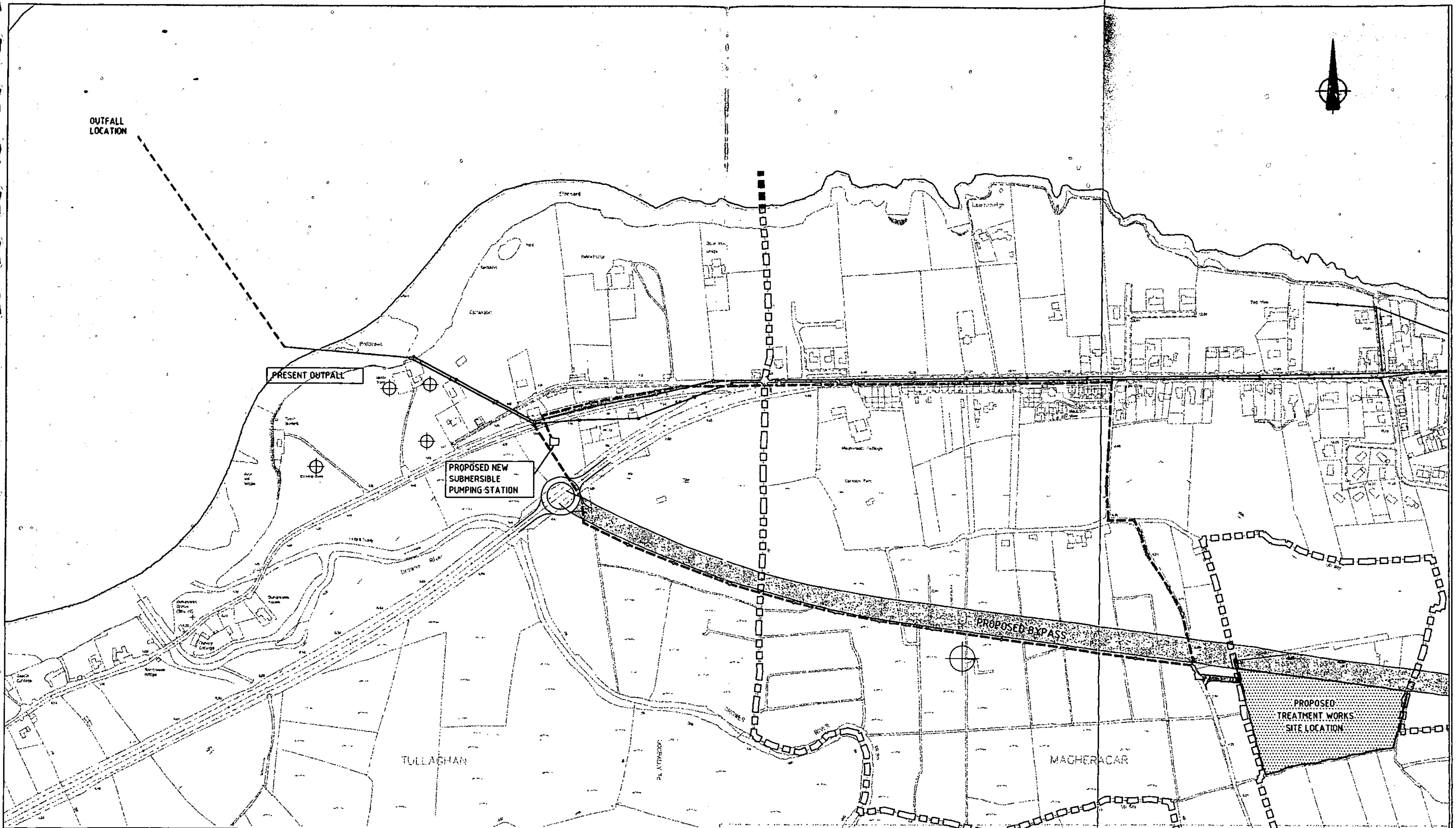
There is no record of archaeological activity at or within the vicinity of the proposed pipeline route. However a small circular earthwork was identified c. 40 metres south of the proposed pipeline route see Figure 11.1. This is not marked on any edition of the OS 6" map. The site was identified during a field survey. It is situated in treacherous, marshy low ground. Low, sub-circular mound of earth and stone(dims. At base 11.2m NNE-SSW:11m WNW-ESE) defined by an irregular scarp (H 0.15m-0.4m). The top of the mound is relatively level. There is no enclosing bank. At the foot of the scarp are ephemeral traces of a possible fosse. This monument cannot be more definitively classified on the basis of the upstanding remains.

In addition the remainder of the pipeline route is low lying and waterlogged - a typical setting for fulachta fiadh (see Section 11.9). Buried remains of fulachta fiadh or other monuments may be uncovered during the soil stripping and excavation stages of the project.

The proposed outfall will be located a few hundred metres beyond the existing outfall. There are four archaeological sites: two megalithic tombs and two standing stones, a short distance south-west of the existing outfall, all are protected by law (see Section 11.9.3). The nearest to the outfall is a wedge tomb, given the number DL 106-014- in the *Record of Monuments and Places for County Donegal* (see Section 11.9 for description of this monument). These sites are illustrated on Fig. 11.1.

11.3 Characteristics of the Proposed Development

The development proposes to upgrade the existing sewer system, construct a new pumping station in the centre of the town adjacent to the existing pumping station, build a wastewater treatment works on a green field site and extend the existing outfall pipe.



KEY

- NEW RISING MAIN
- EXISTING SEWER
- SITE OF ARCHAEOLOGICAL INTEREST

LOCATION OF ARFCHAEOLOGICAL SITES

FIG. 11.1

11.4 Potential Impact of Proposal

Construction Phase

The possibility exists that damage may occur to known monuments in the vicinity of the existing outfall and to the unknown enclosure close to the proposed pipeline route . In addition now buried archaeological features and /or artefacts may be uncovered during the ground disturbance phase of the project.

Operation

During the operation of the development no impacts on the cultural heritage are envisaged.

Do Nothing Scenario

If the development does not proceed there will be no impact vis-à-vis archaeology.

However the development is required in order to comply with EU and National legislation to the treatment of urban waste water.

11.5 Mitigation Measures

If excavation is to be undertaken within 30m of the outer extent (as defined by a professional archaeologist) of the enclosure at Magheracar, Dúchas – The Heritage Service must be notified at least two months in advance of this intention.

In addition extra care should be taken with the pipeline in proximity to the existing outfall because of the proximity of the wedge tomb and other monuments. If excavation is carried out within 30 metres of the wedge tomb or any other known or suspected archaeological site or monument Dúchas – The Heritage Service will be notified.

General monitoring of ground disturbance is outlined in Section 11.7.

11.6 Predicted Impact of Proposal

The mitigation measures outlined in section 11.5 and 11.7 will ensure that the impact of the development on the archaeology of Magheracar and its environs will be negligible.

11.7 Monitoring:

The ground disturbance phases of the project will be monitored on a full-time basis by a professional archaeologist approved by Dúchas – The Heritage Service.

It is very important to point out that in the event of the discovery of archaeological features and/or artifacts the monitoring archaeologist shall be empowered to halt the development works. He/she will then notify the National Museum of Ireland and Dúchas - The Heritage Service of the Department of Arts, Heritage, the Gaeltacht and the Islands of these finds.

11.8 Reinstatement

Should monitoring or archaeological excavation reveal archaeological material, preservation 'in situ' may be required.

11.9 Description of Terms

Fulachta Fiadh

Fulachta fiadh are traditionally held to be the ancient cooking places of the legendary Fionn MacCumhail and the Fianna. They are generally recognisable as small, low, grass-covered, horseshoe-shaped mounds composed of fragments of burnt stone and earth found close to streams or in low lying marshy ground. Archaeological excavations and experiments have revealed that these represent the remains of Bronze Age cooking-places and have given unique insight into their operation and applications. The cooking was done in a water-filled rectangular pit whose sides and floor were lined with wooden planks or stone slabs. A fire was lit nearby and stones placed in it until they reached the appropriate temperature. These were then placed in the pit to heat the water and cook the food. After cooking the burnt and shattered stones were removed from the pit, and piled up around it, forming the horseshoe-shaped mound. Fulachta fiadh are among the most common of pre-historic monument types. The majority of the 4500 identified to date are located in Munster and south Leinster, with over 2000 known from County Cork alone.

Legislation

Known and suspected archaeological monuments are protected under the National Monuments Acts 1930-94. Of these probably the most important is Section 12 (3) of the National Monuments (Amendment) Act 1994:

When the owner or occupier (not being the Commissioners) of a monument or place which has been recorded under subsection (1) of this section or any person proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such monument or place, he shall give notice in writing of his proposal to carry out the work to the Commissioners and shall not, except in the case of urgent necessity and with the consent of the Commissioners, commence the work for a period of two months after having given the notice.

A person contravening this requirement for two months notification to the Commissioners of Public Works in Ireland of proposed works at or in relation to a recorded monument or place shall (under Section 13 of the Act) be guilty of an offence and be liable on summary conviction to a maximum penalty of a IR£1000 fine and 12 months imprisonment and on conviction on indictment to a maximum penalty of a IR£50,000 fine and 5 years imprisonment.

Description of Wedge Tomb at Magheracar

'This monument was not marked on the OS Revision of 1900. It is situated on pasture land near the Passage-tomb at the edge of the sea cliff in the same townland. The tomb is constructed of rather small slabs none of which protrude more than .5m above the surrounding mound. A gallery, at least 4m long and a little more than 1m wide is represented by seven stones, four at the N and three at the S. Four outer wall stones are visible at the N and three at the S. A single façade stone adjoins the entrance at the S. The mound is about 15m in diameter. (Lockwood 1901, 88).' From the *Archaeological Survey of County Donegal,* p.43 (Site. No. 110).

11.10 Addresses and Telephone Numbers of Authorities to be contacted in the event of the discovery of Archaeological Features/Artefacts

The Chief Archaeologist,
Dúchas - The Heritage Service,
51 St. Stephen's Green,
DUBLIN 2.

Telephone: (01) 647 3000

The Director,
The National Museum,
Kildare Street,
DUBLIN 2.

Telephone : (01) 677 7444

11.11 Bibliography

Lacy B. et. al. (1983) *Archaeological Survey of County Donegal.* Lifford Lockwood F.W. (1901) *Some Notes* in the Ulster Journal of Archaeology, Ser. 2, Vol. 7, pp.82-92 Office of Public Works (1995) *Record of Monuments and Places – County Donegal.* Dublin.

12.0 SOIL

12.1 Introduction

This section has been prepared by P.H. McCarthy & Partners to assess the impact on soil due to development.

12.2 Receiving Environment

The subsoil conditions at the proposed wastewater treatment site were examined using a lightweight rubber tracked excavator on the 23rd February 2000.

Three trial holes were excavated at the Wastewater Treatment Works Site. Details of the information gathered from trial holes 1, 2 and 3 are included in Appendix C. The ground conditions consisted of very soft dark brown/black very fibrous PEAT with much wood material to depths of 1.20m below ground level overlying a soft to firm bluish grey slightly sandy silty CLAY with much cobbles and some boulders to a maximum proven depth of 3.50m.

The upgraded sewer network involves the construction of a new pipeline route to and from the treatment works. The soil along this route is similar to that at the treatment works site.

The proposed pumping station site consists of sandy silty CLAY. The site is currently separated from a sandy shoreline by a shingle berm deposited as part of the construction works taking place adjacent to the tourist office.

The existing outfall is to be retained but extended a further 400m out into Donegal Bay. This is located approximately 2km to the west of the town centre at Pollbrean. The outfall is located approximately 80m from the upper shoreline. The upper shoreline is backed by a low cliff with a thin band of glacial over-burden on limestone bedrock. The limestone pavement extends to the lower inter-tidal where it steps down approximately 3m to a boulder, cobble and gravel substrate which overlies the limestone bedrock.

12.3 Characteristics of the Proposed Development

The proposed development will involve the removal of soil or compaction of soil at both the treatment works and pumping station sites and along the proposed route for the rising main.

12.4 Potential Impact of the Proposal

Construction

The potential impacts to the existing soils will vary considerably depending on the method of construction chosen by the appointed contractor because of the design build nature of this project. The potential impacts are likely to be due to the; excavation of peat and clay, filling with suitable fill material to raise level of site above flood plain level, piling and various methods of ground improvement and the possible contamination of groundwater or soils due to spillages or other accidents. The impacts will be the removal of the peat and soft clays from the site or the building up of the ground level thereby burying these soils below suitable fill material.

Operation

No potential impact is envisaged due to the operation of the works except the possible contamination of the soils and groundwater by accidents such as spillages.

Do Nothing Scenario

If no development of this kind takes place the current soils will remain undisturbed. However the development must proceed to meet the EU and National legislation pertaining to the treatment of urban wastewater.

12.5 Mitigation Measures

Silt traps should be installed to prevent the washing of silt material from the sites especially during the construction phase into nearby watercourses. Wheel washing areas will be installed to minimise the silt and dirt that leaves both site. Proper management practices and health and safety procedures should prevent impacts from such things as accidents. Sods removed from pipeline excavation from the site to the outfall will be stockpiled and replaced as detailed in Section 7.25.

12.6 Predicted Impacts of Proposal

The predicted impacts to the existing soils will be that they will be removed or covered over.

The loss of such small quantities of soils that are in such abundance in the area is not seen as a loss to the geological heritage of the locality or the country.

12.7 Monitoring

Monitoring will take place at the ingress and discharge of any waters to and from the site.

12.8 Reinstatement

Reinstatement will take place where necessary to restore land (other than that being landscaped around the Wastewater Treatment Works and Pumping station) to a condition at least equal to if not better to that when the contractor arrived on site.

13.0 TRAFFIC

13.1 Introduction

This section undertaken by P. H. McCarthy & Partners examines the traffic and highways aspects of the proposed wastewater treatment plant and main pumping station. The aim of this report is to assess the traffic impact of the proposed development on the surrounding highway network.

The report includes an appraisal of all transport-related issues related to the treatment works and includes for the following.

- The proposed development;
- The current traffic and highway situation;
- The preferred route for vehicular access to the proposed development;
- Traffic generation and distribution from the proposed development;
- The safety records of the highway network in the vicinity of the proposed development;
- Traffic impact of the development on the surrounding highway network;
- Mitigation measures applicable to the current road network to facilitate the proposed development.

The site for the new pumping station is located in the centre of Bundoran on the west bank of the Bradoge River and adjacent to the existing bridge. Access to the site is via the existing public car park. Traffic flows during operation will be on average one two way trip per day and in terms of traffic impact on the N15 is considered minimal. Traffic flows during construction are likely to reach 3 vehicle/movements (2 way) per hour. Given the traffic flow on the N15 and the flow from the existing car park this will have a minimal impact on traffic in the area. The following sections of this EIS have concentrated on the traffic associated with the wastewater treatment works development.

13.2 Receiving Environment

The Current Traffic and Highway Situation

The site for the wastewater treatment works is located south of the N15 which passes through the town of Bundoran and east of the R280 which runs from Bundoran. Figure 13.1 illustrates the proposed highway network serving the site. Presently the site can be accessed from both the N15 and R280 along a single road joining the two. The road is classified as a Rural County Undivided (RCU) standard. For the purposes of this assessment it has been assumed that the development would be fully completed and operational by the year 2003. This is the year adopted for the traffic impact assessment. It is assumed that the proposed by-pass will not be in operation. This is considered the worst case scenario.

Route for Vehicles Wishing to Access the Proposed Development

The highway network through to the wastewater treatment site from the N15 to R280 consists of the following roads and key junctions.

Roads:

- N15 – National Primary Route through Bundoran
- R280 – Bundoran to Kinlough Regional Road
- County Road joining N15 and R280.

Junctions:

- N15 with County road.
- R280 with the County road.

The most direct access route to the site is from the N15. On construction of the proposed Bundoran by-pass the access from the N15 will be severed and the only remaining access route to the site will be via the County Road from the R280. The distance of the site from N15 is 0.5Km while the distance from the R280 is 1.7Km.

As part of the proposed bypass development the junction of the R280 and the access road will be upgraded.

There are two minor T-junctions on the access road from the R280 to the site. The first is a County road which connects to the N15, the second is with another County road which connects to the R280. Both these minor junctions are indicated as Junctions C and B respectively on Fig 13.1. On construction of the proposed by-pass the road connecting the site with the N15 at junction A will be severed.

The proposed route to the site will be from the N15 until construction of the by-pass, after this route is severed the proposed route will be from the R280.

Traffic Volumes

Traffic count surveys were carried out at three sites along the proposed access route described above. The location of these and movements at these junctions are shown on Fig 13.1.

Surveys of sites C and D were carried out on the 7th & 8th June 2000 and covered the following time periods:

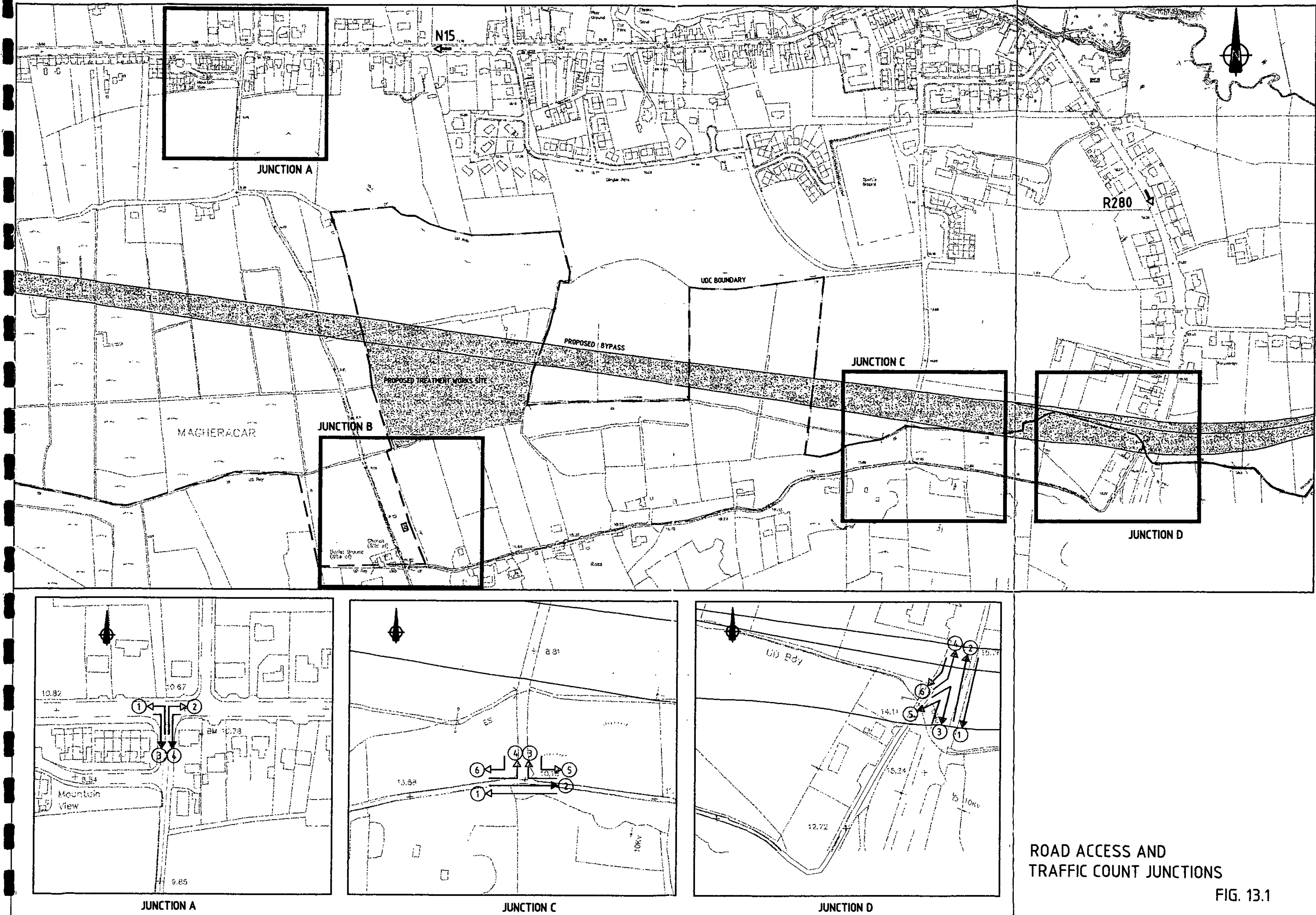
- 3.25 – 4.25pm 7th June Site D
- 1.45 – 2.45pm 8th June Site D
- 4.42 – 5.42pm 7th June Site C
- 2.47 – 3.47pm 8th June Site C

A survey of site A was carried out on the 14th September 2000 and covered the period:

- 4.00 – 5.00pm

Flows on the N15 were taken from the NRA traffic count records.

The traffic count surveys which included full junction turning movement are summarised in Table 13.1. The turning movements are shown on Fig. 13.1.



ROAD ACCESS AND
TRAFFIC COUNT JUNCTIONS

FIG. 13.1

Table 13.1 - Summary of all Daily Turning Movements Surveyed Along Preferred Access Route

	TURNING MOVEMENT - N15 Access (A)					
	1	2	3	4		
Total Vech's	40	110	40	140		
	TURNING MOVEMENT-T-JUNCTION ALONG ACCESS ROAD (C)					
	1	2	3	4	5	6
Total Vech's	20	10	30	40	50	40
	TURNING MOVEMENT- R280 Access (D)					
	1	2	3	4	5	6
Total Vech's	720	810	20	40	20	30

The figures give a breakdown of flows in total vehicle (vech's) movements including commercial vehicles movements.

The survey shows that the highest existing two way traffic flows in the study area were:

N15	313	vech/hr
R280	153	vech/hr
Access from N15	33	vech/hr
Access from R280	11	vech/hr

The count shows that the existing county road access to the treatment works site is lightly trafficked.

The Safety Records of the Highway Network in the Vicinity of the Proposed Development

Personal Injury Accident (PIA) data has been obtained from Donegal County Council for locations in the vicinity of the proposed development. This data covers the period from 1994 to the 1998. The accident incidents are shown in Appendix D. There are no reported accidents at the junction with the proposed access road and the N15 or R280.

Existing Highway Condition

The direct access to the site from the N15 is via a newly constructed road 7.5m wide for a length of 300m. From this point the road reduces in width to 3.0m over a length of 200m. The pavement condition of the new road is good and the old road condition is fair.

The pavement conditions for the proposed access route from the R280 to chainage 340m is generally good with an average width of approximately 6m. The pavement condition for the remaining 1.36km of the access route from the R280 is fair and the road width varies between 2.5m and 5.5m with an average width of 3m.

13.3 Characteristics of the Proposed Development

The proposed development consists of the construction of a wastewater treatment works south of the N15 and west of the R280. The site is located on the south side of the proposed future by-pass for Bundoran. On completion the site will accommodate up to three staff on a full-time basis. Other traffic movements will relate to activities related to routine operation and maintenance.

13.4 Potential Impact of the Proposal

Traffic Generation

This section of the report identifies the likely trips generated by the proposed development and details the distribution, which has been used to assign generated trips to the local road network. The site can be classified in two stages, construction and operation.

Construction

It is perceived that the greatest impact caused by the proposed development in relation to traffic movements is during the construction stage. The construction period is estimated to be two years. A maximum of 14 truck and car movements per hour with an average of 11 truck and car movements per hour, are estimated during a two year construction period. Maximum movements will be in the initial stages of the contract and should be evenly spread over the working day.

Operation

Once constructed, the proposed site would require a maximum of 3 operational staff on a full time basis. In addition the wastewater works would require a maximum of 2 truck movements per day with a further 6 car movements per day to facilitate routine operations and maintenance. These additional two way movements would only occur during the summer months when the works throughput is at a maximum.

Do Nothing Scenario

In the do nothing scenario there would be no impact on the traffic in the area. However the scheme is required to meet EU and National legislation pertaining to wastewater treatment.

Traffic Impact of the Development on the Surrounding Highway Network

The greatest impact of the proposed development on the current road network and on the access road joining the R280 to the N15 would be during construction. The impact of traffic at the N15 and R280 at different stages is detailed in Table 13.2.

Table 13.2 Traffic Impact

	N15 Access	
	Vehicle/hr	Vehicle/day
Existing	33	330
Construction Maximum	47	470
Construction Average	43	430
On Commissioning	33	330
	R280 Access	
	Vehicle/hr	Vehicle/day
Existing	11	110
Construction Maximum	25	250
Construction Average	21	210
On Commissioning	13	130

Before the bypass is constructed it is envisaged that construction traffic will travel to the site via the access road from the N15. After the construction of the bypass all access will be restricted to the road from the R280.

Construction traffic will be limited to between 8am and 8pm Monday-Friday and 9am to 1pm on Saturday

The existing width over a 1.7km length of the County Road from the R280 will not allow for the safe passing of vehicles travelling in opposite directions.

The low lying area of the road in the location of the access to the site is subject to flooding following periods of high rainfall.

13.5 Mitigation Measures

Access to the site will require strengthening of the pavement structure. The road in the location of the site entrance would be regraded to a level above the flood plain in the area and the junction with the R280 will be upgraded in accordance with the Council's plans for this location.

To accommodate safe passage of vehicles the road between the R280 and the site would be upgraded. Passing bay will be installed with a road width of 6m. These bays, at approximately 100m intervals, could be accommodated by the removal of hedgerows and grass verges at strategic locations.

All mitigating measures will be put in place at the start of construction.

13.6 Predicted Impact of the Proposal

The predicted impacts of the proposed development will be similar to those highlighted under potential impacts in section 13.3. However with the mitigation measures outlined in Section 13.4, widening the county road and the re-grading of the road at the site entrance will ensure that vehicles travelling from the R280 will be able to pass safely and flooding at the site entrance will be avoided.

13.7 Monitoring

No particular traffic monitoring other than routine County Council and or NRA and Garda monitoring is proposed.

13.8 Reinstatement

No reinstatement other than that associated with the development is proposed.

14.0 CLIMATE

14.1 Introduction

This section is prepared by P H McCarthy & Partners and examines the impact the proposed development may have on the local climate.

14.2 Receiving Environment

Bundoran is situated on the north-west coast of Ireland approximately 20 miles south of Donegal town. The town of Bundoran is strongly influenced by the Atlantic and is both wetter and cloudier than most parts of the country. Mean monthly rainfall levels and temperatures recorded at Cathleen's Fall Ballyshannon, the nearest measuring station to Bundoran are outlined in Table 14.1 below.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	109	75	88	57	68	74	73	99	103	118	111	107	1082
Temperature (degrees Celsius)													
mean max.	7.3	7.3	9.1	11.3	14.1	16.5	17.7	17.7	15.7	13.1	9.5	8.2	12.3
mean min.	2.1	1.8	3.1	4.4	6.9	9.7	11.5	11.3	9.8	7.7	4.2	3.2	6.3
mean	4.7	4.6	6.1	7.9	10.5	13.1	14.6	14.5	12.7	10.4	6.9	5.7	9.3

Table 14.1 Data recorded at Cathleen's Fall, Ballyshannon, Co. Donegal (Met Éireann)

14.3 Characteristics of the Proposed Development

The proposed development consists of the construction of a new wastewater treatment works, a new pumping station, the upgrading of the existing sewer system and an extension to the existing outfall.

14.4 Potential Impacts of the Proposed Development

14.4.1 Construction Phase

During the construction phase the proposed development will not impact on the climate of Bundoran.

14.4.2 Operational Phase

The operation of the both the treatment works and the pumping station is not considered likely to impact of the climate.

14.4.3 Do Nothing Scenario

If the development does not evolve nothing will change vis à vis climate.

14.5 Mitigation Measures

Mitigation measures are not applicable in this instance.

15.0 INTERACTIONS BETWEEN HUMAN BEINGS, FLORA, FAUNA, SOIL, WATER, ODOUR, CLIMATE, NOISE, LANDSCAPE, CLIMATE AND ARCHAEOLOGY

15.1 Introduction

In addition to describing the likely significant effects of the proposed development on particular aspects of the environment, the European Communities (Environmental Impact Assessment) Regulations, 1999 require us to consider the interactions between those aspects where an interaction is considered to be both likely and significant.

15.2 Interaction Matrix

The matrix below tabulates each aspect of the environment which is considered in detail in the Environmental Impact Statement and highlights the areas both where interactions occur and are considered to be of a scale which may be potentially significant. These interactions are described under the respective sections of the EIS.

	Human Beings	Flora & Fauna	Soil	Water	Odour	Traffic	Noise	Landscape	Archaeology	Climate
Human Beings		✓	✓	✓	✓	✓	✓	✓	✓	✓
Flora & Fauna			✓	✓				✓		✓
Soil				✓				✓	✓	
Water								✓		
Odour								✓		
Traffic										
Noise										
Landscape										
Archaeology										
Climate										

BUNDORAN SEWERAGE SCHEME – TREATMENT WORKS PRELIMINARY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

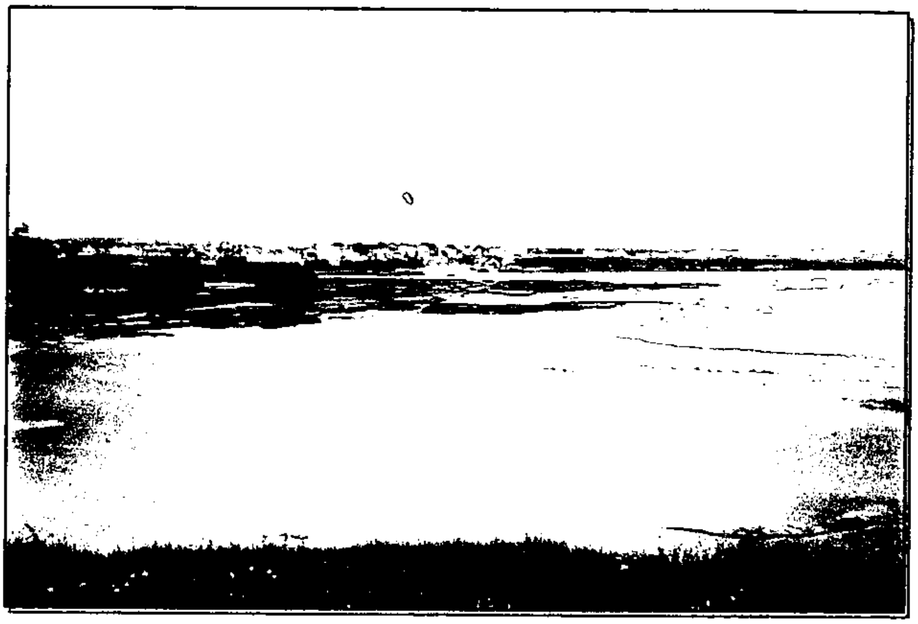
GLOSSARY

AADT	Annual Average Daily Traffic (expressed in vehicles per day)
Amelioration (of impacts etc.)	"Ameliorate" means to make less severe or to improve. Impact amelioration proposals suggest ways to avoid or lessen the negative effects of a project on the environment.
BATNEEC	Best Available Technology Not Entailing Excessive Cost
BOD	Biological Oxygen Demand
BT	Balancing Tank
COD	Chemical Oxygen Demand
DBA	A – Weighted Decibels – Measurement of Sound Frequencies
DO	Dissolved Oxygen
DWF	Dry Weather Flow measured in litres per second
DB	Design Build
DBO	Design Build Operate
DoMNR	Department of the Marine & Natural Resources
DoELG	Department of the Environment and Local Government
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statements
Embankment	A bank or mound constructed to carry a roadway at a level higher than the original level
EPA	Environmental Protection Agency
EU	European Union
Fauna	A collective term for the animals of a region
Fill	Material used for the raising of the level of the ground
Flora	A collective term for the plants of a region
Ha	Hectares = 10,000 square metres
HT	Holding Tank
H_2S	Hydrogen Sulphide
Infrastructure	Basic public facilities, eg. Roads, sewers, water supply, telephones, electricity
Leq	Equivalent sound level
l/s	Litres per second
mg/l	Milligrammes per litre
mg/m^3 air	Microgrammes per cubic metre of air.
m^3 day	Metres cubed per day
m/s	Metres per second
Mitigation Measures	To mitigate means to ease or soothe the effect of an impact. Mitigation measures suggest ways to avoid or lessen the negative effects of a project on the environment

N	Nitrogen
NH_3	Ammonia
N15	The National Primary Route from Lifford to Sligo
NTS	Non Technical Summary
OD	Ordnance Datum
OS	Ordnance Survey
OU/m^3	The concentration of odourants in air is expressed in odour units per cubic metre. Its numerical value is quantified as the number of dilutions with clean air required to reach the odour perception threshold
OU/s	Odour units per second
P	Phosphorous
PE	Population Equivalent
PFT	Picket Fence Thickener
PST	Primary Settlement Tank
PS	Pumping Station
SI	Statutory Instrument
SS (kg/d)	Suspended Solids measured in kilogrammes per day
SST	Secondary Settlement Tank
Underpass	Way below another road or structure to facilitate traffic flow
WWTW	Wastewater Treatment Works
UDC	Urban District Council
tds	Tonnes dry solids
NRA	National Roads Authority

Comhairle Chontae Dhún na nGall
Donegal County Council

BUNDORAN
WASTEWATER TREATMENT WORKS



ENVIRONMENTAL IMPACT STATEMENT

Volume 3 of 3

Appendices

PH McCarthy & Partners
CONSULTING ENGINEERS
Civil • Environmental • Structural

February 2001

DONEGAL COUNTY COUNCIL

BUNDORAN WASTEWATER TREATMENT WORKS

ENVIRONMENTAL IMPACT STATEMENT

APPENDICES - Volume 3 of 3

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APPENDIX A

WASTEWATER TREATMENT OPTIONS

ASSESSMENT OF WASTEWATER TREATMENT OPTIONS

1. INTRODUCTION.

The following secondary treatment processes are considered in this Section.

- Conventional Activated Sludge
- Extended Aeration - Oxidation Ditch
- UNOX
- Deep Shaft
- A-B Process
- Sequencing Batch Reactor (SBR)
- Biological Aeration Filtration (BAF)

The criteria under which these processes are discussed are as follows:

- Process Overview
- Process Suitability for Meeting Treatment Objectives.
- Satisfactory Demonstration on a Comparable Scale.
- Operational Complexity.
- Ease of Uprating for Increased Throughput.
- Ease of Uprating for Stricter Effluent Standards.
- Sludge Production and Characteristics.
- Process Reliability, Flexibility of Operation and Standby Requirement.
- Land Requirement.
- Hydraulic Head Requirement.
- Construction Aspects.

It is unlikely that processes such as the Deep Shaft and UNOX would be commercially viable for the Bundoran WWTW with a design capacity of 30,000 p.e. The A-B Process does have primary settlement and therefore would not comply with the DOELG requirement that all works with a p.e. greater than 5,000 should have primary settlement. Therefore, it would not be a suitable process for Bundoran. Similarly extended aeration without primary settlement would not be an acceptable option. However extended aeration with a primary settlement stage upstream would comply with DOELG requirements. In the wintertime the operational mode for a works would be extended aeration with a primary settlement and conventional activated sludge mode operating during peak summer time

loads. SBRs and BAF plants would be suitable process option for Bundoran and their acceptability would be dependant on primary settlement upstream to meet current DOELG requirements.

2. CONVENTIONAL ACTIVATED SLUDGE.

(a) Process Overview.

The activated sludge (AS) process involves contacting settled sewage with a population of naturally occurring micro-organisms in the presence of dissolved oxygen. The organisms or biomass consume the pollutants and increase in numbers. They are subsequently separated by settlement and are recycled to be reused. The clarified effluent is discharged to the receiving waters. A proportion of the biomass needs to be wasted from the system to maintain a steady population of micro-organisms.

Screened and degritted sewage either settled (primary settlement) or unsettled can be treated by this process. However, the aeration tanks would need to be about 80% larger in volume for treating settled sewage, and aeration energy requirement would also be significantly higher. It is not therefore generally considered to be cost effective to treat unsettled sewage.

Aeration is normally provided either by submerged fine bubble equipment or by mechanical surface aerators. Hybrid aeration systems employing surface aerators at the inlet and diffused aeration at the outlet of plug flow plants have recently been constructed in the UK. These systems can reduce operating costs in works where oxygen transfer efficiency is low because of the presence of detergents and other surfactants. Where detergent levels are low the additional mechanical complexity of the system outweighs any potential advantages. Another aeration alternative is to provide a tapered aeration input to match the varying dissolved oxygen demand along the length of the plug flow tank. Requirement for very high aeration intensity could be achieved if necessary by a supplement of oxygen injection. For fine bubble aeration, reactor tanks are usually 4-6m deep, but depths of up to 20m have been used in some of the recent designs. Mechanical surface aerators are normally suitable for tanks 4-5m deep.

The activated sludge process is well established and proven for use at medium to large sewage treatment works. Carbonaceous oxidation or full nitrification can be achieved by operating the plant at different sludge loading rates and by increasing the supply of dissolved oxygen.

Limiting factors on performance have been oxygen transfer rate and efficiency and the ability to separate the activated sludge from the effluent. Recent developments in equipment technology have improved the efficiency of aeration systems. Current design practice includes a 'selector' zone at the inlet to the aeration tanks which has been found to improve the settleability of sludge, and reduce the risk of occurrence of poor settleability. For a nitrifying plant the 'selector' zone would be anoxic, whereas for a carbonaceous oxidation plant the zone should be kept anerobic.

The intensity of aeration for fine bubble diffused air is normally limited to about 200g/m^3.h with an operational aeration efficiency in the range of 1.8 to 3.5kg DO/kWh. For vertical-shaft surface aerators however, the corresponding values are 125g/m^3.h and 0.8 to 1.6kg DO/kWh respectively.

(b) Process Suitability for Meeting Treatment Objectives.

The activated sludge process treating settled sewage can be adapted to meet a range of effluent standards, with or without nitrification and nitrogen removal. It can also be modified to achieve partial removal of phosphorus without the need for chemical additives.

(c) Satisfactory Demonstration on a Comparable Scale.

The activated sludge process is by far the predominant treatment process world-wide at works of 25,000 pe or more, to achieve a 25:35 (BOD:SS) 95 percentile standard, with or without nitrification.

(d) Operational Complexity.

The process itself is relatively simple and straight forward to operate. Adequate dissolved oxygen monitoring is required to ensure correct levels of dissolved oxygen. Inclusion of automated control systems can be cost-effective in terms of optimising energy use.

(e) **Ease of Uprating for Increased Throughput.**

Treatment capacity can be uprated by the installation of additional primary settlement tanks, aeration tanks, aeration equipment and secondary settlement tanks provided there is sufficient area of land available.

(f) **Ease of Uprating for Stricter Effluent Standards.**

The process is relatively easy to uprate for stricter effluent standards. Nitrification can be achieved in the same treatment stage by reducing sludge loading rate and substantially increasing dissolved oxygen input. Additional treatment tanks and aeration equipment would be required. No additional final settlement tank capacity would be necessary, provided the sludge settles well.

Full or partial denitrification of a nitrified effluent can be achieved by inclusion of anoxic zones within the treatment stage. However, for full denitrification the additional volume for these zones would be 30% of the tank volume (aerated and anoxic).

Biological phosphorus removal could be achieved by inclusion of anaerobic zones at the tank inlets and/or addition of chemicals.

(g) **Sludge Production and Characteristics.**

One of the important process features of the activated sludge plant design and operation is to provide conditions which ensure good sludge settleability, as it is vital to successful operation of the Works.

The production of secondary sludge can vary significantly depending on quantity of inert debris in the settled sewage, sludge loading rate and temperature of the sewage. Production is generally taken at about 25 to 32g DS/capita.d, or 0.7 to 0.9 kg/kg BOD removed. Underloading of treatment units can cause partial nitrification resulting in poor sludge settleability and risk to effluent quality. However, it has been found that by increasing the degree of plug-flow through the aeration tanks and the inclusion of a selector zone at the tank inlet, problems associated with poor sludge settleability can be minimised.

Surplus activated sludge has a good stability characteristic and can normally be easily thickened and dewatered mechanically. Gravity thickening alone would achieve about 2-3% dry solids (DS), or up to 6% DS if a polyelectrolyte is used. A maximum of 18%DS can be expected for a dewatered activated sludge. Up to 25% DS could be achieved for a mixed primary and secondary sludge

(h) Process Reliability, Flexibility of Operation and Standby Requirement.

A number of parallel process lanes can be designed to ensure that effluent quality does not suffer during maintenance of plant. Standby equipment such as air blowers and sludge recycling pumps should be provided. The activated sludge process can be designed to handle variations in hydraulic and BOD loads.

(i) Land Requirement.

To achieve the 25:35 (BOD:SS) 95 percentile standard without nitrification, the area of land required for aeration tanks is greater than for the other single-stage processes considered except the extended aeration/oxidation ditch system. However, if either nitrification or nitrogen removal were required, the land requirement for a single-stage activated sludge nitrifying plant would be less than for two-stage processes, especially where there are associated secondary settlement tanks.

(k) Hydraulic Head Requirement.

This is not excessive, and likely to be comparable to the other options under evaluation. Most of the head loss would occur as the result of flow splitting into a number of plug-flow aeration lanes.

(k) Construction Aspects.

The costs of available construction techniques are well established without the possibility of unexpected extras. No specialist equipment or materials are required.

3. EXTENDED AERATION - OXIDATION DITCH.

(a) Process Overview.

Oxidation ditches are low aeration intensity activated sludge systems traditionally designed to be operated at the lower end of sludge loading rate range (0.05 to 0.1 kg BOD/kg MLSS per day). Consequently, the aeration tank volume is significantly greater compared to an equivalent conventional AS system. For this reason, oxidation ditches are most common for small to medium sized Works. They are generally not favoured for large Works, as landtake required is significant.

Extended aeration processes can be designed to treat screened and degritted crude sewage, without primary sedimentation, using an 'endless loop' or 'closed circuit' aeration channel with a sewage hydraulic retention time of about 1 to 3 days.

In a typical system, mechanical surface aeration is used to provide dissolved oxygen and horizontal impetus to recirculate the contents of the ditch and keep the MLSS in suspension. The intensity of aeration is normally limited to about 100 g/m^3h with either rotor type aerators or vertical aerators. The aeration efficiency is normally within the range 0.6-1.6kg DO/kWh depending on the type of aerator used, the composition of the sewage and the configuration of the aeration tanks. Recently, sub-surface mixers have been used in deeper tanks, with fine-bubble sub-surface aeration, although few plants have been constructed and energy use would be higher than normal.

After aeration, mixed liquor gravitates into conventional secondary settlement tanks.

Except where stated otherwise, the following sections refer to oxidation ditch treatment using mechanical surface aerators, of screened and degritted sewage without primary treatment, to produce a substantially nitrified effluent.

(b) Process Suitability for Objectives.

Oxidation ditches can produce an effluent quality of 25mg BOD/l and 35mg SS/l on a 95 percentile basis. In achieving this standard, nitrification will incidentally occur because of the low loading involved in operation of these ditches.

(c) **Satisfactory Demonstration on a Comparable Scale.**

Oxidation ditch plants for populations ranging from 1000 to 500,000 pe have been installed widely in Ireland, Europe and world-wide. They have been performing satisfactorily, producing consistent quality effluent.

(d) **Operational Complexity.**

The original oxidation ditch concept, designed to serve small communities, was to avoid complexity and have a simple system with few operational requirements. Energy saving measures to avoid over aeration have resulted in the use of control systems linked to the aerators. Such systems are fully automated and the basic process, remains relatively simple to control.

(e) **Ease of Uprating for Increased Throughput.**

Due to the large aeration tank volume and the normal provision of extra standby aerator capacity, an oxidation ditch will accommodate a significant increase in load before it becomes overloaded and needs uprating.

To increase flow rates beyond the original design value will require additional secondary settlement tanks.

(f) **Ease of Uprating for Stricter Effluent Standards.**

Oxidation ditches usually produce a high quality nitrified effluent and are not normally designed for achieving a 25:35 (BOD:SS) 95 percentile effluent without nitrification.

The ease of uprating will depend on the type of aerators used. Additional horizontal rotors (aerators) can be relatively easily added to the system with TNO rotors.

The process is normally designed to be operated at a low sludge loading rate with a long period of mixed liquor aeration which will ensure full nitrification. Inclusion of a zone of high floc loading rate at the inlet, in which partial denitrification of the recycled sludge occurs, is a recent development. Uprating would be necessary to achieve full nitrogen removal. Although some degree of denitrification is commonly achieved in ditch systems, to achieve greater nitrogen removal would require extensive

modifications to change the plant configuration together with provision of about 33% more tank capacity.

(g) Sludge Production and Characteristics.

Treatment of screened and degritted sewage without primary settlement, would produce less sludge than the total amount produced from primary settlement plus surplus activated sludge when treating settled sewage.

This reduction in sludge would be achieved at the expense of increased electrical energy for aeration in the ditch, which would biochemically oxidise a proportion of the organic matter normally present in primary sludge. This option differs from the others in that a single type of sludge is produced. Because of its aerobic treatment and long sludge age, the waste sludge would have lower calorific value than sludge from other options.

The settleability of sludge from an oxidation ditch is likely to be poorer than sludge from a plug-flow activated sludge plant. It may also be more prone to the production of stable foam. Dewatering of sludge would produce a filtrate low in Amm.N, BOD and suspended solids, but it would contain oxidised nitrogen and phosphate.

(h) Process Reliability, Flexibility of Operation and Standby Requirements.

The oxidation ditch is as reliable as a conventional activated sludge system. It would require adequate standby aerators or blowers and readily available spares for mechanical equipment.

As the aeration volume in an oxidation ditch is large relative to that of conventional AS systems, it has the capacity to withstand sudden variations in BOD load and sewage flow-rate, without significant effect on effluent quality, provided that the secondary settlement tanks were designed to cope with the peak flow rates. This benefits both process reliability and operational flexibility.

(i) **Land Requirement.**

The area of land required would be the largest of all the options considered, because of the increased aeration volume of the ditch and its relatively shallow depth. The land area required for final settlement tanks would be the same as for the conventional activated sludge process.

(j) **Hydraulic Head Requirement.**

The hydraulic head required would be marginally greater than for the conventional activated sludge system given the greater number of process units.

(k) **Construction Aspects.**

Owing to the relatively shallow depth of the oxidation ditch, compared with up to 4-6m tank depth for fine-bubble diffused air system, construction of oxidation ditch tanks is generally comparatively easy.

4. UNOX OXYGEN ACTIVATED SLUDGE PROCESS.

(a) Process Overview.

The Unox process is a relatively recent development of the activated sludge process for the treatment of sewage. Mixed liquor is oxygenated and mixed by mechanical surface aerators in an atmosphere of oxygen in enclosed reactors. Oxygen at about 90% purity is supplied to the gas space above the mixed liquor in response to a decrease in pressure resulting from oxygen uptake by the activated sludge. Supply of oxygen can be closely matched to demand and, as the rate at which it dissolves is much higher in an atmosphere of oxygen than in air, a high rate of oxygen demand can be met. The process is most applicable to situations where it is necessary to satisfy a higher rate of oxygen demand than can be met by aeration. This occurs when the sewage strength is high. The Unox process is a high-rate process, capable of treating sludge loadings of up to 1 kg BOD/kg MLSS per day to achieve a good quality effluent with nitrification. It has been applied to settled domestic and mixed wastes and the treatment of industrial effluents such as from brewing. Treatment of screened, degritted but unsettled sewage would require larger oxygenation tanks and use more energy than treatment of settled sewage and is not preferred. A process schematic is shown in Figure B2.

The source of oxygen would depend on the amount of oxygen required for the process. For small and medium sized plants, oxygen can either be as liquid oxygen tankered to site or on-site production by separation from air using a 'package' pressure-swing adsorption (PSA) plant. For larger plants it would be necessary to install on-site oxygen generation plant. Two processes are available for the production of oxygen on site viz.; the Cryogenic method or the molecular sieve technique using PSA. Oxygen production is a complex operation and would require highly skilled and trained operatives and plant attendants. An alternative option for the supply would be to make an arrangement with a specialist supplier such as BOC Gases.

(b) Process Suitability to Meet Objectives.

The Unox process is capable of achieving a high degree of carbonaceous oxidation, to meet a 25:35 (BOD:SS) 95 percentile standard when treating settled sewage in a single very compact biological stage.

(c) **Satisfactory Demonstration on a Comparable Scale.**

The Unox process is well established in Europe, USA and Japan treating flows up to 751,680m^3/d.

(d) **Operational Complexity.**

The treatment process is as straightforward as conventional activated sludge. If liquid oxygen were used as oxygen source the system remains simple. If on-site oxygen production were used, the PSA system would add complexity.

Instrumentation required is for the oxygen feed control mechanism (pressure monitors), vent-gas oxygen measurement, and hydrocarbon alarm system to protect against oil spillages etc. The PSA plant has a complex system of instrumentation and control included in the package. Additional instrumentation to monitor the influent flow and its composition, and vent gas flow would be likely to be cost effective in controlling the use of oxygen.

(e) **Ease of Uprating for Increased Throughput.**

As oxygen input is unlikely to be limiting, existing units can be partially uprated by increasing BOD load without an increase in hydraulic loading, with little effect on effluent quality. Further uprating to cope with increasing hydraulic load can be achieved by addition of parallel oxygenated reactors and settlement tank.

Future demands on the PSA or cryogenic oxygen production process should be considered in the initial design.

(f) **Ease of Uprating for Stricter Effluent Standards.**

The Unox process does not normally produce a nitrified effluent. The sludge loading rate is relatively high with a consequent low sludge age, which precludes growth of nitrifiers. There is also a potential for reduction in pH value during the process, depending upon the alkalinity of the waste water, due to the accumulation of dissolved carbon dioxide. Both of these factors would adversely affect nitrification. Nitrification of settled Unox effluent can be achieved in a second biological treatment stage which would be conventionally aerated.

It would be possible to follow directly a conventional Unox plant with a conventionally-aerated AS plant, without intermediate settlement. This novel integrated arrangement would permit high-rate carbonaceous oxidation at the inlet end of the process plus lower-rate nitrification at the outlet end.

In a two-stage treatment system, denitrification would be difficult to achieve using an anoxic zone system. No denitrification would be possible in the first stage, as no nitrification would have taken place. Denitrification linked with a second nitrifying stage would require provision of an organic carbon source, such as a small bypass of settled sewage, since effluent from the Unox stage would have insufficient organic carbon available for denitrifying bacteria. Nitrogen removal could be more easily achieved in an integrated Unox and AS plant by mixing sewage with recycled sludge at the inlet of the Unox plant in an anoxic zone.

Phosphorus removal would be by chemical addition. It would also be feasible using anaerobic zones, in an integrated Unox and AS plant.

(g) Sludge Production and Characteristics.

The Unox process has been reported to produce less sludge than comparable aerated activated sludge systems. This is particularly true in hard water areas where inorganic compounds in the mixed liquor are solubilised as the pH value decreases. At one UK works, sludge production was 80% of that in an aerated activated sludge plant operated in parallel in a hard-water area

Settleability of sludge from the Unox process is generally better than that of conventionally aerated sludge. In some circumstances the evidence is inconclusive, and periods of poor settleability may be experienced. However, an average sludge settleability of 80 ml/g may be assumed for design purposes, compared to 120 ml/g for conventional AS treatment, permitting operation at higher MLSS.

Sludge characteristics which facilitate thickening and dewatering have been found to be satisfactory.

Because of the high degree of oxidation of activated sludge in the Unox reactors, the surplus sludge would be expected to be stable, and similar to that of conventional AS process.

(h) **Process Reliability, Flexibility of Operation, Standby Requirements.**

The process is very reliable. Generally, several parallel streams are installed to allow removal of one stream from operation and diversion of flow without loss of treatment and performance. Sludge loading rate can be increased up to about 1 kg BOD/kg MLSS per day without loss of treatment, assuming adequate settlement capacity is available and nitrification is not required.

The process requires a reliable supply of oxygen. Local production facilities are preferred, together with a storage capacity on site. The PSA oxygen plant is essentially an absorption process with unlimited turn-down. However, there may be loss in efficiency if operated far from optimum design capacity. Storage of oxygen would require the production of liquified gas on site.

PSA is a well established oxygen separation process for industrial use, but there were some problems with its reliability in the first generation of Unox plants in 1974 in the UK. Another option is the production of oxygen on site, in a plant owned and operated by a specialist supplier, such as BOC. Liquid oxygen is normally stored on site as standby, with compressed air (used for the air feed to the PSA plant) giving further back-up and providing a safety facility of purging the gas space in the enclosed oxygenated reactors.

(i) **Land Requirements.**

Unox reactors would require about one quarter of the volume of a conventionally aerated plant to produce an effluent of 25:35 (BOD:SS) 95 percentile standard. The area required for final settlement tanks would be the same as for conventional activated sludge plant. The area required for oxygen production plant is expected to be similar to that required for air blowers of a conventional AS plant. However, oxygen storage would add to the land requirement, particularly as equipment would be required to liquify the gas.

If nitrification, or nitrogen removal were required, an additional area of land would be needed for a further activated sludge treatment stage and a blower house. The intermediate settlement stage could be avoided in an integrated Unox and activated sludge system.

(j) **Hydraulic Head Required.**

The hydraulic head required would be similar to that for conventional activated sludge treatment plant.

(k) **Construction Aspects.**

No particular differences are anticipated compared to the construction difficulties associated with conventional activated sludge plant. Covered oxygenation reactors would be required. The use of oxygen and storage of liquid oxygen require stringent safety considerations.

5. THE DEEP-SHAFT PROCESS.

(a) Process Overview.

The Deep-Shaft Process was developed by ICI in the UK during the early 1970's to treat sewage in what is essentially an activated sludge process. It is designed to increase the rate at which oxygen dissolves in water by increasing the total pressure in the system, and hence increasing the saturation concentration of dissolved oxygen at the bottom of a Deep-Shaft, without a corresponding increase in energy to compress the air used for aeration. Results from both pilot-scale and full-scale Deep-Shaft installations indicate that the aeration efficiency is about 1.5-2kg DO/kWh with an aeration intensity of about 3000 g/m^3h for a shaft 135m deep. This aeration intensity is about 15 to 30 times the maximum rate for conventional aeration systems.

The Deep-Shaft process consists of a vertical shaft sunk into the ground, lined with concrete or suitable alternative material, and either divided by a vertical partition into a downflow (downcomer) and an upflow (riser) sections or as two concentric tubes. Recirculation and aeration of the mixed liquor is achieved by 'start-up' and 'process' air. Initially, a large flow-rate of start-up air is provided to the riser which creates an air-lift action to the mixed liquor to start circulation. Once the liquor is recirculating at a velocity greater than about 0.6m/s, the supply of process air is commenced and the start-up air is reduced.

Process air, entering the downcomer, is drawn down by the relatively high velocity of the liquor and dissolves rapidly in the turbulent flow, as the pressure increases until all the air is dissolved just prior to the bottom of the shaft. As the pressure decreases in the riser, bubbles of gas, mostly nitrogen and carbon dioxide and possibly some residual oxygen present, are formed to assist with air-lifting the liquor and maintaining recirculation. A schematic arrangement of the Deep-Shaft Process is shown in Figure B3.

Experience has shown that a small proportion (10 to 30%) of start-up air is always required to ensure that recirculation is maintained irrespective of the dissolved oxygen requirements of the activated sludge.

The shaft terminates at ground level in a header tank which serves to disengage the bubbles to the atmosphere and prevent them from being drawn into the downcomer. Settled sewage following primary treatment and recycled activated sludge enter the process in the header tank above the downcomer and recirculate in the shaft up to 30 to 40 times, depending on the BOD of the sewage and the effluent quality required, before passing from the header tank to a degassing system.

The treated liquor from the header tank is supersaturated with nitrogen and carbon dioxide, and contains micro-bubbles attached to sludge flocs. The presence of these gases impairs effective separation of activated sludge by the ensuing settlement process. Hence a bubble stripping system is used. This consists of further aeration of the mixed liquor in plug-flow type conventionally-aerated tanks. The method has been successfully used to strip excess gases before recycling the mixed liquor into the downcomer of the shaft. The mixed liquor after degassing, flows into conventional secondary settlement tanks.

The depth of the shaft and the rate of recirculation of mixed liquor depends on the rate of demand for dissolved oxygen by the activated sludge and the BOD of the sewage. For a typical domestic sewage with a BOD concentration of about 250 mg/l, the depth of the shaft would be about 60m.

(b) Process Suitability to Meet Objectives.

As a development of the AS process, the Deep-Shaft process is capable of producing either a non-nitrified or fully-nitrified effluent with denitrification, depending upon the sludge loading rate applied. The sludge loading rate must be reduced to achieve nitrification by providing larger aerated AS tanks downstream of the Deep-Shaft reactor. Sludge settleability is improved by plug-flow conditions in the shaft.

(c) Satisfactory Demonstration on a Comparable Scale.

Although several pilot-scale studies carried out in the UK, at Aylesbury, Bournemouth and Tadcaster demonstrated satisfactory performance with respect to effluent quality, full-scale works were not installed at any of these sites because capital costs were subsequently found to be too high.

A full-scale Deep-Shaft treatment works was established at Tilbury (UK) in 1979 for Anglian Water plc to treat a mixed domestic and predominantly industrial sewage, for a population equivalent of 140,000. This plant is presently being extended to double its treatment capacity. There are several Deep-Shaft plants in Europe and the UK treating industrial effluent for population equivalents up to 400,000. ICI Ltd. claims that there are about 20 Deep-Shaft installations in Japan, serving populations equivalent of about one million.

(d) Operational Complexity.

To avoid wastage of air and excessive use of energy in compressing the process air, it is essential to control the air flow rate based on measurement of dissolved oxygen in the mixed liquor prior to the gas-lift pump, where start up air is continuously injected. It is very important to ensure that the recirculation velocity in the shaft does not fall below about 0.6m/s, to avoid reverse circulation of the flow and consequent overflow of the mixed liquor from the top of the shaft. Effective degassing of mixed liquor from the shaft is important to ensure that aeration efficiency is maintained at optimum level.

Control of air flow rates to the downcomer, riser and subsequent aeration tank for degassing, can be effected by DO monitors linked to a suitable programmable logic controller. Maintaining stable operating conditions in the shaft, irrespective of sewage flow rate, aeration requirements and BOD load, requires an automatic system, as manual operation is undesirable and would lead to inconsistent plant performance and significant wastage of energy for compressed air.

(e) Ease of Uprating for Increased Throughput.

To be efficient in the use of energy and to achieve reliable operation, the shaft must to be designed for maximum and minimum flow rates and BOD loads. Thus the number and size of shafts have to satisfy initial design criteria.

Therefore, for increased sewage flow and BOD load above the initial design rates, additional capacity would be required. This may require additional shaft(s) to be constructed, and/or additional aeration capacity added downstream of the shaft(s) in the degassing tanks. The additional treatment units would then become a large

proportion of the total capacity, thus increasing substantially the total area occupied by the Deep-Shaft plant.

(f) Ease of Uprating for Stricter Effluent Standards.

The Deep-Shaft process is essentially a conventional type of activated sludge plant with a high intensity aerator at the inlet end of a plug-flow aeration tank. To achieve full nitrification would require the sludge age to be increased and the sludge loading rate to be decreased. This could be accomplished by either increasing the suspended solids in the mixed liquor, which may require additional final settlement tank capacity, or increasing the volume of the aeration tank.

The consequence of a reduction in sludge loading rate would be to reduce the rate at which micro-organisms require dissolved oxygen to biochemically oxidise Amm.N and to satisfy BOD. Thus, the need for high aeration intensity available from a Deep-Shaft would be reduced, which could adversely affect aeration efficiency.

Provision for both additional aeration capacity, and extra settlement tanks would be relatively straight forward.

(g) Sludge Production and Characteristics.

In the original development of the Deep-Shaft process, it was considered that the conditions of plug-flow, intensive turbulence and high pressure would encourage respiration, and reduce sludge production. In practice, however, the productions were found to be similar to other activated sludge systems. Because of the high-floc loading rate at the inlet to the downcomer of the shaft, and plug-flow of mixed liquor around the shaft and through the bubble-stripping aeration tanks, the settleability of sludge is found to be generally very good. As such, the volume of surplus activated sludge is likely to be relatively low and its dewatering characteristics are likely to be good.

(h) Process Reliability, Flexibility of Operation and Standby Requirements.

The process reliability is comparable to any other type of activated sludge plant. However, because the shafts would provide a major proportion of the total requirement for dissolved oxygen to produce an effluent of 25:35 (BOD:SS) 95

percentile standard, it may be necessary to provide additional standby shaft(s) alongside the operational shafts.

In order to provide effective treatment in the event of aeration failure in one of the operational shafts, full standby compressors would be essential.

(i) Land Requirements.

As the land area needed to construct the Deep-Shaft system for full nitrification and denitrification will be marginally smaller than that required for a conventional activated sludge plant treating to the same standard, the saving in land area would be minimal. This marginal benefit is due to the fact that the preliminary and primary treatment stages would be identical to that required for the conventional activated sludge process, as would be the number and size of secondary settlement tanks and the buildings to house compressors and blowers.

(j) Hydraulic Head Requirements.

The head loss through the activated sludge plant downstream of the Deep-Shaft will be influenced by the restrictions to flow introduced into the process units. The Deep-Shaft has a recirculation air-lift pump as part of its equipment which would minimise head loss across the shaft. A preliminary assessment of the hydraulic head requirement for the Deep-Shaft indicated that this process requires an additional one metre head over the conventional activated sludge plant with plug-flow aeration streams.

(k) Construction Aspects.

Successful construction of a Deep-Shaft plant will be largely governed by subsoil ground conditions at the site. Poor soil conditions with silts, running sands, water bearing gravels or large boulders would make shaft excavation difficult and expensive. The construction method can only be determined following a detailed geotechnical site investigation.

The construction of several shafts would compound the magnitude and scale of construction problems and may encounter further difficulties associated with poor ground conditions and control of ground water ingress into deep excavations.

6. THE A-B (ADSORPTION-BIO-OXIDATION) PROCESS.

(a) Process Overview.

The A-B process was developed in Germany by Professor Bohnke during the late 1970's. Over 70 plants are in operation or planned, mostly in Germany.

Essentially, it is a two-stage activated sludge process without primary treatment. The main features of the process are that the first stage operates under very high loading conditions, typically 5 kg BOD/kg MLSS.d with a short retention time, typically 30 minutes. The second stage is operated at a more conventional loading rate, depending on the treatment level required. The disadvantage of the process is that two complete settlement stages are required, which increases the land take. Professor Bohnke claims that 40-60% of the load is removed in the A-stage, mostly by adsorption and flocculation, rather than by bio-oxidation. The A-stage is aerated, but only to promote the flocculation and not sufficiently for biodegradation. The A-stage also provides a buffer to the second B-stage against shock loads. However, there is evidence that the A-stage mostly removes particulate BOD load.

(b) Process Suitability for Objectives.

The process can be adapted usually via the loading rate of the second stage to achieve a range of effluent standards, including full nitrification and some degree of denitrification. Full nitrogen removal is not achievable without addition of organic carbon or sewage bypassing the A-stage into downstream anoxic zones in the B-stage.

(c) Satisfactory Demonstration at Comparable Scale.

Over 70 A-B plants have come into operation or been planned in the last 15 years, mostly in Germany, ranging in size from small (<5,000 pe) to large (>100,000 pe).

(d) Operational Complexity.

Being essentially two AS plants in series, the process is relatively straight forward. It obviates the operational complexities of primary treatment. However, two aeration control mechanisms are required, together with two sets of settlement tanks, sludge recycle pumps and two surplus activated sludge arrangements.

(e) **Ease of Uprating for Increased Throughput.**

Treatment capacity can be increased by installation of an additional parallel plant, for both A and B stages. Additional settlement capacity for both stages would be required based upon the increase in hydraulic loading. Therefore, uprating treatment capacity is relatively straight-forward, provided sufficient land area is available.

(f) **Ease of Uprating for Stricter Effluent Standards.**

An A-B process plant designed to produce a 25:35 (BOD:SS) 95 percentile effluent, would be relatively simple to uprate to achieve full nitrification, by increasing the volume and aeration capacity of the B-stage. The B-stage settlement tanks capacity might also need to be extended.

However nitrogen removal is not as efficient in this process configuration as in a single stage activated sludge system. This is because much of the readily biodegradable organic carbon, necessary for denitrification to proceed rapidly, will have been removed in the A-stage, and any denitrification would have to be performed in the B-stage. This detracts from the benefit of the A-stage.

Phosphorus reduction, if required, could be provided by chemical precipitation, or by the use of purpose designed anaerobic zones. However, the process configuration could lead to phosphorus uptake in the A-stage with subsequent release in the sludge liquors unless combined with chemical treatment.

(g) **Sludge Production and Characteristics.**

The process produces two sludges, one from the A-stage and one from the B-stage.

It is claimed that the B-stage sludge is similar to a conventional secondary sludge but the quantity is reduced by approximately one third. However, increased sludge production in the A-stage, compared to primary sludge, reflects an overall increase in total sludge production. The A-stage sludge is likely to be rather less stable than primary sludge, being 'enriched' with adsorbed BOD and COD, and could be more malodorous and difficult to dewater. However, the overall mixture of the sludges may be more manageable than primary plus secondary sludge. Both sludges are claimed by Professor Bohnke to settle very well.

(h) Process Reliability, Flexibility of Operation and Standby Requirements.

The very high loading on the A-stage permits some degree of increased loading, including shock toxic loading, to be absorbed, without detriment to the B-stage operation.

(i) Land Requirement.

The area required for the A stage would be greater than for primary settlement in the conventional activated sludge process and the land requirement for the B-stage would be slightly less than that of a conventional activated sludge plant, producing a 25:35 (BOD:SS) 95 percentile effluent. Bohnke claims that higher volumetric loadings, and therefore a smaller land-take is possible for nitrifying aeration stages. Secondary settlement tank requirements for the B-stage is the same as for conventional AS treatment.

(j) Hydraulic Head Requirement.

Hydraulic head loss through the plant would be greater than that for the activated sludge process as it is a two stage process. Head loss through the B-stage would be mainly as a result of flow-splitting into multiple treatment lanes.

(k) Construction Aspects.

The installation of an A-B process plant is not expected to provide particular constructional difficulties. It would also be necessary to provide a sludge recycle facility for the A-stage.

7. SEQUENCING BATCH REACTOR (SBR).

(a) Process Overview.

A sequencing batch reactor (SBR) is a fill and draw activated sludge treatment system. The unit processes involved in the SBR and conventional activated sludge systems are identical. Aeration and sedimentation/clarification are carried out in both systems. However, there is one important difference. In conventional plants, the processes are carried out simultaneously in separate tanks, whereas in SBR operation the processes are carried out sequentially in the same tank.

As currently used, all SBR systems have five steps in common that are carried out in sequence as follows:

1. fill
2. react (aeration)
3. settle (sedimentation/clarification)
4. draw (decant)
5. idle

A number of process modifications have been made in the times associated with each step to achieve specific treatment objectives.

Sludge wasting is another important step in the SBR operation that greatly affects performance. Wasting is not included as one of the five basic process steps because there is no time period within the cycle dedicated to wasting. The amount and frequency of sludge wasting is determined by performance requirements, as with a conventional continuous flow system. In an SBR operation, sludge wasting usually occurs during the settle or idle phases. A unique feature of the SBR system is that there is no need for a return activated sludge (RAS) system. Because both aeration and settling occur in the same chamber, no sludge is lost in the react step, and none has to be returned from the clarifier to maintain the sludge content in the aeration chamber. Some modifications of the SBR process also include continuous flow modes of operation.

(b) **Process Suitability for Objectives.**

In the early 1960's, with the development of new technology and equipment, interest was revived in the fill and draw systems. Improvements in aeration devices and control systems have allowed the development of fill and draw systems to achieve their present level of efficiency, which now enables SBR technology to compete successfully with conventional systems. All waste waters commonly treated by conventional activated sludge plants can be treated with SBRs.

(c) **Satisfactory Demonstration on a Comparable Scale.**

In recent years variations of SBR technology have been developed and installed throughout the world treating both municipal and industrial waste waters, works of up to 1.8 million pe have been designed.

(d) **Operational Complexity.**

The SBR process requires significant levels of automation and control for optimum treatment. This requires a high level of plant operator experience. However it is because of developments in technological reliability that this process has become a viable treatment process.

(e) **Ease of Uprating for Increased Throughput.**

Treatment capacity can be uprated by the installation of additional reactor tanks and equipment provided sufficient land is available as the process is modular by nature.

(f) **Ease of Uprating for Stricter Effluent Standards.**

The process has a greater sludge age than conventional activated sludge and uprating to stricter effluent discharge standards will be relatively easy. Nitrification can be achieved in the same treatment stage by reducing the loading rate and increasing dissolved oxygen input although many SBR applications are designed to denitrify initially. Anoxic conditions can be achieved by sequencing of the fill, aerate and decant stages achieving partial or even complete denitrification.

Biological phosphorus removal can be achieved, again by careful sequencing of the aeration sequences and by including an anoxic zone at the inlet to the tanks.

(g) Sludge Production and Characteristics.

Sludge production would be typically equivalent to the oxidation ditch process and the comments therein would apply here.

(h) Process Reliability, Flexibility of Operation and Standby Requirement.

The SBR is in principle as reliable as other conventionally aerated activated sludge systems. However it is more reliant on sequencing of equipment for fill, draw and aerate operations which require satisfactory telemetry and control systems and these require specialist management and maintenance. There is also more aeration and other equipment and hence greater maintenance requirements.

The SBR process generally has the capacity to withstand sudden variations in BOD load although it can be susceptible to large variations in hydraulic loading hence careful design of the flow regimes for flows to full treatment is required.

(i) Land Requirement.

The SBR process is a compact treatment system as it combines both aeration and settlement in the same reactor and employs common wall construction in the tankage layout.

(j) Hydraulic Head Requirement.

The hydraulic head would be greater than for the conventional activated sludge system although it does depend on the particular development of the SBR process, some variations claim similar head requirements where a continuous flow design has been employed.

(k) Construction Aspects.

As the number of process units are similar in size and shape, requiring no final settlement tanks, construction of the plant would be relatively simple compared to the activated sludge plant. No constructional difficulties are envisaged, as deep excavation is not expected.

8. BIOLOGICAL AERATED FILTER (BAF).

(a) Process Overview.

Biological aerated filter (BAF) processes were developed during the seventies and eighties and are only relatively recently commercially available. Pollutants in settled sewage are oxidised and absorbed by micro-organisms as it flows through a flooded mineral or plastic media bed, which acts as the support for attached micro-organisms and which is forcibly aerated. The lower part of the bed is generally not aerated and serves to remove suspended solids from the oxidised effluent, thereby obviating the need for secondary settlement tanks.

BAF filter units are much more compact than an equivalent conventional percolating filter, because it is able to treat much higher loading rates; up to 4 kg $BOD/m^3.d$ for Biocarbone compared to up to 0.12 kg $BOD/m^3.d$ for conventional filtration. The biological treatment volume for carbonaceous treatment is also smaller than that for an activated sludge plant which would be loaded at a maximum of about 1 kg $BOD/m^3.d$ excluding settlement capacity.

The media has a very high specific surface area upon which a high density of bacteria (active biomass) can grow. This high density of active biomass can be sustained because the filter bed is submerged by sewage and forcibly aerated. Thus, food and dissolved oxygen are readily available to a large proportion of bacteria in a relatively small volume, and a high rate of oxidation is achieved.

The BAF process for carbonaceous treatment only is shown in Figure B5. Settled sewage usually enters at the top of the filter bed which is normally 2.5-4.5m deep and process air is injected approximately 300mm above the base of the bed to provide a counter current air supply. The media below the process air injection point is not aerated and serves to strain out suspended solids. Treated effluent passes out through the bottom of the filter and into a holding tank before final discharge. This tank holds sufficient effluent for backwashing the filter bed. The bed requires periodic cleaning due to the natural accumulation of solids from biological oxidation and normal retention of suspended solids within the filter. Backwashing can be initiated on a time sequence or head loss basis. The sewage flow is stopped during backwashing and both air and final effluent are injected from the base of the filter to flush out the solids. Filter units in parallel are required to ensure continuous treatment of sewage, and their

size is limited by the need to distribute the flow evenly through the bed and backwash effectively.

(b) Process Suitability for Objectives.

The BAF process has a proven track record of achieving an effluent standard of 25mg BOD/l, and 35mg SS/l on a 95 percentile basis. Nitrification can be achieved in a single stage by decreasing the BOD loading. Average ammoniacal nitrogen concentrations of 2.5mg/l have been reported for single stage plants, but lower levels are achieved if an additional filter is used as a tertiary nitrifying stage. Total nitrogen removal requires at least two stages to achieve average concentrations of less than 10mg/l. Several independent studies have corroborated the manufacturers' claims for the process.

(c) Satisfactory Demonstration on a Comparable Scale.

There are a number of proprietary types of BAF plants currently in operation with a proven track record. The majority of the plants are for p.e. less than 100,000.

(d) Operational Complexity.

The BAF process is essentially simple in operation. However, backwashing would be required about once every 24 hours for each unit. All installations are fully automated. The main difficulty is the operation of units in parallel, involving a considerable supervisory effort for the large number of control mechanisms.

During backwashing a number of valves have to be opened or closed, requiring operations to be controlled automatically by several level sensors and timers.

The flow splitting arrangements need to be carefully designed given the larger number of treatment units in order to ensure good process performance.

The input of process air can be controlled by dissolved oxygen monitors as in the activated sludge process, though the number of sensors required would be larger.

(e) **Ease of Uprating for Increased Throughput.**

A significant increase in hydraulic loading and/or pollutant concentration would require the addition of more units to achieve the same effluent standard and to avoid frequent backwashing. Uprating the plant would be relatively simple as extra units and associated ancillary equipment can be added to operate in parallel.

(f) **Ease of Uprating for Stricter Effluent Standards.**

A BAF plant producing 25mg BOD/l, 35mg SS/l 95 percentile effluent could be uprated to achieve full nitrification either by increasing the number of units operating in parallel and thereby reducing the loading rate, or by adding tertiary nitrifying units downstream of the carbonaceous oxidation plant.

Total nitrogen removal can be achieved by the addition of anoxic filter units prior to aerobic filters and recycling of final effluent.

Increasing the number of treatment units is relatively simple, provided there is sufficient space available. Units can be stacked to save space, but this arrangement would require additional pumping to provide the necessary hydraulic head.

(g) **Sludge Production and Characteristics.**

Sludge production from carbonaceous treatment is reported to be similar to that of conventional activated sludge at about 0.8 kg/kg BOD removed. The sludge is removed regularly from the beds by backwashing. The volume of backwash water is about 10-15% of the average daily sewage throughput to the plant, and the concentration of solids in the waste water from backwash is usually between 500 and 1000mg/l. Hence a relatively large volume of dilute sludge has to be treated or returned to the works inlet. The latter would have a major hydraulic impact on the sewage treatment stream unless a balancing tank to attenuate the flow was provided.

(h) Process Reliability, Flexibility of Operation and Standby Requirement.

As a BAF plant has a greater number of treatment units a unit could be temporarily taken out of operation, for example for maintenance, without noticeable detriment to the effluent standard. In this respect the BAF plant has an advantage over other processes with fewer treatment streams.

BAF is a single pass, short retention, plug-flow treatment process, and is therefore unable to buffer large variations in loads.

(j) Land Requirement.

The principal attraction of the BAF process is its compactness requiring a significantly smaller land take compared to conventional activated sludge plant.. However, space would be required for the backwash water holding tanks.

(k) Hydraulic Head Requirement.

Settled sewage will have to be pumped to the BAF plant and the head loss through the plant is likely to be marginally higher than in an activated sludge plant owing to the losses in pipework and valves in the flow distribution. Backwash of the media beds requires further pumping.

(m) Construction Aspects.

As the number of process units are similar in size and shape, requiring no final settlement tanks, construction of the plant would be relatively simple compared to the activated sludge plant. No constructional difficulties are envisaged, as deep excavation is not required.

APPENDIX B

WATER MODELLING REPORT

CONTENTS

1.0 INTRODUCTION

P. H. McCarthy and Partners commissioned Kirk McClure Morton to investigate and report on the dispersion of effluent from the outfall serving the proposed Bundoran Waste Water Treatment Works (WWTW) and its effects on water quality in Donegal Bay. Particular attention was paid to the bathing waters in Bundoran and the water quality at the mouth of the Drowse River, a salmonid fishery. P. H. McCarthy and Partners will use this report as supporting information in the preparation of the Environmental Impact Statement for the WWTW.

The methodology adopted for the water quality modelling study undertaken by Kirk McClure Morton can be summarised as follows:

- to utilise Kirk McClure Morton's existing hydrodynamic model of Donegal Bay to provide spring and neap boundary conditions for more detailed hydrodynamic models of the Bundoran area;

- to develop a series of patched hydrodynamic models of the southern shore of Donegal Bay with sufficiently fine grid resolution to accurately define the tidal flow characteristics around the proposed outfall;

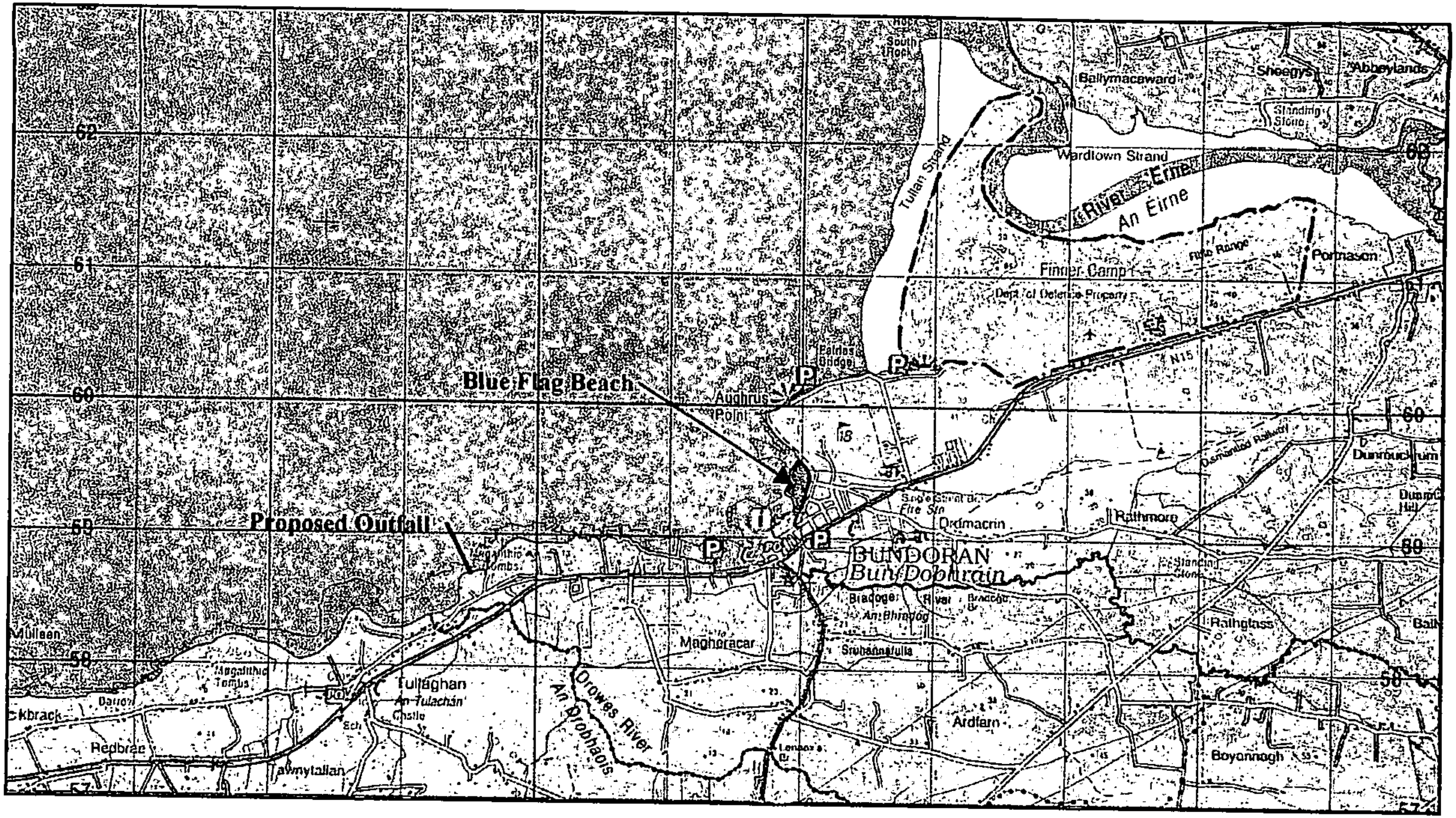
- to verify the accuracy of the various hydrodynamic models by comparing model predictions to actual field observations of tidal heights and currents;

- to develop a series of water quality models to predict the dispersion of effluent from the proposed outfall west of Bundoran, with particular emphasis on assessing the impact on bacteriological water quality at the bathing beach;

- to undertake an assessment of the potential impact of the proposed discharge and other local discharges on water quality at the mouth of the Drowse River which is an important salmonid river.

This report outlines in detail, the development of the various models, the verification of the hydrodynamic models, and the results of the predictive effluent dispersion modelling. The potential impact on receiving water quality in Donegal Bay and the bathing waters at Bundoran in particular of effluent discharged from the proposed WWTW is also quantified in so far as is possible within the limitations of the modelling.

A location map of Donegal Bay showing the approximate location of the proposed outfall and the Blue Flag bathing beach at Bundoran is presented as Figure 1.1.



Extract from OS Map showing Locations of Proposed Outfall and Blue Flag Beach

Figure 1.1

2.0 HYDRODYNAMIC MODELLING

2.1 General

The tidal flow conditions within the main body of Donegal Bay which give rise to the dispersal of effluent can generally be considered to be well mixed and thus a two-dimensional, depth integrated hydrodynamic model can be employed. The TIDEWAY-2D, suite of computer models developed by H R Wallingford was therefore utilised in this study.

In order to correctly model the water exchange between Bundoran Bay and the main body of Donegal Bay it was necessary to ensure that the boundary conditions were well removed from the study area. Kirk McClure Morton therefore utilised their existing hydrodynamic model of Donegal Bay to provide the boundary conditions to the final Bundoran Bay model. The western limit of the base hydrodynamic model lies along a line between Malin Beg Head and Ballyconnel Point at the entrance to Donegal Bay.

2.2 Modelling the Seabed Characteristics

The base model of Donegal Bay was developed by setting up a 270m grid system over the entire region and inputting the depth at each nodal point to a computer. A series of dynamically linked "patches" of finer grid spacing were incorporated in the coarse grid model to improve the spatial resolution of the model within the area of interest. Two levels of patching were used to zoom into the Bundoran area during this study.

The final model of the Bundoran area had a grid spacing of 30 m and covered the southern shoreline of Donegal Bay between Merling Rocks in the west and Ballyshannon Bar in the east. Over 83,000 nodal points were required to adequately define the seabed within the patched model.

Bathymetric data for the various models was obtained from the Admiralty Chart of Donegal Bay, the Admiralty source data on which the chart was based along with data from a specially commissioned hydrographic survey of the area around the outfall. All depths were converted to a common datum, chosen as LAT (Lowest Astronomical Tide), before being input to the computer.

A contour map of the seabed of Donegal Bay as represented in the base model is shown in Figure 2.1, depth contours have been drawn relative to LAT, over the range 0m to 70m. A similar seabed map of Bundoran Bay as generated by the final computer model is shown in Figure 2.2 in this case the contours have been drawn relative to LAT at intervals over the range -2 m to 30 m.

2.3 Implementation of the Hydrodynamic Models

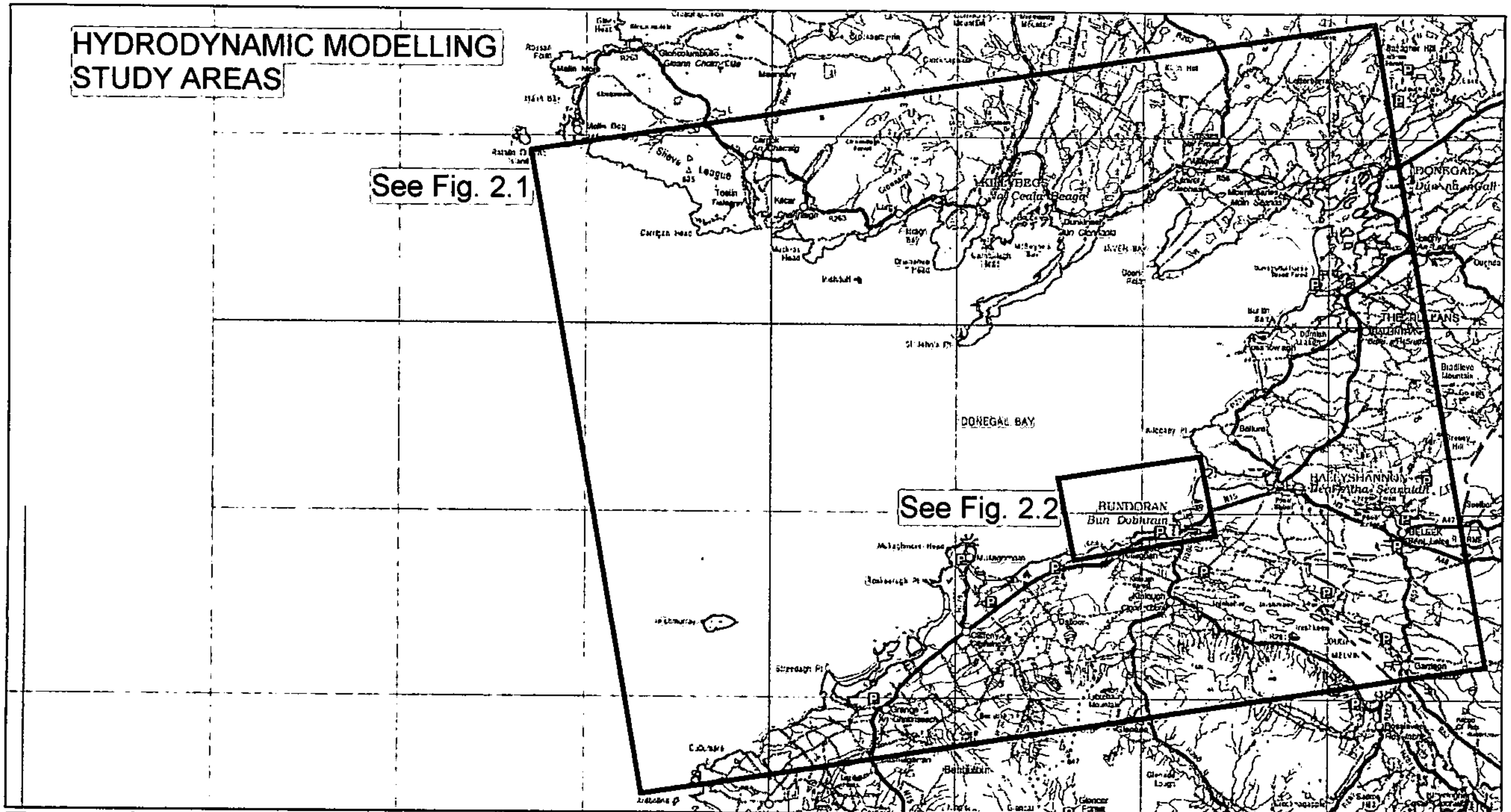
The tidal computations were performed on Unix based SUN Sparc Workstations with the flow results, i.e. water levels, velocities and discharges between each model element, stored in the computer at 10 minute intervals throughout the tidal cycle for subsequent processing.

The two-dimensional depth integrated flow equations were solved using implicit finite difference techniques based on the Crank Nicholson method. The solution to the dynamic regime using this method should always be stable, however, to maintain accuracy the time step was limited to five times the explicit stability limit Δ_{te} where

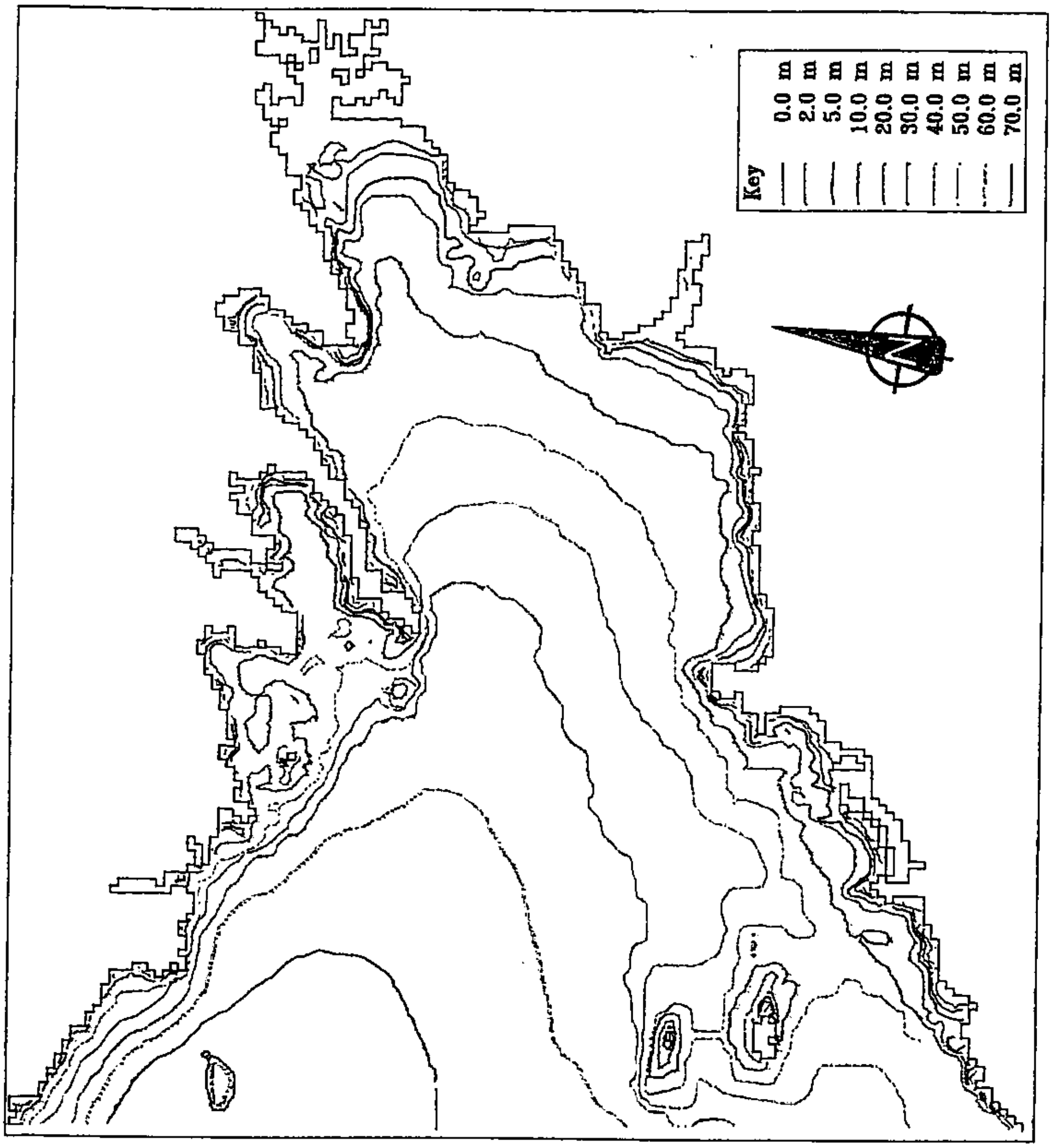
$$\Delta_{te} = \frac{\Delta_s}{\sqrt{2gd_{max}} + V_{max}} \qquad (1)$$

and

Δ_s = minimum grid spacing (m)
d_{max} = maximum water depth (m)
V_{max} = maximum velocity (m/s)
g = acceleration due to gravity (m/s^2)



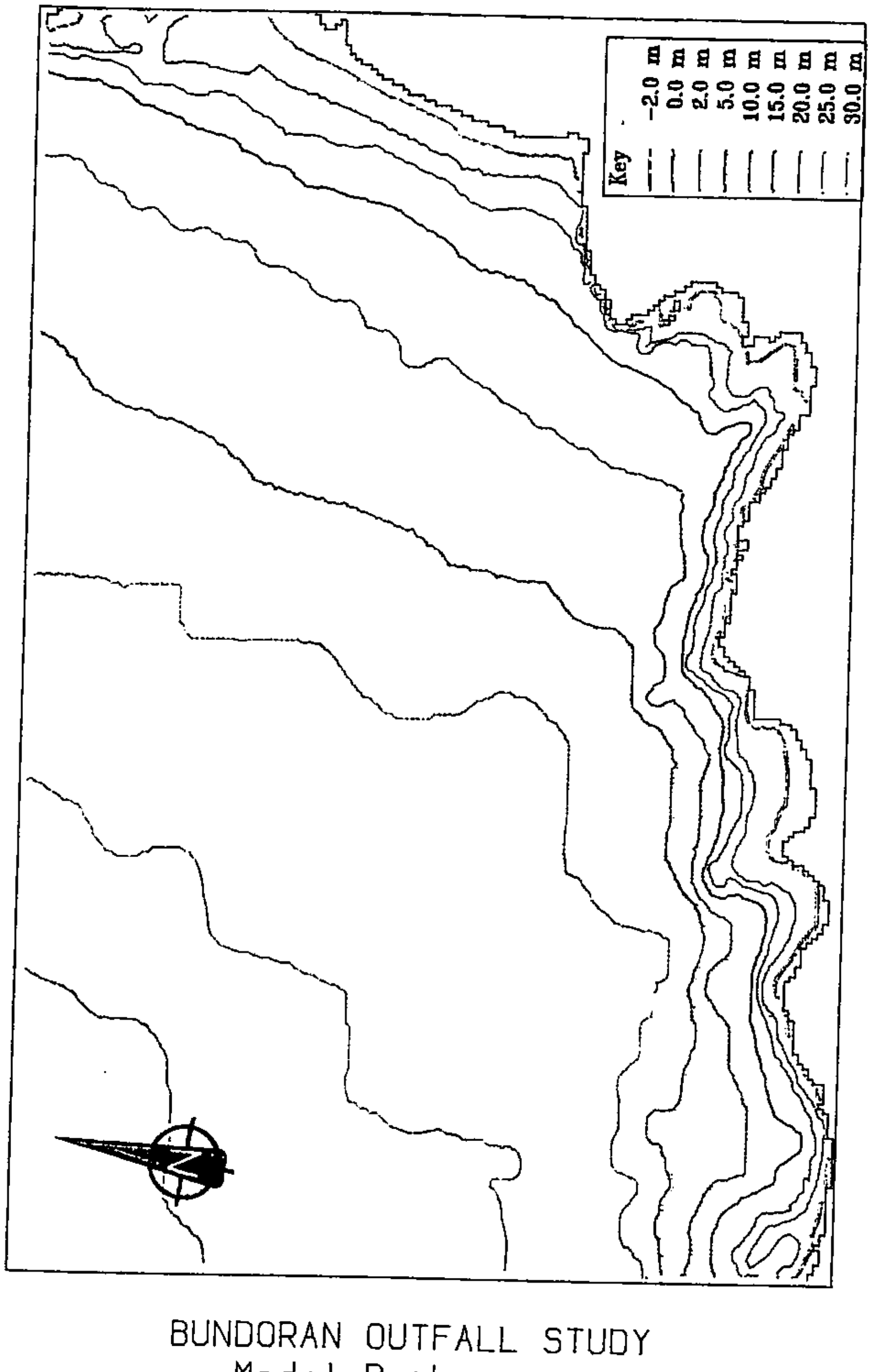
Extract from OS Map showing the area of Donegal Bay modelled in Fig 2.1 and 2.2 respectively



DONEGAL BAY TIDAL MODEL
Base Model Bathymetry
Grid Spacing - 270m

Hydraulics Research Tideway System

Figure 2.1



BUNDORAN OUTFALL STUDY
Model Bathymetry
Grid Spacing - 30m

Hydraulics Research Tideway System

Figure 2.2

The actual time step used for the final hydrodynamic model of Bundoran Bay was 5.3 seconds.

To prove stability, the complete model was run for three tidal cycles. Tidal height and velocity predictions for the second and third tides were compared and found to be identical showing that the model had reached a stable solution.

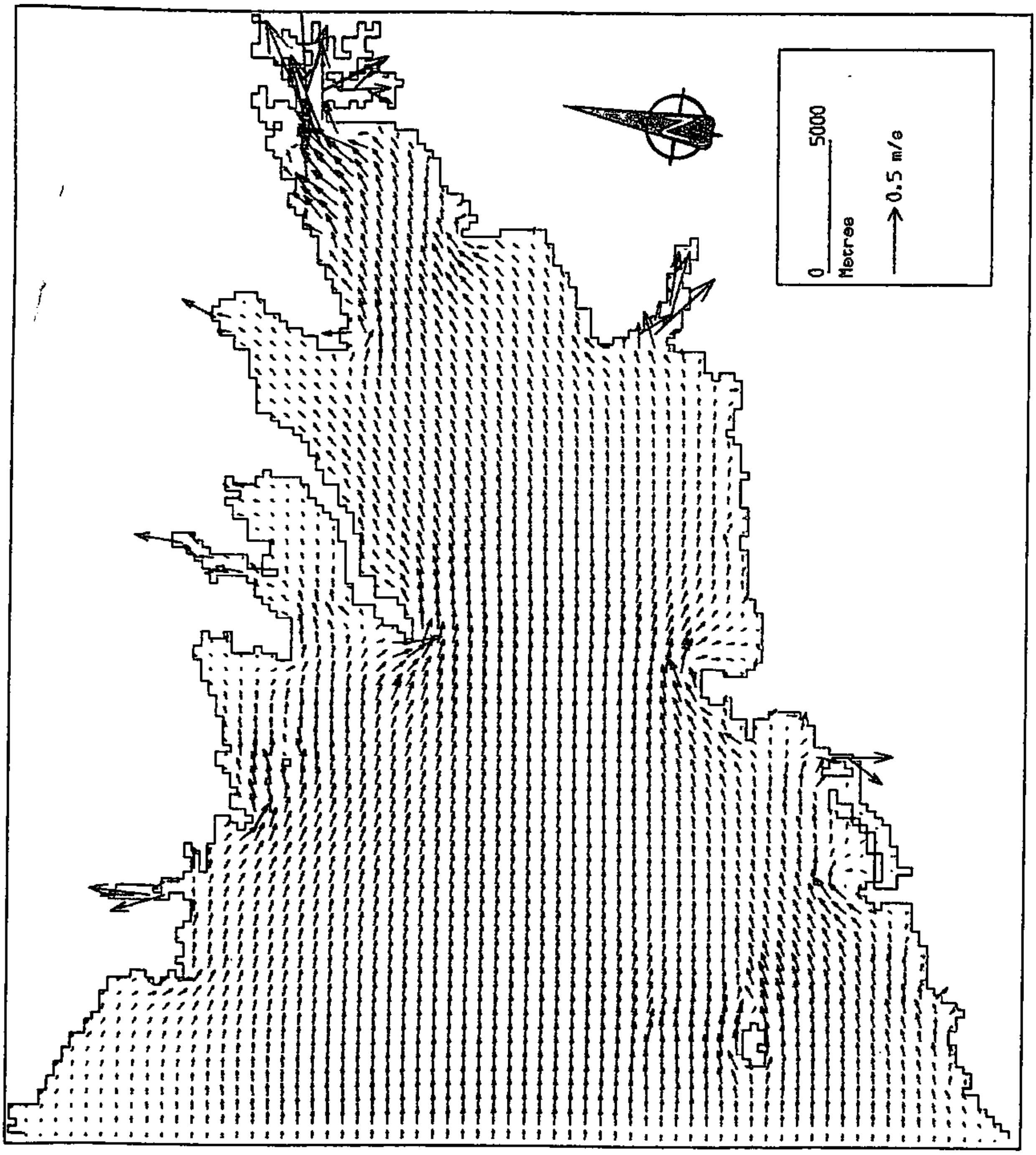
As noted previously the boundary conditions for the main model were defined by specifying tidal elevations at the western extremity of Donegal Bay. This boundary was deliberately kept remote from the area of interest to ensure that any boundary influences would not be significant. A series of dynamically linked 'patches' running within the main model were used to undertake the detailed modelling. The use of dynamically linked patching ensures that the correct flow is maintained between the patch and the main model and that there is the correct transfer of momentum at the patch boundary.

2.4 The Tidal Flow Regime

The tidal flow regime predicted by the computerised base model of Donegal Bay is illustrated in Figures 2.3 and 2.4. The figures show the tidal flow pattern expected at 3 hours before and after high water at Killybegs. The length and direction of the vectors are proportional to the current velocity at each nodal point. In order to improve the clarity of the representation of the tidal flow pattern only one in every four vectors calculated has been plotted.

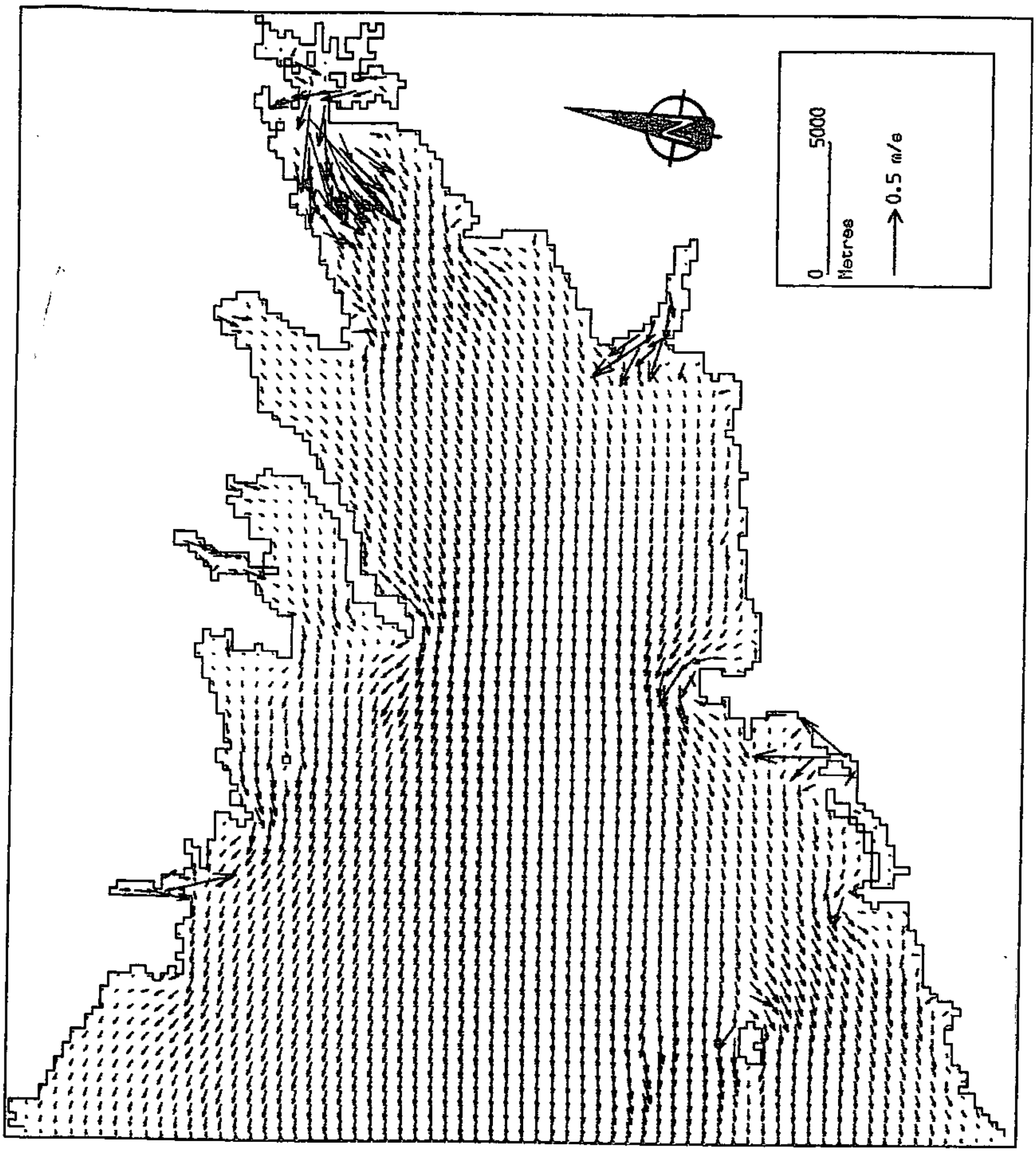
Two dynamically linked patched models with grid spacings of 90m and 30m respectively were used to zoom into the area of interest around Bundoran. The tidal flow regime at 3 hours before and after High Water at Killybegs predicted by each of the patched models is illustrated in Figures 2.5 to 2.8.

The tidal flow regime depicted by the final patched model shows the tidal currents in the Bundoran Bay area to be very weak. The peak flood and ebb current



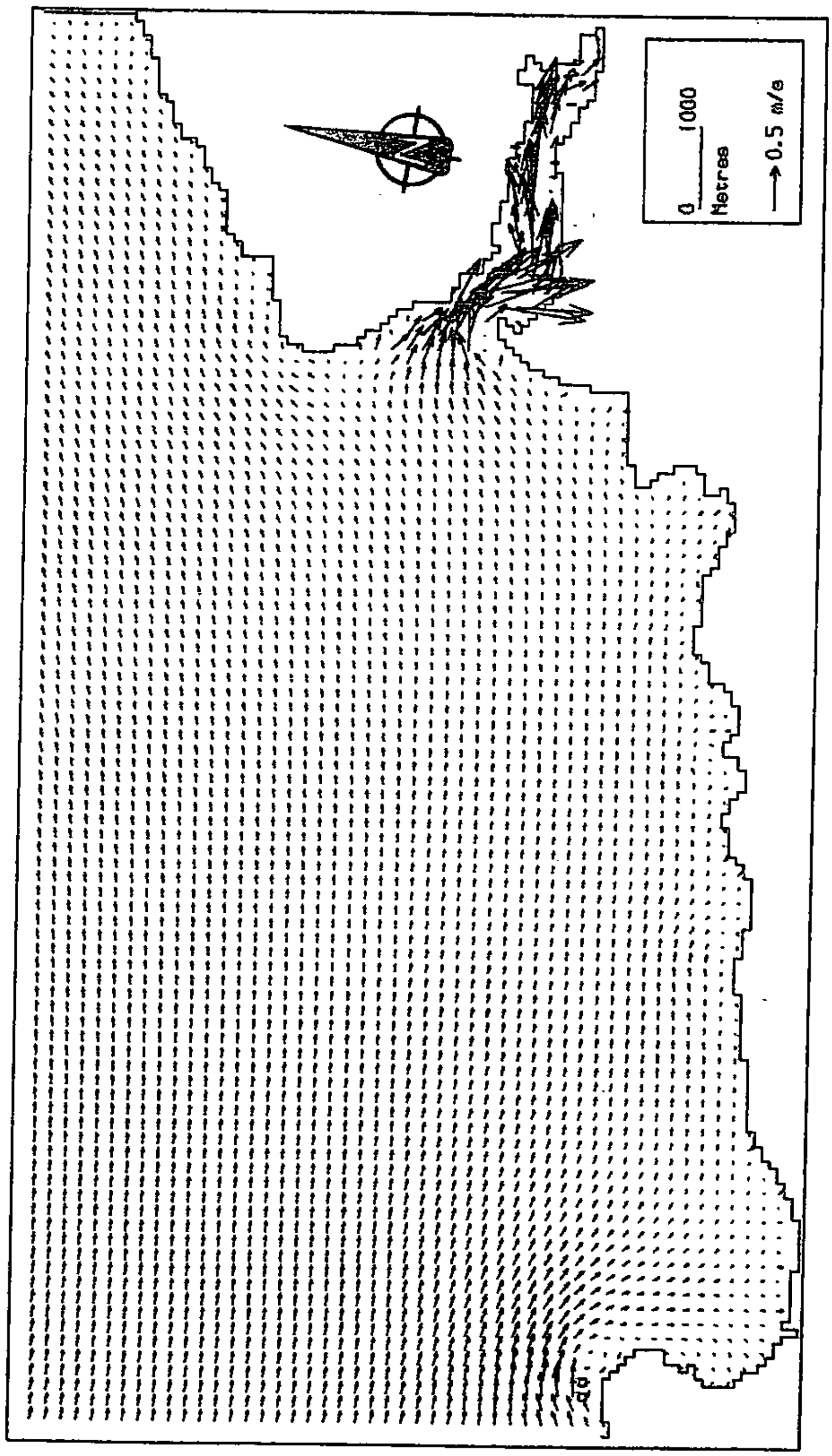
Donegal Bay Tidal Model
Spring Tidal Flow Regime
at 3 hours before HW Killybegs **Figure 2.3**

Hydraulics Research Tideway System



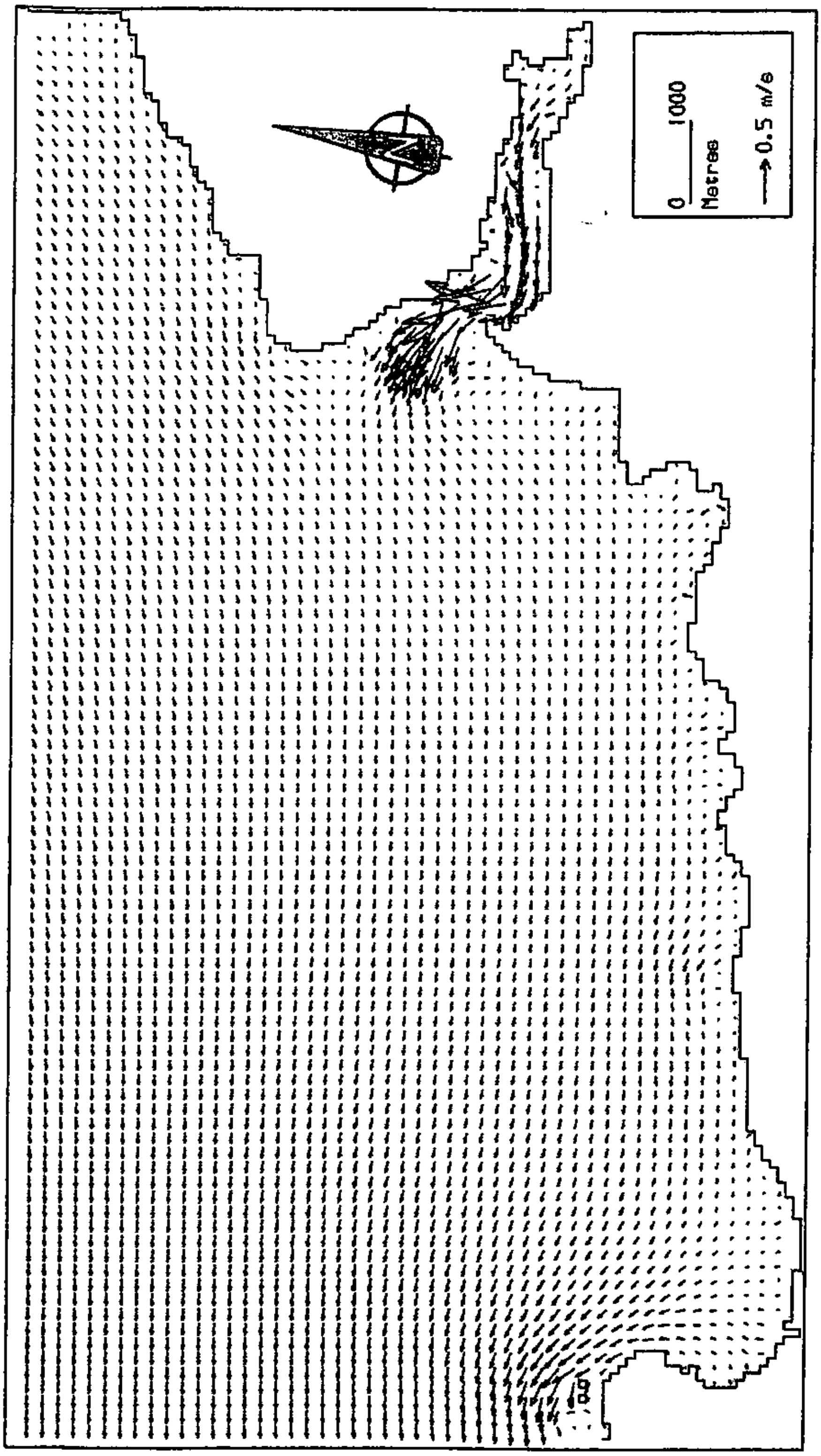
Donegal Bay Tidal Model
Spring Tidal Flow Regime
at 3 hours after HW Killybegs **Figure 2.4**

Hydraulics Research Tideway System



Bundoran Outfall Study
Spring Tidal Flow Regime
at 3 hours before HW Killybegs **Figure 2.5**

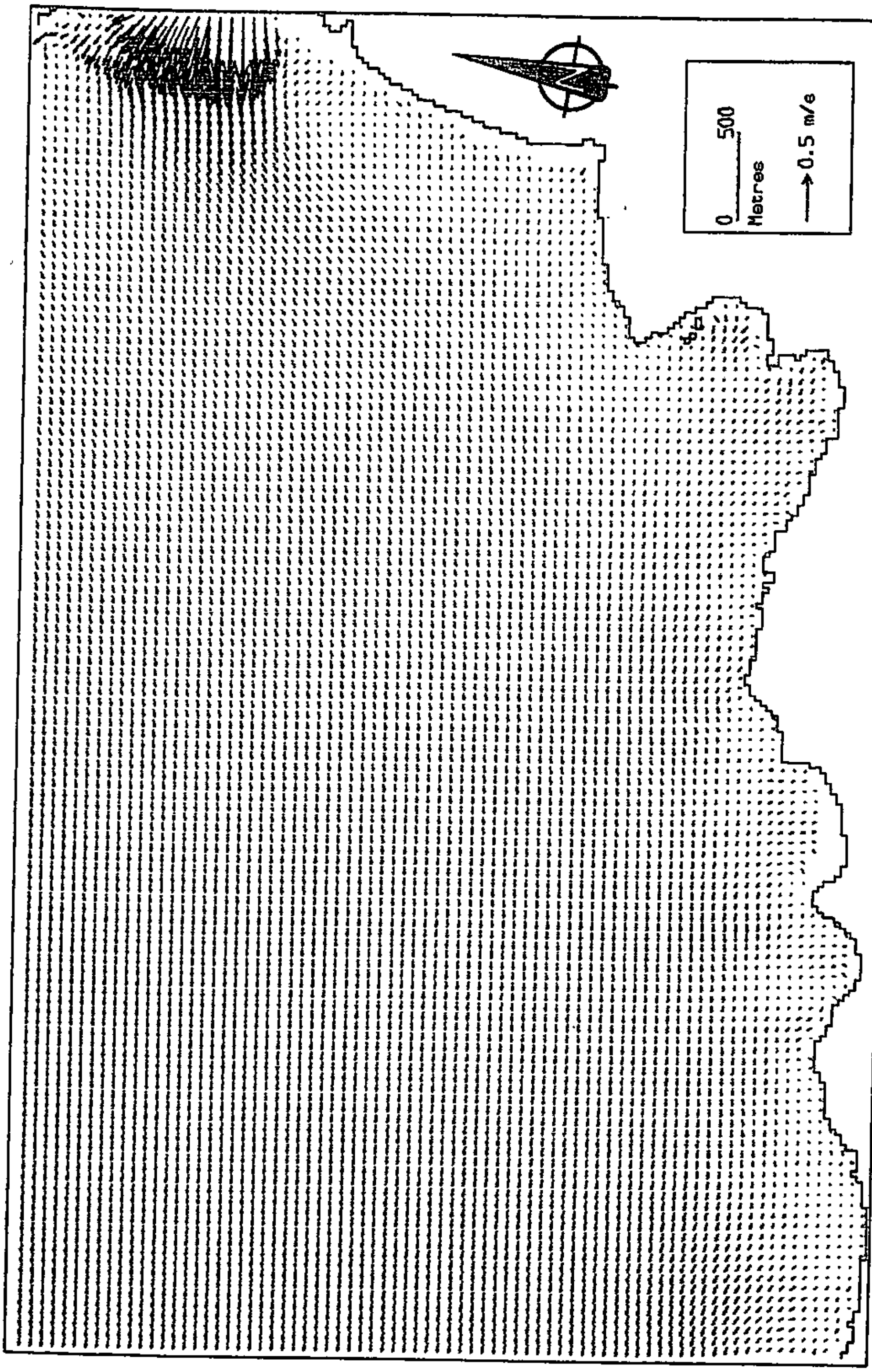
Hydraulics Research Tideway System



Bundoran Outfall Study
Spring Tidal Flow Regime
at 3 hours after HW Killybegs

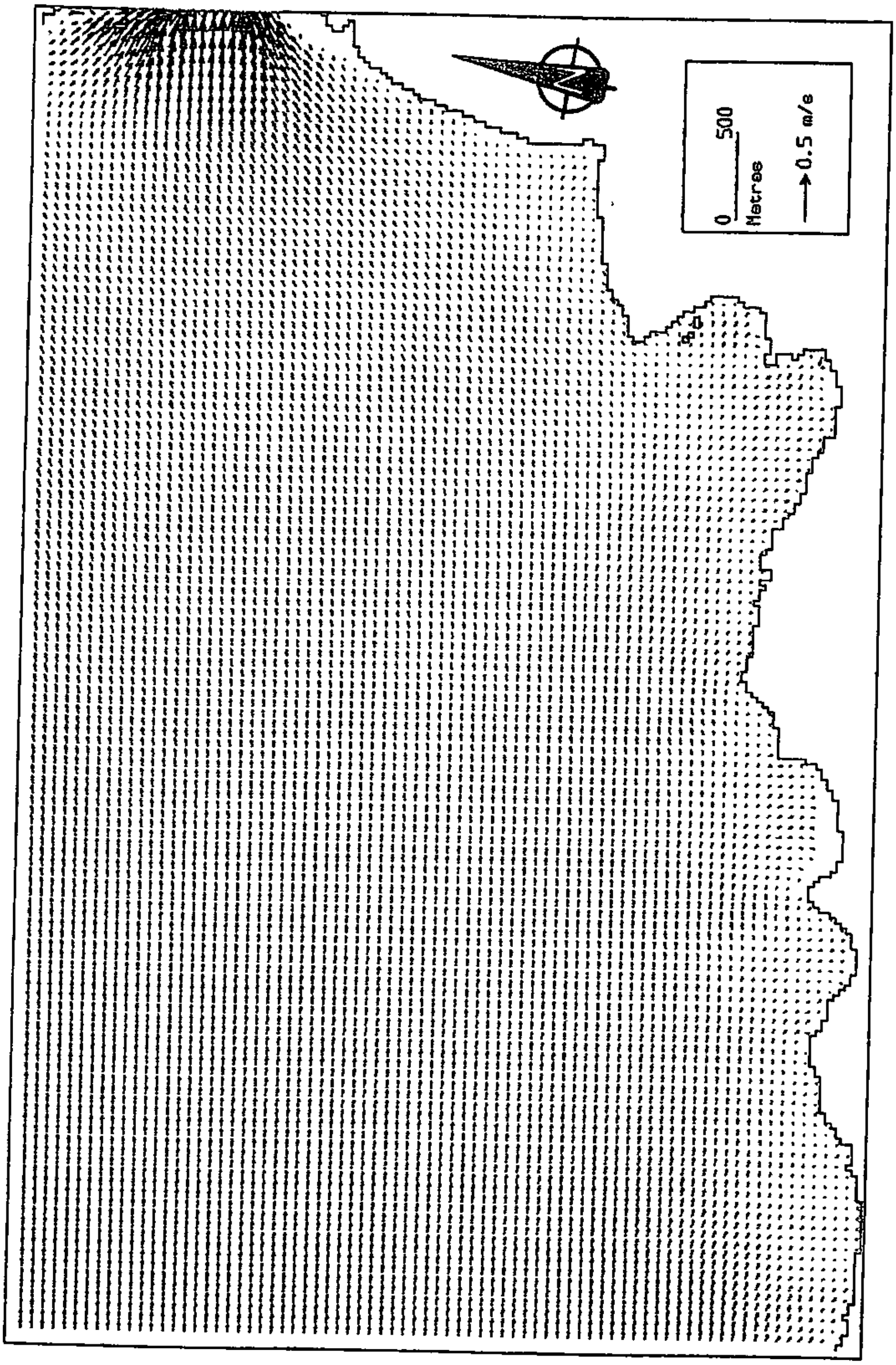
Figure 2.6

Hydraulics Research Tideway System



Bundoran Outfall Study
Spring Tidal Flow Regime
at 3 hours after HW Killybegs **Figure 2.8**

Hydraulics Research Tideway System



Bundoran Outfall Study
Spring Tidal Flow Regime
at 3 hours before HW Killybegs **Figure 2.7**

velocities predicted by the model in the vicinity of the existing outfall at Pollbrean are only 0.04 m/s during spring tides. By comparison wind induced surface currents generated during Force 3 winds can be up to 0.15 m/s which will easily dominate any tidal advection.

The model results are in close agreement with observations and comments made in the Irish Coast Pilot, which describes the tidal streams within the study area as barely perceptible. The model results also correlate well with the movements of drogues released by An Foras Forbartha during a detailed marine survey of the study area undertaken in 1983, Reference 1. The results of this float tracking survey showed that the floats travelled in the direction of the wind irrespective of tidal currents i.e. the magnitude of the wind derived currents encountered during the survey period were much greater than the tidal currents. This was also confirmed by dye releases undertaken by An Foras Forbartha off Pollbrean outfall, which showed that the water movements are controlled mainly by the speed and direction of the prevailing wind.

Similarly, the tidal current metering results collected for this study and presented graphically in Figures 2.9 to 2.12 show the magnitude of the tidal flows to be very low. The dominance of wind derived currents is also clearly illustrated in Figures 2.9 to 2.12 by the lack of any apparent cyclical variation in tidal current velocity. That is, the measurements do not indicate the occurrence of a slack tidal period during the switch over between flood and ebb.

2.5 Verification of the Hydrodynamic Model

The successful application of computational models to the prediction of receiving water quality is dependent upon both the hydrodynamic and water quality models employed being adequately verified against fieldwork results. Our ability to verify the hydrodynamic and water quality models for Bundoran has been restricted by the dominance of wind effects, however sufficient verification has been completed to show that the model predictions are reasonably representative of tidal effects in the Bundoran area.

Tidal Current Measurements, Offshore Site
Spring Tides 6/4/00

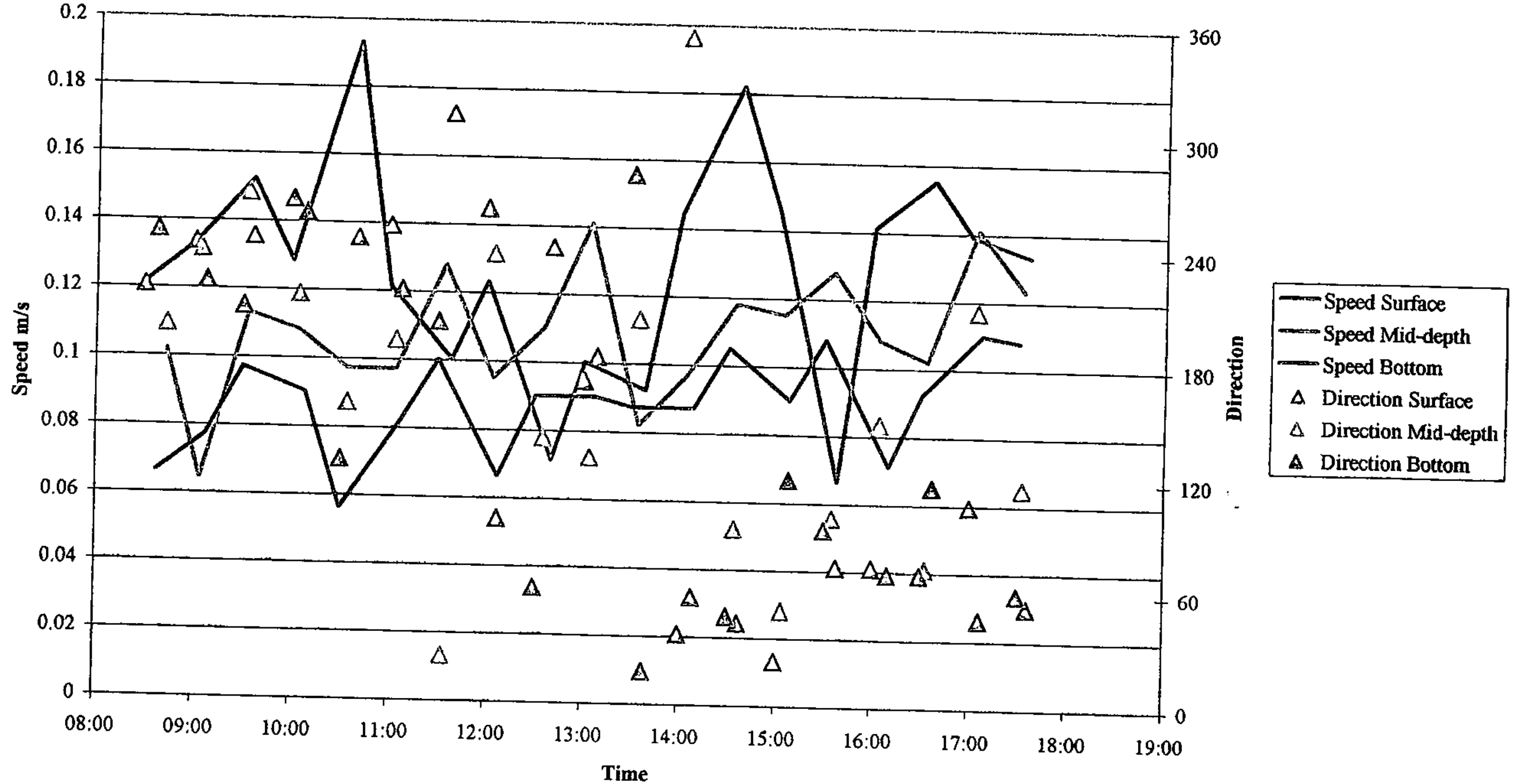


Figure 2.9

Tidal Current Measurements, Inshore Site
Spring Tides 5/4/00

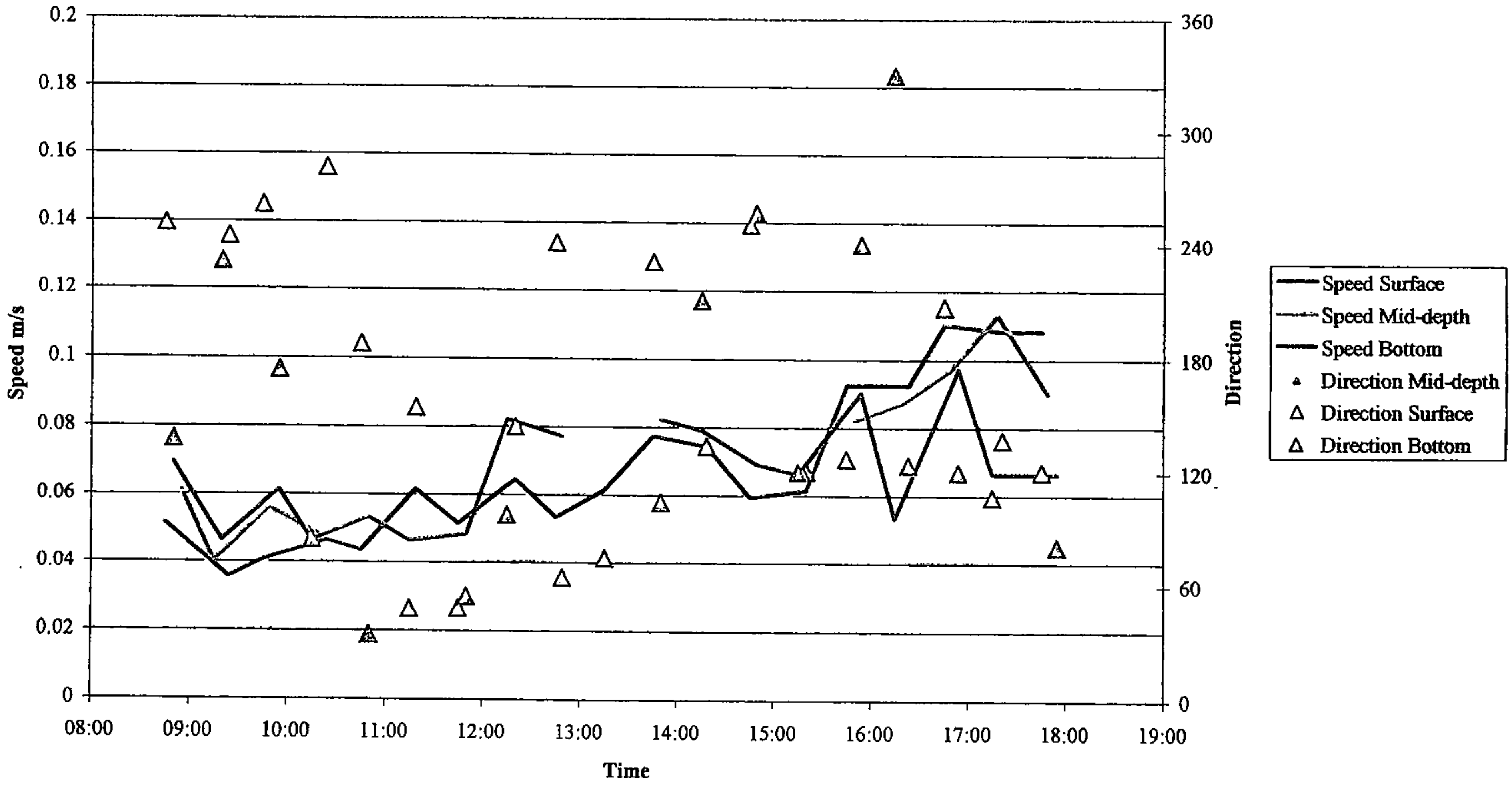


Figure 2.10

Tidal Current Measurements, Offshore Site
Neap Tides 31/3/00

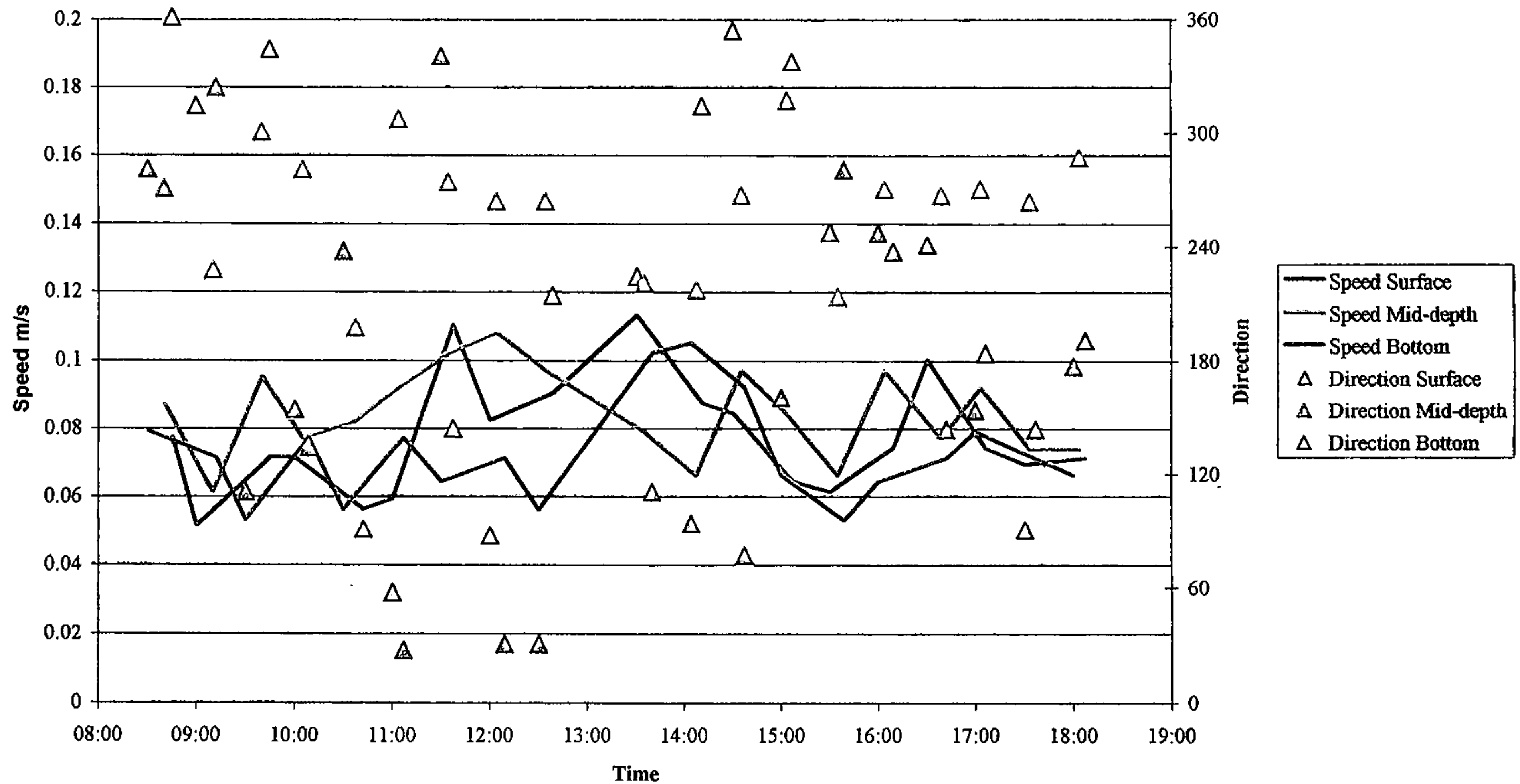


Figure 2.11

Tidal Current Measurements, Inshore Site
Neap Tides 30/3/00

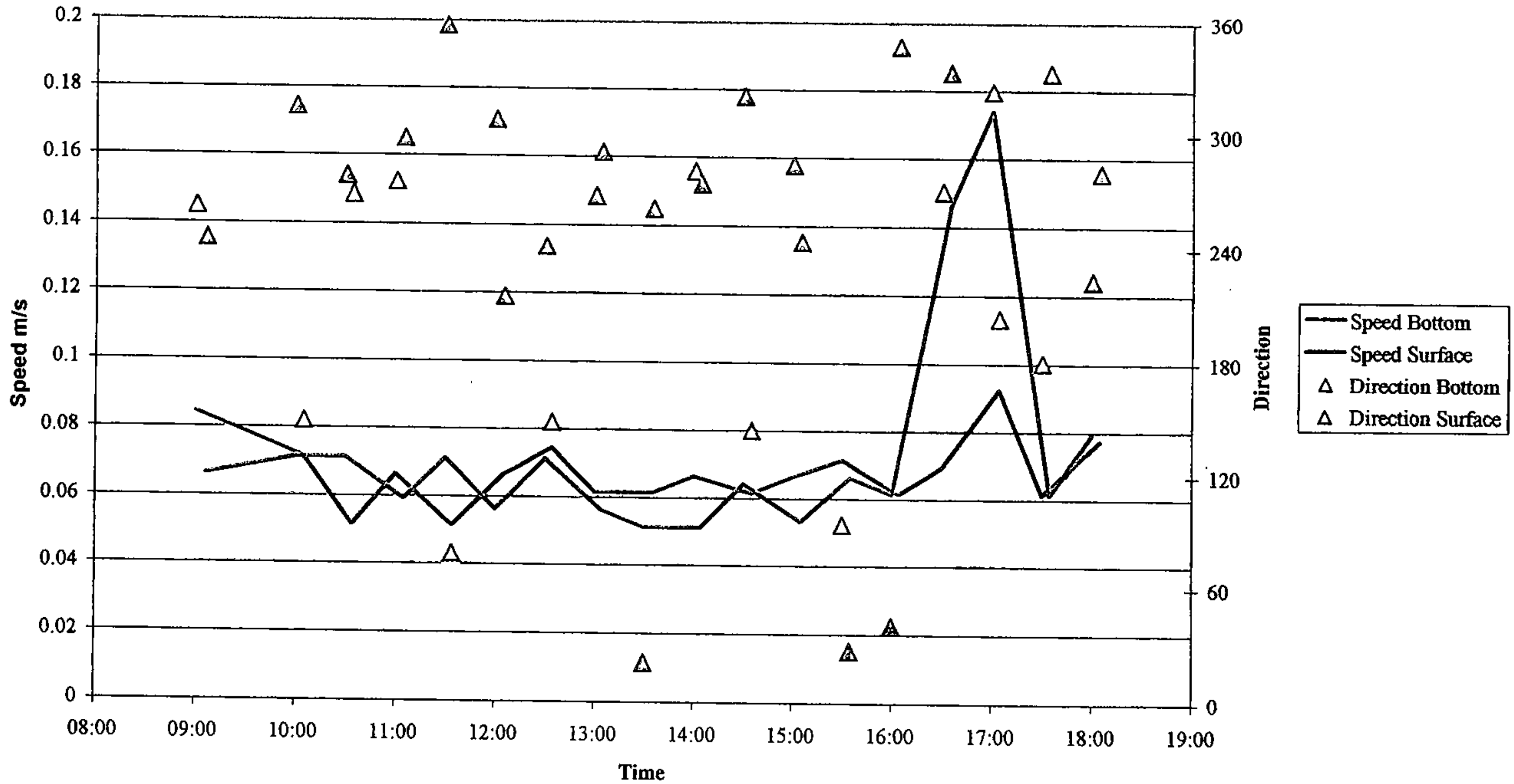


Figure 2.12

The verification procedure for the hydrodynamic model involved adjusting the parameters of the model until the results obtained were adjudged to be representative of field survey observations for a particular set of tidal conditions. The model was then re-run for a different set of boundary conditions without adjusting any of the model parameters used in the initial simulation and the predictions compared to corresponding field survey results. For the hydrodynamic models of Donegal Bay and Bundoran, spring and neap tidal height observations at Bundoran and Mullaghmore were employed as shown in Figures 2.13 to 2.16. It was also hoped that the tidal current measurements recorded by Aquafact as part of this study would provide additional information for model verification. However, as noted previously, these results were so wind dominated that the normal cyclical variation in the tidal currents had been masked out.

The results of the tidal height comparisons presented in Figures 2.13 to 2.16 show that the hydrodynamic models are predicting the correct magnitude, shape and phasing of the tidal curves. In preparing these figures, the model predictions that are based on mean tidal ranges have been scaled to compensate for the difference between the mean tidal range and the actual tidal range on the day of the observations. No modifications however were made to the timing of the model predictions.

Overall, these results are sufficient to show that the models are capable of predicting both the magnitude and phasing of the tides within Donegal Bay during any given set of tidal conditions.

Model Calibration, Mullaghmore (Spring Tide, 4-5/4/2000)

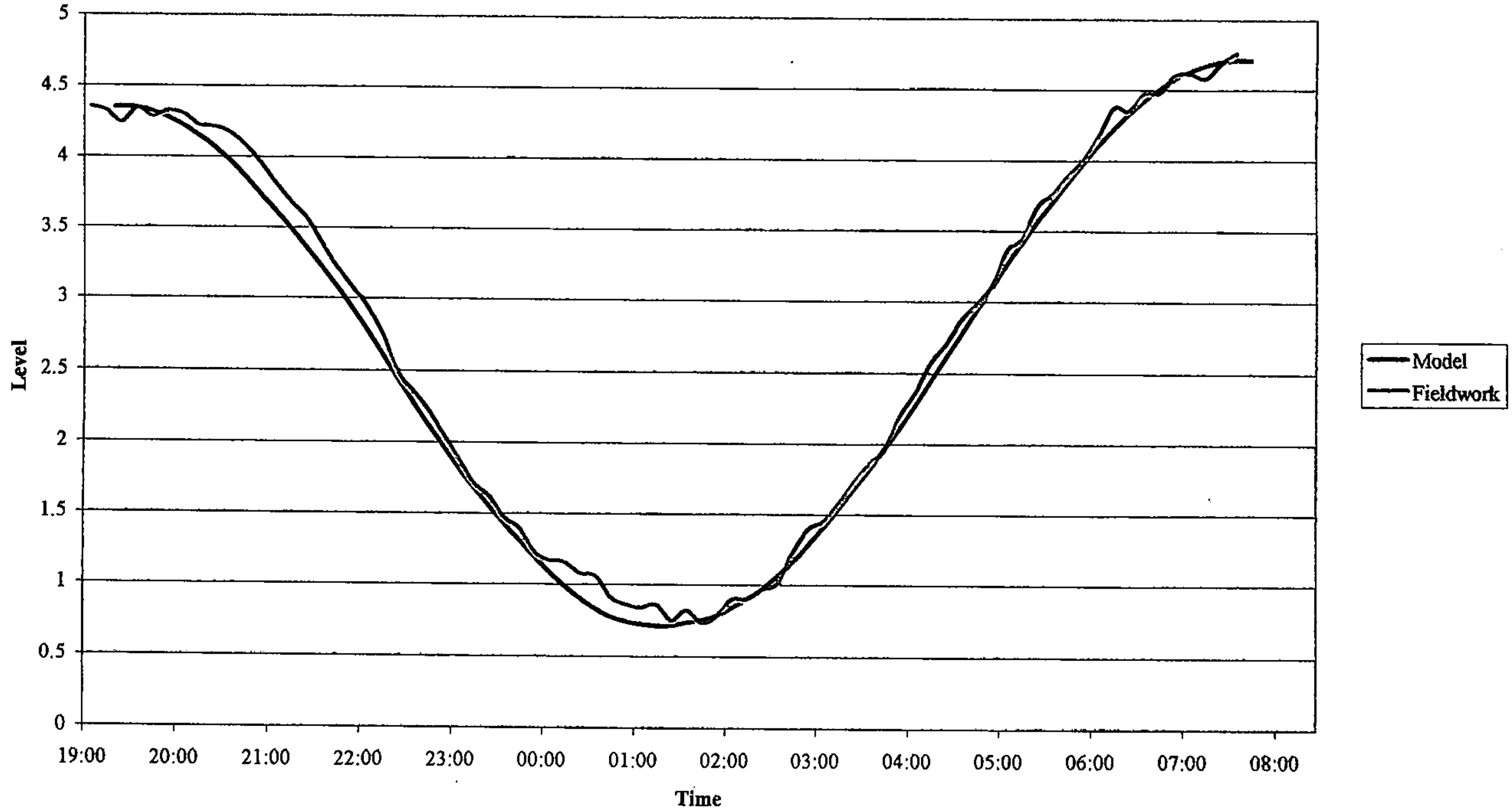


Figure 2.13

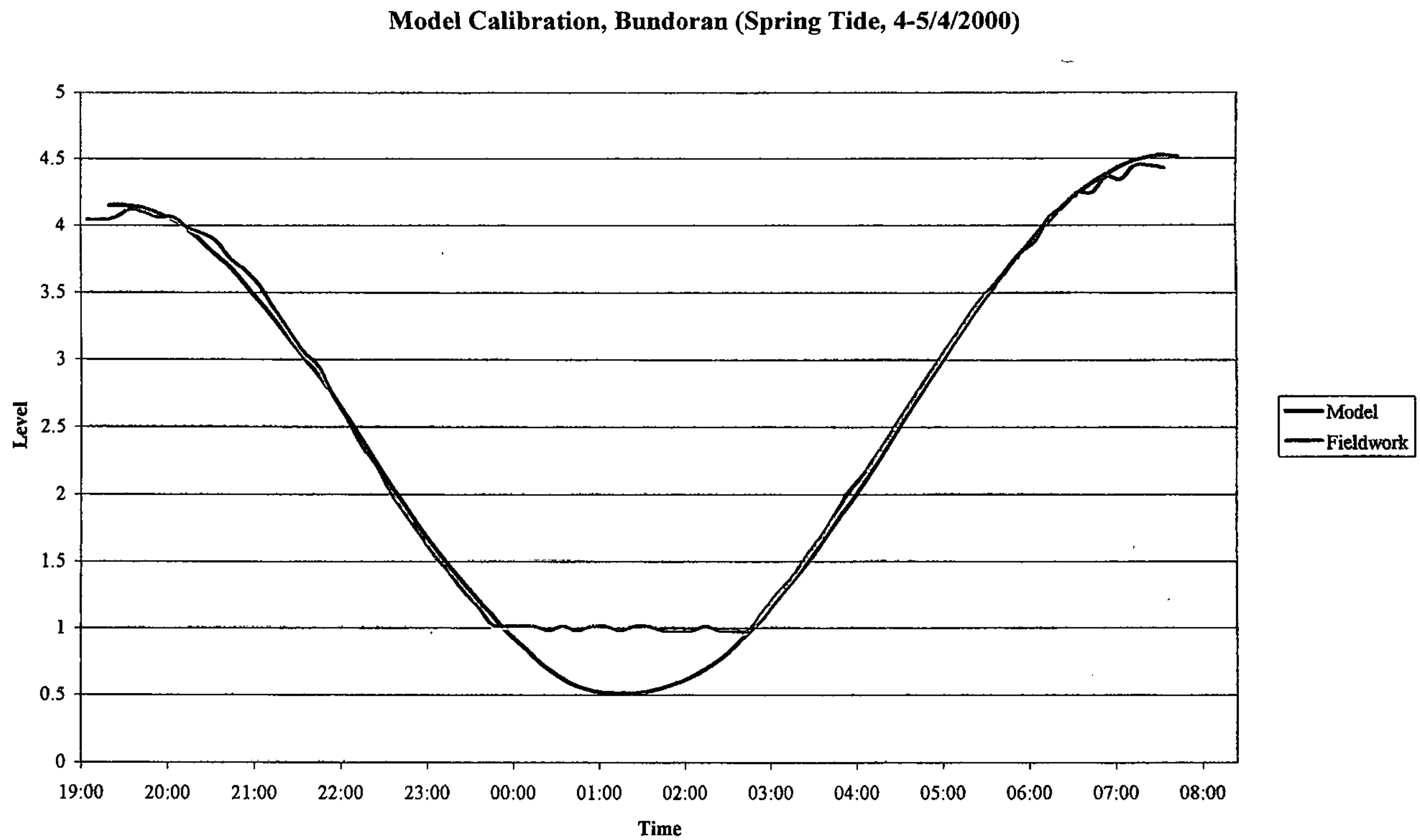
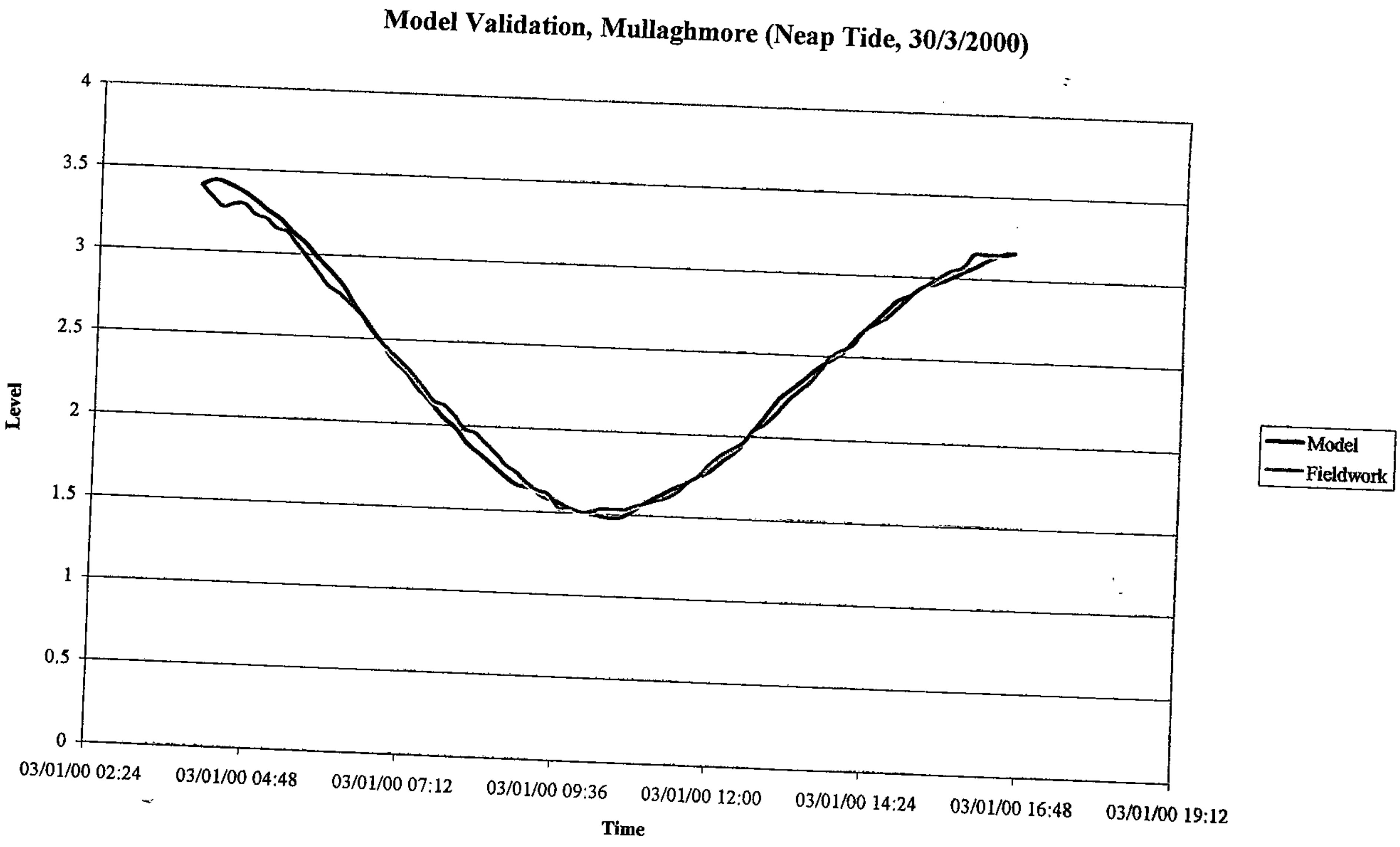

Model Calibration, Bundoran (Spring Tide, 4-5/4/2000)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Level
19:00
20:00
21:00
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
Time
Model
Fieldwork

Figure 2.14



Model Validation, Mullaghmore (Neap Tide, 30/3/2000)
Level
4
3.5
3
2.5
2
1.5
1
0.5
0
03/01/00 02:24
03/01/00 04:48
03/01/00 07:12
03/01/00 09:36
03/01/00 12:00
03/01/00 14:24
03/01/00 16:48
03/01/00 19:12
Time
Model
Fieldwork

Figure 2.15

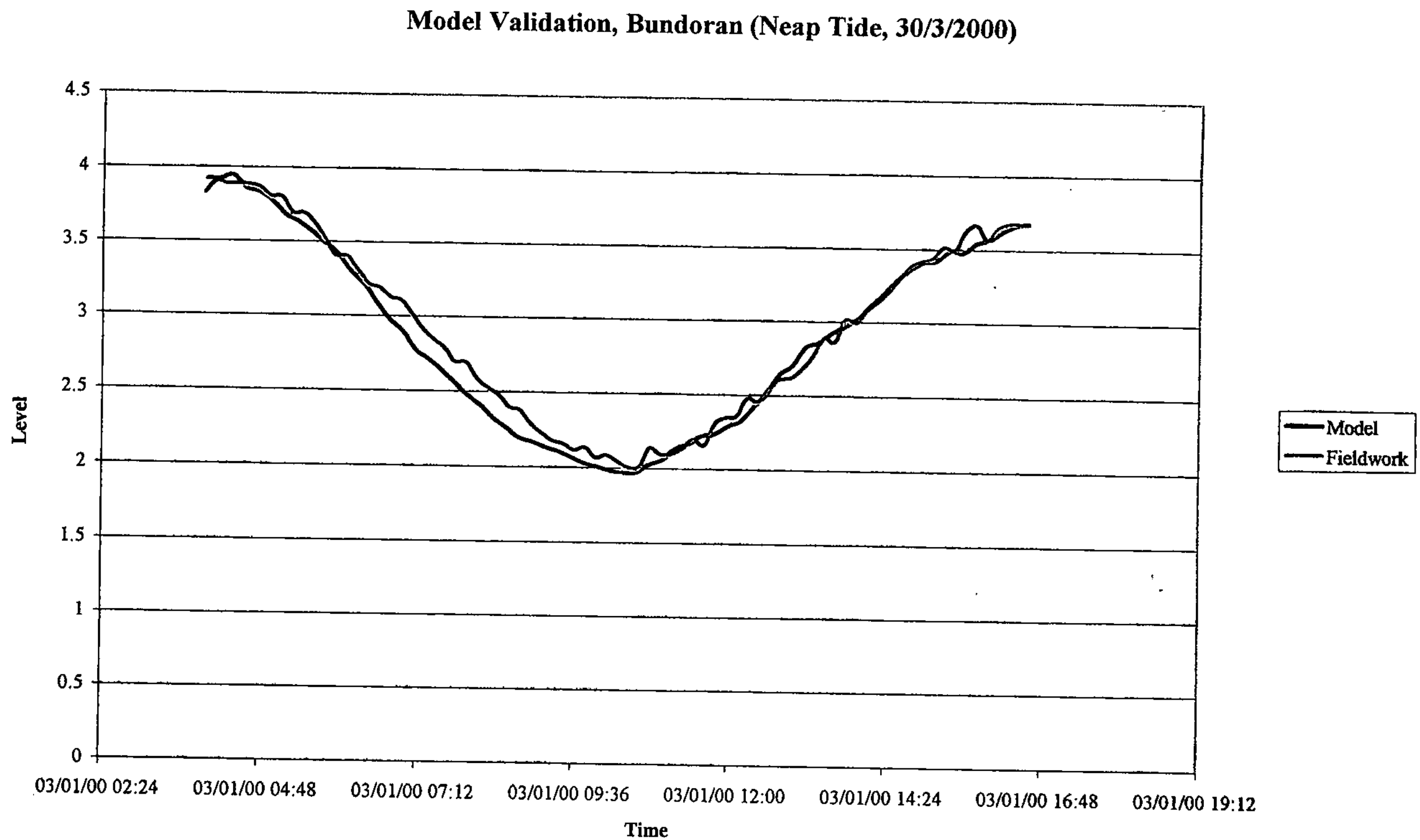

Model Validation, Bundoran (Neap Tide, 30/3/2000)
Level
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
03/01/00 02:24
03/01/00 04:48
03/01/00 07:12
03/01/00 09:36
03/01/00 12:00
03/01/00 14:24
03/01/00 16:48
03/01/00 19:12
Time
Model
Fieldwork

Figure 2.16

3.0 WATER QUALITY MODELLING

3.1 General

The computational models used to assess the potential impact of the proposed changes to the effluent discharge regime at Bundoran on water quality in Donegal Bay comprise a suite of post processing packages to the hydrodynamic model. The water quality models are capable of accurately simulating the advection, dispersion and fate of conservative and non-conservative substances, for example sewage effluent. The models can also simulate the settlement of suspended solids.

The effluent dispersal model, PLUME-RW, was utilised to model the discharge of sewage effluent from Bundoran to the receiving waters of Donegal Bay via a proposed extended outfall at Pollbrean.

PLUME-RW is designed to compute the dispersion of pollutant under the influence of both tidal and wind-driven currents. Either buoyant or neutrally buoyant effluents can be simulated using this package.

3.2 Dispersion Characteristics of the Receiving Waters

The dispersion characteristics most appropriate to the receiving waters of Bundoran Bay were estimated from the results of dye release experiments conducted by An Foras Forbartha during a Marine Survey undertaken in 1983.

The dispersal of dye patches as measured in the field is normally used to calculate the effective diffusivity coefficients applicable to the area of interest. The patch outlines shown by contour plots of fluorescence concentrations are corrected for the effects of tidal advection and the width and length of each patch tabulated as a function of time. The length scales are converted to standard deviations by assuming that:

Patch size = 4 x (standard deviation of concentration distribution)

The standard deviations in the along-patch and across-patch directions are subsequently plotted against diffusion time on log/log axes.

For a Fickian diffusion model

$$\sigma^2 = 2\,Kt \qquad (2)$$

where K is the diffusivity (m^2/s)
t is time (s)

Hence

$$Log\,(\sigma) = 0.5\,log\,(t) + 0.5\,log\,(2K) \qquad (3)$$

Thus by drawing a line with a slope of 0.5 through the data points, the intercept and hence the diffusivity can be estimated. The calculations are made for both the along-patch and across-patch directions to obtain estimates of K_x and K_y respectively. For the receiving water of Bundoran Bay, the following diffusivity coefficients were estimated.

Diffusivity Coefficients
K_x = 1.0 m^2/s in direction of flow
K_y = 0.2 m^2/s perpendicular to flow

Average Diffusivity K = 0.6 m^2/s

3.3 Implementation of the Effluent Dispersal Model: PLUME-RW

As with the hydrodynamic modelling the effluent dispersal computations were performed on SUN Sparc Workstations and were based on the flow results, ie water levels, velocities and discharges from the hydrodynamic model.

The dispersion of pollutant plumes in marine waters is dependent on the tidal flow regime of the coastal region, wind driven currents and small scale turbulent eddies. In the random walk pollution transport model, the discharge of pollutant is represented as a regular discharge of discrete particles. During the model run the amount of pollutant represented by each particle, the particle "mass", can be either constant for a conservative pollutant, or can decrease at a specified decay rate, eg.

$$m(t) = m_o \exp^{(-kt)} \qquad (4)$$

where *m(t)* is particle "mass" at time t
m_o is the initial particle "mass" at the outfall
k is a decay constant (s^{-1})

In simulations of faecal coliform releases, m will represent the number of bacteria and k bacterial mortality. *k* can be related to specified T_{90} values (hours) through the following equation.

$$k = 6.4 \times 10^{-4}/T_{90} \qquad (5)$$

The value of T_{90}, the time taken for 90% of the faecal bacteria to die off, varies due to physical conditions in the receiving waters such as temperature, sunlight intensity and nutrient level. The variation in T_{90} expected within UK coastal waters has been investigated by the Water Research Centre (WRc). The findings of this study can be summarised as follows.

"Under normal conditions a value of T_{90} equal to 10 hours is widely accepted to be a representative design approximation for coastal waters in the UK. In clear coastal waters T_{90} may be reduced to 6 hours, however, this assumption is not considered to be conservative and may not always produce results which are consistent with bacterial sampling studies. In coastal waters where there is a high suspended solids loading, the reduction in sunlight penetration can increase the value of T_{90} to around 20-40 hours. An upper limit of T_{90} equal to 60 hours represents the slowest bacterial mortality rate typically experienced in complete darkness."

For the purposes of this study an average T_{90} value of 30 hours has been assumed in all the faecal coliform simulations. This makes allowance for the increased frequency of cloud cover in the North West of Ireland and the resulting restricted hours of sunlight.

Kirk McClure Morton has previously undertaken an investigation of the sensitivity of the Plume-RW model results to the value of T_{90} specified during the simulations as part of the modelling studies for the Larne Borough Sewerage Scheme (Reference 2). This analysis indicated that although the model predictions show some variation with T_{90} the effect is significantly less than that associated with variations in loading and climatic conditions.

In the simulations of other parameters of the sewage effluent the decay rate was input directly based on the following assumptions.

Parameter	Decay Rate (day^{-1})	T_{90} (days)
BOD	0.25	9.2
Ammonia	0.28	8.2
Suspended Solids	0.0	NIL

In order to simulate the effects of turbulent eddies on pollutant plumes in coastal waters particles in PLUME-RW are subjected to random displacements in addition to the ordered movements that represent advection by mean currents. The motion of simulated plumes is, therefore, a random walk, being the resultant of ordered and random movements. Provided the lengths of the turbulent displacements are correctly chosen, the random step procedure is analogous to the use of turbulent diffusivities as calculated from dye dispersion experiments.

3.4 Wind Driven Currents

Plumes in coastal waters will also move in response to wind driven currents in addition to advection by mean tidal currents. This is particularly prevalent in areas of slack tidal currents such as Bundoran.

In PLUME-RW the surface wind driven current velocity is computed from a specified wind speed or time-history of wind data. It is assumed that the surface wind driven current is parallel to the wind vector with a speed given by:

$$S = \alpha w \qquad (6)$$

where

S = surface wind driven current speed	(m/s)
α = an empirical constant	
w = wind speed at 10 m above the sea surface	(m/s)

A value of approximately 0.03 is normally adopted for α, based on the results of many observations of surface drift currents (see Reference 3). Having computed S, the wind-driven current speed at any depth in the water column can be computed from:

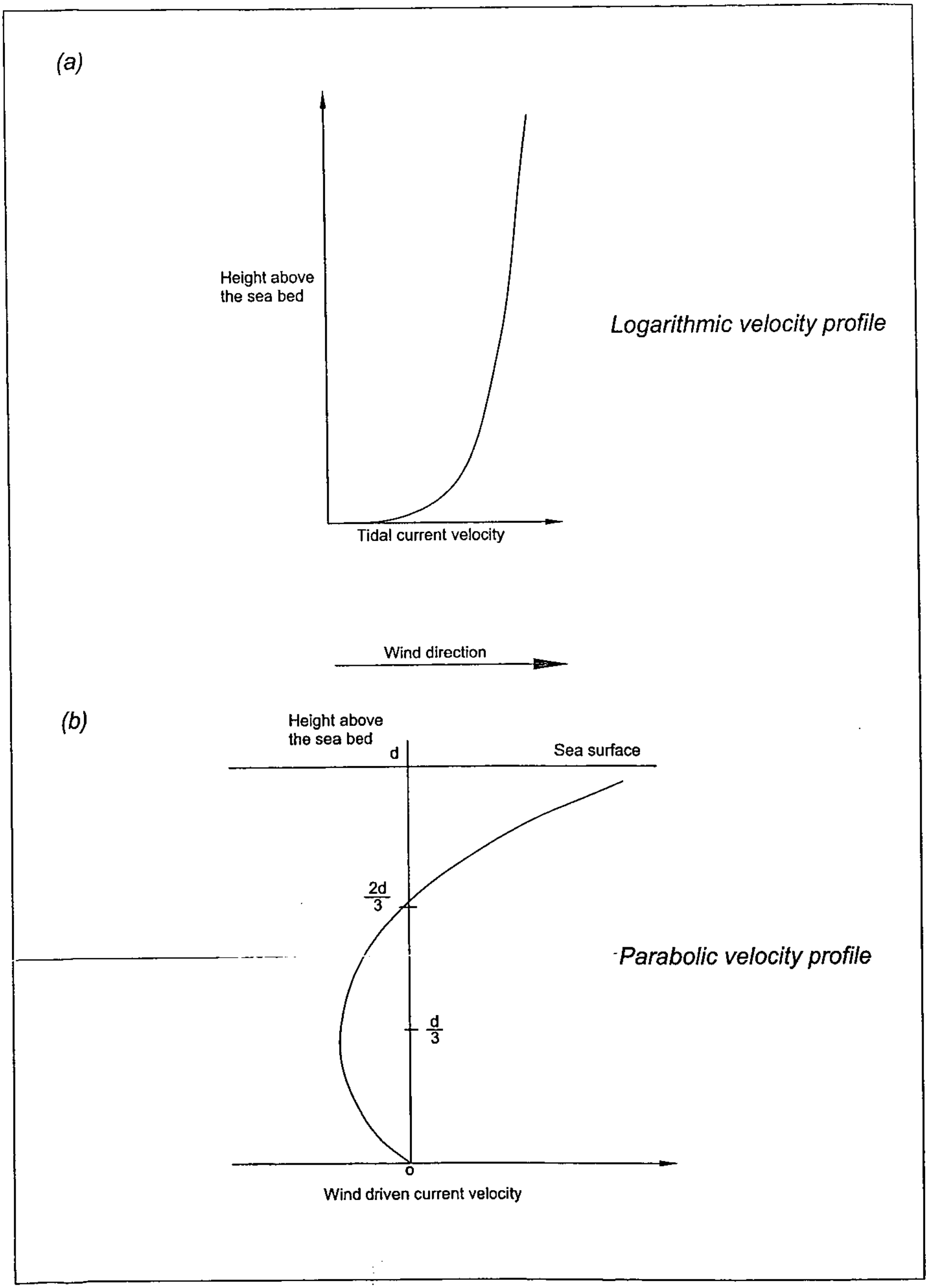
$$U_w(z) = S(3(1-z/d)^2 - 4((1-z/d)+1)) \qquad (7)$$

where

U_w = wind-driven current velocity	(m/s)
d = water depth	(m)

Equation (7) is derived in Reference 4 and generates a parabolic wind-driven velocity profile as shown in Figure 3.1. Velocities are downwind in the upper third of the water column and decrease from S at the surface to zero at one-third of the total depth below the surface. Upwind velocities have a maximum at two-thirds of the total depth below the surface and decrease to zero at the sea bed.

The effects of wind on pollutant plumes are simulated in PLUME-RW by adding the wind driven current component to the main tidal current vector. Where the wind is directed onshore in a shoreline cell, particles move shoreward near the sea surface and offshore near the seabed due to the wind driven current. In PLUME-RW as particles near the sea surface approach the land boundary, the model



Depth Structure of (a) Tidal and (b) Wind-driven Currents in Plume-RW

Figure 3.1

relocates them near the seabed. Thus, the effects of an overturning wind driven current on plume movement are simulated and unrealistic accumulations of particles in cells adjacent to land boundaries are reduced. In shoreline cells where the wind is offshore, overturning currents are also simulated, with particles moving onshore near the seabed, upwelling near the land boundary and moving offshore near the sea surface.

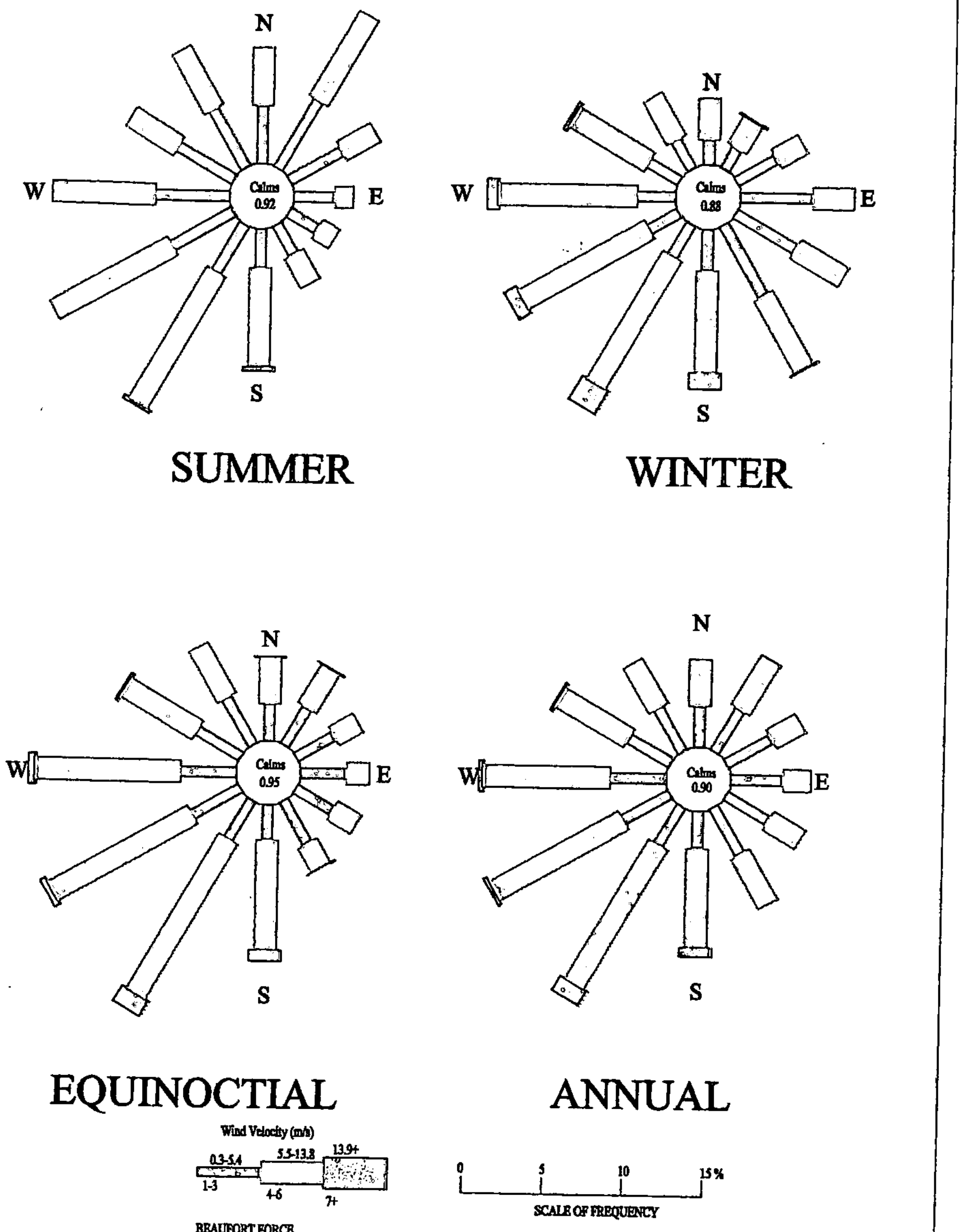
3.4.1 Wind Records

A probabilistic analysis of wind data recorded at Bellmullet meteorological station over the thirty-year period 1966 to 1995 was undertaken to estimate the wind speeds that are likely to occur on a seasonal basis. This enables the effects of the wind driven currents during an average year to be included in the assessment of compliance criteria at the Blue Flag beach.

Data in the form of mean hourly wind speeds and the number of occurrences for a series of directions were used as the base data for the study. In the preparation of the wind roses, the raw data was reduced into 30° sectors and classified into three speed groups. The wind data is presented in the form of annual and seasonal wind roses in Figure 3.2, where the length of each sector represents the percentage frequency of winds blowing from that direction.

The summer wind rose is based on the wind records for the months of April to August inclusive while the winter wind rose is based on the October to February data.

The various wind roses clearly illustrate that the prevailing wind at Belmullet is from a south westerly direction. Further analysis of the wind records for the entire year indicates that winds of less than Beaufort Force 4 occur for approximately 37% of the time in the average year, irrespective of direction. Conversely winds of greater than Force 4 blow for 45% of the time from the south and west sectors and 16% of the time from the north and east sectors.



Belmullet Wind Roses (1966-1995)

Figure 3.2

The seasonal wind roses illustrate the variation in the wind field throughout a typical year and clearly show that there are less southerly winds in summer than in winter (27% summer, 34% winter). The summer wind rose also shows a higher occurrence of northerly and westerly winds (58% of the time) than in the winter (44% of the time).

3.5 Effluent Inputs from Bundoran WWTW

Due to the popularity of Bundoran as a holiday resort the flows and loadings from the sewer network show significant variation over the year. It is projected that in 2030 the population equivalent could vary from circa 4,250 on a weekday during the winter to circa 30,000 on a busy weekend in the summer. Consequently the flow and loading to the new outfall will also vary significantly over the year. However since the prime concern relates to protection of the Blue Flag Bathing Beach at Bundoran it is appropriate to restrict the scope of the modelling study to the investigation of the maximum summer discharge.

Under the current proposal spills from the combined stormwater overflow in the upgraded sewerage scheme will be restricted to an average of three occurrences during a typical bathing season. This follows the guidelines set out by the DOELG in the publication 'Procedures and Criteria in relation to Stormwater Overflows'. This restriction on spill frequency ensures that the water quality standards as set out in the Bathing Water Directive will be achieved on at least a 98.2% basis and thus water quality will not be compromised by this overflow. The impact of overflows from the proposed pumping station therefore has not been modelled in this study.

All effluent retained within the Bundoran sewer network will be passed forward to the new WWTW where it will receive secondary treatment prior to being discharged to the receiving waters of Donegal Bay. Estimated design flows and concentrations for the final effluent from the proposed works were provided by P.H. McCarthy & Partners as follows;

Table 1 Design Parameters - Bundoran WWTW

Maximum Summer Population (2030)	30,000
Dry Weather Flow	5,270 m^3/day
Average daily flow	77.0 l/s
50%ile BOD concentration	12.5 mg/l
50%ile Suspended Solids concentration	17.5 mg/l
50%ile Ammonia concentration (no nitrification)	48 mg/l*
50%ile Ammonia concentration (with nitrification)	2 mg/l
Faecal coliform concentration	1.2×10^6 FC/100ml

P. H. McCarthy & Partners also requested that the dispersion modelling include the effects of the sewage loading from a possible future Tullaghan outfall which may be constructed a short distance to the west of the proposed outfall position. Indications are that this discharge will ultimately receive secondary treatment hence a secondary treated discharge has been assumed for this study. The resulting estimated loadings for this facility are summarised in table 2 below.

Table 2 Model Inputs – Tullaghan WWTW

Maximum Summer Population	1,000
Average Daily Flow	3.5 l/s
Faecal Coliform concentration	1.2×10^6FC/100ml
50%ile BOD concentration	12.5 mg/l
50%ile Suspended Solids concentration	17.5 mg/l
50%ile Ammonia concentration	42.0 mg/l

For the purposes of this modelling study, it was also assumed that the effluent from Tullaghan would be discharged via a short outfall extending to the low water mark approximately 1km west of the mouth of the Drowse River.

Another important background source of bacterial contamination arises from overflows and discharges to the stream that flows across the Blue Flag beach at Bundoran. The bacterial loading appropriate to this stream was estimated using the results of a recent water quality survey undertaken by Donegal County Council as

shown in Table 3 below. The loading used exceeds the 5,000 FC/100ml used in the 1996 Beach Study Report and is representative of the higher concentrations recorded during the recent survey i.e. this loading represents the worst case loading. Hence, the use of this relatively high value should ensure that the water quality modelling results are robust.

Table 3 Model Inputs – Bundoran Stream

Estimated Summer Flow	6.0 l/s
Faecal Coliform concentration	14,000 FC/100ml

For the purposes of this modelling study it was further assumed that this stream would discharge below the low water mark following the recommendations of the 1996 Beach Study, Reference 5.

The impact of any effluent loading from the Bradoge River has not been included in this investigation since the modelling undertaken during the 1996 Bundoran Beach Study indicated that effluent from this source did not impact on the bathing beach in sufficient quantities to cause a breach of the standards.

3.6 Water Quality Model Simulations

A series of plume simulation runs were carried out in order to illustrate the impact of the various discharges on the bacteriological status of the receiving waters at Bundoran. The influence of selected wind generated surface currents was included in the analysis to illustrate the potential variation in water quality during different climatic conditions.

The following plume simulation runs were carried out in order to assess the bacteriological water quality at Bundoran.

RUN 1 Discharge of the future secondary treated effluent loading from Bundoran through the proposed new outfall at Pollbrean during various wind conditions over spring tidal cycles.

RUN 2 Discharge of the future secondary treated effluent loading from Bundoran through the proposed new outfall at Pollbrean during various wind conditions over neap tidal cycles.

In order to illustrate the impact of the additional loading from Tullaghan and the stream at Bundoran the following additional plume simulations were undertaken.

RUN 3 Combined impact of the bacterial inputs from Bundoran WWTW, Tullaghan and the stream at Bundoran during various wind conditions over spring tidal cycles.

RUN 4 Combined impact of the bacterial inputs from Bundoran WWTW, Tullaghan and the stream at Bundoran during various wind conditions over neap tidal cycles.

An envelope of the maximum faecal coliform concentration attained at every point in the model during each simulation is presented in Appendix 1. These envelopes represent the highest coliform concentration reached at every cell in the model although the event may have happened for only a short period during the tidal cycle. The envelope therefore marks the outer limit of the plume's influence and the excursion of the effluent plume at any given time during the tidal cycle will consequently lie entirely within the area covered by the plume envelope.

Contours equivalent to 100 faecal coliforms/100 ml (EC Guideline Value for Bathing Waters) and 1,000 faecal coliforms/100 ml (Irish National Mandatory Standard for Bathing Waters) have been drawn to illustrate the impact of the effluent discharges on the Blue Flag beach at Bundoran. An analysis of the temporal variation in faecal coliforms predicted to occur at a number of points along the Blue Flag beach has also been completed for each of the combinations of tidal and wind

conditions modelled. These results have been combined with the results of the wind frequency analysis to determine the likely percentile compliance with the guideline standard of the EC Bathing Waters Directive at the Blue Flag Beach. The results of this exercise will be an underestimate of the likely compliance since it has been assumed that the discharge will be equal to the maximum weekend loading over the whole of the bathing season. Also the assumed T_{90} of 30 hours would normally be considered slow for faecal bacteria in seawater, particularly during the longer daylight hours in the summer months when the outfall loading will be at it's maximum. Consequently the results presented in this report should be considered a conservative estimate of the compliance likely to be achieved at the Blue Flag beach.

The following dispersion model simulations of the BOD, Suspended Solids and Ammonia loadings from Bundoran and Tullaghan were undertaken in order to assess the potential impact on the migration of salmonids into the Drowse River

RUN 5 Impact of the BOD loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

RUN 6 Impact of the Suspended Solids loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

RUN 7 Impact of the Ammonia loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

RUN 8 Impact of the Ammonia loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River, with a nitrification plant installed at Bundoran.

Again, an envelope of the maximum pollutant concentration attained at every point in the model for each of the above model runs is presented in Appendix 1. A range of contours has been drawn to illustrate the variation in pollutant concentration over the study area.

Analysis of the temporal variation in pollutant concentration has also been undertaken and the results of this exercise used in determining the pollutant concentration occurring at the mouth of the Drowse River on a percentile basis. In undertaking this analysis percentiles were calculated for a number of locations in order to ensure that the spatial variation in percentile concentrations around the bay was also included in the analysis. The results obtained from this analysis have been compared to the limit's specified in the EC Directive on `Freshwaters Requiring Protection to Support Fish Life' in order to identify the likely significance of the predicted impact. Where possible reference has also been made to the EPA's proposed water quality standards for marine waters which are more relevant to the receiving waters of Donegal Bay.

4.0 CONCLUSIONS

The water quality resulting from the commissioning of a new Waste Water Treatment Works and outfall at Bundoran has been investigated using numerical modelling techniques. The following conclusions have been drawn with the aid of the computational model simulations.

1. A series of hydrodynamic models of Donegal Bay have been set-up and the model predictions of tidal heights compared to field observations. These models have proven to be capable of accurately simulating the tidal regime within Donegal Bay during both spring and neap tidal cycles.

2. The tidal flow regime at Bundoran has been shown to be very weak, an observation which is backed up by the notes in the Irish Coast Pilot and the results of current meter and drogue surveys. Hence, the wind will play an extremely important part in the dispersion of effluent from an outfall located off the southern shore of Donegal Bay.

3. A series of effluent dispersion models have been developed to assess what impact the bacterial loadings from Bundoran, Tullaghan and the stream at Bundoran will have on water quality at the Blue Flag beach in Bundoran. The diffusion parameters employed in these models have previously been used and successfully verified during numerous other effluent dispersion studies at various locations around the Irish coast.

4. Simulations of the combined impact of the faecal coliform loadings from the new WWTW, Tullaghan and the stream during spring tidal conditions indicate that the bathing beach will only be effected during winds from the westerly and north-westerly sectors. Similarly simulations of the combined impact during neap tides also indicate any impact on the bathing beach to be restricted to periods of westerly and north-westerly winds. Analysis of the temporal variation in bacterial concentrations and the likelihood of these winds occurring indicates that the EC guideline limit for bathing water will only be exceeded for approximately 2.5%

of the time during a typical summer i.e. the water quality targets will be achieved on 97.5% of occasions.

5. The results of the simulations for the outfall serving the proposed Bundoran WWTW in isolation indicate any impact on the bathing beach to be restricted to periods of westerly winds. In this case analysis of the temporal variation in bacterial concentrations and winds indicates that the EC guideline limit will only be exceeded for less than 1.5% of the time in a typical summer i.e. the water quality targets will be achieved on 98.5% of occasions.

6. Compliance with the guideline standard of the EC Bathing Water Directive requires the receiving waters in question to achieve the appropriate limit on an 80%ile basis. Due to sampling errors and other effects it is generally considered that in order to achieve this degree of compliance bacterial concentrations within the receiving waters must not exceed the required value for more that 90% of the time during a typical bathing season. The model simulations undertaken during this study clearly show that the EC guideline limit for faecal coliforms will be achieved at the beach for significantly more than 90% of the time during a typical summer. Thus the receiving waters at the designated beach in Bundoran should easily satisfy the water quality requirements for a Blue Flag Beach.

7. Simulations of the impact of the combined BOD loading from the Bundoran and Tullaghan sewer networks on water quality at the mouth of the Drowse River indicate that maximum concentrations will not exceed the proposed EPA standard for marine waters of 4mg/l. The simulations of the Bundoran discharge in isolation produce an almost identical distribution of BOD concentrations thereby indicating that the Bundoran outfall is the primary source of the BOD impact at the mouth of the Drowse. Analysis of the temporal variation in BOD concentrations for both discharge scenarios modelled, indicates the following percentile concentrations occurring around the mouth of the Drowse River.

	Combined	Bundoran
Maximum	3.6 mg/l	3.3 mg/l
95%ile	3.1 mg/l	3.0 mg/l
50%ile	2.0 mg/l	1.4 mg/l

The BOD levels indicated above should not pose a risk to the passage of migratory fish since the 95%ile value is similar to the EC guideline limit of 3mg/l for Salmonid freshwaters. The maximum BOD concentrations are predicted to occur in the nearshore waters close to the position of the outfall. Within these waters BOD levels can exceed 12 mg/l at certain times however any migratory fish should be able to avoid the impacted area. BOD concentrations at the bathing beach in Bundoran are predicted to be less than 1 mg/l and therefore do not pose a risk to water quality.

8. The impact of the combined Suspended Solids loadings from Tullaghan and Bundoran indicate that concentrations at the mouth of the Drowse will not exceed the EC guideline limit of 25mg/l for Salmonid waters. Simulations of the Bundoran discharge in isolation show a very similar distribution of suspended solids concentrations indicating that most of the suspended solids impact is associated with this discharge. The results of an analysis of the temporal variation in suspended solids concentrations at the mouth of the Drowse are summarised below.

	Combined	Bundoran
Maximum	20 mg/l	20 mg/l
95%ile	10 mg/l	9 mg/l
50%ile	0.5 mg/l	0.4 mg/l

9. Simulations of the combined ammonia discharge from Bundoran and Tullaghan indicate that concentrations within the bay west of the proposed outfall will exceed both the EC guideline and mandatory limits for salmonid freshwaters. The model results for the Bundoran outfall in isolation also depict a similar

distribution of ammonia concentrations indicating that the loading from this source is the primary cause of the elevated concentrations. The installation of a nitrification plant at Bundoran is however predicted to reduce the maximum ammonia concentrations around the mouth of the Drowse to circa 1 mg/l although much of this is due to the Tullaghan discharge. The results of an analysis of the temporal variation in ammonia concentrations for both discharge scenarios in the area of the Drowse River are summarised below.

	No Nitrification		With Nitrification*	
	Combined	Bundoran	Combined	Bundoran
Maximum	6.6 mg/l	5.9 mg/l	1.0 mg/l	0.25 mg/l
95%ile	2.6 mg/l	1.9 mg/l	0.7 mg/l	0.10 mg/l
50%ile	0.25 mg/l	0.2 mg/k	0.15 mg/l	0.02 mg/l

* Nitrification at Bundoran Only

The results of the simulations for no nitrification plant at Bundoran indicate that even if the population served by the works was halved to 15,000 the resulting ammonia levels at the mouth of the Drowse would significantly exceed the mandatory standard for freshwaters. Thus even for this size of a population a nitrification plant would be required at the proposed WWTW.

In order to achieve compliance with the EPA's proposed standard for ammonia in marine waters of not exceeding 0.3mg/l on a 95%ile basis it is clear that nitrification will be required at both Bundoran and Tullaghan. Provided nitrification plants are installed at both locations the results of the modelling indicate that there should be no problem with ammonia concentrations at the mouth of the Drowse forming a barrier to fish migration.

10. Due to the slack nature of the tidal currents in the vicinity of Bundoran there is little to be gained in terms of effluent dispersion by moving the point of discharge further offshore. This would give some increase in initial dilution and increase the journey time between the point of discharge and the shore by possibly a few hours at most. The increased journey time would not have a

significant impact on BOD or ammonia concentrations occurring at the mouth of the Drowse as the decay of these parameters is significantly longer than the journey time from the point of discharge. Thus it is extremely unlikely that the increased construction costs associated with a longer outfall would be justified by any slight improvement in water quality at the mouth of the Drowse. In addition a nitrification plant would still be required at Bundoran WWTW.

11. Overall the results of the effluent dispersion simulations indicate that the proposed discharge from the Bundoran WWTW should not result in the bathing beach failing to meet the water quality criteria for Blue Flag status. Similarly the impact of this discharge in combination with the likely discharge from Tullaghan is not predicted to cause BOD or Suspended Solids concentrations at the mouth of the Drowse to exceed the relevant standards. However, only by the inclusion of a nitrification process at Bundoran can ammonia concentrations at the mouth of the Drowse be reduced sufficiently to comply with the present and proposed legislation.

5.0 REFERENCES

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2. Kirk McClure Morton, 1994. Larne Borough Sewerage Scheme, Mathematical Modelling and Environmental Impact – Final Report, Addendum (Sensitivity of the Effluent Dispersal Model Plume-RW to T_{90}). A report for the Department of the Environment (NI), Water Service, Northern Division.

3. K F Bowden, 1983. Physical Oceanography of Coastal Waters, Chichester, Ellis Horwood Ltd. 302 pp.

4. B Hellstrom, 1941. Wind Effects on Lakes and Rivers. Handlingar No. 158. Royal Swedish Institute for Engineering Research, Stockholm. 191 pp.

5. Kirk McClure Morton, 1996. Bundoran Beach Study - Water Quality and Sediment Transport Modelling. A report for Bundoran Urban District Council and Donegal County Council.

Appendix 1 – Details of Model Runs

BUNDORAN OUTFALL

RUN 1 Discharge of the future secondary treated effluent loading from Bundoran through the proposed new outfall at Pollbrean during various wind conditions over spring tidal cycles.

These runs were designed to illustrate the impact of the proposed effluent loading from Bundoran WWTW on bacteriological water quality at the Blue Flag beach in Bundoran during spring tidal cycles.

The following assumptions were made for these computer runs:

1. The effluent was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

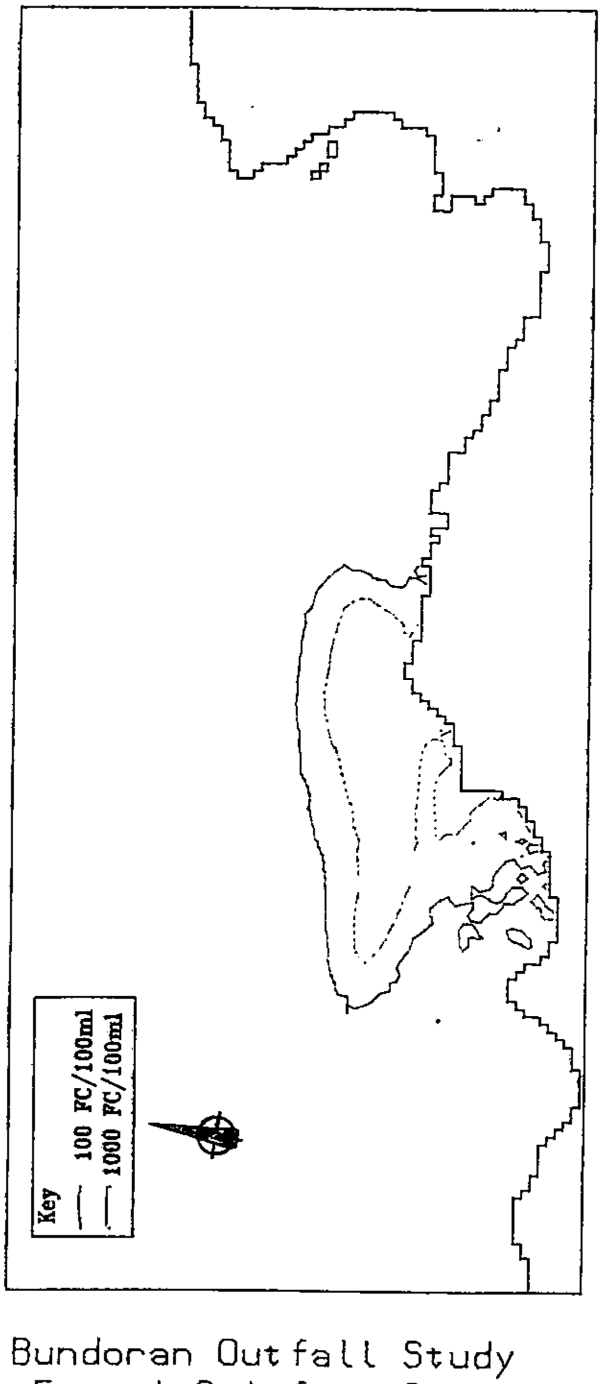
2. Conventional secondary treatment was assumed to reduce the bacterial count of the effluent to 1.2×10^6 faecal coliforms/100ml at average daily flow.

3. A decay rate equivalent to T_{90} = 30 hours was assumed, where T_{90} is defined as the time taken for 90% of the faecal bacteria to die off.

4. The following climatic conditions prevailed during the simulation:
   - Run 1a Calm weather conditions.
   - Run 1b Force 3 southerly winds.
   - Run 1c Force 3 south-westerly winds.
   - Run 1d Force 3 westerly winds.
   - Run 1e Force 3 north-westerly winds.

5. The discharge was continuous over four spring tidal cycles.

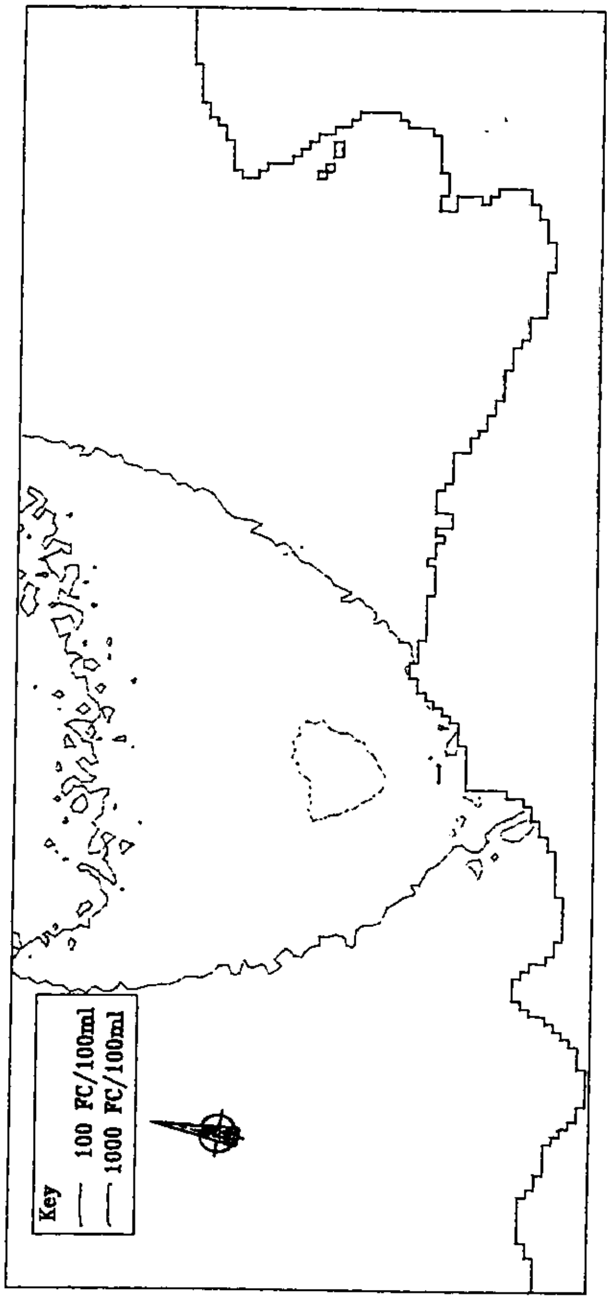
The furthest excursion of the effluent plumes are presented in Figures 3.3 to 3.7.



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Calm Weather, Spring Tide

Hydraulics Research Tideway System

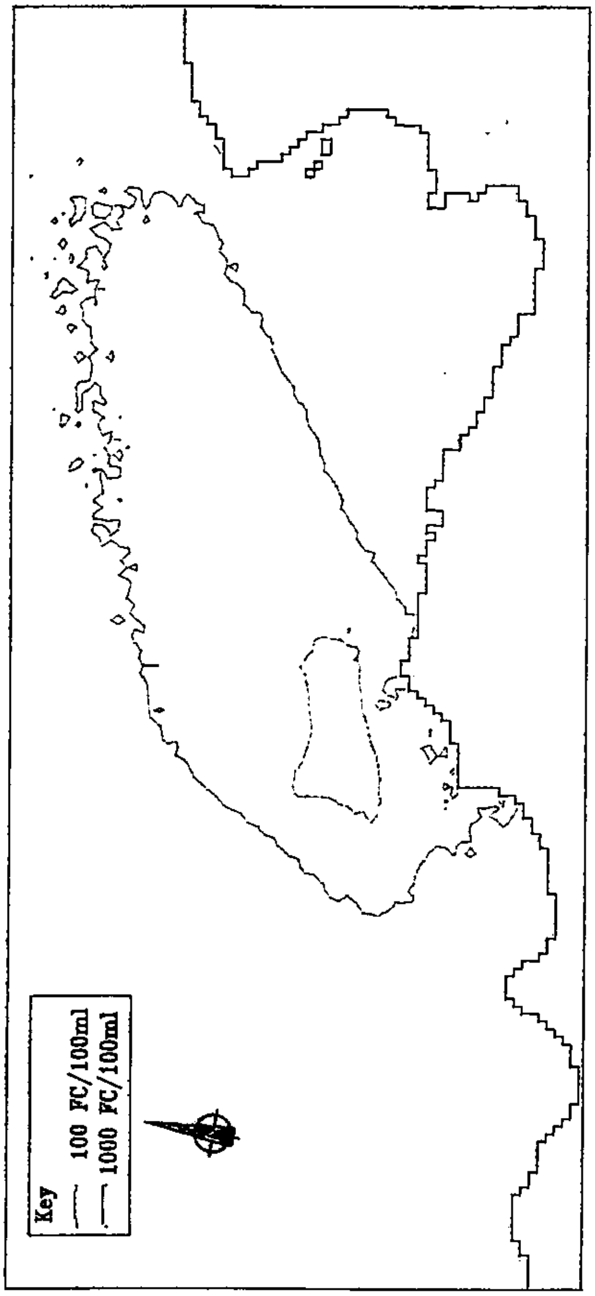
Figure 3.3



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 Southerly Wind, Spring Tide

Hydraulics Research Tideway System

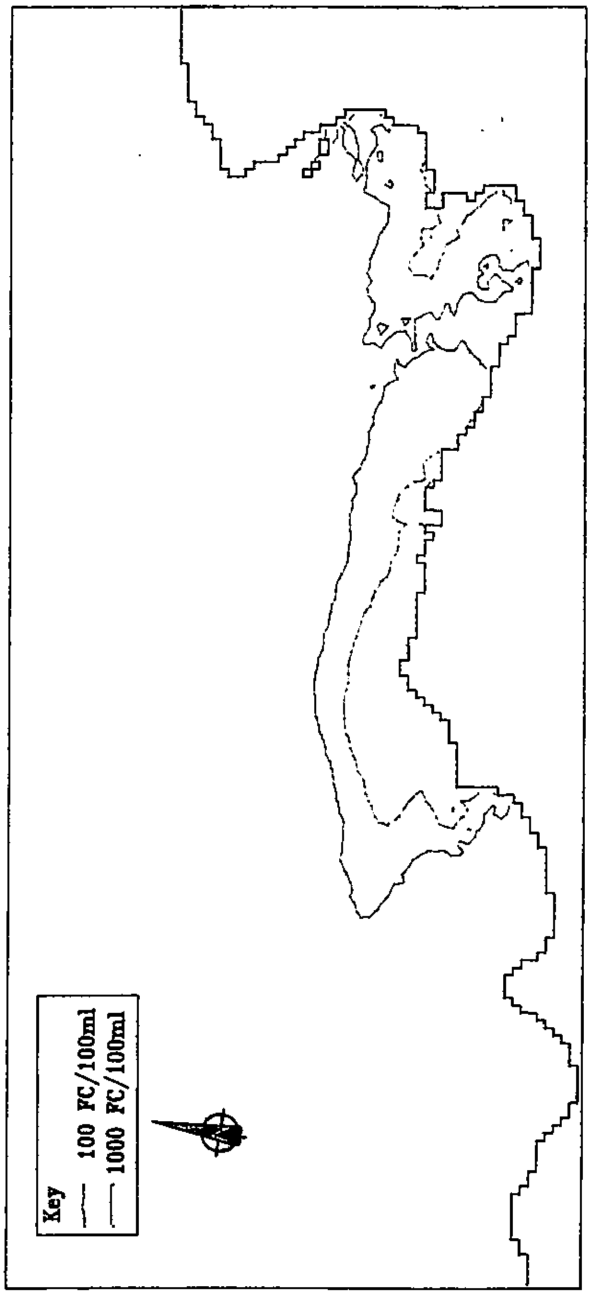
Figure 3.4



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 South-westerly Wind, Spring Tide

Hydraulics Research Tideway System

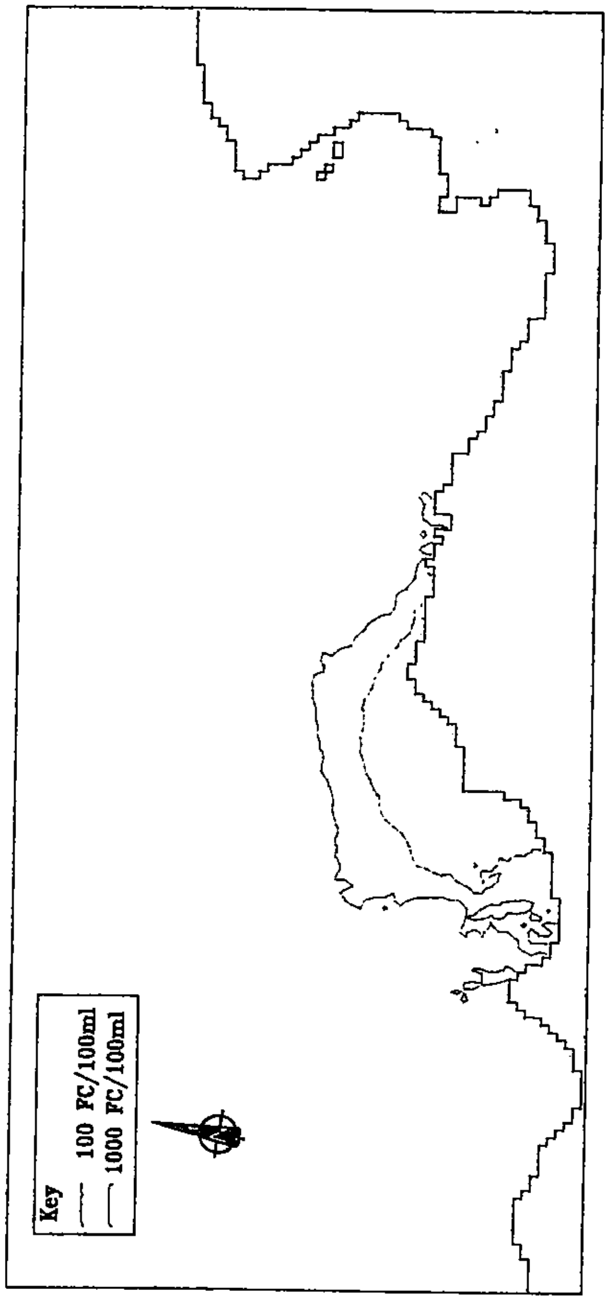
Figure 3.5



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 Westerly Wind, Spring Tide

Hydraulics Research Tideway System

Figure 3.6



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 North-westerly Wind, Spring Tide

Hydraulics Research Tideway System

Figure 3.7

BUNDORAN OUTFALL

RUN 2 Discharge of the future secondary treated effluent loading from Bundoran through the proposed new outfall at Pollbrean during various wind conditions over neap tidal cycles.

These runs were designed to illustrate the impact of the proposed effluent loading from Bundoran WWTW on bacteriological water quality at the Blue Flag beach in Bundoran during neap tidal cycles.

The following assumptions were made for these computer runs:

1. The effluent was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

2. Conventional secondary treatment was assumed to reduce the bacterial count of the effluent to 1.2×10^6 faecal coliforms/100ml at average daily flow.

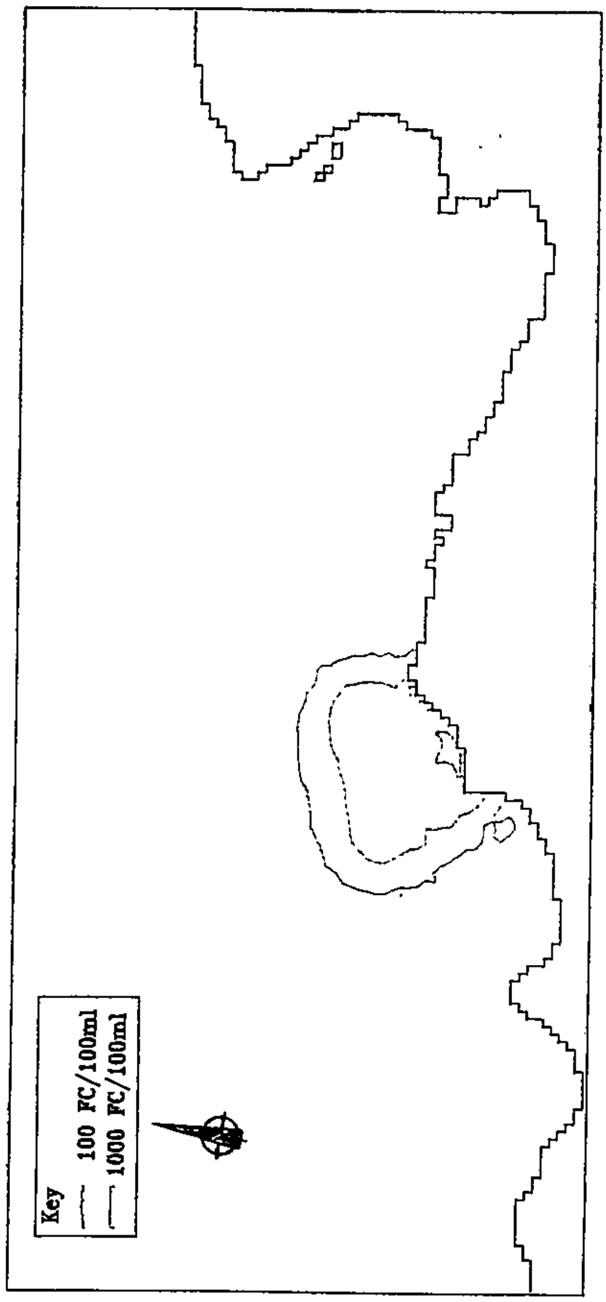
3. A decay rate equivalent to T_{90} = 30 hours was assumed, where T_{90} is defined as the time taken for 90% of the faecal bacteria to die off.

4. The following climatic conditions prevailed during the simulation:

   Run 2a Calm weather conditions.
   Run 2b Force 3 southerly winds.
   Run 2c Force 3 south-westerly winds.
   Run 2d Force 3 westerly winds.
   Run 2e Force 3 north-westerly winds.

5. The discharge was continuous over four neap tidal cycles.

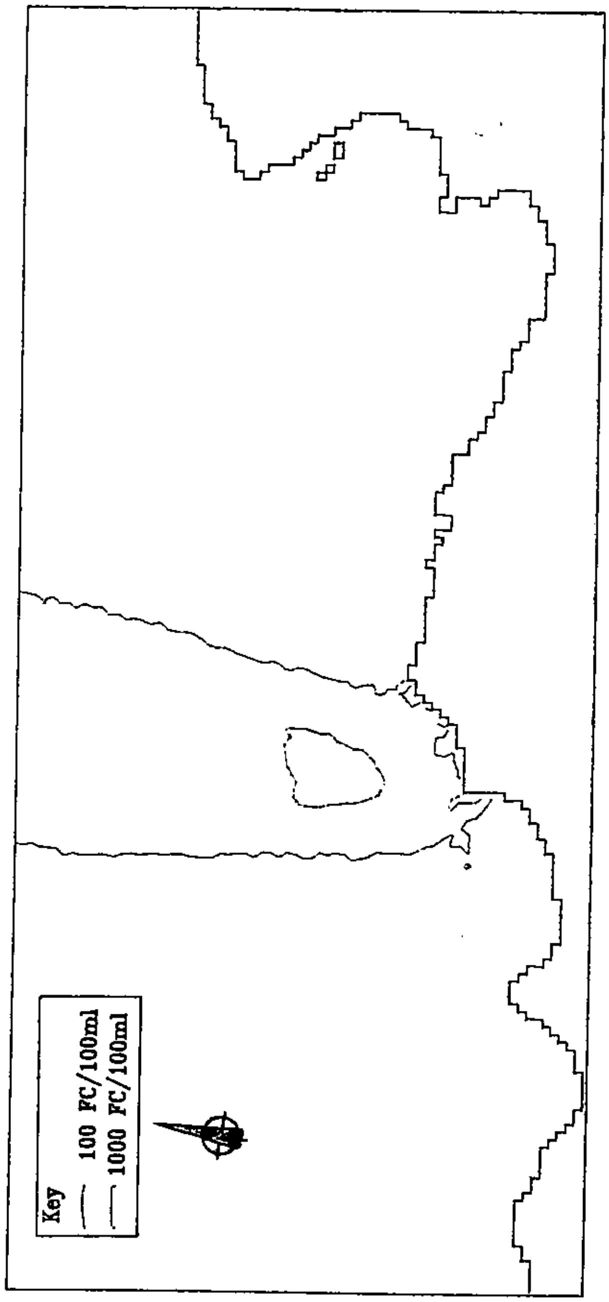
The furthest excursion of the effluent plumes are presented in Figures 3.8 to 3.12.



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Calm Weather, Neap Tide

Hydraulics Research Tideway System

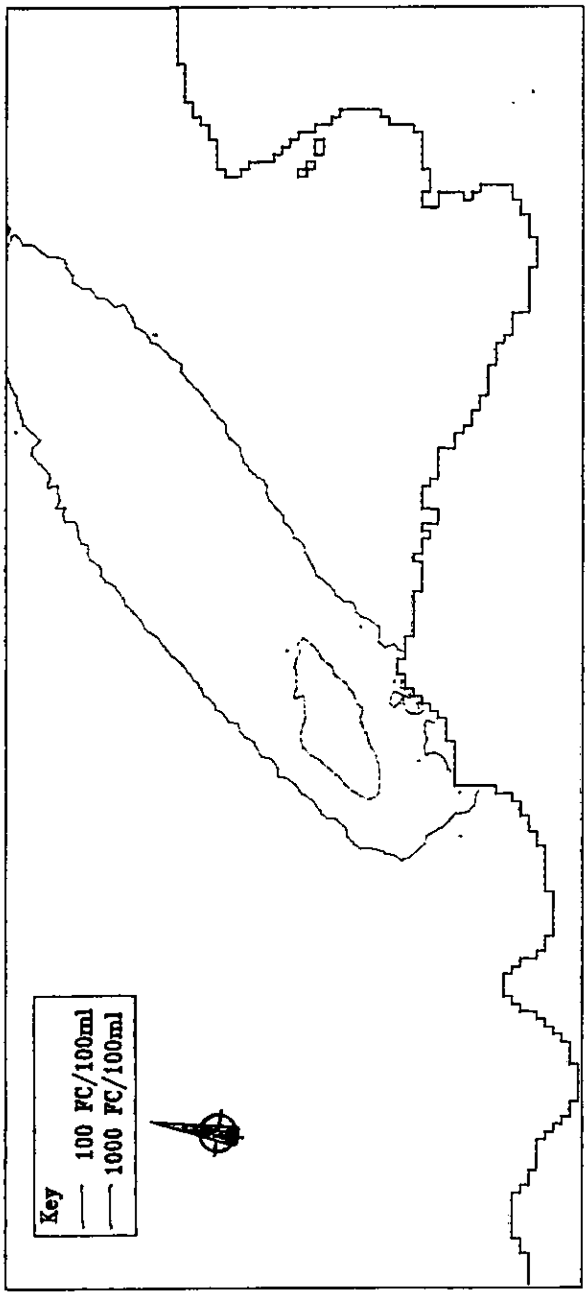
Figure 3.8



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 Southerly Wind, Neap Tide

Hydraulics Research Tideway System

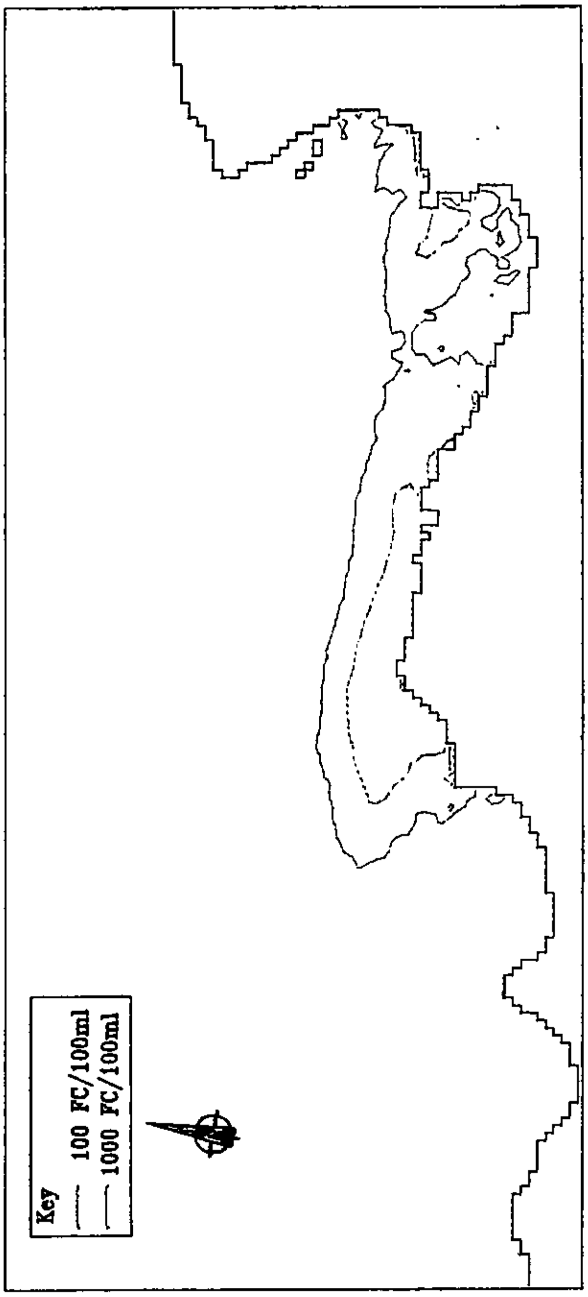
Figure 3.9



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 South-westerly Wind, Neap Tide

Hydraulics Research Tideway System

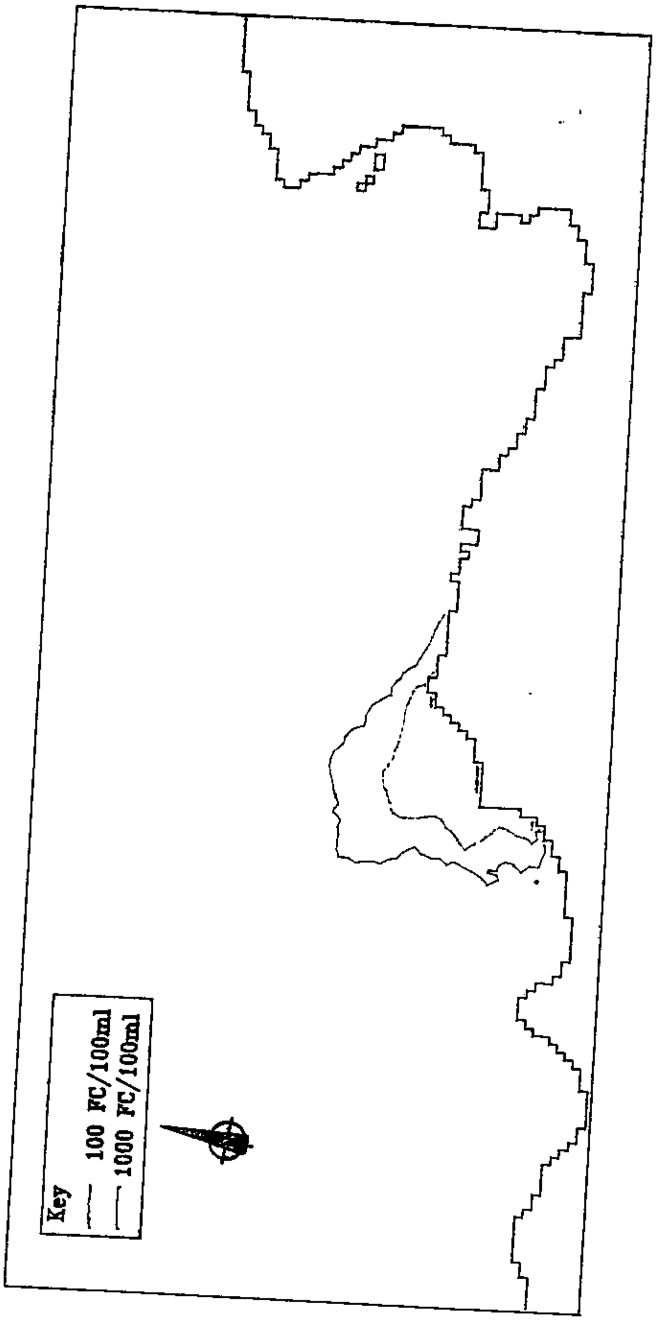
Figure 3.10



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 Westerly Wind, Neap Tide

Hydraulics Research Tideway System

Figure 3.11



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Proposed Bundoran Outfall
Force 3 North-westerly Wind, Neap Tide

Hydraulics Research Tideway System

Figure 3.12

COMBINED IMPACT

RUN 3 Combined impact of the bacterial inputs from Bundoran WWTW, Tullaghan and the stream at Bundoran during various wind conditions over spring tidal cycles.

These runs were designed to illustrate the combined impact of the proposed effluent loading from Bundoran WWTW and the bacterial loadings from Tullaghan and the stream at Bundoran on bacteriological water quality at the Blue Flag beach in Bundoran during spring tidal cycles.

The following assumptions were made for these computer runs:

1. Secondary treated effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

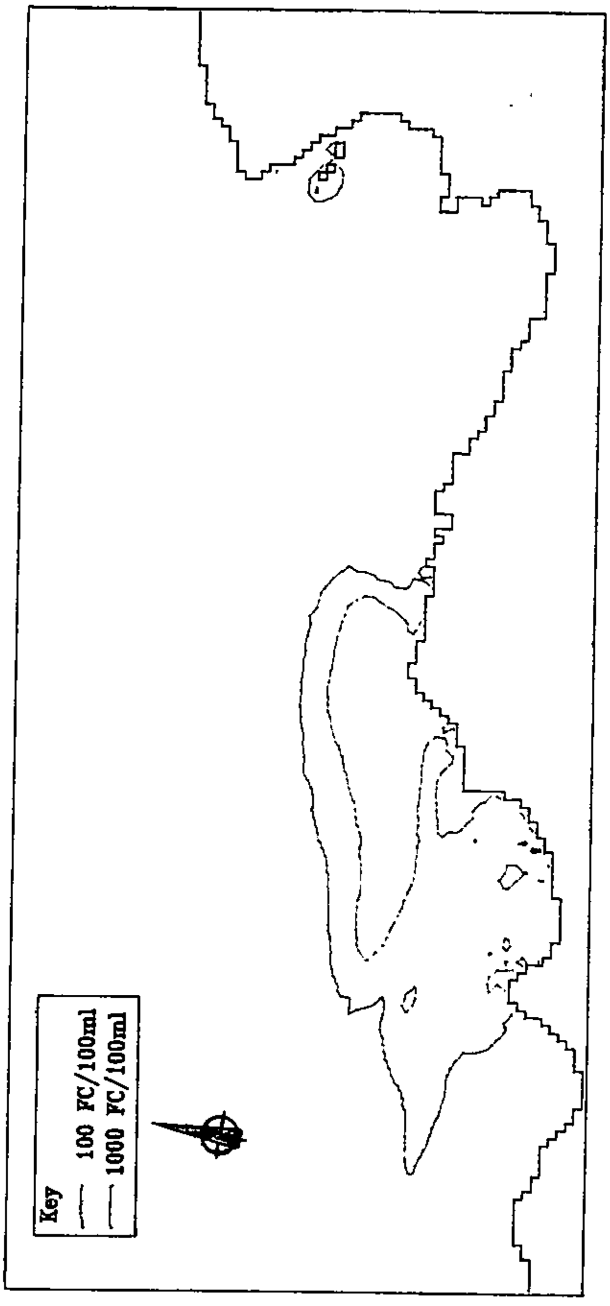
3. A background loading equivalent to 14,000 FC/100ml was discharged at 6 l/s from the stream at Bundoran beach.

4. A decay rate equivalent to T_{90} = 30 hours was assumed, where T_{90} is defined as the time taken for 90% of the faecal bacteria to die off.

5. The following climatic conditions prevailed during the simulation:
   Run 3a Calm weather conditions.
   Run 3b Force 3 southerly winds.
   Run 3c Force 3 south-westerly winds.
   Run 3d Force 3 westerly winds.
   Run 3e Force 3 north-westerly winds.

6. The discharge was continuous over four spring tidal cycles.

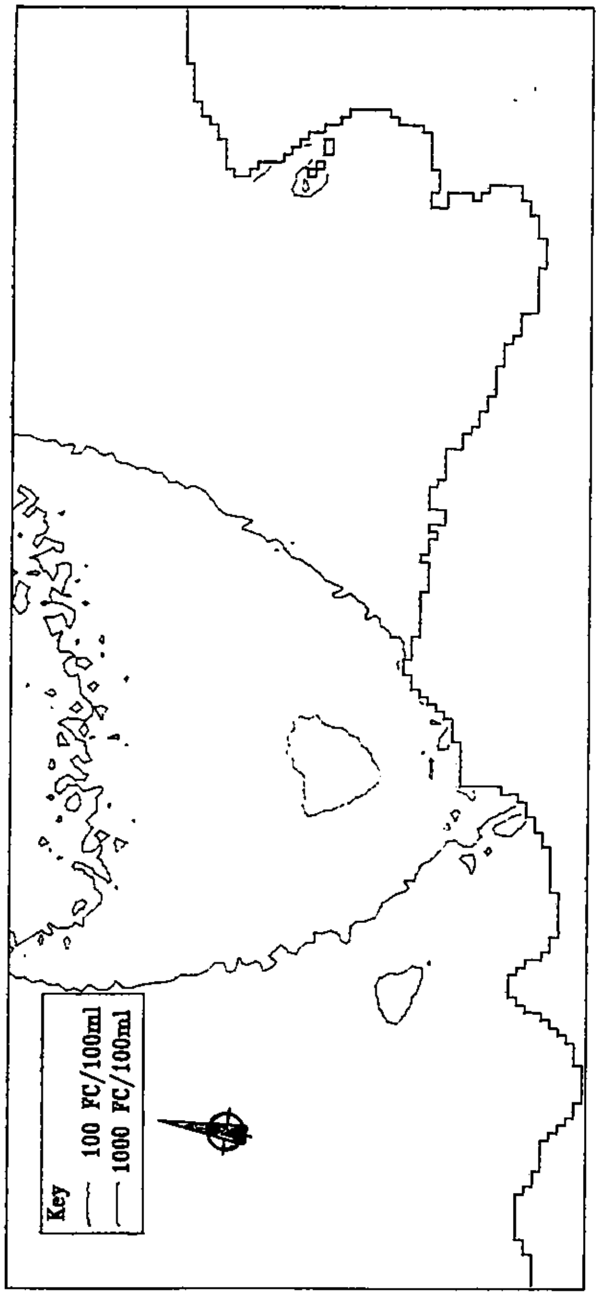
The furthest excursion of the effluent plumes are presented in Figures 3.13 to 3.17.



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Calm Weather, Spring Tide

Hydraulics Research Tideway System

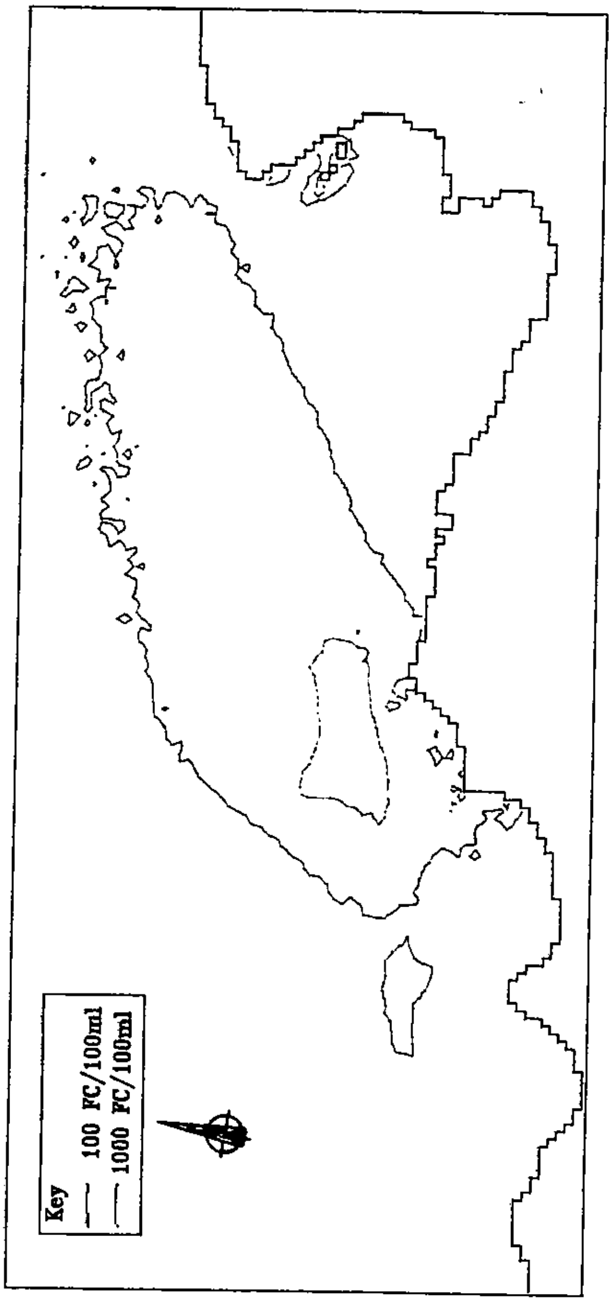
Figure 3.13



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 Southerly Wind, Spring Tide

Hydraulics Research Tideway System

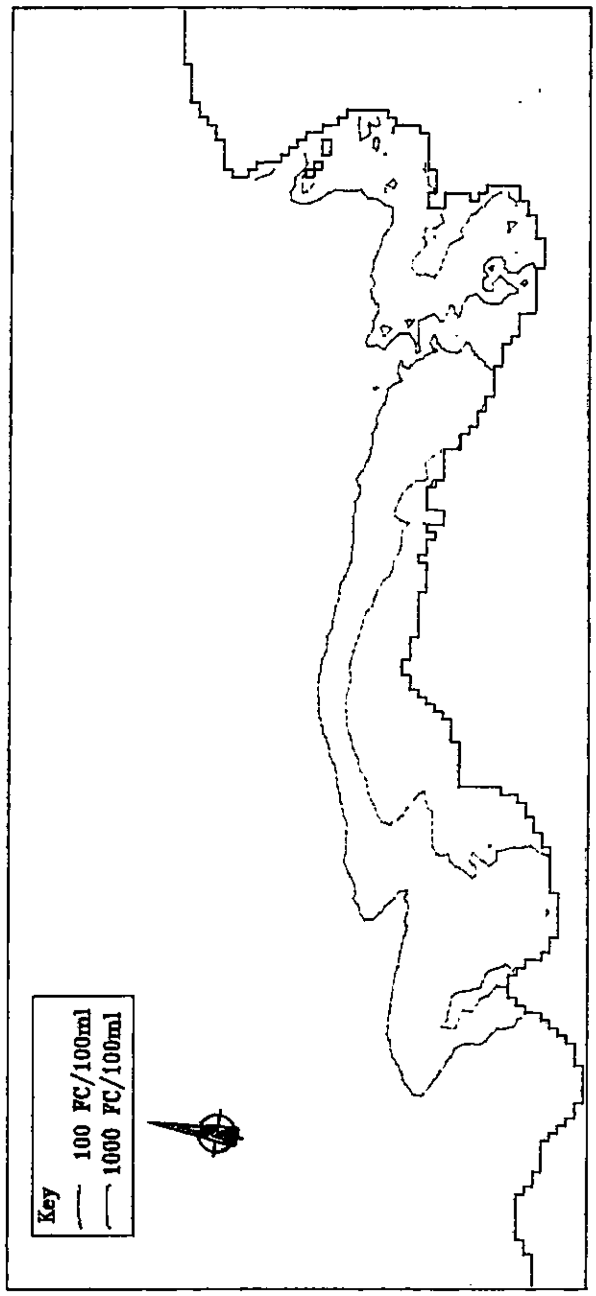
Figure 3.14



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 South-westerly Wind, Spring Tide

Hydraulics Research Tideway System

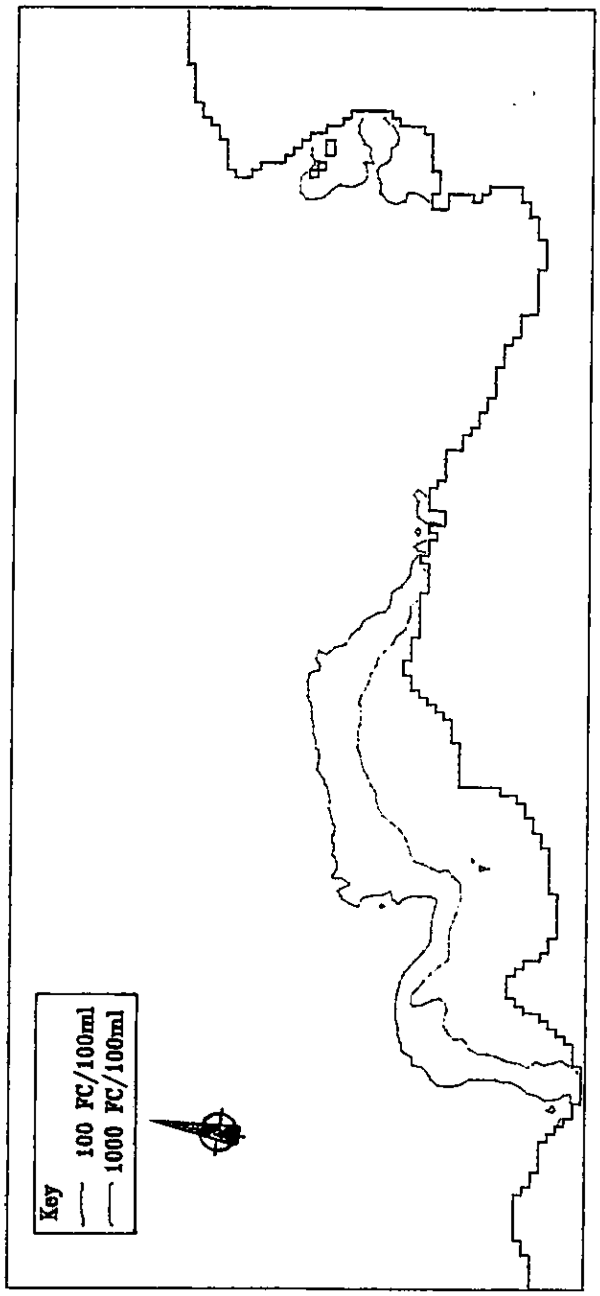
Figure 3.15



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 Westerly Wind, Spring Tide

Hydraulics Research Tideway System

Figure 3.16



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 North-westerly Wind, Spring Tide

Hydraulics Research Tideway System

Figure 3.17

COMBINED IMPACT

RUN 4 Combined impact of the bacterial inputs from Bundoran WWTW, Tullaghan and the stream at Bundoran during various wind conditions over neap tidal cycles.

These runs were designed to illustrate the combined impact of the proposed effluent loading from Bundoran WWTW and the bacterial loadings from Tullaghan and the stream at Bundoran on bacteriological water quality at the Blue Flag beach in Bundoran during neap tidal cycles.

The following assumptions were made for these computer runs:

1. Secondary treated effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

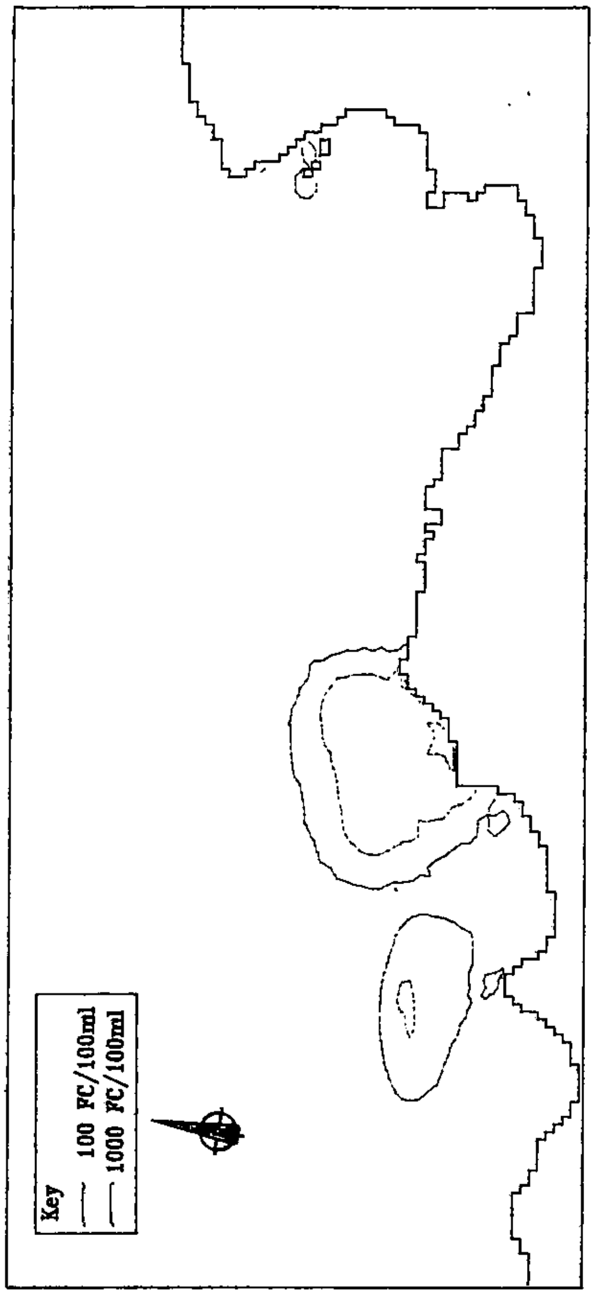
3. A background loading equivalent to 14,000 FC/100ml was discharged at 6 l/s from the stream at Bundoran beach.

4. A decay rate equivalent to T_{90} = 30 hours was assumed, where T_{90} is defined as the time taken for 90% of the faecal bacteria to die off.

5. The following climatic conditions prevailed during the simulation:
   Run 4a Calm weather conditions.
   Run 4b Force 3 southerly winds.
   Run 4c Force 3 south-westerly winds.
   Run 4d Force 3 westerly winds.
   Run 4e Force 3 north-westerly winds.

6. The discharge was continuous over four neap tidal cycles.

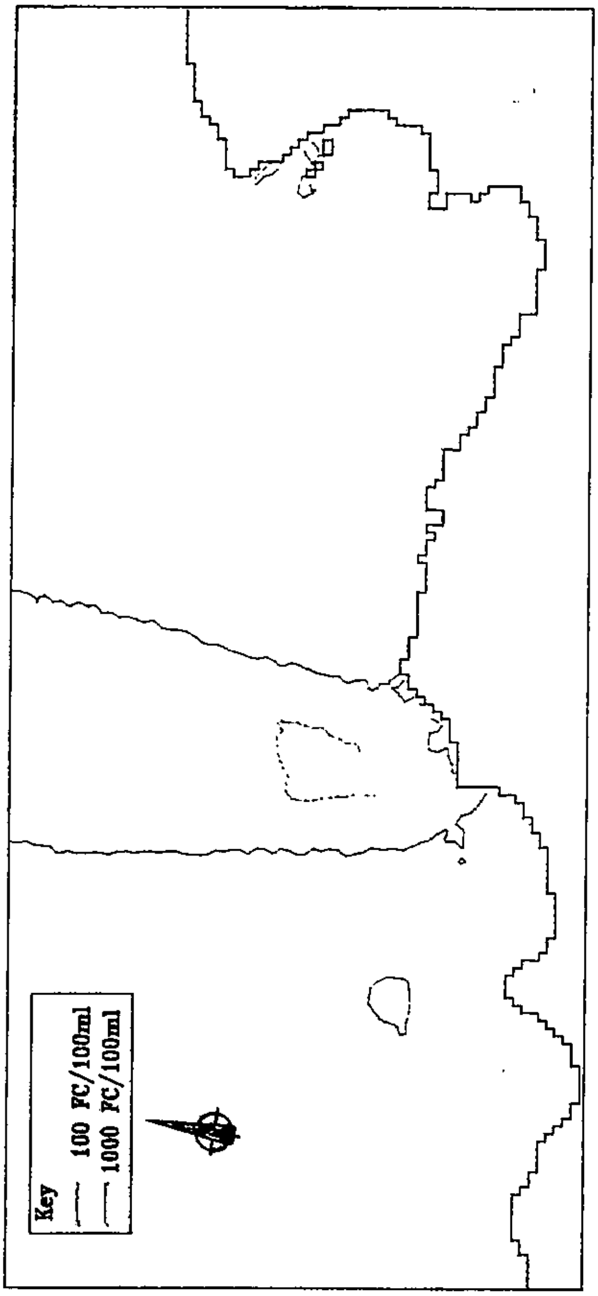
The furthest excursion of the effluent plumes are presented in Figures 3.18 to 3.22.



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Calm Weather, Neap Tide

Hydraulics Research Tideway System

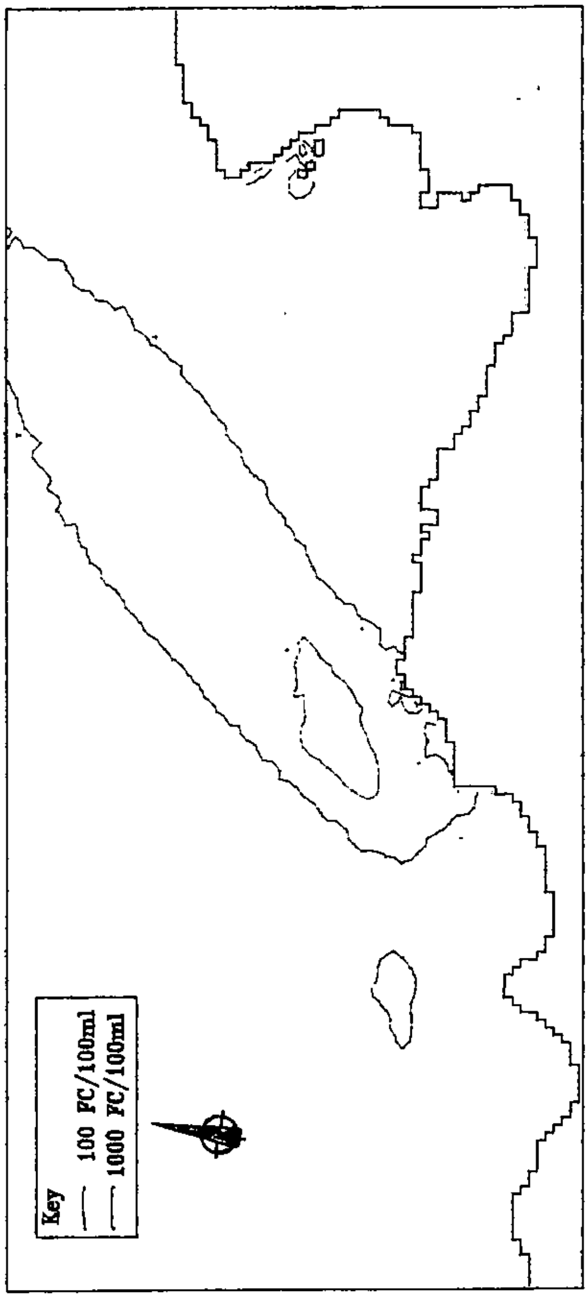
Figure 3.18



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 Southerly Wind, Neap Tide

Hydraulics Research Tideway System

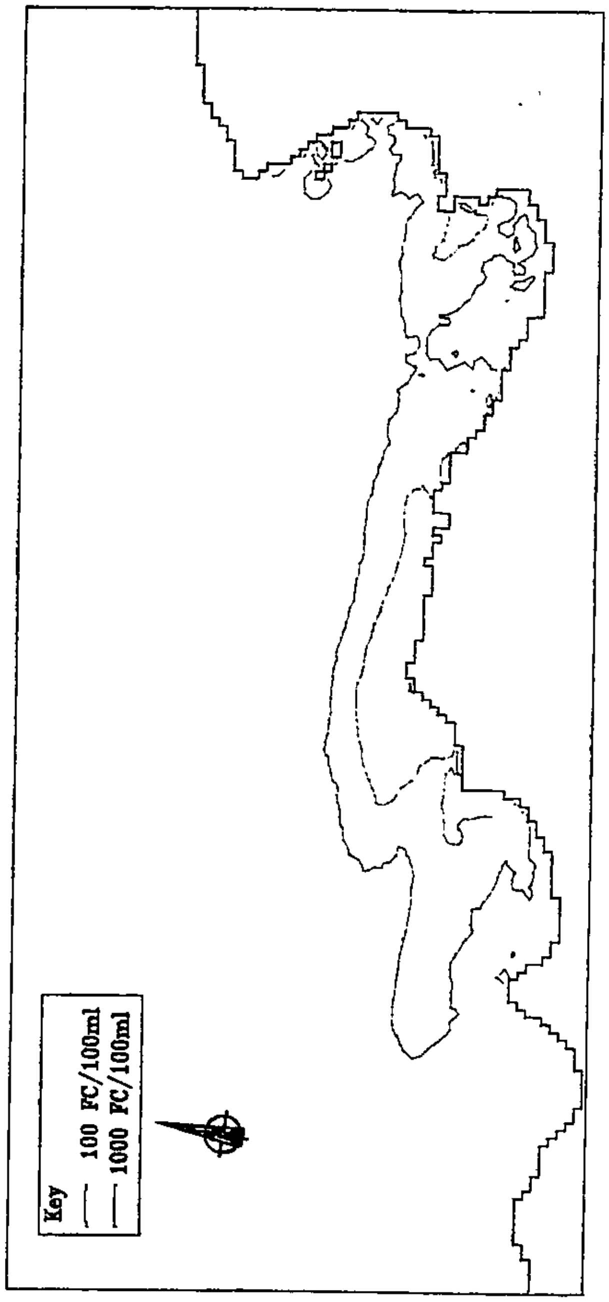
Figure 3.19



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 South-westerly Wind, Neap Tide

Hydraulics Research Tideway System

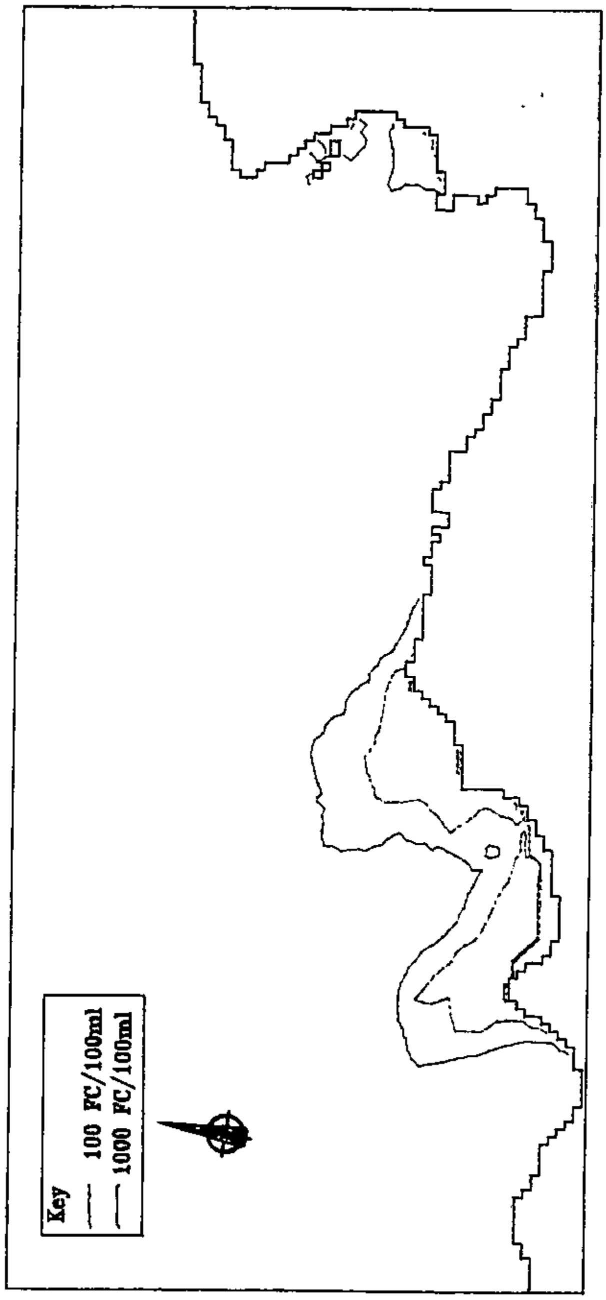
Figure 3.20



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 Westerly Wind, Neap Tide

Hydraulics Research Tideway System

Figure 3.21



Bundoran Outfall Study
Maximum Faecal Coliform Concentrations
Combined Effluent Discharges
Force 3 North-westerly Wind, Neap Tide

Hydraulics Research Tideway System

Figure 3.22

BOD SIMULATIONS

RUN 5 Impact of the BOD loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

These runs were designed to illustrate the impact of the BOD loading in the effluents from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

The following assumptions were made for these computer runs:

1. Secondary treated effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

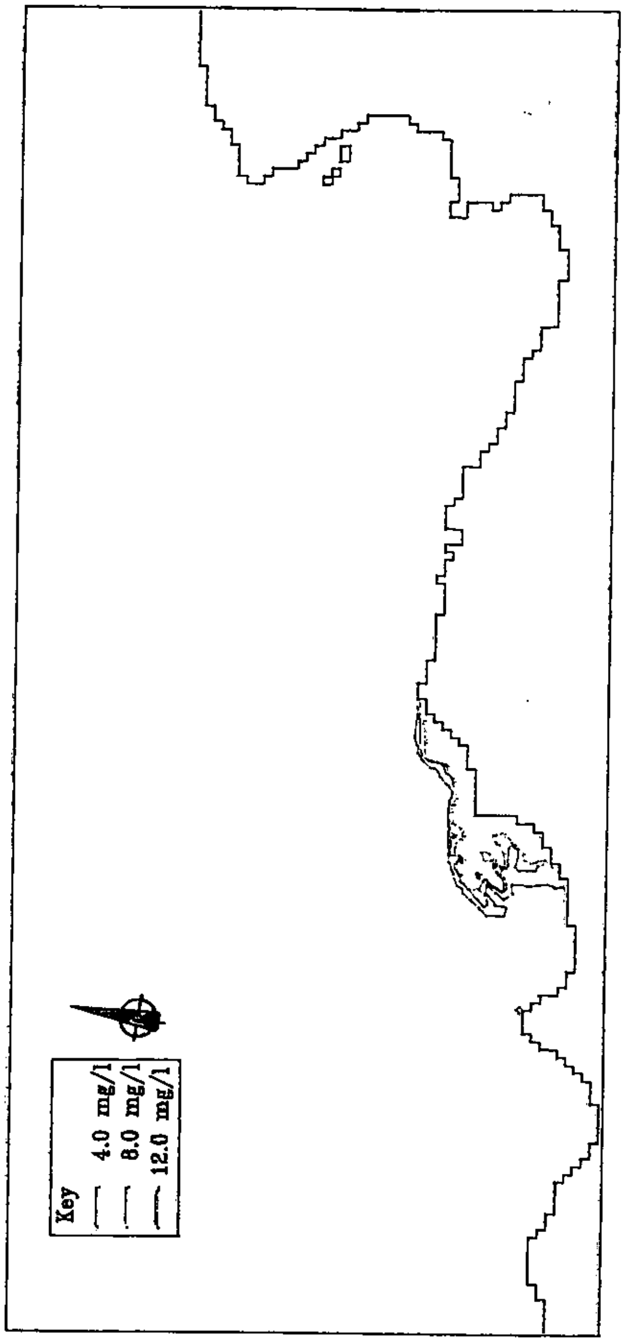
2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

3. The BOD loadings in the final effluent streams were as follows:
   Bundoran 83.2 kg/day
   Tullaghan 3.8 kg/day

4. A decay rate equivalent to a T_{90} of 9.2 days was applied.

5. The discharge was continuous over a synthesised spring / neap tidal cycle.

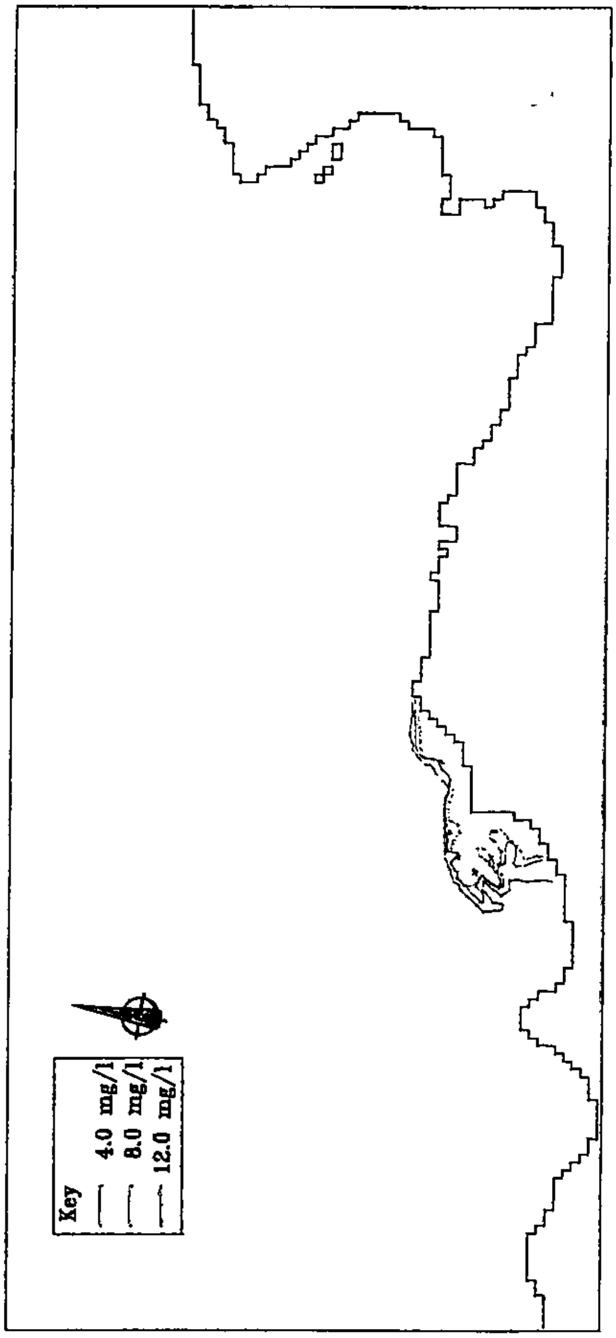
The envelope of BOD concentrations for the combined discharges is presented in Figure 3.23, while the BOD concentrations due to the Bundoran outfall are shown in Figure 3.24.



Bundoran Outfall Study
Maximum BOD Concentrations
Combined Discharge

Hydraulics Research Tideway System

Figure 3.23



Bundoran Outfall Study
Maximum BOD Concentrations
Bundoran WWTW Discharge

Hydraulics Research Tideway System

Figure 3.24

SUSPENDED SOLIDS SIMULATIONS

RUN 6 Impact of the Suspended Solids loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

These runs were designed to illustrate the impact of the suspended solids loading in the effluents from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

The following assumptions were made for these computer runs:

1. Secondary treated effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

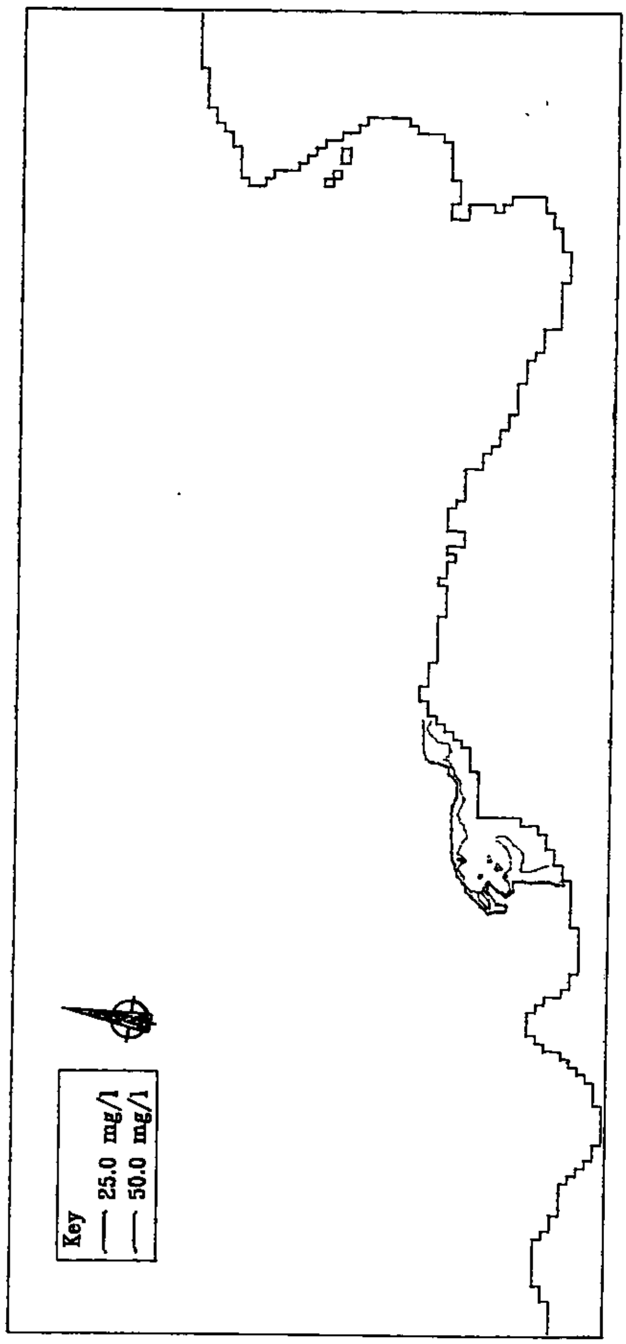
2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

3. The Suspended Solids loadings in the final effluent streams were as follows:
   Bundoran 116.4 kg/day
   Tullaghan 5.3 kg/day

4. A decay rate of zero was assumed, i.e. concentrations of suspended solids are only reduced by the physical processes of diffusion, dispersion and settling.

5. The discharge was continuous over a synthesised spring / neap tidal cycle.

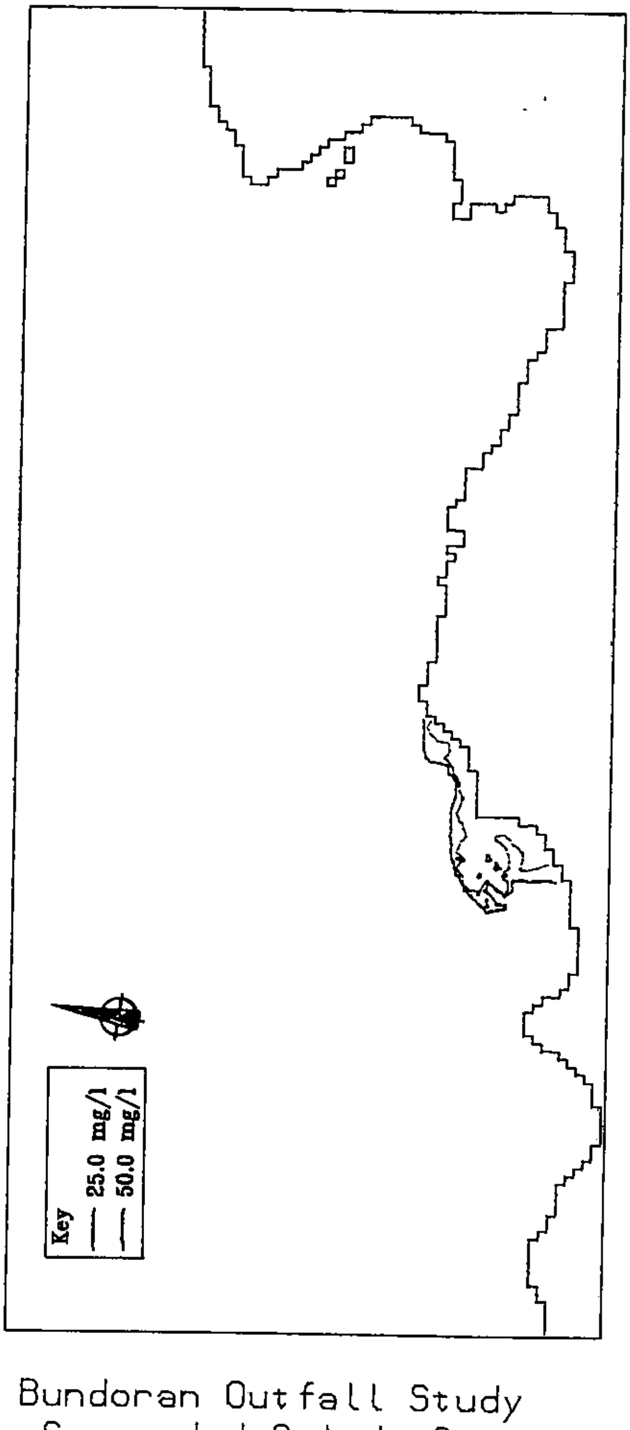
The envelope of suspended solids concentrations for the combined discharges is presented in Figure 3.25, while the suspended solids concentrations due to the Bundoran outfall are shown in Figure 3.26.



Bundoran Outfall Study
Maximum Suspended Solids Concentrations
Combined Discharge

Hydraulics Research Tideway System

Figure 3.25



Bundoran Outfall Study
Maximum Suspended Solids Concentrations
Bundoran WWTW Discharge

Hydraulics Research Tideway System

Figure 3.26

AMMONIA SIMULATIONS

RUN 7 Impact of the Ammonia loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

These runs were designed to illustrate the impact of the Ammonia loading in the effluents from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River.

The following assumptions were made for these computer runs:

1. Secondary treated effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

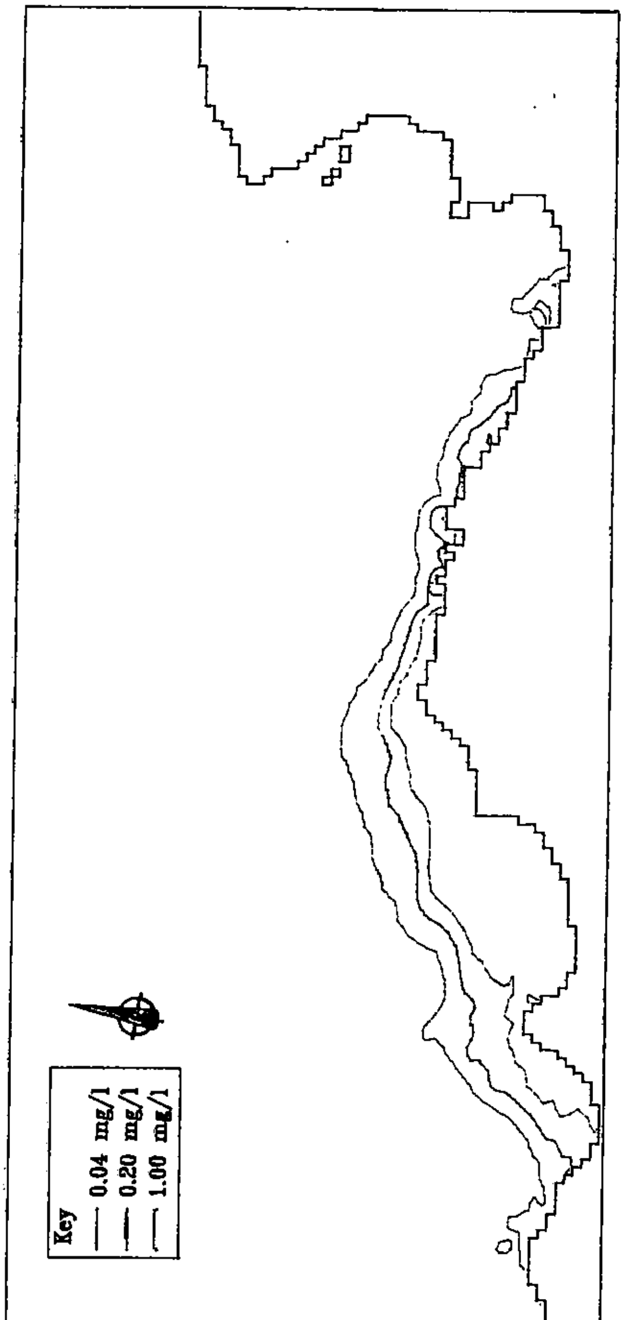
2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

3. The Ammonia loadings in the final effluent streams were as follows:
   Bundoran 319.3 kg/day
   Tullaghan 12.7 kg/day

4. A decay rate equivalent to a T_{90} of 8.2 days was applied.

5. The discharge was continuous over a synthesised spring / neap tidal cycle.

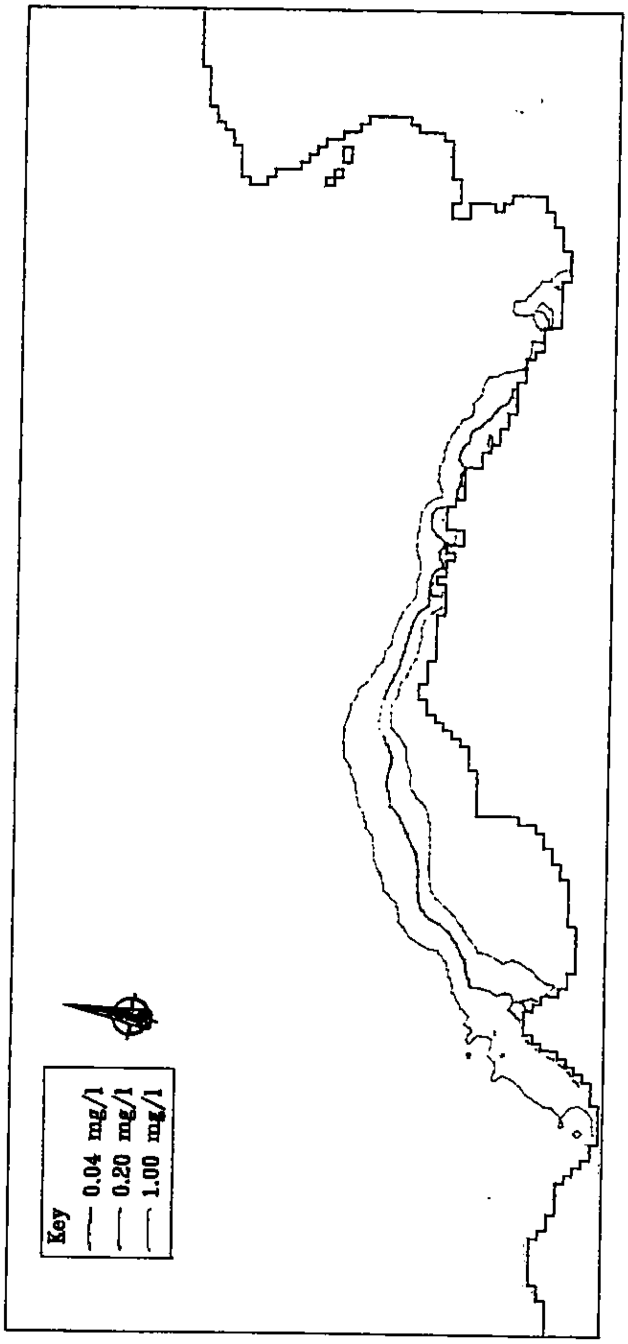
The envelope of ammonia concentrations for the combined discharges is presented in Figure 3.27, while the ammonia concentrations due to the Bundoran outfall are shown in Figure 3.28.



Bundoran Outfall Study
Maximum Ammonia Concentrations
Combined Discharge

Hydraulics Research Tideway System

Figure 3.27



Bundoran Outfall Study
Maximum Ammonia Concentrations
Bundoran WWTW Discharge

Hydraulics Research Tideway System

Figure 3.28

AMMONIA SIMULATIONS

RUN 8 Impact of the Ammonia loadings from Bundoran and Tullaghan on receiving water quality at the mouth of the Drowse River with a nitrifying plant installed at Bundoran.

These runs were designed to illustrate the impact of installing a nitrification plant at the proposed Bundoran WWTW on receiving water quality at the mouth of the Drowse River.

The following assumptions were made for these computer runs:

1. Nitrified sewage effluent from Bundoran was discharged at a rate of 77.0 l/s, corresponding to the average daily flow for the estimated maximum summer population equivalent of 30,000.

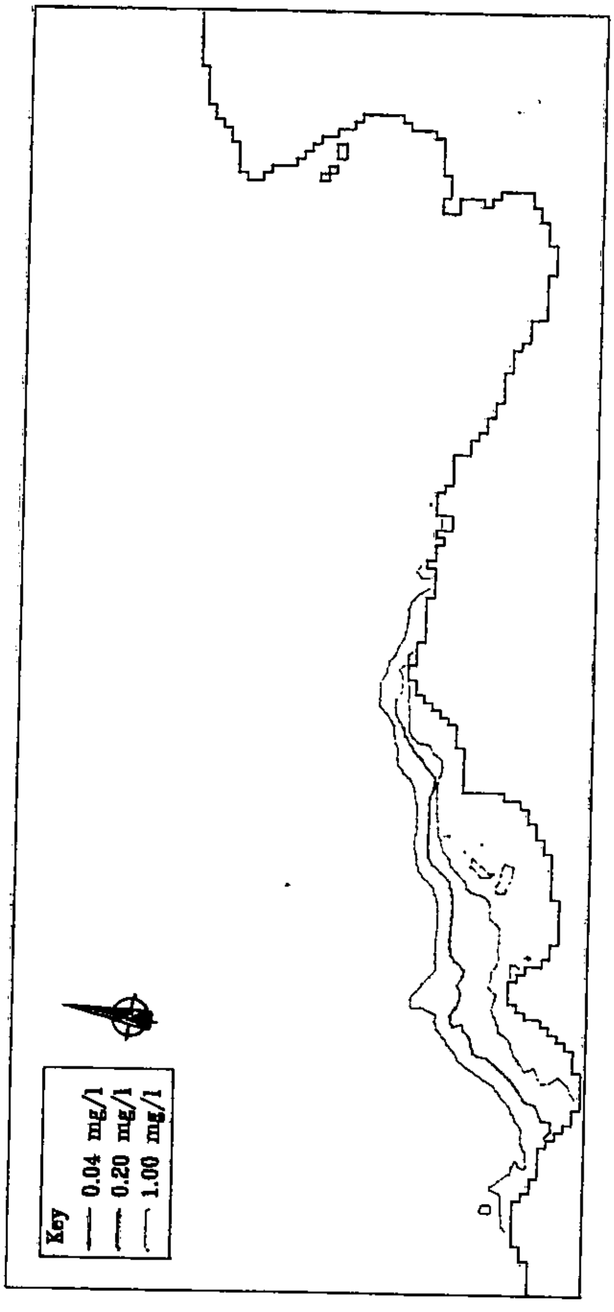
2. Secondary treated effluent from Tullaghan was discharged at a rate of 3.5 l/s, corresponding to the estimated average daily flow for a population equivalent of 1,000.

3. The Ammonia loadings in the final effluent streams were as follows:
   Bundoran 13.3 kg/day
   Tullaghan 12.7 kg/day

4. A decay rate equivalent to a T_{90} of 8.2 days was applied.

5. The discharge was continuous over a synthesised spring / neap tidal cycle.

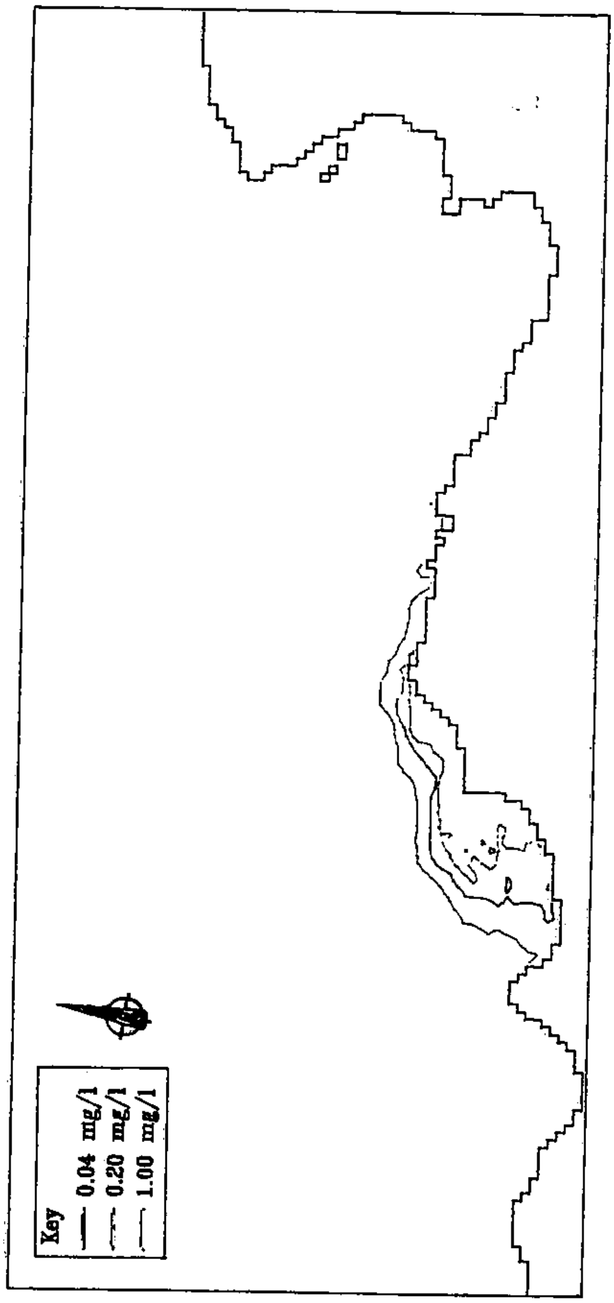
The envelope of ammonia concentrations for the combined discharges is presented in Figure 3.29, while the ammonia concentrations due to the Bundoran outfall in isolation are shown in Figure 3.30.



Bundoran Outfall Study
Maximum Ammonia Concentrations
Combined Discharge
Nitrification at Bundoran

Hydraulics Research Tideway System

Figure 3.29



Bundoran Outfall Study
Maximum Ammonia Concentrations
Bundoran WWTW Discharge
Nitrification at Bundoran

Hydraulics Research Tideway System

Figure 3.30

APPENDIX C

TRIAL HOLE LOGS

PH McCarthy & Partners
CONSULTING ENGINEERS
Civil • Environmental • Structural

Rosemount Hall, Dundrum Road, Dublin 14
Tel: (01)2989377, Fax: (01)2989521, Email: info@phmc.ie

Trial Hole Log Sheet

Project: Bundoran Wastewater Treatment Plant		**Project Number: 6690005**
Logged By: Peter Hallinan	**Date: 23/02/00**	**Sketch of Trial Hole:** (Dimensions in metres)
Trial Hole No. : TH1 Site 6	**Pit Size (in metres): 0.90 x 3.00 x 3.30m deep**	
Map Ref.:	**Equipment Used: Kobelco** **Bucket width: 2 ft (0.61m)**	
Ground Level: 3.95	**Weather: Cold and windy.**	
Groundwater Observations: Groundwater seeping in from ground level and throughout.	**Pit Stability: Sides vertical, some small collapses, very unstable.**	

Depth (metres)	**Description of Strata**	**Samples Taken Thickness**
0.00 – 0.70	**Peaty topsoil.**	**0.70**
0.70 – 2.15	**Very soft dark brown very fibrous plastic PEAT very much organics.**	**1.45**
2.15 – 3.50	**Very soft reddish brown PEAT with very much organics, wood, branches etc.**	**1.35**

General Comments:

PH McCarthy & Partners
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Trial Hole Log Sheet

Project: Bundoran Wastewater Treatment Plant		**Project Number: 6690005**
Logged By: Peter Hallinan	**Date: 23/02/00**	**Sketch of Trial Hole:** (Dimensions in metres)
Trial Hole No. : TH2 Site 6	**Pit Size (in metres): 1.00 x 3.10 x 2.50m deep.**	
Map Ref.:	**Equipment Used: Kobelco** **Bucket width: 2 ft (0.61m)**	
Ground Level: 5.08	**Weather: Cold and windy.**	
Groundwater Observations: Groundwater seeping in rapidly from surface and throughout pit.	**Pit Stability: Sides vertical, some small collapses, very unstable.**	

Depth (metres)	**Description of Strata**	**Samples Taken**
0.00 – 0.90	**Peaty topsoil.**	**0.90**
0.90 – 1.50	**Very soft dark brown very fibrous very plastic PEAT with much organics and wood material.**	**0.60**
1.50 – 2.50	**Very soft reddish brown very fibrous very plastic PEAT with much organics and wood material.**	**1.30**

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Trial Hole Log Sheet

Project: Bundoran Wastewater Treatment Plant		**Project Number: 6690005**
Logged By: Peter Hallinan	**Date: 23/02/00**	**Sketch of Trial Hole:** (Dimensions in metres)
Trial Hole No. : TH3 Site 6	**Pit Size (in metres):**	
Map Ref.:	**Equipment Used: Kobelco** **Bucket width: 2 ft (0.61m)**	
Ground Level: 4.55	**Weather:**	
Groundwater Observations: Groundwater seeping in at approximately 0.70m and from the surface.	**Pit Stability: Sides vertical, some small collapses, very unstable.**	

Depth (metres)	**Description of Strata**	**Samples Taken**
0.00 – 1.20	**Very soft dark brown very fibrous PEAT with much wood material.**	**1.20**
1.20– 2.90	**Very soft dark reddish brown very fibrous PEAT with much wood material, branches, etc., still intact.**	**1.70**

General Comments:

APPENDIX D

TRAFFIC ACCIDENT DATA

Appendix D
Traffic Accident Data

Townland	Road Name	Location
BUNDORAN, MAIN ST	BUNDORAN/SLIGO	250E JNT BOGTOWN LANE
BUNDORAN,MAIN ST (WEST END)	BUNDORAN/SLIGO	JNT MARINE LANE
BUNDORAN, MAIN ST (WEST END)	BUNDORAN/SLIGO	25W JNT MARINE LANE
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	JNT BRIGHTON TCE
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	OPP O'BRIEN'S SHOP
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	100W CHURCH ROAD
MAGHERACAR, TULLAGHAN JNT	BUNDORAN/SLIGO	JNT TULLAGHAN
MAGHERACAR	BUNDORAN/SLIGO	STRAIGHT
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	JNT DRUMACRIN RD
MAGHERACAR	BUNDORAN/SLIGO	JNT TULLAGHAN
BUNDORAN, MAIN ST (FINNER)	BUNDORAN, MAIN ST	BUNDORAN, MAIN ST, 200W POST 0470
BUNDORAN, MAIN ST (FINNER)	BUNDORAN, MAIN ST	JNT ASTORIA ROAD
BUNDORAN, MAIN ST (WEST END)	BUNDORAN, MAIN ST	BUNDORAN, MAIN ST, WESTEND. 450S POST 0470
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	10E RAILWAY ROAD
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	JNT LANE @ 25W JNT ASTORIA ROAD
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	120 E BOGTOWN LANE
BUNDORAN, MAIN ST (EAST END)	BUNDORAN, MAIN ST	175W CHURCH ROAD
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	JNT RAILWAY ROAD
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	JNT BAYVIEW AVE
DRUMGUN	BUNDORAN/SLIGO	1000W BALLYDEVITT JNT
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	24N SEA RD
BUNDORAN, BUNDORAN, RAILWAY RD	BUNDORAN, MAIN ST	60S JCT MAIN ST (BUNDORAN)
BUNDORAN, MAGHERAGH ON SLIGO RD	BUNDORAN, MAIN ST	1100S 0470 (100W BOGTOWN LAVR)
MAGHERACAR	BUNDORAN, MAIN ST	150S BOGTOWN LANE
BUNDORAN, SINGLE ST	BUNDORAN, MAIN ST	?
BUNDORAN, MAIN ST	BUNDORAN, MAIN ST	
MAGHERACAR	BUNDORAN, MAIN ST	?
MAGHERACAR	BUNDORAN/SLIGO	220 YDS NORTH OF POST 0501
BUNDORAN	BUNDORAN, MAIN ST	300 YDS SOUTH OF POST NO. 0479
BUNDORAN	BUNDORAN, MAIN ST	550 YDS SOUTH OF POST NO. 0479
BUNDORAN	BUNDORAN, MAIN ST	INT WITH SEA RD
BUNDORAN	BUNDORAN, MAIN ST	250M SOUTH OF POST NO 0479
BUNDORAN	BUNDORAN, MAIN ST	INT WITH RAILWAY RD
BUNDORAN	BUNDORAN, MAIN ST	INT WITH ACCESS RD TO DIEGLE: COASH HOUSING EST.
BUNDORAN	BUNDORAN, MAIN ST	115 YDS WEST OF POST NO. 0487
BUNDORAN	BUNDORAN, MAIN ST	INT WIYH BRIGHTON TCE
MAGHERCAR	BUNDORAN/SLIGO	JNTK-6477, TULLAGHAN RD
WESTEND	BUNDORAN/SLIGO	200 NORTH POST NO 0497
BUNDORAN	WEST END	200 M WEST OF KINLOUGH RD